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MINE RECLAMATION AND CLOSURE PLAN UPDATE NOVEMBER 2015

PREPARED FOR:

THE MINISTRY OF ENERGY AND MINES

PREPARED BY:

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MINES ACT PERMIT: M-200

NOVEMBER 4, 2015

TABLE OF CONTENTS

Table of Contents ..... **i**
List of Tables **1**
List of Figures **2**
List of Appendices **3**
List of Abbreviations **4**
1. Introduction **5**
1.1. Report Overview 5
1.2. Project Summary 6
1.2.1. Project History *6*
1.2.2. Tailings Dam Failure *6*
1.2.3. Current Project Status *7*
1.3. Summary of Regulatory Permits and Requirements 12
1.4. Biophysical Setting 14
1.4.1. Physiography *14*
1.4.2. Geological Characterization *14*
1.4.3. Soils *16*
1.4.4. Watersheds *17*
1.4.5. Climate *19*
1.4.6. Air Quality *23*
2. Mine Operations **24**
2.1. Access and Transportation 24
2.2. Mill and Processing Plant Description 24
2.2.1. Primary, Secondary, Tertiary Crushing and Ore Handling *24*
2.2.2. Grinding *24*
2.2.3. Flotation *24*
2.2.4. Concentrate Dewatering *25*
2.2.5. Concentrate Handling and Transport *25*
2.2.6. Mill Reagents *25*
2.2.7. Instrumentation and Control Philosophy *25*
2.2.8. Processing History *26*
2.3. Four Year Mine Plan 27
2.3.1. Underground *28*

2.3.2. Material Handling 28
2.3.3. Area of Disturbance 29
2.3.4. Future Considerations 29
2.4. Water Management 34
2.4.1. Water Management System Overview 34
2.4.2. Mill Process Water 37
2.4.3. Water Discharge 38
3. Land Use and Capability Objectives 44
3.1. Reclamation Objectives 44
3.1.1. End Land Use Objectives 44
3.1.2. Land Capability Criteria 45
3.1.3. Towards Sustainable Mining Program Biodiversity Protocol 46
4. Reclamation Approach 47
4.1. Reclamation Approach 47
4.2. Progressive Reclamation 47
4.3. Reclamation Research Program Update 51
4.3.1. Wildlife Monitoring 51
4.3.2. Tree Plots 53
4.3.3. Tailings Beach 54
4.3.4. Anaerobic Biological Reactor 55
4.3.5. NEZ Dump 55
4.3.6. North Bell Dump 56
4.3.7. Trace Elements in Soils and Uptake in Vegetation 57
4.3.8. Hazeltine Creek Terrestrial Rehabilitation 58
5. Reclamation Strategies 59
5.1. Physical Stability 59
5.1.1. Waste Dump Stability 59
5.1.2. Pit Wall Stability 59
5.1.3. Road Stability 60
5.1.4. TSF Stability 60
5.2. Water Quality and Watercourse Protection 61
5.2.1. Sediment Retention and Erosion Control 62
5.2.2. Material Characterization and Placement 62

5.2.3. Water Quality Monitoring 63
5.2.4. Long-Term Effluent Quality and Quantity Predictions 67
5.3. Soil Management 68
5.3.1. Soil Stockpile Inventory 68
5.3.2. Soil Use in Reclamation 71
5.4. Re-vegetation Prescriptions 72
5.4.1. Species Selection 73
5.4.2. Prescriptions 75
5.5. Invasive Plant Management 77
5.6. Fugitive Particulate Management 77
5.7. Waste Management 78
6. Reclamation Units 79
6.1.1. Mill and Plant Area 82
6.1.2. Removal of Fuels, Reagents, and Toxic Materials 83
6.1.3. Removal of Structures and Equipment 83
6.1.4. Test Heap Leach 83
6.1.5. Power Lines 84
6.1.6. Pit Reclamation 84
6.1.7. Waste Dump Reclamation 87
6.1.8. Road Reclamation 87
6.1.9. Watercourses 89
6.1.10. Tailings Area Reclamation 89
6.1.11. Underground Reclamation 91
7. Post-Closure Monitoring 92
7.1. Closure Management Manual 92
7.2. Inspections and Maintenance of Geotechnical Structures 92
7.3. Water Chemistry and Aquatic Effects Monitoring 92
7.3.1. Groundwater Monitoring and Characterization 92
7.3.2. Surface Water Chemistry Monitoring 93
7.3.3. Water Discharge Aquatic Effects Monitoring 94
7.4. Re-vegetation Monitoring 95
7.4.1. Re-vegetation Assessments 95
7.4.2. Vegetation Metal Uptake 95

8. Reclamation and Closure Schedule 97
9. Reclamation Cost Estimates 99
9.1. Modeling of Mine Areas 99
9.2. Costing Parameters 100
9.2.1. Re-Sloping 100
9.2.2. Load/Haul Time Calculation 100
9.2.3. Spreading 101
9.2.4. Ripping 101
9.3. Reclamation Costing Calculations 101
9.3.1. Internal Costing 101
9.3.2. External Costing 102
10. Consultation and Engagement 105
11. Closure 107
12. References 108

LIST OF TABLES

Table 1.1 Current Mount Polley Mine permits 12
Table 1.2 Permit M-200 amendments 13
Table 1.3 Permit 11678 amendments 14
Table 1.4 Mount Polley Mine and Likely climate stations....19
Table 1.5 Mount Polley Mine snow courses 19
Table 1.6 Monthly average, minimum and maximum temperatures for the Mount Polley Mine site (1995 – current)....21
Table 1.7 Projected annual precipitation for the Mount Polley Mine 22
Table 1.8 Monthly snowpack levels for the Mount Polley Mine site (1995 – current) 22
Table 1.9 Average lake evaporation for the Mount Polley Mine site 23
Table 2.1 Reagent types and quantities used in the Mount Polley Mill 25
Table 2.2 History of mill processing at the Mount Polley Mine....26
Table 2.3 Mine plan material tonnages 29
Table 2.4 Mount Polley Mine existing and projected disturbed areas 31
Table 2.5 Changes in disturbed areas with the projected closure footprint....32
Table 3.1 Land capability criteria for reclamation of the Mount Polley Mine site 46
Table 4.1 Summary of Completed Progressive Reclamation at Mount Polley Mine....48
Table 4.2 Detailed progressive reclamation prescriptions 50
Table 4.3 2014 wildlife observations at Mount Polley Mine 52
Table 4.4 Comparison of 2013 soil stockpile sample results with soil guidelines for metal levels 57
Table 5.1 Mine site drainage water quality monitoring program....65
Table 5.2 Soil stockpile inventory (as of September 2015)....69
Table 5.3 Methods of habitat creation for target wildlife species in waste dump reclamation....72
Table 5.4 Incorporation of traditionally important species into reclamation prescriptions....74
Table 5.5 BC Forest Development Plan stocking standards (ICHmk3 biogeoclimatic zone)....75
Table 5.6 Mount Polley native species grasses and forbes seed mix....75
Table 5.7 Mount Polley Mine site general re-vegetation prescriptions....76
Table 5.8 MPMC waste management matrix....78
Table 6.1 Designated end land uses for Mount Polley Mine major reclamation units 80
Table 7.1 Conceptual closure water quality monitoring schedule 94
Table 7.2 Sample re-vegetation assessment form 96
Table 8.1 Mount Polley conceptual reclamation schedule 98
Table 10.1 Relevant Consultation since the Reclamation and Closure Plan Update 2012 106
Table 11.1 Qualified Professionals (retained and in house) responsible for completing components of MPMC's Reclamation and Closure Plan Update 2015 107

LIST OF FIGURES

Figure 1.1 Mount Polley Mine property location map 9
Figure 1.2 Mount Polley Mine mineral claims and leases map 10
Figure 1.3 Mount Polley Mine site facilities 11
Figure 1.4 Mount Polley Mine site and surrounding area water bodies and topography 18
Figure 1.5 Mount Polley Mine weather station and snow course locations 20
Figure 2.1 Projected closure disturbed areas 33
Figure 2.2 Mount Polley Mine water management system 41
Figure 2.3 Mount Polley Mine water collection catchments 42
Figure 2.4 Proposed short-term water discharge strategy overview 43
Figure 4.1 Progressive reclamation areas 49
Figure 5.1 Environmental monitoring locations 66
Figure 5.2 Soil stockpile locations 70
Figure 6.1 Mount Polley Mine conceptual closure plan 81

LIST OF APPENDICES

APPENDIX A – Baseline Environmental Setting and Land Capability

APPENDIX B – Mill Process Flow Sheets

APPENDIX C – Geochemical Characterization of Ore Stockpiles (SRK 2015)

APPENDIX D – 2014 Vegetation Assessment Results

APPENDIX E – 2012 Tree Plots Assessment (Meister 2014)

APPENDIX F – Tree Plots Root Development Study (McDougall 2015)

APPENDIX G – 2014 ABR Summary Report

APPENDIX H – 2012 NEZ Dump Reclamation Assessment

APPENDIX I – 2014 North Bell Dump Reclamation Update

APPENDIX J – Mount Polley Tree Trial 2014 Progress Report (Metro Vancouver 2015)

APPENDIX K – MPMC Sediment and Erosion Control Plan

APPENDIX L – Site Wide Water Balance and Water Quality Model – Closure and Post-Closure for Restricted Operations (Golder 2015); Cariboo-Springer Pit Phase 4 Water Management Plan (TSF 970 m Design) (Golder 2015); Springer Pit Water Level Predictions and Model Verification (Golder 2015)

APPENDIX M – MPMC Soil Management Plan

APPENDIX N – MPMC Invasive Plant Management Plan

APPENDIX O – Mount Polley Fugitive Dust Management Plan (Golder 2015); Summary of Particulate Monitoring July 7 to September 29, 2015 (Golder 2015)

APPENDIX P – Contaminated Site Assessment Plan (Golder 2015)

APPENDIX Q – Groundwater Seepage Predictions for the Springer Pit – Restricted Operations (Golder 2015); Groundwater Seepage Predictions for the Phase 4 Springer and Cariboo Open Pits – Mount Polley Mine (Golder 2015)

APPENDIX R – Springer Pit Spillway Conceptual Design (Golder 2015)

APPENDIX S – Results of Geotechnical Assessment for the Springer Pit Slope Stability, Mount Polley Mine – Return to Full Operations (Golder 2015)

APPENDIX T – Preliminary Predictions of Groundwater Seepage for the Wight Open Pit at Closure – Mount Polley Mine (Golder 2015)

APPENDIX U – Tailings Storage Facility 950 masl Spillway Conceptual Design (Golder 2015)

APPENDIX V – Review of Groundwater Characterization and Monitoring Program at Mount Polley Mine (Golder 2015)

APPENDIX W – Vegetation Metal Uptake Monitoring Plan

APPENDIX X – Liability Bond Costing

APPENDIX Y – Consultation Documents

LIST OF ABBREVIATIONS

ABA	acid-base accounting
ABR	anaerobic biological reactor
ARD	acid rock drainage
cm	centimetre(s)
d	day(s)
dm^2	square decimetre(s)
FoS	factor of safety
FSR	Forest Service Road
g/t	gram(s) per ton
Golder	Golder Associates Ltd.
ha	hectare(s)
IERP	Independent Engineering Review Panel
km	kilometre(s)
km^2	square kilometre(s)
m	metre(s)
m^3	cubic metre(s)
m/s	metre(s) per second
masl	metre(s) above sea level
MEM	Ministry of Energy and Mines
MESCP	Main Embankment Seepage Collection Pond
mg	milligram(s)
mm	millimetre(s)
MoE	Ministry of Environment
MPMC	Mount Polley Mining Corporation
NAG	non-acid generating
NBD	North Bell Dump
NEZ	Northeast Zone
NPR	neutralizing potential ratio
OSA	on-stream analyzer
PAG	potentially-acid generating
PESCP	Perimeter Embankment Seepage Collection Pond
PETB	Perimeter Embankment Till Borrow
PLC	programmable logic controller
QA/QC	quality assurance quality control
RDS	rock disposal site
SESCP	South Embankment Seepage Collection Pond
SERDS	Southeast Rock Disposal Site
SEZ	Southeast Zone
sph	stems per hectare
SRK	SRK Consulting
t	tonne(s)
TAR	Tailings Access Road
TDAR	Tailings Dam Access Road
tpd	tonne(s) per day
TSF	Tailings Storage Facility

1. INTRODUCTION

1.1. Report Overview

This document is an update to the "Reclamation and Closure Plan Update 2015", submitted to the Ministry of Energy and Mines (MEM) on September 30, 2015. This "Mine Reclamation and Closure Plan Update November 2015" (herein referred to as the "Plan") is being submitted by Mount Polley Mining Corporation (MPMC) as a requirement under Section 10 of the *Mines Act and Health, Safety and Reclamation Code of British Columbia*. This document is being submitted to the MEM as part of a permit amendment application package, in which MPMC is applying to return to full-scale operations with tailings deposition in the Tailings Storage Facility (TSF). The September 30, 2015 submission assumed closure of the Mount Polley Mine following the completion of the milling of 4,000,000 tonnes (t) of ore within the one year authorized restricted operations period. This Plan incorporates the disturbance and reclamation requirements associated with continued mining over approximately four years, in accordance with the Cariboo-Springer Pit Phase 4 mine plan. The Cariboo-Springer Phase 4 Pit mine plan, which includes a return to full-scale operation with tailings deposition in the TSF, is described in detail in the permit amendment application and is referenced and summarized in this document.

This Plan presents reclamation closure objectives and strategies for all permitted mine units, and provides associated liability cost estimates. The reclamation program is designed to meet the environmental protection and reclamation requirements of all applicable provincial and federal legislation, including the British Columbia (BC) *Mines Act* and *Health, Safety and Reclamation Code*, the BC *Environmental Management Act*, and the Canadian *Fisheries Act* (including the annexed *Metal Mining Effluent Regulations*).

Included in this Plan in the subsequent sections is:

- A summary of the project background, permits, and biophysical setting (Section 1);
- An overview of mining and milling operations and site water management (Section 2);
- A description of the designated end land uses and capability objectives (Section 3);
- An overview of MPMC's reclamation approach and update on progressive reclamation and reclamation research (Section 4);
- Descriptions of MPMC's reclamation strategies and management plans for achieving the outlined reclamation objectives (Section 5);
- Reclamation plans for the major disturbance units at the mine site (Section 6);
- Projected post-closure monitoring requirements (Section 7);
- The conceptual site reclamation schedule (Section 8);
- Reclamation liability costing (Section 9); and
- An overview of relevant consultation and engagement activities since the last Reclamation and Closure Plan update (Section 10).

1.2. Project Summary

1.2.1. *Project History*

Mount Polley Mine, operated by MPMC (a wholly owned subsidiary of Imperial Metals Corporation), is an open pit copper/gold mine with an underground component, and has the capacity to process 20,000 to 22,000 tonnes per day (tpd) of ore. The Mine is located eight kilometres (km) southwest of Likely and 56 km (100 km by road) northeast of Williams Lake, BC (Figure 1.1). The Mount Polley property covers 18,892 hectares (ha), which consist of seven mining leases totaling 2,007 ha, and 43 mineral claims encompassing 16,855 ha (Figure 1.2). Mount Polley concentrates are trucked to facilities at the Port of Vancouver and then shipped to overseas smelters or transported by rail to smelters in North America.

Clearing of the site and construction of the entire facility began in 1995, with the mill being commissioned in June 1997. In May of 1997, the Mine received a Ministry of Environment (MoE) (previously the Ministry of Water, Land and Air Protection) Effluent Permit, Permit 11678, issued under the provisions of the provincial *Environmental Management Act*. This permit authorized the discharge of concentrator tailings, mill site runoff, mine rock runoff, open pit water, and septic tank effluent to a tailings impoundment. Approval of the "Mount Polley Mine Reclamation and Closure Plan*"* by the MEM resulted in the issuance of Permit M-200 in July of 1997. The first full year of mining and milling at Mount Polley Mine took place in 1998. The mine suspended operations in October 2001 due to low metal prices, then reopened in December 2004, with mill production commencing again in March of 2005. MoE Permit 11678 was amended in May 2005 to allow the discharge of effluent from the Main Embankment Seepage Collection Pond (MESCP). There have been no discharges from this location since 2005. In November 2012, MoE approved an amendment of Permit 11678 to allow effluent discharge into Hazeltine Creek. Discharge from the MESCP is no longer permitted. A summary of MPMC permits is provided in Section 1.3.

1.2.2. *Tailings Dam Failure*

On August 4, 2014, a breach occurred in the Perimeter Embankment of the TSF; this event is herein referred to as the "tailings dam failure". The tailings dam failure released tailings, water and embankment construction materials to the downstream environments of Polley Lake, Hazeltine Creek and Quesnel Lake. The MoE issued MPMC Pollution Abatement Order 107461, dated August 5, 2014, ordering MPMC to attend to the environmental impacts of the tailings dam failure. The short-term environmental emergency response included addressing health and safety concerns, containment to prevent further release of materials from the TSF, water quality monitoring, cleanup of woody debris on Quesnel Lake, lowering of the Polley Lake water level (which had been increased by the event), assessment of the Polley Lake sediment plug stability, and implementation of sediment and erosion control measures in Hazeltine Creek.

A Temporary Upstream Rockfill Berm was constructed within the area of the tailings dam failure location to retain tailings solids during situations where low flows of water could occur. An alternative method was, however, required to prevent further loss of mine-affected materials and sediments from the TSF during the 2015 freshet, as well as to provide short-term contingency

water storage for freshet. Given this, MPMC applied for, and was issued, the *Mines Act* M-200 Permit amendment on December 17, 2014, "Approving TSF Breach Repair and Perimeter Embankment Buttress Design for 2015 Freshet". Through the winter of 2014-2015, MPMC constructed a breach repair incorporating a cutoff wall, under the design, engineering and construction monitoring services of Golder Associates Ltd. (Golder).

Following the tailings dam failure on August 4, 2014, mining and milling operations at Mount Polley Mine were suspended along with the permitted water discharge to Hazeltine Creek. The focus of Mine operations shifted to remediation work at the TSF, around Polley Lake, and down Hazeltine Creek to Quesnel Lake.

1.2.3. *Current Project Status*

On January 12, 2015, MPMC applied for Permit M-200 and Permit 11678 amendments to allow return to restricted operations at the Mount Polley Mine, with tailings being deposited in the Springer Pit. A revised application was submitted March 20, 2015, incorporating screening comments from the MoE, the MEM and First Nations, and permit amendments were received on July 9, 2015. The approved restricted restart allows milling for the period of one year, up to a maximum throughput of 4,000,000 t of ore (approximately half the pre-tailings dam failure annual throughput). Mill operations restarted on August 4, 2015.

The current project infrastructure consists of the Mill site, active mining in the Cariboo Pit, two active rock disposal sites (RDSs): the Southeast Rock Disposal Site (SERDS); and the Temporary Northwest (NW) Potentially-Acid Generating (PAG) Stockpile, as well as the access roads, power lines, a tailings pipeline, drainage collection systems, and sediment/seepage control ponds. Additional active mining is ongoing in the Boundary Zone underground operation, with the portal in the bottom of the Wight Pit. The Boundary Zone Pit, the Pond Zone Pit, the Southeast Zone (SEZ) Pit, the Bell Pit, and the Springer Pit are not currently active. Back-filling of the Bell Pit and Pond Zone Pit with waste rock was completed in 2012, and the SEZ Pit was backfilled in 2013. A detailed mine site map is included as Figure 1.3.

Currently, the TSF is not permitted to store site contact water and no permitted water discharge is in place following the tailings dam failure. All contact water is currently directed to, and stored in, the Springer Pit. The Springer Pit has a finite capacity, necessitating implementation of a short-term water discharge strategy. On July 16, 2015, MPMC submitted a permit amendment application to the MoE to amend Permit 11678 to allow short-term (maximum two years) discharge of site contact water to Quesnel Lake via Hazeltine Creek, which is currently not fish-bearing and is undergoing rehabilitation following the tailings dam failure. MPMC has installed all required pipelines, diffusers, and water treatment plant infrastructure (this was completed prior to October 30, 2015, as required by Permit M-200), and the permit amendment to commence discharging is anticipated to be received from the MoE in early November 2015.

MPMC is also taking steps to develop a long-term water management strategy; the July 9, 2015 Permit 11678 amendment requires submission of a draft Technical Assessment Report for this long-term water management strategy by June 30, 2016 and a draft schedule of consultation meetings for development of this strategy was submitted to the MoE on September 30, 2015. In

parallel with implementation of a short-term water management plan and development of a long-term water management plan for the Mount Polley Mine, MPMC plans to apply for a Permit M-200 amendment in 2015 to allow temporary contingency water storage in the TSF to manage 2016 freshet flows, prior to the December 17, 2015 expiry of the current permit for 2015 freshet.

Following a 2014/2015 site investigation program designed and supervised by Golder and executed by MPMC, stability analyses were updated for the TSF. MPMC submitted an M-200 Permit amendment application for completion of additional buttressing activities for the Main and Perimeter Embankments to the MEM on July 31, 2015. This permit amendment was received from the MEM on October 22, 2015, and buttressing work as per this permit amendment is incorporated in mine planning.

No permits for operation beyond the one year restricted operations period are in place, and the Reclamation and Closure Plan Update 2015, submitted September 30, 2015, assumed closure following the completion of the milling of 4,000,000 t of ore within the one year restricted operations period as currently authorized. Identified ore reserves indicate approximately ten more years of viable mine life, with the current Permit M-200 and M-200 Permit amendment applications presenting a four year plan for the development of the Phase 4 Cariboo-Springer Pit with a return to full operations and tailings deposition in the TSF. This Plan has been developed to reflect the development associated with the Phase 4 Cariboo-Springer Pit and incorporates the disturbed area and infrastructure changes and the related reclamation requirements associated with continued mining, as per the four year mine plan described in this document.

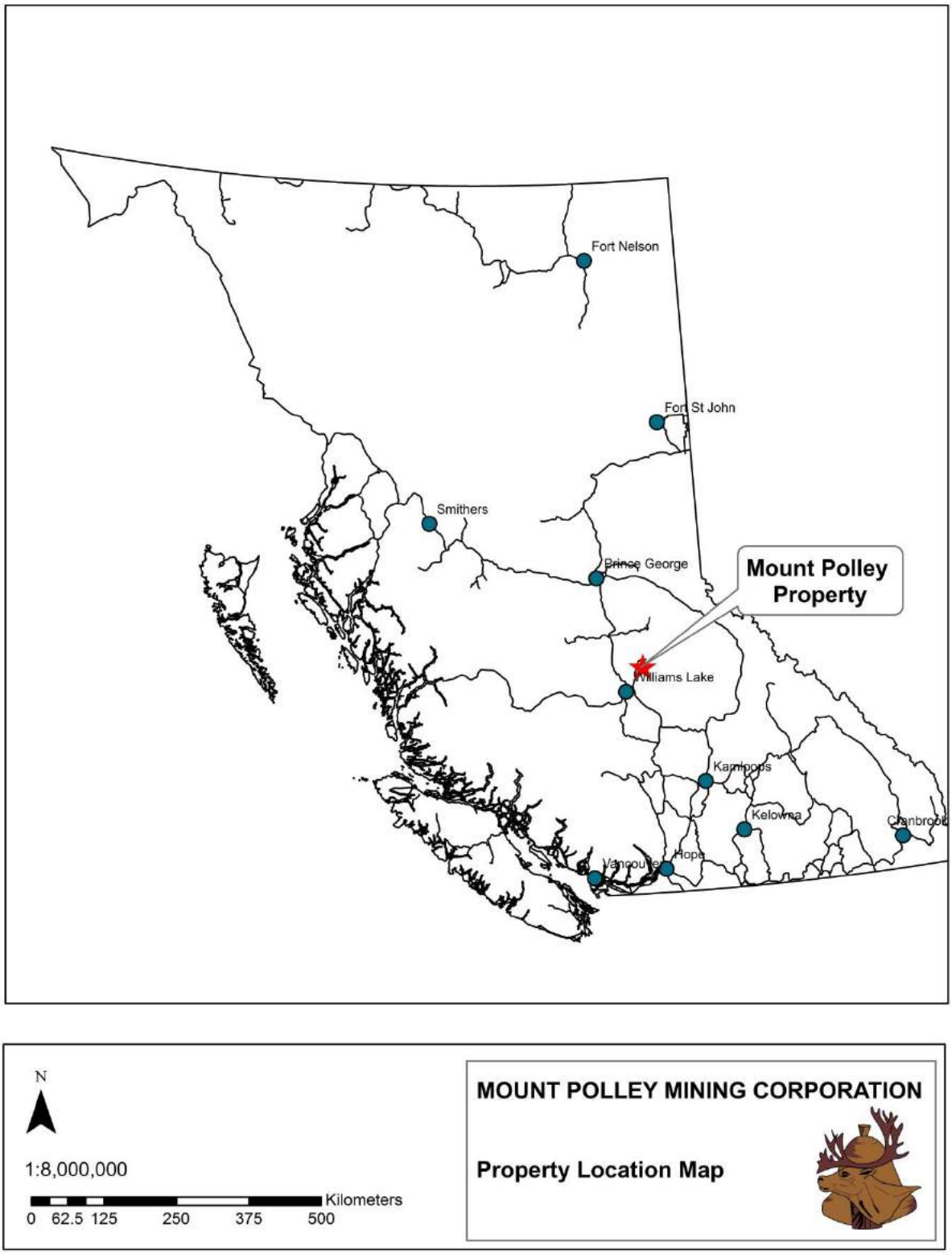


Figure 1.1 Mount Polley Mine property location map

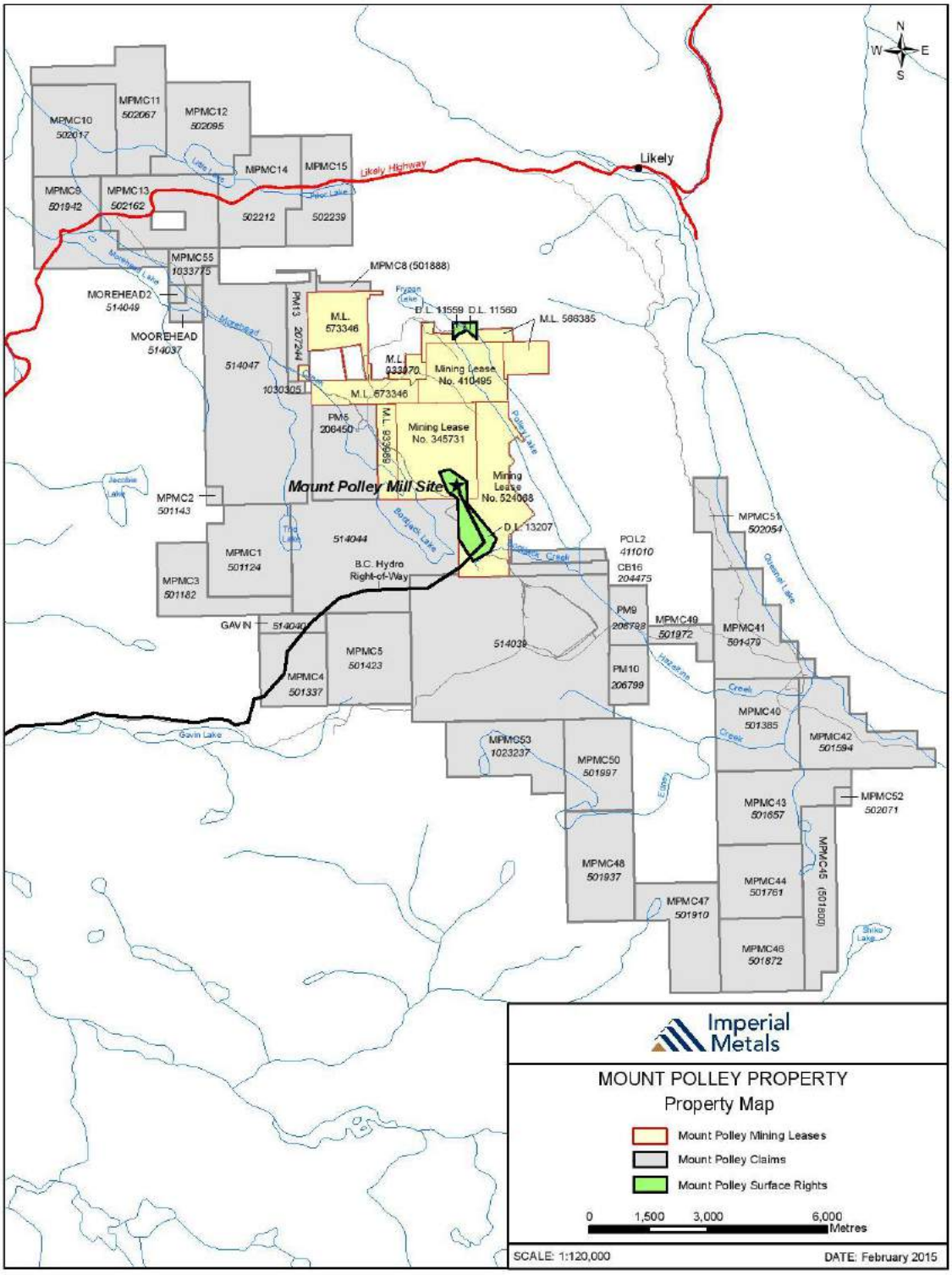
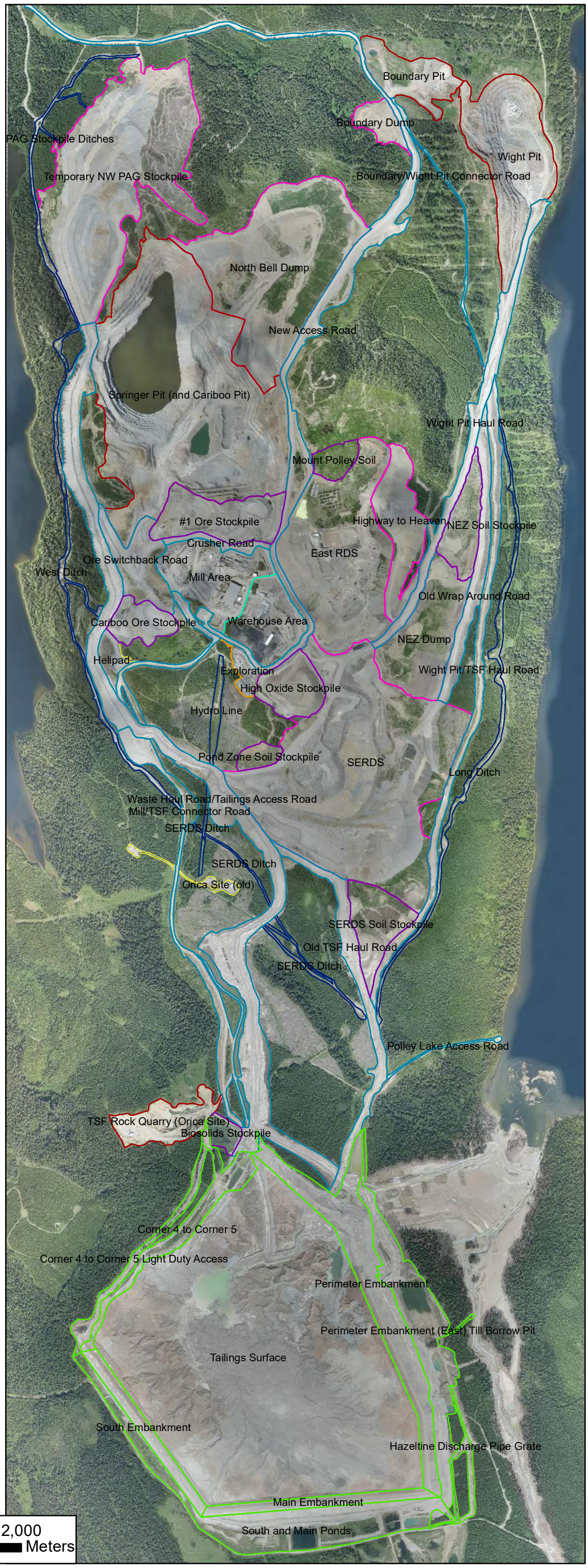


Figure 1.2 Mount Polley Mine mineral claims and leases map



1:21,000

Drawn by: KM

Date: 30/09/2015

N

Infrastructure Type

- Dumps
- Geology
- Linear
- Miscellaneous
- Pits
- Plant Site
- Roads
- Stockpiles
- TSF Areas

MOUNT POLLEY MINING CORPORATION

Figure 1.3
Mine Site Infrastructure

0 250 500 1,000 1,500 2,000 Meters

1.3. Summary of Regulatory Permits and Requirements

Provincially, all phases of the mine life (construction, operation, decommissioning, and reclamation) are regulated under the *Environmental Management Act* and the *Mines Act*, as well as the *Water Act* and other legislation implemented by the BC Ministry of Forests, Lands and Natural Resource Operations (MFLNRO). A summary of existing Mount Polley permits under these regulations is provided in Table 1.1. Table 1.2 provides a list of amendments to the MEM Permit M-200 that have been received throughout the mine life. Permit 11678 authorizes discharge of effluent to the land. Table 1.3 lists amendments to MoE Permit 11678 that have been issued over the course of the mine life.

Federal regulation is primarily through the *Fisheries Act* which aims to protect fish habitat by prohibiting the entry of deleterious substances into fish-bearing waters, as well as the disruption or disturbance of fish habitat without the necessary approvals. Protection of fish habitat also includes the Metal Mining Effluent Regulations (annexed under the *Fisheries Act*) which regulate deposition of mining waste (effluent) into fish-bearing waters.

Table 1.1 Current Mount Polley Mine permits

Ministry	Authorization	Purpose	Permit #	Date Issued	Comment
MFLNRO	Conditional Water License	Dust suppression and industrial.	111741	December 1996	
MFLNRO	Conditional Water License	Diversion of water from Polley Lake	101763	June 2002	
MFLNRO	Conditional Water License	Storage of water in Polley Lake; Edney Creek , Hazeltine Creek, Polley Lake rights	5002458	August 2015	For rehabilitation purposes following the tailings dam failure
MoE	Waste Discharge Permit	Landfill	14590	March 1997	
MoE	Effluent Discharge Permit	Effluent discharge	11678	May 1997	Many amendments. Most recent July 2015.
MoE	Waste Generator Registration	Waste Regulation	01559	July 1997	Updated 2010
MoE	Effluent Discharge (Biosolids)	Store and apply biosolids	15554	May 1998	Updated July 2014
MoE	Air Contaminant Discharge	Waste management	15087	August 1997	
MFLNRO	Road Use Permit	Road use obligations	01-4160-08	March 2008	Gavin Lake FSR
MEM	Permit Approving Mining and Reclamation Program	Mining activities	M-200	August 1995	Many amendments. Most recent October 2015.

Table 1.2 Permit M-200 amendments

Date	Amendment Title
June 13, 1996	Name Change
September 23, 1996	Approval to Construct Tailings Storage Facility to Elevation 934m
July 11, 1997	Amended Reclamation Permit, Approval to Construct Open Pits and Waste Dumps, and Traffic Control Plan
April 7, 1998	Approval to Construct Tailings Storage Facility to Elevation 940m
June 13, 2000	Approval to Construct Tailings Storage Facility to Elevation 944m
August 2, 2000	Approving Tailings Storage Facility and Amended Metal Leaching and Acid Rock Drainage Conditions
May 30, 2001	Approval to Construct Tailings Storage Facility to Elevation 945m
February 16, 2004	Approving Milling of Ore and Tailings Deposition from the International Wayside Bulk Sample
November 1, 2004	Approving Mining and Reclamation Program for the Northeast Zone and Approving Mine Restart
May 25, 2005	Approving Tailings Storage Facility Stage 4 Construction
August 2, 2005	Approving Haulage Road Construction from the Northeast Zone to TSF
November 24, 2005	Approving Mining of Southeast Zone
August 2, 2006	Approving Change of Name and Deletion of Requirement to Monitor Blasting
August 2, 2006	Approving Tailings Storage Facility Stage 5 Construction
March 29, 2007	Approving Northeast Zone Dump Expansion
March 29, 2007	Approving Coper Oxide Test Heap Leach Facility
August 31, 2007	Approving Boundary Road
December 5, 2007	Approving Wight Pit High Wall Rehabilitation
February 19, 2008	Approving Tailings Storage Facility Stage 6 Construction
March 6, 2008	Approving Transfer of Road Use, Maintenance, and Reclamation
July 8, 2009	Approving Pond Zone
August 15, 2011	Approving Mining of C2 and Boundary Zone Pits
June 29, 2012	Approving Tailings Storage Facility Stage 8 Construction
October 15, 2012	Approving Tailings Storage Facility Stage A Construction
March 25, 2013	Approving Boundary Zone Underground
April 22, 2013	Approving Processing of 15000 Tonnes of Ore from Dome Mountain
July 25, 2013	Approving Northwest PAG Dump Expansion and South Haul Road
August 9, 2013	Approving Tailings Storage Facility Stage 9 Construction
March 17, 2014	Approving Cariboo Phase 4 Expansion
March 27, 2014	Approving Change to Reclamation Security Schedule
June 24, 2014	Approving Waste Rock and Tailings Comingling Research Project
December 17, 2015	Approving TSF Breach Repair and Perimeter Embankment Buttress Design for 2015 Freshet
July 9, 2015	Approving Return to Restricted Restart of Operations
October 22, 2015	Approving Main Embankment Buttress

Table 1.3 Permit 11678 amendments

Date	Scope of Amendment
May 30, 1997	Original permit
October 20, 1997	Amended authorized tailings discharge rate (10,000 tpd increase)
June 12, 1998	Amended reporting requirements
September 8, 1999	Amended monitoring requirements
February 1, 2000	Amended authorized tailings discharge rate (4,500 tpd increase)
February 7, 2002	Approval to discharge effluent from the Perimeter Embankment Seepage Collection pond (PESCP) and MESCP; approval to store TSF supernatant and site contact water in the Cariboo and Bell Pits
May 4, 2005	Amended authorized tailings discharge rate (5,000 tpd increase); discharge of groundwater to Polley Lake; updates to reference analytical procedures and monitoring program
April, 17 2009	Amended monitoring, water level and supernatant characteristic requirements for the Cariboo and Bell Pits
November 7, 2012	Approval to discharge to Hazeltine Creek
June 7, 2013	Sulphate guidelines
July 9, 2015	Tailings discharge to the Springer Pit

1.4. Biophysical Setting

1.4.1. *Physiography*

The Mount Polley project area is near the eastern edge of the Fraser Plateau physiographic subdivision, approximately 10 km west of its boundary with the Quesnel Highland subdivision, as defined by Holland (1967). Within the study area, the plateau has somewhat stronger relief, with Mount Polley rising approximately 300 metres (m) above the surrounding terrain. Topographically, the mine site area consists of north-south trending ridges of moderate elevation and relief. Local elevations range from 922 m at Polley Lake to 1266 m at the top of Polley Mountain. The area is within the Quesnel Highlands Ecosection as described by Demarchi *et al*. (1990), and the area has been glaciated; both Polley Lake and Bootjack Lake are overdeepened glaciated lakes.

1.4.2. *Geological Characterization*

The Mount Polley site is located within the Quesnel Terrane, a belt of mafic to intermediate volcanic rocks, which are mostly of Upper Triassic to Lower Jurassic age. The Mount Polley mineral body is hosted within an alkali intrusive complex. Most of the project area is covered by blankets and veneers of glacial tills, but there are also small inclusions of alluvial, lacustrine, colluvial, and organic landforms.

The Mount Polley deposit is classified as a porphyry copper gold deposit (BC MINFILE No. 093A 008) hosted within Jurassic – Triassic Polley Stock that intrudes the Nicola Group volcanic rocks. The Polley Stock is a northwesterly, elongated body approximately five km long and

extends from Bootjack Lake to Polley Lake in the east-west direction. The Polley Stock is a multi-phase pluton with composition ranging from diorite to monzodiorite to monzonite. It is variably altered and brecciated. Felsic (plagioclase phyric) and mafic (augite phyric) dykes occur as late stage intrusive phases. Late brittle faults offset lithologies, alteration, and mineralization.

It has been mined from several different mineralized zones, which have common features (SRK 2015):

- The host rocks for porphyry mineralization are intrusions into the Nicola Volcanics varying in composition from diorite to syenite.
- Alteration is potassic (secondary biotite and pink orthoclase) and propylitic (calcite-epidote-chlorite-pyrite).
- Sulphide mineralization consists mainly of chalcopyrite ($CuFeS_2$) and pyrite (FeS_2), with lesser bornite (Cu_5FeS_4), covellite (CuS), and digenite (Cu_9S_5).
- Carbonate mineralization is principally calcite, with occurrences of malachite ($Cu_2CO_3(OH)_2$). Iron carbonates have not been reported.
- Oxidized copper mineralization is present at approximately 50% of the 0.3% total copper in the upper portions of the ore body, primarily as the silicate chrysocolla ($(Cu,Al)_2H_2Si_2O_5(OH)4\cdot nH_2O$) and the carbonate malachite ($Cu_2CO_3(OH)_2$) in equal proportions (Henry 2009).

1.4.2.1. Lithologies

Volcanics: These volcanic and volcaniclastic rocks are the oldest on the property, form part of the Nicola Group, and are Upper Triassic in age. They consist mainly of andesitic basalt or augite phyric alkali basalt, and volcanic breccias. Volcanic rocks do not make up a significant component of material from the pits.

Diorite: The diorite occurs mainly in the eastern section of the Springer Pit and is bluish-grey, fine to medium grained and equigranular to weakly porphyritic. Phenocrysts are plagioclase, minor augite, and occasional magnetite, biotite, calcite, and apatite.

Monzonite: The monzonite unit is brown to pinkish grey or greenish grey, medium to coarse-grained, and equigranular to weakly feldspar phyric. Predominate feldspars are orthoclase and albite. Accessory minerals include magnetite, augite, biotite, calcite, apatite, and epidote. This unit is variably flooded with potassic alteration. This unit is variable brecciated and hosts copper/gold mineralization.

Potassium feldspar phyric dykes: These dykes are pinkish orange to orangish grey. The matrix is fine to medium grained, orangish grey and composed largely of potassium feldspar. The phenocrysts are elongated subhedral to euhedral plagioclase laths up to 10 millimetres (mm) long. These dykes are often planar, occurring in various orientations and filling fractures of the brecciated monzonite. They vary in width from fractions of 1 m to 5 m wide.

Augite Phyric Dykes: These dykes are distinctive dark green with a fine to medium grained mafic matrix and scattered up to 3 mm augite phenocrysts (up to 8% of rock) and occasionally up to 2% euhedral magnetite phenocrysts. Dykes are generally planar in form and tend to fill fractures and faults. They occasionally exhibit orange potassic alteration.

1.4.2.2. Alteration and Mineralization:

Brecciation and hydrothermal alteration variably affected the Polley Stock and the surrounding Nicola Group volcanics. Alteration can be described in terms of a potassic core enveloped by a propylitic zone. In the core of the system, intense potassic alteration is accompanied by variable strong albite, magnetite, and actinolite alteration. Propylitic alteration (calcite – chlorite – minor pyrite) occurs near the perimeter of the system. In the Springer Pit, alteration is generally characterized by veins of actinolite, epidote, and magnetite which cut across the earlier potassium feldspar and albite flooding in the breccia.

Mineralization is variable, but strongly associated with brecciation and alteration. In the Springer Pit, chalcopyrite is the dominant copper sulphide, with local accumulations of bornite in the higher-grade areas. Sulphides occur disseminated to finely blebbed within potassium feldspar, albite, magnetite, and actinolite alteration. In the southern portion of the Springer Pit, pyrite occurs strongly disseminated in both ore and waste rock. The pyritic waste generally constitutes PAG rock, with sulphur values up to 3%. This pyritic zone extends south to encompass the neighbouring WX Zone, where gold values are typically higher.

1.4.2.3. Structures

Faults recognized to date are late and brittle. Two dominate fault sets have been recognized. One is a north-north-east trending, steeply dipping set. The other is a west-northwest trending, also steeply dipping. Both fault sets offset and terminate the ore.

1.4.3. *Soils*

The following description is an excerpt from Meister (2010). The majority of soils are derived from morainal deposits overlying bedrock. The soils are typically loams to sandy loams, and contain between 15% to 35% (by volume) coarse fragment content (> 2 mm diameter). The pH of the parent material ranges from 6.0 to 7.5 ($CaCl_2$ solution). This reflects the calcareous nature of the underlying bedrock. The calcareous horizon occurs generally at 120 to 150 centimeters (cm) in depth. The organic matter content of the mineral soil is low.

The dominant soil development process is the downward translocation of clay particles, resulting in a Bt horizon and the development of Brunisolic Gray Luvisol soils. In areas where the Luvisolic soil development is weak, soils are therefore classified as Orthic or Eluviated Eutric Brunisols reflecting a weaker rate of soil formation. On more acidic areas, the soils are classed as Dystric Brunisols.

Detailed soil descriptions and terrain classification from inventories carried out for the various areas of the mine site are provided in Appendix A (Baseline Environmental Setting and Land Capability).

1.4.4. *Watersheds*

Then mine is located on the divide of two sub-watersheds within the Quesnel Lake watershed. The western watershed, which includes drainage from Bootjack Lake, Trio Lake, and Morehead Lake, discharges to the Quesnel River via Morehead Creek and drained approximately 60% of the Mount Polley area prior to mine construction. The eastern watershed includes Polley Lake, which discharges to the east via Hazeltine Creek, to Edney Creek and the western arm of Quesnel Lake. The Hazeltine Creek and Edney Creek watershed areas at Quesnel Lake are currently approximately 30.2 square km (km^2) and 87.4 km^2, respectively. Approximately 10.5 km^2 that historically reported to this watershed is now within the mine contact water runoff collection system catchment.

Bootjack Creek is a small tributary of Hazeltine Creek downstream of Polley Lake. Historically, Bootjack Lake discharged into Hazeltine Creek via Bootjack Creek, but in 1913 a dam was constructed at the south end of Bootjack Lake and the flow direction was reversed in order to direct water into Morehead Lake for hydropower production. This resulted in 14 km^2 being diverted from the Hazeltine Creek catchment. The Morehead Creek watershed, including the Bootjack Lake catchment area, is approximately 11.2 km^2. Approximately 2.3 km^2 that historically reported to this watershed is now within the mine contact water runoff collection system catchment.

The regional topography, water bodies, and pre-mining watersheds are shown in Figure 1.4. Refer to Section 2.4.1 for more information on site water collection systems and catchment areas.

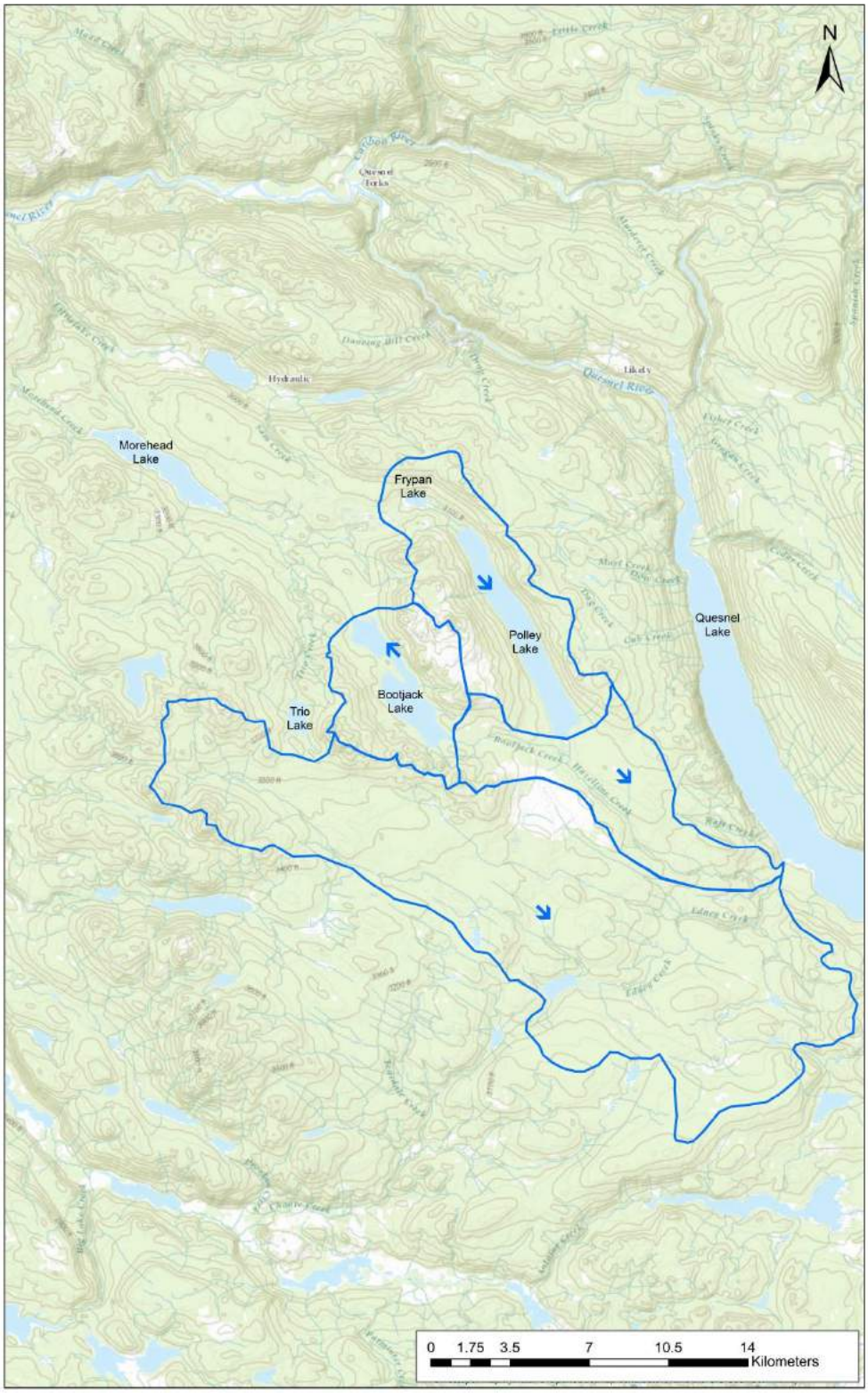


Figure 1.4 Mount Polley Mine site and surrounding area water bodies and topography

1.4.5. *Climate*

Climate data has been recorded at the Mount Polley site since 1995 (although the record is not continuous) and data was recorded from 1973 through 1993 at the Environment Canada weather station in Likely. Weather stations operated, their locations, periods of record, and the parameters measured are summarized in Table 1.4. In winter, snowpack measurements are made at snow courses sites monthly, at minimum. A summary of the stations' locations and periods of record is provided in Table 1.5. A map of the weather station and snow course locations is provided as Figure 1.5.

Table 1.4 Mount Polley Mine and Likely climate stations

Station Name	Northing (m N, UTM Zone 10)	Easting (m N, UTM Zone 10)	Elevation (masl)	Sensors	Period of Record
Likely	5828785	599332	724	Temperature, rainfall, snowfall, total precipitation	1974 – 1993
Mill site	5822420	592495	1,181	Rainfall, temperature	1995 – 2012
Station #1 (near Mill)	5822420	592792	1,171	Rainfall, temperature, relative humidity, solar radiation, wind speed, wind direction	2012 – 2015
Station #2 (TSF)	5819955	594059	964	Rainfall, temperature, relative humidity, solar radiation, wind speed, wind direction	2012 – 2015

Table 1.5 Mount Polley Mine snow courses

Station Name	Northing (m N, UTM Zone 10)	Easting (m N, UTM Zone 10)	Elevation (masl)	Period of Record
#1 (near Mill)	5823182	592792	724	1997 – 2010
#2 (near TSF)	5819976	594092	1,181	1997 – 2015
#3	5823895	593632	1,171	2012 – 2015
#4	5823537	590835	964	2015



Figure 1.5 Mount Polley Mine weather station and snow course locations

1.4.5.1. Temperature

Monthly average, maximum and minimum temperatures for the mine site (1995 to current) are provided in Table 1.6. Comparison with data from the Likely weather station shows that average temperatures at the Mine site are generally 0.3 to 1.0 degrees Celsius (°C) cooler. Average monthly temperatures at the Mount Polley Mine range from -6.0 °C in January to 15.3 °C in July and August.

Table 1.6 Monthly average, minimum and maximum temperatures for the Mount Polley Mine site (1995 – current)

Month	Average Temperature (°C)	Minimum Temperature (°C)	Maximum Temperature (°C)
January	-6.0	-22.3	5.9
February	-4.3	-16.3	5.5
March	-1.5	-16.9	11.1
April	2.9	-7.6	17.5
May	8.8	-1.6	23.8
June	12.7	2.5	27.8
July	15.3	5.4	29.6
August	15.3	4.6	29.8
September	10.9	0.4	25.9
October	3.9	-4.8	18.0
November	-1.9	-14.7	9.9
December	-5.4	-19.7	6.0

1.4.5.2. Precipitation

Long-term precipitation time series representative of the climate conditions at Mount Polley Mine were derived using the long-term regional data from the Likely station (1974 – 1993) and available local data from the three on-site climate stations (1995 to 2015; Golder 2015a). The Mine site experiences high summer precipitation due to summer storms, with the lowest precipitation occurring in February. Precipitation typically occurs as snowfall starting in November, and accumulates until March. Average annual precipitation at Mount Polley is estimated to be 670 mm. Estimated 1:200-year dry, average, and 1:200-year wet precipitation depths are shown in Table 1.7. The 1:200 year dry and wet precipitation values were determined by distributing the average annual precipitation (derived based on Likely and on-site stations) among the months based on average percentage of precipitation for each month. The average monthly snowpack for the winter months from data collected at the Mine site since 1995 is shown in Table 1.8

Table 1.7 Projected annual precipitation for the Mount Polley Mine

Month	Precipitation (mm)		
	Average	1:200-Year Dry	1:200-Year Wet
January	50.8	26.9	82.9
February	37.5	19.8	61.1
March	42.8	22.7	69.8
April	49.5	26.2	80.7
May	53.5	28.3	87.3
June	78.2	41.4	128
July	58.9	31.2	96
August	52.2	27.6	85.1
September	48.2	25.5	78.6
October	58.2	30.8	94.9
November	53.5	28.3	87.3
December	85.6	45.3	140
Annual	**669**	**354**	**1092**

Table 1.8 Monthly snowpack levels for the Mount Polley Mine site (1995 – current)

Month	Snowpack (mm)
January	144
February	162
March	178
April	25
November	16
December	109

1.4.5.3. Wind

Prevailing winds are from the north-north-east and from the south-south-west near the TSF and from the northwest (and to a lesser extent the southeast) near the Mill site, with a predominance of winds designated as calm (below 3 metres per second [m/s]; Golder 2015b).

1.4.5.4. Evaporation

Currently, at the Mine, there are two climate stations that measure and record precipitation (rain), temperature, wind speed and direction, solar radiation, and relative humidity every 30 minutes. Lake (open water) evaporation is calculated by Golder (2015a) based on measured climate parameters such as solar radiation, wind and temperature, using the Penman equation (Penman 1984). Lake evaporation estimates have been derived for the period 2005 to 2012.

Lake evaporation shows a typical seasonal profile, with no evaporation in the winter months and maximum evaporation in the summer months. Average annual lake evaporation at Mount Polley is estimated to be 404 mm. Estimated average monthly and annual lake evaporation values are provided in Table 1.9.

Table 1.9 Average lake evaporation for the Mount Polley Mine site

Month	Lake Evaporation (mm)
January	0
February	0
March	0
April	0
May	52.0
June	94.3
July	102
August	88.8
September	48.1
October	18.2
November	0.3
December	0
Annual	**404**

1.4.6. *Air Quality*

The Mount Polley Mine site is a remote site, but is subject to seasonal pollen and fugitive dust and particulate matter from the logging industry, forest fires, recreational traffic, and nearby wood-burning stoves. The slightly undulating terrain around Mount Polley permits unobstructed atmospheric exchanges and permits prolonged inversions. Major storm tracks are from the west off of the Pacific Ocean. A monthly dustfall monitoring program was initiated at Mount Polley in 1995 to establish baseline dustfall data on total deposition amounts of fugitive dust (particles) during the non-winter months (June to September). The dustfall collectors were set up at seven locations on the mine property and collected monthly. Monitoring results did not exceed 3.95 milligrams per decimeter squared per day (mg/dm^2/d) (Hallam Knight Piésold, 1996).

2. MINE OPERATIONS

2.1. Access and Transportation

Primary access to the mine site is via the Likely Highway. The route from Williams Lake involves diving 14 km south on Highway 97 to the Horsefly/Likely Road turnoff and continuing on this road 4.3 km, then turning left onto the Likely Road and continuing 66 km to the Bootjack Forest Service Road (FSR). Shortly after the Morehead Lake Resort, the Bootjack FSR turnoff is to the right of the highway. The Bootjack FSR is a radio controlled (frequency 153.635) industrial road operated and maintained by the MPMC. All mine personnel, supplies and concentrate trucks use this access road, in addition to use by the forest industry and people who camp, fish, hunt and trap in the area or stay at the Bootjack Lake forestry campsite, which is located at 8.5 km along the Bootjack FSR. There are also several private properties that are accessed via the Bootjack FSR. After the turnoff to the Bootjack Lake forestry campsite at 8 km, the road splits and the remaining 6 km of road to the mine site are private. There is a gatehouse at the entrance to the mine which controls access.

Mine personnel use the Likely Highway from areas north and south of the Bootjack FSR access. Employees live in many communities along this secondary highway, including: 150 Mile House, Beaver Valley, Big Lake, Morehead Lake, Hydraulic, Little Lake and Likely.

Neither the Likely Highway nor the Bootjack FSR has seasonal road restrictions, allowing year-round hauling of concentrate and other supplies. The mine is responsible for the maintenance of the Bootjack FSR year-round, including grading, repairs, dust suppression, and clearing of snow. The Likely Highway is maintained under contract by the Ministry of Transportation.

2.2. Mill and Processing Plant Description

The process flow sheets outlining the processes of the Mount Polley Mill and processing plant are included in Appendix B.

2.2.1. *Primary, Secondary, Tertiary Crushing and Ore Handling*

Ore is crushed in three stages to produce a 16 mm product for the grinding circuit, which is stored in a 15,000 t stockpile. Sized rock for the pebble mill is removed from the secondary crusher feed and stored in a 2,000 t surge pile.

2.2.2. *Grinding*

Rod mills receive the crusher product from storage and reduce it to ball mill feed size at a rate of approximately 915 t per hour. Product from the ball mills is fed to the pebble mill, where it is reduced to flotation feed sized at 65% passing 200 mesh. Pumps and a hydrocyclone classify pulp to process ore efficiently to the required product size.

2.2.3. *Flotation*

A combination of column and mechanical cells recover rougher and scavenger concentrates for regrinding and subsequent cleaning to produce high grade concentrates. The circuit has been

designed with sufficient flexibility to accommodate anticipated variations in the head grade and degree of oxidation of the ore.

2.2.4. *Concentrate Dewatering*

The concentrate from the flotation circuit is thickened and stored in a stock tank that provides surge capacity between thickening and filtering. Two pressure filters reduce the moisture content of the final concentrate to 8% for shipment. A conveyor deposits the filtered concentrate in a storage area accessible to a front-end loader in the truck loading area.

2.2.5. *Concentrate Handling and Transport*

Mount Polley's concentrate is transported to the Port of Vancouver by Arrow Transportation Systems Inc. trucks and shipped to overseas smelters. The principal market for Mount Polley concentrate is Asia. As of December 31, 2012, copper concentrate sales contracts were in place with three buyers. New concentrate sales arrangements are negotiated as required.

2.2.6. *Mill Reagents*

Table 2.1 summarizes the types and estimated amounts of reagents used at Mount Polley in Mill processing. Depending on the type, mill reagents are shipped to Mount Polley in drum as water solutions or as organic liquids. Mixing and storage tanks, which are heated when necessary, provide up to 48 hours of supplies of reagent ready for feeding by metering pumps. A spare system is provided for trials of experimental reagents. A ventilation system ensures that there is no build-up of noxious fumes in the area.

Table 2.1 Reagent types and quantities used in the Mount Polley Mill

Reagent	**Rate of Use – Pre-Tailings Dam Failure**	**Rate of Use – Post-Tailings Dam Failure (August 2015)**
Potassium amyl xanthate	15 g/t	22 g/t
W22C	20 g/t	20 g/t
Flocculant	0.13 g/t	0.13 g/t
Lime	90 g/t	90 g/t

2.2.7. *Instrumentation and Control Philosophy*

The entire processing operation is controlled through a central programmable logic controller (PLC). This PLC and its principal auxiliary components are located in a control room in the concentrator building and it communicates with the remote input/output stations at the fresh water pump house, the water head tanks, the reclaim water pump barge and the reclaim water booster pump house by way of an overhead data highway cable.

An on-stream analyzer (OSA) provides up-to-date information on the changing ore and operating results by measuring assays for five streams. This enables flotation operators to control recovery and concentrate grades. The OSA minimizes the requirements for personnel who would otherwise be required to provide these control assays. The OSA package includes an X-ray analyzer (including X-ray tube and spectrometer) and computer hardware and software

for data collection and analysis. The sample streams to the OSA are used for shift composite samples for metallurgical accounting purposes, along with five other hand-cut samples from other streams.

2.2.8. *Processing History*

A summary of the history of processing at the Mount Polley Mine is provided in Table 2.2.

Table 2.2 History of mill processing at the Mount Polley Mine

Year of Production	Ore Processed (t)	Tailings Produced (t)	Grinding Circuit	Sources of Tailings	Changes and Geochemical Considerations
Mine Start in 1997	2,346,829	2,333,186	2 rod, 2 ball, 3 pebble mills	Three tailings streams: (1) sand scavenger; (2) oxide; and (3) cleaner tails from cyclone overflow. All streams combined for disposal in the impoundment.	NaHS used to float copper oxide minerals.
1998	5,828,358	5,788,498			
1999	7,051,212	6,986,932			
2000	6,948,339	6,883,317			
2001	5,385,796	5,328,581			
5 year shutdown					Consolidation of the tailings in the impoundment.
2005	4,814,083	4,758,757	2 rod, 2 ball, 3 pebble mills	Two streams; rougher and scavenger tails. Both streams combined for disposal in the impoundment.	Higher proportion of sulphide ore and lower NaHS addition.
2006	6,235,221	6,133,088			
2007	6,444,112	6,346,640	2 rod, 3 ball, 3 pebble mills		Addition of third ball mill to increase production from 6.4 to 7 million t per year.
2008	6,848,983	6,735,444			
2009	7,045,737	6,977,681			
2010	7,894,596	7,825,178	2 rod, 3 ball, 3 pebble mills and flash flotation		Addition of flash flotation for remainder of operations to date with the potential to lower sulphide content in the tailings.
2011	7,716,856	7,663,577		One stream combined.	More oxidized ore and higher NaH_2S addition.
2012	8,121,878	8,056,496		One flotation stream and addition of circuit to remove magnetite.	Addition of magnetite removal circuit. Tailings produced after 2012 would contain lower amounts of magnetite.
2013	7,956,738	7,882,625			
2014 (to July 31, 2014)	4,486,121	4,440,700			
1 year shutdown					
2015 (August 5 to October 30)	912,429	903,813	2 rod, 3 ball, 3 pebble mills and flash flotation	One flotation stream and addition of circuit to remove magnetite.	Tailings deposition in Springer Pit.

2.3. Four Year Mine Plan

The mine plan used in mine scheduling reflects a combination of the permitted one year restricted operations phase and the planned return to full operations (the latter of which is being applied for in the M-200 Permit amendment application package of which this document is a component).

The mine schedule outlines a mine plan which utilizes the available capacity of a fully repaired TSF which has been made operational to the 970 masl elevation. Should the TSF be made operational and raised in the area of the Freshet Embankment and around the existing embankments to an elevation of 970 masl (approximately the height of the existing embankment outside of the Freshet Embankment area), then a volume of 25,100,000 m^3 would be available for tailings storage. This volume can accommodate approximately 33,900,000 t of tailings, or roughly four years of production at full production rates. This quantity of production would allow for the completion of the Phase 4 Cariboo-Springer Pit, which has been developed over the last three years of waste production. The Phase 4 Cariboo-Springer Pit contains approximately 27,000,000 t of reserves that will be processed for deposition in the TSF and/or stockpiled. The remaining capacity of the 970 masl TSF repair is consumed by a combination of Boundary Zone underground, Boundary Zone open pit, and stockpiled ore (500,000t, 591,000t, and 5,310,000t, respectively).

This mine plan reflects three general phases: the restricted operating period, the full operating period, and the pre-closure period. The restricted operating period extends from August 2015 to April 2016. From August to November 2015, processing is completed on a week-on, week-off schedule targeting 20,000 tpd on operating days (i.e., half capacity). Because of the challenges inherent with operating during the winter, from December 2015 to April 2016, processing under the restricted operations will be undertaken seven days per week at a target daily throughput of 18,000 tpd. Substantially weakened copper prices provide additional impetus to this revised operating regime, as revenues initially projected during restricted operations have diminished while fixed costs have not. The restricted operations period maximum permitted throughput of 4,000,000 t of ore is expected to be reached in April of 2016. This April completion date is two months (or 15%) earlier than the one-year deadline for completion of restricted operations as included in the amended Permit 11678 and amended M-200 Permit (each as received on July 9, 2015). Under the amended Permit 11678 and M-200 Permit for restricted operations (during which a short-term water discharge is being implemented to reduce surplus water stored in the Springer Pit), production tonnages and timing of milling will be adjusted based on the filling of the Springer Pit in accordance with the considerations for potential groundwater exfiltration, which is projected to occur at 1,030 masl.

It is assumed in this mine schedule that construction activities are completed and relevant permits have been received such that the TSF can be returned to operation on May 1, 2016. Should this not be the case, ore processing on site will cease as there will be no permitted tailings storage location available for use. Construction requirements at the TSF require a significant volume of material from the open pit in the form of buttress rock. To facilitate this, ore processed from January 2016 to April 2016 will be constituted primarily of stockpiled ore. Using stockpiled ore as the primary mill processing feed will enable almost the full capacity of the open

pit haulage fleet to be utilized for hauling construction material to the TSF. Upon completion of the required raise under the 970 masl TSF design construction program, and renewed operation of the TSF, the mining fleet will return to normal mining activities, mining the Phase 4 Cariboo-Springer Pit at approximately 70,000 tpd.

The return to full operations includes mining of the Phase 4 Cariboo-Springer Pit, and is expected to be completed in the first quarter of 2019. In order to complete the Phase 4 Springer Pit, the contact water deposited into the Phase 3 Springer Pit will need to be removed prior to the first quarter of 2018 to facilitate removal of the tailings deposited during restricted operations. It is expected that tailings will be removed by a combination of hydraulic and conventional shovel-truck methods. The exact methodology will be heavily influenced by the speed at which free water can be removed from the pit as part of the site water discharge strategy. Additional options for storage of these tailings (i.e., comingling in RDSs) will be investigated, implementation of which would result in additional capacity being realized in the 970 masl TSF for conventional slurry tailings disposal.

The pre-closure period is that when new mining has been completed and ore stockpiles are being milled while PAG material is being re-handled into the Springer Pit for subaqueous storage. As the Phase 4 Springer-Cariboo Pit is exhausted, if the mine is to be prepared for closure and the Phase 5 Springer Pit is not pursued, then stockpile ore will be substituted for fresh pit ore. Mining of the Boundary Zone open pit will be undertaken at this time. PAG rock from the Temporary NW PAG Stockpile will be re-handled into the Springer Pit as haulage capacity allows, over a period of at least two years. The exact amount of stockpiled ore milled during this period will depend on the volume available in the 970 masl TSF and the amount of stockpile ore which is generated prior to this point. It is currently expected that 5,310,000 tonnes of stockpile ore will be milled (with approximately 6,000,000 tonnes remaining in stockpiles); although this scheduling may be re-evaluated based on material management requirements and economic considerations in a closure condition.

2.3.1. *Underground*

Underground mining (portal located in the bottom of the Wight Pit) will be undertaken according to existing permits in the Boundary/Zuke Zones, generating an expected 500,000 t of ore feed over a 500 day period extending into early 2017. Potential extensions to the underground mine life are being investigated.

Mining method and stope shapes will remain unchanged from currently permitted activities. Ore hauled out of the underground is dumped immediately at surface of the portal, and hauled by the open-pit fleet to the crusher.

2.3.2. *Material Handling*

A summary of expected quantities of different material types generated and handled during the mine life is provided in Table 2.3. Referenced locations are shown in Figure 1.3.

Non-acid generating (NAG) waste rock mined under this restricted operating condition will be either placed at the SERDS or, alternatively, used for on-site projects or as buttress materials

around the TSF. PAG rock will continue to be characterized according to the current Acid-Base Accounting (ABA) sampling regime (Section 5.2.2), and placed on the Temporary NW PAG Stockpile before being re-handled into the pits at the end of the mine life. Refer to Section 5.2.2 for a discussion of handling PAG material. As required by the July 9, 2015 Permit M-200 amendment condition, MPMC retained SRK Consulting (SRK) to conduct an assessment of metal leaching and acid rock drainage (ARD) potential from ore stockpiles for October 31, 2015 (Appendix C). This is further discussed in Section 5.2.2.

Table 2.3 Mine plan material tonnages

Material Type	Quantity
NAG Waste	40,000,000t
Tailings Moved from Springer Pit to TSF	4,000,000t*
New PAG Waste Stockpiled	9,250,000t
Total PAG Waste Rehandled at Closure	24,250,000t
Ore Direct to Mill from Pits and Underground	24,600,000t*
New Ore Stockpiled	3,550,000t
Stockpile Ore Processed Over Entire Period	5,310,000t*
Total Ore Processed	**29,910,000t**

*denotes material to be deposited in the TSF for the 970 m configuration

2.3.3. *Area of Disturbance*

Table 2.4 outlines current disturbed and reclaimed areas (organized by individual feature and disturbance type). 1,245.43 ha is the current footprint of the mine, with 76.76 ha currently undergoing progressive reclamation. These areas, organized by feature type, are shown in Figure 1.3. Areas designated as undergoing progressive reclamation are discussed and shown on a map in Section 4.2.

Table 2.4 also includes the projected closure areas for the four year mine plan; 1,277.02 ha is projected to be the closure footprint, which is a total increase of 31.59 ha over the existing site footprint; 89.55 ha of the closure footprint is projected to form lakes (Boundary Pit, Cariboo-Springer Pit, Wight Pit and TSF Pond). Changes in disturbed areas are summarized in Table 2.5 and the projected closure footprint is shown in Figure 2.1. An additional 7.07 ha may be disturbed for the Tailings Dam Access Road (TDAR) construction, which is permitted, but construction of which will depend on haulage efficiencies and economics realized by MPMC.

2.3.4. *Future Considerations*

Open pit reserves exist at Mount Polley beyond the Phase 4 Cariboo-Springer Pit. These reserves have not, however, been included in the mine plan included in the permit amendment application and described in this section because the storage of the tailings generated by the remaining reserve base would require additional space in the TSF beyond the 970 masl design capacity. Relevant permits for this mining and tailings management will be sought when

sufficient planning and engineering has been completed. Should such permits be sought and received prior to the capacity of the 970 masl TSF design capacity being consumed, it is possible that some of the capacity inside the 970 masl TSF design could be used to store tailings generated from processing Phase 5 Cariboo-Springer Pit ore, with processing of the stockpile ore being deferred to the then-revised end of mine life.

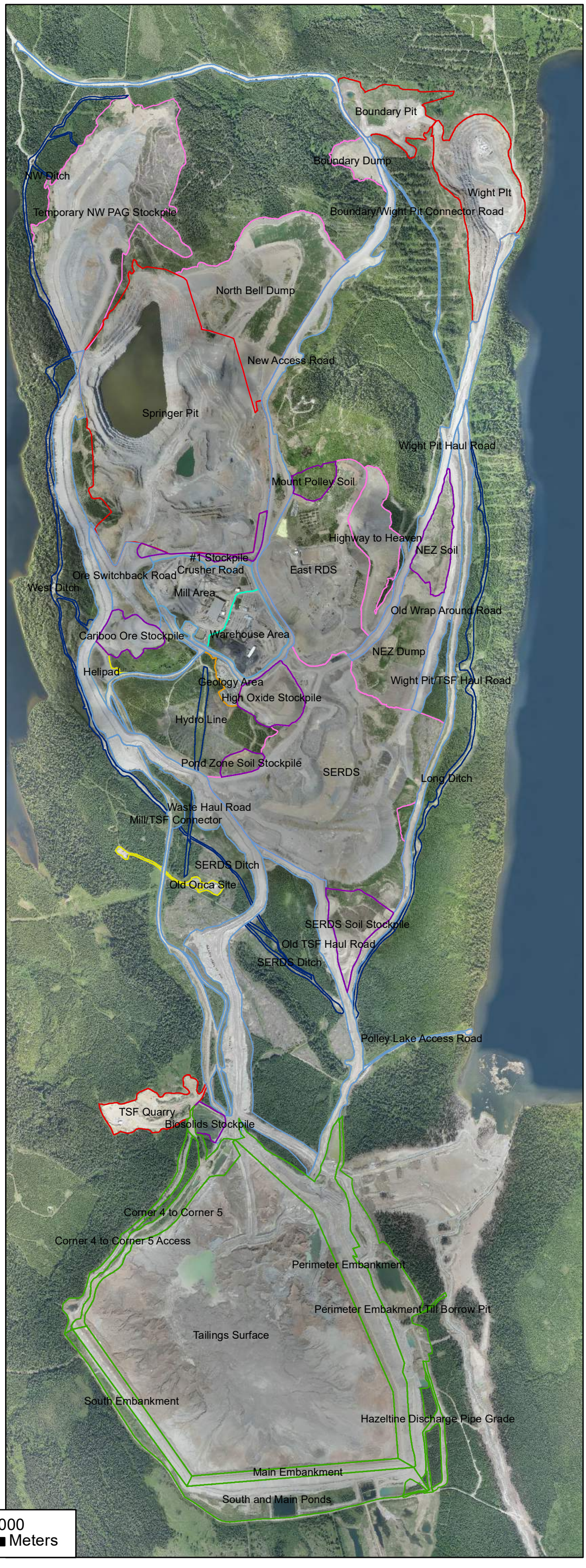
Table 2.4 Mount Polley Mine existing and projected disturbed areas

Area	End Land Use	Existing Area (ha)	Closure Area (ha)	Reclaimed Area (Recountontoured) (ha)	Lake Area (ha)	Remaining Area (ha)
Dumps						
~~Bell Dump~~	Wildlife/Forestry	-	-	-	-	-
Boundary Dump	Wildlife/Forestry	5.35	5.35	4.70	-	0.65
East RDS	Wildlife/Forestry	51.33	51.33	6.09	-	45.24
Highway to Heaven	Wildlife/Forestry	16.45	16.45	6.58	-	9.87
NEZ Dump	Wildlife/Forestry	23.03	23.03	5.13	-	17.90
North Bell Dump	Wildlife/Forestry	62.54	***54.35***	26.97	-	27.38
SERDS	Wildlife/Forestry	109.45	***110.45***	-	-	110.45
Temporary NW PAG Stockpile	Wildlife/Agroforestry	78.50	***81.11***	-	-	81.11
Total		**346.65**	**342.07**	**49.47**	**-**	**292.60**
Pits						
Boundary Pit	Pit Walls/Lake	12.17	***15.28***	-	6.37	8.91
~~C2 Pit~~	N/A	-	-	-	-	-
~~Caribou Pit~~	N/A	-	-	-	-	-
~~Pond Zone Pit~~	N/A	-	-	-	-	-
TSF Quarry	Pit Walls/Lake	11.25	11.25	-	-	11.25
~~SEZ Pit~~	N/A	-	-	-	-	-
Springer Pit	Pit Walls/Lake	128.58	***178.50***	-	49.69	128.81
Wight Pit	Pit Walls/Lake	38.66	38.66	-	1.46	37.20
Total		**190.66**	**243.69**	**-**	**57.52**	**186.17**
Stockpiles						
#1 Stockpile	Wildlife/Forestry	17.10	***2.85***	-	-	2.85
Biosolids	Wildlife/Forestry	2.79	2.79	-	-	2.79
High Ox Stockpile	Wildlife/Forestry	10.40	10.40	-	-	10.40
Mount Polley Soil	Wildlife/Forestry	4.17	4.17	-	-	4.17
NEZ Soil	Wildlife/Forestry	9.52	9.52	-	-	9.52
Ore Stockpile	Wildlife/Forestry	7.17	7.17	-	-	7.17
Pond Zone	Wildlife/Forestry	2.81	2.81	-	-	2.81
SERDS Soil Stockpile	Wildlife/Forestry	11.86	***11.15***	-	-	11.15
Tailings Soil	Wildlife/Forestry	2.95	2.95	-	-	2.95
Total		**68.77**	**53.81**	**-**	**-**	**53.81**
Roads						
Boundary/Wight Pit Connector Road	Wildlife/Forestry	1.69	1.69	-	-	1.69
Crusher Road	Wildlife/Forestry	2.31	***2.11***	-	-	2.11
Mill/TSF Connector Road	Wildlife/Forestry	17.33	17.33	-	-	17.33
New Access Road	Wildlife/Forestry	29.21	29.21	-	-	29.21
~~Old Mine Access Road (Bootjack) - Mine Component~~	N/A	-	-	-	-	-
~~Old Pond Zone Road~~	N/A	-	-	-	-	-
Old Tailings Haul Road	Wildlife/Forestry	12.47	12.47	-	-	12.47
Old Wraparound Road	Wildlife/Forestry	11.16	11.16	-	-	11.16
Ore Switchback Road	Wildlife/Forestry	11.69	***11.32***	-	-	11.32
Polley Lake Access Road	Access Road	0.71	0.71	-	-	0.71
Waste Haul Road	Access Road	71.34	**70.01**	1.81	-	68.20
Wight Pit Haul Road	Access Road	14.40	14.40	-	-	14.40
Wight Pit/Tailings Road	Access Road	17.75	17.75	-	-	17.75
Total		**190.06**	**188.16**	**1.81**	**-**	**186.35**
TSF						
Corner 4 to Corner 5	Wildlife	11.34	11.34	-	-	11.34
Corner 4 to Corner 5 Light Duty Access Road	Access Road	5.71	5.71	-	-	5.71
East Till Borrow	Wildlife/Agroforestry	27.56	27.56	-	-	27.56
Hazeltine Discharge Pipe Grade	Wildlife/Forestry	6.86	6.86	-	-	6.86
Main Embankment	Access Road	7.88	7.88	-	-	7.88
Perimeter Embankment	Access Road	33.21	33.21	-	-	33.21
South Embankment	Access Road	8.03	8.03	-	-	8.03
Southeast Till Borrow	Wildlife/Agroforestry	26.27	26.27	23.95	-	2.32
~~Tailings Pipe Grade~~	N/A	-	-	-	-	-
TSF - South and Main Ponds	Wildlife/Agroforestry	32.62	32.62	-	-	32.62
TSF - Southwest Pond	Wildlife/Agroforestry	3.83	3.83	-	-	3.83
TSF Surface	Wildlife - Forested Wetland	213.53	213.53	-	32.03	181.50
Total		**376.84**	**376.84**	**23.95**	**32.03**	**320.86**
Miscellaneous						
Geology Area	Wildlife/Forestry	2.83	2.83	-	-	2.83
Helipad	Wildlife/Forestry	3.13	3.13	1.53	-	1.60
Hydro Line	Wildlife/Forestry	3.29	3.29	-	-	3.29
Long Ditch	Watercourse	8.84	8.84	-	-	8.84
Mill Area	Wildlife/Forestry	21.35	21.35	-	-	21.35
~~Northwest PAG Ditch~~	N/A	-	-	-	-	-
~~Old Dispatch~~	N/A	-	-	-	-	-
Old Orica Sites	Wildlife/Forestry	1.87	1.87	-	-	1.87
South SERDS Ditch	Watercourse	2.74	2.74	-	-	2.74
Warehouse Area	Wildlife/Forestry	14.01	14.01	-	-	14.01
West Ditch	Watercourse	14.39	14.39	-	-	14.39
Total		**72.45**	**72.45**	**1.53**	**-**	**70.92**
	Total:	**1,245.43**	**1,277.02**	**76.76**	**89.55**	**1,110.71**

Notes: ***Bold Italics*** indicates a change in disturbed area (increase or decrease) between current and projected closure areas.
All of these areas are as per May 27, 2015 Drone Survey.
Areas considered part of the tailings dam failure remediation are not included.
Wildlife includes secondary end landuses associated with wildlife (hunting, trapping, etc.)

Table 2.5 Changes in disturbed areas with the projected closure footprint

Area Type	Current Area (ha)	Closure Area (ha)	Change in Area (ha)	Change in Area (Unit, ha)	
Dumps					
North Bell Dump	62.54	54.35	-8.19	Springer Pit	-8.19
SERDS	109.45	110.45	1.00	SERDS Stockpile	0.71
				New disturbed area	**0.29**
Temporary NW PAG Dump	78.50	81.11	2.61	**New disturbed area**	**2.61**
Pits					
Boundary Pit	12.17	15.28	3.11	**New disturbed area**	**3.11**
Springer Pit	128.58	178.50	49.92	#1 Stockpile	14.45
				North Bell Dump	8.19
				Ore Switchback Road	0.37
				West Haul Road	1.33
				New disturbed area	**25.58**
Stockpiles					
#1 Stockpile	17.10	2.85	-14.25	Springer Pit	-14.45
				Crusher Road	0.20
SERDS Soil Stockpile	11.86	11.15	-0.71	SERDS	-0.71
Roads					
Crusher Road	2.31	2.11	-0.20	#1 Stockpile	-0.20
Ore Switchback Road	11.69	11.32	-0.37	Springer Pit	-0.37
West Haul Road	71.34	70.01	-1.33	Springer Pit	-1.33



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Date: 29-Oct-2015

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Infrastructure Type

- Dumps
- Geology
- Linear
- Miscellaneous
- Pits
- Plant Site
- Roads
- Stockpiles
- TSF Area

MOUNT POLLEY MINING CORPORATION

Figure 2.1
Projected Closure Disturbed Areas

0 250 500 1,000 1,500 2,000 Meters

2.4. Water Management

2.4.1. *Water Management System Overview*

To protect natural watercourses from potentially mine-influenced contact water, a series of collection ditches and water containment structures have been established below waste rock dumps and disturbed areas. Site collection ditches (including flow direction) and sumps are shown in Figure 2.2, and catchment areas for the system are shown in Figure 2.3.

The current objective for site water management is to keep the water level in the TSF as low as practicable, with all contact water being directed to the Springer Pit for storage.

Existing infrastructure is described below. Details regarding water management specifications, inspections, operation, maintenance, and inspections are contained within the MPMC Operation, Maintenance, and Surveillance (OMS) Manual, which is updated at a minimum annually, and otherwise as required to reflect site conditions.

- **Mill Site Ditches**: Mill site and crusher runoff is collected in gravity feed ditches which convey water to the Mill Site Sump.
- **Mill Site Sump**: Receives water from the Mill Site Ditches and sewage/domestic water from the Mill and Administration buildings. Water from the Mill Site Sump is pumped into the Tailings Line downstream of the Mill.
- **Tailings Line**: Gravity feed pipeline carrying tailings slurry from the Mill to the Springer Pit.
- **Springer Pit**: Storage location for tailings and site contact water. Water is pumped from the Springer Pit to the Central Collection Sump (CCS) via the West Ditch to supply water for processing and dust suppression.
- **Cariboo Pit**: Not currently dewatered. Will be pumped to the Mill process water tank or Springer Pit as required to facilitate mining.
- **Joe' Creek Coffer Dam and Pipeline**: Collects seepage flow from the North Bell Dump (NBD) and conveys the water in a gravity feed pipeline to the Wight Pit or Long Ditch, depending on the season and pumping scenario.
- **Wight Pit**: Pumped to the Mill process water tank, with excess water pumped to the Springer Pit or, during non-winter months, to six snowmakers on the East RDS. Dewatering of the Wight Pit allows underground operations to continue. Any water that exceeds pumping capacity to move water to these areas reports to the Long Ditch. All water can be directed to the Long Ditch in winter months, when the aforementioned infrastructure is subject to freezing.
- **Junction Zone Ditch:** Gravity feed ditch which collects seepage and runoff from the Temporary NW PAG Stockpile. Reports to the 9km Sump.
- **9km Sump**: Collects water from the Junction Zone Ditch and pumps it to the NW Sump.

- **Northwest Ditch**: Collects seepage and runoff from the Temporary NW PAG Stockpile.
- **NW Sump**: Gravity feed ditch which collects water from the 9km Sump and the Northwest Ditch and pumps it to the Springer Pit.
- **West Ditch**: Collects seepage and runoff water from the west side of the mine site. Two gravity feed sections flow into the Mine Drainage Creek Sump, from which water is pumped to a third section of the ditch, which gravity feeds into the SERDS Ditch. Water from the Springer Pit which is pumped to the CCS to supply water for milling and dust suppression feeds into this third section.
- **Mine Drainage Creek Sump**: Collects water from the West Ditch and upper Mine Drainage Creek, and is pumped into the lower section of the West Ditch.
- **SERDS Ditch**: Gravity feed ditch which collects seepage and runoff water from the southwest portion of the SERDS. Other inputs include the West Ditch (Mine Drainage Creek Sump), Orica Ditch, and Bootjack Creek Sump. This ditch also conveys process water pumped from the Springer Pit during mill operations.
- **SERDS Sump**: Collects water from the SERDS Ditch and conveys it in a gravity feed pipeline into the lower Long Ditch, just upstream of the CCS.
- **Orica Ditch**: Gravity feed ditch which collects runoff below the SERDS Ditch and Orica Site, and joins with the SERDS Ditch downstream of the Tailings Access Road (TAR).
- **TAR Ditch**: Gravity feed ditch which collects runoff from the TAR and conveys it into the Bootjack Creek Sump.
- **Bootjack Creek Sump**: Collects runoff from the TAR and TAR Ditch and is pumped into the SERDS Ditch. Diversion culverts allow Bootjack Creek water outside the TAR runoff catchment to flow under the road.
- **SEZ Ditch**: A gravity feed ditch which collects runoff from the East RDS and conveys it into the Long Ditch catchment area.
- **Long Ditch**: A gravity feed ditch which collects seepage and runoff from the east side of the mine site.
- **Long Ditch Sump**: Receives water from the Long Ditch and conveys it in a gravity feed pipeline to the lower Long Ditch, which feeds into the CCS.
- **Central Collection Sump**: Receives water from the Long Ditch, SERDS Ditch, Perimeter Embankment Till Borrow (PETB) and TSF Settling Pond. Water is pumped to the Mill for processing via the Booster Station, with surplus water going to the Springer Pit. Water from the CCS can be pumped to the TSF or flow in a gravity feed ditch to the PETB in the event that inflow is greater than the pumping capacity. The CCS is allowed to gravity feed to the PETB in order to supply extra water for dust suppression at the MESCP or provide water for the treatment plant.

- **South Embankment Seepage Collection Pond**: Collects seepage from the TSF South Embankment and pumps it to the MESCP via the South Toe Drain ditch.
- **Main Embankment Seepage Collection Pond**: Collects seepage from the Main Embankment toe drains and foundation drains, as well as pumped water from the South Embankment Seepage Collection Pond (SESCP), gravity feed inflow from the South Toe Drain, and, at times, pumped water from the PETB (when additional water is required for the sprinklers and Turbomisters). The MESCP also collects water from the collection ditch along the Gavin Lake FSR (below the South and Main Embankments). Water is pumped to the sprinklers on the TSF and the evaporators (Turbomisters) during non-winter months. Surplus water is pumped to the PETB.
- **Perimeter Embankment Till Borrow**: Collects local runoff from the Perimeter Embankment and adjacent areas, can pump or receive water to/from the MESCP, and stores surplus water from the CCS (either as a contingency during high runoff periods, or for water treatment plant raw water feed). Water is pumped to the MESCP if additional water is required to run the sprinklers and Turbomisters.
- **TSF**: Collects runoff from the upstream biosolids stockpile and rock quarry and direct precipitation on the TSF surface. Water is pumped from the **Upstream 1** sump to the **TSF Settling Pond**, and then pumped to the CCS. The TSF may also act as a contingency temporary storage basin in the event that water inflow to the CCS exceeds the capacity of the pumps.

MPMC uses evaporation infrastructure to reduce surplus water captured on site and for dust suppression purposes:

- **Water Truck Fill Stations**: Fill stations are located at the Springer Pit, the CCS and the Wight Pit. Water trucks spray water from these stations on the haul roads for dust control in non-winter months when conditions are dry.
- **Snowmakers**: Six snowmakers are located along the top of the East RDS, and are operated on day shift in non-winter months when there is surplus water being pumped from the Wight Pit, beyond what is used for the milling process.
- **Sprinklers**: Eleven big gun sprayers are located on the TSF along the Main Embankment and the southern portion of the South Embankment, along with two sets of ten and 13 smaller sprinklers. On day shift during non-winter months when it is not raining, two big gun sprayers or one big gun sprayer and a circuit of smaller sprinklers are run at any given time for dust control.
- **Evaporators**: Three Turbomisters are in place along the MESCP and operate on day shift during non-winter months.

Clean water systems are also in place to prevent unnecessary collection of water and leave as much water as possible in the natural watersheds:

- **TSF Clean Water Ditch**: Divert runoff upstream of the TSF (between 4 Corner and 5 Corner) into Edney Creek.
- **Wight Pit Clean Water Ditch**: Diverts runoff above the Wight Pit into Polley Lake.
- **Gavin's Ditch**: Diverts runoff upstream of the Wight Pit Haul Road into Joe's Creek (which passes under the road in two culverts).

2.4.2. *Mill Process Water*

2.4.2.1. Restricted Operations

Process water for the Mill is sourced primarily from the CCS, which receives water from a variety of locations depending upon the season and site water management conditions. Water is pumped from the CCS to the Booster Station and from the Booster Station to the Mill process water tank. From the Mill process water tank, any water required for process will be directed to the Mill, with surplus water reporting to the tailings line and, ultimately, to the Springer Pit.

Pumping capacity is available in the Springer Pit to provide sufficient water to the CCS as required to continually supply the Mill and to provide raw feed water for the water treatment plant.

Active mining of the Cariboo Pit will require the continued draw-down of the water stored therein. This water may be used to supplement process water for milling operations, and will ultimately be directed to the Springer Pit.

2.4.2.2. Full Operations

During full operations, the Mill process water source will transition from the CCS to the TSF reclaim barge, the latter of which will be re-installed in the TSF. Both the CCS and the TSF reclaim barge would receive water from a variety of locations depending upon the season and site water management conditions. Water would be pumped from the CCS or TSF to the Booster Station and from the Booster Station to the process water tank. From the Mill process water tank, any water required for the process will be directed to the mill, with surplus water reporting to the tailings line, and ultimately, to the TSF.

For the resumption of full operations, the TSF is assumed to be operational in May 2016, with tailings deposition in the Springer Pit ceasing and deposition in the TSF commencing. A minimum TSF pond volume of one million m^3 will be targeted for the operation of reclaim pumps for processing requirements, and adequate tailings beaches (goal of a minimum of 100m) will be maintained. Existing site water management infrastructure will remain, with site contact water and Springer Pit dewatering being directed to the PETB for treatment and discharge, to the maximum extent possible. When the inflows to the PETB exceed the treatment and discharge rate (typically during the freshet period), excess site contact water will be directed from the CCS to the TSF for temporary detention.

The Springer Pit will be dewatered progressively over time and to facilitate the transfer (either as slurry or as mined tailings) of the tailings which have been deposited in the Springer Pit during restricted operations to the TSF. Tailings transfer to the TSF (~4,000,000t) is scheduled to occur between the fourth quarter of 2017 and third quarter of 2018. During resumed operations in the Phase 4 Cariboo-Springer Pit, groundwater and runoff inflow will be managed to facilitate mining objectives.

Due to large freshet volumes, it will be necessary to utilize the TSF for temporary detention; however, a principal objective of the water management plan is not to accumulate water on site, and to not carry over water year-to-year. Golder was retained to model water management over the course of the restricted operations, return to full operations and into closure, and a copy of their report is included in Appendix L. Modelling completed for the Mine Plan shows that, under average climate conditions, the peak TSF free water volume is within the normal operating range, and is not projected to exceed 1.5 Mm^3 (including the one million m^3 minimum operating volume). This increases to a peak volume of 2.0 Mm^3 in the 1-in-10 wet year freshet and a peak volume of 3.3 Mm^3 in the 1-in-200 wet year freshet. To allow temporary detention of freshet volumes in the TSF, MPMC will be pursuing an M-200 Permit amendment.

Long-term effluent quality and quantity predications are included in Section 5.2.4.

2.4.3. *Water Discharge*

2.4.3.1. Water Discharge Background

MPMC has a positive water balance and the annual surplus of water has increased over the life of the project as the mine footprint has expanded, necessitating the collection of surface runoff from a larger area. When MPMC closed in the early 2000's, a surplus of water accumulated in the TSF and water was discharged to Edney Creek under Permit 11678 during the period in the early 2000's when the mine was in care and maintenance due to low metal prices. In November 2011, MPMC received an amendment to Permit 11678 that allowed for discharge of dam filtered water into Hazeltine Creek; however, permit restrictions on the quality and quantity of water to be discharged, discharge season, and water source did not allow for MPMC to fully discharge the surplus water that was accumulating in the TSF. At the time of the tailings dam failure, MPMC was actively pursuing permit amendments for a short-term discharge (reverse osmosis-treated water to Polley Lake, with the process reject stream (brine) stored in the TSF), to manage the surplus of water for a period of approximately three to four years while a long-term water management plan was developed.

Following the tailings dam failure, MPMC has no permitted discharge, and all contact water is being stored in the Springer Pit. However, the mine site continues to have a positive water balance (Golder 2015a) and the Springer Pit has a finite capacity. Golder estimates that once the pit water elevation reaches approximately 1,030 masl, the water will exfiltrate to the groundwater and discharge towards Bootjack Lake. At 1,050 masl the Springer Pit will overflow. There is, therefore, some urgency to developing a system for treatment and discharge of site contact water. For this reason, MPMC has applied for an amendment to Permit 11678 (along with the required supporting permits and authorizations) for a short-term water discharge to be

utilized in the interim, while consultation and planning is carried out to develop a long-term water management strategy.

2.4.3.2. Short-Term Water Management Plan

On July 16, 2015, MPMC applied to the MoE for an amendment to Permit 11678 to allow short-term (maximum two year) discharge of treated mine effluent to Quesnel Lake via the Hazeltine Creek channel which has been constructed and armoured, but is not appropriately rehabilitated to allow return of fish to the system (i.e., is not fish bearing).

The proposed short-term water management plan is to direct mine contact water to the PETB, primarily by pumping water from the Springer Pit to the West Ditch (which has been armoured to reduce erosion). The West Ditch gravity feeds to the CCS (via the SERDS Ditch), and the CCS will be allowed to gravity flow to the PETB. This water will then undergo suspended solids removal using Veolia ACTIFLO® water treatment technology prior to discharge to upper Hazeltine Creek and conveyance in the reconstructed, non-fish bearing, creek channel. In lower Hazeltine Creek, the water will be transferred into Quesnel Lake from Hazeltine Creek Pond #1 via intake structures feed two pipelines with diffusers (two sedimentation ponds were constructed in lower Hazeltine Creek following the 2014 tailings dam failure to reduce suspended solids loadings into Quesnel Lake, the first of which the intake structures for the outfall pipes have been installed in). The planned water discharge will have flow rates of up to 0.3 m^3/s, be continuous (year-round), and be operational for a maximum of two years, during which time the long-term strategy is planned to be implemented. An overview of this proposed system is provided in Figure 2.4.

The proposed short-term water discharge option was selected in an options analysis workshop with First Nations, public, and regulatory representatives because: it does not require extensive infrastructure that will influence or bind long-term option selection; it can convey the necessary flows to a receiving environment with an appropriate dilution ratio; and, Hazeltine Creek is currently not fish-bearing. This is only considered a short-term option, as MPMC plans to continue rehabilitating Hazeltine Creek and return it to fish-bearing status.

Construction of required pipelines and diffusers, and procurement of water treatment infrastructure was completed prior to October 30, 2015, as required by the July 9, 2015 Permit M-200 amendment. It is anticipated that an amended effluent permit from MoE will be received in early November, allowing discharge to commence. When the permit amendment is received and the system is operational, it will be incorporated into the site OMS Manual and the approved environmental monitoring program will be initiated.

Details on the proposed discharge system and assessment of potential effects on the receiving environment are available in the “Mount Polley Mine: Short Term Effluent Discharge Technical Assessment Report in Support of an Effluent Permit Amendment” developed by Golder (2015a).

2.4.3.3. Long-Term Water Management Plan

As noted above, MPMC is developing a long-term water management plan in parallel with implementation of the short-term water management plan, which will only be operational for a

maximum of two years. MPMC is required by the MoE under Permit 11678 to complete a draft Technical Assessment Report for a long-term water management plan by June 30, 2016.

Given that this plan is currently under development and much consultation will be required, MPMC has made some preliminary assumptions to allow predictions of long-term effluent quality and quantity (Section 5.2.4) for closure. It is anticipated that this plan will be adjusted through the consultation and regulatory review process. The plan will likely involve discharge to Quesnel Lake or the Quesnel River, with active treatment of the water being discharged using, for example, Veolia ACTIFLO® in the interim, while site specific passive treatment options are tested and validated for use in closure. The preferred option for closure is to have passive treatment systems distributed around the site, such that there will be minimal operation and maintenance requirements, and water will flow back into its pre-mining watercourse and/or watershed.



Date: 29-Oct-2015

Drawn by: KM

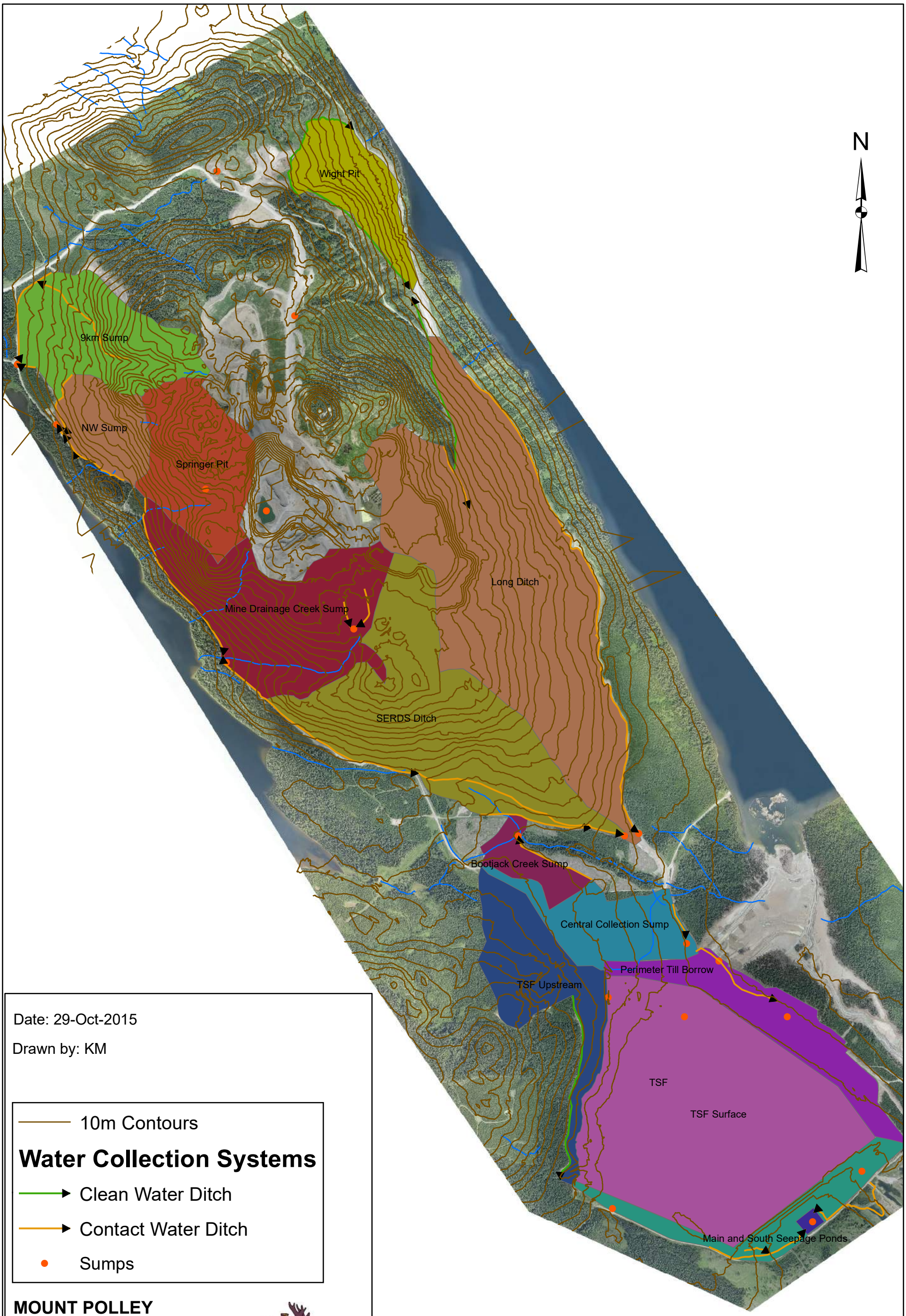
Water Collection Systems

- Clean Water Ditch
- Contact Water Ditch
- Pipeline
- Pipes and Culverts
- Sumps

MOUNT POLLEY MINING CORPORATION

Figure 2.2
Site Water Management

0 250 500 1,000 1,500 2,000 Meters



Date: 29-Oct-2015

Drawn by: KM

10m Contours

Water Collection Systems

Clean Water Ditch

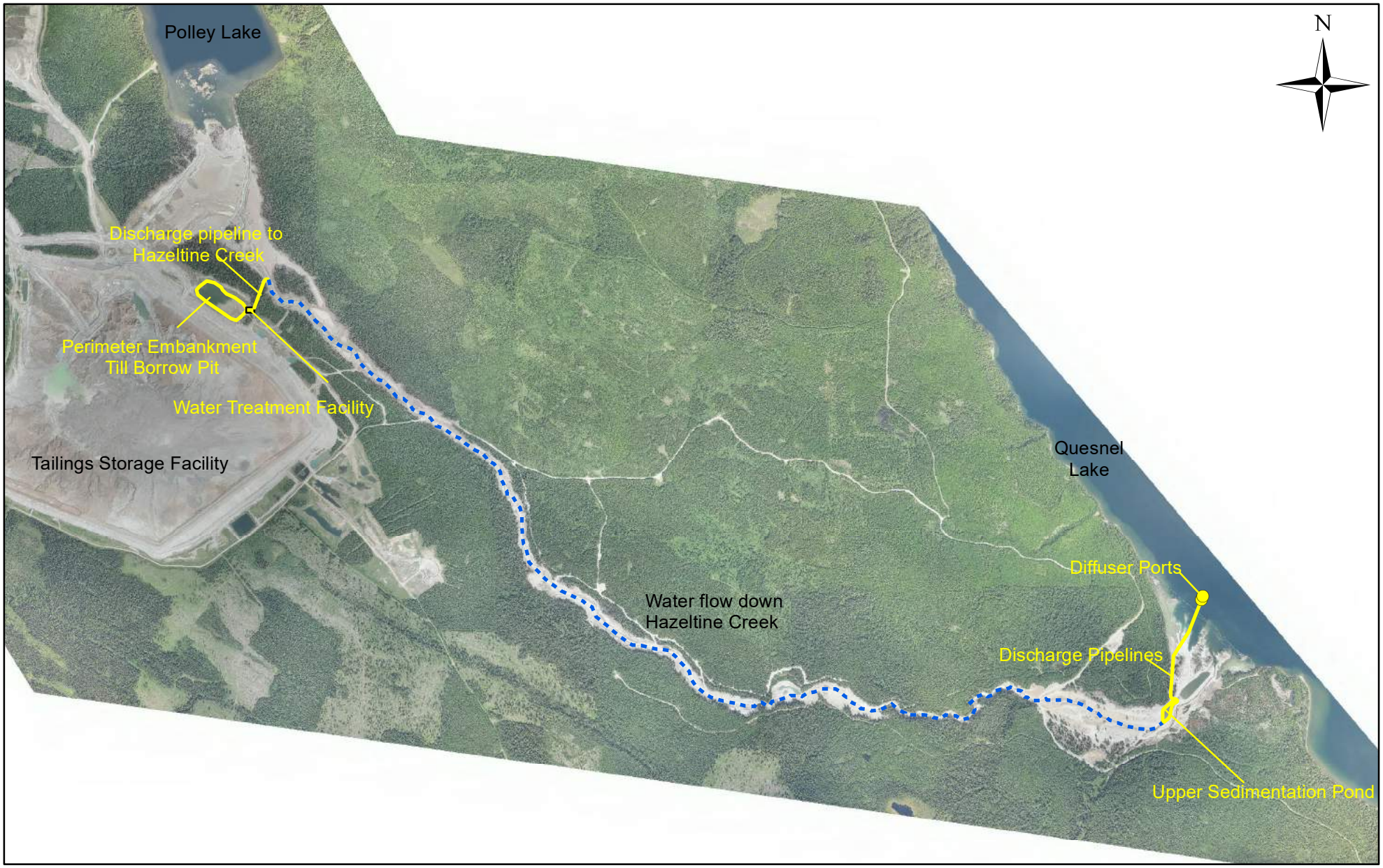
Contact Water Ditch

Sumps

MOUNT POLLEY MINING CORPORATION

Figure 2.3
Site Watersheds

0 250 500 1,000 1,500 2,000
Meters



1:33,000

0 500 1,000 2,000 3,000 4,000 Meters

MOUNT POLLEY MINING CORPORATION

Figure 2.4
Short-term Discharge System Overview

Date: 29-Oct-2015 Drawn by: KM

3. LAND USE AND CAPABILITY OBJECTIVES

3.1. Reclamation Objectives

3.1.1. *End Land Use Objectives*

Prior to mine development, the main site land uses were commercial forestry and wildlife habitat. Portions of the development area were also used for cattle grazing, recreational activities, hunting, and trapping. There was no agriculture in the area, and in baseline assessments the site was determined to have poor agricultural capacity. Detailed baseline land capability and historic land use information is provided in Appendix A.

The main objective of the reclamation program is to return all areas that have been disturbed by mining operations (except pit walls) to equivalent or greater land capability than existed prior to mining, on an average property basis. Consistent with previous Reclamation and Closure Plan updates, wildlife habitat and commercial forestry are designated as the primary end land uses. Reclaimed areas should be capable of supporting secondary uses associated with wildlife resources, such as hunting, guide-outfitting, trapping, and outdoor recreation. Sport fishing and livestock grazing have also been considered as secondary land uses in formulating the Reclamation and Closure Plan.

The following goals are implicit in achieving these end land use objectives:

- Long-term preservation of water quality within and downstream of decommissioned operations.
- Long-term stability of engineered structures, including the waste rock dumps, TSF and open pits, as well as all exposed erodible materials.
- Removal and proper disposal of all access roads, structures, and equipment not required after the mine closes.
- Natural integration of disturbed lands into surrounding landscape, and restoration of the natural appearance of the area after mining ceases, to the greatest possible extent.
- Establishment of self-sustaining vegetation cover, consistent with the end land uses.

Commercial forestry is a longer-term objective. Site research that was initiated at the Mount Polley Mine in 1998 indicates that conifer growth on reclaimed waste rock dumps is an attainable goal for parts of the site. To create appropriate microsites for conifers that grow in later successional stages; however, it is often necessary to promote early successional stage vegetation growth, allowing the process of natural succession to establish suitable vegetation cover and moisture conditions. Establishment of early successional stage communities can effectively support wildlife and associated secondary land uses; forage species are widely available and forest stands can also be managed using a variety of strategies, including agroforestry and integration of diverse wildlife habitats. Over time, as succession and native species ingress occur at reclamation sites, climax forest communities will be established.

Rehabilitation of the site's wildlife capability will require development of self-sustaining vegetation that imitates pre-development cover. Restoration of the natural appearance and creation of suitable habitats will allow for natural integration of disturbed lands into the surrounding landscape and improve wildlife use and access over time once the mine has reached full closure. Post-closure, as wildlife usage increases and public access to parts of the site is re-established, the MFLNRO will have the opportunity to sanction the secondary end land uses of hunting, guide-outfitting, and trapping.

Similarly, livestock grazing is a compatible end land use, as there is overlap in wildlife and livestock forage species and vegetative cover preferences. Select areas overlapping with existing range tenures can be designed to ensure access of cattle to water and can take advantage of re-vegetation patterns that protect plants from being trampled and allow understory growth for forage.

Other forms of outdoor recreation, including sport fishing, will be supported by maintaining appropriate water quality and aquatic habitats in receiving environment water bodies. Improving access to the Bootjack and Polley Lakes and improving the Polley Lake recreation site will also support this objective. Establishment of an interpretive walking trail and picnic site on the NBD is also being considered.

The specific strategies for achieving end land use objectives are outlined in Section 5 and the detailed reclamation objectives and plans for each mine unit are outlined in Section 6.

3.1.2. *Land Capability Criteria*

As re-vegetation progresses with implementation of the closure plan, detailed methods will be designed to assess if land capability criteria have been met. Table 3.1 outlines the land capability criteria to be met, and general methods of assessment to be used.

Table 3.1 Land capability criteria for reclamation of the Mount Polley Mine site

Objective	Criteria	Method(s) of Assessment
Wildlife (primary)	Capability to support wildlife usage equivalent to pre-mining conditions. Note: species composition may vary due to presence of early successional stages or previously unavailable habitat types.	- Habitat suitability assessments and/or wildlife usage studies (for comparison with data from baseline studies and the surrounding undisturbed areas, with consideration for creation of new habitats).
Commercial forestry (primary)	Capability to grow harvestable stands of conifer species over time.	- Vegetation surveys to ensure natural succession is progressing and seral stage advancement towards a harvestable climax community is occurring. - Comparison with regional forest growth indices can be used to assess if the vegetation community is on this trajectory (not necessarily with the same rate of productivity, but with succession towards the specified growth capability occurring).
Hunting, guide-outfitting, trapping (secondary)	Capability to support wildlife species targeted by hunters and trappers and access to portions of the Mine site.	- Meet wildlife objectives for species targeted by hunters and trappers. - Access roads to portions of the mine site open to the public.
Outdoor recreation, including sport fishing (secondary)	Capability of receiving environment water bodies to support fish targeted in sport fishing and access to Polley and Bootjack Lakes.	- Appropriate public access to Polley and Bootjack Lakes. - Water quality and biological monitoring of water courses with reference to provincial and federal guidelines.
Cattle grazing (secondary)	Capability to support cattle grazing in designated areas.	- Assessment of availability of cattle forage species and watering locations. - Presence of grazing cattle.

3.1.3. *Towards Sustainable Mining Program Biodiversity Protocol*

As a member of the Mining Association Canada, Imperial Metals Corporation is a participant in the Towards Sustainable Mining (TSM) program. TSM is a set of guiding principles and performance elements that govern key activities of companies in all sectors of the mining and mineral-processing industry, and the program works to promote corporate social responsibility. To achieve the indicators outlined in TSM's Biodiversity Conservation Management Protocol, MPMC is currently developing a Biodiversity Management Plan that will complement this Plan. The Biodiversity Management Plan will formalize MPMC's commitment to biodiversity conservation through development and implementation of systems which ensure a continued focus on creation of diverse wildlife habitats and establishment of varied vegetation, with input from First Nations and relevant stakeholders.

4. RECLAMATION APPROACH

4.1. Reclamation Approach

To achieve the outlined goals, MPMC has developed strategies to promote physical stability, water quality and watercourse protection, sediment retention and erosion control, appropriate soil handling, suitable re-vegetation, and invasive species management.

Site reclamation and closure is still partially in the conceptual phase and these strategies are designed to be adaptable and evolve based on findings from progressive reclamation, site monitoring and research, and advancements in engineering and science. The subsequent sections outline progressive reclamation and research activities MPMC is currently undertaking, results of which will continue to influence site reclamation strategies. Section 5 describes MPMC's existing reclamation strategies in detail.

4.2. Progressive Reclamation

Progressive reclamation sites at Mount Polley Mine are treated as large scale research projects, with outcomes influencing future reclamation plans and prescriptions. Table 4.1 shows the total areas that have been re-contoured, have had fertilizer or biosolids applied, and have been seeded or planted. Detailed reclamation prescriptions for all progressive reclamation and research sites are provided in Table 4.2. These areas are shown in Figure 4.1. Note that the figure and table do not include areas that may be disturbed again in the future, but were seeded for sediment retention and prevention of invasive species establishment.

Reclamation on the East RDS commenced as part of a research trial, and larger scale reclamation on the Northeast Zone (NEZ) Dump, and NBD commenced in 2010 and 2011, respectively. For an overview of the reclamation activities on the NEZ Dump, NBD, and Tree Plots, refer to Section 4.3.

Progressive reclamation of the Boundary Dump, Highway to Heaven, East RDS, Waste Haul Road, and Helipad parcels has been initiated in the past few years, and vegetation assessments were carried out in 2014. General findings were:

- Timely establishment of overstory vegetation (primary successional trees and shrubs) will be important for preventing establishment of invasive and non-native species.
- Selection of trees and shrubs should account for site specific conditions, specifically hot, dry conditions on south and west facing slopes.
- Direct placement of stripped soil is an effective way to maintain soil nutrients, and native species will grow from the seed sources in the soil, fully or partially negating the need for seeding of ground cover.
- Growth is improved on reclamation areas with deeper soil and surface roughening.
- Continued monitoring is recommended.

Detailed results are presented in Appendix D.

Table 4.1 Summary of Completed Progressive Reclamation at Mount Polley Mine

Area	Parcel	Re-contoured (ha)		Soil/Till Applied (ha)		Seeded (ha)		Fertilizer/Biosolids (ha)		Tree-Planted (ha)	
		2014	Total	2014	Total	2014	Total	2014	Total	2014	Total
NEZ Dump	**2a, 2b1, 2b2**	0.00	5.13	0.00	5.13	0.00	5.13	0.00	5.13	0.00	5.13
	Beside 2a/2b	0.00	2.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NBD	**Parcels 1 - 10**	0.00	11.59	0.00	11.59	0.00	11.59	0.00	11.59	11.59	11.59
	South Triangle	0.00	1.30	0.00	1.30	0.00	1.30	0.00	1.30	1.30	1.30
	Phase 1	0.00	2.21	0.00	2.21	0.00	2.21	0.00	2.21	0.00	0.00
	Phase 2	0.00	2.87	0.00	2.87	0.00	2.87	0.00	2.87	0.00	0.00
	Metro Van Research 1	0.00	2.81	0.00	2.81	1.87	1.87	0.00	2.34	2.34	2.34
	Wrap Around Toe	0.00	2.20	0.00	2.20	0.00	2.20	0.00	0.00	0.00	0.00
	Beside Research 1	0.00	4.76	0.00	1.99	0.00	0.00	0.00	0.00	0.00	0.00
	Metro Van Research 2	0.00	2.00	2.00	2.00	1.33	1.33	1.66	1.66	2.00	2.00
	Beside Research 2	0.00	2.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boundary Zone	**Dump**	0.00	4.70	4.70	4.70	0.00	0.00	0.00	0.00	0.00	0.00
East RDS	**Above Access Road**	0.00	9.10	1.62	3.78	3.78	3.78	0.00	0.00	0.00	0.00
	Highway to Heaven	9.47	9.47	6.58	6.58	6.58	6.58	0.00	0.00	0.00	0.00
	Tree Plots	0.00	2.31	0.00	2.31	0.00	2.31	0.00	1.20	0.00	2.31
Waste Haul Road	**Above WHR**	0.00	1.81	0.00	1.81	0.00	1.81	0.00	0.00	0.00	0.00
	Below Helipad	0.00	1.53	0.00	1.53	1.53	1.53	1.53	1.53	0.00	0.00
South Till Borrow		0.00	23.95	0.00	0.00	0.00	14.75	0.00	12.00	0.00	0.00
	TOTAL	9.47	93.00	14.90	52.81	15.09	59.26	3.19	41.83	17.23	24.67



N

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MOUNT POLLEY MINING CORPORATION

Figure 4.1
Progressive Reclamation Sites

Date: 25/09/2015 Drawn by: KM

Table 4.2 Detailed progressive reclamation prescriptions

Site Specifications				Soil				Revegetation			Schedule						
Site	Parcel(s)	Area	End Land Use Objectives	Soil Stockpile Source	Volume (m^3)	Application Depth (cm)	Ammendments	Grass Seed Mix[1]	Shrub & Deciduous Tree Planting	Conifer Tree Planting	Re-Contour	Soil Application	Soil Ammendment Application	Coarse Woody Debris Applicaiton	Grass Seeding	Shrub & Deciduous Tree Planting	Conifer Planting
North Bell Dump	Parcels 1-10	11.59	Wildlife, forestry	Wight Till	10,600	20	Biosolids (122 dt/ha)	Native grasses (30 kg/ha) (hydroseeded with fibre mulch, except southern-most Parcel 10 hand seeded at 35 kg/ha)	Black cottonwood - 60 sph Paper birch - 34 sph Trembling aspen - 34 sph Sitka alder - 172 sph Saskatoon - 34 sph Prickly rose - 34 sph Scoulers willow - 79 sph Soopolalie - 100 stem trial plot	Lodgepole pine - 1075 sph Douglas fir - 451 sph Western red cedar - 54 sph Hybrid spruce - 54 sph Consider underplanting with later successional species in future.	2011	2011	2011	2011	2011	2013 - poor survival 2014 - re-plant	2014
	South Triangle	1.30	Wildlife, forestry	North Bell Dump Till	1,733	30	18-19-18 Fertilizer (75 kg/ha)	Native grasses (35 kg/ha) (hydroseeded with fibre mulch)	2013 Black cottonwood - 1000 sph Sitka alder - 800 sph 2014 Soopolalie - 100 stem trial plot	Lodgepole pine - 1400 sph Douglas fir - 600 sph Consider underplanting with later successional species in future.	2011	2011	2011	-	2011/2012	2013/2014	2014
	Phase 1	2.21	Wildlife, forestry	North Bell Dump Till	3,920	20	Biosolids (138 dt/ha)	Native grasses/forbes (35 kg/ha) (hand seeded)			2012	2012	2012	-	2012		
	Phase 2	2.87	Wildlife, forestry	North Bell Dump Top	4,680	20	Biosolids (135 kg/ha)	Native grasses + lupine (35 kg/ha) (hand seeded)			2012	2012	2012	-	2012		
	Metro Van Research Parcel 1	2.81	Wildlife, forestry	North Bell Dump Till	4,680	20	Biosolids (107 dt/ha) (on 2.34 ha)	1) No seed 2) Forbes mixture (75 g/ha fireweed, 1 kg/ha lupine, 113 g/ha Dryas drummondii, 4.9 kg/ha june grass, yarrow, pearly everlasting mix) 3) Fireweed (75 g/ha) 4) No seed 5) Native grasses/forbes (5kg/ha) 6) Native grasses/forbes (10 hg/ha)	Black cottonwood - 200 sph Paper birch - 50 sph Trembling aspen - 50 sph Sitka alder - 200 sph Saskatoon - 50 sph Prickly rose - 50 sph Scoulers willow - 50 sph Huckleberry - 50 sph	Lodgepole pine - 1120 sph Douglas fir - 480 sph Consider underplanting with later successional species in future.	2012	2013	2013	-	2014	2014	2014
	Wrap Around Toe	2.20	Wildlife	North Bell Dump Till	14,418	6	None	Native grasses (~15 kg/ha) (hand seeded)	Monitor natural vegetation ingress		-	2012	-	-	2012	TBD - monitor ingress	
	Beside Research	2.00	Wildlife, forestry	Direct Placement: SEZ Stripping	4,000	20	None	Monitor natural growth from direct placement.			2012	2013	-	TBD - monitor ingress			
	Metro Van Research Parcel 2 (in Beside Phase 2 parcel 4.79 ha area)	2.00	Wildlife, forestry	North Bell Dump Top	4,000	20	Biosolids (107 dt/ha)	1) No seed 2) Forbes mixture (75 g/ha fireweed, 1 kg/ha lupine, 113 g/ha Dryas drummondii, 4.9 kg/ha june grass, yarrow, pearly everlasting mix) 3) Fireweed (75 g/ha) 4) No seed 5) Native grasses/forbes (5kg/ha) 6) Native grasses/forbes (10 hg/ha)	Black cottonwood - 200 sph Paper birch - 50 sph Trembling aspen - 50 sph Sitka alder - 200 sph Saskatoon - 50 sph Prickly rose - 50 sph Scoulers willow - 50 sph Huckleberry - 50 sph	Lodgepole pine - 1190 sph Douglas fir - 510 sphh Consider underplanting with later successional species in future.	2012	2014	2014	-	2014	2015	2015
Waste Haul Road	Heli Pad Area	1.53	Wildlife, forestry	Old Cariboo Stockpile/ Springer Pit	3,825	28	18-19-18 Fertilizer (170 kg/ha)	Aggressive seed mix (26 kg/ha) (hydroseeded)	Monitor natural vegetation ingress	Douglas fir - 216 sph	-	2013	-	TBD - monitor ingress	2014		2015
	Above WHR (Pond Zone)	1.81	Wildlife, forestry	Old Cariboo Stockpile/ Springer Pit	5,456	30	None	Native grasses/forbes (22 kg/ha)	Monitor natural vegetation ingress		-	2013	-	TBD - monitor ingress	2013		
East RDS	Highway to Heaven	11.52	Wildlife, forestry	2014: Direct Placement: Cariboo Ore Stockpile, WX Zone Stripping 2015: Highway to Heaven	2014: 26,700 2015: 8,200	40	None	Native grasses/forbes (30 kg/ha)			2014 - 9.47 ha	2014 - 6.58 ha	-	TBD - monitor ingress	2014		
	Tree Plots[2]	2.13	Wildlife, forestry	Bell Pit Stockpile	Not Calculated	0 - 65	Amendment Tested: Fertilizer (RTI Bio Pack's, 10g/bag) Biosolids (50 - dt/ha) Tailings (20cm)	Domistic grasses (20kg/ha - 40 kg/ha) Native grasses/forbes (40 kg/ha) - two different mixtures	-	Lodgepole pine - 1400 sph Douglas fir - 600 sph	2000	1998 - 2000	1998 - 2000	-	1998 - 2000	-	1998 - 2000
	Above Access Road	3.78	Wildlife, forestry	Direct Placement: TSF Rd Stripping (Bootjack Creek), Cariboo Ore Stockpile, WX Zone	9,000	25	None	~ 0.75 kg/ha lupine ~2 kg/ha june grass, yarrow, pearly everlasting mix ~35 g/ha Fireweed (~1 ha on eastern side only) Remaining area: Native grasses/forbes (30 kg/ha)			2011	2014	-	TBD - monitor ingress	2014		
		23.95	Wildlife, forestry, In	South Till Borrow	N/A	N/A	Biolids - 12.00 ha	Unknown			Unknown	N/A	Unknown	-	Unknown		
NEZ Dump	Parcel 2 (a/b)	5.13	Wildlife, forestry	Wight Till	20,000	40	2a: fertilizer (238 kg/ha) 2b1: biosolids 2b2: fertilizer (71 kg/ha), biosolids	Native grasses/forbes (handseeded) 2a: 45 kg/ha 2b: 34 kg/ha	Paper birch - 100 sph Trembling aspen - 100 sph Black cottonwood - 200 sph Sitka alder - 100 sph saskatoon - 100 sph wood rose - 100 sph Willow live stakes - 40 sph	Lodgepole pine - 1300 sph Douglas fir - 700 sph	2010	2010	2010	-	2011	2012	2012
Boundary Zone	Boundary Dump	4.70	Wildlife, forestry	PAG Dump Stripping	12,000	28	None	Monitor growth from direct placement and natural ingress (monitor invasive species establishment)			2011	2014	-	TBD - monitor ingress	Monitor growth from direct placement and natural ingress		

Notes:

1) Native grasses/forbes: mountain brome, native red fescue, Rocky Mountain fescue, wheat grass - blue bunch, blue wild rye, june grass, tickle grass, fireweed.
Native grasses: mountain brome, native red fescue, Rocky Mountain fescue, wheat grass - blue bunch, blue wild rye.
Aggressive seed mix: dahurian wildrye, slender wheatgrass, perennial ryegrass, timothy

2) Refer to summary reports on the tree plots for detailed information on the treatment units and research design

4.3. Reclamation Research Program Update

The reclamation research program at Mount Polley commenced in 1998. Since this time, many research trials have been established at various locations on the site. Progressive reclamation sites also act as research tool, and indicate which treatments and vegetation strategies are most successful.

4.3.1. *Wildlife Monitoring*

Given that creation of wildlife habitat is one of MPMC's primary end land use objectives, observing wildlife usage on and around the mine site (particularly on reclamation sites) is important for monitoring reclamation success. This wildlife monitoring program was initiated in 2011 and will continue throughout the mine life and closure, and will become more robust as MPMC's Biodiversity Management Plan (a component of the TSM Biodiversity Protocol discussed in Section 3.1.3) is developed and implemented. Considerations of local species at risk, documented pre-mining wildlife presence, and creation of varied wildlife habitats will be incorporated.

Table 4.2 summarizes the 269 wildlife sightings recorded in 2014; while the number of reported observations is only a fraction of actual observations and wildlife use, these observations do document the species present, and suggest regular use of the site by wildlife. Note that groups of animals reported (such as schools of fish or flocks of ducks) are documented as a single observation. Bird species observed included bald eagles, red tailed hawks, osprey, grouse, barn swallows, and kill deer. Insects include bees, butterflies, caterpillars, water striders, and water beetles. Table 4.3 includes some generic observations such as "Bird", "Eagle" and "Fish"; these entries refer to sightings with no positive species identification. Two species at risk documented for the area (Appendix A) were observed: the great blue heron (*Ardea Herodias*) and the Western toad (*Anaxyrus boreas*).

Table 4.3 2014 wildlife observations at Mount Polley Mine

	On Site		Surrounding Area	
Wildlife Observed	**Number Of Observations**	**Tracks/Scat Observations**	**Number of Observations**	**Tracks/Scat Observations**
Bald Eagle	11			
Beaver	1			
Bird	3			
Black Bear	72	5/4		
Blue Heron			1	
Bobcat	1			
Bumble Bee	1			
Butterfly	2			
Catepillers	1			
Common Merganser	1			
Coyote	4	6		
Deer	15	4		
Duck	13		1	
Eagle	2			
Fish	4			
Fox	1		1	
Frog	4			
Frog/toad	3			
Garter Snake	2			
Geese	1			
Goose/Duck	1			
Grizzly Bear	1			
Grouse	2			
Hawk	5			
Killdeer	1			
Loon	2		3	
Lynx	5	4	2	
Marten	2			
Moose	17	5/1	5	1
Muskrat		Muskrat hole		
Osprey	3			
Rainbow Trout	12		1	
River Otter	1	4	1	
Sandhill Crane	2			
Seagulls			1	
Snowshoe Hare	7		1	
Spider	1			
Squirrel	1	1		
Swallow	2			
Tadpoles	1			
Water Beetle	1			
Water Striders	5			
Weasel	2			
Wolf	3	1	1	1
Wood pecker	1			

4.3.2. *Tree Plots*

This first site reclamation trial focused on the reclamation of the tops and slopes of the East RDS. In 1998, 25 plots, each 15 square metres (m^2), were established on the top of the East RDS to test the response of grasses and tree seedlings to various thicknesses of soils, the use of fertilizer and various concentrations of biosolids. In 1999, an additional 11 plots were added to the overall configuration, to repeat some of the prescriptions as well as test the use of tailings as an amendment to the growth medium. In 2000, a total of 12 plots were created on the re-sloped surface between the 1,170 masl and 1,150 masl platforms of the East RDS. These plots tested various soil thicknesses as well as the use of biosolids in a similar manner to the 1998 and 1999 plots.

Every year between 1998 and 2001, then in 2006, 2007 and again in 2012, the trees in each plot were monitored for parameters including total height, leader height, diameter at breast height or base, and vigour. In each study year, this data was collated and presented in a report written by Ron Meister, RPF, P.Ag. (Forestmeister Services). The 2007 report was appended to the *2008 Annual Environmental and Reclamation Report*, and the 2012 report has been included as Appendix E. Key findings to date are:

- Soil placement of 15 cm is adequate for tree survival and growth, but growth is significantly improved in soil depths of 40 cm or greater.
- Fertilization with tea bags improved survival, but did not have a lasting effect on tree growth parameters.
- Soil amelioration with biosolids improved tree growth, but has a limited period of effect.
- Seeding areas with grasses when biosolids are used reduces tree survival, likely due to competition from increased grass growth when seedlings are trying to establish.
- The seedling mortality rate is high, likely due to the exposed locale and harsh climate.

Recommendations based on these results are:

> "At this stage of the research, the reclamation recommendations assembled from current data would be a minimum soil amendment of 40cm with light addition of biosolids (50 to 75dT/ha) with a light seeding (5 -10kg/ha) of low-growing, non-competing species of grasses and forbs (bias towards native species). Care is required in re-vegetation choices both to minimize vegetation competition and to accomplish erosion and noxious weed control. The addition of coarse woody debris to the site (20 to 40 m^3/ha) is also recommended, as science (Timberline Forestry Consultants Ltd, 2006) increasingly indicates its importance in maintaining healthy ecosystems."

In May 2014, cross sections of select trees in representative plots were excavated to assess soil development and root growth. Findings from this study conducted by Ruth McDougall, P.Ag., are presented in Appendix F. Key findings were:

- Root systems of trees planted directly into waste rock with no amendment (overburden or biosolids) are very small and poorly developed. This is clearly not a suitable growing medium for conifers.

- Waste rock does not appear to be a physical or chemical barrier to tree root growth. On several plots tree roots extended well into the waste rock. It seems to be the lack of moisture and nutrients in the waste rock that discourages root growth.

- Overburden is the preferred rooting medium for the trees on site. Trees planted on sites with 25 cm or more of overburden had roots primarily in the overburden. Tree roots exploited the whole depth of overburden, even at the deepest depth of 65 cm. Trees planted on sites with 15 cm of overburden had roots throughout the overburden and extending 10 to 15 cm into the waste rock below. This suggests that the trees on site required a minimum rooting depth of 25 to 30 cm for normal root development and that this can be provided by overburden or a combination of overburden and waste rock.

- Tailings in combination with overburden and biosolids also provided an excellent root growing medium, equivalent to overburden. Trees utilized the whole depth of overburden and tailings for root growth. It is not known whether tailings without biosolids and/or overburden would be an equally good rooting medium.

- Biosolids are also very effective at enhancing rooting of trees. If overburden is unavailable, biosolids at a minimum of 50 dry t/ha provide a similar degree of rooting enhancement as does 15 to 30 cm of overburden.

- There was no difference in root abundance and size (with the obvious exception of trees on control plots) with differing depths of overburden, between tree species or on flat versus sloping waste rock. Amendment with biosolids may have produced slightly increased root abundance and size. Amendment with tailings may have produced slightly increased root abundance and roots of smaller size than overburden alone; this plot was also amended with biosolids which may have contributed to the enhanced rooting.

- Amendment with biosolids appears to enhance the development of the surface layer, but also increases grass growth which has potential to cause higher tree mortality.

4.3.3. *Tailings Beach*

Starting in 2002 and continuing through 2004, there was also an attempt to grow grass on the tailings beach while the mine was in a care and maintenance period and the mill was not operating. Through visual observations, Mount Polley personnel noted vegetation growing on the beach in the spring and summer months of 2002. It was believed that this was due to the manure from the cattle that grazed in the area during this period, combined with native seeds blown onto the beach from the surrounding areas. To test if grass could grow on the tailings beach under these conditions, but with a greater concentration of seed spread across the area, a typical grass seed mixture was purchased and spread across approximately 8 ha of the beach at the northeast corner of the TSF. Germination following the 2002 winter seeding program was observed in spring in 2003. No formal research was conducted at this site, but photos were

collected in 2003 and 2004 to document the successful growth. This information may be useful for the future reclamation of the TSF surface.

4.3.4. *Anaerobic Biological Reactor*

The Anaerobic Biological Reactor (ABR) was a pilot passive water treatment system constructed at the Mount Polley site in 2009 in partnership with the Genome BC project. The objective of the ABR was to reduce elevated parameters in mine effluent through microbial activity to concentrations appropriate for discharge into the natural environment. Throughout operation of the pilot system, ABR water quality results continually informed modifications to system design. The ABR was decommissioned in 2015 to allow for expansion of the TSF buttress; however, this pilot project has provided a number of useful research findings, which may be applicable to development of the site long-term water management plan.

Results indicate that the ABR was capable of treating dam-filtered toe drain water to meet BC water quality guidelines for aquatic life at the outflow of the ABR for all water quality parameters except sulphate. Results suggest that in the reducing environment at the bottom of the ABR and through the water column in winter when the ABR is covered with ice, sulphate reducing bacteria are reducing sulphate to sulphides; however, a lack of iron or other metals for sulphides to complex with results in re-oxidation to sulphate upon contact with oxygen at the outflow. The lack of available iron may also have resulted in an increase of phosphorus through the system, because under anaerobic conditions, iron bound to phosphorus in the bottom sediments is reduced and becomes soluble. The soluble iron is then available to complex with sulphides that are present, while phosphorus remains in the water column.

Recommendations to improve sulphate reduction in future passive treatment projects are to:

- Create a cover or similar to prevent oxygen from entering the system, creating an anaerobic environment year-round to promote activity of suphate reducing bacteria.
- Allow addition of iron into the system (or use influent water sources with elevated iron levels). This is expected to provide more metal ions to bind to sulphides, preventing re-oxidation into sulphate.

A report detailing construction, modifications, and results through 2014 is provided as Appendix G.

4.3.5. *NEZ Dump*

In 2010, 6.8 ha of the NEZ Dump were re-sloped. Reclamation research was initiated on 5.1 ha of this eastern aspect site. Three reclamation treatment units were established to determine the effectiveness of different soil treatments, seeding rates, and fertilizer rates for re-vegetation. A third party consultant completed formal transects of this research project in 2013 to assess re-vegetative success, including ingress of unplanted native species; however, due to extenuating circumstances, the report has not yet been completed. Refer to Appendix H for descriptions of each treatment unit and results from the 2012 assessment. No assessment was completed in 2014. MPMC plans to complete another assessment in late fall 2015.

The primary finding from this research to date indicates that a seeding rate of 34 or 45 kg/ha results in ground cover out-competing planted trees and shrubs on reclamation parcels where soil nutrient amendments (fertilizer and biosolids) are used, even when the seeded species are native grasses and forbes. Further, a heavy ground cover provides habitat for voles, which have been observed to girdle and kill planted seedlings.

4.3.6. *North Bell Dump*

In 2011, 11.6 ha of the NBD (Parcels 1 – 10) were re-sloped and re-vegetated. A manufactured soil of biosolids, till, and rock (1:2:1 by volume, respectively), was applied to the site. This ratio was designed by SYLVIS (retained by Metro Vancouver, provider of the biosolids) who were designated as the Qualified Professionals overseeing the project. The area was seeded with a native species grass mixture.

In 2012, biosolids reclamation continued with Phase 1 (Parcels 11 – 13) and Phase 2 of the NBD (Parcels 17 – 19) with a total area of 5.0 ha. Till was also cast over a 2.2 ha area along the dump toe, which was left at the angle of repose to maintain permit disturbance boundaries. All areas were seeded with a native grasses and forbes seed mixture.

In 2013, Parcels 1 – 10 and the South Triangle were planted with deciduous native tree and shrub species; however, survival was poor due to unfavorable weather conditions. An additional 2.34 ha of the sloped rock dump was reclaimed with a manufactured soil incorporating biosolids as part of a joint research project with Metro Vancouver. This trial was implemented to test alternative biosolids application methods, and re-vegetation prescriptions that promote primary succession of shrubs and trees, with these trees and shrubs not being out-competed by dense grass growth (caused by the biosolids nutrient flush).

In 2014, the Metro Vancouver biosolids trial was planted, and a second duplicate trial established on an area of the NBD with western aspect. The trial implemented the previous year was on a northern aspect slope. Re-planting of Parcels 1 – 10 and the South Triangle took place.

Recommendations for future reclamation based on findings to date include:

- Hand-seeding is as effective as hydroseeding for re-vegetation, and is more cost effective.
- During the design phase, the reclamation surface should be constructed with access for equipment, to prevent the need for improvised road construction, which causes soil compaction. Any access roads should be ripped up and seeded as reclamation activities conclude. Slopes should also be designed with consideration of equipment constraints, and the inability to “push” soil long distances.
- Conduct surface roughening and application of coarse woody debris to create more diverse microsites and help dry waste rock dumps retain moisture.
- Tree and shrub survival and success are better on parcels without extensive ground cover; this ground cover provides competition for moisture and nutrients. On plots where biosolids or soil nutrient amendments are incorporated, decrease application

rates of native grass and forbe seed mixes to less than 30 kg/ha mixtures. Monitor results from the Metro Vancouver research trials for selection of ground cover species that compete less with tree and shrub growth.

- Continue to monitor presence of invasive species closely, and implement treatment programs as necessary.
- Continue the tree and shrub planting program to promote development of early successional stages of forest development. Creation of a shade and overstory will help out-compete invasive species.

Refer to Appendix I for a detailed summary of reclamation on the NBD, and results to date, and Appendix J for a progress report by Metro Vancouver on the biosolids trials.

4.3.7. *Trace Elements in Soils and Uptake in Vegetation*

Metal content in soil was evaluated as part of a soil stockpile quality assessment completed in September 2013 (refer to Section 5.3 for more information). Metal levels of the 23 soil stockpiles sampled are compared with available guidelines in Table 4.4. Guidelines were only exceeded for copper; however, baseline samples of soil test pits in 1995 had an average copper concentration of 350 ppm, indicating that soils in the area naturally have elevated copper levels.

Assessment of metal concentrations in soils constructed from biosolids and MPMC overburden were completed by Sylvis during 2011 and 2012 NBD reclamation to ensure the Organic Matter Recycling Regulations guidelines for agriculture (the most stringent category) were not exceeded (Sylvis 2012). Mixing ratios that were designed through this research (or more conservative ratios) continue to be used on site. Salvaged soil used in future reclamation projects (even when biosolids are not being incorporated) will continue to be analyzed for metal content prior to use.

Table 4.4 Comparison of 2013 soil stockpile sample results with soil guidelines for metal levels

Parameter	Canadian Soil Quality Guidelines	BC Contaminated Sites Regulation Guideline	Average Soil Stockpile Concentration (ppm)	Number of Sample Exceeding the Guideline
Copper	63		58.4	7
Zinc	200		5	0
Boron	2		0.2	0
Manganese		1800	55.8	0

In an ongoing research project initiated in 1989, vegetation (various grass, legume, and shrub species that may be foraged by cattle and wildlife) is sampled and analyzed for metal content. This work is conducted to investigate if vegetation growing on reclamation sites at the mine has different levels of metal uptake when compared with baseline and reference site data, and assess if elevated metal levels (if encountered) are of concern for grazing or wildlife species.

The conceptual vegetation metal uptake monitoring plan for reclamation areas at closure discussed in Section 7.4.2 presents data collected in baseline monitoring programs in 1989,

1995 and 1996, and from reclamation areas in 2007, 2012 and 2014. These data are currently being used in work that is being conducted by Golder in the Human Health and Ecological Risk Assessment for the tailings dam failure, which will establish an acceptable concentration range for metals in vegetation in the Mount Polley area to enable a streamlined data evaluation process moving forward.

4.3.8. *Hazeltine Creek Terrestrial Rehabilitation*

Following the tailings dam failure, rehabilitation of terrestrial ecosystems impacted along the Hazeltine Creek corridor is planned (Golder 2015c). While this area is being reclaimed as per the Pollution Abatement Order issued to MPMC, and is outside the scope of this Plan, findings from this reclamation work will likely help inform reclamation methodologies for the Mine site. Planned approaches include new techniques for the Mount Polley site, such as soil transfers, potential use of commercial miycorrhizal inoculums, and fall tree planting. This work is currently in the planning phase, but reclamation monitoring results will provide useful feedback for general reclamation techniques to be used at site, as well as specific recommendations for reclamation of the tailings in the TSF at closure.

MPMC is also working with Thompson Rivers University and the University of British Columbia on a research project in the area downstream of the tailings dam failure that is using genomics to assess the role of wetlands and riparian soils in tailings reclamation. The study will track soil microbial communities and soil chemistry in monitoring locations throughout the watershed, and in established bioaugmentation plots, which incorporate combinations of straw, wood chips, and sulphate reducing bacterial inoculums, as well as different mixing treatments. Results from this project will provide insight into potential techniques for reclamation of the tailings in the TSF at closure.

5. RECLAMATION STRATEGIES

To promote successful reclamation of the mine site, MPMC has (or is in the process of developing) reclamation strategies and approaches regarding:

- Physical stability;
- Water quality and watercourse protection;
- Soil management;
- Re-vegetation prescriptions; and
- Invasive species management.

Plans and protocols in place or under development related to these areas are described in the following subsections.

5.1. Physical Stability

5.1.1. *Waste Dump Stability*

Consideration of physical long-term stability of RDSs begins prior to dumping of waste rock, is continued through the construction phase, and is completed when reclamation techniques are implemented. A chronology of events to ensure this stability is as follows:

- A Qualified Professional conducts a footprint stability assessment to determine if any special construction techniques are required to ensure the long-term stability of the RDSs.
- The soft organic soils within the footprint of the RDSs are removed and stockpiled, so that they can be used for reclamation once use of the disposal site is complete. By removing the soft organic materials prior to dumping, the stability of the site will be improved, as the waste dump will be constructed on more solid materials such as tills and bedrock.
- When the RDSs are under construction, a Qualified Professional conducts annual visits to determine if the construction technique being utilized will ensure long-term stability.
- When the RDSs are complete, they are re-sloped from an angle of 37º to 26.5º (from the angle-of-repose to a slope ratio of 2:1).

Greater long-term physical stability can be achieved at locations where excavated pits are back-filled with waste rather than RDSs being constructed on flat to gently sloping terrain. This is the case with the NBD over top of the Bell Pit, and the SERDS over top of Pond Zone and SEZ Pits.

5.1.2. *Pit Wall Stability*

During the excavation of the pits, stability of the surrounding surfaces and pit walls is a priority, as this is necessary for the safety of the mine workers. As a result, there will not be many steps required upon completion of the pits to ensure its long-term stability. A chronology of events to ensure this stability is as follows:

- The pits are excavated with wall angles that have been discussed and agreed to with a qualified geotechnical consultant. The angle of the walls is be chosen to ensure the stability of the pits throughout the excavation phase, as well as for the long-term stability.
- Prior to the excavation of benches below the top surfaces, all soils and tills are removed and pulled away from the area immediately surrounding the maximum boundary of the pits. This is completed to prevent the continual sloughing of loose materials down the pit walls.

5.1.3. *Road Stability*

The long-term stability of large access and haul roads (that are essentially waste rock dumps) will be ensured using similar techniques as those employed for the RDSs, but will differ in some areas. A chronology of events to ensure this stability is as follows:

- The soft organic soils from within the footprint of the roads will be salvaged and stockpiled, so that they can be used for reclamation once they are no longer required. Through this technique, the stability of the road will be improved, as it will be constructed on harder materials, such as tills and bedrock.
- Culverts that were used in the construction of the road and have potential to affect fish-bearing streams will be removed and water bars will be dug across the roads to continue to facilitate the movement of water past the structure to the downstream slopes.
- When roads are no longer needed, if possible (without encroaching on watercourses or sensitive undisturbed areas), road edges will re-sloped from an angle of 37º to 26.5º (from the angle-of-repose to a slope ratio of 2:1).

5.1.4. *TSF Stability*

The long-term stability of the TSF will be assessed during the design and construction of the facility, as well as through the operational and post-closure monitoring of the embankments and spillway. Measures to ensure this stability are as follows:

- Any geotechnically undesirable material, as determined by the design consultant retained by MPMC, shall be removed from within the footprint of the embankments. Material appropriate for reclamation will be salvaged and stockpiled for use as required.
- All structures are constructed with materials specified by the design consultant retained by MPMC, and are selected, placed and tested in accordance with the construction methodologies outlined in construction monitoring manual(s) submitted by the design consultant and subsequently approved by the MEM.

- Monitoring instruments, including vibrating wire piezometers, slope inclinometers, and ShapeAccelArray, will continue to be monitored as per the OMS Manual. The OMS Manual is a "live" document administered by MPMC, created in collaboration with the retained design consultant, and reviewed by the MEM.
- The TSF is monitored by the qualified design consultant retained to ensure stability is being maintained and to provide changes to the monitoring program, if required:
    - Annually, the TSF is inspected by the qualified design consultant retained, the results of which are included in an As-built Report (based on construction activities) and Annual Review provided to the MEM; and
    - The design consultant retained administers, reviews and approves quality assurance/quality control (QA/QC) in accordance with the construction monitoring manual (approved by the MEM), the yearly results of which are included in an As-built Report (based on construction activities) and Annual Review provided to the MEM.
- MPMC has an Independent Engineering Review Panel (IERP), to whom technical operational developments are presented such that they can provide review and recommendations as necessary. The MPMC IERP is specifically used to review site water management, reclamation and TSF design elements of the Mount Polley Mine.
- An independent geotechnical consultant is hired to conduct a Dam Safety Review of the TSF, scheduled in accordance with the Canadian Dam Safety Guidelines to ensure that the facility is safe and is being maintained correctly. The next scheduled Dam Safety Review is required to be completed by December 2016 under the conditions of the M-200 Permit.
- Upon closure of the mine and TSF, re-contouring of the embankments will proceed as directed by the design consultant. A spillway will also be installed, as discussed in Section 6.1.10, so that the long-term water table will be maintained at a safe elevation.

5.2. Water Quality and Watercourse Protection

To protect water quality and watercourses in the receiving environment, MPMC employs the following approaches:

- Prevention of erosion and sediment into watercourses;
- Collection of potentially mine-influenced contact water;
- Waste rock characterization and management;
- Monitoring of seep and contact water chemistry to improve the understanding of site geochemistry; and

- Water chemistry monitoring of downstream environments to verify if these strategies are working as designed.

These components are described in detail in the following sub-sections.

5.2.1. *Sediment Retention and Erosion Control*

Development of an open-pit mine and associated works creates surface disturbances which may result in erosion. Erosion prevention strategies for construction activities and site reclamation sites are used and sediment control procedures are in place in the event that reactive measures are required. These measures are detailed in MPMC's "Sediment and Erosion Control Management Plan", which is included as Appendix K and is based on available guidance documents and best management practices.

5.2.2. *Material Characterization and Placement*

Active monitoring of ARD potential in the Mount Polley waste rock is part of an established protocol, and encompasses two stand-alone ABA procedures: ARD analysis of diamond drillcore pulps to model a preliminary PAG body; and ongoing ABA determination of individual blasthole samples during mining operations to enhance the segregation of PAG from NAG. The program characterizes all material types that will be handled during the mine life. Analysis is completed on site by Mount Polley's LECO analytical machine, allowing the Mine to best manage mine waste by directing it to suitable storage sites, or to construction usage when required (and if deemed suitable).

Samples with a neutralizing potential ratio (NPR) greater than 2 are considered NAG, and samples with NPR less than 2 are considered PAG. PAG material is currently stored in the Temporary NW PAG Stockpile.

On each bench, a sample of cuttings is collected from each blast hole and analyzed for total copper, non-sulphide copper, iron, and gold. Blasthole patterns are on average 7.4 m burden by 8.5 m spacing in the Springer Pit and 8.14 m by 9.4 m in the Cariboo Pit. Bench height is 12 m in both Pits. Areas of ore and waste were identified by indicator kriging and assigning assay values, mill head value, etc. using an inverse distance calculation. Ore/waste boundaries are then established based on the calculated mill head values. In areas of known NAG, the waste tonnage in each blast is divided by 40,000 in order to determine the number of ABA samples to be submitted (i.e., one per 40,000 t of waste). However, in areas of PAG, (or where NAG and PAG may coincide), the sample density is doubled to one per 20,000 t. This helps to determine NAG/PAG boundaries, and provides a more robust dataset for the PAG.

As of 2015, this monitoring program now includes sampling of any ore that will be stockpiled at a frequency of one per 20,000t. As required by the July 9, 2015 Permit M-200 amendment condition, MPMC retained SRK Consulting (SRK) to conduct an assessment of metal leaching and ARD potential from ore stockpiles for October 31, 2015 (Appendix C). Findings indicate that:

- The ore stockpiles have low ARD potential. It is not expected that acid conditions will develop in the stockpiles in the long-term should they not be processed.
- Some differences between stockpiles were apparent (for example, the lower sulphide content of the high oxide stockpile), but the bulk characteristics of the stockpiles are generally not significantly different from waste rock at the site with the exception of copper content, which is elevated in the ore stockpiles.
- Contact water chemistry for the ore stockpiles is expected to be similar to waste rock with both being pH basic and chemistry controlled by secondary gypsum, primary calcite, iron oxides and copper oxides. Selenium may be more leachable from the ore stockpiles than waste rock dumps, though this depends on the mineralogical association of selenium.
- The presence of leachable selenium is a consideration for processing of the stockpiled ore. Operating conditions may result in a flush of selenium into process waters.

As an additional QA/QC measure required by Permit M-200, the Environmental Department takes random weekly grab samples from the NAG waste dump when PAG is being mined to verify that waste is being appropriately characterized and handled.

Mine planning is carried out such at that the open pits have sufficient capacity that PAG material can be re-handled into the open pits and stored subaqueously at closure (Section 6.1.7.1).

5.2.3. *Water Quality Monitoring*

An important component in determining long-term chemical stability of drainage from the pits and waste rock dumps is water quality monitoring. These data help in developing long-term water quality projections. Seepage and runoff monitoring locations monitored by MPMC, sampling periods, and sampling frequencies (at the time of publication of this Plan) are provided in Table 5.1. Furthermore, since spring 2013, MPMC has conducted bi-annual seep surveys of all waste rock dumps on site, with representative seeps being monitored monthly. Locations sampled include the:

- Temporary NW PAG Stockpile;
- Waste Haul Road;
- SERDS;
- NEZ Dump;
- East Dump;
- NBD; and
- Boundary Dump.

Additional surface water and groundwater quality monitoring of the receiving environment is completed as per the requirements in Permit 11678 under *the Environmental Management Act*

to verify that the water management strategy in place is sufficiently protective of the receiving environment. All sample locations are shown in Figure 5.1. Sampling and QA/QC procedures follow those described in the "British Columbia Field Sampling Manual for Continuous Monitoring plus the Collection of Air, Air Emission, Water, Wastewater, Soil, Sediment, and Biological Samples" (MoE 2013) and the MPMC "Environmental Department Quality Assurance/Quality Control Manual".

Water quality information is supplemented by other monitoring required under Permit 11678:

- Hydrological monitoring, including groundwater static water level readings, staff gauge readings, flow monitoring, and continuous pressure transducer data. These data are important inputs into the site water balance. The hydrological monitoring program also includes hydrological monitoring of the site water collection system as outlined in the OMS Manual, as well as receiving environment sites (W1b, Morehead Creek; W4a, North Dump Creek; W5, Bootjack Creek; and W12, 6K Creek).
- Meteorological data collection (these data are used to maintain the site water balance).
- Monitoring of receiving environment lakes, including water quality samples, secchi disk readings, and lake profiles.
- Receiving environment aquatic effects monitoring programs, in particular those associated with authorized water discharges under Permit 11678 and the federal Metal Mining Effluent Regulations.

Monitoring results are compiled and analyzed each year and submitted in MPMC's Annual Environmental and Reclamation Report. Results provide important verification that mine water management and discharge systems are functioning as designed and not causing adverse impacts on the receiving environment. Readers are referred to the most recent version of this Annual Environmental and Reclamation Report to review results.

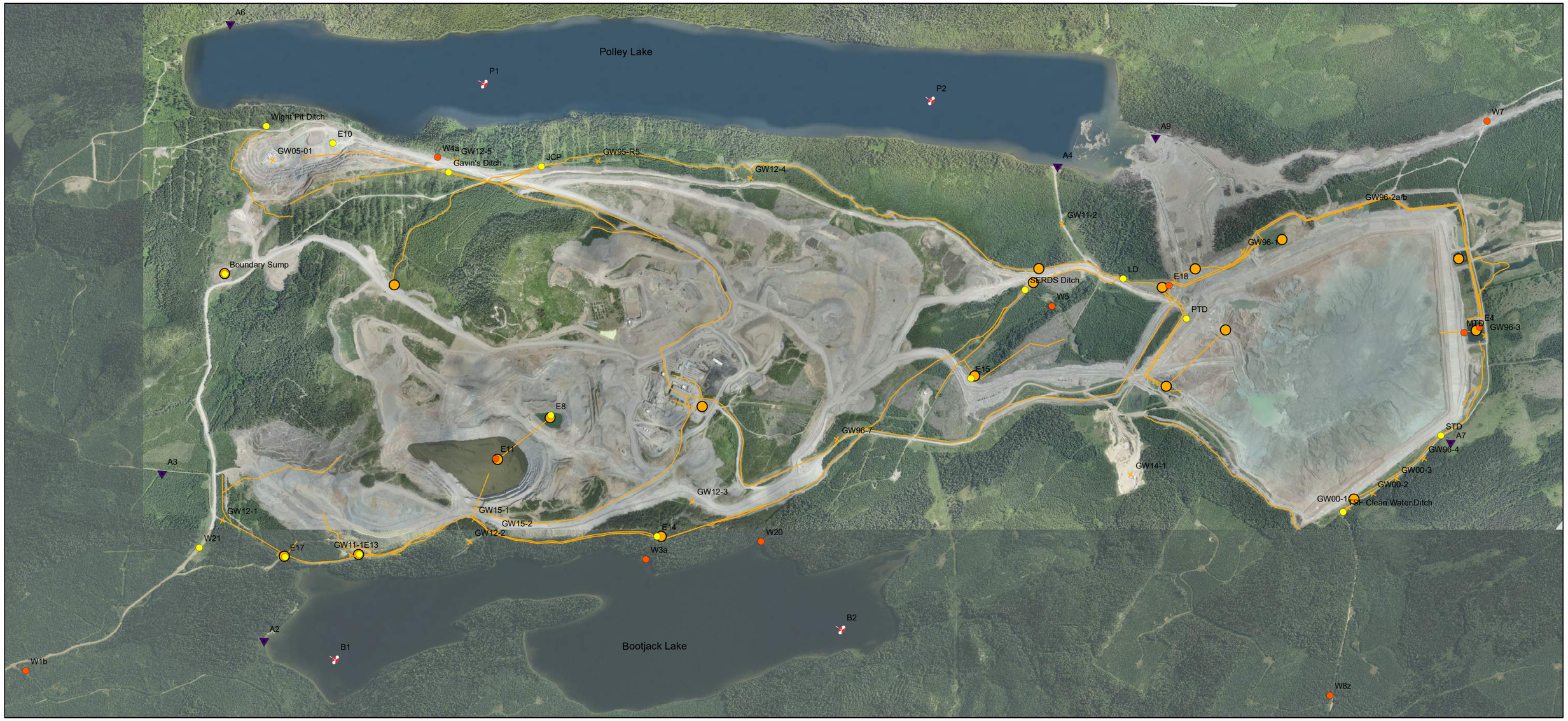
Monitoring programs are updated annually, as required by Permit 11678, with third party Qualified Professional reviews occurring every three years. Updates to monitoring plans are reported each year in the Annual Environmental and Reclamation Report, and are also incorporated into OMS Manual updates.

Note that monitoring of areas of the receiving environment impacted by the tailings dam failure, including Polley Lake and Hazeltine Creek, is also ongoing, but is reported on in post-event environmental impact assessment and risk assessment reports required under the Pollution Abatement Order.

Table 5.1 Mine site drainage water quality monitoring program

Sample Location	Drainage Area	Sampling Period	Current Sampling Frequency
Cariboo Pit Sump (E8)		1997 – current	Bi-annually*
Wight Pit (E10)		2006 – current	Bi-annually
Pond Zone Pit Sump (E12)		2010 – 2012	N/A
Springer Pit (E11)		2011 – current	Bi-annually
Boundary Pit		2012 – current	Bi-annually
Joe's Creek Pipe	NBD seep	2010 – current	Monthly
Long Ditch	East RDS, NEZ Dump, SERDS, Wight Pit dewatering	2008 – current	Monthly
SERDS Ditch	SERDS, West Ditch, MDC Sump	2012 – current	Monthly
NW Sump (E13)	Temporary NW PAG Stockpile	2012 – current	Monthly
Mine Drainage Creek Sump (E14)	Upper Mine Drainage Creek, Springer Pit dewatering, West Ditch	2013 – current	Monthly
Bootjack Creek Culvert Sump (E15)	TSF Haul Road, Upper Bootjack Creek	2013 – current	Quarterly
9km Sump (E17)	Temporary NW PAG Stockpile	2014 – current	Monthly
TSF Supernatant (E1)	Tailings slurry, seepage collection ponds	1997 – 2014	N/A
MESCP (E4)	MTD, STD, Main Embankment foundation drains	2001 – current	Quarterly
PESCP (E7)	Long Ditch, SERDS Ditch, PTD	2001 – 2014	N/A
Central Collection Sump (E18)	Long Ditch, SERDS, Ditch, PTD, MESCP, South Embankment Seepage Collection Pond	2014 – current	Monthly
East/West Main Toe Drains (MTDs)	TSF Main Embankment toe drains	1998 – current	Monthly
Perimeter Toe Drain (PTD)	TSF Perimeter Embankment toe drain	2009 – 2014	N/A
South Toe Drain (STD)	TSF South Embankment toe drain	2011 – current	Quarterly

*when water from other sources is not being pumped into the sump



- Permitted Surface Water Sites
- Supplemental Surface Water Sites
- Lake Sites
- Groundwater Sites
- Dustfall Stations
- Water Collection Infrastructure

0 375 750 1,500 2,250 3,000 Meters

N

MOUNT POLLEY MINING CORPORATION

Figure 5.1
Environmental Monitoring Locations

Drawn by: KM
Date: 30/09/2015

5.2.4. *Long-Term Effluent Quality and Quantity Predictions*

MPMC's water collection system for runoff from waste rock dumps, roads, and other disturbed areas within the Mine's footprint that could affect the receiving environment water quality, along with current and planned methods of treating and discharging the water collected, is detailed in Section 2.4.1.

A key component for long-term water management planning, and development of the long-term water management plan described in Section 2.4.3.3, is projections of closure effluent quality and quantity. MPMC has retained Qualified Professionals to project long-term effluent chemistry and quantity for the Mount Polley Mine site into closure. SRK developed scoping level source terms for mine components, including waste rock dumps, ore stockpiles, re-handled PAG material, pit walls, and tailings (saturated and unsaturated). Golder incorporated these source terms into the GoldSim™ model that has been developed for the Mount Polley Mine site. This model, incorporating water quality and water balance components, was adapted to represent closure conditions, and generate probabilistic flow and pit filling rates, along with water chemistry results for site water collection system components at closure (immediately following closure, when reclamation work is ongoing) and in post-closure (following reclamation work).

In the model previously developed for closure predictions following the one year restricted operations phase, concentrations of most constituents were projected to decrease in the pits and in the TSF over time. Through comparisons with Metal Mining Effluent Regulation limits and BC maximum water quality guidelines for aquatic life, copper in the Springer Pit and iron in the Wight Pit, Cariboo Pit and the TSF were identified as constituents of potential concern in the long-term closure period. Results and recommendations for refining this model are presented in Appendix L.

An update to this model was prepared in the context of extending the mine life to the four year mine plan and is also provided in Appendix L. With respect to water quality, the following elements were evaluated quantitatively and semi-quantitatively to determine potential changes from the water quality predictions prepared for the closure after restricted operations scenario:

- The Springer and Cariboo Pits will be larger, which will result in larger pit wall exposures and longer subaerial exposure periods;
- More PAG material will be stored at the surface during operations and closure and deposited into the pit at closure; and,
- The PAG material stored at surface will be subaerially exposed for a longer period.

Findings indicate that many constituent concentrations are higher in comparison with the previous post-closure predictions; however, remain consistent with the restricted operations model in that only copper was identified as a potential constituent of concern in the post-closure period. Since development of the model closure after restricted operations scenario, sampling of Mill process water by MPMC has been conducted, allowing for a reduction in related uncertainties in the model. This is further described in Appendix L.

Verification of the water balance effluent quantity predictions since the tailings dam failure (when major changes to the tailings dam failure occurred) was carried out in October 2015. The technical memo prepared by Golder is also provided in Appendix L.

5.3. Soil Management

MPMC has developed a Soil Management Plan (Appendix M) which includes protocol for soil salvaging, stockpiling, and use in reclamation. To collect information for developing the Plan, and to guide future reclamation practices, a comprehensive quality assessment of site soil stockpiles was completed in September 2013. Results are appended to the Soil Management Plan. The Soil Management Plan was reviewed by a third party consultant, Moss Giasson, P.Ag., of Montane Environmental Services.

5.3.1. *Soil Stockpile Inventory*

Refer to Table 5.2 for the site soil stockpile inventory (updated as of September 2015), and Figure 5.2 for the locations of all site stockpiles and projected stripping. Excluding areas that already have soil applied to them, ditches and hydro right-of-ways, the TSF surface, and the open pit walls/projected pit lake areas (which will not be reclaimed), the total projected disturbed area of the mine at closure will be 713.78 ha. Based on the 1,468,882 m^3 of soil stored on site, there is enough material to reclaim all disturbed areas using approximately 21 cm of soil to all disturbed areas. This is a conservative estimate of soil that will be available for reclamation, because a total of 31.59 ha of area is projected to be disturbed during the four year mine plan. Based on the data collected in the soil and landform inventories described in Appendix A, 187,760 m^3 is projected to be salvaged from these new disturbed areas, resulting in a total of 1,656,642 m^3 of soil (sufficient to reclaim projected disturbed areas at closure with 23 cm of soil).

If the TDAR is constructed, an anticipated 7.07 more ha of area will be disturbed. Using soil survey data, an estimated volume of 35,350 m^3 of soil will be stripped from these areas, which is sufficient for reclamation of this area. The soil stockpile inventory and disturbed areas will continue to be updated each year in the Annual Environmental and Reclamation Report.

Table 5.2 Soil stockpile inventory (as of September 2015)

Stockpile Name	Location	Soil Volumes (m^3)	Year Established	Source of Stockpiled Soils	Stockpile Depth (m)
TSF Corner 1 - Windrow	TSF Corner 1	5,100	1995	New Corner 1 construction	1.5
Upper PAR - Windrow	Along upper PAR	1,700	2015	PAR Road stripping	1.5
Plug - Stockpiles	Polley Lake Plug	37,400	2015	Perimeter Embankment construction/expansion	2.0
Perimeter Pond - Stockpile	Both sides of Perimeter Pond	4,700	2013	Perimeter Embankment construction/expansion	2.0 - 3.0
Till Borrow - Windrow	North of (Perimeter) Till Borrow	34,900	1995	North American Laydown	1.5
Perimeter Embankment - Windrow	Edge of Perimeter Embankment	3,800	2013	Perimeter Embankment construction/expansion	1.50
Main Embankment - Stockpile	SE of Main Embankment	94,612	1995	ME OG, MESCP, Main Till Borrow, ME Basin Liner	2.0
South Till Borrow - Stockpile	Till Borrow Area 1	11,600	2014	Hazeltine Creek Restoration	2.0
	Till Borrow Area 2	65,340	2000	ME Till Core Waste	1.0
Gavin Lake Road - Windrow	Gavin Lake Road (along South/Main Embankment)	24,200	1995	Bootjack - Morehead Connector	0.5
Tailings Reclaim Road - Windrow	Tailings Reclaim Road	36,800	1995	Tailings Reclaim Road	1
TSF Access Road (TAR) - Windrow	Adjacent to TAR	35,000	2013/2014	TAR Stripping	2.0
Mill Site - Stockpile	East of Mill/Admin Building (includes berms)	13,700	1995	Mill Site Area (concentrator & crusher)	2.0
Access Road km 11.5 - Stockpile	Across from NBD Reclamation Parcels 1 - 10	7,500	Unknown	Unknown	2.0
Access Road km 12 - Stockpile	S-SW of Mount Polley Peak (by km 12 on Acces Rd)	83,600	1995	Cariboo Pit stripping	2.5
East RDS - Stockpile	Top of East RDS	92,000	2000	Cariboo Pit Stripping	2.0
Leach Pad - Stockpile	Top of East RDS	2,500	2015	Till deposit below CAR	1.5
Highway to Heaven - Windrow	Highway to Heaven Access Road	16,200	2010/2015	Unknown/Till deposit below CAR	2.0
NEZ Dump Top - Stockpile	Top of NEZ Dump	6,500	Unknown	Unknown	2.0
		25,000	2014	WX Zone, Cariboo Ore Stockpile, PAG Dump	2.0
NEZ Dump Lower - Stockpile	Off Wight Pit Haul Road	57,000	2005 - 2008/2014	Wight Pit/Cariboo Pit Expansion, Cariboo Ore Stockpile, PAG Dump, WX Zone, TSF Settling Pond	1.0 -5.0
Wight Pit Till - Stockpile	Bottom of Wight Pit Haul Rd	47,500	2005 - 2008	Wight Pit	0.0 - 2.0
Wrap Around Road - Windrow	Wight Pit - TSF Connector Road (below NEZ Dump)	101,600	2010	Moved from M1 Stockpile	2.0
North Bell Dump Till - Stockpile	North Bell Dump	164,000	2007 - 2012	Springer Pit	1.0 - 4.0
North Bell Dump Top - Stockpile	Top of North Bell Dump	8,500	2012	Southeast Zone	2.0
Springer North	Between North Bell Dump and Springer Pit	20,000	Unknown	Unknown	1.5
Ore Switchback	Below Cariboo Connector Road	34,500	2011/2013	Ore Switchback/Cariboo Access Road construction	2.0
Northwest Sump Road - Windrow	Northwest Sump Road	7,500	2012	Temporary PAG Stockpile stripping	2.0
PAG Dump - Windrow	Below PAG Dump	30,900	2014	Temporary PAG Stockpile stripping	1.5
SEZ 1 - Stockpile	Top of Old Pond Zone Pit	62,686	2012/2013/2015	Old Cariboo Pit Stockpile/Cariboo Pit expansion/Till deposit below CAR	10.0
SEZ 2 - Stockpile	Top of SERDS (near SEZ - 1)	14,000	2012-2014	Old Cariboo Pit Stockpile/Cariboo Pit expansion	1.5
SEZ-3	Below Co-mingling Project	66,000	2009	SEZ Expansion	2.0
SERDS - Stockpile	Below SERDS Dump	51,000	2012/2013	SERDS expansion	2.0
Lower SERDS - Stockpile 1	Below SERDS Dump	30,930	1995/2014	Perimeter Embankment Stockpiles/Central Collection Sump and TSF settling pond/ TSF breach abutments and foundation	1.0 - 10.0
Lower SERDS - Stockpile 2	Below SERDS Dump	18,514	2015	Perimeter Embankment Stockpiles/Central Collection Sump and TSF settling pond/ TSF breach abutments and foundation	1.0 - 3.0
Lower SERDS - Stockpile 3	Below SERDS Dump	140,100	1995/2014	Perimeter Embankment Stockpiles/Central Collection Sump and TSF settling pond/ TSF breach abutments and foundation	1.0 - 10.0
	Total Volume of Stockpiled Soils	**1,456,882**			



MOUNT POLLEY MINING CORPORATION

Figure 5.2
Soil Stockpile Locations

N

Drawn by: KM

Date: 29/09/2015

0 265 530 1,060 1,590 2,120
Meters

5.3.2. *Soil Use in Reclamation*

5.3.2.1. Soil Amendments

Analysis carried out in 2012 on the research tree plots (established 1998 – 1999), indicated that biosolids significantly increased tree growth and site indices initially, with no difference between 75 dt/ha and 150 dt/ha. It appears the phase of response to biosolids has now passed. For the 2000 research tree plots, biosolids at all application rates had an adverse effect on survival of trees (potentially due to competition from heavy grass growth).

Based on this information and results from progressive reclamation, soil amendment for any soil that has not recently been stripped is recommended. Biosolids should be used at approximately 75 – 100 dt/ha. Areas where biosolids are applied should be seeded at a reduced rate and/or with less competitive species.

If biosolids are not available, assessment of existing site soil stockpiles carried out in 2013 indicates that average nutrient requirements of stockpiled soil are: 52 mg/kg of nitrogen, 13 mg/kg of phosphorus, and 19 mg/kg of potassium, which corresponds to a need for 61.9-15.7-22.5 (nitrogen-phosphorus-potassium) fertilizer at 187 kg/ha.

Alternatively, a longer-term approach to progressive reclamation can be taken, and soil amelioration through establishment of primary successional species (in particularly nitrogen fixing species, such as alder); it is anticipated that this will be successful, but that it will take longer to restore the land capability.

When possible, direct placement of soil and immediate progressive reclamation is pursued to avoid nutrient loss. When direct placement is carried out, no fertilizer or biosolids are incorporated into the soil, unless the material is primarily subsoil.

Additional recommendations for all sites are:

- Incorporate woody debris when salvaging soil and, when possible, lay coarse woody debris on reclamation sites as long-term organic matter and carbon inputs.
- Include nitrogen fixing species in re-vegetation prescriptions (refer to Section 5.4).

Results from ongoing site specific research will continue to provide guidance on when soil amendments are necessary, and what types and quantities to use. This will include long-term considerations, as soil amendments are typically only a short-term nutrient source.

5.3.2.2. Soil Application

Excerpt from the *Soil Management Plan* (Appendix M):

> *Soil placement should only occur under appropriate moisture conditions, as described in the soil salvage section* [Avoid handling soil if it is too wet or dry to prevent degradation of the physical structure. If the soil sticks to the equipment, wait until the soil has dried to a friable state. If the soil is too dry and hard to handle, resembling flour, wait until precipitation wets the soil, altering it to a loose, friable texture]. *Soil should be placed to minimum depth of 15 cm, which has been shown by site research to be sufficient for*

seedling establishment; however, tree growth was shown to improve with increased soil cover up to 40 cm. Thus, when material is available, and especially on undesirable substrates, such as waste rock dumps, soil should be applied at greater than 15 cm. Stockpiled soil quantities and disturbed areas requiring reclamation are to be assessed annually to determine appropriate replacement depths. Progressive reclamation sites and site research projects are to be continually monitored to provide guidance on appropriate soil depths.

Surface roughening and landform design efforts initiated on the NBD are to be continued, and widely applied across the site.

Application of boulders or small rock piles will also continue to be carried out as a method of creating varied habitats on reclamation sites (Table 5.3).

Table 5.3 Methods of habitat creation for target wildlife species in waste dump reclamation

Target Wildlife Species	Habitat Creation	Game Species
Deer mouse	Application of rock piles/boulders and coarse woody debris will provide cover and denning areas.	-
Bushy-tailed Woo drat		-
Northwestern Chipmunk		-
Marten		Trapping
Long-tailed Weasel		Trapping
Ermines		Trapping
Snowshoe Hare		Trapping
Red Squirrel		Trapping
Coyote	Will be attracted to reclaimed waste dumps when ungulates and small mammals occupy the area.	Trapping
Gray Wolf		Trapping
Cougar		Hunting
Red Fox	Will be attracted to reclaimed waste dumps when small mammals occupy the area, and grasses/berries are present. They may den if soft substrates are available.	Trapping
Fisher	Eventual creation of continuous forest habitats, with the availability of carrion, small mammals, insects berries, and mushrooms will attract fishers	Trapping
Lynx	Will be attracted to area as snowshoe hare population increases, as they are very dependent on hares as a food source.	Hunting/Trapping
Black bear	As vegetation is established, they will be attracted to food sources including berries (Saskatoon, raspberries), buds, grasses, shoots and shrubs. Bears will also be attracted by the presence of mammals for prey and carrion.	Hunting
Mule Deer	Planting native shrubs and woody species including willows, red elderberry, Douglas-fir, Western redcedar, and trembling aspen will provide ungulate forage.	Hunting
Moose		Hunting

5.4. Re-vegetation Prescriptions

While ingress of native species into reclamation areas is expected to take place over time, active planting of native vegetation is pursed at Mount Polley to prevent erosion, prevent establishment of invasive species, and initiate the process of natural succession. Establishment of the selected native vegetation begins the processes of nitrogen fixation and accumulation of

organic matter in the soil, provides native seed sources, and begins to create microsites that will in time be appropriate for growth of secondary successional species which may be underplanted or naturally establish from seed sources on adjacent undisturbed areas.

5.4.1. *Species Selection*

To imitate natural succession in the area, reclamation is done with native seeds and plants, and species are selected for reclamation based on early successional species documented in the region, as well as species identified in the baseline vegetation assessment (Appendix A). Input from First Nations consultation (refer to Section 10) and vegetation documented in a traditional use study of the area (Xat'súll and T'exelc 2012) are also considered (Table 5.4).

Because the end land use objectives selected for the site align with pre-mining land uses, native species for the region promote wildlife values (Table 5.3) and development of conifer species used for commercial forestry in the area (Table 5.5). To incorporate the secondary land use of livestock grazing, a native grasses and forbes seed mix developed for use at the Mount Polley Mine by consultant Moss Giasson, P.Ag., (Montane Environmental Services) was checked against recommended native grazing forage species for the area in the British Columbia Rangeland Seeding Manual (Dobb and Burton, 2012) (Table 5.6). Use of an annual groundcover species (for example, fall rye) is being considered for future use at the site to provide erosion control and organic matter inputs in the short-term while trees and shrubs are being developed, without being competitive to the trees and shrubs in the long-term. This would move away from developing grass-covered areas which are not a typical component of regional natural successional pathways.

Table 5.4 Incorporation of traditionally important species into reclamation prescriptions

Species	**MPMC Comment**
Lodgepole Pine	Incorporated into re-vegetation prescriptions
Cedar	A later successional species – underplanting of reclamation sites may be required if natural ingress is not observed
Balsam Fir *(Abies balsamea)*	This species appears to have been incorrectly identified, as it is only present east of the Rocky Mountains
Paper birch	Incorporated into re-vegetation prescriptions
Chamomile	Not native to the area (species introduced and is only found to naturally occur in southwestern BC)
Huckleberry	Difficult to establish, but a trial was planted in 2014
Blueberry	Difficult to establish, consider based on outcome of huckleberry trial
Cranberry	Not documented in the baseline vegetation survey – consider in future reclamation of wet areas
Raspberry	Strong natural ingress observed on reclamation sites
Saskatoon	Incorporated into re-vegetation prescriptions
Elderberry	Natural ingress into reclamation areas observed; incorporation into re-vegetation prescriptions being considered
Wild strawberry	Incorporation into re-vegetation prescriptions to be considered if a seed or plant source is found
Soapberry	A trial plot was planted in 2014
Cow parsnip	Expected to naturally ingress at late stages of natural succession in moist areas
Common juniper	Not native to the area; however, a trial plot was planted in 2015 on a hot dry reclamation site
Kinnikinnick	Not documented in the baseline vegetation survey – a trial is being considered for a dry site if a seed or plant source is found
Falsebox	Expected to naturally ingress at late stages of natural succession in moist areas
Labrador Tea	Consider in future reclamation of non-forested organic site (wet areas)
Devil's club	Expected to naturally ingress at late stages of natural succession in established conifer forests
Yarrow	Included in the forbe mixture used in Metro Vancouver trial plots
Tiger lily	Not documented in the baseline vegetation survey – lake margins reported to grow this species in the traditional use study will not be disturbed by the mine
Wild potatoes	Not documented in the baseline vegetation survey
Mosses	Expected to naturally ingress at late stages of natural succession in moist areas
Fiddlehead ferns	Expected to naturally ingress at late stages of natural succession in moist areas

Table 5.5 BC Forest Development Plan stocking standards (ICHmk3 biogeoclimatic zone)

BGC Classification			Regeneration Guide: Species										Free Growing Guide: Assessment		Free Growing Guide: Min. Height (ii)	
			Conifer						Stocking (i)							
									Target	Min pa	Min p					
Zone	Series	General Site Conditions	Primary	Preferred (p)	Secondary	Acceptable (a)	Tertiary	Broadleaf	(well-spaced/ha)			Regen Delay (Max yrs)	Earliest (yrs)	Latest (yrs)	Species	Ht (m)
ICHmk3	01	Submesic to mesic, poor to rich nutrients	Fd Pl Sx	Fd Pl Sx	Bl Cw[5]	Bl Cw[5]		Act[a] At[a] Ep[a]	1200	700	600	4	9	15	Pl Fd Others	2.0 1.4 1.0
	02*	Subxeric to xeric, Poor to rich nutrients	Fd Pl	Fd Pl		Sx[2]	Bl Sx[2]	At[b]	1000	500	400	7	12	15	Pl Fd Others	1.4 1.0 0.8
	03	Subxeric to submesic, poor to rich nutrients	Fd Pl	Fd Pl		Cw[2] Sx[2]	Bl[2] Cw[2] Sx[2]	At[b]	1000	500	400	7	12	15	Pl Fd Others	1.4 1.0 0.8
	04	Subhygric medium nutrients to mesic rich nutrients	Fd[3] Sx	Fd[3] Sx	Bl Cw[3,5] Pl	Bl Cw[3,5] Pl		Act[a] At[a] Ep[a]	1200	700	600	4	9	15	Pl Fd Others	2.0 1.4 1.0
	05	Subhygric, poor to rich nutrients	Sx[3] Pl	Sx[3] Pl	Cw[3,5] Bl[3]	Cw[3,5] Bl[3]		Act[a] At[b]	1200	700	600	4	9	15	Pl Others	2.0 1.0
	06	Subhygric to hygric, rich to very rich nutrients	Fd[3,4] Sx	Fd[3,4] Sx[4] Cw[3,4,5]	Bl[4] Cw[3,4,5] Pl[4]	Bl[4] Pl[4]		Act[a] At[b] Ep[a]	1200	700	600	4	9	15	Pl Fd Others	2.0 1.4 1.0
	07	Hydric, poor to rich nutrients	Sx[1,3]	Sx[1,3] Cw[1,3,5]	Bl[1,3] Cw[1,3,5] Pl[1]	Bl[1,3] Pl[1]		Act[a]	1000	500	400	4	9	15	Pl Others	1.4 0.8

*Avoid logging

[a] productive, reliable, and feasible regeneration option

[b] limited in productivity, reliability and/or feasibility

[1] elevated microsites preferred

[2] limited by moisture deficit

[3] limited by growing season

[4] risk of snow damage

[5] risk of heart rots

Coniferous Species Codes

Fd- Douglas-fir
Pl- lodgepole pine
Sx- lybrid spruce
Cw - Western redcedar
Bl- apline Fir

Deciduous Species Codes

Act- black cottonwood
At- trembling aspen
Ep- paper birch

Table 5.6 Mount Polley native species grasses and forbes seed mix

Species	% (by weight)	% (by seed count)
Mountain Brome	20	8.61
Native Red Fescue	10	17.81
Rocky Mountain Fescue*	15	28.94
Wheatgrass, Bluebunch*	25	10.76
Blue Wildrye*	25	3.34
Junegrass*	3	17.81
Ticklegrass	1	11.87
Lupinus polyphyllus	0.97	0.07
Fireweed	0.03	0.81

*Forage species

5.4.2. *Prescriptions*

Table 5.7 shows general prescriptions for reclamation of disturbed surfaces on the Mine site, which includes the Mill and explosive sites, waste rock dumps, roads, and the TSF embankments. Specific reclamation considerations for specialized areas, including riparian and wetland areas, are described in Section 6, which individually discuss each reclamation unit at the mine site.

Table 5.7 Mount Polley Mine site general re-vegetation prescriptions

Substrate Type	Groundcover	Trees and Shrubs[4]	
		Deciduous[5]	Conifers
Subsoil or previously stockpiled soil (with biosolids or fertilizer)[1]	Native grasses/forbes[2] (5 - 10 kg/ha) OR Forbe mixture[3] (~5 kg/ha)	Black cottonwood - 200 sph Paper birch - 50 sph Trembling aspen - 50 sph Sitka alder - 200 sph Saskatoon - 50 sph Prickly rose - 50 sph Scoulers willow - 50 sph	Lodgepole pine - 1400 SPH Douglas-fir - 600 SPH Consider underplanting with later successional species (sub-alpine fir, hybrid spruce, and Western redcedar) in future.
Subsoil or previously stockpiled soil (without nutrient amendment)	Native grasses/forbes[2] (30 kg/ha)		
Directly placed stripped material	If native ingress is not sufficient: Native grasses/forbes[2] (5 - 10 kg/ha) OR Forbe mixture[3] (~5 kg/ha)		

Notes:

1) Biosolids research trials started on the NBD will provide insight into ideal low competition groundcover for higher nutrient substrates
2) Native grasses/forbes: mountain brome, native red fescue, Rocky Mountain fescue, wheat grass - blue bunch, blue wild rye, june grass, tickle grass
   Consider use of annual cover crop instead
3) Variation on forbe mixture used in the NBD biosolids research trials:
   75 g/ha fireweed, 1 kg/ha lupine, 113 g/ha Dryas drummondii, 4.9 kg/ha june grass, yarrow, pearly everlasting mix
4) Adjust species composition based on site series in accordance with biogeoclimatic zone site series classifications for moisture and nutrient level
   Increase the proportion of alder, cottonwood and willow on low nutrient sites where a soil nutrient amendment was not applied
5) Consider planting huckleberry, blueberry, common juniper and soopalalie based on trial results

As prescribed in Table 5.7, ground cover vegetation is established (through seeding if necessary) to prevent the establishment of invasive species, prevent erosion, add organic matter to the soil, and, in some cases, fix nitrogen. Planting of deciduous trees and shrubs promotes these same functions, as well as wildlife values and biodiversity. Early seral stage conifers used in the logging industry (lodgepole pine and Douglas-fir) are planted, with climax woody species (Western redcedar, subalpine fir, and hybrid spruce) expected to ingress naturally when microsite conditions are appropriate. If natural ingress is not occurring as projected, these species may also be underplanted on reclamation sites in the future.

Conifer species are planted at a roughly uniform density, while targeting ideal moist, protected microsites. Planting of deciduous tree and shrub species is done in a similar manner, except higher density biodiversity islands can be established in occasional depressions that retain water and nutrients.

Fall seeding has been successful on site, while tree and shrub planting in the spring is more favourable than planting in the summer. Fall tree and shrub planting may be a viable option, with result from Hazeltine Creek rehabilitation fall planting to inform future planning. Hand seeding has been shown to be more cost-effective compared to hydroseeding, with equally successful results.

These prescriptions will be slightly adapted in areas identified to be reclaimed with livestock grazing as a secondary end land use objective. These areas will be seeded with the native grasses/forbes mixture and provide grazing areas during earlier successional stages before a closed canopy is established. Roadsides will act as long-term grazing areas. In selected

agroforestry areas, lower densities of deciduous trees and shrubs will be planted, and conifers will be planted at minimum reforestation stocking targets (500 to 700 stems per hectare [sph]) using techniques such as cluster or corridor planting. This will allow for up to 30 years of good forage production (Forest Renewal BC, 2001). Precautionary measures will be taken, including planting trees adjacent to obstacles to prevent seedlings from being trampled.

These general prescriptions do not directly address different aspects; however, as noted in Table 5.5, species composition should be adjusted in accordance with the interior cedar hemlock biogeoclimatic zone site series classifications for moisture and nutrient levels. Reclamation sites, such as waste rock dump slopes, will typically be 02 and 03 sites series (very xeric to submesic with poor nutrient availability); however, some plateau and depressional areas may be 01 or 05 series sites. The influence of aspect on re-vegetation growth is being assessed in the joint research project with Metro Vancouver on the NBD (Section 4.3.6), and relevant results will be incorporated into site re-vegetation prescriptions.

Ongoing changes are being made to these prescriptions based on results from site reclamation results and industry research. In particular, reclamation work in the Hazeltine Creek corridor following the tailings dam failure (Section 4.3.8) will provide large-scale results, and initial finding will be available prior to commencing site-wide reclamation at closure.

5.5. Invasive Plant Management

In order to promote natural succession, invasive plants on the Mine site must be managed such that they do not inhibit growth of native species (both planted and naturally ingressing). To address this issue, MPMC maintains and implements an “Invasive Plant Management Plan” (Appendix N). As per this plan, invasive plants to the Mount Polley Mine site are managed in accordance with the Cariboo Chilcotin Coast Invasive Plant Council Regional Strategic Plan and the BC *Weed Control Act*.

5.6. Fugitive Particulate Management

Under Air Permit 15087, MPMC monitors dustfall in areas adjacent to the Mine site to verify that fugitive dust from the Mine site does not exceed the MoE objective of 2.9 mg/dm^2/d. Dust control measures are implemented during non-winter months if conditions are hot and dry (i.e., if it is not raining, or has not rained recently). These measures include use of water trucks on site haul roads and application of calcium chloride to the Mine Access Road (when the Mine and Mill are operating, and industrial traffic is using the road).

Following the tailings dam failure, MPMC, with support from Golder, has also developed and implemented a Fugitive Dust Management Plan for the TSF area (Appendix O). This plan applies a “Plan, Do, Check, Act” management approach, that will continue to be implemented through the operations and reclamation phases of the mine life, until monitoring results indicate that further mitigation measures and monitoring are no longer necessary. Also included in Appendix O is a technical memorandum from Golder reporting on results from particulate monitoring around the TSF area from July 7 to September 29, 2015, and associated recommendations based on the monitoring results.

5.7. Waste Management

Recycling and waste management at the Mount Polley Mine follows provincial requirements, including the BC Hazardous Waste Regulation, as well as MPMC's landfill Permit 14590, with environmentally responsible disposal and recycling practices implemented, where possible.

A summary of current waste management segregation practices and disposal locations is provided in Table 5.8. The MPMC Environmental Department staff conducts routine (typically weekly) inspections of waste management disposal areas on site to verify that correct waste segregation is being carried out. These practices will continue to be carried out through the operating and reclamation periods of the mine life until such a time when these materials are not used or present at the site. Discussions on removal of fuels, reagent and toxic materials, and removal of structures and equipment at closure are provided in Sections 6.1.2 and 6.1.3, respectively.

Table 5.8 MPMC waste management matrix

Item	**Correct Disposal Location(s)**
Food Waste	Lunchroom garages, bear-proof garbages (fuel islands, parking lot), and admin entrance garbages
Drink Containers	Recycling bins: lunchrooms, admin building entrances/2nd floor/3rd floor, Warehouse, Purchasing and Planning Trailers, Control Room, and Fuel Island
Cardboard	Warehouse, Pit Shop (east side), front of Admin Building
Paper	Small blue bins in offices/big bin outside Admin Building
5 Gallon Pails (oily)	Warehouse 5 gallon pail disposal bin (beside light vehicle fuel island)
Oily/Greasy rags, used spill pads, motor oil containers, etc.	Black enviro barrels designated for oily waste at the fuel islands, Pit Shop, Crusher, and maintenance laydowns.
Scrap Metal	Warehouse scrap metal disposal site (separate according to signs)
Aerosol Cans (including brake clean)	Black enviro barrels designated for aerosols at the Warehouse (beside light vehicle fuel island), Pit Shop, Crusher, and maintenance laydowns
Large Batteries	Warehouse bin (beside light vehicle fuel island)
Small Batteries	Box inside warehouse at counter, Admin building 3rd floor hallway
Paint Cans (not empty)	Warehouse disposal bin
Lamps, Ballasts, and Fixtures	Bin on Mill second floor (near Electrical Shop)
Engine Oil	Waste oil tank at Pit Shop or black enviro barrels at laydowns (to be emptied into waste oil tank)
Engine Coolant	Black enviro barrels in maintenance areas
Electronic Waste	Bin under stairs on 1st floor of the Admin building (Mill side)
Wood, plastic, rages (not oily), and any other products not listed above	Landfill

6. RECLAMATION UNITS

Figure 6.1 shows the projected end land uses for the different units of the mine site, as well as areas exempt from reclamation (pit walls, including benches constructed in rock and/or steeply sloping footwalls are not required to be re-vegetated under Section 10.7.14 of the *Health, Safety and Reclamation Code for Mines in British Columbia*). Reclamation units are shown in the closure footprint map (Figure 2.1). The projected end land use for each reclamation unit is specified in the disturbed areas Table 2.4. A description of the different units to be reclaimed and specific reclamation considerations (beyond the general reclamation strategies and prescriptions in Section 5) are provided in the subsequent sections, and are consistent with the summary table of conceptual end land uses for the major reclamation units provided in Table 6.1. Note that reclamation prescriptions for areas scheduled to be reclaimed later on, as per the conceptual schedule (Section 8), may be refined based on results from progressive reclamation.

Table 6.1 Designated end land uses for Mount Polley Mine major reclamation units

Disturbance Type	Forestry	Wildlife Habitat	Cattle Grazing	Outdoor Recreation & Sport Fishing	Hunting, Trapping & Guide Outfitting
Waste Dumps	Re-vegetation with early successional species, to develop into a climax forest, for appropriate site series.	Create diverse habitats (rock piles, coarse woody debris), and establish ground cover of palatable shrub and forbes for wildlife forage.	Incorporate agroforestry silvopasture systems that provide livestock forage in young conifer forests, and open-canopy mature forests.	Incorporate hiking, walking, and/or interpretive trails, and establish picnic and/or viewpoint sites. Manage runoff to maintain appropriate aquatic conditions in receiving environments.	Establish appropriate habitats and food sources for game species.
Open Pits (excluding pit walls)	Reclaim ramps and accessible, non-flooded areas with early successional species, to develop into a climax forest, for appropriate site series.	Create specialized micro-habitats (cliffs, caves, and boulder piles), and support aquatic life and riparian habitats with pit lake construction (dependent on water quality).		Manage runoff to maintain appropriate aquatic conditions in receiving environments.	
Tailings Storage Facility	Reclaim upland portions with early successional species, to develop into a climax forest, for appropriate site series.	Establish wetlands in lowland areas. Incorporate small mammal habitat (rock piles, coarse woody debris) and establish ground cover of palatable shrub and forbes for wildlife forage.	Incorporate agroforestry silvopasture systems that provide livestock forage in young conifer forests, and open-canopy mature forests.	Manage runoff to maintain appropriate aquatic conditions in receiving environments	Establish appropriate habitats and food sources for game species.
Watercourses		Create habitats for riparian species and aquatic life. Establish forage for wildlife in wetland and riparian areas.		Manage runoff to maintain appropriate aquatic conditions in receiving environments	
Roads	Access roads no longer required will be reclaimed with early successional species, to develop into a climax forest, for appropriate site series.	Maintained, seeded roads will provide forage for wildlife.	Maintained, seeded roads will provide forage for livestock.	Maintained roads will provide access to recreation areas.	Maintained, seeded roads will provide access and attract foraging wildlife.
Mill Site	Re-vegetation with early successional species, to develop into a climax forest, for appropriate site series.	Create diverse habitats (rock piles, coarse woody debris), and establish ground cover of palatable shrub and forbes for wildlife forage.			Establish appropriate habitats and food sources for game species.



1:21,000

Drawn by: KM

Date: 29-Oct-2015

N

Watercourses

Water Flow

End Land Use Type

- Access Road
- Pit Walls/Lake
- Watercourse
- Wildlife
- Wildlife - Forested Wetland
- Wildlife/Agroforestry
- Wildlife/Forestry

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Figure 6.1
Conceptual Closure Plan

0 250 500 1,000 1,500 2,000 Meters

6.1.1. *Mill and Plant Area*

The Mill and plant site area, occupying 35.36 ha (Mill and Warehouse), encompasses nearly all the structures and equipment that exist at the Mount Polley Mine, including the crusher and stockpile facilities, mill, concentrator, electrical substation, maintenance shops, warehouse, offices, laboratory, fuel storage facilities, and potable water systems. Exploration geology buildings and core shacks are also located in this area. Craigmont Industries Ltd. operates a magnetite recovery plant on the Mill site. The Mill site is located on a gently-sloping south-facing plateau.

6.1.1.1. Reclamation Plan

During the first operation period from 1997 through 2001, there was some discussion with MoE officials about the potential to convert the mill building into a truck repair shop or some other industrial complex. Since the mill building has offices, electricity, telephones and all the other requirements of an industrial complex, as well as a close proximity to several communities that are home to many people in the forest industry, there may be benefits to keeping the mill building and infrastructure in place and converting the land use of the mill site to a permanent industrial complex. This potential conversion will be evaluated further upon closure, to see if there is interest in following an alternate path for the future of the Mill site. Alternatively, infrastructure will be decommissioned and dismantled as described in this section.

Reclamation of the Mill site will be a gradual process, as infrastructure including offices, power, sewage and domestic water systems, will be required for employees overseeing closure activities. A gate and berms blocking site access will be maintained and signage indicating that the area is a closed mine site will be put in place. Decommissioning will include the following steps:

- Recovery, removal and recycling of products that may be hazardous to the environment and a Contaminated Sites Assessment (Section 6.1.2).
- Removal and salvage of buildings, pipelines and overhead structures (Section 6.1.3). Core shacks may be left on site pending a decision that will be made in collaboration with the MEM.
- Break-up and burial of concrete pads and foundations as required.
- Re-contouring of site to mimic surrounding natural landscape and restore drainage patterns towards Mine Drainage Creek (the Mill Site Sump and Ditch will be removed when no longer required and when water quality meets discharge guidelines.
- Site preparation and re-distribution of stockpiled overburden, incorporating amendments as per Section 5.3.2.
- Re-vegetation for wildlife and forestry values as per the prescriptions in Section 5.4 (02 and 03 site series).
- Post-reclamation monitoring, as per Section 7.

6.1.2. *Removal of Fuels, Reagents, and Toxic Materials*

All tanks and fuel storage facilities will be emptied of their contents before they are removed from their foundations. Tank residues will be transferred by a proven and reputable waste oil reprocessing company or by a special waste recycling company, as appropriate. This will follow similar procedures that have been in place throughout the operating period of the mine (Section 5.7). Unused reagents and laboratory chemicals will be repackaged and shipped to other authorized users, or to an appropriate waste disposal facility. Any contaminated soils will be collected and stockpiled for treatment or disposed of in an approved manner.

A conceptual plan for a Contaminated Sites Assessment under the BC Contaminated Sites Regulation has been developed for the Mount Polley Mine site by Golder (Appendix P). This scope of this plan includes hydrocarbons, fuel, chemical dispensing and storage areas, blasting products (the Orica Site), and stockpiled materials (ore and PAG). Associated cost estimates have been incorporated into the liability bond costing calculations.

6.1.3. *Removal of Structures and Equipment*

All buildings, overhead structures, water management infrastructure, and pipelines will be catalogued, and their potential for salvage or other uses will be determined. Any infrastructure not required for future use will be dismantled and removed from the site.

- Non-salvageable, non-combustible, and non-recyclable materials will be buried within the landfill site, covered with waste rock, and reclaimed to match the end land use of the surrounding area(s). Any materials that would require the landfill to have an engineered cover will be disposed of offsite. Combustible, non-salvageable materials will be burned pending receipt of a refuse permit, and the burned residues will be buried in the landfill site.
- Water intake systems and all above-ground pipework will be lifted and removed from the site. Underground pipework, such as fire, sewage and communications lines, will remain buried. Groundwater wells, both potable and monitoring, will be decommissioned when they are no longer required.
- Above-ground foundations will be broken down to ground level, covered with stockpiled soils and prepared for reclamation, as required.

6.1.4. *Test Heap Leach*

The test heap leach facility is located on top of the East RDS. Just prior to closure, the leached ore will be removed from the pad by a loader and haul trucks. The ore will be blended with mill feed through the crusher. This will allow for recovery of sulphide copper minerals and gold that will still be available in the ore. Alternatively, it will be subaqueously disposed of in the Springer Pit. After all ore has been removed, the liner will be punctured and exposed liner will be disposed of in an environmentally safe manner.

All project operating and maintenance facilities will be dismantled and removed from the property as per Section 6.1.3; much of the process equipment will retain value as used equipment and will be sold for use at other operations or projects. That which cannot be disposed of by recyclers will be buried in the ore heap or the site landfill. Any reagents or chemicals, including the sulphur stockpile will be disposed of as per Section 6.1.2. Concrete pads will be broken up and buried as required. Residual material will be evaluated for hazardous content in the site Contaminated Site Assessment and appropriately treated or removed from the site.

6.1.5. *Power Lines*

Removal of power infrastructure will depend upon the power requirements for post-closure care and maintenance, and requirements of other potential power users in the region at closure. When no longer required, overhead power lines and infrastructure on site will be removed by a specialty contractor. Materials will be sold (if they have salvage value) or disposed of in an approved method. Buried cables will remain in the ground. Post holes will be backfilled and reclamation will be carried out in a manner consistent with adjacent reclamation units. As a ground cover already exists in power line right of ways, re-vegetation will only include planting of trees and shrubs, if not already naturally regenerating.

6.1.6. *Pit Reclamation*

243.69 ha of the property is projected to be open pits at closure, which includes the Boundary Pit, the Wight Pit, the Springer Pit, the Cariboo Pit, and the TSF Rock Quarry. Of this area, 57.52 ha is projected to be in the form of lakes (Boundary Pit, Cariboo-Springer Pit, Wight Pit).

6.1.6.1. General

Public safety is the most important issue to consider during the reclamation of the open pits. When mining of the pits is complete, appropriate barriers and signage will be installed around the perimeter of the pits. Efforts will be made, as safe access allows, to re-vegetate the rims of pits visible from Bootjack and Polley Lakes to help the straight edge blend in.

Exposed pit faces of the remaining pits will have an average slope of 52˚. Little or none of the upper pit walls can be reclaimed due to steep terrain and poor access, and as permitted under Section 10.7.14 of the *Health, Safety and Reclamation Code for Mines in British Columbia,* they will not be re-vegetated. If any benches are safely accessible by foot at closure, they will be broadcast-seeded with a native grasses and forbes seed mixture (Table 5.6) and potentially fertilized. If access allows, these areas will then be hand-planted with seedlings which grow naturally on colluvial veneers and steep droughty sites in the region, such as of lodgepole pine, black cottonwood, sitka alder, and common juniper.

Ramps down to the level of flooding will be ripped up with heavy equipment, and a minimum of 20 cm of stockpiled soil will be spread with site preparation carried out as per Section 5.3.2., and re-vegetated for dry sites (site series 02) as outlined in Section 5.4

The un-vegetated rock face areas have potential to add to the area's biodiversity, by providing microhabitats that do not presently exist in the project area. Cliff faces, particularly those with ledges, boulder piles, crevices, and overhangs, may provide nest sites for a variety of cliff nesting birds, such as the common raven, species of hawks and falcons, cliff swallows, barn swallows and Say's phoebe. Cavities in boulder piles can provide nesting and denning habitat for bats, the bushy-tailed woodrat, deermice, the northwestern chipmunk and other small mammals.

The flooded pits will create isolated water bodies that have little potential as fish habitat. The surface waters of the ponds have potential to support aquatic invertebrates, and may provide useable spawning habitat for northwestern toad and spotted frog. To promote this, species including duckweed, pond weed, yellow pond lily, water sedge, beaked sedge, common cattail, river horsetail, and bull rush will be considered as reclamation tools. Floating species will help build up organic matter, creating potential habitats for riparian species to be introduced over time. Such plants may also help remediate pit water quality through microbial activity and the pit lakes may have the potential to act as a drinking water source for wildlife, depending on water quality and access; however, this will depend on the actual water quality observed in post-closure monitoring (currently only long-term predictions exist; Section 5.2.4 and the selected long-term water management plan (Section 2.4.3.3).

6.1.6.2. Springer and Cariboo Pits

A hydrogeological assessment of the Springer and Cariboo Pits (which will be combined into a conjoined pit at closure) completed by Golder (Appendix Q) assessed formation of a pit lake at closure and potential exfiltration of pit lake water to groundwater (flowing in the direction of Bootjack Lake). Once the pit lake elevation is above approximately 1,028 masl, the pit lakes in the Springer Pit and Cariboo Pit merge and form a single pit lake. Results indicate that seepage to groundwater will occur when the lake level reaches 1,030 masl and seepage at the spillover elevation (1,050 masl) is projected to be approximately 260 m^3/d (combined seepage of 250m^3/day from the Springer Pit and 10m^3/day from the Cariboo Pit). If results from ongoing groundwater monitoring indicate that seepage to groundwater is having adverse effects on the receiving environment, mitigation options include decreasing the spillover elevation, installing a low-permeability barrier, and/or construction of a passive seepage collection system. These mitigation options are described in more detail in Appendix Q.

Closure water balance and water chemistry modelling (Appendix L) indicates that, under natural accumulation conditions, the Springer-Cariboo Pit will fill to 1,030 masl in April 2031 (following draw down for mining and subsequent placement of PAG material) and 1,050 masl in 2034. Depending on water management requirements and site objectives, water may be directed (i.e., pumped) to the Springer Pit to advance this filling schedule. A summary of projected long-term water chemistry for the Springer and Cariboo Pits at closure is provided in Section 5.2.4. This projected chemistry will dictate treatment requirements and inform selection of treatment options for development of the long-term water management plan (Section 2.4.3.3). The closure surface area of the combined pit lake is projected to be 49.69 ha at 1,050 masl.

A conceptual design for a spillway on the west side of the Springer Pit (towards Bootjack Lake) was developed by Golder and is included as Appendix R. The spillway is designed to safely

discharge overflow from the Springer Pit caused by storm water runoff and other inflows to the catchment, conveying water through the grouted rip rap structure. It also designed to allow vehicle passage for access to the northwest portion of the mine site.

A geotechnical assessment of the slope stability of the southwest wall of the Springer Pit (the wall between the pit and Bootjack Lake) was conducted by Golder and is provided in Appendix S. Findings from the assessment indicate that adequate long-term slope stability conditions are expected to be achieved; results of the analyses exceeded the minimum recommended factor of safety (FoS) of 1.3.

6.1.6.3. Wight Pit

Upon completion of underground operations (portal located in the bottom of the Wight Pit), the Wight Pit will be allowed to fill to the spillover elevation into Polley Lake of 926 masl. A hydrogeological assessment by Golder (Appendix T) projects that at this elevation, seepage to groundwater towards Polley Lake will occur at approximately 500 m^3/d, with groundwater seepage into the pit lake of approximately 600 m^3/s. The hydrogeological assessment makes recommendations for reconditioning of old borehole wells or installation of new wells to refine this model; MPMC has commenced investigations of the old borehole wells.

Closure water balance and water chemistry modelling (Appendix L) indicate that the Wight Pit will fill in November 2032, submerging the PAG material deposited in the pit. A summary of projected long-term water chemistry for the Wight Pit at closure is provided in Section 5.2.4. This projected chemistry will dictate treatment requirements and inform selection of treatment options for development of the long-term water management plan (Section 2.4.3.3).

At closure, a spillway toward Polley Lake will be constructed, applying the same concept and design basis as the Springer Pit spillway. The closure surface area of the pit lake is projected to be 14.91 ha.

6.1.6.4. Boundary Pit

The Boundary Pit is a small pit, and observations through the operating period of the mine life (prior to further mining planned in the four year mine plan) indicate that the water exists in a roughly steady state (does not overflow). Holding the observed steady state water elevation for the completed pit scenario would result in a projected pit lake forming at approximately the 1070 masl, with a projected closure surface area of 6.37 ha. A groundwater characterization and monitoring assessment completed by Golder (Section 7.3.1) indicates that groundwater seepage from this area would flow towards the Wight Pit. Accessible disturbed areas will be reclaimed as outlined in Section 6.1.6.1.

6.1.6.5. TSF Rock Quarry

When the TSF quarry is available to reclaim, soil will be applied to accessible areas (pit access) and re-vegetation will take place as outlined in Section 6.1.6.1, with the pit walls remaining in their current state. Runoff will continue to be directed into the downstream TSF.

6.1.7. *Waste Dump Reclamation*

The Mount Polley site is projected to have 342.07 ha of waste dumps at closure, including areas that are currently undergoing progressive reclamation. Refer to Section 2.3.3 for the locations and areas of all waste dumps.

For reclamation, waste dumps are sloped equal to or less than a 2:1 slope ratio. Re-contouring occurs with consideration of landform design and aesthetics to promote natural integration of reclamation sites into the surrounding landscapes. Designs encompass scales ranging from micro-topography to regional landscapes. This will help to minimize the long-term visual impact from Bootjack, Polley, and Morehead Lakes.

Landform design will take place with consideration of recreating pre-mining drainage pathways shown in Figure 1.4 and conceptual closure drainages in Figure 6.1. Procedures for soil handling and application to reduce compaction and create microsites, along with placement of coarse woody debris and other habitat features, are outlined in Section 5.3.

End land uses for each waste rock dump to be reclaimed are provided in Table 2.4 and corresponding reclamation prescriptions are outlined in Section 5.4. This includes reclamation of ore stockpiles (#1 Stockpile and Cariboo Ore Stockpile) when all economical ore has been removed and processed, and the Temporary NW PAG Stockpile NAG pad.

At closure, an interpretive walking trail and picnic area may be established to promote outdoor recreation and public education. The NBD has views over the Mill site, Temporary NW PAG Stockpile, Springer Pit, and Cariboo Pit, and thus may be a suitable location.

6.1.7.1. Temporary NW PAG Stockpile

At the end of mine life, all PAG material from the Temporary NW PAG Stockpile will be relocated to the bottom of the Springer-Cariboo Pit and submerged. This will reduce the risk of these materials generating acid in the long-term. As referenced in the Golder Springer Pit hydrogeological assessment (Appendix Q), sufficient space exists such that PAG, which will fill the pit to the 1028 masl elevation, will be covered by water which will reach the spillover elevation of 1050 masl eleven years after closure, under natural accumulation conditions. Accelerated filling of the Springer Pit to meet water management (quantity or quality) objectives may be pursued by directing additional flow (i.e., pumping) to the Springer-Cariboo Pit.

An iterative sampling procedure will be used to ensure that only NAG waste from the underlying NAG pad is left. Waste will be excavated a few meters beyond the surveyed PAG/NAG boundary. At this point, grab samples will be taken to ensure all PAG rock has been removed. If any PAG waste remains, additional rock will be removed, and this process will continue until only NAG waste remains, and resloping and re-vegetation may take place. PAG has previously been transported to the bottom of the Wight Pit (to be submerged upon closure), and incorporated into the Low Sulphur Waste Dump.

6.1.8. *Road Reclamation*

188.16 ha of roads are projected to exist at closure, with a potential additional 7.07 ha if the TDAR is constructed. The TDAR, which is already permitted by the MEM, would connect the

Waste Haul Road and TAR in a more direct route, overtop of the old Orica Site (the start of the TDAR can be seen on Figure 1.3).

Two types of roads at the Mount Polley Mine exist: light vehicle roads (often old forestry roads that pre-date mine operations) and large haul roads made from run-of-mine NAG waste (often built up, and are essentially linear waste rock dumps). Roads scheduled for reclamation will be reclaimed to meet the end land uses of their surrounding areas (generally wildlife and forestry), as shown in Table 2.4.

6.1.8.1. Light Vehicle Roads

As the post-closure monitoring program is carried out, roads not necessary for access will be identified. Roads required for monitoring will be preserved. Additional roads may be preserved for logging and forestry use, for ranchers to reach their grazing cattle, and for recreation, guide-outfitting, hunting and trapping. These roads and roadsides will be seeded with the native grasses and forbes mixture in Table 5.6 to provide forage for wildlife and livestock.

Culverts will be removed and replaced with cross-drainages where required. Surface runoff channels will be improved to accommodate design capacity flows, and cleared of debris, to prevent new channels from interfering with newly reclaimed areas. Roads will be ripped to a minimum depth of 30 cm, and side-cast material and cutbanks will be recovered and spread over the road surface. This material can be supplemented with stockpiled soil to reach an appropriate depth for vegetation (minimum 15 cm). Cutbanks will be re-contoured below the angle of repose to reduce future slumping. Surface preparation will be carried out as per Section 5.3.2. The surface will then planted according to the prescriptions of in Section 5.4, with any adjustments made to match the end land uses designated in Table 2.4.

6.1.8.2. Haul Roads

Site haul roads include the Waste Haul Road, TAR, New Access Road, Wight Pit Haul Road, Wight Pit TSF Haul Road, and the Old TSF Haul Road. These roads are essentially linear waste dumps, and the sides will be sloped to equal to or less than a 2:1 slope ratio, to the maximum extent possible, with some limitations based on water body crossings (for example the TAR crossing of Bootjack Creek) and proximity to sensitive undisturbed footprints. Re-sloping will incorporate landform design, with wildlife passage pathways being a key feature. Culverts will be removed and replaced with cross-drainages as appropriate. Surface runoff channels will be improved to accommodate design capacity flows, and cleared of debris, to prevent new channels from interfering with newly reclaimed areas.

Roads not required for access during closure will be fully reclaimed to match their end land use designations following the soil application and amendment techniques and re-vegetation approaches for waste dumps, as described in Sections 5.3.2 and 5.4, respectively. Roads required for access will be partially reclaimed (edges re-sloped and reclaimed as discussed above), with light vehicle and/or equipment access maintained, as required.

6.1.9. *Watercourses*

Consistent with the long-term water management plan that is being developed (Section 2.4.3.3), water will be collected and treated prior to discharge to the receiving environment, as required to not have adverse effects on the receiving aquatic environments. The long-term intent is to have a number of passive water treatment systems distributed around the site, such that water is returned to its original pre-mining watersheds and/or water courses (Section 5.2.4).

Any collection system ditches that remain in perpetuity (currently the SERDS Ditch and Long Ditch as per the conceptual long-term plan) will be armoured with the banks and adjacent areas re-vegetated with riparian species, such as black cottonwood, willow (plugs or wattles and live stakes), and sitka alder.

6.1.10. *Tailings Area Reclamation*

Reclamation of the TSF area is broken into the following subsections: infrastructure; till borrow pits; embankments, and surface (tailings area). These areas are shown in Figure 2.1. Specific areas of disturbance for the separate components are shown in Table 2.4, along with the planned end land uses. Details on the reclamation of the TSF are available in the detailed design report for the 970 masl TSF.

6.1.10.1. Infrastructure

Upon mine closure, surface facilities will be removed in stages, salvaged and sold as per Section 6.1.3.; however, the seepage recovery wells and monitoring piezometers in the tailings dam will be maintained as long-term monitoring devices. Water management infrastructure will be maintained of decommissioned and removed in accordance with the long-term water management plan (Section 2.4.3.3).

6.1.10.2. Till Borrow Pits

The till borrow pits adjacent to the TSF were mined to obtain material for constructing embankments' core. The primary land use objectives for this area are wildlife habitat (including wetland habitat) and agroforestry. There is also long-term potential for outdoor recreation and hunting/trapping.

23.95 ha of the Southeast Till Borrow area has been recontoured, with biosolids applied to 12 ha, and re-vegetation has begun. The wetland areas that have developed in low lying depressions have several emergent grasses, bull rush, and beaked sedge growing. The dry land areas have a robust grasses and forbes cover, with some early successional species (black cottonwood) ingressing. Monitoring is ongoing to determine requirements for additional planting; however it is likely that additional tree and shrub planting (02 and 03 site series) will occur, as per Section 5.4. The agroforestry forage species and planting strategies discussed in are to be used to continue promoting range lands for the livestock which currently graze in this area.

These till borrow areas that still require reclamation have low nutrient till (substrate), and soil preparation and amendment, as well as placement of habitat features are recommended as described in Section 5.3.2; however, planting of early successional and, in particular, nitrogen fixing species without adding amendments is an alternative approach. Re-vegetation will follow the prescriptions in Section 5.4 for the upland areas (site series 02 and 03). Low lying areas (site series 01, 05 and 07) will focus on planting of deciduous species, including black cottonwood, willow (plugs or wattles and live stakes), sitka alder, and red-osier dogwood. Potential transplants and seeding of wetland species could be carried out using vegetation already growing in the southeast till borrow area, or from Bootjack Lake, Polley Lake and neighbouring areas where species such as water sedge, beaked sedge, common cattail, river horsetail, yellow pond lily, narrow-leaved bur-reed are found. This will be done through collection of turfs, offsets, stolons, cuttings and winter buds of aquatic plants from local sources. The key wildlife species for the management of this wetland could include: Columbia spotted frog, Pacific northwestern toad, mallard, green-winged teal, bufflehead, common snipe, common yellowthroat, Lincoln's sparrow, muskrat and moose.

6.1.10.3. Embankments

The TSF consists of a glacial till core with a free-draining rock shell on the downstream side. It is composed of one overall embankment subdivided into three sections, referred to as the Perimeter, Main, and South Embankments, which are 40 m, 58 m, and 32 m in height, respectively. At closure, each of these embankments will be buttressed to have a minimum FoS of 1.5, and sloped to a 2:1 ratio. Application of growth substrate and re-vegetation will occur as per Sections 5.3.2 and 5.4, respectively, with the area expected be characterized as 02 site series.

6.1.10.4. Tailings Surface

The largest component of the TSF disturbance is the tailings pond and beach (213.53 ha). This area is grouped into two categories: beach areas and the closure pond. Post-closure, there will always be water quantity fluctuations in these areas as evaporation and precipitation levels change with the seasons. The MPMC tailings have been characterized to be non-PAG (Golder 2015a).

At closure, a spillway will be constructed at an abutment. The spillway will be sized to manage the Probable Maximum Flood. The conceptual designs for the spillway by Golder is included as part of the 970m detailed design package, and the spillway is designed to safely discharge overflow from the TSF caused by storm water runoff and other inflows from the surrounding catchment, with considerations for maintaining appropriate freeboard. The spillway design for the current TSF configuration (950m elevation Freshet Embankment) is included as Appendix U. The design involves a constructed grouted rip rap channel and diffusion structure, with water to flow in the direction of site water management structures.

The general concept is to reclaim the tailings beaches as a mosaic of forested and wetland habitats, with a gradual transition towards a pond and artificial wetland above the outflow spillway. The area of the final pond (wetted area) at closure is modelled to be 15% of the beach area, or 32.03 ha, and understanding the closure tailings saturation levels and groundwater

table elevation has been identified as an area where more modelling is required (and will be carried out as part of ongoing long-term water management planning), as discussed by Golder in Appendix L. This has implications for long-term water quality, as source terms for saturated and dewatered tailings are different. Further, the long-term role of the TSF is still to be decided with development of the long-term water management plan.

Upland portions of the tailings beaches will consist of a fine-textured, stone-free, sandy to silty deposit of variable thickness. Accessible portions of tailings area will undergo an application of biosolids (currently in storage at the TSF biosolids stockpile) using a harrow or roto-tiller system. Reclamation will aim to create a patchy mosaic of closed coniferous forest, deciduous shrub thickets and small openings that have some area of forest, but primarily promote wildlife usage, and the associated end land uses of hunting and trapping. Drier upland areas (site series 03 and 01) will be re-vegetated with a non-competitive grasses and forbe mixture and the species outlined in Section 5.4. Wetter low lying areas (site series 05 and 07) will be re-vegetated with deciduous species, including black cottonwood, willow (plugs or wattles and live stakes), sitka alder, and red-osier dogwood. Turfs, offsets, stolons, cuttings and winter buds of aquatic plants will be collected from local sources, and planted in the pond. Water sedge, beaked sedge, common cattail, river horsetail, yellow pond lily, narrow-leaved bur-reed are all present in Bootjack Lake, Polley Lake and in small wetlands adjacent to the Mount Polley project area. The key wildlife species for the management of this wetland could include: Columbia spotted frog, Pacific northwestern toad, mallard, green-winged teal, bufflehead, common snipe, common yellowthroat, Lincoln's sparrow, muskrat and moose.

6.1.11. *Underground Reclamation*

The underground mining operations in the Boundary Zone will be flooded by the final closure of the Wight Pit (Section 6.1.6.3). To prevent someone entering the portal when the underground is flooding, a solid bulkhead will be constructed at the portal. The bulkhead will be built with a timber frame, plank cover and a welded rebar mesh. Alternatively, rock can be dumped in front of the portal. The ventilation raise will be filled with cemented rock fill and mounded over with till.

All of the buildings and services at the pit bottom are skid mounted with the exception of the shop and the cement slurry plant. The shop and slurry plant (after removal of all mechanical and electric equipment) will be dismantled and removed from the site. Non-salvageable, non-combustible, and non-recyclable materials will be disposed of as per Section 6.1.2, and the fuel island will be removed as per Section 6.1.3. Combustible, non-salvageable materials will be burned pending receipt of a refuse permit, and the burned residues will be buried in the landfill site. All that will remain will be the concrete footings. The remaining above ground disturbed will be reclaimed following the prescriptions in Section 5.4.

7. POST-CLOSURE MONITORING

7.1. Closure Management Manual

All activities and monitoring during the closure phase of the mine life will occur as per the Closure Management Manual. MPMC developed a Closure Management Manual when the site was in care and maintenance following the tailings dam failure, and this manual will be updated prior to the end of operations to reflect the content of this Plan, as well as any remaining management requirements from operations that have not yet ceased. Post-closure activities will include:

- Inspections and maintenance of geotechnical structures;
- Water chemistry and aquatic effects monitoring;
- Water treatment and discharge;
- Reclamation monitoring; and
- Final decommissioning of site infrastructure.

Requirements associated with these activities are described in the following subsections.

7.2. Inspections and Maintenance of Geotechnical Structures

The TSF will be inspected by a qualified dam safety engineer annually following mine closure. The inspections will focus on any conditions that could potentially adversely impact the long-term function and stability of the structure. Annual inspection reports will be submitted to the MEM for review. TSF management in closure will continue to occur under the OMS Manual, which will be revised, as required. After the reclamation phase (approximately ten years) remote monitoring instrumentation may be installed and monitored.

It is anticipated that after the first five years of monitoring and inspection, monitoring frequency may be reduced to Dam Safety Reviews, as defined by the Canadian Dam Association requirements.

7.3. Water Chemistry and Aquatic Effects Monitoring

7.3.1. *Groundwater Monitoring and Characterization*

Golder completed a review of the groundwater and monitoring program at the Mount Polley Mine (Appendix V); however, plans are in place for a more detailed assessment of the TSF monitoring wells to be carried out. As indicated in the plan, monitoring at closure will likely consist of:

- Sampling of the Springer Pit wells quarterly and water levels daily until conditions are stable and appropriately characterized, and then reducing monitoring frequency to annual monitoring for approximately five years.
- Installation of a nested pair of monitoring wells between the Cariboo Pit and Bootjack Lake, which would follow a similar monitoring pattern as described for the Springer Pit wells.

- Re-conditioning or installation of new nested wells adjacent to the Wight Pit, which would follow a similar monitoring pattern as described for the Springer Pit wells.
- Continued bi-annual monitoring of wells adjacent to other facilities until trends are stable and the water chemistry and flow patterns are appropriately characterized, at which point the monitoring frequency will be reduced.

Existing groundwater monitoring wells are shown in Figure 5.1. Contingency measures would be implemented if it is determined that the water quality in the pit lakes and associated seepage quantities are of concern, such as lowering pit lake levels, installation of low-permeability barriers, treatment, and/or implementation of passive interception systems. Detailed evaluations of these options will be developed as part of the ongoing water quality and water balance assessments for long-term water management planning.

7.3.2. *Surface Water Chemistry Monitoring*

Surface water chemistry monitoring will continue during closure for the same parameters monitored during operations (total and dissolved metals, nutrients, physical parameters, ions, and dissolved organic carbon), with QA/QC sampling procedures to continue.

For the ten years following closure when reclamation work is being conducted, monitoring will continue quarterly at adjacent receiving environment surface water locations (North Dump Creek, W4a; Bootjack Creek, W5; W8, upper Edney Creek; W20 Creek, W20; 6km Creek, W12; Morehead Creek, W1; and Mine Drainage Creek, W3a), with bi-annual monitoring of Polley Lake and Bootjack Lake, following the program designed for Bootjack Lake in the current MPMC Biological and Lake Monitoring Plan. Following this reclamation period, if results are stable and meet applicable water quality guidelines, sampling frequency will be reduced to annually.

During this ten year reclamation phase, quarterly monitoring will continue at key water collection sites to understand changes in geochemistry of the site waste dumps and disturbed areas over time, and to verify the accuracy of the long-term effluent quality predictions. These monitoring locations will include: the 9km Sump (E17), the NW Sump (E13), Mine Drainage Creek Sump (E14); the Bootjack Creek Sump (E15); the SESCP; the MESCP (E4); the CCS (E18); the Springer Pit (E11); the Cariboo Pit (E8); the Wight Pit; and the TSF (E1). Following this period, the monitoring frequency will be reduced to annually if stable results are observed.

Water quality monitoring stations are shown in Figure 5.1 and a summary of this monitoring is provided in Table 7.1. Monitoring at some stations may be more frequent, if water discharge is occurring, as discussed in the next section.

Because water quality monitoring is planned to occur at all major water management works, routine inspections will be carried out with all sampling events.

Table 7.1 Conceptual closure water quality monitoring schedule

		Reclamation Phase (Years 1 - 10)	Post Closure (Years 10 -15)[1]	Post Closure (Year 15 Onwards)[1]
Sites		**Sampling Frequency**		
Receiving Environment	North Dump Creek (W4a)	Quarterly	Annually	Anually
	Bootjack Creek (W5)	Quarterly	Monthly	Quarterly
	Upper Edney Creek (W8)	Quarterly	Monthly	Quarterly
	Hazeltine Creek (W7/HAC-05)	Quarterly	Monthly	Quarterly
	W20 Creek (W20)	Quarterly	Annually	Annually
	Mine Drainage Creek (W3a)	Quarterly	Monthly	Quarterly
	Morehead Creek (W1)	Quarterly	Monthly	Quarterly
	6km Creek (W12)	Quarterly	Monthly	Quarterly
	Bootjack Lake (B1, B2)	Bi-annually	Bi-annually	Bi-annually
	Polley Lake (P1, P2)	Bi-annually	Bi-annually	Bi-annually
Mine water Collection System	TSF (E1)	Quarterly	Monthly	Annually
	MESCP (E4)	Quarterly	Monthly	Quarterly
	Cariboo Pit (E8)	Quarterly	Annually	Anually
	Springer Pit (E11)	Quarterly	Monthly	Quarterly
	Wight Pit	Quarterly	Monthly	Quarterly
	NW Sump (E13)	Quarterly	Monthly	Quarterly
	Mine Drainage Creek Sump (14)	Quarterly	Monthly	Quarterly
	Bootjack Creek Sump (E15)	Quarterly	Monthly	Quarterly
	9km Sump (E17)	Quarterly	Monthly	Quarterly
	CCS (E18)	Quarterly	Monthly (at PETBP)	Quarterly
	SESCP	Quarterly	Monthly	Quarterly

Notes:

1) Samling frequency to be decreased over time, as water quality shown to be stable

7.3.3. *Water Discharge Aquatic Effects Monitoring*

During the first ten years of closure (as described in the long-term effluent quality and quantity predictions in Appendix L), discharge is anticipated to occur at a single location. Monitoring of this discharge will occur according to a monitoring plan that will require MoE approval, and will likely be similar to the monitoring plan for the proposed short-term water discharge. MPMC will apply to become a closed mine under the Metal Mining Effluent Regulations, which includes conducting a final Biological Monitoring Study.

Upon implementation of the final long-term water management plan, which will likely involve passive treatment systems at multiple locations around the site (Section 2.4.3.3), monitoring will be adjusted accordingly. It is anticipated that monitoring will consist of monthly water quality samples of the at the discharge points (described in the conceptual long-term water management plan; Appendix L) and in the receiving environment, and biological monitoring (fish population and fish tissues, sediment chemistry and benthic invertebrate monitoring) will continue every three years, with the frequency of all monitoring decreasing as results stabilize (for example quarterly sampling and biological monitoring every six years), until such time when treatment of mine site runoff is not required, or passive systems are deemed to be sufficiently effective and not require long-term monitoring.

7.4. Re-vegetation Monitoring

7.4.1. *Re-vegetation Assessments*

Reclamation monitoring and inspections of progressive reclamation sites is to continue into closure. Monitoring is typically completed in the summer or early fall when plants are most easily identifiable. A general schedule for reclamation assessments is as follows:

- Post-application visual inspections after application of growth material to assess application depth and if recommended application methods described Section 5.3.2 were appropriately implemented;
- Vegetation assessments of seeded grasses and forbes following their first growing season for species composition (including presence of invasive species) and cover, as well as any areas of erosion;
- Observations of wildlife or grazing occurrences and usage;
- Survival surveys of planted trees and shrubs immediately after planting (for quality control purposes);
- Survival surveys of planted trees and shrubs following their first growing season; and
- Periodic assessments of tree survival/growth and ground cover vegetation, decreasing in frequency over time (for example years two, five and ten).

A sample re-vegetation assessment form developed for use on site is included as Table 7.2. Monitoring is to continue, with additional reclamation activities occurring in an adaptive management process, until performance criteria for these assessments provided in Table 3.1 have been met.

7.4.2. *Vegetation Metal Uptake*

A conceptual vegetation metal uptake monitoring plan (Appendix W) for reclamation areas at closure incorporating soil and tissue sampling has been developed and incorporated into the liability cost estimates. This plan builds on work that is being conducted by Golder in the Human Health and Ecological Risk Assessment for the tailings dam failure, which will establish an acceptable concentration range for metals in vegetation in the Mount Polley area to enable a streamlined data evaluation process moving forward. Data collected in baseline monitoring programs in 1989, 1995 and 1996, and from reclamation areas in 2007, 2012 and 2014 are appended to the plan, and are being incorporated into the Golder risk assessment analysis.

Table 7.2 Sample re-vegetation assessment form

MOUNT POLLEY RECLAMATION RE-VEGETATION ASSESSMENT FORM

Date: _____ Transect: _____
Assessor(s): _____ Plot: _____
Reclamation Site: _____ Plot Size: _____
Site Conditions (slope position, slope angle, aspect): _____

Ground Surface

Surface Roughening (present, description):	
Coarse Woody Debris (% cover, types):	

Understorey Vegetation

General

% Cover (all species)	
% Cover (invasive species)	
Average Height (m)	
Vigor (0 - 5)	

Species Specific

Species	# Species	% Cover	Height (m)	Vigor (0 - 5)	Planted/Ingress/Invasive

Trees/Shrubs

Species	# Present	Average Height (m)		Vigour (0 - 5	Planted/Ingress

Wildlife Value

Wildlife Observations:	
Habitat Types Present:	

Comments

(ex. erosion, variation across plot)

8. RECLAMATION AND CLOSURE SCHEDULE

MPMC's conceptual schedule for site reclamation and closure is presented in Table 8.1. This plan may evolve based on findings of reclamation research and progressive reclamation projects. It is also subject to change in accordance with changes to the mine plan.

Table 8.1 Mount Polley conceptual reclamation schedule

Reclamation Unit	Reclamation Phase														C
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Structures and Equipment/Materials															
Orica Site															
Test Heap Leach															
Underground															
Crusher and Mill															
Geology Area															
Warehouse															
Admin Building															
Waste Dumps															
PAG rehandling															
Temporary NW Stockpile															
North Bell Dump															
Boundary Dump															
East RDS															
NEZ Dump															
SERDS															
Open Pits															
Spillway construction															
Reclamation of accessible areas															
TSF															
Spillway construction															
Embankments															
Surface															
Water Management															
Active Treatment															
Passive Treatment															
Watercourse reclamation															
Site Decommissioning															
Haul Roads															
Roads (not required for monitoring)															
Power infrastructure															
Monitoring															
Contaminated Site Assessment															
TSF Annual Geotechnical Inspections															
TSF Instrumentation	Manual monitoring, as per OMS										Remote monitoring system in				
Re-vegetation															
Vegetation Metal Uptake															
Surface Water Quality - Creeks	At frequency for active treatment and verification of effluent predictions/stability										At frequency for active treatment and ver				
Surface Water Quality - Lake	At frequency for active treatment and verification of effluent predictions/stability										At frequency for dispe				
Groundwater	Quarterly / Bi-Annual					Annual					Anr				
Biological Studies (Discharge)															
Hydrology															
Meteorology															
Dustfall															

9. RECLAMATION COST ESTIMATES

Reclamation costing is completed using site costing and equipment information in combination with the most current available survey and computer modeling data. Cost modeling is summarized in an Excel spreadsheet that calculates both internal and external costing and organizes data into the thirteen categories as included in the MEM Reclamation Costing Spreadsheet for Reclamation Liability Cost Estimates (http://www.empr.gov.bc.ca/Mining/Permitting-Reclamation/Costing-Security/Pages/default.aspx): RDS Slopes; RDS Tops; Pit Lakes and Surfaces; Pit Walls; Roads; Millsite; Tailings Impoundments; Tailings Dam Surfaces; Stockpile Pads; Linear; Other; TSF Additional Areas; and Exploration. A description of the process used in calculating reclamation costs is provided below:

Update cost estimates are provided in Appendix X (submitted to the MEM only).

9.1. Modeling of Mine Areas

Modeling of the areas identified as requiring reclamation in closure planning is tracked in a spreadsheet sheet entitled “Existing Area Calculations”. Disturbed areas are delineated using the MineSight 3-D modeling software by creating two-dimensional polygons overlaid on the most recent (for this Plan May 2015) graphical flyover. Disturbed areas are identified by individual locations within six categories used for internal tracking purposes: Dumps; Pits; Stockpiles; Roads; TSF; and Miscellaneous. These individual two-dimensional polygons are then used, again in the MineSight software, to create three-dimensional surfaces from topographical survey data within the bounds of the polygons. The surface area of these three-dimensional areas is the area to be reclaimed.

In the case of areas projected to be disturbed during the Phase 4 Cariboo-Springer Pit Mine Plan (i.e., pit and dump development), final disturbed areas are generated from pit shell models and final dump configurations, and are modelled as additional disturbance to that existing on site as verified from current site survey information. These are input in a separate column in the Existing Area Calculation for tracking against existing disturbance.

Modeling of reclaimed areas is completed through the MineSight software, using the same process as outlined above; utilizing survey data outlining reclamation areas through the history of mine operations. These areas are entered into a column in the Existing Area Calculations spreadsheet, next to the disturbed areas, with reclaimed areas nomenclature reflecting that used in the aforementioned column. Alternatively, reclaimed areas are provided by the Environmental Department through survey data collected and modelled through ArcGIS.

Pit lake areas are generated by modelling the spillover elevations of the respective areas (Cariboo-Springer Pit, Boundary Pit, Wight Pit) in MineSight, and calculating the area intersected within the pit limits. The TSF Pond area is as provided in the detailed design package, and is numerically entered as 15% of the TSF surface area.

A column is then generated (called ‘Remaining Area’ in the spreadsheet); subtracting the site reclaimed areas and lake areas from the disturbed areas at closure to determine that left to be

reclaimed. This is the area that is used in calculating remaining reclamation work to be completed for closure planning.

These areas (individual items grouped into the aforementioned six categories for internal tracking purposes) are then translated from the internal tracking nomenclature into the thirteen categories as used by the MEM for the reporting template: RDS Slopes (corresponding portions of Boundary Dump, East RDS, Highway to Heaven, NEZ Dump, North Bell Dump, SERDS & Tailings Road [TAR], and Temporary NW PAG Dump); RDS Tops (corresponding portions of Boundary Dump, East RDS, Highway to Heaven, NEZ Dump, North Bell Dump, SERDS & Tailings Road [TAR], and Temporary NW PAG Dump); Pit Lakes and Surfaces (corresponding portions of Boundary Pit, TSF Quarry, Springer Pit [includes Cariboo Pit] and Wight Pit); Pit Walls (corresponding portions of Boundary Pit, TSF Quarry, Springer Pit [includes Cariboo Pit] and Wight Pit); Roads (Boundary/Wight Pit Connector, Crusher, Mill/TSF Connector, New Access, Old Tailings Haul, Old Wraparound, Ore Switchback, Polley Lake Access, West Haul, Wight Pit Haul, Wight Pit/); Millsite (Mill Area and Warehouse Area); Tailings Impoundments (Main Embankment, Perimeter Embankment and South Embankment); Tailings Dam Surfaces (TSF Surface); Stockpile Pads (#1 Stockpile, Biosolids, High Ox, Mount Polley Soil, NEZ Soil, Ore, Pond Zone, SERDS Soil, and Tailings Soil); Linear (Hydro Line, Long Ditch, South SERDS Ditch and West Ditch); Other (Helipad, Old Orica Site); TSF Additional Areas (Corner 4 to Corner 5, Corner 4 to Corner 5 Light Duty Access Road, East Till Borrow, Hazeltine Discharge Pipe Grade, Southeast Till Borrow, TSF – Southwest Pond); and Exploration (Geology Area).

9.2. Costing Parameters

Once the reclamation areas required for closure have been calculated in the “Existing Area Calculations” sheet, each area is evaluated independently to determine the specific reclamation required. These previously calculated areas are populated into a new spreadsheet page, titled “Cost Calculation Sheet”. This sheet specifies re-sloping requirements, soil cover requirements (loading, hauling and spreading) and “ripping” (ground texturing) requirements for each item as identified in the modeling of mine areas and based on the prescriptions as outlined in this Plan.

9.2.1. *Re-Sloping*

The spreadsheet requires user input into whether each area requires re-sloping, based on reclamation prescription. By entering “Yes” or “No” in the corresponding “Re-sloping (yes/no)?” box, the spreadsheet toggles on or off the re-sloping cost calculation. Re-sloping rates are based on a time/ha figure established through site tracking. A user also specifies the type of dozer to be used in completing the work.

9.2.2. *Load/Haul Time Calculation*

For areas requiring soil cover, a specific material source is specified. Sources are selected based on haul economics as well as reclamation timing (i.e., access to certain sites depending on timing in mine plan), and distances are modeled using MineSight software. For each area, a user specifies the loading equipment, haul truck and material to be loaded.

9.2.3. *Spreading*

For areas requiring soil cover, a user specifies what type of dozer will be used in completing the spreading of the material.

9.2.4. *Ripping*

The spreadsheet requires user input into whether each area requires ripping. By entering “Yes” or “No” in the corresponding “Ripping (yes/no)?” box, the spreadsheet toggles on or off the ripping cost calculation. Ripping rates are based on a time/ha established through site tracking. A user also specifies the type of dozer to be used in completing the work.

9.3. Reclamation Costing Calculations

In accordance with the MEM reporting requirements, reclamation costing is completed for both “Internal” and “External” completion of the projected work. Internal costing utilizes only equipment currently available on-site, while external costing uses industry best practices (i.e., projected best contractor efficiency/economics) in completing the projected work.

9.3.1. *Internal Costing*

Internal costing is completed using equipment currently on site in addition to internal manpower. Costing is broken down into hourly rates (summarized in the Internal Equipment Cost sheet in the spreadsheet), with equipment rates being calculated from a blended internal equipment cost compiled from data collected between 2007 and 2014 (at the time of this report, information was not available from 2015). Operator rates are not included in the equipment costing reports, and so are based on the rates outlined in the existing collective bargaining agreement between MPMC and the United Steel Workers (calculated in the spreadsheet in the Internal Labour Costs sheet). These two cost parameters feed into the sheet titled Cost Calculation Sheet, in which both internal and external costing are completed.

9.3.1.1. Re-Sloping

Re-sloping costs are calculated by predicting the amount of re-sloping hours required and multiplying this by the sum of the dozer cost per hour and the operator cost per hour. Hours required vary based on the type of surface being re-sloped: for dumps, the requirement is 35 hours/ha (site tracking data) for the slope portion of the dump as well as half (50%) of the dump top required to achieve desired slope. For all other surfaces, the hours are based on 35 hours/ha (site tracking data). Costing for the equipment is calculated as described above, and reflects the equipment selected by the user. Operator costing is as outlined above.

9.3.1.2. Load/Haul Time Calculation

Loading and hauling costs are calculated by modelling each individual haul route based on loading equipment and haul trucks specified by the user. Haul cycle calculations are completed based on optimized truck to loading ratios and the specific haul distances and loading and truck parameters. The process for the calculation is as described herein.

First, the user-defined material to be loaded and hauled is used to calculate the loose density from material properties measured on site. Next, the user-defined loading and haul truck equipment is used to populate the bucket sizing and truck capacity fields in the spreadsheet (taken from equipment specifications included in the spreadsheet sheet Haulage Specifications). Using these equipment specifications, an equipment optimization calculation is completed, using equipment loading capacity and timing (inclusive of swing time, spot time and cleanup time) matched with haulage capacity and timing (based on distance, loaded average speed, average empty speed and dump time) to calculate the optimized amount of haul trucks to be matched to the loading equipment. With the optimized loading and hauling fleet in place, the material able to be moved per hour is calculated based on these same equipment specifications, and is used to determine the total hours required to reclaim the specific area (depending on the area to be reclaimed in addition to the user-defined soil thickness to be applied).

Costing is then completed by multiplying the loading equipment hours required by the sum of the loading equipment cost per hour and the operator cost per hour and adding this to the multiplication of the haulage equipment hours required by the sum of the haul truck cost per hour and the operator cost per hour. Costing for the equipment is calculated as described above, and reflects the equipment selected by the user. Operator costing is as outlined above.

9.3.1.3. Spreading

Spreading costs are calculated by predicting the amount of spreading hours required and multiplying this by the sum of the dozer cost per hour and the operator cost per hour. Hours required are 15 hours/ha (site tracking data). Costing for the equipment is calculated as described above, and reflects the equipment selected by the user. Operator costing is as outlined above.

9.3.1.4. Ripping

Ripping costs are calculated by multiplying user-input dozer productivity (based on equipment selection) and the user-specified depth of the material to be “ripped” to attain an hourly area that can be treated (m^2/hour). Based on the total area to be treated, costing is calculated by dividing the area to be treated by the hourly treatment area rate to determine the amount of dozer hours required. Costing is completed by multiplying the required amount of dozer hours by the sum of the dozer cost per hour and the operator cost per hour. Costing for the equipment is calculated as described above, and reflects the equipment selected by the user. Operator costing is as outlined above.

9.3.2. *External Costing*

External costing is completed using industry best practices (i.e., projected best contractor efficiency/economics) in completing the projected work. Costing is broken down into hourly rates (summarized in the External Specifications & Costs sheet in the spreadsheet), with equipment rates being calculated from an average of two local contractor costs and the most current “blue book” costing. Equipment rates are modelled as “all-found” and so include all fueling,

maintenance and operation of equipment. This parameter feeds into the sheet entitled Cost Calculation Sheet, in which both internal and external costing are completed.

9.3.2.1. Re-Sloping

Re-sloping costs are calculated by predicting the amount of re-sloping hours required and multiplying this by the external dozer all-found rate. Hours are calculated as included in the internal costing section, and costing for the equipment is calculated as described above, and reflects the equipment selected by the user.

9.3.2.2. Load/Haul Time Calculation

Loading and hauling costs are calculated by modelling each individual haul route based on the use of scrapers. The process for the calculation is as described herein.

First, the user-defined material to be loaded and hauled is used to calculate the loose density from material properties measured on site. Next, a user-defined scraper parameter is used to populate the load sizing field in the spreadsheet. Using this equipment specification, an equipment optimization calculation is completed, using equipment loading capacity and timing matched with haulage capacity and timing (based on distance, loaded average speed, average empty speed and dump time) to calculate the optimized amount of scrapers to be utilized. In using scrapers, dozers are also required to push material to the equipment, and so the dozer hours required are calculated by dividing the total hours required by the size of the optimized fleet (i.e., one dozer is required while the operation is ongoing). With the optimized fleet determined, the material able to be moved per hour is calculated based on these same equipment specifications, and is used to determine the total hours required to reclaim the specific area (depending on the area to be reclaimed in addition to the user-defined soil thickness to be applied).

Costing is then completed by adding the scraper cost (total scraper hours multiplied by all-found rental cost) and the dozer cost (total dozer hours multiplied by all-found rental cost). Costing for the equipment and operator is calculated as described above, and reflects the equipment selected by the user.

9.3.2.3. Spreading

Spreading costs are calculated by predicting the amount of spreading hours required by a dozer, multiplying this by the external dozer all-found rate and adding this to the scraper dump times (as scrapers are self-spreading) multiplied by the external scraper all-found rate. Scraper spread hours are calculated from user-input dump times, and hours for the dozer are calculated as included in the internal costing section. Costing for the equipment and operator is calculated as described above, and reflects the equipment selected by the user.

9.3.2.4. Ripping

Ripping costs are calculated by predicting the amount of “ripper” hours required and multiplying this by the external dozer all-found rate. Hours are calculated as included in the internal costing

section, and costing for the equipment and operator is calculated as described above, and reflects the equipment selected by the user.

10. CONSULTATION AND ENGAGEMENT

In 2012, MPMC implemented Participation Agreements with both First Nations groups that have interest in the area: Xat'sull Cm'etem (Soda Creek/Deep Creek Band) and the T'exelc (Williams Lake Band). Through these respective Participation Agreements, Implementation Committees were formed in order to facilitate open dialogue between both Nations and MPMC for discussing environmental, social and economic matters related to mine development, operation, reclamation and closure (i.e., mine updates, permitting, environmental protection, reclamation, employment opportunities, and potential joint ventures). Meetings have taken place since March 16, 2012 with the Williams Lake Indian Band (WLIB) and since July 19, 2012 with the Soda Creek Indian Band (SCIB). Since October 18, 2012, Joint Implementation Committee meetings have been held, including representatives from MPMC, the WLIB and the SCIB. These meetings occur nominally every two months or less (quarterly at minimum) and provide a well-defined, constructive forum in which issues, reviews, and comments relating to the present and future operations of Mount Polley Mine may be discussed.

Similar discussions take place at Public Liaison Committee meetings which are held by MPMC with community stakeholders, including representatives from conservation organizations, local, regional, and provincial government, business owners, the WLIB, the SCIB, and recreation groups. These meetings were typically held bi-annually prior to the tailings dam failure and have since been increased to meeting quarterly, as per conditions of Permit 11678.

Such initiatives are undertaken by MPMC to improve understanding of operations in the region and local community; forming an integral part of the validation of a broader license to operate for Mount Polley Mine.

Relevant consultation on reclamation activities since the last Reclamation and Closure Plan Update 2012 submission are included in Table 10.1. Minutes and excerpts from minutes for all meetings (except the Williams Lake Field Naturalists and agrologists tour) are included as Appendix Y. Extensive information sharing and consultation with First Nations and relevant stakeholders has occurred related to MPMC's permit amendment applications for return to restricted operations and implementation of a short-term water discharge strategy, which have included preliminary discussions regarding development of a long-term water management strategy for the Mount Polley Mine site. Consultation activities for the return to restricted operations and short-term water discharge permit amendment applications are detailed in the corresponding consultation reports which are provided in Appendix Y.

This document will be presented in its current form at the next scheduled Joint Implementation Committee meeting and the next scheduled Public Liaison Committee Meeting; minutes of these meetings will be available upon request from the MEM for consideration as part of the review process. This document will also be shared with the Regional Mine Development Review Committee.

Table 10.1 Relevant Consultation since the Reclamation and Closure Plan Update 2012

Date	Consultation Activity	Details
December 20, 2012	Joint Implementation Committee meeting (SCIB/WLIB)	MPMC provided background information on drafting of 5 year reclamation plan and asked for general feedback and input.
January 22, 2013	Joint Implementation Committee meeting (SCIB/WLIB)	MPMC reviewed the *Reclamation and Closure Plan Update* 2012. An electronic copy of the document was provided to SCIB and WLIB, and comments requested.
March 12, 2013	Joint Implementation Committee meeting (SCIB/WLIB)	SCIB requested another copy of the report provided in the January 22, 2013 meeting, and WLIB updated that they were reviewing the document.
May 11, 2013	Public Liaison Committee meeting	Presentation on reclamation approach, research projects, and prescriptions.
August 7, 2013	WLIB Elders mine tour and discussion	Discussion of current reclamation approach and opportunity for Elders to provide feedback.
November 6, 2013	Public Liaison Committee meeting	Review of 2013 reclamation completed, 2014 reclamation plans, and long-term objectives.
June 7, 2014	Williams Lake Field Naturalists and Cariboo Central Interior Agrology Branch tour	Site reclamation tour.
June 18, 2014	Regional Mine Development Review Committee	Presentation of MPMC reclamation approaches, long-term objectives, reclamation research, and progressive reclamation projects.
September 23, 2015	Joint Implementation Committee meeting (SCIB/WLIB)	Presentation on forthcoming Reclamation and Closure Plan update, including a summary of new components to be included since last update and overview of the function of the plan. An overview of the conceptual Springer Pit spillway design. [minutes not yet available]
October 7, 2015	WLIB (SCIB was invited, but unable to attend last minute)	Participation in MEM reclamation inspection.
September 30, 2015	Submission of Reclamation and Closure Plan update for return to restricted operations	This updated plan was shared with the Regional Mine Development Review Committee, which includes representation from First Nations, relevant government agencies, and local stakeholders

11. CLOSURE

This Plan reflects a comprehensive and accurate representation of currently planned mining, construction, environmental monitoring, and reclamation. Project planning and review conducted internally by Mount Polley employees and externally by consultants confirms that all aspects of the project are feasible and abide by the regulations of all governing bodies. Consultants and Qualified Professionals were retained to complete work deemed to be outside the expertise of in-house personnel, as outlined in Table 11.1. Work by consultants to MPMC is primarily included as appended reports or technical memos. The information presented in this Plan is consistent with the level of care and skill normally exercised by professional scientists and engineers, or similar, currently practicing under similar conditions. Results, conclusions and recommendations are based on information known at the point of report publication, and are based on any described assumptions. These results, conclusions and recommendations and may change with the availability of additional information.

Table 11.1 Qualified Professionals (retained and in house) responsible for completing components of MPMC's Reclamation and Closure Plan Update 2015

Report Component	Qualified Professional(s)
Mine Planning	Ryan Brown, P.Eng. (MPMC)
Geotechnical stability (Springer Pit)	Ed Saunders, M.EngSci. (Golder) Al Chance, P.Eng. (Golder)
Spillway designs	James Ogilvie, P.Eng. (Golder) Allan Bronsro, MCIP, M.Sc., P.Eng. (Golder)
Effluent source term development Ore stockpile geochemistry	Stephen Day, M.Sc, P. Geo. (SRK) Chris Kennedy, Ph.D., P.Geo. (SRK)
Effluent modelling	Kristina Skeries, M.Sc. (Golder) Skya Fawcett, Ph.D., P.Geo. (Golder) Jerry Vandenberg, M.Sc., P.Eng. (Golder)
Water balance modelling Water management planning	Skya Fawcett, Ph.D., P.Geo. (Golder) Johanna F. Richards, M.Sc., P.Eng. (Golder) Robert G. Millar, Ph.D., P.Eng., P.Geo. (Golder) Jerry Vandenberg, M.Sc., P.Eng. (Golder) Lee Nikl, M.Sc., R.P.Bio. (Golder)
Hydrogeology	Willy Zawadzki, P.Geo. (Golder) Don Chorley, P.Geo. (Golder)
Reclamation – re-vegetation and soil management	Katie McMahen, P.Ag. (MPMC) Moss Giasson, P.Ag. (Montane Environmental Services) Ruth McDougall, M.Sc, P.Ag. (Consulting Agrologist) Ronald Meister, P.Ag., RPF (Forestmeister Services)
Reclamation liability costing	Luke Moger, PMP (MPMC)
Contaminated sites assessment	Trish Miller, M.Sc, R.P.Bio. (Golder) Reidar Zapf-Gilje, Ph.D., P.Eng. (Golder)
Fugitive dust management Particulate monitoring	Jeffrey Ramkellawan, M.Sc., P.Eng. (Golder) Sean Capstick, P.Eng. (Golder) Rachel Wyles, M.Eng., P.Eng. (Golder)

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[1] No lead author listed. The research in the T'exelc community was supervised and conducted by Elected Band Councillor Rick Gilbert, assisted by community member Jamie Thomas, and Elder Jean William, under the direction of Aaron Higginbottom, Natural Resource Manager. The research in the Xatśūll community was supervised and conducted by Donna Dixon and Sheri Sellars, under the direction of Jacinda Mack M.A., Manager, Natural Resources with the assistance of Chus Sam Natural Resources Referral Coordinator. Xatśūll community member Teena Sellars led field tours in the study areas. Erin Robinson M.A., conducted interviews in Likely and transcribed interviews. Final report edits were conducted by Jacinda Mack. Archival, archaeological and historical research and report preparation was undertaken by Aaron Blake Evans M.A. Project organization, training, supervision and report preparations were undertaken by Beth Bedard PhD Candidate. Final graphic report layout and production by CopperMoon.

APPENDIX A:

BASELINE ENVIRONMENTAL SETTING AND LAND CAPABILITY

Mount Polley Mine Site Baseline Environmental Setting and Land Capability

Contents

1. Soils 4
   1.1. Terrain 4
   1.2. Soil Land Capability 5
2. Vegetation Classification 7
   2.1. Zonal Site Series (ICHmk3/01) 7
   2.2. Xeric to Subxeric Site Series (ICHmk3/02, ICHmk3/03) 8
   2.3. Mesic to Moist Nutrient-Rich Site Series (ICHmk3/04, ICHmk3/05) 9
   2.4. Moist, Very Rich Sites (ICHmk3/06, ICHmk3/07) 10
   2.5. Non-Forested Organic Sites 10
3. Wildlife and Wildlife Habitat 12
   3.1. Wildlife Species Present 12
      3.1.1. Amphibians 14
      3.1.2. Waterfowl, Shorebirds and other Water-Oriented Birds 14
      3.1.3. Upland Game Birds 14
      3.1.4. Birds of Prey 15
      3.1.5. Woodpeckers and Songbirds 15
      3.1.6. Small Mammals (Insectivores, Hares and Rodents) 16
      3.1.7. Carnivores 17
      3.1.8. Ungulates (Hoofed Animals) 19
   3.2. Species at Risk 20
   3.3. Wildlife Habitat Classification 23
      3.3.1. Clear-cuts 24
      3.3.2. Mid-Seral Forests 25
      3.3.3. Selectively Logged Areas 25
      3.3.4. Mature and Old Growth Forests 26
      3.3.5. Forests on Southern and Western Aspects 26
      3.3.6. Non-forested Rock Cliffs and Talus 26
      3.3.7. Riparian Forest Habitat Complex 26
      3.3.8. Riparian Habitats near Small Streams 27

3.3.9. Shrub Carr/Sedge Fen Habitat Complex 27
3.3.10. Marsh/Shallow Open Water Habitat Complex 28
3.3.11. Small and Medium-sized Lakes (< 1000 hectares) 28
3.3.12. Large Lakes and Reservoirs (>1000 hectares) 28
3.3.13. Urban Areas 28
3.3.14. Transportation/Transmission Corridors 28
4. Fisheries and Aquatic Resources 30
4.1. Limnology 30
4.2. Fisheries Resources 32
4.2.1. Regional 32
4.2.2. Local Fisheries 32
4.2.3. Fish Tissue Analysis 35
4.3. Sediments 37
4.3.1. Creeks 37
4.3.2. Lakes 38
4.4. Gravel Quality 39
4.5. Benthic Invertebrates 39
4.5.1. Creeks 39
4.5.2. Lakes 41
4.6. Zooplankton 42
4.7. Phytoplankton 45
4.8. Periphyton 47
5. Historic Land Uses 49
5.1. Forest Resources 49
5.2. Range Management 49
5.3. Hunting, Guiding, and Trapping 50
5.4. Recreation 50
5.4.1. Creel Surveys 51
5.5. Culturally and Environmentally Sensitive Areas 51
6. Prior Land Uses of Site Reclamation Units 52
6.1. Mill and Plant Area 52
6.2. Open Pits 52

6.3. Waste Rock Dumps 53
6.4. Tailings Storage Facility 54
7. References 56

The following sections are primarily excerpts from *The Mount Polley Mine Project Reclamation Plan* (Hallam Knight Piésold, 1996a), supplemented with information from more recent reports (references included).

1. SOILS

1.1. Terrain

Using airphoto interpretation, Blashill (1995a) conducted a preliminary terrain analysis of the Mount Polley project area. The principal terrain units are blankets and veneers of glacial atill (Mb and Mv), colluvial veneers (Cv), and gently to steeply sloping bedrock knobs (Rj to Rk). He also identified units of organic terrain (Ob and Obv) overlying glaciolacustrine materials (L^G). There are many small outcrops of bedrock, most of which are covered by thin veneers of glacial till, colluvium, or mixtures of the two. Even where soils are deeper, bedrock is usually found at depths of approximately 3 to 7.6m.

Veneers (less than 50cm thick) and blankets (more than 50cm thick) of morainal material are the most extensive landforms in the Mount Polley area. These morainal materials, also known as glacial till, were laid down by glacier ice, and they show little evidence of any subsequent reworking by water. Tills are generally poorly sorted, so that they contain a wide range of particle sizes, and the particles are often rounded and derived from a variety of rock sources. The morainal deposits at Mount Polley correspond to the Lanezi soil association of Lord (1984). Lanezi soils are loams oils developed on morainal materials deposited along the boundary zone of the Quesnel Highland. Parent materials range from load to clay loam with an acid to neutral reaction, and with moderate amounts of stones and gravel. In the Mount Polley are, Lanezi soils often occur in complexes with the Dragon soil association, which is described below. Soils mapped as Lanezi-Dragon units may contain 30 to 50% inclusions of the colluvial soils of the Dragon Association.

Veneers of colluvium, less than 1m thick, are the second most common landform in the project area. They are best expressed on the bedrock knobs and ridges in the Bell Pit and Springer/Cariboo Pit areas, as well as near the summit of Mount Polley itself, in Terrain Units #1 and #3 (Blashill, 1995a). “Colluvium” refers to soil materials that have been redistributed by gravity. Colluvium sometimes shows a degree of sorting by size, with the larger particles occurring farther downslope than the smaller ones. In contrast to till, coluvial particles often have rougher, more angular edges and they have the same lithology as the betrock occurring upslope from a colluvial deposit. The colluvial units recognized by Blashill (1995a) correspond to the Dragon and Lanezi-Dragon soil associations. Dragon soils are loamy and sandy soils developed on strongly sloping terrain at elevations above 900m.

Galciolacustrin landforms (L^G) ar those that have originated within the basins of proglacial lakes. Although Lord (1984) did not map glaciolacustrine landforms within the Mount Pole area itself, he showed extensive glaciolacustrine areas adjacent to the upper Quesnel and lower Cariboo rivers. He assigned these units to the Bednesti soil association, which includes fine loamy soils developed on silty, stratified glaciolacustrine deposits. These soils generally have a low stone content, are fine-textured, and often have a varved or layered appearance. Blashill (1005) reported that deep excavations by

engineering staff found glaciolacustrine deposits beneath a surficial till in the proposed tailings area, although the glaciolacustrine deposits were not continuous. IN that area, the sediments were up to 20m thick over bedrock.

Glaciofluvial landforms include both erosion and depositional landforms that have been formed by the water from melting glaciers. Lord (1984) did not recognize any glaciofluvial deposits within the Mount Polley area itself, although he mapped two such areas nearby. One such area ws int eh valley northwest of Polley Lake, and a second in the valley containing Prior and Little Lakes. He assigned these units to the Ptarmigan-Catfish Creek soil complex, which referes to sandy-sekeltal soils developed on glaciofluvial material at elevations from 900 to 1200m, which also contain significant inclusions of sedge fen peat. Blashill (1995a) did no note any glaciofluvial landforms within the Mount Polley area.

Organic landforms are the result of biological activity. In the Moutn Polley area, organic landforms are the result of the centrurues if accumu.ation sedge or moss peat. Lord (1984) assigned these units to the Catfish Creek-Spakwaniko (CC-SW) soil landscape complex, and mapped two such units in the Mount Polley area. The units are the small wetland at the south end of Polley Lake, and that within the southern portion of the tailings area. Blashill (1995a) mapped a small area of organic terrain northeast of the Main Pit (Terrain Unit #5), and two small organic unites within the tailings area.

A terrain classification map for the site and a soil/landform classifications map are provided as Figures 2.1 and 2.3[1] (extracted from Hallam Knight Piésold Ltd., 1996a).

Detailed soil and landform inventories have been completed across the site prior to development of the mine (Blashill, 1995a; Blashill, 1995b; Meister, 1998; Meister, 2001; Meister, 2004; Meister, 2005; Meister 2006; Meister, 2010), and can be referenced for further details.

1.2. Soil Land Capability

The Land Capability for Agriculture in BC contains 7 classes differentiated on the basis of the inherent capability of soils and climate to support agricultural crops. There was no agriculture practiced in the area and agriculture is not planned as an end land use at mine closure; however, agriculture land capability was assessed in soil and landform inventories completed across the site (Blashill, 1995a; Blashill, 1995b; Meister, 1998; Meister, 2001; Meister, 2004; Meister, 2005; Meister 2006; Meister, 2010). There is no climatic moisture deficit (CMD) number for the Mount Polley area, but the climatic capability for most of the site was mapped as 3GF. The CMD was estimated to be the minimum for the Class 3 unit, 116 mm, and based on average site soil conditions, the soil moisture deficit (SMD) was estimated to be 56.5 mm. This places the mine site in Class 2A for moisture limitations. The SMD calculated for each soil pit does not improve or increase the moisture limitations beyond Class 2A. Improved ratings were based on topographic changes due to bedrock removal, stone picking and improved drainage, although classes 6 and 7 normally have no improved rating. The depth to bedrock (R) and the climatic capability (3C) (limited by a short frost-free period and low thermal class) remain the

[1] MPMC is currently working to develop digitized versions of these map.

limiting factors for agricultural production. Overall the agricultural capability for the site is poor. None of the land in the project area is included in the Agricultural Land Reserve.

The soil map units are rated as suitable for forestry. The Ministry of Forests and Range site index estimates by site series for Mount Polley are 24 meters for Douglas-fir and lodgepole pine, and 21 meters for spruce. This site index provides a numeric description of site productivity for a particular target species; this is the height of the largest diameter (at breast height) site tree on a 0.01 ha plot at age 50, provided the tree is suitable for measurement (Ministry of Forests and Range, 2006). Due to favorable climatic and soil conditions, this site is very productive in terms of timber for a B.C. Interior site.

2. VEGETATION CLASSIFICATION

Biogeoclimatic maps of the Cariboo Forest Region indicate that the Mount Polley site is located within the Horsefly Moist Cool variant of the Interior Cedar-Hemlock Biogeoclimatic Zone (ICHmk3), which occurs between Quesnel and Horsefly Lakes, in the valley of McKinley Creek, and near Canim Lake. Table 2.1 provides a summary of the ICHmk3 site series. The dominant trees on upland sites in the ICHmk3 are Douglas-fir, Western red cedar, hybrid spruce, and subalpine fir. Lodgepole pine, trembling aspen, and paper birch are also present in the early stages of forest succession. The forests in lower valley bottoms are often dominated by hybrid spruce and black cottonwood.

Field surveys of the Mount Polley site have found that the dominant trees in mature and old growth stands are Western red cedar, Douglas-fir, and subalpine fir. Subalpine fir usually dominates the seedling regeneration in mid-seral, mature, and old forests. Black cottonwood dominates the early stages of forest succession after logging, while trembling aspen and paper birch are usually secondary species. Western hemlock is present in the area, but rare. Large portions of the project area have been selectively logged to remove the largest Douglas-firs and Western red-cedars, and some clearcut sites have been replanted with lodgepole pine seedlings. Hybrid spruce occur sparingly on lower, middle and upslope positions in the Mount Polley site area, and is most common near streams and lakeshores.

Table 2.1 Interior Cedar Hemlock Horsefly Moist Cool Variant vegetation summary

Site Association	Moisture Regime	Slope Position	Gradient (%)	Aspect	Parent Material	Vegetation
ICHmk3/01	mesic, submesic	middle	0 - 20	variable	gravelly, loamy morainal blanket	western redcedar, subalpine fir, falsebox, black huckleberry, bunchberry round-leaved violet, foamflower, rosy twistedstalk, red stemmed feathermoss
ICHmk3/02	xeric, subxeric	crest	0 - 10	variable	loamy gravelly moraina veneer over	Douglas-fir, western redcedar, saskatoon, soopolallie, pussytoes, wild strawberry, white hawkweed, juniper haircap moss, lichens
ICHmk3/03	subxeric, xeric	upper	50 - 70	variable	gravelly loamy colluvial veneer over morainal blanket	Douglas-fir, western redcedar, saskatoon, soopolallie, rough-leaved ricegrass, wavy-leaved moss, Peltigera sp. Mosses not forming carpet-like ground cover.
ICHmk3/04	subhygric, mesic	lower, middle	10 - 35	variable	loamy morainal blanket	western redcedar, falsebox, devil's club, (10% cover or less), foamflower, oak fern (average cover 30%), leafy mosses, red-stemmed feathermoss
ICHmk3/05	subhygric	middle, lower	10 - 35	variable	loamy morainal blanket, silty fluvial blanket	hybrid white spruce, subalpine fir, thimbleberry, black twinberry, red-osier dogwood, fringed aster, sweet-cicely, ragged moss. Shrubs diverse and abundant up to 70% cover.
ICHmk3/06	subhygric, mesic	lower, middle	0 - 25	variable	loamy morainal blanket, loamy to silty fluvial blanket	hybrid white spruce, subalpine fir, devil's club (up to 40% cover), black gooseberry, lady fern, oak fern, enchanter's nightshade, stream violet, leafy mosses. Trees and shrubs show good to excellent vigour.
ICHmk3/07	hygric	toe or depression	0	level	loamy morainal or fuvial blanket	hybrid white spruce, western redcedar, red-osier dogwood, black twinberry, devil's club (average 10% cover), horsetails, soft-leaved sedge, American brooklime, leafy mosses, ragged moss. Thallose liverworts in depressions and moss layer very diverse.
Non-forested unit	subhygric	depression	0	level	organic blanket	hybrid white spruce and lodgepole pine, when present occur as stunted trees. Scrub birch, Labrador-tea, hardhack, sedges, sphagnum mosses.

2.1. Zonal Site Series (ICHmk3/01)

"Zonal" sites are those of average moisture and nutrient conditions, on moderate to gentle slopes. This site series occurs on gentle slopes of 0 to 50°, generally on till blankets, which are sometimes mantled with colluvial veneers where slopes range from 35 to 50°.

According to Steen (1989), mature and old stands on zonal sites are dominated by Western red cedar and subalpine fir, with an understory of falsebox, black huckleberry, bunchberry, round-leaved violet, and foamflower. The herb and shrub layers are relatively poorly developed (especially on north and northeastern aspects), and the forest floor tends to be carpeted with feather mosses, especially red-stemmed feather moss.

Baseline field studies found that the vegetation of zonal sites to be much richer and more diverse. Much of the project area was selectively logged in the 1970's, when the larger, merchantable Douglas-firs and Western redcedars were removed. Selective logging removed the tallest trees in the canopy, but left smaller conifers, advance seedling regeneration by subalpine fir, and large back cottonwoods in place. Much of the mine development area now supports a mixed forest with a sparse canopy of veteran conifers; a moderately dense pole sapling cover of subalpine fir, Western red cedar, and Douglas; and a dense tall shrub canopy of black cottonwood, Sitka alder, Douglas maple, Scouler willow and Bebbian willow. Most cut-over stands have a luxuriant low shrub understory dominated by red elderberry, black huckleberry, black twinberry, various willows, thimbleberry, western mountain-ash, prickly currant, and wild red raspberry. The herb layer in cut-over areas is also well-developed on zonal sites and is dominated by fireweed, bluejoint, and other grasses, Solomon's seal, twinflower, and bunchberry.

2.2. Xeric to Subxeric Site Series (ICHmk3/02, ICHmk3/03)

The driest sites on steep south-facing slopes and ridge crests belong to the ICHmk3/02 and ICHmk3/03 site series. Such sites are dominated by open to closed forests of Douglas-fir and Western red cedar. Common shrub species in the understorey are Saskatoon, soopalallie, and common herbs, including pussytoes, wild strawberry, white-flowered hawkweed, and rough-leaved rice grass. Juniper hair cap moss and lichens dominate the forest floor on very dry sites, while rough-leaved rice grass, wavy-leaved moss, and dog's-tongue lichen are characteristic species of slightly moisture sites (Steen, 1989).

Baseline field surveys found the driest sites (on ridge crests) with thin, rapidly drained soils conforming to 02 and 03 site series. The 02 site series is found on south- or west-facing ridge crests where soil depths less than 20 cm and it has a very localized distribution. They are dominated by an open forest of lodgepole pine and Douglas-fir. The tall shrub understorey is dominated by an advance regeneration of subalpine fir seedlings, but is otherwise poorly developed. The low shrub understory is dominated by black huckleberry, birch-leaved spiraea, falsebox, prickly rose and prince's pine. Common juniper is very scarce at Mount Polley. The herb layer is generally poorly developed, usually making up less than 1% of the groundcover. Twinflower, white hawkweed, and hear-leaved arnica are the most prominent herbs. The common mosses are red stemmed feather moss, juniper hair cap moss and dog's tongue lichen. Though usually present with low cover, coral lichen is never dominant.

Stands conforming to the 03 site series are more widespread, generally where soils are 20 to 50 cm deep, on upper slope positions. These sites are distinguished from the 02 by:

- A somewhat more vigorous growth of Douglas-fir, lodgepole pine, and subalpine fir;
- The presence of occasional Western red cedar;

- The presence of Sitka alder, Saskatoon, Western mountain-ash, and tall willows in the tall shrub understory;
- Higher coverage and greater species diversity in the low shrub and herb understory;
- Fair to good development of bear's hair and witches' hair lichens in the epiphyte layer.

An 03 site immediately west of the mill area was selectively logged in the 1970's, resulting in the removal of some very large Douglas-firs and Western red cedars with stump diameters of 70 to 100 cm. The cut-over area was slash-burned, and the natural vegetation was allowed to regenerate. The resulting forest provides excellent summer range for mule deer and moose. This stand has a very variable, patchy cover by Western red cedar, subalpine fir, black cottonwood, alder, and willow, and a very rich shrub understory with several very palatable species, such as Western mountain-ash, Saskatoon, wild rose, and willows. Many of the common shrub species are berry-producing, and important factor for black bears and birds, such as cedar waxwing, bohemian waxwing, America robin, and other thrushes.

2.3. Mesic to Moist Nutrient-Rich Site Series (ICHmk3/04, ICHmk3/05)

These sites occupy middle and lower slopes, with gradients of 10 to 35°. They often receive inputs of moisture and nutrients from overland seepage, and are usually associated with deep blankets (soil depths greater than 50 cm) of glacial till or fluvial deposits.

According to Steen (1989), site series 04 is dominated by western red-cedar, oak fern (30% cover), falsebox, foamflower, and red-stemmed feather moss. Devil's club has a cover of less than 10%. On the slightly moisture 05 site series, hybrid spruce and subalpine fir become increasingly dominant in the tree canopy. The shrub layer is much better developed than on zonal sites, and is dominated by thimbleberry, black twinberry, black gooseberry, and red-osier dogwood. The herb layer is also much lusher, and is dominated by species such as oak fern, fringed aster, wild sarsaparilla, lady fern and sweet-cicely. Leafy mosses and ragged mosses become increasingly important in the moss layer as moisture and nutrient levels increase.

Field studies at Mount Polley found many sites that generally conform to the 04 and 05 series, however many of these sites have been selectively logged, then slash-burned, so that the actual vegetation is atypical. Selectively logged areas are dominated by a mixed forest of black cottonwood, Douglas-fir, and subalpine fir. These sites typically have a very well-developed tall shrub understory dominated by black cottonwood seedlings, aspen poplar, Sitka alder, Douglas maple, Scouler willow, and Bebbian willow. The low shrub understory is also well developed, and often includes thimbleberry, black huckleberry, oval-leaved blueberry, red elderberry, black twinberry, black gooseberry, and wild raspberry. The herb understory is often very rich, and usually includes oak fern, lady fern, false Solomon's-seal, star-flowered Solomon's –seal, rosy twisted stalk, bunchberry, fireweed, and one-leaved foamflower. Some 04 and 05 sites near Bootjack Lake have been set back to a very early stage of succession, and are dominated by black cottonwood, alder, willows, fireweed, pearly everlasting, dandelion and various tame grasses, legumes, and weeds.

Mature and older forests in the 04 and 05 site series tend to be dominated by species that are of relatively low palatability to ungulates, the main exception being red-osier. These mature stands almost always have excellent growths of arboreal lichens, notably witches' hair and bear's hair, growing in thick beards up to 30 cm long. These arboreal lichens may provide an important forage source for mule deer, particularly in the early spring. Many of the dominant shrub species are good berry-producers, a feature that may be important to black bears and some songbirds.

Forest regeneration following logging has had varying degrees of success in the Mount Polley area. In some areas, selective logging has actually improved the area's capability as summer habitat for moose and mule deer by removing the tree canopy and allowing more light on the herb and shrub understory. Removal of the coniferous tree canopy has increased the cover of several highly palatable forage species, notably black cottonwood, trembling aspen, Scouler and Bebbian willow, Western mountain-ash, Saskatoon, red-osier dogwood, and red elderberry.

2.4. Moist, Very Rich Sites (ICHmk3/06, ICHmk3/07)

They are found at the toes of long slopes in riparian habitats and in topographic depressions. These sites are associated with deep blankets of morainal or fluvial materials. They are often dominated by forests of hybrid spruce and Western red cedar, with an understory of red-osier, black twinberry, devil's club, horsetails, soft-leaved sedge, American speedwell, and various mosses. Tree growth is good to excellent in these sites, and the shrub cover is usually lush and diverse.

At Mount Polley, site series 06 is readily recognized by the devil's club cover of up to 40%. Other prominent plant indicators include oak fern, spiny wood-fern, lady fern, foamflower, false Solomon's-seal, rosy twisted stalk, and clasping twisted stalk. As good example, is SE of the mill site. Another is adjacent to the Bootjack Lake Recreation Site. A small tract of mature forest of the 06 site association occurred in the north-central portion of the Tailings Storage Facility (TSF) area, and extensive areas of large stumps indicate that it may have been much more extensive before clear-cutting in the 1970's.

Site series 07 is not found within the mine development area itself, although a good example of this vegetation occurs in the riparian zone of Hazeltine Creek, about 3 km east of the tailings area. That area supports very tall, vigorous stands of hybrid spruce and black cottonwood. Smaller examples may occur near the shores of Bootjack and Polley Lakes. These areas may be important foraging areas for bears, and wintering for moose and mule deer. Horsetail, sedges and red-osier dogwood are particularly important forage species.

2.5. Non-Forested Organic Sites

There was a wetland in the south-western portion of the tailings area. The vegetation adjacent to the pond is dominated by poor-fen sphagnum, common green sphagnum, and narrow-leaved cottongrass, and it had many plant indicators of true bog conditions, such as Labrador-tea, buck-bean, narrow-leaved sundew, bog laurel and sphagnum mosses. The pond itself was surrounded by floating mats of sphagnum and cotton grass, but there is no emergent zone of sedges, cattails, or bulrushes. The

submergent zone is also poorly developed, consisting of a single plant of yellow pond lily. A shrub wetland northeast of the pond was dominated by dense thickets of hardhack, Sitka alder, and tall willows. Where willows were a significant component of the vegetation, these shrub carrs may be important wintering areas for moose. In this wetland, scrub birch, Sitka alder, Labrador-tea, and hardhack were the only important shrub species, and its value for ungulates was low.

3. WILDLIFE AND WILDLIFE HABITAT

Baseline wildlife and wildlife habitat reconnaissance was completed in 1995 by Knight Piésold to guide reclamation activities for optimising wildlife habitat after mine closure. The major findings of this study were:

1. The project will have negligible effects on local and regional populations of raptors, waterfowl, other water birds, and shorebirds.
2. The songbirds found in the mine development area also found outside the mine development area in large populations.
3. The project will not cause any wildlife population to disappear from the local area or from the surrounding region.
4. So far as can be determined, the project will not result in the loss of mineral licks, winter yarding areas, migration corridors, or rutting areas used by ungulates.
5. The project will not affect specialized wildlife habitats such as caves, cliffs, or canyons.
6. The wetland in the tailings area has a small area of less than 10 ha, and it has a low capability for waterfowl, shorebirds, wetland songbirds and moose. Mine development will displace one colony of beavers in this wetland.
7. The project will not affect the ability of wildlife to use or gain access to Polley or Bootjack Lakes.
8. Although most mine development will take place on the areas that have been selectively logged or clear-cut, the project will displace small areas of mature forest habitat.
9. The project will displace small numbers of mule deer and moose from summer and autumn rages that they currently use. However, alternate ranges of comparable quality exist in adjacent areas and improved grazing will be available in reseeded areas.

3.1. Wildlife Species Present

The baseline wildlife study identified 44 bird species and 10 mammal species in the project area, with another 18 bird species identified in the surrounding region. These species are listed in Table 3.1.

Table 3.1 Checklist of the wildlife of the Mount Polley Mine and adjacent areas near Likely, B.C.

Notes:

BIRDS	
* Common Loon	*Gavia immer*
*Green-winged Teal	*Anas crecca*
*Mallard	*Anas Pltyrhynchos*
*Bufflehead	*Bucephala albeola*
*Bald Eagle	*Haliaeetus leucocephalus*
*Sharp-shinned Hawk	*Accipiter striatus*
*Blue Grouse	*Dendragapus obscurus*
Spruce Grouse	*Dendragapus Canadensis*
Ruffed Grouse	*Bonasa umbellus*
*Sharp-tailed Grouse	*Tympanuchus phasianellus*
White-tailed Ptarmigan	*Lagopus leucurus*
*Killdeer	*Charadrius vociferus*
*Greater Yellowlegs	*Tringa melanoleuca*
Spotted Sandpiper	*Actitis macularia*
*Common Snipe	*Gallinago gallinago*
*Sandhill Crane	*Grus Canadensis*
*Great Blue Heron	Ardea herodias
Belted Kingfisher	*Ceryle alcyon*
*Northern Flicker	*Colaptes auratus*
*Yellow-bellied Sapsucker	*Sphyrapicus varius*
Downy Woodpecker	*Picoides pubescens*
*Three-toed Woodpecker	*Picoides tridactylus*
*Black-backed Woodpecker	*Picoides arcticus*
*Pileated Woodpecker	*Dryocopus pileatus*
*Western Wood-Pewee	*Contopus sordidulus*
*Olive-sided Flycatcher	*Contopus borealis*
*Hammond's Flycatcher	*Empidonax hammondii*
*Willow Flycatcher	*Empidonax traillii*
Violet-green Swallow	*Tachycineta thalassina*
Cliff Swallow	*Hirundo pyrrhonota*
*Barn Swallow	*Hirundo rustica*
*Gray Jay	*Perisoreus Canadensis*
Steller's Jay	*Cyanocitta stelleri*
*Common Raven	*Corvus corax*
*Common Crow	*Corvus brachyrhynchos*
Black-capped Chickadee	*Parus atricapillus*
*Mountain Chikadee	*Parus gambeli*
*Boreal Chikadee	*Parus hudsonicus*
*Red-breasted Nuthatch	*Sitta Canadensis*
*Winter Wren	*Troglodytes troglodytes*
*Golden-crowned Kinglet	*Regulus strapa*
*Ruby-crowned Kinglet	*Regulus calendula*
*Townsend's Solitaire	*Myadestes townsendi*
*Swainson's Thrush	*Catharus usstulatus*
*American Robin	*Turdus migratorius*
*Varied Thrush	*Ixoreus naevius*
European Starling	*Sturnus vulgaris*

BIRDS (continued)	
*Warbling Vireo	*Vireo gilvus*
*Solitary Vireo	*Vireo solitaries*
*Orange-crowned Warbler	*Vermivora celata*
Nashville Warbler	*Vermivora ruficapilla*
*Yellow-rumped Warbler	*Dendroica coronate*
*Magnolia Warbler	*Dendroicamagnolia*
*Blackpoll Warbler	*Dendroicastriata*
*Townsend's Warbler	*Dendroica townsendi*
*MacGillivray's Warbler	*Oporornis tolmiei*
*Common Yellowthroat	*Geothlypis trichas*
*Wilson's Warbler	*Wilsonia pusilla*
*Common Redstart	*Setophaga ruticilla*
*Western Tanager	*Piranga ludoviciana*
*Chipping Sparrow	*Spizella passerine*
*Lincoln's Sparrow	*Melospiza lincolnii*
*Song Sparrow	*Melospiza melodia*
*Dark-eyed Junco	*Junco hyemalis*
Red-winged Blackbird	*Agelaius phoeniceus*
Brown-headed Cowbird	*Molothrus ater*
*Pine Siskin	*Carduelis pinus*
*Evening Grosbeak	*Coccothraustes vespertinus*

MAMMALS	
*Snowshoe Hare	*Lepus americanus*
*Northwestern Chipmunk	*Tamias amoenus*
*Red Squirrel	*Tamiasciurus hudsonicus*
*Beaver	*Castor Canadensis*
*Coyote	*Canis latrans*
*Gray Wolf	*Canis lupus*
Red Fox	*Vulpes vulpes*
*Marten	*Martes americana*
Fisher	*Martes pennanti*
*Long-tailed Weasel	*Mustela frenata*
River Otter	*Lontra canadensis*
Wolverine	*Gulo gulo*
* Cougar	*Felis concolor*
* Lynx	*Lynx canadensis*
*Black Bear	*Ursus americanus*
* Grizzly Bear	*Ursus arctos*
*Mule Deer	*Odocoileus hemionus*
*Moose	*Alces alces*

1) Asterisk (*) indicates the species has been recorded in the Mount Polley Mine area. Note that some bird species without an asterisk have likely been observed, but not recorded.
2) Species names follow the system of scientific names currently used in British Columbia (Luttmerding et al., 1991).

3.1.1.*Amphibians*

During field studies in the mine development area in May-June 1995, only one adult frog or toad was seen, which escaped before it could be identified. Frog tadpoles, which could not be identified to species, were recorded in a beaver pond outside the project area, near “Ditch Road” Forest Service Road.

3.1.2.*Waterfowl, Shorebirds and other Water-Oriented Birds*

The Mount Polley project area has a relatively diverse land bird fauna, but relatively few species of waterfowl, shorebirds and other water-oriented birds. There is a greater diversity of aquatic habitats outside the project area, at Bootjack, Polley, Morehead, Prior and Quesnel Lakes, and at Hazeltine Creek and the Quesnel River. There is a correspondingly greater diversity of water birds and wetland species outside the project area.

Within the project area itself, potential habitat for waterfowl and shorebirds is limited to a small 3-ha bog pond in the southwestern portion of the proposed tailings area, the surrounding 2-ha wetlands, and to short sections of the tributary to South Edney Creek. In May-June 1995, the known waterfowl population of the mine development area consisted of one pair of green-winged teal, and a trio of a male and two female buffleheads. At most, the shorebird population may have amounted to one or two pairs of killdeer, greater yellowlegs and common snipe.

Two sandhill cranes were recorded in the tailings area on 27 July 1989, and a greater blue heron was recorded at the Upper Hazeltine Bridge on 15 August 1989 (Imperial Metals Corporation 1990). Neither of these species was recorded in the project area in May-June 1995, and their present status in the project area is uncertain.

The only other water-oriented birds recorded in the project area in May-June 1995 were songbirds that characteristically occur in wetlands, such as willow flycatcher, common yellowthroat, song sparrow and Lincoln’s sparrow.

3.1.3.*Upland Game Birds*

The only grouse record for the mine area is one of a pile of winter grouse droppings in the Maine Pit area, in a cut-over tract of red cedar-Douglas-fir forest. However, according to Mr. Robert Toupin, a long-time resident, five grouse species occur in the Likely area. These are the ruffed grouse, blue grouse, spruce grouse, sharp-tailed grouse and white-tailed ptarmigan. Of these species, the ruffed grouse is usually found in deciduous and mixed-wood forest, and the blue grouse is usually found in mature to old coniferous forests dominated by western red cedar and Douglas-fir. Mr. Toupin reports that a flock 10-20 sharp-tailed grouse regularly frequents the East corner of the tailings area.

3.1.4.*Birds of Prey*

Though they actively looked for them, Hallam Knight Piésold staff did not record any birds of prey in the mine development area during field studies in May-June 1995. Though they searched for them intensively in the mine area, HKP did not find any large stick nests, large nesting cavities, "whitewashed" cliffs or rock outcrops, which could indicate potential nest sites for a variety of raptors.

An unidentified hawk was recorded at Bootjack Creek on 15 October 1989 (Imperial Metals Corporation 1990). Only two species of raptors were recorded during field studies in May-June 1995, both well outside the proposed mine development area. These records were of a sharp-shinned hawk at Km 11 on the "Ditch Road", and of a pair of barred owls heard calling at Likely in the early morning of 30 May 1995.

Robert Toupin states that there was a pair of bald eagles on Polley Lake in 1995, although he did not record a nest location. HKP did not record any eagles on Polley, Bootjack or Morehead Lakes during field studies in May-June 1995. There appears to be little or no foraging habitat for bald eagles within the mine development area. The bog pond does not contain fish, while the small creeks draining the mine and mill area dry up by mid-summer. There may be a small amount of fish habitat in the tributary to South Edney Creek, which could provide a limited amount of foraging habitat for eagles.

3.1.5.*Woodpeckers and Songbirds*

Five woodpecker species were recorded in the mine development area, and a sixth was recorded in the village of Likely. None of these species is considered rare in British Columbia. The yellow-bellied sapsucker is often associated with deciduous woodlands, particularly those dominated by aspens or birches. The northern flicker is a common and widespread species, found in both deciduous and coniferous forests, as well as in aspen parkland. The downy woodpecker, which was recorded twice at Likely, is more characteristic of deciduous or mixed forests. Pileated woodpecker diggings were found in large western red cedars at four locations in the mine development area. Both the black-backed woodpecker and its close relative, the three-toed woodpecker, occur in mature cedar and Douglas-fir forests in the mine development area. An active nest of three-toed woodpeckers was found on 10 June 1995 in an old growth western red cedar – Douglas-fir forest, east of the North Pit area.

Between 29 May and 12 June 1995, nearly 30 species of songbirds were recorded in the mine development area, and another 10-15 species were recorded between Mount Polley and Likely. Songbirds were the most numerous and frequently recorded wildlife group in the Mount Polley area. From 8-12 June 1995, Hallam Knight Piésold used call counts to index the relative abundance of songbirds in the project area. Twelve locations in the mine development area were sampled, over a total of 17.6 km of transect length. Results of call counts are discussed in Section 3 of Hallam Knight Piésold (1995b).

Songbirds that are typically associated with young clear cuts and recent burns include chipping sparrow, dark-eyed junco, Hammond's flycatcher, western wood-pewee, warbling vireo, orange-crowned

warbled and American robin. As clear cuts and burns mature, they become increasingly dominated by thickets of deciduous trees and shrubs. At this stage, the pioneer bird species are joined by gray jay, Swainson's trush, yellow-rumped warbler and pine siskin. Typical songbirds of shrub thickets in wet areas are willow flycatcher, Wilson's warbler, common yellowthroat, song sparrow and Lincoln's sparrow.

Common bird species in mixed forests of deciduous trees and conifers include: Hammond's flycatcher, olive-sided flycatcher, ruby-crowned kinglet, American robin, Swainson's trush, varied trush, warbling vireo, solitary vireo, orange-crowned warbler, yellow-rumped warbler, Wilson's warbler, MacGillivray's warbler, chipping sparrow, dark-eyed junco and pine siskin. Typical species in dry forest of lodgepole pine and Douglas-fir include dark-eyed junco, chipping sparrow, yellow-rumped warbler, pine siskin, red-breasted nuthatch, Swainson's thrush and gray jay.

Characteristic songbird species in mature and old growth stands at Mount Polley include: Hammond's flycatcher, western-wood-pewee, red-breasted nuthatch, golden-crowned kinglet, Swainson's thrush, American robin, varied thrush, solitary vireo, yellow-rumped warbler, blackpoll warbler, magnolia warbler, Wilson's warbler, Townsend's warbler, chipping sparrow, dark-eyed junco and pine siskin. Of these species, the blackpoll, Townsend's and Magnolia warblers appear to be more common in mature and old forests than in any other habitat type.

3.1.6.*Small Mammals (Insectivores, Hares and Rodents)*

No shrews, moles or bats were recorded in the Mount Polley project area in 1989 or 1995.

Snowshoe hare sign, such as droppings and girdled shrubs, were relatively common in most forested habitats in the Mount Polley project area. However, hare droppings were not abundant enough to develop a reliable relative index of hare abundance in the various habitat types.

Hallam Knight Piésold recorded only three northwestern chipmunks in the Mount Polley project area in May-June 1995. Analysis of call-count data indicated low densities of 10 to 31 chipmunks/ 100 ha in the tailings area. No chipmunks were recorded on call-count transects in other parts of the mine area.

During 29 May to 12 June, Hallam Knight Piésold obtained only five records of red squirrels in the Mount Polley project area, including visual observations, calls and middens. Red squirrels were recorded on only 2 of the 12 call-count transects, at densities estimated at 6 to 8 squirrels /100ha. The Observer considered red squirrels numbers at Mount Polley to be low in comparison to other parts of the B.C Interior.

Fur harvest summaries do not distinguish between red squirrel and flying squirrel, and both species are reported simply as "squirrel". Squirrel is in fourth place among the species reported in fur harvest returns from Registered Trapping Area no. TR0502T056, which includes the Mount Polley area. The largest fur harvest of squirrels in this trapping area was in 1985, when 22 squirrels were trapped. Two or three squirrels were reported in each of the years 1986 to 1989, but none were reported from 1990 to

1994. In other trap lines in the region (TR0502T032, TR0502T037, TR0502T043 and TR00515T008), squirrel is in third position in terms of the total number of fur bearers harvested.

The beaver was recorded at only one location in the project area, in the small bog pond in the southwestern corner of the tailings area. Two beaver lodges, and one medium-sized adult were seen there between 29 May and 12 June 1995. Beaver sign (girdled or felled trees, beaver dams or beaver lodges) were not found anywhere else in the project area. There is an active beaver colony outside the project area, in a small wetland near Km 11 on the "Ditch Road". Next to marten, beaver is the second-most important fur-bearer in the five trap lines in the region surrounding Mount Polley. In trapping area TR0502T056 (which includes the Mount Polley project area), from 7 to 15 beaver per year were harvested in 1985-89, none were harvested from 1989 to 1993 and 4 were taken in 1994. Fur returns do not specify exactly where beaver were harvested within this large trapping area.

No muskrat were recorded during field studies in May-June 1995, although they were actively searched for. Neither muskrat nor muskrat lodges were found in the small bog pond in the southwestern part of the proposed tailings area, and little or no potential muskrat habitat exists elsewhere in the mine development area. However, from 11 to 24 muskrat were harvested annually from 1984 to 1988 from trapping area TR0502T056, the trap line that surrounds the mine development area. No muskrat have been harvested there in the years 1989 to 1994. Fur returns do not specify where the muskrats were harvested in this large trapping area.

There is no information on which species of mice and voles occur in the Mount Polley area, or on their status. The deer mouse, northern red-backed vole and meadow vole are expected to be the most common mice in the project area.

3.1.7.*Carnivores*

Red fox, coyote and grey wolf have been trapped in several of the registered trapping areas surrounding Mount Polley, from 1985 to 1994. On most of these trap lines, one or two animals were harvested per trap line per year. However from 1985 to 1994, only one fox and no wolves or coyotes were taken from TR0502T056, the trap line which includes Mount Polley.

There are a few sight records of wolves and coyotes in or near the project area. One wolf was seen in the Morehead Lake area on 19 November 1989 (Imperial Metals Corporation 1990). No wolves or wolf sign were recorded during field work on May-June 1995. One coyote was seen in the proposed tailings area on 26 July 1989 (Imperial Metals Corporation 1990). Four coyote tracks and scats were recorded in the proposed tailings area in May-June 1995, but none were recorded elsewhere in the mine development area. One fox was recorded at Bootjack Creek on 2 November 1989 (Imperial Metals Corporation 1990).

The Ministry of Environment Lands and Parks believe that gray wolves are regularly present in the Mount Polley area (P. Deilman to M. Demers, 17 Oct 1995). A few years ago, the Ministry monitored a radio-collared pack of five wolves, whose home range may have been centred around Antoine Lake. This

radio-collared pack was subsequently destroyed, so that by November 1995, there was no longer any radio-collared wolves in the Mount Polley are (Pat Deilman pers. Comm to D. Karasiuk).

Black bears appear to be relatively common in the area surrounding Mount Polley, while grizzly bears are either very scarce or absent. Mr. Robert Toupin, a long-time resident of Likely, believes that black bears are quite common in the Likely area generally, and in the Mount Polley project area specifically. The ministry of Environment Lands and Parks believes that the Mount Polley project area has a healthy black bear population, and that numbers are stable (P. Deilman letter to M. Demers, 17 October 1995).

Imperial Metals Corporation (1990) compiled nine black bear records for the Mount Polley area in 1989, consisting of at least two males, one female and four cubs. These records did not appear to be grouped around any single location. No grizzly bears were recorded in 1989. Hallam Knight Piésold recorded six bear scats in the project area, mainly on abandoned roads to the north and northeast pf the open pits. HKP recorded another scat near Morehead Lake, where black bears are regularly seen, and a sight record of a three-year-old black-phase bear on the “Ditch Road” near Polley Lake. All of the sightings and scats were from black bear, and no grizzly or grizzly sign were recorded.

The Ministry of Environment Lands and Parks completes a Compulsory Inspection data (CID) Form for every grizzly bear kill that comes to its attention (A. Bowser, pers Comm to D. Karasiuk). During the years 1983 to 1995, only one CID form has been completed for a grizzly kill in Wildlife Management Unit 5-02, which includes Mount –Polley. This kill took place at Edwards Lake, far to the south of the project area, in September 1983. In contrast, 28 CID forms were completed for Wildlife Management Unit 5-15, which lies east of Quesnel Lake and the Quesnel River. The nearest CID kill was for an animal control action at the community of Likely in June 1992. When the location of CID kills is plotted, it appears that grizzly bears are scarce in the Mount Polley area, but much more common in the highlands and mountains farther to the east.

The marten is probably the most important mustelid species at Mount Polley. No mustelids were recorded during field studies in 1989 (Imperial Metals Corporation). Field studies in May-June 1995 yielded a few additional records of weasels and marten, but none for other mustelids. In May 1995, Mr. Wayne Blashill reported a long-tailed weasel in the project area. In May-June 1995, Hallam Knight Piésold obtained a sight record of a marten near the mill area, and recorded two marten scats in the North Dump area. There are no sight records of other weasels, mink, fisher, otter, skunks or wolverine within the footprint of the mine development area.

Mount Polley is in the northern part of trapping area TR0502T056. From 1985 to 1994, more marten were trapped in this trapping area than any other fur-bearer, but few weasel and mink were taken. Small numbers of river otter, fisher and wolverine were trapped in neighbouring trapping areas (TR0502T056, TR0502T043 and TR0515T008) but none of these species were trapped in TR0502T056 from 1985 to 1994.

There is little information on the occurrence of the fisher in the Mount Polley project area. No fishers were recorded during filed investigations of the project area in 1989 or 1995, and no fishers were

reported in fur returns from TR0502T056 from 1985 to 1994. Mount Polley is about 10-15 km east of the study area where Richard Weir (1995) investigated of the diet, spatial organisation and habitat preferences of a transplanted, radio-collared population of fishers. None of these fishers established permanent home ranges in the Mount Polley area, although there were no obvious geographic barriers to prevent them from doing so. All of these fishers established permanent home ranges in the Sub-Boreal Spruce zone, in the area of Beaver Creek, Beedy Creek, Sheridan Creek and Moffat Creek. Perhaps the fishers preferred to establish permanent home ranges in the zone of lower snow accumulation, which is 5-10 km west of the project area.

No wolverine or wolverine signs were recorded during fields investigations of the project area in 1989 and 1995, and no wolverine have been reported in fur returns from TR0505T056, which includes the project area, from 1985 to 1994. No wolverine were reported in fur returns for this periods from the adjacent trap lines in Management Zone 5-02 (TR0502T032, TR0502T037 and TR0505T043). Five wolverine were taken from TR0515T008, which is east of Quesnel Lake and Quesnel River in Management Zone 5-15. Because they often maintain large home ranges, it is possible that wolverine may enter the project area from time to time, but would probably do so very infrequently.

No cougar, lynx or bobcat were recorded during the field studies of the project area in 1989 or 1995 (Imperial Metals Corporation 1990, Hallam Knight Piésold 1995). Only one lynx was trapped in TR0502T056 from 1985 to 1994. The lynx harvest in the neighbouring trapping areas TR0502T037, TR0502T043 and TR0515T008 was also low. In contrast, 16 lynx were harvested from TR0502T032 between 1985 to 94, though there was some year-to –year variation in the number of animals trapped.

Compulsory Inspection Data (CID) forms are completed by the Ministry of Environment Lands and Parks for every cougar kill that comes to its attention (A. Bowser, pers. Comm. to D. Karasiuk). There is only one CID form for cougar in Management Unit 5-15 for the year 1982-95, compared to 51 records for Management unit 5-02 for the same period. This suggests that the cougar is much less common in the Quesnel Highlands Ecosection than it is at lower elevations in the Cariboo Plateau Ecosection. The only CID record for Management Unit 5-15 refers to a female cougar that was trapped at Cariboo Lake in 1987. No CID forms have been completed for cougar in the immediate area of Mount Polley. The nearest CID location is Gavin Lake, where a male cougar was killed by hunters in December 1987. When the 51 CID records for cougar are plotted on a map, they are concentrated in an axis along the Beaver Creek valley, which extends from Gerimi Creek to the village of Horsefly. Most of these records within the Cariboo Plateau Ecosection, and the Sub-Boreal Spruce zone.

3.1.8.*Ungulates (Hoofed Animals)*

Moose and mule deer are the only ungulates that have been recorded during wildlife studies in the Mount Polley area. There does not appear to be any suitable habitat for either the bighorn sheep or mountain goat at Mount Polley. Neither elk nor mule deer are listed by the Technical Working Group (1993) as species of special management interest for the Cariboo Region. There is a herd of 200-300 caribou in the Quesnel Highland and Cariboo Mountains east of Quesnel Lake, but there is little information on caribou use of the Mount Polley area.

Hallam Knight Piésold (1995b) conducted pellet group counts and range surveys at 12 locations in the Mount Polley project area. Pellet counts were counted on 60 plots, each measuring 5 x 5 m, and forage preferences were assessed on each plot. Section 4 of Hallam Knight Piésold (1995b) discusses these results in detail.

Aerial surveys of the project area in March 1995, when the snow pack was still more than 1 m deep, found no moose or moose tracks at higher elevations in the project area (that is, near the open pits, waste rock dumps, and the mill area). Low numbers of moose tracks and feeding craters were recorded at lower elevations with less snow, especially near Bootjack and Hazeltine Creeks. Although no moose were seen in the project area during field investigations in May-June 1995, moose signs were common throughout the project area. Moose droppings were found in low to medium densities throughout the project area, and in higher densities along abandoned logging trails. Most of the droppings were the so-called “winter pellets”.

Selective logging appears to have been especially favourable for moose, as it has decreased the cover of the coniferous tree canopy, and thereby fostered the growth of a wide variety of palatable browse species. Unlogged mature and old stands tend to have a poorly developed shrub understorey, which is often dominated by species of lower palatability to moose. The interior of such stands typically have very low densities of moose pellets, and show little evidence of browsing. Areas with large amounts of deadfall are typically lightly utilized.

Wetlands vary greatly in the amount of moose utilization they receive. Wetlands that are dominated by tall willows, herbs and sedges appear to be well used by moose, particularly if they are located near patches of coniferous forest that are used as bedding areas. Wetlands dominated by hardhack, Sitka alder and scrub birches are little used. The most heavily used part of the project area is a well-drained gravel ridge west of the mill area, which formerly supported an open forest of Douglas-fir and western red cedar. The area was selectively cut and slash-burned, and now supports a mixed forest with rich and diverse tall shrub, low shrub and herb understoreys. It has exceptionally high concentration of moose scats and browsed bushes.

Eleven mule deer were seen during field studies in May-June 1995, eight of which were in the mine area. The largest group was five animals, about 600 m north of the tailings area. Most observations were of single animals. Deer tracks were common in the project area, especially near the main pit and in the tailings area. Tracks were most commonly observed near mud puddles in roads, and the tracks sometime followed abandoned roads for several hundred meters. Pellet group counts found that deer pellet were less numerous than moose pellets.

3.2. Species at Risk

SNC Lavalin (SNC; Golder, 2015) compiled an updated list of at-risk species for the ICHwk2 and ICHmk3 Cariboo Region that are potentially in the Mount Polley area (Table 3.2). Species presence and the timing and duration of their residence time in the project area will vary with habitat characteristics and other factors, such as social interactions, timing of life history events, seasonal and inter-annual

variation in habitat use, population cycling, immigration routes and timing, and weather. The following is an excerpt from SNC's assessment (Golder, 2015) which outlines possible use of the project area.

- Hagen's bluet (*Enallagma hageni*) is a blue damselfly that inhabits marshy lake edges, slow streams, and ponds. It is associated with marsh and fen wetland types (Wm01-02, Wm04-07, and Wf01) and flies in June and July (Royal British Columbia Museum and the Spencer Entomological Museum, 2004).
- The magnum mantleslug (*Magnipelta mycophaga*) has rarely been detected in Canada (COSEWIC, 2012a). Only 13 records of the species exist for BC, and the closest occurrence to Mount Polley Mine is in Wells Gray Park. COSEWIC (2012a) does not list any surveys for terrestrial gastropods completed near Quesnel Lake. The magnum mantleslug has been found in moist microsites in heavily shaded coniferous forests in the ICH and ESSF biogeoclimatic zones. Individuals have been located both on the ground surface and under bark, logs or rocks. Important habitat features may include seepage sites, coarse woody debris, and undisturbed forests with intact duff layers (COSEWIC 2012a).
- The western toad (*Anaxyrus boreas*) is an amphibian that is widely distributed across the province (COSEWIC 2012b). Adult western toads may be found in a variety of habitats including grasslands, forests, shrublands, riparian areas, and wetlands. Adult toads congregate to breed communally in the spring and exhibit fidelity to their breeding sites. Females lay strings of eggs in stream margins, wetlands, river backchannels, ponds, and human-made sites such as ditches, road ruts, and tailings ponds (COSEWIC 2012b). The eggs hatch into tadpoles that metamorphose in 4-12 weeks and leave the water by late July or August. Adults may move up to several kilometres away from breeding sites, and show a strong fidelity to summer foraging sites. Adult western toads feed on invertebrates including worms (Clitellata), slugs (Gastropoda), spiders (Arachnida), bees (Hymenoptera), beetles (Coleoptera), sow bugs (Isopoda), grasshoppers (Orthoptera), caddisflies (Trichoptera), moths and butterflies (Lepidoptera), flies (Diptera), true bugs (Hemiptera), and ants (Formicidae) (reviewed in COSEWIC 2012b). Larvae eat organic detritus, filamentous algae and carrion (ibid). Adult toads hibernate underground during the winter.
- The Great Blue Heron (*Ardea herodias*) is a large wading bird that feeds on fish, amphibians, small mammals, snakes, and aquatic insects (Gebauer and Moul 2001). The *arodias* subspecies is provincially Blue-listed and is the subspecies present in the Cariboo region. Herons are present in the Cariboo region between April and November (Roberts et al. 2013). During the rest of the year, they winter in southern BC or further south. Herons are colonial nesters and build bulky stick nests in coniferous or deciduous trees. The closest known colony to the study area is the Big Lake Forest Service Road colony (Colony 502-005), which was active between 1997 and 1999 and was located 2.4 km west of the north end of Polley Lake (Great Blue Heron Management Team 2015).
- The Common Nighthawk (*Chordeiles minor*) is a brown, black and grey-mottled bird that forages aerially for flying insects. Nighthawks are migratory and may be present in the Cariboo region between the beginning of June and mid-September (Roberts et al. 2013). Nighthawks lay their eggs

on the ground in sparsely-vegetated areas and may nest in disturbed sites such as roadsides, gravel pits and recent clear-cuts.

- The Olive-sided Flycatcher (*Contopus cooperi*) is a robin-sized songbird that frequents forest edges. It forages from a perch on a tree or snag from which it makes short flights in pursuit of flying insects. Olive-sided Flycatchers are migratory and are present in the Cariboo region between May and mid-August (Roberts et al. 2013).
- The wolverine (*Gulo gulo*) is a large mustelid that feeds on a wide variety of prey from small mammals to ungulates. The *luscus* subspecies is provincially Blue-listed and is the subspecies present in the Cariboo region. Although it is associated with high-elevation forests and large areas of wilderness, wolverine distribution is governed more by food supply than by particular habitats. It is both a generalist and an opportunist and will readily scavenge carrion. Wolverines range widely (50-100 km^2 for females and up to 1580 km^2 for males) and may become nomadic if food is scarce (COSEWIC 2014).
- The little brown myotis (*Myotis lucifugus*) and northern myotis (*M. septentrionalis*) are small insectivorous bats that roost in tree cavities, under loose bark, in buildings, and in rock fissures. Although the little brown myotis has been described as the most common and widely distributed Canadian bat species (van Zyll de Jong 1985), both it and the northern myotis are now listed under SARA as endangered due to a fungal disease known as white-nose syndrome (Government of Canada 2014). The disease is not currently present in western Canada, but is spreading westward from the eastern provinces. The northern myotis is very difficult to distinguish from similar species in the field and its identification must be confirmed via DNA typing. Little brown myotis and one individual field-identified as a northern myotis were captured in 2012 near Spanish Lake (approximately 11 km northeast of the mouth of Hazeltine Creek) (data file at http://a100.gov.bc.ca/pub/siwe/details.do?id=5044). A species model for little brown myotis and northern myotis is presented in Golder (2015).
- The fisher (*Pekania pennanti*) is a large mustelid or weasel. Fishers are forest-dwellers that feed primarily on small mammals. Females require cavities in large deciduous trees for use as reproductive dens. There are large-diameter *Populus balsamifera* present along Hazeltine Creek that are potential natal den sites for fishers. A fisher species account is presented in Golder (2015).
- Grizzly bears (*Ursus arctos*) are considered by the province to be extirpated in the area west of the west arm of Quesnel Lake (Province of BC 2014). A viable grizzly population (the Quesnel Lake North grizzly bear population unit) is present east of the west arm of Quesnel Lake.
- Mountain caribou (*Rangifer tarandus*) was removed from consideration within this assessment as caribou have been extirpated from the area west of the west arm of Quesnel Lake (Province of BC 2014).

Table 3.2 Species at risk potentially present in the Mount Polley area

Scientific Name	Common Name	BC List	Other List
Enallagma hageni	Hagen's Bluet	Blue	-
Magnipelta mycophaga	Magnum Mantleslug	Blue	-
Anaxyrus boreas	Western Toad	Blue	SARA Schedule 1 –Special Concern
Ardea herodias herodias	Great Blue Heron, *herodias* subspecies	Blue	-
Chordeiles minor	Common Nighthawk	Yellow	SARA Schedule 1 - Threatened
Contopus cooperi	Olive-sided Flycatcher	Blue	SARA Schedule 1 - Threatened
Gulo gulo luscus	Wolverine, *luscus* subspecies	Blue	-
Myotis lucifugus	Little Brown Myotis	Yellow	SARA Schedule 1 - Endangered
Myotis septentrionalis	Northern Myotis	Blue	SARA Schedule 1 - Endangered
Pekania pennanti	Fisher	Blue	-
Ursus arctos	Grizzly Bear	Blue	SARA Schedule 1 – Extirpated
Rangifer tarandus	Mountain Caribou		SARA Schedule 1 – Threatened

3.3. Wildlife Habitat Classification

At the time that wildlife studies were being planned for the Mount Polley Project, there was no formal system of wildlife habitat classification for the Cariboo Forest Region. The only available wildlife habitat mapping for the surrounding region was a generalized draft map at 1:250,000 scale, showing winter habitat capability for moose, deer and bear. An *ad hoc* wildlife habitat classification for the Mount Polley area was carried out based on the habitat classifications of the ICH Biogeoclimatic Zone, the Prince Rupert Forest District, and of the wildlife branch for the Omineca Sub-Region of the Prince George Region.

With an elevation range of 920 m (Polley Lake) to 1260 m (the summit of Polley Mountain), all of the project area is in the ICH. There are no alpine or subalpine habitats, and the summit of Polley Mountain is below the lower elevation limits of the Engelmann Spruce – Subalpine Fir Zone. There are no avalanche tracks, talus slopes, or other mountain features that would be considered significant wildlife

habitats. There are no cliffs or canyons, and no arable agricultural land. Man-made habitats include logging clear-cuts and the network of roads for logging.

Before European contact, the primeval vegetation of the project area was probably a continuous closed forest of Douglas-fir and lodgepole pine on drier sites, and of western red cedar, hybrid spruce and black cottonwood on riparian sites. Much of the mine development area was selectively logged or clear-cut in the 1970s, and is now covered by open, young seral forests. The different baseline habitat types are delineated in Figure 2.18[2] (extracted from Hallam Knight Piésold Ltd., 1996a), and described in the following sections.

A summary of habitat types present at Mount Polley is provided in Table 3.3.

Table 3.3 Habitat types at the Mount Polley Mine

Habitat Grouping	**Habitat Type**	**Present in the Mount Polley Area?**
1	Alpine Habitats	No
2	Habitats of the Engelmann Spruce-Subalpine Fir Zone	No
3	Forest Habitats of the ICH Zone	
	3.1 Clearcuts and burns (0-20 years +)	Yes
	3.2 Young stands (20-40 years)	Yes
	3.3 Mid-seral stands (40-120 years)	Yes
	3.4 Mature and old growth stands (120+ years)	Yes
	3.5 Douglas-fir – Lodgepole Pine Forest (south slopes and ridge crests)	Yes
	3.6 Rocky cliffs and talus	No
4	Wetland and Aquatic Habitats	
	4.1 Riparian forest complex	No
	4.2 Riparian habitats near small streams	No
	4.3 Shrub carr/sedge fen habitat complex	Yes
	4.4 Marsh/shallow open water habitat complex	No
	4.5 Small and medium-sized lakes (<1000 ha)	Yes
	4.6 Large lakes and reservoirs (>1000 ha)	No
5	Man-Made Habitats	
	5.1 Urban areas	No
	5.2 Transportation / Transmission Corridor	No
	5.3 Agricultural areas	No

3.3.1.*Clear-cuts*

Clear-cutting, followed by moderate to intense slash burning, has been practiced in several locations on the Bootjack Lake road, and throughout much of the Tailings Storage Facility Area. Although harvested at approximately the same time, clear-cut areas have reverted to a much earlier stage of forest succession than those that were selectively logged, and the existing vegetation is quite different. In

[2] MPMC is currently working to develop a digitized version of this map.

general, clear-cutting followed by slash burning has removed most of the advance regeneration by subalpine fir and western red cedar, and the area has not been sufficiently restocked from natural sources. Cover by conifer seedlings in such areas is well under 5%. Black cottonwood, aspen, Sitka alder, and paper birch have re-sprouted in a few favoured spots, but much of the clear-cuts in the tailings area are dominated by low shrubs, grasses and herbs. Typical herbs and legumes are bluejoint, tame wheatgrasses, broom, dandelion, fireweed, big-leaved avens, fescues and thistles. North of the tailings area, some clear-cut areas have been hand-planted with lodgepole pine plantations, which are now 3 – 4 m tall, with 20 to 30% ground cover. Portions of the tailings area have been replanted with spruce seedlings, in an area that once supported well-grown stands of western red cedar and Douglas fir. Re-stocking of clear-cuts in the tailings area has generally been unsuccessful, as the spruce seedlings are widely spaced, with poor vigour and high mortality.

Pellet counts and general observations in the tailings area indicate that ungulates make little use of open areas in the centres of large clear-cuts, where there is little cover. However, ecotonal areas at the boundaries of clear-cuts and mature forests appear to be quite heavily used by both moose and mule deer. Such areas offer a combination of thermal and predator avoidance cover (in the forests), as well as palatable forage (in the clear-cuts). Small bird densities appear to be very low in the clear-cut areas, where chipping sparrow and dark-eyed junco are the principal species. Warbling vireo, orange-crowned warbler and Hammond's flycatcher are strongly associated with dense thickets of black cottonwood, trembling aspen, tall willow and Sitka alder. Varying hare and northwestern chipmunk were the only small mammals recorded in clear-cuts. Coyote tracks and scats were also recorded in the tailings area.

3.3.2.*Mid-Seral Forests*

Mid-seral stands at Mount Polley have many of the same species as mature and older stands discussed below. The number of individuals and the diversity of species may increase somewhat as mid-seral stands mature, and as the complexity and structural diversity of the habitat increases; however, species that prefer open woodlands and herb- or shrub-dominated habitats tend to decrease.

3.3.3.*Selectively Logged Areas*

Much of the mine development area was selectively logged during the mid-1970s. During selective logging, most of the large Douglas-firs and western red cedars were removed from the site, but smaller conifers were left in place, as were both large and small black cottonwoods. During the 25 years prior to mining, this advanced regeneration matured, resulting in a complex and variable mixed-wood forest, with a diverse and well-developed tall shrub, low shrub and herb understorey. The height, crown cover and species composition of the tree canopy are quite variable in selectively logged areas. Typically, the tree canopy is 10 – 15 m high, with a crown cover of 10 to 20%, and it is dominated by a mixture of western red cedar, subalpine fir, Douglas-fir and black cottonwood. A few veteran black cottonwoods and western red cedars reach heights of 20 – 25 m. The tall shrub understorey is dominated by a variable mixture of black cottonwood and subalpine fir saplings, Sitka alder, trembling aspen, Scouler willow, Bebbian willow and unidentified willows. The low shrub understorey is lush and diverse, and is typically dominated by thimbleberry, black twinberry, western mountain-ash, red elderberry, black

currant, black huckleberry, and falsebox. There is also a rich and diverse her understorey, where fireweed, bunchberry, twinflower, foamflower, star-flowered Solomon's-seal, false Solomon's-seal, rosy twisted stalk and queen's cup are typical species.

At Mount Polley, areas that were selectively logged in the 1970s now support a complex, patchy vegetation that provides fair to good spring and summer habitat for mule deer, moose and black bears. Removal of the continuous, dense and shady canopy of western red cedar and Douglas fir has favoured the development of deciduous trees and shrubs, some of which are highly palatable to moose and deer. It has also increased the cover of a wide variety of berry-producing shrubs, which is favourable for bears and fruit-eating birds such as thrushes. Dense thickets of tall shrubs provide good escape cover for mule deer. MacGillivray's warbler, Wilson's warbler, orange-crowned warbler and the warbling vireo are all strongly associated with this second-growth vegetation.

3.3.4.*Mature and Old Growth Forests*

According to Ketcheson et al. (1991), moose, mule deer, black bear, wolverine, marten, southern red-backed vole, various owls, pileated woodpecker, Steller's jay, gray jay, varied thrush, golden-crowned kinglet, Townsend's warbler, bohemian waxwing, red crossbill, winter wren, and mountain chickadee are representative species of mature and old growth forests in the ICH Zone in general. Some of these species have been recorded in the Mount Polley project area, although they are not restricted to mature or old growth forests.

3.3.5.*Forests on Southern and Western Aspects*

These slopes may be significant for moose and mule deer in the late winter, spring, and summer. Due to favourable insolation, these slopes are likely to have a lighter snow cover than average during the winter. These slopes are likely to be snow-free earlier in the season, and to green up earlier than most other habitats. Even with a favourable insolation regime, south-facing slopes in the project area are likely to be too deeply covered with snow to be suitable for mule deer in the winter. However, in spring, these slopes may be important for mule deer, due to rapid snowmelt and early green-up. For the same reasons, they may also be important for bears emerging from winter hibernation. Ketcheson et al. (1991) list several other species that they consider to be closely associated with south-facing slopes in the ICH Zone (e.g. yellow bellied marmot, rubber boa, elk), but it is doubtful that these species occur in the Mount Polley area.

3.3.6.*Non-forested Rock Cliffs and Talus*

There are no rocky cliff or talus habitats in the Mount Polley project area.

3.3.7.*Riparian Forest Habitat Complex*

There are no riparian forest habitats in the Mount Polley project area, such as would be associated with rivers or large creeks with channel widths greater than 5 m. The project area does not contain any landscape features that are typically associated with large streams, and which may be significant to

wildlife, such as: alluvial fans, alluvial terraces, braided channels, oxbows, meander scrolls, backwaters, floodplains, canyons or gallery forests.

3.3.8.*Riparian Habitats near Small Streams*

There are five riparian areas associated with small streams in the Mount Polley project area: Hazeltine Creek; Bootjack Creek; Mine Drainage Creek; W20 Creek; and North Dump Creek. All of these are small creeks, with channels less than 5 m wide. Bootjack Creek is entrenched in a ravine for much of its length with two small wetlands near its inlet and one near its outlet. The riparian zone of Hazeltine Creek is somewhat more conspicuous on aerial photographs than that of Bootjack Creek. Hazeltine Creek has an area of shrub carr and sedge meadow near its mouth in Polley Lake, and smaller areas of shrub carr in its upper reaches. No lakes or backwaters are associated with any of the creeks, and all of the creeks except North Dump Creek are fish-bearing. Beaver and mink are the main wildlife species that are likely to be found in the riparian zones of these small creeks. The streamside vegetation may provide above-average habitat for black bears, moose, and mule deer.

3.3.9.*Shrub Carr/Sedge Fen Habitat Complex*

The only example of this habitat complex within the mine development area is a 5 to 10 hectare area located in the southwest part of the tailings area, about 300 m northeast of the bog pond. The centre of this wetland is a sedge meadow, dominated by beaded sedge, and dead spruce snags, and standing water from 20 to 50 cm deep. The sedge meadow is surrounded by dense thickets of hardhack, black twinberry, and Sitka alder, where shrub clumps grow on elevated hummocks, and where standing water occupies the intervening low spots. Surveys prior to mine construction show no evidence of moose browsing or pellets in the thicket. None of these shrubs are considered to be palatable to ungulates. In June 1995, this wetland had one or two pairs each of willow flycatcher, orange-crowned warbler, Wilson's warbler and song sparrow. These are all common and widespread songbird species typical of wet shrub carrs. No waterfowl or shorebirds were recorded within the shrub carr.

Additional examples of this complex are found outside the mine development area, southeast of Morehead Lake, near the outlet of Bootjack Lake, about 500 m downstream from the outlet of Bootjack Lake, and along Hazeltine Creek. The largest shrub carr and fen complex in the local area is at the south end of Polley Lake. No large ponds are associated with this complex. At the southern end of Polley Lake, fen and shrub carr grade into a swamp forest. There are a few widenings of Hazeltine Creek, which may be due to beaver damming.

A few moose tracks were seen in these habitats during aerial surveys of the mine area in March 1995, but no moose were seen. For the present analysis, riparian habitats along Bootjack and Hazeltine Creeks can be considered Class 3 or Class 4 winter range, and Class 3 summer range for moose. Due to heavy winter snow accumulations, these habitats should be considered Class 5 or Class 6 winter range for deer.

3.3.10. *Marsh/Shallow Open Water Habitat Complex*

If a marsh is defined as a permanently flooded wetland dominated by tall emergent plants, such as cattails, bulrushes, or *Phragmintes* reeds, then there are no marshes in the project area. If a shallow open water habitat is defined as an area dominated by lush beds of submergent plants, such as yellow pond lily, hornwort, milfoil, or pondweeds, then there are not shallow water habitats in the project area.

3.3.11. *Small and Medium-sized Lakes (< 1000 hectares)*

Both Polley and Bootjack Lakes support a good to very good sport fishery based on rainbow trout. Bald eagles and the common loon have been observed on both lakes, however; there is no foraging or nesting habitat for either species within the mine development area. The Canada Land Inventory assigned a rating of 6-JZ to both lakes. This rating implies severe limitations to waterfowl production. The major limitations being excessively deep waters and a limited area of marsh edge development.

The only lake within the mine development area is a bog pond of approximately 3 ha located in the south-western corner of the tailings area. During a survey on May 30, 1995, the waterfowl population of this pond amounted to one male green-winged teal, and two females and one male bufflehead. One greater yellowlegs, and one common snipe were also seen. On June 9, 2005, a female green-winged teal with five young were present on the lake, as well as the trio of buffleheads. A common snipe was heard, but the yellowlegs was no longer present. The lake had two beaver lodges, and one beaver was observed during these surveys. One or two pairs of willow flycatcher, common yellowthroat, Wilson's Warbler and song sparrow were recorded in shrub thickets near the lake. These are all common and widespread songbird species, which are also present in shrub-dominated wetlands near Morehead and Bootjack Lake. Development of the tailings area would not cause significant losses of habitat for local or regional populations of any of these species.

A single frog or toad, which swam away before it was accurately identified, was recorded at the pond. No amphibian egg masses or tadpoles were recorded in either survey.

3.3.12. *Large Lakes and Reservoirs (>1000 hectares)*

There are no large lakes in the project area, although the site is within the Quesnel Lake Watershed. Quesnel Lake is located approximately 10 km east of the mine.

3.3.13. *Urban Areas*

The Wildlife Branch (1994) defines urban areas as man-made habitats, such as residential, commercial and industrial areas. Agricultural lands are considered a distance habitat type. There were no urban areas in the Mount Polley project areas prior to exploration and mine development.

3.3.14. *Transportation/Transmission Corridors*

Transportation and transmission corridors are linear facilities that carry people, goods, and services from one point to another. There are no major roads or power line corridors in the project area;

however, there is a large network of logging and skid roads throughout the area, and a further network of trails to reach exploration drilling sites.

Roads typically occupy a small proportion of the land area, but they may be significant to wildlife. Early stages of forest succession often include plants that are palatable to wildlife, such as willows, prickly rose, fireweed, and elderberry. Commercial seed mixes are sometimes sown to stabilize roadsides and ditches, and they often contain plants that are palatable to wildlife, such as Kentucky bluegrass, red fescue, timothy and red clover. Consequently, moose, deer and black bear sometimes forage preferentially along transportation and transmission corridors. Where winter snows are deep, moose coyotes and wolves sometimes used plowed roads as travel routes, and may be killed in collisions with vehicles. Forest road networks make the back-country more accessible to outdoor recreationists. Unregulated hunting and wildlife harassment become a concern for wildlife managers.

Moose, deer, coyotes, and bears regularly use roads and trails in the project area as travel routes. During surveys in June 1995, animal tracks appeared to follow roads, rather than crossing roads by the shortest and most direct route. There were substantially more moose and deer pellet groups on roads than in the nearby natural vegetation, particularly if there were large amounts of deadfall.

4. FISHERIES AND AQUATIC RESOURCES

4.1. Limnology

There are four major lakes in Mount Polley area: Bootjack Lake, Polley Lake, Morehead Lake, and Kay Lake (also known locally as Fry Pan). Morehead Lake is a man-made and relatively shallow reservoir. The other three are all natural, accessible to the public. Bootjack and Polley Lakes have been manipulated for water storage and diversion.

Bootjack Lake is essentially a long and narrow basin, with two depressions over 15m deep. Polley Lake is a long narrow lake that is almost twice as deep and has almost twice the surface area and four times the volume of Bootjack Lake. Polley Lake does not have multiple depressions. Shoal areas occur at both ends of the lake but are severely restricted along the steep sides of the basin. One permanent stream enters Polley Lake from the north draining Kay Lake. Kay Lake is smaller, but is very deep for its surface area. Its shoreline resembles a bog with floating vegetation mats. There is no distinguishing inlet stream and the outlet is impounded by beaver dams. This small stream between these two lakes flows through swamp and meadow and is heavily braided with numerous beaver dams and minimal recognized surface flow. The steep slopes on either side of Polley Lake are drained by intermittent drainage channels, but no permanent streams. Polley Lake is some 64m lower in elevation than Bootjack and has a maximum depth of 35m.

The outlet of Polley Lake forms Hazeltine Creek, which flows a distance of 7,900m to its confluence with Edney Creek drainage, 500m upstream of the discharge to Quesnel Lake. Bootjack Creek is a 2,800m long tributary of Hazeltine Creek, which flows in an easterly direction to its confluence 450m downstream of Polley Lake outlet.

Morehead Lake was created by damming Morehead Creek. It is a shallow lake, usually less than 6m deep (Ron Williams, personal communication). Small tributary streams flowing into Morehead Lake include Morehead Creek, which contains the discharge from Bootjack Lake, Trio Lake, 4K Creek and other intermittent drainages off the hill sides. A concrete culvert and long spillway control the downstream from Morehead Lake. A ditch on the east side of the lake, which was once used to carry lake discharge to the placer mines, has now been abandoned and blocked.

In Bootjack Lake, both basins thermally stratify with the epilimnion extending down to a depth of six meters. The two basins exhibit similar patterns of stratification with only minor indications of differences in the hypolimnion in the vicinity of 10m depth. Surveys in June and October 1989 indicate that the lake was probably unstratified at those times. In mid-summer, the hypolimnion of both basins exhibits some reduction in dissolved oxygen. These patterns reflect productive lake conditions, and probable light attenuation in maximum depths. These observations indicate that Bootjack Lake is a mesotrophic lake that does not become anoxic.

In Polley Lake, thermal stratification is apparent with the epilimnion extending down to a depth of approximately 7 m. The hypolimnion extends from around 14m to the bottom. In late fall thermal stratification was still evident but was being eroded by decreasing temperatures in the epilimnion. The

narrow, deep, north-south orientation of Polley Lake and the steep slopes surrounding it probably shield it from wind action and results in a somewhat different stratification pattern from Bootjack Lake. The hypolimnion of Polley Lake is better oxygenated than Bootjack Lake, both in mid-summer and late fall, suggesting Polley Lake is slightly less productive.

In Kay Lake strong stratification is apparent with the epilimnion extending to approximately 4m depth mid-summer. By late fall, stratification broke down with the epilimnion extending to a depth of about 8m. The lake surface is protected from the strong winds that dissipate stratification. The hypolimnion extends from a depth of approximately 8 or 9m to the bottom. Dissolved oxygen is markedly depressed in the hypolimnion in the summer, although it is not anoxic. Kay Lake is probably mesotrophic, and perhaps, more dystrophic than either Bootjack or Polley Lakes. The heavily organic deposits on the lake margins and the peaty souks surrounding it support dystrophic characterization.

In 1995, a total of four limnology stations were established: two in Bootjack Lake and two in Polley Lake (Figure 2.8[3], extracted from Hallam Knight Piésold Ltd., 1996a). Dissolved oxygen and temperature profiles were collected at 1m intervals from each station once a month from May until October of 1995. In addition, one set of profiles was completed in January, 1996. The results are summarized by Hallam Knight Piésold Ltd. (1996b).

Results from the 1995 sampling season showed that for Bootjack Lake, stratification began in May. Water temperatures were colder during this month and consequently, oxygen concentration were higher than those measured later in the year. From June to September, the thermocline dropped in the water column, reaching a maximum depth of 8 to 12m in September. Water temperatures were highest in July (20.0^{o}C at the surface), and dissolved oxygen concentrations reached their seasonal low during this month. In October, the thermocline had completely disappeared, indicating that the fall overturn had occurred in the previous months. Water temperatures in January were the lowest recorded during the year, and dissolved oxygen concentrations were similar to those recorded in May.

Profiles collected from Polley Lake in 1995 indicate thermal stratification throughout the summer and into the fall. Beginning in May, surface warming established a minor thermocline at about 2m depth. Average water temperatures were coldest during this month (except for January), and concentrations f dissolved oxygen were higher than those measured later in the year. As surface temperatures increased, the thermocline became more pronounced, reaching a maximum in July when the difference between surface (21.8^{o}C) and bottom (4.9^{o}C) temperatures was more than 15.0^{o}C. From August to October, surface temperatures dropped and the thermocline sank in the water column, reaching its maximum depth of 15 to 17m in October. Water temperatures below 17m depth were relatively constant between 4.0^{o}C to 5.5^{o}C throughout all months (except January). Oxygen profiles indicated only minor stratification during all months. A surface layer with relatively constant concentrations of dissolved oxygen indicated near complete mixing in that zone. Below the mixed layer, dissolved oxygen concentrations slowly decreased down through the water column. Oxygen concentrations were lowest in September, when DO at the lake bottom dropped to 2.1ppm.

[3] MPMC is currently working to develop a digitized version of this map.

4.2. Fisheries Resources

4.2.1.*Regional*

Fisheries resources in the Quesnel River and Quesnel Lake system consists of diverse populations of sport fish including anadromous chinook and coho salmon and resident kokanee, rainbow and lake trout, Dolly Varden char, whitefish and several forage species. In addition, large populations of Horsefly sockeye salmon annually migrate from the Fraser River to spawn in tributary streamswhich drain into Quesnel Lake. Salmonoid enhancement facilities have been constructed by the Department of Fisheries and Oceans on the Horsefly River for sockeye and on the Quesnel River for chinook to improve survival of upper Fraser River stocks. The lakes in the vicinity of Mount Polley provide good recreational angling for rainbow trout. These trout populations are natural and maintained without stocking. A summary of creel surveys carried out on Bootjack and Polley Lake is presented in section 2.8.5.2.

4.2.2.*Local Fisheries*

1989 Surveys

No streams flow into Bootjack Lake that would support spawning. Thus its rainbow trout must spawn downstream in Morehead Creek, with fish from Trio and Morehead Lakes. The storage dam and spillway at the outlet of Morehead Lake prohibit the return of any fish or their offspring that migrate down the spillway. In addition, an active beaver dam also restricts movement of both to and from Bootjack Lake. Given this, it would appear that fish production in these three lakes may be limited by spawning area available. Large numbers of juvenile trout were captured with baited Gee traps in the streams in June, August and October. This suggests the streams may be the principal nurseries where trout rearing occurs. Recruitment into the lake population depends on the rearing and successful returns to the lake of the offspring. Because of their apparent success in coexisting with rough fish, Bootjack Lake rainbow trout populations are being investigated as a potential source of brood stock for the provincial fish culture program (Demers, M., personal communication). Fisheries biophysical inventory is presented on Figure 2.15[4] to (extracted from Hallam Knight Piésold Ltd., 1996a) show the habitat characteristics and species distribution.

Rearing salmonoid populations ranged from 0.071/m^2 (Upper Hazeltine Creek) to 1.50/m^2 in Bootjack Creek, the highest density of rearing juvenile rainbow trout in the entire study area. The results illustrate the importance of Bootjack Creek and Hazeltine Creek for rearing of Polley Lake rainbow trout populations. Reconnaissance along the streams revealed numerous locations where trout were actively spawning at the time. The greatest frequency of spawning was in the upper reaches of Morehead Creek and Hazeltine Creek but spawning was common in all creeks.

The Edney /Hazeltine Creek system is physically divided by topography which creates water velocity barriers in a steep gradient canyon located 1,650m upstream of Edney Creek confluence. This canyon

[4] MPMC is currently working to prepare a digitized version of this map.

barrier isolated the rainbow trout populations in the headwater lakes and streams and prevents encroachment by the mixed residents and anadromous salmonoid and forage fish populations found in the lower reaches. In lower Hazeltine and Edney Creeks mixed populations of rainbow trout, mountain whitefish, burbot, suckers, rearing juvenile chinooks, and adult sockeye salmon were documented in 1989. The lower reaches of Hazeltine and Edney Creeks are low gradient streams consisting of deep pools and riffles, large log jams and areas with excellent spawning gravels for salmon. On the Morehead Creek system barrier is even more dramatic. A waterfall exists about 1,500m upstream of the confluence with the Quesnel River and the spillway at the outlet of Morehead Lake further divides the system to migrating fish. Watercourses located at higher elevations such as Bootjack Creek, upper Hazeltine Creek, upper Edney Creek, upper Morehead Creek, 4K Creek and 6K Creek are also relatively low gradient streams associated with the lake systems and are used mainly by rainbow trout populations for spawning and rearing.

The lower reaches of Morehead Creek, near the Quesnel River, were investigated on October 20, 1989 with baited Gee traps. The creek contained good populations of rearing chinook salmon. The lower reaches of Hazeltine Creek and Edney Creek sampled in May, August and October 1989 always contained rearing populations of rainbow trout. Juvenile chinook salmon (greater than 1 year old) were found there in August and October, suggesting they entered the stream from Quesnel Lake. Lower Edney Creek provided good spawning habitat for sockeye salmon when it was inventoried in October 1989, coinciding with record runs to the Horsefly River System. Heavy spawning activity by sockeye was evident in this reach at that time.

Headwater lakes in the vicinity of Mount Polley were historically used for water storage in connection with early placer mining. The redirection of flow from Bootjack Lake by the construction of an earth-filled dam in about 1913 at the southern end of the lake prevented further use of important spawning and nursery areas in Bootjack and Hazeltine Creeks by the trout populations from Bootjack Lake. The outlet of Bootjack Lake presently consists of a large excavated channel which redirects flow to Morehead Lake. A beaver dam at the outlet of Bootjack Lake restricts movement of rainbow trout both to and from the steam habitat particularly during the summer low flow period. Nevertheless, during the fish inventory of May 31 – June 2, 1989 rainbow trout populations were observed in large numbers spawning in the vicinity of the Morehead Creek bridge crossing when the water temperature was 14.5^{o}C. It is not certain which lake they came from. The spawning habitat between Morehead, Bootjack and Trio Lakes is probably used by spawners from all three systems.

1995 Surveys

A fisheries assessment of the two Edney Creek tributaries was implemented in 1995, to determine the potential fish habitat losses and develop corresponding compensation options in accordance with federal government policy. Survey sites are shown in Figure 2.16[5] (extracted from Hallam Knight Piésold Ltd., 1996a). The only fish captured during sampling in the Edney Creek watershed were rainbow trout. Surveys were conducted during the peak spawning time for Bootjack and Polley Lakes fish (May 12-21)

[5] MPMC is currently working to develop a digitized verson of this map.

and again during base flow conditions, well after rainbow trout fry emergence (July 31-August 4). Hallam Knight Piésold (1996c) discusses these results in detail.

An additional objective of the May sampling program was to characterize the adult rainbow trout populations using the potentially impacted tributaries. The distributions of rainbow trout in Edney Tributary 1, Edney Tributary 2, and the Edney Creek mainstem are presented in Figure 2.16[6] (extracted from Hallam Knight Piésold Ltd., 1996a), as are the locations of presence/absence sampling sites.

The largest specimen captured had a fork length of 17cm (from Edney Tributary 2), but most were much smaller. This may reflect the size adult fish can be expected to attain in these small tributaries.

Only male fish were captured, suggesting that the population of adults use these tributaries for spawning and earl life history phases only, and that they have migrated from a larger stream or lake (Edney Creek/Edney Lake). The utilization of these streams by large, Quesnel Lake resident rainbow trout may be ruled out because the habitat structure is simply too small.

During the August field trip, spot-check electrofishing revealed that the upstream extent of fish distribution in Edney Tributaries 1 and 2 had not changed since May, even though stream discharges had been greatly reduced. An important result was that fish were still present in the upstream section of Edney Tributary 1, even though flow was subsurface for approximately 50% of the distance at that location. These fish appear capable of surviving in pools with no surface of the distance at that location. These fish appear capable of surviving in pools with no surface inflow, although their presence appeared to be dependent on good cover and depth (20cm achieved somewhere in the pool). Because there was no measurable discharge at several of these locations, fish presence cannot be correlated to a threshold minimum discharge, and therefore this parameter cannot be used to predict post-impact distribution in these tributaries.

Presence/absence electrofishing was also conducted on Edney Creek above Edney Lake. Importantly, Edney Creek was found to be barren of all species at two road-accessible locations above the lake (Sites F3, P/A 11, shown in Figure 2.16[7], extracted from Hallam Knight Piésold Ltd., 1996a), even though the rearing habitat at these locations was of high quality. A series of falls in a short canyon was later discovered between Edney Lake and the road crossing approximately 1km upstream, and is an absolute barrier to fish migration.

A summary of the fry and juvenile density estimates from the August survey is presented in Table 4.1 (Hallam Knight Piésold 1996c). Fry densities ranged from 0 fish/m^2 at site F3 to 1.02 fish/m^2 at site F2. The high densities at site F2 may be due to very high nitrate levels at the site, or due to a recent extensive fry emergence at this site, as habitat appeared highly suitable from spawning (Hallam Knight Piésold 1996c).

Visual estimation of critical habitat types in August revealed that Edney Tributary 1 provides totals of 3554m^2 of fry rearing, 1045m^2 of juvenile rearing, and 92m^2 of spawning habitat over the 3604m of its

[6] MPMC is currently working to develop a digitized version of this map.
[7] MPMC is currently working to develop a digitized version of this map.

useable length. Edney Tributary 2 was found to provide totals of 7059m^2 of fry rearing, 1696m^2 of juvenile rearing, and 15m^2 of spawning habitat over the 5073m of its useable length (Hallam Knight Piésold 1996c). These two streams are obviously highly suited to rainbow trout fry production at base flow conditions, mainly because water velocities are typically low across the entire wetted width.

A maximum 46% reduction in discharge s predicted for the Edney Tributary 1, and 12% for Edney Tributary 2 (see section 3.5.6) based on reduction in catchment area. Following mine closure, reclamation activities will restore the diverted flows to their pre-impact native channels, restoring the habitat capability to pre-impact levels. Post-closure reclamation planning specifies the return of the pre-impact flow regime to these channels.

Table 4.1 Rainbow trout density estimates (fish/m^2) for August, 1995 Edney Creek watershed survey

Sampling Site Location	F1 (lower Edney)	F1 (replicate)	F2 (below Edney Lake)	F3 (upper Edney)	F4 (Edney Tributary 1)	F6 (Edney Tributary 2)
Capture density (fry)	0.015	0.015	3.43	0	>1.09	1
Capture density (juvenile)	0.075	0.075	1.02	0	>0.29	0.26
Capture density (total)	0.09	0.09	4.45	0	>1.38	1.26

4.2.3.*Fish Tissue Analysis*

1989 Sampling

In October 1989 nine sexually mature rainbow trout were captured using a 2.0 inch monofilament gill net in Bootjack Lake. Metal analysis was conducted of muscle and liver tissues from these fish to establish baseline conditions prior to mining operations. Metal concentrations varied among fish. Metals that were above the detection limits are presented in Table 4.2.

Table 4.2 Fish tissue metals above detection limit in Bootjack Lake (1989)

	Tissue	Liver
Copper	0.83 – 1.86 mg/kg	205 mg/kg
Iron	14.7 – 33.5 mg/kg	1042 mg/kg
Manganese	0.49 – 1.31 mg/kg	4.66 mg/kg
Lead	0.05 – 0.30 mg/kg	0.10 mg/kg
Zinc	19.9 – 27.1 mg/kg	162 mg/kg

1995 Sampling

Fish tissue sampling in both Bootjack and Polley lakes was conducted in September and October, 1995 in order to establish a baseline for fish tissue metal content. The species targeted for this sampling effort were rainbow trout (*Oncorhynchus mykiss*) and longnose suckers (*Catostomus catostomus*). The fish tissue was analyzed for antimony, arsenic, cadmium, chromium, lead, mercury, nickel and selenium. The complete results are presented in the Mount Polley Environmental Baseline Report (Hallam Knight Piésold, 1996b).

Bootjack Lake

In Bootjack Lake rainbow trout, mean muscle and liver levels of antimony were found to be below the minimum detection level. However, cadmium levels exceeded the minimum detection level. In addition, mean levels of lead, chromium and selenium were well above those found in muscle tissue. In particular, mean liver selenium levels exceeded muscle levels by more than 10 times. In contrast, mean levels of mercury and nickel were slightly higher in muscle tissue. Metal levels were found to vary widely between samples for any given metal.

With the exception of mercury, the mean muscle metal content of Bootjack Lake longnose suckers appeared to be very similar to that of Bootjack Lake rainbow trout. The mean mercury level, however, exceeded the equivalent rainbow trout level by more than two times. As with the rainbow trout results, antimony readings were below the detection limit, while the majority of the samples exhibited cadmium levels below the detection limit, as well. With the exception of arsenic, chromium and selenium, metal levels were found to vary between samples.

While the mean liver levels of antimony, cadmium and lead appeared similar between Bootjack Lake longnose suckers and Bootjack Lake rainbow trout, rainbow trout mean liver selenium levels are nearly three times higher than the longnose suckers levels. In addition, mean levels of arsenic, mercury, chromium and nickel appeared to be higher in longnose suckers than in rainbow trout.

With the exception of mercury, mean longnose suckers liver metal content levels exceeded those found in longnose sucker muscle tissue. Mean muscle mercury levels, however, were more than two times higher than in liver tissue. Variability in metal levels among the samples appeared high, with the exceptions being selenium and antimony.

Polley Lake

Mean rainbow trout muscle levels of antimony and cadmium in Polley Lake were below detection limits. Polley lake rainbow trout exhibited higher mean muscle levels of mercury and lead, and lower mean levels of chromium, nickel, and selenium than Bootjack rainbow trout. With the exceptions of lead and mercury, variation in metal levels between samples appeared to be low.

Mean Polley Lake rainbow trout levels of arsenic, cadmium, chromium, lead, nickel and selenium were all higher in liver tissue. Only mean mercury levels were higher in muscle tissue. As seen in the Bootjack Lake samples, mean liver selenium levels exceeded mean muscle selenium levels by more than ten

times. A comparison between Bootjack Lake and Polley Lake rainbow trout liver metal content reveals that Bootjack Lake rainbow trout contained higher mean levels of arsenic, lead, mercury and nickel. Mean cadmium and selenium levels were found to be higher in Polley Lake rainbow trout. The level of variability of the metal content between samples appeared high, with the exception of arsenic.

In Polley Lake longnose suckers, mean muscle antimony and cadmium levels were found to be below the detection limit. This finding is consistent with the results of rainbow trout and longnose sucker muscle analyses from Bootjack and Polley Lakes. Mean muscle levels of the remaining metals appear to be comparable to those found in most of the Bootjack Lake longnose suckers. It should be noted, however, that the mean muscle level of arsenic in Polley Lake longnose suckers was more than twice that found in Bootjack Lake fish. In addition, mean arsenic muscle levels in longnose suckers were more than three times higher, and nickel and chromium muscle levels were more than two times higher than in Polley Lake rainbow trout muscle. On the other hand, mean chromium muscle levels were nearly three times higher in rainbow trout. These results differ from Bootjack Lake results, where the only major difference between the two species appeared to be the mercury muscle levels. With the exceptions of antimony, cadmium and selenium, metal muscle levels appeared to be quite variable between samples.

As with Bootjack Lake longnose suckers, Polley Lake longnose sucker mean liver antimony levels were below detection limits. Mean liver levels of cadmium, nickel and selenium also appear to compare well with those seen in the Bootjack Lake fish. However, mean liver levels of lead and arsenic were higher in Polley Lake fish, while Bootjack Lake fish were characterized by higher mean liver levels of chromium and mercury. Mean liver levels of antimony, arsenic, lead and nickel appeared to be comparable to Polley Lake rainbow trout liver levels. However, mean liver levels of cadmium and chromium were higher in longnose suckers, while mean liver levels of mercury and selenium were higher in rainbow trout. This situation differs from that in Bootjack Lake, where mercury, arsenic and nickel liver levels were higher in longnose suckers. With the exceptions of antimony and selenium, metal liver levels appeared to be quite variable between samples.

4.3. Sediments

4.3.1. *Creeks*

On September 21 and 25, 1995 sediment samples were collected under summer low flow conditions from ten spatially-separated, normalized locations in conjunction with benthic invertebrate sampling. The objectives of the sediment program are to provide:

- Baseline benthic invertebrate habitat quality data, both physically and chemically, for benthos studies;
- Baseline characterization of sediment quality of potentially impacted streams for future monitoring purposes; and
- Baseline data to develop site-specific sediment quality guidelines

Collected samples were divided into coarse and fine fractions at the laboratory. The coarse fractions were submitted for particle size analysis (Wentworth scale). The fine fraction underwent physical tests

(loss on ignition of the minus 200 mesh fraction, as well as moisture content) as well as total metal content analysis for Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag and Zu. Mean metal levels were compared to the BC provincial sediment quality guidelines (1994). The complete results are presented in the Mount Polley Environmental Baseline Report (Hallam Knight Piésold, 1996b)

In addition, power analyses of copper concentrations for each sampled station were carried out to determine adequate sample size to detect a 50% change in concentration.

Mean metal levels for all stations were below the lowest effect levels for cadmium, lead, selenium, silver and zinc. However, exceedances for the lowest effect levels included arsenic (eight stations), chromium (four stations), copper and manganese (all stations), iron (nine stations) and nickel (six stations). The station W5 reading exceeded the severe effect level of manganese (Hallam Knight Piésold, 1996b).

The results of the power analysis indicated that six were not sampled to level of effort required to detect a change of 50% while remaining stations were sampled to an equal, or higher, level of effort required to detect a change of 50%. Copper concentrations from stations which were not sampled to an adequate level of effort typically showed four replicate samples with fairly similar copper concentrations, while the other two replicates showed elevated levels of copper. Isolated areas of elevated copper levels would not be unexpected in an area known for copper occurrence. In addition, stations which were not sampled to an adequate level of effort were, with the exception of station W7, of narrower wetted width than the remaining stations. These smaller sites contained less available substrate for replicate sampling, and were typically more abundant in gravels and cobbles than in suitable sediment substrate. It was therefore more difficult to find enough suitable sediments for the required number of replicates at these sites, and in order to satisfy this requirement, samples may have been taken from sites which were not suitable similar with respect to substrate composition , flows and other physical parameters. This heterogeneity in substrate is further illustrated by the fact that laboratory subsamples taken from replicates from sites W6 and W10 varied considerably in copper levels (Hallam Knight Piésold, 1996b). Due to this limited supply of appropriate stream sediments at these sites, it may not be feasible to take as many replicate samples as prescribed by the power if analysis results. One solution may be to take more, but smaller volumes of sample per replicate for these sites, ie. Stratify into larger and smaller systems, and adjust sample volume appropriately.

Comparison of total copper levels to B.C. provincial guidelines show that mean levels, which ranged from 19.50 to 57.67mg/g (Hallam Knight Piésold, 1996b), are above recommended lowest effect level of 16mg/g but are less than the level of “severe effects” of 110mg/g.

4.3.2.*Lakes*

Sediments were collected from Bootjack Lake and Polley Lake in 1989 and again in 1995. Sediment samples were analyzed in the laboratory for metal concentrations, distribution of particle size and relative concentration of combustible (organic) fractions. Results of the 1995 analyses are presented by Hallam Knight Piésold (1996b).

Samples collected from deep water in both lakes show relatively high concentrations of organics and low concentrations of large particle sizes. The sediment material in these circumstances is what would be expected in lakes exhibiting relatively high pelagic productivity. The continual settling of dead and dying plankton organisms to the deeper water creates these sediments characterized by high concentration of fine particles and high organics. These sediments would overlay any sand and gravel deposit that might have been left in the basin at the time of lake formation during the last glaciation.

At shallower stations these analyses illustrate transition from the deep water sediments to the shallower shoals where sand and silt composition are predominant. Wave disturbance of the shoals probably reduces accumulation of organic sediments unlike in deeper parts of the lake.

Bootjack Lake sediments have generally higher concentrations of total and dissolved copper than Polley Lake. Deep water sediments show greater accumulations or arsenic, chromium, copper, mercury, molybdenum and nickel (in addition, Polley Lake sediments are elevated in arsenic, lead and manganese). Comparison of the 1995 metals analysis results to the 1994 BC government sediment quality criteria indicated that lake sediments in both lakes are slightly acidic and naturally contain metals above government criteria levels for arsenic, chromium, copper, mercury and nickel.

4.4. Gravel Quality

Gravel sampling was conducted in lower Edney and lower Hazeltine Creeks in the fall of 1995 in order to document the baseline gravel quality in these systems. Withdrawal of water from the Edney tributary catchment system for mine use may affect the gravel size distribution, which in turn many affect the success of salmon spawning in the lower Edney and Hazeltine systems. A gravel quality monitoring program will be able to use the baseline results to detect any changes in gravel due to withdrawal of water for mine use.

Gravel sampling was conducted on September 18, 1995 at gravel sampling sites G1 and G2 (Figure 2.8[8], extracted from Hallam Knight Piésold Ltd., 1996a). These sites were chosen as they are located in sections of lower Hazeltine and Edney creeks which are used for salmon spawning. At each site, three replicate samples were obtained using a McNeil Sampler. Approximately 3 to 7kg of sample were obtained for each replicate site. Samples were then shipped to Golder Associates Ltd. for sieve analysis. Complete results of the sieve analysis can be found in the Mount Polley Environmental Baseline Report (Hallam Knight Piésold, 1996b).

4.5. Benthic Invertebrates

4.5.1. *Creeks*

A baseline study of benthic macroinvertebrates was conducted at selected stations on Bootjack Creek, Edney Creek, Edney creek tributaries and Hazeltine Creek in the fall of 1995. The objective of this sampling program was to establish a master species list for each site, and to determine the baseline

[8] MPMC is currently working to develop a digitized version of this map.

species composition and abundance at each site. These baseline data will serve as a reference for comparison to future stream benthos sampling results over the life of the mine monitoring program.

The location of the sites is given in Figure 2.8[9] (extracted from Hallam Knight Piésold Ltd., 1996a). The sites were sampled over three consecutive weeks, from September 27 to October 15, 1995. A complete summary of the results of the taxonomic analyses of the samples is presented in the Mount Polley Environmental Baseline Report (Hallam Knight Piésold, 1996b).

Abundance

The order which contained the species with the greatest abundance throughout the sampling period was Diptera, which peaked in the third sampling week at 40,044.4 individuals/m^2 (Chironomidae). The taxum which contained the species with the second-greatest abundance in weeks one and two was the order Ephemeroptera, with a peak in week two of 25,644.4 individuals/m^2 (*Baetis sp.*), followed by the order Plecoptera, which peaked in a week three at 14,577.8 individuals/m^2 (Plecoptera, unidentified). In week three, abundance of *Nais sp.*in the order Oligochaeta was 31,644.4 individuals/m^2, making it the second-most abundant species during that week (Hallam Knight Piésold 1996b).

Tolerance

The general trend observed at all stations was a decrease in the number of sensitive organism, along with an increase in the number of facultative organisms. At stations W1, W5, W8 and W9, the tolerance ratio shifted predominantly sensitive organisms in week one to predominantly facultative organisms by week three. At station W8a, facultative organisms dominated throughout the sample period, while at stations W7 and W10, sensitive organisms dominated throughout the sample period (Hallam Knight Piésold, 1996b).

The sample from W6 site (Hazeltine Creek) was the only one with a tolerance ratio that indicated more tolerant organisms than sensitive organisms. The ratio of sensitive to facultative to tolerant at this site was approximately 1:10:5 (Hallam Knight Piésold, 1996b). IT should be kept in mid that this site was located in a very slow-flowing channel, and therefore represents significantly different habitat from the remaining sites.

EPT Ratio

This section examines the changes in the EPT ratio over the three week sample period. When examining the results presented here, it should be kept in mind that the ratios are calculated by dividing both Ephemeroptera and Plecoptera mean counts by the Trichoptera mean count.

At stations W1, W7 and W11, the EPT ratio favoured Ephemeroptera over Plecoptera over the entire sampling period. At stations W8 and W8a, the EPT ratio shifted from predominantly Ephemeroptera in week one to predominantly Plecoptera by week three. At stations W5, W9 and W10, Plecoptera were more abundant than Ephemeroptera throughout the entire sampling period. Station W6, which was

[9] MPMC is currently working to develop a digitized version of this map.

only sampled during the first week also indicated a greater abundance of Plecoptera over Ephemeroptera (Hallam Knight Piésold, 1996b).

4.5.2.*Lakes*

1989 Survey

As an early development of an ongoing environmental monitoring program for the Mount Polley mining operation, benthic invertebrate samples were collected in August, 1989 to document baseline conditions in the lakes. Results using diversity indices are summarized in Table 4.3.

Table 4.3 Benthic invertebrate diversity indices for Bootjack and Polley Lakes (1989)

	Bootjack Lake				**Polley Lake**	
Date	**Aug 18**				**Aug 19**	
Sampling Stations	LN	B2	B3	LS	B	L
Depth (M)	12	7	3	11	8	20
Group 3 Organisms	4	-	-	-	-	-
Group 2 Organisms	316	7	81	12	90	7
Group 1 Organisms	9	2	2	7	-	-
Total No. of Organisms (N)	329	9	83	19	90	7
Total No. of Taxa (S)	17	5	9	8	13	6
Diversity (d)	2.16	1.88	0.97	2.71	2.55	2.52
Total No. of Organisms/m^2	6663	172	158	364	1723	134

The invertebrate populations of Bootjack Lake on August 18, 1989 consisted predominantly of Group 2 pollution facultative organism composed of Chironomidae species which are commonly associated with lake bottom substrates. Pollution tolerant Group 1 organisms were found at all sampling locations in low numbers represented by Tubificidae. Pollution sensitive Group 3 organisms were found in low numbers only at the north basin at 11.0m depth. This location contained the highest total number of organisms/m^2 (6663), the highest number of taxa per sample (17) and high diversity (2.61).

Benthic populations near shore (Station B2) were in low numbers (9) and diversity of species present (1.88). In the south basin, populations consisted of similar species dominated by Group 2 organisms (Chironomidae larvae) at both the shallow and deep sites. Total number of organisms/m^2 was higher on the shallow depth (1583) compared to (364) and the diversity was lower (0.97 compared to 2.71).

In Polley Lake August 19, 1989 the shallower sampling site contained a diverse population of benthic organisms/m^2 (1723) dominated by Group 2 Cammaridae, Pelecypoda and several Chironomidae species. The deeper site contained lower numbers of organisms/m^2 (134) represented by only a few taxonomic groups (6). Species diversity was similar for both sites.

1995 Survey

Results from the taxonomic analysis of the 1995 samples are presented in the Mount Polley Environmental Baseline Report (Hallam Knight Piésold, 1996b). In 1995, two stations in each of Bootjack and Polley Lakes were sampled at spring and fall overturns.

At the time of spring overturn both the number of species and abundance of benthic invertebrates found at Bootjack Lake sampling stations was very low. Abundance ranged from 43.48 to 173.91 #/m^2, and only three of the replicates contained more than 2 species. The most common species (found in 60% of the samples) was *Chironomus sp.* Other species detected included one species each from the taxa Hydracarina, Chaoborinae, Nematoda and Oligochaeta. Fall overturn samples appeared to contain greater abundances (43.48 to 1,086.96 #/m^2) and more species than the spring overturn samples. The most common species was *Chaoborus sp.* (found in 80% of the replicates), while the most abundant species were of the order Cyclopoida (86.96 to 1086.96 #/m^2). In contrast to the spring overturn results, species from the orders Cladocera and Copepoda were found, while species from the order Oligochaeta were absent.

Polley Lake benthos samples taken at the time of spring overturn contained a greater variety of species, as well as higher abundances (43.48 to 1913.04 #/m^2) than the Bootjack Lake samples. The most common species was *Chironomus sp.*, which was found in ever replicate sample from both stations P1 and P2. The most abundant species belonged to the order Cyclopoida (1913.04 #/m^2). In contrast to the Bootjack Lake samples, the Polley Lake samples also contained species from the orders Ephemeroptera and Ostracoda. However, species from the orders Hydracarina and Chaoborina were not detected in the Polley Lake samples. In contrast to the spring overturn samples, Polley Lake benthos samples contained fewer species and showed lower abundances (43.48 to 304.35 #/m^2) than the Bootjack Lake samples. The most common (found in 60% of the replicates) and abundant (43.48 to 305.35 #/m^2) species were of the order Harpaticoida (Copepoda). Species from the orders Ostracoda and Nematoda, which were found at spring overturn, were absent from these samples.

The low abundances and low number of species indicates that Bootjack and Polley Lakes may be very oligotrophic.

4.6. Zooplankton

1989 Survey

Zooplankton samples were collected form the water column in the lake to establish baseline conditions for the monitoring program. The data summary in Table 4.4 describes the results of the 1989 sampling program.

Table 4.4 Zooplankton sample results for Bootjack and Polley Lakes (1989)

	Bootjack Lake			**Polley Lake**		**Kay Lake**
Date (1989)	**Aug 18**	**Aug 18**	**Oct 16**	**Aug 19**	**Oct 16**	**Oct 17**
Sampling Location	LN	LS	LS	L	L	L
Tow Distance (m)	7	7	10	7	15	12
Total No. of Organisms (N)	157	85	137	344	2851	142
Total No. of Taxa (S)	9	12	13	9	15	9
Diversity (d)	2.03	2.84	2.72	2.30	1.29	2.65
Total No. Per m^3	345.4	1700.6	1412.9	625.7	2162.7	1785.6

The zooplankton community in the August 18-19, 1989 survey for Bootjack and Polley Lakes displayed wide variability in the species present, relative abundance of organisms density and species dominance between lake and also between basins in Bootjack Lake. The south basin of Bootjack Lake contained the highest number of species present (12) and highest diversity (2.84) but no species was clearly dominant and the cladoceran, *Daphnia rosea* was the most abundant zooplankton species present. In the north basin only 9 species were represented and diversity was lower (2.03). A rotifer*, Keratella quadrata* and *Cladoceran ocelli* were dominant species. In Polley Lake only 9 speices were present with a cladoceran, *Daphnia galeata mendota*, and copepods, *Cryptocyclops bicolour*, and *Ospranticum labronectum* being dominant.

The comminutes in the October survey again displayed considerable variety in species presence, relative abundance of organisms, density and species dominance as well as changes since August. The south basin of Bootjack Lake contained 13 zooplankton species with the rotifers, *Asplanchna sp*. and *Kellicottia longispina* now being dominant. Species diversity was also the highest observed (2.72). Polley Lake now contained the highest number of species present (15) dominated by a copepod, *Cryptocyclops bicolour*. The very high density of unidentifiable cladeceran naupii distorted the diversity index (1.29) and the total density estimates. The other two dominant species found in the August survey were present but at low levels. Kay Lakes contained 9 species in the October survey with two copepods, *Ectocyclops phaleratus* and *Paracyclops fimriata poppei* the most abundant zooplankton present. Once again high naupii density created distortions in some indicators.

These differences may be reflections of differences in the basins (nutrient availability, phytoplankton productivity, physical-chemical environment, predation, etc.). Only long term trends will clarify that. The Mount Polley samples contained several species widely distributed in B.C. including *Cryptocyclops bicolour, Daphnia pulex, Daphnia rosea, Diacyclops bicuspidatus, Ectocyclops phaleratus, Leptodora kindti*, and *Tropocyclops prasinus*. Also present in the study area were several species that tend to be

found in more saline and more alkaline environments. These included *Daphnia schoedleri, Daphnia magna, Daphnia similis, Moina hutchinsoni, Paracyclops fimbriatus* (Pennack, 1989).

1995 Survey

In both Bootjack and Polley Lakes, vertical plankton hauls were conducted monthly from spring overturn to fall overturn (May to October) in order to establish preliminary information on zooplankton diversity and abundance. The results of the taxonomic analyses are summarized in the Mount Polley Environmental Baseline Report (Hallam Knight Piésold, 1996b).

During the May 14-15 sampling period, more species in the order Rotifera were present at the Polley Lake sites than at the Bootjack Lake sites. In addition, the Poley Lake sites had greater Rotifera abundances. While a greater number of Cladocera species were present at the Polley Lake sites, the abundances of Calonoia species were higher at Bootjack Lake. A greater number of Cyclopoida species were present at the Polly Lake sites, with abundances ranging from 0.47 to 7403.87 #/m^3. Insecta species were not found at Bootjack Lake sites and in only very low abundances (0.47 #/m^3) at Polley Lake sites. Benthic organisms such as *Hydracarina* and *Tanytarsus sp.* were present in low abundances at both Polley and Bootjack Lake sites.

Abundance data for the June 14, 1995 sampling period indicated that species from the order Protozoa were present in low abundances at both Bootjack and Polley Lakes sites. Species in the order Rotifera were present at high abundances at both Polley Lake sites (to 10416.71 #/m^3) and at the Bootjack Lake sites (to 26316.37 #/m^3). While a greater number of Cladocera species were present at the Polley Lake sites, the abundances of the Cladocera species were again higher at Bootjack Lake. Similarly, abundances of Calonoia species were higher at Bootjack Lake. A greater number of Cyclopoida species were present at the Polley Lake sites, with abundances ranging from 86.27 to 17727.54 #/m^3. Insecta species were found at both Polley and Bootjack Lake sites, but only in very low abundances (0.74 to 2.36 #/m^3). Benthic organisms such as Hydracarina, Oligochaeta, *Procladius sp.* and *Tanytarsus sp.* were present in low abundances at both Polley and Bootjack Lake sites.

For the August 24, 1995 sampling period, a different mesh haul net was used, and consequently direct comparisons to abundance from other sampling periods cannot be made. Only comparisons with regard to species presence/absence are thus warranted. There appear to be more species from the orders Rotifera (*Tetramatrix sp., Polyartha sp., Keratella cochlearis*) and Cladocera (*Leptodora kindti* and *Polyphemous pediculous*) present than in the month of June, while the species composition in the remaining taxa appears to be similar to that seen in June.

During the September 20-22, 1995 sampling species from the order Protozoa were present in low abundances at both Bootjack and Polley Lake sites. Species in the order Rotifera were present at medium abundances at but Polley sites (to 928.43 #/m^3) and at the Bootjack Lake sites (to 769.96 #/m^3). The number and abundance of Cladocera species appeared similar between the Polley Lake and Bootjack Lake sites. Abundances of Calanoia species were higher at Bootjack Lake. A greater number of Cyclopoida were present at the Polley Lake sites, with abundances ranging from 44.21 to 8400.09 #/m^3. Insecta species were found at both Polley and Bootjack Lake sites, but only in very low abundances (2.30

to 30.56 #/m^3). Benthic organisms such as Hydracarina, Oligochaeta, *Prodcladium sp.* and *Tanytarsus sp.* were present in low abundances at both Polley and Bootjack Lake sites.

Results from the October 16-17, 1995 sampling showed that species from the order Protozoa were present in low abundances at only the Polley Lake site P2. Species in the order Rotifera were present at medium abundances at both Polley Lake sites (to 373.78 #/m^3) and at the Bootjack Lake sites (to 979.44 #/m^3). While a greater number of Cladocera species were present at the Polley Lake sites, the abundances of the Cladocera species were higher at Bootjack Lake (to 4979.93 #/m^3). While the number of Calanoia species was low at both Polley and Bootjack Lake sites, the abundances at the Bootjack Lake sites was slightly higher (to 631.20 #/m^3). Cyclopoida species were more abundant at the Polley Lake sites, with abundances ranging from 373.78 to 1997.70 #/m^3. Insecta species were found at both Polley and Bootjack Lake sites, but only in very low abundances (0.53 to 1.88 #/m^3). Benthic organism such as Naididae, Hyrdacarina and *Procladius sp.* were present in low abundances at both Polley and Bootjack Lake sites.

4.7. Phytoplankton

1989 Survey

Phytoplankton samples were also collected from the lakes in August and October in conjunction with limnology studies. The data summary in Table 4.5describes the result of the 1989 sampling program.

Table 4.5 Phytoplankton sample results for Bootjack and Polley Lakes (1989)

	Bootjack Lake			**Polley Lake**		**Kay Lake**
Date (1989)	**Aug 18**	**Aug 18**	**Oct 16**	**Aug 19**	**Oct 16**	**Oct 17**
Sampling	Ln	LS	Ls	L	L	L
Location Sampling						
Depth (m)	4	4	4	6	4	3
Total No. of Organisms (N)	264	275	140	502	402	331
Total No. of Taxa (S)	19	19	23	19	21	17
Diversity (d)	1.77	2.08	2.87	1.39	2.38	2.27
Total No. per mL	252.9	263.5	134.1	480.9	385.1	317.1

The august sampling of both basins of Bootjack Lake contained 19 phytoplankton taxa, and a cryptophyte species, *Chroomonas acuta* was dominant at both sites. Polley Lake also contained 19 species and the highest density (480.9 per mL) and was also dominated by *Chroomonas acuta.*

During the October survey total taxa and diversity had increased in Bootjack and Polley Lakes. The Kay Lake contained 17 species, a moderate species diversity (2.27) and moderate density (317.1 per mL). The dominant species continued to be *Chroomonas acuta* in all three lakes. In Bootjack and Polley Lakes a blue-green algae, *Aphanizomenon flos-aquae* displayed a strong seasonal response (bloom) in October but was not even present in Kay Lake.

1995 Survey

Bootjack and Polley lakes were sampled on a monthly basis from May to October in order to obtain information on the baseline diversity and abundance of phytoplankton in these lakes over time. Chlorophyll "a" analysis was carried out to determine phytoplankton standing crop. Results of the taxonomic and chlorophyll "a" analyses of these samples are available in the Mount Polley Environmental Baseline Report (Hallam Knight Piésold, 1996b).

All May samples were similar in the overwhelming abundance of small chrysophytes (*Ochromonas* and *Chromulina sp.*). However, Polley Lake samples differed in species composition from the Bootjack Lake samples. In Polley Lake, the diatoms *Synedra radians* and *Melosira italica* were abundant along with the chrysophytes. In Bootjack Lake, these diatoms were rare, but the cryptophyte *Rhodomonas minuta* and chrysophyte *Chrysochromulina parva* were abundant along with the chrysophytes.

The predominant species in all June samples was the chrysophyte *Uroglena Americana* accounting for between 25.6% and 46.6% of the total cells counted. Uroglena was not found in the May samples. All five June samples again had very high numbers of small chrysophytes (*Ochromonas, Chromulina spp.* and *Chrysochromulina parva*). Among the Bootjack Lake samples, *Rhodomonas minuta* (cryptophyte), *Stephanodiscus niagare* and *Asterionella formosa* (diatoms) appear common. *Mallomonas akrokomas* (chrysophyte) and *Gloeocystis sp.* (green) were common in B2. In contrast, Polley Lake samples showed high concentrations of *Aphanothece spp.* and *Anabaena flos-aquae* (blue-greens), *Eudorina elegans* (green), *Synedra radians* and *Melosira italica,* predominant in May, were much less abundant in June.

The July samples contained a much higher incidence of blue-green algae than either the May or June samples. All July samples had high numbers of small chrysophytes (*Ochromonas, Chromulina spp.* and *Chrysochromulina parva*). The colonial blue-green *Aphanothece clathrata* was predominant in both Bootjack and Polley Lake samples, accounting for between 11.9% and 23.6% of the counts. Large species *such as the diatom Asterionella formosa and dinoflagellate Ceratium hirudinella were common in the* Bootjack Lake samples. The chrysophyte *Dinobryon cylindricum* was predominant and the blue-green *Anabaena flos-aquae* was common in the Polley Lake samples.

During August, small chrysophytes (*Ochromonas spp., Chromulina spp.*) continued to dominate the cell numbers. In addition, blue-green algae continued to increase in abundance. In Polley Lake, the colonial blue-green *Aphanothece spp.* and filamentous blue-green *Aphanizomenon flos-aquae* were predominant, while the filamentous blue-green *Anabaena spp.* were common. While Bootjack Lake samples did not exhibit any clear predominant species, the most common species were the diatoms *Asterionella formosa* and *Cyclotella bodanica*, the colonial blue-greens *Gomphosphaeria lacustris,*

Gomphosphaeria aponica, and *Aphanothece spp.*, the filamentous blue-greens *Aphanizomenon flos-aquae* and *Anabaena spp.* and the cryptoflagellate *Rhodomonas minuta*.

The September samples were similar in comparison to the August Samples. Small chrysophytes (*Ochromonas spp.* and *Chromulina spp.*) continued to dominate the cells numbers in Bootjack Lake samples, accounting for between 50.2% and 71.9% of the total cell count. However, the blue-green algae were much more abundant in September than earlier in the season. In the Polley Lake samples, the colonial blue-green *Aphanothece spp.* were the most abundant phytoplankton, constituting from 38.8% to 42.9% off the total cell count. In Polley Lake, the colonial blue-green *Aphanothece spp.* and filamentous blue-green *Aphanizomenon flos-aquae* continued to be predominant. The filamentous blue-green *Anabaena spp.* were common. In Bootjack Lake, *Anabaena spp.* and *Aphanizomenon flos-aquae* were predominant. The common species were the diatoms *Asterionella formosa* and *Cyclotella bodanica*, the colonials blue-greens *Gomphosphaeria lacustris, Gomphosphaeria aponica,* and *Aphanothece spp.*, and the cryptoflagellate *Rhodomonas minuta*.

The October samples were fairly similar in composition to the September and August samples. Small chrysophytes (*Ochromonas spp.* and *Chromulina spp.*) continue to dominate the cell numbers, accounting for between 57.2% and 67.5% of the total count. Blue-green algae continued to be abundant, as well. In samples from all four sites, the filamentous blue-green *Aphanizomenon flos-aquae* continued to be predominant. The filamentous blue-green *Anabaena spp.* were much less abundant in September. The cryptoflagellate *Rhodomonas minuta* and varieties, blue-green *Anabaena spp.*, diatoms *Asterionella formosa and Tabellaria fenestrata* were common in all five samples. In Polly Lake, the blue-green *Aphanothece spp.* and chrysophyte *Dinobryon cylindricum* were common. In Bootjack, the blue-green *Gomphosphaeria lacustris* and diatom *Stephanodiscus niagare* were common.

Total cells numbers decreased steadily from a spring bloom high in May of 10000cells/mL to approximately 2000cells/mL for August, September and October. This decline in the total cell count appears to be due to the decline of the cell count associated with the 1000X size. In addition, the August, September and October samples were composed of colonies of small (1-5µm) cells, whereas the May samples consisted of small flagellates and large diatoms. Chlorophyll “a” measurements may show more similar quantities of phytoplankton over time than raw counts suggest. The decrease in numbers may also be related to the sampling depth of 0.5m, where surface water temperatures and light levels are high and nutrients are becoming depleted over the course of the summer.

Results from the chlorophyll “a” analysis indicated that the chlorophyll “a” content ranged from 0.28 µg/L to 4.17 µg/L, with an overall mean of 1.22 µg/L. The chlorophyll “a”content appeared to remain fairly stable from May through September, but increased greatly in October.

4.8. Periphyton

Periphyton sampling was conducted in mid-summer 1995 during maximum periphyton growth, in order to establish baseline periphyton diversity and abundance in selected stream within the study area. Complete results are presented by Hallam Knight Piésold (1996b).

The periphyton sample collection was carried out at water quality (W) sites 7 (Hazeltine Creek), 8 (Edney Creek tributary 1), 8a (Edney Creek tributary 2) and 9 (Edney Creek mainstem) on August 25, 1995 (Figure 2.8[10], extracted from Hallam Knight Piésold Ltd., 1996a). At each site, 3 replicate samples were randomly collected using a "Stockner sampler", a modified wide-barrelled syringe fitted with a toothbrush. In addition, samples were analyzed for chlorophyll "a" content, to determine periphyton standing crop.

The samples from site W7 contained some sediment, mostly silt and detritus with relatively little algae. All three samples had similar composition. Diatoms comprised 99% to 100% of periphyton. Empty frustules (dead cells) were common in these samples. The predominant species were *Nitzschia spp., Synedra ulna,* and *Navicula spp.*

[10] MPMC is currently working to develop a digitized version of this map.

5. HISTORIC LAND USES

5.1. Forest Resources

All of the project area is within the ICHmk3 biogeoclimatic zone, and with very few exceptions, the land is Crown owned. Under the administration of the Ministry of Forests, commercial forestry has been the predominant land use activity in the project area.

Clear-cut and selective logging occurred over a significant portion of the project area and its surroundings. Many of these cut blocks were replanted for commercial timber species, although a few blocks were replanted for a combination of silviculture and cattle grazing uses. The cut blocks planted for cattle grazing are mostly south of Polley Lake, as shown in Figure 2.20[11] (extracted from Hallam Knight Piésold Ltd., 1996a). The wildlife capability map in Figure 2.18[12] (extracted from Hallam Knight Piésold, 1996a) shows.

Forest capability varies greatly over the project area due to varying stages of regeneration from previous logging activity, mine exploration activity, and scattered marshy areas. Overall forest capability is medium to good class timber.

5.2. Range Management

There are two ranchers with range tenures neighbouring the site. Fred Tillitson is authorized to graze cattle to the southeast of the mine, adjacent to the TSF, and Dan Hamblin is authorized to graze cattle to the north and east of the mine site on either side of the access road (encompassing the area around Bootjack Lake and Trio Lake, stretching to Frypan Lake). Contact with each of these ranchers was established in 1988 by Imperial Metals Corporation prior to development (and infringement on grazing land) to verify grazing activities, and to discuss potential points of contact and mechanisms for avoiding conflicts between the mine and grazing. The ranchers identified a spring used by their cattle near the Gavin Lake Road south of Polley Lake, and asked to have it preserved for cattle watering. It was also confirmed that the most productive and successfully re-vegetated grazing areas are located south of Polley Lake and outside of the project area.

Areas disturbed by logging have created opportunity for cattle grazing in the area. In some cases, whole cut blocks were re-vegetated with a combination of forage species for cattle, as well as commercial timber species. Road sites, abandoned roads and tracks, and log landing areas were typically planted with species suitable for cattle grazing. The selected species include several domestic grasses and legumes. This has resulted in the creation of summer grazing areas on Crown owned lands by regional ranches. Prior to mine development, several cut blocks in the vicinity of Bootjack Creek were used for

[11] MPMC is currently working to develop a digitized version of this map.
[12] MPMC is currently working to develop a digitized version of this map.

grazing and were either re-vegetated or in a transitional state from 1970s logging, as shown in Figure 2.20[13] (Hallam Knight Piésold, 1996a).

5.3. Hunting, Guiding, and Trapping

There is an extensive system of logging roads surrounding the Mount Polley area, giving vehicle access to areas on both sides of Bootjack and Polley Lake. These roads also connect with north-south and east-west forestry roads, giving hunters convenient access loops. Hunting is a common recreational activity in the region, and local moose and deer populations attract both local and non-resident hunters. The roads in the areas surrounding the mine are used frequently by resident hunters during hunting season. Out-of-province hunters must hire guide-outfitters to assist them in hunting. The boundary between two guide-outfitting territories runs through the Mount Polley Mine site as shown in Figure 1. The project area was not previously an important destination for either guide-outfitter, as it does not contain substantial amounts of prime moose habitat. Both guide-outfitters were contacted by Imperial Metals Corporation prior to project development, and both confirmed that the area only formed a minor element in their annual hunting and guiding activity. They recognized that no-shooting areas around the mine would be necessary for safety, and agreed to make adjustments. Black bear have been hunted in the past from the Mount Polley project area, particularly during the spring bear hunt. Grouse and rabbits were sometimes taken by hunters seeking deer and moose. The area had low waterfowl capability and was used little by duck and goose hunters.

Marten, weasel, muskrat, beaver, and squirrel are the major fur-bearers in the region surrounding Mount Polley, although fox, lynx, mink, otter, wolf, and coyote are trapped in small numbers. The Mount Polley project area is entirely within the registered trapping area TR0502T056 as shown in Figure 1.

5.4. Recreation

Recreational activities in the area are centred around lake fishing, hunting, and camping. The natural populations of rainbow trout in the lakes attract both local residents and tourists.

The Forest Service maintains campgrounds that are equipped with boat launches, campsites, toilets, and picnic tables on both Bootjack and Polley Lakes, which are used steadily throughout the camping season, often by fishermen with canoes or boats. Hunters often use the campsites as well. Because no fees are collected for campsite use, no accurate utilization records exist. Hiking, nature study, cross country skiing, snowmobiling, and vehicles touring might be expected as minor components in the recreational use of the area, particularly on the network of logging roads and tracks.

Two private parcels (L11560, L11559) at the north end of Polley Lake are owned by Imperial Metals Corporation, and there is also a private cabin (L12023) at the northeast end of Bootjack Lake.

[13] MPMC is currently working to develop a digitized version of this map.

The Morehead Lake Resort on the Likely Road at the north end of Morehead Lake is the closest accommodation to the project site. Hunters, fishermen, tourists, and mining and forest industry workers stay in the cabins or use the campsites. Parcels of private land with cabins and homes can be found near Morehead Lake.

5.4.1.*Creel Surveys*

BC Fisheries Branch personnel in Williams Lake indicated that during a creel survey conducted in August 1982, catch rates of rainbow trout in Polley Lake were 1.9 fish per hour (8.4 fish per angler day) and 0.94 fish per hour (6.6 fish per angler day) in Bootjack Lake. Creel survey information for Bootjack and Polley Lakes also exists for the years 1987 to 1990. During the period of June to September 1990, angler catch rates on Polley Lake ranged from 0.97 fish per hour in September to 3.37 fish per hour in June. Bootjack Lake catch rates for the same period ranged from 0.71 fish per hour in July to 1.68 fish per hour in June (Lirette and Tredger, 1991).

Judged on the basis of angler effort and success, Polley Lake is among the top three unstocked (wild) Cariboo lakes, and Bootjack Lake is among the top ten (M. Lirette, personal communication).

Imperial Metals Corporation conducted weekend boat counts and creel surveys at Polley Lake and Bootjack Lake from May 20 to September 16, 2,995. Anglers fished an estimated 1,744 weekend hours or 761 weekend days on Bootjack Lake, and 4,095 weekend hours or 1,087 weekend days on Polley Lake. For the period of May 1 to September 30 1995, anglers on Polley Lake caught an estimated 9,009 trout and kept an estimated 7,248 trout. For the same time period, anglers on Bootjack Lake caught an estimated 4,884 trout and kept an estimated 4,253 trout (Hallam Knight Piésold, 1996c).

5.5. Culturally and Environmentally Sensitive Areas

There are no reserves in the Mount Polley project area; however it falls on the traditional territory of the Xat'sull Cm'etem (Soda Creek/Deep Creek Band) and the T'exelc (Williams Lake Band). A traditional use study was conducted in 2012 by Points West Heritage Consulting Ltd. The report summary states:

Points West Heritage Consulting Ltd. conducted an overview assessment of the heritage resources in the project area prior to mine construction. The abstract of their report (which was filed with the Archaeology and Outdoor Recreation Branch in Victoria) states:

"Most of the development area has a low heritage resource potential. A few isolated areas have a low-moderate potential. All have been disturbed to some degree, and involve narrow corridors. Two locations have moderate heritage resource potential. Area A is adjacent to Bootjack Lake and appears to be undisturbed. No additional studies of this site are contemplated, because it is outside of the mine development area. The other is adjacent to a potential transmission line corridor, and it appears to have been disturbed by previous land use activities. "

No parks or protected areas fall within the project development area.

6. PRIOR LAND USES OF SITE RECLAMATION UNITS

6.1. Mill and Plant Area

The mill area was previously a gently-sloping south-facing plateau, most of which is blanketed with glacial till deposits to seven meters deep, although there was a small inclusion of organic soils in the center of the area (Blashill 1995a, 1995b). The Mill area was clear-cut in 1972, except for isolated red cedar stands, and was labelled NSR (not sufficiently restocked) on forest cover maps prior to mining. Areas to the east, north, and west of the mill area were selectively logged in 1972, and these areas have had good natural regeneration by Douglas-fir, western red cedar, and subalpine fir. In general, the mill area had a medium site class capability for commercial forestry. South and west-facing slopes, located west of the mill site, have good capability (Class 2) as summer range for moose and mule deer, but a fair to poor capability for winter range (Classes 3,4). These high-quality ranges will not be cleared for mine development. The selectively logged areas surrounding the mill have a fair capability for marten, weasel, hare, squirrel, and lynx. Breeding bird densities and bird species diversity are both high. Prior to clearing, the mill area had a very low capability for waterfowl and aquatic furbearers such as beaver, muskrat or mink. The two small intermittent streams that drained the mill area did not constitute fisheries habitat. There are no heritage resources or historic features within the mill area.

6.2. Open Pits

The southern portions of the Cariboo Pit were selectively logged in the 1970's, leaving a variable forest with some advance regeneration by western red cedar and subalpine fir. The remaining portion of the Cariboo Pit and the now backfilled Bell Pit were not logged, but consisted of mid-seral Douglas-fir and lodgepole pine stands which dated back to forest fires some 120 to 160 years ago. Forest cover maps indicate that most of this area had a poor to low site class rating for commercial forestry.

The area of the Springer Pit does not appear to have been logged, but consisted of mid-seral Douglas-fir and lodgepole pine stands, which date back to forest fires some 120-160 years ago. Forest cover maps indicate that most of the area for the Springer Pit has a poor (P) to low (L) site class rating for commercial forestry.

Pellet group counts and range surveys indicate that the Springer, Cariboo and Bell Pits offer poor to fair summer range for mule deer and moose, poor winter range for moose, and very poor winter range for mule deer. Better mule deer and moose habitat exists on the west-facing slopes below this, overlooking Bootjack Lake. The pit area probably has low to moderate capability as black bear habitat, due to the high cover by black huckleberry and kinnikinnick, which provide some berries in season. Habitat capability for marten, squirrel and hare appears low to moderate. Call count transects indicate that breeding bird densities are low, with few species. The pit area had no capability for waterfowl, or aquatic fur bearers such as beaver, mink, or muskrat. There were no permanent ponds, lakes, or streams in the pit area, and thus the area has no potential as fish habitat. No wildlife trees, cliffs, caves or other special wildlife features were been found in the pit area.

The Wight Pit is located in an area identified as MOG (mature and old growth habitat), CL (clear-cut) and RSS (riparian zone of small stream). It contains a mixture of Western red cedar, Douglas-fir, spruce and balsam trees. The stands were all greater than 141 years, with some greater than 251 year. Forest cover Maps indicate that the area for the Wight Pit had a poor (P), medium (M) to good (G) site class rating for commercial forestry. While there were no studies in the specific area where the Wight Pit will be located, mature and old growth forests in the Interior Cedar-Hemlock zone may be home to the following wildlife: moose, mule deer, black beer, wolverine, marten, owls, woodpeckers and several passerine species. In a field study during the spring of 2004, riparian vegetation near the creeks flowing into Polley Lake from the west were dominated by devils club, ferns, alder, huckleberry and willow species. The area of the Wight Pit will encompass the mid and upper reaches of an un-named creek. Fisheries studies in the spring of 2004 concluded that this drainage does not provide rearing or spawning habitat for the rainbow trout in Polley Lake. Further, it provided no nutrients (benthic invertebrates), as this drainage does not connect with the lake.

While the rock borrow at the TSF is included with the areas associated with the pits, all prior land uses are similar or the same as those for the TSF. Please refer to Section 6.4 on the TSF for more information.

6.3. Waste Rock Dumps

Most of the North Bell Dump occupies a side valley enclosed by rock knobs that was logged in 1975, and regenerated to a dense second-growth mixed forested dominated by alder, willow, cottonwood and tall shrubs, with a scattered veteran Douglas-fir and Western red cedar, and with strong advance regeneration by subalpine fir. Forest cover maps rate the site capability of this area as good (G). There was no evidence of livestock grazing in this unit prior to mining.

The North Bell Dump area had moderate densities of breeding birds, but fewer species than the East RDS, Wight RDS and Leach Pad areas. No pellet groups were found on pellet group plots, but moose dropping groups and deer tracks were found along an abandoned road. Ungulate browsing was very localized, but tall willows, Douglas maple and western mountain-ash were heavily browsed at favoured locations. Some individual alders and willows in the North Bell Dump area were girdled and killed by snowshoe hares.

The East Rock Disposal Site occupies a sloping eastward aspect plateau. Prior to mining disturbance, the vegetation was a complex mosaic of young seral, mid-seral and mature forest. Much of the area east of the mill site was selectively logged in 1972, and supported a rich and diverse patchwork of deciduous shrub thicket, veteran black cottonwoods, and vigorous advance regeneration by Douglas-fir, western redcedar and subalpine fir. Parts of the waste dump overlap stands of mature forest, dominated by large, well-grown western redcedars and Douglas-firs, with a rich a variable shrub understory, of the 05 and 07 site series. Forest cover maps rate the forest site capability as medium (M) to good (G). There is no evidence of livestock grazing in this unit prior to mining activity.

Neither of these areas had permanent lakes or ponds, although there were small seepages and swampy areas in both the North Bell Dump and East Rock Disposal Site. The creeks draining the ravines were small and intermittent, and were reduced to a trickle by mid-June. They had very low capability for

waterfowl, shorebirds or aquatic mammals, such as beaver, due to their small sizes and intermittent flows. No amphibian eggs, larvae or adults were found near any of the creeks draining these waste rock dumps. These streams did not support fish. There were no cliffs, caves, canyons, talus slopes, permanent streams, lakes, wetlands or mineral licks in either of these areas.

The areas for the East Rock Disposal Site, NEZ Dump, and North Bell Dump did not have permanent lakes or ponds, although there are small seepages and swampy areas in ravines of all four locations. The creeks draining the ravines are small, and intermittent. By mid-June, these creeks are reduced to small trickles. These creeks have a very low capability for waterfowl, shorebirds or aquatic mammals such as beach, due to their small sizes and intermittent flows. No amphibian eggs, larvae or adults were found near any of the creeks draining these existing or proposed waste rock locations. These streams do not support fish. There are no cliffs, caves canyons, talus slopes, permanent streams, lakes, wetlands or mineral licks in either of these areas.

6.4. Tailings Storage Facility

Large portions of the tailings area were clearcut logged in 1970, 1979 and 1983. Cut stumps indicate that the original vegetation was a closed forest of large, vigorous western red cedars and Douglas-firs. After harvest, these clear cuts were subjected to moderate to intense slash-burning. Portions of the clear cuts were re-planted with spruce seedlings, which show poor vigour and high mortality. Forest cover maps assign a poor (P) site class code to most of the tailings area. Most of the clear cuts would probably be judged NSR (not sufficiently re-stocked). There was no evidence of recent cattle grazing in these clear cuts in 1995. However, throughout the mining operations from 1997 through 2001, as well as the care and maintenance period of 2001 through 2004, the TSF area was used extensively by various herds of cattle for summer grazing.

Breeding bird densities are very low in these clearcut areas, and there are very few bird species. This habitat has moderate numbers of northwestern chipmunk. Moose and mule deer appear to make little use of open, exposed areas in the clear cuts, although use of forest edge areas with better cover may be high to very high. Several coyote tracks were seen in this habitat.

Approximately 20% of the tailings area is occupied by a stand of mature to old growth forest, dominated by western red cedar, with lesser cover by sub-alpine fir and Douglas-fir. Breeding bird densities and the number of bird species in this forested area are both high. Red squirrels are present in low densities. Neither moose nor deer appear to use the interior of this stand, as little of the available vegetation is palatable to ungulates. However, the edges of this stand appear to be heavily used by moose. Stand edges combine good thermal cover with abundant forage.

The remaining 20% is occupied by a small wetland dominated by wet shrub thickets of Sitka alder, scrub birch and hardhack, containing a 3 ha bog pond. It is the only permanent wetland in the mine development area, but it is neither unique nor important in a regional context. It supports one or two pairs of each of green-winged teal, bufflehead, common snipe, willow flycatcher, common yellowthroat, Lincoln's sparrow and song sparrow. Although the first four species are not found elsewhere in the mine development area, they are widespread and common in British Columbia. Moose and mule deer

do not appear to utilize the surrounding shrub vegetation, probably due to the low palatability of hardhack and alder, the dominant shrubs.

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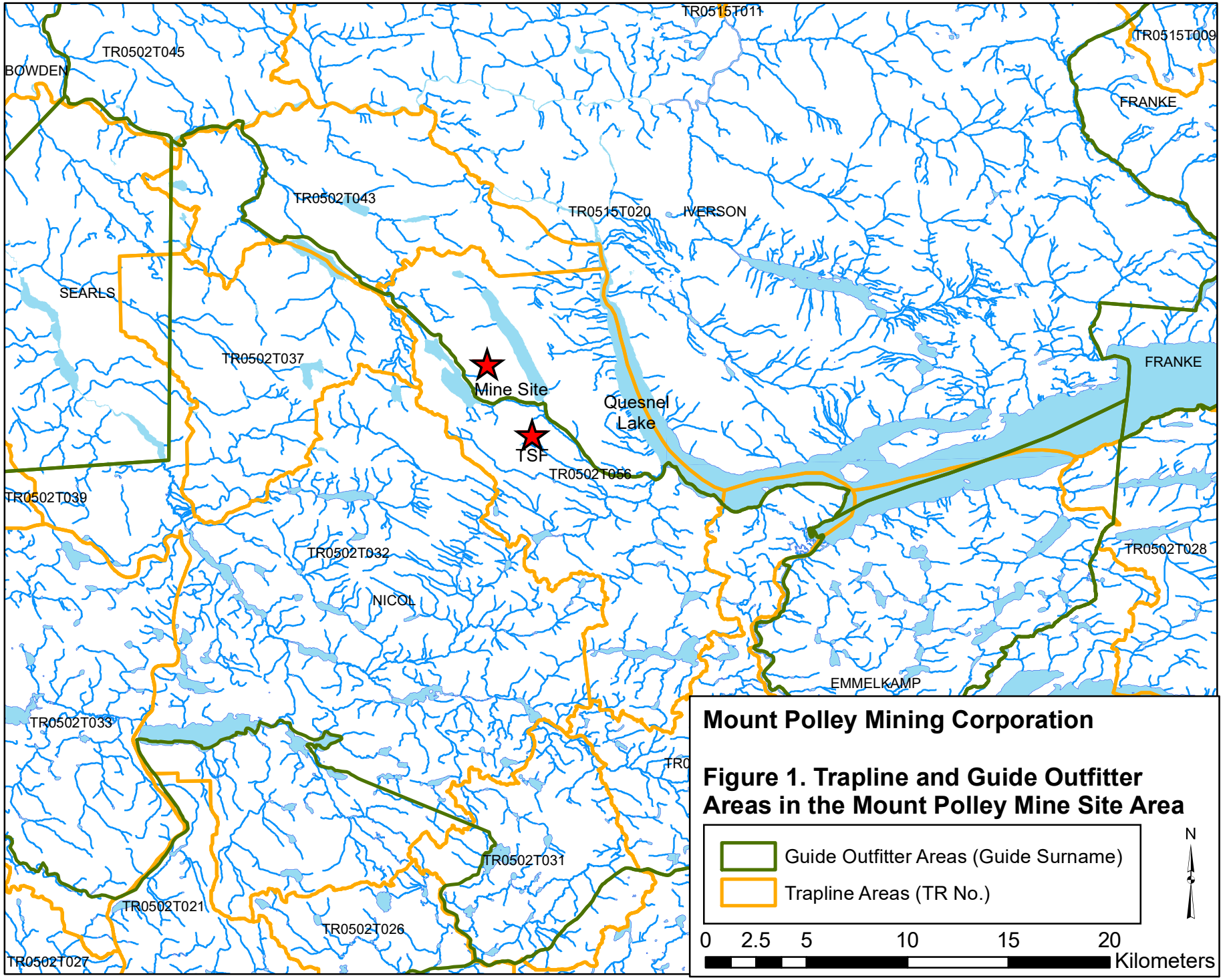
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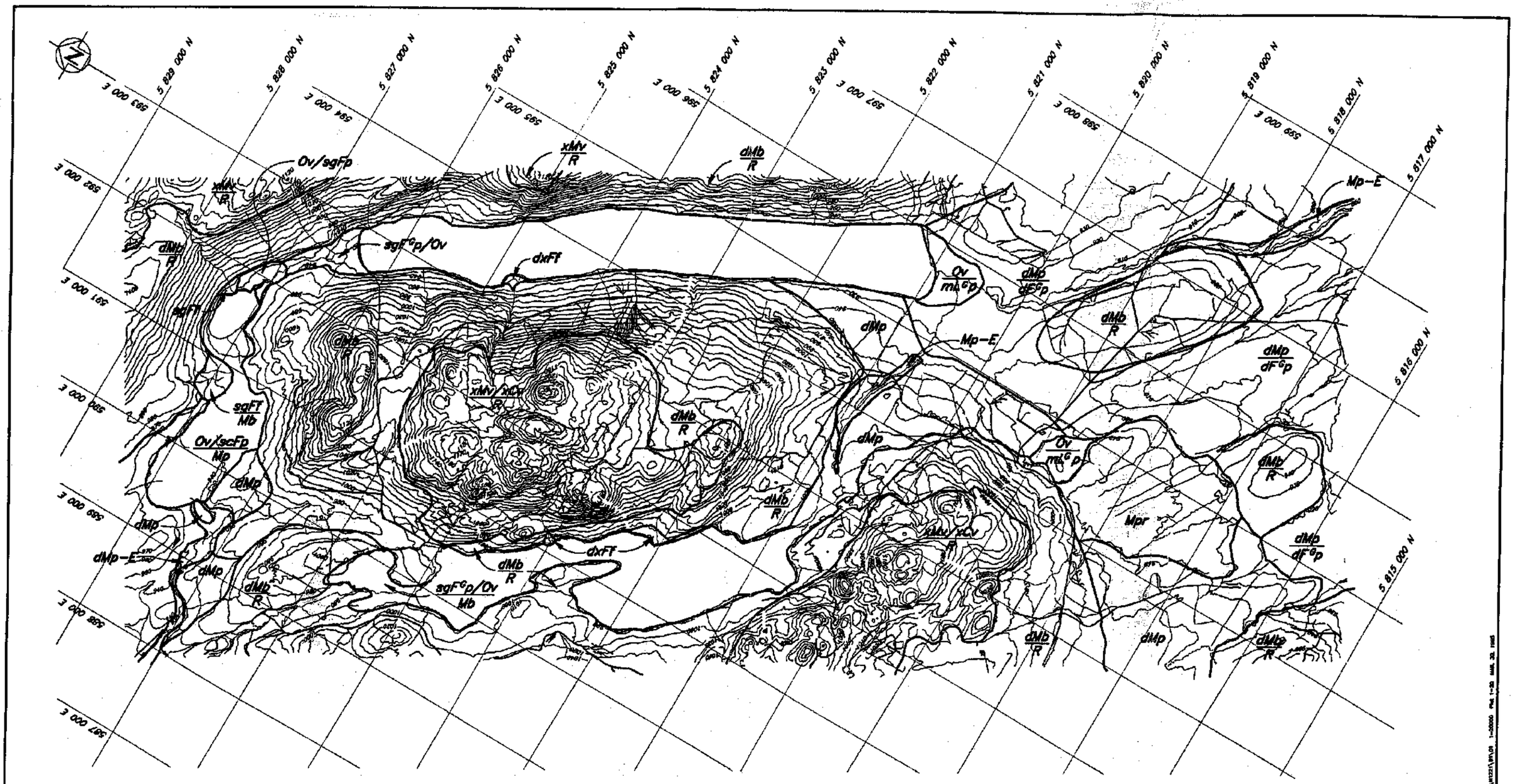
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TR0515T011
TR0515T009
TR0502T045
BOWDEN
FRANKE
TR0502T043
TR0515T020
IVERSON
SEARLS
TR0502T037
FRANKE
Mine Site
Quesnel
Lake
TSF
TR0502T056
TR0502T039
TR0502T032
TR0502T028
NICOL
EMMELKAMP
TR0502T033
TR0502T031
TR0502T021
TR0502T026
TR0502T027
Mount Polley Mining Corporation
Figure 1. Trapline and Guide Outfitter Areas in the Mount Polley Mine Site Area
Guide Outfitter Areas (Guide Surname)
Trapline Areas (TR No.)
N
0 2.5 5 10 15 20
Kilometers



DRG. NO.	DESCRIPTION	REV.	DATE	DESCRIPTION	APPROVED	REV.	DATE	DESCRIPTION	APPROVED
REFERENCE DRAWINGS		REVISIONS				REVISIONS			

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IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

TERRAIN CLASSIFICATION
SHEET 1 OF 2
FIGURE 2.1

DESIGNED	MBS		
DRAWN	VY		
CHECKED	DJR		
APPROVED			
DATE MARCH 14, 1995	SCALE AS SHOWN	DRG. NO. H1221	REV. —

C:\D PLE\PROJECTS\1000\H1221\MAP.DGN 1:50000 Plot 1:1 MAR 30, 1995

TEXTURE

Symbol	Name	Size(mm)	Other Characteristics
a	blocks	>256	angular particles
b	boulders	>256	rounded & subrounded particles
k	cobbles	64–256	rounded & subrounded particles
p	pebbles	2–64	rounded & subrounded particles
s	sand	.062–2	
ŝ	silt	.002–.062	
c	clay	<.002	
d	mixed fragments	>2	mix of rounded and angular particles
g	gravel	>2	mix of boulders, cobbles and pebbles
x	angular fragments	>2	mix of rubble and blocks
r	rubble	2–256	angular particles
m	mud	<.062	mix of clay and silt
y	shells	–	shell or shell fragments
e	fibric	well-preserved fibre; (40%) identified after rubbing	
u	mesic	intermediate decomposition between fibric and mesic	
h	humic	decomposed organic material; (10%) identified after rubbing	

SURFACE EXPRESSION

Symbol	Name	Description
a	moderate slope	Unidirectional surface; >15° to ≤26°
b	blanket	A mantle of unconsolidated material: >1m thick
c	cone	A cone or segment of a cone: >15°
d	depression	A lower area enclosed by higher surrounding terrain
f	fan	A segment of a cone; up to 15°
h	hummocky	Hillocks and hollows, irregular in plan; 15–35°
j	gentle slope	Unidirectional surface; >3° and ≤15°
k	moderately steep	Unidirectional surface; >26° and ≤35°
m	rolling	Elongate hillocks; 3 to 15° ; parallel forms in plan
p	plain	Unidirectional surface; up to 3°
r	ridged	Elongate hillocks; 15 to 35° ; parallel forms in plan
s	steep	Steep slopes; >35°
t	terraced	Step-like topography
u	undulating	Hillocks and hollows; up to ≤15° ; irregular in plan
v	veneer	Mantle of unconsolidated material; 10cm to 1m thick

SURFICIAL MATERIALS

Symbol	Name	(Assumed Status of Formative Process)	Description
A	anthropogenic	(A)	Man-made or man-modified materials
C	colluvial	(A)	Products of mass wastage
D	weathered bedrock	(A)	In situ, decomposed bedrock
E	eolian	(I)	Materials deposited by wind action
F	fluvial	(I)	River deposits
FG	glaciofluvial	(I)	Ice contact fluvial materials
I	ice	(A)	Permanent snow, glaciers and icefields
L	lacustrine	(I)	Lake sediments; includes wave deposits
LG	glaciolacustrine	(I)	Ice contact lacustrine materials
M	morainal	(I)	Material deposited directly by glaciers
O	organic	(A)	Accumulation/decay of vegetative matter
R	bedrock	(–)	Outcrops/rock covered by less than 10cm
U	undifferentiated	(–)	Layered sequence; three materials or more
V	volcanic	(I)	Unconsolidated pyroclastic sediments
W	marine	(I)	Marine sediments; includes wave deposits
WG	glaciomarine	(I)	Ice contact marine sediments

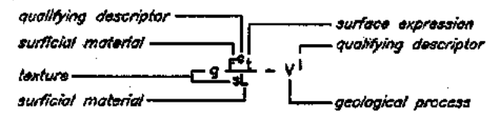
GEOLOGICAL PROCESSES

Symbol	Name	(Assumed Process Status)	Description
A	avalanches	(A)	Terrain modified by snow avalanches
B	braiding	(A)	Diverging/converging channels: unvegetated bars
C	cryoturbation	(A)	Sediments modified by frost heaving and churning
D	deflation	(A)	Removal of sand and silt by wind action
E	channelled	(I)	Channel formation by meltwater
F	slow mass movement	(A)	Slow downslope movement of masses of cohesive or non-cohesive material and/or bedrock
H	kettled	(I)	Depressions due to the melting of buried glacier ice
I	irregular channel	(A)	A single, clearly defined main channel displaying irregular turns and bends
J	anastamosing channel	(A)	A channel zone where channels diverge and converge converge around many vegetated islands
K	karst	(A)	Processes associated with the solution of carbonates
M	meandering channel	(A)	Channel characterized by a regular pattern of bends with uniform amplitude and wave length
N	nivation	(A)	Erosion beneath and along the margin of snow patches
P	piping	(A)	Subterranean erosion by flowing water
R	rapid mass movement	(A)	Rapid downslope movement of dry, moist or saturated debris
S	solifluction	(A)	Slow downslope movement of saturated overburden across a frozen or otherwise impermeable substrate
U	inundation	(A)	Seasonally under water due to high watertable
V	gully erosion	(A)	Parallel/subparallel ravines due to running water
W	washing	(A)	Modification by wave action
X	permafrost	(A)	Processes controlled by the presence of permafrost
Z	periglacial processes	(A)	Solifluction, cryaturbation and nivation processes occurring within a single unit

MAP UNIT LETTER NOTATION

A terrain map unit symbol is composed of a combination of letters which designate different characteristics of the terrain. The relative position of letters within the symbol indicates the characteristics that they represent.

SAMPLE TERRAIN UNIT SYMBOL

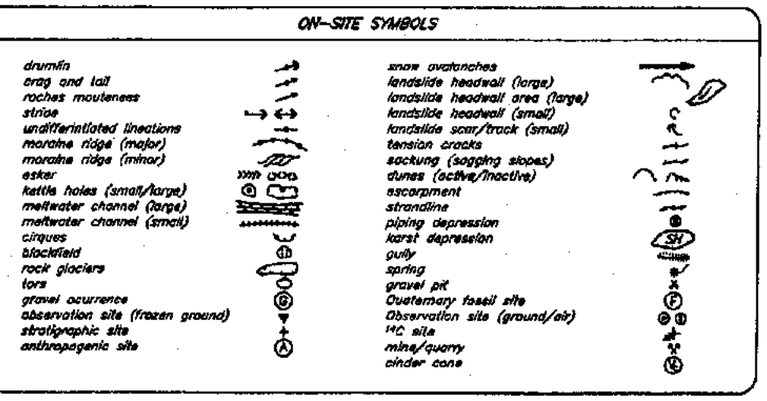


This map unit consists of a gravelly glaciofluvial terrace that overlies sandy lacustrine materials and is modified by gullies that are no longer active.

Explanatory Notes

1. Units consisting of two or more types of terrain are designated by two or more groups of letters separated by slashes and/or dots

ON-SITE SYMBOLS



QUALIFYING DESCRIPTORS

Symbol	Name	Description
G	glacial	Used to qualify surficial materials where there is evidence that glacier ice affected the mode of deposition of materials
A	active	Used to qualify surficial materials and geological processes with regard to their current state of activity
I	inactive	

DRG. NO.	DESCRIPTION
REFERENCE DRAWINGS	

REV.	DATE	DESCRIPTION	APPROVED
REVISIONS			

REV.	DATE	DESCRIPTION	APPROVED
REVISIONS			

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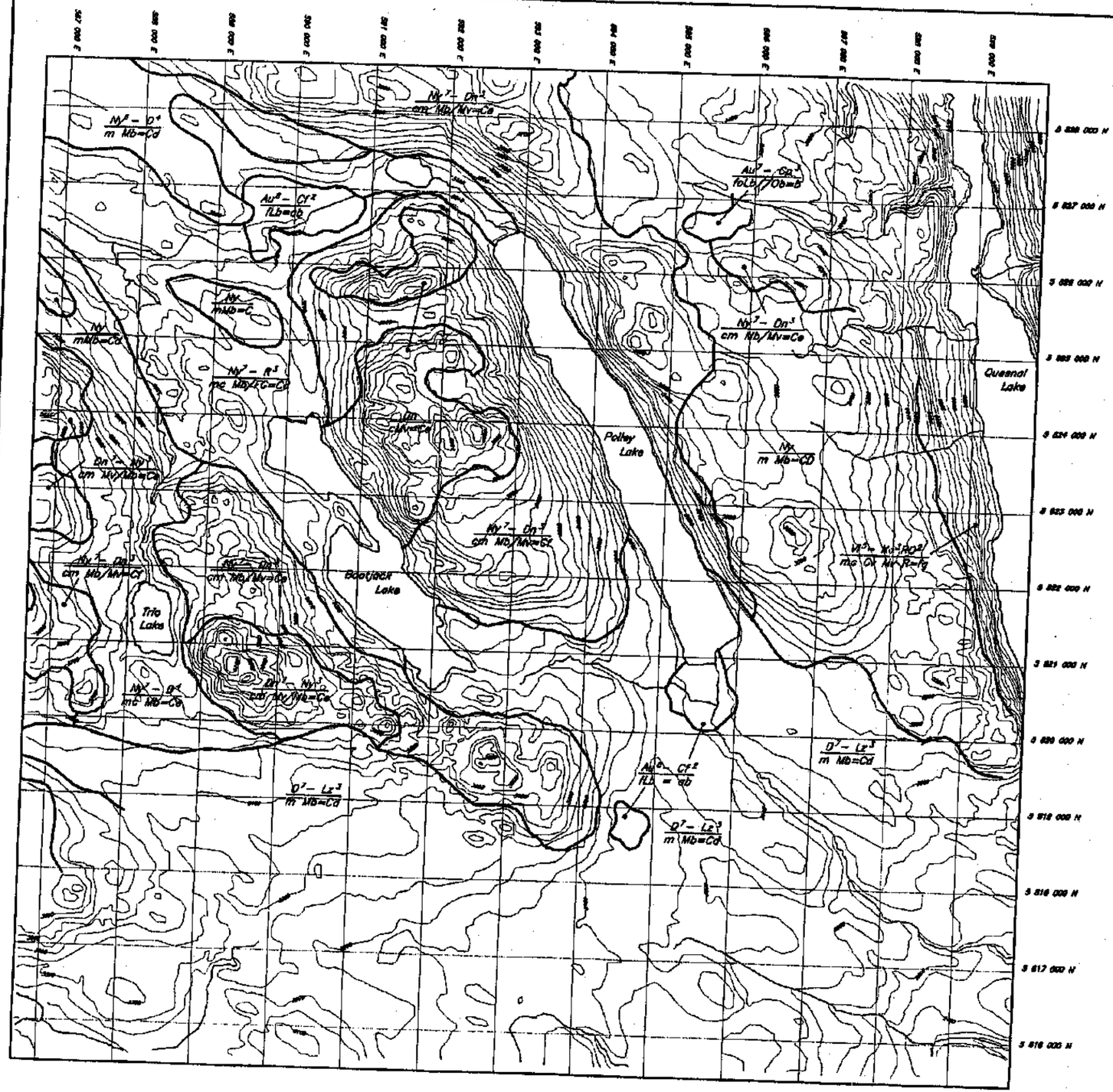
MT. POLLEY PROJECT

TERRAIN CLASSIFICATION LEGEND
SHEET 2 OF 2
FIGURE 2.1

DESIGNED MBS
DRAWN W.A. Lakoda
CHECKED DJR
APPROVED

DATE MARCH 14, 1995 | SCALE AS SHOWN | DRG. NO. H1221 | REV. A

DWG FILE: \PROJECTS\H1221\FIG2-1 1:1500 PLOTTED: MAR. 20, 1995



NOTE:
Contours are in feet.

Scale 1000 500 0 1000 2000 3000 Metres

DRG. NO.	DESCRIPTION
REFERENCE DRAWINGS	

REV.	DATE	DESCRIPTION	APPROVED
REVISIONS			

REV.	DATE	DESCRIPTION	APPROVED
REVISIONS			

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MT. POLLEY PROJECT

SOILS AND LANDFORMS IN THE MOUNT POLLEY AREA
SHEET 1 OF 2
FIGURE 2.3

DESIGNED	DJR
DRAWN	VY
CHECKED	–
APPROVED	
DATE	— — — —
SCALE	AS SHOWN
DRG. NO.	H1221
REV.	—

IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT
SOILS AND LANDFORMS MAP LEGEND

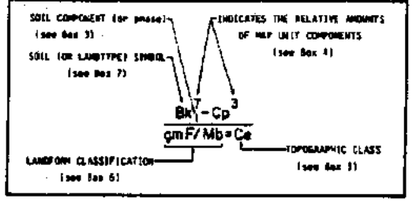
1. Explanatory Notes

The information contained on the following pages explains some important characteristics of the soils and landforms that were mapped at a reconnaissance level of investigation. Each of the individual boxes is cross referenced.

The information provided in this legend is brief. Further details on the soils and their environment are provided in the soil reports and maps for adjoining soil survey areas No. 24,29,31,36 and 40. The report and maps Soils of the Horsefly Area is in preparation for printing.

This key describes all soils and landforms mapped at a scale of 1:50 000 for maps 93A/3,4,5,6,11,12,13,14

2. Example



3. Soil Components

Where soil components are used they are shown and characterized in Box 7. Some map unit numbers refer to soil component numbers used in adjoining survey areas.

4. Composite Units

Composite units are employed where two or three types of map unit components are intermixed or occur such small areas that they cannot be designated as separate units at the scale of mapping.

Numbers show the relative amounts of each soil or land type component of a map unit as: 9 (90%), 8 (80%), 7 (70%), 6 (60%), 5 (50%), 4 (40%), 3 (30%), 2 (20%), 1 (10%).

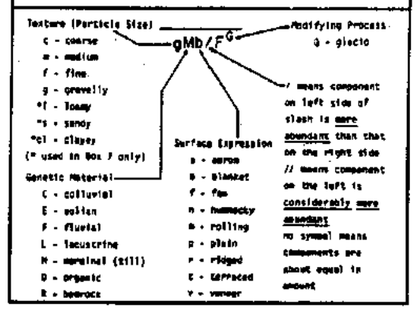
The components of the denominator are described in Boxes 5 and 6.

5. Topographic Classes[1]

Simple Topography	Complex Topography	Slope
Single Slopes (regular surface)	Complex Slopes (irregular surface)	%
A geomorphional to level	a nearly level	0-0.5
B very gently sloping	b gently undulating	0.5-2
C gently sloping	c undulating	2-5
D moderately sloping	d gently rolling	5-9
E strongly sloping	e moderately rolling	9-15
F steeply sloping	f strongly rolling	15-30
G very steeply sloping	g hilly	30-60
H extremely sloping	h very hilly	over 60

[1]Ref. The System of Soil Classification for Canada 1974, (revised).

6. Landform Classification



7. SOIL ASSOCIATION DESCRIPTIONS

Symbol	Map Unit	Biogeoclimatic Zones and Sub-Zones (see Box 8)	Soil Parent Material (see Box 8)	Most Common Soil	Most Common Soil Drainage (see Box 9)	Comments
Au	Anbau	SBS b,c	1 & clM	Orthic Luvic Glaysol	p	associated with Chief soils
B	Bednesti	SBS b	IL	Brunisolic Gray Luvisol	m	in soil Reports No. 2, 4, 10, 31
Cf	Chief	SBS b,c	O	Typic Mesisol	vp	in Soil Reports No. 2, 31
Cp	Captain Creek	IMH b, ESSF b	glm	Orthic Humo-Ferric Podzol	m	seepage areas common
D	Deserters	SBS b	gslm	Brunisolic Gray Luvisol	m	drumlinized areas of Fraser Plateau
Dn	Dragon	SBS b, IMH a	slMv	Orthic Humo-Ferric Podzol	w	on high areas of the plateau
(E)	eroded phase					
Hr	Heger	SBS b, ESSF b	gsC	Eluviated Dystric Brunisol	w	associated with lithic soils overlying metamorphic rock
Ko_1	Keno Lake	IMH b	gsM	Orthic Humo-Ferric Podzol	w	
Ko_2	Keno Lake	IMH b	gsM	Orthic Humo-Ferric Podzol	w	associated with imperfectly drained soils
Lz	Lanezi	IMH a	lm	Luvisolic Humo-Ferric Podzol	m	similar to Dominion soils
My	Myland	SBS b	IM	Podzolic Gray Luvisol	m	similar to Dominion soils (Report 23)
R	Ramsey	SBS b, IMH b	gsFB	Orthic Humo-Ferric Podzol	r	wetter valleys
RO	Rockland	land type				
Vl	Vimland	ESSF b	gslM	Lithic Humo-Ferric Podzol	r	similar to Keno Lake soils

8. Forest Zonation Symbols[1]

Biogeoclimatic zones and subzones are used instead of forest zones.

AT	Alpine Tundra Zone
ESSFb	Engelmann Spruce - Subalpine Fir (wet subzone)
IMHa	Interior Western Hemlock (cedar subzone)
IMHb	Interior Western Hemlock (wet subzone)
SBSb	Subboreal Spruce (Douglas Fir - white spruce subzone)
SBSc	Subboreal Spruce (white spruce - subalpine fir - Douglas fir subzone)
IDF b	Interior Douglas Fir (pinegrass subzone)

[1]Ref. Annas & Coupé 1979

9. Drainage Classes

r	Rapidly drained	The soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions.
w	Well drained	The soil moisture content does not normally exceed field capacity in any horizon (excepts possibly the C) for a significant part of the year.
m	Moderately well drained	The soil moisture in excess of field capacity remains for a small but significant portion of the year.
i	Imperfectly drained	The soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year.
p	Poorly drained	The soil moisture in excess of field capacity remains in all horizons a larger part of the year.
vp	Very poorly drained	Free water remains at or within 12 inches (30 cm) of the surface most of the year.

10. References

E.L.U.C. Secretariat, 1976 - Terrain Classification System

Canada Soil Survey Committee (C.S.S.C.), 1978 - The Canadian System of Soil Classification, Can. Dep. Agric. Publ. 1646

Annas, R.M. and R. Coupe 1979. Biogeoclimatic zones and subzones of the Cariboo Forest Region.

Soil Survey Reports No. 2, 4, 10, 29, 31, 36.

Background Materials

Holland, S.S., 1976 - Landforms of British Columbia: A Physiographic Outline, B.C. Dept. of Mines and Petroleum Resources, Bull. 48

Soil Data File contains physical and chemical data of most soil associations described in the area.

Maps and reports available from and information from SDF (see key):

The Map Library
Assessment and Planning Division
Ministry of Environment
Parliament Buildings
Victoria, B.C.
V8V 1X4

11. Credits

Mapping by T. Lord, Agriculture Canada

Mapping correlated by T. Lord, Agriculture Canada

Date of field mapping: 1971-73

Photography used for Mapping:

Date: 1970

Scale: 80mm ,40ch

Drafted by Cartography Section, Resources Analysis Branch, Ministry of Environment, Victoria, British Columbia

Date: 1972

Revision Dates: 1976, 1980, ____, ____

Base map provided by Map Production Division, Surveys and Mapping Branch, Ministry of Environment, Victoria, British Columbia

SOILS LEGEND
For the Horsefly River – Keithley Creek Map Area
Sheet 2 of 2

CAD FILE: \PROJECT\1995\1221\DWG\H1221B04 Plot 1of1

Mar. 23, 1995

HALLAM KNIGHT PIESOLD LTD.
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FIGURE 2.3

AQUATIC BIOPHYSICAL

STREAM SYMBOL

Rb Ch (Co)
9 81.5 2341

- Fish Species: Rainbow trout (present); Chinook (migration); Coho (probable)
- Channel Components (see Box 4): Width = 9 metres; Valley flat to channel ratio is between 2 and 5; Average reach slope = 1.5%
- Box (Substrate) Materials (see Box 5): Fines = 20%; Gravels = 30%; Larges = 40%; Bedrock = 10%

CHANNEL COMPONENTS

1. Channel width in metres. Equal to distance between treed vegetation, including islands.
2. Valley flat to channel ratio. The ratio between width of valley flat and width of channel.

Map Designation	Ratio
A	0-1
B	2-3
C	5-10
D	10+
E	N/A (e.g. Fan or delta)

3. Slope (elevation gain/reach length) calculated as an average for the reach, expressed as a percentage; measured from topographic base map.
   - > 5% rounded off to the nearest percent
   - < 5% rounded off to 1 decimal place.

BED / SUBSTRATE / MATERIALS

Fines, gravels, larges and bedrock are listed in sequence to amount 100%, expressed as an integer.

1. Fines 'F'; materials in the 0-2 mm size class
   Gravels 'G'; materials in the 2-64 mm size class
   Larges 'L'; materials greater than 64 mm
   Bedrock 'R'; consolidated materials
2. F, G, L or R used alone indicates 90-100% reach is in that size class.
3. A cross, of bedrock (0-5%) may be indicated by R following the 3 material components (e.g. 253R). Traces (0-5%) of fine, gravel, or large material are indicated by a 0 (e.g. 0073).

LAKE SYMBOL

General: Fish Species | T.D.S.
Max. depth | Littoral area

1. Fish species:
2. T.D.S.: total dissolved solids, if available
3. Maximum depth: measured to nearest metre
4. Littoral area: measurement or visual estimate of % of total area <6m. When estimate is made, the symbol is placed in parenthesis.

FISH SPECIES

1. Fish Species Abbreviations (known or inferred in this map area at time of survey).

Map Abbrev.	Common Name	Map Abbrev.	Common Name
S	no fish detected at time and place of sampling	Gr	Arctic grayling
		GSg	Green sturgeon
AC	Arctic char	HW	Humpbacked whitefish
As	anad. (ana-mou)	In	Inconnu
	Cutthroat trout	Ke	Kokanee
ADV	anad. Dolly Varden char	LMB	Largemouth bass
		LT	Lake (trout) char
AEB	anad. Eastern Brook trout	LW	Lake whitefish
		MW	Mountain whitefish
AGB	anad. Brown trout	NP	Northern pike
AS	Atlantic salmon	OS	Sockeye salmon
BB	Burbot (Ling)	P	Perch, general
BCB	Black crappie	PM	Pumpkinseed
BS	Bass/smallmouth, gen.	PW	Pigmy whitefish
BW	Broad whitefish	Rb	Rainbow trout
CA	Arctic cisco	RW	Round whitefish
Ch	Chinook salmon	Sa	Salmon, general
CL	Lake cisco(tullibee)	Sg	Sturgeon, general
Cm	Chum salmon	Sk	Sockeye salmon
Co	Coho salmon	SMB	Smallmouth bass
Cp	Carp	Sp	fish observed, unidentified
CS	Least cisco	St	Steelhead trout
Ct	Coastal Cutthroat trout	Tr	trout, general
DV	Dolly Varden char	WF	Whitefish, general
EB	Eastern Brook trout	WP	Walleye
	char	WS	White Sturgeon
Es	Redsides	YC	Yellowmouth & Westslope Cutthroat trout
GB	Brown trout	YP	Yellow perch
GE	Goldeneye		

2. OS - indicates known but non-sport or non-commercial species, data bank must be consulted for complete species list.
3. Absence of any fish species symbol indicates that no sampling information was available.
4. (Co) - indicates probable but unconfirmed presence.
5. Rb! - indicates reach used by species for migration only, no resident population.
6. Ch - Underlined fish abbrev. indicates special circumstances. Refer to B.C. Aquatic Data Base for clarification.
7. Note: no specific symbol exists for a barren stream. Where such a condition is suspected, it may be indicated by (0 which is an inference that if sampling took place, fish would not be detected.

LEGEND

- R_1 — Upstream extent of Reach 1
- BR — Bridge
- Cv — Culvert
- BD — Beaver Dam
- Chan — Channel
- DAM — Dam
- T_1 — Transects (3 Cross sections)
- Rb Spwn — Rainbow Trout Spawning

Species
Channel Components | Substrate Materials

Fisheries Biophysical

Scale 1000 500 0 1000 2000 3000 4000 m

Rb 4.0 B 1.0|4420
Rb OS|110 30 (110)
Rb OS|60 12 (10)
Rb 3.3 B 1.3|1540
Rb OS 9.0 B 0.3|1810
1.8 B 1.5|1810
Rb 2.5 B 1.2|9100
Rb 4.0 B 1.0|9100
Rb (OS) 5.0 B 5.0|0226
Sk Ch Rb MW BB OS 20.0 B 0.5|2710
Sk Ch Rb MW OS 6.5 B 1.5|1360
Rb OS 13.5 B 0.8|1630

REFERENCE DRAWINGS		REVISIONS			REVISIONS		
DWG NO	DESCRIPTION	REV	DATE	DESCRIPTION / APPROVED	REV	DATE	DESCRIPTION / APPROVED

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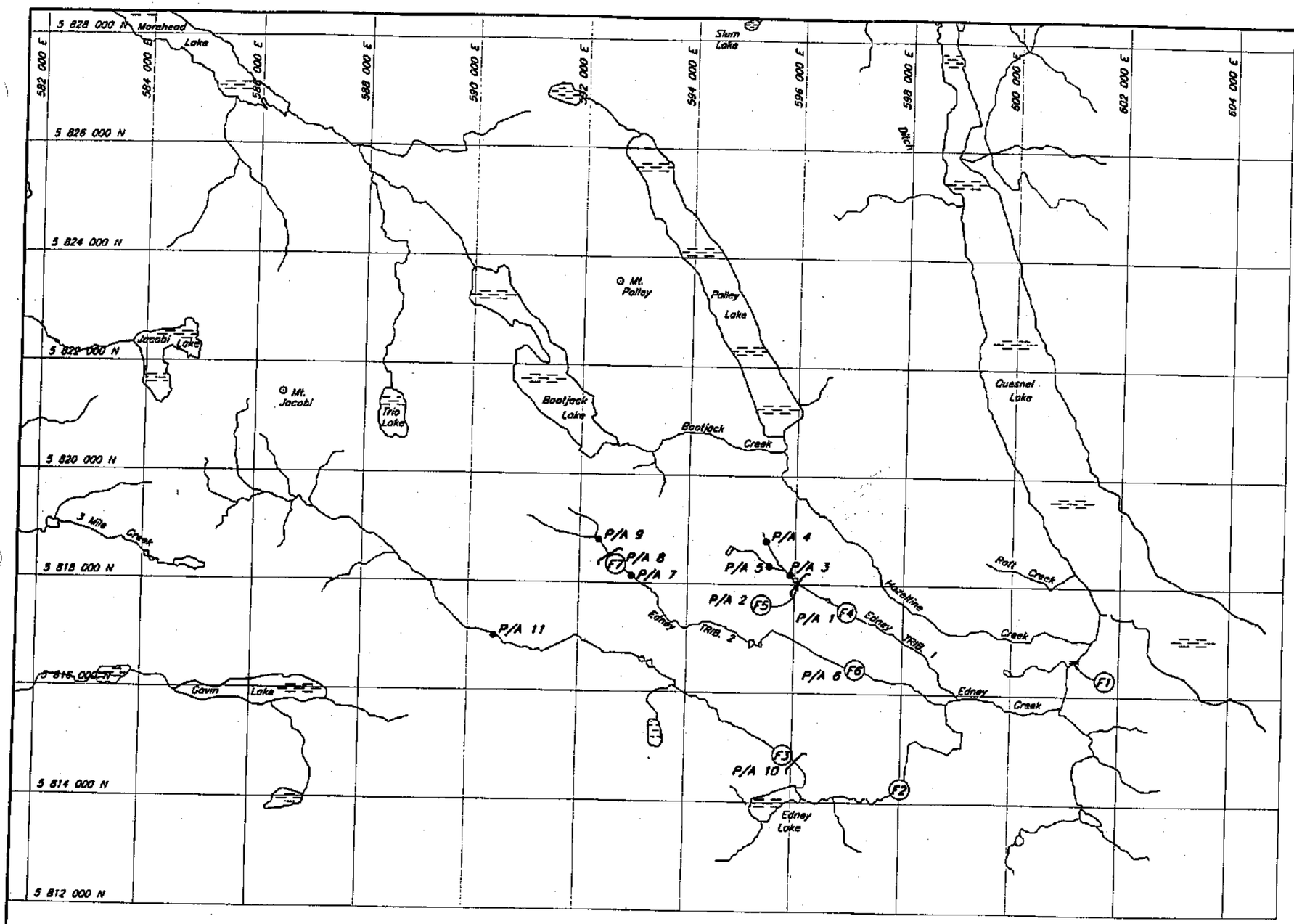
DESIGNED
DRAWN JW
CHECKED
APPROVED

IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

FISHERIES BIOPHYSICAL INVENTORY

DATE | SCALE AS SHOWN | FIGURE 2.15 | REV



N

LEGEND

- Extent of fish distribution
- P/A 5 ● Presence / Absence Sample Site
- (F6) Electrofishing / Density Sample Site

Scale 1000 0 2000 4000 m

CAD FILE: 1:\1000\H1221\DWG\H1221-018.DWG Plot: 1-to-1 on March 22, 1996

DRG. NO.	DESCRIPTION
REFERENCE DRAWINGS	

REV.	DATE	DESCRIPTION	APPROVED
REVISIONS			

REV.	DATE	DESCRIPTION	APPROVED
REVISIONS			

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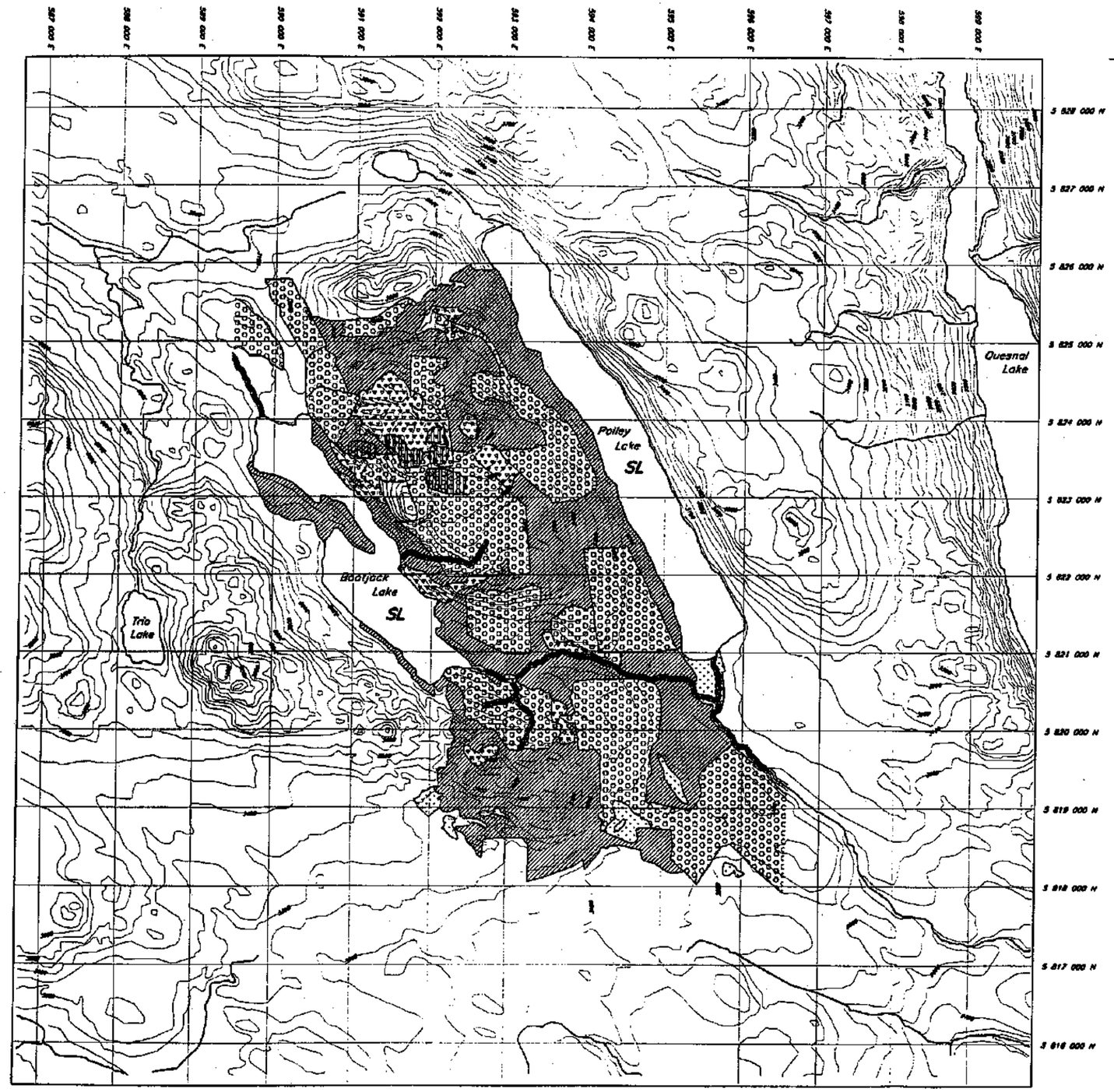
IMPERIAL METALS CORPORATION

MT. POLLEY PROJECT

FIGURE 2.16
CREEKS OF THE MT. POLLEY AREA
AND FISHERIES STUDY SITES

DESIGNED	DJR
DRAWN	TAM
CHECKED	DJR
APPROVED	

DATE JAN. 5, 1996 | SCALE AS SHOWN | DRG. NO. H1221 | REV. —



LEGEND

FOREST HABITATS OF THE INTERIOR CEDAR-HEMLOCK (ICH) ZONE

- Clearcuts and Burns (0-20 years+) / Young Stands (20-40 years)
- Mid-seral Stands (40-120 years)
- Mature and Old Growth Stands (120 years+)
- Douglas-Fir-Lodgepole Pine Forest (South Slopes)

WETLAND AND AQUATIC HABITATS

- Riparian Habitats near Small Streams
- Shrub Carr / Sedge Fen Habitat Complex
- SL — Small and Medium-sized Lakes (<1000 ha)

NOTE: Contours are in feet.

Scale 1000 500 0 1000 2000 3000 Metres

DRG. NO.	DESCRIPTION	REV.	DATE	DESCRIPTION	APPROVED	REV.	DATE	DESCRIPTION	APPROVED
REFERENCE DRAWINGS		REVISIONS				REVISIONS			

HALLAM KNIGHT PIESOLD LTD.
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MT. POLLEY PROJECT

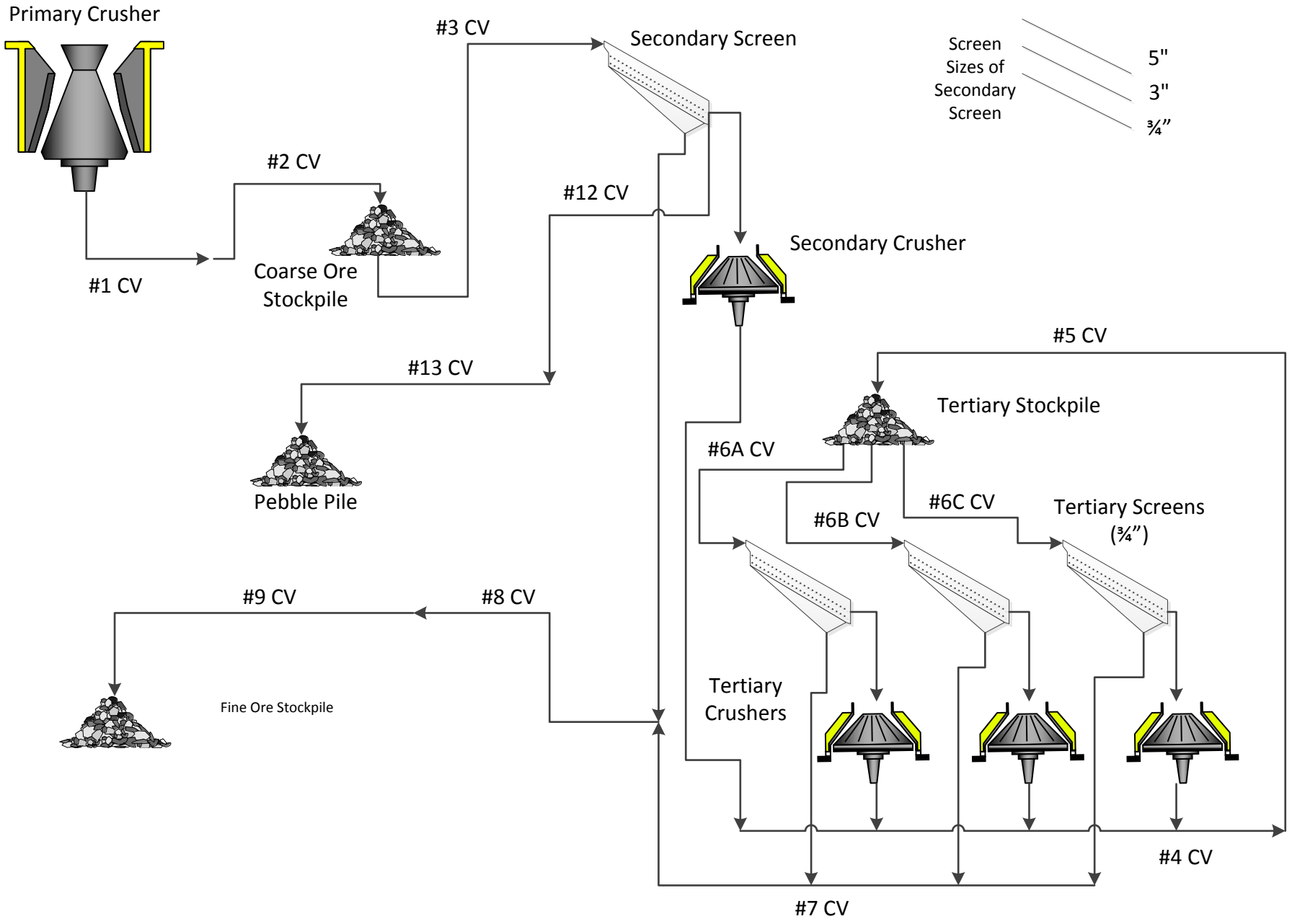
FIGURE 2.18
WILDLIFE CAPABILITY

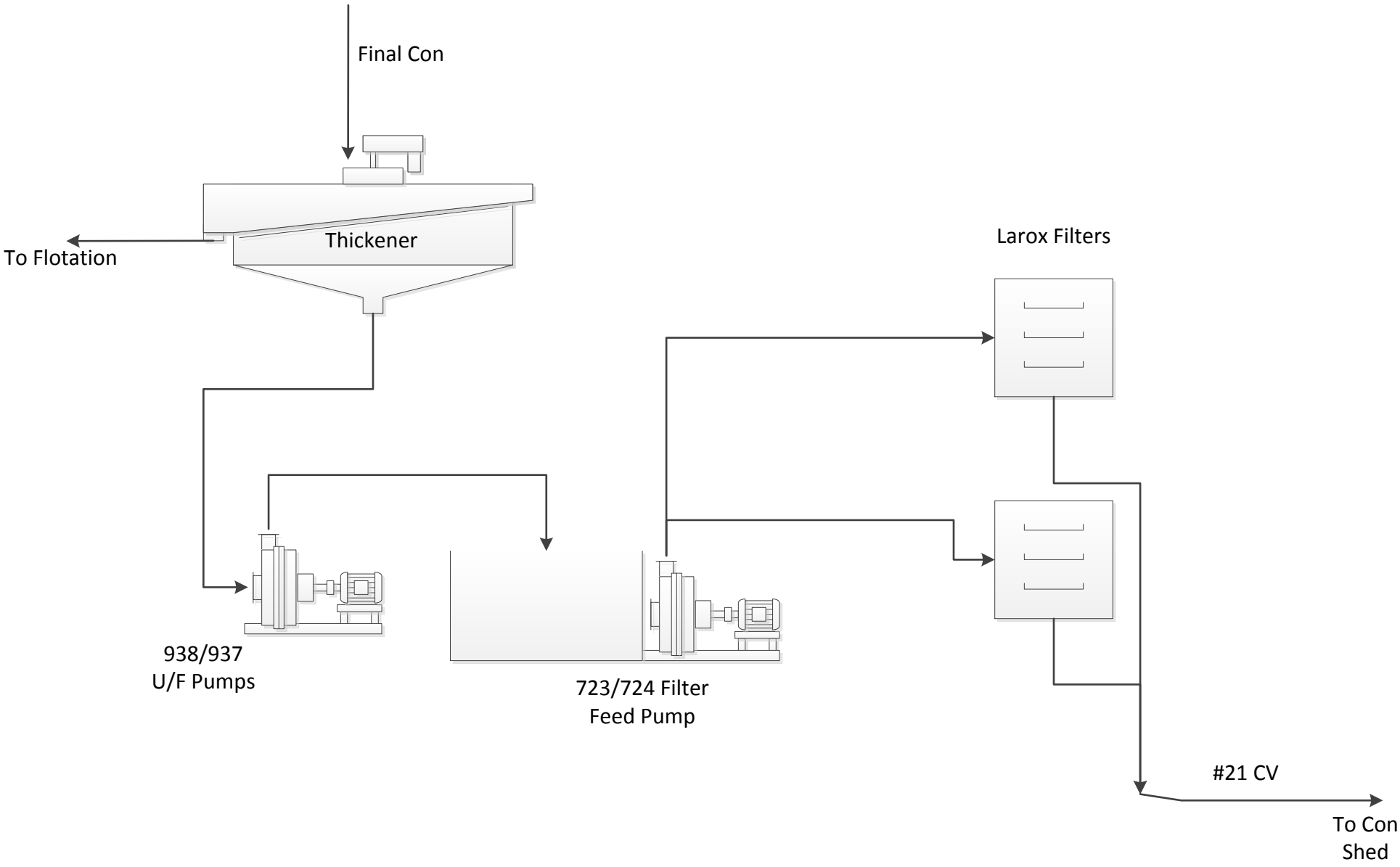
DESIGNED	DJR		
DRAWN	NAR		
CHECKED	-		
APPROVED			
DATE	------	SCALE AS SHOWN	DRG. NO. H1221 REV. —

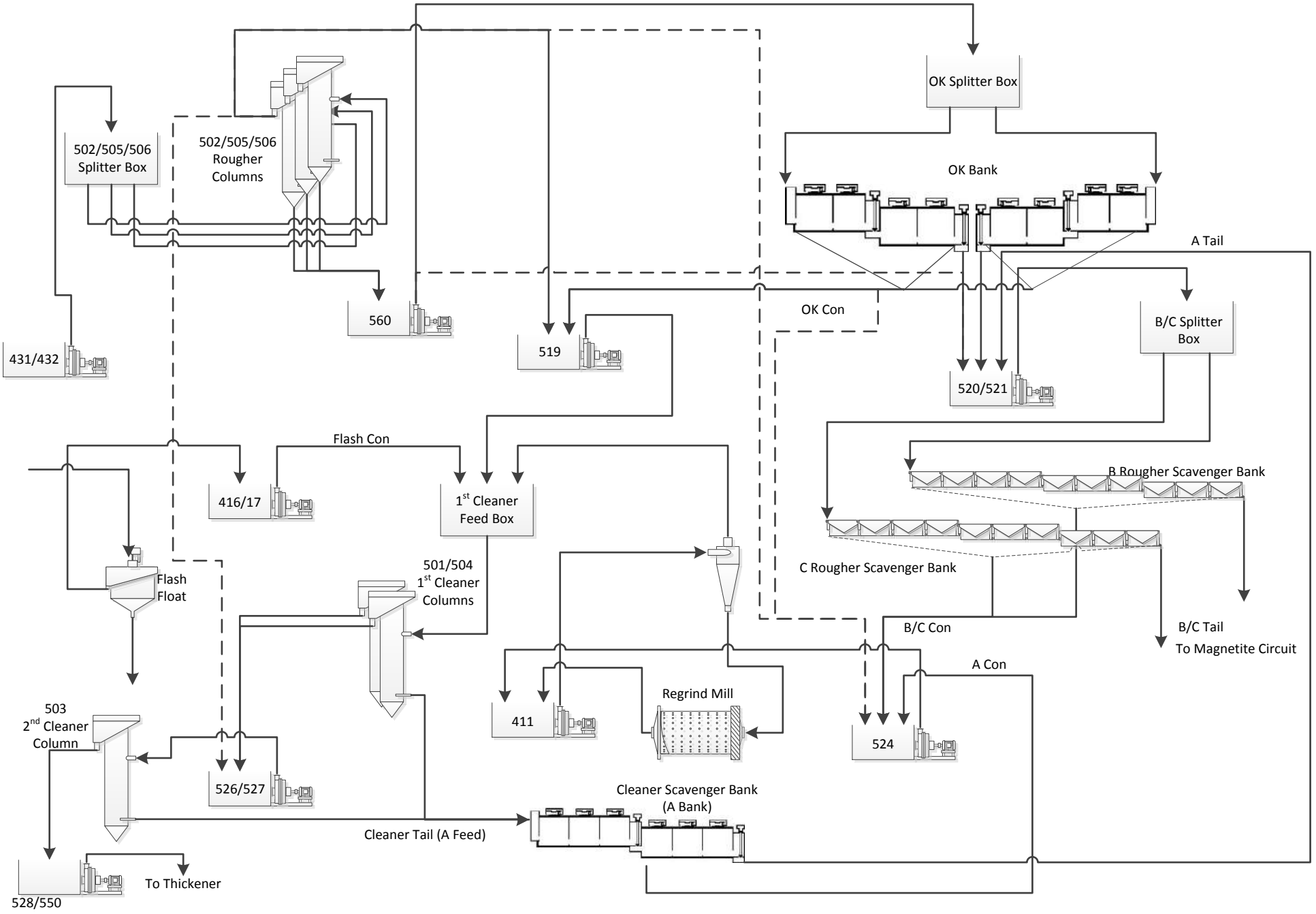
CAD FILE: \PROJECT\1221\FIG\H1221FIG2.MAP\1:30000 Plot 1:30 AUG 30, 1996

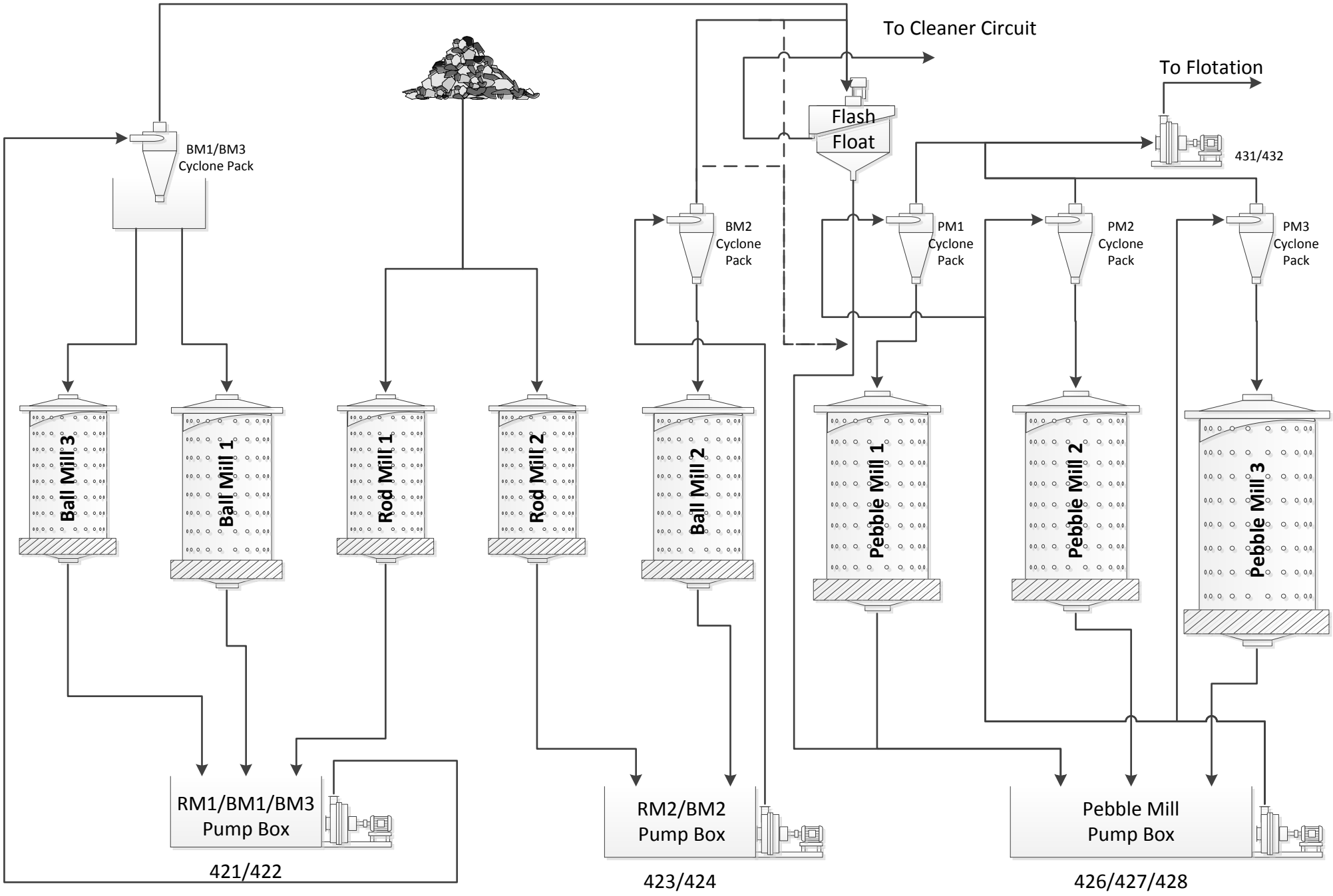
APPENDIX B:

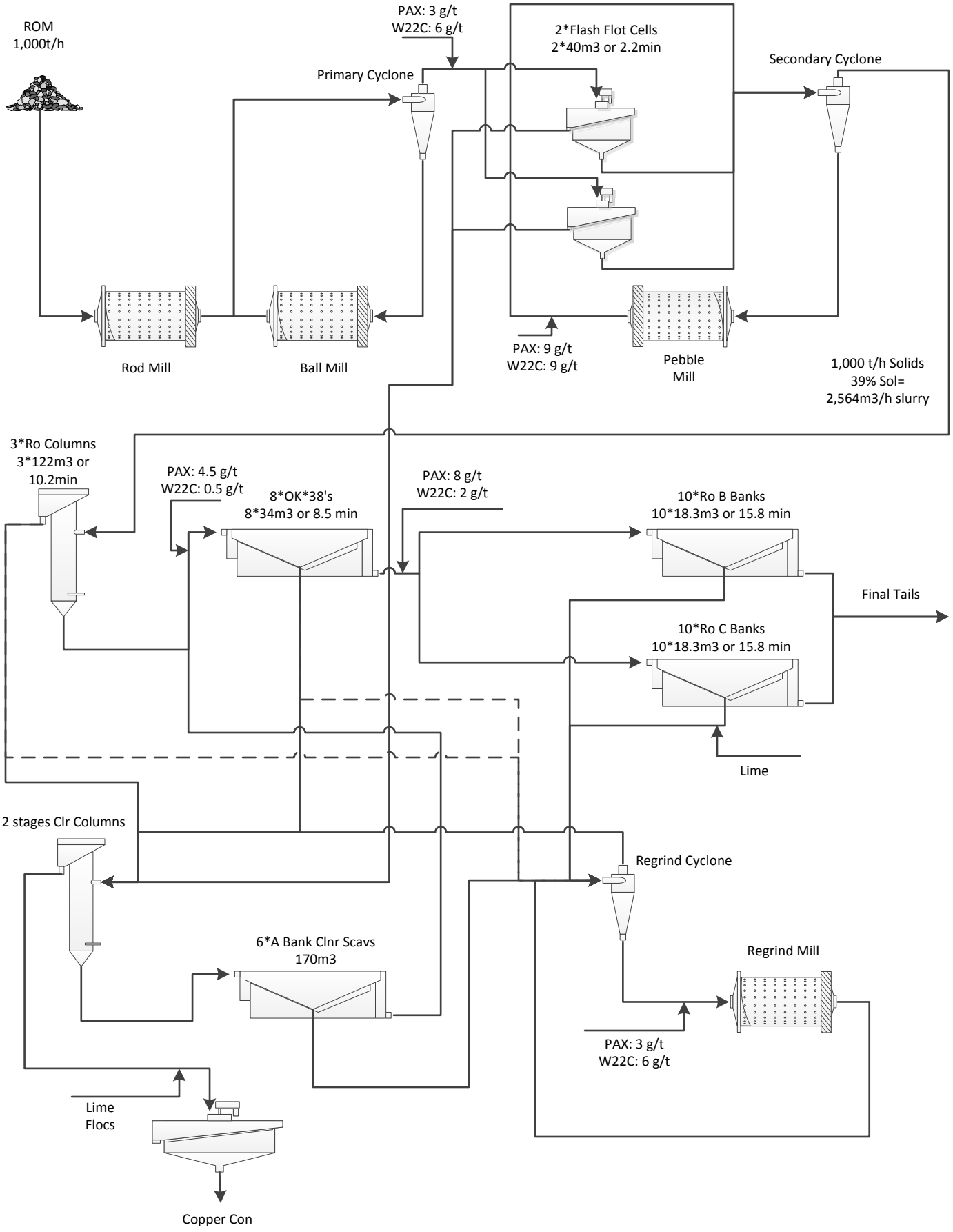
MILL PROCESS FLOW SHEETS


Primary Crusher
#3 CV
Secondary Screen
Screen Sizes of Secondary Screen
5"
3"
¾”
#2 CV
#12 CV
#1 CV
Coarse Ore Stockpile
Secondary Crusher
#5 CV
#13 CV
Tertiary Stockpile
#6A CV
Pebble Pile
#6C CV
#6B CV
Tertiary Screens (¾”)
#9 CV
#8 CV
Tertiary Crushers
Fine Ore Stockpile
#4 CV
#7 CV


Final Con
Thickener
To Flotation
Larox Filters
938/937
U/F Pumps
723/724 Filter
Feed Pump
#21 CV
To Con
Shed


OK Splitter Box
502/505/506
Splitter Box
502/505/506
Rougher
Columns
OK Bank
A Tail
560
OK Con
519
B/C Splitter
Box
431/432
520/521
Flash Con
B Rougher Scavenger Bank
416/17
1st Cleaner
Feed Box
C Rougher Scavenger Bank
Flash
Float
501/504
1st Cleaner
Columns
B/C Con
B/C Tail
To Magnetite Circuit
A Con
503
2nd Cleaner
Column
Regrind Mill
411
524
526/527
Cleaner Scavenger Bank
(A Bank)
Cleaner Tail (A Feed)
To Thickener
528/550


To Cleaner Circuit
To Flotation
Flash
Float
BM1/BM3
Cyclone Pack
BM2
Cyclone
Pack
PM1
Cyclone
Pack
PM2
Cyclone
Pack
PM3
Cyclone
Pack
431/432
Ball Mill 3
Ball Mill 1
Rod Mill 1
Rod Mill 2
Ball Mill 2
Pebble Mill 1
Pebble Mill 2
Pebble Mill 3
RM1/BM1/BM3
Pump Box
421/422
RM2/BM2
Pump Box
423/424
Pebble Mill
Pump Box
426/427/428


ROM
1,000t/h
PAX: 3 g/t
W22C: 6 g/t
2*Flash Flot Cells
2*40m3 or 2.2min
Primary Cyclone
Secondary Cyclone
Rod Mill
Ball Mill
PAX: 9 g/t
W22C: 9 g/t
Pebble
Mill
1,000 t/h Solids
39% Sol=
2,564m3/h slurry
3*Ro Columns
3*122m3 or
10.2min
PAX: 4.5 g/t
W22C: 0.5 g/t
8*OK*38's
8*34m3 or 8.5 min
PAX: 8 g/t
W22C: 2 g/t
10*Ro B Banks
10*18.3m3 or 15.8 min
Final Tails
10*Ro C Banks
10*18.3m3 or 15.8 min
Lime
2 stages Clr Columns
Regrind Cyclone
6*A Bank Clnr Scavs
170m3
Regrind Mill
PAX: 3 g/t
W22C: 6 g/t
Lime
Flocs
Copper Con

APPENDIX C:

GEOCHEMICAL CHARACTERIZATION OF ORE STOCKPILES

(SRK 2015)

Mount Polley Mine
Geochemical Characterization of Ore Stockpiles

Prepared for

Mount Polley Mining Corporation

Prepared by

SRK Consulting (Canada) Inc.
1CI008.005
October 2015

Mount Polley Mine
Geochemical Characterization of Ore Stockpiles

October 2015

Prepared for

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Executive Summary

The Mount Polley Mining Corporation (MPMC) built four ore-grade rock stockpiles that are intended for processing to recover copper. *Mines Act* Permit M-200 contains a new condition to characterize the metal leaching and acid rock drainage (ML/ARD) potential of the stockpiles.

SRK Consulting (Canada) Inc. was retained by MPMC to develop a plan to characterize the geochemical stability of the ore stockpiles, including the following considerations:

- ARD potential using acid-base accounting data.
- Evaluation of element enrichment relative to other stockpiles.
- Evaluation of whether stockpile seepage chemistry can be expected to differ from existing drainage chemistry, using shake flask data as a proxy for stockpile seepage.

This report provides the results and interpretations from implementation of the ore stockpile geochemical characterization plan, which indicated that:

- The ore stockpiles have low ARD potential. It is not expected that acid conditions will develop in the stockpiles in the long term should they not be processed.
- Some differences between stockpiles were apparent (lower sulphide content of high oxide stockpile), but the bulk characteristics of the stockpiles are generally not significantly different from waste rock at the site with the exception of copper content which is elevated in the ore stockpiles.
- Contact water chemistry for the ore stockpiles is expected to be similar to waste rock with both being pH basic and chemistry controlled by secondary gypsum, primary calcite, iron oxides and copper oxides. Selenium may be more leachable from the ore stockpiles than waste rock though this depends on the mineralogical association of selenium.
- The presence of leachable selenium is a consideration for processing of the stockpiled ore. Operating conditions may result in a flush of selenium into process waters.

Table of Contents

1 Introduction 1
2 Background 1
2.1 Solids Geochemistry 1
2.2 Aqueous Geochemistry – Seep Sampling 3
3 Methods 3
3.1 Sample Collection 3
3.2 Laboratory Analysis 4
3.3 Interpretation Methods 5
3.3.1 ARD Potential 5
3.3.2 Element Enrichment 5
3.3.3 Interpretation of Shake Flask Leachate Chemistry 5
3.4 Quality Assurance and Quality Control 6
4 Results and Discussion 6
4.1 Test Pit Sampling 6
4.2 Assessment of ARD Potential 7
4.2.1 Sulphur Form 7
4.2.2 Carbonate Content and Neutralization Potential 7
4.2.3 Acid Rock Drainage Potential 8
4.3 Element Enrichment 10
4.4 Contact Water Chemistry 10
4.4.1 Shake Flask Results 10
4.4.2 Interpretation 10
5 Conclusions 13
6 References 16

List of Figures

Figure 2-1: Location of Ore Stockpiles. The figure is approximately 1.7 km across (Source: MPMC)..... 2

Figure 4-1: Comparison of Modified NP and Total Inorganic Carbon..... 8

List of Tables

Table 2-1: Description of Ore Stockpiles 3

Table 2-2: Statistical Summary of Selected Parameters in Mount Polley Seep Samples. 3

Table 3-1: Summary of QA/QC Checks and Outcomes 6

Table 4-1. 95% Confidence Limits on Means for Selected Parameters 7

Table 4-2: Summary of Acid-Base Accounting and Trace Element Results 9

Table 5-1: Summary of SFE Leachate Concentrations 12

Table 5-2. Results of Upscaling Shake Flask Extraction Results 12

Appendices

Appendix A – Field Notes

Appendix B – Analytical Results

List of Abbreviations

AP	acid potential
CRC	collision reaction cell
CVAFS	cold vapour atomic fluorescence spectroscopy
FAL	Freshwater Aquatic Life
HCT	humidity cell test
ICP-AES	inductively coupled plasma atomic emission spectrometry
ICP-MS	inductively coupled plasma mass spectrometry
LCL	lower confidence limit
LOD	limit of detection
MPM	Mount Polley Mine
MPMC	Mount Polley Mining Corporation
ML/ARD	metal leaching and acid rock drainage
ND	not detected
NP	neutralization potential
NPR	neutralization potential ratio
RPD	relative percent difference
SFE	shake flask extraction
SI	saturation index
TIC	total inorganic carbon
UCL	upper confidence limit
QA/QC	quality assurance and quality control

1 Introduction

The Mount Polley Mining Corporation (MPMC) built four ore-grade rock stockpiles at the Mount Polley Mine (MPM), located approximately 55 km north-east of Likely, British Columbia, between 2006 and 2014. The ore stockpiles total about 8 million tonnes and the MPMC plans to process these stockpiles to recover copper. *Mines Act* Permit M-200 contains a new condition to characterize the metal leaching and acid rock drainage (ML/ARD) potential of the stockpiles.

SRK Consulting (Canada) Inc. was retained by MPMC to develop a plan to characterize the geochemical stability of the ore stockpiles. The outcomes of implementation of the plan were to consider:

- ARD potential using acid-base accounting data.
- Evaluation of element enrichment relative to other stockpiles.
- In the absence of specific seepage from the stockpile, interpretation of shake flask data to determine if seepage chemistry for the stockpiles can be expected to be different from other existing drainage chemistry on site.

This report provides the results and interpretations from implementation of the plan by MPMC personnel.

2 Background

2.1 Solids Geochemistry

The ore characterization plan provided a summary of the geological and geochemical characteristics expected in the ore stockpiles (SRK 2015). In summary, the main features of the Mount Polley deposit are:

- The deposit is classified as an alkalic porphyry copper gold deposit (BC MINFILE No. 093A 008).
- The host rocks for porphyry mineralization are intrusions into the Nicola Volcanics varying in composition from diorite to syenite.
- Sulphide mineralization is predominantly chalcopyrite ($CuFeS_2$) and pyrite (FeS_2), with lesser bornite (Cu_5FeS_4), covellite (CuS), and digenite (Cu_9S_5).
- Carbonate mineralization is principally calcite, with occurrences of malachite ($Cu_2CO_3(OH)_2$); iron carbonates have not been reported.
- A significant portion of the copper at the MPM is not associated with sulphides (upwards of 50% in the upper portions of each pit).

The characteristics of the four ore stockpiles as provided by MPMC are summarized in Table 2-1. The relative locations of the stockpiles are shown in Figure 2-1. More than 50% of stockpiled ore is contained in the High-Oxide Stockpile which originated from the oxide cap of the Springer Zone. Stockpile #1 also originates from the Springer Zone but has lower copper grade dominated by copper sulphide (oxide ratio 18%). The other two stockpiles (#3 and Cariboo) originated from the Cariboo and Bell Zones. The maximum age of the stockpiled rock is 9 years.

SRK's current assessment of site data is that there is no correlation between copper grade and ARD potential. ARD potential at Mount Polley reflects the balance between sulphide as pyrite and calcite which is not correlated with the presence of copper sulphide. For this reason, the designation of rock as ore means that its ARD potential is not expected to be different from waste rock.



Figure 2-1: Location of Ore Stockpiles. The figure is approximately 1.7 km across (Source: MPMC)

Table 2-1: Description of Ore Stockpiles

Stockpile	Primary Source	Approximate Construction Time	Mass tonnes	Total Copper (%)	Oxide Copper (%)	Oxide Ratio
#1 Stockpile	Springer - Low Oxide	2008-2014	1,200,000	0.26	0.047	18%
#3 Stockpile	Cariboo/Bell	2006-2007	1,900,000	0.26	0.12	44%
High-Oxide Stockpile	Springer - Oxide Cap	2007-2009	4,100,000	0.35	0.26	76%
Cariboo Stockpile	Cariboo	2014	730,000	0.19	0.066	36%
Total			*8,000,000*	*0.30*	*0.18*	*56%*

Source: MPMC

Note: values rounded to two significant figures.

2.2 Aqueous Geochemistry – Seep Sampling

Results from seep sampling from across the site (not specifically ore stockpiles) at seven different locations between 2010 and 2014 were provided to SRK as part of this assessment. Table 2-2 is a statistical summary of results for parameters with guidelines for the protection of freshwater aquatic life in British Columbia (BC FAL guidelines) and also concentrations above detection limits in the seep samples and laboratory testing.

Table 2-2: Statistical Summary of Selected Parameters in Mount Polley Seep Samples.

Statistic	pH (field)	Alkalinity mg $CaCO_3$/L	Sulphate mg/L	Nitrate mg/L	As mg/L	Ba mg/L	Ca mg/L	Cu mg/L	Fe mg/L	Mo mg/L	Se mg/L
Minimum	6.9	21	110	0.05	<0.0005	0.024	55	0.00025	<0.03	0.0017	0.0017
5th Percentile	7.5	34	170	0.39	<0.0005	0.029	84	0.002	<0.03	0.0045	0.0045
25th Percentile	7.8	87	470	6.4	0.0003	0.048	170	0.006	<0.03	0.043	0.022
Median	8	100	630	9.3	0.00055	0.054	240	0.012	<0.03	0.076	0.038
Average	8	110	610	19	0.00076	0.063	230	0.02	<0.03	0.089	0.042
75th Percentile	8.1	130	790	32	0.0014	0.077	300	0.016	<0.03	0.12	0.05
95th Percentile	8.5	180	1000	55	0.0017	0.11	350	0.036	0.057	0.21	0.13
Maximum	8.8	220	1100	58	0.0029	0.13	360	0.52	0.33	0.26	0.16

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3 Methods

3.1 Sample Collection

Samples were collected from test pits in each of the ore stockpiles by MPMC personnel under direction by SRK. Six test pits per stockpile were spread evenly over the dump platform of each of the three smaller stockpiles (#1, #3 and Cariboo). Twelve test pits were sampled in the larger oxide stockpile. Thirty-three samples were collected using a backhoe to excavate to a depth of approximately two metres. Each sample was 5 kg.

During excavation, MPMC geologists documented distinctive features such as differences in rock types and degree of oxidation. Distinctive materials were segregated into piles by the test pit, photographed and logged for:

- Sulphide content.
- Copper oxide content as indicated by green and blue colours.
- Iron oxide content as indicated by red-brown colouration.
- Reaction of rock fines with 10% hydrochloric acid (degree of fizz) rated as none, moderate or strong.
- Any other mineral precipitates (such as gypsum).

Field observations are provided in Appendix A.

3.2 Laboratory Analysis

Samples were shipped by MPMC to ALS Environmental in Burnaby, BC.

Following drying, each sample was split into two parts. One part was sieved to yield the -2 mm fraction which is assumed to represent the more reactive component of the rock. This fraction was analysed as follows:

- Moisture content.
- Rinse pH and conductivity.
- Total sulphur and sulphur as sulphate (hydrochloric acid leach).
- Total carbonate and modified neutralization potential.
- Ultra-trace level 51 element scan by ICP-MS and ICP-AES following aqua regia digestion.

Based on review of the results obtained, a sub-set of samples were selected by SRK for shake flask extraction (SFE) tests as per the MEND (2009) method. Two samples per stockpile were selected on the basis of high selenium content and high electrical conductivity values within their stockpile. Samples with high selenium content were chosen in order to obtain conservative results for leachable components.

SFE leachates were analysed for:

- pH
- Conductivity
- Leachable anions and nutrients
  - Alkalinity
  - Nitrate
  - Sulphate
  - Chloride

  - Total phosphate
- Leachable Metals
  - 33 element scan by collision reaction cell (CRC) ICP-MS
  - Mercury by CVAFS

Laboratory reports are provided in Appendix B.

3.3 Interpretation Methods

3.3.1 ARD Potential

ARD potential was evaluated using the neutralization potential ratio (NPR) calculated from total inorganic carbon (TIC) as a proxy for reactive (calcium and magnesium) carbonate content, and acid potential (AP) calculated from sulphide content:

$$\text{NPR} = \frac{\text{TIC}}{\text{AP}}$$

Potentially ARD generating (PAG) rock is indicated by NPR≤2.

3.3.2 Element Enrichment

Element enrichment relative to other waste rock stockpiles (as indicated by previous analysis of drill cores) was evaluated by calculating confidence limits on mean concentrations for selected parameters and considering overlap in the resulting ranges. 95% confidence limits were calculated conventionally using standard error and a Student's t-statistic.

3.3.3 Interpretation of Shake Flask Leachate Chemistry

Concentrations in shake flask leachate chemistry must be corrected to address the high dilution factor (3 L/kg) relative to full-scale conditions. To interpret concentrations obtained by the method, it was assumed that natural moisture in the sample is in equilibrium with sample solids, and that the extraction test dilutes this contact water. Using this assumption, concentrations in the contact water ($[C]_{contact}$) can be calculated from the moisture content of the sample using the following equation:

$$[C]_{\text{contact}} = \frac{[C]_{\text{SFE}}\,(\text{mg of C/L of water}) \times V_{\text{SFE}}\,(\text{L of water})}{M_{\text{SFE}}\,(\text{kg of rock})} \times \frac{1000\ \text{g of water/L of water}}{u(\text{g of } H_2O/100\ \text{g of rock}) \times 10(100\ \text{g/ kg})}$$

$[C]_{SFE}$ is the concentration of an ion in the SFE leachate obtained by leaching M_{SFE} rock using V_{SFE} of water. The gravimetric water content is u expressed as a percentage.

The resulting up-scaled concentrations were evaluated using PHREEQC (Parkhurst and Appelo 1999) to determine mineral saturation indices (SIs). If the resulting SIs are near 0, it is likely the contact water is in equilibrium with the secondary minerals. If the SIs are well above 0, it is interpreted that the extraction test is leaching additional load from the solids during the procedure.

3.4 Quality Assurance and Quality Control

The QA/QC checks and their associated outcomes are outlined in Table 3-1. SRK's assessment was that the quality of the analytical data was acceptable, pending duplicate outcomes (described in Table 3-1).

Table 3-1: Summary of QA/QC Checks and Outcomes

Parameter	Criterion	Result
Sulphur balance	Total Sulphur ≥ Sulphate Sulphur, for samples >10X DL.	Passed
Neutralization potential consistent with fizz test	NP does not exceed maximum NP indicated by acid strength and acid volume indicated by fizz.	Passed
Neutralization potential consistent with carbonate content	NP correlated with carbonate and values near parity.	Passed
Field Duplicates	Relative percent difference (RPD) better than about ±30% for levels >10 times limit of detection (LOD).	In-progress.
Leachate Ion Balance	Imbalance not greater than ±10%.	Passed

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4 Results and Discussion

4.1 Test Pit Sampling

The majority of test pits showed homogeneous material and there was no segregation into distinctive material types. There were three exceptions that showed two distinct materials, and two samples were taken at the following locations:

- Cariboo SP-14
- #1 SP-21
- High Oxide SP-7

A duplicate was taken from the Cariboo, #1, and High Oxide stockpiles as part of quality assurance and quality control measures.

Overall, material properties were comparable between the piles. The main rock type as described by MPM geologists was monzodiorite with variations to monzonite. Sulphides were generally absent and only observed some of the time in minor amounts. Secondary minerals included malachite in minor to moderate amounts in all samples, with iron oxide distribution following a similar distribution. All samples showed moderate to strong HCl fizz test reaction. This was consistent with calcite observed in all but one sample.

4.2 Assessment of ARD Potential

4.2.1 Sulphur Form

Sulphate-sulphur concentrations were near or below the limit of detection for all samples, therefore; total sulphur was used to represent sulphide content in the stockpiles, which is consistent with the known mineralogy at the site.

Sulphur content ranged from a minimum of 0.01% to a maximum of 0.62%, with an overall average value of 0.15% (Table 4-1). The High Oxide Stockpile had the lowest average sulphur content (0.04%) which was statistically different from the #1 and #3 stockpiles (Table 4-1). These latter stockpiles had higher sulphur contents which were not statistically different from each other.

Table 4-1. 95% Confidence Limits on Means for Selected Parameters

Stockpile	Statistic	Total S %	As ppm	Cd ppm	Cu ppm	Se ppm
Stockpiles						
Cariboo	LCL	0.05	17	0.14	1600	2.4
n=7	UCL	0.22	23	0.27	3500	3.7
#1	LCL	0.18	12	0.12	2600	3.9
n=7	UCL	0.33	18	0.35	4600	7.1
High-Oxide	LCL	0.02	11	0.22	2200	1.4
n=13	UCL	0.06	18	0.37	4000	2.8
#3	LCL	0.07	14	0.18	2500	2.8
n=6	UCL	0.46	19	0.40	3900	6
Zone Samples						
Springer	LCL	0.24	11	0.27	390	1.2
n=30	UCL	0.78	17	0.49	590	2.8
Bell	LCL	ND	20	0.057	1700	ND
n=2963	UCL	ND	27	0.072	1800	ND
NE	LCL	0.49	11	0	460	ND
n=20	UCL	1.3	17	0.33	940	ND
SE	LCL	0.89	12	0.049	170	0.99
n=48	UCL	1.2	14	0.1	240	1.6
Pond	LCL	0.3	14	0	390	1.5
n=27	UCL	1.2	21	3	810	2.6

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ND – No data; LCL – Lower confidence limit; UCL – Upper confidence limit

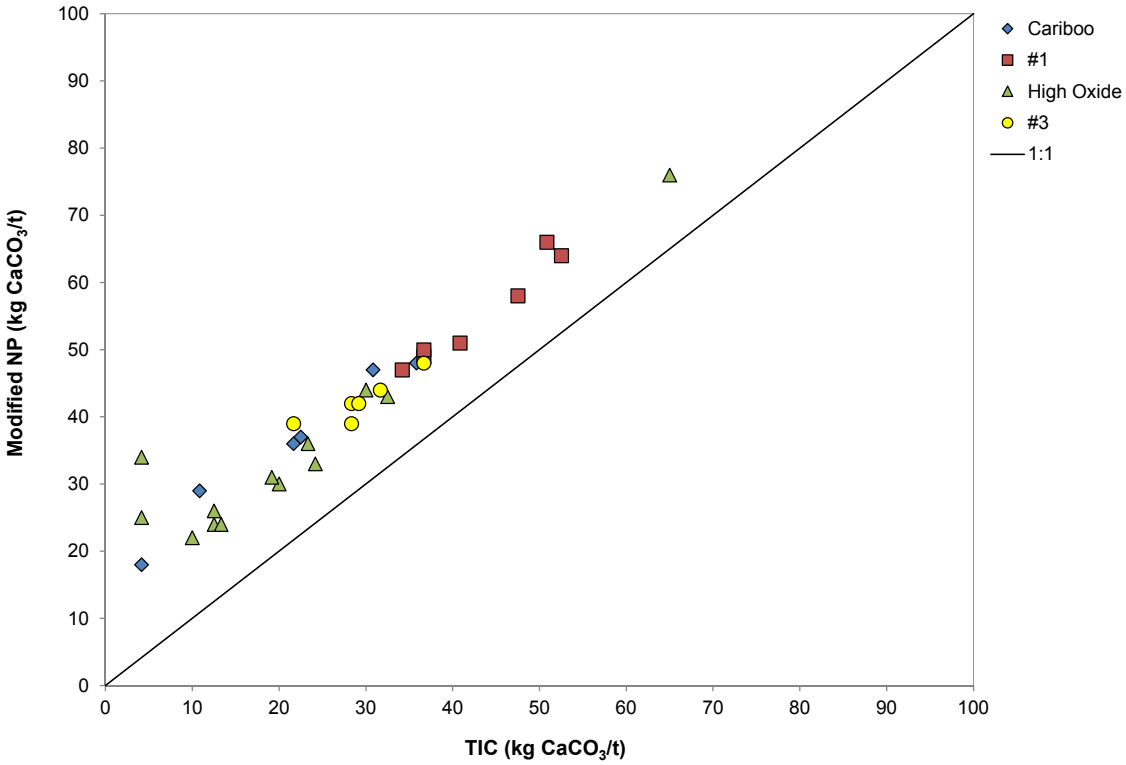
4.2.2 Carbonate Content and Neutralization Potential

Carbonate and neutralization potential (NP) results are summarized in Table 4-2.

Total inorganic carbon (TIC) ranged from a minimum of 4.2 to a maximum of 93 kg $CaCO_3$/t, with an average value of 29 kg $CaCO_3$/t. The High Oxide Stockpile had the lowest average TIC

(21 kg $CaCO_3$/t), whereas as the #1 Stockpile had the highest average TIC (43 kg $CaCO_3$/t). TIC averaged 31 kg $CaCO_3$/t for the Cariboo Stockpile and 29 kg $CaCO_3$/t for the #3 Stockpile.

Modified NP determined by titration was always greater than TIC as shown in Figure 4-1. The higher modified NP compared to TIC is attributed to weakly reactive silicates that would consume acid during testing, but may not provide neutralization capacity under field conditions. TIC was used for buffering potential in this assessment because it is a proxy for acid neutralizing carbonate minerals. Iron carbonates, which do not consume acid, have not been documented at the MPM.



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Figure 4-1: Comparison of Modified NP and Total Inorganic Carbon

4.2.3 Acid Rock Drainage Potential

Paste pH values (Table 4-2) for all samples taken were basic, indicating that net acidity had not developed in any of the samples at the time of sampling. This is also consistent with the presence of abundant calcite and malachite observed during test pit sampling.

Based on NPR calculated as described in Section 3.3.1, all but one sample (#3 Stockpile-27, with NPR = 1.4) were determined to be non-PAG.

Based on the samples collected in this assessment, the ARD potential for the ore stockpiles is low.

Table 4-2: Summary of Acid-Base Accounting and Trace Element Results

Stockpile	Statistic	Paste pH	Total Sulphur	AP	Modified NP	TIC	TIC/AP	As	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	Pb	Se	U	V	Zn
			%	kgCaCO3/t				mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Cariboo (n=7)	Average	8.4	0.13	4.2	45	31	7.5	20	0.2	12	2600	5.2	0.11	660	9.9	11	5	3	0.77	210	53
#1 (n=7)	Average	8.4	0.25	7.9	55	43	5.4	15	0.23	15	3600	6	0.13	670	13	22	6.6	5.5	1.2	190	52
High Oxide (n=13)	Average	8.4	0.042	1.3	34	21	16	15	0.3	23	3100	5.6	0.11	830	5.8	40	9.1	2.1	0.97	180	70
#3 (n=6)	Average	8.4	0.26	8.2	42	29	3.6	16	0.29	13	3200	6.4	0.14	750	12	16	12	4.4	1.4	190	63
All Stockpiles (n=33)	Minimum	8.1	0.01	0.31	18	4.2	1.5	1.5	0.09	5	130	3.6	0.01	460	0.42	5	2.9	0.7	0.18	120	31
	P25	8.3	0.04	1.3	31	19	5.5	14	0.18	9	2300	5.2	0.1	640	3.5	9.4	4.9	1.9	0.82	170	48
	Median	8.4	0.12	3.8	42	28	6.9	16	0.23	14	3100	5.6	0.12	740	7.5	12	6.9	3.6	1.1	180	60
	P75	8.4	0.2	6.3	48	37	13	19	0.3	22	3800	6.4	0.14	840	11	24	9.9	3.8	1.3	200	69
	Maximum	8.7	0.62	19	100	93	52	25	0.54	62	6600	8.5	0.2	1200	30	190	19	8.1	1.6	450	120
	Average	8.4	0.15	4.6	43	29	6.4	16	0.26	17	3100	5.7	0.12	750	9.2	26	8.1	3.4	1	190	61

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4.3 Element Enrichment

Confidence limits on mean concentrations for selected elements are shown in Table 4-1 by stockpile and compared to other zones. For the stockpiles, a statistically significant difference is apparent for #1 which has distinctively higher selenium concentrations. The lower confidence limit is 3.9 mg/kg compared to the highest upper confidence limit of 3.7 mg/kg for the Cariboo stockpile.

Compared to other zones waste rock samples, copper concentrations are clearly enriched, which is consistent with the classification of the stockpiles as ore. Other than for copper, the Southeast Zone and Pond Zone had lower average selenium concentrations than the #1 and #3 stockpiles. There is some indication of subtle differences for arsenic, such as the lower arsenic concentrations for the Southeast Zone compared to the Cariboo stockpile. However, there is a lack of strong (e.g. order-of-magnitude) differences for any of the parameters. Variability in element content is not expected to generally influence drainage chemistry.

4.4 Contact Water Chemistry

4.4.1 Shake Flask Results

Shake flask extraction (SFE) test results for parameters with BC FAL guidelines and above analytical detection limits are shown in Table 4-3.

The SFE leachates had pHs near 9 for most samples, which is higher than is typical of carbonate-buffered waters in equilibrium with the atmosphere (closer to pH 8.6). The elevated pHs may reflect abrasion of silicate minerals during sample processing (drying and sieving) and shaking in the extraction procedure. Hydrolysis of abraded silicate surfaces yields hydroxyl ions (OH^-) that result in higher pHs. The higher pHs are potentially important for interpreting leaching of oxyanions such as selenium and arsenic.

Leachate chemistry was dominated by sulphate, alkalinity and calcium, with lesser amounts of sodium, silicon, potassium and magnesium. Sulphate was significantly correlated with bulk rock sulphur content at the 99% confidence level ($r = 0.87$) implying that it is derived from oxidation of pyrite rather than a primary sulphate mineral.

4.4.2 Interpretation

Upscaled Concentrations

Results of applying the SFE upscaling methodology described in Section 3.3.3 yielded the results shown in Table 4-4.

Raw SFE sulphate concentrations were in the tens of mg/L (Table 4-3) which, based on concentration factors of about 100, became scaled up concentrations in the thousands of mg/L. PHREEQC indicated that these concentrations were generally consistent with moisture being in equilibrium with gypsum (calcium sulphate dehydrate) because saturation indices were close to 0. Barite (barium sulphate) saturation indices in contrast were well above 0, implying that raw

barium concentrations in the SFE leachates resulted from equilibration of weakly soluble barite with the SFE leachates, and therefore that barium concentrations in the contact water are not at the levels indicated by the calculation.

Following similar interpretation approaches, alkalinity and calcium concentrations in the raw SFE leachates reflect dissolution of calcite during the procedure because up-scaled concentrations yielded saturation indices well above 0. Scaled up copper concentrations appear to realistically reflect rock moisture equilibration with copper carbonate (malachite) and oxide (tenorite) as shown by saturation indices near 0.

Scaled up concentrations for three elements occurred as oxyanions (As, Mo, Se) are shown. Molybdenum concentrations were assessed using saturation indices for calcium molybdate. Since saturation indices were typically between 0 and 1, upscaled molybdenum concentrations may realistically reflect molybdenum concentrations in pore waters. In addition, since upscaled calcium concentrations are probably in reality controlled by calcite, $CaMoO_4$ saturation indices would decrease.

Arsenic and selenium concentrations are not readily assessed with respect to known secondary minerals in this geological setting because they occur as trace elements. Mobile arsenic probably occurs as a trace component of secondary iron oxides or adsorbed to the secondary oxides; however, iron oxides have low solubility at these pHs as shown by undetected iron concentrations in the shake flask leachates (<0.03 mg/L). Saturation indices for iron oxides are not shown in Table 4-4 but are well above 0. Scaled up arsenic concentrations therefore do not realistically represent concentrations in contact water and pore water arsenic concentrations are not expected to exceed those shown in the raw SFE leachates (Table 4-3).

Scaled up selenium concentrations approached 3 mg/L. Selenium may occur as a trace component of secondary sulphate (gypsum, barite) or in association with iron oxide (either adsorbed or co-precipitated). If associated with gypsum, the up-scaled selenium concentrations reflect concentrations in the contact water because the water chemistry appears to be controlled by gypsum dissolution. If barite is the host, the low solubility of barite would limit Se concentrations to those observed in the raw SFE leachates (approximately two orders of magnitude below those indicated by scale-up).

If selenium is being leached by de-sorption, concentrations may be controlled by several factors (pH, kinetics of de-sorption, distribution coefficients for the solutions). Due to the elevated pH, selenium leaching may be unrealistically accelerated compared to natural conditions resulting in elevated raw and upscaled concentrations.

Comparison with Observed Seepage Chemistry

Raw (Table 4-3) and upscaled pore water (Table 4-4) concentrations for selected parameters were compared to observed seep chemistry (Table 2-2). For the latter, concentrations at the 95th percentile and higher probably reflect the least dilution and are therefore the relevant comparison point for the SFE data.

Table 4-3: Summary of SFE Leachate Concentrations

Sample ID	pH	SO_4 mg/L	Alkalinity $mgCaCO_3/L$	As mg/L	Ba mg/L	Ca mg/L	Cu mg/L	Fe mg/L	Mo mg/L	Se mg/L
CARIBOO SP-15 (1)	9	12	27	0.007	0.011	8.2	0.0013	<0.03	0.023	0.021
CARIBOO SP-16 (1)	8.9	18	29	0.0065	0.016	11	<0.001	<0.03	0.04	0.007
#1 SP-20(1)	8.9	17	27	0.0034	0.011	9.7	0.0026	<0.03	0.017	0.016
#1 SP-24(1)	8.9	26	23	0.0028	0.021	11	<0.001	<0.03	0.045	0.016
HIGH OXIDE SP-12 (1)	8.7	15	31	0.003	0.042	13	0.0089	<0.03	0.022	0.0024
HIGH OXIDE SP-3 (1)	9	10	29	0.0028	0.012	9.3	0.008	<0.03	0.017	0.018
#3 SP-29 (1)	9	13	29	0.003	0.011	9.6	0.0028	<0.03	0.023	0.016
#3 SP-27 (1)	8.8	35	29	0.0017	0.034	17	0.004	<0.03	0.043	0.02

Source: P:\01_SITES\Mt_Polley\1CI008.005_2015_ReStart_Source_Terms\!080_Deliverables\2015-08_Stockpile_SFE\[StockpileSFE_1CI008005_REV02.xlsx]

Table 4-4. Results of Upscaling Shake Flask Extraction Results

		Up-Scaled Concentrations									Saturation Indices					
Sample ID	pH	SO_4 mg/L	Alkalinity $mgCaCO_3/L$	As mg/L	Ba mg/L	Ca mg/L	Cu mg/L	Fe mg/L	Mo mg/L	Se mg/L	Calcite	Malachite	Tenorite	Barite	Gypsum	$CaMoO_4$
CARIBOO SP-15 (1)	9.0	1500	3400	0.89	1.4	1000	0.16	<3.8	2.8	2.6	3.2	-0.9	-0.4	2.1	-0.1	0.7
CARIBOO SP-16 (1)	8.9	3100	4900	1.1	2.7	1900	<0.17	<5.1	6.9	1.2	3.5	-1.0	-0.6	2.5	0.2	1.1
#1 SP-20(1)	8.9	2100	3500	0.43	1.4	1200	0.33	<3.8	2.2	2.1	3.2	-0.3	-0.1	2.2	0.0	0.6
#1 SP-24(1)	8.9	3500	3100	0.37	2.8	1400	<0.13	<4.0	6	2.1	3.2	-1.0	-0.4	2.7	0.3	1.0
HIGH OXIDE SP-12 (1)	8.7	940	1900	0.18	2.6	780	0.54	<1.8	1.4	0.15	2.8	0.9	0.5	2.3	-0.3	0.4
HIGH OXIDE SP-3 (1)	9.0	1400	4000	0.38	1.7	1300	1.1	<4.1	2.3	2.5	3.4	0.6	0.4	2.1	-0.1	0.6
#3 SP-29 (1)	9.0	1100	2300	0.24	0.86	760	0.22	<2.4	1.8	1.3	3.0	-0.1	0.1	1.8	-0.3	0.5
#3 SP-27 (1)	8.8	4000	3300	0.19	3.9	1900	0.45	<3.4	4.9	2.3	3.2	-0.1	0.0	2.8	0.4	0.0

Source: P:\01_SITES\Mt_Polley\1CI008.005_2015_ReStart_Source_Terms\!080_Deliverables\2015-08_Stockpile_SFE\[StockpileStatics_1CI008005_REV03_SJD.xlsx]

Observed sulphate concentrations in seeps are comparable to up-scaled concentrations. Highest seep concentrations were above 1000 mg/L which approaches gypsum saturation though some dilution is indicated. Likewise, pH and alkalinity concentrations are consistent with control by calcite dissolution. Iron has been generally undetected (<0.03 mg/L) in seeps with 95th percentile concentrations at 0.06 mg/L. These concentrations are consistent with the low solubility of iron oxides at basic pHs.

95th percentile copper concentrations in seeps are 0.04 mg/L ranging up to 0.5 mg/L as a maximum concentration compared to 0.1 to 1 mg/L for upscaled concentrations. Considering that seeps reflect some dilution (as indicated by sulphate concentrations), the upscaled concentrations are comparable to the seeps.

Higher arsenic concentrations in seeps show a narrow range from 0.001 to 0.003 mg/L which are comparable to the raw concentrations from SFE (0.002 to 0.007 mg/L) indicating control by the low solubility of secondary iron oxides as described above.

Higher molybdenum concentrations likewise show a narrow range from 0.1 to 0.3 mg/L. This concentration range is between that of the raw SFE leachates (0.02 to 0.05 mg/L) and upscaled concentrations (1 to 7 mg/L). Molybdenum concentrations in the stockpile rock averaged 9 mg/kg and are therefore probably associated with iron oxides rather than discrete mineral phases. Leaching of molybdenum may therefore be controlled by iron solubility rather than solubility of calcium molybdate.

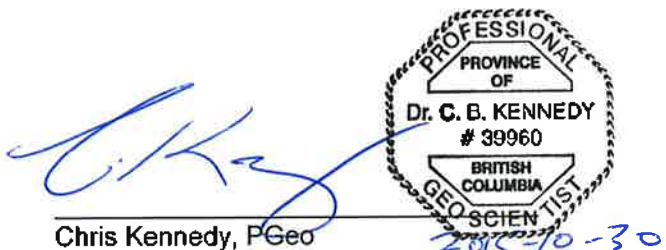
Likewise, seep selenium concentrations of about 0.1 to 0.2 mg/L are between the range indicated for the raw SFE leachates (0.002 to 0.02 mg/L) and the upscaled concentration range of 0.2 to 3 mg/L. At these pHs, and oxidizing conditions, selenium is expected to be mobile as the selenate ion (SeO_4^{2-}) resulting in the conclusion that the ore stockpiles may leach selenium at higher concentrations than waste rock. The presence of leachable selenium is also a consideration for the influence of processing oxide ore on process water chemistry.

5 Conclusions

The following are concluded:

- The ore stockpiles have low ARD potential. It is not expected that acid conditions will develop in the stockpiles in the long term should they not be processed.
- Some differences between stockpiles were apparent (lower sulphide content of high oxide stockpile) but the bulk characteristics of the stockpiles are generally not significantly different from waste rock at the site with the exception of copper content which is elevated in the ore stockpiles.
- Contact water chemistry for the ore stockpiles is expected to be similar to waste rock with both being pH basic and chemistry controlled by secondary gypsum, primary calcite, iron oxides and copper oxides. Selenium may be more leachable from the ore stockpiles than waste rock though this depends on the mineralogical association of selenium.
- The presence of leachable selenium is a consideration for processing of the stockpiled ore. Operating conditions may result in a flush of selenium into process waters.

This report, Geochemical Characterization of Ore Stockpiles, was prepared by



2015-10-30

Chris Kennedy, PGeo
Principal Consultant (Geochemistry)

and reviewed by



Stephen Day, MSc, PGeo
Corporate Consultant (Geochemistry)
2015-10-30

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

6 References

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SRK. 2015. Ore Stockpile Characterization Plan, Mount Polley Mine. Prepared for Mount Polley Mining Corporation. 1CI008.005. May 2015.

Appendix A – Field Notes

Stockpile	Test Pit(Sample) ID	Depth (m)	Material (Rock) Type	No. of Material Types	Sulphides	Copper Oxides	Iron Oxides	Fizz Reaction	Other Observations
Cariboo	Cariboo SP-17 (1)	2.2	Monzodiorite to diorite	1	None observed	Malachite (low)	Low	Strong	Calcite, low degree of oxidation
	Cariboo SP-14 (1)	2.4	Monzonite	2	None observed	Malachite	Present	Moderate	Calcite, moderate to strong oxidation (red/pink/brown)
	Cariboo SP-14 (2)	2.4	Monzodiorite to diorite		None observed	Malachite	Present	Moderate	Calcite, low oxidation (grey)
	Cariboo SP-13 (1)	2.6	Monzodiorite	1	Pyrite (low)	Malachite	Present	Moderate	Calcite, low oxidation
	Cariboo SP-15 (1)	2.7	Monzodiorite	1	Pyrite (low)	Malachite	Low	Moderate	Calcite, low oxidation (grey/pink)
	Cariboo SP-16 (1)	2.6	Diorite to monzonite	1	None observed	Low	Present	Strong	Calcite, low oxidation (grey)
	Cariboo SP-18 (1)	2.5	Monzonite to monzodiorite	1	Pyrite	Malachite	None observed	Strong	Calcite, moderate oxidation (pink with grey (dioritic) brecciation)
#1	#1 SP-21 (1)	3	Monzonite	2	Pyrite to chalcopyrite (low)	Malachite	Present	Strong	Calcite, low oxidation, dendritic manganese present
	#1 SP-21 (2)	3	Monzodiorite to diorite			Malachite	Present	Strong	Calcite, low oxidation
	#1 SP-20 (1)	3.2	Monzodiorite	1	Pyrite to chalcopyrite (low)	Malachite	Present	Strong	Calcite, low oxidation, homogenous-brecciated monzodiorite
	#1 SP-22 (1)	2.7	Monzodiorite	1	None observed	Malachite	Present	Strong	Calcite, low oxidation (grey)
	#1 SP-23 (1)	2.4	Monzodiorite	1	Pyrite to chalcopyrite	Malachite	Present	Strong	Calcite, low oxidation (grey)
	#1 SP-24 (1)	3.3	Monzodiorite	1	Pyrite (low)	Malachite (low)	Present (moderate)	Strong	Calcite, low oxidation, dendritic manganese present
	#1 SP-19 (1)	3	Monzodiorite	1	Pyrite (low)	Malachite	Present (moderate)	Moderate	Calcite, low to moderate oxidation, dendritic manganese present
High Oxide	High Oxide SP-9 (1)	2.8	Monzonite to monzodiorite	1	Pyrite (low)	Malachite (high)	Present (moderate)	Moderate	Calcite, moderate oxidation
	High Oxide SP-8 (1)	3.1	Monzonite to monzodiorite	1	Pyrite to chalcopyrite (low)	Malachite (high)	Present (moderate)	Moderate	Calcite, low oxidation
	High Oxide SP-7 (1)	2.6	Dioritic (dark, crumbly, grt, albite, zeolites)	2	None observed	None observed	Present (high)	None	No mineral precipitates observed, moderate oxidation
	High Oxide SP-7 (2)	2.6	Monzodiorite		None observed	Malachite (moderate)	Present (moderate)	None	Calcite, moderate oxidation
	High Oxide SP-5 (1)	3.2	Monzodiorite	1	None observed	Malachite	Present (high)	Strong	Calcite, strong oxidation (brown), similar to SP-6
	High Oxide SP-6 (1)	3	Monzodiorite	1	None observed	Malachite	Present (high)	Moderate	Calcite, strong oxidation (brown)
	High Oxide SP-12 (1)	2.9	Monzonite to monzodiorite	1	None observed	Malachite (moderate)	Present (moderate)	Moderate	Calcite, moderate to strong oxidation (light brown)
	High Oxide SP-11 (1)	2.9	Monzonite to monzodiorite	1	None observed	Malachite (low to moderate)	Present (moderate)	Moderate	Calcite, moderate oxidation (brown)
	High Oxide SP-10 (1)	2.7	Monzonite to monzodiorite	1	Pyrite (low)	Malachite (moderate to high)	Present (moderate to high)	Moderate	Calcite, moderate to strong oxidation, high manganese alteration
	High Oxide SP-4 (1)	2.7	Brecciated monzonite to monzodiorite	1	None observed	Malachite (high)	Present	Moderate	Calcite, strong oxidation (red/brown), high manganese alteration
	High Oxide SP-3 (1)	2.5	Monzodiorite	1	Pyrite to chalcopyrite	Malachite (low to moderate)	Present	Moderate	Calcite, moderate to high oxidation
	High Oxide SP-1 (1)	2.6	Monzodiorite to diorite	1	Pyrite to chalcopyrite (low)	Malachite (moderate)	Present (moderate)	Strong	Calcite, moderate oxidation
	High Oxide SP-2 (1)	2.7	Monzodiorite	1	Pyrite (low)	Malachite (moderate)	Present (moderate)	Strong	Calcite, moderate oxidation, manganese alteration
#3	#3 SP-26 (1)	2.2	Monzodiorite	1	Pyrite to chalcopyrite (low)	Malachite (low)	Low	Moderate	Calcite, low oxidation
	#3 SP-25 (1)	2.2	Monzodiorite	1	Pyrite to chalcopyrite (low)	Malachite (low)	Low	Moderate	Calcite, low to moderate oxidation
	#3 SP-29 (1)	2.5	Monzodiorite	1	Pyrite to chalcopyrite (moderate)	Malachite (low)	Low	Moderate	Calcite, low oxidation (grey, light brown)
	#3 SP-28 (1)	2.6	Monzodiorite	1	Pyrite to chalcopyrite (moderate), bornite (low)	Malachite (low)	Low	Moderate	Calcite, low to moderate oxidation
	#3 SP-27 (1)	2.2	Monzodiorite to diorite	1	Pyrite to chalcopyrite (moderate)	Malachite (low)	Low to moderate	Moderate	Calcite, low to moderate oxidation
	#3 SP-30 (1)	2.6	Monzodiorite	1	Pyrite to chalcopyrite (low)	Malachite (low)	Low to moderate	Moderate	Calcite, low to moderate oxidation (grey, light brown)

Appendix B – Analytical Results

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To: **MOUNT POLLEY MINING CORPORATION**
PO BOX 12
LIKELY BC V0L 1N0

Finalized Date: 22-JUL-2015
Account: NOU

CERTIFICATE VA15101982

Project: One Stockpile Project 2015

This report is for 33 Sediment samples submitted to our lab in Vancouver, BC, Canada on 7-JUL-2015.

The following have access to data associated with this certificate:

MCLEAN DONOHOE	COLLEEN HUGHES	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
OA-GRA10b	Moisture - Bulk Samples
PUL-QC	Pulverizing QC Test
PUL-31	Pulverize split to 85% <75 um
SCR-51	Screening
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO
C-GAS05	Inorganic Carbon (CO2)	
OA-ELE04	Specific Conductivity 1:10	
ME-MS41	51 anal. aqua regia ICPMS	
OA-VOL08mn	NP MEND 1991	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ

To: **MOUNT POLLEY MINING CORPORATION**
ATTN: MCLEAN DONOHOE
PO BOX 12
LIKELY BC V0L 1N0

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

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PO BOX 12
LIKELY BC V0L 1N0

Finalized Date: 22- JUL- 2015
Account: NOU

Project: One Stockpile Project 2015

CERTIFICATE OF ANALYSIS VA15101982

Sample Description	Method Analyte Units LOR	WEI- 21 Recvd Wt. kg 0.02	SCR- 51 WT.+ 2mm g 0.1	SCR- 51 WT.- 2mm g 0.1	OA- VOL08m MPA tCaCO3/1Kt 0.3	OA- VOL08m FIZZ RAT Unity 1	OA- VOL08m NNP tCaCO3/1Kt 1	OA- VOL08m NP tCaCO3/1Kt 1	OA- ELE07 pH Unity 0.1	OA- VOL08m Ratio (N Unity 0.01	S- IR08 S % 0.01	S- GRA06 S % 0.01	S- GRA06a S % 0.01	S- CAL06 S % 0.01	C- GAS05 C % 0.05	C- GAS05 CO2 % 0.2
Cariboo SP- 17 (1)		11.84	5320	278.7	2.5	2	35	37	8.4	14.80	0.08	<0.01	<0.01	0.08	0.27	1.0
Cariboo SP- 14 (1)		10.68	4820	276.0	0.6	1	17	18	8.4	28.80	0.02	0.01	<0.01	0.01	0.05	0.2
Cariboo SP- 14 (2)		11.48	5180	256.1	3.4	2	26	29	8.4	8.44	0.11	<0.01	<0.01	0.11	0.13	0.5
Cariboo SP- 13 (1)		10.54	4720	167.8	3.8	2	32	36	8.3	9.60	0.12	<0.01	<0.01	0.12	0.26	1.0
Cariboo SP- 15 (1)		12.18	4800	288.8	3.8	2	44	48	8.4	12.80	0.12	<0.01	<0.01	0.12	0.43	1.6
Cariboo SP- 16 (1)		11.02	4960	186.1	9.7	2	91	101	8.1	10.43	0.31	<0.01	0.02	0.31	1.12	4.1
Cariboo SP- 18 (1)		10.22	4660	171.7	5.6	2	41	47	8.6	8.36	0.18	<0.01	0.01	0.18	0.37	1.3
#1 SP- 21 (1)		10.22	4860	247.1	5.3	2	44	49	8.7	9.22	0.17	<0.01	0.01	0.17	0.44	1.6
#1 SP- 21 (2)		11.44	5400	191.1	5.6	2	44	50	8.6	8.89	0.18	<0.01	0.01	0.18	0.44	1.6
#1 SP- 20 (1)		9.60	4420	167.1	11.3	2	47	58	8.2	5.16	0.36	<0.01	0.01	0.36	0.57	2.1
#1 SP- 22 (1)		10.68	4620	261.9	7.5	2	57	64	8.4	8.53	0.24	<0.01	0.01	0.24	0.63	2.3
#1 SP- 23 (1)		9.34	4080	166.2	10.0	2	56	66	8.3	6.60	0.32	<0.01	<0.01	0.32	0.61	2.2
#1 SP- 24 (1)		10.14	4560	299.8	10.0	2	41	51	8.2	5.10	0.32	<0.01	<0.01	0.32	0.49	1.8
#1 SP- 19 (1)		9.98	4780	205.7	5.6	2	41	47	8.4	8.36	0.18	<0.01	0.02	0.18	0.41	1.5
High Oxide SP- 9 (1)		10.38	4500	435.9	1.6	2	24	26	8.3	16.64	0.05	<0.01	0.01	0.05	0.15	0.6
High Oxide SP- 8 (1)		10.82	5020	275.8	0.6	2	23	24	8.5	36.40	0.02	<0.01	0.01	0.02	0.15	0.5
High Oxide SP- 7 (1)		8.38	3400	450.6	0.3	1	34	34	8.5	108.80	0.01	0.01	<0.01	<0.01	<0.05	<0.2
High Oxide SP- 7 (2)		10.48	4520	429.9	0.6	1	24	25	8.5	40.00	0.02	<0.01	0.02	0.02	<0.05	<0.2
High Oxide SP- 5 (1)		11.06	4900	233.8	1.6	2	28	30	8.4	19.20	0.05	<0.01	0.02	0.05	0.24	0.9
High Oxide SP- 6 (1)		10.40	4620	212.0	1.3	2	32	33	8.3	26.40	0.04	<0.01	0.01	0.04	0.29	1.1
High Oxide SP- 12 (1)		10.72	4840	211.7	2.8	2	28	31	8.4	11.02	0.09	<0.01	0.01	0.09	0.23	0.8
High Oxide SP- 11 (1)		8.94	4220	139.6	0.6	2	21	22	8.4	35.20	0.02	<0.01	0.01	0.02	0.12	0.4
High Oxide SP- 10 (1)		10.20	4700	133.6	0.6	2	43	44	8.5	70.40	0.02	<0.01	<0.01	0.02	0.36	1.3
High Oxide SP- 4 (1)		9.44	4280	128.0	0.6	2	23	24	8.3	38.40	0.02	<0.01	0.01	0.02	0.16	0.6
High Oxide SP- 3 (1)		7.28	3380	135.5	4.1	2	39	43	8.2	10.58	0.13	<0.01	<0.01	0.13	0.39	1.4
High Oxide SP- 1 (1)		10.86	5000	241.9	1.3	2	75	76	8.4	60.80	0.04	<0.01	0.01	0.04	0.78	2.9
High Oxide SP- 2 (1)		10.72	4740	210.9	1.3	2	35	36	8.4	28.80	0.04	<0.01	0.04	0.04	0.28	1.0
#3 SP- 26 (1)		9.12	3880	319.7	6.3	2	33	39	8.3	6.24	0.20	<0.01	0.02	0.20	0.34	1.2
#3 SP- 25 (1)		10.70	4600	484.8	3.1	2	41	44	8.5	14.08	0.10	<0.01	0.02	0.10	0.38	1.4
#3 SP- 29 (1)		10.12	4480	223.2	7.2	2	41	48	8.3	6.68	0.23	<0.01	0.01	0.23	0.44	1.6
#3 SP- 28 (1)		10.70	4840	252.1	5.0	2	37	42	8.3	8.40	0.16	<0.01	0.01	0.16	0.34	1.2
#3 SP- 27 (1)		10.12	4400	184.5	19.4	2	23	42	8.3	2.17	0.62	<0.01	0.02	0.62	0.36	1.3
#3 SP- 30 (1)		9.98	4440	351.2	8.4	2	31	39	8.4	4.62	0.27	<0.01	0.02	0.27	0.26	1.0

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Project: One Stockpile Project 2015

CERTIFICATE OF ANALYSIS VA15101982

Sample Description	Method Analyte Units LOR	OA- ELE04 Conducti uS/cm 1	ME- MS41 Ag ppm 0.01	ME- MS41 Al % 0.01	ME- MS41 As ppm 0.1	ME- MS41 Au ppm 0.2	ME- MS41 B ppm 10	ME- MS41 Ba ppm 10	ME- MS41 Be ppm 0.05	ME- MS41 Bi ppm 0.01	ME- MS41 Ca % 0.01	ME- MS41 Cd ppm 0.01	ME- MS41 Ce ppm 0.02	ME- MS41 Co ppm 0.1	ME- MS41 Cr ppm 1	ME- MS41 Cs ppm 0.05
Cariboo SP- 17 (1)		144	0.86	2.30	22.2	2.9	<10	220	0.80	0.06	2.69	0.14	18.25	21.7	13	0.88
Cariboo SP- 14 (1)		94	0.36	1.82	16.3	0.5	<10	300	1.12	0.07	1.47	0.29	17.45	22.2	16	1.27
Cariboo SP- 14 (2)		133	0.29	3.28	19.4	<0.2	<10	280	1.14	0.10	2.54	0.12	13.75	18.1	8	2.78
Cariboo SP- 13 (1)		156	0.47	2.27	20.3	0.2	<10	320	0.98	0.14	2.67	0.25	19.80	21.9	14	1.23
Cariboo SP- 15 (1)		149	0.54	2.08	24.5	0.3	<10	260	0.90	0.11	3.03	0.28	21.8	19.0	12	0.84
Cariboo SP- 16 (1)		276	0.33	2.13	16.3	0.2	<10	240	0.91	0.09	4.77	0.14	20.0	20.9	14	0.98
Cariboo SP- 18 (1)		150	0.30	1.89	21.4	0.3	10	350	1.25	0.06	2.56	0.19	25.4	20.7	9	0.83
#1 SP- 21 (1)		130	0.53	2.67	10.8	0.2	<10	360	0.65	0.06	4.05	0.15	14.20	22.2	7	1.24
#1 SP- 21 (2)		130	0.52	2.77	11.3	0.2	<10	360	0.70	0.07	4.10	0.15	16.10	23.2	9	1.33
#1 SP- 20 (1)		215	1.36	2.38	20.5	0.3	<10	250	0.98	0.16	3.59	0.29	19.95	26.2	15	1.40
#1 SP- 22 (1)		150	0.80	2.40	16.2	0.4	<10	340	0.99	0.09	4.50	0.29	19.70	20.6	12	1.97
#1 SP- 23 (1)		203	0.90	2.20	14.6	0.4	<10	270	0.98	0.18	3.38	0.45	23.0	23.1	24	1.21
#1 SP- 24 (1)		273	0.45	2.07	16.2	0.2	<10	300	0.90	0.14	3.46	0.09	20.5	22.8	15	0.89
#1 SP- 19 (1)		132	0.92	2.24	13.2	0.8	<10	380	0.83	0.14	3.04	0.21	18.00	24.3	22	1.22
High Oxide SP- 9 (1)		102	0.72	2.66	19.0	0.9	<10	680	1.12	0.11	1.93	0.20	20.5	34.9	28	2.63
High Oxide SP- 8 (1)		93	0.41	2.54	14.0	0.2	<10	460	0.85	0.08	2.62	0.16	16.35	25.4	11	1.78
High Oxide SP- 7 (1)		80	0.06	3.01	1.5	<0.2	<10	3320	2.11	0.03	2.02	0.12	167.5	32.8	62	1.30
High Oxide SP- 7 (2)		77	0.17	2.69	5.6	0.2	<10	2130	1.92	0.05	1.81	0.20	112.0	29.3	39	2.44
High Oxide SP- 5 (1)		95	0.96	2.42	22.5	0.3	<10	230	1.17	0.14	2.72	0.22	20.7	24.2	6	2.32
High Oxide SP- 6 (1)		105	0.87	2.67	18.6	<0.2	<10	120	1.08	0.15	3.02	0.44	23.0	24.6	5	2.48
High Oxide SP- 12 (1)		115	0.56	2.15	17.2	<0.2	<10	390	0.79	0.10	2.65	0.35	20.0	20.3	23	2.22
High Oxide SP- 11 (1)		89	0.72	2.06	15.2	0.4	<10	520	0.87	0.10	2.76	0.30	18.10	23.7	14	2.14
High Oxide SP- 10 (1)		103	0.29	2.71	13.8	<0.2	<10	560	0.92	0.07	2.91	0.30	19.05	26.6	48	1.59
High Oxide SP- 4 (1)		96	0.46	2.31	13.4	0.3	<10	590	0.94	0.11	1.97	0.23	19.95	24.7	17	1.80
High Oxide SP- 3 (1)		128	0.78	2.97	18.3	<0.2	<10	240	1.38	0.09	3.38	0.39	22.5	26.5	8	2.39
High Oxide SP- 1 (1)		100	0.35	2.46	14.4	<0.2	<10	520	0.84	0.06	4.45	0.54	17.95	20.0	30	1.94
High Oxide SP- 2 (1)		114	0.51	2.63	17.2	<0.2	<10	360	0.91	0.09	2.83	0.43	23.4	24.2	11	3.30
#3 SP- 26 (1)		135	0.53	2.56	15.5	0.2	<10	530	0.95	0.07	2.79	0.20	21.5	28.9	8	2.58
#3 SP- 25 (1)		108	0.55	2.35	14.7	<0.2	<10	540	1.02	0.09	2.61	0.22	24.1	28.3	26	2.09
#3 SP- 29 (1)		138	0.58	2.80	15.4	0.2	<10	370	0.88	0.06	3.55	0.18	17.60	27.7	12	3.32
#3 SP- 28 (1)		125	0.84	2.55	19.1	0.3	<10	240	1.07	0.09	3.27	0.42	20.9	29.5	7	1.87
#3 SP- 27 (1)		169	0.99	2.51	20.3	0.2	<10	240	1.02	0.14	2.92	0.41	21.1	28.2	14	2.03
#3 SP- 30 (1)		115	0.63	2.23	13.9	0.2	<10	700	0.89	0.11	2.59	0.30	21.3	23.9	10	1.66

***** See Appendix Page for comments regarding this certificate *****

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To: **MOUNT POLLEY MINING CORPORATION**
PO BOX 12
LIKELY BC V0L 1N0

Finalized Date: 22- JUL- 2015
Account: NOU

Project: One Stockpile Project 2015

CERTIFICATE OF ANALYSIS VA15101982

Sample Description	Method Analyte Units LOR	ME- MS41 Cu ppm 0.2	ME- MS41 Fe % 0.01	ME- MS41 Ga ppm 0.05	ME- MS41 Ge ppm 0.05	ME- MS41 Hf ppm 0.02	ME- MS41 Hg ppm 0.01	ME- MS41 In ppm 0.005	ME- MS41 K % 0.01	ME- MS41 La ppm 0.2	ME- MS41 Li ppm 0.1	ME- MS41 Mg % 0.01	ME- MS41 Mn ppm 5	ME- MS41 Mo ppm 0.05	ME- MS41 Na % 0.01	ME- MS41 Nb ppm 0.05
Cariboo SP- 17 (1)		1625	5.35	10.05	0.25	0.37	0.14	0.049	0.14	9.9	14.6	1.30	566	3.49	0.11	0.07
Cariboo SP- 14 (1)		4620	4.50	8.66	0.31	0.32	0.09	0.128	0.16	9.0	10.5	0.93	897	2.81	0.14	0.08
Cariboo SP- 14 (2)		2100	3.63	9.51	0.33	0.21	0.07	0.056	0.30	7.5	17.2	1.37	593	6.24	0.49	0.16
Cariboo SP- 13 (1)		3060	4.92	10.00	0.36	0.39	0.10	0.081	0.16	11.1	14.5	1.29	740	5.20	0.10	0.08
Cariboo SP- 15 (1)		2210	4.83	10.10	0.30	0.37	0.14	0.062	0.14	12.3	14.7	1.43	618	7.61	0.06	0.07
Cariboo SP- 16 (1)		1975	4.77	10.35	0.22	0.31	0.14	0.073	0.13	10.5	15.8	1.54	737	29.6	0.04	<0.05
Cariboo SP- 18 (1)		2160	8.52	13.60	0.50	0.40	0.06	0.112	0.21	13.7	13.1	1.55	498	14.50	0.06	0.15
#1 SP- 21 (1)		2750	6.39	11.50	0.43	0.37	0.14	0.165	0.15	8.3	17.6	1.17	588	4.29	0.09	0.07
#1 SP- 21 (2)		2730	6.56	11.85	0.44	0.40	0.12	0.169	0.16	9.5	18.7	1.22	610	4.81	0.09	0.10
#1 SP- 20 (1)		5530	5.77	10.85	0.40	0.37	0.17	0.204	0.12	11.4	15.0	1.23	639	14.60	0.06	0.05
#1 SP- 22 (1)		3070	5.65	10.95	0.45	0.48	0.15	0.159	0.13	11.5	18.9	1.20	1060	11.20	0.07	0.07
#1 SP- 23 (1)		3820	5.21	10.45	0.46	0.39	0.10	0.161	0.18	13.2	17.2	2.04	603	21.6	0.06	0.08
#1 SP- 24 (1)		2700	6.38	11.60	0.53	0.44	0.10	0.216	0.13	11.9	13.2	1.26	458	26.2	0.05	0.07
#1 SP- 19 (1)		4590	6.35	10.80	0.49	0.35	0.11	0.186	0.13	10.3	16.3	1.48	756	7.12	0.06	0.06
High Oxide SP- 9 (1)		6590	6.62	12.45	0.46	0.41	0.13	0.184	0.13	12.0	21.4	1.89	813	3.26	0.06	0.06
High Oxide SP- 8 (1)		3390	6.35	12.45	0.43	0.40	0.07	0.132	0.13	9.7	20.1	1.30	781	2.05	0.05	<0.05
High Oxide SP- 7 (1)		134.0	4.86	11.35	0.31	0.50	0.01	0.016	1.08	92.7	12.6	3.41	737	0.42	0.14	1.73
High Oxide SP- 7 (2)		2260	4.98	10.25	0.35	0.48	0.04	0.071	0.68	60.7	14.0	2.37	834	1.21	0.13	0.32
High Oxide SP- 5 (1)		3900	5.60	12.75	0.57	0.47	0.20	0.160	0.19	11.8	19.7	1.17	669	8.11	0.04	0.06
High Oxide SP- 6 (1)		4000	5.57	12.05	0.52	0.40	0.16	0.191	0.21	13.1	20.9	1.26	683	7.53	0.04	0.05
High Oxide SP- 12 (1)		2260	5.17	10.15	0.31	0.41	0.12	0.102	0.17	11.2	21.6	1.17	919	5.20	0.10	0.12
High Oxide SP- 11 (1)		3530	5.99	11.20	0.53	0.40	0.14	0.242	0.14	10.4	21.5	1.08	957	19.80	0.08	0.08
High Oxide SP- 10 (1)		2570	5.40	10.60	0.31	0.40	0.09	0.100	0.14	10.5	20.6	2.00	850	3.41	0.06	<0.05
High Oxide SP- 4 (1)		3940	5.61	10.85	0.37	0.29	0.08	0.163	0.13	11.5	17.2	1.19	769	2.74	0.05	0.10
High Oxide SP- 3 (1)		3770	6.32	12.30	0.45	0.35	0.12	0.151	0.16	12.8	19.6	1.33	691	10.85	0.05	0.05
High Oxide SP- 1 (1)		1245	4.63	10.50	0.25	0.35	0.12	0.084	0.11	9.9	19.1	1.46	1240	2.47	0.10	0.06
High Oxide SP- 2 (1)		2630	5.53	11.30	0.36	0.40	0.14	0.122	0.25	13.1	25.7	1.23	894	8.10	0.10	0.08
#3 SP- 26 (1)		3560	6.68	12.25	0.49	0.41	0.13	0.181	0.14	13.5	21.3	1.31	695	10.15	0.08	0.05
#3 SP- 25 (1)		3100	6.62	11.60	0.35	0.39	0.10	0.183	0.13	14.2	20.5	1.64	855	6.33	0.08	0.06
#3 SP- 29 (1)		2550	5.94	12.50	0.41	0.44	0.20	0.202	0.13	10.9	19.3	1.29	681	9.71	0.14	0.05
#3 SP- 28 (1)		4060	7.25	12.15	0.51	0.37	0.15	0.176	0.12	12.3	22.1	1.23	715	11.90	0.05	0.05
#3 SP- 27 (1)		3790	6.27	12.00	0.53	0.43	0.14	0.148	0.17	12.2	24.5	1.51	704	22.2	0.07	0.07
#3 SP- 30 (1)		2430	5.46	11.15	0.38	0.42	0.14	0.151	0.14	12.3	19.5	1.22	841	9.40	0.07	0.06

***** See Appendix Page for comments regarding this certificate *****

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To: MOUNT POLLEY MINING CORPORATION
PO BOX 12
LIKELY BC V0L 1N0

Project: One Stockpile Project 2015

CERTIFICATE OF ANALYSIS VA15101982

Sample Description	Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41
	Analyte	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti
	Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
	LOR	0.2	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005
Cariboo SP- 17 (1)		12.8	1910	4.3	6.7	0.012	0.10	0.73	7.1	3.0	0.9	386	<0.01	0.05	1.0	0.153
Cariboo SP- 14 (1)		9.5	1950	7.4	7.3	0.004	0.03	0.31	6.6	1.9	1.2	202	<0.01	0.03	1.1	0.124
Cariboo SP- 14 (2)		6.1	1560	2.9	18.9	0.018	0.15	0.39	4.8	2.2	0.9	414	<0.01	0.04	1.1	0.126
Cariboo SP- 13 (1)		12.8	1790	6.5	8.0	0.013	0.15	0.61	7.1	3.4	1.1	295	<0.01	0.05	1.1	0.155
Cariboo SP- 15 (1)		12.1	1510	4.6	6.4	0.019	0.16	0.82	8.1	3.7	0.9	257	<0.01	0.04	1.0	0.150
Cariboo SP- 16 (1)		9.8	1420	4.9	6.3	0.104	0.35	0.70	9.7	3.7	0.9	154.0	<0.01	0.04	1.0	0.130
Cariboo SP- 18 (1)		15.8	1900	4.7	10.3	0.072	0.20	0.55	8.8	3.3	1.2	161.0	<0.01	0.05	1.3	0.201
#1 SP- 21 (1)		7.4	1170	4.3	9.0	0.013	0.19	0.47	8.0	3.6	1.6	175.0	<0.01	0.21	0.7	0.198
#1 SP- 21 (2)		8.5	1190	4.4	9.5	0.014	0.19	0.49	8.6	3.8	1.7	189.5	<0.01	0.19	0.8	0.205
#1 SP- 20 (1)		17.1	1240	7.1	5.2	0.044	0.41	0.39	6.4	8.1	2.4	166.5	<0.01	0.38	1.1	0.126
#1 SP- 22 (1)		9.4	1270	9.4	6.4	0.030	0.30	0.46	6.4	7.1	2.0	297	<0.01	0.30	1.1	0.147
#1 SP- 23 (1)		78.4	1420	10.5	10.4	0.090	0.38	0.55	6.6	6.4	1.9	282	<0.01	0.21	1.3	0.175
#1 SP- 24 (1)		12.3	1230	4.8	6.6	0.089	0.38	0.48	6.9	5.1	2.2	159.5	<0.01	0.26	1.1	0.161
#1 SP- 19 (1)		24.0	1330	5.7	6.7	0.021	0.20	0.38	8.1	4.6	2.0	144.0	<0.01	0.12	0.9	0.160
High Oxide SP- 9 (1)		46.7	1410	5.3	7.8	0.004	0.06	0.45	9.5	3.8	2.1	158.0	<0.01	0.10	0.9	0.184
High Oxide SP- 8 (1)		11.8	1470	4.8	7.6	0.002	0.04	0.44	8.3	1.5	1.7	177.5	<0.01	0.09	0.7	0.141
High Oxide SP- 7 (1)		190.5	5320	17.4	41.4	0.001	0.03	0.08	4.8	0.7	0.7	432	0.01	0.01	1.7	0.613
High Oxide SP- 7 (2)		112.0	4100	13.6	28.6	0.001	0.02	0.16	7.4	0.8	0.8	420	<0.01	0.03	1.8	0.400
High Oxide SP- 5 (1)		5.9	1440	8.2	10.1	0.004	0.07	0.51	8.0	3.7	2.3	209	<0.01	0.64	1.2	0.152
High Oxide SP- 6 (1)		5.0	1400	11.9	13.1	0.004	0.06	0.35	8.6	3.7	2.4	126.5	<0.01	0.32	1.2	0.160
High Oxide SP- 12 (1)		21.8	1470	11.1	8.5	0.009	0.12	0.52	7.6	1.7	1.3	176.5	<0.01	0.07	1.2	0.159
High Oxide SP- 11 (1)		10.4	1650	6.5	7.1	0.014	0.04	0.40	8.3	1.6	2.6	184.5	<0.01	0.08	0.8	0.146
High Oxide SP- 10 (1)		61.3	1440	6.9	6.9	0.003	0.04	0.39	8.2	1.4	1.3	163.5	<0.01	0.09	1.1	0.170
High Oxide SP- 4 (1)		10.5	1240	6.2	6.6	0.003	0.03	0.35	7.5	1.7	1.6	161.5	<0.01	0.11	1.0	0.140
High Oxide SP- 3 (1)		9.6	1590	9.9	9.4	0.023	0.16	0.41	8.3	3.6	2.2	193.0	<0.01	0.18	1.2	0.139
High Oxide SP- 1 (1)		27.9	1320	6.9	5.6	0.005	0.05	0.46	8.0	1.2	1.0	187.0	<0.01	0.05	1.0	0.120
High Oxide SP- 2 (1)		10.3	1520	9.3	14.9	0.011	0.07	0.44	8.5	2.2	1.7	275	<0.01	0.14	1.2	0.157
#3 SP- 26 (1)		7.3	1300	7.5	8.1	0.032	0.24	0.41	7.7	3.7	2.0	282	<0.01	0.17	1.0	0.150
#3 SP- 25 (1)		25.8	1310	8.1	7.4	0.015	0.15	0.35	8.2	2.7	1.9	157.0	<0.01	0.08	1.2	0.148
#3 SP- 29 (1)		14.8	1180	5.4	7.2	0.026	0.31	0.39	8.3	4.1	2.3	266	<0.01	0.18	0.8	0.151
#3 SP- 28 (1)		9.0	1710	14.1	6.3	0.034	0.19	0.55	7.6	5.4	2.0	248	<0.01	0.17	1.3	0.148
#3 SP- 27 (1)		28.1	1490	19.0	10.9	0.075	0.67	0.56	8.1	6.9	2.1	319	<0.01	0.24	1.3	0.173
#3 SP- 30 (1)		9.4	1190	14.9	8.2	0.019	0.30	0.37	7.2	3.5	1.6	202	<0.01	0.11	1.0	0.155

***** See Appendix Page for comments regarding this certificate *****

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To: **MOUNT POLLEY MINING CORPORATION**
PO BOX 12
LIKELY BC V0L 1N0

Finalized Date: 22-JUL-2015
Account: NOU

Project: One Stockpile Project 2015

CERTIFICATE OF ANALYSIS VA15101982

Sample Description	Method Analyte Units LOR	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	OA-GRA10b H2O % 0.01
Cariboo SP-17 (1)		0.02	0.63	191	1.02	12.70	45	11.5	3.01
Cariboo SP-14 (1)		0.02	0.75	157	0.74	15.05	48	9.5	2.97
Cariboo SP-14 (2)		0.04	0.49	128	0.60	10.65	44	6.8	3.02
Cariboo SP-13 (1)		0.03	0.96	171	0.82	13.35	60	11.7	2.73
Cariboo SP-15 (1)		0.03	1.17	176	0.75	13.20	80	11.8	2.37
Cariboo SP-16 (1)		0.02	0.55	179	0.53	16.40	45	8.5	1.76
Cariboo SP-18 (1)		0.03	0.82	451	0.89	14.55	46	11.3	1.30
#1 SP-21 (1)		0.02	0.82	190	0.58	11.55	43	11.2	1.52
#1 SP-21 (2)		0.02	0.87	195	0.59	12.35	43	13.0	1.84
#1 SP-20 (1)		0.02	1.41	172	0.87	14.35	51	12.1	2.35
#1 SP-22 (1)		0.02	1.49	170	1.38	15.15	66	15.1	2.26
#1 SP-23 (1)		0.04	1.37	178	0.75	14.90	75	12.9	1.53
#1 SP-24 (1)		0.02	1.19	206	0.74	13.50	31	13.7	2.25
#1 SP-19 (1)		0.02	1.02	204	0.82	14.30	58	10.1	2.35
High Oxide SP-9 (1)		0.02	1.32	200	0.80	15.55	60	13.6	4.99
High Oxide SP-8 (1)		<0.02	0.91	191	0.71	12.20	51	12.7	2.80
High Oxide SP-7 (1)		0.19	0.18	119	0.23	12.65	72	20.7	6.81
High Oxide SP-7 (2)		0.14	0.41	155	0.37	13.40	66	20.6	4.12
High Oxide SP-5 (1)		0.02	1.22	188	1.00	14.30	47	16.3	3.66
High Oxide SP-6 (1)		0.04	1.34	187	0.80	14.55	67	14.0	4.32
High Oxide SP-12 (1)		0.03	0.97	176	1.01	13.90	80	13.8	4.93
High Oxide SP-11 (1)		0.02	1.12	227	1.16	14.55	69	14.9	3.04
High Oxide SP-10 (1)		0.02	0.91	180	0.71	14.80	66	13.6	3.11
High Oxide SP-4 (1)		0.02	1.18	173	0.79	14.40	52	10.4	3.35
High Oxide SP-3 (1)		0.02	1.27	227	0.64	14.75	64	13.1	2.19
High Oxide SP-1 (1)		0.02	0.76	155	0.81	13.35	122	11.5	1.97
High Oxide SP-2 (1)		0.03	1.03	187	1.01	16.60	89	13.8	2.62
#3 SP-26 (1)		0.02	1.46	182	0.78	15.65	50	14.3	3.68
#3 SP-25 (1)		0.02	1.30	213	0.97	17.65	67	13.2	2.75
#3 SP-29 (1)		0.02	1.35	166	0.82	13.55	52	15.6	3.78
#3 SP-28 (1)		0.03	1.42	227	1.01	15.70	73	12.6	3.04
#3 SP-27 (1)		0.04	1.62	199	0.98	15.80	74	14.0	2.65
#3 SP-30 (1)		0.03	1.13	176	1.02	16.85	63	13.0	2.55

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.
2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **MOUNT POLLEY MINING CORPORATION**
PO BOX 12
LIKELY BC V0L 1N0

Finalized Date: 22- JUL- 2015
Account: NOU

Project: One Stockpile Project 2015

CERTIFICATE OF ANALYSIS VA15101982

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Applies to Method: Gold determinations by this method are semi- quantitative due to the small sample weight used (0.5g).
ME- MS41

LABORATORY ADDRESSES

Applies to Method: Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

C- GAS05	LOG- 22	ME- MS41	OA- ELE04
OA- ELE07	OA- GRA10b	OA- VOL08mn	PUL- 31
PUL- QC	S- CAL06	SCR- 51	S- GRA06
S- GRA06a	S- IR08	SPL- 21	WEI- 21

MOUNT POLLEY MINING CORP.
ATTN: McLean Donohue
PO Box 12
Likely BC V0L 1N0

Date Received: 14-SEP-15
Report Date: 23-SEP-15 15:25 (MT)
Version: FINAL

Client Phone: 250-790-2215

Certificate of Analysis

Lab Work Order #: L1672948

Project P.O. #: NOT SUBMITTED
Job Reference: ONE STOCKPILE PROJECT 2015
C of C Numbers:
Legal Site Desc:

Can Dang
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1672948-1 Soil CARIBOO SP-15 (1)	L1672948-2 Soil CARIBOO SP-16 (1)	L1672948-3 Soil #1 SP-20(1)	L1672948-4 Soil #1 SP-24(1)	L1672948-5 Soil HIGH OXIDE SP-12 (1)
Sample ID		L1672948-1	L1672948-2	L1672948-3	L1672948-4	L1672948-5
Description		Soil	Soil	Soil	Soil	Soil
Sampled Date						
Sampled Time						
Client ID		CARIBOO SP-15 (1)	CARIBOO SP-16 (1)	#1 SP-20(1)	#1 SP-24(1)	HIGH OXIDE SP-12 (1)
SOIL						
Physical Tests	Moisture (%)	0.51	0.60	0.77	0.39	0.65
Leachable Anions & Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	26.9	28.8	27.2	23.2	31.4
	Chloride (Cl) (mg/L)	<0.50	<0.50	<0.50	<0.50	0.87
	Conductivity (uS/cm)	80.5	110	91.0	112	99.9
	Nitrate (as N) (mg/L)	0.0973	1.40	0.0401	0.837	0.0297
	pH (pH)	8.95	8.94	8.87	8.91	8.69
	Sulfate (SO4) (mg/L)	12.1	17.9	16.7	26.1	15.4
Leachable Metals	Aluminum (Al)-Leachable (mg/L)	0.143	0.178	0.0920	0.167	0.165
	Antimony (Sb)-Leachable (mg/L)	0.00062	0.00085	0.00019	0.00045	0.00037
	Arsenic (As)-Leachable (mg/L)	0.0070	0.0065	0.0034	0.0028	0.0030
	Barium (Ba)-Leachable (mg/L)	0.0110	0.0160	0.0113	0.0207	0.0424
	Beryllium (Be)-Leachable (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Bismuth (Bi)-Leachable (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Boron (B)-Leachable (mg/L)	0.012	0.018	0.011	0.011	0.014
	Cadmium (Cd)-Leachable (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Calcium (Ca)-Leachable (mg/L)	8.24	11.1	9.72	10.5	12.8
	Chromium (Cr)-Leachable (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Cobalt (Co)-Leachable (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Leachable (mg/L)	0.0013	<0.0010	0.0026	<0.0010	0.0089
	Iron (Fe)-Leachable (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Leachable (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Lithium (Li)-Leachable (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Magnesium (Mg)-Leachable (mg/L)	1.01	1.80	1.60	1.85	1.14
	Manganese (Mn)-Leachable (mg/L)	0.00099	0.00104	0.00071	0.00078	0.00549
	Mercury (Hg)-Leachable (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Molybdenum (Mo)-Leachable (mg/L)	0.0225	0.0402	0.0171	0.0451	0.0222
	Nickel (Ni)-Leachable (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Phosphorus (P)-Leachable (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Leachable (mg/L)	1.97	2.96	1.24	1.85	1.94
	Selenium (Se)-Leachable (mg/L)	0.0206	0.00699	0.0161	0.0161	0.00243
	Silicon (Si)-Leachable (mg/L)	4.35	3.95	5.74	4.07	4.68
	Silver (Ag)-Leachable (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Sodium (Na)-Leachable (mg/L)	4.05	4.70	4.76	4.76	4.05
	Strontium (Sr)-Leachable (mg/L)	0.0475	0.170	0.0768	0.0636	0.138
	Thallium (Tl)-Leachable (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Tin (Sn)-Leachable (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1672948-6	L1672948-7	L1672948-8		
	Description	Soil	Soil	Soil		
	Sampled Date					
	Sampled Time					
	Client ID	HIGH OXIDE SP-3 (1)	#3 SP-29 (1)	#3 SP-27 (1)		
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	0.77	0.86	0.70		
Leachable Anions & Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	29.4	28.9	29.3		
	Chloride (Cl) (mg/L)	0.95	0.53	0.71		
	Conductivity (uS/cm)	83.8	88.7	141		
	Nitrate (as N) (mg/L)	0.0897	0.0334	0.0607		
	pH (pH)	9.04	8.95	8.76		
	Sulfate (SO4) (mg/L)	10.3	13.3	35.0		
Leachable Metals	Aluminum (Al)-Leachable (mg/L)	0.201	0.158	0.0976		
	Antimony (Sb)-Leachable (mg/L)	0.00014	0.00025	0.00046		
	Arsenic (As)-Leachable (mg/L)	0.0028	0.0030	0.0017		
	Barium (Ba)-Leachable (mg/L)	0.0121	0.0108	0.0344		
	Beryllium (Be)-Leachable (mg/L)	<0.00050	<0.00050	<0.00050		
	Bismuth (Bi)-Leachable (mg/L)	<0.00050	<0.00050	<0.00050		
	Boron (B)-Leachable (mg/L)	0.014	0.012	0.029		
	Cadmium (Cd)-Leachable (mg/L)	<0.000050	<0.000050	<0.000050		
	Calcium (Ca)-Leachable (mg/L)	9.34	9.61	16.7		
	Chromium (Cr)-Leachable (mg/L)	<0.00050	<0.00050	<0.00050		
	Cobalt (Co)-Leachable (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Leachable (mg/L)	0.0080	0.0028	0.0040		
	Iron (Fe)-Leachable (mg/L)	<0.030	<0.030	<0.030		
	Lead (Pb)-Leachable (mg/L)	<0.00010	<0.00010	<0.00010		
	Lithium (Li)-Leachable (mg/L)	<0.0050	<0.0050	<0.0050		
	Magnesium (Mg)-Leachable (mg/L)	0.669	0.782	1.75		
	Manganese (Mn)-Leachable (mg/L)	0.00105	0.00112	0.00361		
	Mercury (Hg)-Leachable (mg/L)	<0.000050	<0.000050	<0.000050		
	Molybdenum (Mo)-Leachable (mg/L)	0.0167	0.0232	0.0434		
	Nickel (Ni)-Leachable (mg/L)	<0.00050	<0.00050	<0.00050		
	Phosphorus (P)-Leachable (mg/L)	<0.30	<0.30	<0.30		
	Potassium (K)-Leachable (mg/L)	2.21	0.803	1.94		
	Selenium (Se)-Leachable (mg/L)	0.0182	0.0164	0.0203		
	Silicon (Si)-Leachable (mg/L)	5.35	5.21	4.48		
	Silver (Ag)-Leachable (mg/L)	<0.000050	<0.000050	<0.000050		
	Sodium (Na)-Leachable (mg/L)	5.15	5.76	6.17		
	Strontium (Sr)-Leachable (mg/L)	0.0376	0.0297	0.225		
	Thallium (Tl)-Leachable (mg/L)	<0.00010	<0.00010	<0.00010		
	Tin (Sn)-Leachable (mg/L)	<0.00050	<0.00050	<0.00050		
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010	<0.010		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1672948-1 Soil CARIBOO SP-15 (1)	L1672948-2 Soil CARIBOO SP-16 (1)	L1672948-3 Soil #1 SP-20(1)	L1672948-4 Soil #1 SP-24(1)	L1672948-5 Soil HIGH OXIDE SP-12 (1)
Sample ID		L1672948-1	L1672948-2	L1672948-3	L1672948-4	L1672948-5
Description		Soil	Soil	Soil	Soil	Soil
Sampled Date						
Sampled Time						
Client ID		CARIBOO SP-15 (1)	CARIBOO SP-16 (1)	#1 SP-20(1)	#1 SP-24(1)	HIGH OXIDE SP-12 (1)
SOIL						
Leachable Metals	Uranium (U)-Leachable (mg/L)	0.000053	0.000027	0.000083	0.000102	0.000117
	Vanadium (V)-Leachable (mg/L)	0.0154	0.0190	0.0095	0.0103	0.0060
	Zinc (Zn)-Leachable (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1672948-6	L1672948-7	L1672948-8		
	Description	Soil	Soil	Soil		
	Sampled Date					
	Sampled Time					
	Client ID	HIGH OXIDE SP-3 (1)	#3 SP-29 (1)	#3 SP-27 (1)		
Grouping	**Analyte**					
SOIL						
Leachable Metals	Uranium (U)-Leachable (mg/L)	0.000052	0.000072	0.000076		
	Vanadium (V)-Leachable (mg/L)	0.0052	0.0116	0.0036		
	Zinc (Zn)-Leachable (mg/L)	<0.010	<0.010	<0.010		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L1672948-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Magnesium (Mg)-Leachable	MS-B	L1672948-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Silicon (Si)-Leachable	MS-B	L1672948-1, -2, -3, -4, -5, -6, -7, -8

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-SHKFLSK-PCT-VA	Soil	Alkalinity by PCT (SHAKEFLASK)	BC MINISTRY OF ENERGY AND MINES

TThis analysis is based upon the extraction procedure outlined in "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND Report 1.20.1)" (William A. Price, 2009). In summary, a sample is extracted with deionized water at a 3:1 liquid to solids ratio for 24 hours. The extract is then allowed to settle and subsequently filtered through a 0.45 micron membrane filter and analysed using procedures adapted from APHA Method 2320 "Alkalinity".

CL-SHKFLSK-IC-VA Soil Chloride by IC (SHAKEFLASK) BC MIN. OF ENERGY AND MINES/APHA 4110 B.

This analysis is based upon the extraction procedure outlined in "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND Report 1.20.1)" (William A. Price, 2009). In summary, a sample is extracted with deionized water at a 3:1 liquid to solids ratio for 24 hours. The extract is then allowed to settle and subsequently filtered through a 0.45 micron membrane filter. The analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Anions routinely determined by this method include: bromide, chloride, fluoride, nitrate, nitrite and sulphate.

EC-SHKFLSK-PCT-VA Soil EC by PCT (SHAKEFLASK) BC MINISTRY OF ENERGY AND MINES

This analysis is based upon the extraction procedure outlined in "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND Report 1.20.1)" (William A. Price, 2009). In summary, a sample is extracted with deionized water at a 3:1 liquid to solids ratio for 24 hours. The extract is then allowed to settle and subsequently filtered through a 0.45 micron membrane filter and analysed using procedures adapted from APHA Method 2510 "Conductivity".

HG-SHKFLSK-CVAFS-VA Soil Mercury by CVAFS (SHAKEFLASK) BC MINISTRY OF ENERGY AND MINES

This analysis is based upon the extraction procedure outlined in "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND Report 1.20.1)" (William A. Price, 2009). In summary, a sample is extracted with deionized water at a 3:1 liquid to solids ratio for 24 hours. The extract is then allowed to settle and subsequently filtered through a 0.45 micron membrane filter and analysed using cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

MET-SHKFLSK-MS-VA Soil Metals by ICPMS (SHAKEFLASK) BC MINISTRY OF ENERGY AND MINES

This analysis is based upon the extraction procedure outlined in "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND Report 1.20.1)" (William A. Price, 2009). In summary, a sample is extracted with deionized water at a 3:1 liquid to solids ratio for 24 hours. The extract is then allowed to settle and subsequently filtered through a 0.45 micron membrane filter and analysed using inductively coupled plasma - mass spectrophotometry (EPA Method 6020A).

MOISTURE-VA Soil Moisture content ASTM D2974-00 Method A

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

NO3-SHKFLSK-IC-VA Soil Nitrate by IC (SHAKEFLASK) BC MIN. OF ENERGY AND MINES/APHA 4110 B.

This analysis is based upon the extraction procedure outlined in "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND Report 1.20.1)" (William A. Price, 2009). In summary, a sample is extracted with deionized water at a 3:1 liquid to solids ratio for 24 hours. The extract is then allowed to settle and subsequently filtered through a 0.45 micron membrane filter. The analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Anions routinely determined by this method include: bromide, chloride, fluoride, nitrate, nitrite and sulphate.

PH-SHKFLSK-MAN-VA Soil pH by Manual Meter (SHAKEFLASK) BC MINISTRY OF ENERGY AND MINES

This analysis is based upon the extraction procedure outlined in "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND Report 1.20.1)" (William A. Price, 2009). In summary, a sample is extracted with deionized water at a 3:1 liquid to solids ratio for 24 hours. The extract is then allowed to settle and subsequently analysed using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-SHKFLSK-IC-VA Soil Sulfate by IC (SHAKEFLASK) BC MIN. OF ENERGY AND MINES/APHA 4110 B.

This analysis is based upon the extraction procedure outlined in "Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND Report 1.20.1)" (William A. Price, 2009). In summary, a sample is extracted with deionized water at a 3:1 liquid to solids ratio for 24 hours. The extract is then allowed to settle and subsequently filtered through a 0.45 micron membrane filter. The analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Reference Information

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L1672948-COFC

Analysis Request Form

Date:	9/3/2015
Workorder Number:	VA15101982
Analyzing Laboratory:	ALSE - ALS Environmental
Client Contact Name:	McLean Donohoe
Client Company Name:	Mount Polley Mining Corporation
Project Name:	One Stockpile Project 2015
Number of Samples & Country of Origin:	8 Samples - Canada
Sample IDs:	Cariboo SP-15 (1); Cariboo SP-16(1); #1 SP-20(1); #1 SP-24(1); High Oxide SP-12(1); High Oxide SP-3(1); #3 SP-29(1); #3 SP-27(1)
Sample Type:	☐ Drill Core ☐ Percussion ☐ Rock ☐ Soil ☐ Pulp ☐ Other
Analysis Required:	Shake Flask Analysis
Special Instructions:	MET-SHKFLSK-MS-VA: pH Alkalinity; Total (as CaCO3); Chloride; Conductivity; Nitrate (as N); pH; Sulfate (SO4). Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Hg, Mo, Ni, P, K, Se, Si, Ag, Na, Sr, Tl, Sn, Ti, U, V, Zn
Sample Disposition:	☐ Return ☒ Dispose after analysis
Results to:	**Please send the results to the client directly** **Attention:** McLean Donohue Address: PO Box 12, Likely, BC, V0L 1N0 Phone: 250-790-2215 Email: mdonohoe@mountpolley.com
Invoice to:	**Please send the results to the client directly at:** **Attention:** McLean Donohue Address: PO Box 12, Likely, BC, V0L 1N0 Phone: 250-790-2215 Email: mdonohoe@mountpolley.com

Shake/Sept. 14/1000/23, 23°C

APPENDIX D:

2014 VEGETATION ASSESSMENT RESULTS

The sections below summarize the results of 2014 walkthrough vegetation assessments completed by MPMC staff member Katie McMahen, P.Ag on the Boundary Dump, Waste Haul Road, and Helipad reclamation areas at the Mount Polley Mine site. This is a supporting document to the MPMC 2015 Reclamation and Closure Plan Update.

BOUNDARY DUMP

Soil salvaged from the expanding of the Temporary PAG Stockpile was direct placed at approximately 28 cm on the 4.70 ha Boundary Dump. Coarse woody debris was contained in this material, and because it was freshly stripped, it was not seeded, as it was anticipated that there would still be viable seed and active microbes in the soil.

A walkthrough assessment of re-vegetation was completed on September 5, 2014. Figure 12.2 shows a picture of growth on the dump taken during the assessment, and observations are outlined in Table 0.1. General observations are that a diverse array of native plants, including early successional trees and shrubs, are ingressing, with greater growth observed on the flat dump top than the eastern aspect slope. This is possibly related to greater soil depths and rougher soil application (i.e. more plant microsites) on the dump top. Recommendations are to continue to monitor natural ingress in 2015 (this area is adjacent to undisturbed forest) and use monitoring results to assess the need for planting of trees and shrubs; trees and shrubs which create an overstory will be important for managing invasive species.

Table 0.1 Observations from Boundary Dump re-vegetation walkthrough assessment

Parameter	Top (flat)	Slope (East Aspect)
Course woody debris	5 – 10%	5% (concentrated at bottom)
Surface roughening	Some mounding	Minimal
Average vegetation height	20 cm	10 cm
Average vigour (0-5)	4	3
Cover (all species)	10 – 20% (<5% invasive species)	5% (<1% invasive species)
Cover (species specific)	~3%: clover (aslike/red), equisetum <3%: ferns, fireweed, grasses, pineapple weed, pearly everlasting, dandelion, *Persicaria maculosa*, lupine, lettuces, annual hawksbeard, hawkweed, Canada thistle	~3%: clover (aslike/red) ~2%: grasses <1%: Canada thistle, hawkweed, annual hawksbeard, fireweed, *Aster conspicuus*
Trees and shrubs	Cottonwood (numerous) Raspberry/thimbleberry (numerous) Wild rose (sparse) Huckleberry/blueberry (sparse)	Cottonwood (sparse) Huckleberry/blueberry (few)



Figure 12.2 Growth on the Boundary Dump reclamation area in its first growing season

EAST RDS

On the East RDS 9.47 ha of the Highway to Heaven were recontoured using the lifts of the dump to create step-like landforms and work towards re-creating the pre-mining drainage pattern. Overburden salvaged from the expanding Cariboo Ore Stockpile and WX Zone stripping was directly applied at approximately 40 cm to the site as rough and loosely as possible to improve microsite diversity for vegetation growth. In fall 2014 the area was seeded at approximately 30 kg/ha with the native seed mix outlined in **Error! Reference source not found.**. This work is shown in Figure 12.3.

Soil salvaged from construction of the TAR Bootjack Creek crossing in 2013 and stockpiled on the East RDS was pushed out in May 2014. Salvaged material from the Cariboo Ore Stockpile and WX Zone was spread on adjacent areas in June 2014. Average soil depth was approximately 25 cm on the 3.78 ha area of the East RDS. An effort was made to apply it roughly to improve microsite diversity for vegetation growth (Figure 12.4). Approximately 1.0 ha on the eastern side of the area was seeded with roughly 0.75 kg of lupine, 2 kg of a june grass, yarrow, pearly everlasting mix, and 35 g of fireweed in spring 2014. The

remaining area was seeded at 30 kg/ha of the native seed mix in **Error! Reference source not found.** in the fall.

A walkthrough re-vegetation assessment of the approximately 1.0 ha East RDS area seeded in spring was completed on September 5, 2014. Observations are presented in Table 0.1. General observations are that a diverse array of native plants, including early successional shrubs, is ingressing. Recommendations are to continue to monitor natural ingress in 2015 and use monitoring results to plan for planting of trees and shrubs in 2016; trees and shrubs which create an overstory will be important for managing invasive species. Selection of trees and shrubs should take into considerations to hot, dry conditions on this south-west facing slope.

Table 0.1 Observations from East RSD re-vegetation walkthrough assessment

Parameter	Observations
Course woody debris	~5%
Surface roughening	Minimal (on this section – good roughness on other areas)
Average vegetation height	15 cm
Average vigour (0-5)	4
Cover (all species)	10 – 20% (<5% invasive species)
Cover (species specific)	~5%: clover (aslike/red) ~3%: equisetum, grasses, fireweed <3%: Canada thistle, perennial sow thistle, pineapple weed, *Aster conspicuus,* annual hawksbeard, pearly everlasting, lettuces
Trees and shrubs	Raspberry/thimbleberry (numerous) Wild rose (sparse) Huckleberry/blueberry (sparse)



Figure 12.3 Reclamation work on the Highway to Heaven



Figure 12.4 Till application on the East RDS

WASTE HAUL ROAD

In May 2014, the 1.53 ha area below the Helipad and above the WHR was hydroseeded by a crew from the WLIB with 26kg/ha of the aggressive seed mix in **Error! Reference source not found.** and 170 kg/ha of 18-19-18 (N-P-K) fertilizer. A walkthrough assessment of this area was conducted on September 5, 2014 and observations are presented in Table 0.1.

A walkthrough assessment was also completed of the 1.8 ha area above the WHR (seeded in 2014) and observations are presented in Table 0.2.

In general on these two areas, growth of diverse native species was observed and recommendations are that monitoring of re-vegetation at these sites continue in 2015 and that tree planting occur in 2015 to promote the succession process. Tree establishment will also work towards creation of a canopy that shades out invasive species.

Table 0.1 Observations from re-vegetation walkthrough assessment of the area below the helipad

Parameter	Slope (West Aspect)	Knoll Top (flat)	Slope (North Aspect)
Course woody debris	~5%, some large boulders	~10%	~15% (including placement of rocks and boulders)
Surface roughening	Minimal	Some mounding and hummocks	Small variations and ridges
Average vegetation height	15-20 cm	20 cm	10 cm
Average vigour (0-5)	3	3	4
Cover (all species)	30-40% (~5% invasive species)	40% (<5% invasive species)	40% (<1% invasive species)
Cover (species specific)	10-20%: native grasses (planted), *Polygonum aviculare* ~5%: clover (aslike/red), fireweed (big patches) <5%: pineapple weed, Canada thistle, oxeye daisy, perennial sow thistle, *Lactuca serriola*	~20%: native grasses (planted) ~15%: clover (aslike/red) <5%: Canada thistle, ferns, *Aster conspicuus*, perennial sow thistle	~35%: clover (aslike/red) ~5%: native grasses(planted) <1%: Canada thistle
Trees and shrubs	Cottonwood (sparse with large patch at very south end) Wild rose (few) Raspberry/thimbleberry (few)	Cottonwood (few) Huckleberry/blueberry (few) Raspberry/thimbleberry (few)	Raspberry (few) Huckleberry/blueberry (few)

Table 0.2 Observations from re-vegetation walkthrough assessment of the reclamation area above the Waste Haul Road

Parameter	Southern Section	Central Section	Northern Section
Course woody debris	~10%	Minimal	5-10%
Surface roughening	Minimal	Minimal	Minimal
Average vegetation height	20 cm	20 cm	30 cm
Average vigour (0-5)	3-4	3	3-4
Cover (all species)	45% (<5% invasive species)	10-20% (<1% invasive species)	50% (<5% invasive species)
Cover (species specific)	20%: clover (aslike/red) 15%: native grasses (planted) 5%: equisetum <5%: lupine (planted) <1%: fireweed (planted), annual hawksbeard	5-15 %: native grasses (planted) 5-10%: clover (red/aslike) <5%: lupine (planted), annual hawksbeard	30%: clover (aslike/red) 5-10%: native grasses (planted), equisetum 3%: Canada thistle <3%: lupine (planted), fireweed (planted)
Trees and shrubs	Huckleberry/blueberry (few) Raspberry/thimbleberry (sparse) Gooseberry (one)		Cottonwood (numerous) Raspberry/thimbleberry (sparse)

APPENDIX E:

2012 TREE PLOTS ASSESSMENT

(MEISTER 2014)

Mount Polley Mining Corporation

Tree Plots Research Report

2012

Ronald Paul Meister, P.Ag., RPF

Forestmeister Services

February 2014

Table of Contents

INTRODUCTION AND METHODS 2
Table 1: Treatments Applied in the 1998 Trial 3
Table 2: Treatments Applied in the 1999 Trial 4
Table 3: Treatments Applied in the 2000 Trial 4
Table 4: Particle Size Distribution Top 50 cm Rock Disposal Site. 7
STATISTICAL ANALYSIS 9
Methods 9
Table 5: Vigour Codes † 9
Results 9
RESULTS AND DISCUSSION 9
1998 – 1999 TRIAL – Soil Depth – Productivity. 9
2000 TRIAL – Soil Depth – Productivity. 11
1998 – 1999 TRIAL – Soil Amelioration – Productivity. 12
2000 TRIAL – Soil Amelioration – Productivity 14
1998 – 1999 – 2000 TRIALS – Revegetation – Productivity. 15
1998 – 1999 TRIAL – Soil Depth – Mortality. 16
2000 TRIAL – Soil Depth – Mortality 18
1998 – 1999 TRIAL – Soil Amelioration – Mortality. 21
2000 TRIAL – Soil Amelioration – Mortality. 21
1998 – 1999 – 2000 TRIALS – Revegetation – Mortality 25
CONCLUSION. 27
Research Trial and Productivity Objectives 27
Soil Depth 28
Soil Amelioration 30
Revegetation. 30
Recommendations: 31
REFERENCES: **32**
APPENDICES **33**
APPENDIX 1 – COMPOSITION SEED MEXTURES. **33**
APPENDIX 2 – ANALYSIS OF BIOSOLIDS. **33**
APPENDIX 3 – AVAILABLE WATER STORAGE CAPACITY **33**
APPENDIX 4 – SUMMARY OF MEANS. **33**
APPENDIX 5 – WEATHER DATA SUMMARY 2006 -2012. ..... **33**
APPENDIX 6 – DATA 2012 ..... **33**
APPENDIX 7 – STATISTIC SIGNIFICANCE SUMMARY 2012. ..... **33**
APPENDIX 8 – MORTALITY TABLE 2012. ..... **33**
APPENDIX 9 – VIGOUR CROSSTABULATION. **33**
APPENDIX 10 – SOIL DEPTH REGRESSION RUNS. **33**
APPENDIX 11 – GENERAL LINEAR MODAL RUNS. **33**
APPENDIX 12 – 2006 TREATMENT PHOTOS **33**

Introduction and Methods

The Mount Polley project is a gold / copper porphyry deposit located in the Fraser Plateau physiographic region adjacent to the Quesnel Highlands in central British Columbia, approximately 56 km northeast of Williams Lake and 8 km southwest of Likely. The site is in the ICHmk3 Biogeoclimatic Subzone (Interior Cedar-Hemlock moist cool subzone Horsefly Variant) and dominated by the 01 site series (false box – knight's plume). The area's mature forests consist of western red cedar, subalpine fir, and hybrid spruce. A minor component of Douglas-fir, paper birch and lodgepole pine occurs. The shrub layer is a sparse to moderate cover of false box and black huckleberry. Common forbs consist of wild sarsaparilla, foamflower, queen's cup, bunchberry, twinflower and five-leaved bramble. The mosses form a nearly continuous carpet of red-stem feathermoss, step moss and knight's plume. The site's dominant terrain is moderately sloping with deep medium textured morainal soils. The climate is cool and moist with a total annual precipitation estimated to be 856 mm ± 110 mm SD with 30 to 35% of the precipitation as snowfall and 40% of the precipitation falling during the summer months. Mean monthly temperatures for Mount Polley range from 13.7°C in July to -10.7°C in January; mean annual temperature is 2.6°C ±1.4°C (see 1996 Mt. Polley Reclamation Plan). Temperature and precipitation data are presented for the 2006 to 2012 period in Appendix 5. The mean temperature in this period appears to be 1 to 2^{o}C above this average and precipitation near the historic average. The mining method employed is open pit mining. Mine disturbance at the end of 2013 was approximately 186 hectares with expansion plans. Operational reclamation has commenced, but is still in the research stage.

The objective of the reclamation research program is to develop the methods, materials and protocol for achieving specific end land use objectives for each reclamation unit (see Mount Polley Reclamation and Closure Plan). The implementation of operational research trials occurred in the spring of 1998 on top of the East rock disposal site (RDS) (1170-meter dump),at Mount Polley.

Test plots were established in 1998, 1999 and 2000 to evaluate the following variables, parameters and components:

- The depth of topsoil required to establish a suitable medium for growth given the reclamation objectives;
- The essential ecosystem components required for re-establishing a forested ecosystem;
- The requirements for soil amendments, if any;
- The suitability of tailings solids as a growth medium;

- The suitability and practicality of re-colonization of disturbed areas by native species;
- The selection of tree species for reclamation objectives;
- The interaction of vegetation competition with tree survival and growth;
- The extent of metal uptake by vegetation;
- Vegetation relationships to various soil amendments.

The research trial for 1998 consisted of 8 treatments and a control (see 1998 Annual Reclamation Research Report for a description of the treatments and methodology for 1998). The research trial in 1999 added 4 additional treatments and completed the triplication of Treatment I (see 1999 Annual Reclamation Research Report). The research trial for 2000 added 13 treatments, 12 of which occurred on the RDS side slope below the dump (see 2000 Annual Reclamation Research Report). No monitoring of these trials occurred during the period of 2001 to 2005 and the period of 2007 to 2011. The trial was last monitored in 2006; 2012 marks a monitoring return. The monitoring at 2012 will be used to establish how the reclamation research trial is differentiating. The treatment blocks for the 1998 – 1999 trial are 13 by 15 meters (195 m^2) in size. Each block is separated by 3 meters of non-treated area (see Figure 1). Each treatment block was randomly selected and completed in triplicate: a total of 36 treatment blocks were established. The exception is treatment J (15 cm soil addition plus domestic grasses) which was done in duplicate. The following tables list the treatments that were established on top of the 1170-meter level of the East RDS:

Table 1: Treatments Applied in the 1998 Trial

Treatment Regime	Basic prep.: Scarify top of rock disposal site	Soil added, (cm)	Fertilizer: (tea bag)	Fertilizer: Biosolids (dT/ha)	70:30 Lodgepole pine: Douglas-fir (stems/ha)	Domestic grasses (Kg/ha)	Native grasses (Kg/ha)
A control	Basic prep.	0			2000	40	
B	Basic prep.	15			2000	40	
C	Basic prep	15	1 / tree		2000	40	
D	Basic prep	15		75	2000	40	
E	Basic prep	15		150	2000	40	
F	Basic prep	25			2000	40	
G	Basic prep	15			2000		40
H	Basic prep	40			2000	40	
I_1	Basic prep	65			2000		40

Table 2: Treatments Applied in the 1999 Trial

Treatment Regime	Basic prep.: Scarify top of rock disposal site	Soil added, (cm)	Tailings added, (cm)	Fertilizer: Biosolids (dT/ha)	70:30 Lodgepole pine: Douglas-fir (stems/ha)	Domestic grasses (Kg/ha)
I_{2+3}	Basic prep.	65			2000	40
J	Basic prep.	15			2000	40
K	Basic prep.	25			2000	40
L	Basic prep.	40			2000	40
M	Basic prep.	20	20	75	2000	40

The research trial for 2000 consisted of establishing 12 treatments on a Rock Disposal Site side slope between the 1170 and 1150 meter levels of the East RDS. This trial is northeast of the trial established in 1998, and is directly over the crest of the 1170 dump. The slope range is from 3.5:1 to 2.5:1 (28 to 40 %) on an easterly aspect. The entire slope from the 1170 to 1150 dump has been planted within the treatment units. Due to the contouring, the slope length between treatments is variable. Each treatment is unique, with no replication, and the size of each treatment block is approximately 833m^2. Treatment Z was established on the 1170 dump adjacent to the main trial and is 40 X 50m in size (2000m^2). Due to industrial activity, Treatment Z was destroyed and therefore terminated in 2006. In the 2000 trial all treatments were planted at a ratio 70:30 lodgepole pine to Douglas-fir at 2000 stems/ha. The following is the listing of treatments established in 2000 (see Figure 1):

Table 3: Treatments Applied in the 2000 Trial

Treatment Regime	Basic prep.: Scarify top of rock disposal site	Soil added, (cm)	Dump fines added, (cm)	Fertilizer: Biosolids (dT/ha)	70:30 Lodgepole pine: Douglas-fir (stems/ha)	Dry-seeded Domestic grasses (Kg/ha)	Hydroseeded Domestic grasses (Kg/ha)
N	Basic prep.	30		50	2000	20	
O	Basic prep.	15		50	2000	20	
P	Basic prep.	0		50	2000	20	
Q	Basic prep.	0		50	2000		20
R	Basic prep.	15		50	2000		20
S	Basic prep.	30		50	2000		20
T	Basic prep.	30			2000		20
U	Basic prep.	15			2000		20
V	Basic prep.	0			2000		20
W	Basic prep.	0			2000	20	
X	Basic prep.	15			2000	20	
Y	Basic prep.	30			2000	20	
Z	Basic prep.	20	20		2000	20	

Figure 1 Research Plot Plan 2000 Trial

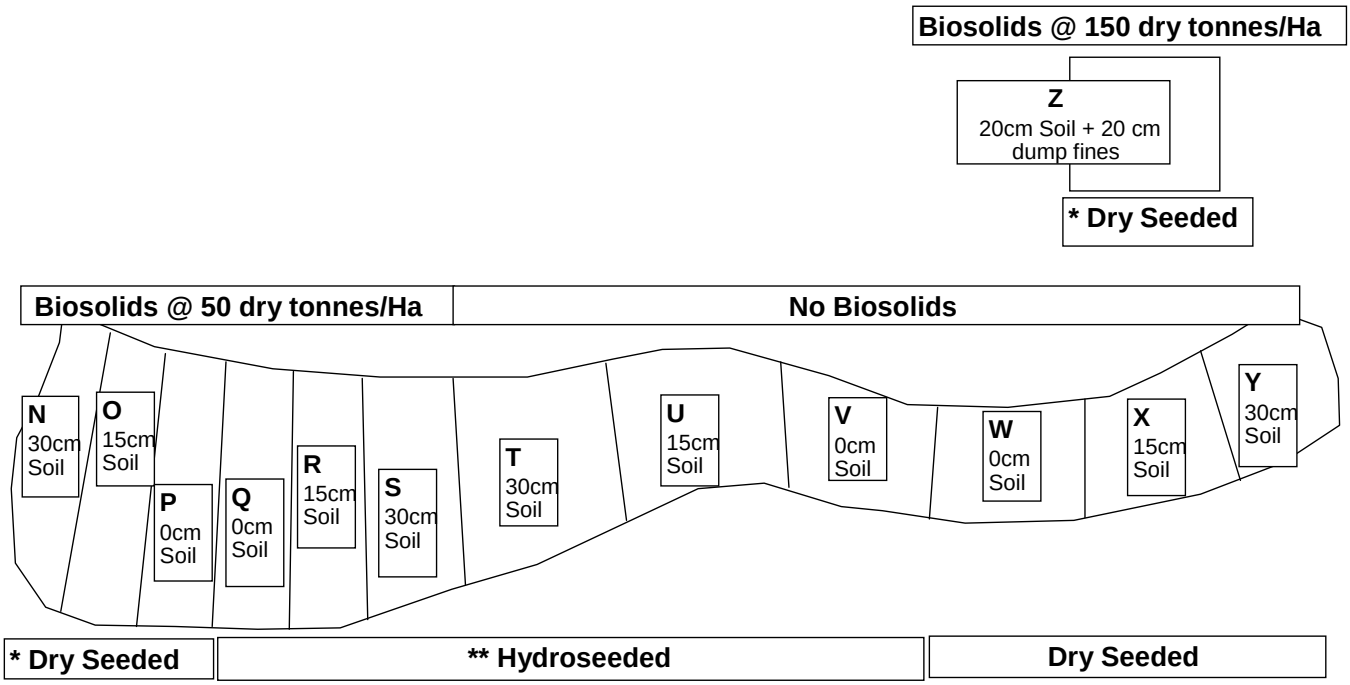
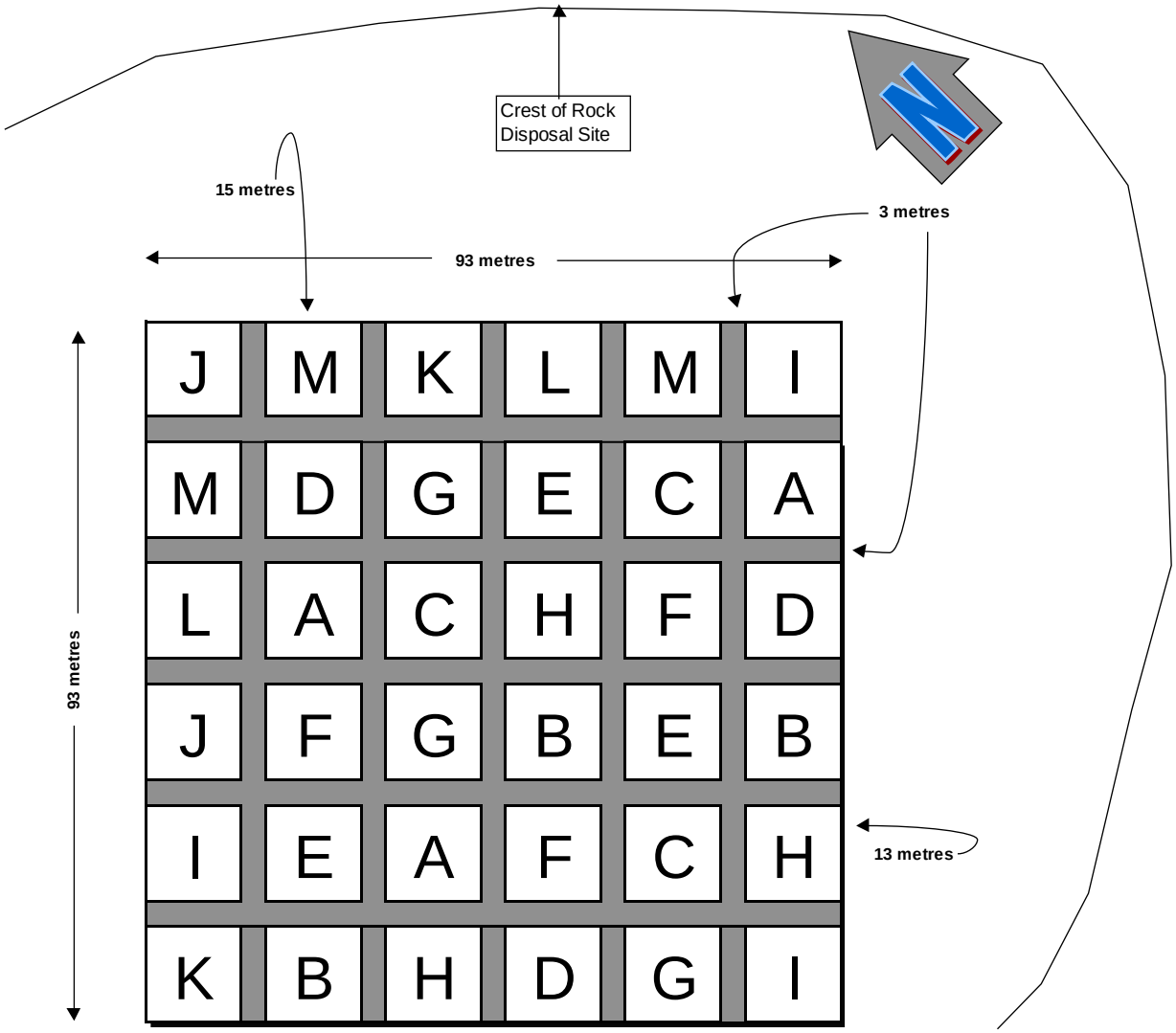


Figure 2 Research Plot Plan 1998 - 1999 Trial



Legend:
A = Control (scarify ground + tree
B = A + 15 cm soil
C = A + 15 cm soil + fertilizer
D = A + 15 cm soil + 75 T/Ha biosolids
E = A + 15 cm soil + 150 T/Ha biosolids
F = A + 25 cm soil
G = A + 15 cm soil + Native Grasses
H = A + 40 cm soil
I = A + 65 cm soil
J = A + 15 cm soil
K = A + 25 cm soil
L = A + 40 cm soil
M = A + 20 cm soil + 20 cm Tailings + 75 T/Ha biosolids

Reclamation Plot Sign

The planting target for the seedlings was 2000 st/ha with a triangular inter-tree spacing of 2.4 meters: species target percentage mixture was 70% lodgepole pine and 30% Douglas-fir. The lodgepole pine seedlings were Ministry of Forest stock (PLI PCT313B 1+0; 1998 seedlot 60297, 1999 seedlot 8497 and 2000 seedlot 31003); while the Douglas-fir was Riverside Williams Lake stock (FDI PSB410 1+0 seedlot 14406 for 1998, 1999 and 2000). The fertilizer amendment used was RTI Bio-Paks containing 10 grams/bags; the treatment is 1 bag/seedling. The composition of the bag is 16% nitrogen, 6% phosphoric acid (P_2O_5), 8% potash (K_2O), 2.69% sulfur (S), 0.64% iron (Fe), 0.15% manganese (Mn), and 0.54% zinc (Zn). The formulation also includes humic/acid/lignum matrix, Vitamin B1, and naphthalene acetic acid. Biosolid metal composition is given in Appendix 2. The quality of the biosolids met the regulatory guidelines for such material at the period of utilization. Two native grass seed mixtures were used. For Treatment G, 3 kg of custom seed mix (supplier: Pickseed) was used at 1 kg/ block. Species composition is given in Appendix 1. For Treatment I1, 1 kg of custom mixture was used on the one block (supplier: Symbios Research and Restoration). For Treatments I2, I3, J, K, L, and M a domestic mixture was used at 1 kg/block. On the 2000 treatments the domestic mixture was spread with a cyclone seeder or hydroseeded at a rate of 20 kg/ha. Species composition for the domestic mixture is given in Appendix 1.

Treatment M is a mixture of salvaged soil, tailings and biosolids on which the seedlings did well in 1999; however, due to vigorous vegetative growth of the grass layer in subsequent years seedling mortality was high (>90%). Therefore monitoring of tree growth is limited to a few survivors which has narrowed the statistical analysis of this more innovative treatment. This herbaceous response was likely due to an excessive nutrient flush from the biosolids and tailings mineralization. Additional treatments added to the research trial in 2000 were to round out additional treatments on the side slopes of the rock disposal site.

Particle size distribution for the top 50 cm of the rock disposal site is given in Table 4. The available water storage capacity estimated for the site is 7 mm / 50 cm of soil. The material on the side slope of the RDS was generally directly dumped and pushed over and re-contoured with a large cat, therefore this material is subject to less mechanical aggravation from haul trucks. So it is likely composed of fewer fines and will have more coarse fragments with a larger proportion of larger fragments.

Table 4: Particle Size Distribution Top 50 cm Rock Disposal Site.

DEPTH (CM)	Coarse Fragment % (>2mm)	Fine Content % (<2mm)
0 – 10	72.4	27.6
10 – 20	85.5	14.5
20 – 30	86.3	13.7
30 - 50	90.0	10.0

The material used as soil amendment is variable in coarse fragment content and position within the soil profile, causing soil properties (chemical, physical) to be variable between treatments and treatment replicates. An estimate of coarse fragment content is used with an estimate of soil texture to calculate the available water storage capacity (AWSC) for each treatment replicate. AWSC is the water retained in the soil between the states of field capacity and permanent wilting point. AWSC was calculated using SPAW (version 6.02.70) software (Keith E. Saxton, USDA Agriculture Research Service). The soil used for amendment purposes came from the adjacent Bell Pit soil stockpiles: an average particle size distribution for the A and B horizons is sand 60%; silt 30% and clay 10%. The above AWSC calculations used an estimated figure of 1% organic matter. See Appendix 3 for an estimate of treatment AWSC. The interface of the soil amendment and the material of the RDS is a textural stratification change known as a hydrological discontinuity: this acts as a moisture barrier and leads to a much higher field capacity than normally found in free draining soils. This potential higher field capacity may allow the treatments with shallow soil amendments to compensate their limited AWSC, more so as the water demand of the juvenile forest stand is still limited. As the stand matures, greater stress will be placed on the soil's capacity for both nutrient and water supply.

Site index (SI) is used as an estimate of a forest stand's potential productivity and reflects inherent environmental factors (climate and soil) on the site. Site Index was calculated using Site Tools (version 3.3) (Research Branch, Ministry of Forests, Province of BC). The data was run through two models: the Growth Intercept (GI) Model using tree age at breast height; and the site index curve (TA) model using the trees' total age from seed. Tree GI model is considered more accurate in determination of maximum site productivity, but tree selection for this model is more specific (better indicating potential maximum site productivity) while the TA model can be less specific which averages the stand productivity over a wider range of sample trees. Both models give an estimated height at a base age of 50 years. Climatic patterns since 2000 have been within the area's normal climatic variations and the trial mortality and growth should be reflective of the site climatic capability for tree growth.

Statistical Analysis

Methods

The data collected in the field, which are total height, leader height, diameter at breast height (dbh) and tree vigour (Table 5). Calliper of tree at ground level was recorded for trees that have not reach dbh (1.3m). Trees assessed with Vigour 3 and 4, and with no defects affecting tree growth, were assessed for age in years above dbh for growth intercept site index calculations. This data was entered in Excel and checked for accuracy and validity (Appendix 6) Statistics were generated in Minitab, Systat and Excel, using basic descriptive statistics, the General Linear Model for testing the difference between results of sets of unequal size, correlation and regression analysis.

Table 5: Vigour Codes †

Code	Description
0	Species Dead
1	Vigour Poor
2	Vigour Fair
3	Vigour Good
4	Vigour Excellent

† Adapted from *Northern Interior Vegetation Management Association – Field Research Guide*, Table 4.3, p. D-6.

Results

Refer to Appendices for a detailed statistical analysis of the collected data on tree mortality and growth. Appendix 4 is a summary of the mean values for total height, leader height, dbh and site index. Appendix 7 is a graphical representation of which trials were significantly different when compared to each other. Appendix is a mortality table of tree seedling by treatment regime. Appendix 9 is frequency chart representation of tree vigour of the various treatments of the 2006 data. Appendix 10 is the Analyses of Variance, calculated using the General Linear Model at 95% and 90% confidence intervals. Regression and correlation analysis on height *vs.* vegetation cover and height *vs*. AWSC is in Appendix 10. Mean Site Index by treatment is summarized in Appendix 4 and AWSC calculation summary is in Appendix 3. Two photos of all treatments were taken (Appendix 12): the first photo is of the treatment stand; the second photo is of the primary ground cover.

Results and Discussion

1998 – 1999 TRIAL – Soil Depth – Productivity.

In the 2012 data was collected in the autumn, after the cessation of leader growth and the terminal buds were set, for the 1998, 1999 and 2000 trials (tree ages are respectively 16, 15 and 14 years, total age from seed). Certain trends are evident. The comparative Treatment Regimes (T.R.) for soil depth are: 0cm soil -T.R. A; 15cm soil – T.R. B and T.R. J; 25cm soil - T.R. F and T.R. K; 40cm soil – T.R. H and T. R I; 65cm soil – T.R I. Referring to the statistical analysis, mortality tables and vigour charts found in the Appendices the following can be concluded:

Doulas-fir:

- In the 1998 and 1999 trials, soil depth of 0cm or planted directly into waste rock Douglas-fir had a significantly lower total height and leader length against treatments of increasing soil depth (15cm to 65cm).
- In these trials, Douglas-fir on 15cm and 25cm of soil are significantly shorter in total height than treatments with 40cm and 65cm of soil amendment. No trends are evident in leader length or dbh.
- In the 1998 trial, no significant difference is seen between 15cm and 25cm in total height, but leader growth was significantly longer on the 15cm treatment over the 25cm.
- No difference is seen in total height, leader length, and dbh between the 40cm and 65cm treatments.
- When tree height is adjusted to 15 years, treatments with 40 and 65 cm are significantly taller than treatments with shallower soil replacement depths (15 to 25cm). No significance is indicated between the 40 and 65 cm depths.
- Site Index total age model results for treatments with no soil are significantly lower than treatments with soil. Treatments with 15 and 25 cm of soil are generally significantly lower than treatments with 40 and 65 cm. There is no difference in site index is seen between 40 and 65cm soil depths.
- The growth intercept site index model is more selective in sample tree selection and biased toward only the better tree and did not show meaningful trends in site index and soil depth.

Lodgepole Pine:

- In the 1998 and 1999 trials, soil depth of 0cm or planted directly into waste rock lodgepole pine had significantly lower total height, leader length and dbh against treatments of increasing soil depth (15cm to 65cm).
- Lodgepole pine on 15cm and 25cm of soil are significantly shorter in total height

than treatments with 65cm of soil amendment. No major trends are evident in leader length or dbh variables.

- Lodgepole pine showed a positive growth response by increasing soil depth from 40 to 65 cm. The pine planted on 40 cm soil in 1999 showed poor growth compared to the 1998 plantation.
- Height adjusted to age of 15 years differentiates significantly in growth up to 40cm of soil. No differences in growth are seen with increasing soil depth beyond 40cm.
- Site index with total age model indicates: poor site index with no soil; no differentiation below 40 cm of soil; trees on 40 cm of soil have significantly better productivity than shallow treatments; and the 65 cm soil amendment treatment showed no significant increase in site index over the 40 cm treatment.
- Site index with the growth intercept model indicates mixed results between the 15 and 25 cm soil amendment treatments; the 40 cm soil depth indicated a modest positive response; no significant response was seen between the 40 and 65 cm soil amendment treatment.

2000 TRIAL – Soil Depth – Productivity.

For the 2000 data, the comparative treatment regimes for depths are: for 0cm soil – T.R. W; 15cm soil – T.R. X; and 30cm soil – T.R Y. All these treatments were dry seeded (20 kg/ha). For the sites which were hydroseeded, the comparative treatment regimes are: 0cm – T.R.V; 15cm – T.R. U; and 30cm – T.R. T.

Douglas-fir:

- In the 2000 trials, soil depth of 0cm or planted directly into waste rock (T.R. W) Douglas-fir had a 98% mortality rate therefore growth data is nonexistent. T.R. V has a lower mortality rate (33%) and showed significantly lower growth (total height and leader length than comparable treatments with soil amendments (15 and 30 cm soil).
- Growth Intercept Site Index indicates a significantly higher productivity on sites with 30cm soil amendment as compared with sites with no soil. No differences are seen in site indexes between the 15 and 30cm soil amendments. Survival of Douglas-fir on the waste rock is low making statistical inferences difficult.

Lodgepole Pine:

- In the 2000 trials, soil depth of 0cm or planted directly into waste rock lodgepole pine had significantly lower total height, leader length and dbh against treatments of increasing soil depth (15cm to 30cm).
- No significant difference is noted between the 15 and 30cm soil amendment treatments.
- Total age and growth intercept site index shows significantly lower tree productivity on sites with no soil amendment as opposed to sites with amendments (15 and 30cm). No significance is seen between the 15 and 30cm soil amendment treatments.

Discussion: Soil Depth and Productivity.

There is no tree productivity without soil. A minimum of soil placement of 15cm over the waste rock produces a reasonable stand with adequate growth. Shallow placement of 15 and 25cm of soil showed significantly poorer growth than deep soil placement of 40 and 65cm on the 1998/1999 trials. These shallow and deeper placements did not differentiate between 15 and 25cm and 40 and 60cm groupings. The 2000 trial proved that a minimal soil is required for tree survival and adequate growth. There was no significant tree productivity difference noted between 15 and 30cm depths. No deep (>30cm) soil placements occurred on the 2000 trial. The sites indices are comparable between the 1998/1999 trial and the 2000 trial between comparable treatments.

1998 – 1999 TRIAL – Soil Amelioration – Productivity.

In the 2012 data collected in the autumn, after the cessation of leader growth and the terminal bud were set, for the 1998, 1999 and 2000 trials (tree ages are respectively 16, 15 and 14 years, total age from seed). Certain trends are evident. The comparative Treatment Regimes (T.R.) for soil amelioration on the 1998 – 1999 trials are: 15cm soil with no amelioration -T.R. B and T.R. J; 15cm soil plus tea bags – T.R. C; 15cm soil plus 75 dT/ha biosolids – T.R. D; 15cm soil and 150 dT/ha biosolids - T.R E. T.R. M consists of a mixture of soil (20cm) plus tailings 20cm and 75 dT/ha biosolids. Referring to the statistical analysis, mortality tables and vigour histograms found in the Appendices, the following can be concluded:

Douglas-fir:

- The results of the tea bag treatment are significantly lower in total height, leader height and dbh in the 1998 data set than the non-treated trees. The adjusted 15 year total height data indicates significantly lower growth than non-treated sites.
- The tea bag treatment (T.R. C) had a significantly lower GI Site Index (18.2m) than for non-treated sites (T.R. B & J) GI Site Index 23.m and 24.9m.
- Biosolid amendments (T.R. D 75 dT/ha, T.R. E 150 dT/ha) were significantly greater in total height and dbh, but no difference was seen in leader growth for both treatments.
- The normalized height to 15 years shows a significant positive response to biosolid amendment that makes the 15cm soil depth with biosolids comparable in growth to a 40cm soil treatment with no biosolids.
- No significant difference is seen in growth and productivity between the 75 and 150 dT/ha biosolid treatments.
- Total age site index indicates a significant positive response to biosolid amendments, but less so using GI site indices.
- The positive significant response of biosolids on 15cm soil is evident as this treatment's growth outpaces deeper soil amendments of 25cm (T.R. F).

Lodgepole Pine:

- Pine trees show a significantly lower total height, leader length, and dbh with the tea bag treatment (T.R. C) over comparable treatments (T.R. B).
- The tea bag treatment showed a lower GI and total age site index over its comparable treatments.
- Biosolid amendments of 75 dt/ha (T.R. D) led to a significant positive response in total height and dbh, but not in the current leader growth. Amendments of 150 dt/ha (T.R. E) led to no significant response to any of the growth variables used as compared to T.R. B; however, T.R. D and T.R. E showed significantly better growth than T.R. F (25cm soil amendment).
- The normalized height to 15 years shows a positive response to biosolid amendment on some all comparable treatments treatment.
- TA site index informed of no significant biosolid response against T.R. B but a significant response to T.R. G (15cm soil plus native seed), indicating a middling

response. The GI site index indicates no significant response against T.R.B but a significant response against T.R F and T.R. G.

- No significance in growth is seen between the 75 dT/ha and 150 dT/ha biosolids treatments.

2000 TRIAL – Soil Amelioration – Productivity

The comparative Treatment Regimes (T.R.) for soil amelioration, biosolids 50 dT/ha vs. non-treatment no amendment (on dry seeded sites), on the 2000 trials are: N vs. Y; O vs. X; P vs. W. For the biosolids vs. non-treatment (on hydroseeded sites) the comparatives are: Q vs. V; R vs. U and S vs. T. The soils' depths are varied; therefore, comparisons are made on comparable treatments.

Douglas-fir:

- The only significance seen in comparative treatments is the combination of no soil, hydroseeded, with 50 dT/ha (T.R. Q) which had significantly greater growth (tree height, leader length and dbh) than no soil, hydroseeded, with no biosolid amendment (T.R. V).
- Conclusions and meaningful statistical analysis as to the tree productivity effects of biosolids is hampered due to poor survival of Douglas-fir on this trial.

Lodgepole Pine:

- No soil, with hydroseeding, and with biosolid amelioration (T.R.Q) had significant better growth (tree length, leader length) than the comparable treatment without biosolids (T.R. V). Both treatments have no soil amendments; therefore biosolids directly on waste rock improved the growing conditions of the trees, but tree growth was still relatively poor.
- No soil with dry seeding and with biosolid amelioration (T.R.P) had significant better growth (tree length, leader length, dbh) than the comparable treatment without biosolids (T.R. W).
- Biosolids with no soils and dry seeded had a significant increase in total age site index over the non-biosolid comparative treatment (17.4m vs. 11.4m).

Discussion Soil Amelioration and Productivity.

Tea bag amelioration had an initial two-year positive effect on tree growth; however, there was no positive long-term effect, as this treatment is not keeping pace with its cohort of treatments. In the 1998/1999 trials there is generally a positive response to biosolid amelioration, but this response in tree growth may have come to an end as no significance in leader length is seen in this last round of measurements. Biosolids showed a more problematic response in the 2000 trial: tree mortality is high and no significant response was seen with the soil/biosolid mixtures. Biosolids directly onto waste rock showed a significant improvement over the non-biosolid treatment, but still not enough to be comparable to soil amendment treatments or meet stand productivity targets.

1998 – 1999 – 2000 TRIALS – Revegetation – Productivity.

In the 2012 data collected in the autumn, after the cessation of leader growth and the terminal buds were set, for the 1998, 1999 and 2000 trials (tree ages are respectively 16, 15 and 14 years, total age from seed). Certain trends are evident. The comparative Treatment Regimes (T.R.) for the 1998 / 1999 trials for revegetation are: T.R. B and T.R. J - Mount Polley seed mix; and T.R. G - native seed mix; all with 15cm soil amendment at a seeding rate of 40Kg/ha. For T.R. I (65cm soil) planted in 1998, the plot was planted with a native plant mixture. The two additional plots to T.R. I planted in 1999 used the Mount Polley seed mixture (see Appendix 1 for seed mixture compositions). For the 2000 trial the comparative treatments for dry seeded vs.. hydroseeded are: 0cm soil - T.R. W vs. T.R. V; 15cm - T.R. X vs.. T.R. U; 30cm – T.R. Y vs.. T.R. T. The comparatives with biosolids (50dt/Ha.) are 0cm soil – T.R. P vs.. T.R. Q; 15cm soil T.R. O vs. T.R. R; and 30cm soil – T.R. N and T.R. S. Referring to the statistical analysis, mortality tables and vigour histograms found in the Appendices the following can be concluded:

Douglas-fir:

- No significance in tree growth is seen between comparative treatments in these trials.
- No significance is seen in total age site index and growth intercept site index for the 1998/1999 trials.
- No significance in tree growth is seen between dry seeded and hydroseeded

treatments with comparable soil depths and no biosolid amendments.

- No significance in tree growth is seen between dry seeded and hydroseeded treatments with comparable soil depths and with 50 ndt/Ha biosolid amendments.
- No significance in site index is seen between comparative treatments of revegetation on all trials.

Lodgepole Pine:

- No significance in tree height and leader growth is seen between comparative treatments on the 1998/1999 trial. Domestic seeding had significantly larger dbh than the native seeding on these trials.
- No significance is seen in total and growth intercept age site indices between comparative treatments on the 1998/1999 trials.
- No significance in tree growth is seen between dry seeded and hydroseeded treatments with comparable soil depths and no biosolid amendments.
- No significance in tree growth is seen between dry seeded and hydroseeded treatments with comparable soil depths and with 50 dt/Ha biosolid amendments.
- Only one comparative significance is seen in the 2000 trial of the total site index variable. The treatment with no soil, but added 50 dt/ha biosolid and hydroseeded (TR Q), had a significantly lower site index (alpha = 0.10) than a comparable treatment that was dry seeded (TR P).

Discussion Revegetation and Productivity.

Vegetation seed composition, seeding rates, or application method had no significant affect on tree seedling growth.

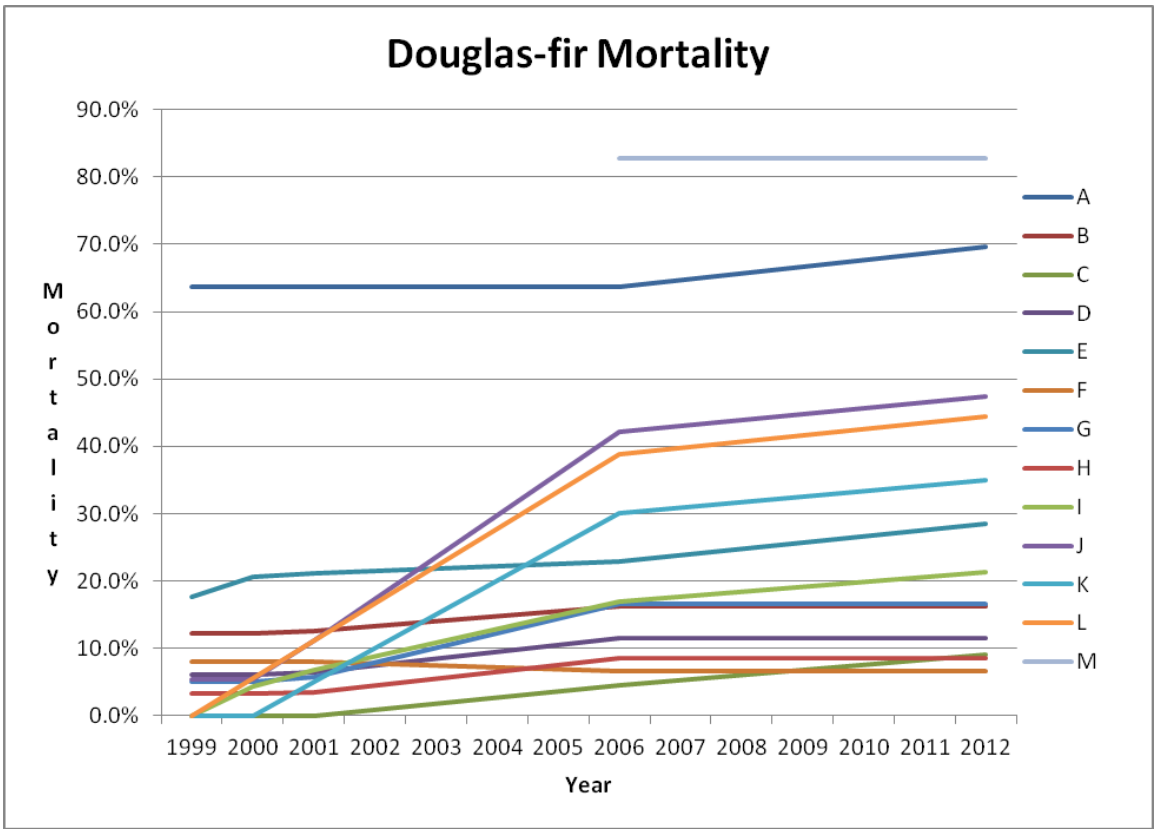
1998 – 1999 TRIAL – Soil Depth – Mortality.

In the 2012 data collected in the autumn, after the cessation of growth and the terminal buds were set, for the 1998, 1999 and 2000 trials (tree ages are respectively 16, 15 and 14 years, total age from seed). Certain trends are evident. The comparative Treatment Regimes (T.R.) for soil depth are: 0cm soil -T.R. A; 15cm soil – T.R. B and T.R. J; 25 cm soil - T.R. F and T.R. K; 40 cm soil – T.R. H and T.R.L; and 65 cm soil - T.R I. Referring to the mortality tables and vigour histograms found in the appendices the following trends are evident:

Doulas-fir:

- T.R A (trees were planted directly into waste rock) had poor initial survival (34%) in 1999; however, these initial survivors managed to hang on to 2012 and there was a survival rate of 30%, but with poor vigour and growth.
- Average mortality among all the comparable treatments is 29.5% by 2012. There are no trends as to tree survival with changes to soil depth. The 1999 trial had above average mortality, a higher mortality rate then the 1998 trial. Initial seedling survival is greatly influenced by seedling handling and climatic conditions during the first growing season.
- Up to 2001 the initial survival of Douglas-fir seedlings was fair - the comparative T.R. mortality was 14.1%, but by the 2006 survey mortality had nearly doubled to 26.6%. The following 6 years to 2012 has seen the mortality stabilize at a low rate.

Figure 3: Douglas-fir Mortality 1998 - 1999 Trials



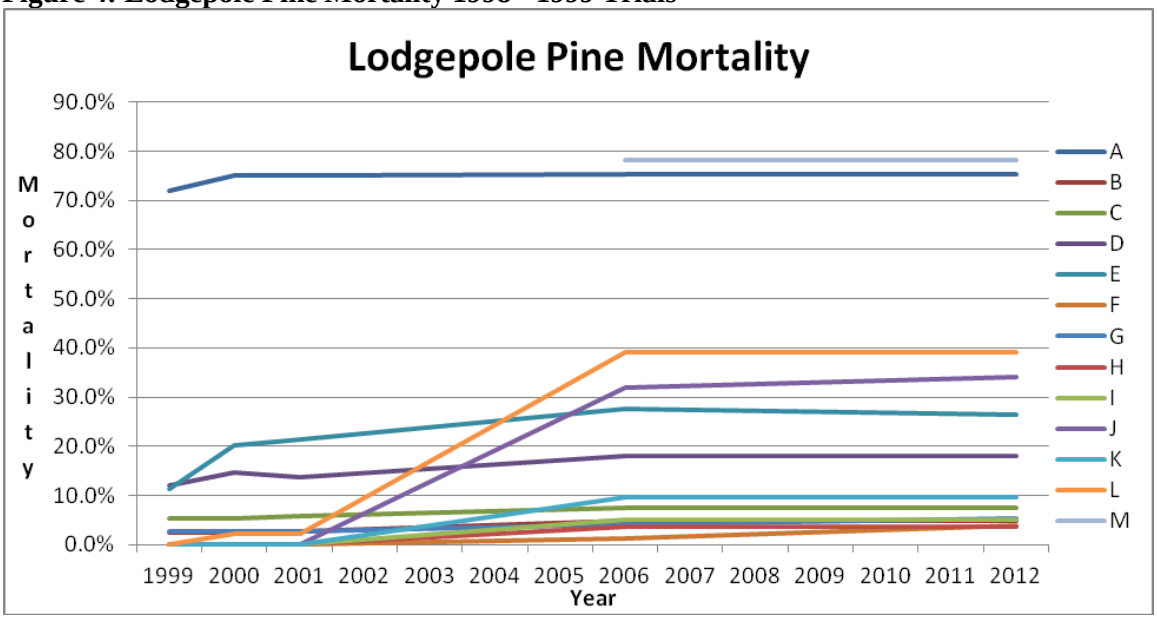
Lodgepole Pine:

- Lodgepole pine planted directing into waste rock with no soil had a low

survival rate (72% mortality). These survivors are still hanging on (25% survival in 2012), but with limited vigour and growth.

- Average mortality among all the comparable treatments is 20.1% by 2012. There are no trends as to tree survival with changes to soil depth. The 1999 trial had above average mortality, therefore a higher mortality rate then the 1998 trial.
- T.R J and T.R. L are outliers as to mortality in 1999 trials (34.0% and 39.1% lodgepole pine mortality respectively and 47.4% and 44.4% Douglas-fir mortality), even though the initial three year survival rates were good. There is no apparent factor, neither biological nor environmental, to account for this observation.
- The lodepole pine mortality spiked from 2001 (9.2%) to 2006 (19.4%) mirroring Douglas-fir, indicating a common factor in tree mortality during this period.

Figure 4: Lodgepole Pine Mortality 1998 - 1999 Trials



2000 TRIAL – Soil Depth – Mortality.

The following trends are seen in tree seedling mortality with varying mortality on the 2000 Trials.

Doulas-fir:

- On dry seeded sites exclusively the following were the amendment soil depths: T.R. W – 0cm; T.R. X – 15cm; and T.R. Y – 30cm. There is 98% mortality of Douglas-fir seedlings with no soil amendment. There is no mortality with 15cm soil amendment and 22% mortality with 30cm soil amendment.

Lodgepole pine:

- On dry seeded sites exclusively the following were the amendment soil depths: T.R. W – 0cm, T.R. X – 15cm, and T.R. Y – 30cm. There is 37.7% mortality of lodgepole pine seedlings with no soil amendment. There is 1.7% mortality with 15cm soil amendment and 27.5% mortality with 30cm soil amendment.

Figure 5: Douglas-fir Mortality 2000 Trials

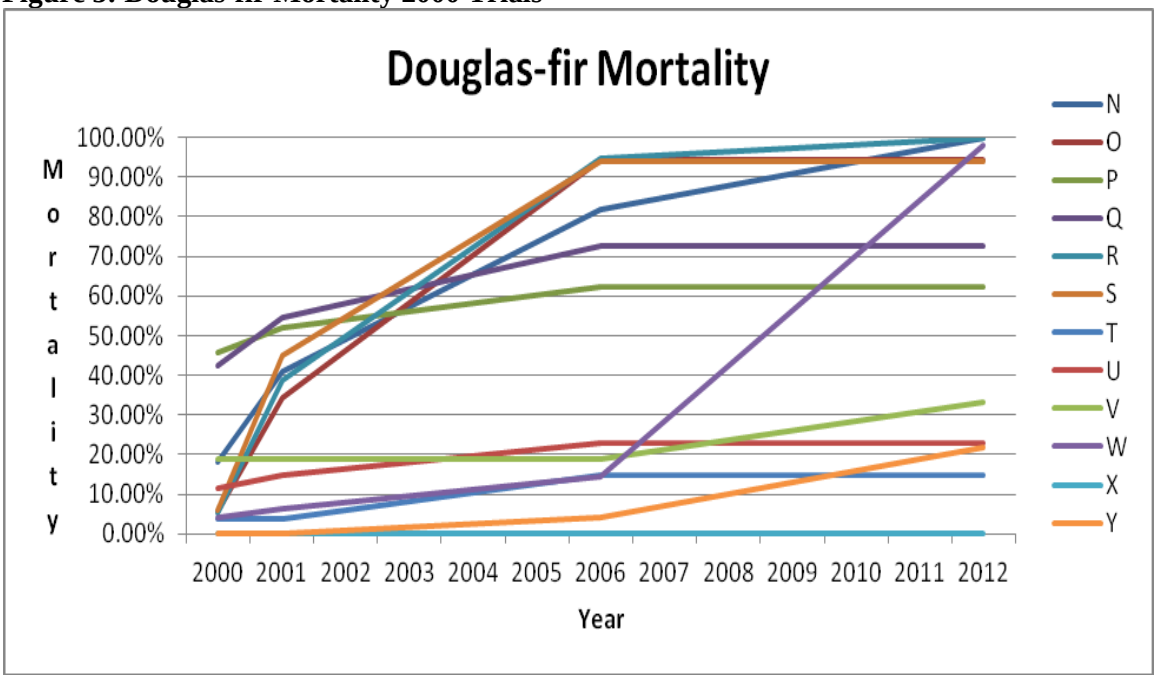
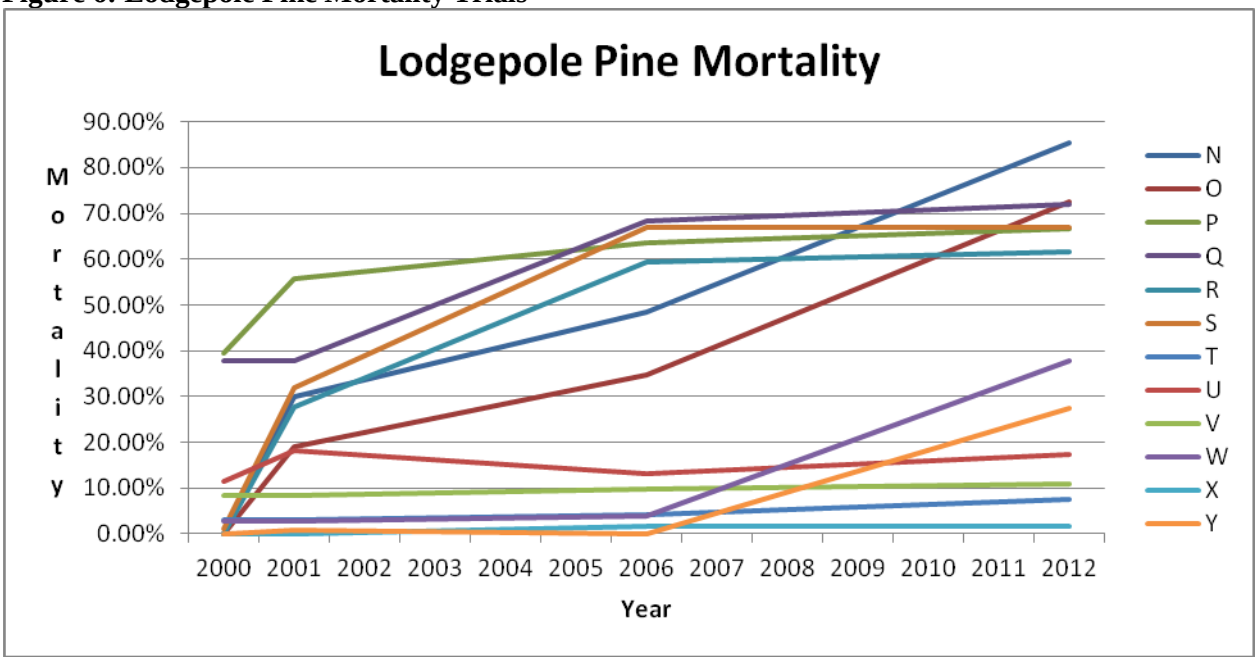


Figure 6: Lodgepole Pine Mortality Trials



Discussion Soil Depth and Mortality.

Increasing soil depth, after a minimum of 15cm, had no influence as to tree seedling survival. Trees require a minimum of 15cm of soil for survival and growth as survival and productivity is poor when planted directly into waste rock. On this set of comparative plots Douglas-fir mortality by 2012 (29.5%) is much higher than lodgepole pine (20.1%). This may be due to Douglas-fir being near its ecological upper elevation limit (1250m) for this region and being more susceptible to cold temperatures, especially during the growing season (Klinka,2000). The higher mortality seen on the 1999 trial is likely to be attributed to a high temperature and dry period following planting. Initial three year survival of the seedlings was fair; between Years 3 and 6 survival was poor, which is unexpected as by this time seedlings should have established sufficient foliage and root mass for survival. Vegetation completion was not a factor on these plots and climatic conditions seem normal. The mortality on this overall trial appears to be exceptionally high. Forest Licencees do not report a high tree seedling mortality rate within the ICHmk3 for their plantations. It is difficult to compare a natural plantation to a reclaimed area, and similarly, it is difficult to compare this study to an operational plantation regeneration survey. Tolko Industries Ltd. reports within the ICHmk3 an average density of 1103 wsph (well spaced

stems per hectare) and 2019 total stems per hectare on their plantations. This indicates very good plantation survival as it is close to original planting densities. This study indicates higher planting stocking is required to compensate high tree seedling mortality on reclaimed mine sites.

1998 – 1999 TRIAL – Soil Amelioration – Mortality.

The comparative Treatment Regimes (T.R.) for soil amelioration on the 1998 – 1999 trials are: 15cm soil with no amelioration -T.R. B and T.R. J; 15cm soil plus tea bags– T.R. C; 15cm soil plus 75 dT/ha biosolids – T.R. D; 15cm soil and 150 dT/ha biosolids .T.R. E. The following are observations of tree mortality on comparable soil amelioration treatments:

Doulas-fir:

- Trees planted with tea bags had a lower initial mortality and to-date have had a very good survival rate.
- Application of 75 dT/ha biosolids had no apparent affect as to survival of tree seedlings.
- Trees planted on the150 dT/ha biosolids treatment incurred an especially high mortality in their initial growing season.

Lodgepole pine:

- Tea bags made a significant difference in improving tree seedling survival.
- Both biosolid treatments had increased mortality (75 dT/ha – 17.9%, 150 dT/ha – 26.5%) over the control 4.9% mortality. For these biosolid treatments the initial year mortality was especially high.

2000 TRIAL – Soil Amelioration – Mortality.

One-half of the trial is treated with biosolids (T.R. N to T.R. S) and the other half of the trial does not have any biosolid amelioration. These two halves are set up as mirror images of each other; therefore, the comparable treatment to T.R. N is T.R. Y; T.R. O –T.R. X; T.R. P – T.R. W; T.R. Q – T.R. V; T.R. R – T.R U and T.R. S –T.R. T.

Table 6: Mortality % of comparable treatment groups for Year 2000 Trial

	Douglas-fir				Lodgepole Pine			
Year	2000	2001	2006	2012	2000	2001	2006	2012
Biosolids All	20.5%	44.3%	83.4%	87.3%	13.1%	33.7%	56.9%	70.9%
No Biosolids All	6.4%	7.3%	12.6%	31.8%	4.4%	5.6%	5.5%	17.1%
Biosolids +S*	23.2%	42.4%	79.5%	85.6%	13.1%	34.9%	48.9%	74.9%
No Biosolids +S*	1.4%	2.1%	6.2%	40.0%	0.9%	1.2%	1.8%	22.3%
Biosolids +HS**	17.8%	46.2%	87.2%	88.9%	13.0%	32.5%	64.9%	66.9%
No Biosolids +HS**	11.4%	12.6%	18.9%	23.7%	7.8%	10.0%	9.1%	11.9%
Hydroseeded All	14.6%	29.4%	53.1%	56.3%	10.4%	21.2%	37.0%	39.4%
Dry Seeded All	12.3%	22.3%	42.9%	62.8%	7.0%	18.0%	25.4%	48.6%

* Dry Seeded ** Hydroseeded

The observations regarding the biosolid amelioration treatment (50 dT/ha) are:

Doulas-fir:

- The half of the trial with biosolids (T.R. N, O, P, Q, R, & S) compared to its mirror image without biosolids (T.R. T, U, V, W, X, &Y) shows a mortality of 87.3% for the biosolids group as compared to 31.8% mortality for the non-biosolid group.
- For the sub-group treatment of dry seeded, the biosolids (T.R. N, O, P) vs. the non-biosolids (T.R. W, X, Y), the biosolid group had a mortality of 85.6% vs. 40% for the non-biosolid group.
- For the sub-group treatment of hydoseeded, the comparative biosolid group (T.R. Q, R, S) had a tree seedling mortality of 88.9% vs. 23.7% for the non-biosolid group (T.R. T, U,V).

Lodgepole pine:

- The half of the trial with biosolids (T.R. N, O, P, Q, R, & S) compared to its mirror image without biosolids (T.R. T, U, V, W, X, &Y) shows a mortality of 70.9% for the biosolids group as compared to 17.1% mortality for the non-biosolid group.

- For the sub-group treatment of dry seeded, the biosolids (T.R. N, O, P) vs. non-biosolids (T.R. W, X, Y), the biosolid group had a mortality of 74.9% vs. 22.3% for the non-biosolid group.
- For the hydoseeded comparative groups, the biosolid group (T.R. Q, R, S) had a tree seedling mortality of 66.9% vs. 11.9% for the non-biosolid group (T.R. T, U, V).
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Figure 7: Douglas-fir Mortality 2000 Trials by Treatment Groups

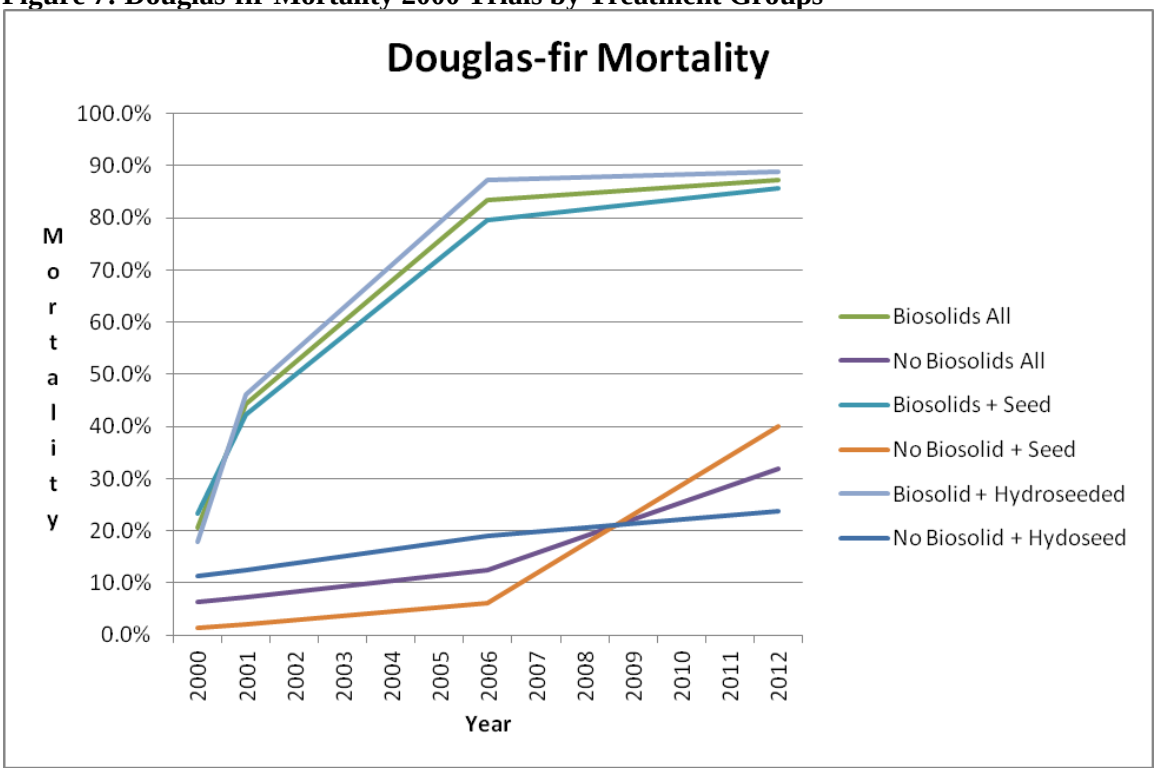
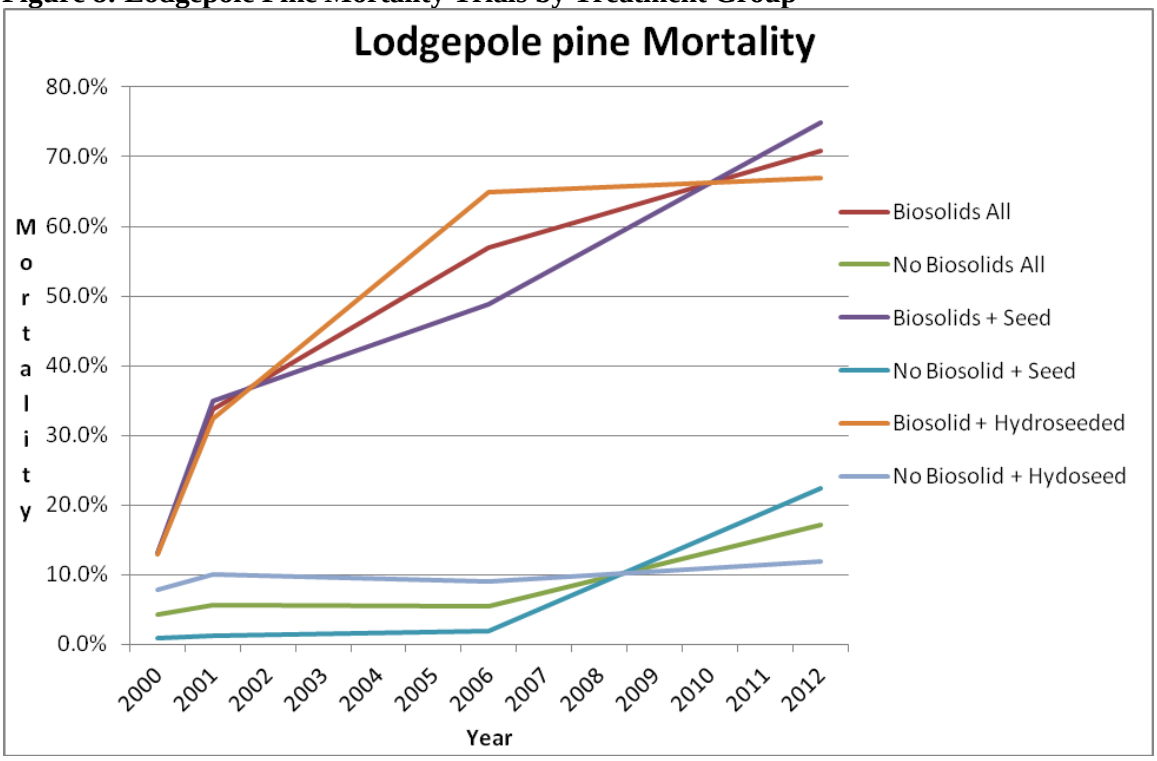


Figure 8: Lodgepole Pine Mortality Trials by Treatment Group



Discussion:

Biosolids appear to have a negative effect on overall tree seedling survival. In the 1998 Trial Douglas-fir survival was not affected by 75 dT/ha of biosolids, but this amount was adverse to lodgepole pine survival. Both species were adversely affected by the 150 dt/ha on the 1998 trial. In the 2000 trial the lesser amount of 50 dT/ha was able to adversely affect both Doulas-fir and Lodgepole pine survival. Complete, or near complete, plantation failure occurred on much of the 2000 Trial with biosolids used as an amendment. On 2000 trial, general plantation failure did not occur at the end of the initial growing season but started on the following (2001) growing season and it appeared to pick up between 2001 and 2006 (8 year old seedlings). Overall, there appears to have been an initial seedling reaction in the second growing season, then the seedling mortality rate picked up and continued till the 2006 monitoring of these sites. During the period of 2006 to 2012 the rate generally leveled off. The initial seedling mortality in the first year may be attributed to NH_3 but it is difficult to attribute later years to toxicity, as free NH_3 should have only a short-term exposure.

Biosolids amelioration may have promoted luxury consumption of nitrogen by subjected plants resulting in lush growth and consequent susceptibility to cold damage. Mortality due to poor tree stock, poor stock handling or planting technique would occur early while a majority of

the mortality occurred after two growing seasons. No significant mortality is attributed to diseases or pests in any trials. Only one Treatment Regime (T.R. M) resulted in a significant vegetation (grass and forbs) competition for tree survival. Otherwise, vegetation did not appear to have a significant influence of tree growth and survival.

1998 – 1999 – 2000 TRIALS – Revegetation – Mortality

In the 2012 data collected in the autumn, after the cessation of leader growth and the terminal buds were set for the 1998, 1999 and 2000 trials (tree ages are respectively 16, 15 and 14 years, total age from seed). The comparative Treatment Regimes (T.R.) for the 1998 / 1999 trials for revegetation are: T.R. B and T.R. J - Mount Polley seed mix: and T.R. G - native seed mix; all with 15cm soil amendment at a seeding rate of 40Kg/ha. For T.R. I (65cm soil) planted in 1998, the plot was planted with a native plant mixture. The addition plots to T.R. I planted in 1999 used the Mount Polley seed mixture. (See Appendix 1 for seed mixture compositions). For the 2000 trial, the comparative treatments for seeded and hydroseeded are: 0cm soil - T.R. W vs. T.R. V; 15cm - T.R. X vs. T.R. U; 30cm – T.R. Y vs. T.R. T. The comparatives with biosolids (50dt/Ha.) are 0cm soil – T.R. P vs. T.R. Q; 15cm soil T.R. O vs. T.R. R; and 30cm soil – T.R. N and T.R. S. Referring to the statistical analysis, mortality tables and vigour histograms found in the Appendices the following can be concluded:

Douglas-fir:

- Mortality between comparable treatments in 1998 (T.R. B-Mount Polley, and T.R. G-native seed) are almost identical (16.3% vs. 16.7%). T.R. J (15cm soil + Mount Polley seed) in the 1999 trial had a higher mortality (47.4%) than either T.R. B or T.R. G. On the 2000 trial all treatments hydroseeded compared to the mirror image of dry seeded trials had a similar mortality rate (hydroseeded 56.3% mortality vs. dry seeded 62.8% mortality).
- Hydroseeding on a treatment with no soil and no biosolids (T.R. V) has a better survival, 77%, than the comparable treatment that was dry seeded (T.R. W) with only 3% survival.
- The comparable no soil amendment, but with 50 d/ha biosolids T.R. P (dry seeded) had 63% mortality vs. T.R. Q (hydroseeded) with 73% mortality

Lodgepole pine:

- Mortality between comparable treatments in 1998 (T.R. B and T.R. G) are almost identical (4.9% vs. 5.4%). T.R. J (15cm soil + Mount Polley seed) in the 1999 trial had a higher mortality (34.0%) than either of the comparable seed mix treatments (T.R. B-Mount Polley, or T.R. G-native seed) from the 1998 trial.
- In the 2000 trial all treatments hydroseeded compared to their mirror image dry seeded trials in a similar mortality rate (hydroseeded at 39.4% vs. dry seeded at 48.6%).
- Hydroseeding on a treatment with no soil and no biosolids, T.R. V, has a much better survival (89%) than the comparable treatment that was dry seeded, T.R. W, (only 62%). However, mortality rates between T.R. Q, the hydroseeded treatment with 50 d/ha biosolids, (72% mortality) and T.R. P, the dry seeded comparable treatment (67% mortality) were less different.

Discussion:

The factors of seed mixtures utilized or methodology of seed application for this trial appear to have little influence in seed tree survival. Hydroseeding directly over waste rock with no soil amendment does improve survivability, but the tree growth is so limited that it is of no practical value. Hydroseeding onto to sloped sites with soil amendments has no negative effects as to tree survival and may be used for erosion control. Although, on the direct dry seeded sites with slope no erosion concerns were noted and other methodologies for erosion control may be utilized. The rate of vegetative seeding, or a more native as opposed to non-native, seed mixture made little difference in tree mortality. Notably, a lower application rate will save money and native sourced seeds will address biodiversity and longer term soil productivity issues. Only one treatment (T.R. M) had vegetation completion issues. T.R. M consisted of 20cm soil plus 20cm tailings and 75 dT/ha biosolids with the Polley domestic grass mixture which resulted in a nutrient flush and vigorous vegetation growth. This resulted in a poor initial tree survival due to light competition from forbs and grasses, and snow press. If a comparable treatment is being considered, then a timing delay of seeding, a lower seeding rate, and less competitive (shorter) species should be considered.

Conclusion.

Research Trial and Productivity Objectives

British Columbia's regulatory requirements state that the reclamation plan is to "return all mine disturbed areas to an equivalent level of capability to that which existed prior to mining on an average property basis, unless the owner, agent or manager can provide evidence which demonstrates to the satisfaction of the chief inspector the impracticality of doing so". To estimate the Site Index of young stands the growth intercept (GI) model is used. The assumption of this model is that the newly regenerated stand has the same patterns of growth as natural stands used to construct the model. It is highly problematic and most unlikely that stands occurring on these severely disturbed sites will have the same growth patterns as natural stands; however, we can use the GI model to see which reclamation treatments are currently tracking the height growth curves of the model.

The GI model requires trees to be greater than 1.3 meters and should be the best to reflect the sites' long term productivity. These are trees with the best growth, vigour and form. The GI model was run on trees with a vigour class of 3 or 4. A mean was calculated on the remaining trees Appendix 4 Summary of Means These criteria resulted in an unequal sample size (3 tree minimum) and a bias to homogenise the data to a fewer best-growing trees. The site index curve model (TA) using the trees total age from seed and can use wider range of sample trees. Tree site index GI model is considered best in determination of maximum site productivity, but tree selection for this model is more selective. The site index curve model (TA) is best for stands 50 to 140 years because it can be less selective in sampling indicating the averages stand productivity. The Site Index-Biogeoclimatic Ecosystem Classification Modals (SIBEC) correlates site index with site series within the biogeoclimatic ecosystem classification (BEC). Within the ICHmk3 there are seven site series. Of these, the following, ICHmk3 (01, 03, 04 & 05) are circummesic or around the subzones' zonal site. These site series together represent a majority of the area's ecosystem distribution and covers the sites' well, moderately-well and imperfectly-drained areas. They represent the model site series and those adjacent to it. The mean SIBEC site indices of these site series for major tree species is presented in Table 7 and represent a reasonable target for Mount Polley reclamation tree productivity targets (objectives).

Table 7: Reclamation Target Site Index 50 years (m)

Species	Subalpine fir	Cedar	Douglas-fir	Lodgepole pine	Spruce
Site Index(m)	19.8	16.4	22.1	22.4	20.9

As this trial is in an unnatural environment, growth projections are challenging. Also, the early growth patterns of the trees are subject to great variability. We are only at the beginning of a long-term trial and as the trial advances in time, and the stands approaches stand closure, it will differentiate due to increase in forest stand requirements for moisture, nutrients and space. It is evident that growth on these sites requires a minimum of soil amendment for successful growth. The optimal combination of soil and amendments can only be determined when nutrient and moisture requirements of the forest reach a maximum, usually at 45 years of age (Kimmins, 1987). Reclamation by its nature is unnatural and the sustainability of the ecosystem will always be uncertain.

Soil Depth

The study proves that some minimal soil on the rock disposal site (RDS) is required for tree productivity and survival - no amendments such as biosolids or a hydroseeded blanket can change this. A soil placement of only 15cm proved adequate for tree growth and survival. Tree mortality was not influenced by soil depth. The tree growth response to varying soil depth placements split into two groups: a shallow 15 to 30cm depth and a deeper 40 to 65cm depth. Regression analyses did not show a strong relationship between soil depth and tree growth parameters used in this study. There are significant differences in growth parameters (total height, leader length, dbh and site index) between, but not within, these groupings. There is a very high tree seedling mortality on treatments with no soil, but tree survival is not influenced by varying soil depth once a minimal depth is met.

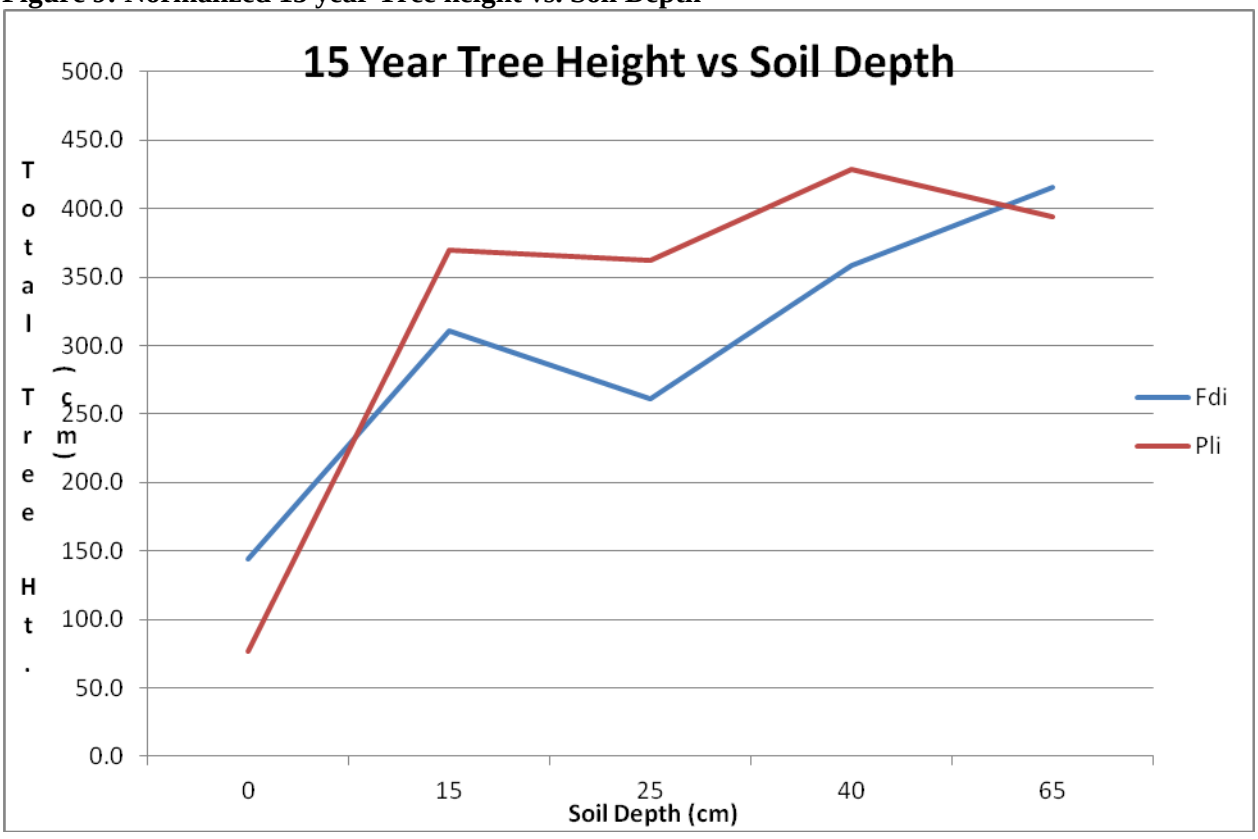
Table 8: Growth parameter means on 1998 / 1999 Trial at varying soil depth

	MEANS									
	Total. Height 15yr (cm)		Site Index (TA) 50yr (m)		Site Index (GI) 50yr (m)		Dbh (cm)		Leader Length (cm)	
Soil(cm)	Pli	Fdi	Pli	Fdi	Pli	Fdi	Pli	Fdi	Pli	Fdi
0	76.6	144.0	9.8	13.3	15.0	20.9	2.8	2.4	9.2	21.8
15	370.1	310.5	16.2	18.0	18.6	23.4	6.6	4.2	43.8	49.2
25	362.3	260.8	15.6	16.8	18.5	20.9	6.2	3.4	41.9	36.5
40	428.6	358.7	17.4	19.4	19.3	23.7	7.6	4.9	41.3	46.7
65	393.9	415.7	16.3	21.7	18.9	24.8	6.3	5.9	51.7	51.3

Table 8 gives the means of various growth parameters at varying soil depths on the

1998/1999 trial. This table excludes treatments with ameliorated soils, but treatments with varying seeding mixes as seeding mixes proved to be of no influence to tree growth. The growth intercept site index for Douglas-fir is meeting target site index (22.1m) with the minimal soil depth of 15cm. The Douglas-fir leader growths are similar on all soil replacement sites, therefore current tree growth is keeping pace even on the minimal soil of 15cm. Lodgepole pine site index (GI) (18.5 to 19.3m) is very similar on varying soil depths. They are tracking below the target of 22.4m and are not on track to meet growth expectation on any soil depth treatment. The leader growth is similar for the 15 to 40cm soil depths, but it increases nearly 20% on the 65cm soil depth. We may be seeing a future differential of tree growth due to soil depth. Lodgepole pine is less drought and heat tolerate than Douglas-fir, but it is less nutrient demanding (Klinka, 2000). This may allow for adequate soil nutrients and moisture at the beginning, but forecast the onset of future moisture deficits for lodgepole pine due to inadequate soil moisture capacity. Figure 8 shows an increase of tree growth through the shallow soil depth group (15 -25cm) and then another significant increase in tree growth for the deeper soil group (40 – 65cm). During the last reporting phase (2006 – 2012) the mean annual temperature is 1 to 2^0 C warmer, which favours Douglas-fir growth over lodgepole pine.

Figure 9: Normalized 15 year Tree height vs. Soil Depth



Soil Amelioration

Tests with various soil amendments were conducted to test their effect on tree seedling survival and growth. Tea bags proved to have no lasting effect on any tree growth parameter, but seemed to affect survival of the seedlings. Biosolids results are inconsistent based on the year of the trial. The 1998/1999 Trial showed a significant increase in growth and site indices due to biosolid additions. Leader growth, however, is similar on non-biosolid treatments and biosolid treatments, indicating that the phase of response to biosolids is past. On the 1998/1999 Trial no significant difference is seen in growth and productivity between the 75 and 150 dT/ha treatments. In the 2000 Trial, the 50 dT/ha application showed no affect on tree growth on treatments with soil amendments. Trees did, however, show some response to biosolids directly mixed with waste rock - but not enough to produce adequate growth.

Tea bags improved initial tree survival and the survival for both tree species. On the 1998/1999 trial 75 dt/ha did not affect Douglas-fir mortality, but seemed to have a modest effect on lodgepole pine. The 150 dT/ha did increase tree mortality for both species. Biosolids has had a catastrophic effect on tree survival in the 2000 trial, even at the lower application rate of 50 dT/ha. The mortality greatly increased in the second growing season and lasted to year 6 which seems to rule out poor seedling handling, inadequate planting quality, and biosolid toxicity.

Revegetation.

The overall trial was limited to the following variables as to revegetation techniques: the custom Mount Polley seed blend at 20 and 40 kg/ha that was either direct dry seeded or hydroseeded; and a more native based blend that was direct dry seeded at 40 kg/ha. With one exception, where the treatment was nutrient-loaded with added tailings and biosolids, the graminoids and forbs, either by direct seeding or natural ingress, offered no competition to the plantation. Hydroseeding directly onto waste rock improved survivability of tree seedlings, but growth was very poor. Otherwise, no effect on tree mortality and productivity was noted. Lower seed rates with greater proportions of native species should be considered to promote biodiversity and long term soil productivity. The seedling mortality rate is high, likely due to the site's locale being exposed and harsh climate; the environment being exacerbated by this being a reclaimed site. Consideration should be given to an increase of tree planting density and/or direct seeding with tree seed for an improved tree survival and stocking rate.

Recommendations:

At this stage of the research, the reclamation recommendations assembled from current data would be a minimum soil amendment of 40cm with light addition of biosolids (50 to 75dT/ha) with a light seeding (5 -10kg/ha) of low-growing, non-competing species of grasses and forbs (bias towards native species). Care is required in revegetation choices both to minimize vegetation competition and to accomplish erosion and noxious weed control. The addition of coarse woody debris to the site (20 to 40m^3/ha) is also recommended, as science (Timberline Forestry Consultants Ltd, 2006) increasingly indicates its importance in maintaining healthy ecosystems.

The following are future study recommendations for this trial:

- Continue maintenance of the trial for the foreseeable future--ideally to a full 50 years. This trial is highly beneficial to operational reclamation which is at its infancy for this mine site: it acts as an early warning to possible challenges for the future function and stability of this planned re-constructed ecosystem;
- Consider tree foliar analysis to determine tree nutrient and heavy metal levels and do additional analysis with the tree growth data collected;
- Measure soil nutrient, heavy metal and soil physical proprieties. This will characterize the soil used in the trial and help with additional data for analysis;
- Measure vegetation biomass on the trial plots to help correlation to soil and ecosystem productivity and, in conjunction, do heavy metal analysis. (Refer to Mount Polley Mining Corporation Vegetation Metal Survey, 2007);
- Initiate a trial on the Tailings Disposal Site to determine reclamation options on this material; and
- Do a study of root growth and possible extension through to the rock waste material.

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APPENDICES

Appendix 1 – Composition Seed Mixtures.

Appendix 2 – Analysis of Biosolids.

Appendix 3 – Available Water Storage Capacity.

Appendix 4 – Summary of Means.

Appendix 5 – Weather Data Summary 2006 -2012.

Appendix 6 – Data 2012.

Appendix 7 – Statistic Significance Summary 2012.

Appendix 8 – Mortality Table 2012.

Appendix 9 – Vigour Crosstabulation.

Appendix 10 – Soil Depth Regression Runs.

Appendix 11 – General Linear Modal Runs.

Appendix 12 – 2012 Treatment Regime Plot Photos

- Appendix 12 is too large to submit in this document. All photos from the 2012 assessment are available upon request.

Appendix 1 – Composition Seed Mixtures

Appendix 1 – Composition of Seed Mixtures.

Mount Polley Mixture		Pickseed Mixture		Symbios Mixture	
Species	**%***	**Species**	**%***	**Species**	**%***
Poa compressa	5.0	*Elymus cinereus*	25.0	*Lupinus polyphyllus*	82.5
Trifolium pratense	20.0	*Festuca ovina*	25.0	*Brachyrhizobium* inn.	0.7
Trifolium repens	5.0	Wild-Flowers	12.5	*Elymus glaucus*	7.1
Festuca rubra	20.0	*Dactylis glomerata*	12.5	*Dryas drummondii*	1.4
Agrostis alba	2.0	*Trifolium repens*	12.5	*Carex mertensii*	6.4
Phleum pratense	5.0	*Poa palustris*	12.5	*Achillea millefolium*	1.3
Lotus comiculatus	10.0			*Festuca occidentalis*	0.7
Festuca ovina	8.0				
Lollum perenne	25.0				

* % Composition by weight.

Appendix 2 – Analysis of Biosolids

Appendix 2 – Analysis of Biosolids (GVRD).

SAMPLE	Annacis Bin 5 #1	Annacis Bin 5 #2
Date Collected	1998/07/08 15:00	1998/07/08 15:00
Ammonia as N mg/kg-dry	6940	6950
Arsenic Total mg/kg-dry	7.6	9.0
Cadmium Total mg/kg-dry	4.8	4.9
Cobalt Total mg/kg-dry	3.2	3.5
Kjeldahl Nitrogen Total mg/kg-dry	42 000	43 900
Lead Total mg/kg-dry	122	131
Mercury Total mg/kg-dry	2.9	3.2
Molybdenum Total mg/kg-dry	7.9	8.4

Appendix 3 – Available Water Storage Capacity

Appendix 3 - Available Water Storage Capacity by Treatment.

Treatment	A	B	C	D	E	F	G	H	I	J	K	L	M
AWSC (cm)*	0.0	1.0	0.9	1.0	1.0	1.5	1.0	2.8	5.4	1.1	1.9	3.4	3.9
Treatment	N	O	P	Q	R	S	T	U	V	W	X	Y	
AWSC (cm)*	*2.1*	*1.1*	*0.0*	*0.0*	*1.1*	*2.1*	*2.1*	*1.1*	*0.0*	*0.0*	*1.1*	*2.1*	

* Soil amendment AWSC contribution does not include RDS material contribution.

Appendix 4 – Summary of Means

Appendix 4 - Summary of Means

Douglas-Fir Planted 1998					Lodgepole Pine Planted 1998				
Treatment Regime	**Count**	**Total Height (cm)**	**Leader Length (cm)**	**dbh (cm)**	**Treatment Regime**	**Count**	**Total Height (cm)**	**Leader Length (cm)**	**dbh (cm)**
A	7	165.9	21.8	2.4	A	19	85.4	9.2	2.8
B	35	359.1	46.7	4.4	B	76	450.0	42.0	7.4
C	20	205.8	23.0	2.3	C	85	335.5	26.6	4.7
D	29	535.7	51.6	7.5	D	62	505.6	41.5	8.5
E	25	499.0	57.2	7.0	E	58	463.5	44.8	8.3
F	28	289.9	33.4	3.7	F	75	415.4	37.0	6.8
G	32	349.4	47.9	4.3	G	69	404.7	41.1	6.2
H	28	455.7	50.3	5.5	H	74	496.6	40.2	8.2
I	28	488.6	51.6	6.5	I	-------	-------	-------	-------

Douglas-Fir Planted 1999					Lodgepole Pine Planted 1999				
Treatment Regime	**Count**	**Total Height (cm)**	**Leader Length (cm)**	**dbh (cm)**	**Treatment Regime**	**Count**	**Total Height (cm)**	**Leader Length (cm)**	**dbh (cm)**
H	4	247.9	40.4	2.6	H	7	488.6	51.6	6.5
I	9	349.3	50.3	3.9	I	57	393.9	51.7	6.3
J	10	340.8	59.8	3.6	J	31	322.8	50.8	5.4
K	13	267.4	42.9	2.9	K	47	338.4	49.6	5.3
L	10	272.2	39.2	3.4	L	28	393.0	47.3	6.9
M	5	389.7	74.1	5.1	M	18	341.0	44.8	6.3

Douglas-Fir Planted 2000					Lodgepole Pine Planted 2000				
Treatment Regime	**Count**	**Total Height (cm)**	**Leader Length (cm)**	**dbh (cm)**	**Treatment Regime**	**Count**	**Total Height (cm)**	**Leader Length (cm)**	**dbh (cm)**
N	------	------	-------	------	N	13	339.0	48.1	5.0
O	2	370.7	62.3	4.0	O	26	335.9	52.6	5.1
P	9	330.1	54.8	3.9	P	34	340.1	39.4	5.9
Q	9	335.6	54.5	4.6	Q	23	300.6	41.3	4.5
R	------	------	------	------	R	33	324.1	49.8	5.0
S	3	255.3	49.7	2.4	S	31	316.2	48.8	4.7
T	46	312.2	58.4	3.3	T	87	315.6	50.0	4.6
U	47	280.0	54.8	3.3	U	100	312.0	48.1	4.4
V	14	72.1	9.0	1.8	V	73	85.2	11.1	3.2
W	1	224.0	46.2	1.4	W	67	77.2	9.2	2.7
X	31	280.4	55.6	3.0	X	114	337	53.4	5.0
Y	39	302.6	55.3	3.3	Y	99	333.2	46.9	4.8

Douglas-Fir						Lodgepole Pine					
T.R	Height	#	SI TA	#	SI GI	T.R	Height	#	SI TA	#	SI GI
A	144.0	4	13.3	3	20.9	A	76.6	3	9.8	3	15.0
B	311.4	36	17.6	32	23.1	B	409.4	76	17.2	67	19.5
C	182.8	14	13.7	12	18.2	C	306.5	87	13.7	69	14.9
D	484.6	31	24.0	29	26.0	D	462.3	64	18.5	63	20.3
E	441.8	25	22.8	25	25.2	E	422.1	61	17.4	50	19.5
F	257.7	24	16.6	20	19.2	F	377.1	76	16.1	68	18.3
G	309.8	32	18.5	31	23.1	G	363.8	70	15.8	63	17.6
H	385.7	32	20.3	28	23.7	H	441.0	81	17.7	71	19.4
I	415.7	37	21.7	31	24.8	I	394.0	57	16.7	51	18.9
J	340.8	10	18.3	10	24.9	J	312.7	31	14.4	26	18.4
K	267.4	11	17.3	11	24.0	K	338.4	47	14.8	39	18.8
L	272.2	9	16.5	8	23.8	L	393.0	28	16.5	26	18.8
M	389.7	5	20.4	4	24.8	M	341.0	18	14.9	17	17.6
N	------	------	------	------	------	N	387.1	13	16.2	13	19.2
O	433.0	2	21.6	2	27.8	O	388.6	26	16.1	26	19.3
P	385.0	9	20.0	9	26.4	P	379.5	29	17.4	29	18.6
Q	390.1	9	19.9	9	25.5	Q	341.9	23	14.7	23	17.8
R	------	------	------	------	------	R	373.9	33	15.6	33	18.7
S	305.0	3	16.5	3	23.9	S	365.0	31	15.3	31	19.3
T	370.6	45	19.4	45	26.7	T	365.6	84	15.6	83	19.9
U	334.8	47	17.6	47	26.6	U	360.1	100	15.2	100	19.4
V	76.7	3	13.5	2	17.2	V	91.3	11	13.0	7	18.2
W	270.2	1	14.8	1	22.4	W	85.1	7	11.9	5	16.2
X	336.0	30	17.9	30	25.5	X	391.3	114	16.1	113	19.7
Y	358.0	39	18.7	39	25.8	Y	376.8	98	16.0	98	19.2

SI TA – Site Index using Site Index curve modal (total age).

SI GI – Site Index using Growth Intercept modal (breast height age).

Appendix 5 – Weather Data Summary 2006-2012

Appendix 5 - Weather Data Summary 2006 - 2013

Weather Data Mount Polley Mining Corp
Current Year 2013

Month	Monthly Precipitation (mm as rain)							Average Temperature						
	2006	2007	2008	2009	2010	2011	2012	2006	2007	2008	2009	2010	2011	2012
January					0.8	0.00	0.00	-1.9	-5.31	-7.48	-7.48	-2.18	-7.30	-7.12
February					1	0.00	0.00	-5.2	-3.95	-3.43	-6.12	-1.92	-9.63	-3.33
March	4.6	70.1			20.603	0.00	0.00	-0.5	0.18	-1.65	-4.2	1.75	-1.65	-1.37
April	29.802	123.02	116.21	21.4	26.8	71.4	121	4.8	2.91	1	2.51	4.57	1.13	3.7
May	34.004	21.801	66	55.2	48.402	92.8	32.2	9.4	9.4		7.796	7.63	7.34	8.03
June	41.603	68.002		42.8	83.608	80.2	118.4	14	11.81		13.23	11.53	11.13	10.79
July	55.806	27.804	56	38.2	20.6	104.1	40.0	11.38	16.99		17.65	16.04	11.73	16.92
August	19.202	16.4	60.6	15	47.204	63.2	9.2	14.47	13.52	14.11	15.95	14.71	14.31	15.93
September	58.4	2.6	25.2	47.4	69.20	19.4	6.4	10.99	11.07	10.41	12.2	8.51	12.15	12.45
October	39.8		28.4	58.4	23.40	35.2	55.6	3.74		3.86	1.56	5.87	3.77	2.46
November		40.2	62	43.6	27.4	24	36.4	-1.97	-2.8	0.73	0.76	-4.711	-3.707	-1.69
December			0.2		0.6	0	0	-2.9	-12	-11.37	-10.5	-4.24	-3.75	-5.77
Total	283.22	369.93	414.61	322	369.619	490.3	419.2	4.7	3.8	0.7	3.6	4.8	3.0	4.3
Snowpack	484	222	135	856	436	744	672							
Total Moist.	767.22	591.925	549.61	1178	805.619	1234.3	1091.2							
Pediod Avg.	**888.27**							**3.5**						

Appendix 5 - Weather Data Summary 2006 - 2013

Weather Data Mount Polley Mining Corp
Current Year 2013

Month	Max Temperature							Minimum Temperature						
	2006	2007	2008	2009	2010	2011	2012	2006	2007	2008	2009	2010	2011	2012
January	6.22	3.74	2.03	2.89	5.81	3.74	5.81	-6.82	-25.19	-33.7	-25.19	-18.76	-22.6	-32.5
February	5.4	4.15	7.43	3.74	6.22	3.31	4.51	-16.68	-13.49	-20.24	-22.6	-6.82	-26.11	-16.68
March	9.82	9.82	6.62	7.43	11.38	8.23	9.82	-14.1	-10.01	-12.29	-26.11	-10.01	-23.44	-14.1
April	19.42	18.28	14.09	13.32	22.09	12.55	14.09	-4.82	-14.73	-10.56	-8.38	-5.81	-5.81	-5.31
May	28.31	24.01	28.5	23.63	20.57	19.81	20.95	-3.37	-0.16	-2.6	-1.51	-2.9	-0.16	-1.51
June	29.5	29.1		25.95	22.86	22.48	25.17	4.15	3.31		2.89	2.46	3.74	2.03
July	32.34	32.3	33	31.12	28.31	22.86	27.91	6.62	7.43		7.03	3.74	2.89	4.99
August	26.73	28.31	29.1	31.12	27.91	24.79	29.9	4.15	3.74	2.89	5.81	4.15	4.15	4.15
September	28.7	22.48	23.63	27.2	21.71	26.34	26.32	0.29	4.99	0.73	-0.61	0.29	2.46	0.73
October	16.38		23.63	12.93	22.09	12.93	15.87	-10.56		-4.82	-8.91	-2.44	-1.97	-9.41
November	10.6	6.62	9.82	9.42	13.7	4.57	8.54	-29.1	-16.68	-6.31	-10.01	-25.19	-16.68	-13.39
December	4.15	4.49	4.57	2.46	4.99	3.74	6.69	-12.29	-19.49	-29.1	-29.1	-17.36	-11.7	-18.47

AVERAGE SNOWPACK DEPTH (SNOW WATER EQUIVALENT, mm)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
January		131	120	119	107	147	206	103	99		206	103	160	198	139
February		173	127		139	139	177	99	123		177	99	195	193	123
March		190	133	271	114		227	177			277	177	284	169	248
December	195	189	88	96		135	196	105		135	196	57	105	112	
Total		683	468	486	360	421	806	484	222	135	856	436	744	672	510

EVAPORATION (mm)

	1997	1998	1999	2000	2001	2002	2003	2005	2006	2007	2008	2009	2010	2011	2012
April											19.8				
May	47	40	47	64.3	21.5	47	47		55.0	66.9	53.4	47.0	61.7	70.0	46.0
June	71	139.9	105.8	105.5	89.9	98.3	112		73.0	49.5	66.5	112.0	77.2	98.1	71.4
July	65.7	143.4	108.9	107	103.5	107	145	64.54	106.0	65.6	81.6	107.0	99.2	81.0	88.4
August	94.2	144	110	92	78.8	92	145	79.59	66.0	60.4	35.3	92.0	81.9	60.6	65.3
September	51.6	59	49	50	50	43.3	50	25.7	60.0	21.9	76.3	50.0	61.6	33.9	65.8
October	14.9	16.7	26.9	15	26	22.5	15	17	27.0	18.9	5.3	15.0	38.7	12.9	21.3
November	2.8														

Appendix 6 – Data 2012

Appendix 6 - Data 2012

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1055	A	A20	Fdi	367.5	2	6	16	42.9	4.1		324.6	18.15	23.17	0	0	0	0	CONV
1056	A	A20	Fdi	236.2	2	4	16	35.3	1.9		200.9	12.84	19.20	0	0	0	0	CONV
1	A	A20	Pli	35.7	1		16	3.8		1.7	31.9			0	0	0	0	CONV
1054	A	A20	Pli	72.6	1		16	5.2		2.3	67.4			0	0	0	0	CONV
1057	A	A20	Pli	253.2	2	5	16	22.1	3.0		231.1	11.00	15.24	0	0	0	0	CONV
1058	A	A20	Pli	20.7	1		16	8.9		1.1	11.8			0	0	0	0	CONV
1	A	A28	Fdi	36.0	1		16	4.0		3.0	32			0	0	0	0	CONV
1059	A	A28	Pli	61.0	1		16	5.0		1.6	56			0	0	0	0	CONV
1	A	A5	Fdi	245.8	3	4	16	35.5	1.2		210.3	13.83	20.27	0	0	0	0	CONV
1183	A	A5	Fdi	44.5	1		16	7.0		2.5	37.5			0	0	0	0	CONV
1184	A	A5	Fdi	97.5	1		16	8.0		5.3	89.5			0	0	0	0	CONV
1189	A	A5	Fdi	133.5	2		16	20.0		5.6	113.5	8.25		0	0	0	0	CONV
1094	A	A5	Pli	83.0	1		15	9.0		1.5	83.0			0	0	0	0	CONV
1097	A	A5	Pli	77.5	1		15	8.0		2.7	77.5			0	0	0	0	CONV
1179	A	A5	Pli	98.0	1		16	8.6		2.8	89.4			0	0	0	0	CONV
1180	A	A5	Pli	63.0	1		16	7.5		1.7	55.5			0	0	0	0	CONV
1181	A	A5	Pli	47.0	1		16	5.0		1.1	42.0			0	0	0	0	CONV
1182	A	A5	Pli	30.1	1		16	9.5		1.1	20.6			0	0	0	0	CONV
1185	A	A5	Pli	78.0	1		16	6.5		2.2	71.5			0	0	0	0	CONV
1186	A	A5	Pli	65.5	1		16	3.5		1.5	62.0			0	0	0	0	CONV
1187	A	A5	Pli	91.0	1		16	4.5		2.6	86.5			0	0	0	0	CONV
1188	A	A5	Pli	14.2	1		16	0.0		0.7	14.2			0	0	0	0	CONV
1190	A	A5	Pli	167.0	3	2	16	10.2		5.9	156.8	7.72	15.19	0	0	0	0	CONV
1191	A	A5	Pli	54.0	1		16	9.0		1.2	45.0			0	0	0	0	CONV
1192	A	A5	Pli	243.3	1	5	16	37.8	2.5		205.5	10.76	14.63	0	0	0	0	CONV
1193	A	A5	Pli	53.0	1		16	4.5		1.5	48.5			0	0	0	0	CONV
1194	A	A5	Pli	107.5	1		16	10.1		3.1	97.4			0	0	0	0	CONV
1195	A	A5	Pli	68.5	1		16	14.0		2.0	54.5			0	0	0	0	CONV
2	B	B15	Fdi	378.3	3	6	16	54.0	3.7		324.3	18.80	23.88	15	0	0	0	CONV
6	B	B15	Fdi	253.6	2	5	16	32.3	2.4		221.3	14.14	17.48	15	0	0	0	CONV
405	B	B15	Fdi	375.1	3	7	16	58.5	3.9		316.6	18.64	20.74	15	0	0	0	CONV
413	B	B15	Fdi	440.6	2	7	16	44.4	5.3		396.2	19.96	24.46	15	0	0	0	CONV
416	B	B15	Fdi	330.0	2	7	16	47.0	3.8		283.0	16.50	18.02	15	0	0	0	CONV
421	B	B15	Fdi	218.3	1		16	49.2		4.6	169.1	12.37		15	0	0	0	CONV
424	B	B15	Fdi	366.6	3	5	16	65.8	3.5		300.8	17.99	26.80	15	0	0	0	CONV
427	B	B15	Fdi	376.2	3	6	16	58.2	4.0		318.0	18.69	23.74	15	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
428	B	B15	Fdi	322.2	2	6	16	45.8	3.2		276.4	16.50	20.08	15	0	0	0	CONV
431	B	B15	Fdi	446.2	4	7	16	57.7	5.1		388.5	20.22	24.77	15	0	0	0	CONV
433	B	B15	Fdi	275.0	1	5	16	41.0	2.4		234.0	14.14	19.40	15	0	0	0	CONV
436	B	B15	Fdi	217.4	2	3	16	44.3	1.2		173.1	12.37	21.52	15	0	0	0	CONV
1	B	B15	Pli	477.2	3	9	16	54.8	8.7		422.4	18.04	18.28	15	0	0	0	CONV
3	B	B15	Pli	510.4	3	8	16	37.4	8.5		473.0	19.14	20.48	15	0	0	0	CONV
4	B	B15	Pli	391.5	2	7	16	48.8	6.2		342.7	15.60	18.23	15	0	0	0	CONV
5	B	B15	Pli	416.3	3	9	16	46.8	8.5		369.5	15.81	16.50	15	0	0	0	CONV
410	B	B15	Pli	381.5	3	8	16	32.2	5.2		349.3	15.60	16.52	15	0	0	0	CONV
411	B	B15	Pli	399.6	3	9	16	56.6	6.4		343.0	15.60	15.99	15	0	0	0	CONV
414	B	B15	Pli	535.0	3	10	16	36.9	9.1		498.1	19.98	18.67	15	0	0	0	CONV
415	B	B15	Pli	436.0	3	7	16	49.7	6.0		386.3	16.55	19.74	15	0	0	0	CONV
417	B	B15	Pli	516.8	4	10	16	47.4	7.0		469.4	19.38	18.21	15	0	0	0	CONV
418	B	B15	Pli	455.5	3	9	16	53.7	8.4		401.8	17.22	17.66	15	0	0	0	CONV
419	B	B15	Pli	442.6	3	10	16	43.2	8.3		399.4	16.80	16.22	15	0	0	0	CONV
420	B	B15	Pli	478.7	2	9	16	40.9	8.0		437.8	18.10	18.32	15	0	0	0	CONV
423	B	B15	Pli	519.5	3	7	16	47.9	7.7		471.6	19.48	22.32	15	0	0	0	CONV
425	B	B15	Pli	487.3	3	8	16	60.9	9.6		426.4	18.35	19.82	15	0	0	0	CONV
426	B	B15	Pli	486.2	3	7	16	54.1	9.2		432.1	18.31	21.32	15	0	0	0	CONV
429	B	B15	Pli	435.9	2	8	16	25.9	7.0		410.0	16.55	18.28	15	0	0	0	CONV
430	B	B15	Pli	329.0	1		16	0.0	8.6		329.0	13.57		15	0	0	0	CONV
432	B	B15	Pli	334.0	1		16	0.0	8.1		334.0	13.88		15	0	0	0	CONV
432	B	B15	Pli	450.9	1	8	16	41.3	8.3		409.6	17.12	18.74	15	0	0	0	CONV
435	B	B15	Pli	439.7	3	8	16	31.7	6.6		408.0	16.69	18.40	15	0	0	0	CONV
437	B	B15	Pli	335.5	1		16	22.9	7.0		312.6	13.94		15	0	0	0	CONV
442	B	B15	Pli	406.9	2	8	16	41.9	5.2		365.0	15.60	17.36	15	0	0	0	CONV
443	B	B15	Pli	464.5	4	10	16	44.1	8.1		420.4	17.56	16.83	15	0	0	0	CONV
5	B	B25	Fdi	386.1	3	7	16	61.6	3.8		324.5	19.31	21.38	15	0	0	0	CONV
7	B	B25	Fdi	205.9	3		16	34.9		5.1	171.0	12.35		15	0	0	0	CONV
143	B	B25	Fdi	484.0	4	8	16	39.1	6.1		444.9	22.39	23.97	15	0	0	0	CONV
144	B	B25	Fdi	558.8	4	8	16	58.7	7.7		500.1	24.75	27.49	15	0	0	0	CONV
146	B	B25	Fdi	419.3	3	7	16	35.7	5.8		383.6	19.80	23.27	15	0	0	0	CONV
147	B	B25	Fdi	538.5	4	7	16	58.1	6.9		480.4	24.75	29.66	15	0	0	0	CONV
149	B	B25	Fdi	599.2	3	9	16	41.5	7.9		557.7	25.47	26.41	15	0	0	0	CONV
159	B	B25	Fdi	568.7	4	8	16	46.7	7.0		522.0	24.75	27.95	15	0	0	0	CONV
160	B	B25	Fdi	520.5	4	8	16	44.3	7.3		476.2	24.40	25.71	15	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
174	B	B25	Fdi	575.1	4	8	16	59.6	6.7		515.5	24.75	28.24	15	0	0	0	CONV
176	B	B25	Fdi	323.9	3	4	16	67.2	2.4		256.7	16.50	28.07	15	0	0	0	CONV
1153	B	B25	Fdi	278.9	2	4	15	55.5	1.4		278.9	16.5	23.74	15	0	0	0	CONV
1	B	B25	Pli	522.4	4	9	16	51.7	9.0		470.7	19.55	19.52	15	0	0	0	CONV
2	B	B25	Pli	618.4	4	9	16	48.0	10.4		570.4	20.92	21.95	15	0	0	0	CONV
4	B	B25	Pli	557.9	4	9	16	46.4	9.5		511.5	20.12	20.44	15	0	0	0	CONV
6	B	B25	Pli	302.5	1		16	22.1		11.6	280.4	12.73		15	0	0	0	CONV
8	B	B25	Pli	536.0	4	8	16	50.8	8.3		485.2	20.02	21.20	15	0	0	0	CONV
9	B	B25	Pli	694.6	3	9	16	58.7	12.8		635.9	23.06	23.74	15	0	0	0	CONV
10	B	B25	Pli	629.1	3	9	16	39.7	9.7		589.4	21.23	22.21	15	0	0	0	CONV
151	B	B25	Pli	552.2	4	8	16	48.6	7.4		503.6	20.12	21.64	15	0	0	0	CONV
152	B	B25	Pli	597.9	4	9	16	48.2	9.4		549.7	20.32	21.45	15	0	0	0	CONV
154	B	B25	Pli	120.2	1		16	24.8		4.7	95.4			15	0	0	0	CONV
155	B	B25	Pli	516.8	4	8	16	40.6	7.7		476.2	19.38	20.66	15	0	0	0	CONV
157	B	B25	Pli	494.5	3	9	16	39.2	7.9		455.3	18.62	18.76	15	0	0	0	CONV
158	B	B25	Pli	544.8	4	8	16	27.4	10.4		517.4	20.12	21.44	15	0	0	0	CONV
162	B	B25	Pli	511.3	3	8	16	40.8	6.5		470.5	19.17	20.51	15	0	0	0	CONV
164	B	B25	Pli	590.9	2	8	16	31.4	9.7		559.5	20.13	22.66	15	0	0	0	CONV
165	B	B25	Pli	472.2	3	7	16	36.8	6.5		435.4	17.86	20.89	15	0	0	0	CONV
166	B	B25	Pli	550.6	3	9	16	36.2	9.9		514.4	20.12	20.25	15	0	0	0	CONV
167	B	B25	Pli	409.9	3	7	16	24.9	6.0		385.0	15.63	18.87	15	0	0	0	CONV
168	B	B25	Pli	494.7	1	9	16	41.2	9.2		453.5	18.63	18.77	15	0	0	0	CONV
169	B	B25	Pli	366.6	1		16	41.2		12.0	325.4	15.24		15	0	0	0	CONV
171	B	B25	Pli	622.3	4	9	16	51.1	9.7		571.2	21.05	22.05	15	0	0	0	CONV
173	B	B25	Pli	377.6	2	6	16	40.3	5.2		337.3	15.60	19.39	15	0	0	0	CONV
177	B	B25	Pli	580.8	3	9	16	59.5	8.9		521.3	20.12	21.02	15	0	0	0	CONV
178	B	B25	Pli	601.2	4	9	16	56.0	9.1		545.2	20.43	21.53	15	0	0	0	CONV
1152	B	B25	Pli	552.6	3	8	15	49.7	7.8		552.6	20.55	21.65	15	0	0	0	CONV
1	B	B3	Fdi	133.0	1		16	0.0	4.5		133.0	8.25		15	0	0	0	CONV
2	B	B3	Fdi	386.5	2	6	16	57.5	4.4		329.0	19.33	24.41	15	0	0	0	CONV
4	B	B3	Fdi	173.3	2	2	16	27.0		5.5	146.3	10.40	19.95	15	0	0	0	CONV
329	B	B3	Fdi	375.4	4	8	16	53.2	5.4		322.2	18.65	18.49	15	0	0	0	CONV
334	B	B3	Fdi	140.0	1		16	14.0		4.1	126.0	9.00		15	0	0	0	CONV
336	B	B3	Fdi	370.4	2	7	16	53.9	3.3		316.5	18.29	20.46	15	0	0	0	CONV
338	B	B3	Fdi	304.7	2	5	16	44.7	3.0		260.0	16.19	21.92	15	0	0	0	CONV
347	B	B3	Fdi	286.6	2	5	16	44.1	2.4		242.5	14.87	20.40	15	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
356	B	B3	Fdi	287.8	2	5	16	46.6	3.4		241.2	14.93	20.50	15	0	0	0	CONV
358	B	B3	Fdi	276.2	2	4	16	45.8	2.5		230.4	14.14	23.47	15	0	0	0	CONV
362	B	B3	Fdi	329.9	3	6	16	46.4	3.5		283.5	16.50	20.62	15	0	0	0	CONV
364	B	B3	Fdi	325.8	2	5	16	57.3	3.2		268.5	16.50	23.63	15	0	0	0	CONV
3	B	B3	Pli	198.1	1		16	26.3	5.3		171.8	9.32		15	0	0	0	CONV
328	B	B3	Pli	475.0	4	8	16	62.7	8.1		412.3	17.96	19.46	15	0	0	0	CONV
330	B	B3	Pli	439.0	3	8	16	38.4	6.0		400.6	16.67	18.38	15	0	0	0	CONV
331	B	B3	Pli	517.5	3	10	16	28.0	8.2		489.5	19.41	18.23	15	0	0	0	CONV
333	B	B3	Pli	417.6	1		16	54.0	6.6		363.6	15.86		15	0	0	0	CONV
335	B	B3	Pli	483.0	3	8	16	46.7	7.9		436.3	18.19	19.70	15	0	0	0	CONV
337	B	B3	Pli	443.0	3	7	16	32.6	7.1		410.4	16.82	19.97	15	0	0	0	CONV
337	B	B3	Pli	453.4	3	7	16	33.8	7.4		419.6	17.14	20.30	15	0	0	0	CONV
339	B	B3	Pli	348.7	3	6	16	40.3	4.8		308.4	14.49	18.23	15	0	0	0	CONV
340	B	B3	Pli	387.8	3	6	16	49.0	5.7		338.8	15.60	19.79	15	0	0	0	CONV
341	B	B3	Pli	399.6	3	7	16	51.0	4.7		348.6	15.60	18.52	15	0	0	0	CONV
342	B	B3	Pli	462.0	3	8	16	26.0	7.4		436.0	17.47	19.08	15	0	0	0	CONV
343	B	B3	Pli	375.4	2	6	16	39.9	4.5		335.5	15.60	19.31	15	0	0	0	CONV
345	B	B3	Pli	232.3	1		16	17.0	5.6		215.3	10.76		15	0	0	0	CONV
346	B	B3	Pli	382.5	2	6	16	45.8	6.0		336.7	15.60	19.58	15	0	0	0	CONV
348	B	B3	Pli	420.3	2	7	16	30.7	7.8		389.6	15.96	19.22	15	0	0	0	CONV
349	B	B3	Pli	427.0	3	8	16	45.4	6.2		381.6	16.21	18.00	15	0	0	0	CONV
350	B	B3	Pli	317.4	2	6	16	56.1	4.5		261.3	13.09	16.89	15	0	0	0	CONV
353	B	B3	Pli	413.0	3	6	16	44.3	5.1		368.7	15.75	20.73	15	0	0	0	CONV
354	B	B3	Pli	454.3	3	8	16	40.1	7.6		414.2	17.18	18.84	15	0	0	0	CONV
355	B	B3	Pli	402.0	2	7	16	32.4	6.4		369.6	15.60	18.60	15	0	0	0	CONV
357	B	B3	Pli	494.5	3	8	16	54.5	6.5		440.0	18.62	20.03	15	0	0	0	CONV
359	B	B3	Pli	335.0	2	4	16	58.0	3.4		277.0	13.92	22.43	15	0	0	0	CONV
360	B	B3	Pli	351.0	2	6	16	62.7	4.4		288.3	14.59	18.33	15	0	0	0	CONV
361	B	B3	Pli	431.0	3	6	16	56.2	7.2		374.8	16.36	21.38	15	0	0	0	CONV
363	B	B3	Pli	491.9	3	8	16	56.2	10.0		435.7	18.52	19.96	15	0	0	0	CONV
365	B	B3	Pli	296.0	2	6	16	47.5	4.0		248.5	12.73	15.91	15	0	0	0	CONV
366	B	B3	Pli	460.7	3	9	16	49.4	6.4		411.3	17.42	17.81	15	0	0	0	CONV
368	B	B3	Pli	459.5	1		16	45.8	8.8		413.7	17.37		15	0	0	0	CONV
639	C	C11	Fdi	98.4	1		16	9.9		3.4	88.5			15	0	0	1	CONV
643	C	C11	Fdi	112.4	2		16	6.5		3.0	105.9			15	0	0	1	CONV
648	C	C11	Fdi	194.1	2	4	16	27.8	1.3		166.3	11.00	14.08	15	0	0	1	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
649	C	C11	Fdi	132.0	2		16	12.1	0.4		119.9	8.25		15	0	0	1	CONV
652	C	C11	Fdi	186.7	2	6	16	9.0	1.6		177.7	11.00	9.11	15	0	0	1	CONV
1	C	C11	Pli	275.0	2	8	16	18.6	4.3		256.4	12.20	12.48	15	0	0	1	CONV
616	C	C11	Pli	329.5	2	9	16	19.2	5.6		310.3	13.59	13.66	15	0	0	1	CONV
617	C	C11	Pli	377.0	3	9	16	19.5	5.9		357.5	15.60	15.27	15	0	0	1	CONV
618	C	C11	Pli	263.2	2	7	16	12.7	4.0		250.5	11.60	13.05	15	0	0	1	CONV
619	C	C11	Pli	412.0	3	9	16	19.6	6.1		392.4	15.71	16.37	15	0	0	1	CONV
620	C	C11	Pli	341.5	2	8	16	15.8	4.7		325.7	14.19	15.11	15	0	0	1	CONV
621	C	C11	Pli	331.5	3	9	16	12.5	5.9		319.0	13.73	13.73	15	0	0	1	CONV
622	C	C11	Pli	270.0	2	7	16	21.4	4.0		248.6	11.98	13.37	15	0	0	1	CONV
623	C	C11	Pli	389.1	3	9	16	34.0	5.1		355.1	15.60	15.66	15	0	0	1	CONV
624	C	C11	Pli	464.4	3	8	16	40.1	6.7		424.3	17.56	19.15	15	0	0	1	CONV
625	C	C11	Pli	460.5	3	9	16	33.1	7.6		427.4	17.41	17.81	15	0	0	1	CONV
626	C	C11	Pli	287.2	2	8	16	22.3	5.0		264.9	12.73	13.00	15	0	0	1	CONV
627	C	C11	Pli	342.9	2	9	16	16.5	5.4		326.4	14.25	14.13	15	0	0	1	CONV
628	C	C11	Pli	323.0	2	8	16	17.6	4.5		305.4	13.32	14.42	15	0	0	1	CONV
629	C	C11	Pli	151.8	1	3	16	4.5	1.1		147.3	6.83	9.35	15	0	0	1	CONV
630	C	C11	Pli	153.0	1	4	16	6.2	1.3		146.8	7.27	7.97	15	0	0	1	CONV
631	C	C11	Pli	297.3	2	9	16	16.9	3.9		280.4	12.73	12.47	15	0	0	1	CONV
632	C	C11	Pli	250.0	2	8	16	9.6	3.3		240.4	10.78	11.36	15	0	0	1	CONV
632	C	C11	Pli	250.9	2	8	16	12.4	3.2		238.5	10.82	11.40	15	0	0	1	CONV
633	C	C11	Pli	305.0	2		16	25.6	3.9		279.4	12.73		15	0	0	1	CONV
634	C	C11	Pli	265.4	2	7	16	11.4	3.9		254.0	11.69	13.15	15	0	0	1	CONV
635	C	C11	Pli	265.8	2		16	10.8	5.0		255.0	11.71		15	0	0	1	CONV
636	C	C11	Pli	428.6	3	8	16	34.7	6.7		393.9	16.27	18.05	15	0	0	1	CONV
637	C	C11	Pli	391.1	3	8	16	36.5	4.7		354.6	15.60	16.84	15	0	0	1	CONV
638	C	C11	Pli	348.7	2	8	16	21.4	5.1		327.3	14.49	15.37	15	0	0	1	CONV
641	C	C11	Pli	273.6	2	8	16	15.3	3.8		258.3	12.14	12.42	15	0	0	1	CONV
642	C	C11	Pli	232.5	2	6	16	10.2	2.3		222.3	10.76	12.60	15	0	0	1	CONV
644	C	C11	Pli	193.7	2	8	16	9.7	2.4		184.0	9.20	8.35	15	0	0	1	CONV
645	C	C11	Pli	263.6	2	8	16	14.5	3.6		249.1	11.61	11.98	15	0	0	1	CONV
646	C	C11	Pli	235.1	2	7	16	15.1	3.3		220.0	10.76	11.63	15	0	0	1	CONV
647	C	C11	Pli	220.6	2	6	16	10.1	3.1		210.5	10.20	11.88	15	0	0	1	CONV
650	C	C11	Pli	383.7	3	9	16	31.7	6.2		352.0	15.60	15.48	15	0	0	1	CONV
651	C	C11	Pli	343.4	2	8	16	22.7	4.7		320.7	14.27	15.18	15	0	0	1	CONV
653	C	C11	Pli	205.6	1	6	16	8.4	1.7		197.2	9.32	10.90	15	0	0	1	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
654	C	C11	Pli	306.9	2	7	16	22.6	4.3		284.3	12.73	15.00	15	0	0	1	CONV
751	C	C11	Pli	297.3	2	8	16	22.0	4.1		275.3	12.73	13.41	15	0	0	1	CONV
1	C	C22	Fdi	83.3	1		16	2.7		2.6	80.6			15	0	0	1	CONV
489	C	C22	Fdi	64.6	1		16	2.1		2.3	62.5			15	0	0	1	CONV
493	C	C22	Fdi	41.8	1		16	9.2		3.1	32.6			15	0	0	1	CONV
494	C	C22	Fdi	170.6	2	3	16	12.3	1.0		158.3	10.24	14.03	15	0	0	1	CONV
505	C	C22	Fdi	151.0	2	4	16	4.0	1.0		147.0	9.44	7.36	15	0	0	1	CONV
510	C	C22	Fdi	289.1	3	7	16	36.8	3.0		252.3	15.00	15.42	15	0	0	1	CONV
515	C	C22	Fdi	92.4	1		16	2.5		3.1	89.9			15	0	0	1	CONV
2	C	C22	Pli	171.2	1		16	27.4	1.1		143.8	8.19		15	0	0	1	CONV
481	C	C22	Pli	428.4	3	9	16	26.4	6.6		402.0	16.27	16.87	15	0	0	1	CONV
482	C	C22	Pli	269.9	1		16	15.3	4.8		254.6	11.98		15	0	0	1	CONV
483	C	C22	Pli	57.2	1		16	7.3	2.0		49.9			15	0	0	1	CONV
484	C	C22	Pli	364.7	2	8	16	27.2	4.6		337.5	15.16	15.94	15	0	0	1	CONV
485	C	C22	Pli	400.0	2	8	16	22.2	6.0		377.8	15.60	17.13	15	0	0	1	CONV
486	C	C22	Pli	310.0	2	6	16	22.0	4.5		288.0	12.74	16.56	15	0	0	1	CONV
487	C	C22	Pli	238.8	1	7	16	10.6	3.0		228.2	10.76	11.83	15	0	0	1	CONV
490	C	C22	Pli	261.3	2	6	16	20.5	2.9		240.8	11.43	14.19	15	0	0	1	CONV
491	C	C22	Pli	407.7	2		16	40.9	5.6		366.8	15.60		15	0	0	1	CONV
492	C	C22	Pli	337.1	2	7	16	39.3	4.4		297.8	14.01	16.22	15	0	0	1	CONV
496	C	C22	Pli	151.2	1		16	10.2	1.6		141.0	6.80		15	0	0	1	CONV
497	C	C22	Pli	346.7	2		16	43.8	5.6		302.9	14.41		15	0	0	1	CONV
498	C	C22	Pli	246.2	2	6	16	13.8	3.0		232.4	10.76	13.38	15	0	0	1	CONV
499	C	C22	Pli	351.6	2	8	16	27.8	5.6		323.8	14.61	15.48	15	0	0	1	CONV
500	C	C22	Pli	218.5	2	4	16	22.8	2.0		195.7	9.97	14.87	15	0	0	1	CONV
502	C	C22	Pli	396.0	2	8	16	33.2	5.2		362.8	15.60	17.00	15	0	0	1	CONV
503	C	C22	Pli	284.0	2	6	16	16.5	3.6		267.5	12.71	15.34	15	0	0	1	CONV
504	C	C22	Pli	259.0	2	7	16	17.0	4.0		242.0	11.33	12.85	15	0	0	1	CONV
511	C	C22	Pli	340.0	2	7	16	40.1	5.1		299.9	14.13	16.34	15	0	0	1	CONV
512	C	C22	Pli	210.5	2	5	16	16.8	2.2		193.7	9.34	12.39	15	0	0	1	CONV
513	C	C22	Pli	289.9	2	7	16	21.5	4.2		268.4	12.73	14.27	15	0	0	1	CONV
514	C	C22	Pli	412.0	3	9	16	35.5	5.3		376.5	15.71	16.37	15	0	0	1	CONV
1162	C	C22	Pli	213.0	2	4	15	23.4	2.3		213.0	10.76	14.42	15	0	0	1	CONV
1163	C	C22	Pli	255.6	2	6	15	21.1	2.8		255.6	12.62	13.89	15	0	0	1	CONV
254	C	C8	Fdi	142.3	1		16	14.4	0.5		127.9	9.00		15	0	0	1	CONV
255	C	C8	Fdi	249.6	2	3	16	38.7	1.8		210.9	14.14	25.73	15	0	0	1	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
258	C	C8	Fdi	322.1	2	6	16	45.1	3.0		277.0	16.50	20.07	15	0	0	1	CONV
262	C	C8	Fdi	339.3	2	6	16	33.3	3.8		306.0	16.50	21.27	15	0	0	1	CONV
266	C	C8	Fdi	312.2	3	6	16	48.6	2.3		263.6	16.50	19.37	15	0	0	1	CONV
277	C	C8	Fdi	435.8	3	7	16	47.8	4.5		388.0	19.80	24.19	15	0	0	1	CONV
283	C	C8	Fdi	292.2	3	6	16	41.7	2.4		250.5	15.25	17.93	15	0	0	1	CONV
286	C	C8	Fdi	407.0	4	5	16	56.4	4.9		350.6	19.80	29.78	15	0	0	1	CONV
253	C	C8	Pli	488.0	3	9	16	41.0	8.0		447.0	18.38	18.58	15	0	0	1	CONV
256	C	C8	Pli	478.7	2		16	57.6	7.1		421.1	18.10		15	0	0	1	CONV
257	C	C8	Pli	528.0	3	9	16	46.2	6.0		481.8	19.72	19.66	15	0	0	1	CONV
259	C	C8	Pli	130.0	1		16	26.0	1.0		104.0	5.16		15	0	0	1	CONV
260	C	C8	Pli	568.4	4	11	16	33.8	7.0		534.6	20.12	18.43	15	0	0	1	CONV
261	C	C8	Pli	510.4	3	11	16	50.4	6.7		460.0	19.14	17.02	15	0	0	1	CONV
263	C	C8	Pli	467.5	3		16	42.2	6.5		425.3	17.68		15	0	0	1	CONV
265	C	C8	Pli	516.9	3		16	34.6	7.9		482.3	19.38		15	0	0	1	CONV
268	C	C8	Pli	419.4	3	7	16	43.2	6.5		376.2	15.92	19.19	15	0	0	1	CONV
269	C	C8	Pli	403.2	3	9	16	47.0	5.7		356.2	15.60	16.10	15	0	0	1	CONV
270	C	C8	Pli	393.6	3	9	16	24.6	6.2		369.0	15.60	15.80	15	0	0	1	CONV
271	C	C8	Pli	359.5	2	9	16	35.9	5.0		323.6	14.94	14.69	15	0	0	1	CONV
272	C	C8	Pli	458.4	3	9	16	43.3	6.4		415.1	17.33	17.75	15	0	0	1	CONV
273	C	C8	Pli	383.0	2		16	23.5	5.8		359.5	15.60	17.92	15	0	0	1	CONV
274	C	C8	Pli	382.5	3	7	16	36.3	5.6		346.2	15.60	17.36	15	0	0	1	CONV
275	C	C8	Pli	444.9	3	9	16	58.3	7.1		386.6	16.89		15	0	0	1	CONV
276	C	C8	Pli	348.9	2		16	36.1	4.3		312.8	14.50		15	0	0	1	CONV
278	C	C8	Pli	378.1	2		16	47.2	6.6		330.9	15.60		15	0	0	1	CONV
279	C	C8	Pli	419.6	3	8	16	37.5	6.5		382.1	15.93	17.77	15	0	0	1	CONV
280	C	C8	Pli	455.4	3	8	16	35.3	7.2		420.1	17.22	18.88	15	0	0	1	CONV
281	C	C8	Pli	496.2	3	9	16	42.4	7.1		453.8	18.69	18.81	15	0	0	1	CONV
282	C	C8	Pli	365.3	3	8	16	45.6	4.9		319.7	15.18	15.96	15	0	0	1	CONV
284	C	C8	Pli	526.8	4	10	16	38.6	7.1		488.2	19.67	18.46	15	0	0	1	CONV
285	C	C8	Pli	299.1	2		16	37.1	3.7		262.0	12.73		15	0	0	1	CONV
287	C	C8	Pli	353.0	2		16	31.2	5.0		321.8	14.67		15	0	0	1	CONV
288	C	C8	Pli	256.9	2		16	29.9	3.0		227.0	11.24		15	0	0	1	CONV
1158	C	C8	Pli	251.0	1		15	24.0	3.7		251.0	12.24		15	0	0	1	CONV
4	D	D13	Fdi	381.2	3	6	16	37.0	3.4		344.2	18.94	24.07	15	0	75	0	CONV
8	D	D13	Fdi	429.3	4	6	16	37.6	6.0		391.7	19.80	27.12	15	0	75	0	CONV
76	D	D13	Fdi	487.5	4	7	16	50.3	5.7		437.2	22.55	27.00	15	0	75	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
80	D	D13	Fdi	489.3	4	8	16	52.8	6.0		436.5	22.63	24.22	15	0	75	0	CONV
84	D	D13	Fdi	445.5	3	7	16	48.9	5.1		396.6	20.19	24.73	15	0	75	0	CONV
85	D	D13	Fdi	592.3	4	9	16	42.6	7.1		549.7	25.17	26.13	15	0	75	0	CONV
87	D	D13	Fdi	514.7	1		16	37.0	7.0		477.7	24.13		15	0	75	0	CONV
88	D	D13	Fdi	456.0	4	7	16	51.6	5.6		404.4	20.81	25.30	15	0	75	0	CONV
90	D	D13	Fdi	424.3	3	7	16	54.3	4.4		370.0	19.80	21.73	15	0	75	0	CONV
92	D	D13	Fdi	524.5	4	8	16	47.5	8.0		477.0	24.59	25.90	15	0	75	0	CONV
96	D	D13	Fdi	507.6	3	7	16	50.0	5.9		457.6	23.64	28.06	15	0	75	0	CONV
97	D	D13	Fdi	569.6	4	9	16	56.9	7.0		512.7	24.75	25.20	15	0	75	0	CONV
98	D	D13	Fdi	634.6	4	9	16	39.5	8.5		595.1	27.17	27.83	15	0	75	0	CONV
99	D	D13	Fdi	545.5	3	9	16	32.0	9.0		513.5	24.75	24.20	15	0	75	0	CONV
101	D	D13	Fdi	681.1	4	9	16	58.7	8.4		622.4	29.37	29.66	15	0	75	0	CONV
1148	D	D13	Fdi	503.2	4	8	15	44.1	6.0		503.2	24.75	24.89	15	0	75	0	CONV
1	D	D13	Pli	250.6	1	4	16	33.0	2.9		217.6	10.81	17.28	15	0	75	0	CONV
2	D	D13	Pli	479.5	2	8	16	56.2	6.5		423.3	18.09	19.60	15	0	75	0	CONV
3	D	D13	Pli	569.4	2	8	16	38.2	8.3		531.2	20.12	22.10	15	0	75	0	CONV
5	D	D13	Pli	454.9	2	8	16	49.9	7.0		405.0	17.20	18.86	15	0	75	0	CONV
6	D	D13	Pli	659.2	3	9	16	52.1	8.9		607.1	22.09	22.92	15	0	75	0	CONV
7	D	D13	Pli	618.5	2	8	16	27.1	8.9		591.4	20.92	23.37	15	0	75	0	CONV
9	D	D13	Pli	522.8	4	9	16	31.5	9.1		491.3	19.56	19.53	15	0	75	0	CONV
10	D	D13	Pli	430.0	3	8	16	46.5	5.6		383.5	16.33	18.10	15	0	75	0	CONV
11	D	D13	Pli	353.1	1	7	16	37.0	3.3		316.1	14.68	16.84	15	0	75	0	CONV
66	D	D13	Pli	458.2	2	9	16	29.8	6.5		428.4	17.33	17.74	15	0	75	0	CONV
68	D	D13	Pli	436.6	3	7	16	25.1	9.9		411.5	16.58	19.76	15	0	75	0	CONV
70	D	D13	Pli	463.9	3	8	16	35.7	7.1		428.2	17.54	19.13	15	0	75	0	CONV
73	D	D13	Pli	545.0	3	10	16	30.0	9.9		515.0	20.12	18.92	15	0	75	0	CONV
74	D	D13	Pli	585.0	3	10	16	22.4	9.1		562.6	20.12	19.90	15	0	75	0	CONV
75	D	D13	Pli	525.4	3	8	16	30.4	8.8		495.0	19.62	20.90	15	0	75	0	CONV
77	D	D13	Pli	536.0	3	8	16	24.9	9.3		511.1	20.02	21.20	15	0	75	0	CONV
82	D	D13	Pli	509.6	4	8	16	39.0	9.1		470.6	19.11	20.46	15	0	75	0	CONV
89	D	D13	Pli	595.7	3	9	16	39.7	10.9		556.0	20.29	21.40	15	0	75	0	CONV
91	D	D13	Pli	567.0	4	10	16	37.8	9.8		529.2	20.12	19.46	15	0	75	0	CONV
93	D	D13	Pli	479.0	3	8	16	48.0	9.5		431.0	18.11	19.58	15	0	75	0	CONV
94	D	D13	Pli	408.7	2	8	16	55.3	9.2		353.4	15.60	17.42	15	0	75	0	CONV
95	D	D13	Pli	521.1	3	9	16	30.6	9.0		490.5	19.54	19.48	15	0	75	0	CONV
100	D	D13	Pli	516.0	3	8	16	58.7	9.7		457.3	19.35	20.64	15	0	75	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
102	D	D13	Pli	468.1	3	9	16	42.1	10.0		426.0	17.70	18.02	15	0	75	0	CONV
8	D	D29	Fdi	510.7	4	9	16	60.1	7.9		450.6	23.86	22.73	15	0	75	0	CONV
9	D	D29	Fdi	589.5	4	9	16	57.1	9.8		532.4	25.05	26.01	15	0	75	0	CONV
11	D	D29	Fdi	584.0	3	8	16	52.5	8.9		531.5	24.77	28.65	15	0	75	0	CONV
727	D	D29	Fdi	622.7	4	10	16	62.1	9.8		560.6	26.61	25.03	15	0	75	0	CONV
733	D	D29	Fdi	491.6	4	8	16	50.1	6.8		441.5	22.81	24.33	15	0	75	0	CONV
738	D	D29	Fdi	615.2	3	8	16	68.5	8.5		546.7	26.24	30.05	15	0	75	0	CONV
742	D	D29	Fdi	485.2	4	8	16	44.7	5.7		440.5	22.44	24.02	15	0	75	0	CONV
743	D	D29	Fdi	616.7	3	8	16	75.2	9.7		541.5	26.31	30.12	15	0	75	0	CONV
1	D	D29	Pli	495.2	3	8	16	31.5	7.7		463.7	18.65	20.05	15	0	75	0	CONV
2	D	D29	Pli	462.7	4	8	16	31.1	7.9		431.6	17.50	19.10	15	0	75	0	CONV
3	D	D29	Pli	566.4	3	7	16	52.3	10.0		514.1	20.12	23.65	15	0	75	0	CONV
4	D	D29	Pli	632.1	4	9	16	53.6	10.7		578.5	21.33	22.28	15	0	75	0	CONV
5	D	D29	Pli	519.0	3	7	16	46.5	9.1		472.5	19.46	22.30	15	0	75	0	CONV
6	D	D29	Pli	334.6	1	5	16	25.8	8.0		308.8	13.91	19.61	15	0	75	0	CONV
7	D	D29	Pli	488.7	3	8	16	49.8	9.8		438.9	18.40	19.86	15	0	75	0	CONV
10	D	D29	Pli	551.1	2	8	16	43.3	9.4		507.8	20.12	21.61	15	0	75	0	CONV
735	D	D29	Pli	578.7	3	8	16	41.2	12.3		537.5	20.12	22.34	15	0	75	0	CONV
744	D	D29	Pli	541.0	3	8	16	40.6	10.2		500.4	20.12	21.33	15	0	75	0	CONV
747	D	D29	Pli	598.5	4	8	16	53.9	10.2		544.6	20.34	22.86	15	0	75	0	CONV
748	D	D29	Pli	263.2	2	3	16	32.6	3.3		230.6	11.60	21.55	15	0	75	0	CONV
749	D	D29	Pli	592.7	3	9	16	42.1	9.4		550.6	20.19	21.32	15	0	75	0	CONV
1	D	D4	Fdi	420.4	1		16	63.4		11	357.0	19.80		15	0	75	0	CONV
2	D	D4	Fdi	525.6	3	9	16	54.9	8.1		470.7	24.64	23.36	15	0	75	0	CONV
604	D	D4	Fdi	529.1	4	9	16	43.0	8.1		486.1	24.75	23.51	15	0	75	0	CONV
609	D	D4	Fdi	582.5	4	9	16	52.3	8.5		530.2	24.75	25.73	15	0	75	0	CONV
610	D	D4	Fdi	649.0	4	10	16	57.7	10.2		591.3	27.89	26.00	15	0	75	0	CONV
611	D	D4	Fdi	629.0	4	8	16	57.0	9.5		572.0	26.93	30.67	15	0	75	0	CONV
1174	D	D4	Fdi	481.5	3	7	15	61.2	12.9		481.5	24.75	26.68	15	0	75	0	CONV
581	D	D4	Pli	390.0	3	7	16	48.6	5.6		341.4	15.60	18.18	15	0	75	0	CONV
583	D	D4	Pli	578.8	3	9	16	63.8	8.7		515.0	20.12	20.97	15	0	75	0	CONV
584	D	D4	Pli	599.5	4	9	16	43.9	10.6		555.6	20.37	21.49	15	0	75	0	CONV
585	D	D4	Pli	377.4	2	7	16	37.9	3.3		339.5	15.60	17.73	15	0	75	0	CONV
586	D	D4	Pli	534.6	3	9	16	30.8	9.4		503.8	19.96	19.84	15	0	75	0	CONV
587	D	D4	Pli	621.0	3	9	16	53.7	8.7		567.3	21.01	22.01	15	0	75	0	CONV
588	D	D4	Pli	515.4	3	8	16	35.0	8.3		480.4	19.33	20.62	15	0	75	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
589	D	D4	Pli	514.4	4	9	16	44.0	8.3		470.4	19.29	19.30	15	0	75	0	CONV
590	D	D4	Pli		1		16			15.1	0.0			15	0	75	0	CONV
592	D	D4	Pli	484.0	2	8	16	38.2	9.9		445.8	18.23	19.73	15	0	75	0	CONV
593	D	D4	Pli	586.4	2	5	16	36.4	8.5		550.0	20.12	29.49	15	0	75	0	CONV
594	D	D4	Pli	491.5	3	9	16	48.5	8.3		443.0	18.51	18.68	15	0	75	0	CONV
595	D	D4	Pli	598.0	4	9	16	43.8	11.1		554.2	20.32	21.45	15	0	75	0	CONV
597	D	D4	Pli	479.5	3	8	16	50.0	7.8		429.5	18.09	19.60	15	0	75	0	CONV
598	D	D4	Pli	504.0	4	8	16	44.4	8.7		459.6	18.94	20.30	15	0	75	0	CONV
599	D	D4	Pli	490.1	3	8	16	45.9	6.7		444.2	18.46	19.90	15	0	75	0	CONV
600	D	D4	Pli	460.1	3	7	16	50.8	6.4		409.3	17.40	20.51	15	0	75	0	CONV
601	D	D4	Pli	511.7	4	8	16	39.1	8.9		472.6	19.19	20.52	15	0	75	0	CONV
602	D	D4	Pli	564.8	3	9	16	55.1	8.2		509.7	20.12	20.62	15	0	75	0	CONV
603	D	D4	Pli	445.8	3	7	16	31.7	7.6		414.1	16.93	20.06	15	0	75	0	CONV
605	D	D4	Pli	566.4	2	8	16	32.9	10.5		533.5	20.12	22.02	15	0	75	0	CONV
606	D	D4	Pli	458.5	2	8	16	48.0	7.3		410.5	17.34	18.97	15	0	75	0	CONV
608	D	D4	Pli	457.4	1		16	55.0	8.4		402.4	17.30		15	0	75	0	CONV
613	D	D4	Pli	533.3	2	8	16	51.6	8.5		481.7	19.92	21.12	15	0	75	0	CONV
614	D	D4	Pli	497.2	2	8	16	37.0	8.2		460.2	18.72	20.11	15	0	75	0	CONV
615	D	D4	Pli	507.2	3	8	16	44.2	12.3		463.0	19.02	20.39	15	0	75	0	CONV
1173	D	D4	Pli	529.7	3	9	15	46.4	9.0		529.7	20.12	19.71	15	0	75	0	CONV
1175	D	D4	Pli	286.0	2	5	15	36.0	3.0		286.0	12.87	17.13	15	0	75	0	CONV
671	E	E17	Fdi	654.7	4	10	16	67.9	8.9		586.8	28.13	26.21	15	0	150	0	CONV
674	E	E17	Fdi	631.5	4	10	16	43.0	10.4		588.5	27.04	25.36	15	0	150	0	CONV
683	E	E17	Fdi	541.7	4	8	16	68.4	8.0		473.3	24.75	26.70	15	0	150	0	CONV
878	E	E17	Fdi	528.4	4	7	16	61.4	7.9		467.0	24.75	29.14	15	0	150	0	CONV
656	E	E17	Pli	592.4	4	10	16	34.4	9.9		558.0	20.18	20.07	15	0	150	0	CONV
657	E	E17	Pli	622.8	4	11	16	41.2	9.2		581.6	21.07	19.68	15	0	150	0	CONV
658	E	E17	Pli	658.8	4	11	16	59.5	12.3		599.3	22.08	20.48	15	0	150	0	CONV
659	E	E17	Pli	519.6	3	9	16	50.0	8.9		469.6	19.49	19.44	15	0	150	0	CONV
660	E	E17	Pli	618.4	4	10	16	41.1	12.0		577.3	20.92	20.69	15	0	150	0	CONV
661	E	E17	Pli	669.0	4	11	16	50.1	11.0		618.9	22.37	20.71	15	0	150	0	CONV
662	E	E17	Pli	552.5	3	11	16	38.9	11.4		513.6	20.12	18.05	15	0	150	0	CONV
663	E	E17	Pli	462.4	4	7	16	56.7	5.8		405.7	17.48	20.59	15	0	150	0	CONV
664	E	E17	Pli	595.0	3	10	16	42.0	10.6		553.0	20.27	20.14	15	0	150	0	CONV
666	E	E17	Pli	710.1	4	10	16	56.9	12.8		653.2	23.52	22.75	15	0	150	0	CONV
667	E	E17	Pli	420.0	3		16	34.2	10.7		385.8	15.95		15	0	150	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
668	E	E17	Pli	533.5	3	9	16	57.2	10.0		476.3	19.92	19.81	15	0	150	0	CONV
670	E	E17	Pli	491.1	3	10	16	45.5	10.4		445.6	18.49	17.54	15	0	150	0	CONV
672	E	E17	Pli	559.4	3	9	16	41.1	11.1		518.3	20.12	20.48	15	0	150	0	CONV
677	E	E17	Pli	511.8	3	10	16	33.4	12.0		478.4	19.19	18.08	15	0	150	0	CONV
680	E	E17	Pli	550.0	3	10	16	52.7	11.4		497.3	20.12	19.05	15	0	150	0	CONV
681	E	E17	Pli	505.6	3	9	16	41.1	9.7		464.5	18.96	19.06	15	0	150	0	CONV
682	E	E17	Pli	595.2	4	10	16	36.6	10.2		558.6	20.27	20.14	15	0	150	0	CONV
684	E	E17	Pli	566.6	4	10	16	35.6	10.8		531.0	20.12	19.45	15	0	150	0	CONV
685	E	E17	Pli	466.5	3	7	16	57.0	7.2		409.5	17.64	20.71	15	0	150	0	CONV
686	E	E17	Pli	360.9	1		16	26.1	6.1		334.8	15.00		15	0	150	0	CONV
688	E	E17	Pli	618.0	4	11	16	60.2	13.5		557.8	20.91	19.58	15	0	150	0	CONV
689	E	E17	Pli	581.7	4	9	16	66.4	10.4		515.3	20.12	21.05	15	0	150	0	CONV
1176	E	E17	Pli	449.5	3	8	15	45.5	7.5		449.5	18.68	18.7	15	0	150	0	CONV
1177	E	E17	Pli	549.5	3	9	15	45.1	8.2		549.5	20.43	20.23	15	0	150	0	CONV
2	E	E26	Fdi	401.9	2	7	16	41.4	6.5		360.5	19.80	22.29	15	0	150	0	CONV
179	E	E26	Fdi	541.2	4	9	16	64.0	8.2		477.2	24.75	24.02	15	0	150	0	CONV
180	E	E26	Fdi	488.0	3	8	16	40.0	6.6		448.0	22.57	24.16	15	0	150	0	CONV
191	E	E26	Fdi	459.8	3	7	16	68.6	5.9		391.2	20.98	25.51	15	0	150	0	CONV
192	E	E26	Fdi	411.6	3	8	16	47.0	5.5		364.6	19.80	20.37	15	0	150	0	CONV
197	E	E26	Fdi	590.3	4	9	16	63.7	7.9		526.6	25.09	26.04	15	0	150	0	CONV
205	E	E26	Fdi	478.5	4	8	16	63.4	6.4		415.1	22.06	23.70	15	0	150	0	CONV
1	E	E26	Pli	487.1	4	8	16	60.5	8.1		426.6	18.34	19.82	15	0	150	0	CONV
181	E	E26	Pli	455.6	3	7	16	44.9	7.7		410.7	17.23	20.37	15	0	150	0	CONV
182	E	E26	Pli	463.8	3	8	16	40.9	7.6		422.9	17.54	19.13	15	0	150	0	CONV
184	E	E26	Pli	523.5	1		16	49.6	10.3		473.9	19.59		15	0	150	0	CONV
186	E	E26	Pli	484.0	4	7	16	39.5	9.8		444.5	18.23	21.26	15	0	150	0	CONV
188	E	E26	Pli	394.3	3	7	16	34.6	6.3		359.7	15.60	18.33	15	0	150	0	CONV
190	E	E26	Pli	386.6	1		16	60.6	8.1		326.0	15.60		15	0	150	0	CONV
193	E	E26	Pli	322.6	2	5	16	55.1	5.3		267.5	13.31	19.03	15	0	150	0	CONV
198	E	E26	Pli	567.8	3	10	16	30.8	10.1		537.0	20.12	19.48	15	0	150	0	CONV
199	E	E26	Pli	301.3	2	5	16	44.0	5.0		257.3	12.73	17.95	15	0	150	0	CONV
201	E	E26	Pli	476.8	4	9	16	56.6	7.2		420.2	18.03	18.27	15	0	150	0	CONV
204	E	E26	Pli	462.8	3	8	16	50.0	8.5		412.8	17.50	19.10	15	0	150	0	CONV
206	E	E26	Pli	579.4	4	7	16	49.7	8.0		529.7	20.12	24.01	15	0	150	0	CONV
208	E	E26	Pli	383.9	3		16	39.7	8.0		344.2	15.60		15	0	150	0	CONV
209	E	E26	Pli	171.6	1		16	18.2	1.4		153.4	8.21		15	0	150	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
210	E	E26	Pli	427.2	3	8	16	34.0	8.1		393.2	16.22	18.01	15	0	150	0	CONV
212	E	E26	Pli	486.2	4	7	16	49.3	9.3		436.9	18.31	21.32	15	0	150	0	CONV
213	E	E26	Pli	375.5	3	6	16	49.9	5.7		325.6	15.60	19.31	15	0	150	0	CONV
1155	E	E26	Pli	465.5	3	8	15	55.5	7.1		465.5	19.27	19.18	15	0	150	0	CONV
3	E	E9	Fdi	680.0	4	9	16	66.0	11.0		614.0	29.32	29.62	15	0	150	0	CONV
4	E	E9	Fdi	471.1	3	7	16	54.3	6.5		416.8	21.64	26.12	15	0	150	0	CONV
373	E	E9	Fdi	587.7	4	9	16	59.7	8.2		528.0	24.89	25.94	15	0	150	0	CONV
379	E	E9	Fdi	426.0	2	6	16	52.5	5.3		373.5	19.80	26.92	15	0	150	0	CONV
380	E	E9	Fdi	535.4	3	8	16	63.9	7.0		471.5	24.75	26.41	15	0	150	0	CONV
383	E	E9	Fdi	496.7	4	8	16	70.8	7.1		425.9	23.13	24.58	15	0	150	0	CONV
385	E	E9	Fdi	490.0	2	8	16	58.7	8.5		431.3	22.66	24.25	15	0	150	0	CONV
386	E	E9	Fdi	475.1	2	8	16	62.2	5.6		412.9	21.82	23.53	15	0	150	0	CONV
387	E	E9	Fdi	354.2	2	6	16	44.2	3.9		310.0	17.27	22.28	15	0	150	0	CONV
393	E	E9	Fdi	534.0	3	8	16	48.6	8.0		485.4	24.75	26.34	15	0	150	0	CONV
398	E	E9	Fdi	354.0	2	5	16	64.0	3.6		290.0	17.26	25.84	15	0	150	0	CONV
400	E	E9	Fdi	447.5	4	7	16	59.9	6.3		387.6	20.35	24.84	15	0	150	0	CONV
404	E	E9	Fdi	398.3	2	6	16	47.3	4.2		351.0	19.80	25.17	15	0	150	0	CONV
406	E	E9	Fdi	497.0	3	8	16	49.6	8.3		447.4	23.14	24.59	15	0	150	0	CONV
1	E	E9	Pli	231.8	1	3	16	52.2	1.8		179.6	10.76	18.96	15	0	150	0	CONV
2	E	E9	Pli	317.4	2	6	16	19.8	4.0		297.6	13.09	16.89	15	0	150	0	CONV
5	E	E9	Pli	321.0	3	5	16	66.8	3.5		254.2	13.24	18.95	15	0	150	0	CONV
369	E	E9	Pli	401.0	3	8	16	35.0	6.4		366.0	15.60	17.17	15	0	150	0	CONV
371	E	E9	Pli	393.0	3	7	16	46.0	6.0		347.0	15.60	18.29	15	0	150	0	CONV
372	E	E9	Pli	515.4	3	9	16	38.3	8.5		477.1	19.33	19.33	15	0	150	0	CONV
374	E	E9	Pli	349.8	1		16	31.8	9.4		318.0	14.54		15	0	150	0	CONV
375	E	E9	Pli	328.8	2	6	16	42.3	5.0		286.5	13.56	17.39	15	0	150	0	CONV
376	E	E9	Pli	415.0	2	7	16	29.5	7.1		385.5	15.76	19.04	15	0	150	0	CONV
378	E	E9	Pli	236.4	1	3	16	50.6	2.0		185.8	10.76	19.36	15	0	150	0	CONV
382	E	E9	Pli	419.0	1		16	51.0	8.0		368.0	15.91		15	0	150	0	CONV
388	E	E9	Pli	488.0	2	8	16	44.6	9.7		443.4	18.38	19.84	15	0	150	0	CONV
390	E	E9	Pli	434.4	1		16	47.1	7.8		387.3	16.49		15	0	150	0	CONV
392	E	E9	Pli	422.6	1		16	58.6	8.1		364.0	16.05		15	0	150	0	CONV
394	E	E9	Pli	382.2	1		16	45.2	7.4		337.0	15.60		15	0	150	0	CONV
399	E	E9	Pli	301.0	2	4	16	52.0	4.4		249.0	12.73	20.51	15	0	150	0	CONV
401	E	E9	Pli	416.5	2	7	16	22.2	7.8		394.3	15.81	19.09	15	0	150	0	CONV
1	F	F10	Fdi	199.1	2	5	16	22.2	1.0		176.9	11.45	12.07	25	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
2	F	F10	Fdi	206.0	2	4	16	16.1	1.7		189.9	12.36	15.62	25	0	0	0	CONV
544	F	F10	Fdi	50.0	1		16	4.0		3.4	46.0			25	0	0	0	CONV
545	F	F10	Fdi	238.1	2	5	16	22.1	2.7		216.0	13.10	16.03	25	0	0	0	CONV
553	F	F10	Fdi	255.4	2	5	16	24.5	1.9		230.9	14.14	17.65	25	0	0	0	CONV
555	F	F10	Fdi	195.1	2	5	16	16.1	0.9		179.0	11.00	11.63	25	0	0	0	CONV
556	F	F10	Fdi	221.8	2	5	16	18.0	1.4		203.8	12.37	14.44	25	0	0	0	CONV
564	F	F10	Fdi	98.0	1		16	9.5		3.5	88.5			25	0	0	0	CONV
568	F	F10	Fdi	204.9	2	5	16	10.0	1.4		194.9	12.29	12.69	25	0	0	0	CONV
572	F	F10	Fdi	63.0	1		16			3.2	63.0			25	0	0	0	CONV
575	F	F10	Fdi	155.5	2	3	16	11.5	0.3		144.0	9.90	10.91	25	0	0	0	CONV
543	F	F10	Pli	379.2	3	7	16	28.9	6.1		350.3	15.60	17.80	25	0	0	0	CONV
546	F	F10	Pli	345.6	1	6	16	29.9	5.7		315.7	14.36	18.10	25	0	0	0	CONV
548	F	F10	Pli	435.2	2	7	16	48.1	5.7		387.1	16.52	19.71	25	0	0	0	CONV
549	F	F10	Pli	376.6	3	7	16	26.4	6.6		350.2	15.60	17.70	25	0	0	0	CONV
550	F	F10	Pli	511.9	3	8	16	25.4	9.3		486.5	19.20	20.53	25	0	0	0	CONV
552	F	F10	Pli	442.5	3	8	16	37.1	8.3		405.4	16.80	18.48	25	0	0	0	CONV
554	F	F10	Pli	383.8	3	7	16	46.4	5.9		337.4	15.60	17.96	25	0	0	0	CONV
557	F	F10	Pli	315.1	3	8	16	27.6	3.8		287.5	13.00	14.12	25	0	0	0	CONV
558	F	F10	Pli	536.2	3	9	16	33.2	8.0		503.0	20.02	19.88	25	0	0	0	CONV
559	F	F10	Pli	297.4	1	5	16	28.4	3.5		269.0	12.73	17.74	25	0	0	0	CONV
560	F	F10	Pli	298.5	1	4	16	39.1			259.4	12.73	20.36	25	0	0	0	CONV
561	F	F10	Pli	377.2	3	7	16	19.4	5.5		357.8	15.60	17.73	25	0	0	0	CONV
562	F	F10	Pli	374.6	3	7	16	19.8	5.6		354.8	15.58	17.63	25	0	0	0	CONV
563	F	F10	Pli	320.0	3	6	16	20.5	4.5		299.5	13.20	17.01	25	0	0	0	CONV
565	F	F10	Pli	486.9	3	9	16	30.4	6.7		456.5	18.33	18.55	25	0	0	0	CONV
566	F	F10	Pli	419.9	3	5	16	40.9	6.6		379.0	15.94	23.39	25	0	0	0	CONV
567	F	F10	Pli	224.1	2	5	16	27.6	1.8		196.5	10.36	13.36	25	0	0	0	CONV
569	F	F10	Pli	382.5	3	7	16	44.0	6.1		338.5	15.60	17.92	25	0	0	0	CONV
570	F	F10	Pli	430.5	3	8	16	35.3	5.8		395.2	16.35	18.11	25	0	0	0	CONV
571	F	F10	Pli	200.2	2	4	16	10.2	2.4		190.0	9.32	13.31	25	0	0	0	CONV
573	F	F10	Pli	435.4	3	7	16	31.8	8.6		403.6	16.53	19.72	25	0	0	0	CONV
575	F	F10	Pli	325.5	1	6	16	25.1	5.9		300.4	13.43	17.25	25	0	0	0	CONV
576	F	F10	Pli	394.7	3	7	16	25.1	5.5		369.6	15.60	18.35	25	0	0	0	CONV
577	F	F10	Pli	407.5	1	6	16	34.1	7.6		373.4	15.60	20.53	25	0	0	0	CONV
1172	F	F10	Pli	284.0	2	5	15	40.9	3.7		284.0	12.78	17.02	25	0	0	0	CONV
4	F	F14	Fdi	459.4	4	8	16	76.7	4.4		382.7	20.96	22.77	25	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
216	F	F14	Fdi	527.5	4	7	16	65.3	5.7		462.2	24.73	29.09	25	0	0	0	CONV
217	F	F14	Fdi	502.6	4	8	16	59.7	6.9		442.9	23.40	24.86	25	0	0	0	CONV
222	F	F14	Fdi	324.7	3	7	16	46.6	4.2		278.1	16.50	17.69	25	0	0	0	CONV
225	F	F14	Fdi	303.7	2		16	20.6	4.4		283.1	16.13		25	0	0	0	CONV
227	F	F14	Fdi	294.8	2	5	16	51.1	2.7		243.7	15.48	21.09	25	0	0	0	CONV
229	F	F14	Fdi	542.5	4	8	16	69.0	6.7		473.5	24.75	26.74	25	0	0	0	CONV
241	F	F14	Fdi	410.6	3	8	16	46.2	6.1		364.4	19.80	20.32	25	0	0	0	CONV
245	F	F14	Fdi	468.8	4	8	16	62.4	6.4		406.4	21.54	23.23	25	0	0	0	CONV
248	F	F14	Fdi	349.4	2		16	32.8	3.7		316.6	16.92		25	0	0	0	CONV
251	F	F14	Fdi	504.4	4	8	16	61.1	7.0		443.3	23.49	24.94	25	0	0	0	CONV
1	F	F14	Pli	373.2	2	8	16	43.2	5.1		330.0	15.57	16.23	25	0	0	0	CONV
2	F	F14	Pli	469.6	2		16	31.8	8.4		437.8	17.76		25	0	0	0	CONV
3	F	F14	Pli	561.1	4	9	16	49.8	10.6		511.3	20.12	20.52	25	0	0	0	CONV
5	F	F14	Pli	512.3	4	9	16	58.1	9.6		454.2	19.21	19.24	25	0	0	0	CONV
6	F	F14	Pli	522.6	3	10	16	61.0	8.5		461.6	19.56	18.36	25	0	0	0	CONV
215	F	F14	Pli	518.3	3	10	16	49.9	9.7		468.4	19.44	18.25	25	0	0	0	CONV
218	F	F14	Pli	463.2	3	9	16	31.9	6.7		431.3	17.51	17.88	25	0	0	0	CONV
219	F	F14	Pli	553.1	3	10	16	55.3	8.7		497.8	20.12	19.12	25	0	0	0	CONV
220	F	F14	Pli	484.1	2		16	46.3	8.8		437.8	18.23		25	0	0	0	CONV
226	F	F14	Pli	494.4	4	9	16	36.0	10.1		458.4	18.62	18.76	25	0	0	0	CONV
228	F	F14	Pli	436.3	3	8	16	36.9	7.8		399.4	16.57	18.29	25	0	0	0	CONV
230	F	F14	Pli	528.2	3	8	16	48.8	9.1		479.4	19.72	20.98	25	0	0	0	CONV
231	F	F14	Pli	333.5	1		16	35.7	5.4		297.8	13.81		25	0	0	0	CONV
232	F	F14	Pli	378.7	2		16	37.1	6.9		341.6	15.60		25	0	0	0	CONV
234	F	F14	Pli	435.4	3	9	16	27.6	7.7		407.8	16.53	17.08	25	0	0	0	CONV
235	F	F14	Pli	659.3	3	11	16	56.3	10.5		603.0	22.10	20.50	25	0	0	0	CONV
237	F	F14	Pli	312.7	1		16	23.1	4.4		289.6	12.90		25	0	0	0	CONV
238	F	F14	Pli	443.5	3	7	16	39.0	6.9		404.5	16.84	19.98	25	0	0	0	CONV
239	F	F14	Pli	567.1	4	11	16	45.6	10.8		521.5	20.12	18.40	25	0	0	0	CONV
240	F	F14	Pli	557.8	4	11	16	49.5	9.4		508.3	20.12	18.18	25	0	0	0	CONV
242	F	F14	Pli	491.7	3	9	16	53.6	8.3		438.1	18.52	18.68	25	0	0	0	CONV
243	F	F14	Pli	454.8	2	7	16	47.8	7.7		407.0	17.20	20.35	25	0	0	0	CONV
247	F	F14	Pli	536.6	3	9	16	42.7	9.7		493.9	20.04	19.89	25	0	0	0	CONV
249	F	F14	Pli	591.5	3	10	16	40.1	9.2		551.4	20.15	20.05	25	0	0	0	CONV
252	F	F14	Pli	394.4	3	8	16	40.8	6.9		353.6	15.60	16.95	25	0	0	0	CONV
1	F	F27	Fdi	55.0	1		16	0.0		1.3	55.0			25	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
4	F	F27	Fdi	256.5	3	5	16	30.5	2.0		226.0	14.14	17.75	25	0	0	0	CONV
9	F	F27	Fdi	383.8	3	7	16	40.8	4.3		343.0	19.19	21.25	25	0	0	0	CONV
1072	F	F27	Fdi	169.5	2		16	24.0		4.2	145.5	9.96		25	0	0	0	CONV
1083	F	F27	Fdi	161.5	2		16	20.5		4.2	141.0	9.90		25	0	0	0	CONV
1088	F	F27	Fdi	515.6	4	9	16	39.3	6.2		476.3	24.17	22.94	25	0	0	0	CONV
2	F	F27	Pli	394.1	3	8	16	30.6	6.0		363.5	15.60	16.94	25	0	0	0	CONV
3	F	F27	Pli	228.3	2	5	16	19.2	2.7		209.1	10.70	13.65	25	0	0	0	CONV
5	F	F27	Pli	377.0	3	8	16	52.8	7.0		324.2	15.60	16.36	25	0	0	0	CONV
6	F	F27	Pli	308.0	3	5	16	43.8	3.0		264.2	12.73	18.29	25	0	0	0	CONV
7	F	F27	Pli	436.7	3	7	16	30.5	6.2		406.2	16.58	19.76	25	0	0	0	CONV
8	F	F27	Pli	525.6	3	10	16	31.2	9.3		494.4	19.63	18.43	25	0	0	0	CONV
1032	F	F27	Pli	178.3	2		16	24.1		6.7	154.2	8.21		25	0	0	0	CONV
1060	F	F27	Pli	407.8	3	9	16	29.8	6.9		378.0	15.60	16.24	25	0	0	0	CONV
1061	F	F27	Pli	203.1	2		16	40.8		4.0	162.3	9.32		25	0	0	0	CONV
1062	F	F27	Pli	169.2	2		16	21.2		4.9	148.0	8.04		25	0	0	0	CONV
1063	F	F27	Pli	470.7	3	10	16	31.4	6.3		439.3	17.80	17.00	25	0	0	0	CONV
1064	F	F27	Pli	474.4	3	9	16	31.2	7.3		443.2	17.94	18.20	25	0	0	0	CONV
1066	F	F27	Pli	441.2	3	7	16	33.8	6.3		407.4	16.75	19.91	25	0	0	0	CONV
1067	F	F27	Pli	414.0	3	7	16	61.6	4.8		352.4	15.72	19.01	25	0	0	0	CONV
1068	F	F27	Pli	390.5	3	8	16	41.9	6.5		348.6	15.60	16.82	25	0	0	0	CONV
1069	F	F27	Pli	508.4	4	9	16	33.5	6.2		474.9	19.06	19.14	25	0	0	0	CONV
1070	F	F27	Pli	427.6	3	9	16	30.8	8.0		396.8	16.24	16.84	25	0	0	0	CONV
1074	F	F27	Pli	335.6	3	5	16	44.2	4.0		291.4	13.95	19.66	25	0	0	0	CONV
1077	F	F27	Pli	557.5	3	7	16	41.6	10.6		515.9	20.12	23.40	25	0	0	0	CONV
1078	F	F27	Pli	306.2	3	7	16	35.1	4.8		271.1	12.73	14.97	25	0	0	0	CONV
1079	F	F27	Pli	312.3	3	6	16	43.2	3.6		269.1	12.88	16.66	25	0	0	0	CONV
1081	F	F27	Pli	344.3	3	6	16	30.3	4.5		314.0	14.31	18.05	25	0	0	0	CONV
1084	F	F27	Pli	477.0	4	8	16	56.9	8.0		420.1	18.04	19.52	25	0	0	0	CONV
1085	F	F27	Pli	245.7	2	4	16	16.1	2.4		229.6	10.76	16.93	25	0	0	0	CONV
1087	F	F27	Pli	519.3	4	9	16	59.2	8.3		460.1	19.47	19.43	25	0	0	0	CONV
1089	F	F27	Pli	530.3	3	9	16	41.1	7.9		489.2	19.80	19.72	25	0	0	0	CONV
1	G	G21	Fdi	406.4	3	6	16	57.4	4.6		349.0	19.80	25.68	15	0	0	0	NAT
3	G	G21	Fdi	246.1	2	4	16	40.7	1.6		205.4	13.84	20.30	15	0	0	0	NAT
5	G	G21	Fdi	246.7	2	4	16	53.2	2.0		193.5	13.88	20.37	15	0	0	0	NAT
7	G	G21	Fdi	332.2	2	5	16	52.2	3.5		280.0	16.50	24.14	15	0	0	0	NAT
445	G	G21	Fdi	590.0	4	9	16	70.9	7.2		519.1	25.07	26.03	15	0	0	0	NAT

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
447	G	G21	Fdi	490.2	4		16	62.9	6.3		427.3	22.67		15	0	0	0	NAT
448	G	G21	Fdi	198.8	2	3	16	38.3	1.5		160.5	11.43	18.80	15	0	0	0	NAT
451	G	G21	Fdi	391.0	3	8	16	57.3	5.0		333.7	19.67	19.31	15	0	0	0	NAT
465	G	G21	Fdi	424.5	4	7	16	62.3	5.5		362.2	19.80	23.56	15	0	0	0	NAT
471	G	G21	Fdi	315.7	3	5	16	52.2	3.4		263.5	16.50	22.82	15	0	0	0	NAT
473	G	G21	Fdi	367.5	3	6	16	49.1	4.2		318.4	18.15	23.17	15	0	0	0	NAT
2	G	G21	Pli	486.5	2	7	16	50.8	10.5		435.7	18.32	21.33	15	0	0	0	NAT
4	G	G21	Pli	458.5	3	8	16	40.7	7.0		417.8	17.34	18.97	15	0	0	0	NAT
6	G	G21	Pli	186.5	2	3	16	40.6	1.5		145.9	8.63	14.38	15	0	0	0	NAT
444	G	G21	Pli	495.4	2	8	16	50.4	8.0		445.0	18.65	20.06	15	0	0	0	NAT
446	G	G21	Pli	482.5	3	9	16	31.7	9.1		450.8	18.17	18.43	15	0	0	0	NAT
449	G	G21	Pli	560.0	4	10	16	48.2	8.9		511.8	20.12	19.29	15	0	0	0	NAT
450	G	G21	Pli	435.7	3	6	16	52.7	7.8		383.0	16.54	21.55	15	0	0	0	NAT
452	G	G21	Pli	429.0	3	8	16	27.5	7.8		401.5	16.29	18.06	15	0	0	0	NAT
453	G	G21	Pli	374.0	2	7	16	44.7	5.7		329.3	15.57	17.61	15	0	0	0	NAT
454	G	G21	Pli	558.3	3	9	16	53.5	10.0		504.8	20.12	20.45	15	0	0	0	NAT
460	G	G21	Pli	374.4	3	6	16	52.4	3.0		322.0	15.59	19.27	15	0	0	0	NAT
461	G	G21	Pli	477.2	3	7	16	69.8	7.2		407.4	18.04	21.05	15	0	0	0	NAT
462	G	G21	Pli	434.8	3		16	43.5	7.3		391.3	16.51		15	0	0	0	NAT
463	G	G21	Pli	554.4	3	8	16	76.4	10.1		478.0	20.12	21.70	15	0	0	0	NAT
464	G	G21	Pli	416.0	4	7	16	51.3	6.2		364.7	15.80	19.08	15	0	0	0	NAT
466	G	G21	Pli	371.2	3	7	16	40.2	5.6		331.0	15.43	17.51	15	0	0	0	NAT
467	G	G21	Pli	505.6	3	7	16	104.1	2.0		401.5	18.96	21.91	15	0	0	0	NAT
469	G	G21	Pli	482.5	3	9	16	68.8	8.2		413.7	18.17	18.43	15	0	0	0	NAT
472	G	G21	Pli		0		16				0.0			15	0	0	0	NAT
474	G	G21	Pli	367.5	1		16	53.0	7.5		314.5	15.27		15	0	0	0	NAT
476	G	G21	Pli	258.0	2	5	16	45.0	2.3		213.0	11.29	15.53	15	0	0	0	NAT
477	G	G21	Pli	341.4	3	5	16	53.6	4.4		287.8	14.19	19.94	15	0	0	0	NAT
479	G	G21	Pli	573.4	2		16	55.2	10.5		518.2	20.12		15	0	0	0	NAT
1161	G	G21	Pli	374.5	3	7	15	53.0	4.6		374.5	15.62	17.63	15	0	0	0	NAT
1	G	G23	Fdi	84.5	1		16	9.0		2.6	75.5			15	0	0	0	NAT
697	G	G23	Fdi	269.5	3	6	16	24.7	3.0		244.8	14.14	16.22	15	0	0	0	NAT
698	G	G23	Fdi	50.6	1		16	26.2		4.0	24.4		12.14	15	0	0	0	NAT
704	G	G23	Fdi	179.6	2		16	28.6		4.4	151.0	11.00		15	0	0	0	NAT
711	G	G23	Fdi	197.0	2	4	16	18.1	1.2		178.9	11.08	14.46	15	0	0	0	NAT
719	G	G23	Fdi	105.8	2		16	11.0		3.1	94.8			15	0	0	0	NAT

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
2	G	G23	Pli	376.2	3	8	16	22.3	5.3		353.9	15.60	16.34	15	0	0	0	NAT
2	G	G23	Pli	409.0	3	8	16	33.2	5.9		375.8	15.60	17.43	15	0	0	0	NAT
3	G	G23	Pli	173.7	1	3	16	16.2	0.9		157.5	8.21	12.77	15	0	0	0	NAT
690	G	G23	Pli	230.1	2	5	16	27.9	2.2		202.2	10.76	13.77	15	0	0	0	NAT
691	G	G23	Pli	370.0	3	7	16	37.8	4.7		332.2	15.38	17.47	15	0	0	0	NAT
692	G	G23	Pli	337.4	2	7	16	23.0	4.3		314.4	14.02	16.24	15	0	0	0	NAT
693	G	G23	Pli	232.3	2	6	16	14.8	3.4		217.5	10.76	12.58	15	0	0	0	NAT
694	G	G23	Pli	222.0	2	5	16	14.2	2.3		207.8	10.27	13.22	15	0	0	0	NAT
695	G	G23	Pli	272.7	2	6	16	29.7	4.1		243.0	12.10	14.78	15	0	0	0	NAT
699	G	G23	Pli	244.8	2	7	16	8.8	2.8		236.0	10.76		15	0	0	0	NAT
700	G	G23	Pli	297.3	2	6	16	26.0	4.0		271.3	12.73	15.97	15	0	0	0	NAT
701	G	G23	Pli	389.8	3	8	16	35.4	5.9		354.4	15.60	16.80	15	0	0	0	NAT
702	G	G23	Pli	304.0	2	6	16	25.5	4.5		278.5	12.73	16.29	15	0	0	0	NAT
703	G	G23	Pli	481.2	3	8	16	48.2	6.6		433.0	18.12	19.65	15	0	0	0	NAT
706	G	G23	Pli	329.1	2	7	16	27.5	4.0		301.6	13.58	15.91	15	0	0	0	NAT
707	G	G23	Pli	375.4	3	8	16	25.2	4.8		350.2	15.60	16.31	15	0	0	0	NAT
708	G	G23	Pli	363.6	3	8	16	26.9	5.0		336.7	15.11	15.90	15	0	0	0	NAT
709	G	G23	Pli	291.3	2	8	16	20.1	3.7		271.2	12.73	13.17	15	0	0	0	NAT
710	G	G23	Pli	318.7	3	7	16	28.3	4.8		290.4	13.15	15.49	15	0	0	0	NAT
713	G	G23	Pli	161.2	2	2	16	13.1		4.7	148.1	7.34	14.04	15	0	0	0	NAT
714	G	G23	Pli	305.1	2	6	16	19.1	4.2		286.0	12.73	16.34	15	0	0	0	NAT
715	G	G23	Pli	298.8	2	7	16	18.4	3.9		280.4	12.73	14.66	15	0	0	0	NAT
716	G	G23	Pli	232.4	1	6	16	20.3	1.9		212.1	10.76	12.59	15	0	0	0	NAT
717	G	G23	Pli	446.5	3	9	16	38.4	6.7		408.1	16.95	17.40	15	0	0	0	NAT
718	G	G23	Pli	416.1	3	8	16	35.4	6.7		380.7	15.80	17.66	15	0	0	0	NAT
721	G	G23	Pli	373.5	3	8	16	35.9	5.6		337.6	15.58	16.24	15	0	0	0	NAT
723	G	G23	Pli	330.0	2	8	16	19.1	4.7		310.9	13.61	14.69	15	0	0	0	NAT
15	G	G7	Fdi	429.6	4	7	16	50.4	4.8		379.2	19.80	23.85	15	0	0	0	NAT
17	G	G7	Fdi	459.7	3	8	16	38.7	6.0		421.0	20.97	22.78	15	0	0	0	NAT
18	G	G7	Fdi	322.0	3	5	16	52.0	2.9		270.0	16.50	23.33	15	0	0	0	NAT
19	G	G7	Fdi	338.5	3	5	16	55.5	3.6		283.0	16.50	24.64	15	0	0	0	NAT
20	G	G7	Fdi	455.0	3	7	16	72.0	3.9		383.0	20.76	25.25	15	0	0	0	NAT
33	G	G7	Fdi	292.5	3	5	16	37.1	3.1		255.4	15.36	20.90	15	0	0	0	NAT
36	G	G7	Fdi	350.6	4	5	16	56.7	3.1		293.9	16.98	25.58	15	0	0	0	NAT
41	G	G7	Fdi	436.2	3	8	16	41.8	5.9		394.4	19.80	21.62	15	0	0	0	NAT
44	G	G7	Fdi	415.0	4	7	16	44.5	4.2		370.5	19.80	23.03	15	0	0	0	NAT

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
45	G	G7	Fdi	514.5	4	8	16	61.5	6.3		453.0	24.12	25.42	15	0	0	0	NAT
48	G	G7	Fdi	337.5	4	5	16	56.7	3.0		280.8	16.50	24.56	15	0	0	0	NAT
50	G	G7	Fdi	436.0	3	7	16	58.5	4.5		377.5	19.80	24.20	15	0	0	0	NAT
52	G	G7	Fdi	505.5	3	8	16	45.8	7.2		459.7	23.54	25.00	15	0	0	0	NAT
53	G	G7	Fdi	478.0	4	7	16	72.8	6.0		405.2	22.03	26.49	15	0	0	0	NAT
65	G	G7	Fdi	515.0	3	7	16	74.2	6.2		440.8	24.14	28.44	15	0	0	0	NAT
1144	G	G7	Fdi	425.0	4	6	15	48.6	4.1		425.0	21.91	26.85	15	0	0	0	NAT
1145	G	G7	Fdi	360.0	4	5	15	59.0	3.8		360.0	19.8	26.3	15	0	0	0	NAT
1146	G	G7	Fdi	408.9	4	5	15	58.2	4.2		408.9	20.83	29.91	15	0	0	0	NAT
30	G	G7	Pli	463.5	3	9	16	47.5	7.6		416.0	17.53	17.89	15	0	0	0	NAT
31	G	G7	Pli	471.6	2	7	16	54.9	7.7		416.7	17.83	20.87	15	0	0	0	NAT
32	G	G7	Pli	457.9	2		16	56.9	10.0		401.0	17.31		15	0	0	0	NAT
34	G	G7	Pli	477.8	2	8	16	56.6	7.6		421.2	18.07	19.55	15	0	0	0	NAT
37	G	G7	Pli	387.0	4	6	16	48.5	6.2		338.5	15.60	19.76	15	0	0	0	NAT
39	G	G7	Pli	534.5	2	10	16	53.4	8.2		481.1	19.96	18.66	15	0	0	0	NAT
40	G	G7	Pli	436.0	3	8	16	50.8	7.6		385.2	16.55	18.28	15	0	0	0	NAT
43	G	G7	Pli	410.0	1	7	16	13.3	8.0		396.7	15.63	18.87	15	0	0	0	NAT
46	G	G7	Pli	913.1	1		16	50.1	6.0		863.0	28.33		15	0	0	0	NAT
47	G	G7	Pli	500.0	2	8	16	42.3	8.9		457.7	18.83	20.19	15	0	0	0	NAT
49	G	G7	Pli	419.0	2	7	16	28.0	7.0		391.0	15.91	19.18	15	0	0	0	NAT
51	G	G7	Pli	457.7	4	9	16	47.5	8.3		410.2	17.31	17.73	15	0	0	0	NAT
54	G	G7	Pli	466.0	3	8	16	55.7	7.9		410.3	17.62	19.20	15	0	0	0	NAT
55	G	G7	Pli	426.4	2	8	16	51.9	7.3		374.5	16.19	17.98	15	0	0	0	NAT
56	G	G7	Pli	505.7	2		16	57.0	9.9		448.7	18.96		15	0	0	0	NAT
59	G	G7	Pli	480.8	3	10	16	37.8	8.4		443.0	18.14	17.27	15	0	0	0	NAT
60	G	G7	Pli	485.6	4	9	16	67.3	8.6		418.3	18.29	18.51	15	0	0	0	NAT
61	G	G7	Pli	458.7	2	7	16	60.0	6.3		398.7	17.34	20.47	15	0	0	0	NAT
62	G	G7	Pli	461.3	3	10	16	51.1	7.6		410.2	17.44	16.74	15	0	0	0	NAT
63	G	G7	Pli	506.0	2	8	16	59.0	8.0		447.0	18.98	20.36	15	0	0	0	NAT
518	H	H16	Fdi	264.3	3	6	16	30.8	2.3		233.5	14.14	15.82	40	0	0	0	CONV
528	H	H16	Fdi	214.1	2	3	16	41.0	1.0		173.1	12.38	21.05	40	0	0	0	CONV
536	H	H16	Fdi	208.0	2	4	16	28.2	1.2		179.8	12.38	15.87	40	0	0	0	CONV
537	H	H16	Fdi	232.0	2	4	16	29.2	1.5		202.8	12.47	18.73	40	0	0	0	CONV
1165	H	H16	Fdi	133.5	2		15	24.5		3.9	133.5	9		40	0	0	0	CONV
1171	H	H16	Fdi	316.4	3	6	15	36.7	3.6		316.4	17.2	19.67	40	0	0	0	CONV
1	H	H16	Pli	424.9	3	7	16	33.4	5.1		391.5	16.13	19.37	40	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1	H	H16	Pli	485.4	3	8	16	39.8	7.0		445.6	18.28	19.77	40	0	0	0	CONV
516	H	H16	Pli	449.8	3	8	16	36.3	6.4		413.5	17.08	18.71	40	0	0	0	CONV
517	H	H16	Pli	456.0	4	9	16	38.4	8.2		417.6	17.24	17.68	40	0	0	0	CONV
519	H	H16	Pli	387.5	1	7	16	27.9	6.6		359.6	15.60	18.09	40	0	0	0	CONV
520	H	H16	Pli	333.5	3	6	16	30.4	4.6		303.1	13.81	17.59	40	0	0	0	CONV
521	H	H16	Pli	420.9	3	7	16	34.0	6.3		386.9	15.98	19.24	40	0	0	0	CONV
522	H	H16	Pli	397.2	2	6	16	46.6	6.3		350.6	15.60	20.14	40	0	0	0	CONV
523	H	H16	Pli	431.0	3	7	16	32.5	6.5		398.5	16.36	19.58	40	0	0	0	CONV
524	H	H16	Pli	343.9	2	7	16	32.3	4.4		311.6	14.29	16.49	40	0	0	0	CONV
525	H	H16	Pli	440.1	1	7	16	37.6	7.5		402.5	16.71	19.87	40	0	0	0	CONV
526	H	H16	Pli	506.1	3	9	16	34.1	8.1		472.0	18.98	19.08	40	0	0	0	CONV
527	H	H16	Pli	571.4	3	8	16	34.9	8.1		536.5	20.12	22.15	40	0	0	0	CONV
529	H	H16	Pli	408.9	3	7	16	36.4	6.4		372.5	15.60	18.84	40	0	0	0	CONV
530	H	H16	Pli	331.8	1	6	16	27.2	4.9		304.6	13.74	17.52	40	0	0	0	CONV
531	H	H16	Pli	363.3	2	7	16	28.0	6.5		335.3	15.10	17.22	40	0	0	0	CONV
533	H	H16	Pli	372.4	3	7	16	15.5	6.4		356.9	15.48	17.55	40	0	0	0	CONV
534	H	H16	Pli	390.1	3	7	16	31.9	6.3		358.2	15.60	18.19	40	0	0	0	CONV
535	H	H16	Pli	325.4	3	6	16	24.9	5.0		300.5	13.42	17.24	40	0	0	0	CONV
539	H	H16	Pli	468.9	3	9	16	28.8	7.1		440.1	17.73	18.05	40	0	0	0	CONV
540	H	H16	Pli	299.7	3	6	16	24.7	4.4		275.0	12.73	16.09	40	0	0	0	CONV
541	H	H16	Pli	205.0	1		16	16.2		7.0	188.8	9.32		40	0	0	0	CONV
1164	H	H16	Pli	301.1	2	4	15	51.9	3.3		301.1	13.64	20.51	40	0	0	0	CONV
1166	H	H16	Pli	177.7	1	2	15	19.0		3.7	177.7	9.11	17.11	40	0	0	0	CONV
1167	H	H16	Pli	157.3	2	2	15	12.8	1.1	5.0	157.3	7.87	13.21	40	0	0	0	CONV
1168	H	H16	Pli	219.0	2	4	15	26.1	2.7		219.0	10.76	14.91	40	0	0	0	CONV
1169	H	H16	Pli	223.5	2	4	15	26.7	2.6		223.5	10.76	15.27	40	0	0	0	CONV
1170	H	H16	Pli	435.5	3	8	15	31.9	7.7		435.5	18.1	18.27	40	0	0	0	CONV
8	H	H19	Fdi	603.5	4	8	16	51.3	9.5		552.2	25.65	29.53	40	0	0	0	CONV
9	H	H19	Fdi	582.8	4	9	16	98.4	7.7		484.4	24.75	25.74	40	0	0	0	CONV
105	H	H19	Fdi	533.4	4	8	16	46.6	6.4		486.8	24.75	26.31	40	0	0	0	CONV
106	H	H19	Fdi	535.1	4	8	16	62.9	7.1		472.2	24.75	26.39	40	0	0	0	CONV
107	H	H19	Fdi	492.5	3	6	16	63.8	5.7		428.7	22.86	30.93	40	0	0	0	CONV
109	H	H19	Fdi	499.9	4	8	16	60.0	5.9		439.9	23.28	24.73	40	0	0	0	CONV
110	H	H19	Fdi	386.4	3	7	16	60.6	3.9		325.8	19.32	21.40	40	0	0	0	CONV
120	H	H19	Fdi	514.9	3	6	16	56.9	6.2		458.0	24.14	32.24	40	0	0	0	CONV
128	H	H19	Fdi	490.5	3	6	16	44.0	4.1		446.5	22.69	30.81	40	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
129	H	H19	Fdi	475.5	3	7	16	36.1	6.0		439.4	21.92	26.36	40	0	0	0	CONV
132	H	H19	Fdi	478.7	4	8	16	49.9	6.2		428.8	22.07	23.71	40	0	0	0	CONV
136	H	H19	Fdi	492.3	4	8	16	50.4	6.1		441.9	22.85	24.36	40	0	0	0	CONV
137	H	H19	Fdi	525.8	4	9	16	47.3	7.3		478.5	24.65	23.37	40	0	0	0	CONV
141	H	H19	Fdi	489.2	4	8	16	18.4	6.2		470.8	22.63	24.22	40	0	0	0	CONV
190	H	H19	Fdi	650.1	4	9	16	46.7	8.3		603.4	27.93	28.44	40	0	0	0	CONV
1151	H	H19	Fdi	299.7	3	5	15	47.6	2.2		299.7	16.5	21.5	40	0	0	0	CONV
1	H	H19	Pli	523.0	1	9	16	31.0	8.9		492.0	19.57	19.53	40	0	0	0	CONV
2	H	H19	Pli	585.7	4	9	16	24.1	10.6		561.6	20.12	21.15	40	0	0	0	CONV
3	H	H19	Pli	586.4	4	9	16	49.9	9.8		536.5	20.12	21.16	40	0	0	0	CONV
4	H	H19	Pli	683.5	2	10	16	49.0	8.0		634.5	22.75	22.16	40	0	0	0	CONV
5	H	H19	Pli	628.1	3	10	16	31.7	9.6		596.4	21.20	20.91	40	0	0	0	CONV
6	H	H19	Pli	618.6	3	9	16	36.5	9.8		582.1	20.93	21.96	40	0	0	0	CONV
7	H	H19	Pli	470.5	3	9	16	33.5	7.6		437.0	17.79	18.09	40	0	0	0	CONV
10	H	H19	Pli	554.7	3	8	16	30.2	9.2		524.5	20.12	21.70	40	0	0	0	CONV
11	H	H19	Pli	224.8	1		16	0.0		9.2	224.8	10.40		40	0	0	0	CONV
12	H	H19	Pli	634.2	4	9	16	52.0	11.0		582.2	21.40	22.33	40	0	0	0	CONV
13	H	H19	Pli	591.9	3	9	16	34.9	9.8		557.0	20.16	21.30	40	0	0	0	CONV
14	H	H19	Pli	510.0	2	8	16	34.6	9.2		475.4	19.13	20.47	40	0	0	0	CONV
15	H	H19	Pli	634.3	2	10	16	32.2	10.6		602.1	21.41	21.05	40	0	0	0	CONV
16	H	H19	Pli	306.7	2	4	16	36.8	3.1		269.9	12.73	20.84	40	0	0	0	CONV
115	H	H19	Pli	714.0	2		16	38.0	10.5		676.0	23.60		40	0	0	0	CONV
117	H	H19	Pli	535.2	3	8	16	31.1	11.0		504.1	19.99	21.17	40	0	0	0	CONV
119	H	H19	Pli	596.1	1	9	16	43.2	11.2		552.9	20.30	21.41	40	0	0	0	CONV
121	H	H19	Pli	586.3	3	9	16	40.2	8.5		546.1	20.12	21.16	40	0	0	0	CONV
126	H	H19	Pli	561.9	2		16	33.5	9.4		528.4	20.12		40	0	0	0	CONV
133	H	H19	Pli	530.5	2	8	16	40.7	9.9		489.8	19.81	21.05	40	0	0	0	CONV
134	H	H19	Pli	567.0	3	9	16	43.7	9.5		523.3	20.12	20.68	40	0	0	0	CONV
135	H	H19	Pli	572.8	2	8	16	38.9	8.6		533.9	20.12	22.19	40	0	0	0	CONV
139	H	H19	Pli	535.9	3	8	16	29.8	10.4		506.1	20.01	21.19	40	0	0	0	CONV
1150	H	H19	Pli	424.5	2	7	15	37.1	5.2		424.5	17.64	19.36	40	0	0	0	CONV
297	H	H2	Fdi	291.5	2	6	16	38.0	3.2		253.5	15.21	17.87	40	0	0	0	CONV
299	H	H2	Fdi	365.5	2	7	16	51.2	4.0		314.3	17.93	20.17	40	0	0	0	CONV
301	H	H2	Fdi	481.0	3	9	16	45.3	6.5		435.7	22.25	21.45	40	0	0	0	CONV
303	H	H2	Fdi	594.3	4	9	16	70.3	7.9		524.0	25.26	26.21	40	0	0	0	CONV
308	H	H2	Fdi	448.5	2		16	68.5	5.2		380.0	20.39		40	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
316	H	H2	Fdi	443.0	2		16	54.5	6.4		388.5	20.07		40	0	0	0	CONV
318	H	H2	Fdi	457.5	3		16	55.5	4.8		402.0	20.87		40	0	0	0	CONV
322	H	H2	Fdi	473.0	3	8	16	54.0	6.5		419.0	21.73	23.43	40	0	0	0	CONV
326	H	H2	Fdi	536.8	4	9	16	48.5	7.2		488.3	24.75	23.83	40	0	0	0	CONV
1159	H	H2	Fdi	241.8	2	4	15	52.7	2.0		241.8	14.14	19.83	40	0	0	0	CONV
289	H	H2	Pli	499.9	3	10	16	41.3	10.2		458.6	18.82	17.77	40	0	0	0	CONV
290	H	H2	Pli	497.5	3	9	16	47.2	8.4		450.3	18.73	18.84	40	0	0	0	CONV
291	H	H2	Pli	507.2	3	10	16	36.2	10.3		471.0	19.02	17.96	40	0	0	0	CONV
292	H	H2	Pli	632.3	3	11	16	53.3	8.6		579.0	21.34	19.9	40	0	0	0	CONV
293	H	H2	Pli	589.0	3	10	16	40.4	9.0		548.6	20.12	19.99	40	0	0	0	CONV
294	H	H2	Pli	548.8	3	10	16	40.6	8.5		508.2	20.12	19.02	40	0	0	0	CONV
295	H	H2	Pli	462.2	2	8	16	70.5	8.0		391.7	17.48	19.08	40	0	0	0	CONV
296	H	H2	Pli	608.3	3	10	16	50.1	8.6		558.2	20.63	20.45	40	0	0	0	CONV
298	H	H2	Pli	608.7	4	10	16	64.2	8.8		544.5	20.64	20.46	40	0	0	0	CONV
300	H	H2	Pli	514.0	3	8	16	44.7	8.8		469.3	19.27	20.59	40	0	0	0	CONV
302	H	H2	Pli	514.0	2		16	32.2	7.8		481.8	19.27		40	0	0	0	CONV
304	H	H2	Pli	527.5	3	9	16	56.2	8.9		471.3	19.7	19.65	40	0	0	0	CONV
305	H	H2	Pli	615.6	4	10	16	79.1	10.3		536.5	20.87	20.62	40	0	0	0	CONV
306	H	H2	Pli	434.0	3	10	16	66.2	10.2		367.8	16.48	15.98	40	0	0	0	CONV
307	H	H2	Pli	548.0	3	7	16	50.0	7.4		498.0	20.12	23.14	40	0	0	0	CONV
309	H	H2	Pli	397.0	1		16	19.4	6.4		377.6	15.6		40	0	0	0	CONV
310	H	H2	Pli	507.3	3	10	16	46.3	8.4		461.0	19.02	17.96	40	0	0	0	CONV
312	H	H2	Pli	576.0	4	9	16	65.3	10.1		510.7	20.12	20.9	40	0	0	0	CONV
313	H	H2	Pli	597.5	3		16	44.8	7.5		552.7	20.31		40	0	0	0	CONV
314	H	H2	Pli	484.4	3	8	16	52.6	7.0		431.8	18.24	19.74	40	0	0	0	CONV
315	H	H2	Pli	472.0	3	9	16	41.0	7.5		431.0	17.85	18.13	40	0	0	0	CONV
317	H	H2	Pli	567.0	3	10	16	51.2	9.8		515.8	20.12	19.46	40	0	0	0	CONV
319	H	H2	Pli	526.5	3	9	16	60.5	8.5		466.0	19.66	19.62	40	0	0	0	CONV
320	H	H2	Pli	339.0	1		16	37.5	4.5		301.5	14.09		40	0	0	0	CONV
321	H	H2	Pli	593.0	4	10	16	46.5	10.0		546.5	20.2	20.09	40	0	0	0	CONV
323	H	H2	Pli	402.5	2		16	42.0	6.3		360.5	15.6		40	0	0	0	CONV
324	H	H2	Pli	561.8	3	9	16	82.8	9.5		479.0	20.12	20.54	40	0	0	0	CONV
325	H	H2	Pli	488.0	2		16	50.5	10.0		437.5	18.38		40	0	0	0	CONV
327	H	H2	Pli	567.5	4	9	16	53.5	10.0		514.0	20.12	20.69	40	0	0	0	CONV
1	I	I1	Fdi	464.1	3	7	16	59.4	6.1		404.7	21.32	25.74	65	0	0	0	CONV
2	I	I1	Fdi	497.9	3	7	16	58.8	6.2		439.1	23.18	27.55	65	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
3	I	I1	Fdi	640.8	4	9	16	62.2	8.8		578.6	27.43	28.08	65	0	0	0	CONV
4	I	I1	Fdi	247.3	1		16	18.7	3.4		228.6	13.91		65	0	0	0	CONV
5	I	I1	Fdi	609.2	4	10	16	46.5	9.3		562.7	25.99	24.53	65	0	0	0	CONV
6	I	I1	Fdi	174.6	1		16	12.3	1.2		162.3	10.91		65	0	0	0	CONV
7	I	I1	Fdi	381.0	2	7	16	43.1	4.5		337.9	18.93	21.08	65	0	0	0	CONV
8	I	I1	Fdi	503.7	3	8	16	48.3	6.6		455.4	23.45	24.91	65	0	0	0	CONV
9	I	I1	Fdi	586.6	4	10	16	63.4	8.0		523.2	24.84	23.68	65	0	0	0	CONV
10	I	I1	Fdi	515.5	3	8	16	60.2	6.7		455.3	24.16	25.47	65	0	0	0	CONV
11	I	I1	Fdi	527.8	3	9	16	63.0	6.6		464.8	24.75	23.46	65	0	0	0	CONV
12	I	I1	Fdi	382.1	2	7	16	44.2	3.4		337.9	19.11	21.15	65	0	0	0	CONV
13	I	I1	Fdi	539.8	3	8	16	59.6	6.7		480.2	24.75	26.61	65	0	0	0	CONV
14	I	I1	Fdi	522.2	3	8	16	49.0	6.5		473.2	24.48	25.79	65	0	0	0	CONV
15	I	I1	Fdi	562.8	4	9	16	59.8	8.5		503.0	24.75	24.92	65	0	0	0	CONV
17	I	I1	Fdi	448.8	2		16	48.3	7.0		400.5	20.41		65	0	0	0	CONV
18	I	I1	Fdi	565.4	4	8	16	70.3	6.9		495.1	24.75	27.80	65	0	0	0	CONV
19	I	I1	Fdi	535.5	3	9	16	55.9	7.9		479.6	24.75	23.78	65	0	0	0	CONV
20	I	I1	Fdi	576.0	3		16	44.8	8.9		531.2	24.75		65	0	0	0	CONV
21	I	I1	Fdi	490.8	3	8	16	50.2	6.4		440.6	22.70	24.29	65	0	0	0	CONV
22	I	I1	Fdi	545.7	3		16	50.0	9.0		495.7	24.75		65	0	0	0	CONV
23	I	I1	Fdi	525.6	3	8	16	65.0	6.7		460.6	24.64	25.95	65	0	0	0	CONV
24	I	I1	Fdi	482.9	2		16	24.7	6.8		458.2	22.33		65	0	0	0	CONV
25	I	I1	Fdi	522.2	3	8	16	60.4	6.2		461.8	24.48	25.79	65	0	0	0	CONV
26	I	I1	Fdi	457.4	3	7	16	56.4	6.5		401.0	20.87	25.38	65	0	0	0	CONV
27	I	I1	Fdi	482.8	3	7	16	58.6	5.7		424.2	22.33	26.75	65	0	0	0	CONV
28	I	I1	Fdi	498.4	3	7	16	56.7	7.3		441.7	23.21	27.57	65	0	0	0	CONV
29	I	I1	Fdi	394.6	3	8	16	54.6	5.2		340.0	19.80	19.50	65	0	0	0	CONV
1109	I	I1	Pli	498.8	3	8	15	53.9	7.5		498.8	20.12	20.15	65	0	0	0	CONV
1129	I	I1	Pli	459.1	3	9	15	40.9	6.9		459.1	19.01	17.77	65	0	0	0	CONV
1130	I	I1	Pli	463.5	3		15	39.3	7.9		463.5	19.19		65	0	0	0	CONV
1131	I	I1	Pli	622.9	4	9	15	66.6	8.5		622.9	22.77	22.06	65	0	0	0	CONV
1132	I	I1	Pli	530.1	3	10	15	49.3	9.4		530.1	20.12	18.55	65	0	0	0	CONV
1133	I	I1	Pli	495.4	3	8	15	44.9	8.7		495.4	20.12	20.06	65	0	0	0	CONV
1134	I	I1	Pli	397.1	2	7	15	56.4	7.2		397.1	16.57	18.43	65	0	0	0	CONV
1135	I	I1	Pli	508.0	3	8	15	52.8	8.4		508.0	20.12	20.42	65	0	0	0	CONV
1136	I	I1	Pli	587.8	4	11	15	53.7	9.4		587.8	21.68	18.88	65	0	0	0	CONV
1137	I	I1	Pli	571.1	3	9	15	68.4	8.3		571.1	21.15	20.78	65	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1138	I	I1	Pli	583.9	4	9	15	55.5	9.8		583.9	21.53	21.1	65	0	0	0	CONV
1139	I	I1	Pli	505.6	3	8	15	45.6	8.3		505.6	20.12	20.35	65	0	0	0	CONV
1140	I	I1	Pli	323.0	1		15	43.2	7.8		323.0	14.84		65	0	0	0	CONV
1141	I	I1	Pli	423.7	2		15	46.4	8.7		423.7	17.61		65	0	0	0	CONV
1142	I	I1	Pli	467.4	4	9	15	34.3	8.3		467.4	19.35	18.00	65	0	0	0	CONV
1143	I	I1	Pli	365.6	2		15	45.7	6.1		365.6	15.6		65	0	0	0	CONV
1	I	I32	Fdi	321.7	3	4	15	40.7	3.3		321.7	17.69	27.87	65	0	0	0	CONV
2	I	I32	Fdi	348.4	4	5	15	46.9	3.6		348.4	19.71	25.41	65	0	0	0	CONV
4	I	I32	Fdi	396.7	3	6	15	59.3	5.4		396.7	19.96	25.07	65	0	0	0	CONV
6	I	I32	Fdi	266.7	3	5	15	28.1	2.3		266.7	16.00	18.66	65	0	0	0	CONV
797	I	I32	Fdi	350.0	4	5	15	65.3	3.5		350.0	19.80	25.53	65	0	0	0	CONV
811	I	I32	Fdi	376.3	4	6	15	56.1	4.0		376.3	19.80	23.75	65	0	0	0	CONV
3	I	I32	Pli	301.0	3	4	15	63.0	3.3		301.0	13.64	20.51	65	0	0	0	CONV
5	I	I32	Pli	282.6	2	5	15	41.7	3.4		282.6	12.73	16.94	65	0	0	0	CONV
790	I	I32	Pli	425.5	4	7	15	80.0	6.3		425.5	17.68	19.39	65	0	0	0	CONV
791	I	I32	Pli	154.0	1		15	25.5		3.2	154.0	7.41		65	0	0	0	CONV
792	I	I32	Pli	416.9	3	8	15	44.8	6.4		416.9	17.33	17.68	65	0	0	0	CONV
794	I	I32	Pli	363.7	3	7	15	46.8	5.8		363.7	15.60	17.23	65	0	0	0	CONV
795	I	I32	Pli	322.2	3	5	15	58.0	4.3		322.2	14.80	19.01	65	0	0	0	CONV
798	I	I32	Pli	349.4	3	6	15	54.0	5.0		349.4	15.60	18.26	65	0	0	0	CONV
799	I	I32	Pli	260.5	3	4	15	60.0	2.6		260.5	12.73	17.96	65	0	0	0	CONV
801	I	I32	Pli	340.5	4	6	15	58.0	4.5		340.5	15.60	17.89	65	0	0	0	CONV
802	I	I32	Pli	260.0	2	5	15	32.4	3.2		260.0	12.73	15.65	65	0	0	0	CONV
804	I	I32	Pli	381.7	3	6	15	68.6	4.7		381.7	15.92	19.55	65	0	0	0	CONV
805	I	I32	Pli	324.3	3	5	15	53.8	4.2		324.3	14.90	19.11	65	0	0	0	CONV
806	I	I32	Pli	364.7	1	7	15	52.0	5.8		364.7	15.60	17.27	65	0	0	0	CONV
807	I	I32	Pli	346.7	3	6	15	33.6	6.0		346.7	15.60	18.15	65	0	0	0	CONV
809	I	I32	Pli	316.8	3	5	15	58.3	4.0		316.8	14.45	18.74	65	0	0	0	CONV
810	I	I32	Pli	343.7	3	5	15	64.3	3.7		343.7	15.60	20.05	65	0	0	0	CONV
812	I	I32	Pli	336.3	3	5	15	59.6	3.9		336.3	15.45	19.70	65	0	0	0	CONV
813	I	I32	Pli	390.0	4	7	15	45.6	7.2		390.0	16.27	18.18	65	0	0	0	CONV
815	I	I32	Pli	273.1	3	5	15	42.0	3.9		273.1	12.73	16.41	65	0	0	0	CONV
816	I	I32	Pli	323.7	3	6	15	30.4	4.7		323.7	14.87	17.17	65	0	0	0	CONV
11	I	I6	Fdi	331.4	2	7	15	26.1	4.4		331.4	18.43	18.11	65	0	0	0	CONV
1099	I	I6	Fdi	326.3	3	4	15	49.9	3.7		326.3	17.95	28.29	65	0	0	0	CONV
1107	I	I6	Fdi	426.5	3	6	15	80.1	4.6		426.5	21.99	26.95	65	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1	I	I6	Pli	344.2	3	7	15	39.8	5.5		344.2	15.60	16.50	65	0	0	0	CONV
2	I	I6	Pli	448.3	4	8	15	75.9	8.0		448.3	18.63	18.66	65	0	0	0	CONV
3	I	I6	Pli	442.1	3	8	15	57.0	8.0		442.1	18.37	18.47	65	0	0	0	CONV
4	I	I6	Pli	397.8	3	7	15	54.3	7.0		397.8	16.60	18.45	65	0	0	0	CONV
5	I	I6	Pli	337.0	3	7	15	51.6	5.6		337.0	15.48	16.22	65	0	0	0	CONV
6	I	I6	Pli	336.3	3	5	15	48.8	5.3		336.3	15.45	19.70	65	0	0	0	CONV
7	I	I6	Pli	400.4	3	7	15	47.2	6.5		400.4	16.70	18.54	65	0	0	0	CONV
8	I	I6	Pli	414.4	3	7	15	64.4	6.9		414.4	17.22	19.02	65	0	0	0	CONV
9	I	I6	Pli	287.9	3	3	15	68.5	4.1		287.9	12.96	23.38	65	0	0	0	CONV
10	I	I6	Pli	423.2	3	8	15	55.7	6.3		423.2	17.59	17.88	65	0	0	0	CONV
12	I	I6	Pli	368.9	2		15	38.6	7.8		368.9	15.60		65	0	0	0	CONV
1098	I	I6	Pli	336.0	3	6	15	61.0	5.2		336.0	15.44	17.70	65	0	0	0	CONV
1103	I	I6	Pli	333.0	2	5	15	59.2	4.5		333.0	15.30	19.54	65	0	0	0	CONV
1106	I	I6	Pli	441.7	3	8	15	40.8	7.6		441.7	18.36	18.46	65	0	0	0	CONV
1108	I	I6	Pli	377.0	2	8	15	65.7	8.0		377.0	15.73	16.36	65	0	0	0	CONV
1112	I	I6	Pli	338.0	3	4	15	33.6	4.2		338.0	15.53	22.60	65	0	0	0	CONV
1113	I	I6	Pli	440.9	3	7	15	56.7	7.0		440.9	18.32	19.90	65	0	0	0	CONV
1115	I	I6	Pli	476.5	4	7	15	64.5	6.0		476.5	19.66	21.02	65	0	0	0	CONV
1120	I	I6	Pli	460.0	3	7	15	47.0	8.0		460.0	19.05	20.51	65	0	0	0	CONV
1123	I	I6	Pli	371.0	3	7	15	45.5	8.0		371.0	15.60	17.50	65	0	0	0	CONV
6	J	J33	Fdi	317.0	4	5	15	53.2	2.8		317.0	17.24	22.93	15	0	0	0	CONV
10	J	J33	Fdi	519.9	4	7	15	65.8	6.9		519.9	24.75	28.70	15	0	0	0	CONV
16	J	J33	Fdi	368.5	4	5	15	72.8	3.9		368.5	19.80	26.94	15	0	0	0	CONV
824	J	J33	Fdi	253.4	2	3	15	42.1	2.0		253.4	14.57	26.20	15	0	0	0	CONV
825	J	J33	Fdi	321.6	4	5	15	45.0	3.0		321.6	17.59	23.30	15	0	0	0	CONV
1	J	J33	Pli	308.3	3	5	15	61.1	4.3		308.3	14.07	18.31	15	0	0	0	CONV
2	J	J33	Pli	253.4	3	3	15	46.8	2.8		253.4	12.43	20.77	15	0	0	0	CONV
3	J	J33	Pli	401.7	4	6	15	74.2	5.2		401.7	16.76	20.31	15	0	0	0	CONV
4	J	J33	Pli	287.0	3	5	15	42.3	4.3		287.0	12.92	17.18	15	0	0	0	CONV
5	J	J33	Pli	314.7	3	6	15	44.9	4.5		314.7	14.36	16.77	15	0	0	0	CONV
7	J	J33	Pli	327.1	3	5	15	53.0	5.1		327.1	15.03	19.25	15	0	0	0	CONV
8	J	J33	Pli	271.4	2	4	15	28.2	3.1		271.4	12.73	18.68	15	0	0	0	CONV
9	J	J33	Pli	313.5	3	4	15	54.9	5.2		313.5	14.30	21.23	15	0	0	0	CONV
11	J	J33	Pli	275.4	2	3	15	51.9	3.3		275.4	12.73	22.47	15	0	0	0	CONV
12	J	J33	Pli	183.5	2		15	60.5		4.6	183.5	9.32		15	0	0	0	CONV
13	J	J33	Pli	163.6	2		15	54.0		3.4	163.6	8.21		15	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
14	J	J33	Pli	300.6	3	6	15	52.4	5.1		300.6	13.62	16.13	15	0	0	0	CONV
15	J	J33	Pli	233.2	2	4	15	40.7	3.9		233.2	11.08	16.02	15	0	0	0	CONV
17	J	J33	Pli	261.4	3	5	15	50.8	5.1		261.4	12.73	15.73	15	0	0	0	CONV
817	J	J33	Pli	197.9	1		15	47.9		4.5	197.9	9.65		15	0	0	0	CONV
823	J	J33	Pli	315.0	4	5	15	56.4	4.3		315.0	14.37	18.65	15	0	0	0	CONV
827	J	J33	Pli	382.9	3	7	15	29.8	6.7		382.9	15.97	17.93	15	0	0	0	CONV
839	J	J33	Pli	440.8	4	6	15	68.5	6.6		440.8	18.32	21.73	15	0	0	0	CONV
848	J	J33	Pli	310.2	3	5	15	50.6	4.8		310.2	14.15	18.41	15	0	0	0	CONV
1	J	J36	Fdi	269.0	3	4	15	55.4	2.2		269.0	16.14	22.73	15	0	0	0	CONV
4	J	J36	Fdi	396.8	3	5	15	70.3	4.6		396.8	19.96	29.04	15	0	0	0	CONV
918	J	J36	Fdi	377.4	3	6	15	63.4	4.8		377.4	19.80	23.82	15	0	0	0	CONV
930	J	J36	Fdi	270.9	3	4	15	62.5	2.1		270.9	16.42	22.93	15	0	0	0	CONV
932	J	J36	Fdi	313.0	3	5	15	67.5	3.6		313.0	16.92	22.60	15	0	0	0	CONV
944	J	J36	Fdi				15				0.0			15	0	0	0	CONV
2	J	J36	Pli	346.0	2	7	15	57.7	5.5		346.0	15.60	16.57	15	0	0	0	CONV
3	J	J36	Pli	340.1	3	6	15	50.6	5.6		340.1	15.60	17.87	15	0	0	0	CONV
920	J	J36	Pli	481.4	3	8	15	53.9	8.1		481.4	19.86	19.65	15	0	0	0	CONV
922	J	J36	Pli	350.2	2		15	57.2	5.7		350.2	15.60		15	0	0	0	CONV
926	J	J36	Pli		0		15				0.0			15	0	0	0	CONV
927	J	J36	Pli	308.0	2		15	35.8	4.7		308.0	14.05		15	0	0	0	CONV
928	J	J36	Pli	462.0	3	7	15	61.0	9.9		462.0	19.13	20.57	15	0	0	0	CONV
929	J	J36	Pli	350.3	3	7	15	58.9	5.8		350.3	15.60	16.73	15	0	0	0	CONV
935	J	J36	Pli	414.2	3	8	15	25.5	8.9		414.2	17.22	17.60	15	0	0	0	CONV
936	J	J36	Pli	311.1	2	7	15	46.8	4.7		311.1	14.19	15.18	15	0	0	0	CONV
938	J	J36	Pli	417.8	3	8	15	62.3	7.4		417.8	17.36	17.71	15	0	0	0	CONV
939	J	J36	Pli	328.3	2	5	15	47.5	5.0		328.3	15.08	19.31	15	0	0	0	CONV
941	J	J36	Pli	355.7	3	6	15	49.7	6.7		355.7	15.60	18.52	15	0	0	0	CONV
945	J	J36	Pli				15				0.0			15	0	0	0	CONV
992	K	K24	Fdi	285.3	3	4	15	56.9	2.4		285.3	16.50	24.38	25	0	0	0	CONV
997	K	K24	Fdi	89.0	1		15	18.0		4.3	89.0			25	0	0	0	CONV
999	K	K24	Fdi	503.6	4	8	15	59.5	6.5		503.6	24.75	24.91	25	0	0	0	CONV
1002	K	K24	Fdi	59.0	1		15	9.0		2.4	59.0			25	0	0	0	CONV
1005	K	K24	Fdi	222.0	2	3	15	47.6	1.2		222.0	14.14	22.15	25	0	0	0	CONV
1009	K	K24	Fdi	339.7	3	5	15	54.1	5.0		339.7	19.11	24.73	25	0	0	0	CONV
1013	K	K24	Fdi	266.2	3	4	15	48.2	2.1		266.2	15.97	22.44	25	0	0	0	CONV
1017	K	K24	Fdi	208.4	2	3	15	30.2	1.3		208.4	12.50	20.23	25	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1	K	K24	Pli	173.5	2		15	46.7	1.2		173.5	8.67		25	0	0	0	CONV
2	K	K24	Pli	176.3	2		15	55.0	1.3		176.3	9.04		25	0	0	0	CONV
3	K	K24	Pli	471.4	4	8	15	62.4	7.1		471.4	19.45	19.36	25	0	0	0	CONV
4	K	K24	Pli	373.3	3	8	15	23.8	7.1		373.3	15.60	16.24	25	0	0	0	CONV
987	K	K24	Pli	473.0	4	8	15	57.7	8.6		473.0	19.51	19.40	25	0	0	0	CONV
988	K	K24	Pli	338.4	3	7	15	26.2	4.2		338.4	15.55	16.27	25	0	0	0	CONV
993	K	K24	Pli	318.5	3		15	36.1	7.8		318.5	14.53		25	0	0	0	CONV
1001	K	K24	Pli	356.3	3	7	15	45.3	5.4		356.3	15.60	16.96	25	0	0	0	CONV
1003	K	K24	Pli	224.4	2	3	15	37.4	3.0		224.4	10.76	18.29	25	0	0	0	CONV
1004	K	K24	Pli	427.5	2		15	47.0	9.3		427.5	17.77		25	0	0	0	CONV
1006	K	K24	Pli	395.1	3	6	15	37.4	8.6		395.1	16.48	20.06	25	0	0	0	CONV
1007	K	K24	Pli	336.3	2		15	34.7	8.0		336.3	15.45		25	0	0	0	CONV
1008	K	K24	Pli	415.0	3	7	15	27.7	6.8		415.0	17.25	19.04	25	0	0	0	CONV
1010	K	K24	Pli	392.8	3	8	15	44.1	8.2		392.8	16.39	16.90	25	0	0	0	CONV
1011	K	K24	Pli	399.4	3	8	15	55.2	8.0		399.4	16.66	17.11	25	0	0	0	CONV
1012	K	K24	Pli	397.1	3	9	15	53.0	6.6		397.1	16.57	15.91	25	0	0	0	CONV
1015	K	K24	Pli	292.5	2		15	28.1	5.2		292.5	13.16		25	0	0	0	CONV
1016	K	K24	Pli	519.7	4	9	15	48.4	9.1		519.7	20.12	19.44	25	0	0	0	CONV
1020	K	K24	Pli	351.3	2	6	15	49.0	6.1		351.3	15.60	18.34	25	0	0	0	CONV
8	K	K31	Fdi	268.6	3	3	15	56.2	1.9	5.2	268.6	16.12	28.00	25	0	0	0	CONV
19	K	K31	Fdi	339.4	4	5	15	42.3	3.8		339.4	19.09	24.71	25	0	0	0	CONV
781	K	K31	Fdi	355.5	4	5	15	52.3	3.6		355.5	19.80	25.96	25	0	0	0	CONV
782	K	K31	Fdi	274.9	3	5	15	43.3	2.2		274.9	16.50	19.39	25	0	0	0	CONV
783	K	K31	Fdi	264.7	4	3	15	40.6	1.8	5.8	264.7	15.72	27.55	25	0	0	0	CONV
1	K	K31	Pli	292.2	3	5	15	43.2	4.5		292.2	13.15	17.47	25	0	0	0	CONV
2	K	K31	Pli	262.4	3	3	15	55.3	3.2	6.4	262.4	12.73	21.48	25	0	0	0	CONV
3	K	K31	Pli	216.5	1		15	53.0		6.7	216.5	10.76		25	0	0	0	CONV
4	K	K31	Pli	279.5	3	5	15	45.3	3.8		279.5	12.73	16.77	25	0	0	0	CONV
5	K	K31	Pli	421.6	3	7	15	47.4	6.3		421.6	17.52	19.26	25	0	0	0	CONV
6	K	K31	Pli	293.5	3	5	15	39.8	4.9		293.5	13.30	17.53	25	0	0	0	CONV
7	K	K31	Pli	383.1	4	7	15	57.2	6.3		383.1	15.98	17.94	25	0	0	0	CONV
9	K	K31	Pli	346.8	4	5	15	59.5	4.6		346.8	15.60	20.19	25	0	0	0	CONV
10	K	K31	Pli	429.8	3	7	15	63.2	5.8		429.8	17.86	19.54	25	0	0	0	CONV
11	K	K31	Pli	421.6	4	7	15	45.7	6.1		421.6	17.52	19.26	25	0	0	0	CONV
12	K	K31	Pli	354.4	3	6	15	58.9	5.0		354.4	15.60	18.47	25	0	0	0	CONV
13	K	K31	Pli	353.1	4	6	15	49.9	5.2		353.1	15.60	18.41	25	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
14	K	K31	Pli	275.9	2	4	15	67.5	2.6	5.7	275.9	12.73	18.96	25	0	0	0	CONV
15	K	K31	Pli	198.6	1		15	33.2		5.2	198.6	9.68		25	0	0	0	CONV
16	K	K31	Pli	293.0	3	3	15	64.3	3.2	6.4	293.0	13.19	23.74	25	0	0	0	CONV
17	K	K31	Pli	328.5	3	4	15	74.1	3.9	7.1	328.5	15.09	22.08	25	0	0	0	CONV
18	K	K31	Pli	349.0	2	5	15	53.1	4.5		349.0	15.60	20.30	25	0	0	0	CONV
20	K	K31	Pli	267.6	2	3	15	66.2	2.5	6.9	267.6	12.73	21.88	25	0	0	0	CONV
21	K	K31	Pli	363.0	4	5	15	56.5	4.2		363.0	15.60	20.94	25	0	0	0	CONV
22	K	K31	Pli	299.1	3	6	15	27.7	3.4		299.1	13.55	16.06	25	0	0	0	CONV
23	K	K31	Pli	380.6	4	6	15	53.7	5.9		380.6	15.88	19.51	25	0	0	0	CONV
24	K	K31	Pli	290.2	3	4	15	50.0	3.0	7.7	290.2	13.06	19.86	25	0	0	0	CONV
25	K	K31	Pli	317.2	4	5	15	51.5	4.3		317.2	14.47	18.76	25	0	0	0	CONV
26	K	K31	Pli	274.7	3	5	15	30.3	3.0		274.7	12.73	16.50	25	0	0	0	CONV
27	K	K31	Pli	432.3	3	8	15	95.4	6.0		432.3	17.97	18.17	25	0	0	0	CONV
163	K	K31	Pli	317.8	4	6	15	55.3	5.4		317.8	14.50	16.91	25	0	0	0	CONV
758	K	K31	Pli	345.3	4	6	15	59.4	4.7		345.3	15.60	18.09	25	0	0	0	CONV
764	K	K31	Pli	284.7	3	3	15	57.5	3.7	7.0	284.7	12.81	23.15	25	0	0	0	CONV
2	L	L18	Fdi	263.1	3	4	15	45.1	2.4		263.1	15.62	22.12	40	0	0	0	CONV
9	L	L18	Fdi	340.5	3	4	15	66.5	2.8		340.5	19.15	29.58	40	0	0	0	CONV
10	L	L18	Fdi	219.4	2	2	15	44.7		5.0	219.4	13.99	28.36	40	0	0	0	CONV
12	L	L18	Fdi	169.4	3	2	15	19.6		4.3	169.4	11.00	19.06	40	0	0	0	CONV
1033	L	L18	Fdi	323.9	2	7	15	15.5	4.0		323.9	17.81	17.65	40	0	0	0	CONV
1037	L	L18	Fdi	381.5	4	7	15	38.8	5.0		381.5	19.80	21.11	40	0	0	0	CONV
1	L	L18	Pli	291.4	2	6	15	40.4	4.2		291.4	13.11	15.70	40	0	0	0	CONV
3	L	L18	Pli	483.7	2	7	15	45.8	6.4		483.7	19.95	21.25	40	0	0	0	CONV
4	L	L18	Pli	427.6	4	8	15	40.8	7.0		427.6	17.77	18.02	40	0	0	0	CONV
5	L	L18	Pli	460.5	3	8	15	50.8	9.0		460.5	19.07	19.03	40	0	0	0	CONV
6	L	L18	Pli	435.4	4	8	15	46.4	8.5		435.4	18.10	18.26	40	0	0	0	CONV
7	L	L18	Pli	515.5	2	8	15	53.1	10.0		515.5	20.12	20.63	40	0	0	0	CONV
8	L	L18	Pli	532.4	3	8	15	61.1	10.0		532.4	20.12	21.10	40	0	0	0	CONV
11	L	L18	Pli	451.1	3	8	15	45.9	7.9		451.1	18.68	18.75	40	0	0	0	CONV
1021	L	L18	Pli	361.4	3	6	15	39.6	5.6		361.4	15.60	18.75	40	0	0	0	CONV
1032	L	L18	Pli	348.5	4	6	15	44.9	6.0		348.5	15.60	18.22	40	0	0	0	CONV
1034	L	L18	Pli	390.7	2	6	15	50.6	5.8		390.7	16.30	19.90	40	0	0	0	CONV
1040	L	L18	Pli	409.9	3	8	15	41.5	7.3		409.9	17.10	17.46	40	0	0	0	CONV
1042	L	L18	Pli	436.7	3	8	15	54.0	7.6		436.7	18.15	18.31	40	0	0	0	CONV
1043	L	L18	Pli	476.3	3	8	15	50.9	8.8		476.3	19.65	19.50	40	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1050	L	L18	Pli	379.2	1	7	15	27.5	9.8		379.2	15.82	17.80	40	0	0	0	CONV
1051	L	L18	Pli	262.6	2		15	41.0	4.1		262.6	12.73		40	0	0	0	CONV
1052	L	L18	Pli	239.0	1		15		4.0		239.0	11.50		40	0	0	0	CONV
1053	L	L18	Pli	384.5	2	7	15	30.5	8.1		384.5	16.04	17.99	40	0	0	0	CONV
1	L	L34	Fdi	100.5	1		15	20.3		3.2	100.5			40	0	0	0	CONV
2	L	L34	Fdi	396.5	3	6	15	52.9	5.2		396.5	19.95	25.05	40	0	0	0	CONV
3	L	L34	Fdi	370.5	3	5	15	58.2	3.8		370.5	19.80	27.09	40	0	0	0	CONV
7	L	L34	Fdi	157.0	1		15	30.5	0.4		157.0	11.00		40	0	0	0	CONV
4	L	L34	Pli	373.7	3	6	15	48.2	5.4		373.7	15.60	19.24	40	0	0	0	CONV
5	L	L34	Pli	507.4	4	8	15	55.4	10.7		507.4	20.12	20.40	40	0	0	0	CONV
6	L	L34	Pli	378.3	3	6	15	54.5	7.2		378.3	15.78	19.42	40	0	0	0	CONV
853	L	L34	Pli	349.5	3	7	15	56.5	6.1		349.5	15.60	16.70	40	0	0	0	CONV
855	L	L34	Pli	437.6	3	8	15	62.1	7.9		437.6	18.19	18.33	40	0	0	0	CONV
856	L	L34	Pli	362.7	3	7	15	48.7	5.6		362.7	15.60	17.20	40	0	0	0	CONV
858	L	L34	Pli	410.6	2	7	15	40.8	7.9		410.6	17.07	18.89	40	0	0	0	CONV
865	L	L34	Pli	288.8	2	4	15	48.6	3.7		288.8	13.00	19.77	40	0	0	0	CONV
878	L	L34	Pli	220.3	2	3	15	47.5	2.2		220.3	10.76	17.91	40	0	0	0	CONV
880	L	L34	Pli	389.5	3	6	15	51.3	6.6		389.5	16.25	19.85	40	0	0	0	CONV
7	M	M12	Fdi	261.4	3	3	15	56.5	2.1		261.4	15.36	27.16	20	20	75	0	CONV
1	M	M12	Pli	257.0	3	4	15	49.1	3.2		257.0	12.69	17.72	20	20	75	0	CONV
2	M	M12	Pli	313.3	2	5	15	48.3	5.6		313.3	14.29	18.56	20	20	75	0	CONV
3	M	M12	Pli	171.7	1	2	15	34.8		4.4	171.7	8.37	16.07	20	20	75	0	CONV
4	M	M12	Pli	352.9	3	7	15	34.6	5.3		352.9	15.60	16.83	20	20	75	0	CONV
5	M	M12	Pli	328.0	3	6	15	57.5	4.4		328.0	15.07	17.36	20	20	75	0	CONV
6	M	M12	Pli	320.2	3	7	15	27.3	5.5		320.2	14.61	15.55	20	20	75	0	CONV
8	M	M12	Pli	199.3	2	2	15	56.7		4.6	199.3	9.84	20.41	20	20	75	0	CONV
9	M	M12	Pli	361.1	2	7	15	35.2	6.1		361.1	15.60	17.14	20	20	75	0	CONV
949	M	M30	Fdi	393.4	3	6	15	76.4	4.8		393.4	19.85	24.85	20	20	75	0	CONV
959	M	M30	Fdi	463.3	4	7	15	89.8	7.0		463.3	24.32	25.70	20	20	75	0	CONV
1	M	M30	Pli	290.0	2	6	15	57.6	5.4		290.0	13.05	15.63	20	20	75	0	CONV
948	M	M30	Pli	350.0	3	7	15	44.3	7.8		350.0	15.60	16.72	20	20	75	0	CONV
950	M	M30	Pli	327.5	2	6	15	24.7	6.0		327.5	15.04	17.33	20	20	75	0	CONV
952	M	M30	Pli	395.1	3	7	15	51.8	7.3		395.1	16.48	18.36	20	20	75	0	CONV
962	M	M30	Pli	353.0	3	8	15	33.3	6.8		353.0	15.60	15.53	20	20	75	0	CONV
973	M	M30	Pli	352.0	3	7	15	38.5	7.1		352.0	15.60	16.80	20	20	75	0	CONV
985	M	M30	Pli	380.0	2		15	49.3	6.8		380.0	15.85		20	20	75	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1	M	M35	Fdi	395.2	2		15	77.2	4.4		395.2	19.88		20	20	75	0	CONV
889	M	M35	Fdi	435.2	4	8	15	70.7	7.2		435.2	22.58	21.57	20	20	75	0	CONV
885	M	M35	Pli	378.8	3	6	15	53.5	6.2		378.8	15.80	19.44	20	20	75	0	CONV
890	M	M35	Pli	542.7	4	8	15	58.9	9.2		542.7	20.22	21.38	20	20	75	0	CONV
891	M	M35	Pli	465.3	3	8	15	51.4	8.7		465.3	19.27	19.18	20	20	75	0	CONV
2467	N	N	Pli	406.1	3	6	14	62.3	6.2		468.4	18.78	20.48	30	0	50	0	CONV
2469	N	N	Pli	263.9	2	4	14	53.1	3.7		317.0	13.11	18.18	30	0	50	0	CONV
2534	N	N	Pli	286.0	4	4	14	40.5	3.7		326.5	14.48	19.60	30	0	50	0	CONV
2535	N	N	Pli	359.6	3	6	14	52.2	5.3		411.8	16.63	18.68	30	0	50	0	CONV
2536	N	N	Pli	410.5	4	7	14	59.7	6.0		470.2	18.92	18.89	30	0	50	0	CONV
2537	N	N	Pli	256.3	3	4	14	50.0	2.8		306.3	12.73	17.67	30	0	50	0	CONV
2544	N	N	Pli	310.7	2	5	14	51.3	3.6		362.0	15.60	18.43	30	0	50	0	CONV
2616	N	N	Pli	346.6	3	6	14	59.3	4.5		405.9	15.98	18.14	30	0	50	0	CONV
	N	N	Pli	268.9	2	4	14	21.7	5.0		290.6	13.44	18.51	30	0	50	0	CONV
	N	N	Pli	304.8	3	5	14	42.8	4.0		347.6	15.57	18.13	30	0	50	0	CONV
	N	N	Pli	365.7	4	5	14	35.4	6.1		401.1	16.91	21.06	30	0	50	0	CONV
	N	N	Pli	413.2	3	6	14	63.4	6.1		476.6	19.05	20.74	30	0	50	0	CONV
	N	N	Pli	414.6	2	6	14	33.1	7.6		447.7	19.11	20.79	30	0	50	0	CONV
2690	O	O	Fdi	449.0	4	7	14	63.9	5.9		512.9	24.75	24.92	15	0	50	0	CONV
	O	O	Fdi	292.3	2	3	14	60.7	2.1		353.0	18.45	30.67	15	0	50	0	CONV
2372	O	O	Pli	382.3	4	7	14	47.4	6.6		429.7	17.68	17.91	15	0	50	0	CONV
2373	O	O	Pli	295.3	3	4	14	59.7	4.4		355.0	15.04	20.17	15	0	50	0	CONV
2374	O	O	Pli	335.6	3	5	14	47.6	5.0		383.2	15.60	19.66	15	0	50	0	CONV
2454	O	O	Pli	233.7	3	3	14	43.7	2.5		277.4	12.71	19.12	15	0	50	0	CONV
2455	O	O	Pli	318.0	3	5	14	34.7	4.2		352.7	15.60	18.80	15	0	50	0	CONV
2458	O	O	Pli	398.4	3	5	14	67.8	6.2		466.2	18.43	22.49	15	0	50	0	CONV
2473	O	O	Pli	298.3	2	4	14	58.6	5.2		356.9	15.29	20.35	15	0	50	0	CONV
2528	O	O	Pli	396.3	4	6	14	56.7	6.0		453.0	18.33	20.11	15	0	50	0	CONV
2529	O	O	Pli	421.0	4	6	14	69.2	6.6		490.2	19.41	21.02	15	0	50	0	CONV
2530	O	O	Pli	348.6	3	6	14	52.9	7.0		401.5	16.07	18.23	15	0	50	0	CONV
2531	O	O	Pli	387.7	3	6	14	50.3	6.4		438.0	17.93	19.78	15	0	50	0	CONV
2532	O	O	Pli	306.5	3	5	14	35.7	4.4		342.2	15.60	18.22	15	0	50	0	CONV
2533	O	O	Pli	265.9	2	5	14	46.1	2.9		312.0	13.29	16.00	15	0	50	0	CONV
2546	O	O	Pli	298.7	3	5	14	55.7	4.8		354.4	15.31	17.81	15	0	50	0	CONV
2547	O	O	Pli	265.4	3	3	14	42.7	2.7		308.1	13.27	21.72	15	0	50	0	CONV
2550	O	O	Pli	253.8	2	4	14	46.6	3.0		300.4	12.73	17.50	15	0	50	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
2612	O	O	Pli	281.1	3	5	14	51.7	3.9		332.8	14.23	16.86	15	0	50	0	CONV
2613	O	O	Pli	298.6	2	5	14	49.6	4.1		348.2	15.30	17.80	15	0	50	0	CONV
2614	O	O	Pli	370.0	3	6	14	61.0	2.7		431.0	17.11	19.09	15	0	50	0	CONV
2701	O	O	Pli	519.7	4	8	14	73.1	8.4		592.8	21.28	20.75	15	0	50	0	CONV
2703	O	O	Pli	291.3	2	5	14	24.7	5.1		316.0	14.84	17.42	15	0	50	0	CONV
	O	O	Pli	188.4	2	2	14	50.6		4.4	239.0	10.36	18.82	15	0	50	0	CONV
	O	O	Pli	307.5	3	4	14	54.6	4.0		362.1	15.60	20.89	15	0	50	0	CONV
	O	O	Pli	330.8	2	5	14	61.9	3.7		392.7	15.60	19.43	15	0	50	0	CONV
	O	O	Pli	418.0	4	7	14	61.6	7.0		479.6	19.27	19.14	15	0	50	0	CONV
	O	O	Pli	523.3	4	7	14	64.1	10.1		587.4	21.42	22.43	15	0	50	0	CONV
2	P	P	Fdi	375.8	4	5	14	63.3	4.0		439.1	21.84	27.49	0	0	50	0	CONV
3	P	P	Fdi	281.3	3	4	14	55.1	2.2		336.4	17.41	23.98	0	0	50	0	CONV
4	P	P	Fdi	169.5	2	1	14	41.3		5.4	210.8	12.37	31.21	0	0	50	0	CONV
8	P	P	Fdi	435.0	4	6	14	63.0	5.6		498.0	24.75	27.47	0	0	50	0	CONV
13	P	P	Fdi	243.4	3	3	14	49.4	2.1		292.8	16.50	24.96	0	0	50	0	CONV
15	P	P	Fdi	296.7	2	4	14	41.1	3.2		337.8	18.91	25.50	0	0	50	0	CONV
1573	P	P	Fdi	339.5	2	5	14	49.9	4.2		389.4	19.80	24.72	0	0	50	0	CONV
2207	P	P	Fdi	401.1	2	6	14	63.9	4.4		465.0	23.82	25.35	0	0	50	0	CONV
2452	P	P	Fdi	429.0	4	6	14	66.5	5.7		495.5	24.75	27.10	0	0	50	0	CONV
1	P	P	Pli	348.6	4	5	14	51.4	5.7		400.0	16.07	20.28	0	0	50	0	CONV
5	P	P	Pli	211.3	2	3	14	23.3	2.3		234.6	10.83	17.04	0	0	50	0	CONV
6	P	P	Pli	346.0	2	6	14	44.0	5.2		390.0	15.95	18.12	0	0	50	0	CONV
7	P	P	Pli	343.6	4	6	14	28.1	4.6		371.7	15.78	18.02	0	0	50	0	CONV
9	P	P	Pli	320.3	3	7	14	50.2	4.4		370.5	15.60	15.56	0	0	50	0	CONV
10	P	P	Pli	124.0	1		14	10.8		3.3	134.8			0	0	50	0	CONV
11	P	P	Pli	401.3	2	6	14	52.7	6.0		454.0	18.56	20.30	0	0	50	0	CONV
12	P	P	Pli	269.7	3	5	14	22.5	3.7		292.2	13.48	16.22	0	0	50	0	CONV
14	P	P	Pli	99.0	2		14	12.0		3.7	111.0			0	0	50	0	CONV
1211	P	P	Pli	113.0	1		14	7.5		4.2	120.5			0	0	50	0	CONV
1410	P	P	Pli	120.0	1		14	20.0		3.0	140.0			0	0	50	0	CONV
1411	P	P	Pli	119.0	1		14	11.0		3.5	130.0			0	0	50	0	HySeed
1576	P	P	Pli	402.0	4	6	14	52.2	7.0		454.2	18.59	20.32	0	0	50	0	CONV
1751	P	P	Pli	338.3	2	6	14	55.7	6.1		394.0	15.61	17.80	0	0	50	0	CONV
1752	P	P	Pli	377.9	1	6	14	66.0	5.9		443.9	17.48	19.40	0	0	50	0	CONV
2378	P	P	Pli	249.7	3	4	14	45.3	2.7		295.0	12.73	17.21	0	0	50	0	CONV
2379	P	P	Pli	365.5	2	5	14	63.6	3.8		429.1	16.90	21.05	0	0	50	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
2381	P	P	Pli	369.5	3	8	14	25.8	6.3		395.3	17.09	16.11	0	0	50	0	CONV
2382	P	P	Pli	260.8	3	5	14	23.4	3.3		284.2	12.88	15.70	0	0	50	0	CONV
2449	P	P	Pli	317.5	3	6	14	24.6	4.7		342.1	15.60	16.90	0	0	50	0	CONV
2480	P	P	Pli	451.2	4	7	14	58.5	7.2		509.7	20.12	20.23	0	0	50	0	CONV
2481	P	P	Pli	423.6	2	7	14	36.9	6.9		460.5	19.53	19.33	0	0	50	0	CONV
2517	P	P	Pli	433.4	2	7	14	52.1	7.6		485.5	19.91	19.65	0	0	50	0	CONV
2518	P	P	Pli	506.7	2	8	14	84.7	6.6		591.4	20.82	20.38	0	0	50	0	CONV
2519	P	P	Pli	453.7	2	8	14	57.5	7.3		511.2	20.12	18.83	0	0	50	0	CONV
2520	P	P	Pli	548.0	4	8	14	52.2	8.9		600.2	22.26	21.52	0	0	50	0	CONV
2522	P	P	Pli	376.2	2	7	14	25.3	5.6		401.5	17.40	17.69	0	0	50	0	CONV
2554	P	P	Pli	296.4	2	6	14	38.9	4.5		335.3	15.10	15.93	0	0	50	0	CONV
2555	P	P	Pli	479.5	4	8	14	58.3	8.1		537.8	20.12	19.60	0	0	50	0	CONV
2557	P	P	Pli	444.3	3	7	14	28.1	6.8		472.4	20.12	20.01	0	0	50	0	CONV
2558	P	P	Pli	403.7	1	7	14	43.7	7.7		447.4	18.67	18.66	0	0	50	0	CONV
2606	P	P	Pli	310.6	0	6	14	10.6	4.3		321.2	15.60	16.59	0	0	50	0	CONV
2609	P	P	Pli	435.1	4	7	14	46.4	7.2		481.5	19.99	19.71	0	0	50	0	CONV
2610	P	P	Pli	504.2	4	8	14	57.2	10.1		561.4	20.72	20.31	0	0	50	0	CONV
1	Q	Q	Fdi	163.5	2	1	14	44.4		3.0	207.9	12.37	29.05	0	0	50	0	HySeed
4	Q	Q	Fdi	383.2	4	6	14	66.9	4.0		450.1	22.51	24.20	0	0	50	0	HySeed
5	Q	Q	Fdi	383.0	2	6	14	42.6	5.5		425.6	22.38	24.18	0	0	50	0	HySeed
6	Q	Q	Fdi	382.9	3	5	14	54.5	5.2		437.4	22.38	28.02	0	0	50	0	HySeed
7	Q	Q	Fdi	175.3	2	2	14	42.0		4.7	217.3	12.38	20.38	0	0	50	0	HySeed
8	Q	Q	Fdi	339.0	4	5	14	57.8	3.7		396.8	19.80	24.68	0	0	50	0	HySeed
11	Q	Q	Fdi	480.7	4	7	14	62.3	7.0		543.0	25.39	26.63	0	0	50	0	HySeed
2485	Q	Q	Fdi	334.5	3	5	14	62.1	3.0		396.6	19.80	24.32	0	0	50	0	HySeed
2570	Q	Q	Fdi	378.7	4	5	14	57.5	4.1		436.2	22.01	27.71	0	0	50	0	HySeed
2	Q	Q	Pli	287.3	3	5	14	18.9	4.4		306.2	14.54	17.20	0	0	50	0	HySeed
3	Q	Q	Pli	300.5	3	4	14	46.9	3.3		347.4	15.40	20.48	0	0	50	0	HySeed
9	Q	Q	Pli	208.9	2	3	14	20.5	2.3		229.4	10.77	16.81	0	0	50	0	HySeed
10	Q	Q	Pli	279.6	3	5	14	29.6	3.4		309.2	14.15	16.78	0	0	50	0	HySeed
13	Q	Q	Pli	305.0	3	4	14	51.1	3.7	3.0	356.1	15.58	20.74	0	0	50	0	HySeed
1577	Q	Q	Pli	160.2	1	1	14	38.2		4.1	198.4	8.41	24.17	0	0	50	0	HySeed
1578	Q	Q	Pli	306.2	2	5	14	28.7	4.1		334.9	15.60	18.20	0	0	50	0	HySeed
1986	Q	Q	Pli	359.0	3	6	14	49.0	5.0		408.0	16.60	18.65	0	0	50	0	HySeed
1987	Q	Q	Pli	388.5	3	7	14	42.7	6.0		431.2	17.97	18.13	0	0	50	0	HySeed
2176	Q	Q	Pli	387.4	2	7	14	49.7	6.5		437.1	17.92	18.09	15	0	50	0	HySeed

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
2179	Q	Q	Pli	369.4	4	7	14	49.9	6.2		419.3	17.08	17.44	0	0	50	0	HySeed
2348	Q	Q	Pli	369.4	4	7	14	45.4	6.3	4.0	414.8	17.08	17.44	0	0	50	0	HySeed
2448	Q	Q	Pli	202.8	4	7	14	34.7	2.0	2.0	237.5	10.76	9.77	0	0	50	0	HySeed
2515	Q	Q	Pli	345.0	4	6	14	53.4	6.1		398.4	15.85	18.08	0	0	50	0	HySeed
2559	Q	Q	Pli	338.9	3	4	14	67.9	4.9		406.8	15.62	22.64	0	0	50	0	CONV
2561	Q	Q	Pli	266.5	3	5	14	19.6	3.5		286.1	13.32	16.03	0	0	50	0	CONV
2564	Q	Q	Pli	309.6	3	5	14	38.1	5.0		347.7	15.60	18.38	0	0	50	0	HySeed
2566	Q	Q	Pli	264.0	2	5	14	25.7	3.0		289.7	13.12	15.89	0	0	50	0	HySeed
2604	Q	Q	Pli	300.0	3	5	14	51.3	3.7		351.3	15.38	17.88	0	0	50	0	HySeed
2647	Q	Q	Pli	352.7	2	6	14	72.2	5.9		424.9	16.31	18.40	0	0	50	0	CONV
2648	Q	Q	Pli	279.8	3	6	14	21.8	4.4		301.6	14.16	15.13	0	0	50	0	HySeed
2682	Q	Q	Pli	209.8	2	3	14	39.3	2.6		249.1	10.82	16.90	0	0	50	0	CONV
2688	Q	Q	Pli	323.3	2	6	14	55.8	6.1		379.1	15.60	17.15	0	0	50	0	HySeed
1	R	R	Pli	241.4	2	3	14	59.3	2.2		300.7	12.73	19.78	15	0	50	0	HySeed
2	R	R	Pli	343.9	3	6	14	52.4	5.1		396.3	15.80	18.03	15	0	50	0	HySeed
3	R	R	Pli	385.4	2	7	14	53.1	6.0		438.5	17.82	18.02	15	0	50	0	HySeed
4	R	R	Pli	262.0	2	4	14	32.2	3.7		294.2	12.94	18.06	15	0	50	0	HySeed
5	R	R	Pli	211.6	2	3	14	59.2	2.1		270.8	10.84	17.07	15	0	50	0	HySeed
6	R	R	Pli	429.4	4	7	14	68.3	7.3		497.7	19.73	19.52	15	0	50	0	HySeed
7	R	R	Pli	442.0	4	7	14	68.7	6.7		510.7	20.12	19.94	15	0	50	0	HySeed
8	R	R	Pli	279.0	1	4	14	55.5	3.1		334.5	14.12	19.16	15	0	50	0	HySeed
9	R	R	Pli	248.0	2	4	14	36.2	3.3		284.2	12.73	17.09	15	0	50	0	HySeed
10	R	R	Pli	236.9	1	3	14	46.6	2.7		283.5	12.73	19.40	15	0	50	0	HySeed
11	R	R	Pli	377.0	4	7	14	52.4	6.6		429.4	17.44	17.72	15	0	50	0	HySeed
12	R	R	Pli	325.2	2	5	14	38.7	5.6		363.9	15.60	19.16	15	0	50	0	HySeed
1214	R	R	Pli	328.0	2	6	14	24.9	4.6		352.9	15.60	17.36	15	0	50	0	HySeed
1215	R	R	Pli	289.0	2	5	14	57.0	4.9		346.0	14.63	17.29	15	0	50	0	HySeed
1217	R	R	Pli	452.6	3	8	14	47.6	7.0		500.2	20.12	18.79	15	0	50	0	HySeed
1384	R	R	Pli	267.4	1	4	14	44.8	4.1		312.2	13.37	18.41	15	0	50	0	HySeed
1579	R	R	Pli	409.2	4	7	14	47.6	7.9		456.8	18.86	18.85	15	0	50	0	HySeed
1944	R	R	Pli	428.5	2	7	14	28.9	7.9		457.4	19.68	19.49	30	0	50	0	HySeed
1950	R	R	Pli	295.7	3	4	14	51.3	3.8		347.0	15.06	20.19	15	0	50	0	HySeed
1990	R	R	Pli	311.7	3	4	14	54.6	3.7		366.3	15.60	21.13	15	0	50	0	HySeed
2216	R	R	Pli	290.8	4	6	14	21.8	4.0		312.6	14.81	15.67	15	0	50	0	HySeed
2340	R	R	Pli	260.0	2	3	14	64.6	2.9		324.6	12.84	21.30	30	0	50	0	HySeed
2345	R	R	Pli	387.5	3	6	14	60.8	7.5		448.3	17.92	19.77	15	0	50	0	HySeed

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
2441	R	R	Pli	323.4	4	6	14	60.0	5.3		383.4	15.60	17.16	30	0	50	0	HySeed
2443	R	R	Pli	347.6	4	5	14	63.8	4.2		411.4	16.02	20.23	15	0	50	0	HySeed
2446	R	R	Pli	346.6	4	6	14	36.3	7.2		382.9	15.98	18.14	15	0	50	0	HySeed
2507	R	R	Pli	288.7	3	4	14	50.2	3.3		338.9	14.62	19.77	30	0	50	0	HySeed
2510	R	R	Pli	360.7	2	6	14	58.2	6.1		418.9	16.68	18.72	15	0	50	0	HySeed
2571	R	R	Pli	293.9	3	5	14	49.9	3.8		343.8	14.97	17.56	15	0	50	0	HySeed
2576	R	R	Pli	356.4	3	6	14	54.1	5.9		410.5	16.48	18.55	30	0	50	0	HySeed
2597	R	R	Pli	315.5	3	5	14	53.8	5.0		369.3	15.60	18.67	30	0	50	0	HySeed
2598	R	R	Pli	227.9	3	3	14	51.5	3.0		279.4	12.25	18.61	15	0	50	0	HySeed
2653	R	R	Pli	331.9	4	6	14	39.9	7.3		371.8	15.60	17.52	15	0	50	0	HySeed
1	S	S	Fdi	285.5	3	4	14	45.3	2.1		330.8	17.84	24.40	30	0	50	0	HySeed
6	S	S	Fdi	179.5	2	2	14	44.0		6.0	223.5	12.38	21.27	30	0	50	0	HySeed
1589	S	S	Fdi	300.9	3	4	14	59.9	2.6		360.8	19.37	25.90	30	0	0	0	HySeed
2	S	S	Pli	374.0	4	7	14	30.5	6.6		404.5	17.30	17.61	30	0	50	0	HySeed
3	S	S	Pli	217.3	2	3	14	43.4	2.0		260.7	11.41	17.63	30	0	50	0	HySeed
4	S	S	Pli	369.1	4	7	14	54.6	6.9		423.7	17.07	17.43	30	0	50	0	HySeed
5	S	S	Pli	352.2	3	5	14	51.3	4.9		403.5	16.29	20.45	30	0	50	0	HySeed
7	S	S	Pli	380.5	2	6	14	43.3	6.7		423.8	17.60	19.50	30	0	50	0	HySeed
8	S	S	Pli	357.5	3	4	14	63.5	6.0		421.0	16.53	23.63	30	0	50	0	HySeed
9	S	S	Pli	249.4	2	3	14	52.4	3.3		301.8	12.73	20.45	30	0	50	0	HySeed
1224	S	S	Pli	215.7	2	3	14	41.1	2.4		256.8	11.32	17.47	30	0	50	0	HySeed
1225	S	S	Pli	316.5	2	5	14	53.3	4.7		369.8	15.60	18.72	30	0	50	0	HySeed
1423	S	S	Pli	279.3	1	3	14	53.8	4.1		333.1	14.14	22.76	30	0	50	0	HySeed
1588	S	S	Pli	249.6	2	4	14	49.5	4.2		299.1	12.73	17.21	30	0	50	0	HySeed
1737	S	S	Pli	292.4	3	4	14	34.4	4.0		326.8	14.89	19.99	30	0	50	0	HySeed
1937	S	S	Pli	361.0	2	5	14	71.5	4.7		432.5	16.70	20.85	30	0	50	0	HySeed
1997	S	S	Pli	331.6	3	5	14	53.8	5.4		385.4	15.60	19.47	30	0	50	0	HySeed
2220	S	S	Pli	259.6	3	3	14	48.1	2.7		307.7	12.82	21.27	30	0	50	0	HySeed
2222	S	S	Pli	283.2	2	5	14	40.8	5.2		324.0	14.34	16.98	30	0	50	0	HySeed
2225	S	S	Pli	347.7	2	5	14	62.2	5.0		409.9	16.03	20.24	30	0	50	0	HySeed
2227	S	S	Pli	288.8	2	5	14	49.8	4.2		338.6	14.62	17.28	30	0	50	0	HySeed
2339	S	S	Pli	299.1	3	4	14	56.4	4.3		355.5	15.33	20.39	30	0	50	0	HySeed
2390	S	S	Pli	254.5	3	4	14	50.0	3.2		304.5	12.73	17.55	30	0	50	0	HySeed
2392	S	S	Pli	327.8	2	5	14	31.8	5.6		359.6	15.60	19.28	30	0	50	0	HySeed
2393	S	S	Pli	303.8	3	4	14	62.1	3.1		365.9	15.57	20.67	30	0	50	0	HySeed
2440	S	S	Pli	338.8	4	6	14	48.5	5.6		387.3	15.62	17.82	30	0	50	0	HySeed

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
2493	S	S	Pli	271.0	2	3	14	68.6	3.3		339.6	13.55	22.14	30	0	50	0	HySeed
2495	S	S	Pli	278.4	3	4	14	42.5	3.6		320.9	14.09	19.12	30	0	50	0	HySeed
2662	S	S	Pli	288.5	2	4	14	35.7	3.6		324.2	14.61	19.75	30	0	50	0	HySeed
2663	S	S	Pli	346.0	3	6	14	38.4	5.6		384.4	15.95	18.12	30	0	50	0	HySeed
2664	S	S	Pli	439.3	3	7	14	52.3	8.4		491.6	20.12	19.85	30	0	50	0	HySeed
2665	S	S	Pli	339.5	2	6	14	37.2	4.3		376.7	15.60	17.85	30	0	50	0	HySeed
2666	S	S	Pli	426.2	3	7	14	36.1	7.1		462.3	19.65	19.42	30	0	50	0	HySeed
2678	S	S	Pli	363.6	4	6	14	54.9	4.9		418.5	16.82	18.84	30	0	50	0	HySeed
2	T	T	Fdi	377.6	4	5	14	72.1	3.4		449.7	21.95	27.63	30	0	0	0	HySeed
3	T	T	Fdi	277.0	4	3	14	48.6	2.0		325.6	16.97	28.97	30	0	0	0	HySeed
5	T	T	Fdi	303.8	3	4	14	57.2	3.0		361.0	19.56	26.18	30	0	0	0	HySeed
6	T	T	Fdi	358.5	3	4	14	65.5	3.4		424.0	20.50	31.17	30	0	0	0	HySeed
7	T	T	Fdi	380.4	3	5	14	52.0	4.0		432.4	22.23	27.83	30	0	0	0	HySeed
9	T	T	Fdi	295.2	3	4	14	55.0	2.2		350.2	18.82	25.35	30	0	0	0	HySeed
11	T	T	Fdi	283.6	3	3	14	70.3	2.1		353.9	17.55	29.71	30	0	0	0	HySeed
13	T	T	Fdi	182.1	1	2	14	32.8		6.2	214.9	12.52	21.81	30	0	0	0	HySeed
14	T	T	Fdi	196.2	1	2	14	50.5		3.2	246.7	14.14	24.49	30	0	0	0	HySeed
15	T	T	Fdi	357.8	3	5	14	60.5	3.9		418.3	20.46	26.13	30	0	0	0	HySeed
17	T	T	Fdi	389.5	4	5	14	60.5	4.3		450.0	22.88	28.51	30	0	0	0	HySeed
18	T	T	Fdi	418.7	4	6	14	57.4	4.7		476.1	24.75	26.46	30	0	0	0	HySeed
20	T	T	Fdi	318.8	3	4	14	65.6	2.9		384.4	19.80	27.60	30	0	0	0	HySeed
21	T	T	Fdi	258.2	2	3	14	63.7	1.9		321.9	16.50	26.78	30	0	0	0	HySeed
24	T	T	Fdi	406.4	4	5	14	65.8	4.5		472.2	24.26	29.73	30	0	0	0	HySeed
26	T	T	Fdi	163.8	2	2	14	22.8		5.0	186.6	12.37	17.72	30	0	0	0	HySeed
27	T	T	Fdi	274.0	3	5	14	49.5	2.4		323.5	16.61	19.31	30	0	0	0	HySeed
28	T	T	Fdi	322.0	4	5	14	56.7	3.5		378.7	19.80	23.33	30	0	0	0	HySeed
30	T	T	Fdi	250.6	2	3	14	56.3	2.0		306.9	16.50	25.85	30	0	0	0	HySeed
1370	T	T	Fdi	384.7	3	6	14	54.6	5.8		439.3	22.60	24.29	30	0	0	0	HySeed
1373	T	T	Fdi	117.5	1		14	28.0		4.1	145.5			30	0	0	0	HySeed
1430	T	T	Fdi	346.7	4	6	14	61.2	4.0		407.9	19.80	21.77	30	0	0	0	HySeed
1432	T	T	Fdi	271.1	3	3	14	62.6	2.0		333.7	16.50	28.29	30	0	0	0	HySeed
1435	T	T	Fdi	262.1	2	3	14	61.6	2.0		323.7	16.50	27.24	15	0	0	0	HySeed
1436	T	T	Fdi	240.2	3	3	14	53.1	1.5		293.3	16.50	24.55	15	0	0	0	HySeed
1591	T	T	Fdi	293.6	4	3	14	71.8	2.1		365.4	18.53	30.82	30	0	0	0	HySeed
1593	T	T	Fdi	315.9	3	4	14	63.2	2.5		379.1	19.80	27.33	30	0	0	0	HySeed
1706	T	T	Fdi	293.4	4	3	14	68.4	2.0		361.8	18.52	30.79	30	0	0	0	HySeed

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1728	T	T	Fdi	322.6	3	5	14	75.7	2.8		398.3	19.80	23.38	30	0	0	0	HySeed
1733	T	T	Fdi	285.8	3	4	14	56.8	2.0		342.6	17.86	24.43	30	0	0	0	HySeed
1792	T	T	Fdi	357.5	3	4	14	52.7	3.6		410.2	20.44	31.09	30	0	0	0	HySeed
1927	T	T	Fdi	348.3	4	4	14	59.5	4.5		407.8	19.80	30.28	30	0	0	0	HySeed
1932	T	T	Fdi	417.3	4	6	14	66.3	4.6		483.6	24.75	26.37	30	0	0	0	HySeed
2010	T	T	Fdi	416.7	3	6	14	72.1	5.0		488.8	24.75	26.33	30	0	0	0	HySeed
2012	T	T	Fdi	197.0	3	2	14	45.5		4.6	242.5	14.14	24.64	30	0	0	0	HySeed
2149	T	T	Fdi	316.1	3	3	14	55.9	3.4		372.0	19.80	33.20	30	0	0	0	HySeed
2160	T	T	Fdi	235.4	3	4	14	32.0	2.5		267.4	16.18	19.11	30	0	0	0	HySeed
2223	T	T	Fdi	251.5	2	3	14	65.0	1.8		316.5	16.50	25.96	30	0	0	0	HySeed
2234	T	T	Fdi	361.0	4	4	14	74.4	3.6		435.4	20.76	31.39	30	0	0	0	HySeed
2330	T	T	Fdi	369.5	3	5	14	65.4	4.1		434.9	21.36	27.02	30	0	0	0	HySeed
2331	T	T	Fdi	328.5	4	4	14	63.5	3.3		392.0	19.80	28.49	30	0	0	0	HySeed
2399	T	T	Fdi	459.0	4	6	14	69.7	4.6		528.7	24.75	28.94	30	0	0	0	HySeed
2401	T	T	Fdi	408.3	4	6	14	70.5	4.8		478.8	24.37	25.80	30	0	0	0	HySeed
2406	T	T	Fdi	316.1	3	4	14	58.9	2.5		375.0	19.80	27.34	30	0	0	0	HySeed
2430	T	T	Fdi	242.7	3	2	14	56.4	6.0		299.1	16.50	31.78	30	0	0	0	HySeed
2432	T	T	Fdi	386.7	4	6	14	59.6	4.6		446.3	22.72	24.42	30	0	0	0	HySeed
1	T	T	Pli	97.0	1		14	13.0			110.0			30	0	0	0	HySeed
4	T	T	Pli	403.1	1	6	14	30.6	5.4		433.7	18.64	20.36	30	0	0	0	HySeed
10	T	T	Pli	340.9	3	6	14	55.9	5.5		396.8	15.66	17.91	30	0	0	0	HySeed
12	T	T	Pli	317.6	2	4	14	67.6	3.2		385.2	15.60	21.47	30	0	0	0	HySeed
16	T	T	Pli	337.6	2	5	14	36.2	4.7		373.8	15.60	19.76	30	0	0	0	HySeed
19	T	T	Pli	141.5	1	1	14	30.7	3.9		172.2	7.34	15.73	30	0	0	0	HySeed
22	T	T	Pli	321.4	3	5	14	46.2	5.3		367.6	15.60	18.97	30	0	0	0	HySeed
23	T	T	Pli	376.1	3	5	14	64.8	5.1		440.9	17.39	21.53	30	0	0	0	HySeed
25	T	T	Pli	291.5	3	3	14	51.4	4.2		342.9	14.85	23.64	30	0	0	0	HySeed
29	T	T	Pli	237.7	1	3	14	46.2	3.9		283.9	12.73	19.47	30	0	0	0	HySeed
31	T	T	Pli	137.6	1		14	29.3		4.7	166.9	6.88		30	0	0	0	HySeed
32	T	T	Pli	301.0	3	4	14	57.0	4.0		358.0	15.43	20.51	30	0	0	0	HySeed
1230	T	T	Pli	295.9	3	4	14	52.3	4.0		348.2	15.07	20.20	30	0	0	0	HySeed
1231	T	T	Pli	374.2	4	5	14	50.2	6.1		424.4	17.31	21.44	30	0	0	0	HySeed
1232	T	T	Pli	318.9	3	5	14	53.9	4.4		372.8	15.60	18.85	30	0	0	0	HySeed
1233	T	T	Pli	83.6	1		14	22.4		2.1	106.0			30	0	0	0	HySeed
1362	T	T	Pli	302.4	2	4	14	62.5	3.5		364.9	15.50	20.59	15	0	0	0	HySeed
1364	T	T	Pli	296.7	3	4	14	48.5	3.6		345.2	15.11	20.25	30	0	0	0	HySeed

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1365	T	T	Pli	343.0	4	6	14	47.5	5.1		390.5	15.76	17.99	30	0	0	0	HySeed
1366	T	T	Pli	305.7	3	5	14	44.7	4.4		350.4	15.60	18.18	30	0	0	0	HySeed
1367	T	T	Pli	251.8	3	4	14	49.8	3.2		301.6	12.73	17.36	30	0	0	0	HySeed
1368	T	T	Pli	400.5	3	6	14	63.0	5.6		463.5	18.52	20.27	30	0	0	0	HySeed
1369	T	T	Pli	340.5	3	4	14	69.4	2.7		409.9	15.64	22.73	30	0	0	0	HySeed
1371	T	T	Pli	339.5	2	5	14	51.9	3.9		391.4	15.60	19.85	30	0	0	0	HySeed
1372	T	T	Pli	304.1	3	5	14	20.8	3.5		324.9	15.59	18.09	30	0	0	0	HySeed
1374	T	T	Pli	371.0	2	5	14	58.2	6.7		429.2	17.16	21.30	30	0	0	0	HySeed
1426	T	T	Pli	124.0	1		14	25.0		4.0	149.0			30	0	0	0	HySeed
1427	T	T	Pli	230.2	3	3	14	37.6	3.4		267.8	12.52	18.81	30	0	0	0	HySeed
1428	T	T	Pli	281.3	3	4	14	42.8	3.6		324.1	14.24	19.31	30	0	0	0	HySeed
1429	T	T	Pli	384.6	3	6	14	60.4	4.9		445.0	17.79	19.66	30	0	0	0	HySeed
1431	T	T	Pli	361.9	3	6	14	50.4	6.1		412.3	16.74	18.77	30	0	0	0	HySeed
1592	T	T	Pli	300.0	2	4	14	24.0	4.2		324.0	15.38	20.45	30	0	0	0	HySeed
1596	T	T	Pli	296.7	2	4	14	57.4	3.9		354.1	15.11	20.25	15	0	0	0	HySeed
1727	T	T	Pli	284.0	3	4	14	48.6	3.5		332.6	14.38	19.48	15	0	0	0	HySeed
1730	T	T	Pli	316.9	3	4	14	54.3	3.6		371.2	15.60	21.43	30	0	0	0	HySeed
1731	T	T	Pli	328.8	2	5	14	52.4	4.2		381.2	15.60	19.33	30	0	0	0	HySeed
1732	T	T	Pli	285.0	3	4	14	56.0	4.0		341.0	14.43	19.54	30	0	0	0	HySeed
1734	T	T	Pli	304.4	2	4	14	51.9	5.3		356.3	15.55	20.71	30	0	0	0	HySeed
1735	T	T	Pli	291.0	3	3	14	62.2	3.3		353.2	14.82	23.60	30	0	0	0	HySeed
1736	T	T	Pli	336.2	2	4	14	57.8	4.8		394.0	15.60	22.50	30	0	0	0	HySeed
1784	T	T	Pli	379.6	3	6	14	56.3	6.0		435.9	17.56	19.47	30	0	0	0	HySeed
1787	T	T	Pli	261.0	3	4	14	48.7	2.8		309.7	12.89	17.99	30	0	0	0	HySeed
1788	T	T	Pli	312.0	3	4	14	64.4	3.0		376.4	15.60	21.15	30	0	0	0	HySeed
1789	T	T	Pli	337.4	2	5	14	63.0	4.5		400.4	15.60	19.75	30	0	0	0	HySeed
1790	T	T	Pli	260.5	1	3	14	50.0	2.8		310.5	12.86	21.34	30	0	0	0	HySeed
1791	T	T	Pli	329.3	2	4	14	66.3	4.0		395.6	15.60	22.12	30	0	0	0	HySeed
1793	T	T	Pli	266.8	3	3	14	65.7	2.6		332.5	13.34	21.82	15	0	0	0	HySeed
1929	T	T	Pli	258.8	2	4	14	39.1	3.6		297.9	12.78	17.84	30	0	0	0	HySeed
1935	T	T	Pli	300.2	3	4	14	55.7	4.1		355.9	15.39	20.46	30	0	0	0	HySeed
2005	T	T	Pli	391.3	4	7	14	17.1	6.7		408.4	18.10	18.23	30	0	0	0	HySeed
2015	T	T	Pli	342.1	3	6	14	65.7	5.0		407.8	15.72	17.96	15	0	0	0	HySeed
2052	T	T	Pli	290.1	4	4	14	51.6	4.3		341.7	14.78	19.85	30	0	0	0	HySeed
2148	T	T	Pli	318.1	3	5	14	48.6	4.6		366.7	15.60	18.81	15	0	0	0	HySeed
2150	T	T	Pli	281.5	3	4	14	49.0	3.4		330.5	14.25	19.32	30	0	0	0	HySeed

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
2153	T	T	Pli	331.8	4	5	14	56.2	4.3		388.0	15.60	19.48	30	0	0	0	HySeed
2154	T	T	Pli	366.3	4	5	14	62.1	6.0		428.4	16.94	21.09	30	0	0	0	HySeed
2155	T	T	Pli	352.0	4	5	14	60.9	5.0		412.9	16.28	20.44	30	0	0	0	HySeed
2157	T	T	Pli	278.0	3	4	14	53.4	3.1		331.4	13.99	19.10	30	0	0	0	HySeed
2158	T	T	Pli	435.1	4	6	14	97.7	6.3		532.8	19.99	21.53	30	0	0	0	HySeed
2159	T	T	Pli	271.1	2	4	14	49.1	3.0		320.2	13.56	18.66	30	0	0	0	HySeed
2228	T	T	Pli	353.2	4	5	14	47.7	5.7		400.9	16.34	20.49	30	0	0	0	HySeed
2229	T	T	Pli	447.7	4	7	14	39.1	6.6		486.8	20.12	20.12	30	0	0	0	HySeed
2230	T	T	Pli	447.5	4	7	14	37.8	7.5		485.3	20.12	20.11	30	0	0	0	HySeed
2235	T	T	Pli	262.0	3	5	14	41.7	5.5		303.7	12.94	15.77	30	0	0	0	HySeed
2236	T	T	Pli	302.5	2	4	14	59.0	3.8		361.5	15.50	20.60	30	0	0	0	HySeed
2237	T	T	Pli	292.7	3	4	14	39.4	5.3		332.1	14.91	20.01	30	0	0	0	HySeed
2238	T	T	Pli	253.0	3	3	14	53.3	2.9		306.3	12.73	20.74	15	0	0	0	HySeed
2322	T	T	Pli	304.5	3	5	14	60.1	4.0		364.6	15.56	18.11	15	0	0	0	HySeed
2323	T	T	Pli	344.6	3	6	14	52.2	6.3		396.8	15.83	18.06	30	0	0	0	HySeed
2324	T	T	Pli	221.3	2	2	14	55.1	4.2		276.4	11.76	23.29	30	0	0	0	HySeed
2327	T	T	Pli	399.7	3	5	14	77.8	6.2		477.5	18.49	22.55	30	0	0	0	HySeed
2328	T	T	Pli	411.6	2	6	14	38.3	5.9		449.9	18.97	20.68	30	0	0	0	HySeed
2402	T	T	Pli	363.1	2	5	14	55.5	4.9		418.6	16.79	20.94	30	0	0	0	HySeed
2404	T	T	Pli	327.8	3	4	14	61.9	4.0		389.7	15.60	22.04	30	0	0	0	HySeed
2420	T	T	Pli	383.1	4	6	14	45.3	6.0		428.4	17.72	19.60	30	0	0	0	HySeed
2421	T	T	Pli	294.2	3	4	14	45.4	4.2		339.6	14.99	20.10	30	0	0	0	HySeed
2424	T	T	Pli	410.0	3	6	14	35.0	6.3		445.0	18.90	20.62	30	0	0	0	HySeed
2425	T	T	Pli	409.5	4	7	14	37.7	6.7		447.2	18.88	18.86	30	0	0	0	HySeed
2426	T	T	Pli	243.6	3	3	14	39.9	2.5		283.5	12.73	19.97	30	0	0	0	HySeed
2428	T	T	Pli	257.0	1	5	14	50.1	4.7		307.1	12.73	15.47	30	0	0	0	HySeed
2429	T	T	Pli	286.1	2	4	14	60.9	3.5		347.0	14.48	19.61	30	0	0	0	HySeed
2431	T	T	Pli	383.8	2	6	14	37.6	6.7		421.4	17.75	19.63	30	0	0	0	HySeed
2433	T	T	Pli	412.8	3	7	14	52.2	6.2		465.0	19.03	18.97	30	0	0	0	HySeed
2434	T	T	Pli	331.5	2	6	14	46.9	5.0		378.4	15.60	17.51	30	0	0	0	HySeed
2435	T	T	Pli	374.3	2	6	14	37.2	4.7		411.5	17.31	19.26	30	0	0	0	HySeed
3325	T	T	Pli	463.9	4	7	14	60.1	6.2		524.0	20.12	20.63	30	0	0	0	HySeed
	T	T	Pli	360.0	3	5	14	57.7	4.5		417.7	16.65	20.80	30	0	0	0	HySeed
1	U	U	Fdi	189.6	2	2	14	39.6		4.0	229.2	13.75	23.27	15	0	0	0	HySeed
2	U	U	Fdi	185.7	2	1	14	46.1		4.6	231.8	13.00	36.26	15	0	0	0	HySeed
3	U	U	Fdi	402.0	3	6	14	77.3	4.1		479.3	23.87	25.40	15	0	0	0	HySeed

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
10	U	U	Fdi	248.2	3	3	14	38.9	2.1		287.1	16.50	25.56	15	0	0	0	HySeed
11	U	U	Fdi	293.3	3	4	14	67.1	2.6		360.4	18.51	25.17	15	0	0	0	HySeed
12	U	U	Fdi	270.5	2	3	14	60.5	2.3		331.0	16.50	28.22	15	0	0	0	HySeed
15	U	U	Fdi	275.1	2	4	14	51.6	2.2		326.7	16.85	23.35	15	0	0	0	HySeed
16	U	U	Fdi	211.5	3	2	14	55.2	5.2		266.7	14.14	27.11	15	0	0	0	HySeed
18	U	U	Fdi	143.6	2	1	14	30.2		3.1	173.8	11.00	19.73	15	0	0	0	HySeed
19	U	U	Fdi	206.5	3	2	14	53.1		5.4	259.6	14.14	26.28	15	0	0	0	HySeed
21	U	U	Fdi	196.3	3	2	14	50.8	6.7		247.1	14.14	24.51	15	0	0	0	HySeed
25	U	U	Fdi	275.1	3	4	14	50.4	2.0		325.5	16.85	23.35	15	0	0	0	HySeed
1350	U	U	Fdi	290.8	3	3	14	59.2	3.5		350.0	18.36	30.51	15	0	0	0	HySeed
1351	U	U	Fdi	236.6	3	2	14	55.7		6.1	292.3	16.27	30.93	15	0	0	0	HySeed
1352	U	U	Fdi	318.0	3	4	14	59.3	2.7		377.3	19.80	27.52	15	0	0	0	HySeed
1443	U	U	Fdi	218.1	2	2	14	54.1		8.0	272.2	14.14	28.16	15	0	0	0	HySeed
1445	U	U	Fdi	336.4	3	4	14	57.6	3.3		394.0	19.80	29.21	15	0	0	0	HySeed
1448	U	U	Fdi	197.4	2	2	14	41.1	6.9		238.5	14.14	24.71	15	0	0	0	HySeed
1563	U	U	Fdi	253.3	3	3	14	58.3	2.0		311.6	16.50	26.18	15	0	0	0	HySeed
1599	U	U	Fdi	57.0	1		14	5.0		2.0	62.0	11.00	19.73	15	0	0	0	HySeed
1600	U	U	Fdi	331.7	4	5	14	57.1	3.7		388.8	19.80	24.10	15	0	0	0	HySeed
1601	U	U	Fdi	409.4	4	5	14	65.9	4.1		475.3	24.44	29.95	15	0	0	0	HySeed
1602	U	U	Fdi	254.6	3	3	14	52.6	2.0		307.2	16.50	26.34	15	0	0	0	HySeed
1603	U	U	Fdi	265.5	3	3	14	67.4	2.1		332.9	16.50	27.64	15	0	0	0	HySeed
1604	U	U	Fdi	289.8	3	3	14	58.3	2.2		348.1	18.29	30.40	15	0	0	0	HySeed
1605	U	U	Fdi	264.8	3	3	14	54.5	2.3		319.3	16.50	27.56	15	0	0	0	HySeed
1714	U	U	Fdi	355.6	4	5	14	63.7	3.3		419.3	20.22	25.96	15	0	0	0	HySeed
1718	U	U	Fdi	367.0	4	5	14	62.0	4.3		429.0	21.10	26.83	15	0	0	0	HySeed
1722	U	U	Fdi	311.5	3	4	14	56.5	2.1		368.0	19.80	26.91	15	0	0	0	HySeed
1796	U	U	Fdi	206.9	3	2	14	37.9		6.4	244.8	14.14	26.35	15	0	0	0	HySeed
1798	U	U	Fdi	343.6	3	5	14	62.9	2.8		406.5	19.80	25.04	15	0	0	0	HySeed
1801	U	U	Fdi	311.4	3	4	14	68.1	2.4		379.5	19.80	26.90	15	0	0	0	HySeed
1803	U	U	Fdi	340.4	3	4	14	58.0	4.6		398.4	19.80	29.57	15	0	0	0	HySeed
1804	U	U	Fdi	385.8	4	5	14	71.5	4.3		457.3	22.67	28.23	15	0	0	0	HySeed
1916	U	U	Fdi	357.5	4	4	14	62.3	3.0		419.8	20.44	31.09	15	0	0	0	HySeed
1918	U	U	Fdi	468.0	3	6	14	51.7	5.9		519.7	24.75	29.48	15	0	0	0	HySeed
1925	U	U	Fdi	313.8	3	4	14	58.5	2.8		372.3	19.80	27.13	15	0	0	0	HySeed
1926	U	U	Fdi	144.3	2	1	14	35.0		3.4	179.3	11.00	20.16	15	0	0	0	HySeed
2018	U	U	Fdi	316.4	3	4	14	69.1	2.2		385.5	19.80	27.37	15	0	0	0	HySeed

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
2020	U	U	Fdi	277.3	3	4	14	50.1	2.2		327.4	16.98	23.58	15	0	0	0	HySeed
2021	U	U	Fdi	311.4	3	4	14	62.2	2.5		373.6	19.80	26.90	15	0	0	0	HySeed
2309	U	U	Fdi	192.0	2	2	14	47.2	5.3		239.2	14.10	23.72	15	0	0	0	HySeed
2312	U	U	Fdi	322.7	3	4	14	60.2	2.6		382.9	19.80	27.96	15	0	0	0	HySeed
2314	U	U	Fdi	363.6	4	5	14	62.1	4.7		425.7	20.91	26.57	15	0	0	0	HySeed
2317	U	U	Fdi	236.8	3	3	14	57.9	2.0		294.7	16.43	24.12	15	0	0	0	HySeed
2413	U	U	Fdi	266.4	3	3	14	58.1	2.1		324.5	16.50	27.75	15	0	0	0	HySeed
2414	U	U	Fdi	347.1	4	5	14	52.7	3.9		399.8	19.80	25.31	15	0	0	0	HySeed
4	U	U	Pli	312.7	2	5	14	66.2	4.8		378.9	15.60	18.53	15	0	0	0	HySeed
5	U	U	Pli	399.0	3	7	14	58.7	5.5		457.7	18.45	18.50	15	0	0	0	HySeed
6	U	U	Pli	347.4	3	5	14	31.5	5.4		378.9	16.01	20.22	15	0	0	0	HySeed
7	U	U	Pli	257.7	1	2	14	43.9		8.1	301.6	12.76	27.37	15	0	0	0	HySeed
7	U	U	Pli	400.9	3	5	14	34.2	7.4		435.1	18.54	22.60	15	0	0	0	HySeed
8	U	U	Pli	299.0	1	4	14	58.9	3.4		357.9	15.32	20.39	15	0	0	0	HySeed
9	U	U	Pli	291.6	3	4	14	55.6	4.0		347.2	14.85	19.94	15	0	0	0	HySeed
13	U	U	Pli	144.5	1	1	14	12.1		8.0	156.6	7.35	17.41	15	0	0	0	HySeed
14	U	U	Pli	298.8	3	5	14	52.3	5.1		351.1	15.31	17.82	15	0	0	0	HySeed
17	U	U	Pli	367.4	3	6	14	30.1	5.5		397.5	16.99	18.99	15	0	0	0	HySeed
20	U	U	Pli	226.2	3	3	14	42.2	2.5		268.4	12.16	18.45	15	0	0	0	HySeed
22	U	U	Pli	294.5	3	4	14	50.5	3.5		345.0	15.00	20.12	15	0	0	0	HySeed
23	U	U	Pli	328.9	2	5	14	33.4	5.1		362.3	15.60	19.34	15	0	0	0	HySeed
24	U	U	Pli	260.0	2	4	14	47.0	3.1		307.0	12.84	17.92	15	0	0	0	HySeed
26	U	U	Pli	235.0	2	3	14	54.0	2.0		289.0	12.73	19.24	15	0	0	0	HySeed
27	U	U	Pli	156.2	3	1	14	42.3			198.5	8.21	22.67	15	0	0	0	HySeed
28	U	U	Pli	237.9	3	3	14	55.8	2.2		293.7	12.73	19.49	15	0	0	0	HySeed
1237	U	U	Pli	308.2	3	6	14	28.8	5.7		337.0	15.60	16.48	15	0	0	0	HySeed
1243	U	U	Pli	410.8	2	6	14	57.4	4.8		468.2	18.94	20.65	15	0	0	0	HySeed
1246	U	U	Pli	307.0	3	5	14	39.2	4.6		346.2	15.60	18.24	15	0	0	0	HySeed
1247	U	U	Pli	241.3	2	4	14	46.2	3.1		287.5	12.73	16.62	15	0	0	0	HySeed
1437	U	U	Pli	278.4	2	4	14	52.9	3.5		331.3	14.09	19.12	15	0	0	0	HySeed
1444	U	U	Pli	216.8	1	3	14	26.5	2.2		243.3	11.38	17.58	15	0	0	0	HySeed
1446	U	U	Pli	231.0	3	4	14	27.4	2.6		258.4	12.56	15.85	15	0	0	0	HySeed
1447	U	U	Pli	284.3	1	4	14	35.2	4.1		319.5	14.39	19.49	15	0	0	0	HySeed
1449	U	U	Pli	202.0	1	3	14	43.1	2.6		245.1	10.76	16.10	15	0	0	0	HySeed
1558	U	U	Pli	235.0	1	3	14	51.0	2.3		286.0	12.73	19.24	15	0	0	0	HySeed
1559	U	U	Pli	215.3	2	3	14	43.0	2.3		258.3	11.30	17.43	15	0	0	0	HySeed

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1560	U	U	Pli	198.8	3	2	14	46.5		7.3	245.3	10.76	20.34	15	0	0	0	HySeed
1561	U	U	Pli	199.0	1	2	14	30.5		6.7	229.5	10.76	20.37	15	0	0	0	HySeed
1562	U	U	Pli	267.9	2	4	14	49.6	3.1		317.5	13.39	18.45	15	0	0	0	HySeed
1564	U	U	Pli	272.8	2	3	14	66.3	3.1		339.1	13.64	22.28	15	0	0	0	HySeed
1565	U	U	Pli	252.6	1	3	14	44.3	3.3		296.9	12.73	20.71	15	0	0	0	HySeed
1597	U	U	Pli	252.6	2	3	14	51.5	2.1		304.1	12.73	20.71	15	0	0	0	HySeed
1598	U	U	Pli	299.0	1	4	14	57.4	3.8		356.4	15.32	20.39	15	0	0	0	HySeed
1607	U	U	Pli	233.7	3	4	14	43.8	2.1		277.5	12.71	16.05	15	0	0	0	HySeed
1608	U	U	Pli	328.6	2	5	14	59.9	4.2		388.5	15.60	19.32	15	0	0	0	HySeed
1712	U	U	Pli	359.1	3	6	14	54.7	5.3		413.8	16.61	18.66	15	0	0	0	HySeed
1713	U	U	Pli	309.0	2	4	14	47.0	4.1		356.0	15.60	20.98	15	0	0	0	HySeed
1715	U	U	Pli	234.3	3	3	14	40.5	2.6		274.8	12.73	19.17	15	0	0	0	HySeed
1716	U	U	Pli	317.4	2	5	14	44.1	4.6		361.5	15.60	18.77	15	0	0	0	HySeed
1719	U	U	Pli	262.2	2	3	14	54.4	2.4		316.6	12.95	21.47	15	0	0	0	HySeed
1720	U	U	Pli	360.0	3	5	14	60.3	4.2		420.3	16.65	20.80	15	0	0	0	HySeed
1721	U	U	Pli	330.1	3	5	14	60.6	4.6		390.7	15.60	19.40	15	0	0	0	HySeed
1723	U	U	Pli	288.3	3	4	14	64.3	3.2		352.6	14.60	19.74	15	0	0	0	HySeed
1724	U	U	Pli	290.0	3	5	14	50.5	4.0		340.5	14.77	17.35	15	0	0	0	HySeed
1725	U	U	Pli	308.0	3	4	14	56.9	3.7		364.9	15.60	20.92	15	0	0	0	HySeed
1726	U	U	Pli	336.3	3	5	14	60.9	3.8		397.2	15.60	19.70	15	0	0	0	HySeed
1746	U	U	Pli	312.0	3	5	14	23.5	4.2		335.5	15.60	18.50	15	0	0	0	HySeed
1795	U	U	Pli	368.6	3	6	14	68.2	4.7		436.8	17.05	19.04	15	0	0	0	HySeed
1797	U	U	Pli	345.7	3	5	14	51.7	5.1		397.4	15.88	20.14	15	0	0	0	HySeed
1799	U	U	Pli	345.3	3	6	14	57.9	5.2		403.2	15.86	18.09	15	0	0	0	HySeed
1800	U	U	Pli	346.0	2	5	14	43.0	4.5		389.0	15.95	20.16	15	0	0	0	HySeed
1802	U	U	Pli	385.0	3	6	14	57.3	5.9		442.3	17.81	19.68	15	0	0	0	HySeed
1915	U	U	Pli	417.5	3	7	14	48.7	5.5		466.2	19.24	19.13	15	0	0	0	HySeed
1919	U	U	Pli	410.5	3	6	14	57.6	6.1		468.1	18.92	20.64	15	0	0	0	HySeed
1920	U	U	Pli	425.6	2	6	14	42.3	6.4		467.9	19.62	21.19	15	0	0	0	HySeed
1921	U	U	Pli	362.1	4	6	14	54.2	6.1		416.3	16.75	18.78	15	0	0	0	HySeed
1922	U	U	Pli	294.3	1	5	14	43.3	4.2		337.6	14.99	17.58	15	0	0	0	HySeed
1923	U	U	Pli	343.1	3	5	14	51.2	5.5		394.3	15.76	20.02	15	0	0	0	HySeed
1924	U	U	Pli	173.0	2	1	14	54.9		3.9	227.9	9.32	28.38	15	0	0	0	HySeed
2016	U	U	Pli	353.5	2	6	14	51.1	3.9		404.6	16.35	18.43	15	0	0	0	HySeed
2017	U	U	Pli	351.4	3	5	14	61.4	4.2		412.8	16.25	20.41	15	0	0	0	HySeed
2019	U	U	Pli	322.4	3	5	14	25.8	4.3		348.2	15.60	19.02	15	0	0	0	HySeed

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
2023	U	U	Pli	421.3	2	7	14	44.8	5.9		466.1	19.42	19.25	15	0	0	0	HySeed
2024	U	U	Pli	321.0	3	6	14	44.9	4.4		365.9	15.60	17.05	15	0	0	0	HySeed
2027	U	U	Pli	428.5	3	7	14	61.3	6.0		489.8	19.68	19.49	15	0	0	0	HySeed
2138	U	U	Pli	328.9	3	5	14	38.5	4.1		367.4	15.60	19.34	15	0	0	0	HySeed
2139	U	U	Pli	409.5	4	6	14	77.5	5.9		487.0	18.88	20.60	15	0	0	0	HySeed
2140	U	U	Pli	370.2	3	6	14	44.7	5.1		414.9	17.12	19.10	15	0	0	0	HySeed
2141	U	U	Pli	407.2	3	7	14	43.5	5.8		450.7	18.77	18.78	15	0	0	0	HySeed
2142	U	U	Pli	453.8	2	7	14	69.4	6.4		523.2	20.12	20.31	15	0	0	0	HySeed
2144	U	U	Pli	295.4	2	4	14	54.6	4.2		350.0	15.05	20.17	15	0	0	0	HySeed
2145	U	U	Pli	320.2	3	5	14	51.8	4.6		372.0	15.60	18.91	15	0	0	0	HySeed
2146	U	U	Pli	354.5	2	5	14	42.2	4.0		396.7	16.40	20.55	15	0	0	0	HySeed
2147	U	U	Pli	329.0	2	5	14	22.5	4.9		351.5	15.60	19.34	15	0	0	0	HySeed
2239	U	U	Pli	319.3	2	5	14	53.3	3.7		372.6	15.60	18.87	15	0	0	0	HySeed
2240	U	U	Pli	323.1	3	4	14	54.8	4.3		377.9	15.60	21.78	15	0	0	0	HySeed
2241	U	U	Pli	293.6	3	5	14	49.2	3.9		342.8	14.96	17.54	15	0	0	0	HySeed
2242	U	U	Pli	280.0	3	4	14	41.5	4.5		321.5	14.18	19.22	15	0	0	0	HySeed
2243	U	U	Pli	349.0	3	5	14	89.0	4.2		438.0	16.09	20.30	15	0	0	0	HySeed
2245	U	U	Pli	406.0	3	6	14	50.3	6.0		456.3	18.78	20.47	15	0	0	0	HySeed
2246	U	U	Pli	333.6	3	5	14	39.2	4.7		372.8	15.60	19.57	15	0	0	0	HySeed
2248	U	U	Pli	393.8	3	6	14	53.8	5.6		447.6	18.21	20.01	15	0	0	0	HySeed
2249	U	U	Pli	325.3	3	5	14	53.3	4.4		378.6	15.60	19.16	15	0	0	0	HySeed
2250	U	U	Pli	388.3	3	7	14	51.3	5.0		439.6	17.96	18.12	15	0	0	0	HySeed
2251	U	U	Pli	289.6	3	5	14	34.4	4.2		324.0	14.66	17.33	15	0	0	0	HySeed
2252	U	U	Pli	329.9	3	5	14	46.1	4.8		376.0	15.60	19.39	15	0	0	0	HySeed
2308	U	U	Pli	310.1	3	5	14	49.2	4.2		359.3	15.60	18.40	15	0	0	0	HySeed
2310	U	U	Pli	293.6	3	5	14	41.0	4.7		334.6	14.96	17.54	15	0	0	0	HySeed
2311	U	U	Pli	291.4	3	4	14	47.6	4.0		339.0	14.84	19.93	15	0	0	0	HySeed
2313	U	U	Pli	317.0	2	6	14	37.8	5.0		354.8	15.60	16.87	15	0	0	0	HySeed
2315	U	U	Pli	305.4	2	5	14	18.7	4.8		324.1	15.60	18.16	15	0	0	0	HySeed
2318	U	U	Pli	339.9	3	6	14	50.2	5.9		390.1	15.61	17.86	15	0	0	0	HySeed
2320	U	U	Pli	274.4	2	4	14	30.0	4.0		304.4	13.81	18.87	15	0	0	0	HySeed
2412	U	U	Pli	289.4	2	5	14	32.2	4.4		321.6	14.65	17.31	15	0	0	0	HySeed
2415	U	U	Pli	219.5	2	2	14	44.5		4.3	264.0	11.52	23.07	15	0	0	0	HySeed
2416	U	U	Pli	337.7	3	5	14	55.4	4.3		393.1	15.60	19.76	15	0	0	0	HySeed
2417	U	U	Pli	387.8	3	6	14	50.4	5.2		438.2	17.94	19.79	15	0	0	0	HySeed
2418	U	U	Pli	322.2	3	4	14	81.2	5.3		403.4	15.60	21.73	15	0	0	0	HySeed

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1255	V	V	Fdi	42.5	1		14	6.6		1.9	49.1			0	0	0	0	HySeed
1257	V	V	Fdi	36.4	1		14	1.5		1.1	37.9			0	0	0	0	HySeed
1260	V	V	Fdi	140.2	1		14	21.4	1.6		161.6	11.00		0	0	0	0	HySeed
1261	V	V	Fdi	201.8	2	3	14	16.1	1.3		217.9	14.14	19.25	0	0	0	0	HySeed
1262	V	V	Fdi	229.4	2	5	14	44.3	2.4		273.7	15.48	15.19	0	0	0	0	HySeed
1453	V	V	Fdi		0		14				0.0			0	0	0	0	HySeed
1456	V	V	Fdi	37.2	1		14	0.6		1.2	37.8			0	0	0	0	HySeed
1608	V	V	Fdi	34.4	1		14	0.6		1.2	35.0			0	0	0	0	HySeed
1710	V	V	Fdi	10.5	1		14	2.4		0.8	12.9			0	0	0	0	HySeed
1809	V	V	Fdi	29.8	1		14	1.1		1.1	30.9			0	0	0	0	HySeed
1810	V	V	Fdi	56.0	1		14	3.3		2.0	59.3			0	0	0	0	HySeed
1811	V	V	Fdi	40.1	1		14	3.4		1.3	43.5			0	0	0	0	HySeed
1812	V	V	Fdi	42.5	1		14	0.9		1.8	43.4			0	0	0	0	HySeed
1813	V	V	Fdi	22.6	1		14	0.9		1.3	23.5			0	0	0	0	HySeed
1913	V	V	Fdi	86.2	1		14	22.3		3.7	108.5			0	0	0	0	HySeed
1	V	V	Pli	10.4	1		14	6.9		0.9	17.3			0	0	0	0	HySeed
1	V	V	Pli	24.3	1		14	3.1		0.4	27.4			0	0	0	0	HySeed
1	V	V	Pli	24.3	1		14	3.1		0.6	27.4			0	0	0	0	HySeed
4	V	V	Pli	300.5	2	5	14	64.9	3.9	1.1	365.4	15.40	17.90	0	0	0	0	HySeed
5	V	V	Pli	261.8	2	4	14	48.8	3.6	2.0	310.6	12.93	18.04	0	0	0	0	HySeed
6	V	V	Pli	261.6	2		14	47.9	2.8	1.3	309.5	12.92		0	0	0	0	HySeed
7	V	V	Pli	353.8	3	6	14	49.3	6.1	0.7	403.1	16.36	18.44	0	0	0	0	HySeed
1248	V	V	Pli	32.2	1		14	2.5		1.3	34.7			0	0	0	0	HySeed
1251	V	V	Pli	53.9	1		14	3.6		1.3	57.5			0	0	0	0	HySeed
1252	V	V	Pli	37.4	1		14	2.4		1.0	39.8			0	0	0	0	HySeed
1253	V	V	Pli	33.3	1		14	2.6		0.6	35.9			0	0	0	0	HySeed
1254	V	V	Pli	53.3	1		14	7.1		1.4	60.4			0	0	0	0	HySeed
1256	V	V	Pli	60.5	1		14	6.3		1.6	66.8			0	0	0	0	HySeed
1258	V	V	Pli	56.3	1		14	3.7		1.7	60.0			0	0	0	0	HySeed
1259	V	V	Pli	149.1	1		14	20.7	1.2		169.8	8.20		0	0	0	0	HySeed
1337	V	V	Pli	116.0	1	5	14	9.9		4.2	125.9			0	0	0	0	HySeed
1338	V	V	Pli	47.5	1		14	4.8		1.9	52.3			0	0	0	0	HySeed
1339	V	V	Pli	43.7	1		14	4.7		1.2	48.4			0	0	0	0	HySeed
1340	V	V	Pli	49.3	1		14	2.7		0.8	52.0			0	0	0	0	HySeed
1341	V	V	Pli	45.5	1		14	2.3		0.9	47.8			0	0	0	0	HySeed
1342	V	V	Pli	41.8	1		14	3.3		0.9	45.1			0	0	0	0	HySeed

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1343	V	V	Pli	31.6	1		14	3.4		0.7	35.0			0	0	0	0	HySeed
1344	V	V	Pli	40.2	1		14	1.8		0.8	42.0			0	0	0	0	HySeed
1345	V	V	Pli		0		14				0.0			0	0	0	0	HySeed
1451	V	V	Pli	19.2	1		14	0.6		0.4	19.8			0	0	0	0	HySeed
1452	V	V	Pli		0		14				0.0			0	0	0	0	HySeed
1454	V	V	Pli	27.2	1		14	1.9		0.6	29.1			0	0	0	0	HySeed
1455	V	V	Pli	48.6	1		14	4.3		0.8	52.9			0	0	0	0	HySeed
1457	V	V	Pli		0		14				0.0			0	0	0	0	HySeed
1458	V	V	Pli	53.1	1		14	4.4		1.1	57.5			0	0	0	0	HySeed
1459	V	V	Pli	47.6	1		14	5.8		1.1	53.4			0	0	0	0	HySeed
1551	V	V	Pli	63.8	1		14	2.3		1.0	66.1			0	0	0	0	HySeed
1552	V	V	Pli	36.7	1		14	1.9		0.7	38.6			0	0	0	0	HySeed
1553	V	V	Pli	79.9	1		14	6.8		2.0	86.7			0	0	0	0	HySeed
1554	V	V	Pli	64.2	1		14	3.4		1.3	67.6			0	0	0	0	HySeed
1555	V	V	Pli	14.2	1		14	0.7		0.7	14.9			0	0	0	0	HySeed
1556	V	V	Pli	44.6	1		14	3.2		1.0	47.8			0	0	0	0	HySeed
1557	V	V	Pli	47.2	1		14	3.3		1.0	50.5			0	0	0	0	HySeed
1619	V	V	Pli	62.1	1		14	4.0		1.7	66.1			0	0	0	0	HySeed
1620	V	V	Pli	70.9	1		14	5.2		1.4	76.1			0	0	0	0	HySeed
1704	V	V	Pli	39.5	1		14	3.9		1.1	43.4			0	0	0	0	HySeed
1705	V	V	Pli	71.2	1		14	4.5		1.2	75.7			0	0	0	0	HySeed
1706	V	V	Pli	16.5	1		14	0.5		0.7	17.0			0	0	0	0	HySeed
1707	V	V	Pli		0		14				0.0			0	0	0	0	HySeed
1708	V	V	Pli	33.8	1		14	3.1		0.8	36.9			0	0	0	0	HySeed
1709	V	V	Pli	52.6	1		14	1.2		0.8	53.8			0	0	0	0	HySeed
1711	V	V	Pli	83.6	1		14	17.6		2.0	101.2			0	0	0	0	HySeed
1805	V	V	Pli	92.6	1		14	6.5		2.7	99.1			0	0	0	0	HySeed
1806	V	V	Pli	29.7	1		14	2.3		0.4	32.0			0	0	0	0	HySeed
1807	V	V	Pli	31.2	1		14	2.1		0.7	33.3			0	0	0	0	HySeed
1811	V	V	Pli	40.1	1		14	3.9		1.8	44.0			0	0	0	0	HySeed
1814	V	V	Pli	35.7	1		14	3.0		0.7	38.7			0	0	0	0	HySeed
1903	V	V	Pli	57.7	1		14	6.0		1.7	63.7			0	0	0	0	CONV
1904	V	V	Pli	88.7	1		14	5.7		3.3	94.4			0	0	0	0	CONV
1905	V	V	Pli	61.2	1		14	6.1		1.8	67.3			0	0	0	0	HySeed
1906	V	V	Pli	65.5	1		14	6.8		1.9	72.3			0	0	0	0	HySeed
1907	V	V	Pli	66.9	1		14	9.6		1.3	76.5			0	0	0	0	HySeed

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1908	V	V	Pli	38.8	1		14	4.7		1.1	43.5			0	0	0	0	HySeed
1909	V	V	Pli	54.1	1		14	4.3		1.0	58.4			0	0	0	0	HySeed
1910	V	V	Pli	78.9	1		14	8.7		1.3	87.6			0	0	0	0	HySeed
1911	V	V	Pli	22.2	1		14	0.7		0.9	22.9			0	0	0	0	HySeed
1912	V	V	Pli	65.2	1		14	5.0		1.5	70.2			0	0	0	0	HySeed
2028	V	V	Pli	180.3	1		14	43.6	2.2		223.9	9.47		0	0	0	0	HySeed
2029	V	V	Pli	74.2	1		14	9.7		2.3	83.9			0	0	0	0	HySeed
2030	V	V	Pli	116.8	1		14	22.4		3.4	139.2			0	0	0	0	HySeed
2031	V	V	Pli	32.8	1		14	3.5		0.8	36.3			0	0	0	0	HySeed
2032	V	V	Pli	35.5	1		14	3.3		1.1	38.8			0	0	0	0	HySeed
2033	V	V	Pli	74.2	1		14	10.9		1.9	85.1			0	0	0	0	HySeed
2034	V	V	Pli	119.0	1		14	6.6		2.8	125.6			0	0	0	0	HySeed
2035	V	V	Pli	94.1	1		14	12.3		2.3	106.4			0	0	0	0	HySeed
2036	V	V	Pli	99.8	1		14	7.2		3.8	107.0			0	0	0	0	HySeed
2037	V	V	Pli	109.8	1		14	9.0		2.9	118.8			0	0	0	0	HySeed
2133	V	V	Pli	188.2	1	3	14	23.9	2.2	1.4	212.1	10.35	14.58	0	0	0	0	HySeed
2134	V	V	Pli	342.4	3	5	14	50.6	4.4	1.7	393.0	15.73	19.99	0	0	0	0	HySeed
2135	V	V	Pli	321.7	2	5	14	61.7	3.9	1.2	383.4	15.60	18.98	0	0	0	0	HySeed
2136	V	V	Pli	218.1	1		14	25.9	1.8		244.0	11.45		0	0	0	0	HySeed
2253	V	V	Pli	282.4	2	4	14	58.8	2.8		341.2	14.30	19.38	15	0	0	0	HySeed
1827	W	W	Fdi	224.0	3	3	14	46.2	1.4		270.2	14.84	22.42	15	0	0	0	CONV
1	W	W	Pli	285.4	3	5	14	39.4	2.4		324.8	14.45	17.10	0	0	0	0	CONV
2	W	W	Pli	80.0	1		14	9.7		2.9	89.7			0	0	0	0	CONV
3	W	W	Pli	23.3	1		14	2.2		0.5	25.5			0	0	0	0	CONV
4	W	W	Pli	28.6	1		14	1.8		0.5	30.4			0	0	0	0	CONV
5	W	W	Pli	38.9	1		14	4.8		1.0	43.7			0	0	0	0	CONV
1815	W	W	Pli	47.4	1		14	4.6		1.3	52.0			0	0	0	0	CONV
1818	W	W	Pli	44.4	1		14	3.6		1.3	48.0			0	0	0	0	CONV
1821	W	W	Pli	48.2	1		14	6.5		1.1	54.7			0	0	0	0	CONV
1822	W	W	Pli	50.6	1		14	7.6		1.1	58.2			0	0	0	0	CONV
1823	W	W	Pli	65.6	1		14	4.8		2.1	70.4			0	0	0	0	CONV
1824	W	W	Pli	59.8	1		14	4.6		1.9	64.4			0	0	0	0	CONV
1825	W	W	Pli	21.4	0		14	2.6		1.9	24.0			0	0	0	0	CONV
1826	W	W	Pli	299.0	3	5	14	58.2	3.8		357.2	15.32	17.83	15	0	0	0	CONV
1891	W	W	Pli	55.2	1		14	3.4		1.7	58.6			0	0	0	0	CONV
1892	W	W	Pli	29.0	1		14	3.2		1.6	32.2			0	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1893	W	W	Pli	57.0	1		14	5.1		1.3	62.1			0	0	0	0	CONV
1894	W	W	Pli	42.2	1		14	2.6		1.8	44.8			0	0	0	0	CONV
1895	W	W	Pli	37.0	1		14	2.9		1.9	39.9			0	0	0	0	CONV
1896	W	W	Pli	71.5	1		14	6.0		2.1	77.5			0	0	0	0	CONV
1897	W	W	Pli	35.7	1		14	1.8		1.6	37.5			0	0	0	0	CONV
1898	W	W	Pli	163.8	1		14	42.6	1.1		206.4	9.01		0	0	0	0	CONV
1899	W	W	Pli	39.7	1		14	2.1		1.6	41.8			0	0	0	0	CONV
1900	W	W	Pli	31.0	2		14	1.9		1.0	32.9			0	0	0	0	CONV
1901	W	W	Pli	34.7	1		14	2.3		1.1	37.0			0	0	0	0	CONV
1902	W	W	Pli	32.3	1		14	2.6		0.8	34.9			0	0	0	0	CONV
2038	W	W	Pli	100.2	1		14	5.0		2.0	105.2			0	0	0	0	CONV
2039	W	W	Pli	106.6	1		14	12.2		1.1	118.8			0	0	0	0	CONV
2040	W	W	Pli	36.2	1		14	7.7		2.1	43.9			0	0	0	0	CONV
2041	W	W	Pli	55.6	1		14	3.7		1.3	59.3			0	0	0	0	CONV
2042	W	W	Pli	73.4	1		14	5.4		1.7	78.8			0	0	0	0	CONV
2043	W	W	Pli	69.8	1		14	9.0			78.8			0	0	0	0	CONV
2044	W	W	Pli	67.3	1		14	4.9		1.0	72.2			0	0	0	0	CONV
2045	W	W	Pli	36.0	1		14	3.8		1.0	39.8			0	0	0	0	CONV
2046	W	W	Pli	10.4	1		14	2.0		0.3	12.4			0	0	0	0	CONV
2047	W	W	Pli	57.7	1		14	3.0		1.7	60.7			0	0	0	0	CONV
2048	W	W	Pli	45.9	1		14	4.8		1.7	50.7			0	0	0	0	CONV
2049	W	W	Pli	65.3	1		14	3.4		1.6	68.7			0	0	0	0	CONV
2050	W	W	Pli	79.7	1		14	6.8		2.0	86.5			0	0	0	0	CONV
2051	W	W	Pli	53.6	1		14	3.6		1.5	57.2			0	0	0	0	CONV
2052	W	W	Pli	50.3	1		14	4.6		1.3	54.9			0	0	0	0	CONV
2053	W	W	Pli	71.2	1		14	14.7		1.4	85.9			0	0	0	0	CONV
2054	W	W	Pli	80.0	1		14	7.0		1.8	87.0			0	0	0	0	CONV
2120	W	W	Pli	67.7	1		14	10.9		2.3	78.6			0	0	0	0	CONV
2122	W	W	Pli		0		14				0.0			0	0	0	0	CONV
2123	W	W	Pli	59.0	1		14	5.6		1.1	64.6			0	0	0	0	CONV
2124	W	W	Pli	33.8	1		14	3.8		1.7	37.6			0	0	0	0	CONV
2125	W	W	Pli	51.4	1		14	3.0		1.6	54.4			0	0	0	0	CONV
2126	W	W	Pli	38.0	1		14	2.2		1.8	40.2			0	0	0	0	CONV
2127	W	W	Pli	53.9	1		14	2.7		2.6	56.6			0	0	0	0	CONV
2128	W	W	Pli	90.3	1		14	6.2		3.1	96.5			0	0	0	0	CONV
2129	W	W	Pli	83.4	1		14	9.6		1.3	93.0			0	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
2130	W	W	Pli	38.4	1		14	2.6		3.9	41.0			0	0	0	0	CONV
2132	W	W	Pli	135.0	1		14	8.1		2.8	143.1	6.64		0	0	0	0	CONV
2254	W	W	Pli	241.6	2	4	14	20.3	2.5		261.9	12.73	16.64	0	0	0	0	CONV
2255	W	W	Pli	227.4	2	4	14	32.9	1.9		260.3	12.22	15.58	0	0	0	0	CONV
2256	W	W	Pli	251.7	2	6	14	32.2	4.2		283.9	12.73	13.68	0	0	0	0	CONV
2257	W	W	Pli	95.7	1		14	6.0		2.4	101.7			0	0	0	0	CONV
2258	W	W	Pli	93.4	1		14	14.6		2.5	108.0			0	0	0	0	CONV
2259	W	W	Pli	70.3	1		14	6.5		2.1	76.8			0	0	0	0	CONV
2260	W	W	Pli	83.9	1		14	8.6		1.8	92.5			0	0	0	0	CONV
2261	W	W	Pli	73.8	1		14	13.2		1.7	87.0			0	0	0	0	CONV
2262	W	W	Pli	99.8	1		14	13.6		2.5	113.4			0	0	0	0	CONV
2263	W	W	Pli	86.8	1		14	14.3		1.6	101.1			0	0	0	0	CONV
2264	W	W	Pli	68.8	1		14	9.0		2.8	77.8			0	0	0	0	CONV
2265	W	W	Pli	104.0	1		14	25.8		1.7	129.8			0	0	0	0	CONV
2266	W	W	Pli	65.3	1		14	10.8		1.6	76.1			0	0	0	0	CONV
2267	W	W	Pli	56.3	1		14	5.9		2.8	62.2			0	0	0	0	CONV
2268	W	W	Pli	122.1	1		14	20.2		1.7	142.3			0	0	0	0	CONV
6	X	X	Fdi	183.4	2	2	14	35.9	6.3		219.3	12.61	22.07	15	0	0	0	CONV
7	X	X	Fdi	242.0	3	3	14	62.1	2.0		304.1	16.50	24.78	15	0	0	0	CONV
12	X	X	Fdi	261.7	3	3	14	57.2	2.0		318.9	16.50	27.19	15	0	0	0	CONV
17	X	X	Fdi	187.3	2	1	14	40.7	4.5		228.0	13.35	36.71	15	0	0	0	CONV
19	X	X	Fdi	337.4	4	5	14	62.3	3.1		399.7	19.80	24.55	15	0	0	0	CONV
21	X	X	Fdi	201.4	1	2	14	41.1		9.2	242.5	14.14	25.41	15	0	0	0	CONV
22	X	X	Fdi	307.4	3	4	14	66.1	2.2		373.5	19.80	26.52	15	0	0	0	CONV
23	X	X	Fdi	249.6	3	3	14	41.5	2.1		291.1	16.50	25.73	15	0	0	0	CONV
24	X	X	Fdi	260.2	3	4	14	46.7	2.1		306.9	16.50	21.81	15	0	0	0	CONV
1316	X	X	Fdi	326.5	4	4	14	56.4	3.6		382.9	19.80	28.31	15	0	0	0	CONV
1319	X	X	Fdi	240.5	1	3	14	56.8	2.0		297.3	16.50	24.59	15	0	0	0	CONV
1476	X	X	Fdi	307.7	4	4	14	43.7	2.9		351.4	19.80	26.55	15	0	0	0	CONV
1480	X	X	Fdi	286.9	3	4	14	62.6	2.4		349.5	17.93	24.54	15	0	0	0	CONV
1531	X	X	Fdi	210.6	3	3	14	43.3	2.0		253.9	14.14	20.55	15	0	0	0	CONV
1535	X	X	Fdi	244.3	3	3	14	31.3	2.4		275.6	16.50	25.07	15	0	0	0	CONV
1835	X	X	Fdi	269.0	3	3	14	65.1	2.0		334.1	16.50	28.05	15	0	0	0	CONV
1836	X	X	Fdi	249.0	3	3	14	48.3	2.1		297.3	16.50	25.66	15	0	0	0	CONV
1837	X	X	Fdi	321.6	4	5	14	64.6	3.5		386.2	19.80	23.30	15	0	0	0	CONV
1838	X	X	Fdi	373.7	4	5	14	76.2	4.4		449.9	21.72	27.33	15	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1839	X	X	Fdi	456.6	4	6	14	73.3	5.7		529.9	24.75	28.79	15	0	0	0	CONV
1878	X	X	Fdi	390.8	3	5	14	108.8	3.1		499.6	22.96	28.60	15	0	0	0	CONV
1885	X	X	Fdi	324.9	3	4	14	70.6	2.9		395.5	19.80	28.16	15	0	0	0	CONV
1886	X	X	Fdi	347.8	4	5	14	73.1	3.4		420.9	19.80	25.36	15	0	0	0	CONV
2056	X	X	Fdi	143.6	2	1	14	36.4		2.6	180.0	11.00	19.73	15	0	0	0	CONV
2060	X	X	Fdi	427.9	4	6	14	66.3	4.3		494.2	24.75	27.03	15	0	0	0	CONV
2062	X	X	Fdi	226.3	3	3	14	39.3	1.2		265.6	14.99	22.73	15	0	0	0	CONV
2067	X	X	Fdi	187.4	2	3	14	27.9	1.1		215.3	13.35	16.98	15	0	0	0	CONV
2072	X	X	Fdi	364.5	4	5	14	62.9	3.7		427.4	20.96	26.64	15	0	0	0	CONV
2073	X	X	Fdi	330.6	4	5	14	57.8	3.2		388.4	19.80	24.02	15	0	0	0	CONV
2108	X	X	Fdi	112.6	2		14	40.3		2.6	152.9			15	0	0	0	CONV
2109	X	X	Fdi	319.7	4	4	14	66.0	2.8		385.7	19.80	27.68	15	0	0	0	CONV
1	X	X	Pli	277.0	2	4	14	56.0	3.1		333.0	13.94	19.03	15	0	0	0	CONV
2	X	X	Pli	347.8	2	5	14	62.8	5.6		410.6	16.03	20.24	15	0	0	0	CONV
3	X	X	Pli	352.9	2	5	14	55.9	5.6		408.8	16.32	20.48	15	0	0	0	CONV
4	X	X	Pli	246.1	2	3	14	54.1	3.6		300.2	12.73	20.18	15	0	0	0	CONV
5	X	X	Pli	397.6	2	6	14	50.6	6.5		448.2	18.39	20.16	15	0	0	0	CONV
8	X	X	Pli	305.8	1	6	14	88.3	5.6		394.1	15.60	16.37	15	0	0	0	CONV
9	X	X	Pli	408.0	2	6	14	46.4	6.1		454.4	18.81	20.55	15	0	0	0	CONV
10	X	X	Pli	313.0	2	5	14	57.5	5.7		370.5	15.60	18.55	15	0	0	0	CONV
11	X	X	Pli	344.0	2	6	14	42.7	5.9		386.7	15.80	18.04	15	0	0	0	CONV
13	X	X	Pli	376.8	3	5	14	77.5	4.9		454.3	17.43	21.56	15	0	0	0	CONV
14	X	X	Pli	214.4	2	3	14	49.1	2.3		263.5	11.26	17.35	15	0	0	0	CONV
15	X	X	Pli	229.5	1	3	14	42.2	3.3		271.7	12.48	18.75	15	0	0	0	CONV
16	X	X	Pli	218.6	1	2	14	49.6	6.1		268.2	11.48	22.95	15	0	0	0	CONV
18	X	X	Pli	320.8	3	5	14	54.2	4.1		375.0	15.60	18.94	15	0	0	0	CONV
20	X	X	Pli	293.8	3	4	14	58.8	3.2		352.6	14.97	20.08	15	0	0	0	CONV
25	X	X	Pli	257.1	2	3	14	56.1	2.6		313.2	12.73	21.07	15	0	0	0	CONV
26	X	X	Pli	295.2	3	4	14	53.2	4.4		348.4	15.04	20.16	15	0	0	0	CONV
27	X	X	Pli	322.6	4	5	14	59.5	5.5		382.1	15.60	19.03	15	0	0	0	CONV
28	X	X	Pli	321.0	3	5	14	45.4	5.0		366.4	15.60	18.95	15	0	0	0	CONV
29	X	X	Pli	363.6	4	6	14	55.6	6.5		419.2	16.82	18.84	15	0	0	0	CONV
30	X	X	Pli	408.5	2	7	14	70.1	6.4		478.6	18.83	18.82	15	0	0	0	CONV
31	X	X	Pli	421.8	3	5	14	84.4	6.3		506.2	19.44	23.47	15	0	0	0	CONV
32	X	X	Pli	301.0	3	5	14	57.3	4.3		358.3	15.43	17.93	15	0	0	0	CONV
1282	X	X	Pli	366.7	3	6	14	48.8	5.9		415.5	16.96	18.96	15	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1283	X	X	Pli	378.2	4	6	14	53.7	7.6		431.9	17.49	19.41	15	0	0	0	CONV
1284	X	X	Pli	309.8	3	4	14	47.5	4.3		357.3	15.60	21.02	15	0	0	0	CONV
1285	X	X	Pli	259.4	3	3	14	53.5	2.7		312.9	12.81	21.25	15	0	0	0	CONV
1286	X	X	Pli	243.6	1	3	14	41.3	2.3		284.9	12.73	19.97	15	0	0	0	CONV
1315	X	X	Pli	371.1	3	6	14	59.3	5.4		430.4	17.16	19.14	15	0	0	0	CONV
1317	X	X	Pli	290.9	3	4	14	52.1	4.1		343.0	14.82	19.90	15	0	0	0	CONV
1318	X	X	Pli	360.1	4	5	14	49.9	5.4		410.0	16.65	20.81	15	0	0	0	CONV
1320	X	X	Pli	291.9	1	4	14	41.3	4.5		333.2	14.87	19.96	15	0	0	0	CONV
1321	X	X	Pli	237.9	2	4	14	6.6	4.0		244.5	12.73	16.37	15	0	0	0	CONV
1322	X	X	Pli	305.0	2	4	14	50.6	4.1		355.6	15.58	20.74	15	0	0	0	CONV
1323	X	X	Pli	383.7	3	6	14	55.3	5.0		439.0	17.75	19.63	15	0	0	0	CONV
1324	X	X	Pli	271.2	2	4	14	35.8	3.3		307.0	13.56	18.66	15	0	0	0	CONV
1325	X	X	Pli	394.2	3	6	14	66.3	5.9		460.5	18.23	20.03	15	0	0	0	CONV
1326	X	X	Pli	290.4	3	4	14	60.0	3.7		350.4	14.79	19.87	15	0	0	0	CONV
1477	X	X	Pli	342.7	3	7	14	54.7	6.0		397.4	15.74	16.44	15	0	0	0	CONV
1478	X	X	Pli	342.3	3	5	14	53.9	5.3		396.2	15.72	19.98	15	0	0	0	CONV
1479	X	X	Pli	379.3	3	7	14	57.3	5.2		436.6	17.54	17.80	15	0	0	0	CONV
1481	X	X	Pli	247.0	1	3	14	59.6	2.7		306.6	12.73	20.25	15	0	0	0	CONV
1523	X	X	Pli	357.5	2	6	14	48.6	6.0		406.1	16.53	18.59	15	0	0	0	CONV
1524	X	X	Pli	372.5	2	5	14	61.8	4.3		434.3	17.23	21.37	15	0	0	0	CONV
1525	X	X	Pli	252.7	1		14	48.7	3.3		301.4	12.73		15	0	0	0	CONV
1528	X	X	Pli	196.3	1	2	14	52.3	7.3		248.6	10.76	19.99	15	0	0	0	CONV
1530	X	X	Pli	291.8	1	4	14	41.9	4.0		333.7	14.86	19.95	15	0	0	0	CONV
1532	X	X	Pli	230.6	2	3	14	32.2	2.7		262.8	12.54	18.85	15	0	0	0	CONV
1533	X	X	Pli	284.5	1	4	14	52.1	3.3		336.6	14.40	19.51	15	0	0	0	CONV
1534	X	X	Pli	286.9	1	5	14	46.6	4.4		333.5	14.52	17.18	15	0	0	0	CONV
1633	X	X	Pli	230.8	1	3	14	39.3	2.5		270.1	12.55	18.87	15	0	0	0	CONV
1634	X	X	Pli	209.7	3	4	14	69.2	4.1		278.9	10.81	14.14	15	0	0	0	CONV
1634	X	X	Pli	286.2	2	3	14	57.2	3.7		343.4	14.49	23.26	15	0	0	0	CONV
1635	X	X	Pli	216.6	1	3	14	51.8	2.9		268.4	11.37	17.56	15	0	0	0	CONV
1638	X	X	Pli	233.5	1	2	14	56.7	2.1		290.2	12.70	24.73	15	0	0	0	CONV
1639	X	X	Pli	312.1	3	4	14	54.6	4.1		366.7	15.60	21.15	15	0	0	0	CONV
1640	X	X	Pli	156.9	1	2	14	28.3		2.7	185.2	8.21	13.12	15	0	0	0	CONV
1679	X	X	Pli	411.3	3	5	14	58.7	5.2		470.0	18.96	23.03	15	0	0	0	CONV
1683	X	X	Pli	301.3	1	4	14	62.6	3.3		363.9	15.44	20.52	15	0	0	0	CONV
1685	X	X	Pli	280.8	1	4	14	42.1	3.8		322.9	14.22	19.28	15	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1686	X	X	Pli	370.0	2	5	14	67.6	5.6		437.6	17.11	21.26	15	0	0	0	CONV
1687	X	X	Pli	316.5	3	5	14	56.5	4.9		373.0	15.60	18.72	15	0	0	0	CONV
1688	X	X	Pli	286.3	3	4	14	60.6	4.0		346.9	14.49	19.62	15	0	0	0	CONV
1802	X	X	Pli	373.2	2	6	14	35.4	7.5		408.6	17.26	19.22	15	0	0	0	CONV
1830	X	X	Pli	345.3	2	6	14	46.1	5.2		391.4	15.86	18.09	15	0	0	0	CONV
1831	X	X	Pli	369.9	3	6	14	48.4	6.6		418.3	17.11	19.09	15	0	0	0	CONV
1832	X	X	Pli	349.3	3	6	14	54.7	4.4		404.0	16.10	18.26	15	0	0	0	CONV
1833	X	X	Pli	310.6	3	5	14	41.6	5.1		352.2	15.60	18.43	15	0	0	0	CONV
1834	X	X	Pli	283.6	3	4	14	43.3	3.6		326.9	14.36	19.45	15	0	0	0	CONV
1840	X	X	Pli	344.2	2	6	14	36.0	5.8		380.2	15.81	18.04	15	0	0	0	CONV
1877	X	X	Pli	352.3	3	5	14	54.1	5.4		406.4	16.29	20.45	15	0	0	0	CONV
1879	X	X	Pli	346.9	3	8	14	67.6	5.4		414.5	15.99	15.31	15	0	0	0	CONV
1880	X	X	Pli	342.4	2	6	14	41.4	5.7		383.8	15.73	17.97	15	0	0	0	CONV
1881	X	X	Pli	433.0	2	6	14	57.0	6.4		490.0	19.89	21.45	15	0	0	0	CONV
1883	X	X	Pli	330.5	1	5	14	50.5	4.8		381.0	15.60	19.42	15	0	0	0	CONV
1884	X	X	Pli	373.6	3	5	14	87.0	4.5		460.6	17.28	21.42	15	0	0	0	CONV
1887	X	X	Pli	372.4	2	6	14	34.9	6.7		407.3	17.22	19.19	15	0	0	0	CONV
1888	X	X	Pli	435.5	3	7	14	65.3	7.9		500.8	20.01	19.72	15	0	0	0	CONV
1889	X	X	Pli	405.9	3	5	14	61.3	6.8		467.2	18.77	22.81	15	0	0	0	CONV
2018	X	X	Pli	411.3	3	6	14	55.8	6.4		467.1	18.96	20.67	15	0	0	0	CONV
2057	X	X	Pli	477.8	4	7	14	60.4	7.4		538.2	20.12	21.06	15	0	0	0	CONV
2058	X	X	Pli	373.3	2	6	14	48.9	6.1		422.2	17.27	19.22	15	0	0	0	CONV
2059	X	X	Pli	394.4	3	6	14	56.4	5.5		450.8	18.24	20.04	15	0	0	0	CONV
2061	X	X	Pli	480.5	3	7	14	48.5	7.5		529.0	20.12	21.15	15	0	0	0	CONV
2063	X	X	Pli	539.2	3	7	14	68.2	6.9		607.4	21.99	22.89	15	0	0	0	CONV
2064	X	X	Pli	435.7	2	7	14	55.4	8.7		491.1	20.01	19.73	15	0	0	0	CONV
2065	X	X	Pli	411.5	3	7	14	57.5	6.3		469.0	18.97	18.92	15	0	0	0	CONV
2066	X	X	Pli	402.4	2	7	14	45.8	7.0		448.2	18.61	18.61	15	0	0	0	CONV
2069	X	X	Pli	352.4	3	4	14	69.4	4.6		421.8	16.30	23.36	15	0	0	0	CONV
2070	X	X	Pli	325.7	3	5	14	53.0	4.5		378.7	15.60	19.18	15	0	0	0	CONV
2071	X	X	Pli	344.6	3	6	14	62.1	4.3		406.7	15.83	18.06	15	0	0	0	CONV
2110	X	X	Pli	330.4	4	5	14	58.5	4.6		388.9	15.60	19.41	15	0	0	0	CONV
2111	X	X	Pli	386.5	3	5	14	15.8	4.8		402.3	17.88	21.98	15	0	0	0	CONV
2112	X	X	Pli	340.4	2	6	14	52.8	5.0		393.2	15.64	17.89	15	0	0	0	CONV
2113	X	X	Pli	415.6	3	7	14	48.2	6.0		463.8	19.16	19.06	15	0	0	0	CONV
2114	X	X	Pli	356.3	3	5	14	52.8	5.0		409.1	16.48	20.63	15	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
2115	X	X	Pli	427.0	2	6	14	60.8	8.5		487.8	19.62	21.24	15	0	0	0	CONV
2116	X	X	Pli	421.4	3	7	14	64.4	5.9		485.8	19.42	19.26	15	0	0	0	CONV
2117	X	X	Pli	369.7	3	6	14	59.1	5.1		428.8	17.10	19.08	15	0	0	0	CONV
2118	X	X	Pli	419.8	3	6	14	58.5	6.4		478.3	19.35	20.98	15	0	0	0	CONV
2119	X	X	Pli	315.0	3	5	14	52.8	4.3		367.8	15.60	18.65	15	0	0	0	CONV
2269	X	X	Pli	243.7	3	4	14	36.7	2.8		280.4	12.73	16.79	15	0	0	0	CONV
2270	X	X	Pli	305.5	3	4	14	52.1	3.5		357.6	15.60	20.77	15	0	0	0	CONV
2271	X	X	Pli	335.4	3	5	14	40.3	4.2		375.7	15.60	19.65	15	0	0	0	CONV
2272	X	X	Pli	325.8	3	5	14	62.1	4.5		387.9	15.60	19.19	15	0	0	0	CONV
2273	X	X	Pli	377.4	3	5	14	73.8	4.8		451.2	17.45	21.58	15	0	0	0	CONV
2274	X	X	Pli	457.1	3	7	14	52.1	7.3		509.2	20.12	20.42	15	0	0	0	CONV
2275	X	X	Pli	417.3	2	7	14	43.0	7.4		460.3	19.23	19.12	15	0	0	0	CONV
2276	X	X	Pli	445.1	4	6	14	67.4	6.1		512.5	20.12	21.88	15	0	0	0	CONV
2277	X	X	Pli	411.5	4	6	14	53.9	5.6		465.4	18.97	20.67	15	0	0	0	CONV
2278	X	X	Pli	378.5	3	6	14	54.2	5.3		432.7	17.51	19.43	15	0	0	0	CONV
2279	X	X	Pli	350.1	3	5	14	62.1	4.2		412.2	16.14	20.35	15	0	0	0	CONV
2280	X	X	Pli	374.2	2	6	14	37.2	6.2		411.4	17.31	19.26	15	0	0	0	CONV
2281	X	X	Pli	313.3	3	4	14	56.3	4.3		369.6	15.60	21.22	15	0	0	0	CONV
2	Y	Y	Fdi	334.0	4	5	14	57.7	3.2		391.7	19.80	24.28	30	0	0	0	CONV
3	Y	Y	Fdi	256.0	3	3	14	55.8	2.7		311.8	16.50	26.51	30	0	0	0	CONV
10	Y	Y	Fdi	367.8	4	6	14	62.5	4.0		430.3	21.26	23.19	30	0	0	0	CONV
14	Y	Y	Fdi	277.8	3	3	14	47.8	2.7		325.6	17.02	29.06	30	0	0	0	CONV
18	Y	Y	Fdi	334.6	2	5	14	51.9	4.5		386.5	19.80	24.33	30	0	0	0	CONV
20	Y	Y	Fdi	426.2	3	7	14	38.1	7.3		464.3	24.75	23.66	30	0	0	0	CONV
33	Y	Y	Fdi	290.3	3	3	14	69.7	2.4		360.0	18.33	30.46	30	0	0	0	CONV
34	Y	Y	Fdi	293.5	3	4	14	53.2	2.7		346.7	18.53	25.19	30	0	0	0	CONV
42	Y	Y	Fdi	164.0	2	1	14	29.4		4.3	193.4	12.38	29.24	30	0	0	0	CONV
45	Y	Y	Fdi	242.3	3	3	14	31.8	2.1		274.1	16.50	24.82	30	0	0	0	CONV
46	Y	Y	Fdi	232.1	3	3	14	41.4	2.3		273.5	15.81	23.50	30	0	0	0	CONV
48	Y	Y	Fdi	215.1	2	3	14	27.6	2.0		242.7	14.14	21.19	30	0	0	0	CONV
49	Y	Y	Fdi	235.7	4	6	14	58.0	3.0		293.7	16.20	13.52	30	0	0	0	CONV
50	Y	Y	Fdi	358.0	3	5	14	67.6	3.3		425.6	20.47	26.15	30	0	0	0	CONV
51	Y	Y	Fdi	264.2	3	3	14	54.9	2.0		319.1	16.50	27.49	30	0	0	0	CONV
52	Y	Y	Fdi	168.2	3	2	14	23.9		4.2	192.1	12.37	18.78	30	0	0	0	CONV
53	Y	Y	Fdi	283.8	3	5	14	66.8	4.0		350.6	17.74	20.16	30	0	0	0	CONV
54	Y	Y	Fdi	277.4	3	4	14	58.9	2.4		336.3	16.99	23.59	30	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1293	Y	Y	Fdi	342.8	3	5	14	67.3	3.9		410.1	19.80	24.98	30	0	0	0	CONV
1295	Y	Y	Fdi	335.8	4	4	14	57.8	3.5		393.6	19.80	29.16	30	0	0	0	CONV
1296	Y	Y	Fdi	368.5	4	5	14	78.3	3.5		446.8	21.30	26.94	30	0	0	0	CONV
1299	Y	Y	Fdi	195.1	3	2	14	46.7		5.8	241.8	14.14	24.29	30	0	0	0	CONV
1510	Y	Y	Fdi	284.2	2	3	14	58.2	2.0		342.4	17.76	29.78	30	0	0	0	CONV
1511	Y	Y	Fdi	376.0	3	4	14	110.0	3.2		486.0	21.85	32.68	30	0	0	0	CONV
1513	Y	Y	Fdi	228.7	3	2	14	52.2		6.3	280.9	15.44	29.78	30	0	0	0	CONV
1514	Y	Y	Fdi	316.2	4	4	14	59.5	3.1		375.7	19.80	27.35	30	0	0	0	CONV
1518	Y	Y	Fdi	299.3	3	3	14	74.8	2.8		374.1	19.08	31.43	30	0	0	0	CONV
1659	Y	Y	Fdi	351.6	4	4	14	53.8	3.9		405.4	20.00	30.57	30	0	0	0	CONV
1845	Y	Y	Fdi	392.1	3	6	14	61.6	3.6		453.7	23.16	24.77	30	0	0	0	CONV
1848	Y	Y	Fdi	404.6	3	5	14	57.6	3.4		462.2	24.02	29.60	30	0	0	0	CONV
1852	Y	Y	Fdi	354.6	4	6	14	48.1	4.8		402.7	20.17	22.31	30	0	0	0	CONV
1865	Y	Y	Fdi	168.8	3	1	14	33.3		4.1	202.1	12.37	30.97	30	0	0	0	CONV
2075	Y	Y	Fdi	317.7	3	4	14	66.0	2.6		383.7	19.80	27.49	30	0	0	0	CONV
2076	Y	Y	Fdi	307.7	4	4	14	47.4	2.8		355.1	19.80	26.55	30	0	0	0	CONV
2078	Y	Y	Fdi	414.1	4	6	14	60.1	4.5		474.2	24.75	26.17	30	0	0	0	CONV
2079	Y	Y	Fdi	336.1	3	5	14	67.3	3.1		403.4	19.80	24.45	30	0	0	0	CONV
2080	Y	Y	Fdi	267.1	3	4	14	41.3	2.3		308.4	16.50	22.53	30	0	0	0	CONV
2102	Y	Y	Fdi	306.3	3	5	14	61.8	4.1		368.1	19.77	22.05	30	0	0	0	CONV
2105	Y	Y	Fdi	414.3	4	6	14	58.1	4.6		472.4	24.75	26.18	30	0	0	0	CONV
1	Y	Y	Pli	342.9	3	6	14	51.6	5.1		394.5	15.75	17.99	30	0	0	0	CONV
4	Y	Y	Pli	432.7	3	7	14	60.1	5.9		492.8	19.88	19.63	30	0	0	0	CONV
5	Y	Y	Pli	425.3	3	7	14	94.8	6.3		520.1	19.60	19.39	30	0	0	0	CONV
6	Y	Y	Pli	350.0	3	6	14	52.6	4.3		402.6	16.13	18.28	30	0	0	0	CONV
7	Y	Y	Pli	441.9	4	7	14	48.4	7.7		490.3	20.12	19.93	30	0	0	0	CONV
8	Y	Y	Pli	436.5	2	7	14	54.1	6.5		490.6	20.05	19.76	30	0	0	0	CONV
9	Y	Y	Pli	367.3	3	6	14	45.9	4.8		413.2	16.99	18.99	30	0	0	0	CONV
11	Y	Y	Pli	451.5	4	7	14	40.0	7.1		491.5	20.12	20.24	30	0	0	0	CONV
12	Y	Y	Pli	385.7	2	6	14	72.7	6.7		458.4	17.84	19.71	30	0	0	0	CONV
13	Y	Y	Pli	358.1	3	6	14	53.4	5.8		411.5	16.56	18.62	30	0	0	0	CONV
15	Y	Y	Pli	450.0	3	8	14	49.0	7.0		499.0	20.12	18.71	30	0	0	0	CONV
16	Y	Y	Pli	407.5	3	6	14	54.1	5.8		461.6	18.78	20.53	30	0	0	0	CONV
17	Y	Y	Pli	386.0	4	6	14	52.1	6.0		438.1	17.85	19.72	30	0	0	0	CONV
19	Y	Y	Pli	260.2	3	3	14	60.6	2.0		320.8	12.85	21.31	30	0	0	0	CONV
21	Y	Y	Pli	231.8	2	3	14	41.4	2.6		273.2	12.60	18.96	30	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
22	Y	Y	Pli	302.7	3	6	14	25.7	4.5		328.4	15.51	16.23	30	0	0	0	CONV
23	Y	Y	Pli	372.0	3	7	14	44.8	5.0		416.8	17.20	17.54	30	0	0	0	CONV
24	Y	Y	Pli	343.5	2	5	14	48.2	6.6		391.7	15.78	20.04	30	0	0	0	CONV
25	Y	Y	Pli	346.3	2	5	14	69.4	4.6		415.7	15.96	20.17	30	0	0	0	CONV
26	Y	Y	Pli	396.8	2	6	14	56.2	5.5		453.0	18.35	20.13	30	0	0	0	CONV
27	Y	Y	Pli	334.0	3	5	14	58.3	5.0		392.3	15.60	19.59	30	0	0	0	CONV
28	Y	Y	Pli	395.4	2	6	14	57.9	5.8		453.3	18.29	20.07	30	0	0	0	CONV
29	Y	Y	Pli	385.6	2	6	14	47.9	6.4		433.5	17.83	19.70	30	0	0	0	CONV
30	Y	Y	Pli	326.7	3	5	14	51.2	4.4		377.9	15.60	19.23	30	0	0	0	CONV
31	Y	Y	Pli	363.2	2	5	14	36.2	4.7		399.4	16.80	20.95	30	0	0	0	CONV
32	Y	Y	Pli	377.4	3	6	14	53.4	5.6		430.8	17.45	19.38	30	0	0	0	CONV
34	Y	Y	Pli	222.7	3	3	14	50.2	2.0		272.9	11.83	18.13	30	0	0	0	CONV
35	Y	Y	Pli	244.9	1	3	14	48.3	2.3		293.2	12.73	20.08	30	0	0	0	CONV
36	Y	Y	Pli	367.2	4	7	14	50.2	3.9		417.4	16.98	17.36	30	0	0	0	CONV
37	Y	Y	Pli	310.4	1	5	14	44.1	5.2		354.5	15.60	18.42	30	0	0	0	CONV
38	Y	Y	Pli	332.5	2	6	14	51.5	4.9		384.0	15.60	17.55	30	0	0	0	CONV
39	Y	Y	Pli	219.2	1	2	14	43.6		6.8	262.8	11.51	23.03	30	0	0	0	CONV
40	Y	Y	Pli	267.3	2	4	14	58.4	4.0		325.7	13.37	18.41	30	0	0	0	CONV
41	Y	Y	Pli	277.0	3	4	14	36.0	3.6		313.0	13.94	19.03	30	0	0	0	CONV
43	Y	Y	Pli	327.8	3	5	14	19.5	4.7		347.3	15.60	19.28	30	0	0	0	CONV
44	Y	Y	Pli		1	1	14	0.0			0.0			30	0	0	0	CONV
47	Y	Y	Pli	282.3	3	5	14	40.3	3.9		322.6	14.29	16.93	30	0	0	0	CONV
55	Y	Y	Pli	171.2	1	1	14	22.6		5.9	193.8	9.32	27.83	30	0	0	0	CONV
1290	Y	Y	Pli	268.4	2	5	14	53.2	3.0		321.6	13.42	16.14	30	0	0	0	CONV
1291	Y	Y	Pli	356.9	2	6	14	52.8	5.2		409.7	16.51	18.57	30	0	0	0	CONV
1292	Y	Y	Pli	268.7	2	5	14	39.6	4.0		308.3	13.44	16.16	30	0	0	0	CONV
1294	Y	Y	Pli	238.3	3	4	14	46.3	2.8		284.6	12.73	16.40	30	0	0	0	CONV
1297	Y	Y	Pli	283.1	3	5	14	42.6	4.0		325.7	14.33	16.97	30	0	0	0	CONV
1298	Y	Y	Pli	341.7	2	6	14	42.8	5.0		384.5	15.70	17.94	30	0	0	0	CONV
1300	Y	Y	Pli	169.0	2	2	14	40.7		5.3	209.7	9.32	15.57	30	0	0	0	CONV
1301	Y	Y	Pli	275.8	2	5	14	42.7	3.7		318.5	13.88	16.56	30	0	0	0	CONV
1302	Y	Y	Pli	384.7	4	6	14	50.7	5.9		435.4	17.79	19.67	30	0	0	0	CONV
1306	Y	Y	Pli	278.3	1	4	14	36.9	3.9		315.2	14.09	19.12	30	0	0	0	CONV
1307	Y	Y	Pli	357.4	3	6	14	44.5	5.6		401.9	16.53	18.59	30	0	0	0	CONV
1308	Y	Y	Pli	302.1	2	4	14	58.3	3.4		360.4	15.48	20.57	30	0	0	0	CONV
1309	Y	Y	Pli	330.5	3	5	14	25.5	4.3		356.0	15.60	19.42	30	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1310	Y	Y	Pli	302.1	2	5	14	52.1	3.8		354.2	15.48	17.99	30	0	0	0	CONV
1311	Y	Y	Pli	307.0	3	5	14	40.9	3.3		347.9	15.60	18.24	30	0	0	0	CONV
1312	Y	Y	Pli	324.7	4	6	14	49.9	4.3		374.6	15.60	17.21	30	0	0	0	CONV
1314	Y	Y	Pli	318.2	2	5	14	42.8	4.5		361.0	15.60	18.81	15	0	0	0	CONV
1496	Y	Y	Pli	227.0	1	3	14	29.2	2.9		256.2	12.20	18.53	30	0	0	0	CONV
1500	Y	Y	Pli	270.3	1	4	14	48.4	3.0		318.7	13.51	18.60	30	0	0	0	CONV
1509	Y	Y	Pli	252.5	1	4	14	34.0	2.7		286.5	12.73	17.41	30	0	0	0	CONV
1512	Y	Y	Pli	307.4	2	6	14	32.9	5.0		340.3	15.60	16.44	30	0	0	0	CONV
1517	Y	Y	Pli	303.6	2	5	14	62.7	3.9		366.3	15.56	18.07	30	0	0	0	CONV
1519	Y	Y	Pli	220.0	1	3	14	45.8	3.1		265.8	11.69	17.88	30	0	0	0	CONV
1520	Y	Y	Pli	337.5	2	6	14	57.4	4.5		394.9	15.60	17.76	30	0	0	0	CONV
1521	Y	Y	Pli	312.4	2	6	14	55.1	4.3		367.5	15.60	16.67	30	0	0	0	CONV
1522	Y	Y	Pli	180.5	1	1	14	27.6	5.9		208.1	9.48	30.54	30	0	0	0	CONV
1654	Y	Y	Pli	389.4	4	6	14	61.9	5.7		451.3	18.01	19.85	30	0	0	0	CONV
1655	Y	Y	Pli	271.3	2	4	14	55.5	3.1		326.8	13.57	18.67	30	0	0	0	CONV
1656	Y	Y	Pli	303.1	2	4	14	54.1	3.4		357.2	15.53	20.63	30	0	0	0	CONV
1657	Y	Y	Pli	222.8	2	4	14	26.7	3.1		249.5	11.84	15.22	30	0	0	0	CONV
1658	Y	Y	Pli	326.1	2	5	14	51.6	4.4		377.7	15.60	19.20	30	0	0	0	CONV
1664	Y	Y	Pli	308.4	3	5	14	57.4	3.9		365.8	15.60	18.31	30	0	0	0	CONV
1665	Y	Y	Pli	379.0	2	7	14	38.1	6.2		417.1	17.53	17.79	30	0	0	0	CONV
1666	Y	Y	Pli	344.0	2	5	14	47.0	5.8		391.0	15.80	20.06	30	0	0	0	CONV
1667	Y	Y	Pli	397.0	2	6	14	59.6	6.2		456.6	18.36	20.14	30	0	0	0	CONV
1668	Y	Y	Pli	420.1	3	6	14	58.8	6.0		478.9	19.36	20.99	30	0	0	0	CONV
1675	Y	Y	Pli	379.2	2	5	14	60.2	5.6		439.4	17.54	21.66	30	0	0	0	CONV
1676	Y	Y	Pli	404.5	3	6	14	21.3	6.6		425.8	18.71	20.42	30	0	0	0	CONV
1677	Y	Y	Pli	323.1	2	4	14	65.8	4.4		388.9	15.60	21.78	30	0	0	0	CONV
1678	Y	Y	Pli	120.9	1		14	22.8		4.8	143.7			30	0	0	0	CONV
1843	Y	Y	Pli	387.0	2	6	14	49.5	6.1		436.5	17.90	19.76	30	0	0	0	CONV
1844	Y	Y	Pli	259.8	1	3	14	43.5	2.5		303.3	12.83	21.28	30	0	0	0	CONV
1851	Y	Y	Pli	378.8	4	5	14	58.6	4.0		437.4	17.52	21.65	30	0	0	0	CONV
1853	Y	Y	Pli	390.0	3	6	14	45.5	5.3		435.5	18.04	19.87	30	0	0	0	CONV
1854	Y	Y	Pli	385.0	3	6	14	30.4	5.5		415.4	17.81	19.68	30	0	0	0	CONV
1855	Y	Y	Pli	424.2	3	7	14	51.7	5.9		475.9	19.55	19.35	30	0	0	0	CONV
1856	Y	Y	Pli	260.8	3	4	14	55.2	3.3		316.0	12.88	17.98	30	0	0	0	CONV
1857	Y	Y	Pli	322.0	2	6	14	45.0	3.8		367.0	15.60	17.09	30	0	0	0	CONV
1858	Y	Y	Pli	316.7	3	6	14	33.7	4.7		350.4	15.60	16.86	30	0	0	0	CONV

Tree #	Treat	T.R	Species	Total Ht (cm)	Vigour	BA (yrs)	TA (YRS)	L=Ht-1yr (cm)	dbh (cm)	Cal (cm)	TH - 15YR	SI(m) 50 TA	SI(m) 50 GI	SOIL (cm)	Tailings	BS T/ha	Tbag	Seed
1859	Y	Y	Pli	370.5	3	6	14	45.1	4.4		415.6	17.14	19.11	30	0	0	0	CONV
1860	Y	Y	Pli	448.2	2	6	14	37.2	6.8		485.4	20.12	21.98	30	0	0	0	CONV
1861	Y	Y	Pli	333.3	3	5	14	54.7	4.4		388.0	15.60	19.55	30	0	0	0	CONV
1862	Y	Y	Pli	419.3	3	7	14	43.7	5.6		463.0	19.33	19.19	30	0	0	0	CONV
1866	Y	Y	Pli	422.0	4	7	14	52.9	7.0		474.9	19.45	19.28	30	0	0	0	CONV
1867	Y	Y	Pli	428.0	2	7	14	56.7	7.1		484.7	19.66	19.48	30	0	0	0	CONV
1876	Y	Y	Pli	433.8	4	7	14	54.3	6.8		488.1	19.93	19.67	30	0	0	0	CONV
2077	Y	Y	Pli	422.1	3	5	14	45.7	6.6		467.8	19.46	23.48	30	0	0	0	CONV
2084	Y	Y	Pli	390.0	3	6	14	31.4	6.2		421.4	18.04	19.87	30	0	0	0	CONV
2103	Y	Y	Pli	288.7	1	4	14	44.4	3.9		333.1	14.62	19.77	30	0	0	0	CONV
2104	Y	Y	Pli	319.4	2	5	14	31.7	4.8		351.1	15.60	18.87	30	0	0	0	CONV
2106	Y	Y	Pli	370.1	3	6	14	47.1	5.1		417.2	17.12	19.10	30	0	0	0	CONV
2285	Y	Y	Pli	415.8	2	6	14	52.4	6.0		468.2	19.17	20.83	30	0	0	0	CONV

Appendix 7 – Statistical Significance Summary 2012

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Douglas-fir planted in 1998

Total Height

Treatment	A	B	C	D	E	F	G	H	I	Statistical Summary
A		X		X	X		X	X	X	A < B, D, E, G, H, I.
B	X		X	X	X			X	X	B > A, C: B < D, E, H. I.
C		X		X	X		X	X	X	C < B, D, E, G, H, I.
D	X	X	X			X	X			D > A, B, C, F, G.
E	X	X	X			X	X			E > A, B, C, F, G.
F				X	X			X	X	F < D, E, H, I.
G	X		X	X	X			X	X	G < D, E, H, I: G > A, C.
H	X	X	X			X	X			H > A, B, C, F, G.
I	X	X	X			X	X			I > A, B, C, F, G.

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

Ranking: D > E > I > H > B > G > F > C > A.

Leader Length

Leader Length

Treatment	A	B	C	D	E	F	G	H	I	Statistical Summary
A		X		X	X		X	X	X	A < B, D, E, G, H, I.
B	X		X			X				B > A, C, F.
C		X		X	X		X	X	X	C < B, D, E, G, H, I.
D	X		X			X				D > A, C, F.
E	X		X			X				E > A, C, F.
F		X		X	X		X	X	X	F < B, D, E, G, H, I.
G	X		X			X				G > A, C, F.
H	X		X			X				H > A, C, F.
I	X		X			X				I > A, C, F.

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

Ranking: E > D > I > H > G > B > F > C > A.

DBH

DBH

Treatment	A	B	C	D	E	F	G	H	I	Statistical Summary
A				X	X				X	A < D, E, I.
B			X	X	X				X	B > C,: B < D, E, I.
C		X		X	X		X	X	X	C < B, D, E, G, H, I.
D	X	X	X			X	X	X		D > A, B, C, F, G, H.
E	X	X	X			X	X	O		E > A, B, C, F, G, H.
F				X	X			X	X	F < D, E, H, I.
G			X	X	X				X	G > C: G < D, E, I.
H			X	X	O	X				H > C, F: H < D, E.
I	X	X	X			X	X			I > A, B, C, F, G.

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

Ranking: D > E > I > H > B > G > F > A > C.

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Douglas-fir planted in 1998

Treatment	Mean		
	Height (cm)	Leader Lenght (cm)	DBH(cm)
A	165.9	21.8	2.4
B	359.1	47.0	4.3
C	205.8	23.1	2.3
D	535.7	51.6	7.6
E	499.0	57.2	7.0
F	289.9	33.4	3.7
G	349.4	48.5	4.3
H	455.7	49.1	5.2
I	488.6	51.6	6.5

APPENDIX 7
Significant Difference Summary (Tukey Test at alpha=0.05)

Lodgepole pine planted in 1998

Total Height

Treatment	A	B	C	D	E	F	G	H	Statistical Summary
A		X	X	X	X	X	X	X	A < B, C, D, E, F, G, H.
B	X		X	X				O	B > A, C: B < D, H.
C	X	X		X	X	X	X	X	C > A: C < B, D, E, F, G, H.
D	X	X	X			X	X		D > A, B, C, F, G.
E	X		X				X		E > A, C, G.
F	X		X	X				X	F > A, C: F < D, H.
G	X		X	X	X			X	G > A, C: G < D, E, H.
H	X	O	X			X	X		H > A, B, C, F, G.

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

Ranking: D > H > E > B > F > G > C > A.

Leader Length

Treatment	A	B	C	D	E	F	G	H	Statistical Summary
A		X	X	X	X	X	X	X	A < B, C, D, E, F, G, H.
B	X		X						B > A, C.
C	X	X		X	X	X	X	X	C > A: C < B, D, E, F, G H.
D	X		X						D > A, C.
E	X		X			X			E > A, C, F.
F	X		X		X				F > A, C: F < E.
G	X		X						G > A, C.
H	X		X						H > A, C.

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

Ranking: E > B > D > G > H > F > C > A.

DBH

Treatment	A	B	C	D	E	F	G	H	Statistical Summary
A		X		X	X			X	A < B, D, E, H.
B	X		X	O			X		B > A, C, G: B < D
C		X		X	X	X	X	X	C < B, D, E, F, G, H.
D	X	O	X			X	X		D > A, B, C, F, G.
E	X		X			X	X		E > A, C, F, G.
F			X	X	X			X	F > C: F < D, E, H.
G		X	X	X	X			X	G > C: G < B, D, E, F.
H	X		X			X	X		H > A, C, F, G.

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

Ranking: D > E > H > B > F > G > C > A.

APPENDIX 7
Significant Difference Summary (Tukey Test at alpha=0.05)

Lodgepole pine planted in 1998

Treatment	Mean		
	Height (cm)	Leader Lenght (cm)	DBH(cm)
A	85.4	9.2	2.8
B	449.5	42.0	7.4
C	335.5	26.6	4.7
D	505.6	41.5	8.5
E	463.5	44.8	8.3
F	415.4	37.0	6.8
G	404.7	41.1	6.2
H	496.7	40.2	8.2

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Douglas-fir planted in 1999

Total Height

Treatment	A	B	C	D	E	F	G	H	I	J	K	L	M
A		X		X	X		X		X	X	X	X	X
B	X												
C				O	X								
D	X		O					X					
E	X		X					X			O		
F													
G	X												
H				X	X				X			O	
I	X							X		X	X		
J	X								X				
K	X				O				X				
L	X							O					
M	X												

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

Leader Length

Treatment	A	B	C	D	E	F	G	H	I	J	K	L	M
A		X		X	X		X		X	X	X	X	X
B	X												
C							O		X	X	X		X
D	X												
E	X												
F													
G	X		O										
H									X	X	X		X
I	X		X					X					
J	X		X					X					
K	X		X					X					
L	X												
M	X		X					X					

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

DBH

Treatment	A	B	C	D	E	F	G	H	I	J	K	L	M
A													
B													
C													
D								X					
E													
F													
G													
H				X					X			X	O
I								X			O		
J													
K									O			O	
L								X			O		
M								O					

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Douglas-fir planted in 1999

Total Height

Statistical Summary	Treatment	Mean Height (cm)	Leader Lenght (cm)	DBH(cm)
A < B, D, E, G, I, J, K, L, M.	A	80.3	8.5	____
B > A.	B	415.8	52.6	4.6
C < D, E.	C	239.9	22.8	2.9
D > A, C, H.	D	450.1	46.9	7.7
E > A, C, H, K.	E	488.2	48.7	7.6
F no significant differences.	F	284.0	40.9	3.7
G > A	G	392.1	54.7	4.2
H < D, E, I, L.	H	266.4	33.4	3.4
I > A, H, J, K.	I	387.9	51.5	6.0
J > A: J < I.	J	327.2	53.0	5.0
K > A: K < E, I.	K	323.0	48.1	4.8
L > A, H.	L	361.2	45.1	6.2
M > A.	M	351.6	51.2	6.0

Ranking: E > D > B > G > I > L > M > J > K > F > H > C > A.

Leader Length

Statistical Summary
A < B, D, E, G, I, J, K, L, M.
B > A.
C < G, I, J, K, M.
D > A.
E > A.
F no significant differences.
G > A, C.
H < I, J, K, M.
I > A, C, H.
J > A, C, H.
K > A, C, H.
L > A.
M > A, C, H.

Ranking: G > J > B > I > M > E > K > D > L > F > H > C > A.

DBH

Statistical Summary
A no significant differences.
B no significant differences.
C no significant differences.
D > H.
E no significant differences.
F no significant differences.
G no significant differences.
H < D, I, L, O.
I > H, K.
J no significant differences.
K < I, L.
L > H, K.
M > H.

Ranking: D > E > L > I > M > J > K > B > G > F > H > C > A.

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Lodgepole pine planted in 1999

Total Height

Treatment	A	B	C	D	E	F	G	H	I	J	K	L	M
A		X		X	X				X	X	X	X	X
B	X		O										
C		O			X				O				
D	X												
E	X		X					X		O			
F													
G													
H					X				X			O	
I	X		O					X		X	X		
J	X				O				X			O	
K	X								X				
L	X							O		O			
M	X												

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

Leader Length

Treatment	A	B	C	D	E	F	G	H	I	J	K	L	M
A					X		O		X	X	X	X	X
B													
C									X	X	X	X	
D													
E	X												
F													
G	O												
H									X	X	X	X	
I	X		X					X					
J	X		X					X					
K	X		X					X					
L	X		X					X					
M	X												

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

DBH

Treatment	B	C	D	E	F	G	H	I	J	K	L	M
B												
C											X	
D												
E												
F												
G												
H								O			X	
I							O					
J												
K											X	
L		X					X			X		
M												

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Lodgepole pine planted in 1999

Total Height	Treatment	Mean		
Statistical Summary		Height (cm)	Leader Lenght (cm)	DBH(cm)
A < B, D, E, I, J, K, L, M.	A	80.3	8.5	---
B > A, C.	B	552.6	49.7	7.8
C < B, E, I.	C	239.9	22.8	2.9
D > A.	D	407.9	41.2	6.0
E > A, C, H, J.	E	488.2	48.7	7.6
F no significant differences.	F	284.0	40.9	3.7
G no significant differences.	G	374.5	53.0	4.6
H < E, I, L.	H	276.9	29.4	3.8
I > A, C, H, J, K.	I	394.0	51.7	6.3
J > A: J < E, I L.	J	322.8	50.8	5.4
K > A: K < I.	K	338.4	49.6	5.3
L > A, H, J.	L	393.0	47.3	6.9
M > A.	M	341.0	44.2	6.3

Ranking: B > E > D > I > L > G > M > K > J > F > H > C > A.

Leader Length

Statistical Summary
A < E, G, I, J, K, L, M.
B no significant differences.
C < I, J, K, L.
D no significant differences.
E > A.
F no significant differences.
G > A.
H < I, J, K, L.
I > A, C, H.
J > A, C, H.
K > A, C, H.
L > A, C, H.
M > A.

Ranking: G > I > J > B > K > E > L > M > D > F > H > C > A.

DBH

Statistical Summary
B no significant differences.
C < L.
D no significant differences.
E no significant differences.
F no significant differences.
G no significant differences.
H < I, L.
I > H.
J no significant differences.
K < L.
L > C, H, K.
M no significant differences.

Ranking: B > E > L > I > M > D > J > K > G > H > F > C > A.

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Douglas-fir planted in 2000

Total Height

Treatment	O	P	Q	S	T	U	V	X	Y
O							X		
P							X		
Q							X		
S							X		
T							X		
U							X		
V	X	X	X	X	X	X		X	X
X							X		
Y							X		

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

Leader Length

Treatment	O	P	Q	S	T	U	V	X	Y
O							X		
P							X		
Q							X		
S							X		
T							X		
U							X		
V	X	X	X	X	X	X		X	X
X							X		
Y							X		

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

DBH

Treatment	O	P	Q	S	T	U	V	X	Y
O									
P									
Q							X	X	
S									
T									
U									
V			X						
X			X						
Y									

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Douglas-fir planted in 2000

Means:

Statistical Summary	Treatment	Mean Height (cm)	Mean Leader Length (cm)	Mean DBH(cm)
O > V.	**O**	370.7	62.3	4.0
P > V.	**P**	330.1	54.8	3.9
Q > V.	**Q**	335.6	54.5	4.6
S > V.	**S**	255.3	49.7	2.4
T > V.	**T**	312.2	58.4	3.3
U > V.	**U**	280.0	54.8	3.3
V < O, P, Q, S, T, U, X, Y.	**V**	72.1	9.0	1.8
X > V.	**X**	280.4	55.6	2.9
Y > V.	**Y**	302.6	55.3	3.3

Ranking: O > Q > P > T > Y > X > U > S > V.

Leader Length

Statistical Summary
O > V.
P > V.
Q > V.
S > V.
T > V.
U > V.
V < O, P, Q, S, T, U, X, Y.
X > V.
Y > V.

Ranking: O > T > X > Y > P > U > Q > S > V.

DBH

Statistical Summary
O no significant differences.
P no significant differences.
Q > V, X.
S no significant differences.
T no significant differences.
U no significant differences.
V < Q.
X < Q.
Y no significant differences.

Ranking: Q > O > P > T > Y > U > X > S > V.

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Lodgepole pine planted in 2000

Total Height

Treatment	N	O	P	Q	R	S	T	U	V	W	X	Y
N									X	X		
O									X	X		
P									X	X		
Q									X	X		
R									X	X		
S									X	X		
T									X	X		
U									X	X		
V	X	X	X	X	X	X	X	X			X	X
W	X	X	X	X	X	X	X	X			X	X
X									X	X		
Y									X	X		

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

Leader Length

Treatment	N	O	P	Q	R	S	T	U	V	W	X	Y
N									X	X		
O			X						X	X		
P		X			O		X	X	X	X	X	
Q									X	X	X	
R			O						X	X		
S									X	X		
T			X						X	X		
U			X						X	X		
V	X	X	X	X	X	X	X	X			X	X
W	X	X	X	X	X	X	X	X			X	X
X			X	X					X	X		X
Y									X	X	X	

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

DBH

Treatment	N	O	P	Q	R	S	T	U	V	W	X	Y
N									O	X		
O									X	X		
P				X		X	X	X	X	X		X
Q			X									
R									X	X		
S			X						O	X		
T			X						O	x		
U			X								X	
V	O	X	X		X	O	O				X	X
W	X	X	X		X	X	X				X	X
X								X	X	X		
Y			X						X	X		

X – Significant Difference at Alpha = 0.05
O – Significant Difference at Alpha = 0.10
Blank – No Significant Difference

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Lodgepole pine planted in 2000

Total Height	Treatment	Mean		
Statistical Summary		Height (cm)	Leader Lenght (cm)	DBH(cm)
N > V, W.	**N**	339.0	48.1	5.0
O > V, W.	**O**	335.9	52.6	5.1
P > V, W.	**P**	340.1	39.4	5.9
Q > V, W.	**Q**	300.6	41.3	4.5
R > V, W.	**R**	324.1	49.8	5.0
S > V, W.	**S**	316.2	48.8	4.7
T > V, W.	**T**	315.6	50.0	4.6
U > V, W.	**U**	312.0	48.1	4.4
V < N, O, P, Q, R, S, T, U, X, Y.	**V**	85.2	11.1	3.2
W < N, O, P, Q, R, S, T, U, X, Y.	**W**	77.2	9.2	2.7
X > V, W.	**X**	337.9	53.4	5.0
Y > V, W.	**Y**	333.2	46.9	4.8

Ranking: P > N > X > O > Y > R > S > T > U > Q > V > W.

Leader Length

Statistical Summary
N > V, W.
O > V, W.
P > V, W : P < 0, R, T, U, X.
Q > V, W : Q < X.
R > P, V, W :
S > V, W.
T > V, W.
U > V, W.
V < N, O, P, Q, R, S, T, U, X, Y.
W < N, O, P, Q, R, S, T, U, X, Y.
X > P, Q, V, W, Y.
Y > V, W : Y < X.

Ranking: X > O > T > R > S > N > U > Y > Q > P > V > W.

DBH

Statistical Summary
N > V, W.
O > V, W.
P > Q, S, T, U, V, W, Y.
Q < P.
R > V, W.
S > V, W : S < P.
T > V, W : S < P.
U < P, X.
V < N, O, P, R, S, T, U, X, Y.
W < N, O, P, R, S, T, U, X, Y.
X > U, V, W.
Y > V, W: Y < P.

Ranking: P > O > X > N > R > Y > S > T > Q > U > V > W.

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Douglas-fir planted in all years (1998, 1999 and 2000)

Total Height at age 15 years

Treatment	A	B	C	D	E	F	G	H	I	J	K	L	M	O	P	Q	S	T	U	V	W	X	Y
A		X		X	X		X	X	X	X			X	X	X	X		X	X			X	X
B	X		X	X	X				X											X			
C		X		X	X		X	X	X	X			X	O	X	X		X	X			X	X
D	X	X	X			X	X	X		X	X	X						X	X	X		X	X
E	X	X	X			X	X				X	X							X	X		X	
F				X	X			X	X						O	O		X		X			X
G	X		X	X	X				X											X			
H	X		X	X		X					X									X			
I	X	X	X			X	X				X	X							X	X			
J	X		X	X																X			
K				X	X			X	X											X			
L				X	X				X											X			
M	X		X																	X			
O	X		O																	X			
P	X		X			O														X			
Q	X		X			O														X			
S																				O			
T	X		X	X		X														X			
U	X		X	X	X				X											X			
V		X		X	X	X	X	X	X	X	X	X	X	X	X	X	O	X	X			X	X
W																							
X	X		X	X	X															X			
Y	X		X	X		X														X			

X – Significant Difference at Alpha = 0.05

O – Significant Difference at Alpha = 0.10

Blank – No Significant Difference

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

SI 50 TA

Treatment	A	B	C	D	E	F	G	H	I	J	K	L	M	O	P	Q	S	T	U	V	W	X	Y
A				X	X			O	X														
B				X	X				X														
C				X	X		X	X	X				0		X	X		X	O			O	X
D	X	X	X			X	X	X		X	X	X						X	X	X		X	X
E	X	X	X			X	X				X	X						X	X	X		X	X
F				X	X			X	X														
G			X	X	X				O														
H	O		X	X		X																	
I	X	X	X			X	O				O	X							X	X		X	O
J				X																			
K				X	X				O														
L				X	X				X														
M			0																				
O																							
P			X																				
Q			X																				
S																							
T			X	X	X																		
U			O	X	X				X														
V				X	X				X														
W																							
X			O	X	X				X														
Y			X	X	X				O														

X – Significant Difference at Alpha = 0.05

O – Significant Difference at Alpha = 0.10

Blank – No Significant Difference

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Treatment	A	B	C	D	E	F	G	H	I	J	K	L	M	O	P	Q	S	T	U	V	W	X	Y
A																							
B			X			X												X	X				
C		X		X	X		X	X	X	X	X	O		O	X	X		X	X			X	X
D			X			X														O			
E			X			X																	
F		X		X	X		X	X	X	X	X				X	X		X	X			X	X
G			X			X												X	X				
H			X			X												O					
I			X			X																	
J			X			X																	
K			X			X																	
L			O																				
M																							
O			O																				
P			X			X																	
Q			X			X																	
S																							
T		X	X			X	X	O												X			
U		X	X			X	X													X			
V				O														X	X				
W																							
X			X			X																	
Y			X			X																	

X – Significant Difference at Alpha = 0.05

O – Significant Difference at Alpha = 0.10

Blank – No Significant Difference

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Douglas-fir planted in all years (1998, 1999 and 2000)

Total Height at age 15 years

Statistical Summary	Means:		
	Treatment	# of Trees	Tota Height at Age 15 (cm)
A < B, D, E, G, H, I, J, M, O, P, Q, T, U, X, Y.	**A**	7	144.0
B > A, C, V : B < D, E, I.	**B**	36	311.4
C < B, D, E, G, H, I, J, M, O, P, Q, T,U, X, Y.	**C**	20	182.8
D > A, B, C, F, G, H, J, K, L, T, U, V, X, Y.	**D**	31	484.6
E > A, B, C, F, G,K, L, U, V, X.	**E**	25	441.8
F > V : F < D, E, H, I, P, Q, T, Y.	**F**	28	257.7
G > A, C, V, : G < D, E, I.	**G**	35	309.8
H > A, C, F, K, V : H < D.	**H**	32	385.7
I > A, B, C, F, G, K, L, U, V.	**I**	37	415.7
J > A, C, V : J < D.	**J**	10	340.8
K > V : K < D, E, H, I.	**K**	13	267.4
L > V : L < D, E, I.	**L**	10	272.2
M > A, C, V.	**M**	5	389.7
O > A, C, V.	**O**	2	433.0
P > A, C, F, V.	**P**	9	385.0
Q > A, C, F, V.	**Q**	9	390.1
S > V.	**S**	3	305.0
T > A, C, F, V : T < D.	**T**	46	370.6
U > A, C, V : U < D, E, I.	**U**	47	334.8
V < B, D, E, F, G, H, I, J, K, L, M, O, P, Q, S, T, U, X, Y.	**V**	14	81.1
No significant difference.	**W**	1	270.2
X > A, C, V : X < D, E	**X**	31	336.1
Y > A, C, F, V : X < D.	**Y**	39	358.0

Ranking: D > E > O > I > Q > M > H > P > T > Y > J > X > U > B > G > S > L > W > K > F > C > A > V.

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

SI 50 TA

Statistical Summary	Means: Treatment	# of Trees	SI 50 TA (m)
A < D, E, H, I,.	**A**	4	13.3
B < D, E, I.	**B**	36	17.6
C < D, E, G, H, I, M. P, Q, T, U, X, Y.	**C**	14	13.7
D > A, B, C, F, G, H, J, K,L, T, U, V, X, Y.	**D**	31	24.0
E > A, B, C, F, G, K,L, T, U, V, X, Y.	**E**	25	22.8
F < D, E, H, I.	**F**	24	16.6
G > C : G < D, E, I.	**G**	32	18.5
H > A, C, F : H < D.	**H**	32	20.3
I > A, B, C, F, G, K, L, U, V, X, Y.	**I**	37	21.7
J < D.	**J**	10	18.3
K < D, E, I.	**K**	11	17.3
L < D, E, I.	**L**	9	16.5
M > C.	**M**	5	20.4
No Significance	**O**	2	21.6
P > D.	**P**	9	20.0
Q > C.	**Q**	9	19.9
No Significance	**S**	3	16.5
T > C : T < D, E.	**T**	45	19.4
U > C : U < D, E, I.	**U**	47	17.6
V < D, E, I.	**V**	3	13.5
No Significance	**W**	1	14.8
X > C : X < D, E, I.	**X**	30	17.9
Y > C : Y < D, E, I.	**Y**	39	18.7

Ranking: D > E > I > O > M > H > P > Q > T > Y > G > J > X > U > B > K > F > S > L > W > C > V > A.

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Statistical Summary	Treatment	# of Trees	SI 50 GI (m)
No Significance	**A**	3	20.9
B > C, F : B < T, U.	**B**	32	23.1
C < B, D, E, G, H, I, J, K, L, O, P, Q, T, U.	**C**	12	18.2
D > C, F, V.	**D**	29	26.0
E > C, F.	**E**	25	25.2
F < B, D, E, G, H, I, J, K, P, Q, T, U, X, Y.	**F**	20	19.2
G > C, F : G < T,U.	**G**	31	23.1
H > C, F : H < T.	**H**	28	23.7
I > C, F.	**I**	31	24.8
J > C, F.	**J**	10	24.9
K > C, F.	**K**	11	24.0
L > C.	**L**	8	23.8
No Significance	**M**	4	24.8
O > C.	**O**	2	27.8
P > C, F.	**P**	9	26.4
Q > C, F.	**Q**	9	25.5
No Significance	**S**	3	23.9
T > B, C, F, G, H, V.	**T**	45	26.7
U > B, C, F, G, V.	**U**	47	26.6
V < D, T, U.	**V**	2	17.2
No Significance	**W**	1	22.4
X > C, F.	**X**	30	25.5
Y > C, F.	**Y**	39	25.8

Ranking: O > T > U > P > D > Y > X > Q > E > J > I> M > K > S > L > H > B > G > W > A > F > C > V.

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Lodgepole pine planted in all years (1998, 1999 and 2000)

Total Height at age 15 years

Treatment	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
A		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	
B	X		X	O						X	X										X	X	X		
C	X	X		X	X	X	X	X	X			X			X	X		X		X	X	X	X	X	X
D	X	O	X			X	X		X	X	X	O	X		0	X	X	X	X	X	X	X	X	X	X
E	X		X				X			X	X						X			X	X	X	X		
F	X		X	X				X		O												X	X		
G	X		X	X	X			X														X	X		
H	X		X			X	X			X	X		X				X	X	X	X	X	X	X	X	X
I	X		X	X						X												X	X		
J	X	X		X	X	O		X	X			O										X	X	X	X
K	X	X		X	X			X														X	X	O	
L	X		X	O						O												X	X		
M	X			X				X														X	X		
N	X																					X	X		
O	X		X	O																		X	X		
P	X		X	X																		X	X		
Q	X			X	X			X														X	X		
R	X		X	X				X														X	X		
S	X			X				X														X	X		
T	X		X	X	X			X														X	X		
U	X	X	X	X	X			X														X	X		
V		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X
W		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X
X	X		X	X				X		X	O											X	X		
Y	X		X	X				X		X												X	X		

X – Significant Difference at Alpha = 0.05

O – Significant Difference at Alpha = 0.10

Blank – No Significant Difference

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

SI 50 TA

Treatment	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
A		X		X	X	X	X	X	X			X		O	X	X		O		O				X	X
B	X		X							X	X						X			X	X	X	X		
C		X		X	X	X	X	X	X			X			X	X				X	O			X	X
D	X		X			X	X		X	X	X		X		X		X	X	X	X	X	X	X	X	X
E	X		X				O			X	X		O				X		O	X	X	X	X		
F	X		X	X				X														O	X		
G	X		X	X	O			X															O		
H	X		X			X	X			X	X		X				X	X	X	X	X	X	X	X	X
I	X		X	X						X												X	X		
J		X		X	X			X								X									
K		X		X	X			X								X									
L	X		X																			X	X		
M				X	O			X																	
N	O																								
O	X		X	X																			O		
P	X		X							X	X						O				X	X	X		
Q		X		X	X			X								O									
R	O			X				X																	
S				X	O			X																	
T	O	X	X	X	X			X															O		
U		X	O	X	X			X								X									
V		X		X	X	O		X	X			X				X								O	O
W		X		X	X	X	O	X	X			X			O	X				O				X	X
X	X		X	X				X														O	X		
Y	X		X	X				X														O	X		

X – Significant Difference at Alpha = 0.05

O – Significant Difference at Alpha = 0.10

Blank – No Significant Difference

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
A		X		X	X			X							X				X	X	X			X	X
B	X		X			X	X						O				O						X		
C		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
D	X		X			X	X		X	X	X	O	X			X	X	X					X		O
E	X		X				X						O				O						X		
F		X	X	X				O												X	X			X	
G		X	X	X	X			X	O						X				X	X	X			X	X
H	X		X			O	X						O				O						X		
I			X	X			O																		
J			X	X																					
K			X	X																					
L			X	O																					
M		O	X	X	O			O												X	O			X	
N			X																						
O	X		X				X																		
P			X	X																					
Q		O	X	X	O			O												X	O			X	
R			X	X																					
S	X		X				X																O		
T	X		X			X	X						X				X						X		
U	X		X			X	X						O				O						X		
V			X																						
W		X		X	X			X											O	X	X			X	O
X	X		X			X	X						X				X						X		
Y	X		X	O			X																O		

X – Significant Difference at Alpha = 0.05

O – Significant Difference at Alpha = 0.10

Blank – No Significant Difference

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

Lodgepole pine planted in all years (1998, 1999 and 2000)

Total Height at age 15 years

Statistical Summary	Means:		
	Treatment	# of Trees	Tota Height at Age 15 (cm)
A < B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, X,Y.	A	21	76.6
B > A, C, J, K, U, V, W : B < D.	**B**	77	409.4
C > A, V, W : C < B, D, E, F, G, H, I, L, O, P, R, T, U, X, Y.	**C**	88	306.5
D > A, B, D, F, G, I, J, K, L, M, O, P, Q, R, S, T, U, V, W, X, Y.	**D**	64	462.3
E > A, C, G, J, K, Q, T, U, V, W.	**E**	61	422.1
F > A, C, J, V, W : F < D, H.	**F**	76	377.1
G > A, C, V, W : G < D, E, H.	**G**	70	363.8
H > A, C, F, G, J, K, M, Q, R, S, T, U, V, W, X, Y.	**H**	81	441.0
I > A, C, J, V, W : I < D.	**I**	57	394.0
J > A, V, W : J < D, E, F, H, I, L, X, Y.	**J**	32	312.7
K > A, V, W : K < B, D, E, H, X.	**K**	47	338.4
L > A, C, J, V, W : L < D.	**L**	28	393.0
M > A, V, W : M < D, H.	**M**	18	341.0
N > A, V, W.	**N**	13	387.1
O > A, C, V, W : O < D.	**O**	26	388.6
P > A, C, V, W : P < D.	**P**	34	379.5
Q > A, C, V, W : Q < D, E, H	**Q**	23	341.9
R > A, C, V, W : R < D, H.	**R**	33	373.9
S > A, V, W : S < D, H.	**S**	31	365.0
T > A, C, V, W : T < D, E, H.	**T**	87	365.6
U > A, C, V, W : U < B, D, E, H.	**U**	100	360.1
V < B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, X,Y.	**V**	74	95.0
W < B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, X,Y.	**W**	67	86.4
X > A, C, J, K, V, W : X < D, H.	**X**	114	391.3
Y > A, C, J, V, W : Y < D, H.	**Y**	99	380.6

Ranking: D > H > E > B > I > L > X > O > N > Y > P > F > R > T > S > G > U > Q > M > K > J > C > V > W > A.

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)

SI 50 TA

Statistical Summary

A < B, D, E, F, G, H, I, L, N, O, P, R, T, X, Y.
B > A, C, J, K, Q, T, U, V, W.
C < B, D, E, F, G, H, I, L, O, P, T, U, W,Y.
D > A, C, F, G, I, J, K, M, O, Q, R, S, T, U, V, W, X, Y.
E > A, C, G, J, K, M, Q, S, T, U, V, W.
F > A, C, V, W : F < D, H.
G > A, C, W : G < D, E, H.
H > A, C, F, G, J, K, M, Q, R, S, T, U, V, W, X, Y.
I > A, C, J, V, W : I < D.
J < B, D, E, H, P.
K < B, D, E, H, P.
L > A, C, V, W.
M < D, E, H.
N > A.
O > A, C, W : O < D.
P > A, C, J. K, Q, U, V, W.
Q < B, D, E, H, P.
R > A : R < D, H.
S < D, E, H.
T > A, C, W : T < B, D, E, H.
U < B, C, D, E, H, P
V < B, D, E, E, F, H, I, L, P, V, Y.
W < B, D, E, E, F, G, H, I, L, O, P, T, V, Y.
X > A, C, V, W : X < D, H.
Y > A, C, V, W : X < D, H.

Means:

Treatment	# of Trees	SI 50 TA (m)
A	3	9.8
B	76	17.2
C	87	13.7
D	64	18.5
E	61	17.4
F	76	16.1
G	70	15.8
H	81	17.7
I	57	16.7
J	31	14.4
K	47	14.8
L	28	16.5
M	18	14.9
N	13	16.2
O	26	16.1
P	29	17.4
Q	23	14.7
R	33	15.6
S	31	15.3
T	84	15.6
U	100	15.2
V	11	13.0
W	7	11.9
X	114	16.1
Y	98	16.0

Ranking: D > H > E > P > B > I > L > N > X > F > O > Y > G > R > T > S > U > M > K > Q > J > C > V > W > A.

APPENDIX 7

Significant Difference Summary (Tukey Test at alpha=0.05)			
A < B, D, E, H, O, S, T, U, X, Y.	**A**	3	15.0
B > A, C, F, G, M, Q, W.	**B**	67	19.5
C < B, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, X, Y.	**C**	69	14.9
D > A, C, F, G, I, J, K, L, M, P, Q, R, W, Y.	**D**	63	20.3
E > A, C, G, M, Q, W.	**E**	50	19.5
F > C, : F < B, D, H, T, U, X.	**F**	68	18.3
G > C : G < B, C, D, E, H, I, O, S, T, U, X, Y.	**G**	63	17.6
H > A, C, F, G, M, Q, W.	**H**	71	19.4
I > C, G : I < D.	**I**	51	18.9
J > C : J < D.	**J**	26	18.4
K > C : K < D.	**K**	39	18.8
L > C : K < D.	**L**	26	18.8
M > C : M < B, D, E, H, T, U, X.	**M**	17	17.7
N > C.	**N**	13	19.2
O > A, C, G.	**O**	26	19.3
P > C : P < D.	**P**	29	18.6
Q > C : Q < B, D, E, H, T, U, X.	**Q**	23	17.8
R > C : R < D.	**R**	33	18.7
S > A, C, G, W.	**S**	31	19.4
T > A, C, F, G, M, Q, W.	**T**	83	19.9
U > A, C, F, G, M, Q, W.	**U**	100	19.5
V > C.	**V**	7	18.2
W < C, D, E, H, S, T, U, X, Y.	**W**	5	16.2
X > A, C, F, G,M, Q, W.	**X**	113	19.7
Y > A, C, G, W : Y < D,	**Y**	98	19.2

Ranking: D > T > X > E > B > U > H > S > O > Y > N > I > K > L > R > P > J > F > V > Q > M > G > > W > A > C.

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Appendix 8 – Mortality Table 2012

Appendix 8 - Mortality Tables – 2012 Data

Treatment	Douglas-fir Planted 1998			Lodgepole Pine Planted 1998		
	Dead	Count	Mortality	Dead	Count	Mortality
A	16	23	69.6%	44	65	67.7%
B	7	43	16.3%	4	81	4.9%
C	2	22	9.1%	7	95	7.4%
D	4	35	11.4%	14	78	17.9%
E	10	35	28.6%	22	83	26.5%
F	2	30	6.7%	3	79	3.8%
G	7	42	16.7%	4	74	5.4%
H	3	35	8.6%	3	84	3.6%
I	10	47	21.3%	3	60	5.0%
J	9	19	47.4%	16	47	34.0%
K	7	20	35.0%	5	52	9.6%
L	8	18	44.4%	18	46	39.1%
M	24	29	82.8%	65	83	78.3%
Total	109	**398**	**27.4%**	**208**	**927**	**22.4%**

- **Douglas-fir Mortality Ranking: M>A>J>L>K>E>I>G>B>D>C>H>F.**
- **Lodgepole Pine Mortality Ranking: M>A>L>J>E>D>K>C>G>I>B>F>H.**

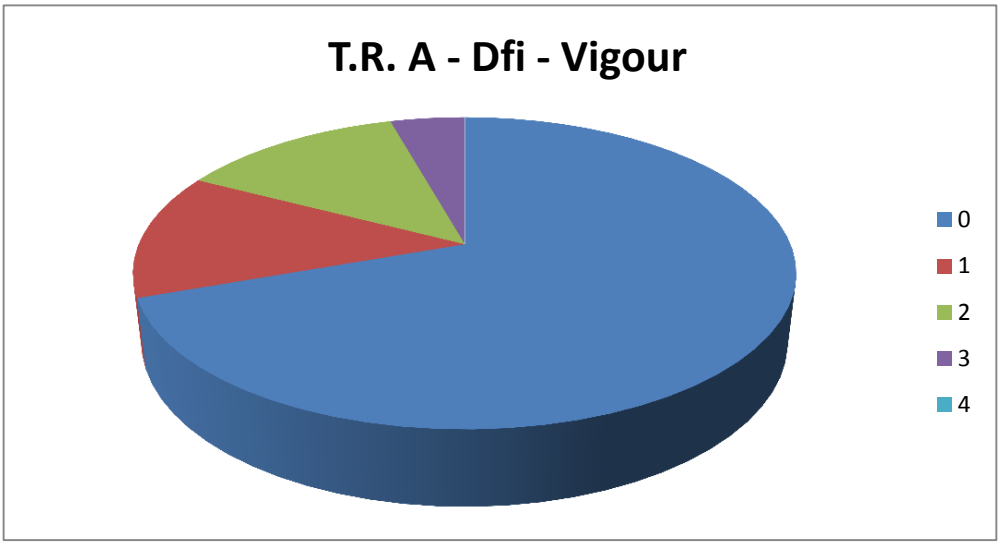
Treatment	Douglas-fir Planted 2000			Lodgepole Pine Planted 2000		
	Dead	Count	Mortality	Dead	Count	Mortality
N	22	22	100.0%	76	89	85.4%
O	33	35	94.3%	69	95	72.6%
P	15	24	62.5%	66	99	66.7%
Q	24	33	72.7%	59	82	72.0%
R	39	39	100.0%	53	86	61.6%
S	48	51	94.1%	63	94	67.0%
T	8	54	14.8%	7	94	7.4%
U	14	61	23.0%	21	121	17.4%
V	7	21	33.3%	9	82	11.0%
W	47	48	97.9%	40	106	37.7%
X	0	31	0.0%	2	116	1.7%
Y	11	50	22.0%	38	138	27.5%
Total	**268**	**469**	**57.1%**	**503**	**1202**	**41.8%**

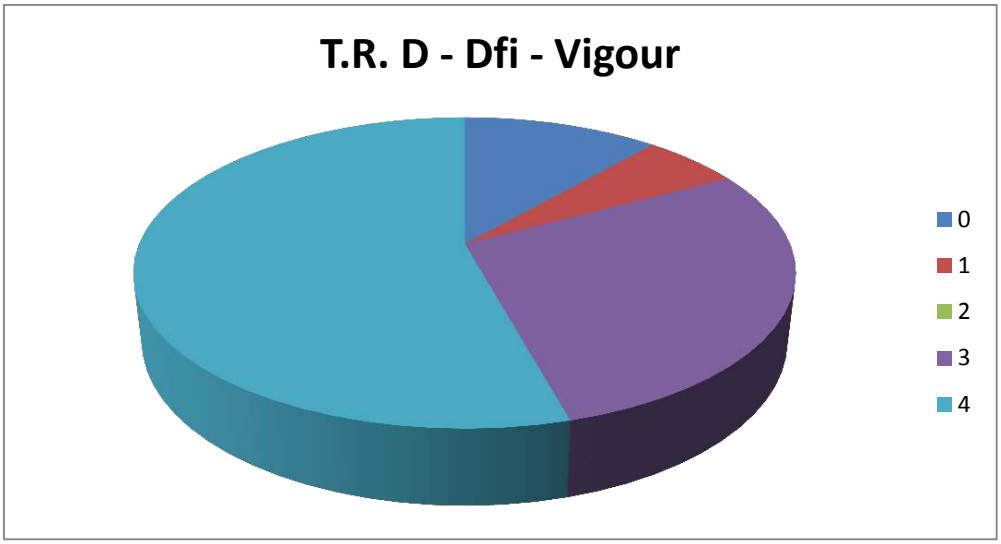
- **Douglas-fir Mortality Ranking: N=R>W>O>S>Q>P>V>Y>U>T>X.**
- **Lodgepole Pine Mortality Ranking: N>O>Q>S>P>R>W>Y>U>V>T>X.**

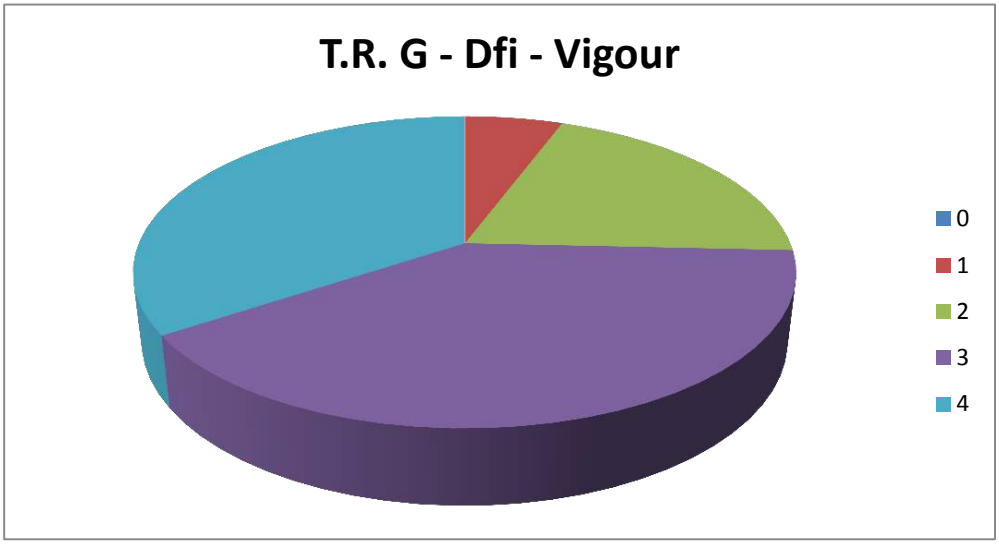
Appendix 9 – Vigour Crosstabulation

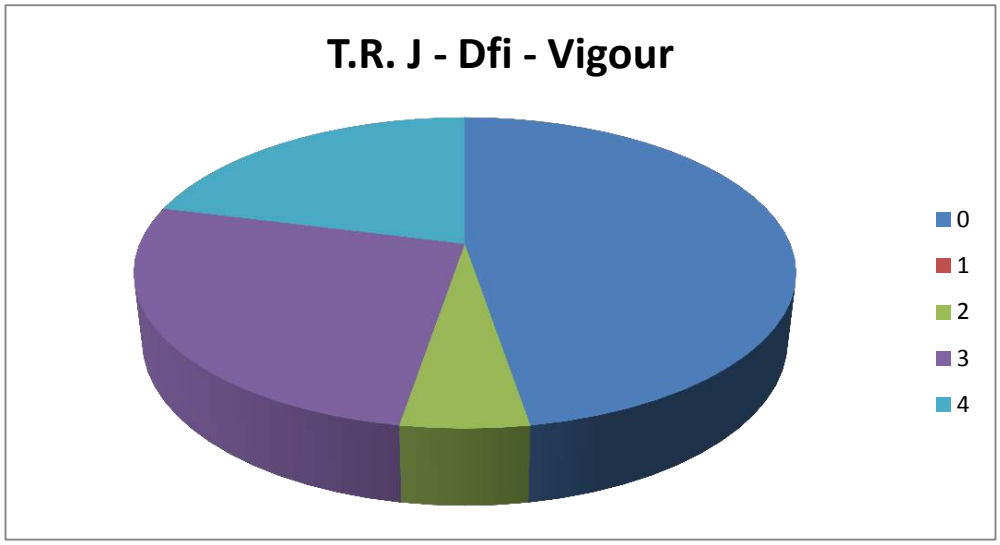
Appendix 9 - Vigour Crosstabulation

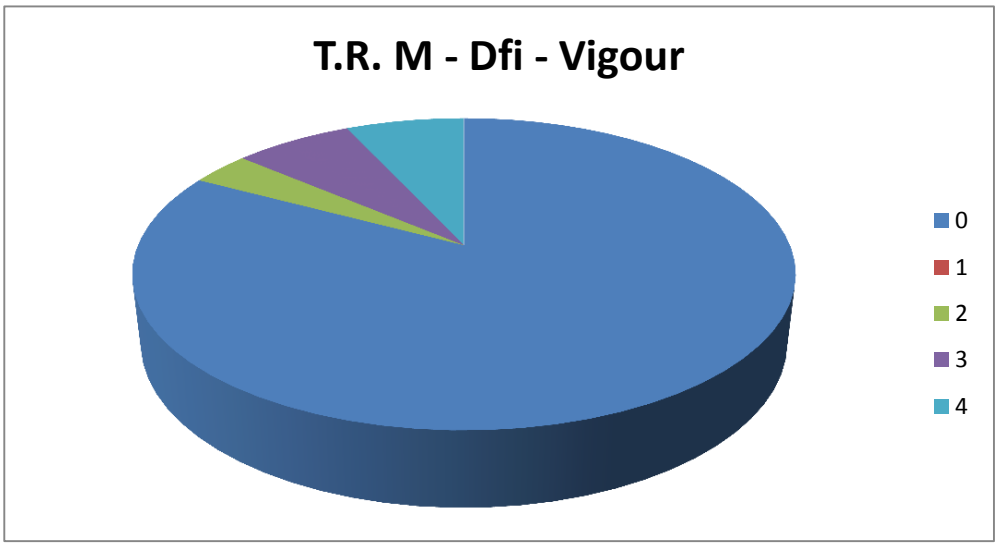
Vigour	A	B	C	D	E	F	G	H
0	16	7	2	4	10	7	0	3
1	3	4	6	2	0	4	2	0
2	3	14	9	0	7	13	7	9
3	1	10	4	10	7	4	14	11
4	0	8	1	19	11	7	12	12
Total	23	43	22	35	35	35	35	35

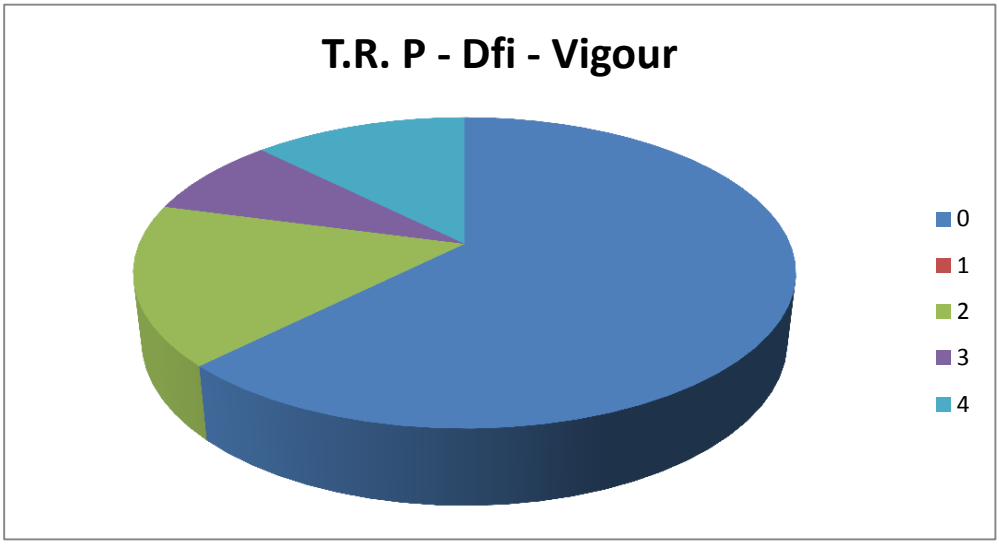


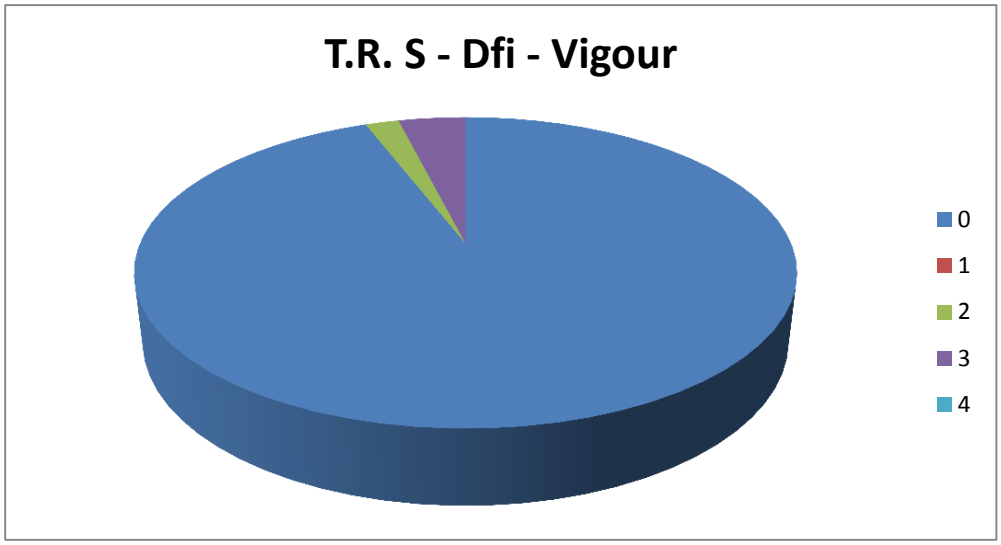


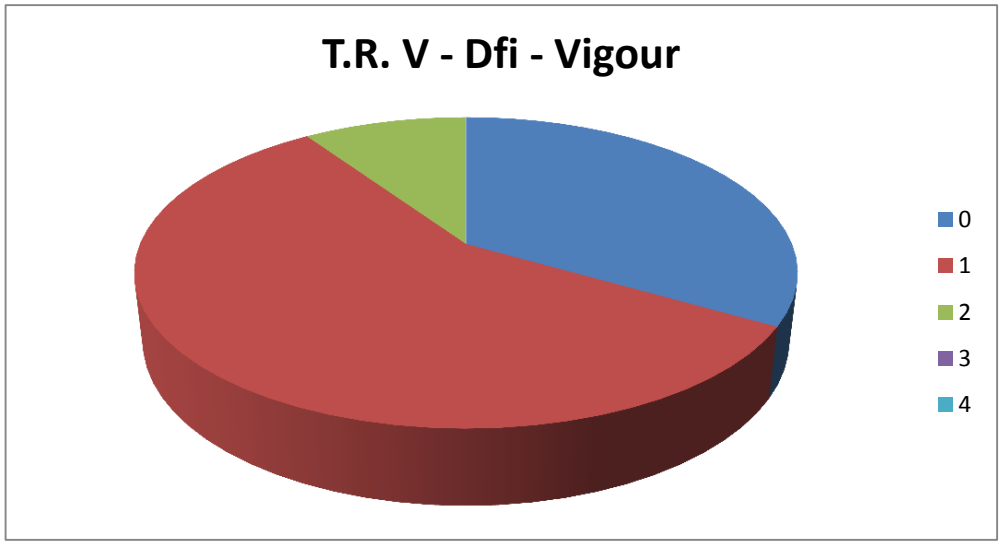

T.R. G - Dfi - Vigour
0
1
2
3
4


T.R. J - Dfi - Vigour
0
1
2
3
4


T.R. M - Dfi - Vigour
0
1
2
3
4

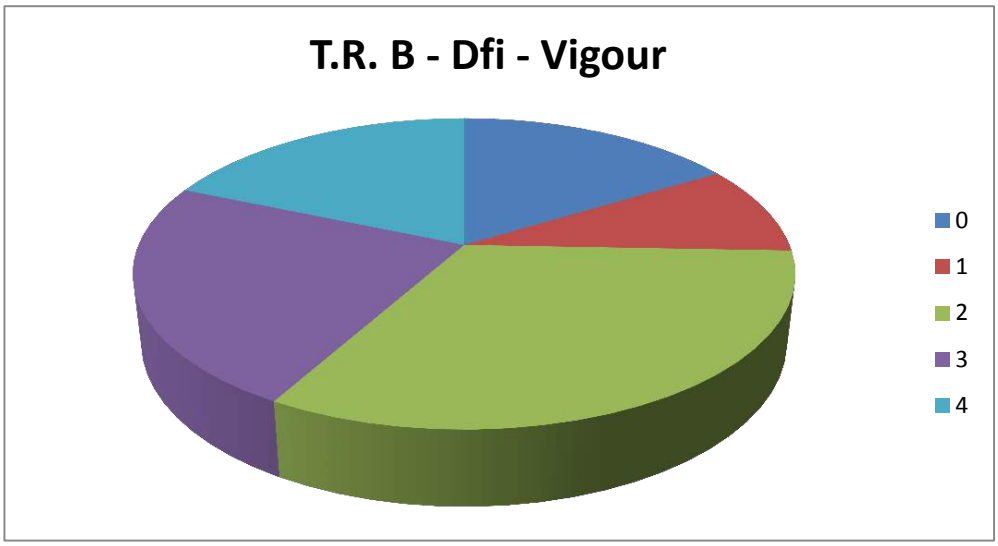

T.R. P - Dfi - Vigour
0
1
2
3
4

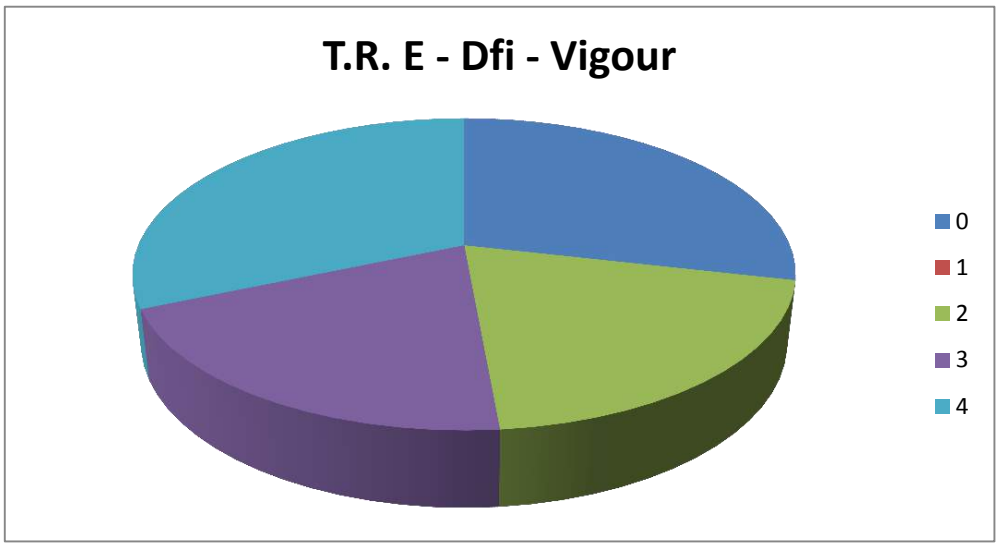

T.R. S - Dfi - Vigour
0
1
2
3
4

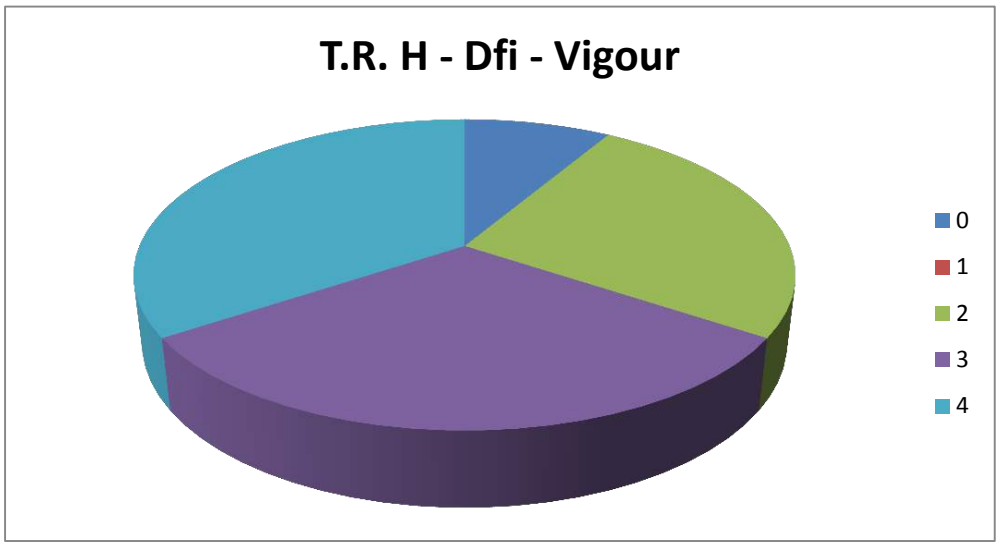

T.R. V - Dfi - Vigour
0
1
2
3
4

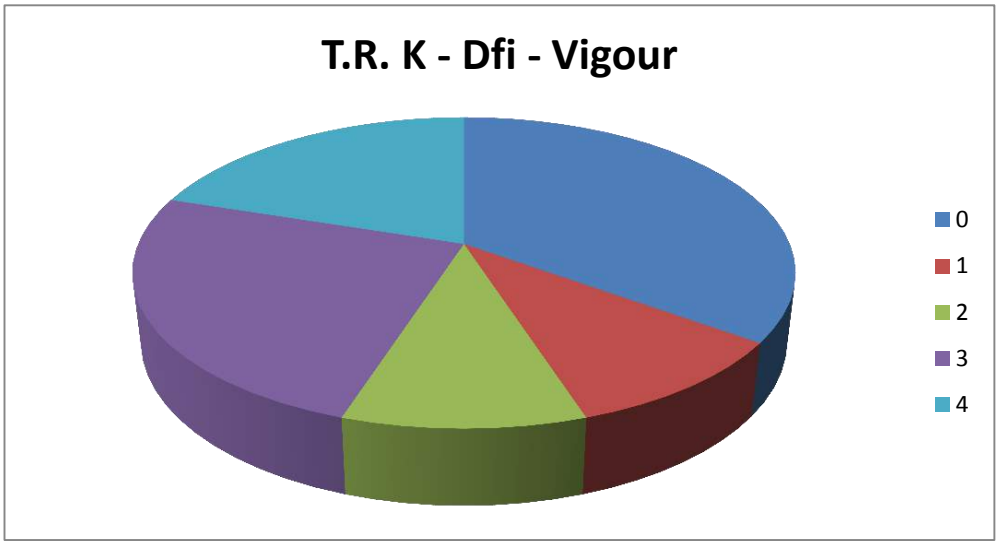
Appendix 9 - Vigour Crosstabulation

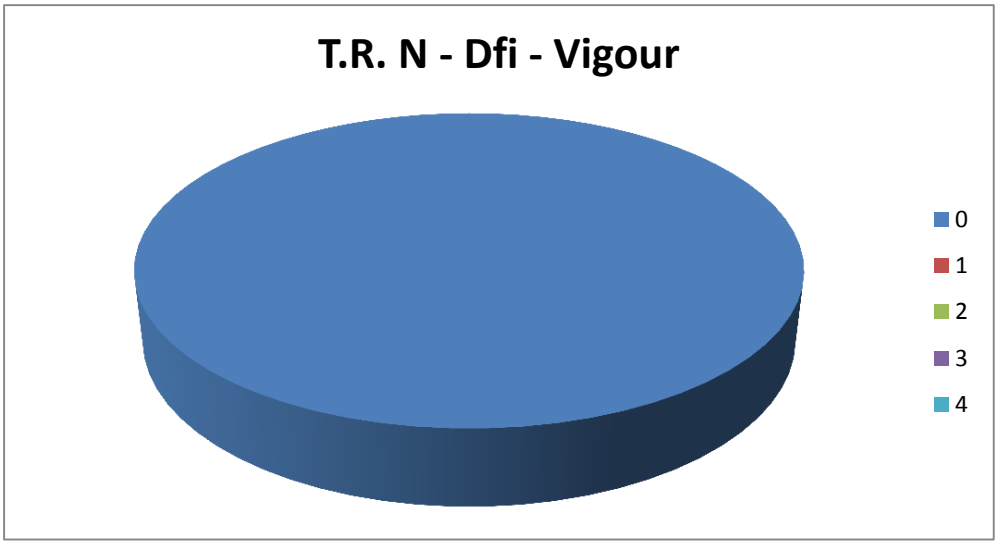
I	J	K	L	M	N	O	P
10	9	7	8	24	22	33	15
2	0	2	2	0	0	0	0
5	1	2	2	1	0	1	4
22	5	5	5	2	0	0	2
8	4	4	1	2	0	1	3
47	19	20	18	29	22	35	24

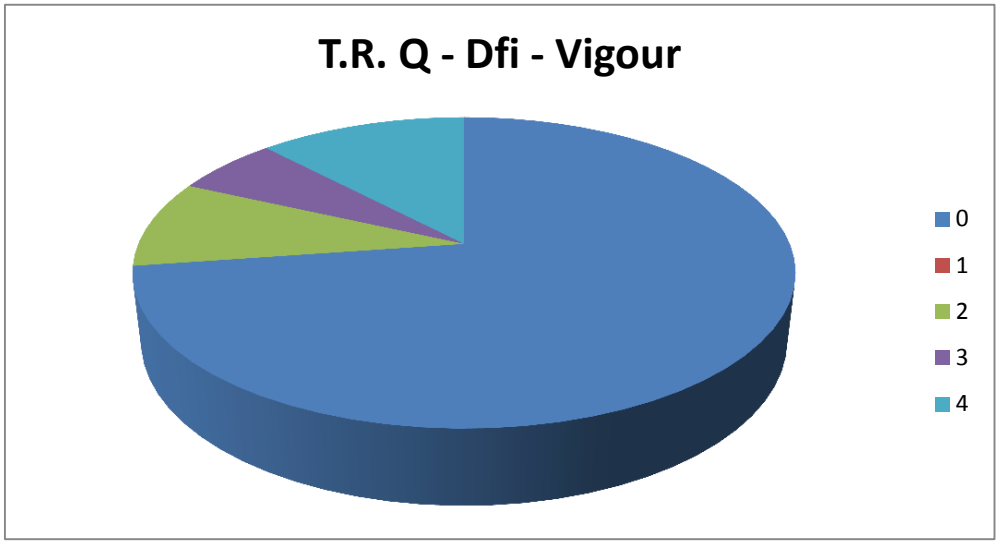


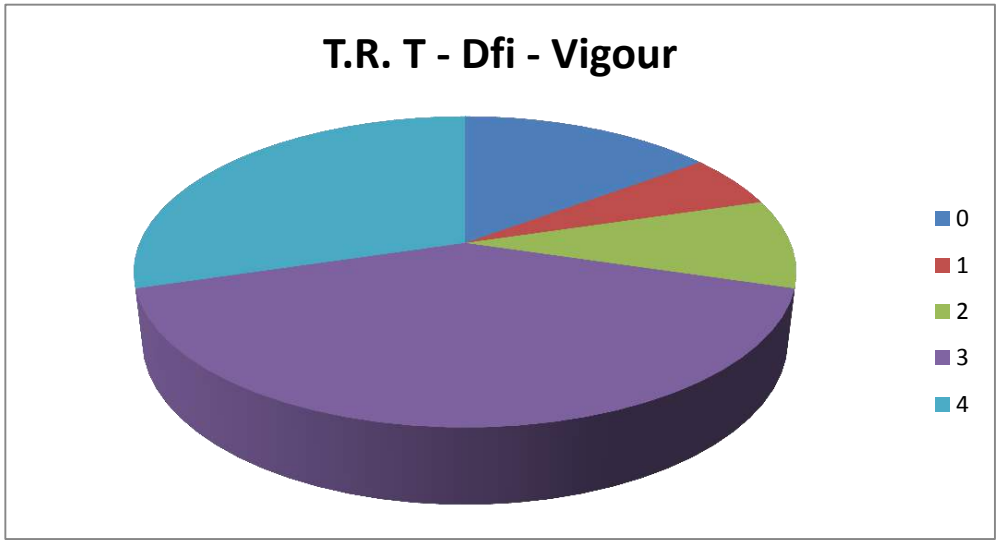


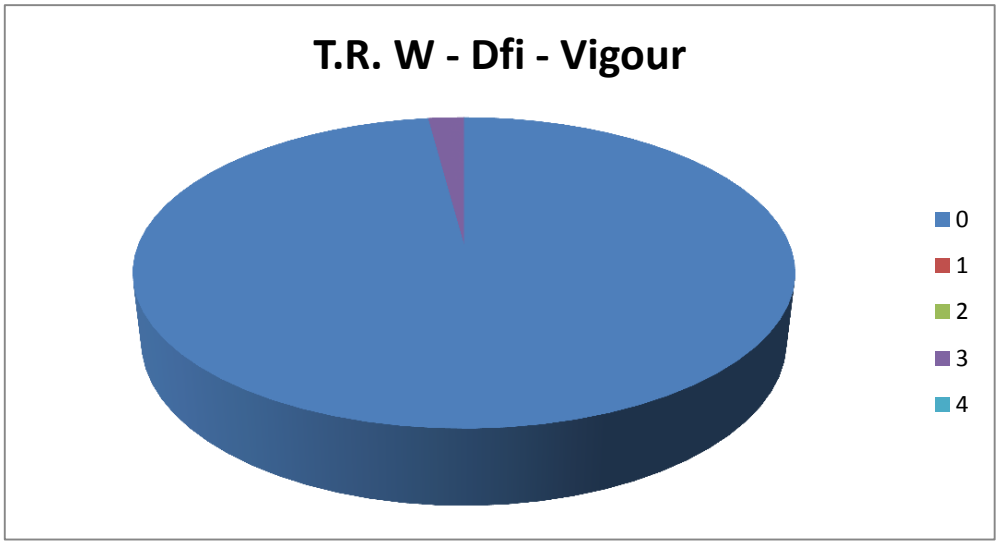

T.R. H - Dfi - Vigour
0
1
2
3
4

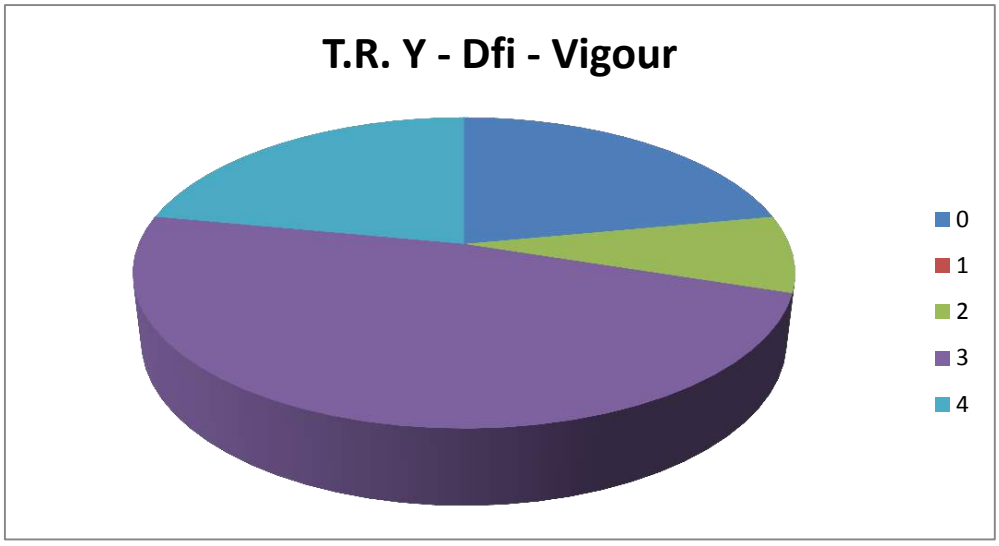

T.R. K - Dfi - Vigour
0
1
2
3
4


T.R. N - Dfi - Vigour
0
1
2
3
4


T.R. Q - Dfi - Vigour
0
1
2
3
4

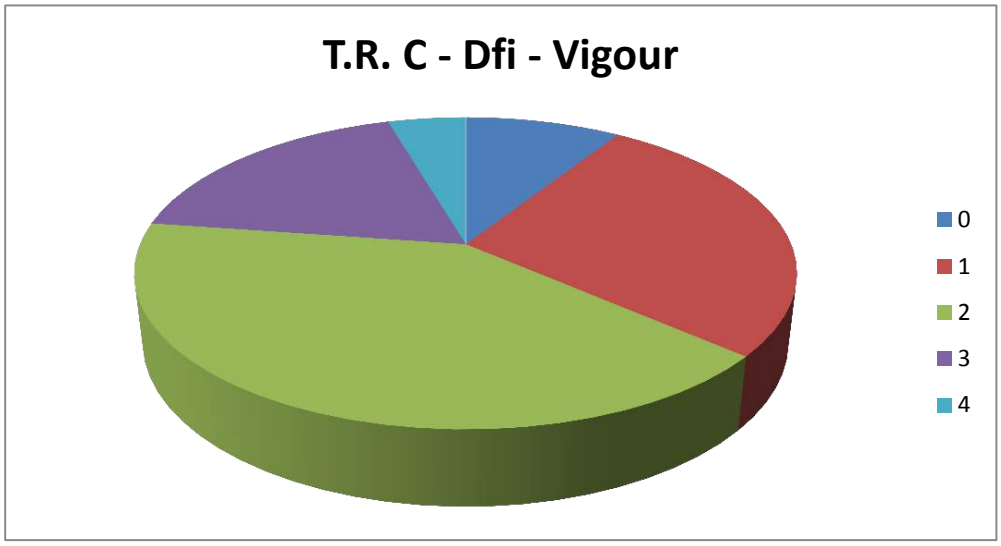

T.R. T - Dfi - Vigour
0
1
2
3
4

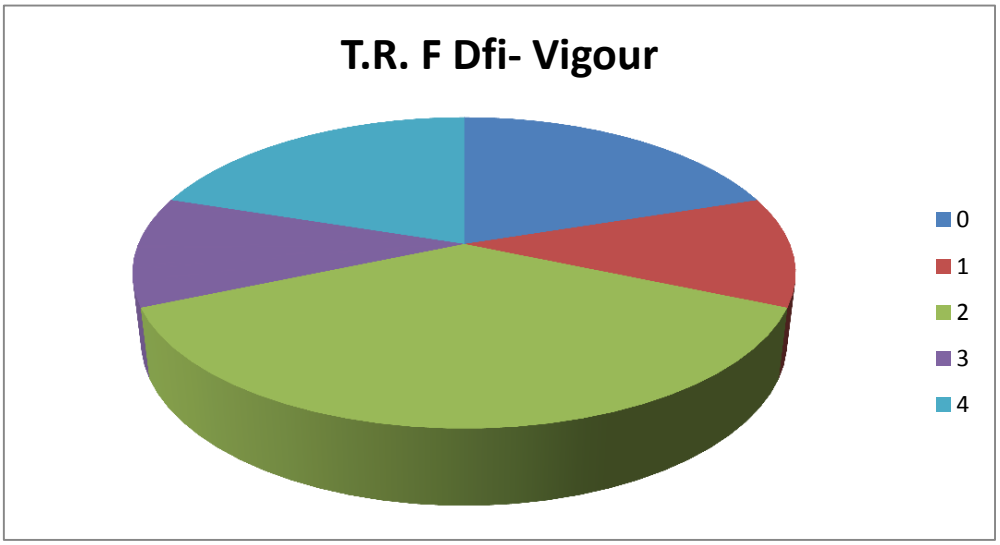

T.R. W - Dfi - Vigour
0
1
2
3
4

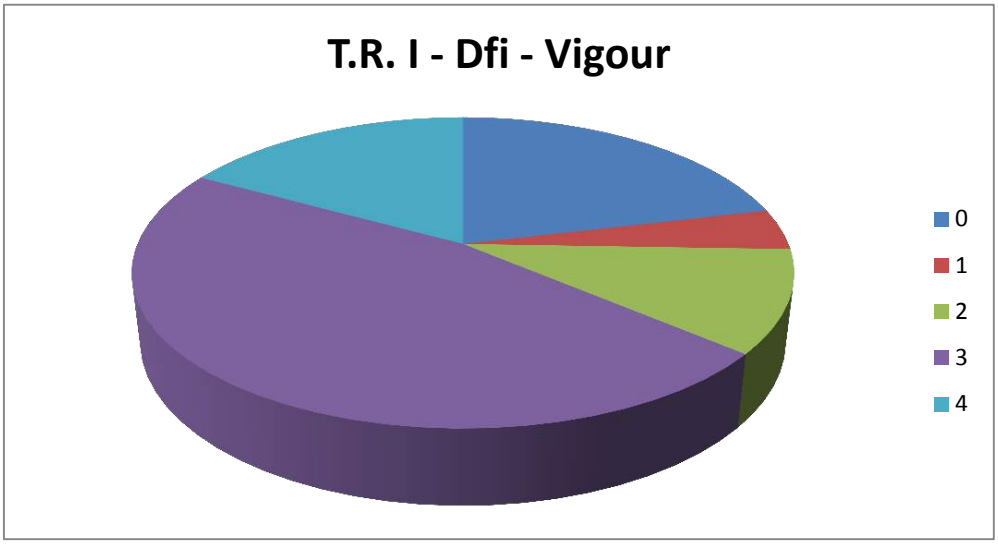

T.R. Y - Dfi - Vigour
0
1
2
3
4

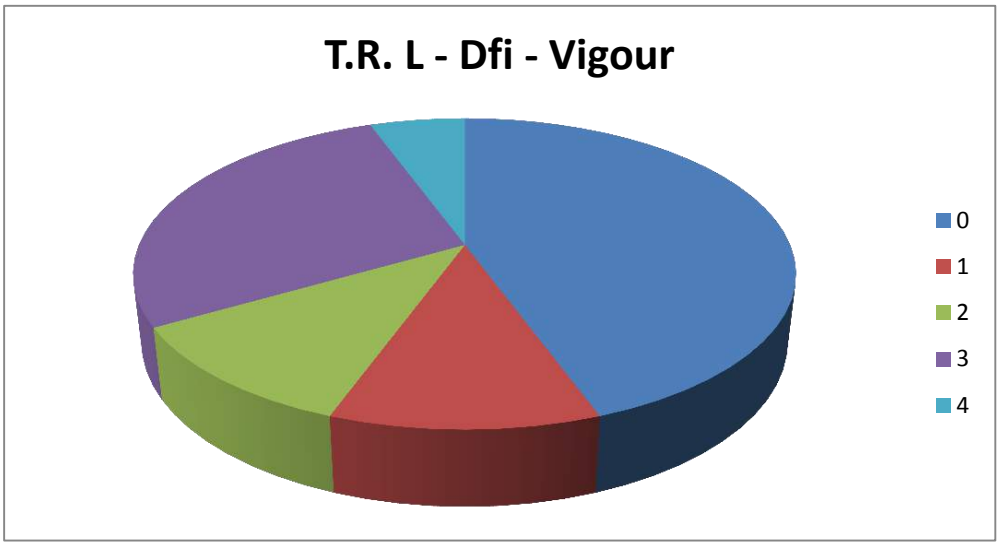
Appendix 9 - Vigour Crosstabulation

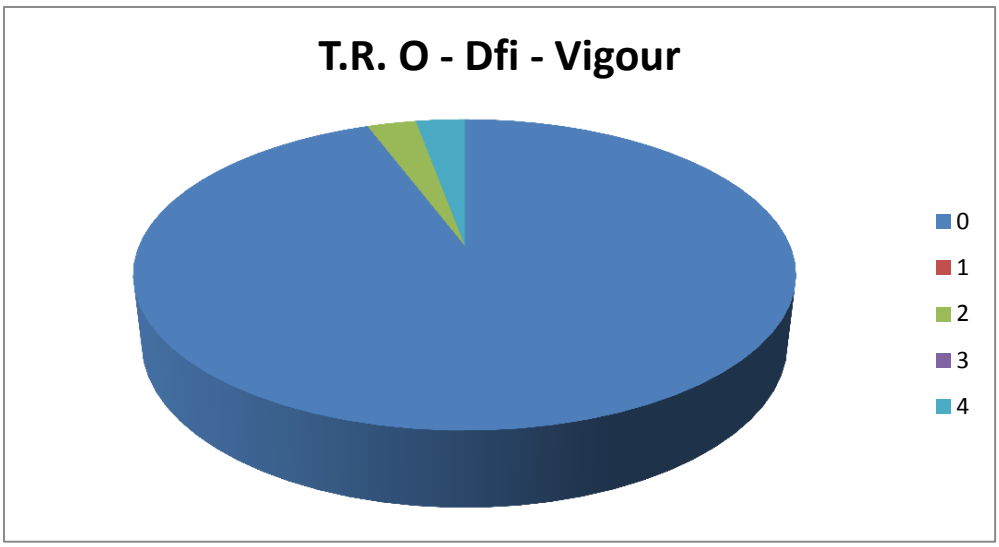
Q	R	S	T	U	V	W	X	Y	Total
24	39	48	8	14	7	47	0	11	375
0	0	0	3	1	12	0	2	0	45
3	0	1	5	9	2	0	5	4	107
2	0	2	22	29	0	1	13	24	195
4	0	0	16	8	0	0	11	11	143
33	39	51	54	61	21	48	31	50	865

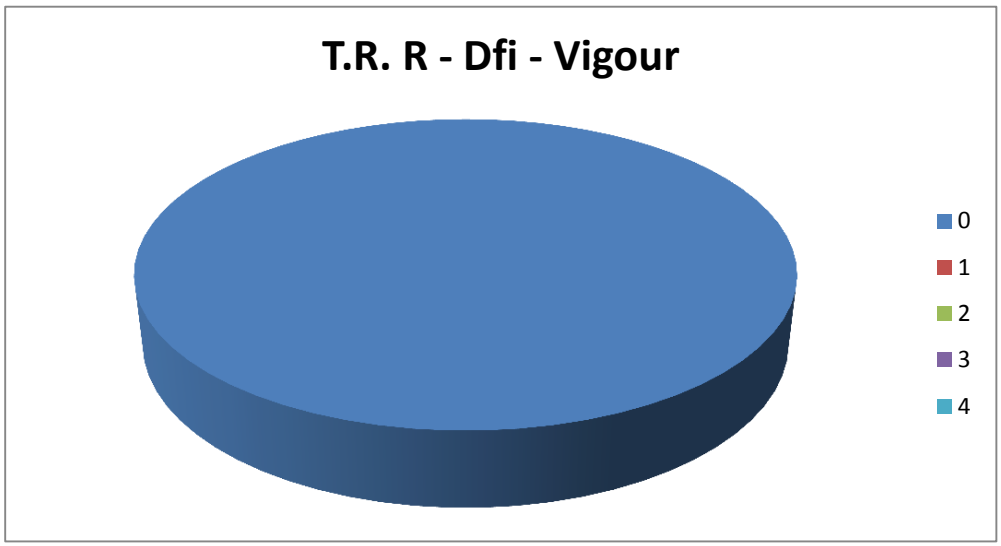


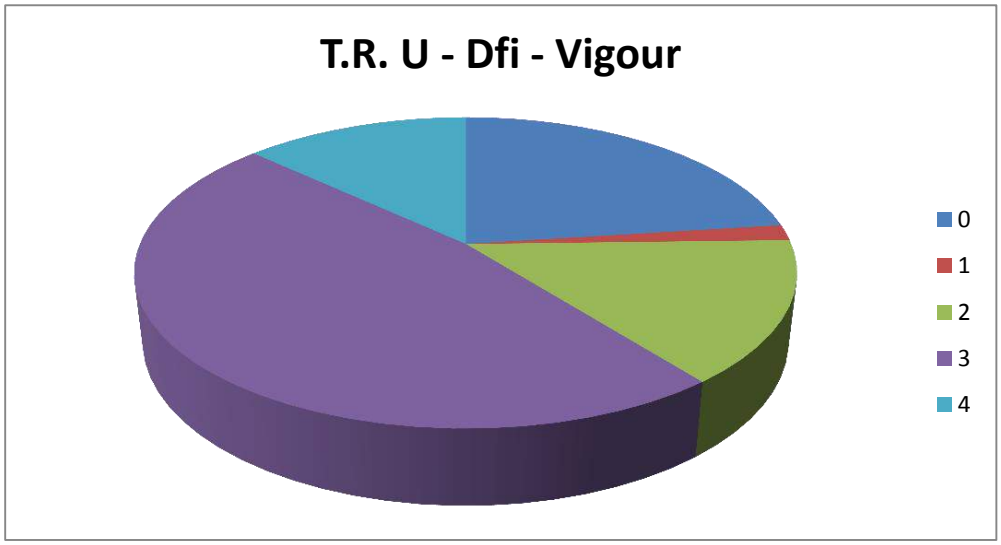


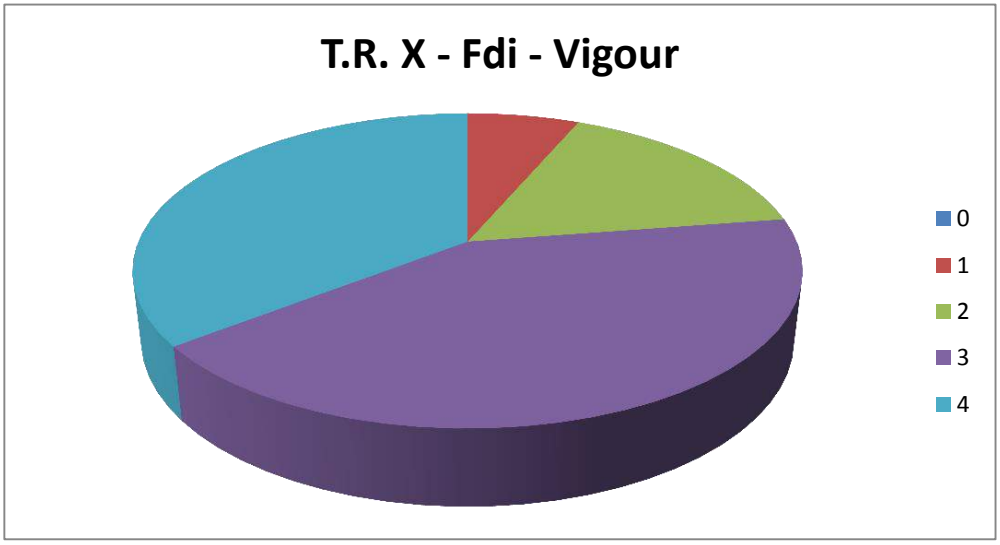

T.R. I - Dfi - Vigour
0
1
2
3
4


T.R. L - Dfi - Vigour
0
1
2
3
4


T.R. O - Dfi - Vigour
0
1
2
3
4


T.R. R - Dfi - Vigour
0
1
2
3
4


T.R. U - Dfi - Vigour
0
1
2
3
4

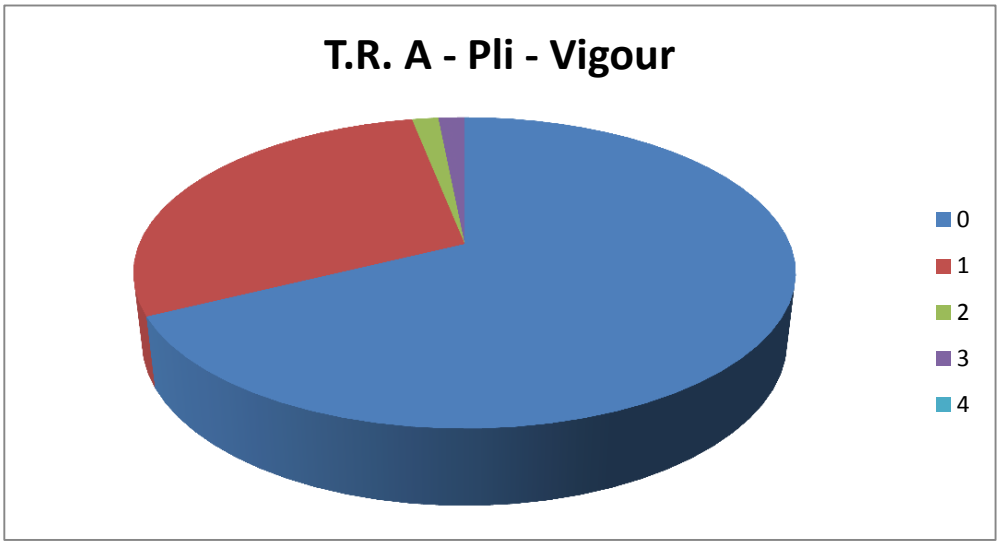

T.R. X - Fdi - Vigour
0
1
2
3
4

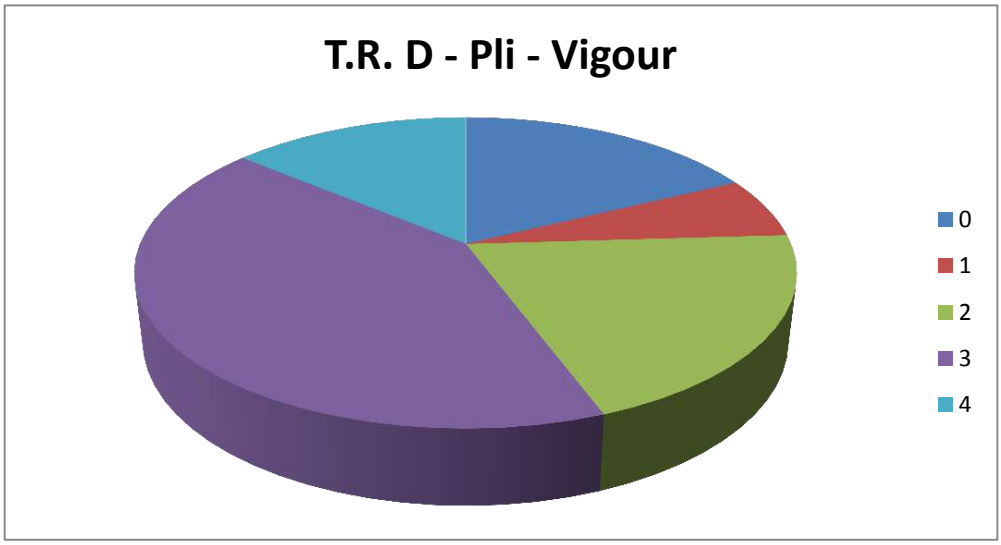
Appendix 9 - Vigour Crosstabulation

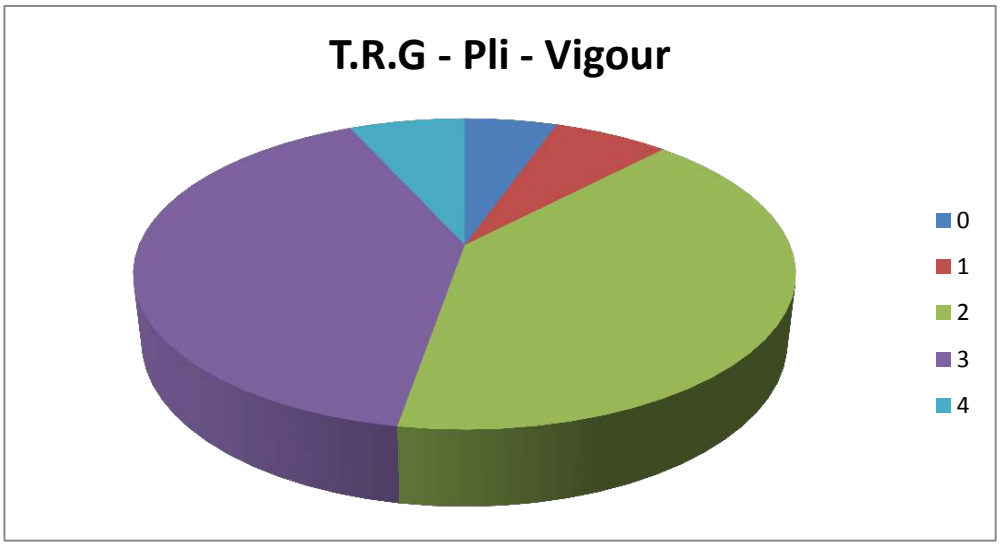
Appendix 9 - Vigour Crosstabulation

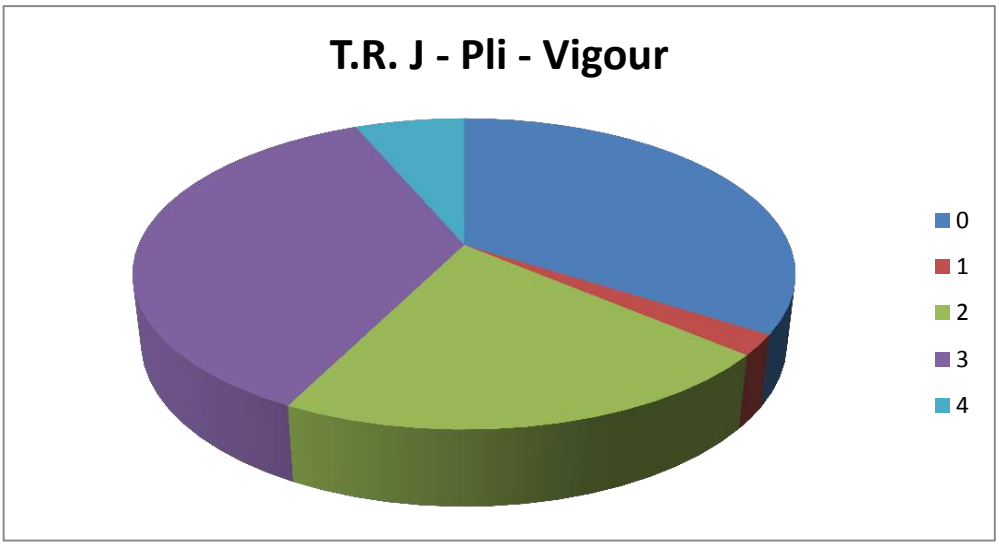
Lodgepole Pine

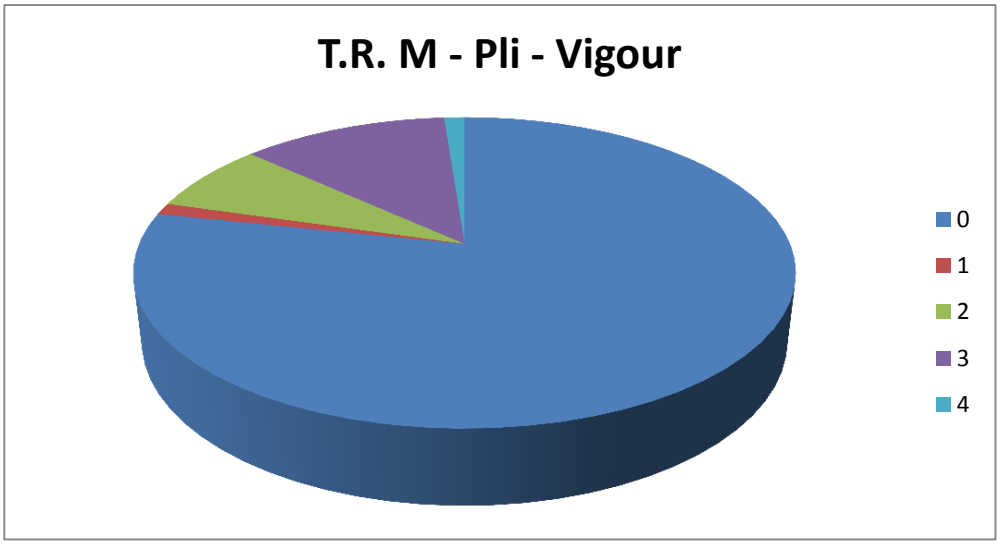
Vigour	A	B	C	D	E	F	G	H
0	44	4	7	14	22	3	4	3
1	19	12	10	5	11	7	5	10
2	1	14	50	16	8	14	30	20
3	1	38	26	33	26	47	30	42
4	0	13	2	11	16	8	5	9
Total	65	81	95	79	83	79	74	84

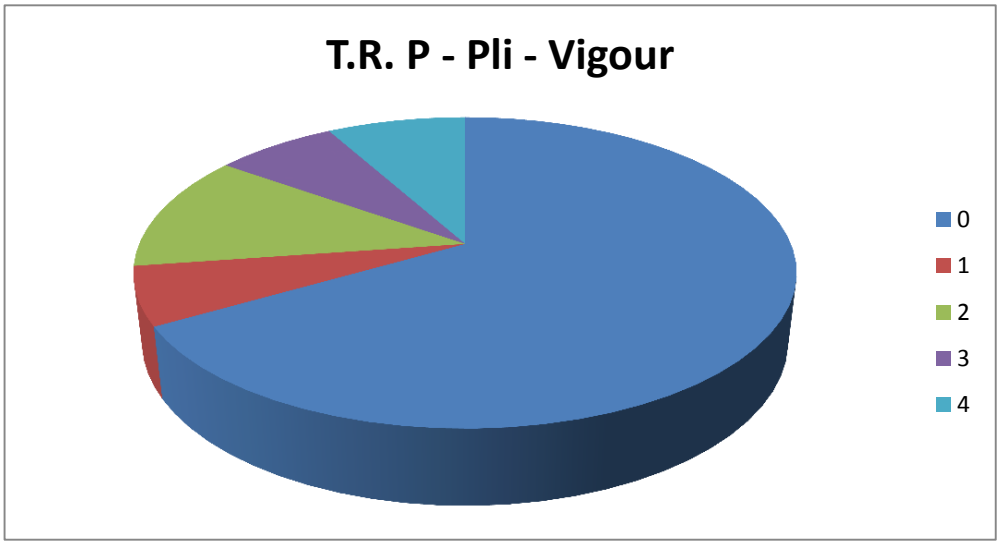

T.R. A - Pli - Vigour
0
1
2
3
4

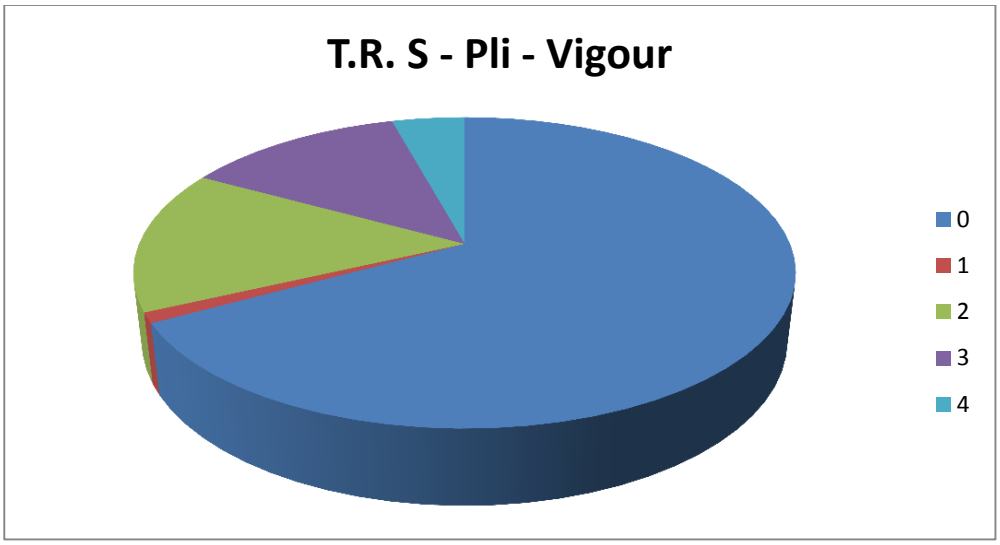

T.R. D - Pli - Vigour
0
1
2
3
4

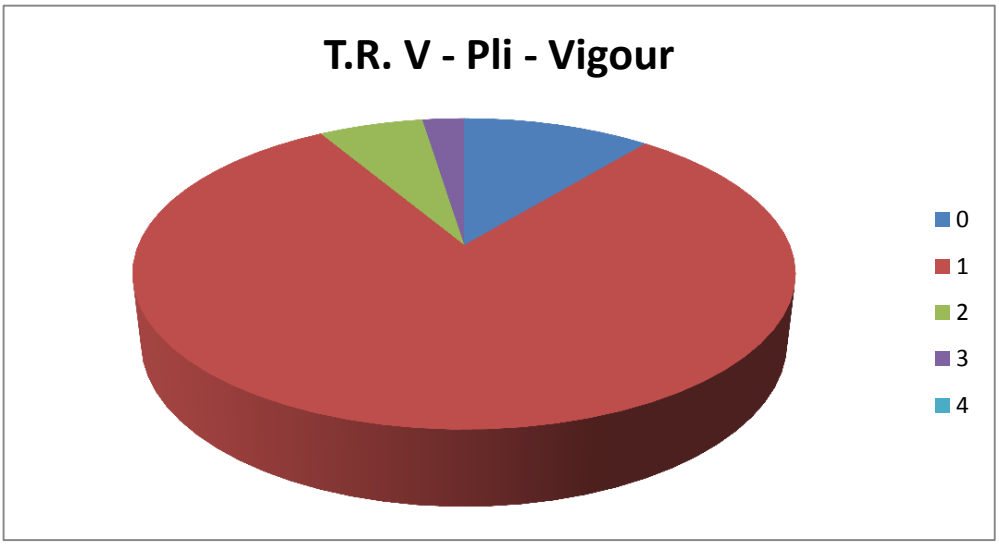

T.R.G - Pli - Vigour
0
1
2
3
4


T.R. J - Pli - Vigour
0
1
2
3
4


T.R. M - Pli - Vigour
0
1
2
3
4

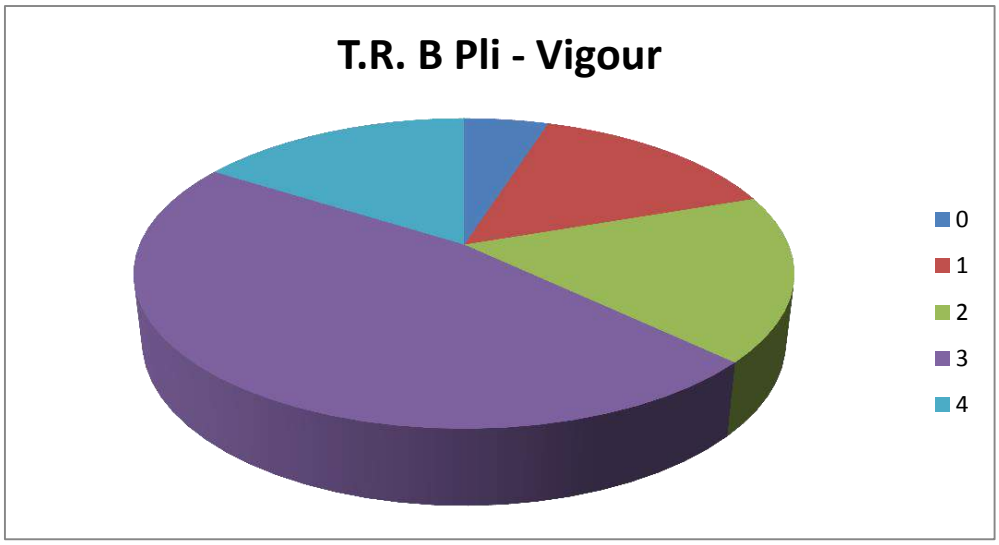

T.R. P - Pli - Vigour
0
1
2
3
4

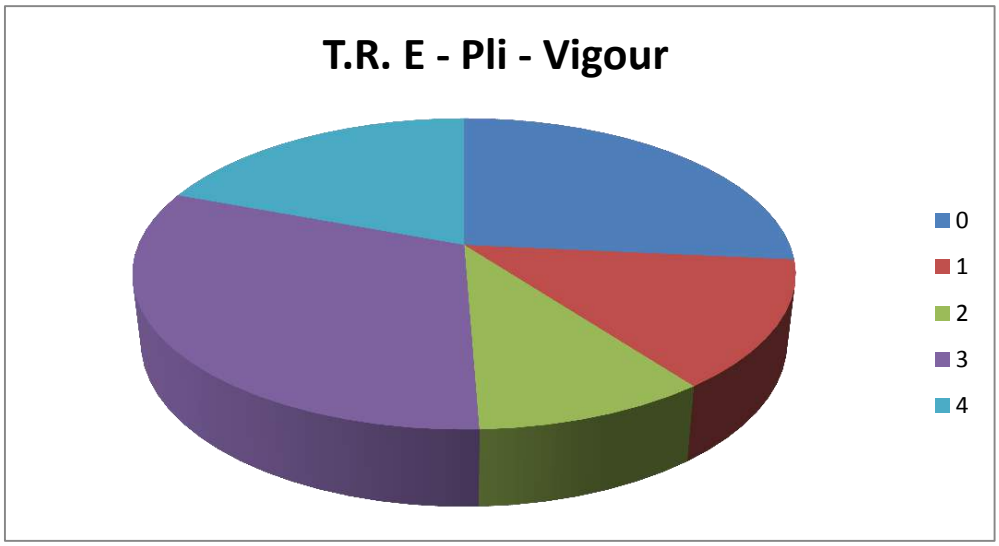

T.R. S - Pli - Vigour
0
1
2
3
4

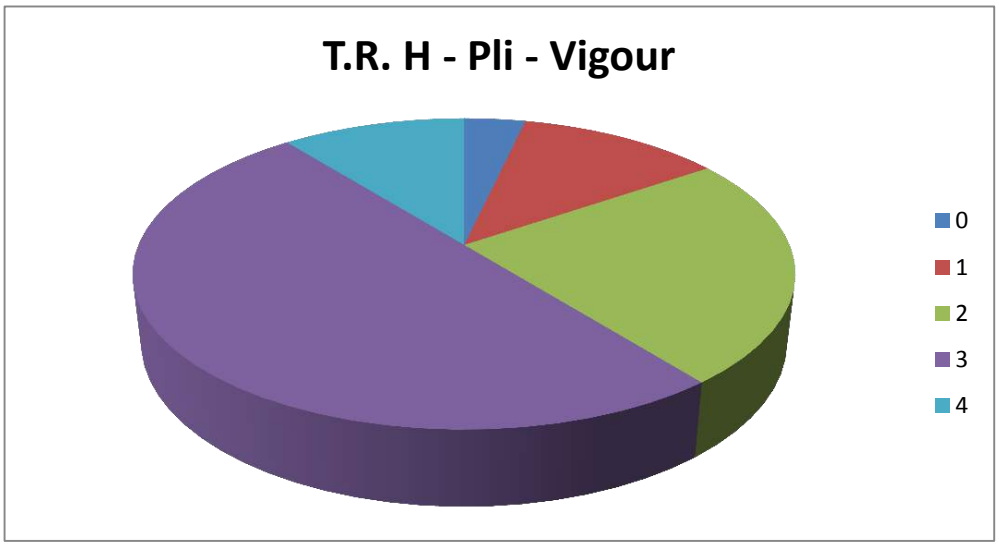

T.R. V - Pli - Vigour
0
1
2
3
4

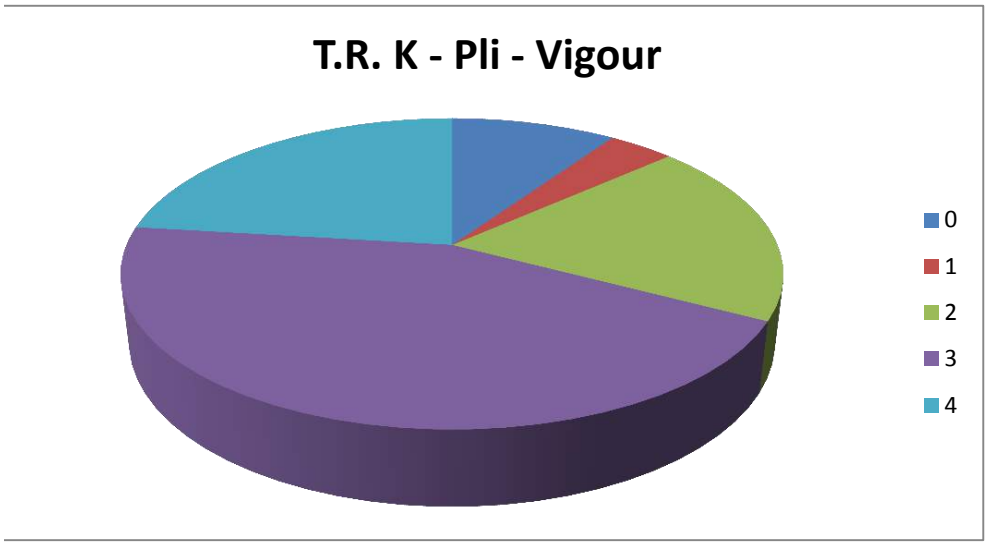
Appendix 9 - Vigour Crosstabulation

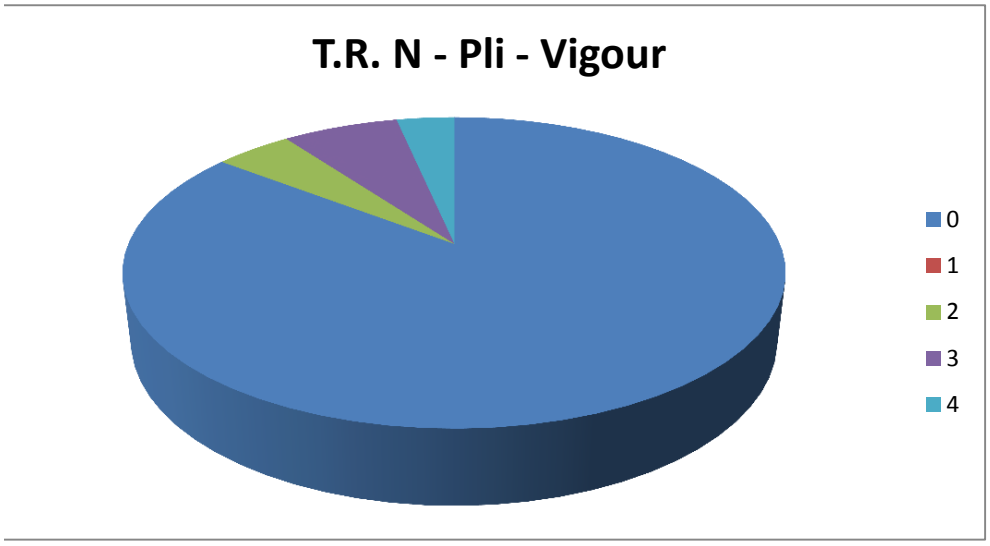
I	J	K	L	M	N	O	P
3	16	5	18	65	76	69	66
3	1	2	2	1	0	0	6
8	10	10	9	6	4	7	12
37	17	23	13	10	6	13	7
9	3	12	4	1	3	6	8
60	47	52	46	83	89	95	99

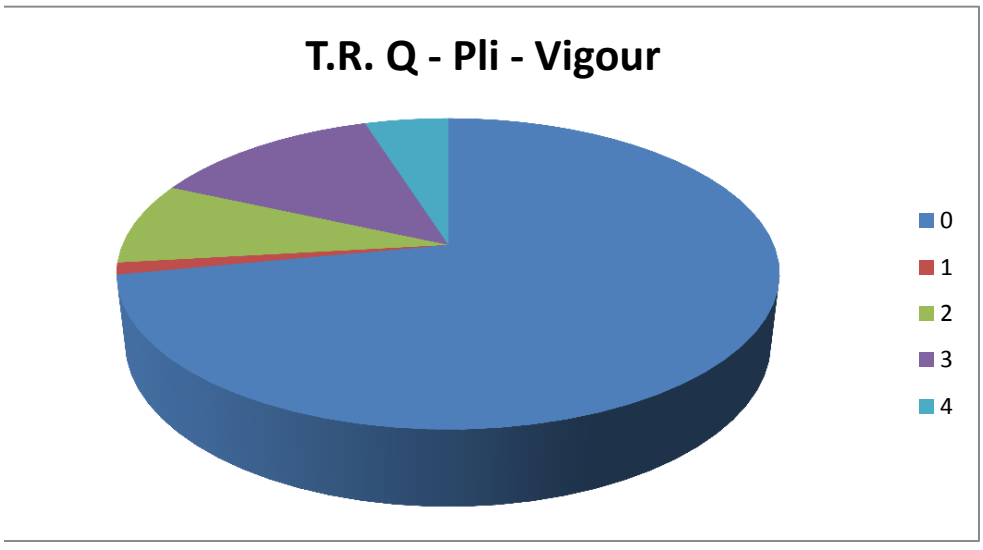

T.R. B Pli - Vigour
0
1
2
3
4

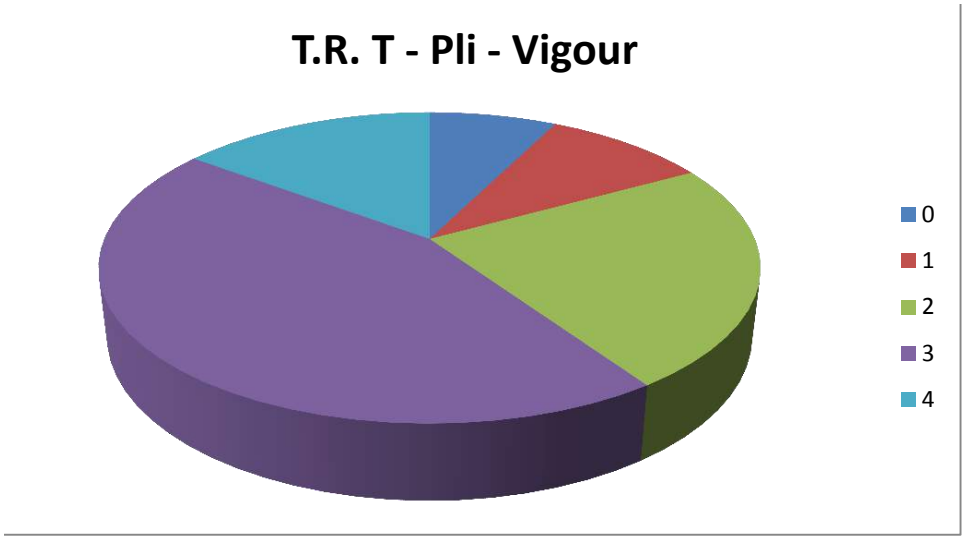

T.R. E - Pli - Vigour
0
1
2
3
4

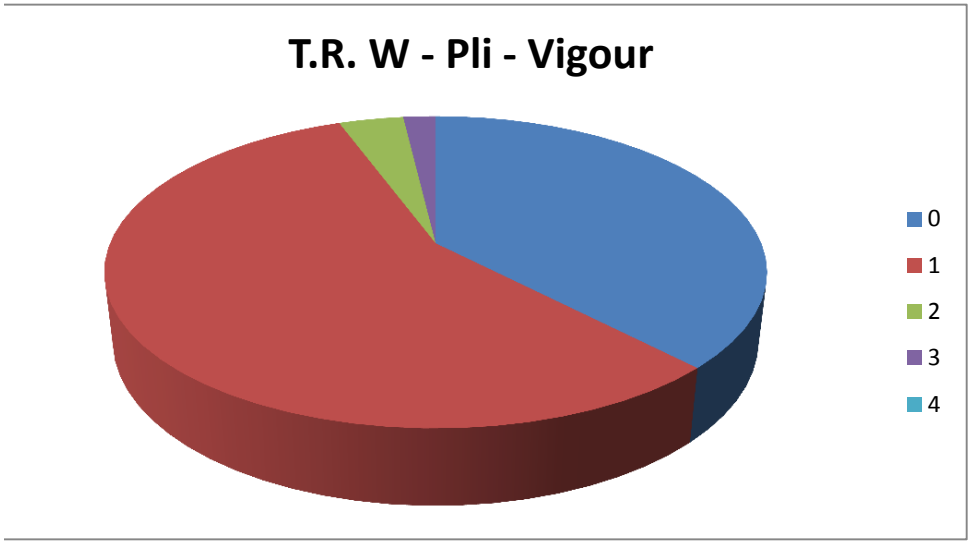

T.R. H - Pli - Vigour
0
1
2
3
4

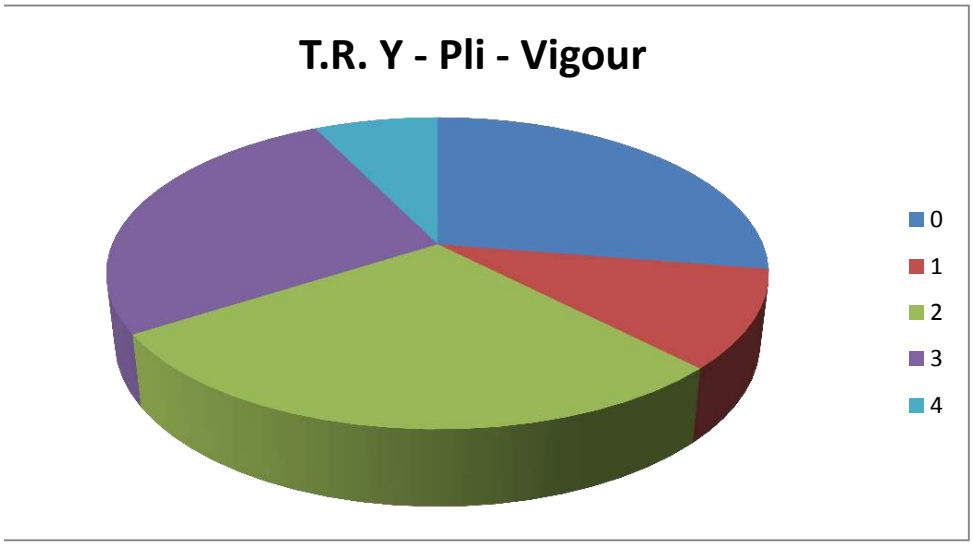

T.R. K - Pli - Vigour
0
1
2
3
4


T.R. N - Pli - Vigour
0
1
2
3
4


T.R. Q - Pli - Vigour
0
1
2
3
4

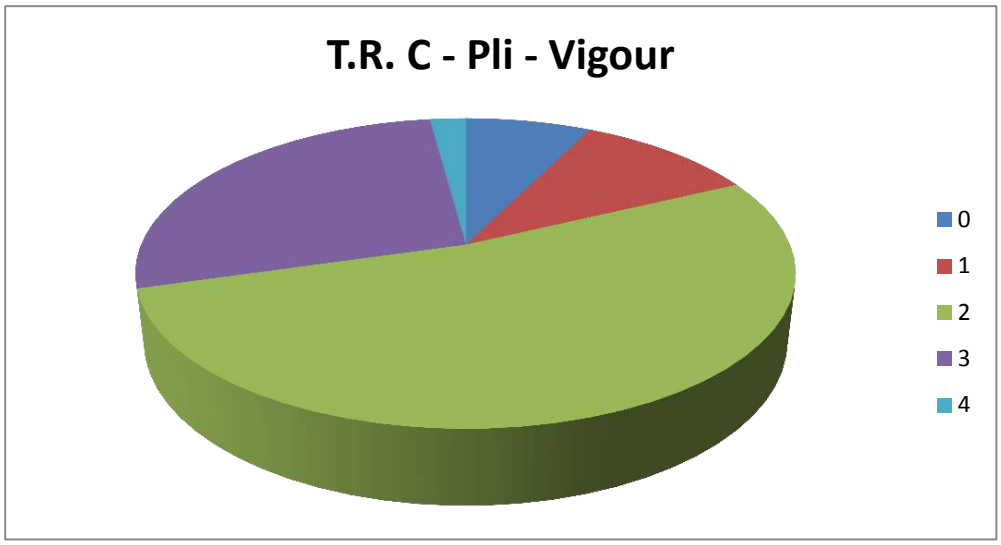

T.R. T - Pli - Vigour
0
1
2
3
4

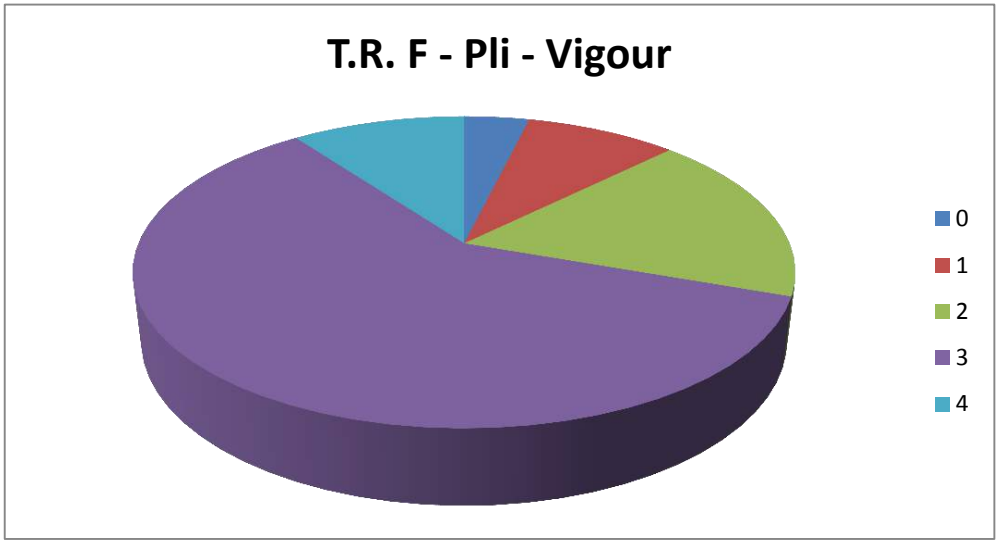

T.R. W - Pli - Vigour
0
1
2
3
4

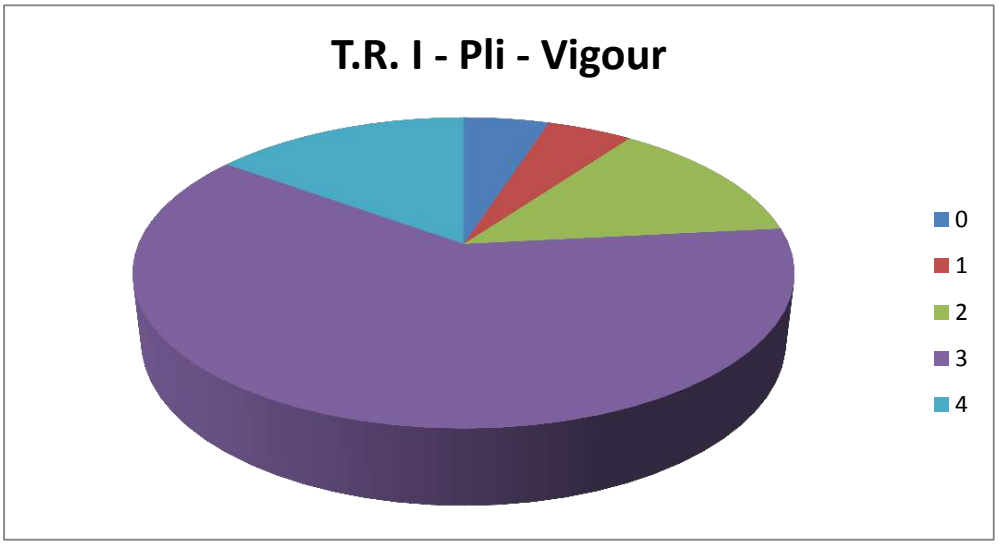

T.R. Y - Pli - Vigour
0
1
2
3
4

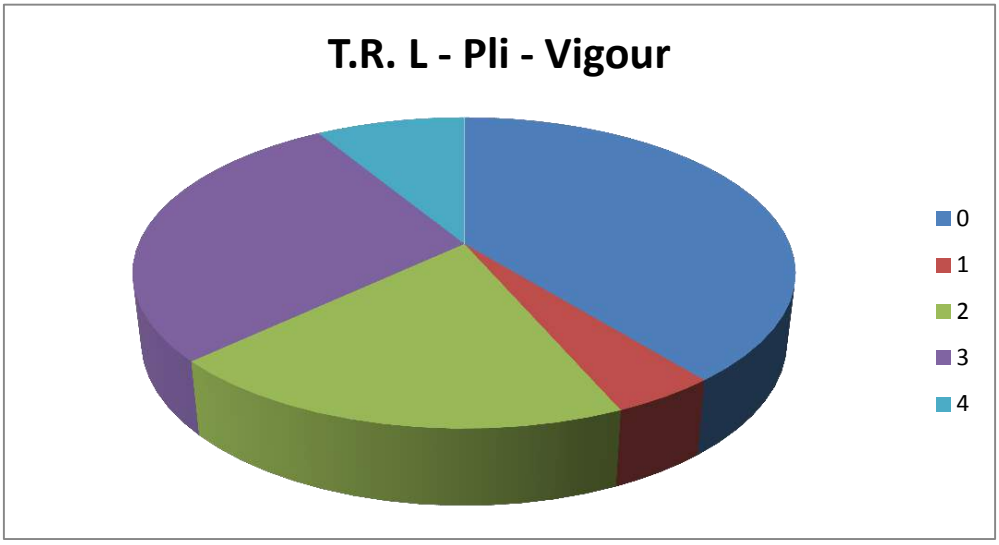
Appendix 9 - Vigour Crosstabulation

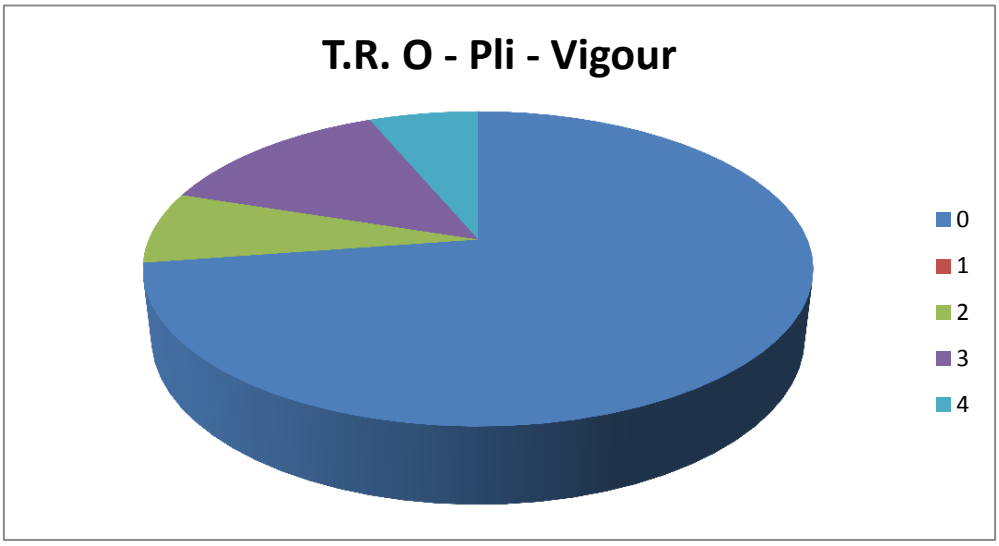
Q	R	S	T	U	V	W	X	Y	Total
59	53	63	7	21	9	40	2	38	711
1	3	1	9	11	66	60	18	14	277
7	11	14	22	30	5	4	32	39	383
11	10	12	42	57	2	2	56	37	598
4	9	4	14	2	0	0	8	10	161
82	86	94	94	121	82	106	116	138	2130

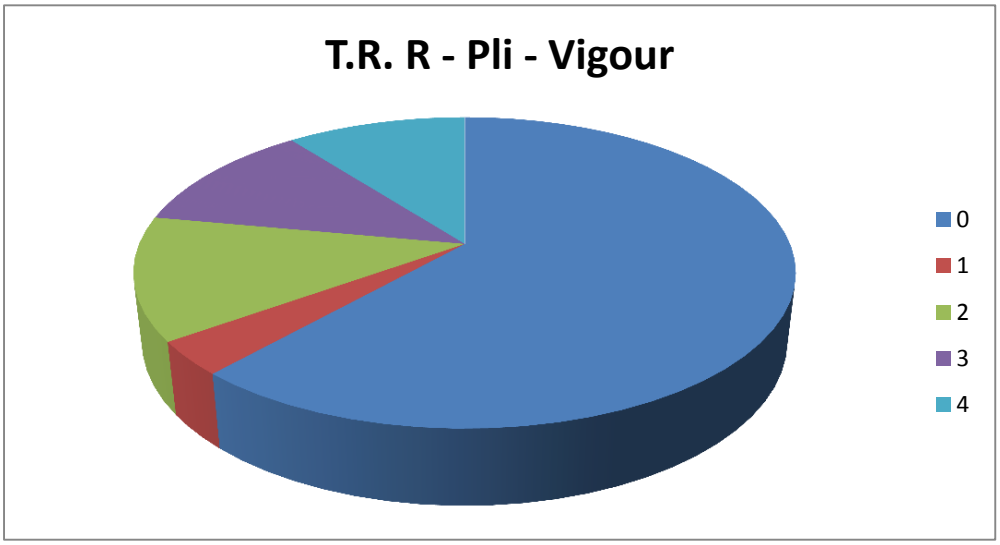

T.R. C - Pli - Vigour
0
1
2
3
4

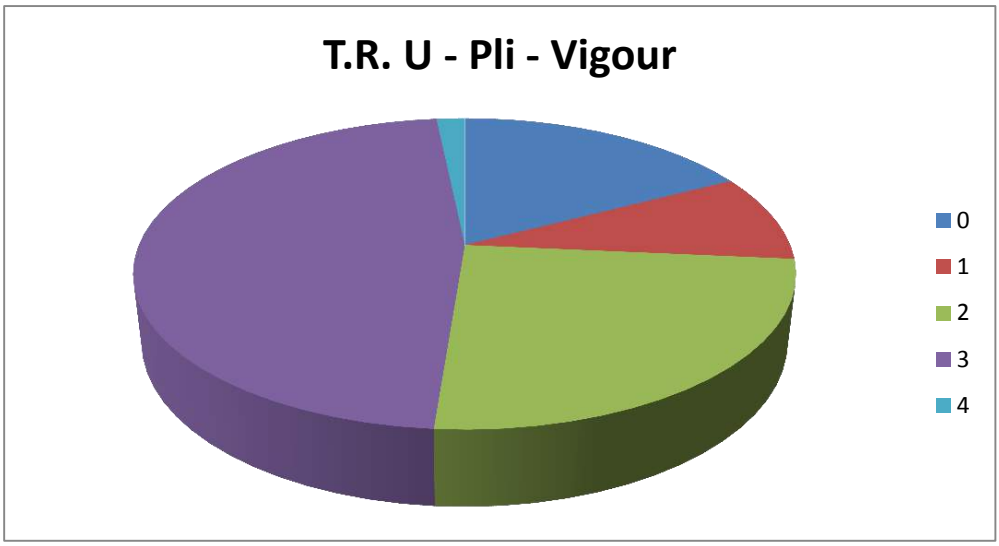

T.R. F - Pli - Vigour
0
1
2
3
4

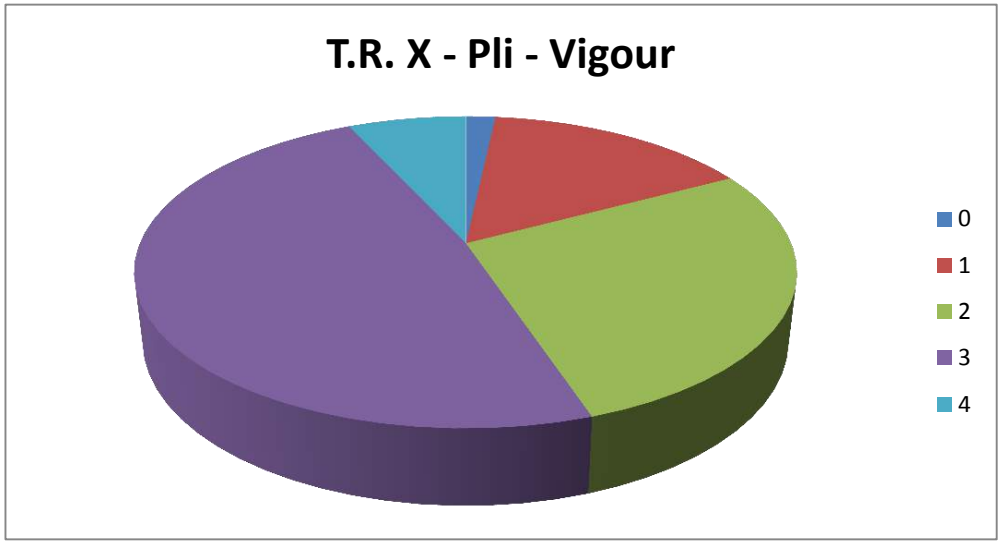

T.R. I - Pli - Vigour
0
1
2
3
4


T.R. L - Pli - Vigour
0
1
2
3
4


T.R. O - Pli - Vigour
0
1
2
3
4


T.R. R - Pli - Vigour
0
1
2
3
4


T.R. U - Pli - Vigour
0
1
2
3
4


T.R. X - Pli - Vigour
0
1
2
3
4

Appendix 10 – Soil Depth Regression Runs

Appendix 10 – OLS Regression

▼OLS Regression

Results for Tree Species = Pli

Dependent Variable	Total Height 15 year
N	491
Multiple R	0.297
Squared Multiple R	0.088
Adjusted Squared Multiple R	0.086
Standard Error of Estimate	116.694

Regression Coefficients B = $(X'X)^{-1}X'Y$

Effect	Coefficient	Standard Error	Std. Coefficient	Tolerance	t	p-Value
CONSTANT	311.275	10.206	0.000	.	30.499	0.000
Soil Dept (cm)	2.130	0.310	0.297	1.000	6.874	0.000

Analysis of Variance

Source	SS	df	Mean Squares	F-Ratio	p-Value
Regression	643,461.413	1	643,461.413	47.252	0.000
Residual	6,659,002.983	489	13,617.593		

*** WARNING *** :

Case 332 is an Outlier (Studentized Residual : 4.550)

Durbin-Watson D-Statistic	1.056
First Order Autocorrelation	0.466

Information Criteria

AIC	6,071.280
AIC (Corrected)	6,071.330
Schwarz's BIC	6,083.870

Results for Tree Species = Fdi

Dependent Variable	Total Height 15 year
N	209
Multiple R	0.390
Squared Multiple R	0.152
Adjusted Squared Multiple R	0.148
Standard Error of Estimate	120.099

Regression Coefficients B = $(X'X)^{-1}X'Y$

Effect	Coefficient	Standard Error	Std. Coefficient	Tolerance	t	p-Value
CONSTANT	242.619	15.663	0.000	.	15.490	0.000
Soil Dept (cm)	2.666	0.438	0.390	1.000	6.091	0.000

Analysis of Variance

Source	SS	df	Mean Squares	F-Ratio	p-Value
Regression	535,072.530	1	535,072.530	37.097	0.000
Residual	2,985,710.205	207	14,423.721		

Durbin-Watson D-Statistic	1.325
First Order Autocorrelation	0.330

Information Criteria

AIC	2,598.622
AIC (Corrected)	2,598.739
Schwarz's BIC	2,608.649

▼OLS Regression

Results for Tree Species = Pli

22 case(s) are deleted due to missing data.

Dependent Variable	Site Index TA (m)
N	469
Multiple R	0.106
Squared Multiple R	0.011
Adjusted Squared Multiple R	0.009
Standard Error of Estimate	3.109

Regression Coefficients B = $(X'X)^{-1}X'Y$

Effect	Coefficient	Standard Error	Std. Coefficient	Tolerance	t	p-Value
CONSTANT	15.681	0.295	0.000	.	53.192	0.000
Soil Dept (cm)	0.020	0.009	0.106	1.000	2.312	0.021

Analysis of Variance

Source	SS	df	Mean Squares	F-Ratio	p-Value
Regression	51.697	1	51.697	5.348	0.021
Residual	4,514.719	467	9.667		

*** WARNING *** :

Case 332 is an Outlier (Studentized Residual : 4.043)

Durbin-Watson D-Statistic	1.242
First Order Autocorrelation	0.376

Information Criteria

AIC	2,399.013
AIC (Corrected)	2,399.064
Schwarz's BIC	2,411.464

Results for Tree Species = Fdi

14 case(s) are deleted due to missing data.

Dependent Variable	Site Index TA (m)
N	195
Multiple R	0.354
Squared Multiple R	0.125
Adjusted Squared Multiple R	0.121
Standard Error of Estimate	4.309

Regression Coefficients B = $(X'X)^{-1}X'Y$

Effect	Coefficient	Standard Error	Std. Coefficient	Tolerance	t	p-Value
CONSTANT	16.025	0.591	0.000	.	27.099	0.000
Soil Dept (cm)	0.085	0.016	0.354	1.000	5.253	0.000

Analysis of Variance

Source	SS	df	Mean Squares	F-Ratio	p-Value
Regression	512.328	1	512.328	27.597	0.000
Residual	3,582.983	193	18.565		

Durbin-Watson D-Statistic	1.329
First Order Autocorrelation	0.325

Information Criteria

AIC	1,127.022
AIC (Corrected)	1,127.147
Schwarz's BIC	1,136.841

▼OLS Regression

Results for Tree Species = Pli

77 case(s) are deleted due to missing data.

Dependent Variable	Site Index GI (m)
N	414
Multiple R	0.116
Squared Multiple R	0.013
Adjusted Squared Multiple R	0.011
Standard Error of Estimate	2.027

Regression Coefficients B = $(X'X)^{-1}X'Y$

Effect	Coefficient	Standard Error	Std. Coefficient	Tolerance	t	p-Value
CONSTANT	18.292	0.204	0.000	.	89.603	0.000
Soil Dept (cm)	0.014	0.006	0.116	1.000	2.371	0.018

Analysis of Variance

Source	SS	df	Mean Squares	F-Ratio	p-Value
Regression	23.096	1	23.096	5.622	0.018
Residual	1,692.547	412	4.108		

Durbin-Watson D-Statistic	1.326
First Order Autocorrelation	0.334

Information Criteria

AIC	1,763.844
AIC (Corrected)	1,763.903
Schwarz's BIC	1,775.922

Results for Tree Species = Fdi

35 case(s) are deleted due to missing data.

Dependent Variable	Site Index GI (m)
N	174
Multiple R	0.178
Squared Multiple R	0.032
Adjusted Squared Multiple R	0.026
Standard Error of Estimate	3.971

Regression Coefficients B = $(X'X)^{-1}X'Y$

Effect	Coefficient	Standard Error	Std. Coefficient	Tolerance	t	p-Value
CONSTANT	22.049	0.575	0.000	.	38.319	0.000
Soil Dept (cm)	0.038	0.016	0.178	1.000	2.376	0.019

Analysis of Variance

Source	SS	df	Mean Squares	F-Ratio	p-Value
Regression	88.980	1	88.980	5.643	0.019
Residual	2,712.087	172	15.768		

Durbin-Watson D-Statistic	1.206
First Order Autocorrelation	0.395

Information Criteria

AIC	977.667
AIC (Corrected)	977.809
Schwarz's BIC	987.145

▼OLS Regression

Results for Tree Species = Pli

Dependent Variable	Total Height 15 year
N	491
Multiple R	0.253
Squared Multiple R	0.064
Adjusted Squared Multiple R	0.062
Standard Error of Estimate	118.231

Regression Coefficients B = $(X'X)^{-1}X'Y$

Effect	Coefficient	Standard Error	Std. Coefficient	Tolerance	t	p-Value
CONSTANT	327.491	9.279	0.000	.	35.292	0.000
Available Water Storage Capavity (cm)	21.177	3.664	0.253	1.000	5.780	0.000

Analysis of Variance

Source	SS	df	Mean Squares	F-Ratio	p-Value
Regression	466,971.356	1	466,971.356	33.406	0.000
Residual	6,835,493.041	489	13,978.513		

*** WARNING *** :

Case 332 is an Outlier (Studentized Residual : 4.440)

Durbin-Watson D-Statistic	1.029
First Order Autocorrelation	0.479

Information Criteria

AIC	6,084.124
AIC (Corrected)	6,084.174
Schwarz's BIC	6,096.714

Results for Tree Species = Fdi

Dependent Variable	Total Height 15 year
N	209
Multiple R	0.381
Squared Multiple R	0.145
Adjusted Squared Multiple R	0.141
Standard Error of Estimate	120.595

Regression Coefficients B = $(X'X)^{-1}X'Y$

Effect	Coefficient	Standard Error	Std. Coefficient	Tolerance	t	p-Value
CONSTANT	255.642	14.170	0.000	.	18.042	0.000
Available Water Storage Capavity (cm)	29.969	5.059	0.381	1.000	5.924	0.000

Analysis of Variance

Source	SS	df	Mean Squares	F-Ratio	p-Value
Regression	510,372.024	1	510,372.024	35.094	0.000
Residual	3,010,410.711	207	14,543.047		

Durbin-Watson D-Statistic	1.313
First Order Autocorrelation	0.336

Information Criteria

AIC	2,600.344
AIC (Corrected)	2,600.461
Schwarz's BIC	2,610.371

▼Robust Regression

Results for Tree Species = Pli

Dependent Variable	Total Height 15 year
No. of cases	491
No. of Regressors	1

Least Absolute Deviations (LAD) Regression

Method of Estimation	IRLS
Raw R-square (1-Residual/Total)	0.910
R-square(Observed vs. Predicted)	0.088

LAD Parameter Estimates

Effect	Coefficient
CONSTANT	341.962
Soil Dept (cm)	1.258

Scale Estimates	178.565
Cutoff Point	3.000
Number of Outliers Detected	0

Ordinary Least Squares (OLS) Regression for Outlier Free Data

Multiple R	0.297
Squared Multiple R	0.088
Adjusted Squared Multiple R	0.086
Standard Error	116.694

OLS Parameter Estimates

Effect	Coefficient	Standard Error	95.00% Confidence Interval Lower	Upper
CONSTANT	311.275	10.206	291.222	331.329
Soil Dept (cm)	2.130	0.310	1.521	2.738

Results for Tree Species = Fdi

Dependent Variable	Total Height 15 year
No. of cases	209
No. of Regressors	1

Least Absolute Deviations (LAD) Regression

Method of Estimation ¦ IRLS

Raw R-square (1-Residual/Total) ¦ 0.881
R-square(Observed vs. Predicted) ¦ 0.152

LAD Parameter Estimates

Effect	Coefficient
CONSTANT	234.696
Soil Dept (cm)	3.168

Scale Estimates ¦ 167.686

Cutoff Point ¦ 3.000
Number of Outliers Detected ¦ 0

Ordinary Least Squares (OLS) Regression for Outlier Free Data

Multiple R ¦ 0.390
Squared Multiple R ¦ 0.152
Adjusted Squared Multiple R ¦ 0.148
Standard Error ¦ 120.099

OLS Parameter Estimates

Effect	Coefficient	Standard Error	95.00% Confidence Interval Lower	Upper
CONSTANT	242.619	15.663	211.740	273.499
Soil Dept (cm)	2.666	0.438	1.803	3.529

Appendix 11 – General Linear Modal Runs

1998 Fir

General Linear Model: dbh (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed       9  A, B, C, D, E, F, G, H, I


Analysis of Variance for dbh (cm), using Adjusted SS for Tests

Source   DF    Seq SS   Adj SS  Adj MS      F      P
Treat     8   513.761  513.761  64.220  18.32  0.000
Error   198   694.257  694.257   3.506
Total   206  1208.018


S = 1.87252   R-Sq = 42.53%   R-Sq(adj) = 40.21%


Unusual Observations for dbh (cm)

Obs  dbh (cm)     Fit  SE Fit  Residual  St Resid
  1    4.1000  2.4000  1.0811    1.7000      1.11 X
  2    1.9000  2.4000  1.0811   -0.5000     -0.33 X
  4    1.2000  2.4000  1.0811   -1.2000     -0.78 X
 63    3.4000  7.4500  0.3539   -4.0500     -2.20 R
103   11.0000  7.0280  0.3745    3.9720      2.16 R
178    1.0000  5.5107  0.3539   -4.5107     -2.45 R
179    1.2000  5.5107  0.3539   -4.3107     -2.34 R
180    1.5000  5.5107  0.3539   -4.0107     -2.18 R
181    9.5000  5.5107  0.3539    3.9893      2.17 R
210    1.2000  6.5357  0.3539   -5.3357     -2.90 R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

Treat   N   Mean  Grouping
D      28  7.450  A
E      25  7.028  A B
I      28  6.536  A B
H      28  5.511    B C
B      31  4.377      C D
G      28  4.275      C D
F      22  3.727        D E
A       3  2.400      C D E
C      14  2.250          E

Means that do not share a letter are significantly different.


Tukey 95.0% Simultaneous Confidence Intervals
Response Variable dbh (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A  subtracted from:
```

Appendix 11 – General Linear Modal Runs

```
Treat   Lower   Center  Upper  ---+---------+---------+---------+---
B      -1.577   1.9774  5.532          (--------*--------)
C      -3.890  -0.1500  3.590     (---------*--------)
D       1.479   5.0500  8.621                (--------*--------)
E       1.036   4.6280  8.220               (--------*--------)
F      -2.291   1.3273  4.945         (--------*--------)
G      -1.696   1.8750  5.446           (--------*--------)
H      -0.461   3.1107  6.682              (--------*--------)
I       0.564   4.1357  7.707                (--------*--------)
                        ---+---------+---------+---------+---
                        -4.0       0.0       4.0       8.0
```

Treat = B subtracted from:

```
Treat   Lower  Center    Upper  ---+---------+---------+---------+---
C      -4.020  -2.127  -0.2344     (----*---)
D       1.540   3.073   4.6053                 (---*---)
E       1.070   2.651   4.2309                (---*---)
F      -2.289  -0.650   0.9887         (---*---)
G      -1.635  -0.102   1.4303           (---*---)
H      -0.399   1.133   2.6660              (---*---)
I       0.626   2.158   3.6910                (--*---)
                         ---+---------+---------+---------+---
                         -4.0       0.0       4.0       8.0
```

Treat = C subtracted from:

```
Treat    Lower  Center  Upper  ---+---------+---------+---------+---
D       3.2757   5.200  7.124                     (----*----)
E       2.8156   4.778  6.740                    (----*----)
F      -0.5326   1.477  3.487             (----*----)
G       0.1007   2.025  3.949              (----*----)
H       1.3364   3.261  5.185                 (----*----)
I       2.3614   4.286  6.210                    (----*----)
                        ---+---------+---------+---------+---
                        -4.0       0.0       4.0       8.0
```

Treat = D subtracted from:

```
Treat   Lower  Center   Upper  ---+---------+---------+---------+---
E      -2.040  -0.422   1.196          (---*---)
F      -5.398  -3.723  -2.048  (---*---)
G      -4.746  -3.175  -1.604   (---*---)
H      -3.510  -1.939  -0.368      (---*---)
I      -2.485  -0.914   0.657         (---*---)
                        ---+---------+---------+---------+---
                        -4.0       0.0       4.0       8.0
```

Treat = E subtracted from:

```
Treat   Lower  Center   Upper  ---+---------+---------+---------+---
F      -5.019  -3.301  -1.582  (----*---)
G      -4.371  -2.753  -1.135    (---*---)
H      -3.135  -1.517   0.100       (---*---)
I      -2.110  -0.492   1.125          (---*---)
                        ---+---------+---------+---------+---
                        -4.0       0.0       4.0       8.0
```

Appendix 11 – General Linear Modal Runs

```
Treat = F  subtracted from:

Treat   Lower  Center  Upper  ---+---------+---------+---------+---
G      -1.127  0.5477  2.223            (---*----)
H       0.109  1.7834  3.458               (---*----)
I       1.134  2.8084  4.483                  (---*---)
                             ---+---------+---------+---------+---
                            -4.0       0.0       4.0       8.0


Treat = G  subtracted from:

Treat    Lower  Center  Upper  ---+---------+---------+---------+---
H      -0.3355   1.236  2.807              (---*---)
I       0.6895   2.261  3.832                 (---*---)
                             ---+---------+---------+---------+---
                            -4.0       0.0       4.0       8.0


Treat = H  subtracted from:

Treat    Lower  Center  Upper  ---+---------+---------+---------+---
I      -0.5462   1.025  2.596              (---*--)
                             ---+---------+---------+---------+---
                            -4.0       0.0       4.0       8.0


Tukey Simultaneous Tests
Response Variable dbh (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A  subtracted from:

       Difference       SE of            Adjusted
Treat    of Means  Difference  T-Value   P-Value
B          1.9774       1.132   1.7465    0.7169
C         -0.1500       1.191  -0.1259    1.0000
D          5.0500       1.138   4.4394    0.0005
E          4.6280       1.144   4.0450    0.0024
F          1.3273       1.152   1.1517    0.9652
G          1.8750       1.138   1.6483    0.7767
H          3.1107       1.138   2.7346    0.1427
I          4.1357       1.138   3.6356    0.0105


Treat = B  subtracted from:

       Difference       SE of            Adjusted
Treat    of Means  Difference  T-Value   P-Value
C          -2.127      0.6030   -3.528    0.0150
D           3.073      0.4882    6.294    0.0000
E           2.651      0.5034    5.266    0.0000
F          -0.650      0.5220   -1.245    0.9452
G          -0.102      0.4882   -0.210    1.0000
H           1.133      0.4882    2.321    0.3345
I           2.158      0.4882    4.421    0.0006


Treat = C  subtracted from:

       Difference       SE of            Adjusted
Treat    of Means  Difference  T-Value   P-Value
D           5.200      0.6129    8.484    0.0000
E           4.778      0.6251    7.644    0.0000
```

F	1.477	0.6402	2.308	0.3427
G	2.025	0.6129	3.304	0.0305
H	3.261	0.6129	5.320	0.0000
I	4.286	0.6129	6.992	0.0000

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	-0.422	0.5152	-0.819	0.9962
F	-3.723	0.5335	-6.978	0.0000
G	-3.175	0.5005	-6.344	0.0000
H	-1.939	0.5005	-3.875	0.0045
I	-0.914	0.5005	-1.827	0.6643

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-3.301	0.5474	-6.030	0.0000
G	-2.753	0.5152	-5.343	0.0000
H	-1.517	0.5152	-2.945	0.0846
I	-0.492	0.5152	-0.955	0.9892

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	0.5477	0.5335	1.027	0.9829
H	1.7834	0.5335	3.343	0.0271
I	2.8084	0.5335	5.264	0.0000

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	1.236	0.5005	2.469	0.2536
I	2.261	0.5005	4.517	0.0004

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	1.025	0.5005	2.048	0.5119

1998 Fir

General Linear Model: L=Ht-1yr (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed       9  A, B, C, D, E, F, G, H, I


Analysis of Variance for L=Ht-1yr (cm), using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS      F      P
Treat     8  24400.3  24400.3  3050.0  12.86  0.000
Error   222  52641.4  52641.4   237.1
Total   230  77041.7


S = 15.3988   R-Sq = 31.67%   R-Sq(adj) = 29.21%


Unusual Observations for L=Ht-1yr (cm)

     L=Ht-1yr
Obs      (cm)      Fit  SE Fit  Residual  St Resid
  1   42.9000  21.8143  5.8202   21.0857      1.48 X
  2   35.3000  21.8143  5.8202   13.4857      0.95 X
  3    4.0000  21.8143  5.8202  -17.8143     -1.25 X
  4   35.5000  21.8143  5.8202   13.6857      0.96 X
  5    7.0000  21.8143  5.8202  -14.8143     -1.04 X
  6    8.0000  21.8143  5.8202  -13.8143     -0.97 X
  7   20.0000  21.8143  5.8202   -1.8143     -0.13 X
 31    0.0000  46.7457  2.6029  -46.7457     -3.08 R
 35   14.0000  46.7457  2.6029  -32.7457     -2.16 R
 62   56.4000  23.0450  3.4433   33.3550      2.22 R
128   76.7000  33.3556  2.9635   43.3444      2.87 R
129   65.3000  33.3556  2.9635   31.9444      2.11 R
134   69.0000  33.3556  2.9635   35.6444      2.36 R
139    0.0000  33.3556  2.9635  -33.3556     -2.21 R
156    9.0000  47.8844  2.7222  -38.8844     -2.57 R
161   11.0000  47.8844  2.7222  -36.8844     -2.43 R
182   98.4000  50.2964  2.9101   48.1036      3.18 R
194   18.4000  50.2964  2.9101  -31.8964     -2.11 R
208   18.7000  51.5857  2.9101  -32.8857     -2.17 R
210   12.3000  51.5857  2.9101  -39.2857     -2.60 R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

Treat   N   Mean  Grouping
E      25  57.22  A
I      28  51.59  A
D      29  51.56  A
H      28  50.30  A
G      32  47.88  A
B      35  46.75  A
F      27  33.36    B
C      20  23.04    B
A       7  21.81    B
```

Means that do not share a letter are significantly different.

Tukey 95.0% Simultaneous Confidence Intervals
Response Variable L=Ht-1yr (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Lower	Center	Upper	--+---------+---------+---------+----
B	4.96	24.931	44.90	(-----*------)
C	-19.95	1.231	22.41	(------*------)
D	9.43	29.748	50.06	(------*------)
E	14.78	35.406	56.03	(------*------)
F	-8.92	11.541	32.00	(------*------)
G	5.94	26.070	46.20	(------*-----)
H	8.10	28.482	48.87	(-----*------)
I	9.39	29.771	50.16	(------*------)
				--+---------+---------+---------+----
				-30 0 30 60

Treat = B subtracted from:

Treat	Lower	Center	Upper	--+---------+---------+---------+----
C	-37.22	-23.70	-10.18	(---*----)
D	-7.30	4.82	16.93	(---*---)
E	-2.16	10.47	23.11	(---*----)
F	-25.75	-13.39	-1.03	(----*---)
G	-10.66	1.14	12.94	(---*---)
H	-8.68	3.55	15.78	(---*---)
I	-7.39	4.84	17.07	(---*---)
				--+---------+---------+---------+----
				-30 0 30 60

Treat = C subtracted from:

Treat	Lower	Center	Upper	--+---------+---------+---------+----
D	14.497	28.52	42.54	(----*---)
E	19.704	34.18	48.65	(---*----)
F	-3.920	10.31	24.54	(---*----)
G	11.090	24.84	38.59	(---*----)
H	13.129	27.25	41.37	(----*----)
I	14.419	28.54	42.66	(----*---)
				--+---------+---------+---------+----
				-30 0 30 60

Treat = D subtracted from:

Treat	Lower	Center	Upper	--+---------+---------+---------+----
E	-7.51	5.66	18.822	(----*---)
F	-31.11	-18.21	-5.307	(---*---)
G	-16.04	-3.68	8.689	(---*---)
H	-14.05	-1.27	11.514	(----*---)
I	-12.76	0.02	12.804	(---*---)
				--+---------+---------+---------+----
				-30 0 30 60

Treat = E subtracted from:

Treat	Lower	Center	Upper	--+---------+---------+---------+----

```
F      -37.25  -23.86  -10.48  (---*----)
G      -22.21   -9.34    3.54       (---*---)
H      -20.20   -6.92    6.35       (----*---)
I      -18.91   -5.63    7.64        (---*----)
                             --+---------+---------+---------+----
                             -30         0        30        60
```

```
Treat = F  subtracted from:

Treat  Lower  Center  Upper  --+---------+---------+---------+----
G      1.924   14.53  27.13              (---*---)
H      3.930   16.94  29.95              (----*---)
I      5.220   18.23  31.24               (---*---)
                           --+---------+---------+---------+----
                           -30         0        30        60
```

```
Treat = G  subtracted from:

Treat   Lower  Center  Upper  --+---------+---------+---------+----
H      -10.07   2.412  14.89          (---*---)
I       -8.78   3.701  16.18          (---*---)
                           --+---------+---------+---------+----
                           -30         0        30        60
```

```
Treat = H  subtracted from:

Treat   Lower  Center  Upper  --+---------+---------+---------+----
I      -11.60   1.289  14.18         (---*----)
                           --+---------+---------+---------+----
                           -30         0        30        60
```

```
Tukey Simultaneous Tests
Response Variable L=Ht-1yr (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A  subtracted from:
```

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
B	24.931	6.376	3.9104	0.0039
C	1.231	6.762	0.1820	1.0000
D	29.748	6.485	4.5874	0.0003
E	35.406	6.585	5.3769	0.0000
F	11.541	6.531	1.7671	0.7037
G	26.070	6.425	4.0574	0.0022
H	28.482	6.507	4.3770	0.0006
I	29.771	6.507	4.5752	0.0003

```
Treat = B  subtracted from:
```

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-23.70	4.316	-5.491	0.0000
D	4.82	3.867	1.246	0.9453
E	10.47	4.032	2.598	0.1936
F	-13.39	3.944	-3.395	0.0227
G	1.14	3.766	0.302	1.0000
H	3.55	3.904	0.909	0.9923
I	4.84	3.904	1.240	0.9467

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	28.52	4.476	6.371	0.0000
E	34.18	4.620	7.398	0.0000
F	10.31	4.543	2.270	0.3652
G	24.84	4.389	5.659	0.0000
H	27.25	4.508	6.045	0.0000
I	28.54	4.508	6.331	0.0000

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	5.66	4.203	1.346	0.9160
F	-18.21	4.118	-4.421	0.0005
G	-3.68	3.948	-0.932	0.9909
H	-1.27	4.080	-0.310	1.0000
I	0.02	4.080	0.006	1.0000

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-23.86	4.274	-5.584	0.0000
G	-9.34	4.110	-2.271	0.3642
H	-6.92	4.237	-1.634	0.7851
I	-5.63	4.237	-1.330	0.9214

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	14.53	4.024	3.611	0.0112
H	16.94	4.153	4.079	0.0021
I	18.23	4.153	4.389	0.0006

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	2.412	3.985	0.6053	0.9996
I	3.701	3.985	0.9289	0.9911

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	1.289	4.116	0.3133	1.000

Results for: 98_fir

General Linear Model: Total Ht (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed       9  A, B, C, D, E, F, G, H, I


Analysis of Variance for Total Ht (cm), using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS      F      P
Treat     8  2696710  2696710  337089  24.43  0.000
Error   223  3077195  3077195   13799
Total   231  5773905


S = 117.469   R-Sq = 46.71%   R-Sq(adj) = 44.79%


Unusual Observations for Total Ht (cm)

       Total
Obs  Ht (cm)      Fit  SE Fit  Residual  St Resid
  1  367.500  165.857  44.399   201.643      1.85 X
  2  236.200  165.857  44.399    70.343      0.65 X
  3   36.000  165.857  44.399  -129.857     -1.19 X
  4  245.800  165.857  44.399    79.943      0.74 X
  5   44.500  165.857  44.399  -121.357     -1.12 X
  6   97.500  165.857  44.399   -68.357     -0.63 X
  7  133.500  165.857  44.399   -32.357     -0.30 X
 26  599.200  359.117  19.856   240.083      2.07 R
 60  435.800  205.845  26.267   229.955      2.01 R
119   50.000  289.900  22.200  -239.900     -2.08 R
129  527.500  289.900  22.200   237.600      2.06 R
134  542.500  289.900  22.200   252.600      2.19 R
139   55.000  289.900  22.200  -234.900     -2.04 R
149  590.000  349.428  20.766   240.572      2.08 R
156   84.500  349.428  20.766  -264.928     -2.29 R
158   50.600  349.428  20.766  -298.828     -2.58 R
161  105.800  349.428  20.766  -243.628     -2.11 R
178  214.100  455.718  22.200  -241.618     -2.09 R
179  208.000  455.718  22.200  -247.718     -2.15 R
208  247.300  488.625  22.200  -241.325     -2.09 R
210  174.600  488.625  22.200  -314.025     -2.72 R

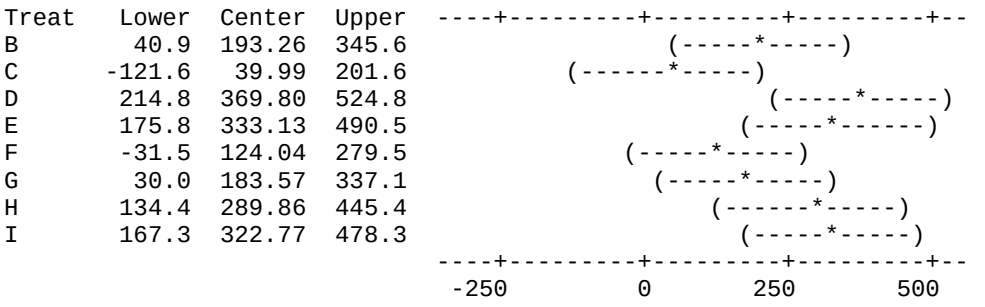
R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

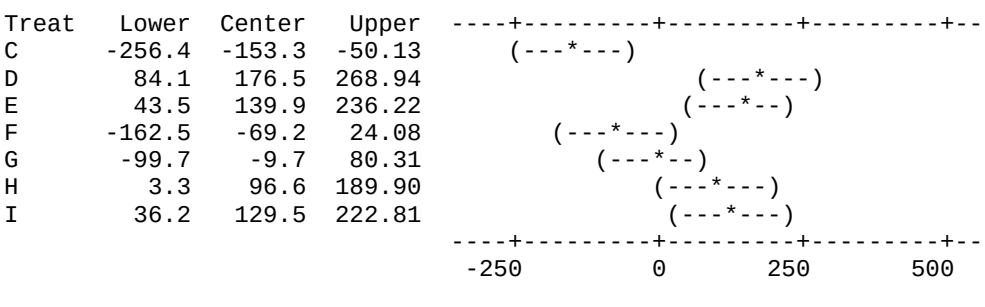
Treat   N   Mean  Grouping
D      29  535.7  A
E      25  499.0  A
I      28  488.6  A
H      28  455.7  A
B      35  359.1    B
G      32  349.4    B
F      28  289.9    B C
C      20  205.8      C
A       7  165.9      C
```

Means that do not share a letter are significantly different.

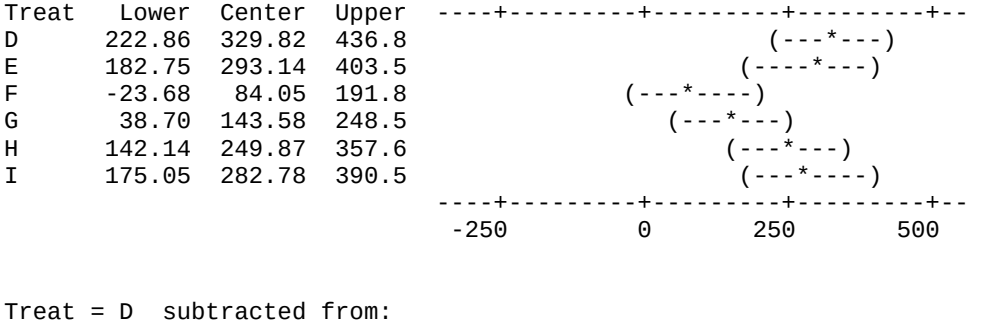
Tukey 95.0% Simultaneous Confidence Intervals
Response Variable Total Ht (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:



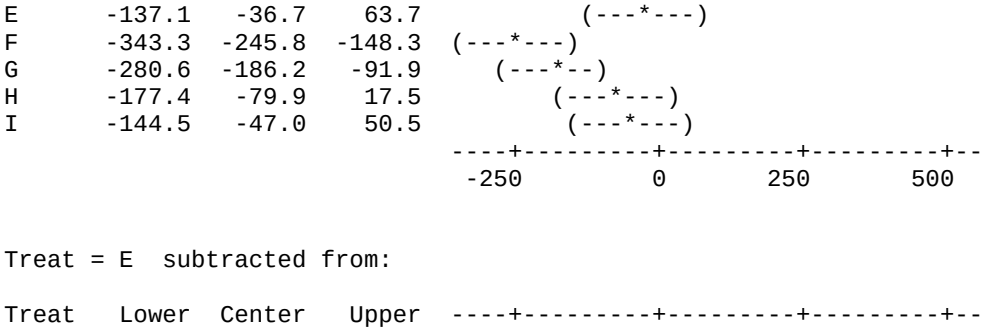
Treat = B subtracted from:



Treat = C subtracted from:



Treat = D subtracted from:



Treat = E subtracted from:

Treat Lower Center Upper

```
F      -310.3  -209.1  -107.8    (---*---)
G      -247.8  -149.6   -51.3      (---*---)
H      -144.5   -43.3    58.0          (---*---)
I      -111.6   -10.4    90.9            (---*---)
                                ----+---------+---------+---------+--
                                 -250         0       250       500
```

Treat = F subtracted from:

```
Treat   Lower  Center  Upper  ----+---------+---------+---------+--
G      -35.69   59.53  154.7              (--*---)
H       67.47  165.82  264.2                  (---*---)
I      100.38  198.72  297.1                   (---*---)
                              ----+---------+---------+---------+--
                               -250         0       250       500
```

Treat = G subtracted from:

```
Treat  Lower  Center  Upper  ----+---------+---------+---------+--
H      11.07   106.3  201.5              (---*---)
I      43.98   139.2  234.4                (---*--)
                            ----+---------+---------+---------+--
                             -250         0       250       500
```

Treat = H subtracted from:

```
Treat   Lower  Center  Upper  ----+---------+---------+---------+--
I      -65.44   32.91  131.3            (---*---)
                              ----+---------+---------+---------+--
                               -250         0       250       500
```

Tukey Simultaneous Tests
Response Variable Total Ht (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
B	193.26	48.64	3.9735	0.0031
C	39.99	51.59	0.7751	0.9974
D	369.80	49.47	7.4756	0.0000
E	333.13	50.23	6.6318	0.0000
F	124.04	49.64	2.4989	0.2382
G	183.57	49.02	3.7452	0.0070
H	289.86	49.64	5.8393	0.0000
I	322.77	49.64	6.5022	0.0000

Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-153.3	32.93	-4.655	0.0002
D	176.5	29.50	5.985	0.0000
E	139.9	30.76	4.547	0.0003
F	-69.2	29.78	-2.324	0.3324
G	-9.7	28.73	-0.337	1.0000
H	96.6	29.78	3.243	0.0361
I	129.5	29.78	4.348	0.0007

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	329.82	34.14	9.660	0.0000
E	293.14	35.24	8.318	0.0000
F	84.05	34.39	2.444	0.2657
G	143.58	33.48	4.288	0.0009
H	249.87	34.39	7.266	0.0000
I	282.78	34.39	8.222	0.0000

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	-36.7	32.06	-1.144	0.9667
F	-245.8	31.12	-7.896	0.0000
G	-186.2	30.12	-6.184	0.0000
H	-79.9	31.12	-2.569	0.2060
I	-47.0	31.12	-1.511	0.8493

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-209.1	32.32	-6.469	0.0000
G	-149.6	31.36	-4.770	0.0001
H	-43.3	32.32	-1.339	0.9186
I	-10.4	32.32	-0.320	1.0000

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	59.53	30.40	1.958	0.5741
H	165.82	31.40	5.282	0.0000
I	198.72	31.40	6.330	0.0000

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	106.3	30.40	3.497	0.0163
I	139.2	30.40	4.579	0.0003

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	32.91	31.40	1.048	0.9806

1998 Pine

General Linear Model: dbh (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed       8  A, B, C, D, E, F, G, H


Analysis of Variance for dbh (cm), using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS      F      P
Treat     7   856.62   856.62  122.37  27.76  0.000
Error   483  2128.90  2128.90    4.41
Total   490  2985.52


S = 2.09944   R-Sq = 28.69%   R-Sq(adj) = 27.66%


Unusual Observations for dbh (cm)

Obs  dbh (cm)     Fit  SE Fit  Residual  St Resid
  3    3.0000  2.7500  1.4845    0.2500      0.17 X
 16    2.5000  2.7500  1.4845   -0.2500     -0.17 X
 48   12.8000  7.4315  0.2457    5.3685      2.57 R
181    2.9000  8.4919  0.2666   -5.5919     -2.69 R
189    3.3000  8.4919  0.2666   -5.1919     -2.49 R
216    3.3000  8.4919  0.2666   -5.1919     -2.49 R
221    3.3000  8.4919  0.2666   -5.1919     -2.49 R
253   12.8000  8.2552  0.2757    4.5448      2.18 R
265   13.5000  8.2552  0.2757    5.2448      2.52 R
281    1.4000  8.2552  0.2757   -6.8552     -3.29 R
285    1.8000  8.2552  0.2757   -6.4552     -3.10 R
286    4.0000  8.2552  0.2757   -4.2552     -2.04 R
287    3.5000  8.2552  0.2757   -4.7552     -2.28 R
294    2.0000  8.2552  0.2757   -6.2552     -3.01 R
318    1.8000  6.8028  0.2492   -5.0028     -2.40 R
321    2.4000  6.8028  0.2492   -4.4028     -2.11 R
374    2.4000  6.8028  0.2492   -4.4028     -2.11 R
377   10.5000  6.1853  0.2546    4.3147      2.07 R
379    1.5000  6.1853  0.2546   -4.6853     -2.25 R
393    2.0000  6.1853  0.2546   -4.1853     -2.01 R
399   10.5000  6.1853  0.2546    4.3147      2.07 R
402    0.9000  6.1853  0.2546   -5.2853     -2.54 R
422    1.9000  6.1853  0.2546   -4.2853     -2.06 R
482    3.1000  8.1611  0.2474   -5.0611     -2.43 R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

Treat   N   Mean  Grouping
D      62  8.492  A
E      58  8.255  A
H      72  8.161  A
B      73  7.432  A B
F      71  6.803    B C
G      68  6.185      C
```

```
C      85  4.744        D
A       2  2.750      C D
```

Means that do not share a letter are significantly different.

Tukey 95.0% Simultaneous Confidence Intervals
Response Variable dbh (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
B       0.117   4.682   9.246           (-----------*----------)
C      -2.562   1.994   6.550     (----------*----------)
D       1.167   5.742  10.317              (----------*-----------)
E       0.925   5.505  10.085             (-----------*----------)
F      -0.513   4.053   8.619          (----------*-----------)
G      -1.134   3.435   8.004        (-----------*----------)
H       0.846   5.411   9.977             (-----------*----------)
                              ---------+---------+---------+-------
                                     0.0       4.0       8.0
```

Treat = B subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
C      -3.704  -2.688  -1.672  (-*--)
D      -0.039   1.060   2.160           (--*-)
E      -0.297   0.824   1.944          (--*--)
F      -1.690  -0.629   0.433       (-*--)
G      -2.320  -1.246  -0.173     (--*--)
H      -0.328   0.730   1.787           (--*-)
                              ---------+---------+---------+-------
                                     0.0       4.0       8.0
```

Treat = C subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
D      2.6848   3.748  4.812                 (-*--)
E      2.4270   3.512  4.596                (--*-)
F      1.0354   2.059  3.083             (-*--)
G      0.4056   1.442  2.478           (--*-)
H      2.3975   3.418  4.438                (--*-)
                            ---------+---------+---------+-------
                                   0.0       4.0       8.0
```

Treat = D subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
E      -1.400  -0.237   0.927       (--*--)
F      -2.796  -1.689  -0.582    (--*--)
G      -3.425  -2.307  -1.188  (--*--)
H      -1.434  -0.331   0.773       (--*--)
                              ---------+---------+---------+-------
                                     0.0       4.0       8.0
```

Treat = E subtracted from:

```
Treat   Lower  Center    Upper  ---------+---------+---------+-------
F      -2.580  -1.452  -0.3252     (-*--)
```

```
G      -3.208  -2.070  -0.9316   (--*--)
H      -1.218  -0.094   1.0296         (--*--)
                                 ---------+---------+---------+-------
                                        0.0       4.0       8.0
```

Treat = F subtracted from:

```
Treat   Lower   Center   Upper  ---------+---------+---------+-------
G      -1.698  -0.6175  0.4631       (-*--)
H       0.293   1.3583  2.4235             (-*--)
                                 ---------+---------+---------+-------
                                        0.0       4.0       8.0
```

Treat = G subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
H      0.8989   1.976  3.053              (--*--)
                              ---------+---------+---------+-------
                                     0.0       4.0       8.0
```

Tukey Simultaneous Tests
Response Variable dbh (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
B	4.682	1.505	3.111	0.0394
C	1.994	1.502	1.327	0.8887
D	5.742	1.508	3.807	0.0035
E	5.505	1.510	3.646	0.0065
F	4.053	1.505	2.692	0.1248
G	3.435	1.506	2.281	0.3042
H	5.411	1.505	3.595	0.0078

Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-2.688	0.3350	-8.024	0.0000
D	1.060	0.3626	2.925	0.0678
E	0.824	0.3693	2.230	0.3333
F	-0.629	0.3499	-1.797	0.6225
G	-1.246	0.3538	-3.522	0.0102
H	0.730	0.3487	2.092	0.4198

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	3.748	0.3506	10.690	0.0000
E	3.512	0.3576	9.821	0.0000
F	2.059	0.3375	6.101	0.0000
G	1.442	0.3416	4.221	0.0006
H	3.418	0.3363	10.163	0.0000

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	-0.237	0.3835	-0.617	0.9987
F	-1.689	0.3649	-4.629	0.0001
G	-2.307	0.3687	-6.257	0.0000
H	-0.331	0.3637	-0.910	0.9853

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-1.452	0.3716	-3.909	0.0024
G	-2.070	0.3752	-5.516	0.0000
H	-0.094	0.3704	-0.254	1.0000

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	-0.6175	0.3562	-1.734	0.6652
H	1.3583	0.3511	3.868	0.0028

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	1.976	0.3550	5.565	0.0000

Pine 1998

General Linear Model: L=Ht-1yr (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed       8  A, B, C, D, E, F, G, H


Analysis of Variance for L=Ht-1yr (cm), using Adjusted SS for Tests

Source   DF    Seq SS   Adj SS  Adj MS      F      P
Treat     7   32436.9  32436.9  4633.8  27.72  0.000
Error   510   85245.2  85245.2   167.1
Total   517  117682.1


S = 12.9286   R-Sq = 27.56%   R-Sq(adj) = 26.57%


Unusual Observations for L=Ht-1yr (cm)

     L=Ht-1yr
Obs      (cm)     Fit  SE Fit  Residual  St Resid
  1     3.800   9.247   2.966    -5.447     -0.43  X
  2     5.200   9.247   2.966    -4.047     -0.32  X
  3    22.100   9.247   2.966    12.853      1.02  X
  4     8.900   9.247   2.966    -0.347     -0.03  X
  5     5.000   9.247   2.966    -4.247     -0.34  X
  6     8.600   9.247   2.966    -0.647     -0.05  X
  7     7.500   9.247   2.966    -1.747     -0.14  X
  8     5.000   9.247   2.966    -4.247     -0.34  X
  9     9.500   9.247   2.966     0.253      0.02  X
 10     6.500   9.247   2.966    -2.747     -0.22  X
 11     3.500   9.247   2.966    -5.747     -0.46  X
 12     4.500   9.247   2.966    -4.747     -0.38  X
 13     0.000   9.247   2.966    -9.247     -0.73  X
 14    10.200   9.247   2.966     0.953      0.08  X
 15     9.000   9.247   2.966    -0.247     -0.02  X
 16    37.800   9.247   2.966    28.553      2.27 RX
 17     4.500   9.247   2.966    -4.747     -0.38  X
 18    10.100   9.247   2.966     0.853      0.07  X
 19    14.000   9.247   2.966     4.753      0.38  X
 36     0.000  42.046   1.483   -42.046     -3.27  R
 37     0.000  42.046   1.483   -42.046     -3.27  R
156    57.600  26.566   1.402    31.034      2.41  R
170    58.300  26.566   1.402    31.734      2.47  R
281    18.200  44.807   1.698   -26.607     -2.08  R
321    10.200  37.047   1.493   -26.847     -2.09  R
388    69.800  41.078   1.556    28.722      2.24  R
390    76.400  41.078   1.556    35.322      2.75  R
393   104.100  41.078   1.556    63.022      4.91  R
394    68.800  41.078   1.556    27.722      2.16  R
406    14.800  41.078   1.556   -26.278     -2.05  R
407    14.200  41.078   1.556   -26.878     -2.09  R
409     8.800  41.078   1.556   -32.278     -2.51  R
419    13.100  41.078   1.556   -27.978     -2.18  R
434    13.300  41.078   1.556   -27.778     -2.16  R
443    67.300  41.078   1.556    26.222      2.04  R
477     0.000  40.181   1.503   -40.181     -3.13  R
```

```
498    70.500  40.181   1.503    30.319      2.36  R
504    79.100  40.181   1.503    38.919      3.03  R
505    66.200  40.181   1.503    26.019      2.03  R
518    82.800  40.181   1.503    42.619      3.32  R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

Treat   N    Mean  Grouping
E      58  44.807  A
B      76  42.046  A B
D      62  41.542  A B
G      69  41.078  A B
H      74  40.181  A B
F      75  37.047    B
C      85  26.566      C
A      19   9.247        D

Means that do not share a letter are significantly different.


Tukey 95.0% Simultaneous Confidence Intervals
Response Variable L=Ht-1yr (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A  subtracted from:

Treat   Lower  Center  Upper   -+---------+---------+---------+-----
B      22.739   32.80  42.86                       (----*----)
C       7.366   17.32  27.27             (----*----)
D      22.011   32.29  42.58                     (----*----)
E      25.193   35.56  45.93                       (----*----)
F      17.727   27.80  37.87                   (----*----)
G      21.670   31.83  41.99                     (----*----)
H      20.847   30.93  41.02                    (----*-----)
                           -+---------+---------+---------+-----
                         -20         0        20        40


Treat = B  subtracted from:

Treat   Lower  Center   Upper   -+---------+---------+---------+-----
C      -21.67  -15.48  -9.289   (--*--)
D       -7.22   -0.50   6.208         (---*--)
E       -4.08    2.76   9.599           (--*---)
F      -11.38   -5.00   1.384       (---*--)
G       -7.49   -0.97   5.554         (---*--)
H       -8.27   -1.86   4.540         (--*--)
                           -+---------+---------+---------+-----
                         -20         0        20        40


Treat = C  subtracted from:

Treat   Lower  Center  Upper   -+---------+---------+---------+-----
D       8.426   14.98  21.53                (--*---)
E      11.562   18.24  24.92                  (--*--)
F       4.268   10.48  16.69              (--*--)
G       8.157   14.51  20.87                (--*--)
H       7.380   13.62  19.85                (--*--)
                           -+---------+---------+---------+-----
```

```
                              -20         0        20        40
```

Treat = D subtracted from:

Treat	Lower	Center	Upper	-+---------+---------+---------+-----
E	-3.90	3.265	10.429	(---*--)
F	-11.23	-4.495	2.236	(---*--)
G	-7.33	-0.464	6.399	(---*--)
H	-8.11	-1.361	5.391	(--*---)
				-+---------+---------+---------+-----
				-20 0 20 40

Treat = E subtracted from:

Treat	Lower	Center	Upper	-+---------+---------+---------+-----
F	-14.62	-7.760	-0.9026	(--*---)
G	-10.72	-3.729	3.2578	(--*---)
H	-11.50	-4.626	2.2520	(---*--)
				-+---------+---------+---------+-----
				-20 0 20 40

Treat = F subtracted from:

Treat	Lower	Center	Upper	-+---------+---------+---------+-----
G	-2.511	4.032	10.574	(--*--)
H	-3.292	3.134	9.560	(---*--)
				-+---------+---------+---------+-----
				-20 0 20 40

Treat = G subtracted from:

Treat	Lower	Center	Upper	-+---------+---------+---------+-----
H	-7.460	-0.8972	5.666	(---*--)
				-+---------+---------+---------+-----
				-20 0 20 40

Tukey Simultaneous Tests
Response Variable L=Ht-1yr (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
B	32.80	3.316	9.891	0.0000
C	17.32	3.281	5.279	0.0000
D	32.29	3.390	9.526	0.0000
E	35.56	3.417	10.405	0.0000
F	27.80	3.321	8.372	0.0000
G	31.83	3.350	9.503	0.0000
H	30.93	3.325	9.303	0.0000

Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-15.48	2.041	-7.585	0.0000
D	-0.50	2.213	-0.228	1.0000

E	2.76	2.254	1.225	0.9248
F	-5.00	2.104	-2.376	0.2532
G	-0.97	2.150	-0.450	0.9998
H	-1.86	2.111	-0.883	0.9876

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	14.98	2.159	6.936	0.0000
E	18.24	2.202	8.284	0.0000
F	10.48	2.048	5.117	0.0000
G	14.51	2.095	6.927	0.0000
H	13.62	2.056	6.624	0.0000

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	3.265	2.362	1.382	0.8656
F	-4.495	2.219	-2.026	0.4643
G	-0.464	2.262	-0.205	1.0000
H	-1.361	2.226	-0.611	0.9987

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-7.760	2.261	-3.433	0.0139
G	-3.729	2.303	-1.619	0.7390
H	-4.626	2.267	-2.040	0.4545

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	4.032	2.157	1.869	0.5722
H	3.134	2.118	1.480	0.8186

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	-0.8972	2.164	-0.4147	0.9999

Results for: 98_pine

General Linear Model: Total Ht (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed       8  A, B, C, D, E, F, G, H


Analysis of Variance for Total Ht (cm), using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS      F      P
Treat     7  3815396  3815396  545057  50.97  0.000
Error   510  5453777  5453777   10694
Total   517  9269173


S = 103.410   R-Sq = 41.16%   R-Sq(adj) = 40.35%


Unusual Observations for Total Ht (cm)

       Total
Obs  Ht (cm)      Fit  SE Fit  Residual  St Resid
  1   35.700   85.437  23.724   -49.737     -0.49 X
  2   72.600   85.437  23.724   -12.837     -0.13 X
  3  253.200   85.437  23.724   167.763      1.67 X
  4   20.700   85.437  23.724   -64.737     -0.64 X
  5   61.000   85.437  23.724   -24.437     -0.24 X
  6   98.000   85.437  23.724    12.563      0.12 X
  7   63.000   85.437  23.724   -22.437     -0.22 X
  8   47.000   85.437  23.724   -38.437     -0.38 X
  9   30.100   85.437  23.724   -55.337     -0.55 X
 10   78.000   85.437  23.724    -7.437     -0.07 X
 11   65.500   85.437  23.724   -19.937     -0.20 X
 12   91.000   85.437  23.724     5.563      0.06 X
 13   14.200   85.437  23.724   -71.237     -0.71 X
 14  167.000   85.437  23.724    81.563      0.81 X
 15   54.000   85.437  23.724   -31.437     -0.31 X
 16  243.300   85.437  23.724   157.863      1.57 X
 17   53.000   85.437  23.724   -32.437     -0.32 X
 18  107.500   85.437  23.724    22.063      0.22 X
 19   68.500   85.437  23.724   -16.937     -0.17 X
 48  694.600  449.532  11.862   245.068      2.39 R
 52  120.200  449.532  11.862  -329.332     -3.21 R
 67  198.100  449.532  11.862  -251.432     -2.45 R
 80  232.300  449.532  11.862  -217.232     -2.11 R
135   57.200  335.459  11.216  -278.259     -2.71 R
159  568.400  335.459  11.216   232.941      2.27 R
181  250.600  505.552  13.133  -254.952     -2.49 R
216  263.200  505.552  13.133  -242.352     -2.36 R
249  669.000  463.528  13.578   205.472      2.00 R
253  710.100  463.528  13.578   246.572      2.41 R
281  171.600  463.528  13.578  -291.928     -2.85 R
285  231.800  463.528  13.578  -231.728     -2.26 R
294  236.400  463.528  13.578  -227.128     -2.22 R
321  200.200  415.433  11.941  -215.233     -2.10 R
341  659.300  415.433  11.941   243.867      2.37 R
357  178.300  415.433  11.941  -237.133     -2.31 R
359  203.100  415.433  11.941  -212.333     -2.07 R
360  169.200  415.433  11.941  -246.233     -2.40 R
```

```
379  186.500  404.690  12.449  -218.190     -2.13 R
402  173.700  404.690  12.449  -230.990     -2.25 R
419  161.200  404.690  12.449  -243.490     -2.37 R
435  913.100  404.690  12.449   508.410      4.95 R
468  205.000  496.646  12.021  -291.646     -2.84 R
477  224.800  496.646  12.021  -271.846     -2.65 R
483  714.000  496.646  12.021   217.354      2.12 R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

Treat   N    Mean  Grouping
D      62  505.55  A
H      74  496.65  A B
E      58  463.53  A B C
B      76  449.53    B C D
F      75  415.43      C D
G      69  404.69        D
C      85  335.46          E
A      19   85.44            F

Means that do not share a letter are significantly different.


Tukey 95.0% Simultaneous Confidence Intervals
Response Variable Total Ht (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A  subtracted from:

Treat  Lower  Center  Upper  --------+---------+---------+--------
B      283.6   364.1  444.6                      (---*---)
C      170.4   250.0  329.6                 (---*--)
D      337.9   420.1  502.4                        (---*---)
E      295.2   378.1  461.0                     (---*---)
F      249.4   330.0  410.6                   (---*----)
G      238.0   319.3  400.5                   (---*---)
H      330.5   411.2  491.9                        (---*---)
                          --------+---------+---------+--------
                                  0       200       400


Treat = B  subtracted from:

Treat   Lower  Center   Upper  --------+---------+---------+--------
C      -163.6  -114.1  -64.55  (-*--)
D         2.3    56.0  109.70         (--*-)
E       -40.7    14.0   68.69       (--*-)
F       -85.2   -34.1   16.96     (-*--)
G       -97.0   -44.8    7.32    (--*-)
H        -4.1    47.1   98.34         (-*--)
                          --------+---------+---------+--------
                                  0       200       400


Treat = C  subtracted from:

Treat   Lower  Center  Upper  --------+---------+---------+--------
D      117.70  170.09  222.5               (--*-)
E       74.64  128.07  181.5             (-*--)
F       30.28   79.97  129.7           (-*-)
```

```
G       18.40   69.23  120.1           (-*--)
H      111.31  161.19  211.1                (-*--)
                              --------+---------+---------+--------
                                      0       200       400
```

Treat = D subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
E       -99.3   -42.0   15.28     (--*--)
F      -144.0   -90.1  -36.27   (-*--)
G      -155.8  -100.9  -45.97  (--*--)
H       -62.9    -8.9   45.10       (--*-)
                              --------+---------+---------+--------
                                      0       200       400
```

Treat = E subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
F      -102.9  -48.09   6.757     (--*-)
G      -114.7  -58.84  -2.956    (--*--)
H       -21.9   33.12  88.131         (--*-)
                              --------+---------+---------+--------
                                      0       200       400
```

Treat = F subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
G      -63.07  -10.74   41.58       (-*--)
H       29.81   81.21  132.61           (--*--)
                              --------+---------+---------+--------
                                      0       200       400
```

Treat = G subtracted from:

```
Treat  Lower  Center  Upper  --------+---------+---------+--------
H      39.46   91.96  144.5           (--*-)
                             --------+---------+---------+--------
                                     0       200       400
```

Tukey Simultaneous Tests
Response Variable Total Ht (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
B	364.1	26.52	13.727	0.0000
C	250.0	26.24	9.528	0.0000
D	420.1	27.12	15.493	0.0000
E	378.1	27.33	13.832	0.0000
F	330.0	26.56	12.425	0.0000
G	319.3	26.79	11.916	0.0000
H	411.2	26.60	15.461	0.0000

Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value

Treat	of Means	Difference	T-Value	P-Value
C	-114.1	16.33	-6.987	0.0000
D	56.0	17.70	3.166	0.0333
E	14.0	18.03	0.776	0.9943
F	-34.1	16.83	-2.026	0.4642
G	-44.8	17.20	-2.608	0.1529
H	47.1	16.89	2.790	0.0975

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	170.09	17.27	9.848	0.0000
E	128.07	17.61	7.272	0.0000
F	79.97	16.38	4.882	0.0000
G	69.23	16.76	4.132	0.0009
H	161.19	16.44	9.804	0.0000

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	-42.0	18.89	-2.225	0.3368
F	-90.1	17.75	-5.077	0.0000
G	-100.9	18.10	-5.574	0.0000
H	-8.9	17.80	-0.500	0.9997

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-48.09	18.08	-2.660	0.1351
G	-58.84	18.42	-3.194	0.0305
H	33.12	18.14	1.826	0.6021

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	-10.74	17.25	-0.6228	0.9986
H	81.21	16.94	4.7931	0.0001

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	91.96	17.31	5.314	0.0000

Results for: 99_fir

General Linear Model: dbh (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      12  B, C, D, E, F, G, H, I, J, K, L, M


Analysis of Variance for dbh (cm), using Adjusted SS for Tests

Source   DF    Seq SS    Adj SS  Adj MS     F      P
Treat    11   180.520   180.520  16.411  3.75  0.000
Error   229  1002.718  1002.718   4.379
Total   240  1183.238


S = 2.09253   R-Sq = 15.26%   R-Sq(adj) = 11.19%


Unusual Observations for dbh (cm)

Obs  dbh (cm)     Fit  SE Fit  Residual  St Resid
  1    1.4000  4.6000  1.4796   -3.2000     -2.16 RX
  2    6.0000  7.7250  1.0463   -1.7250     -0.95  X
  3   12.9000  7.7250  1.0463    5.1750      2.86 RX
  4    4.1000  4.1750  1.0463   -0.0750     -0.04  X
  5    3.8000  4.1750  1.0463   -0.3750     -0.21  X
  6    4.2000  4.1750  1.0463    0.0250      0.01  X
 53    0.4000  6.2000  0.3537   -5.8000     -2.81  R
 61    7.8000  4.6000  1.4796    3.2000      2.16 RX
 62    2.3000  2.9333  1.2081   -0.6333     -0.37  X
 63    2.8000  2.9333  1.2081   -0.1333     -0.08  X
 64    3.7000  2.9333  1.2081    0.7667      0.45  X
 65    9.0000  7.7250  1.0463    1.2750      0.70  X
 66    3.0000  7.7250  1.0463   -4.7250     -2.61 RX
 67    7.5000  7.6000  1.2081   -0.1000     -0.06  X
 68    8.2000  7.6000  1.2081    0.6000      0.35  X
 69    7.1000  7.6000  1.2081   -0.5000     -0.29  X
 70    3.7000  3.7000  2.0925    0.0000         *  X
 71    4.6000  4.1750  1.0463    0.4250      0.23  X
 77    7.7000  3.3778  0.6975    4.3222      2.19  R
161    9.9000  4.9526  0.3395    4.9474      2.40  R
178    9.3000  4.8107  0.2796    4.4893      2.16  R
186    9.1000  4.8107  0.2796    4.2893      2.07  R
235   10.7000  6.2000  0.3537    4.5000      2.18  R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

Treat   N   Mean  Grouping
D       4  7.725  A
E       3  7.600  A B
L      35  6.200  A
M      21  6.043  A B
I      65  5.975  A
J      38  4.953  A B
K      56  4.811  A B
B       2  4.600  A B
```

```
G       4  4.175  A B
F       1  3.700  A B
H       9  3.378    B
C       3  2.933  A B
```

Means that do not share a letter are significantly different.

Tukey 95.0% Simultaneous Confidence Intervals
Response Variable dbh (cm)
All Pairwise Comparisons among Levels of Treat
Treat = B subtracted from:

```
Treat   Lower  Center  Upper      +---------+---------+---------+------
C      -7.975  -1.667  4.641             (---------*----------)
D      -2.859   3.125  9.109                      (---------*---------)
E      -3.308   3.000  9.308                    (----------*----------)
F      -9.363  -0.900  7.563          (--------------*--------------)
G      -6.409  -0.425  5.559               (---------*---------)
H      -6.624  -1.222  4.180               (--------*--------)
I      -3.585   1.375  6.336                    (-------*--------)
J      -4.660   0.353  5.366                 (--------*-------)
K      -4.762   0.211  5.183                 (-------*--------)
L      -3.424   1.600  6.624                   (--------*-------)
M      -3.671   1.443  6.556                   (-------*--------)
                           +---------+---------+---------+------
                       -12.0      -6.0       0.0       6.0
```

Treat = C subtracted from:

```
Treat   Lower  Center   Upper      +---------+---------+---------+------
D      -0.486  4.7917  10.069                       (--------*--------)
E      -0.975  4.6667  10.309                     (---------*--------)
F      -7.212  0.7667   8.746             (------------*-------------)
G      -4.036  1.2417   6.519                  (--------*--------)
H      -4.162  0.4444   5.051                  (-------*------)
I      -1.038  3.0421   7.123                       (------*------)
J      -2.125  2.0193   6.163                    (------*------)
K      -2.218  1.8774   5.972                    (------*------)
L      -0.890  3.2667   7.424                       (-----*------)
M      -1.155  3.1095   7.374                     (------*------)
                           +---------+---------+---------+------
                      -12.0      -6.0       0.0       6.0
```

Treat = D subtracted from:

```
Treat   Lower  Center    Upper      +---------+---------+---------+------
E       -5.40  -0.125   5.1525                (--------*--------)
F      -11.75  -4.025   3.7005      (------------*------------)
G       -8.44  -3.550   1.3361            (-------*-------)
H       -8.50  -4.347  -0.1949            (------*------)
I       -5.31  -1.750   1.8101                 (-----*-----)
J       -6.40  -2.772   0.8599              (-----*-----)
K       -6.49  -2.914   0.6619              (-----*-----)
L       -5.17  -1.525   2.1221                (-----*------)
M       -5.45  -1.682   2.0875                (-----*-----)
                           +---------+---------+---------+------
                      -12.0      -6.0       0.0       6.0
```

Treat = E subtracted from:

```
Treat   Lower  Center   Upper      +---------+---------+---------+------
F      -11.88  -3.900  4.0789     (------------*------------)
G       -8.70  -3.425  1.8525          (--------*--------)
H       -8.83  -4.222  0.3844          (-------*-------)
I       -5.71  -1.625  2.4559               (------*------)
J       -6.79  -2.647  1.4966             (------*-----)
K       -6.88  -2.789  1.3056             (-----*------)
L       -5.56  -1.400  2.7569               (------*------)
M       -5.82  -1.557  2.7078               (------*-------)
                          +---------+---------+---------+------
                        -12.0      -6.0       0.0       6.0
```

Treat = F subtracted from:

```
Treat   Lower   Center  Upper      +---------+---------+---------+------
G      -7.251   0.4750  8.201              (------------*------------)
H      -7.606  -0.3222  6.961             (-----------*------------)
I      -4.687   2.2754  9.238                  (-----------*----------)
J      -5.748   1.2526  8.253                (-----------*-----------)
K      -5.861   1.1107  8.082                (-----------*----------)
L      -4.508   2.5000  9.508                  (-----------*-----------)
M      -4.730   2.3429  9.415                  (-----------*-----------)
                          +---------+---------+---------+------
                        -12.0      -6.0       0.0       6.0
```

Treat = G subtracted from:

```
Treat   Lower   Center  Upper      +---------+---------+---------+------
H      -4.950  -0.7972  3.355                (------*------)
I      -1.759   1.8004  5.360                     (-----*-----)
J      -2.855   0.7776  4.410                  (-----*-----)
K      -2.941   0.6357  4.212                  (-----*-----)
L      -1.622   2.0250  5.672                    (-----*-----)
M      -1.902   1.8679  5.638                    (-----*-----)
                          +---------+---------+---------+------
                        -12.0      -6.0       0.0       6.0
```

Treat = H subtracted from:

```
Treat   Lower  Center  Upper      +---------+---------+---------+------
I       0.140   2.598  5.055                      (---*---)
J      -0.987   1.575  4.136                    (----*---)
K      -1.049   1.433  3.914                    (---*----)
L       0.240   2.822  5.405                      (----*---)
M      -0.088   2.665  5.418                      (---*----)
                          +---------+---------+---------+------
                        -12.0      -6.0       0.0       6.0
```

Treat = I subtracted from:

```
Treat   Lower  Center    Upper      +---------+---------+---------+------
J      -2.434  -1.023  0.38830                    (-*--)
K      -2.425  -1.165  0.09517                    (-*-)
L      -1.224   0.225  1.67333                      (-*--)
M      -1.667   0.067  1.80190                     (--*--)
                          +---------+---------+---------+------
                        -12.0      -6.0       0.0       6.0
```

Treat = J subtracted from:

```
Treat   Lower   Center  Upper      +---------+---------+---------+------
K      -1.594  -0.1419  1.310                    (--*-)
L      -0.371   1.2474  2.866                      (--*--)
M      -0.789   1.0902  2.969                      (--*--)
                                  +---------+---------+---------+------
                               -12.0      -6.0       0.0       6.0
```

Treat = K subtracted from:

```
Treat    Lower  Center  Upper      +---------+---------+---------+------
L      -0.0996   1.389  2.878                       (-*--)
M      -0.5360   1.232  3.000                     (--*--)
                                  +---------+---------+---------+------
                               -12.0      -6.0       0.0       6.0
```

Treat = L subtracted from:

```
Treat   Lower   Center  Upper      +---------+---------+---------+------
M      -2.064  -0.1571  1.750                    (--*--)
                                  +---------+---------+---------+------
                               -12.0      -6.0       0.0       6.0
```

Tukey Simultaneous Tests
Response Variable dbh (cm)
All Pairwise Comparisons among Levels of Treat
Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-1.667	1.910	-0.8725	0.9993
D	3.125	1.812	1.7244	0.8552
E	3.000	1.910	1.5705	0.9179
F	-0.900	2.563	-0.3512	1.0000
G	-0.425	1.812	-0.2345	1.0000
H	-1.222	1.636	-0.7472	0.9998
I	1.375	1.502	0.9156	0.9989
J	0.353	1.518	0.2323	1.0000
K	0.211	1.506	0.1399	1.0000
L	1.600	1.521	1.0517	0.9962
M	1.443	1.548	0.9318	0.9987

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	4.7917	1.598	2.9982	0.1159
E	4.6667	1.709	2.7314	0.2179
F	0.7667	2.416	0.3173	1.0000
G	1.2417	1.598	0.7769	0.9998
H	0.4444	1.395	0.3186	1.0000
I	3.0421	1.236	2.4618	0.3696
J	2.0193	1.255	1.6091	0.9042
K	1.8774	1.240	1.5139	0.9355
L	3.2667	1.259	2.5950	0.2888
M	3.1095	1.292	2.4076	0.4053

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	-0.125	1.598	-0.078	1.0000
F	-4.025	2.340	-1.720	0.8571
G	-3.550	1.480	-2.399	0.4109
H	-4.347	1.257	-3.457	0.0312
I	-1.750	1.078	-1.623	0.8990
J	-2.772	1.100	-2.520	0.3327
K	-2.914	1.083	-2.691	0.2376
L	-1.525	1.104	-1.381	0.9661
M	-1.682	1.142	-1.474	0.9463

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-3.900	2.416	-1.614	0.9024
G	-3.425	1.598	-2.143	0.5925
H	-4.222	1.395	-3.027	0.1077
I	-1.625	1.236	-1.315	0.9765
J	-2.647	1.255	-2.110	0.6165
K	-2.789	1.240	-2.249	0.5159
L	-1.400	1.259	-1.112	0.9939
M	-1.557	1.292	-1.206	0.9881

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	0.4750	2.340	0.2030	1.0000
H	-0.3222	2.206	-0.1461	1.0000
I	2.2754	2.109	1.0791	0.9953
J	1.2526	2.120	0.5909	1.0000
K	1.1107	2.111	0.5261	1.0000
L	2.5000	2.122	1.1780	0.9901
M	2.3429	2.142	1.0939	0.9947

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	-0.7972	1.257	-0.6340	1.0000
I	1.8004	1.078	1.6702	0.8798
J	0.7776	1.100	0.7070	0.9999
K	0.6357	1.083	0.5870	1.0000
L	2.0250	1.104	1.8335	0.7978
M	1.8679	1.142	1.6362	0.8938

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	2.598	0.7442	3.490	0.0281
J	1.575	0.7757	2.030	0.6724
K	1.433	0.7515	1.907	0.7539
L	2.822	0.7821	3.609	0.0191

M	2.665	0.8337	3.197	0.0679

Treat = I subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
J	-1.023	0.4273	-2.393	0.4148
K	-1.165	0.3815	-3.053	0.1006
L	0.225	0.4387	0.512	1.0000
M	0.067	0.5252	0.128	1.0000

Treat = J subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
K	-0.1419	0.4398	-0.3227	1.0000
L	1.2474	0.4902	2.5444	0.3182
M	1.0902	0.5690	1.9161	0.7481

Treat = K subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
L	1.389	0.4509	3.081	0.0933
M	1.232	0.5354	2.301	0.4789

Treat = L subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
M	-0.1571	0.5776	-0.2721	1.000

Results for: 99_fir

General Linear Model: L=Ht-1yr (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      13  A, B, C, D, E, F, G, H, I, J, K, L, M


Analysis of Variance for L=Ht-1yr (cm), using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS     F      P
Treat    12   9965.2   9965.2   830.4  5.01  0.000
Error   244  40449.7  40449.7   165.8
Total   256  50414.9


S = 12.8755   R-Sq = 19.77%   R-Sq(adj) = 15.82%


Unusual Observations for L=Ht-1yr (cm)

     L=Ht-1yr
Obs      (cm)      Fit   SE Fit  Residual  St Resid
  1   55.5000  52.6000   9.1043    2.9000      0.32 X
  2   44.1000  46.9250   6.4377   -2.8250     -0.25 X
  3   61.2000  46.9250   6.4377   14.2750      1.28 X
  4   48.6000  54.7000   6.4377   -6.1000     -0.55 X
  5   59.0000  54.7000   6.4377    4.3000      0.39 X
  6   58.2000  54.7000   6.4377    3.5000      0.31 X
 19   80.1000  51.4788   1.5849   28.6212      2.24 R
 32   18.0000  48.1250   1.6622  -30.1250     -2.36 R
 34    9.0000  48.1250   1.6622  -39.1250     -3.06 R
 47   19.6000  45.1486   2.1167  -25.5486     -2.01 R
 48   15.5000  45.1486   2.1167  -29.6486     -2.33 R
 55   76.4000  51.1913   2.6847   25.2087      2.00 R
 56   89.8000  51.1913   2.6847   38.6087      3.07 R
 57   77.2000  51.1913   2.6847   26.0087      2.07 R
 59    9.0000   8.5000   9.1043    0.5000      0.05 X
 60    8.0000   8.5000   9.1043   -0.5000     -0.05 X
 61   49.7000  52.6000   9.1043   -2.9000     -0.32 X
 62   23.4000  22.8333   7.4336    0.5667      0.05 X
 63   21.1000  22.8333   7.4336   -1.7333     -0.16 X
 64   24.0000  22.8333   7.4336    1.1667      0.11 X
 65   46.4000  46.9250   6.4377   -0.5250     -0.05 X
 66   36.0000  46.9250   6.4377  -10.9250     -0.98 X
 67   45.5000  48.7000   7.4336   -3.2000     -0.30 X
 68   45.1000  48.7000   7.4336   -3.6000     -0.34 X
 69   55.5000  48.7000   7.4336    6.8000      0.65 X
 70   40.9000  40.9000  12.8755    0.0000         * X
 71   53.0000  54.7000   6.4377   -1.7000     -0.15 X
 97   80.0000  51.4788   1.5849   28.5212      2.23 R
 98   25.5000  51.4788   1.5849  -25.9788     -2.03 R
163   25.5000  53.0195   2.0108  -27.5195     -2.16 R
203   74.1000  48.1250   1.6622   25.9750      2.03 R
212   95.4000  48.1250   1.6622   47.2750      3.70 R
254   24.7000  51.1913   2.6847  -26.4913     -2.10 R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
```

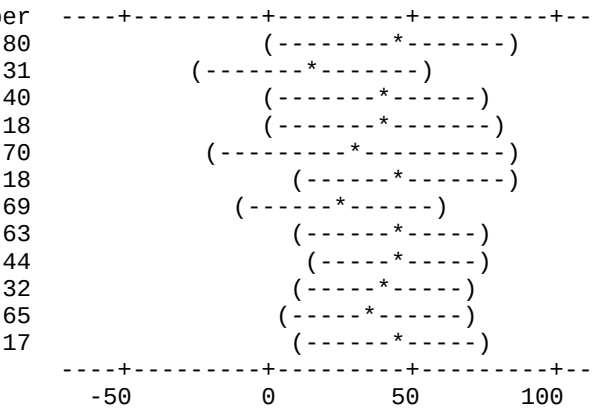
Grouping Information Using Tukey Method and 95.0% Confidence

Treat	N	Mean	Grouping
G	4	54.700	A B C
J	41	53.020	A
B	2	52.600	A B C
I	66	51.479	A
M	23	51.191	A
E	3	48.700	A B C
K	60	48.125	A
D	4	46.925	A B C
L	37	45.149	A B C
F	1	40.900	A B C D
H	11	33.364	C D
C	3	22.833	B C D
A	2	8.500	D

Means that do not share a letter are significantly different.

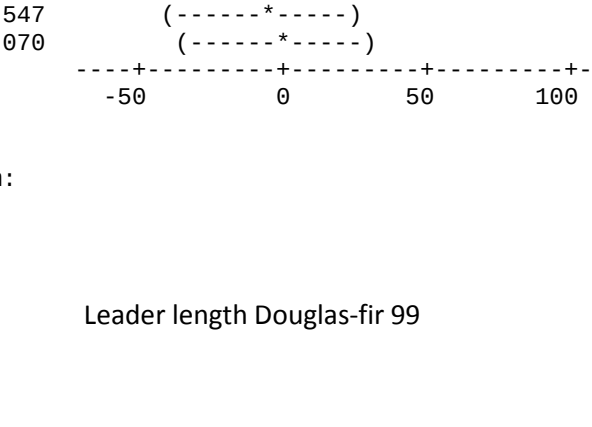
Tukey 95.0% Simultaneous Confidence Intervals
Response Variable L=Ht-1yr (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Lower	Center	Upper
B	1.40	44.10	86.80
C	-24.65	14.33	53.31
D	1.45	38.43	75.40
E	1.22	40.20	79.18
F	-19.90	32.40	84.70
G	9.22	46.20	83.18
H	-7.96	24.86	57.69
I	12.33	42.98	73.63
J	13.60	44.52	75.44
K	8.93	39.63	70.32
L	5.65	36.65	67.65
M	11.21	42.69	74.17



Treat = B subtracted from:

Treat	Lower	Center	Upper
C	-68.75	-29.77	9.212
D	-42.65	-5.67	31.304
E	-42.88	-3.90	35.079
F	-64.00	-11.70	40.596
G	-34.88	2.10	39.079
H	-52.06	-19.24	13.587
I	-31.77	-1.12	29.526
J	-30.50	0.42	31.340
K	-35.17	-4.47	26.217
L	-38.45	-7.45	23.547
M	-32.89	-1.41	30.070



Treat = C subtracted from:

```
Treat   Lower  Center  Upper  ----+---------+---------+---------+--
D       -8.52   24.09  56.70             (------*-----)
E       -9.00   25.87  60.73             (------*------)
F      -31.24   18.07  67.37         (---------*--------)
G       -0.75   31.87  64.48               (-----*------)
H      -17.28   10.53  38.34            (----*-----)
I        3.44   28.65  53.85                (----*----)
J        4.65   30.19  55.72                (----*----)
K        0.03   25.29  50.55              (----*----)
L       -3.32   22.32  47.95             (----*-----)
M        2.15   28.36  54.57               (-----*----)
                          ----+---------+---------+---------+--
                            -50         0        50       100
```

Treat = D subtracted from:

```
Treat   Lower  Center  Upper  ----+---------+---------+---------+--
E      -30.84    1.77  34.39         (-----*------)
F      -53.76   -6.03  41.71     (----------*--------)
G      -22.42    7.77  37.97            (-----*-----)
H      -38.49  -13.56  11.37        (----*----)
I      -17.43    4.55  26.54             (---*---)
J      -16.27    6.09  28.46             (---*----)
K      -20.85    1.20  23.25           (---*----)
L      -24.25   -1.78  20.70          (----*---)
M      -18.87    4.27  27.40            (----*---)
                          ----+---------+---------+---------+--
                            -50         0        50       100
```

Treat = E subtracted from:

```
Treat   Lower  Center  Upper  ----+---------+---------+---------+--
F      -57.10   -7.80  41.50     (--------*---------)
G      -26.61    6.00  38.61           (-----*------)
H      -43.15  -15.34  12.48       (-----*----)
I      -22.43    2.78  27.99            (----*----)
J      -21.22    4.32  29.86            (----*----)
K      -25.84   -0.57  24.69          (----*----)
L      -29.18   -3.55  22.08         (----*----)
M      -23.72    2.49  28.70           (----*-----)
                          ----+---------+---------+---------+--
                            -50         0        50       100
```

Treat = F subtracted from:

```
Treat   Lower  Center  Upper  ----+---------+---------+---------+--
G      -33.94  13.800  61.54         (---------*--------)
H      -52.13  -7.536  37.06      (--------*--------)
I      -32.44  10.579  53.60          (-------*--------)
J      -31.10  12.120  55.34          (-------*--------)
K      -35.83   7.225  50.28         (-------*--------)
L      -39.02   4.249  47.52        (--------*--------)
M      -33.33  10.291  53.91         (--------*--------)
                          ----+---------+---------+---------+--
                            -50         0        50       100
```

Treat = G subtracted from:

```
Treat   Lower  Center   Upper  ----+---------+---------+---------+--
```

```
H      -46.27  -21.34   3.595       (----*----)
I      -25.21   -3.22  18.766           (---*----)
J      -24.05   -1.68  20.686           (----*---)
K      -28.62   -6.57  15.475          (----*---)
L      -32.03   -9.55  12.923          (---*----)
M      -26.64   -3.51  19.623           (---*----)
                              ----+---------+---------+---------+--
                                -50         0        50       100
```

```
Treat = H  subtracted from:

Treat   Lower  Center  Upper  ----+---------+---------+---------+--
I       4.209   18.12  32.02               (--*-)
J       5.157   19.66  34.15               (--*--)
K       0.757   14.76  28.77              (--*--)
L      -2.879   11.79  26.45             (--*--)
M       2.175   17.83  33.48              (---*--)
                            ----+---------+---------+---------+--
                              -50         0        50       100
```

```
Treat = I  subtracted from:

Treat   Lower  Center   Upper  ----+---------+---------+---------+--
J       -6.95   1.541  10.032             (*-)
K      -10.97  -3.354   4.263            (*-)
L      -15.10  -6.330   2.439           (-*)
M      -10.63  -0.287  10.052            (-*-)
                             ----+---------+---------+---------+--
                               -50         0        50       100
```

```
Treat = J  subtracted from:

Treat   Lower  Center  Upper  ----+---------+---------+---------+--
K      -13.55  -4.895  3.757           (-*-)
L      -17.55  -7.871  1.811          (-*-)
M      -12.95  -1.828  9.296           (--*-)
                            ----+---------+---------+---------+--
                              -50         0        50       100
```

```
Treat = K  subtracted from:

Treat   Lower  Center   Upper  ----+---------+---------+---------+--
L      -11.90  -2.976   5.949            (*-)
M       -7.41   3.066  13.538             (-*-)
                             ----+---------+---------+---------+--
                               -50         0        50       100
```

```
Treat = L  subtracted from:

Treat   Lower  Center  Upper  ----+---------+---------+---------+--
M      -5.295   6.043  17.38             (-*-)
                            ----+---------+---------+---------+--
                              -50         0        50       100
```

```
Tukey Simultaneous Tests
Response Variable L=Ht-1yr (cm)
All Pairwise Comparisons among Levels of Treat
```

Treat = A subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
B	44.10	12.875	3.425	0.0350
C	14.33	11.754	1.219	0.9921
D	38.43	11.150	3.446	0.0326
E	40.20	11.754	3.420	0.0355
F	32.40	15.769	2.055	0.6961
G	46.20	11.150	4.143	0.0024
H	24.86	9.897	2.512	0.3662
I	42.98	9.241	4.651	0.0003
J	44.52	9.324	4.775	0.0002
K	39.63	9.255	4.282	0.0013
L	36.65	9.347	3.921	0.0059
M	42.69	9.492	4.498	0.0005

Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-29.77	11.754	-2.533	0.3527
D	-5.67	11.150	-0.509	1.0000
E	-3.90	11.754	-0.332	1.0000
F	-11.70	15.769	-0.742	0.9999
G	2.10	11.150	0.188	1.0000
H	-19.24	9.897	-1.944	0.7695
I	-1.12	9.241	-0.121	1.0000
J	0.42	9.324	0.045	1.0000
K	-4.47	9.255	-0.484	1.0000
L	-7.45	9.347	-0.797	0.9999
M	-1.41	9.492	-0.148	1.0000

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	24.09	9.834	2.450	0.4086
E	25.87	10.513	2.461	0.4012
F	18.07	14.867	1.215	0.9923
G	31.87	9.834	3.241	0.0624
H	10.53	8.386	1.256	0.9898
I	28.65	7.601	3.769	0.0105
J	30.19	7.701	3.920	0.0059
K	25.29	7.617	3.320	0.0489
L	22.32	7.729	2.887	0.1640
M	28.36	7.904	3.588	0.0202

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	1.77	9.834	0.181	1.0000
F	-6.03	14.395	-0.419	1.0000
G	7.77	9.104	0.854	0.9998
H	-13.56	7.518	-1.804	0.8483
I	4.55	6.630	0.687	1.0000
J	6.09	6.744	0.904	0.9996
K	1.20	6.649	0.180	1.0000
L	-1.78	6.777	-0.262	1.0000

M	4.27	6.975	0.612	1.0000

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-7.80	14.867	-0.525	1.0000
G	6.00	9.834	0.610	1.0000
H	-15.34	8.386	-1.829	0.8355
I	2.78	7.601	0.366	1.0000
J	4.32	7.701	0.561	1.0000
K	-0.57	7.617	-0.075	1.0000
L	-3.55	7.729	-0.459	1.0000
M	2.49	7.904	0.315	1.0000

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	13.800	14.40	0.9587	0.9992
H	-7.536	13.45	-0.5604	1.0000
I	10.579	12.97	0.8155	0.9998
J	12.120	13.03	0.9300	0.9994
K	7.225	12.98	0.5565	1.0000
L	4.249	13.05	0.3256	1.0000
M	10.291	13.15	0.7825	0.9999

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	-21.34	7.518	-2.838	0.1847
I	-3.22	6.630	-0.486	1.0000
J	-1.68	6.744	-0.249	1.0000
K	-6.57	6.649	-0.989	0.9989
L	-9.55	6.777	-1.409	0.9732
M	-3.51	6.975	-0.503	1.0000

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	18.12	4.193	4.320	0.0011
J	19.66	4.372	4.496	0.0005
K	14.76	4.223	3.495	0.0277
L	11.79	4.422	2.665	0.2716
M	17.83	4.720	3.777	0.0102

Treat = I subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
J	1.541	2.560	0.602	1.0000
K	-3.354	2.297	-1.460	0.9646
L	-6.330	2.644	-2.394	0.4482
M	-0.287	3.118	-0.092	1.0000

Treat = J subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
K	-4.895	2.609	-1.876	0.8097
L	-7.871	2.920	-2.696	0.2546
M	-1.828	3.354	-0.545	1.0000

Treat = K subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
L	-2.976	2.691	-1.106	0.9968
M	3.066	3.158	0.971	0.9991

Treat = L subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
M	6.043	3.419	1.767	0.8659

Results for: 99_fir

General Linear Model: Total Ht (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      13  A, B, C, D, E, F, G, H, I, J, K, L, M


Analysis of Variance for Total Ht (cm), using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS     F      P
Treat    12   540437   540437   45036  5.70  0.000
Error   245  1935071  1935071    7898
Total   257  2475508


S = 88.8721   R-Sq = 21.83%   R-Sq(adj) = 18.00%


Unusual Observations for Total Ht (cm)

       Total
Obs  Ht (cm)      Fit  SE Fit  Residual  St Resid
  1  278.900  415.750  62.842  -136.850     -2.18 RX
  2  503.200  450.100  44.436    53.100      0.69  X
  3  481.500  450.100  44.436    31.400      0.41  X
  4  425.000  392.100  44.436    32.900      0.43  X
  5  360.000  392.100  44.436   -32.100     -0.42  X
  6  408.900  392.100  44.436    16.800      0.22  X
 21  519.900  327.176  13.879   192.724      2.20  R
 32   89.000  323.002  11.473  -234.002     -2.66  R
 33  503.600  323.002  11.473   180.598      2.05  R
 34   59.000  323.002  11.473  -264.002     -3.00  R
 47  169.400  361.239  14.417  -191.839     -2.19  R
 50  100.500  361.239  14.417  -260.739     -2.97  R
 53  157.000  361.239  14.417  -204.239     -2.33  R
 59   83.000   80.250  62.842     2.750      0.04  X
 60   77.500   80.250  62.842    -2.750     -0.04  X
 61  552.600  415.750  62.842   136.850      2.18 RX
 62  213.000  239.867  51.310   -26.867     -0.37  X
 63  255.600  239.867  51.310    15.733      0.22  X
 64  251.000  239.867  51.310    11.133      0.15  X
 65  529.700  450.100  44.436    79.600      1.03  X
 66  286.000  450.100  44.436  -164.100     -2.13 RX
 67  449.500  488.167  51.310   -38.667     -0.53  X
 68  549.500  488.167  51.310    61.333      0.85  X
 69  465.500  488.167  51.310   -22.667     -0.31  X
 70  284.000  284.000  88.872     0.000         *  X
 71  374.500  392.100  44.436   -17.600     -0.23  X
 82  622.900  387.862  10.939   235.038      2.66  R
 87  587.800  387.862  10.939   199.938      2.27  R
 88  571.100  387.862  10.939   183.238      2.08  R
 89  583.900  387.862  10.939   196.038      2.22  R
 98  154.000  387.862  10.939  -233.862     -2.65  R
186  519.700  323.002  11.473   196.698      2.23  R
246  171.700  351.583  18.531  -179.883     -2.07  R
260  542.700  351.583  18.531   191.117      2.20  R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
```

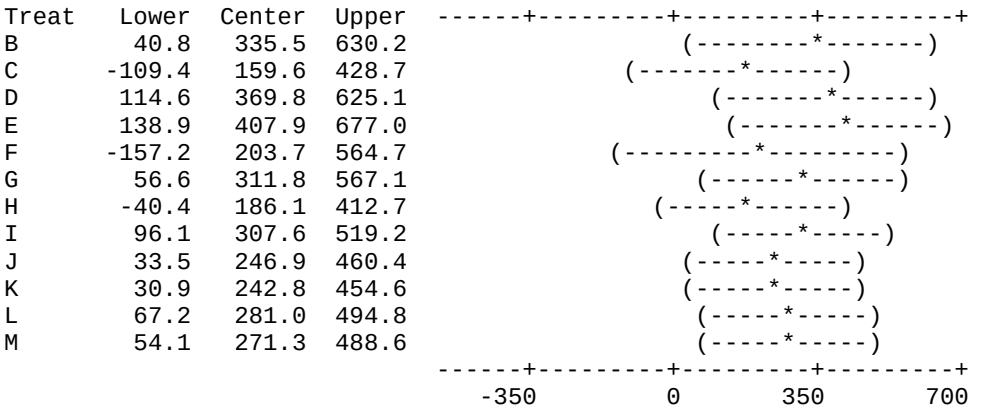
Grouping Information Using Tukey Method and 95.0% Confidence

Treat	N	Mean	Grouping
E	3	488.17	A B
D	4	450.10	A B C D E
B	2	415.75	A B C D E F G H
G	4	392.10	A B C D E F G H
I	66	387.86	A C
L	38	361.24	A B C D E F G H
M	23	351.58	A B C D E F G H
J	41	327.18	A B E H
K	60	323.00	B D E G H
F	1	284.00	A B C D E F G H I
H	11	266.36	F G H I
C	3	239.87	C D E F G H I
A	2	80.25	I

Means that do not share a letter are significantly different.

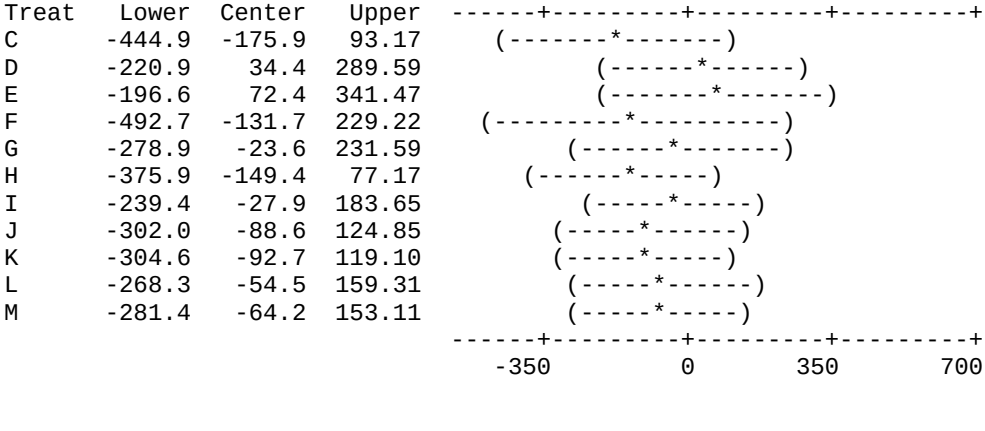
Tukey 95.0% Simultaneous Confidence Intervals
Response Variable Total Ht (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Lower	Center	Upper
B	40.8	335.5	630.2
C	-109.4	159.6	428.7
D	114.6	369.8	625.1
E	138.9	407.9	677.0
F	-157.2	203.7	564.7
G	56.6	311.8	567.1
H	-40.4	186.1	412.7
I	96.1	307.6	519.2
J	33.5	246.9	460.4
K	30.9	242.8	454.6
L	67.2	281.0	494.8
M	54.1	271.3	488.6



Treat = B subtracted from:

Treat	Lower	Center	Upper
C	-444.9	-175.9	93.17
D	-220.9	34.4	289.59
E	-196.6	72.4	341.47
F	-492.7	-131.7	229.22
G	-278.9	-23.6	231.59
H	-375.9	-149.4	77.17
I	-239.4	-27.9	183.65
J	-302.0	-88.6	124.85
K	-304.6	-92.7	119.10
L	-268.3	-54.5	159.31
M	-281.4	-64.2	153.11



Treat = C subtracted from:

```
Treat   Lower  Center  Upper  ------+---------+---------+---------+
D       -14.9  210.23  435.3                 (-----*-----)
E         7.7  248.30  488.9                 (------*------)
F      -296.2   44.13  384.5          (--------*---------)
G       -72.9  152.23  377.3               (-----*------)
H      -165.5   26.50  218.5            (-----*----)
I       -26.0  148.00  322.0               (----*----)
J       -89.0   87.31  263.6             (----*-----)
K       -91.2   83.13  257.5             (----*----)
L       -55.4  121.37  298.1              (----*-----)
M       -69.2  111.72  292.6              (----*----)
                              ------+---------+---------+---------+
                                 -350         0       350       700
```

Treat = D subtracted from:

```
Treat   Lower  Center   Upper  ------+---------+---------+---------+
E      -187.0    38.1  263.17            (-----*------)
F      -495.6  -166.1  163.42   (--------*---------)
G      -266.4   -58.0  150.41         (-----*-----)
H      -355.8  -183.7  -11.65       (----*----)
I      -214.0   -62.2   89.53           (---*----)
J      -277.3  -122.9   31.46         (---*----)
K      -279.3  -127.1   25.10         (---*----)
L      -243.8   -88.9   66.07          (---*----)
M      -258.2   -98.5   61.15          (---*----)
                             ------+---------+---------+---------+
                                -350         0       350       700
```

Treat = E subtracted from:

```
Treat   Lower  Center   Upper  ------+---------+---------+---------+
F      -544.5  -204.2  136.16  (---------*---------)
G      -321.2   -96.1  129.04        (-----*------)
H      -413.8  -221.8  -29.83     (-----*----)
I      -274.3  -100.3   73.68         (----*----)
J      -337.3  -161.0   15.29       (----*----)
K      -339.5  -165.2    9.20       (----*----)
L      -303.7  -126.9   49.82        (----*----)
M      -317.5  -136.6   44.34        (----*----)
                             ------+---------+---------+---------+
                                -350         0       350       700
```

Treat = F subtracted from:

```
Treat   Lower  Center  Upper  ------+---------+---------+---------+
G      -221.4  108.10  437.6           (--------*---------)
H      -325.5  -17.64  290.2        (-------*--------)
I      -193.1  103.86  400.8           (--------*-------)
J      -255.1   43.18  341.5          (-------*--------)
K      -258.2   39.00  336.2          (-------*--------)
L      -221.3   77.24  375.8           (-------*--------)
M      -233.5   67.58  368.7          (--------*--------)
                             ------+---------+---------+---------+
                                -350         0       350       700
```

Treat = G subtracted from:

```
Treat   Lower  Center   Upper  ------+---------+---------+---------+
```

```
H      -297.8  -125.7   46.35         (----*----)
I      -156.0    -4.2  147.53              (---*---)
J      -219.3   -64.9   89.46           (---*----)
K      -221.3   -69.1   83.10           (---*---)
L      -185.8   -30.9  124.07            (---*----)
M      -200.2   -40.5  119.15           (----*---)
                              ------+---------+---------+---------+
                                 -350         0       350       700
```

Treat = H subtracted from:

```
Treat   Lower  Center  Upper  ------+---------+---------+---------+
I       25.51  121.50  217.5                  (-*--)
J      -39.27   60.81  160.9                (--*--)
K      -40.03   56.64  153.3                (--*-)
L       -6.03   94.88  195.8                 (--*--)
M      -22.83   85.22  193.3                (--*---)
                            ------+---------+---------+---------+
                               -350         0       350       700
```

Treat = I subtracted from:

```
Treat   Lower  Center   Upper  ------+---------+---------+---------+
J      -119.3  -60.69   -2.08              (*-)
K      -117.4  -64.86  -12.29              (*-)
L       -86.6  -26.62   33.39               (*-)
M      -107.6  -36.28   35.09              (-*-)
                              ------+---------+---------+---------+
                                 -350         0       350       700
```

Treat = J subtracted from:

```
Treat   Lower  Center   Upper  ------+---------+---------+---------+
K      -63.89  -4.174   55.55               (-*-)
L      -32.30  34.064  100.43                (-*-)
M      -52.37  24.407  101.19                (-*-)
                              ------+---------+---------+---------+
                                 -350         0       350       700
```

Treat = K subtracted from:

```
Treat   Lower  Center   Upper  ------+---------+---------+---------+
L      -22.87   38.24   99.34               (-*-)
M      -43.70   28.58  100.86               (-*-)
                              ------+---------+---------+---------+
                                 -350         0       350       700
```

Treat = L subtracted from:

```
Treat   Lower  Center  Upper  ------+---------+---------+---------+
M      -87.52  -9.657  68.21              (--*-)
                            ------+---------+---------+---------+
                               -350         0       350       700
```

Tukey Simultaneous Tests
Response Variable Total Ht (cm)
All Pairwise Comparisons among Levels of Treat

Treat = A subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
B	335.5	88.87	3.775	0.0103
C	159.6	81.13	1.967	0.7544
D	369.8	76.97	4.805	0.0001
E	407.9	81.13	5.028	0.0001
F	203.7	108.85	1.872	0.8120
G	311.8	76.97	4.052	0.0035
H	186.1	68.32	2.724	0.2395
I	307.6	63.79	4.822	0.0001
J	246.9	64.36	3.837	0.0081
K	242.8	63.88	3.800	0.0094
L	281.0	64.47	4.358	0.0010
M	271.3	65.52	4.141	0.0024

Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-175.9	81.13	-2.168	0.6149
D	34.4	76.97	0.446	1.0000
E	72.4	81.13	0.893	0.9996
F	-131.7	108.85	-1.210	0.9926
G	-23.6	76.97	-0.307	1.0000
H	-149.4	68.32	-2.187	0.6011
I	-27.9	63.79	-0.437	1.0000
J	-88.6	64.36	-1.376	0.9778
K	-92.7	63.88	-1.452	0.9661
L	-54.5	64.47	-0.845	0.9998
M	-64.2	65.52	-0.979	0.9990

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	210.23	67.88	3.0973	0.0945
E	248.30	72.56	3.4218	0.0353
F	44.13	102.62	0.4301	1.0000
G	152.23	67.88	2.2428	0.5594
H	26.50	57.89	0.4577	1.0000
I	148.00	52.46	2.8209	0.1923
J	87.31	53.15	1.6426	0.9166
K	83.13	52.58	1.5812	0.9360
L	121.37	53.30	2.2773	0.5338
M	111.72	54.55	2.0478	0.7009

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	38.1	67.88	0.561	1.0000
F	-166.1	99.36	-1.672	0.9062
G	-58.0	62.84	-0.923	0.9994
H	-183.7	51.89	-3.541	0.0237
I	-62.2	45.76	-1.360	0.9799
J	-122.9	46.55	-2.641	0.2858
K	-127.1	45.89	-2.769	0.2166
L	-88.9	46.72	-1.902	0.7946

M	-98.5	48.15	-2.046	0.7020

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-204.2	102.62	-1.990	0.7401
G	-96.1	67.88	-1.415	0.9723
H	-221.8	57.89	-3.832	0.0083
I	-100.3	52.46	-1.912	0.7888
J	-161.0	53.15	-3.029	0.1140
K	-165.2	52.58	-3.141	0.0834
L	-126.9	53.30	-2.381	0.4572
M	-136.6	54.55	-2.504	0.3718

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	108.10	99.36	1.0879	0.9972
H	-17.64	92.82	-0.1900	1.0000
I	103.86	89.54	1.1599	0.9950
J	43.18	89.95	0.4800	1.0000
K	39.00	89.61	0.4352	1.0000
L	77.24	90.03	0.8579	0.9997
M	67.58	90.78	0.7444	0.9999

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	-125.7	51.89	-2.423	0.4273
I	-4.2	45.76	-0.093	1.0000
J	-64.9	46.55	-1.395	0.9753
K	-69.1	45.89	-1.506	0.9552
L	-30.9	46.72	-0.661	1.0000
M	-40.5	48.15	-0.842	0.9998

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	121.50	28.94	4.198	0.0019
J	60.81	30.18	2.015	0.7231
K	56.64	29.15	1.943	0.7698
L	94.88	30.43	3.118	0.0892
M	85.22	32.58	2.616	0.3006

Treat = I subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
J	-60.69	17.67	-3.434	0.0340
K	-64.86	15.85	-4.091	0.0030
L	-26.62	18.10	-1.471	0.9625
M	-36.28	21.52	-1.686	0.9007

Treat = J subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
K	-4.174	18.01	-0.2318	1.0000
L	34.064	20.01	1.7022	0.8943
M	24.407	23.15	1.0542	0.9980

Treat = K subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
L	38.24	18.43	2.075	0.6817
M	28.58	21.80	1.311	0.9852

Treat = L subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
M	-9.657	23.48	-0.4113	1.000

Results for: 99_pine

General Linear Model: dbh (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      12  B, C, D, E, F, G, H, I, J, K, L, M


Analysis of Variance for dbh (cm), using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS     F      P
Treat    11  136.856  136.856  12.441  3.38  0.000
Error   178  654.643  654.643   3.678
Total   189  791.499


S = 1.91775   R-Sq = 17.29%   R-Sq(adj) = 12.18%


Unusual Observations for dbh (cm)

Obs  dbh (cm)     Fit  SE Fit  Residual  St Resid
  3    7.8000  7.8000  1.9178    0.0000         *  X
  4    2.3000  2.9333  1.1072   -0.6333     -0.40  X
  5    2.8000  2.9333  1.1072   -0.1333     -0.09  X
  6    3.7000  2.9333  1.1072    0.7667      0.49  X
  7    9.0000  6.0000  1.3561    3.0000      2.21 RX
  8    3.0000  6.0000  1.3561   -3.0000     -2.21 RX
  9    7.5000  7.6000  1.1072   -0.1000     -0.06  X
 10    8.2000  7.6000  1.1072    0.6000      0.38  X
 11    7.1000  7.6000  1.1072   -0.5000     -0.32  X
 12    3.7000  3.7000  1.9178    0.0000         *  X
 13    4.6000  4.6000  1.9178    0.0000         *  X
 19    7.7000  3.7667  0.7829    3.9333      2.25  R
103    9.9000  5.4393  0.3624    4.4607      2.37  R
111    1.2000  5.2800  0.2859   -4.0800     -2.15  R
112    1.3000  5.2800  0.2859   -3.9800     -2.10  R
120    9.3000  5.2800  0.2859    4.0200      2.12  R
128    9.1000  5.2800  0.2859    3.8200      2.01  R
177   10.7000  6.9071  0.3624    3.7929      2.01  R
184    2.2000  6.9071  0.3624   -4.7071     -2.50  R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

Treat   N   Mean  Grouping
B       1  7.800  A B C D
E       3  7.600  A B C D
L      28  6.907  A
M      16  6.338  A B C D
I      56  6.314  A B C D
D       2  6.000  A B C D
J      28  5.439  A B C D
K      45  5.280        D
G       1  4.600  A B C D
H       6  3.767      C D
F       1  3.700  A B C D
```

```
C       3  2.933    B C D

Means that do not share a letter are significantly different.


Tukey 95.0% Simultaneous Confidence Intervals
Response Variable dbh (cm)
All Pairwise Comparisons among Levels of Treat
Treat = B  subtracted from:

Treat   Lower  Center  Upper  ---------+---------+---------+-------
C      -12.19  -4.867  2.461    (---------*----------)
D       -9.57  -1.800  5.973       (----------*-----------)
E       -7.53  -0.200  7.128          (----------*---------)
F      -13.08  -4.100  4.875  (------------*------------)
G      -12.18  -3.200  5.775    (------------*------------)
H      -10.89  -4.033  2.821     (---------*---------)
I       -7.89  -1.486  4.917          (--------*--------)
J       -8.82  -2.361  4.098        (---------*--------)
K       -8.94  -2.520  3.896        (--------*---------)
L       -7.35  -0.893  5.566          (---------*--------)
M       -8.00  -1.462  5.079          (--------*--------)
                        ---------+---------+---------+-------
                              -7.0       0.0       7.0


Treat = C  subtracted from:

Treat   Lower  Center  Upper  ---------+---------+---------+-------
D      -2.727  3.0667  8.860                (-------*--------)
E      -0.515  4.6667  9.848                   (-------*------)
F      -6.561  0.7667  8.095           (---------*----------)
G      -5.661  1.6667  8.995            (---------*----------)
H      -3.654  0.8333  5.321               (-----*------)
I      -0.380  3.3810  7.142                   (-----*----)
J      -1.349  2.5060  6.361                 (-----*----)
K      -1.438  2.3467  6.131                 (----*-----)
L       0.118  3.9738  7.829                   (-----*----)
M      -0.589  3.4042  7.397                  (-----*-----)
                        ---------+---------+---------+-------
                              -7.0       0.0       7.0


Treat = D  subtracted from:

Treat   Lower  Center  Upper  ---------+---------+---------+-------
E       -4.19   1.600  7.393              (-------*--------)
F      -10.07  -2.300  5.473       (----------*----------)
G       -9.17  -1.400  6.373        (----------*----------)
H       -7.42  -2.233  2.948          (-------*------)
I       -4.25   0.314  4.881               (-----*------)
J       -5.21  -0.561  4.084             (-----*------)
K       -5.31  -0.720  3.866            (------*------)
L       -3.74   0.907  5.552               (-----*------)
M       -4.42   0.337  5.097              (-----*------)
                        ---------+---------+---------+-------
                              -7.0       0.0       7.0


Treat = E  subtracted from:

Treat   Lower  Center   Upper  ---------+---------+---------+-------
F      -11.23  -3.900  3.4281     (---------*----------)
```

```
G      -10.33  -3.000  4.3281      (----------*---------)
H       -8.32  -3.833  0.6542         (------*-----)
I       -5.05  -1.286  2.4752              (----*-----)
J       -6.02  -2.161  1.6946            (-----*----)
K       -6.10  -2.320  1.4642            (-----*----)
L       -4.55  -0.693  3.1625               (----*-----)
M       -5.26  -1.262  2.7303             (-----*-----)
                              ---------+---------+---------+-------
                                    -7.0       0.0       7.0
```

Treat = F subtracted from:

```
Treat   Lower   Center  Upper  ---------+---------+---------+-------
G      -8.075  0.90000  9.875         (------------*------------)
H      -6.788  0.06667  6.921           (---------*---------)
I      -3.788  2.61429  9.017                (--------*--------)
J      -4.719  1.73929  8.198              (--------*---------)
K      -4.836  1.58000  7.996              (--------*--------)
L      -3.252  3.20714  9.666                (---------*--------)
M      -3.904  2.63750  9.179               (---------*--------)
                              ---------+---------+---------+-------
                                    -7.0       0.0       7.0
```

Treat = G subtracted from:

```
Treat   Lower   Center  Upper  ---------+---------+---------+-------
H      -7.688  -0.8333  6.021         (---------*---------)
I      -4.688   1.7143  8.117             (--------*---------)
J      -5.619   0.8393  7.298           (--------*--------)
K      -5.736   0.6800  7.096           (--------*--------)
L      -4.152   2.3071  8.766             (--------*---------)
M      -4.804   1.7375  8.279           (--------*---------)
                              ---------+---------+---------+-------
                                    -7.0       0.0       7.0
```

Treat = H subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
I      -0.179   2.548  5.274                   (---*---)
J      -1.182   1.673  4.528                 (---*---)
K      -1.245   1.513  4.272                 (---*---)
L       0.285   3.140  5.995                   (---*----)
M      -0.467   2.571  5.609                  (----*---)
                             ---------+---------+---------+-------
                                   -7.0       0.0       7.0
```

Treat = I subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
J      -2.344  -0.875  0.5939                (-*-)
K      -2.305  -1.034  0.2362                (-*)
L      -0.876   0.593  2.0617                  (-*-)
M      -1.776   0.023  1.8222                (--*--)
                              ---------+---------+---------+-------
                                    -7.0       0.0       7.0
```

Treat = J subtracted from:

```
Treat   Lower   Center  Upper  ---------+---------+---------+-------
K      -1.687  -0.1593  1.368                  (-*-)
L      -0.228   1.4679  3.164                    (-*--)
M      -1.091   0.8982  2.887                  (--*--)
                                ---------+---------+---------+-------
                                      -7.0       0.0       7.0


Treat = K  subtracted from:

Treat    Lower  Center  Upper  ---------+---------+---------+-------
L       0.0996   1.627  3.155                    (-*--)
M      -0.7897   1.058  2.905                   (--*-)
                                ---------+---------+---------+-------
                                      -7.0       0.0       7.0


Treat = L  subtracted from:

Treat   Lower   Center  Upper  ---------+---------+---------+-------
M      -2.559  -0.5696  1.419                (--*--)
                                ---------+---------+---------+-------
                                      -7.0       0.0       7.0


Tukey Simultaneous Tests
Response Variable dbh (cm)
All Pairwise Comparisons among Levels of Treat
Treat = B  subtracted from:

       Difference       SE of           Adjusted
Treat    of Means  Difference  T-Value   P-Value
C          -4.867       2.214   -2.198    0.5536
D          -1.800       2.349   -0.766    0.9998
E          -0.200       2.214   -0.090    1.0000
F          -4.100       2.712   -1.512    0.9356
G          -3.200       2.712   -1.180    0.9899
H          -4.033       2.071   -1.947    0.7279
I          -1.486       1.935   -0.768    0.9998
J          -2.361       1.952   -1.210    0.9876
K          -2.520       1.939   -1.300    0.9782
L          -0.893       1.952   -0.457    1.0000
M          -1.462       1.977   -0.740    0.9999


Treat = C  subtracted from:

       Difference       SE of           Adjusted
Treat    of Means  Difference  T-Value   P-Value
D          3.0667       1.751   1.7517    0.8412
E          4.6667       1.566   2.9803    0.1233
F          0.7667       2.214   0.3462    1.0000
G          1.6667       2.214   0.7526    0.9998
H          0.8333       1.356   0.6145    1.0000
I          3.3810       1.136   2.9749    0.1249
J          2.5060       1.165   2.1510    0.5871
K          2.3467       1.144   2.0521    0.6571
L          3.9738       1.165   3.4109    0.0373
M          3.4042       1.207   2.8214    0.1802


Treat = D  subtracted from:
```

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	1.600	1.751	0.914	0.9989
F	-2.300	2.349	-0.979	0.9980
G	-1.400	2.349	-0.596	1.0000
H	-2.233	1.566	-1.426	0.9568
I	0.314	1.380	0.228	1.0000
J	-0.561	1.404	-0.399	1.0000
K	-0.720	1.386	-0.520	1.0000
L	0.907	1.404	0.646	1.0000
M	0.337	1.438	0.235	1.0000

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-3.900	2.214	-1.761	0.8365
G	-3.000	2.214	-1.355	0.9703
H	-3.833	1.356	-2.827	0.1780
I	-1.286	1.136	-1.131	0.9929
J	-2.161	1.165	-1.855	0.7851
K	-2.320	1.144	-2.029	0.6732
L	-0.693	1.165	-0.595	1.0000
M	-1.262	1.207	-1.046	0.9963

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	0.90000	2.712	0.33184	1.0000
H	0.06667	2.071	0.03218	1.0000
I	2.61429	1.935	1.35119	0.9708
J	1.73929	1.952	0.89117	0.9991
K	1.58000	1.939	0.81488	0.9996
L	3.20714	1.952	1.64326	0.8904
M	2.63750	1.977	1.33425	0.9735

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	-0.8333	2.071	-0.4023	1.0000
I	1.7143	1.935	0.8860	0.9992
J	0.8393	1.952	0.4300	1.0000
K	0.6800	1.939	0.3507	1.0000
L	2.3071	1.952	1.1821	0.9897
M	1.7375	1.977	0.8790	0.9992

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	2.548	0.8238	3.093	0.0923
J	1.673	0.8627	1.939	0.7333
K	1.513	0.8335	1.816	0.8074
L	3.140	0.8627	3.640	0.0180
M	2.571	0.9181	2.800	0.1890

Treat = I subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
J	-0.875	0.4439	-1.971	0.7121
K	-1.034	0.3839	-2.694	0.2381
L	0.593	0.4439	1.336	0.9732
M	0.023	0.5436	0.043	1.0000

Treat = J subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
K	-0.1593	0.4616	-0.3451	1.0000
L	1.4679	0.5125	2.8639	0.1634
M	0.8982	0.6010	1.4945	0.9404

Treat = K subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
L	1.627	0.4616	3.525	0.0261
M	1.058	0.5582	1.894	0.7611

Treat = L subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
M	-0.5696	0.6010	-0.9478	0.9985

Results for: 99_pine

General Linear Model: L=Ht-1yr (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      13  A, B, C, D, E, F, G, H, I, J, K, L, M


Analysis of Variance for L=Ht-1yr (cm), using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS     F      P
Treat    12   8949.0   8949.0   745.8  5.62  0.000
Error   187  24825.0  24825.0   132.8
Total   199  33774.0


S = 11.5219   R-Sq = 26.50%   R-Sq(adj) = 21.78%


Unusual Observations for L=Ht-1yr (cm)

     L=Ht-1yr
Obs      (cm)      Fit   SE Fit  Residual  St Resid
  1    9.0000   8.5000   8.1472    0.5000      0.06 X
  2    8.0000   8.5000   8.1472   -0.5000     -0.06 X
  3   49.7000  49.7000  11.5219   -0.0000         * X
  4   23.4000  22.8333   6.6522    0.5667      0.06 X
  5   21.1000  22.8333   6.6522   -1.7333     -0.18 X
  6   24.0000  22.8333   6.6522    1.1667      0.12 X
  7   46.4000  41.2000   8.1472    5.2000      0.64 X
  8   36.0000  41.2000   8.1472   -5.2000     -0.64 X
  9   45.5000  48.7000   6.6522   -3.2000     -0.34 X
 10   45.1000  48.7000   6.6522   -3.6000     -0.38 X
 11   55.5000  48.7000   6.6522    6.8000      0.72 X
 12   40.9000  40.9000  11.5219   -0.0000         * X
 13   53.0000  53.0000  11.5219    0.0000         * X
 14   51.9000  29.3571   4.3549   22.5429      2.11 R
 39   80.0000  51.6684   1.5261   28.3316      2.48 R
 40   25.5000  51.6684   1.5261  -26.1684     -2.29 R
 59   75.9000  51.6684   1.5261   24.2316      2.12 R
 80   74.2000  50.8323   2.0694   23.3677      2.06 R
105   25.5000  50.8323   2.0694  -25.3323     -2.23 R
114   23.8000  49.5596   1.6806  -25.7596     -2.26 R
116   26.2000  49.5596   1.6806  -23.3596     -2.05 R
145   74.1000  49.5596   1.6806   24.5404      2.15 R
154   95.4000  49.5596   1.6806   45.8404      4.02 R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

Treat   N    Mean  Grouping
G       1  53.000  A B C D E F
I      57  51.668  A
J      31  50.832  A
B       1  49.700  A B C D E F
K      47  49.560  A
E       3  48.700  A   C   E
```

```
L      27  47.348  A   C   E
M      18  44.822  A   C   E
D       2  41.200  A B C D E F
F       1  40.900  A B C D E F
H       7  29.357          E F
C       3  22.833      C D E F
A       2   8.500    B   D   F
```

Means that do not share a letter are significantly different.

Tukey 95.0% Simultaneous Confidence Intervals
Response Variable L=Ht-1yr (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

```
Treat   Lower  Center  Upper  ----+---------+---------+---------+--
B       -6.20   41.20  88.60              (--------*---------)
C      -20.99   14.33  49.66           (------*------)
D       -6.00   32.70  71.40              (-------*------)
E        4.87   40.20  75.53                (------*------)
F      -15.00   32.40  79.80            (--------*---------)
G       -2.90   44.50  91.90              (---------*--------)
H      -10.17   20.86  51.89             (-----*-----)
I       15.33   43.17  71.01                  (-----*----)
J       14.10   42.33  70.57                  (----*-----)
K       13.12   41.06  69.00                  (----*-----)
L       10.49   38.85  67.21                (-----*----)
M        7.48   36.32  65.17               (-----*-----)
                          ----+---------+---------+---------+--
                            -50         0        50       100
```

Treat = B subtracted from:

```
Treat   Lower  Center  Upper  ----+---------+---------+---------+--
C      -71.55  -26.87  17.82  (--------*--------)
D      -55.90   -8.50  38.90     (--------*---------)
E      -45.69   -1.00  43.69       (--------*--------)
F      -63.53   -8.80  45.93   (----------*----------)
G      -51.43    3.30  58.03      (----------*----------)
H      -61.71  -20.34  21.03    (-------*-------)
I      -37.07    1.97  41.01         (------*-------)
J      -38.19    1.13  40.45        (-------*-------)
K      -39.25   -0.14  38.97        (-------*-------)
L      -41.76   -2.35  37.06        (-------*------)
M      -44.64   -4.88  34.88       (-------*-------)
                          ----+---------+---------+---------+--
                            -50         0        50       100
```

Treat = C subtracted from:

```
Treat   Lower  Center  Upper  ----+---------+---------+---------+--
D      -16.96  18.367  53.69            (------*------)
E       -5.73  25.867  57.46              (-----*-----)
F      -26.62  18.067  62.75          (--------*--------)
G      -14.52  30.167  74.85            (--------*--------)
H      -20.18   6.524  33.23           (----*-----)
I        5.91  28.835  51.76                (----*---)
J        4.60  27.999  51.40                (----*---)
K        3.68  26.726  49.77                (---*----)
L        0.96  24.515  48.07               (----*----)
```

```
M       -2.14  21.989  46.12               (---*----)
                                  ----+---------+---------+---------+--
                                    -50         0        50       100
```

```
Treat = D  subtracted from:

Treat   Lower  Center  Upper  ----+---------+---------+---------+--
E      -27.83   7.50  42.83          (------*-------)
F      -47.70  -0.30  47.10       (---------*--------)
G      -35.60  11.80  59.20          (---------*---------)
H      -42.87 -11.84  19.19        (------*-----)
I      -17.37  10.47  38.31              (----*-----)
J      -18.60   9.63  37.87            (-----*-----)
K      -19.58   8.36  36.30            (-----*----)
L      -22.21   6.15  34.51            (----*-----)
M      -25.22   3.62  32.47           (-----*----)
                                  ----+---------+---------+---------+--
                                    -50         0        50       100
```

```
Treat = E  subtracted from:

Treat   Lower  Center   Upper  ----+---------+---------+---------+--
F      -52.49  -7.80  36.886       (-------*--------)
G      -40.39   4.30  48.986         (--------*--------)
H      -46.05 -19.34   7.362        (----*----)
I      -19.96   2.97  25.892             (----*---)
J      -21.27   2.13  25.531             (---*----)
K      -22.19   0.86  23.905             (---*----)
L      -24.90  -1.35  22.200           (----*---)
M      -28.01  -3.88  20.255          (----*----)
                                   ----+---------+---------+---------+--
                                     -50         0        50       100
```

```
Treat = F  subtracted from:

Treat   Lower  Center  Upper  ----+---------+---------+---------+--
G      -42.63  12.10  66.83        (----------*----------)
H      -52.91 -11.54  29.83     (--------*-------)
I      -28.27  10.77  49.81          (-------*-------)
J      -29.39   9.93  49.25          (-------*-------)
K      -30.45   8.66  47.77          (-------*-------)
L      -32.96   6.45  45.86         (-------*-------)
M      -35.84   3.92  43.68         (-------*-------)
                                  ----+---------+---------+---------+--
                                    -50         0        50       100
```

```
Treat = G  subtracted from:

Treat   Lower  Center  Upper  ----+---------+---------+---------+--
H      -65.01 -23.64  17.73   (-------*--------)
I      -40.37  -1.33  37.71        (-------*-------)
J      -41.49  -2.17  37.15        (-------*------)
K      -42.55  -3.44  35.67       (-------*-------)
L      -45.06  -5.65  33.76       (-------*-------)
M      -47.94  -8.18  31.58      (-------*-------)
                                  ----+---------+---------+---------+--
                                    -50         0        50       100
```

```
Treat = H  subtracted from:

Treat   Lower  Center  Upper  ----+---------+---------+---------+--
I       6.812   22.31  37.81               (--*---)
J       5.281   21.48  37.67               (--*---)
K       4.524   20.20  35.88               (--*--)
L       1.577   17.99  34.40              (---*--)
M      -1.773   15.47  32.70              (--*---)
                           ----+---------+---------+---------+--
                             -50         0        50       100


Treat = I  subtracted from:

Treat   Lower  Center  Upper  ----+---------+---------+---------+--
J       -9.47  -0.836  7.800            (-*-)
K       -9.73  -2.109  5.516            (-*)
L      -13.36  -4.320  4.721           (-*-)
M      -17.31  -6.846  3.617           (-*-)
                           ----+---------+---------+---------+--
                             -50         0        50       100


Treat = J  subtracted from:

Treat   Lower  Center  Upper  ----+---------+---------+---------+--
K      -10.23  -1.273  7.681            (-*-)
L      -13.67  -3.484  6.703           (-*-)
M      -17.48  -6.010  5.458           (-*-)
                           ----+---------+---------+---------+--
                             -50         0        50       100


Treat = K  subtracted from:

Treat   Lower  Center  Upper  ----+---------+---------+---------+--
L      -11.56  -2.211  7.134            (-*)
M      -15.46  -4.737  5.990           (-*-)
                           ----+---------+---------+---------+--
                             -50         0        50       100


Treat = L  subtracted from:

Treat   Lower  Center  Upper  ----+---------+---------+---------+--
M      -14.30  -2.526  9.250           (-*--)
                           ----+---------+---------+---------+--
                             -50         0        50       100


Tukey Simultaneous Tests
Response Variable L=Ht-1yr (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A  subtracted from:

       Difference       SE of           Adjusted
Treat    of Means  Difference  T-Value   P-Value
B           41.20      14.111    2.920    0.1607
C           14.33      10.518    1.363    0.9784
D           32.70      11.522    2.838    0.1941
E           40.20      10.518    3.822    0.0112
F           32.40      14.111    2.296    0.5229
G           44.50      14.111    3.153    0.0888
```

H	20.86	9.238	2.258	0.5506
I	43.17	8.289	5.208	0.0001
J	42.33	8.406	5.036	0.0001
K	41.06	8.319	4.936	0.0002
L	38.85	8.444	4.601	0.0006
M	36.32	8.588	4.229	0.0025

Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-26.87	13.30	-2.019	0.7189
D	-8.50	14.11	-0.602	1.0000
E	-1.00	13.30	-0.075	1.0000
F	-8.80	16.29	-0.540	1.0000
G	3.30	16.29	0.203	1.0000
H	-20.34	12.32	-1.652	0.9108
I	1.97	11.62	0.169	1.0000
J	1.13	11.71	0.097	1.0000
K	-0.14	11.64	-0.012	1.0000
L	-2.35	11.73	-0.200	1.0000
M	-4.88	11.84	-0.412	1.0000

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	18.367	10.518	1.7462	0.8728
E	25.867	9.408	2.7496	0.2356
F	18.067	13.304	1.3580	0.9790
G	30.167	13.304	2.2674	0.5436
H	6.524	7.951	0.8205	0.9998
I	28.835	6.825	4.2249	0.0026
J	27.999	6.967	4.0190	0.0055
K	26.726	6.861	3.8953	0.0086
L	24.515	7.012	3.4961	0.0327
M	21.989	7.185	3.0603	0.1135

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	7.50	10.518	0.713	1.0000
F	-0.30	14.111	-0.021	1.0000
G	11.80	14.111	0.836	0.9998
H	-11.84	9.238	-1.282	0.9869
I	10.47	8.289	1.263	0.9885
J	9.63	8.406	1.146	0.9951
K	8.36	8.319	1.005	0.9986
L	6.15	8.444	0.728	0.9999
M	3.62	8.588	0.422	1.0000

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-7.80	13.304	-0.586	1.0000
G	4.30	13.304	0.323	1.0000
H	-19.34	7.951	-2.433	0.4260

I	2.97	6.825	0.435	1.0000
J	2.13	6.967	0.306	1.0000
K	0.86	6.861	0.125	1.0000
L	-1.35	7.012	-0.193	1.0000
M	-3.88	7.185	-0.540	1.0000

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	12.10	16.29	0.7426	0.9999
H	-11.54	12.32	-0.9371	0.9993
I	10.77	11.62	0.9265	0.9994
J	9.93	11.71	0.8485	0.9997
K	8.66	11.64	0.7437	0.9999
L	6.45	11.73	0.5496	1.0000
M	3.92	11.84	0.3313	1.0000

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	-23.64	12.32	-1.919	0.7820
I	-1.33	11.62	-0.115	1.0000
J	-2.17	11.71	-0.185	1.0000
K	-3.44	11.64	-0.295	1.0000
L	-5.65	11.73	-0.482	1.0000
M	-8.18	11.84	-0.691	1.0000

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	22.31	4.615	4.835	0.0002
J	21.48	4.822	4.454	0.0010
K	20.20	4.668	4.328	0.0017
L	17.99	4.887	3.681	0.0180
M	15.47	5.132	3.013	0.1279

Treat = I subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
J	-0.836	2.571	-0.325	1.0000
K	-2.109	2.270	-0.929	0.9993
L	-4.320	2.692	-1.605	0.9264
M	-6.846	3.115	-2.198	0.5942

Treat = J subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
K	-1.273	2.666	-0.477	1.0000
L	-3.484	3.033	-1.149	0.9950
M	-6.010	3.414	-1.760	0.8664

Treat = K subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
L	-2.211	2.782	-0.795	0.9999
M	-4.737	3.194	-1.483	0.9582

Treat = L subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
M	-2.526	3.506	-0.7205	1.000

Results for: 99_pine

General Linear Model: Total Ht (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      13  A, B, C, D, E, F, G, H, I, J, K, L, M


Analysis of Variance for Total Ht (cm), using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS     F      P
Treat    12   511191   511191   42599  6.04  0.000
Error   188  1325068  1325068    7048
Total   200  1836259


S = 83.9538   R-Sq = 27.84%   R-Sq(adj) = 23.23%


Unusual Observations for Total Ht (cm)

       Total
Obs  Ht (cm)      Fit  SE Fit  Residual  St Resid
  1   83.000   80.250  59.364     2.750      0.05  X
  2   77.500   80.250  59.364    -2.750     -0.05  X
  3  552.600  552.600  83.954    -0.000         *  X
  4  213.000  239.867  48.471   -26.867     -0.39  X
  5  255.600  239.867  48.471    15.733      0.23  X
  6  251.000  239.867  48.471    11.133      0.16  X
  7  529.700  407.850  59.364   121.850      2.05 RX
  8  286.000  407.850  59.364  -121.850     -2.05 RX
  9  449.500  488.167  48.471   -38.667     -0.56  X
 10  549.500  488.167  48.471    61.333      0.89  X
 11  465.500  488.167  48.471   -22.667     -0.33  X
 12  284.000  284.000  83.954    -0.000         *  X
 13  374.500  374.500  83.954    -0.000         *  X
 19  435.500  276.943  31.732   158.557      2.04  R
 24  622.900  393.946  11.120   228.954      2.75  R
 29  587.800  393.946  11.120   193.854      2.33  R
 30  571.100  393.946  11.120   177.154      2.13  R
 31  583.900  393.946  11.120   189.954      2.28  R
 40  154.000  393.946  11.120  -239.946     -2.88  R
128  519.700  338.379  12.246   181.321      2.18  R
184  220.300  393.029  15.866  -172.729     -2.10  R
188  171.700  340.994  19.788  -169.294     -2.07  R
202  542.700  340.994  19.788   201.706      2.47  R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

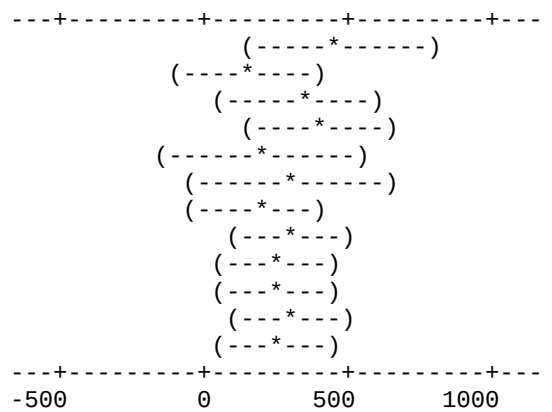
Treat   N    Mean  Grouping
B       1  552.60  A B C D E F G
E       3  488.17  A
D       2  407.85  A B C D E F G
I      57  393.95  A B
L      28  393.03  A B C D E F G
G       1  374.50  A B C D E F G H
M      18  340.99  A B C D E F G
```

```
K      47  338.38  A     D     G
J      31  322.80  A   C D   F G
F       1  284.00  A B C D E F G H
H       7  276.94          E F G H
C       3  239.87    B C D E F G H
A       2   80.25                H
```

Means that do not share a letter are significantly different.

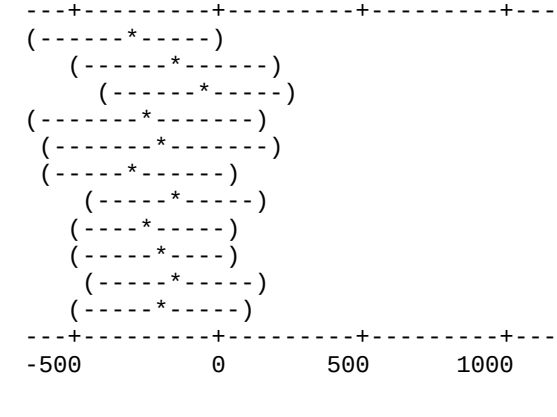
Tukey 95.0% Simultaneous Confidence Intervals
Response Variable Total Ht (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Lower	Center	Upper
B	127.0	472.4	817.7
C	-97.8	159.6	417.0
D	45.6	327.6	609.6
E	150.5	407.9	665.3
F	-141.6	203.8	549.1
G	-51.1	294.3	639.6
H	-29.4	196.7	422.8
I	110.8	313.7	516.6
J	36.8	242.5	448.3
K	54.5	258.1	461.7
L	106.4	312.8	519.2
M	50.6	260.7	470.9



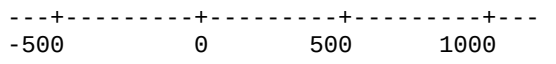
Treat = B subtracted from:

Treat	Lower	Center	Upper
C	-638.3	-312.7	12.87
D	-490.1	-144.7	200.60
E	-390.0	-64.4	261.17
F	-667.4	-268.6	130.18
G	-576.9	-178.1	220.68
H	-577.1	-275.7	25.79
I	-443.1	-158.7	125.79
J	-516.3	-229.8	56.69
K	-499.2	-214.2	70.74
L	-446.5	-159.6	127.40
M	-501.3	-211.6	78.10



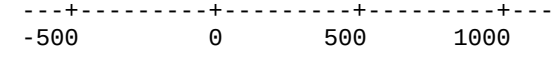
Treat = C subtracted from:

Treat	Lower	Center	Upper
D	-89.4	167.98	425.4
E	18.1	248.30	478.5
F	-281.5	44.13	369.7
G	-191.0	134.63	460.2
H	-157.5	37.08	231.7
I	-13.0	154.08	321.1
J	-87.6	82.93	253.4
K	-69.4	98.51	266.4
L	-18.1	153.16	324.5
M	-74.7	101.13	277.0



Treat = D subtracted from:

Treat	Lower	Center	Upper
E	-177.1	80.3	337.73
F	-469.2	-123.9	221.50
G	-378.7	-33.4	312.00
H	-357.0	-130.9	95.18
I	-216.8	-13.9	188.95
J	-290.8	-85.1	120.67
K	-273.1	-69.5	134.12
L	-221.2	-14.8	191.57
M	-277.0	-66.9	143.32



Treat = E subtracted from:

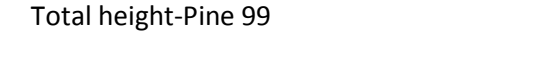
Treat	Lower	Center	Upper
F	-529.8	-204.2	121.44
G	-439.3	-113.7	211.94
H	-405.8	-211.2	-16.64
I	-261.3	-94.2	72.81
J	-335.9	-165.4	5.13
K	-317.7	-149.8	18.13
L	-266.4	-95.1	76.16
M	-323.0	-147.2	28.67

Treat = F subtracted from:

Treat	Lower	Center	Upper
G	-308.3	90.500	489.3
H	-308.5	-7.057	294.4
I	-174.5	109.946	394.4
J	-247.7	38.797	325.3
K	-230.6	54.379	339.3
L	-177.9	109.029	396.0
M	-232.7	56.994	346.7

Treat = G subtracted from:

Treat	Lower	Center	Upper
H	-399.0	-97.56	203.9
I	-265.0	19.45	303.9
J	-338.2	-51.70	234.8
K	-321.1	-36.12	248.8
L	-268.4	18.53	305.5
M	-323.2	-33.51	256.2



Treat = H subtracted from:

```
Treat   Lower  Center  Upper  ---+---------+---------+---------+---
I        4.07  117.00  229.9              (-*--)
J      -72.15   45.85  163.9            (-*-)
K      -52.80   61.44  175.7            (-*--)
L       -3.07  116.09  235.2             (-*--)
M      -61.55   64.05  189.7            (-*--)
                           ---+---------+---------+---------+---
                           -500         0       500      1000
```

Treat = I subtracted from:

```
Treat   Lower  Center   Upper  ---+---------+---------+---------+---
J      -134.1  -71.15  -8.221           (-*)
K      -111.1  -55.57  -0.009            (*)
L       -66.0   -0.92  64.158            (*)
M      -129.2  -52.95  23.288           (-*)
                           ---+---------+---------+---------+---
                           -500         0       500      1000
```

Treat = J subtracted from:

```
Treat   Lower  Center   Upper  ---+---------+---------+---------+---
K      -49.66   15.58   80.83             (*-)
L       -3.28   70.23  143.75              (*-)
M      -65.36   18.20  101.76             (*-)
                           ---+---------+---------+---------+---
                           -500         0       500      1000
```

Treat = K subtracted from:

```
Treat   Lower  Center   Upper  ---+---------+---------+---------+---
L      -12.67  54.650  121.97              (*)
M      -75.55   2.616   80.78            (-*-)
                           ---+---------+---------+---------+---
                           -500         0       500      1000
```

Treat = L subtracted from:

```
Treat   Lower  Center  Upper  ---+---------+---------+---------+---
M      -137.2  -52.03  33.15           (-*-)
                           ---+---------+---------+---------+---
                           -500         0       500      1000
```

Tukey Simultaneous Tests
Response Variable Total Ht (cm)
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
B	472.4	102.82	4.594	0.0006
C	159.6	76.64	2.083	0.6759
D	327.6	83.95	3.902	0.0084
E	407.9	76.64	5.323	0.0001
F	203.8	102.82	1.982	0.7435
G	294.3	102.82	2.862	0.1839
H	196.7	67.31	2.922	0.1597

I	313.7	60.40	5.194	0.0001
J	242.5	61.25	3.960	0.0068
K	258.1	60.61	4.259	0.0022
L	312.8	61.45	5.090	0.0001
M	260.7	62.58	4.167	0.0032

Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-312.7	96.94	-3.226	0.0727
D	-144.7	102.82	-1.408	0.9720
E	-64.4	96.94	-0.665	1.0000
F	-268.6	118.73	-2.262	0.5473
G	-178.1	118.73	-1.500	0.9545
H	-275.7	89.75	-3.071	0.1102
I	-158.7	84.69	-1.873	0.8086
J	-229.8	85.30	-2.694	0.2643
K	-214.2	84.84	-2.525	0.3646
L	-159.6	85.44	-1.868	0.8118
M	-211.6	86.25	-2.453	0.4120

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	167.98	76.64	2.1919	0.5984
E	248.30	68.55	3.6223	0.0218
F	44.13	96.94	0.4553	1.0000
G	134.63	96.94	1.3888	0.9748
H	37.08	57.93	0.6400	1.0000
I	154.08	49.73	3.0983	0.1028
J	82.93	50.76	1.6337	0.9170
K	98.51	49.99	1.9705	0.7506
L	153.16	51.00	3.0031	0.1311
M	101.13	52.35	1.9316	0.7747

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	80.3	76.64	1.048	0.9979
F	-123.9	102.82	-1.205	0.9924
G	-33.4	102.82	-0.324	1.0000
H	-130.9	67.31	-1.945	0.7666
I	-13.9	60.40	-0.230	1.0000
J	-85.1	61.25	-1.389	0.9748
K	-69.5	60.61	-1.146	0.9951
L	-14.8	61.45	-0.241	1.0000
M	-66.9	62.58	-1.068	0.9975

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-204.2	96.94	-2.106	0.6596
G	-113.7	96.94	-1.173	0.9940
H	-211.2	57.93	-3.646	0.0202
I	-94.2	49.73	-1.895	0.7965

J	-165.4	50.76	-3.258	0.0665
K	-149.8	49.99	-2.996	0.1334
L	-95.1	51.00	-1.865	0.8131
M	-147.2	52.35	-2.811	0.2061

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	90.500	118.73	0.76224	0.9999
H	-7.057	89.75	-0.07863	1.0000
I	109.946	84.69	1.29826	0.9855
J	38.797	85.30	0.45484	1.0000
K	54.379	84.84	0.64094	1.0000
L	109.029	85.44	1.27609	0.9874
M	56.994	86.25	0.66077	1.0000

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	-97.56	89.75	-1.087	0.9970
I	19.45	84.69	0.230	1.0000
J	-51.70	85.30	-0.606	1.0000
K	-36.12	84.84	-0.426	1.0000
L	18.53	85.44	0.217	1.0000
M	-33.51	86.25	-0.388	1.0000

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	117.00	33.62	3.480	0.0344
J	45.85	35.13	1.305	0.9848
K	61.44	34.01	1.806	0.8443
L	116.09	35.48	3.272	0.0638
M	64.05	37.40	1.713	0.8872

Treat = I subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
J	-71.15	18.74	-3.798	0.0121
K	-55.57	16.54	-3.359	0.0496
L	-0.92	19.37	-0.047	1.0000
M	-52.95	22.70	-2.333	0.4963

Treat = J subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
K	15.58	19.42	0.8022	0.9999
L	70.23	21.89	3.2087	0.0763
M	18.20	24.88	0.7315	0.9999

Treat = K subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
L	54.650	20.04	2.7268	0.2471
M	2.616	23.27	0.1124	1.0000

Treat = L subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
M	-52.03	25.36	-2.052	0.6973

Results for: 2000_fir

General Linear Model: dbh (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      10  O, P, Q, S, T, U, V, W, X, Y


Analysis of Variance for dbh (cm), using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS     F      P
Treat     9   32.343   32.343   3.594  2.34  0.017
Error   154  236.617  236.617   1.536
Total   163  268.960


S = 1.23955   R-Sq = 12.03%   R-Sq(adj) = 6.88%


Unusual Observations for dbh (cm)

Obs  dbh (cm)      Fit   SE Fit  Residual  St Resid
  1   5.90000  4.00000  0.87649   1.90000      2.17 RX
  2   2.10000  4.00000  0.87649  -1.90000     -2.17 RX
 18   7.00000  4.64286  0.46850   2.35714      2.05  R
 21   2.10000  2.35000  0.87649  -0.25000     -0.29  X
 23   2.60000  2.35000  0.87649   0.25000      0.29  X
 43   5.80000  3.31220  0.19358   2.48780      2.03  R
 68   6.00000  3.31220  0.19358   2.68780      2.20  R
 80   6.70000  3.28947  0.20108   3.41053      2.79  R
 87   6.90000  3.28947  0.20108   3.61053      2.95  R
105   5.90000  3.28947  0.20108   2.61053      2.13  R
119   1.60000  1.76667  0.71565  -0.16667     -0.16  X
120   1.30000  1.76667  0.71565  -0.46667     -0.46  X
121   2.40000  1.76667  0.71565   0.63333      0.63  X
132   1.40000  1.40000  1.23955  -0.00000         *  X
133   6.30000  2.96429  0.23425   3.33571      2.74  R
152   5.70000  2.96429  0.23425   2.73571      2.25  R
169   7.30000  3.30294  0.21258   3.99706      3.27  R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

Treat   N   Mean  Grouping
Q       7  4.643  A
O       2  4.000  A B
P       8  3.925  A B
T      41  3.312  A B
Y      34  3.303  A B
U      38  3.289  A B
X      28  2.964  A B
S       2  2.350  A B
V       3  1.767    B
W       1  1.400  A B

Means that do not share a letter are significantly different.
```

```
Tukey 95.0% Simultaneous Confidence Intervals
Response Variable dbh (cm)
All Pairwise Comparisons among Levels of Treat
Treat = O  subtracted from:

Treat   Lower  Center  Upper  ---------+---------+---------+-------
P      -3.221  -0.075  3.071            (-------*-------)
Q      -2.548   0.643  3.833              (-------*-------)
S      -5.629  -1.650  2.329       (---------*---------)
T      -3.569  -0.688  2.194            (------*------)
U      -3.597  -0.711  2.176            (------*------)
V      -5.866  -2.233  1.399      (--------*--------)
W      -7.474  -2.600  2.274  (------------*-----------)
X      -3.948  -1.036  1.877          (------*-------)
Y      -3.592  -0.697  2.198            (------*------)
                          ---------+---------+---------+-------
                               -4.0       0.0       4.0


Treat = P  subtracted from:

Treat   Lower  Center   Upper  ---------+---------+---------+-------
Q      -1.342   0.718  2.7773                 (----*----)
S      -4.721  -1.575  1.5709         (-------*-------)
T      -2.151  -0.613  0.9252                (--*---)
U      -2.183  -0.636  0.9124                (--*---)
V      -4.852  -2.158  0.5356         (------*-----)
W      -6.746  -2.525  1.6957    (----------*---------)
X      -2.556  -0.961  0.6345               (---*---)
Y      -2.186  -0.622  0.9416                (--*---)
                           ---------+---------+---------+-------
                                -4.0       0.0       4.0


Treat = Q  subtracted from:

Treat   Lower  Center    Upper  ---------+---------+---------+-------
S      -5.483  -2.293   0.8977       (-------*-------)
T      -2.958  -1.331   0.2967              (---*---)
U      -2.990  -1.353   0.2833              (---*---)
V      -5.622  -2.876  -0.1302       (------*------)
W      -7.497  -3.243   1.0112  (----------*----------)
X      -3.360  -1.679   0.0030             (---*---)
Y      -2.992  -1.340   0.3117              (---*---)
                            ---------+---------+---------+-------
                                 -4.0       0.0       4.0


Treat = S  subtracted from:

Treat   Lower   Center  Upper  ---------+---------+---------+-------
T      -1.919   0.9622  3.844               (------*-------)
U      -1.947   0.9395  3.826               (------*-------)
V      -4.216  -0.5833  3.049         (---------*--------)
W      -5.824  -0.9500  3.924      (------------*-----------)
X      -2.298   0.6143  3.527               (-------*------)
Y      -1.942   0.9529  3.848               (------*-------)
                           ---------+---------+---------+-------
                                -4.0       0.0       4.0


Treat = T  subtracted from:
```

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
U      -0.919  -0.023  0.8733                  (-*-)
V      -3.926  -1.546  0.8345            (-----*-----)
W      -5.940  -1.912  2.1153       (---------*---------)
X      -1.323  -0.348  0.6277                (-*--)
Y      -0.932  -0.009  0.9137                 (-*-)
                                ---------+---------+---------+-------
                                      -4.0       0.0       4.0


Treat = U  subtracted from:

Treat   Lower  Center   Upper  ---------+---------+---------+-------
V      -3.909  -1.523  0.8636            (-----*-----)
W      -5.921  -1.889  2.1418       (---------*---------)
X      -1.316  -0.325  0.6659                (-*--)
Y      -0.926   0.013  0.9528                 (-*-)
                                ---------+---------+---------+-------
                                      -4.0       0.0       4.0


Treat = V  subtracted from:

Treat   Lower   Center  Upper  ---------+---------+---------+-------
W      -4.962  -0.3667  4.228         (----------*----------)
X      -1.220   1.1976  3.615                (-----*-----)
Y      -0.860   1.5363  3.933                 (-----*-----)
                                ---------+---------+---------+-------
                                      -4.0       0.0       4.0


Treat = W  subtracted from:

Treat   Lower  Center  Upper  ---------+---------+---------+-------
X      -2.485   1.564  5.614              (---------*---------)
Y      -2.134   1.903  5.940               (---------*---------)
                              ---------+---------+---------+-------
                                    -4.0       0.0       4.0


Treat = X  subtracted from:

Treat    Lower  Center  Upper  ---------+---------+---------+-------
Y      -0.6768  0.3387  1.354                  (--*-)
                                ---------+---------+---------+-------
                                      -4.0       0.0       4.0


Tukey Simultaneous Tests
Response Variable dbh (cm)
All Pairwise Comparisons among Levels of Treat
Treat = O  subtracted from:

       Difference       SE of           Adjusted
Treat    of Means  Difference  T-Value   P-Value
P          -0.075      0.9799   -0.077    1.0000
Q           0.643      0.9938    0.647    0.9997
S          -1.650      1.2395   -1.331    0.9449
T          -0.688      0.8976   -0.766    0.9989
U          -0.711      0.8993   -0.790    0.9986
V          -2.233      1.1315   -1.974    0.6187
W          -2.600      1.5181   -1.713    0.7867
X          -1.036      0.9073   -1.142    0.9795
```

Y	-0.697	0.9019	-0.773	0.9989

Treat = P subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Q	0.718	0.6415	1.119	0.9821
S	-1.575	0.9799	-1.607	0.8428
T	-0.613	0.4791	-1.279	0.9569
U	-0.636	0.4822	-1.318	0.9481
V	-2.158	0.8392	-2.572	0.2402
W	-2.525	1.3147	-1.921	0.6552
X	-0.961	0.4969	-1.933	0.6465
Y	-0.622	0.4871	-1.277	0.9573

Treat = Q subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
S	-2.293	0.9938	-2.307	0.3906
T	-1.331	0.5069	-2.625	0.2152
U	-1.353	0.5098	-2.655	0.2021
V	-2.876	0.8554	-3.363	0.0320
W	-3.243	1.3251	-2.447	0.3059
X	-1.679	0.5238	-3.205	0.0509
Y	-1.340	0.5145	-2.604	0.2247

Treat = S subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
T	0.9622	0.8976	1.0719	0.9867
U	0.9395	0.8993	1.0447	0.9889
V	-0.5833	1.1315	-0.5155	1.0000
W	-0.9500	1.5181	-0.6258	0.9998
X	0.6143	0.9073	0.6771	0.9996
Y	0.9529	0.9019	1.0566	0.9880

Treat = T subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
U	-0.023	0.2791	-0.081	1.0000
V	-1.546	0.7414	-2.085	0.5411
W	-1.912	1.2546	-1.524	0.8805
X	-0.348	0.3039	-1.145	0.9791
Y	-0.009	0.2875	-0.032	1.0000

Treat = U subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
V	-1.523	0.7434	-2.049	0.5664
W	-1.889	1.2558	-1.505	0.8885
X	-0.325	0.3087	-1.053	0.9882
Y	0.013	0.2926	0.046	1.0000

Treat = V subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
W	-0.3667	1.4313	-0.2562	1.0000
X	1.1976	0.7530	1.5904	0.8509
Y	1.5363	0.7466	2.0578	0.5599

Treat = W subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
X	1.564	1.261	1.240	0.9646
Y	1.903	1.258	1.513	0.8851

Treat = X subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Y	0.3387	0.3163	1.071	0.9868

Results for: 2000_fir

General Linear Model: L=Ht-1yr (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      10  O, P, Q, S, T, U, V, W, X, Y


Analysis of Variance for L=Ht-1yr (cm), using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS      F      P
Treat     9  29352.8  29352.8  3261.4  17.98  0.000
Error   191  34646.9  34646.9   181.4
Total   200  63999.7


S = 13.4684   R-Sq = 45.86%   R-Sq(adj) = 43.31%


Unusual Observations for L=Ht-1yr (cm)

     L=Ht-1yr
Obs      (cm)     Fit  SE Fit  Residual  St Resid
  1    63.900  62.300   9.524     1.600      0.17 X
  2    60.700  62.300   9.524    -1.600     -0.17 X
 21    45.300  49.733   7.776    -4.433     -0.40 X
 22    44.000  49.733   7.776    -5.733     -0.52 X
 23    59.900  49.733   7.776    10.167      0.92 X
 39    22.800  58.417   1.986   -35.617     -2.67 R
 44    28.000  58.417   1.986   -30.417     -2.28 R
 89     5.000  54.779   1.965   -49.779     -3.74 R
121    44.300   8.957   3.600    35.343      2.72 R
132    46.200  46.200  13.468    -0.000         * X
153   108.800  55.632   2.419    53.168      4.01 R
159    27.900  55.632   2.419   -27.732     -2.09 R
175    27.600  55.338   2.157   -27.738     -2.09 R
179    23.900  55.338   2.157   -31.438     -2.36 R
187   110.000  55.338   2.157    54.662      4.11 R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

Treat   N    Mean  Grouping
O       2  62.300  A
T      46  58.417  A
X      31  55.632  A
Y      39  55.338  A
P       9  54.833  A
U      47  54.779  A
Q       9  54.456  A
S       3  49.733  A
W       1  46.200  A B
V      14   8.957    B

Means that do not share a letter are significantly different.
```

```
Tukey 95.0% Simultaneous Confidence Intervals
Response Variable L=Ht-1yr (cm)
All Pairwise Comparisons among Levels of Treat
Treat = O  subtracted from:

Treat   Lower  Center   Upper  -------+---------+---------+---------
P      -41.19   -7.47   26.26          (------*-----)
Q      -41.57   -7.84   25.88          (-----*------)
S      -51.95  -12.57   26.82        (------*-------)
T      -35.04   -3.88   27.28           (-----*-----)
U      -38.67   -7.52   23.63          (-----*------)
V      -85.96  -53.34  -20.73  (-----*------)
W      -68.94  -16.10   36.74    (----------*---------)
X      -38.14   -6.67   24.81          (------*-----)
Y      -38.24   -6.96   24.32          (------*-----)
                           -------+---------+---------+---------
                                -50         0        50


Treat = P  subtracted from:

Treat   Lower  Center   Upper  -------+---------+---------+---------
Q      -20.72   -0.38   19.96              (---*---)
S      -33.86   -5.10   23.66           (-----*-----)
T      -12.14    3.58   19.31                (--*--)
U      -15.75   -0.05   15.64               (--*--)
V      -64.31  -45.88  -27.44     (---*---)
W      -54.11   -8.63   36.84       (--------*--------)
X      -15.54    0.80   17.13               (--*--)
Y      -15.45    0.51   16.46               (--*--)
                           -------+---------+---------+---------
                                -50         0        50


Treat = Q  subtracted from:

Treat   Lower  Center   Upper  -------+---------+---------+---------
S      -33.48   -4.72   24.04          (-----*-----)
T      -11.76    3.96   19.69               (--*--)
U      -15.37    0.32   16.02              (--*--)
V      -63.93  -45.50  -27.07     (---*---)
W      -53.73   -8.26   37.22       (--------*--------)
X      -15.16    1.18   17.51               (--*---)
Y      -15.07    0.88   16.84               (--*--)
                           -------+---------+---------+---------
                                -50         0        50


Treat = S  subtracted from:

Treat   Lower  Center   Upper  -------+---------+---------+---------
T      -17.02    8.68   34.39               (----*----)
U      -20.65    5.05   30.74              (----*----)
V      -68.22  -40.78  -13.33    (-----*----)
W      -53.35   -3.53   46.28       (----------*---------)
X      -20.19    5.90   31.98              (----*----)
Y      -20.24    5.61   31.45              (----*----)
                           -------+---------+---------+---------
                                -50         0        50


Treat = T  subtracted from:
```

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
U      -12.59   -3.64    5.31               (-*-)
V      -62.63  -49.46  -36.29      (--*--)
W      -55.83  -12.22   31.39        (--------*-------)
X      -12.81   -2.79    7.24               (-*-)
Y      -12.47   -3.08    6.31                (*-)
                                -------+---------+---------+---------
                                     -50         0        50


Treat = U  subtracted from:

Treat   Lower  Center   Upper  -------+---------+---------+---------
V      -58.96  -45.82  -32.69       (--*-)
W      -52.18   -8.58   35.02         (-------*--------)
X       -9.13    0.85   10.84                (-*-)
Y       -8.78    0.56    9.90                (-*-)
                                -------+---------+---------+---------
                                     -50         0        50


Treat = V  subtracted from:

Treat   Lower  Center  Upper  -------+---------+---------+---------
W      -7.413   37.24  81.90                (-------*--------)
X      32.783   46.68  60.57                        (-*--)
Y      32.940   46.38  59.82                        (-*--)
                               -------+---------+---------+---------
                                    -50         0        50


Treat = W  subtracted from:

Treat   Lower  Center  Upper  -------+---------+---------+---------
X      -34.40   9.432  53.26           (--------*--------)
Y      -34.55   9.138  52.83           (--------*--------)
                               -------+---------+---------+---------
                                    -50         0        50


Treat = X  subtracted from:

Treat   Lower   Center  Upper  -------+---------+---------+---------
Y      -10.67  -0.2938  10.09                (-*-)
                                -------+---------+---------+---------
                                     -50         0        50


Tukey Simultaneous Tests
Response Variable L=Ht-1yr (cm)
All Pairwise Comparisons among Levels of Treat
Treat = O  subtracted from:

       Difference       SE of           Adjusted
Treat    of Means  Difference  T-Value   P-Value
P           -7.47      10.529   -0.709    0.9994
Q           -7.84      10.529   -0.745    0.9992
S          -12.57      12.295   -1.022    0.9906
T           -3.88       9.728   -0.399    1.0000
U           -7.52       9.724   -0.773    0.9989
V          -53.34      10.181   -5.239    0.0000
W          -16.10      16.495   -0.976    0.9933
X           -6.67       9.826   -0.679    0.9996
```

Y	-6.96	9.765	-0.713	0.9994

Treat = P subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Q	-0.38	6.349	-0.060	1.0000
S	-5.10	8.979	-0.568	0.9999
T	3.58	4.909	0.730	0.9993
U	-0.05	4.900	-0.011	1.0000
V	-45.88	5.754	-7.972	0.0000
W	-8.63	14.197	-0.608	0.9998
X	0.80	5.100	0.157	1.0000
Y	0.51	4.981	0.101	1.0000

Treat = Q subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
S	-4.72	8.979	-0.526	1.0000
T	3.96	4.909	0.807	0.9984
U	0.32	4.900	0.066	1.0000
V	-45.50	5.754	-7.907	0.0000
W	-8.26	14.197	-0.582	0.9999
X	1.18	5.100	0.231	1.0000
Y	0.88	4.981	0.177	1.0000

Treat = S subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
T	8.68	8.026	1.082	0.9859
U	5.05	8.020	0.629	0.9998
V	-40.78	8.569	-4.759	0.0002
W	-3.53	15.552	-0.227	1.0000
X	5.90	8.144	0.724	0.9993
Y	5.61	8.070	0.695	0.9995

Treat = T subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
U	-3.64	2.793	-1.30	0.9520
V	-49.46	4.111	-12.03	0.0000
W	-12.22	13.614	-0.90	0.9964
X	-2.79	3.130	-0.89	0.9966
Y	-3.08	2.932	-1.05	0.9886

Treat = U subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
V	-45.82	4.101	-11.17	0.0000
W	-8.58	13.611	-0.63	0.9998
X	0.85	3.116	0.27	1.0000
Y	0.56	2.917	0.19	1.0000

Treat = V subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
W	37.24	13.941	2.671	0.1931
X	46.68	4.337	10.762	0.0000
Y	46.38	4.196	11.053	0.0000

Treat = W subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
X	9.432	13.68	0.6893	0.9996
Y	9.138	13.64	0.6700	0.9996

Treat = X subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Y	-0.2938	3.241	-0.09066	1.000

Results for: 2000_fir

General Linear Model: Total Ht (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      10  O, P, Q, S, T, U, V, W, X, Y


Analysis of Variance for Total Ht (cm), using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS      F      P
Treat     9   743397   743397   82600  13.72  0.000
Error   191  1150215  1150215    6022
Total   200  1893612


S = 77.6020   R-Sq = 39.26%   R-Sq(adj) = 36.40%


Unusual Observations for Total Ht (cm)

       Total
Obs  Ht (cm)      Fit  SE Fit  Residual  St Resid
  1  449.000  370.650  54.873    78.350      1.43 X
  2  292.300  370.650  54.873   -78.350     -1.43 X
  5  169.500  330.144  25.867  -160.644     -2.20 R
 12  163.500  335.644  25.867  -172.144     -2.35 R
 16  175.300  335.644  25.867  -160.344     -2.19 R
 21  285.500  255.300  44.804    30.200      0.48 X
 22  179.500  255.300  44.804   -75.800     -1.20 X
 23  300.900  255.300  44.804    45.600      0.72 X
 44  117.500  312.161  11.442  -194.661     -2.54 R
 89   57.000  280.006  11.319  -223.006     -2.90 R
105  468.000  280.006  11.319   187.994      2.45 R
121  229.400   72.114  20.740   157.286      2.10 R
132  224.000  224.000  77.602    -0.000         * X
152  456.600  280.416  13.938   176.184      2.31 R
162  112.600  280.416  13.938  -167.816     -2.20 R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

Treat   N    Mean  Grouping
O       2  370.65  A
Q       9  335.64  A
P       9  330.14  A
T      46  312.16  A
Y      39  302.63  A
X      31  280.42  A
U      47  280.01  A
S       3  255.30  A
W       1  224.00  A B
V      14   72.11    B

Means that do not share a letter are significantly different.
```

```
Tukey 95.0% Simultaneous Confidence Intervals
Response Variable Total Ht (cm)
All Pairwise Comparisons among Levels of Treat
Treat = O  subtracted from:

Treat   Lower  Center   Upper  ---------+---------+---------+-------
P      -234.8   -40.5   153.8           (------*-------)
Q      -229.3   -35.0   159.3           (-------*------)
S      -342.3  -115.3   111.6       (--------*--------)
T      -238.0   -58.5   121.1           (-------*------)
U      -270.1   -90.6    88.8         (------*-------)
V      -486.4  -298.5  -110.6  (------*-------)
W      -451.1  -146.6   157.8   (-----------*-----------)
X      -271.6   -90.2    91.1         (------*-------)
Y      -248.2   -68.0   112.2          (------*------)
                            ---------+---------+---------+-------
                                  -250         0       250


Treat = P  subtracted from:

Treat   Lower  Center   Upper  ---------+---------+---------+-------
Q      -111.7     5.5   122.7                (---*----)
S      -240.6   -74.8    90.9          (------*------)
T      -108.6   -18.0    72.6                (--*---)
U      -140.6   -50.1    40.3              (---*---)
V      -364.2  -258.0  -151.8     (----*---)
W      -368.2  -106.1   155.9     (----------*---------)
X      -143.8   -49.7    44.4              (---*---)
Y      -119.4   -27.5    64.4               (---*---)
                            ---------+---------+---------+-------
                                  -250         0       250


Treat = Q  subtracted from:

Treat   Lower  Center   Upper  ---------+---------+---------+-------
S      -246.1   -80.3    85.4          (------*-----)
T      -114.1   -23.5    67.1               (---*---)
U      -146.1   -55.6    34.8              (---*--)
V      -369.7  -263.5  -157.3     (---*----)
W      -373.7  -111.6   150.4     (----------*---------)
X      -149.3   -55.2    38.9              (---*---)
Y      -124.9   -33.0    58.9               (---*--)
                            ---------+---------+---------+-------
                                  -250         0       250


Treat = S  subtracted from:

Treat   Lower  Center   Upper  ---------+---------+---------+-------
T       -91.3    56.9  204.98                (-----*-----)
U      -123.3    24.7  172.73               (-----*-----)
V      -341.3  -183.2  -25.04       (------*-----)
W      -318.3   -31.3  255.73       (-----------*----------)
X      -125.2    25.1  175.41               (-----*-----)
Y      -101.6    47.3  196.26                (-----*-----)
                            ---------+---------+---------+-------
                                  -250         0       250


Treat = T  subtracted from:
```

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
U       -83.7   -32.2    19.4                (-*-)
V      -315.9  -240.0  -164.2       (--*--)
W      -339.4   -88.2   163.1      (---------*----------)
X       -89.5   -31.7    26.0               (--*-)
Y       -63.6    -9.5    44.6                (--*-)
                            ---------+---------+---------+-------
                                  -250         0       250
```

Treat = U subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
V      -283.6  -207.9  -132.2        (--*--)
W      -307.2   -56.0   195.2       (---------*---------)
X       -57.1     0.4    57.9                (-*-)
Y       -31.2    22.6    76.5                 (-*-)
                            ---------+---------+---------+-------
                                  -250         0       250
```

Treat = V subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
W      -105.4   151.9  409.2               (---------*---------)
X       128.3   208.3  288.3                        (--*---)
Y       153.1   230.5  308.0                         (--*--)
                           ---------+---------+---------+-------
                                 -250         0       250
```

Treat = W subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
X      -196.1   56.42  309.0            (---------*---------)
Y      -173.1   78.63  330.4             (---------*---------)
                           ---------+---------+---------+-------
                                 -250         0       250
```

Treat = X subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
Y      -37.60   22.21  82.03                  (--*-)
                           ---------+---------+---------+-------
                                 -250         0       250
```

Tukey Simultaneous Tests
Response Variable Total Ht (cm)
All Pairwise Comparisons among Levels of Treat
Treat = O subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
P	-40.5	60.66	-0.668	0.9997
Q	-35.0	60.66	-0.577	0.9999
S	-115.3	70.84	-1.628	0.8327
T	-58.5	56.05	-1.043	0.9891
U	-90.6	56.03	-1.618	0.8380
V	-298.5	58.66	-5.089	0.0001
W	-146.6	95.04	-1.543	0.8729
X	-90.2	56.62	-1.594	0.8497

Y	-68.0	56.26	-1.209	0.9702

Treat = P subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Q	5.5	36.58	0.150	1.0000
S	-74.8	51.73	-1.447	0.9106
T	-18.0	28.28	-0.636	0.9998
U	-50.1	28.24	-1.776	0.7496
V	-258.0	33.16	-7.782	0.0000
W	-106.1	81.80	-1.298	0.9532
X	-49.7	29.38	-1.692	0.7985
Y	-27.5	28.70	-0.959	0.9941

Treat = Q subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
S	-80.3	51.73	-1.553	0.8685
T	-23.5	28.28	-0.830	0.9980
U	-55.6	28.24	-1.970	0.6207
V	-263.5	33.16	-7.948	0.0000
W	-111.6	81.80	-1.365	0.9363
X	-55.2	29.38	-1.880	0.6828
Y	-33.0	28.70	-1.150	0.9786

Treat = S subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
T	56.9	46.24	1.230	0.9667
U	24.7	46.21	0.535	0.9999
V	-183.2	49.37	-3.710	0.0100
W	-31.3	89.61	-0.349	1.0000
X	25.1	46.92	0.535	0.9999
Y	47.3	46.49	1.018	0.9909

Treat = T subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
U	-32.2	16.09	-2.00	0.6017
V	-240.0	23.69	-10.13	0.0000
W	-88.2	78.44	-1.12	0.9817
X	-31.7	18.03	-1.76	0.7589
Y	-9.5	16.89	-0.56	0.9999

Treat = U subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
V	-207.9	23.63	-8.799	0.0000
W	-56.0	78.42	-0.714	0.9994
X	0.4	17.96	0.023	1.0000
Y	22.6	16.81	1.346	0.9414

Treat = V subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
W	151.9	80.33	1.891	0.6752
X	208.3	24.99	8.336	0.0000
Y	230.5	24.18	9.534	0.0000

Treat = W subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
X	56.42	78.84	0.7155	0.9994
Y	78.63	78.59	1.0005	0.9919

Treat = X subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Y	22.21	18.67	1.190	0.9732

Results for: 2000_pine

General Linear Model: dbh (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      12  N, O, P, Q, R, S, T, U, V, W, X, Y


Analysis of Variance for dbh (cm), using Adjusted SS for Tests

Source   DF    Seq SS    Adj SS  Adj MS     F      P
Treat    11   123.668   123.668  11.243  5.66  0.000
Error   542  1076.886  1076.886   1.987
Total   553  1200.554


S = 1.40957   R-Sq = 10.30%   R-Sq(adj) = 8.48%


Unusual Observations for dbh (cm)

Obs  dbh (cm)     Fit  SE Fit  Residual  St Resid
  1    6.2000  4.9692  0.3909    1.2308      0.91  X
  2    3.7000  4.9692  0.3909   -1.2692     -0.94  X
  3    3.7000  4.9692  0.3909   -1.2692     -0.94  X
  4    5.3000  4.9692  0.3909    0.3308      0.24  X
  5    6.0000  4.9692  0.3909    1.0308      0.76  X
  6    2.8000  4.9692  0.3909   -2.1692     -1.60  X
  7    3.6000  4.9692  0.3909   -1.3692     -1.01  X
  8    4.5000  4.9692  0.3909   -0.4692     -0.35  X
  9    5.0000  4.9692  0.3909    0.0308      0.02  X
 10    4.0000  4.9692  0.3909   -0.9692     -0.72  X
 11    6.1000  4.9692  0.3909    1.1308      0.83  X
 12    6.1000  4.9692  0.3909    1.1308      0.83  X
 13    7.6000  4.9692  0.3909    2.6308      1.94  X
 33    8.4000  5.0760  0.2819    3.3240      2.41  R
 39   10.1000  5.0760  0.2819    5.0240      3.64  R
 41    2.3000  5.8793  0.2617   -3.5793     -2.58  R
 55    2.7000  5.8793  0.2617   -3.1793     -2.30  R
 65    8.9000  5.8793  0.2617    3.0207      2.18  R
 73   10.1000  5.8793  0.2617    4.2207      3.05  R
101    2.1000  4.9636  0.2454   -2.8636     -2.06  R
113    7.9000  4.9636  0.2454    2.9364      2.12  R
114    7.9000  4.9636  0.2454    2.9364      2.12  R
157    8.4000  4.6968  0.2532    3.7032      2.67  R
223    7.5000  4.6000  0.1547    2.9000      2.07  R
252    7.4000  4.3624  0.1462    3.0376      2.17  R
351    3.9000  3.1727  0.4250    0.7273      0.54  X
352    3.6000  3.1727  0.4250    0.4273      0.32  X
353    2.8000  3.1727  0.4250   -0.3727     -0.28  X
354    6.1000  3.1727  0.4250    2.9273      2.18 RX
362    1.2000  3.1727  0.4250   -1.9727     -1.47  X
410    2.2000  3.1727  0.4250   -0.9727     -0.72  X
420    2.2000  3.1727  0.4250   -0.9727     -0.72  X
421    4.4000  3.1727  0.4250    1.2273      0.91  X
422    3.9000  3.1727  0.4250    0.7273      0.54  X
423    1.8000  3.1727  0.4250   -1.3727     -1.02  X
424    2.8000  3.1727  0.4250   -0.3727     -0.28  X
425    2.4000  2.6500  0.5755   -0.2500     -0.19  X
437    3.8000  2.6500  0.5755    1.1500      0.89  X
```

445	1.1000	2.6500	0.5755	-1.5500	-1.20	X
478	2.5000	2.6500	0.5755	-0.1500	-0.12	X
479	1.9000	2.6500	0.5755	-0.7500	-0.58	X
480	4.2000	2.6500	0.5755	1.5500	1.20	X
547	2.1000	5.0469	0.1326	-2.9469	-2.10	R
570	7.9000	5.0469	0.1326	2.8531	2.03	R
578	8.7000	5.0469	0.1326	3.6531	2.60	R
589	8.5000	5.0469	0.1326	3.4531	2.46	R
611	7.7000	4.8253	0.1446	2.8747	2.05	R
620	2.0000	4.8253	0.1446	-2.8253	-2.01	R
633	2.0000	4.8253	0.1446	-2.8253	-2.01	R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.

Grouping Information Using Tukey Method and 95.0% Confidence

Treat	N	Mean	Grouping
P	29	5.879	A
O	25	5.076	A B C
X	113	5.047	A B
N	13	4.969	A B C D
R	33	4.964	A B C
Y	95	4.825	B C
S	31	4.697	A B C D E
T	83	4.600	B C D
Q	22	4.473	B C D E
U	93	4.362	C D E
V	11	3.173	D E
W	6	2.650	E

Means that do not share a letter are significantly different.

Tukey 95.0% Simultaneous Confidence Intervals
Response Variable dbh (cm)
All Pairwise Comparisons among Levels of Treat
Treat = N subtracted from:

Treat	Lower	Center	Upper	--------+---------+---------+--------
O	-1.468	0.107	1.68134	(----*-----)
P	-0.627	0.910	2.44705	(----*----)
Q	-2.107	-0.497	1.11438	(----*-----)
R	-1.513	-0.006	1.50227	(----*----)
S	-1.794	-0.272	1.24909	(----*----)
T	-1.743	-0.369	1.00430	(----*---)
U	-1.970	-0.607	0.75663	(----*----)
V	-3.683	-1.797	0.08997	(-----*-----)
W	-4.592	-2.319	-0.04653	(------*-------)
X	-1.271	0.078	1.42628	(---*----)
Y	-1.506	-0.144	1.21776	(----*---)
				--------+---------+---------+--------
				-3.0 0.0 3.0

Treat = O subtracted from:

Treat	Lower	Center	Upper	--------+---------+---------+--------
P	-0.453	0.803	2.0600	(----*---)
Q	-1.949	-0.603	0.7428	(---*---)
R	-1.333	-0.112	1.1086	(---*---)
S	-1.617	-0.379	0.8586	(---*---)

```
T      -1.527  -0.476   0.5745              (--*---)
U      -1.751  -0.714   0.3238             (---*--)
V      -3.569  -1.903  -0.2372        (-----*----)
W      -4.519  -2.426  -0.3326     (------*------)
X      -1.047  -0.029   0.9887               (--*--)
Y      -1.286  -0.251   0.7843              (--*---)
                                --------+---------+---------+--------
                                     -3.0       0.0       3.0
```

Treat = P subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
Q      -2.709  -1.407  -0.105          (---*----)
R      -2.088  -0.916   0.256            (---*---)
S      -2.372  -1.183   0.007           (---*---)
T      -2.273  -1.279  -0.286           (---*--)
U      -2.496  -1.517  -0.538           (--*--)
V      -4.337  -2.707  -1.076      (----*----)
W      -5.295  -3.229  -1.164  (------*------)
X      -1.791  -0.832   0.126             (--*--)
Y      -2.031  -1.054  -0.077            (--*---)
                               --------+---------+---------+--------
                                    -3.0       0.0       3.0
```

Treat = Q subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
R      -0.777   0.491  1.7583               (----*---)
S      -1.060   0.224  1.5077              (----*---)
T      -0.977   0.127  1.2315               (--*---)
U      -1.202  -0.110  0.9814              (---*--)
V      -3.000  -1.300  0.4004         (-----*----)
W      -3.944  -1.823  0.2981       (------*------)
X      -0.499   0.574  1.6472                (---*--)
Y      -0.737   0.353  1.4420                (--*---)
                               --------+---------+---------+--------
                                    -3.0       0.0       3.0
```

Treat = R subtracted from:

```
Treat   Lower  Center    Upper  --------+---------+---------+--------
S      -1.419  -0.267   0.8849              (---*---)
T      -1.311  -0.364   0.5840               (--*--)
U      -1.534  -0.601   0.3318              (--*--)
V      -3.394  -1.791  -0.1877         (----*----)
W      -4.357  -2.314  -0.2700     (------*------)
X      -0.828   0.083   0.9944                (--*--)
Y      -1.069  -0.138   0.7921               (---*--)
                                --------+---------+---------+--------
                                     -3.0       0.0       3.0
```

Treat = S subtracted from:

```
Treat   Lower  Center    Upper  --------+---------+---------+--------
T      -1.066  -0.097  0.87250               (---*--)
U      -1.289  -0.334  0.62059               (--*--)
V      -3.140  -1.524  0.09202          (----*----)
W      -4.101  -2.047  0.00702      (------*------)
X      -0.583   0.350  1.28376                (--*--)
```

```
Y      -0.824   0.128  1.08097                (--*---)
                                  --------+---------+---------+--------
                                       -3.0       0.0       3.0


Treat = T  subtracted from:

Treat   Lower  Center     Upper  --------+---------+---------+--------
U      -0.933  -0.238   0.45769                (-*--)
V      -2.905  -1.427   0.05027          (----*----)
W      -3.897  -1.950  -0.00333       (-----*------)
X      -0.219   0.447   1.11258                 (-*--)
Y      -0.467   0.225   0.91713                (--*-)
                                  --------+---------+---------+--------
                                       -3.0       0.0       3.0


Treat = U  subtracted from:

Treat   Lower  Center   Upper  --------+---------+---------+--------
V      -2.658  -1.190  0.2786           (----*----)
W      -3.652  -1.712  0.2272        (-----*------)
X       0.040   0.685  1.3292                  (-*-)
Y      -0.209   0.463  1.1346                 (--*-)
                                  --------+---------+---------+--------
                                       -3.0       0.0       3.0


Treat = V  subtracted from:

Treat   Lower   Center  Upper  --------+---------+---------+--------
W      -2.860  -0.5227  1.814          (-------*-------)
X       0.420   1.8742  3.329                   (----*----)
Y       0.186   1.6525  3.119                   (----*---)
                                  --------+---------+---------+--------
                                       -3.0       0.0       3.0


Treat = W  subtracted from:

Treat   Lower  Center  Upper  --------+---------+---------+--------
X      0.4677   2.397  4.326                    (-----*-----)
Y      0.2369   2.175  4.114                   (-----*------)
                                  --------+---------+---------+--------
                                       -3.0       0.0       3.0


Treat = X  subtracted from:

Treat    Lower   Center   Upper  --------+---------+---------+--------
Y      -0.8626  -0.2216  0.4193                 (-*-)
                                  --------+---------+---------+--------
                                       -3.0       0.0       3.0


Tukey Simultaneous Tests
Response Variable dbh (cm)
All Pairwise Comparisons among Levels of Treat
Treat = N  subtracted from:

       Difference       SE of           Adjusted
Treat    of Means  Difference  T-Value   P-Value
O           0.107      0.4820    0.222    1.0000
```

P	0.910	0.4705	1.934	0.7376
Q	-0.497	0.4931	-1.007	0.9976
R	-0.006	0.4616	-0.012	1.0000
S	-0.272	0.4658	-0.585	1.0000
T	-0.369	0.4204	-0.878	0.9993
U	-0.607	0.4174	-1.454	0.9525
V	-1.797	0.5775	-3.111	0.0797
W	-2.319	0.6957	-3.334	0.0408
X	0.078	0.4128	0.188	1.0000
Y	-0.144	0.4168	-0.345	1.0000

Treat = O subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
P	0.803	0.3847	2.088	0.6314
Q	-0.603	0.4121	-1.464	0.9502
R	-0.112	0.3737	-0.301	1.0000
S	-0.379	0.3789	-1.001	0.9977
T	-0.476	0.3216	-1.480	0.9462
U	-0.714	0.3176	-2.247	0.5148
V	-1.903	0.5100	-3.732	0.0104
W	-2.426	0.6408	-3.786	0.0085
X	-0.029	0.3115	-0.093	1.0000
Y	-0.251	0.3168	-0.791	0.9997

Treat = P subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Q	-1.407	0.3985	-3.529	0.0213
R	-0.916	0.3588	-2.552	0.3074
S	-1.183	0.3642	-3.247	0.0533
T	-1.279	0.3041	-4.207	0.0016
U	-1.517	0.2998	-5.060	0.0000
V	-2.707	0.4991	-5.423	0.0000
W	-3.229	0.6322	-5.108	0.0000
X	-0.832	0.2934	-2.837	0.1645
Y	-1.054	0.2990	-3.525	0.0217

Treat = Q subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
R	0.491	0.3880	1.265	0.9833
S	0.224	0.3929	0.570	1.0000
T	0.127	0.3380	0.377	1.0000
U	-0.110	0.3342	-0.330	1.0000
V	-1.300	0.5205	-2.498	0.3413
W	-1.823	0.6492	-2.808	0.1765
X	0.574	0.3285	1.748	0.8458
Y	0.353	0.3335	1.057	0.9963

Treat = R subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
S	-0.267	0.3526	-0.757	0.9998
T	-0.364	0.2901	-1.254	0.9845

U	-0.601	0.2856	-2.105	0.6190
V	-1.791	0.4907	-3.649	0.0140
W	-2.314	0.6256	-3.698	0.0117
X	0.083	0.2789	0.299	1.0000
Y	-0.138	0.2848	-0.486	1.0000

Treat = S subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
T	-0.097	0.2967	-0.326	1.0000
U	-0.334	0.2923	-1.144	0.9927
V	-1.524	0.4947	-3.081	0.0868
W	-2.047	0.6287	-3.256	0.0520
X	0.350	0.2858	1.225	0.9871
Y	0.128	0.2916	0.441	1.0000

Treat = T subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
U	-0.238	0.2128	-1.116	0.9940
V	-1.427	0.4523	-3.156	0.0701
W	-1.950	0.5959	-3.272	0.0493
X	0.447	0.2038	2.193	0.5546
Y	0.225	0.2118	1.064	0.9961

Treat = U subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
V	-1.190	0.4494	-2.647	0.2535
W	-1.712	0.5937	-2.884	0.1464
X	0.685	0.1974	3.469	0.0262
Y	0.463	0.2056	2.251	0.5119

Treat = V subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
W	-0.5227	0.7154	-0.7307	0.9999
X	1.8742	0.4452	4.2097	0.0016
Y	1.6525	0.4489	3.6810	0.0125

Treat = W subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
X	2.397	0.5905	4.059	0.0029
Y	2.175	0.5933	3.666	0.0132

Treat = X subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Y	-0.2216	0.1962	-1.130	0.9934

Results for: 2000_pine

General Linear Model: L=Ht-1yr (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      12  N, O, P, Q, R, S, T, U, V, W, X, Y


Analysis of Variance for L=Ht-1yr (cm), using Adjusted SS for Tests

Source   DF  Seq SS  Adj SS  Adj MS      F      P
Treat    11  174716  174716   15883  91.29  0.000
Error   689  119881  119881     174
Total   700  294597


S = 13.1906   R-Sq = 59.31%   R-Sq(adj) = 58.66%


Unusual Observations for L=Ht-1yr (cm)

     L=Ht-1yr
Obs      (cm)      Fit  SE Fit  Residual  St Resid
  1   62.3000  48.0615  3.6584   14.2385      1.12  X
  2   53.1000  48.0615  3.6584    5.0385      0.40  X
  3   40.5000  48.0615  3.6584   -7.5615     -0.60  X
  4   52.2000  48.0615  3.6584    4.1385      0.33  X
  5   59.7000  48.0615  3.6584   11.6385      0.92  X
  6   50.0000  48.0615  3.6584    1.9385      0.15  X
  7   51.3000  48.0615  3.6584    3.2385      0.26  X
  8   59.3000  48.0615  3.6584   11.2385      0.89  X
  9   21.7000  48.0615  3.6584  -26.3615     -2.08 RX
 10   42.8000  48.0615  3.6584   -5.2615     -0.42  X
 11   35.4000  48.0615  3.6584  -12.6615     -1.00  X
 12   63.4000  48.0615  3.6584   15.3385      1.21  X
 13   33.1000  48.0615  3.6584  -14.9615     -1.18  X
 34   24.7000  52.6269  2.5869  -27.9269     -2.16  R
 45   10.8000  39.4265  2.2622  -28.6265     -2.20  R
 48   12.0000  39.4265  2.2622  -27.4265     -2.11  R
 49    7.5000  39.4265  2.2622  -31.9265     -2.46  R
 51   11.0000  39.4265  2.2622  -28.4265     -2.19  R
 54   66.0000  39.4265  2.2622   26.5735      2.04  R
 63   84.7000  39.4265  2.2622   45.2735      3.48  R
 71   10.6000  39.4265  2.2622  -28.8265     -2.22  R
 88   67.9000  41.3217  2.7504   26.5783      2.06  R
 93   72.2000  41.3217  2.7504   30.8783      2.39  R
117   21.8000  49.8242  2.2962  -28.0242     -2.16  R
161   13.0000  50.0034  1.4142  -37.0034     -2.82  R
176   22.4000  50.0034  1.4142  -27.6034     -2.10  R
185   20.8000  50.0034  1.4142  -29.2034     -2.23  R
210   17.1000  50.0034  1.4142  -32.9034     -2.51  R
219   97.7000  50.0034  1.4142   47.6966      3.64  R
231   77.8000  50.0034  1.4142   27.7966      2.12  R
255   12.1000  48.0560  1.3191  -35.9560     -2.74  R
316   77.5000  48.0560  1.3191   29.4440      2.24  R
328   89.0000  48.0560  1.3191   40.9440      3.12  R
340   18.7000  48.0560  1.3191  -29.3560     -2.24  R
347   81.2000  48.0560  1.3191   33.1440      2.53  R
351   64.9000  11.0849  1.5438   53.8151      4.11  R
352   48.8000  11.0849  1.5438   37.7151      2.88  R
353   47.9000  11.0849  1.5438   36.8151      2.81  R
```

354	49.3000	11.0849	1.5438	38.2151	2.92	R
410	43.6000	11.0849	1.5438	32.5151	2.48	R
421	50.6000	11.0849	1.5438	39.5151	3.02	R
422	61.7000	11.0849	1.5438	50.6151	3.86	R
424	58.8000	11.0849	1.5438	47.7151	3.64	R
425	39.4000	9.2104	1.6115	30.1896	2.31	R
437	58.2000	9.2104	1.6115	48.9896	3.74	R
445	42.6000	9.2104	1.6115	33.3896	2.55	R
498	88.3000	53.3781	1.2354	34.9219	2.66	R
514	84.4000	53.3781	1.2354	31.0219	2.36	R
525	6.6000	53.3781	1.2354	-46.7781	-3.56	R
568	87.0000	53.3781	1.2354	33.6219	2.56	R
585	15.8000	53.3781	1.2354	-37.5781	-2.86	R
609	94.8000	46.9130	1.3191	47.8870	3.65	R
641	19.5000	46.9130	1.3191	-27.4130	-2.09	R
642	0.0000	46.9130	1.3191	-46.9130	-3.57	R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.

Grouping Information Using Tukey Method and 95.0% Confidence

Treat	N	Mean	Grouping
X	114	53.378	A
O	26	52.627	A B
T	87	50.003	A B
R	33	49.824	A B C
S	31	48.768	A B C
N	13	48.062	A B C
U	100	48.056	A B
Y	100	46.913	B C
Q	23	41.322	B C
P	34	39.426	C
V	73	11.085	D
W	67	9.210	D

Means that do not share a letter are significantly different.

Tukey 95.0% Simultaneous Confidence Intervals
Response Variable L=Ht-1yr (cm)
All Pairwise Comparisons among Levels of Treat
Treat = N subtracted from:

Treat	Lower	Center	Upper	--------+---------+---------+--------
O	-10.07	4.57	19.20	(----*---)
P	-22.69	-8.64	5.42	(----*----)
Q	-21.69	-6.74	8.21	(----*----)
R	-12.35	1.76	15.87	(----*---)
S	-13.53	0.71	14.94	(----*----)
T	-10.87	1.94	14.76	(----*---)
U	-12.71	-0.01	12.70	(---*---)
V	-49.95	-36.98	-24.00	(----*---)
W	-51.91	-38.85	-25.79	(---*---)
X	-7.30	5.32	17.93	(---*---)
Y	-13.85	-1.15	11.56	(----*---)
				--------+---------+---------+--------
				-30 0 30

Treat = O subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
P      -24.43  -13.20   -1.97           (---*--)
Q      -23.64  -11.31    1.03           (---*---)
R      -14.10   -2.80    8.50              (---*---)
S      -15.32   -3.86    7.60              (---*---)
T      -12.25   -2.62    7.01               (--*--)
U      -14.06   -4.57    4.92              (--*---)
V      -51.38  -41.54  -31.70   (--*--)
W      -53.37  -43.42  -33.46  (---*--)
X       -8.61    0.75   10.12                (--*--)
Y      -15.20   -5.71    3.77              (--*--)
                           --------+---------+---------+--------
                                 -30         0        30
```

Treat = P subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
Q       -9.74    1.90   13.53               (---*---)
R       -0.13   10.40   20.93                  (---*---)
S       -1.36    9.34   20.04                  (---*---)
T        1.86   10.58   19.29                   (--*-)
U        0.07    8.63   17.18                  (---*--)
V      -37.29  -28.34  -19.39       (--*--)
W      -39.29  -30.22  -21.14      (--*--)
X        5.53   13.95   22.37                    (--*-)
Y       -1.07    7.49   16.04                  (-*--)
                           --------+---------+---------+--------
                                 -30         0        30
```

Treat = Q subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
R       -3.20    8.50   20.21                (---*---)
S       -4.41    7.45   19.30                (---*---)
T       -1.42    8.68   18.79                 (---*--)
U       -3.23    6.73   16.70                (---*---)
V      -40.54  -30.24  -19.93     (---*--)
W      -42.53  -32.11  -21.70     (---*---)
X        2.21   12.06   21.91                   (---*--)
Y       -4.37    5.59   15.56                (---*--)
                           --------+---------+---------+--------
                                 -30         0        30
```

Treat = R subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
S      -11.83   -1.06    9.72              (---*--)
T       -8.63    0.18    8.99               (---*--)
U      -10.42   -1.77    6.88               (-*--)
V      -47.78  -38.74  -29.70    (--*--)
W      -49.78  -40.61  -31.45   (---*---)
X       -4.96    3.55   12.07                (---*--)
Y      -11.56   -2.91    5.74              (---*--)
                           --------+---------+---------+--------
                                 -30         0        30
```

Treat = S subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
```

```
T       -7.78    1.24   10.25                (--*--)
U       -9.57   -0.71    8.15                (--*--)
V      -46.92  -37.68  -28.45    (--*---)
W      -48.92  -39.56  -30.20    (--*--)
X       -4.12    4.61   13.34                  (--*-)
Y      -10.71   -1.85    7.00               (--*--)
                              --------+---------+---------+--------
                                    -30         0        30
```

Treat = T subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
U       -8.27   -1.95    4.37                (-*-)
V      -45.76  -38.92  -32.08     (-*-)
W      -47.80  -40.79  -33.79    (-*--)
X       -2.76    3.37    9.51                  (-*-)
Y       -9.41   -3.09    3.23                (-*-)
                              --------+---------+---------+--------
                                    -30         0        30
```

Treat = U subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
V      -43.60  -36.97  -30.34     (--*-)
W      -45.65  -38.85  -32.04     (-*-)
X       -0.58    5.32   11.23                   (-*-)
Y       -7.24   -1.14    4.95                 (-*-)
                              --------+---------+---------+--------
                                    -30         0        30
```

Treat = V subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
W      -9.165  -1.874   5.416                (-*--)
X      35.834  42.293  48.753                             (-*-)
Y      29.194  35.828  42.462                           (-*-)
                              --------+---------+---------+--------
                                    -30         0        30
```

Treat = W subtracted from:

```
Treat  Lower  Center  Upper  --------+---------+---------+--------
X      37.53   44.17  50.80                               (-*-)
Y      30.90   37.70  44.51                            (--*-)
                           --------+---------+---------+--------
                                 -30         0        30
```

Treat = X subtracted from:

```
Treat   Lower  Center    Upper  --------+---------+---------+--------
Y      -12.37  -6.465  -0.5611                (-*-)
                            --------+---------+---------+--------
                                  -30         0        30
```

```
Tukey Simultaneous Tests
Response Variable L=Ht-1yr (cm)
All Pairwise Comparisons among Levels of Treat
```

Treat = N subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
O	4.57	4.481	1.019	0.9973
P	-8.64	4.301	-2.008	0.6885
Q	-6.74	4.577	-1.473	0.9481
R	1.76	4.319	0.408	1.0000
S	0.71	4.359	0.162	1.0000
T	1.94	3.922	0.495	1.0000
U	-0.01	3.889	-0.001	1.0000
V	-36.98	3.971	-9.312	0.0000
W	-38.85	3.998	-9.719	0.0000
X	5.32	3.861	1.377	0.9680
Y	-1.15	3.889	-0.295	1.0000

Treat = O subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
P	-13.20	3.436	-3.84	0.0069
Q	-11.31	3.776	-2.99	0.1101
R	-2.80	3.459	-0.81	0.9997
S	-3.86	3.508	-1.10	0.9947
T	-2.62	2.948	-0.89	0.9992
U	-4.57	2.904	-1.57	0.9186
V	-41.54	3.013	-13.79	0.0000
W	-43.42	3.048	-14.25	0.0000
X	0.75	2.867	0.26	1.0000
Y	-5.71	2.904	-1.97	0.7156

Treat = P subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Q	1.90	3.561	0.53	1.0000
R	10.40	3.223	3.23	0.0569
S	9.34	3.276	2.85	0.1587
T	10.58	2.668	3.96	0.0042
U	8.63	2.619	3.30	0.0460
V	-28.34	2.739	-10.35	0.0000
W	-30.22	2.777	-10.88	0.0000
X	13.95	2.578	5.41	0.0000
Y	7.49	2.619	2.86	0.1559

Treat = Q subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
R	8.50	3.583	2.37	0.4245
S	7.45	3.630	2.05	0.6579
T	8.68	3.093	2.81	0.1768
U	6.73	3.050	2.21	0.5440
V	-30.24	3.154	-9.59	0.0000
W	-32.11	3.188	-10.07	0.0000
X	12.06	3.015	4.00	0.0037
Y	5.59	3.050	1.83	0.8000

Treat = R subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
S	-1.06	3.299	-0.32	1.0000
T	0.18	2.697	0.07	1.0000
U	-1.77	2.648	-0.67	1.0000
V	-38.74	2.767	-14.00	0.0000
W	-40.61	2.805	-14.48	0.0000
X	3.55	2.607	1.36	0.9703
Y	-2.91	2.648	-1.10	0.9948

Treat = S subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
T	1.24	2.759	0.45	1.0000
U	-0.71	2.712	-0.26	1.0000
V	-37.68	2.828	-13.33	0.0000
W	-39.56	2.865	-13.81	0.0000
X	4.61	2.672	1.73	0.8568
Y	-1.85	2.712	-0.68	0.9999

Treat = T subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
U	-1.95	1.934	-1.01	0.9976
V	-38.92	2.094	-18.59	0.0000
W	-40.79	2.144	-19.03	0.0000
X	3.37	1.878	1.80	0.8201
Y	-3.09	1.934	-1.60	0.9103

Treat = U subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
V	-36.97	2.031	-18.21	0.0000
W	-38.85	2.083	-18.65	0.0000
X	5.32	1.807	2.94	0.1254
Y	-1.14	1.865	-0.61	1.0000

Treat = V subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
W	-1.874	2.232	-0.8399	0.9996
X	42.293	1.977	21.3894	0.0000
Y	35.828	2.031	17.6440	0.0000

Treat = W subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
X	44.17	2.031	21.75	0.0000
Y	37.70	2.083	18.10	0.0000

Treat = X subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Y	-6.465	1.807	-3.577	0.0181

Results for: 2000_pine

General Linear Model: Total Ht (cm) versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      12  N, O, P, Q, R, S, T, U, V, W, X, Y


Analysis of Variance for Total Ht (cm), using Adjusted SS for Tests

Source   DF    Seq SS   Adj SS  Adj MS       F      P
Treat    11   6756048  6756048  614186  117.51  0.000
Error   688   3595978  3595978    5227
Total   699  10352026


S = 72.2960   R-Sq = 65.26%   R-Sq(adj) = 64.71%


Unusual Observations for Total Ht (cm)

       Total
Obs  Ht (cm)      Fit  SE Fit  Residual  St Resid
  1  406.100  338.992  20.051    67.108      0.97 X
  2  263.900  338.992  20.051   -75.092     -1.08 X
  3  286.000  338.992  20.051   -52.992     -0.76 X
  4  359.600  338.992  20.051    20.608      0.30 X
  5  410.500  338.992  20.051    71.508      1.03 X
  6  256.300  338.992  20.051   -82.692     -1.19 X
  7  310.700  338.992  20.051   -28.292     -0.41 X
  8  346.600  338.992  20.051     7.608      0.11 X
  9  268.900  338.992  20.051   -70.092     -1.01 X
 10  304.800  338.992  20.051   -34.192     -0.49 X
 11  365.700  338.992  20.051    26.708      0.38 X
 12  413.200  338.992  20.051    74.208      1.07 X
 13  414.600  338.992  20.051    75.608      1.09 X
 33  519.700  335.931  14.178   183.769      2.59 R
 35  188.400  335.931  14.178  -147.531     -2.08 R
 39  523.300  335.931  14.178   187.369      2.64 R
 45  124.000  340.106  12.399  -216.106     -3.03 R
 48   99.000  340.106  12.399  -241.106     -3.39 R
 49  113.000  340.106  12.399  -227.106     -3.19 R
 50  120.000  340.106  12.399  -220.106     -3.09 R
 51  119.000  340.106  12.399  -221.106     -3.10 R
 63  506.700  340.106  12.399   166.594      2.34 R
 65  548.000  340.106  12.399   207.894      2.92 R
 73  504.200  340.106  12.399   164.094      2.30 R
161   97.000  315.630   7.751  -218.630     -3.04 R
166  141.500  315.630   7.751  -174.130     -2.42 R
171  137.600  315.630   7.751  -178.030     -2.48 R
176   83.600  315.630   7.751  -232.030     -3.23 R
187  124.000  315.630   7.751  -191.630     -2.67 R
246  463.900  315.630   7.751   148.270      2.06 R
255  144.500  312.029   7.230  -167.529     -2.33 R
263  156.200  312.029   7.230  -155.829     -2.17 R
351  300.500   85.241   8.462   215.259      3.00 R
352  261.800   85.241   8.462   176.559      2.46 R
353  261.600   85.241   8.462   176.359      2.46 R
354  353.800   85.241   8.462   268.559      3.74 R
421  342.400   85.241   8.462   257.159      3.58 R
```

```
422  321.700   85.241   8.462   236.459      3.29 R
424  282.400   85.241   8.462   197.159      2.75 R
425  285.400   77.204   8.832   208.196      2.90 R
437  299.000   77.204   8.832   221.796      3.09 R
478  241.600   77.204   8.832   164.396      2.29 R
479  227.400   77.204   8.832   150.196      2.09 R
480  251.700   77.204   8.832   174.496      2.43 R
549  156.900  337.908   6.771  -181.008     -2.51 R
577  539.200  337.908   6.771   201.292      2.80 R
644  171.200  333.192   7.266  -161.992     -2.25 R
651  169.000  333.192   7.266  -164.192     -2.28 R
670  180.500  333.192   7.266  -152.692     -2.12 R
684  120.900  333.192   7.266  -212.292     -2.95 R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

Treat    N    Mean  Grouping
P       34  340.11  A
N       13  338.99  A
X      114  337.91  A
O       26  335.93  A
Y       99  333.19  A
R       33  324.08  A
S       31  316.19  A
T       87  315.63  A
U      100  312.03  A
Q       23  300.60  A
V       73   85.24    B
W       67   77.20    B

Means that do not share a letter are significantly different.


Tukey 95.0% Simultaneous Confidence Intervals
Response Variable Total Ht (cm)
All Pairwise Comparisons among Levels of Treat
Treat = N  subtracted from:

Treat   Lower  Center   Upper  -------+---------+---------+---------
O       -83.3    -3.1    77.2              (---*---)
P       -75.9     1.1    78.1              (---*---)
Q      -120.3   -38.4    43.6           (---*---)
R       -92.2   -14.9    62.4            (---*---)
S      -100.8   -22.8    55.2            (---*---)
T       -93.6   -23.4    46.9            (---*--)
U       -96.6   -27.0    42.7            (---*--)
V      -324.8  -253.8  -182.7   (--*---)
W      -333.4  -261.8  -190.2  (---*--)
X       -70.2    -1.1    68.1              (---*--)
Y       -75.5    -5.8    63.9              (---*--)
                            -------+---------+---------+---------
                                -200         0       200


Treat = O  subtracted from:

Treat   Lower  Center   Upper  -------+---------+---------+---------
P       -57.4     4.2    65.7               (--*--)
Q      -102.9   -35.3    32.3            (--*---)
```

```
R       -73.8   -11.8    50.1              (--*---)
S       -82.5   -19.7    43.1              (--*--)
T       -73.1   -20.3    32.5              (--*--)
U       -75.9   -23.9    28.1              (--*-)
V      -304.6  -250.7  -196.7    (-*--)
W      -313.3  -258.7  -204.2   (--*--)
X       -49.4     2.0    53.3                (-*--)
Y       -54.8    -2.7    49.3               (--*-)
                                -------+---------+---------+---------
                                    -200         0       200
```

Treat = P subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
Q      -103.3   -39.5    24.3            (--*--)
R       -73.7   -16.0    41.7             (--*--)
S       -82.6   -23.9    34.7             (--*--)
T       -72.2   -24.5    23.3             (--*-)
U       -75.0   -28.1    18.8             (--*-)
V      -303.9  -254.9  -205.8    (-*--)
W      -312.6  -262.9  -213.2   (--*-)
X       -48.3    -2.2    44.0               (-*-)
Y       -53.9    -6.9    40.0              (--*-)
                                -------+---------+---------+---------
                                    -200         0       200
```

Treat = Q subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
R       -40.7    23.5    87.6               (--*--)
S       -49.4    15.6    80.6               (--*--)
T       -40.3    15.0    70.4               (--*--)
U       -43.2    11.4    66.0               (--*-)
V      -271.8  -215.4  -158.9     (--*--)
W      -280.5  -223.4  -166.3     (--*--)
X       -16.7    37.3    91.3                (--*--)
Y       -22.1    32.6    87.3                (--*-)
                                -------+---------+---------+---------
                                    -200         0       200
```

Treat = R subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
S       -67.0    -7.9    51.2              (--*--)
T       -56.7    -8.5    39.8              (--*-)
U       -59.5   -12.1    35.4              (-*--)
V      -288.4  -238.8  -189.3    (-*--)
W      -297.1  -246.9  -196.7   (--*-)
X       -32.9    13.8    60.5               (--*-)
Y       -38.4     9.1    56.6               (-*--)
                                -------+---------+---------+---------
                                    -200         0       200
```

Treat = S subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
T       -50.0    -0.6    48.8               (-*-)
U       -52.7    -4.2    44.4              (--*-)
V      -281.6  -230.9  -180.3    (-*--)
```

```
W      -290.3  -239.0  -187.7    (--*--)
X       -26.1    21.7    69.6                (-*-)
Y       -31.6    17.0    65.6               (--*-)
                              -------+---------+---------+---------
                                  -200         0       200
```

Treat = T subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
U       -38.2    -3.6    31.0               (-*-)
V      -267.9  -230.4  -192.9      (*-)
W      -276.8  -238.4  -200.0     (-*-)
X       -11.3    22.3    55.9                (-*-)
Y       -17.1    17.6    52.3                (-*-)
                              -------+---------+---------+---------
                                  -200         0       200
```

Treat = U subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
V      -263.1  -226.8  -190.4      (-*)
W      -272.1  -234.8  -197.5     (-*-)
X        -6.5    25.9    58.2                 (*-)
Y       -12.3    21.2    54.6                (-*-)
                              -------+---------+---------+---------
                                  -200         0       200
```

Treat = V subtracted from:

```
Treat   Lower   Center   Upper  -------+---------+---------+---------
W      -47.99   -8.037   31.92               (-*-)
X      217.26  252.667  288.07                            (-*)
Y      211.52  247.951  284.39                            (*-)
                               -------+---------+---------+---------
                                   -200         0       200
```

Treat = W subtracted from:

```
Treat  Lower  Center  Upper  -------+---------+---------+---------
X      224.3   260.7  297.1                          (-*-)
Y      218.6   256.0  293.4                          (-*-)
                            -------+---------+---------+---------
                                -200         0       200
```

Treat = X subtracted from:

```
Treat   Lower  Center  Upper  -------+---------+---------+---------
Y      -37.16  -4.716  27.73              (-*)
                             -------+---------+---------+---------
                                 -200         0       200
```

```
Tukey Simultaneous Tests
Response Variable Total Ht (cm)
All Pairwise Comparisons among Levels of Treat
Treat = N  subtracted from:

       Difference       SE of           Adjusted
```

Treat	of Means	Difference	T-Value	P-Value
O	-3.1	24.56	-0.12	1.0000
P	1.1	23.58	0.05	1.0000
Q	-38.4	25.09	-1.53	0.9324
R	-14.9	23.67	-0.63	1.0000
S	-22.8	23.89	-0.95	0.9985
T	-23.4	21.50	-1.09	0.9953
U	-27.0	21.31	-1.27	0.9833
V	-253.8	21.76	-11.66	0.0000
W	-261.8	21.91	-11.95	0.0000
X	-1.1	21.16	-0.05	1.0000
Y	-5.8	21.33	-0.27	1.0000

Treat = O subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
P	4.2	18.83	0.22	1.0000
Q	-35.3	20.69	-1.71	0.8654
R	-11.8	18.96	-0.62	1.0000
S	-19.7	19.23	-1.03	0.9971
T	-20.3	16.16	-1.26	0.9842
U	-23.9	15.92	-1.50	0.9405
V	-250.7	16.51	-15.18	0.0000
W	-258.7	16.70	-15.49	0.0000
X	2.0	15.71	0.13	1.0000
Y	-2.7	15.93	-0.17	1.0000

Treat = P subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Q	-39.5	19.52	-2.02	0.6770
R	-16.0	17.67	-0.91	0.9991
S	-23.9	17.95	-1.33	0.9751
T	-24.5	14.62	-1.67	0.8803
U	-28.1	14.35	-1.96	0.7233
V	-254.9	15.01	-16.98	0.0000
W	-262.9	15.22	-17.27	0.0000
X	-2.2	14.13	-0.16	1.0000
Y	-6.9	14.37	-0.48	1.0000

Treat = Q subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
R	23.5	19.64	1.20	0.9894
S	15.6	19.90	0.78	0.9998
T	15.0	16.95	0.89	0.9993
U	11.4	16.72	0.68	0.9999
V	-215.4	17.29	-12.46	0.0000
W	-223.4	17.47	-12.79	0.0000
X	37.3	16.53	2.26	0.5074
Y	32.6	16.73	1.95	0.7290

Treat = R subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value

S	-7.9	18.08	-0.44	1.0000
T	-8.5	14.78	-0.57	1.0000
U	-12.1	14.51	-0.83	0.9996
V	-238.8	15.17	-15.75	0.0000
W	-246.9	15.38	-16.06	0.0000
X	13.8	14.29	0.97	0.9983
Y	9.1	14.53	0.63	1.0000

Treat = S subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
T	-0.6	15.12	-0.04	1.0000
U	-4.2	14.86	-0.28	1.0000
V	-230.9	15.50	-14.90	0.0000
W	-239.0	15.70	-15.22	0.0000
X	21.7	14.64	1.48	0.9455
Y	17.0	14.88	1.14	0.9927

Treat = T subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
U	-3.6	10.60	-0.34	1.0000
V	-230.4	11.48	-20.08	0.0000
W	-238.4	11.75	-20.29	0.0000
X	22.3	10.29	2.16	0.5756
Y	17.6	10.62	1.65	0.8891

Treat = U subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
V	-226.8	11.130	-20.38	0.0000
W	-234.8	11.414	-20.57	0.0000
X	25.9	9.905	2.61	0.2723
Y	21.2	10.250	2.06	0.6483

Treat = V subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
W	-8.037	12.23	-0.6570	1.0000
X	252.667	10.84	23.3145	0.0000
Y	247.951	11.15	22.2314	0.0000

Treat = W subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
X	260.7	11.13	23.43	0.0000
Y	256.0	11.44	22.38	0.0000

Treat = X subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value

```
Y          -4.716       9.932  -0.4748     1.000
```

Species: Douglas-fir

General Linear Model: SI(m) 50 GI versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      23  A, B, C, D, E, F, G, H, I, J, K, L, M, O, P, Q, S, T, U,
                       V, W, X, Y


Analysis of Variance for SI(m) 50 GI, using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS     F      P
Treat    22  1976.64  1976.64   89.85  7.22  0.000
Error   408  5076.58  5076.58   12.44
Total   430  7053.22


S = 3.52741   R-Sq = 28.02%   R-Sq(adj) = 24.14%


Unusual Observations for SI(m) 50 GI

Obs  SI(m) 50 GI      Fit  SE Fit  Residual  St Resid
  1      23.1700  20.8800  2.0365    2.2900      0.80 X
  2      19.2000  20.8800  2.0365   -1.6800     -0.58 X
  4      20.2700  20.8800  2.0365   -0.6100     -0.21 X
 48       9.1100  18.1950  1.0183   -9.0850     -2.69 R
 53       7.3600  18.1950  1.0183  -10.8350     -3.21 R
 57      25.7300  18.1950  1.0183    7.5350      2.23 R
 63      29.7800  18.1950  1.0183   11.5850      3.43 R
120      12.0700  19.1855  0.7888   -7.1155     -2.07 R
125      11.6300  19.1855  0.7888   -7.5555     -2.20 R
130      10.9100  19.1855  0.7888   -8.2755     -2.41 R
132      29.0900  19.1855  0.7888    9.9045      2.88 R
137      26.7400  19.1855  0.7888    7.5545      2.20 R
161      12.1400  23.0694  0.6335  -10.9294     -3.15 R
163      14.4600  23.0694  0.6335   -8.6094     -2.48 R
183      15.8200  23.7132  0.6666   -7.8932     -2.28 R
185      15.8700  23.7132  0.6666   -7.8432     -2.26 R
193      30.9300  23.7132  0.6666    7.2168      2.08 R
196      32.2400  23.7132  0.6666    8.5268      2.46 R
197      30.8100  23.7132  0.6666    7.0968      2.05 R
286      27.1600  24.8200  1.7637    2.3400      0.77 X
287      24.8500  24.8200  1.7637    0.0300      0.01 X
288      25.7000  24.8200  1.7637    0.8800      0.29 X
290      21.5700  24.8200  1.7637   -3.2500     -1.06 X
291      24.9200  27.7950  2.4943   -2.8750     -1.15 X
292      30.6700  27.7950  2.4943    2.8750      1.15 X
311      24.4000  23.8567  2.0365    0.5433      0.19 X
312      21.2700  23.8567  2.0365   -2.5867     -0.90 X
313      25.9000  23.8567  2.0365    2.0433      0.71 X
329      17.7200  26.6580  0.5258   -8.9380     -2.56 R
330      19.3100  26.6580  0.5258   -7.3480     -2.11 R
350      19.1100  26.6580  0.5258   -7.5480     -2.16 R
361      36.2600  26.5549  0.5145    9.7051      2.78 R
410      19.2500  17.2200  2.4943    2.0300      0.81 X
411      15.1900  17.2200  2.4943   -2.0300     -0.81 X
422      22.4200  22.4200  3.5274    0.0000         * X
426      36.7100  25.4813  0.6440   11.2287      3.24 R
449      16.9800  25.4813  0.6440   -8.5013     -2.45 R
```

```
466      13.5200  25.7731  0.5648  -12.2531     -3.52 R
469      18.7800  25.7731  0.5648   -6.9931     -2.01 R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

Treat   N   Mean  Grouping
O       2  27.79  A B C D E F
T      45  26.66  A
U      47  26.55  A
P       9  26.42  A B     E F
D      29  25.96  A B     E F
Y      39  25.77  A B     E F
X      30  25.48  A B     E F
Q       9  25.46  A B     E F
E      25  25.20  A B     E F
J      10  24.92  A B     E F
M       4  24.82  A B C D E F
I      31  24.82  A B     E F
K      11  24.04  A B     E F
S       3  23.86  A B C D E F
L       8  23.75  A B C D E F
H      28  23.71  A B     E F
B      32  23.14            F
G      31  23.07          E F
W       1  22.42  A B C D E F
A       3  20.88  A B C D E F
F      20  19.19        D
C      12  18.20      C D
V       2  17.22    B C D E F

Means that do not share a letter are significantly different.


Tukey 95.0% Simultaneous Confidence Intervals
Response Variable SI(m) 50 GI
All Pairwise Comparisons among Levels of Treat
Treat = A  subtracted from:

Treat   Lower  Center   Upper  ---------+---------+---------+-------
B       -5.43   2.265   9.961              (------*-----)
C      -10.91  -2.685   5.542           (------*------)
D       -2.65   5.083  12.813                 (-----*------)
E       -3.47   4.317  12.105               (------*-----)
F       -9.59  -1.695   6.197            (------*-----)
G       -5.52   2.189   9.896               (------*-----)
H       -4.91   2.833  10.576                (-----*------)
I       -3.77   3.940  11.647                 (-----*------)
J       -4.35   4.039  12.429                (------*------)
K       -5.14   3.161  11.463                (------*------)
L       -5.76   2.872  11.501               (------*-------)
M       -5.79   3.940  13.675               (-------*-------)
O       -4.72   6.915  18.550                (---------*--------)
P       -2.96   5.540  14.037                  (------*------)
Q       -3.91   4.583  13.080                 (------*------)
S       -7.43   2.977  13.383              (-------*--------)
T       -1.82   5.778  13.378                  (------*-----)
U       -1.92   5.675  13.265                  (------*-----)
V      -15.30  -3.660   7.975        (---------*---------)
W      -13.18   1.540  16.257          (-----------*-----------)
```

```
X       -3.12   4.601  12.319                  (------*-----)
Y       -2.74   4.893  12.530                   (-----*-----)
                                  ---------+---------+---------+-------
                                         -12         0        12
```

Treat = B subtracted from:

```
Treat   Lower  Center    Upper  ---------+---------+---------+-------
C       -9.26  -4.950  -0.6353             (---*--)
D       -0.45   2.818   6.0862                    (-*--)
E       -1.35   2.053   5.4547                   (--*--)
F       -7.59  -3.959  -0.3261               (--*--)
G       -3.29  -0.075   3.1367                  (--*--)
H       -2.73   0.569   3.8668                   (-*--)
I       -1.54   1.675   4.8873                    (-*--)
J       -2.84   1.774   6.3919                   (--*---)
K       -3.56   0.896   5.3510                  (---*--)
L       -4.43   0.608   5.6460                 (----*---)
M       -5.08   1.675   8.4347                 (----*-----)
O       -4.64   4.650  13.9402                 (-------*-------)
P       -1.53   3.275   8.0843                    (---*---)
Q       -2.49   2.319   7.1277                  (---*---)
S       -6.98   0.712   8.4079               (------*-----)
T        0.57   3.513   6.4606                     (--*-)
U        0.49   3.410   6.3313                     (--*-)
V      -15.21  -5.925   3.3652         (-------*-------)
W      -13.67  -0.725  12.2186           (---------*----------)
X       -0.90   2.337   5.5757                    (--*--)
Y       -0.41   2.628   5.6685                     (-*--)
                                  ---------+---------+---------+-------
                                         -12         0        12
```

Treat = C subtracted from:

```
Treat   Lower   Center   Upper  ---------+---------+---------+-------
D        3.39   7.7681  12.143                       (--*---)
E        2.53   7.0022  11.478                     (---*---)
F       -3.66   0.9905   5.645                 (---*---)
G        0.54   4.8744   9.208                    (---*---)
H        1.12   5.5182   9.916                     (---*--)
I        2.29   6.6250  10.958                      (---*--)
J        1.27   6.7240  12.181                     (----*---)
K        0.53   5.8459  11.166                    (----*---)
L       -0.26   5.5575  11.375                    (----*---)
M       -0.73   6.6250  13.984                  (------*-----)
O       -0.13   9.6000  19.335                   (-------*-------)
P        2.60   8.2250  13.845                     (----*----)
Q        1.65   7.2683  12.889                    (----*----)
S       -2.57   5.6617  13.889                 (------*------)
T        4.32   8.4630  12.604                       (--*---)
U        4.24   8.3599  12.482                       (--*--)
V      -10.71  -0.9750   8.760            (-------*-------)
W       -9.04   4.2250  17.491             (-----------*----------)
X        2.93   7.2863  11.640                      (---*---)
Y        3.37   7.5781  11.786                       (--*---)
                                  ---------+---------+---------+-------
                                         -12         0        12
```

Treat = D subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
E       -4.24  -0.766   2.713               (--*--)
F      -10.48  -6.778  -3.073          (--*--)
G       -6.19  -2.894   0.399              (--*-)
H       -5.63  -2.250   1.127              (--*--)
I       -4.44  -1.143   2.150               (--*--)
J       -5.72  -1.044   3.630              (---*---)
K       -6.44  -1.922   2.591              (--*---)
L       -7.30  -2.211   2.879             (---*---)
M       -7.94  -1.143   5.655            (-----*-----)
O       -7.49   1.832  11.150             (-------*------)
P       -4.41   0.457   5.320               (---*---)
Q       -5.36  -0.500   4.364               (---*---)
S       -9.84  -2.106   5.624            (-----*------)
T       -2.34   0.695   3.730                  (--*-)
U       -2.42   0.592   3.601                  (-*--)
V      -18.06  -8.743   0.575     (-------*------)
W      -16.51  -3.543   9.420      (----------*----------)
X       -3.80  -0.482   2.837                (--*-)
Y       -3.32  -0.190   2.935                (--*-)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = E subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
F       -9.84  -6.012  -2.188           (--*--)
G       -5.55  -2.128   1.298              (--*--)
H       -4.99  -1.484   2.023               (--*--)
I       -3.80  -0.377   3.049                (--*--)
J       -5.05  -0.278   4.491               (---*---)
K       -5.77  -1.156   3.455              (---*---)
L       -6.62  -1.445   3.733             (----*---)
M       -7.24  -0.377   6.487             (-----*----)
O       -6.77   2.598  11.964             (-------*-------)
P       -3.73   1.223   6.177                (---*---)
Q       -4.69   0.266   5.221               (---*---)
S       -9.13  -1.341   6.447            (------*-----)
T       -1.72   1.461   4.640                  (-*--)
U       -1.80   1.358   4.513                  (-*--)
V      -17.34  -7.977   1.389      (------*-------)
W      -15.78  -2.777  10.221       (----------*----------)
X       -3.17   0.284   3.736                (--*--)
Y       -2.69   0.576   3.841                 (-*--)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = F subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
G        0.23   3.884   7.539                   (--*--)
H        0.80   4.528   8.259                    (--*--)
I        1.98   5.634   9.290                     (--*--)
J        0.80   5.734  10.670                    (---*---)
K        0.07   4.855   9.640                   (---*---)
L       -0.76   4.567   9.899                  (----*---)
M       -1.35   5.635  12.616                  (-----*-----)
O       -0.84   8.609  18.062                  (-------*-------)
P        2.12   7.235  12.350                     (---*---)
Q        1.16   6.278  11.394                    (---*---)
S       -3.22   4.671  12.562                (------*-----)
```

```
T        4.05   7.473  10.898                      (--*--)
U        3.97   7.369  10.772                      (--*--)
V      -11.42  -1.965   7.487           (-------*-------)
W       -9.83   3.234  16.295             (----------*----------)
X        2.62   6.296   9.975                     (--*--)
Y        3.08   6.588  10.093                      (-*--)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = G subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
H       -2.68   0.644   3.967                  (--*-)
I       -1.49   1.751   4.988                   (-*--)
J       -2.79   1.850   6.485                  (---*--)
K       -3.50   0.972   5.445                 (---*---)
L       -4.37   0.683   5.738                (----*---)
M       -5.02   1.751   8.522                (----*-----)
O       -4.57   4.726  14.024                (-------*-------)
P       -1.48   3.351   8.177                   (---*---)
Q       -2.43   2.394   7.220                  (---*---)
S       -6.92   0.787   8.494              (------*-----)
T        0.61   3.589   6.564                    (-*-)
U        0.54   3.486   6.435                   (--*-)
V      -15.15  -5.849   3.449        (-------*-------)
W      -13.60  -0.649  12.300          (---------*----------)
X       -0.85   2.412   5.676                  (--*--)
Y       -0.36   2.704   5.771                   (-*--)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = H subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
I       -2.22   1.107   4.430                  (--*--)
J       -3.49   1.206   5.901                 (---*---)
K       -4.21   0.328   4.863                (---*---)
L       -5.07   0.039   5.149                (---*---)
M       -5.71   1.107   7.920               (-----*-----)
O       -5.25   4.082  13.411                (------*-------)
P       -2.18   2.707   7.591                  (---*---)
Q       -3.13   1.750   6.634                 (---*----)
S       -7.60   0.143   7.886              (-----*------)
T       -0.12   2.945   6.013                   (-*--)
U       -0.20   2.842   5.884                   (-*--)
V      -15.82  -6.493   2.836        (-------*------)
W      -14.26  -1.293  11.678         (----------*----------)
X       -1.58   1.768   5.117                   (-*--)
Y       -1.10   2.060   5.217                   (--*-)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = I subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
J       -4.54   0.099   4.734                (---*---)
K       -5.25  -0.779   3.694                (--*---)
L       -6.12  -1.067   3.987               (---*---)
M       -6.77   0.000   6.771              (-----*-----)
O       -6.32   2.975  12.274                (------*-------)
```

```
P       -3.23   1.600   6.426                 (---*---)
Q       -4.18   0.643   5.469                 (---*---)
S       -8.67  -0.963   6.743              (-----*------)
T       -1.14   1.838   4.813                   (--*-)
U       -1.21   1.735   4.684                   (-*--)
V      -16.90  -7.600   1.699       (-------*------)
W      -15.35  -2.400  10.550        (----------*----------)
X       -2.60   0.661   3.926                 (--*-)
Y       -2.11   0.953   4.020                 (--*-)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = J subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
K       -6.45  -0.878   4.691               (---*----)
L       -7.21  -1.167   4.879              (----*----)
M       -7.64  -0.099   7.441              (-----*-----)
O       -7.00   2.876  12.749              (-------*--------)
P       -4.36   1.501   7.357                (----*----)
Q       -5.31   0.544   6.401                (---*----)
S       -9.45  -1.062   7.328             (------*------)
T       -2.72   1.739   6.195                  (--*---)
U       -2.80   1.636   6.075                  (--*---)
V      -17.57  -7.699   2.174      (--------*-------)
W      -15.87  -2.499  10.869        (----------*----------)
X       -4.09   0.562   5.216                  (--*---)
Y       -3.66   0.854   5.372                  (---*--)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = K subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
L       -6.21  -0.288   5.634               (----*----)
M       -6.66   0.779   8.221              (------*-----)
O       -6.04   3.754  13.552               (-------*-------)
P       -3.35   2.379   8.108                 (----*----)
Q       -4.31   1.422   7.151                (----*----)
S       -8.49  -0.184   8.117              (------*------)
T       -1.67   2.617   6.904                   (--*---)
U       -1.76   2.514   6.783                   (--*---)
V      -16.62  -6.821   2.977       (-------*-------)
W      -14.93  -1.621  11.691         (----------*----------)
X       -3.05   1.440   5.933                  (---*---)
Y       -2.62   1.732   6.083                   (--*---)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = L subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
M       -6.74   1.068   8.873              (------*-----)
O       -6.03   4.042  14.119               (-------*--------)
P       -3.53   2.668   8.861                 (----*----)
Q       -4.48   1.711   7.904                (----*-----)
S       -8.52   0.104   8.733              (------*------)
T       -1.98   2.905   7.796                  (---*---)
U       -2.07   2.802   7.677                  (---*---)
V      -16.61  -6.532   3.544       (--------*-------)
```

```
W      -14.85  -1.333  12.186         (----------*----------)
X       -3.34   1.729   6.800                  (---*----)
Y       -2.93   2.021   6.967                   (---*---)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = M subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
O       -8.06   2.975  14.013              (--------*---------)
P       -6.06   1.600   9.259                (-----*------)
Q       -7.02   0.643   8.303               (------*-----)
S      -10.70  -0.963   8.771             (-------*-------)
T       -4.81   1.838   8.488                 (-----*----)
U       -4.90   1.735   8.373                 (----*-----)
V      -18.64  -7.600   3.438     (---------*--------)
W      -16.65  -2.400  11.850       (-----------*-----------)
X       -6.12   0.661   7.446                (-----*----)
Y       -5.74   0.953   7.645                (-----*----)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = O subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
P      -11.34   -1.37   8.589            (-------*-------)
Q      -12.30   -2.33   7.632           (-------*-------)
S      -15.57   -3.94   7.697        (---------*--------)
T      -10.35   -1.14   8.074            (-------*-------)
U      -10.44   -1.24   7.962            (-------*-------)
V      -23.32  -10.57   2.171  (---------*----------)
W      -20.99   -5.37  10.235    (------------*------------)
X      -11.62   -2.31   6.994          (-------*-------)
Y      -11.26   -2.02   7.219           (------*-------)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = P subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
Q       -6.97  -0.957  5.0517              (----*----)
S      -11.06  -2.563  5.9338            (------*------)
T       -4.42   0.238  4.8920                 (---*---)
U       -4.50   0.135  4.7724                 (---*---)
V      -19.16  -9.200  0.7637     (-------*--------)
W      -17.44  -4.000  9.4351      (-----------*----------)
X       -5.78  -0.939  3.9054               (---*---)
Y       -5.36  -0.647  4.0664                (--*---)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = Q subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
S      -10.10  -1.607   6.890            (------*------)
T       -3.46   1.195   5.849                 (---*---)
U       -3.55   1.092   5.729                 (---*---)
V      -18.21  -8.243   1.720      (-------*-------)
W      -16.48  -3.043  10.392       (----------*-----------)
```

```
X       -4.83   0.018   4.862                (---*---)
Y       -4.40   0.310   5.023                (---*---)
                                  ---------+---------+---------+-------
                                         -12         0        12
```

Treat = S subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
T       -4.80   2.801  10.401                (-----*------)
U       -4.89   2.698  10.288                (-----*------)
V      -18.27  -6.637   4.998      (--------*---------)
W      -16.15  -1.437  13.281        (-----------*-----------)
X       -6.09   1.625   9.343                (-----*------)
Y       -5.72   1.916   9.553                (------*-----)
                                  ---------+---------+---------+-------
                                         -12         0        12
```

Treat = T subtracted from:

```
Treat   Lower  Center    Upper  ---------+---------+---------+-------
U       -2.76  -0.103   2.5552                   (-*-)
V      -18.65  -9.438  -0.2274     (-------*-------)
W      -17.12  -4.238   8.6485       (---------*----------)
X       -4.18  -1.177   1.8275                 (-*--)
Y       -3.67  -0.885   1.9035                 (-*--)
                                   ---------+---------+---------+-------
                                          -12         0        12
```

Treat = U subtracted from:

```
Treat   Lower  Center    Upper  ---------+---------+---------+-------
V      -18.54  -9.335  -0.1326      (------*-------)
W      -17.02  -4.135   8.7456       (----------*---------)
X       -4.05  -1.074   1.9049                 (-*--)
Y       -3.54  -0.782   1.9789                 (-*--)
                                   ---------+---------+---------+-------
                                          -12         0        12
```

Treat = V subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
W      -10.41   5.200  20.81           (------------*------------)
X       -1.05   8.261  17.57                   (-------*-------)
Y       -0.69   8.553  17.79                   (-------*-------)
                                  ---------+---------+---------+-------
                                         -12         0        12
```

Treat = W subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
X      -9.895   3.061  16.02            (----------*---------)
Y      -9.555   3.353  16.26            (----------*----------)
                                  ---------+---------+---------+-------
                                         -12         0        12
```

Treat = X subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
```

```
Y      -2.803  0.2917  3.387                   (-*--)
                                  ---------+---------+---------+-------
                                         -12         0        12
```

Tukey Simultaneous Tests
Response Variable SI(m) 50 GI
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
B	2.265	2.130	1.063	1.0000
C	-2.685	2.277	-1.179	1.0000
D	5.083	2.139	2.376	0.7471
E	4.317	2.155	2.003	0.9375
F	-1.695	2.184	-0.776	1.0000
G	2.189	2.133	1.027	1.0000
H	2.833	2.143	1.322	0.9997
I	3.940	2.133	1.847	0.9731
J	4.039	2.322	1.739	0.9866
K	3.161	2.298	1.376	0.9995
L	2.872	2.388	1.203	0.9999
M	3.940	2.694	1.462	0.9987
O	6.915	3.220	2.147	0.8820
P	5.540	2.352	2.356	0.7611
Q	4.583	2.352	1.949	0.9524
S	2.977	2.880	1.034	1.0000
T	5.778	2.103	2.747	0.4580
U	5.675	2.101	2.702	0.4939
V	-3.660	3.220	-1.137	1.0000
W	1.540	4.073	0.378	1.0000
X	4.601	2.136	2.154	0.8789
Y	4.893	2.113	2.315	0.7882

Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-4.950	1.1940	-4.145	0.0071
D	2.818	0.9044	3.116	0.2122
E	2.053	0.9416	2.180	0.8663
F	-3.959	1.0055	-3.938	0.0160
G	-0.075	0.8889	-0.085	1.0000
H	0.569	0.9128	0.623	1.0000
I	1.675	0.8889	1.885	0.9666
J	1.774	1.2779	1.388	0.9994
K	0.896	1.2329	0.727	1.0000
L	0.608	1.3943	0.436	1.0000
M	1.675	1.8707	0.896	1.0000
O	4.650	2.5710	1.809	0.9788
P	3.275	1.3309	2.461	0.6849
Q	2.319	1.3309	1.742	0.9864
S	0.712	2.1299	0.334	1.0000
T	3.513	0.8157	4.307	0.0036
U	3.410	0.8084	4.218	0.0053
V	-5.925	2.5710	-2.304	0.7951
W	-0.725	3.5821	-0.202	1.0000
X	2.337	0.8964	2.607	0.5701
Y	2.628	0.8414	3.124	0.2082

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	7.7681	1.211	6.4159	0.0001
E	7.0022	1.239	5.6525	0.0001
F	0.9905	1.288	0.7690	1.0000
G	4.8744	1.199	4.0644	0.0098
H	5.5182	1.217	4.5340	0.0014
I	6.6250	1.199	5.5242	0.0001
J	6.7240	1.510	4.4520	0.0020
K	5.8459	1.472	3.9703	0.0141
L	5.5575	1.610	3.4518	0.0843
M	6.6250	2.037	3.2531	0.1493
O	9.6000	2.694	3.5633	0.0594
P	8.2250	1.555	5.2879	0.0001
Q	7.2683	1.555	4.6728	0.0007
S	5.6617	2.277	2.4865	0.6654
T	8.4630	1.146	7.3846	0.0001
U	8.3599	1.141	7.3276	0.0001
V	-0.9750	2.694	-0.3619	1.0000
W	4.2250	3.671	1.1508	1.0000
X	7.2863	1.205	6.0476	0.0001
Y	7.5781	1.164	6.5079	0.0001

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	-0.766	0.9627	-0.796	1.0000
F	-6.778	1.0253	-6.611	0.0001
G	-2.894	0.9113	-3.175	0.1830
H	-2.250	0.9346	-2.407	0.7247
I	-1.143	0.9113	-1.254	0.9999
J	-1.044	1.2936	-0.807	1.0000
K	-1.922	1.2491	-1.539	0.9973
L	-2.211	1.4087	-1.569	0.9965
M	-1.143	1.8814	-0.608	1.0000
O	1.832	2.5788	0.710	1.0000
P	0.457	1.3459	0.339	1.0000
Q	-0.500	1.3459	-0.371	1.0000
S	-2.106	2.1393	-0.985	1.0000
T	0.695	0.8400	0.827	1.0000
U	0.592	0.8329	0.710	1.0000
V	-8.743	2.5788	-3.390	0.1013
W	-3.543	3.5877	-0.988	1.0000
X	-0.482	0.9186	-0.524	1.0000
Y	-0.190	0.8649	-0.220	1.0000

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-6.012	1.0582	-5.681	0.0001
G	-2.128	0.9482	-2.244	0.8317
H	-1.484	0.9706	-1.529	0.9975
I	-0.377	0.9482	-0.398	1.0000
J	-0.278	1.3198	-0.211	1.0000
K	-1.156	1.2763	-0.906	1.0000
L	-1.445	1.4328	-1.008	1.0000
M	-0.377	1.8996	-0.199	1.0000

O	2.598	2.5921	1.002	1.0000
P	1.223	1.3712	0.892	1.0000
Q	0.266	1.3712	0.194	1.0000
S	-1.341	2.1553	-0.622	1.0000
T	1.461	0.8799	1.660	0.9925
U	1.358	0.8732	1.555	0.9969
V	-7.977	2.5921	-3.078	0.2331
W	-2.777	3.5973	-0.772	1.0000
X	0.284	0.9552	0.297	1.0000
Y	0.576	0.9037	0.637	1.0000

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	3.884	1.0117	3.8390	0.0230
H	4.528	1.0327	4.3843	0.0026
I	5.634	1.0117	5.5694	0.0001
J	5.734	1.3662	4.1968	0.0058
K	4.855	1.3241	3.6669	0.0422
L	4.567	1.4756	3.0950	0.2235
M	5.635	1.9320	2.9163	0.3330
O	8.609	2.6160	3.2911	0.1345
P	7.235	1.4159	5.1096	0.0001
Q	6.278	1.4159	4.4340	0.0021
S	4.671	2.1840	2.1389	0.8860
T	7.473	0.9480	7.8827	0.0001
U	7.369	0.9417	7.8253	0.0001
V	-1.965	2.6160	-0.7513	1.0000
W	3.234	3.6145	0.8949	1.0000
X	6.296	1.0183	6.1828	0.0001
Y	6.588	0.9701	6.7903	0.0001

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	0.644	0.9196	0.700	1.0000
I	1.751	0.8960	1.954	0.9512
J	1.850	1.2828	1.442	0.9989
K	0.972	1.2379	0.785	1.0000
L	0.683	1.3988	0.488	1.0000
M	1.751	1.8740	0.934	1.0000
O	4.726	2.5735	1.836	0.9749
P	3.351	1.3356	2.509	0.6481
Q	2.394	1.3356	1.792	0.9809
S	0.787	2.1328	0.369	1.0000
T	3.589	0.8233	4.359	0.0029
U	3.486	0.8162	4.271	0.0042
V	-5.849	2.5735	-2.273	0.8147
W	-0.649	3.5838	-0.181	1.0000
X	2.412	0.9034	2.670	0.5192
Y	2.704	0.8488	3.185	0.1784

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	1.107	0.9196	1.203	0.9999
J	1.206	1.2995	0.928	1.0000
K	0.328	1.2552	0.261	1.0000
L	0.039	1.4141	0.028	1.0000
M	1.107	1.8855	0.587	1.0000
O	4.082	2.5818	1.581	0.9961
P	2.707	1.3516	2.003	0.9376
Q	1.750	1.3516	1.295	0.9998
S	0.143	2.1429	0.067	1.0000
T	2.945	0.8490	3.468	0.0801
U	2.842	0.8421	3.375	0.1061
V	-6.493	2.5818	-2.515	0.6431
W	-1.293	3.5898	-0.360	1.0000
X	1.768	0.9269	1.908	0.9619
Y	2.060	0.8737	2.358	0.7600

Treat = I subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
J	0.099	1.2828	0.077	1.0000
K	-0.779	1.2379	-0.629	1.0000
L	-1.067	1.3988	-0.763	1.0000
M	0.000	1.8740	0.000	1.0000
O	2.975	2.5735	1.156	1.0000
P	1.600	1.3356	1.198	0.9999
Q	0.643	1.3356	0.482	1.0000
S	-0.963	2.1328	-0.452	1.0000
T	1.838	0.8233	2.232	0.8383
U	1.735	0.8162	2.126	0.8919
V	-7.600	2.5735	-2.953	0.3083
W	-2.400	3.5838	-0.670	1.0000
X	0.661	0.9034	0.732	1.0000
Y	0.953	0.8488	1.123	1.0000

Treat = J subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
K	-0.878	1.541	-0.570	1.0000
L	-1.167	1.673	-0.697	1.0000
M	-0.099	2.087	-0.047	1.0000
O	2.876	2.732	1.053	1.0000
P	1.501	1.621	0.926	1.0000
Q	0.544	1.621	0.336	1.0000
S	-1.062	2.322	-0.458	1.0000
T	1.739	1.233	1.410	0.9992
U	1.636	1.228	1.332	0.9997
V	-7.699	2.732	-2.818	0.4038
W	-2.499	3.700	-0.675	1.0000
X	0.562	1.288	0.437	1.0000
Y	0.854	1.250	0.683	1.0000

Treat = K subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
L	-0.288	1.639	-0.176	1.0000
M	0.779	2.060	0.378	1.0000
O	3.754	2.712	1.384	0.9994
P	2.379	1.585	1.501	0.9981
Q	1.422	1.585	0.897	1.0000
S	-0.184	2.298	-0.080	1.0000
T	2.617	1.186	2.206	0.8529
U	2.514	1.181	2.128	0.8910
V	-6.821	2.712	-2.516	0.6427
W	-1.621	3.684	-0.440	1.0000
X	1.440	1.243	1.159	1.0000
Y	1.732	1.204	1.438	0.9990

Treat = L subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
M	1.068	2.160	0.494	1.0000
O	4.042	2.789	1.450	0.9989
P	2.668	1.714	1.556	0.9968
Q	1.711	1.714	0.998	1.0000
S	0.104	2.388	0.044	1.0000
T	2.905	1.353	2.147	0.8824
U	2.802	1.349	2.077	0.9119
V	-6.532	2.789	-2.343	0.7702
W	-1.333	3.741	-0.356	1.0000
X	1.729	1.404	1.232	0.9999
Y	2.021	1.369	1.476	0.9985

Treat = M subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
O	2.975	3.055	0.974	1.0000
P	1.600	2.120	0.755	1.0000
Q	0.643	2.120	0.304	1.0000
S	-0.963	2.694	-0.358	1.0000
T	1.838	1.840	0.999	1.0000
U	1.735	1.837	0.944	1.0000
V	-7.600	3.055	-2.488	0.6643
W	-2.400	3.944	-0.609	1.0000
X	0.661	1.878	0.352	1.0000
Y	0.953	1.852	0.515	1.0000

Treat = O subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
P	-1.37	2.757	-0.499	1.0000
Q	-2.33	2.757	-0.846	1.0000
S	-3.94	3.220	-1.223	0.9999
T	-1.14	2.549	-0.446	1.0000
U	-1.24	2.547	-0.487	1.0000
V	-10.57	3.527	-2.998	0.2797
W	-5.37	4.320	-1.244	0.9999
X	-2.31	2.576	-0.898	1.0000
Y	-2.02	2.557	-0.791	1.0000

Treat = P subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Q	-0.957	1.663	-0.575	1.0000
S	-2.563	2.352	-1.090	1.0000
T	0.238	1.288	0.185	1.0000
U	0.135	1.283	0.105	1.0000
V	-9.200	2.757	-3.336	0.1185
W	-4.000	3.718	-1.076	1.0000
X	-0.939	1.341	-0.700	1.0000
Y	-0.647	1.304	-0.496	1.0000

Treat = Q subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
S	-1.607	2.352	-0.683	1.0000
T	1.195	1.288	0.928	1.0000
U	1.092	1.283	0.850	1.0000
V	-8.243	2.757	-2.989	0.2850
W	-3.043	3.718	-0.818	1.0000
X	0.018	1.341	0.013	1.0000
Y	0.310	1.304	0.237	1.0000

Treat = S subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
T	2.801	2.103	1.332	0.9997
U	2.698	2.101	1.285	0.9998
V	-6.637	3.220	-2.061	0.9180
W	-1.437	4.073	-0.353	1.0000
X	1.625	2.136	0.761	1.0000
Y	1.916	2.113	0.907	1.0000

Treat = T subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
U	-0.103	0.7357	-0.140	1.0000
V	-9.438	2.5491	-3.703	0.0373
W	-4.238	3.5664	-1.188	1.0000
X	-1.177	0.8314	-1.415	0.9992
Y	-0.885	0.7717	-1.147	1.0000

Treat = U subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
V	-9.335	2.5468	-3.665	0.0424
W	-4.135	3.5647	-1.160	1.0000
X	-1.074	0.8243	-1.302	0.9998
Y	-0.782	0.7641	-1.023	1.0000

Treat = V subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
W	5.200	4.320	1.204	0.9999
X	8.261	2.576	3.207	0.1687
Y	8.553	2.557	3.344	0.1157

Treat = W subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
X	3.061	3.586	0.8538	1.000
Y	3.353	3.572	0.9386	1.000

Treat = X subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Y	0.2917	0.8566	0.3406	1.000

Species: Lodgepole pine

General Linear Model: SI(m) 50 GI versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      25  A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S,
                       T, U, V, W, X, Y


Analysis of Variance for SI(m) 50 GI, using Adjusted SS for Tests

Source    DF    Seq SS    Adj SS  Adj MS      F      P
Treat     24  1766.929  1766.929  73.622  20.03  0.000
Error   1149  4223.930  4223.930   3.676
Total   1173  5990.860


S = 1.91734   R-Sq = 29.49%   R-Sq(adj) = 28.02%


Unusual Observations for SI(m) 50 GI

 Obs  SI(m) 50 GI      Fit  SE Fit  Residual  St Resid
   3      15.2400  15.0200  1.1070    0.2200      0.14  X
  16      15.1900  15.0200  1.1070    0.1700      0.11  X
  18      14.6300  15.0200  1.1070   -0.3900     -0.25  X
  50      23.7400  19.5100  0.2342    4.2300      2.22  R
 108      19.1500  14.9235  0.2308    4.2265      2.22  R
 113       9.3500  14.9235  0.2308   -5.5735     -2.93  R
 114       7.9700  14.9235  0.2308   -6.9535     -3.65  R
 126       8.3500  14.9235  0.2308   -6.5735     -3.45  R
 132      10.9000  14.9235  0.2308   -4.0235     -2.11  R
 162      19.6600  14.9235  0.2308    4.7365      2.49  R
 168      19.1900  14.9235  0.2308    4.2665      2.24  R
 179      18.8800  14.9235  0.2308    3.9565      2.08  R
 180      18.8100  14.9235  0.2308    3.8865      2.04  R
 234      29.4900  20.3321  0.2416    9.1579      4.81  R
 289      24.0100  19.5174  0.2712    4.4926      2.37  R
 320      14.1200  18.3071  0.2325   -4.1871     -2.20  R
 328      23.3900  18.3071  0.2325    5.0829      2.67  R
 329      13.3600  18.3071  0.2325   -4.9471     -2.60  R
 332      13.3100  18.3071  0.2325   -4.9971     -2.63  R
 364      13.6500  18.3071  0.2325   -4.6571     -2.45  R
 381      23.4000  18.3071  0.2325    5.0929      2.68  R
 395      21.5500  17.5778  0.2416    3.9722      2.09  R
 402      21.7000  17.5778  0.2416    4.1222      2.17  R
 405      21.9100  17.5778  0.2416    4.3322      2.28  R
 415      12.7700  17.5778  0.2416   -4.8078     -2.53  R
 416      13.7700  17.5778  0.2416   -3.8078     -2.00  R
 419      12.5800  17.5778  0.2416   -4.9978     -2.63  R
 420      13.2200  17.5778  0.2416   -4.3578     -2.29  R
 430      13.1700  17.5778  0.2416   -4.4078     -2.32  R
 435      12.5900  17.5778  0.2416   -4.9878     -2.62  R
 484      13.2100  19.4251  0.2275   -6.2151     -3.26  R
 485      14.9100  19.4251  0.2275   -4.5151     -2.37  R
 486      15.2700  19.4251  0.2275   -4.1551     -2.18  R
 586      23.3800  18.8590  0.2685    4.5210      2.38  R
 606      22.4700  18.4338  0.3760    4.0362      2.15  R
 664      23.7400  18.8346  0.3070    4.9054      2.59  R
```

677	23.1500	18.8346	0.3070	4.3154	2.28	R
722	21.3800	17.6476	0.4650	3.7324	2.01	R
724	20.4800	19.1769	0.5318	1.3031	0.71	X
725	18.1800	19.1769	0.5318	-0.9969	-0.54	X
726	19.6000	19.1769	0.5318	0.4231	0.23	X
727	18.6800	19.1769	0.5318	-0.4969	-0.27	X
728	18.8900	19.1769	0.5318	-0.2869	-0.16	X
729	17.6700	19.1769	0.5318	-1.5069	-0.82	X
730	18.4300	19.1769	0.5318	-0.7469	-0.41	X
731	18.1400	19.1769	0.5318	-1.0369	-0.56	X
732	18.5100	19.1769	0.5318	-0.6669	-0.36	X
733	18.1300	19.1769	0.5318	-1.0469	-0.57	X
734	21.0600	19.1769	0.5318	1.8831	1.02	X
735	20.7400	19.1769	0.5318	1.5631	0.85	X
736	20.7900	19.1769	0.5318	1.6131	0.88	X
802	24.1700	17.8426	0.3998	6.3274	3.37	R
809	9.7700	17.8426	0.3998	-8.0726	-4.30	R
811	22.6400	17.8426	0.3998	4.7974	2.56	R
858	23.6300	19.3465	0.3444	4.2835	2.27	R
889	15.7300	19.8945	0.2105	-4.1645	-2.19	R
947	15.7700	19.8945	0.2105	-4.1245	-2.16	R
963	15.4700	19.8945	0.2105	-4.4245	-2.32	R
974	27.3700	19.4451	0.1917	7.9249	4.15	R
1031	28.3800	19.4451	0.1917	8.9349	4.68	R
1074	17.9000	18.1871	0.7247	-0.2871	-0.16	X
1075	18.0400	18.1871	0.7247	-0.1471	-0.08	X
1077	18.4400	18.1871	0.7247	0.2529	0.14	X
1143	14.5800	18.1871	0.7247	-3.6071	-2.03	RX
1144	19.9900	18.1871	0.7247	1.8029	1.02	X
1145	18.9800	18.1871	0.7247	0.7929	0.45	X
1147	19.3800	18.1871	0.7247	1.1929	0.67	X
1148	17.1000	16.1660	0.8575	0.9340	0.54	X
1160	17.8300	16.1660	0.8575	1.6640	0.97	X
1201	16.6400	16.1660	0.8575	0.4740	0.28	X
1202	15.5800	16.1660	0.8575	-0.5860	-0.34	X
1203	13.6800	16.1660	0.8575	-2.4860	-1.45	X
1267	14.1400	19.6647	0.1804	-5.5247	-2.89	R
1270	24.7300	19.6647	0.1804	5.0653	2.65	R
1272	13.1200	19.6647	0.1804	-6.5447	-3.43	R
1287	15.3100	19.6647	0.1804	-4.3547	-2.28	R
1367	27.8300	19.2357	0.1937	8.5943	4.51	R
1393	30.5400	19.2357	0.1937	11.3043	5.93	R
1397	15.2200	19.2357	0.1937	-4.0157	-2.11	R
1424	23.4800	19.2357	0.1937	4.2443	2.23	R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.

Grouping Information Using Tukey Method and 95.0% Confidence

Treat	N	Mean	Grouping
D	63	20.33	A
T	83	19.89	A B
X	113	19.66	A B
E	50	19.52	A B C D
B	67	19.51	A B C D
U	100	19.45	A B C
H	71	19.43	A B C D
S	31	19.35	A B C D E
O	26	19.29	A B C D E F
Y	98	19.24	A B C D E
N	13	19.18	A B C D E F G

```
I       51  18.86    B C D E F G
K       39  18.83    B C D E F G
L       26  18.78  A B C D E F G
R       33  18.67    B C D E F G
P       29  18.57    B C D E F G
J       26  18.43    B C D E F G
F       68  18.31        D E F G
V        7  18.19  A B C D E F G
Q       23  17.84      C D E F G
M       17  17.65      C D E F G
G       63  17.58              G
W        5  16.17          E F G H
A        3  15.02            F G H
C       69  14.92                H

Means that do not share a letter are significantly different.


Tukey 95.0% Simultaneous Confidence Intervals
Response Variable SI(m) 50 GI
All Pairwise Comparisons among Levels of Treat
Treat = A  subtracted from:

Treat   Lower    Center  Upper  -----+---------+---------+---------+-
B       0.354   4.49000  8.626                  (-------*-------)
C      -4.230  -0.09652  4.037         (-------*-------)
D       1.170   5.31206  9.454                   (--------*-------)
E       0.331   4.49740  8.664                  (-------*-------)
F      -0.848   3.28706  7.422               (--------*-------)
G      -1.584   2.55778  6.700              (-------*-------)
H       0.274   4.40507  8.536                  (-------*-------)
I      -0.325   3.83902  8.003                (--------*-------)
J      -0.860   3.41385  7.688               (--------*-------)
K      -0.385   3.81462  8.014                (--------*-------)
L      -0.510   3.76385  8.038                (--------*-------)
M      -1.762   2.62765  7.017            (--------*--------)
N      -0.333   4.15692  8.646                (--------*-------)
O      -0.005   4.26923  8.543                 (--------*-------)
P      -0.703   3.54793  7.799                (-------*--------)
Q      -1.480   2.82261  7.125               (--------*-------)
R      -0.576   3.65061  7.877                 (-------*--------)
S       0.088   4.32645  8.565                  (--------*-------)
T       0.755   4.87446  8.994                    (-------*-------)
U       0.318   4.42510  8.532                   (-------*-------)
V      -1.670   3.16714  8.004               (--------*---------)
W      -3.973   1.14600  6.265         (---------*----------)
X       0.545   4.64469  8.745                  (-------*-------)
Y       0.107   4.21571  8.324                 (-------*--------)
                              -----+---------+---------+---------+-
                                -5.0       0.0       5.0      10.0


Treat = B  subtracted from:

Treat   Lower  Center   Upper  -----+---------+---------+---------+-
C      -5.789  -4.587  -3.384     (--*-)
D      -0.408   0.822   2.052                (--*-)
E      -1.303   0.007   1.317              (--*--)
F      -2.410  -1.203   0.004           (--*-)
G      -3.162  -1.932  -0.702          (-*--)
H      -1.279  -0.085   1.109             (--*-)
I      -1.954  -0.651   0.652            (--*-)
J      -2.696  -1.076   0.543           (--*--)
```

```
K      -2.087  -0.675   0.736            (--*-)
L      -2.346  -0.726   0.893           (---*--)
M      -3.766  -1.862   0.041        (---*---)
N      -2.457  -0.333   1.791          (---*----)
O      -1.840  -0.221   1.399           (---*--)
P      -2.500  -0.942   0.616          (--*--)
Q      -3.361  -1.667   0.027        (---*--)
R      -2.330  -0.839   0.651          (--*--)
S      -1.686  -0.164   1.359            (--*--)
T      -0.767   0.384   1.536             (--*-)
U      -1.172  -0.065   1.042             (-*-)
V      -4.107  -1.323   1.461        (----*-----)
W      -6.594  -3.344  -0.094   (-----*------)
X      -0.926   0.155   1.235             (-*-)
Y      -1.385  -0.274   0.837            (-*--)
                          -----+---------+---------+---------+-
                            -5.0       0.0       5.0      10.0
```

Treat = C subtracted from:

```
Treat   Lower  Center  Upper  -----+---------+---------+---------+-
D       4.187   5.409  6.630                       (--*-)
E       3.292   4.594  5.896                     (-*--)
F       2.186   3.384  4.581                  (--*-)
G       1.433   2.654  3.876                 (-*--)
H       3.317   4.502  5.686                    (-*-)
I       2.641   3.936  5.230                  (--*-)
J       1.897   3.510  5.123                 (--*--)
K       2.507   3.911  5.315                  (--*--)
L       2.247   3.860  5.473                 (---*--)
M       0.826   2.724  4.622               (--*---)
N       2.134   4.253  6.373                 (----*---)
O       2.753   4.366  5.979                   (--*--)
P       2.093   3.644  5.196                 (--*--)
Q       1.231   2.919  4.607               (---*--)
R       2.264   3.747  5.231                  (-*--)
S       2.907   4.423  5.939                   (--*--)
T       3.829   4.971  6.113                     (-*-)
U       3.425   4.522  5.619                    (-*-)
V       0.483   3.264  6.044              (-----*----)
W      -2.004   1.243  4.489         (-----*------)
X       3.670   4.741  5.812                    (-*--)
Y       3.211   4.312  5.414                  (--*-)
                          -----+---------+---------+---------+-
                            -5.0       0.0       5.0      10.0
```

Treat = D subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
E      -2.142  -0.815   0.513            (-*--)
F      -3.251  -2.025  -0.799         (--*-)
G      -4.003  -2.754  -1.505        (-*--)
H      -2.120  -0.907   0.306           (-*--)
I      -2.793  -1.473  -0.153         (--*--)
J      -3.532  -1.898  -0.264         (--*--)
K      -2.926  -1.497  -0.069          (--*--)
L      -3.182  -1.548   0.086          (--*--)
M      -4.600  -2.684  -0.769       (---*--)
N      -3.290  -1.155   0.980         (----*---)
O      -2.677  -1.043   0.591           (--*--)
P      -3.337  -1.764  -0.191         (--*---)
```

```
Q      -4.197  -2.489  -0.782         (--*--)
R      -3.168  -1.661  -0.155           (--*--)
S      -2.523  -0.986   0.552            (--*--)
T      -1.609  -0.438   0.734              (-*-)
U      -2.014  -0.887   0.240             (-*-)
V      -4.937  -2.145   0.648       (-----*----)
W      -7.423  -4.166  -0.909  (------*-----)
X      -1.769  -0.667   0.435             (--*-)
Y      -2.228  -1.096   0.036             (-*-)
                                -----+---------+---------+---------+-
                                  -5.0       0.0       5.0      10.0
```

Treat = E subtracted from:

```
Treat   Lower  Center    Upper  -----+---------+---------+---------+-
F      -2.516  -1.210   0.0955           (--*-)
G      -3.267  -1.940  -0.6121         (--*--)
H      -1.386  -0.092   1.2017             (--*-)
I      -2.053  -0.658   0.7366            (--*-)
J      -2.778  -1.084   0.6112          (---*--)
K      -2.180  -0.683   0.8147            (--*--)
L      -2.428  -0.734   0.9612           (---*--)
M      -3.838  -1.870   0.0981        (---*---)
N      -2.523  -0.340   1.8417           (---*----)
O      -1.923  -0.228   1.4666            (---*--)
P      -2.586  -0.949   0.6866           (--*--)
Q      -3.441  -1.675   0.0912         (---*--)
R      -2.419  -0.847   0.7253           (--*--)
S      -1.773  -0.171   1.4314            (---*--)
T      -0.878   0.377   1.6319              (--*-)
U      -1.286  -0.072   1.1417             (--*-)
V      -4.159  -1.330   1.4984         (----*-----)
W      -6.639  -3.351  -0.0638    (-----*------)
X      -1.043   0.147   1.3378              (-*--)
Y      -1.500  -0.282   0.9365             (-*--)
                                -----+---------+---------+---------+-
                                  -5.0       0.0       5.0      10.0
```

Treat = F subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
G      -1.955  -0.729  0.4964           (--*-)
H      -0.071   1.118  2.3073               (-*--)
I      -0.746   0.552  1.8504              (-*--)
J      -1.489   0.127  1.7430            (--*--)
K      -0.880   0.528  1.9355             (--*--)
L      -1.139   0.477  2.0930             (--*--)
M      -2.560  -0.659  1.2412          (---*--)
N      -1.252   0.870  2.9916            (----*---)
O      -0.634   0.982  2.5984              (--*--)
P      -1.294   0.261  1.8154            (---*--)
Q      -2.155  -0.464  1.2263           (--*--)
R      -1.123   0.364  1.8506             (--*--)
S      -0.480   1.039  2.5584              (--*--)
T       0.441   1.587  2.7339                (-*-)
U       0.036   1.138  2.2398               (-*-)
V      -2.902  -0.120  2.6624          (-----*----)
W      -5.389  -2.141  1.1068      (------*-----)
X       0.282   1.358  2.4334                (-*-)
Y      -0.178   0.929  2.0349               (-*-)
                                -----+---------+---------+---------+-
```

```
                                -5.0       0.0       5.0      10.0
```

Treat = G subtracted from:

```
Treat   Lower  Center  Upper  -----+---------+---------+---------+-
H       0.634   1.847  3.060                (--*-)
I      -0.039   1.281  2.602               (--*-)
J      -0.778   0.856  2.490             (---*--)
K      -0.171   1.257  2.685               (--*-)
L      -0.428   1.206  2.840              (--*---)
M      -1.846   0.070  1.986           (---*---)
N      -0.536   1.599  3.734              (---*---)
O       0.078   1.711  3.345               (--*---)
P      -0.583   0.990  2.563              (--*--)
Q      -1.443   0.265  1.972            (---*--)
R      -0.413   1.093  2.599              (--*--)
S       0.231   1.769  3.306               (---*--)
T       1.145   2.317  3.488                 (--*-)
U       0.740   1.867  2.995                (--*-)
V      -2.183   0.609  3.402           (----*-----)
W      -4.668  -1.412  1.845       (-----*------)
X       0.985   2.087  3.189                 (-*-)
Y       0.526   1.658  2.790                (-*--)
                              -----+---------+---------+---------+-
                                -5.0       0.0       5.0      10.0
```

Treat = H subtracted from:

```
Treat   Lower  Center     Upper  -----+---------+---------+---------+-
I      -1.853  -0.566   0.72054            (--*-)
J      -2.598  -0.991   0.61551          (--*--)
K      -1.987  -0.590   0.80658           (--*--)
L      -2.248  -0.641   0.96551           (--*--)
M      -3.670  -1.777   0.11519         (--*---)
N      -2.363  -0.248   1.86638           (----*---)
O      -1.743  -0.136   1.47089            (--*--)
P      -2.402  -0.857   0.68757          (--*--)
Q      -3.264  -1.582   0.09922         (---*--)
R      -2.231  -0.754   0.72228           (-*--)
S      -1.588  -0.079   1.43029            (--*--)
T      -0.664   0.469   1.60248              (-*-)
U      -1.068   0.020   1.10781             (-*-)
V      -4.015  -1.238   1.53886        (-----*----)
W      -6.502  -3.259  -0.01592    (-----*------)
X      -0.822   0.240   1.30111              (-*--)
Y      -1.282  -0.189   0.90303             (--*-)
                              -----+---------+---------+---------+-
                                -5.0       0.0       5.0      10.0
```

Treat = I subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
J      -2.114  -0.425  1.2639            (--*---)
K      -1.515  -0.024  1.4666             (--*--)
L      -1.764  -0.075  1.6139            (---*--)
M      -3.174  -1.211  0.7516          (---*---)
N      -1.860   0.318  2.4956            (----*---)
O      -1.259   0.430  2.1193             (---*--)
P      -1.921  -0.291  1.3391            (--*---)
Q      -2.777  -1.016  0.7441          (---*--)
```

```
R      -1.754  -0.188  1.3775            (---*--)
S      -1.109   0.487  2.0837              (--*--)
T      -0.212   1.035  2.2825                (-*--)
U      -0.620   0.586  1.7922               (-*--)
V      -3.497  -0.672  2.1534          (-----*----)
W      -5.978  -2.693  0.5917     (------*-----)
X      -0.377   0.806  1.9881               (--*-)
Y      -0.834   0.377  1.5869             (--*-)
                              -----+---------+---------+---------+-
                                -5.0       0.0       5.0      10.0
```

Treat = J subtracted from:

```
Treat   Lower  Center  Upper  -----+---------+---------+---------+-
K      -1.374   0.401  2.175            (---*--)
L      -1.594   0.350  2.294            (---*---)
M      -2.972  -0.786  1.400          (---*----)
N      -1.638   0.743  3.124            (---*----)
O      -1.089   0.855  2.799             (---*---)
P      -1.759   0.134  2.027           (---*---)
Q      -2.598  -0.591  1.415          (---*---)
R      -1.601   0.237  2.075            (--*---)
S      -0.951   0.913  2.777             (---*---)
T      -0.115   1.461  3.036               (--*--)
U      -0.532   1.011  2.554              (--*--)
V      -3.231  -0.247  2.738          (-----*----)
W      -5.691  -2.268  1.155      (-----*------)
X      -0.294   1.231  2.755              (--*---)
Y      -0.744   0.802  2.348              (--*--)
                             -----+---------+---------+---------+-
                               -5.0       0.0       5.0      10.0
```

Treat = K subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
L      -1.825  -0.051  1.7239           (---*--)
M      -3.224  -1.187  0.8501         (---*---)
N      -1.902   0.342  2.5871           (----*---)
O      -1.320   0.455  2.2293            (---*--)
P      -1.985  -0.267  1.4520           (--*---)
Q      -2.835  -0.992  0.8508         (---*---)
R      -1.822  -0.164  1.4939           (---*--)
S      -1.175   0.512  2.1984             (--*--)
T      -0.301   1.060  2.4206              (--*--)
U      -0.713   0.610  1.9338              (-*--)
V      -3.525  -0.647  2.2297          (-----*----)
W      -5.998  -2.669  0.6609     (------*-----)
X      -0.472   0.830  2.1318              (--*-)
Y      -0.926   0.401  1.7282             (--*-)
                             -----+---------+---------+---------+-
                               -5.0       0.0       5.0      10.0
```

Treat = L subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
M      -3.322  -1.136  1.0500         (----*---)
N      -1.988   0.393  2.7740           (----*----)
O      -1.439   0.505  2.4494            (---*---)
P      -2.109  -0.216  1.6772           (---*--)
Q      -2.948  -0.941  1.0652         (---*---)
```

```
R      -1.951  -0.113  1.7248            (---*--)
S      -1.301   0.563  2.4266             (---*---)
T      -0.465   1.111  2.6859               (--*--)
U      -0.882   0.661  2.2043              (--*--)
V      -3.581  -0.597  2.3880          (-----*-----)
W      -6.041  -2.618  0.8050     (------*------)
X      -0.644   0.881  2.4054               (--*--)
Y      -1.094   0.452  1.9981              (--*--)
                              -----+---------+---------+---------+-
                                -5.0       0.0       5.0      10.0
```

Treat = M subtracted from:

```
Treat   Lower  Center  Upper  -----+---------+---------+---------+-
N      -1.053   1.529  4.112              (----*----)
O      -0.545   1.642  3.828               (---*----)
P      -1.221   0.920  3.061              (---*---)
Q      -2.047   0.195  2.437            (---*----)
R      -1.070   1.023  3.116              (---*---)
S      -0.417   1.699  3.814               (---*----)
T       0.381   2.247  4.113                 (--*---)
U      -0.041   1.797  3.636                (---*--)
V      -2.608   0.539  3.687           (-----*-----)
W      -5.048  -1.482  2.084       (------*------)
X       0.194   2.017  3.840                (---*---)
Y      -0.253   1.588  3.430               (---*---)
                             -----+---------+---------+---------+-
                               -5.0       0.0       5.0      10.0
```

Treat = N subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
O      -2.269   0.112  2.4932           (----*----)
P      -2.949  -0.609  1.7305          (----*---)
Q      -3.766  -1.334  1.0978        (----*----)
R      -2.802  -0.506  1.7889          (----*----)
S      -2.147   0.170  2.4856            (---*----)
T      -1.373   0.718  2.8083             (---*----)
U      -1.798   0.268  2.3347            (----*---)
V      -4.276  -0.990  2.2962        (------*------)
W      -6.699  -3.011  0.6776    (------*------)
X      -1.565   0.488  2.5406             (---*---)
Y      -2.010   0.059  2.1277            (---*---)
                             -----+---------+---------+---------+-
                               -5.0       0.0       5.0      10.0
```

Treat = O subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
P      -2.614  -0.721  1.1718           (---*--)
Q      -3.453  -1.447  0.5598         (---*---)
R      -2.457  -0.619  1.2194           (---*--)
S      -1.807   0.057  1.9212            (---*---)
T      -0.970   0.605  2.1805              (--*--)
U      -1.387   0.156  1.6989             (--*--)
V      -4.087  -1.102  1.8826         (-----*-----)
W      -6.546  -3.123  0.2996    (------*------)
X      -1.149   0.375  1.9001             (--*--)
Y      -1.600  -0.054  1.4928            (--*--)
                             -----+---------+---------+---------+-
```

```
                                -5.0       0.0       5.0      10.0
```

Treat = P subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
Q      -2.682  -0.725  1.2318           (---*--)
R      -1.681   0.103  1.8868             (--*---)
S      -1.032   0.779  2.5893              (---*--)
T      -0.185   1.327  2.8385                (--*--)
U      -0.601   0.877  2.3555              (--*--)
V      -3.333  -0.381  2.5709         (-----*-----)
W      -5.796  -2.402  0.9922     (------*------)
X      -0.362   1.097  2.5558              (--*--)
Y      -0.814   0.668  2.1495             (--*--)
                              -----+---------+---------+---------+-
                                -5.0       0.0       5.0      10.0
```

Treat = Q subtracted from:

```
Treat   Lower  Center  Upper  -----+---------+---------+---------+-
R      -1.076   0.828  2.732             (---*--)
S      -0.425   1.504  3.433              (---*---)
T       0.400   2.052  3.704                (--*--)
U      -0.018   1.602  3.223              (--*--)
V      -2.681   0.345  3.370          (-----*-----)
W      -5.135  -1.677  1.782      (------*------)
X       0.219   1.822  3.425              (---*--)
Y      -0.231   1.393  3.017              (--*--)
                            -----+---------+---------+---------+-
                              -5.0       0.0       5.0      10.0
```

Treat = R subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
S      -1.077   0.676  2.4290             (--*---)
T      -0.219   1.224  2.6663               (-*--)
U      -0.633   0.774  2.1817              (--*-)
V      -3.400  -0.483  2.4333         (-----*-----)
W      -5.868  -2.505  0.8591     (------*------)
X      -0.393   0.994  2.3810              (--*--)
Y      -0.846   0.565  1.9758             (--*--)
                              -----+---------+---------+---------+-
                                -5.0       0.0       5.0      10.0
```

Treat = S subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
T      -0.927   0.548  2.0234             (--*--)
U      -1.342   0.099  1.5395            (--*--)
V      -4.092  -1.159  1.7739        (-----*-----)
W      -6.558  -3.180  0.1975    (------*-----)
X      -1.103   0.318  1.7394             (--*-)
Y      -1.555  -0.111  1.3336            (--*--)
                              -----+---------+---------+---------+-
                                -5.0       0.0       5.0      10.0
```

Treat = T subtracted from:

```
Treat   Lower  Center    Upper  -----+---------+---------+---------+-
U      -1.490  -0.449   0.5914            (-*-)
V      -4.466  -1.707   1.0514       (-----*----)
W      -6.956  -3.728  -0.5008   (------*-----)
X      -1.243  -0.230   0.7835             (-*-)
Y      -1.704  -0.659   0.3868            (-*-)
                                -----+---------+---------+---------+-
                                  -5.0       0.0       5.0      10.0


Treat = U  subtracted from:

Treat   Lower  Center     Upper  -----+---------+---------+---------+-
V      -3.998  -1.258   1.48246        (----*-----)
W      -6.491  -3.279  -0.06704    (-----*------)
X      -0.743   0.220   1.18192              (*-)
Y      -1.206  -0.209   0.78692             (-*-)
                                -----+---------+---------+---------+-
                                  -5.0       0.0       5.0      10.0


Treat = V  subtracted from:

Treat   Lower  Center  Upper  -----+---------+---------+---------+-
W      -6.125  -2.021  2.083     (-------*-------)
X      -1.253   1.478  4.208             (-----*----)
Y      -1.694   1.049  3.791             (----*-----)
                              -----+---------+---------+---------+-
                                -5.0       0.0       5.0      10.0


Treat = W  subtracted from:

Treat    Lower  Center  Upper  -----+---------+---------+---------+-
X       0.2954   3.499  6.702                (-----*-----)
Y      -0.1439   3.070  6.283               (-----*------)
                              -----+---------+---------+---------+-
                                -5.0       0.0       5.0      10.0


Treat = X  subtracted from:

Treat   Lower   Center   Upper  -----+---------+---------+---------+-
Y      -1.397  -0.4290  0.5386            (-*-)
                                -----+---------+---------+---------+-
                                  -5.0       0.0       5.0      10.0


Tukey Simultaneous Tests
Response Variable SI(m) 50 GI
All Pairwise Comparisons among Levels of Treat
Treat = A  subtracted from:

       Difference       SE of             Adjusted
Treat    of Means  Difference   T-Value   P-Value
B         4.49000       1.131   3.96823    0.0165
C        -0.09652       1.131  -0.08536    1.0000
D         5.31206       1.133   4.68839    0.0008
E         4.49740       1.140   3.94613    0.0180
F         3.28706       1.131   2.90600    0.3753
G         2.55778       1.133   2.25748    0.8557
H         4.40507       1.130   3.89788    0.0215
I         3.83902       1.139   3.37032    0.1222
```

J	3.41385	1.169	2.92007	0.3650
K	3.81462	1.149	3.32063	0.1405
L	3.76385	1.169	3.21945	0.1841
M	2.62765	1.201	2.18846	0.8897
N	4.15692	1.228	3.38490	0.1171
O	4.26923	1.169	3.65174	0.0511
P	3.54793	1.163	3.05114	0.2765
Q	2.82261	1.177	2.39823	0.7699
R	3.65061	1.156	3.15742	0.2152
S	4.32645	1.159	3.73195	0.0390
T	4.87446	1.127	4.32592	0.0039
U	4.42510	1.123	3.93883	0.0185
V	3.16714	1.323	2.39375	0.7729
W	1.14600	1.400	0.81844	1.0000
X	4.64469	1.122	4.14123	0.0084
Y	4.21571	1.124	3.75133	0.0364

Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-4.587	0.3289	-13.95	0.0001
D	0.822	0.3365	2.44	0.7384
E	0.007	0.3583	0.02	1.0000
F	-1.203	0.3300	-3.64	0.0523
G	-1.932	0.3365	-5.74	0.0001
H	-0.085	0.3266	-0.26	1.0000
I	-0.651	0.3563	-1.83	0.9841
J	-1.076	0.4430	-2.43	0.7483
K	-0.675	0.3862	-1.75	0.9909
L	-0.726	0.4430	-1.64	0.9963
M	-1.862	0.5207	-3.58	0.0653
N	-0.333	0.5811	-0.57	1.0000
O	-0.221	0.4430	-0.50	1.0000
P	-0.942	0.4262	-2.21	0.8794
Q	-1.667	0.4634	-3.60	0.0609
R	-0.839	0.4078	-2.06	0.9386
S	-0.164	0.4165	-0.39	1.0000
T	0.384	0.3149	1.22	1.0000
U	-0.065	0.3027	-0.21	1.0000
V	-1.323	0.7616	-1.74	0.9917
W	-3.344	0.8889	-3.76	0.0351
X	0.155	0.2956	0.52	1.0000
Y	-0.274	0.3039	-0.90	1.0000

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	5.409	0.3341	16.188	0.0001
E	4.594	0.3561	12.901	0.0001
F	3.384	0.3276	10.328	0.0001
G	2.654	0.3341	7.944	0.0001
H	4.502	0.3241	13.889	0.0001
I	3.936	0.3541	11.115	0.0001
J	3.510	0.4412	7.956	0.0001
K	3.911	0.3841	10.182	0.0001
L	3.860	0.4412	8.749	0.0001
M	2.724	0.5192	5.247	0.0001
N	4.253	0.5797	7.337	0.0001
O	4.366	0.4412	9.895	0.0001

P	3.644	0.4243	8.589	0.0001
Q	2.919	0.4616	6.323	0.0001
R	3.747	0.4058	9.234	0.0001
S	4.423	0.4146	10.669	0.0001
T	4.971	0.3124	15.914	0.0001
U	4.522	0.3001	15.069	0.0001
V	3.264	0.7606	4.291	0.0046
W	1.243	0.8880	1.399	0.9997
X	4.741	0.2929	16.185	0.0001
Y	4.312	0.3013	14.311	0.0001

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	-0.815	0.3631	-2.243	0.8631
F	-2.025	0.3353	-6.040	0.0001
G	-2.754	0.3416	-8.062	0.0001
H	-0.907	0.3319	-2.733	0.5098
I	-1.473	0.3612	-4.079	0.0108
J	-1.898	0.4469	-4.247	0.0055
K	-1.497	0.3907	-3.833	0.0273
L	-1.548	0.4469	-3.464	0.0927
M	-2.684	0.5240	-5.123	0.0002
N	-1.155	0.5841	-1.978	0.9598
O	-1.043	0.4469	-2.333	0.8120
P	-1.764	0.4303	-4.100	0.0099
Q	-2.489	0.4671	-5.330	0.0001
R	-1.661	0.4120	-4.033	0.0129
S	-0.986	0.4206	-2.343	0.8059
T	-0.438	0.3204	-1.366	0.9998
U	-0.887	0.3084	-2.876	0.3976
V	-2.145	0.7639	-2.808	0.4500
W	-4.166	0.8908	-4.677	0.0008
X	-0.667	0.3015	-2.214	0.8778
Y	-1.096	0.3096	-3.541	0.0732

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-1.210	0.3572	-3.389	0.1159
G	-1.940	0.3631	-5.341	0.0001
H	-0.092	0.3540	-0.261	1.0000
I	-0.658	0.3816	-1.725	0.9924
J	-1.084	0.4636	-2.337	0.8095
K	-0.683	0.4096	-1.667	0.9953
L	-0.734	0.4636	-1.582	0.9978
M	-1.870	0.5383	-3.473	0.0902
N	-0.340	0.5969	-0.570	1.0000
O	-0.228	0.4636	-0.492	1.0000
P	-0.949	0.4475	-2.122	0.9173
Q	-1.675	0.4831	-3.467	0.0920
R	-0.847	0.4300	-1.969	0.9617
S	-0.171	0.4383	-0.390	1.0000
T	0.377	0.3432	1.099	1.0000
U	-0.072	0.3321	-0.218	1.0000
V	-1.330	0.7738	-1.719	0.9927
W	-3.351	0.8993	-3.727	0.0397
X	0.147	0.3257	0.452	1.0000
Y	-0.282	0.3332	-0.845	1.0000

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	-0.729	0.3353	-2.175	0.8956
H	1.118	0.3253	3.437	0.1007
I	0.552	0.3552	1.554	0.9983
J	0.127	0.4421	0.287	1.0000
K	0.528	0.3851	1.370	0.9998
L	0.477	0.4421	1.078	1.0000
M	-0.659	0.5199	-1.268	0.9999
N	0.870	0.5804	1.499	0.9990
O	0.982	0.4421	2.222	0.8740
P	0.261	0.4252	0.613	1.0000
Q	-0.464	0.4625	-1.004	1.0000
R	0.364	0.4068	0.894	1.0000
S	1.039	0.4155	2.501	0.6951
T	1.587	0.3136	5.062	0.0002
U	1.138	0.3014	3.776	0.0334
V	-0.120	0.7611	-0.158	1.0000
W	-2.141	0.8884	-2.410	0.7618
X	1.358	0.2943	4.614	0.0011
Y	0.929	0.3026	3.069	0.2656

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	1.847	0.3319	5.567	0.0001
I	1.281	0.3612	3.548	0.0717
J	0.856	0.4469	1.915	0.9719
K	1.257	0.3907	3.217	0.1852
L	1.206	0.4469	2.699	0.5378
M	0.070	0.5240	0.133	1.0000
N	1.599	0.5841	2.738	0.5059
O	1.711	0.4469	3.829	0.0276
P	0.990	0.4303	2.301	0.8312
Q	0.265	0.4671	0.567	1.0000
R	1.093	0.4120	2.652	0.5754
S	1.769	0.4206	4.205	0.0065
T	2.317	0.3204	7.231	0.0001
U	1.867	0.3084	6.055	0.0001
V	0.609	0.7639	0.798	1.0000
W	-1.412	0.8908	-1.585	0.9977
X	2.087	0.3015	6.922	0.0001
Y	1.658	0.3096	5.355	0.0001

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	-0.566	0.3519	-1.608	0.9972
J	-0.991	0.4395	-2.255	0.8568
K	-0.590	0.3821	-1.545	0.9984
L	-0.641	0.4395	-1.459	0.9994
M	-1.777	0.5177	-3.433	0.1017
N	-0.248	0.5784	-0.429	1.0000
O	-0.136	0.4395	-0.309	1.0000
P	-0.857	0.4225	-2.029	0.9472

Q	-1.582	0.4600	-3.440	0.0997
R	-0.754	0.4040	-1.868	0.9792
S	-0.079	0.4128	-0.190	1.0000
T	0.469	0.3099	1.514	0.9989
U	0.020	0.2976	0.067	1.0000
V	-1.238	0.7596	-1.630	0.9965
W	-3.259	0.8871	-3.674	0.0475
X	0.240	0.2904	0.825	1.0000
Y	-0.189	0.2988	-0.634	1.0000

Treat = I subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
J	-0.425	0.4620	-0.920	1.0000
K	-0.024	0.4079	-0.060	1.0000
L	-0.075	0.4620	-0.163	1.0000
M	-1.211	0.5370	-2.256	0.8565
N	0.318	0.5957	0.534	1.0000
O	0.430	0.4620	0.931	1.0000
P	-0.291	0.4459	-0.653	1.0000
Q	-1.016	0.4816	-2.111	0.9213
R	-0.188	0.4283	-0.440	1.0000
S	0.487	0.4367	1.116	1.0000
T	1.035	0.3411	3.035	0.2865
U	0.586	0.3299	1.776	0.9888
V	-0.672	0.7728	-0.869	1.0000
W	-2.693	0.8985	-2.997	0.3113
X	0.806	0.3234	2.491	0.7032
Y	0.377	0.3310	1.138	1.0000

Treat = J subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
K	0.401	0.4854	0.826	1.0000
L	0.350	0.5318	0.658	1.0000
M	-0.786	0.5980	-1.315	0.9999
N	0.743	0.6513	1.141	1.0000
O	0.855	0.5318	1.609	0.9971
P	0.134	0.5178	0.259	1.0000
Q	-0.591	0.5488	-1.077	1.0000
R	0.237	0.5028	0.471	1.0000
S	0.913	0.5099	1.790	0.9877
T	1.461	0.4309	3.390	0.1156
U	1.011	0.4221	2.396	0.7714
V	-0.247	0.8164	-0.302	1.0000
W	-2.268	0.9363	-2.422	0.7533
X	1.231	0.4170	2.951	0.3427
Y	0.802	0.4230	1.896	0.9751

Treat = K subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
L	-0.051	0.4854	-0.105	1.0000
M	-1.187	0.5572	-2.130	0.9140
N	0.342	0.6140	0.557	1.0000
O	0.455	0.4854	0.937	1.0000
P	-0.267	0.4701	-0.567	1.0000

Q	-0.992	0.5041	-1.968	0.9619
R	-0.164	0.4535	-0.362	1.0000
S	0.512	0.4614	1.109	1.0000
T	1.060	0.3722	2.847	0.4194
U	0.610	0.3620	1.687	0.9944
V	-0.647	0.7870	-0.823	1.0000
W	-2.669	0.9108	-2.930	0.3578
X	0.830	0.3561	2.331	0.8134
Y	0.401	0.3630	1.105	1.0000

Treat = L subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
M	-1.136	0.5980	-1.900	0.9745
N	0.393	0.6513	0.604	1.0000
O	0.505	0.5318	0.950	1.0000
P	-0.216	0.5178	-0.417	1.0000
Q	-0.941	0.5488	-1.715	0.9930
R	-0.113	0.5028	-0.225	1.0000
S	0.563	0.5099	1.103	1.0000
T	1.111	0.4309	2.577	0.6360
U	0.661	0.4221	1.567	0.9981
V	-0.597	0.8164	-0.731	1.0000
W	-2.618	0.9363	-2.796	0.4594
X	0.881	0.4170	2.112	0.9207
Y	0.452	0.4230	1.068	1.0000

Treat = M subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
N	1.529	0.7064	2.165	0.9000
O	1.642	0.5980	2.745	0.5001
P	0.920	0.5857	1.571	0.9980
Q	0.195	0.6133	0.318	1.0000
R	1.023	0.5724	1.787	0.9879
S	1.699	0.5786	2.936	0.3537
T	2.247	0.5104	4.402	0.0028
U	1.797	0.5030	3.573	0.0660
V	0.539	0.8611	0.627	1.0000
W	-1.482	0.9754	-1.519	0.9988
X	2.017	0.4988	4.044	0.0124
Y	1.588	0.5037	3.153	0.2179

Treat = N subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
O	0.112	0.6513	0.172	1.0000
P	-0.609	0.6400	-0.952	1.0000
Q	-1.334	0.6653	-2.006	0.9532
R	-0.506	0.6278	-0.806	1.0000
S	0.170	0.6335	0.268	1.0000
T	0.718	0.5719	1.255	1.0000
U	0.268	0.5653	0.474	1.0000
V	-0.990	0.8989	-1.101	1.0000
W	-3.011	1.0090	-2.984	0.3201
X	0.488	0.5615	0.869	1.0000
Y	0.059	0.5659	0.104	1.0000

Treat = O subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
P	-0.721	0.5178	-1.393	0.9997
Q	-1.447	0.5488	-2.636	0.5889
R	-0.619	0.5028	-1.230	1.0000
S	0.057	0.5099	0.112	1.0000
T	0.605	0.4309	1.405	0.9997
U	0.156	0.4221	0.369	1.0000
V	-1.102	0.8164	-1.350	0.9998
W	-3.123	0.9363	-3.336	0.1347
X	0.375	0.4170	0.900	1.0000
Y	-0.054	0.4230	-0.127	1.0000

Treat = P subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Q	-0.725	0.5353	-1.355	0.9998
R	0.103	0.4880	0.210	1.0000
S	0.779	0.4953	1.572	0.9980
T	1.327	0.4136	3.207	0.1899
U	0.877	0.4044	2.169	0.8982
V	-0.381	0.8074	-0.472	1.0000
W	-2.402	0.9284	-2.587	0.6282
X	1.097	0.3991	2.748	0.4977
Y	0.668	0.4053	1.648	0.9960

Treat = Q subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
R	0.828	0.5208	1.590	0.9976
S	1.504	0.5277	2.850	0.4172
T	2.052	0.4518	4.541	0.0016
U	1.602	0.4434	3.614	0.0579
V	0.345	0.8276	0.416	1.0000
W	*-1.677*	*0.9461*	*-1.772*	*0.9892*
X	*1.822*	*0.4386*	*4.154*	*0.0080*
Y	1.393	0.4442	3.136	0.2268

Treat = R subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
S	0.676	0.4796	1.409	0.9996
T	1.224	0.3946	3.102	0.2461
U	0.774	0.3849	2.012	0.9516
V	-0.483	0.7979	-0.606	1.0000
W	-2.505	0.9201	-2.722	0.5188
X	0.994	0.3794	2.620	0.6015
Y	0.565	0.3859	1.464	0.9993

Treat = S subtracted from:

Treat	Difference	SE of		Adjusted

Treat	of Means	Difference	T-Value	P-Value
T	0.548	0.4036	1.358	0.9998
U	0.099	0.3941	0.250	1.0000
V	-1.159	0.8023	-1.445	0.9995
W	-3.180	0.9240	-3.442	0.0991
X	0.318	0.3887	0.819	1.0000
Y	-0.111	0.3951	-0.280	1.0000

Treat = T subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
U	-0.449	0.2847	-1.578	0.9978
V	-1.707	0.7546	-2.262	0.8530
W	-3.728	0.8829	-4.223	0.0060
X	-0.230	0.2772	-0.829	1.0000
Y	-0.659	0.2860	-2.303	0.8301

Treat = U subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
V	-1.258	0.7496	-1.678	0.9948
W	-3.279	0.8786	-3.732	0.0389
X	0.220	0.2632	0.834	1.0000
Y	-0.209	0.2725	-0.768	1.0000

Treat = V subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
W	-2.021	1.1227	-1.800	0.9868
X	1.478	0.7468	1.979	0.9596
Y	1.049	0.7501	1.398	0.9997

Treat = W subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
X	3.499	0.8762	3.993	0.0151
Y	3.070	0.8791	3.492	0.0852

Treat = X subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Y	-0.4290	0.2647	-1.621	0.9968

Species: Douglas-fir

General Linear Model: SI(m) 50 TA versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      23  A, B, C, D, E, F, G, H, I, J, K, L, M, O, P, Q, S, T, U,
                       V, W, X, Y


Analysis of Variance for SI(m) 50 TA, using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS     F      P
Treat    22  2603.47  2603.47  118.34  8.46  0.000
Error   435  6086.98  6086.98   13.99
Total   457  8690.45


S = 3.74073   R-Sq = 29.96%   R-Sq(adj) = 26.42%


Unusual Observations for SI(m) 50 TA

Obs  SI(m) 50 TA      Fit  SE Fit  Residual  St Resid
  1      18.1500  13.2675  1.8704    4.8825      1.51 X
  2      12.8400  13.2675  1.8704   -0.4275     -0.13 X
  4      13.8300  13.2675  1.8704    0.5625      0.17 X
  7       8.2500  13.2675  1.8704   -5.0175     -1.55 X
 26      25.4700  17.5858  0.6235    7.8842      2.14 R
 32       8.2500  17.5858  0.6235   -9.3358     -2.53 R
 36       9.0000  17.5858  0.6235   -8.5858     -2.33 R
132      24.7300  16.5696  0.7636    8.1604      2.23 R
137      24.7500  16.5696  0.7636    8.1804      2.23 R
147      24.1700  16.5696  0.7636    7.6004      2.08 R
162      11.0000  18.5209  0.6613   -7.5209     -2.04 R
163      11.0800  18.5209  0.6613   -7.4409     -2.02 R
184      12.3800  20.3409  0.6613   -7.9609     -2.16 R
185      12.3800  20.3409  0.6613   -7.9609     -2.16 R
186      12.4700  20.3409  0.6613   -7.8709     -2.14 R
187       9.0000  20.3409  0.6613  -11.3409     -3.08 R
203      27.9300  20.3409  0.6613    7.5891      2.06 R
218      13.9100  21.7043  0.6150   -7.7943     -2.11 R
220      10.9100  21.7043  0.6150  -10.7943     -2.93 R
265      24.7500  17.2909  1.1279    7.4591      2.09 R
286      15.3600  20.3980  1.6729   -5.0380     -1.51 X
287      19.8500  20.3980  1.6729   -0.5480     -0.16 X
288      24.3200  20.3980  1.6729    3.9220      1.17 X
289      19.8800  20.3980  1.6729   -0.5180     -0.15 X
290      22.5800  20.3980  1.6729    2.1820      0.65 X
291      24.7500  21.6000  2.6451    3.1500      1.19 X
292      18.4500  21.6000  2.6451   -3.1500     -1.19 X
295      12.3700  20.0167  1.2469   -7.6467     -2.17 R
302      12.3700  19.8911  1.2469   -7.5211     -2.13 R
306      12.3800  19.8911  1.2469   -7.5111     -2.13 R
311      17.8400  16.5300  2.1597    1.3100      0.43 X
312      12.3800  16.5300  2.1597   -4.1500     -1.36 X
313      19.3700  16.5300  2.1597    2.8400      0.93 X
409      11.0000  13.5400  2.1597   -2.5400     -0.83 X
410      14.1400  13.5400  2.1597    0.6000      0.20 X
411      15.4800  13.5400  2.1597    1.9400      0.64 X
422      14.8400  14.8400  3.7407    0.0000         * X
```

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.

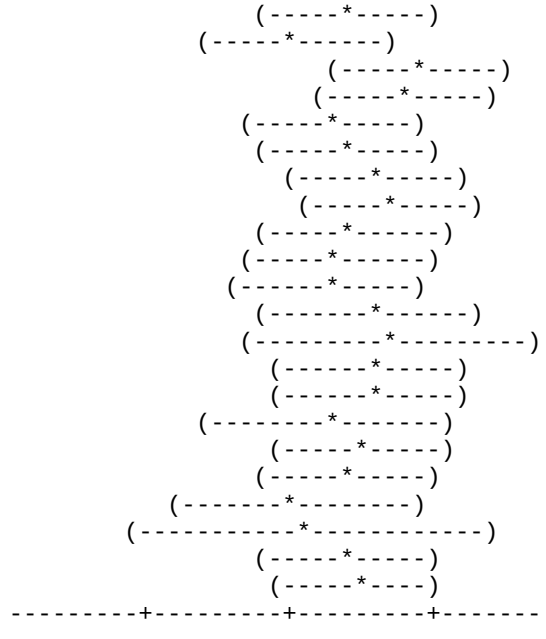
Grouping Information Using Tukey Method and 95.0% Confidence

Treat	N	Mean	Grouping
D	31	24.02	A
E	25	22.81	A B
I	37	21.70	A B C
O	2	21.60	A B C D E F G
M	5	20.40	A B C D E F G
H	32	20.34	B C D
P	9	20.02	A B C D F
Q	9	19.89	A B C D F
T	45	19.36	C D F
Y	39	18.69	C D F
G	32	18.52	C D F
J	10	18.32	B C D E F G
X	30	17.89	D E F G
U	47	17.63	D E F G
B	36	17.59	D E F G
K	11	17.29	C D E F G
F	24	16.57	F G
S	3	16.53	A B C D E F G
L	9	16.46	D E F G
W	1	14.84	A B C D E F G
C	14	13.74	E G
V	3	13.54	D E F G
A	4	13.27	D E F G

Means that do not share a letter are significantly different.

Tukey 95.0% Simultaneous Confidence Intervals
Response Variable SI(m) 50 TA
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Lower	Center	Upper
B	-2.81	4.3183	11.442
C	-7.19	0.4768	8.140
D	3.57	10.7531	17.934
E	2.27	9.5445	16.823
F	-4.00	3.3021	10.602
G	-1.91	5.2534	12.422
H	-0.09	7.0734	14.242
I	1.32	8.4368	15.551
J	-2.94	5.0515	13.048
K	-3.87	4.0234	11.915
L	-4.93	3.1903	11.313
M	-1.94	7.1305	16.198
O	-3.37	8.3325	20.038
P	-1.37	6.7492	14.872
Q	-1.50	6.6236	14.746
S	-7.06	3.2625	13.586
T	-0.96	6.0881	13.140
U	-2.67	4.3651	11.405
V	-10.05	0.2725	10.596
W	-13.54	1.5725	16.684
X	-2.57	4.6275	11.822
Y	-1.67	5.4235	12.520



```
                                  -12         0        12
```

Treat = B subtracted from:

```
Treat   Lower  Center    Upper  ---------+---------+---------+-------
C       -8.10  -3.842   0.4157              (---*--)
D        3.12   6.435   9.7466                        (-*--)
E        1.71   5.226   8.7451                      (--*--)
F       -4.58  -1.016   2.5456                 (--*--)
G       -2.35   0.935   4.2190                   (--*--)
H       -0.53   2.755   6.0390                     (-*--)
I        0.95   4.118   7.2827                     (-*--)
J       -4.10   0.733   5.5648                  (---*---)
K       -4.95  -0.295   4.3616                 (---*---)
L       -6.17  -1.128   3.9092                (---*---)
M       -3.64   2.812   9.2630                  (----*-----)
O       -5.81   4.014  13.8336                (-------*--------)
P       -2.61   2.431   7.4681                   (---*---)
Q       -2.73   2.305   7.3426                   (---*---)
S       -9.18  -1.056   7.0665             (------*------)
T       -1.25   1.770   4.7921                    (-*--)
U       -2.95   0.047   3.0404                   (-*--)
V      -12.17  -4.046   4.0765           (------*-----)
W      -16.45  -2.746  10.9570       (-----------*----------)
X       -3.03   0.309   3.6505                 (--*--)
Y       -2.02   1.105   4.2292                  (--*--)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = C subtracted from:

```
Treat   Lower   Center   Upper  ---------+---------+---------+-------
D        5.92  10.2764  14.629                          (---*--)
E        4.56   9.0677  13.580                        (---*--)
F       -1.72   2.8253   7.371                   (--*---)
G        0.45   4.7767   9.108                    (---*---)
H        2.27   6.5967  10.928                      (--*---)
I        3.72   7.9600  12.201                       (---*--)
J       -1.02   4.5747  10.171                    (----*---)
K       -1.90   3.5466   8.993                   (----*---)
L       -3.06   2.7135   8.488                  (----*----)
M       -0.39   6.6537  13.696                     (-----*----)
O       -2.36   7.8557  18.073                   (--------*-------)
P        0.50   6.2724  12.047                     (----*----)
Q        0.37   6.1468  11.922                     (----*----)
S       -5.81   2.7857  11.385                (------*------)
T        1.47   5.6113   9.748                      (---*--)
U       -0.23   3.8883   8.004                     (--*---)
V       -8.80  -0.2043   8.395              (------*------)
W      -12.90   1.0957  15.087          (-----------*-----------)
X       -0.22   4.1507   8.526                     (--*---)
Y        0.74   4.9467   9.158                      (--*---)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = D subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
E       -4.84   -1.21   2.425                (--*--)
F      -11.13   -7.45  -3.776           (--*--)
```

```
G       -8.91   -5.50  -2.093             (-*--)
H       -7.09   -3.68  -0.273              (--*--)
I       -5.61   -2.32   0.975                (--*--)
J      -10.62   -5.70  -0.786           (---*---)
K      -11.47   -6.73  -1.986          (---*---)
L      -12.68   -7.56  -2.445         (----*---)
M      -10.14   -3.62   2.891            (----*----)
O      -12.28   -2.42   7.440          (-------*-------)
P       -9.12   -4.00   1.114            (----*---)
Q       -9.25   -4.13   0.988            (----*---)
S      -15.66   -7.49   0.682       (------*------)
T       -7.82   -4.67  -1.510             (--*--)
U       -9.52   -6.39  -3.261           (--*-)
V      -18.65  -10.48  -2.308     (------*------)
W      -22.91   -9.18   4.552  (-----------*-----------)
X       -9.59   -6.13  -2.664             (--*--)
Y       -8.58   -5.33  -2.077              (--*-)
                          ---------+---------+---------+-------
                                  -12         0        12
```

Treat = E subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
F      -10.11  -6.242  -2.380            (--*--)
G       -7.90  -4.291  -0.683             (--*--)
H       -6.08  -2.471   1.137               (--*--)
I       -4.61  -1.108   2.392                (--*--)
J       -9.55  -4.493   0.564            (---*---)
K      -10.41  -5.521  -0.631           (---*---)
L      -11.61  -6.354  -1.100          (----*---)
M       -9.04  -2.414   4.208            (-----*-----)
O      -11.14  -1.212   8.721           (-------*-------)
P       -8.05  -2.795   2.459             (----*---)
Q       -8.18  -2.921   2.333             (----*---)
S      -14.54  -6.282   1.977        (------*------)
T       -6.83  -3.456  -0.085              (--*--)
U       -8.53  -5.179  -1.834             (--*-)
V      -17.53  -9.272  -1.013     (------*------)
W      -21.76  -7.972   5.812   (-----------*-----------)
X       -8.58  -4.917  -1.257             (--*--)
Y       -7.58  -4.121  -0.658              (--*-)
                          ---------+---------+---------+-------
                                  -12         0        12
```

Treat = F subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
G       -1.70   1.951   5.601                    (--*--)
H        0.12   3.771   7.421                     (--*--)
I        1.59   5.135   8.677                      (--*--)
J       -3.34   1.749   6.837                  (---*----)
K       -4.20   0.721   5.643                (----*---)
L       -5.39  -0.112   5.171                (---*---)
M       -2.82   3.828  10.473                  (----*-----)
O       -4.92   5.030  14.978                (-------*-------)
P       -1.84   3.447   8.730                  (----*---)
Q       -1.96   3.322   8.605                  (----*---)
S       -8.32  -0.040   8.238              (------*------)
T       -0.63   2.786   6.202                    (--*--)
U       -2.33   1.063   4.454                 (--*--)
V      -11.31  -3.030   5.248            (-----*------)
```

```
W      -15.52  -1.730  12.066        (-----------*----------)
X       -2.38   1.325   5.027                   (--*--)
Y       -1.39   2.121   5.628                    (--*--)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = G subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
H       -1.56   1.820   5.199                   (--*-)
I       -0.08   3.183   6.446                    (--*-)
J       -5.10  -0.202   4.695                (---*---)
K       -5.95  -1.230   3.494               (---*---)
L       -7.16  -2.063   3.037              (---*----)
M       -4.62   1.877   8.377                (-----*----)
O       -6.77   3.079  12.931              (--------*-------)
P       -3.60   1.496   6.596                 (---*---)
Q       -3.73   1.370   6.470                 (---*---)
S      -10.15  -1.991   6.170            (-----*------)
T       -2.29   0.835   3.960                  (--*-)
U       -3.99  -0.888   2.209                 (-*--)
V      -13.14  -4.981   3.180          (------*------)
W      -17.41  -3.681  10.045      (-----------*----------)
X       -4.06  -0.626   2.809                 (-*--)
Y       -3.05   0.170   3.394                 (--*--)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = H subtracted from:

```
Treat   Lower  Center    Upper  ---------+---------+---------+-------
I       -1.90   1.363   4.6263                  (--*--)
J       -6.92  -2.022   2.8749              (---*---)
K       -7.77  -3.050   1.6741              (--*---)
L       -8.98  -3.883   1.2167             (---*---)
M       -6.44   0.057   6.5569               (----*----)
O       -8.59   1.259  11.1108             (-------*-------)
P       -5.42  -0.324   4.7756               (----*---)
Q       -5.55  -0.450   4.6500               (----*---)
S      -11.97  -3.811   4.3504          (------*------)
T       -4.11  -0.985   2.1402                (-*--)
U       -5.81  -2.708   0.3894               (--*-)
V      -14.96  -6.801   1.3604         (-----*------)
W      -19.23  -5.501   8.2251     (----------*-----------)
X       -5.88  -2.446   0.9890               (--*--)
Y       -4.87  -1.650   1.5740                (--*-)
                                  ---------+---------+---------+-------
                                         -12         0        12
```

Treat = I subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
J       -8.20  -3.385   1.432             (---*---)
K       -9.06  -4.413   0.228            (---*---)
L      -10.27  -5.247  -0.223           (----*---)
M       -7.75  -1.306   5.134              (----*----)
O       -9.92  -0.104   9.708            (-------*-------)
P       -6.71  -1.688   3.336              (----*---)
Q       -6.84  -1.813   3.210              (---*----)
S      -13.29  -5.174   2.940          (------*-----)
```

```
T       -5.35  -2.349   0.651                (-*--)
U       -7.04  -4.072  -1.101              (--*-)
V      -16.28  -8.164  -0.050       (------*------)
W      -20.56  -6.864   6.834    (----------*----------)
X       -7.13  -3.809  -0.489              (--*--)
Y       -6.12  -3.013   0.089               (-*--)
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = J subtracted from:

Treat	Lower	Center	Upper
K	-6.93	-1.028	4.878
L	-8.07	-1.861	4.349
M	-5.32	2.079	9.482
O	-7.19	3.281	13.751
P	-4.51	1.698	7.908
Q	-4.64	1.572	7.782
S	-10.69	-1.789	7.109
T	-3.69	1.037	5.762
U	-5.39	-0.686	4.021
V	-13.68	-4.779	4.119
W	-17.66	-3.479	10.697
X	-5.36	-0.424	4.512
Y	-4.42	0.372	5.163

```
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = K subtracted from:

Treat	Lower	Center	Upper
L	-6.91	-0.833	5.242
M	-4.18	3.107	10.397
O	-6.08	4.309	14.699
P	-3.35	2.726	8.801
Q	-3.47	2.600	8.675
S	-9.56	-0.761	8.043
T	-2.48	2.065	6.611
U	-4.19	0.342	4.869
V	-12.55	-3.751	5.053
W	-16.57	-2.451	11.667
X	-4.16	0.604	5.368
Y	-3.21	1.400	6.015

```
                                 ---------+---------+---------+-------
                                        -12         0        12
```

Treat = L subtracted from:

Treat	Lower	Center	Upper
M	-3.60	3.940	11.479
O	-5.42	5.142	15.709
P	-2.81	3.559	9.931
Q	-2.94	3.433	9.805
S	-8.94	0.072	9.083
T	-2.04	2.898	7.833
U	-3.74	1.175	6.093
V	-11.93	-2.918	6.093
W	-15.87	-1.618	12.630
X	-3.70	1.437	6.574
Y	-2.77	2.233	7.232

```
                              ---------+---------+---------+-------
                                     -12         0        12
```

Treat = M subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
O      -10.11   1.202  12.511            (--------*--------)
P       -7.92  -0.381   7.158             (------*-----)
Q       -8.05  -0.507   7.032             (------*-----)
S      -13.74  -3.868   6.003          (-------*-------)
T       -7.41  -1.042   5.329              (----*----)
U       -9.12  -2.765   3.593            (-----*----)
V      -16.73  -6.858   3.013        (-------*--------)
W      -20.36  -5.558   9.249     (------------*------------)
X       -9.03  -2.503   4.026            (-----*----)
Y       -8.13  -1.707   4.714             (-----*----)
                              ---------+---------+---------+-------
                                     -12         0        12
```

Treat = O subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
P      -12.15  -1.583  8.983           (--------*-------)
Q      -12.28  -1.709  8.857           (--------*-------)
S      -17.41  -5.070  7.269      (-----------*---------)
T      -12.01  -2.244  7.523           (-------*-------)
U      -13.73  -3.967  5.791         (-------*-------)
V      -20.40  -8.060  4.279    (---------*----------)
W      -23.31  -6.760  9.794  (------------*-------------)
X      -13.58  -3.705  6.166         (-------*-------)
Y      -12.71  -2.909  6.891         (--------*-------)
                              ---------+---------+---------+-------
                                     -12         0        12
```

Treat = P subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
Q       -6.50  -0.126  6.246              (----*----)
S      -12.50  -3.487  5.524           (------*-------)
T       -5.60  -0.661  4.274              (---*----)
U       -7.30  -2.384  2.534             (---*---)
V      -15.49  -6.477  2.534        (-------*------)
W      -19.42  -5.177  9.071     (-----------*-----------)
X       -7.26  -2.122  3.015             (---*----)
Y       -6.32  -1.326  3.673              (---*---)
                              ---------+---------+---------+-------
                                     -12         0        12
```

Treat = Q subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
S      -12.37  -3.361  5.650           (------*-------)
T       -5.47  -0.536  4.400              (----*---)
U       -7.18  -2.259  2.659             (---*---)
V      -15.36  -6.351  2.660        (-------*------)
W      -19.30  -5.051  9.196     (-----------*-----------)
X       -7.13  -1.996  3.141             (---*----)
Y       -6.20  -1.200  3.798              (---*---)
                              ---------+---------+---------+-------
```

```
                                  -12         0        12
```

Treat = S subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
T       -5.23   2.826  10.885                (-----*------)
U       -6.95   1.103   9.151              (------*------)
V      -14.03  -2.990   8.046        (---------*--------)
W      -17.30  -1.690  13.917      (------------*------------)
X       -6.82   1.365   9.550              (------*------)
Y       -5.94   2.161  10.259               (------*------)
                          ---------+---------+---------+-------
                                  -12         0        12
```

Treat = T subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
U       -4.54  -1.723  1.096               (--*-)
V      -13.88  -5.816  2.244        (------*------)
W      -18.18  -4.516  9.150     (-----------*-----------)
X       -4.65  -1.461  1.725               (--*-)
Y       -3.62  -0.665  2.293                (-*--)
                         ---------+---------+---------+-------
                                 -12         0        12
```

Treat = U subtracted from:

```
Treat   Lower  Center   Upper  ---------+---------+---------+-------
V      -12.14  -4.093   3.956          (------*-----)
W      -16.45  -2.793  10.867       (-----------*----------)
X       -2.90   0.262   3.421                (-*--)
Y       -1.87   1.058   3.986                (--*-)
                          ---------+---------+---------+-------
                                  -12         0        12
```

Treat = V subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
W      -14.31   1.300  16.91        (------------*------------)
X       -3.83   4.355  12.54                (------*-----)
Y       -2.95   5.151  13.25                 (-----*------)
                         ---------+---------+---------+-------
                                 -12         0        12
```

Treat = W subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
X      -10.68   3.055  16.79           (-----------*----------)
Y       -9.84   3.851  17.54            (----------*-----------)
                         ---------+---------+---------+-------
                                 -12         0        12
```

Treat = X subtracted from:

```
Treat   Lower  Center  Upper  ---------+---------+---------+-------
Y      -2.486  0.7960  4.078                (--*-)
                         ---------+---------+---------+-------
```

-12 0 12

Tukey Simultaneous Tests
Response Variable SI(m) 50 TA
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
B	4.3183	1.972	2.19034	0.8610
C	0.4768	2.121	0.22481	1.0000
D	10.7531	1.987	5.41073	0.0001
E	9.5445	2.014	4.73803	0.0006
F	3.3021	2.020	1.63451	0.9939
G	5.2534	1.984	2.64814	0.5367
H	7.0734	1.984	3.56556	0.0590
I	8.4368	1.969	4.28511	0.0040
J	5.0515	2.213	2.28260	0.8088
K	4.0234	2.184	1.84212	0.9740
L	3.1903	2.248	1.41923	0.9992
M	7.1305	2.509	2.84156	0.3862
O	8.3325	3.240	2.57210	0.5978
P	6.7492	2.248	3.00243	0.2770
Q	6.6236	2.248	2.94658	0.3127
S	3.2625	2.857	1.14192	1.0000
T	6.0881	1.952	3.11932	0.2107
U	4.3651	1.948	2.24041	0.8338
V	0.2725	2.857	0.09538	1.0000
W	1.5725	4.182	0.37599	1.0000
X	4.6275	1.991	2.32403	0.7824
Y	5.4235	1.964	2.76155	0.4467

Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-3.842	1.1782	-3.260	0.1463
D	6.435	0.9166	7.021	0.0001
E	5.226	0.9739	5.366	0.0001
F	-1.016	0.9858	-1.031	1.0000
G	0.935	0.9088	1.029	1.0000
H	2.755	0.9088	3.031	0.2594
I	4.118	0.8757	4.703	0.0006
J	0.733	1.3372	0.548	1.0000
K	-0.295	1.2887	-0.229	1.0000
L	-1.128	1.3941	-0.809	1.0000
M	2.812	1.7853	1.575	0.9963
O	4.014	2.7176	1.477	0.9985
P	2.431	1.3941	1.744	0.9863
Q	2.305	1.3941	1.654	0.9929
S	-1.056	2.2479	-0.470	1.0000
T	1.770	0.8365	2.116	0.8962
U	0.047	0.8285	0.056	1.0000
V	-4.046	2.2479	-1.800	0.9800
W	-2.746	3.7923	-0.724	1.0000
X	0.309	0.9247	0.334	1.0000
Y	1.105	0.8646	1.278	0.9998

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	10.2764	1.205	8.53142	0.0001
E	9.0677	1.249	7.26178	0.0001
F	2.8253	1.258	2.24588	0.8307
G	4.7767	1.199	3.98499	0.0133
H	6.5967	1.199	5.50335	0.0001
I	7.9600	1.174	6.78170	0.0001
J	4.5747	1.549	2.95370	0.3080
K	3.5466	1.507	2.35315	0.7630
L	2.7135	1.598	1.69783	0.9901
M	6.6537	1.949	3.41413	0.0944
O	7.8557	2.828	2.77810	0.4339
P	6.2724	1.598	3.92462	0.0168
Q	6.1468	1.598	3.84606	0.0224
S	2.7857	2.380	1.17052	1.0000
T	5.6113	1.145	4.90173	0.0003
U	3.8883	1.139	3.41388	0.0945
V	-0.2043	2.380	-0.08584	1.0000
W	1.0957	3.872	0.28298	1.0000
X	4.1507	1.211	3.42819	0.0905
Y	4.9467	1.165	4.24445	0.0047

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	-1.21	1.0055	-1.202	0.9999
F	-7.45	1.0171	-7.326	0.0001
G	-5.50	0.9427	-5.834	0.0001
H	-3.68	0.9427	-3.903	0.0182
I	-2.32	0.9108	-2.543	0.6210
J	-5.70	1.3604	-4.191	0.0059
K	-6.73	1.3128	-5.126	0.0001
L	-7.56	1.4164	-5.340	0.0001
M	-3.62	1.8028	-2.009	0.9355
O	-2.42	2.7291	-0.887	1.0000
P	-4.00	1.4164	-2.827	0.3970
Q	-4.13	1.4164	-2.916	0.3336
S	-7.49	2.2618	-3.312	0.1269
T	-4.67	0.8731	-5.343	0.0001
U	-6.39	0.8655	-7.381	0.0001
V	-10.48	2.2618	-4.634	0.0009
W	-9.18	3.8006	-2.416	0.7188
X	-6.13	0.9580	-6.394	0.0001
Y	-5.33	0.9001	-5.921	0.0001

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-6.242	1.0690	-5.839	0.0001
G	-4.291	0.9985	-4.298	0.0038
H	-2.471	0.9985	-2.475	0.6744
I	-1.108	0.9685	-1.144	1.0000
J	-4.493	1.3997	-3.210	0.1673
K	-5.521	1.3534	-4.079	0.0092
L	-6.354	1.4541	-4.370	0.0028
M	-2.414	1.8326	-1.317	0.9997
O	-1.212	2.7489	-0.441	1.0000
P	-2.795	1.4541	-1.922	0.9587

Q	-2.921	1.4541	-2.009	0.9357
S	-6.282	2.2856	-2.748	0.4569
T	-3.456	0.9331	-3.704	0.0371
U	-5.179	0.9260	-5.593	0.0001
V	-9.272	2.2856	-4.057	0.0101
W	-7.972	3.8148	-2.090	0.9070
X	-4.917	1.0130	-4.854	0.0003
Y	-4.121	0.9584	-4.300	0.0038

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	1.951	1.0101	1.932	0.9566
H	3.771	1.0101	3.734	0.0335
I	5.135	0.9804	5.237	0.0001
J	1.749	1.4080	1.243	0.9999
K	0.721	1.3620	0.530	1.0000
L	-0.112	1.4621	-0.076	1.0000
M	3.828	1.8389	2.082	0.9101
O	5.030	2.7531	1.827	0.9762
P	3.447	1.4621	2.358	0.7599
Q	3.322	1.4621	2.272	0.8154
S	-0.040	2.2907	-0.017	1.0000
T	2.786	0.9455	2.947	0.3127
U	1.063	0.9385	1.133	1.0000
V	-3.030	2.2907	-1.323	0.9997
W	-1.730	3.8179	-0.453	1.0000
X	1.325	1.0244	1.294	0.9998
Y	2.121	0.9705	2.186	0.8633

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	1.820	0.9352	1.946	0.9531
I	3.183	0.9030	3.525	0.0671
J	-0.202	1.3552	-0.149	1.0000
K	-1.230	1.3074	-0.941	1.0000
L	-2.063	1.4114	-1.462	0.9987
M	1.877	1.7989	1.043	1.0000
O	3.079	2.7265	1.129	1.0000
P	1.496	1.4114	1.060	1.0000
Q	1.370	1.4114	0.971	1.0000
S	-1.991	2.2587	-0.881	1.0000
T	0.835	0.8650	0.965	1.0000
U	-0.888	0.8573	-1.036	1.0000
V	-4.981	2.2587	-2.205	0.8532
W	-3.681	3.7987	-0.969	1.0000
X	-0.626	0.9506	-0.658	1.0000
Y	0.170	0.8922	0.191	1.0000

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	1.363	0.9030	1.510	0.9979
J	-2.022	1.3552	-1.492	0.9983
K	-3.050	1.3074	-2.333	0.7767
L	-3.883	1.4114	-2.751	0.4547

M	0.057	1.7989	0.032	1.0000
O	1.259	2.7265	0.462	1.0000
P	-0.324	1.4114	-0.230	1.0000
Q	-0.450	1.4114	-0.319	1.0000
S	-3.811	2.2587	-1.687	0.9908
T	-0.985	0.8650	-1.139	1.0000
U	-2.708	0.8573	-3.159	0.1908
V	-6.801	2.2587	-3.011	0.2717
W	-5.501	3.7987	-1.448	0.9989
X	-2.446	0.9506	-2.573	0.5972
Y	-1.650	0.8922	-1.849	0.9728

Treat = I subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
J	-3.385	1.3332	-2.539	0.6241
K	-4.413	1.2846	-3.436	0.0886
L	-5.247	1.3903	-3.774	0.0291
M	-1.306	1.7824	-0.733	1.0000
O	-0.104	2.7156	-0.038	1.0000
P	-1.688	1.3903	-1.214	0.9999
Q	-1.813	1.3903	-1.304	0.9998
S	-5.174	2.2456	-2.304	0.7952
T	-2.349	0.8301	-2.829	0.3952
U	-4.072	0.8221	-4.953	0.0002
V	-8.164	2.2456	-3.636	0.0468
W	-6.864	3.7909	-1.811	0.9786
X	-3.809	0.9190	-4.145	0.0071
Y	-3.013	0.8585	-3.510	0.0704

Treat = J subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
K	-1.028	1.634	-0.629	1.0000
L	-1.861	1.719	-1.083	1.0000
M	2.079	2.049	1.015	1.0000
O	3.281	2.898	1.132	1.0000
P	1.698	1.719	0.988	1.0000
Q	1.572	1.719	0.915	1.0000
S	-1.789	2.462	-0.727	1.0000
T	1.037	1.308	0.793	1.0000
U	-0.686	1.303	-0.527	1.0000
V	-4.779	2.462	-1.941	0.9544
W	-3.479	3.923	-0.887	1.0000
X	-0.424	1.366	-0.310	1.0000
Y	0.372	1.326	0.281	1.0000

Treat = K subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
L	-0.833	1.681	-0.496	1.0000
M	3.107	2.018	1.540	0.9973
O	4.309	2.876	1.499	0.9981
P	2.726	1.681	1.621	0.9945
Q	2.600	1.681	1.547	0.9971
S	-0.761	2.436	-0.312	1.0000
T	2.065	1.258	1.641	0.9936

U	0.342	1.253	0.273	1.0000
V	-3.751	2.436	-1.539	0.9973
W	-2.451	3.907	-0.627	1.0000
X	0.604	1.319	0.458	1.0000
Y	1.400	1.277	1.096	1.0000

Treat = L subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
M	3.940	2.086	1.888	0.9658
O	5.142	2.924	1.758	0.9848
P	3.559	1.763	2.018	0.9327
Q	3.433	1.763	1.947	0.9529
S	0.072	2.494	0.029	1.0000
T	2.898	1.366	2.121	0.8938
U	1.175	1.361	0.863	1.0000
V	-2.918	2.494	-1.170	1.0000
W	-1.618	3.943	-0.410	1.0000
X	1.437	1.422	1.011	1.0000
Y	2.233	1.383	1.614	0.9948

Treat = M subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
O	1.202	3.130	0.384	1.0000
P	-0.381	2.086	-0.183	1.0000
Q	-0.507	2.086	-0.243	1.0000
S	-3.868	2.732	-1.416	0.9992
T	-1.042	1.763	-0.591	1.0000
U	-2.765	1.760	-1.572	0.9964
V	-6.858	2.732	-2.510	0.6468
W	-5.558	4.098	-1.356	0.9996
X	-2.503	1.807	-1.385	0.9994
Y	-1.707	1.777	-0.961	1.0000

Treat = O subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
P	-1.583	2.924	-0.541	1.0000
Q	-1.709	2.924	-0.584	1.0000
S	-5.070	3.415	-1.485	0.9984
T	-2.244	2.703	-0.830	1.0000
U	-3.967	2.701	-1.469	0.9986
V	-8.060	3.415	-2.360	0.7581
W	-6.760	4.581	-1.476	0.9985
X	-3.705	2.732	-1.356	0.9996
Y	-2.909	2.712	-1.073	1.0000

Treat = P subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Q	-0.126	1.763	-0.071	1.0000
S	-3.487	2.494	-1.398	0.9993
T	-0.661	1.366	-0.484	1.0000
U	-2.384	1.361	-1.752	0.9855

V	-6.477	2.494	-2.597	0.5778
W	-5.177	3.943	-1.313	0.9997
X	-2.122	1.422	-1.492	0.9983
Y	-1.326	1.383	-0.958	1.0000

Treat = Q subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
S	-3.361	2.494	-1.348	0.9996
T	-0.536	1.366	-0.392	1.0000
U	-2.259	1.361	-1.659	0.9926
V	-6.351	2.494	-2.547	0.6181
W	-5.051	3.943	-1.281	0.9998
X	-1.996	1.422	-1.404	0.9993
Y	-1.200	1.383	-0.868	1.0000

Treat = S subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
T	2.826	2.231	1.2668	0.9999
U	1.103	2.228	0.4950	1.0000
V	-2.990	3.054	-0.9789	1.0000
W	-1.690	4.319	-0.3913	1.0000
X	1.365	2.265	0.6026	1.0000
Y	2.161	2.241	0.9642	1.0000

Treat = T subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
U	-1.723	0.7802	-2.208	0.8515
V	-5.816	2.2305	-2.607	0.5696
W	-4.516	3.7821	-1.194	0.9999
X	-1.461	0.8817	-1.657	0.9927
Y	-0.665	0.8184	-0.812	1.0000

Treat = U subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
V	-4.093	2.2276	-1.837	0.9747
W	-2.793	3.7803	-0.739	1.0000
X	0.262	0.8742	0.300	1.0000
Y	1.058	0.8103	1.306	0.9998

Treat = V subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
W	1.300	4.319	0.3010	1.0000
X	4.355	2.265	1.9226	0.9587
Y	5.151	2.241	2.2983	0.7990

Treat = W subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
X	3.055	3.803	0.8034	1.000
Y	3.851	3.788	1.0165	1.000

Treat = X subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Y	0.7960	0.9084	0.8763	1.000

Species: Lodgepole Pine

General Linear Model: SI(m) 50 TA versus Treat

```
Factor  Type   Levels  Values
Treat   fixed      25  A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S,
                       T, U, V, W, X, Y


Analysis of Variance for SI(m) 50 TA, using Adjusted SS for Tests

Source    DF     Seq SS    Adj SS  Adj MS      F      P
Treat     24   2070.796  2070.796  86.283  11.51  0.000
Error   1243   9320.831  9320.831   7.499
Total   1267  11391.627


S = 2.73837   R-Sq = 18.18%   R-Sq(adj) = 16.60%


Unusual Observations for SI(m) 50 TA

 Obs  SI(m) 50 TA      Fit  SE Fit  Residual  St Resid
   3      11.0000   9.8267  1.5810    1.1733      0.52  X
  16       7.7200   9.8267  1.5810   -2.1067     -0.94  X
  18      10.7600   9.8267  1.5810    0.9333      0.42  X
  50      23.0600  17.2289  0.3141    5.8311      2.14  R
  70       9.3200  17.2289  0.3141   -7.9089     -2.91  R
  83      10.7600  17.2289  0.3141   -6.4689     -2.38  R
 113       6.8300  13.7444  0.2936   -6.9144     -2.54  R
 114       7.2700  13.7444  0.2936   -6.4744     -2.38  R
 135       8.1900  13.7444  0.2936   -5.5544     -2.04  R
 146       6.8000  13.7444  0.2936   -6.9444     -2.55  R
 162      19.7200  13.7444  0.2936    5.9756      2.19  R
 163       5.1600  13.7444  0.2936   -8.5844     -3.15  R
 164      20.1200  13.7444  0.2936    6.3756      2.34  R
 167      19.3800  13.7444  0.2936    5.6356      2.07  R
 182      19.6700  13.7444  0.2936    5.9256      2.18  R
 187      10.8100  18.5283  0.3423   -7.7183     -2.84  R
 222      11.6000  18.5283  0.3423   -6.9283     -2.55  R
 251      12.8700  18.5283  0.3423   -5.6583     -2.08  R
 261      23.5200  17.4390  0.3506    6.0810      2.24  R
 291       8.2100  17.4390  0.3506   -9.2290     -3.40  R
 296      10.7600  17.4390  0.3506   -6.6790     -2.46  R
 305      10.7600  17.4390  0.3506   -6.6790     -2.46  R
 329      10.3600  16.0726  0.3141   -5.7126     -2.10  R
 332       9.3200  16.0726  0.3141   -6.7526     -2.48  R
 353      22.1000  16.0726  0.3141    6.0274      2.22  R
 369       8.2100  16.0726  0.3141   -7.8626     -2.89  R
 371       9.3200  16.0726  0.3141   -6.7526     -2.48  R
 372       8.0400  16.0726  0.3141   -8.0326     -2.95  R
 391       8.6300  15.7856  0.3273   -7.1556     -2.63  R
 415       8.2100  15.7856  0.3273   -7.5756     -2.79  R
 420      10.2700  15.7856  0.3273   -5.5156     -2.03  R
 432       7.3400  15.7856  0.3273   -8.4456     -3.11  R
 448      28.3300  15.7856  0.3273   12.5444      4.61  R
 481       9.3200  17.7388  0.3043   -8.4188     -3.09  R
 483       9.1100  17.7388  0.3043   -8.6288     -3.17  R
 484       7.8700  17.7388  0.3043   -9.8688     -3.63  R
 485      10.7600  17.7388  0.3043   -6.9788     -2.56  R
 486      10.7600  17.7388  0.3043   -6.9788     -2.56  R
```

496	10.4000	17.7388	0.3043	-7.3388	-2.70	R
502	23.6000	17.7388	0.3043	5.8612	2.15	R
544	22.7700	16.6725	0.3627	6.0975	2.25	R
560	7.4100	16.6725	0.3627	-9.2625	-3.41	R
608	8.2100	14.4400	0.4918	-6.2300	-2.31	R
619	19.8600	14.4400	0.4918	5.4200	2.01	R
631	8.6700	14.8447	0.3994	-6.1747	-2.28	R
632	9.0400	14.8447	0.3994	-5.8047	-2.14	R
704	10.7600	16.5493	0.5175	-5.7893	-2.15	R
708	8.3700	14.9211	0.6454	-6.5511	-2.46	R
724	18.7800	16.1777	0.7595	2.6023	0.99	X
725	13.1100	16.1777	0.7595	-3.0677	-1.17	X
726	14.4800	16.1777	0.7595	-1.6977	-0.65	X
727	16.6300	16.1777	0.7595	0.4523	0.17	X
728	18.9200	16.1777	0.7595	2.7423	1.04	X
729	12.7300	16.1777	0.7595	-3.4477	-1.31	X
730	15.6000	16.1777	0.7595	-0.5777	-0.22	X
731	15.9800	16.1777	0.7595	-0.1977	-0.08	X
732	13.4400	16.1777	0.7595	-2.7377	-1.04	X
733	15.5700	16.1777	0.7595	-0.6077	-0.23	X
734	16.9100	16.1777	0.7595	0.7323	0.28	X
735	19.0500	16.1777	0.7595	2.8723	1.09	X
736	19.1100	16.1777	0.7595	2.9323	1.11	X
758	10.3600	16.0500	0.5370	-5.6900	-2.12	R
764	10.8300	17.3666	0.5085	-6.5366	-2.43	R
802	8.4100	14.6800	0.5710	-6.2700	-2.34	R
889	7.3400	15.5673	0.2988	-8.2273	-3.02	R
894	6.8800	15.5673	0.2988	-8.6873	-3.19	R
978	7.3500	15.1744	0.2738	-7.8244	-2.87	R
986	8.2100	15.1744	0.2738	-6.9644	-2.56	R
1031	9.3200	15.1744	0.2738	-5.8544	-2.15	R
1074	15.4000	12.9736	0.8256	2.4264	0.93	X
1075	12.9300	12.9736	0.8256	-0.0436	-0.02	X
1076	12.9200	12.9736	0.8256	-0.0536	-0.02	X
1077	16.3600	12.9736	0.8256	3.3864	1.30	X
1085	8.2000	12.9736	0.8256	-4.7736	-1.83	X
1133	9.4700	12.9736	0.8256	-3.5036	-1.34	X
1143	10.3500	12.9736	0.8256	-2.6236	-1.00	X
1144	15.7300	12.9736	0.8256	2.7564	1.06	X
1145	15.6000	12.9736	0.8256	2.6264	1.01	X
1146	11.4500	12.9736	0.8256	-1.5236	-0.58	X
1147	14.3000	12.9736	0.8256	1.3264	0.51	X
1148	14.4500	11.8714	1.0350	2.5786	1.02	X
1160	15.3200	11.8714	1.0350	3.4486	1.36	X
1168	9.0100	11.8714	1.0350	-2.8614	-1.13	X
1200	6.6400	11.8714	1.0350	-5.2314	-2.06	RX
1201	12.7300	11.8714	1.0350	0.8586	0.34	X
1202	12.2200	11.8714	1.0350	0.3486	0.14	X
1203	12.7300	11.8714	1.0350	0.8586	0.34	X
1272	8.2100	16.0811	0.2565	-7.8711	-2.89	R
1300	21.9900	16.0811	0.2565	5.9089	2.17	R
1367	9.3200	16.0150	0.2766	-6.6950	-2.46	R
1374	9.3200	16.0150	0.2766	-6.6950	-2.46	R
1393	9.4800	16.0150	0.2766	-6.5350	-2.40	R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.

Grouping Information Using Tukey Method and 95.0% Confidence

Treat	N	Mean	Grouping
D	64	18.528	A

```
H       81  17.739  A B
E       61  17.439  A B C
P       29  17.367  A B C D E
B       76  17.229  A B C
I       57  16.672    B C D E F
L       28  16.549  A B C D E F
N       13  16.178  A B C D E F G H I J K
X      114  16.081      C D E F G
F       76  16.073      C D E F G
O       26  16.050    B C D E F G   I
Y       98  16.015      C D E F G   I
G       70  15.786      C D E F G   I
R       33  15.603      C D E F G H I J K
T       84  15.567          E F G H I J
S       31  15.257      C D E F G H I J K
U      100  15.174            F G H I J K
M       18  14.921      C D E F G H I J K
K       47  14.845            F G H I J K
Q       23  14.680        D E F G H I J K
J       31  14.440            F G H I J K
C       87  13.744                      K
V       11  12.974              G H I J K
W        7  11.871                  I J K
A        3   9.827                H   J K
```

Means that do not share a letter are significantly different.

```
Tukey 95.0% Simultaneous Confidence Intervals
Response Variable SI(m) 50 TA
All Pairwise Comparisons among Levels of Treat
Treat = A  subtracted from:

Treat   Lower  Center   Upper  -----+---------+---------+---------+-
B       1.510   7.402  13.295                  (--------*-------)
C      -1.961   3.918   9.796             (--------*-------)
D       2.788   8.702  14.615                    (-------*--------)
E       1.692   7.612  13.532                 (--------*-------)
F       0.353   6.246  12.139                (-------*-------)
G       0.057   5.959  11.861               (--------*-------)
H       2.026   7.912  13.798                  (-------*--------)
I       0.916   6.846  12.776                (--------*-------)
J      -1.440   4.613  10.666              (--------*-------)
K      -0.943   5.018  10.979               (-------*--------)
L       0.641   6.723  12.804                 (--------*-------)
M      -1.148   5.094  11.337              (--------*--------)
N      -0.061   6.351  12.763                (--------*--------)
O       0.119   6.223  12.327                (--------*--------)
P       1.469   7.540  13.611                  (--------*-------)
Q      -1.292   4.853  10.998              (--------*--------)
R      -0.261   5.776  11.813                (-------*--------)
S      -0.623   5.430  11.483               (--------*-------)
T      -0.141   5.741  11.623                (-------*--------)
U      -0.518   5.348  11.214               (--------*-------)
V      -3.373   3.147   9.667           (--------*---------)
W      -4.863   2.045   8.953         (---------*---------)
X       0.399   6.254  12.110                (-------*-------)
Y       0.321   6.188  12.056                (--------*-------)
                           -----+---------+---------+---------+-
                             -7.0       0.0       7.0      14.0


Treat = B  subtracted from:
```

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
C      -5.056  -3.485  -1.913          (-*-)
D      -0.399   1.299   2.998               (--*-)
E      -1.511   0.210   1.931             (-*--)
F      -2.780  -1.156   0.468           (-*--)
G      -3.102  -1.443   0.215           (-*-)
H      -1.089   0.510   2.109             (--*-)
I      -2.311  -0.556   1.198            (-*--)
J      -4.922  -2.789  -0.656          (--*--)
K      -4.242  -2.384  -0.527           (--*-)
L      -2.893  -0.680   1.533             (--*--)
M      -4.932  -2.308   0.316          (---*--)
N      -4.056  -1.051   1.953           (---*----)
O      -3.453  -1.179   1.095            (--*---)
P      -2.047   0.138   2.323              (--*--)
Q      -4.931  -2.549  -0.167          (--*---)
R      -3.713  -1.626   0.461            (--*--)
S      -4.106  -1.972   0.161           (--*--)
T      -3.247  -1.662  -0.077            (--*-)
U      -3.578  -2.055  -0.531            (-*-)
V      -7.485  -4.255  -1.026      (----*----)
W      -9.312  -5.358  -1.403    (----*-----)
X      -2.630  -1.148   0.335             (-*-)
Y      -2.744  -1.214   0.316             (-*-)
                          -----+---------+---------+---------+-
                            -7.0       0.0       7.0      14.0
```

Treat = C subtracted from:

```
Treat   Lower  Center  Upper  -----+---------+---------+---------+-
D       3.135   4.784  6.432                    (--*-)
E       2.023   3.695  5.366                  (-*--)
F       0.756   2.328  3.900                (-*--)
G       0.434   2.041  3.649                (-*-)
H       2.449   3.994  5.540                  (--*-)
I       1.222   2.928  4.634                (-*--)
J      -1.398   0.696  2.790             (--*--)
K      -0.712   1.100  2.913              (--*-)
L       0.630   2.805  4.980                (--*--)
M      -1.415   1.177  3.769             (---*--)
N      -0.543   2.433  5.410              (---*----)
O       0.068   2.306  4.543                (--*--)
P       1.476   3.622  5.769                  (--*--)
Q      -1.412   0.936  3.283             (--*---)
R      -0.188   1.858  3.905               (--*--)
S      -0.582   1.512  3.606              (--*--)
T       0.292   1.823  3.354               (--*-)
U      -0.038   1.430  2.898               (-*-)
V      -3.974  -0.771  2.433          (----*---)
W      -5.806  -1.873  2.060        (----*-----)
X       0.912   2.337  3.762                (-*-)
Y       0.796   2.271  3.745                (-*-)
                         -----+---------+---------+---------+-
                           -7.0       0.0       7.0      14.0
```

Treat = D subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
E       -2.88  -1.089   0.702            (-*--)
F       -4.15  -2.456  -0.757          (-*--)
```

```
G       -4.47  -2.743  -1.011           (-*--)
H       -2.46  -0.790   0.885             (--*-)
I       -3.68  -1.856  -0.033            (-*--)
J       -6.28  -4.088  -1.898        (--*--)
K       -5.61  -3.684  -1.761         (--*-)
L       -4.25  -1.979   0.289           (--*--)
M       -6.28  -3.607  -0.936        (---*---)
N       -5.40  -2.351   0.695         (----*---)
O       -4.81  -2.478  -0.150          (--*---)
P       -3.40  -1.162   1.079            (--*---)
Q       -6.28  -3.848  -1.415        (---*--)
R       -5.07  -2.926  -0.780          (--*--)
S       -5.46  -3.272  -1.081         (--*--)
T       -4.62  -2.961  -1.300          (--*-)
U       -4.96  -3.354  -1.751          (-*-)
V       -8.82  -5.555  -2.287    (----*----)
W      -10.64  -6.657  -2.672  (----*-----)
X       -4.01  -2.447  -0.884           (--*-)
Y       -4.12  -2.513  -0.904           (-*--)
                             -----+---------+---------+---------+-
                               -7.0       0.0       7.0      14.0
```

Treat = E subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
F      -3.087  -1.366   0.355            (-*--)
G      -3.407  -1.653   0.100           (--*-)
H      -1.397   0.300   1.997              (-*--)
I      -2.611  -0.767   1.078            (--*--)
J      -5.207  -2.999  -0.791         (--*--)
K      -4.537  -2.594  -0.651          (-*--)
L      -3.175  -0.890   1.395           (---*--)
M      -5.203  -2.518   0.167         (--*---)
N      -4.319  -1.261   1.797           (---*----)
O      -3.734  -1.389   0.956           (--*--)
P      -2.330  -0.072   2.186             (--*--)
Q      -5.209  -2.759  -0.310         (--*---)
R      -4.000  -1.836   0.327           (--*--)
S      -4.390  -2.182   0.026           (--*--)
T      -3.556  -1.872  -0.188            (-*--)
U      -3.891  -2.265  -0.638           (--*-)
V      -7.745  -4.465  -1.186      (----*---)
W      -9.563  -5.568  -1.573   (-----*-----)
X      -2.946  -1.358   0.230            (-*-)
Y      -3.057  -1.424   0.209            (-*-)
                             -----+---------+---------+---------+-
                               -7.0       0.0       7.0      14.0
```

Treat = F subtracted from:

```
Treat   Lower  Center    Upper  -----+---------+---------+---------+-
G      -1.945  -0.287   1.3713              (--*-)
H       0.067   1.666   3.2648                 (-*--)
I      -1.154   0.600   2.3539               (--*-)
J      -3.766  -1.633   0.5008            (--*--)
K      -3.086  -1.228   0.6297             (-*--)
L      -1.736   0.477   2.6897               (--*--)
M      -3.776  -1.152   1.4726            (--*---)
N      -2.900   0.105   3.1096             (---*---)
O      -2.297  -0.023   2.2518               (--*--)
P      -0.891   1.294   3.4789                 (--*--)
```

```
Q      -3.775  -1.393   0.9898           (--*--)
R      -2.557  -0.470   1.6171            (--*--)
S      -2.949  -0.816   1.3175            (--*--)
T      -2.090  -0.505   1.0795             (-*--)
U      -2.422  -0.898   0.6252             (-*-)
V      -6.328  -3.099   0.1304       (----*---)
W      -8.155  -4.201  -0.2471    (-----*-----)
X      -1.474   0.008   1.4909              (-*-)
Y      -1.588  -0.058   1.4725              (-*-)
                                -----+---------+---------+---------+-
                                  -7.0       0.0       7.0      14.0
```

Treat = G subtracted from:

```
Treat   Lower  Center    Upper  -----+---------+---------+---------+-
H       0.320   1.953  3.58686                (--*-)
I      -0.899   0.887  2.67289               (-*--)
J      -3.505  -1.346  0.81415           (--*--)
K      -2.829  -0.941  0.94694            (--*-)
L      -1.475   0.764  3.00219              (--*--)
M      -3.510  -0.864  1.78113           (---*---)
N      -2.631   0.392  3.41545            (----*---)
O      -2.035   0.264  2.56358             (--*---)
P      -0.630   1.581  3.79172               (--*--)
Q      -3.512  -1.106  1.30043           (--*---)
R      -2.297  -0.183  1.93103             (--*--)
S      -2.689  -0.529  1.63093            (--*--)
T      -1.838  -0.218  1.40178             (--*-)
U      -2.171  -0.611  0.94889             (-*-)
V      -6.059  -2.812  0.43493       (----*----)
W      -7.883  -3.914  0.05425     (----*-----)
X      -1.225   0.295  1.81559              (-*--)
Y      -1.337   0.229  1.79603              (-*--)
                                -----+---------+---------+---------+-
                                  -7.0       0.0       7.0      14.0
```

Treat = H subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
I      -2.797  -1.066   0.664            (-*--)
J      -5.413  -3.299  -1.185         (--*--)
K      -4.730  -2.894  -1.058          (--*-)
L      -3.384  -1.189   1.005            (--*--)
M      -5.426  -2.818  -0.209         (---*---)
N      -4.552  -1.561   1.430          (----*---)
O      -3.945  -1.689   0.568           (---*--)
P      -2.539  -0.372   1.794             (--*---)
Q      -5.424  -3.059  -0.694         (---*--)
R      -4.203  -2.136  -0.069           (--*--)
S      -4.596  -2.482  -0.368          (--*--)
T      -3.730  -2.172  -0.613            (-*-)
U      -4.061  -2.564  -1.068           (-*-)
V      -7.982  -4.765  -1.548      (---*----)
W      -9.811  -5.867  -1.924   (-----*----)
X      -3.112  -1.658  -0.203            (-*-)
Y      -3.227  -1.724  -0.220            (--*-)
                               -----+---------+---------+---------+-
                                 -7.0       0.0       7.0      14.0
```

Treat = I subtracted from:

```
Treat   Lower  Center    Upper  -----+---------+---------+---------+-
J      -4.466  -2.232   0.0016           (--*--)
K      -3.800  -1.828   0.1446            (-*--)
L      -2.433  -0.123   2.1871              (--*--)
M      -4.458  -1.751   0.9553           (--*---)
N      -3.572  -0.495   2.5821            (---*----)
O      -2.992  -0.622   1.7466             (--*--)
P      -1.589   0.694   2.9775               (--*--)
Q      -4.465  -1.992   0.4805           (--*---)
R      -3.259  -1.070   1.1200            (--*---)
S      -3.650  -1.416   0.8184            (--*--)
T      -2.823  -1.105   0.6127             (-*--)
U      -3.159  -1.498   0.1634            (--*-)
V      -6.996  -3.699  -0.4021       (----*---)
W      -8.810  -4.801  -0.7917    (-----*-----)
X      -2.215  -0.591   1.0326              (-*-)
Y      -2.325  -0.657   1.0101              (-*-)
                                -----+---------+---------+---------+-
                                  -7.0       0.0       7.0      14.0
```

```
Treat = J  subtracted from:

Treat   Lower  Center  Upper  -----+---------+---------+---------+-
K      -1.912   0.405  2.721             (---*--)
L      -0.501   2.109  4.719               (---*---)
M      -2.485   0.481  3.448            (----*---)
N      -1.570   1.738  5.046              (---*----)
O      -1.052   1.610  4.272              (---*---)
P       0.340   2.927  5.513                (---*---)
Q      -2.515   0.240  2.995            (---*---)
R      -1.341   1.163  3.667              (---*--)
S      -1.726   0.817  3.360              (--*---)
T      -0.976   1.127  3.231               (--*--)
U      -1.323   0.734  2.792              (--*--)
V      -4.980  -1.466  2.047         (----*----)
W      -6.758  -2.569  1.621       (-----*-----)
X      -0.387   1.641  3.669               (--*--)
Y      -0.488   1.575  3.638               (--*--)
                              -----+---------+---------+---------+-
                                -7.0       0.0       7.0      14.0
```

```
Treat = K  subtracted from:

Treat   Lower  Center  Upper  -----+---------+---------+---------+-
L      -0.685   1.705  4.094               (--*---)
M      -2.698   0.076  2.851            (---*---)
N      -1.804   1.333  4.470             (----*---)
O      -1.241   1.205  3.652              (---*--)
P       0.158   2.522  4.886                (---*--)
Q      -2.712  -0.165  2.383            (---*--)
R      -1.516   0.758  3.032              (--*--)
S      -1.904   0.412  2.728             (---*--)
T      -1.101   0.723  2.546              (--*--)
U      -1.441   0.330  2.100              (-*--)
V      -5.224  -1.871  1.482         (---*----)
W      -7.029  -2.973  1.082       (-----*-----)
X      -0.499   1.236  2.972               (--*-)
Y      -0.606   1.170  2.947               (--*-)
                              -----+---------+---------+---------+-
                                -7.0       0.0       7.0      14.0
```

```
Treat = L  subtracted from:

Treat   Lower  Center    Upper  -----+---------+---------+---------+-
M      -4.653  -1.628   1.3962          (----*---)
N      -3.731  -0.372   2.9882            (---*----)
O      -3.226  -0.499   2.2272            (---*---)
P      -1.835   0.817   3.4696              (---*---)
Q      -4.686  -1.869   0.9479          (---*---)
R      -3.519  -0.947   1.6256            (---*--)
S      -3.902  -1.293   1.3174           (---*---)
T      -3.167  -0.982   1.2025            (---*--)
U      -3.515  -1.375   0.7655            (--*--)
V      -7.138  -3.576  -0.0134       (----*----)
W      -8.908  -4.678  -0.4475    (-----*-----)
X      -2.580  -0.468   1.6432             (--*--)
Y      -2.679  -0.534   1.6109             (--*--)
                          -----+---------+---------+---------+-
                            -7.0       0.0       7.0      14.0


Treat = M  subtracted from:

Treat   Lower  Center  Upper  -----+---------+---------+---------+-
N      -2.387   1.257  4.900              (----*----)
O      -1.941   1.129  4.198              (----*---)
P      -0.558   2.445  5.449                (---*----)
Q      -3.391  -0.241  2.909            (----*---)
R      -2.252   0.682  3.615              (---*---)
S      -2.631   0.336  3.302             (---*----)
T      -1.954   0.646  3.246              (---*---)
U      -2.310   0.253  2.816              (--*---)
V      -5.779  -1.947  1.884         (----*-----)
W      -7.509  -3.050  1.409      (------*-----)
X      -1.379   1.160  3.699               (---*--)
Y      -1.473   1.094  3.661               (---*--)
                        -----+---------+---------+---------+-
                          -7.0       0.0       7.0      14.0


Treat = N  subtracted from:

Treat   Lower  Center   Upper  -----+---------+---------+---------+-
O      -3.528  -0.128  3.2728            (----*----)
P      -2.152   1.189  4.5302              (----*---)
Q      -4.971  -1.498  1.9759          (----*----)
R      -3.853  -0.575  2.7031           (----*----)
S      -4.229  -0.921  2.3869           (----*---)
T      -3.594  -0.610  2.3732            (---*---)
U      -3.955  -1.003  1.9482           (----*---)
V      -7.305  -3.204  0.8971       (----*-----)
W      -8.999  -4.306  0.3869    (------*------)
X      -3.027  -0.097  2.8339             (---*---)
Y      -3.118  -0.163  2.7922             (---*---)
                          -----+---------+---------+---------+-
                            -7.0       0.0       7.0      14.0


Treat = O  subtracted from:

Treat   Lower  Center    Upper  -----+---------+---------+---------+-
P      -1.387   1.317  4.02028               (---*---)
```

```
Q      -4.236  -1.370  1.49559           (---*---)
R      -3.072  -0.447  2.17785             (--*---)
S      -3.455  -0.793  1.86895            (---*---)
T      -2.729  -0.483  1.76392             (--*---)
U      -3.079  -0.876  1.32817             (--*--)
V      -6.677  -3.076  0.52432       (-----*----)
W      -8.441  -4.179  0.08417     (-----*-----)
X      -2.145   0.031  2.20672              (--*--)
Y      -2.243  -0.035  2.17340              (--*--)
                                -----+---------+---------+---------+-
                                  -7.0       0.0       7.0      14.0
```

Treat = P subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
Q      -5.482  -2.687   0.109        (---*---)
R      -4.312  -1.764   0.784          (--*---)
S      -4.696  -2.110   0.476         (---*---)
T      -3.955  -1.799   0.357          (--*---)
U      -4.304  -2.192  -0.081          (--*--)
V      -7.938  -4.393  -0.848      (----*----)
W      -9.711  -5.495  -1.279   (-----*-----)
X      -3.368  -1.285   0.797           (--*--)
Y      -3.468  -1.352   0.765           (--*--)
                              -----+---------+---------+---------+-
                                -7.0       0.0       7.0      14.0
```

Treat = Q subtracted from:

```
Treat   Lower  Center  Upper  -----+---------+---------+---------+-
R      -1.796   0.923  3.642             (---*---)
S      -2.178   0.577  3.332             (---*---)
T      -1.469   0.887  3.243              (--*---)
U      -1.821   0.494  2.809             (---*--)
V      -5.376  -1.706  1.963        (-----*----)
W      -7.130  -2.809  1.513       (-----*-----)
X      -0.887   1.401  3.689               (--*--)
Y      -0.984   1.335  3.654               (--*--)
                            -----+---------+---------+---------+-
                              -7.0       0.0       7.0      14.0
```

Treat = R subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
S      -2.850  -0.346  2.1580             (---*--)
T      -2.092  -0.035  2.0212              (--*--)
U      -2.438  -0.428  1.5814              (-*--)
V      -6.114  -2.629  0.8562        (----*----)
W      -7.897  -3.731  0.4344      (-----*-----)
X      -1.501   0.478  2.4572              (--*--)
Y      -1.603   0.412  2.4271              (--*-)
                              -----+---------+---------+---------+-
                                -7.0       0.0       7.0      14.0
```

Treat = S subtracted from:

```
Treat   Lower  Center   Upper  -----+---------+---------+---------+-
T      -1.793   0.310  2.4142             (--*--)
U      -2.140  -0.082  1.9755             (--*--)
```

```
V      -5.796  -2.283  1.2302         (----*----)
W      -7.575  -3.385  0.8038      (-----*-----)
X      -1.203   0.824  2.8520               (--*--)
Y      -1.305   0.758  2.8211               (--*--)
                              -----+---------+---------+---------+-
                                -7.0       0.0       7.0      14.0
```

```
Treat = T  subtracted from:

Treat   Lower  Center   Upper  -----+---------+---------+---------+-
U      -1.874  -0.393  1.0888             (-*--)
V      -5.804  -2.594  0.6163         (---*----)
W      -7.634  -3.696  0.2424      (-----*----)
X      -0.926   0.514  1.9533               (-*-)
Y      -1.041   0.448  1.9362               (-*-)
                              -----+---------+---------+---------+-
                                -7.0       0.0       7.0      14.0
```

```
Treat = U  subtracted from:

Treat   Lower  Center   Upper  -----+---------+---------+---------+-
V      -5.381  -2.201  0.9793         (----*---)
W      -7.217  -3.303  0.6109       (----*-----)
X      -0.465   0.907  2.2782               (-*-)
Y      -0.582   0.841  2.2635               (-*-)
                              -----+---------+---------+---------+-
                                -7.0       0.0       7.0      14.0
```

```
Treat = V  subtracted from:

Treat   Lower  Center  Upper  -----+---------+---------+---------+-
W      -5.942  -1.102  3.738         (-----*------)
X      -0.053   3.107  6.268                (---*----)
Y      -0.142   3.041  6.225                (---*----)
                             -----+---------+---------+---------+-
                               -7.0       0.0       7.0      14.0
```

```
Treat = W  subtracted from:

Treat   Lower  Center  Upper  -----+---------+---------+---------+-
X      0.3115   4.210  8.108                (-----*-----)
Y      0.2271   4.144  8.060                (-----*-----)
                             -----+---------+---------+---------+-
                               -7.0       0.0       7.0      14.0
```

```
Treat = X  subtracted from:

Treat   Lower    Center  Upper  -----+---------+---------+---------+-
Y      -1.445  -0.06605  1.313               (-*-)
                              -----+---------+---------+---------+-
                                -7.0       0.0       7.0      14.0
```

```
Tukey Simultaneous Tests
Response Variable SI(m) 50 TA
All Pairwise Comparisons among Levels of Treat
Treat = A  subtracted from:
```

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
B	7.402	1.612	4.592	0.0012
C	3.918	1.608	2.436	0.7433
D	8.702	1.618	5.379	0.0001
E	7.612	1.619	4.701	0.0008
F	6.246	1.612	3.875	0.0234
G	5.959	1.615	3.691	0.0449
H	7.912	1.610	4.914	0.0003
I	6.846	1.622	4.220	0.0061
J	4.613	1.656	2.786	0.4671
K	5.018	1.631	3.077	0.2606
L	6.723	1.664	4.041	0.0125
M	5.094	1.708	2.983	0.3207
N	6.351	1.754	3.621	0.0566
O	6.223	1.670	3.727	0.0396
P	7.540	1.661	4.540	0.0016
Q	4.853	1.681	2.887	0.3891
R	5.776	1.651	3.498	0.0837
S	5.430	1.656	3.280	0.1571
T	5.741	1.609	3.568	0.0672
U	5.348	1.605	3.333	0.1358
V	3.147	1.784	1.764	0.9898
W	2.045	1.890	1.082	1.0000
X	6.254	1.602	3.905	0.0210
Y	6.188	1.605	3.856	0.0251

Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-3.485	0.4300	-8.105	0.0001
D	1.299	0.4646	2.797	0.4587
E	0.210	0.4707	0.446	1.0000
F	-1.156	0.4442	-2.603	0.6153
G	-1.443	0.4536	-3.182	0.2026
H	0.510	0.4373	1.166	1.0000
I	-0.556	0.4798	-1.160	1.0000
J	-2.789	0.5836	-4.779	0.0006
K	-2.384	0.5081	-4.692	0.0008
L	-0.680	0.6054	-1.123	1.0000
M	-2.308	0.7178	-3.215	0.1862
N	-1.051	0.8219	-1.279	0.9999
O	-1.179	0.6222	-1.895	0.9752
P	0.138	0.5977	0.230	1.0000
Q	-2.549	0.6517	-3.911	0.0205
R	-1.626	0.5709	-2.849	0.4183
S	-1.972	0.5836	-3.379	0.1190
T	-1.662	0.4335	-3.833	0.0273
U	-2.055	0.4167	-4.930	0.0003
V	-4.255	0.8834	-4.817	0.0005
W	-5.358	1.0816	-4.953	0.0003
X	-1.148	0.4055	-2.831	0.4322
Y	-1.214	0.4185	-2.900	0.3795

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	4.784	0.4510	10.608	0.0001
E	3.695	0.4573	8.079	0.0001

F	2.328	0.4300	5.415	0.0001
G	2.041	0.4397	4.643	0.0010
H	3.994	0.4228	9.447	0.0001
I	2.928	0.4666	6.275	0.0001
J	0.696	0.5728	1.214	1.0000
K	1.100	0.4957	2.220	0.8750
L	2.805	0.5950	4.714	0.0007
M	1.177	0.7091	1.660	0.9955
N	2.433	0.8143	2.988	0.3172
O	2.306	0.6120	3.767	0.0345
P	3.622	0.5872	6.169	0.0001
Q	0.936	0.6420	1.457	0.9994
R	1.858	0.5598	3.319	0.1409
S	1.512	0.5728	2.640	0.5851
T	1.823	0.4189	4.352	0.0035
U	1.430	0.4015	3.562	0.0684
V	-0.771	0.8763	-0.880	1.0000
W	-1.873	1.0758	-1.741	0.9914
X	2.337	0.3898	5.994	0.0001
Y	2.271	0.4034	5.629	0.0001

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	-1.089	0.4900	-2.223	0.8733
F	-2.456	0.4646	-5.286	0.0001
G	-2.743	0.4736	-5.791	0.0001
H	-0.790	0.4580	-1.724	0.9925
I	-1.856	0.4987	-3.721	0.0404
J	-4.088	0.5992	-6.823	0.0001
K	-3.684	0.5260	-7.003	0.0001
L	-1.979	0.6205	-3.190	0.1987
M	-3.607	0.7306	-4.937	0.0003
N	-2.351	0.8331	-2.822	0.4392
O	-2.478	0.6368	-3.891	0.0220
P	-1.162	0.6130	-1.895	0.9752
Q	-3.848	0.6657	-5.781	0.0001
R	-2.926	0.5869	-4.985	0.0002
S	-3.272	0.5992	-5.460	0.0001
T	-2.961	0.4544	-6.517	0.0001
U	-3.354	0.4384	-7.651	0.0001
V	-5.555	0.8938	-6.215	0.0001
W	-6.657	1.0901	-6.106	0.0001
X	-2.447	0.4277	-5.722	0.0001
Y	-2.513	0.4401	-5.711	0.0001

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-1.366	0.4707	-2.903	0.3778
G	-1.653	0.4796	-3.447	0.0975
H	0.300	0.4642	0.646	1.0000
I	-0.767	0.5045	-1.520	0.9988
J	-2.999	0.6040	-4.965	0.0003
K	-2.594	0.5315	-4.881	0.0004
L	-0.890	0.6251	-1.423	0.9996
M	-2.518	0.7345	-3.428	0.1033
N	-1.261	0.8365	-1.508	0.9989
O	-1.389	0.6414	-2.166	0.8996

P	-0.072	0.6177	-0.117	1.0000
Q	-2.759	0.6700	-4.118	0.0093
R	-1.836	0.5917	-3.103	0.2453
S	-2.182	0.6040	-3.613	0.0581
T	-1.872	0.4607	-4.063	0.0115
U	-2.265	0.4449	-5.090	0.0002
V	-4.465	0.8970	-4.978	0.0002
W	-5.568	1.0928	-5.095	0.0002
X	-1.358	0.4344	-3.126	0.2323
Y	-1.424	0.4466	-3.189	0.1992

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	-0.287	0.4536	-0.633	1.0000
H	1.666	0.4373	3.810	0.0296
I	0.600	0.4798	1.250	1.0000
J	-1.633	0.5836	-2.798	0.4581
K	-1.228	0.5081	-2.417	0.7572
L	0.477	0.6054	0.787	1.0000
M	-1.152	0.7178	-1.604	0.9973
N	0.105	0.8219	0.128	1.0000
O	-0.023	0.6222	-0.036	1.0000
P	1.294	0.5977	2.165	0.9000
Q	-1.393	0.6517	-2.137	0.9114
R	-0.470	0.5709	-0.823	1.0000
S	-0.816	0.5836	-1.398	0.9997
T	-0.505	0.4335	-1.166	1.0000
U	-0.898	0.4167	-2.155	0.9039
V	-3.099	0.8834	-3.508	0.0811
W	-4.201	1.0816	-3.884	0.0226
X	0.008	0.4055	0.021	1.0000
Y	-0.058	0.4185	-0.138	1.0000

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	1.953	0.4469	4.371	0.0032
I	0.887	0.4885	1.815	0.9853
J	-1.346	0.5908	-2.278	0.8447
K	-0.941	0.5164	-1.822	0.9846
L	0.764	0.6123	1.247	1.0000
M	-0.864	0.7237	-1.195	1.0000
N	0.392	0.8270	0.474	1.0000
O	0.264	0.6289	0.420	1.0000
P	1.581	0.6047	2.614	0.6063
Q	-1.106	0.6581	-1.680	0.9947
R	-0.183	0.5782	-0.316	1.0000
S	-0.529	0.5908	-0.895	1.0000
T	-0.218	0.4432	-0.493	1.0000
U	-0.611	0.4267	-1.432	0.9995
V	-2.812	0.8882	-3.166	0.2107
W	-3.914	1.0855	-3.606	0.0595
X	0.295	0.4158	0.711	1.0000
Y	0.229	0.4285	0.535	1.0000

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	-1.066	0.4734	-2.252	0.8584
J	-3.299	0.5783	-5.704	0.0001
K	-2.894	0.5021	-5.764	0.0001
L	-1.189	0.6003	-1.981	0.9590
M	-2.818	0.7136	-3.949	0.0178
N	-1.561	0.8182	-1.908	0.9732
O	-1.689	0.6172	-2.736	0.5074
P	-0.372	0.5926	-0.628	1.0000
Q	-3.059	0.6470	-4.728	0.0007
R	-2.136	0.5655	-3.777	0.0333
S	-2.482	0.5783	-4.292	0.0045
T	-2.172	0.4264	-5.092	0.0002
U	-2.564	0.4093	-6.265	0.0001
V	-4.765	0.8799	-5.415	0.0001
W	-5.867	1.0788	-5.439	0.0001
X	-1.658	0.3979	-4.166	0.0076
Y	-1.724	0.4112	-4.192	0.0069

Treat = I subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
J	-2.232	0.6111	-3.653	0.0509
K	-1.828	0.5395	-3.388	0.1162
L	-0.123	0.6320	-0.195	1.0000
M	-1.751	0.7404	-2.366	0.7916
N	-0.495	0.8417	-0.588	1.0000
O	-0.622	0.6480	-0.961	1.0000
P	0.694	0.6246	1.111	1.0000
Q	-1.992	0.6764	-2.945	0.3469
R	-1.070	0.5990	-1.786	0.9880
S	-1.416	0.6111	-2.317	0.8222
T	-1.105	0.4699	-2.352	0.8004
U	-1.498	0.4545	-3.296	0.1502
V	-3.699	0.9018	-4.102	0.0099
W	-4.801	1.0967	-4.378	0.0032
X	-0.591	0.4442	-1.331	0.9999
Y	-0.657	0.4561	-1.441	0.9995

Treat = J subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
K	0.405	0.6336	0.639	1.0000
L	2.109	0.7139	2.954	0.3405
M	0.481	0.8115	0.593	1.0000
N	1.738	0.9048	1.920	0.9711
O	1.610	0.7282	2.211	0.8792
P	2.927	0.7074	4.137	0.0086
Q	0.240	0.7536	0.318	1.0000
R	1.163	0.6849	1.698	0.9939
S	0.817	0.6955	1.174	1.0000
T	1.127	0.5755	1.959	0.9638
U	0.734	0.5629	1.305	0.9999
V	-1.466	0.9610	-1.526	0.9987
W	-2.569	1.1459	-2.241	0.8640
X	1.641	0.5547	2.959	0.3376
Y	1.575	0.5643	2.791	0.4632

Treat = K subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
L	1.705	0.6537	2.608	0.6117
M	0.076	0.7590	0.101	1.0000
N	1.333	0.8581	1.553	0.9983
O	1.205	0.6693	1.801	0.9867
P	2.522	0.6466	3.900	0.0214
Q	-0.165	0.6968	-0.236	1.0000
R	0.758	0.6219	1.219	1.0000
S	0.412	0.6336	0.650	1.0000
T	0.723	0.4988	1.449	0.9994
U	0.330	0.4843	0.681	1.0000
V	-1.871	0.9172	-2.040	0.9441
W	-2.973	1.1094	-2.680	0.5529
X	1.236	0.4747	2.605	0.6140
Y	1.170	0.4859	2.409	0.7626

Treat = L subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
M	-1.628	0.8273	-1.968	0.9619
N	-0.372	0.9190	-0.404	1.0000
O	-0.499	0.7458	-0.669	1.0000
P	0.817	0.7255	1.126	1.0000
Q	-1.869	0.7706	-2.426	0.7508
R	-0.947	0.7036	-1.345	0.9998
S	-1.293	0.7139	-1.810	0.9858
T	-0.982	0.5976	-1.643	0.9961
U	-1.375	0.5855	-2.348	0.8027
V	-3.576	0.9744	-3.669	0.0482
W	-4.678	1.1572	-4.042	0.0124
X	-0.468	0.5776	-0.811	1.0000
Y	-0.534	0.5868	-0.911	1.0000

Treat = M subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
N	1.257	0.9967	1.261	0.9999
O	1.129	0.8396	1.344	0.9998
P	2.445	0.8217	2.976	0.3256
Q	-0.241	0.8618	-0.280	1.0000
R	0.682	0.8024	0.849	1.0000
S	0.336	0.8115	0.414	1.0000
T	0.646	0.7112	0.908	1.0000
U	0.253	0.7011	0.361	1.0000
V	-1.947	1.0480	-1.858	0.9804
W	-3.050	1.2198	-2.500	0.6961
X	1.160	0.6945	1.670	0.9951
Y	1.094	0.7022	1.558	0.9982

Treat = N subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
O	-0.128	0.9302	-0.137	1.0000

P	1.189	0.9140	1.301	0.9999
Q	-1.498	0.9502	-1.576	0.9979
R	-0.575	0.8967	-0.641	1.0000
S	-0.921	0.9048	-1.018	1.0000
T	-0.610	0.8161	-0.748	1.0000
U	-1.003	0.8073	-1.243	1.0000
V	-3.204	1.1218	-2.856	0.4126
W	-4.306	1.2838	-3.354	0.1278
X	-0.097	0.8016	-0.121	1.0000
Y	-0.163	0.8083	-0.201	1.0000

Treat = O subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
P	1.317	0.7396	1.780	0.9885
Q	-1.370	0.7839	-1.748	0.9910
R	-0.447	0.7181	-0.623	1.0000
S	-0.793	0.7282	-1.089	1.0000
T	-0.483	0.6146	-0.786	1.0000
U	-0.876	0.6028	-1.452	0.9994
V	-3.076	0.9849	-3.123	0.2338
W	-4.179	1.1660	-3.584	0.0639
X	0.031	0.5951	0.052	1.0000
Y	-0.035	0.6041	-0.058	1.0000

Treat = P subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Q	-2.687	0.7646	-3.514	0.0797
R	-1.764	0.6970	-2.531	0.6728
S	-2.110	0.7074	-2.982	0.3214
T	-1.799	0.5898	-3.051	0.2768
U	-2.192	0.5775	-3.796	0.0312
V	-4.393	0.9697	-4.530	0.0016
W	-5.495	1.1532	-4.765	0.0006
X	-1.285	0.5695	-2.257	0.8558
Y	-1.352	0.5789	-2.335	0.8111

Treat = Q subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
R	0.923	0.7438	1.241	1.0000
S	0.577	0.7536	0.765	1.0000
T	0.887	0.6444	1.377	0.9998
U	0.494	0.6333	0.781	1.0000
V	-1.706	1.0039	-1.700	0.9938
W	-2.809	1.1821	-2.376	0.7847
X	1.401	0.6259	2.238	0.8657
Y	1.335	0.6345	2.104	0.9236

Treat = R subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
S	-0.346	0.6849	-0.505	1.0000
T	-0.035	0.5626	-0.063	1.0000

U	-0.428	0.5497	-0.779	1.0000
V	-2.629	0.9534	-2.758	0.4900
W	-3.731	1.1395	-3.274	0.1593
X	0.478	0.5413	0.884	1.0000
Y	0.412	0.5511	0.748	1.0000

Treat = S subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
T	0.310	0.5755	0.540	1.0000
U	-0.082	0.5629	-0.146	1.0000
V	-2.283	0.9610	-2.376	0.7849
W	-3.385	1.1459	-2.954	0.3406
X	0.824	0.5547	1.486	0.9991
Y	0.758	0.5643	1.344	0.9998

Treat = T subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
U	-0.393	0.4053	-0.969	1.0000
V	-2.594	0.8780	-2.954	0.3409
W	-3.696	1.0773	-3.431	0.1025
X	0.514	0.3938	1.305	0.9999
Y	0.448	0.4072	1.100	1.0000

Treat = U subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
V	-2.201	0.8699	-2.530	0.6732
W	-3.303	1.0706	-3.085	0.2559
X	0.907	0.3752	2.417	0.7572
Y	0.841	0.3892	2.160	0.9022

Treat = V subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
W	-1.102	1.3240	-0.8325	1.0000
X	3.107	0.8646	3.5942	0.0617
Y	3.041	0.8708	3.4928	0.0850

Treat = W subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
X	4.210	1.066	3.948	0.0179
Y	4.144	1.071	3.868	0.0241

Treat = X subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Y	-0.06605	0.3772	-0.1751	1.000

Species: Douglas-fir

General Linear Model: TH - 15YR versus Treat

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Factor  Type   Levels  Values
Treat   fixed      23  A, B, C, D, E, F, G, H, I, J, K, L, M, O, P, Q, S, T, U,
                       V, W, X, Y


Analysis of Variance for TH - 15YR, using Adjusted SS for Tests

Source   DF   Seq SS   Adj SS  Adj MS      F      P
Treat    22  3389505  3389505  154068  15.82  0.000
Error   467  4548773  4548773    9740
Total   489  7938278


S = 98.6935   R-Sq = 42.70%   R-Sq(adj) = 40.00%


Unusual Observations for TH - 15YR

Obs  TH - 15YR      Fit  SE Fit  Residual  St Resid
  1    324.600  144.043  37.303   180.557      1.98 X
  2    200.900  144.043  37.303    56.857      0.62 X
  3     32.000  144.043  37.303  -112.043     -1.23 X
  4    210.300  144.043  37.303    66.257      0.73 X
  5     37.500  144.043  37.303  -106.543     -1.17 X
  6     89.500  144.043  37.303   -54.543     -0.60 X
  7    113.500  144.043  37.303   -30.543     -0.33 X
 26    557.700  311.442  16.449   246.258      2.53 R
 27    522.000  311.442  16.449   210.558      2.16 R
 29    515.500  311.442  16.449   204.058      2.10 R
 61    388.000  182.800  22.069   205.200      2.13 R
122     46.000  257.736  18.651  -211.736     -2.18 R
129     63.000  257.736  18.651  -194.736     -2.01 R
132    462.200  257.736  18.651   204.464      2.11 R
137    473.500  257.736  18.651   215.764      2.23 R
142     55.000  257.736  18.651  -202.736     -2.09 R
147    476.300  257.736  18.651   218.564      2.26 R
152    519.100  309.809  16.682   209.291      2.15 R
159     75.500  309.809  16.682  -234.309     -2.41 R
161     24.400  309.809  16.682  -285.409     -2.93 R
164     94.800  309.809  16.682  -215.009     -2.21 R
184    173.100  385.725  17.447  -212.625     -2.19 R
185    179.800  385.725  17.447  -205.925     -2.12 R
187    133.500  385.725  17.447  -252.225     -2.60 R
203    603.400  385.725  17.447   217.675      2.24 R
220    162.300  415.705  16.225  -253.405     -2.60 R
265    503.600  267.408  27.373   236.192      2.49 R
266     59.000  267.408  27.373  -208.408     -2.20 R
286    261.400  389.700  44.137  -128.300     -1.45 X
287    393.400  389.700  44.137     3.700      0.04 X
288    463.300  389.700  44.137    73.600      0.83 X
289    395.200  389.700  44.137     5.500      0.06 X
290    435.200  389.700  44.137    45.500      0.52 X
291    512.900  432.950  69.787    79.950      1.15 X
292    353.000  432.950  69.787   -79.950     -1.15 X
311    330.800  305.033  56.981    25.767      0.32 X
312    223.500  305.033  56.981   -81.533     -1.01 X
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313    360.800  305.033  56.981    55.767      0.69 X
334    145.500  370.578  14.552  -225.078     -2.31 R
379     62.000  334.785  14.396  -272.785     -2.79 R
411    273.700   81.071  26.377   192.629      2.03 R
422    270.200  270.200  98.694     0.000         * X

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.


Grouping Information Using Tukey Method and 95.0% Confidence

Treat   N    Mean  Grouping
D      31  484.63  A
E      25  441.76  A B
O       2  432.95  A B C D E F G H I J K L M N O P Q
I      37  415.71  A B C
Q       9  390.10  A B C   E   G     J         O P Q
M       5  389.70  A B C   E   G     J         O P Q
H      32  385.73    B C   E   G     J         O P Q
P       9  384.98  A B C   E   G     J         O P Q
T      46  370.58    B C   E   G     J         O P Q
Y      39  357.97    B C   E   G     J         O P Q
J      10  340.75    B C   E   G     J         O P Q
X      31  336.05      C   E   G     J         O P Q
U      47  334.79                                Q
B      36  311.44                              P Q
G      35  309.81                            O P Q
S       3  305.03  A B C D E F G H I J K L M N O P Q R S
L      10  272.23                  J K L M N O P Q R
W       1  270.20  A B C D E F G H I J K L M N O P Q R S
K      13  267.41              G H I J     M N O P Q R
F      28  257.74          E F G   I J   L   N O P Q R
C      20  182.80        D   F   H I   K L M N       R S
A       7  144.04                                    R S
V      14   81.07                                      S

Means that do not share a letter are significantly different.


Tukey 95.0% Simultaneous Confidence Intervals
Response Variable TH - 15YR
All Pairwise Comparisons among Levels of Treat
Treat = A  subtracted from:

Treat   Lower  Center  Upper  --------+---------+---------+--------
B        20.1  167.40  314.7                    (---*---)
C      -117.9   38.76  195.4                (---*----)
D       191.4  340.59  489.8                        (----*---)
E       145.2  297.72  450.2                       (----*---)
F       -37.0  113.69  264.4                  (---*----)
G        18.1  165.77  313.4                    (---*---)
H        92.9  241.68  390.5                      (---*---)
I       124.7  271.66  418.6                       (---*---)
J        21.0  196.71  372.4                    (----*----)
K       -43.8  123.36  290.5                   (----*---)
L       -47.6  128.19  303.9                   (----*----)
M        36.8  245.66  454.5                     (-----*-----)
O         3.0  288.91  574.8                   (-------*-------)
P        61.2  240.93  420.6                      (----*----)
Q        66.3  246.06  425.8                      (----*----)
S       -85.1  160.99  407.1                 (------*------)
T        81.9  226.54  371.2                     (---*----)
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U        46.3  190.74  335.2                    (---*----)
V      -228.1  -62.97  102.1             (----*----)
W      -255.1  126.16  507.4             (----------*---------)
X        42.8  192.01  341.2                    (---*----)
Y        67.5  213.93  360.3                     (---*---)
                                 --------+---------+---------+--------
                                      -350         0       350
```

Treat = B subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
C      -228.1  -128.6   -29.2            (--*--)
D        85.8   173.2   260.6                    (--*-)
E        37.5   130.3   223.2                   (--*-)
F      -143.6   -53.7    36.2               (-*--)
G       -86.3    -1.6    83.0                 (-*-)
H       -12.4    74.3   160.9                  (-*--)
I        20.8   104.3   187.7                   (-*-)
J       -98.2    29.3   156.8                (---*--)
K      -159.4   -44.0    71.4              (---*--)
L      -166.7   -39.2    88.3              (---*---)
M       -91.9    78.3   248.5                (----*----)
O      -137.6   121.5   380.6               (------*-------)
P       -59.4    73.5   206.4                  (---*---)
Q       -54.2    78.7   211.6                  (---*---)
S      -220.7    -6.4   207.9             (-----*-----)
T       -20.2    59.1   138.5                   (--*-)
U       -55.6    23.3   102.3                  (--*-)
V      -342.7  -230.4  -118.0         (--*---)
W      -402.8   -41.2   320.3       (----------*---------)
X       -62.8    24.6   112.0                  (--*-)
Y       -35.9    46.5   128.9                   (-*--)
                                 --------+---------+---------+--------
                                      -350         0       350
```

Treat = C subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
D       199.6   301.8  404.11                         (--*--)
E       152.0   259.0  365.95                       (--*--)
F       -29.5    74.9  179.34                  (--*--)
G        27.0   127.0  226.97                    (--*-)
H       101.3   202.9  304.57                      (--*--)
I       133.9   232.9  331.88                      (--*-)
J        19.8   157.9  296.06                    (---*--)
K       -42.4    84.6  211.65                  (--*---)
L       -48.7    89.4  227.54                  (---*---)
M        28.6   206.9  385.21                    (----*----)
O       -14.3   250.1  514.62                   (------*-------)
P        59.0   202.2  345.32                     (---*---)
Q        64.2   207.3  350.44                     (---*---)
S       -98.6   122.2  343.03                (-----*------)
T        92.3   187.8  283.29                      (-*--)
U        56.8   152.0  247.19                     (-*--)
V      -226.0  -101.7   22.54              (--*---)
W      -278.0    87.4  452.82            (---------*----------)
X        51.0   153.2  255.53                     (--*--)
Y        77.1   175.2  273.25                      (--*--)
                                 --------+---------+---------+--------
                                      -350         0       350
```

```
Treat = D  subtracted from:

Treat   Lower  Center   Upper  --------+---------+---------+--------
E      -138.7   -42.9    53.0              (--*--)
F      -319.9  -226.9  -133.9          (--*-)
G      -262.8  -174.8   -86.9           (--*--)
H      -188.8   -98.9    -9.0              (-*--)
I      -155.8   -68.9    17.9              (-*--)
J      -273.6  -143.9   -14.2           (---*---)
K      -335.1  -217.2   -99.4         (---*--)
L      -342.1  -212.4   -82.7         (---*---)
M      -266.8   -94.9    76.9           (----*----)
O      -311.9   -51.7   208.5          (-------*------)
P      -234.7   -99.7    35.4           (---*---)
Q      -229.6   -94.5    40.5           (---*---)
S      -395.2  -179.6    36.0        (-----*-----)
T      -196.9  -114.1   -31.2            (--*-)
U      -232.4  -149.8   -67.3           (--*-)
V      -518.4  -403.6  -288.7     (--*---)
W      -576.7  -214.4   147.9    (---------*---------)
X      -239.2  -148.6   -58.0            (--*-)
Y      -212.5  -126.7   -40.9             (-*--)
                                --------+---------+---------+--------
                                     -350         0       350

Treat = E  subtracted from:

Treat   Lower  Center   Upper  --------+---------+---------+--------
F      -282.2  -184.0   -85.9           (--*--)
G      -225.3  -132.0   -38.6             (-*--)
H      -151.2   -56.0    39.2               (-*--)
I      -118.4   -26.1    66.3                (-*--)
J      -234.4  -101.0    32.4           (---*---)
K      -296.3  -174.4   -52.4           (--*---)
L      -303.0  -169.5   -36.1          (---*---)
M      -226.8   -52.1   122.6             (----*----)
O      -270.9    -8.8   253.2           (-------*------)
P      -195.4   -56.8    81.8             (---*---)
Q      -190.3   -51.7    87.0              (---*--)
S      -354.6  -136.7    81.2         (-----*-----)
T      -159.8   -71.2    17.4              (--*-)
U      -195.3  -107.0   -18.7             (--*-)
V      -479.7  -360.7  -241.7      (---*--)
W      -535.2  -171.6   192.1    (---------*---------)
X      -201.6  -105.7    -9.9             (--*--)
Y      -175.2   -83.8     7.6              (--*-)
                                --------+---------+---------+--------
                                     -350         0       350

Treat = F  subtracted from:

Treat   Lower  Center   Upper  --------+---------+---------+--------
G       -38.3    52.1  142.49                  (-*--)
H        35.7   128.0  220.27                    (--*-)
I        68.6   158.0  247.29                     (--*-)
J       -48.4    83.0  214.39                  (--*---)
K      -110.0     9.7  129.36                (--*---)
L      -116.9    14.5  145.87                (--*---)
M       -41.2   132.0  305.10                  (----*----)
O       -85.8   175.2  436.23                 (------*------)
```

```
P        -9.4   127.2  263.89                   (---*---)
Q        -4.3   132.4  269.01                   (---*---)
S      -169.3    47.3  263.94              (-----*------)
T        27.4   112.8  198.32                    (-*--)
U        -8.1    77.0  162.18                   (-*--)
V      -293.4  -176.7  -59.94           (--*--)
W      -350.5    12.5  375.39         (---------*----------)
X       -14.7    78.3  171.29                   (-*--)
Y        11.9   100.2  188.57                   (--*-)
                                --------+---------+---------+--------
                                     -350         0       350
```

Treat = G subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
H       -11.3   75.9   163.1                    (-*--)
I        21.8  105.9   190.0                     (-*-)
J       -96.9   30.9   158.8                (---*---)
K      -158.2  -42.4    73.4              (---*--)
L      -165.4  -37.6    90.3              (---*---)
M       -90.6   79.9   250.4                (----*----)
O      -136.1  123.1   382.4               (-------*------)
P       -58.1   75.2   208.4                 (---*---)
Q       -53.0   80.3   213.6                 (---*---)
S      -219.3   -4.8   209.8              (-----*-----)
T       -19.2   60.8   140.8                   (--*-)
U       -54.6   25.0   104.6                 (--*-)
V      -341.5  -228.7  -116.0         (--*---)
W      -401.3   -39.6   322.1        (---------*---------)
X       -61.7   26.2   114.2                 (--*-)
Y       -34.9   48.2   131.2                  (-*--)
                                --------+---------+---------+--------
                                     -350         0       350
```

Treat = H subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
I       -56.1   30.0   116.1                   (--*-)
J      -174.2  -45.0    84.2                (---*--)
K      -235.6  -118.3   -1.0             (---*--)
L      -242.7  -113.5   15.7             (---*--)
M      -167.5    4.0   175.5               (----*----)
O      -212.7   47.2   307.1              (------*-------)
P      -135.3   -0.7   133.8                (---*---)
Q      -130.2    4.4   138.9                (---*---)
S      -296.0  -80.7   134.6            (-----*-----)
T       -97.2  -15.1    66.9                 (--*-)
U      -132.7  -50.9    30.8               (--*-)
V      -418.9  -304.7  -190.4        (--*---)
W      -477.7  -115.5   246.6     (----------*---------)
X      -139.5   -49.7    40.2               (--*-)
Y      -112.8   -27.8    57.3                (-*--)
                                --------+---------+---------+--------
                                     -350         0       350
```

Treat = I subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
J      -202.1  -75.0    52.1              (---*--)
K      -263.3  -148.3   -33.3           (---*--)
```

```
L      -270.6  -143.5   -16.4           (---*---)
M      -195.9   -26.0   143.9             (----*----)
O      -241.6    17.2   276.1            (------*-------)
P      -163.3   -30.7   101.8              (---*---)
Q      -158.1   -25.6   106.9              (---*---)
S      -324.7  -110.7   103.4          (-----*-----)
T      -123.9   -45.1    33.6              (--*-)
U      -159.3   -80.9    -2.5              (--*-)
V      -446.5  -334.6  -222.7       (--*---)
W      -506.9  -145.5   215.9      (---------*---------)
X      -166.5   -79.7     7.2              (--*-)
Y      -139.6   -57.7    24.1               (-*--)
                                --------+---------+---------+--------
                                     -350         0       350
```

Treat = J subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
K      -223.3   -73.3    76.7             (---*---)
L      -228.0   -68.5    91.0            (----*----)
M      -146.4    49.0   244.3               (----*-----)
O      -184.0    92.2   368.4              (-------*-------)
P      -119.6    44.2   208.1                (---*----)
Q      -114.5    49.4   213.2                (---*----)
S      -270.5   -35.7   199.0           (------*------)
T       -94.6    29.8   154.3                (---*--)
U      -130.2    -6.0   118.2               (---*--)
V      -407.3  -259.7  -112.0       (----*---)
W      -444.6   -70.6   303.5      (----------*----------)
X      -134.4    -4.7   125.0               (---*---)
Y      -109.2    17.2   143.6                (--*---)
                                --------+---------+---------+--------
                                     -350         0       350
```

Treat = K subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
L      -145.2     4.8  154.82              (---*---)
M       -65.4   122.3  309.95                (----*-----)
O      -105.3   165.5  436.41               (-------*------)
P       -37.1   117.6  272.21                 (---*----)
Q       -31.9   122.7  277.33                 (----*---)
S      -190.8    37.6  266.04              (-----*------)
T        -8.8   103.2  215.18                  (--*--)
U       -44.4    67.4  179.13                 (--*--)
V      -323.7  -186.3  -48.98          (---*---)
W      -367.3     2.8  372.86         (---------*----------)
X       -49.2    68.6  186.47                 (--*--)
Y       -23.6    90.6  204.77                 (---*--)
                                --------+---------+---------+--------
                                     -350         0       350
```

Treat = L subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
M       -77.9   117.5  312.79                (----*-----)
O      -115.5   160.7  436.95               (-------*------)
P       -51.1   112.7  276.60                 (---*----)
Q       -46.0   117.9  281.72                 (---*----)
S      -201.9    32.8  267.55             (------*------)
```

```
T       -26.1    98.3  222.77                  (---*--)
U       -61.6    62.6  186.74                 (---*--)
V      -338.8  -191.2  -43.51          (----*---)
W      -376.0    -2.0  371.99         (----------*----------)
X       -65.9    63.8  193.51                  (---*---)
Y       -40.7    85.7  212.14                   (--*---)
                              --------+---------+---------+--------
                                   -350         0       350
```

Treat = M subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
O      -255.1    43.2   341.6            (-------*--------)
P      -203.6    -4.7   194.2             (-----*-----)
Q      -198.5     0.4   199.3             (-----*-----)
S      -345.1   -84.7   175.8          (-------*------)
T      -187.0   -19.1   148.8               (---*----)
U      -222.7   -54.9   112.8             (---*----)
V      -494.4  -308.6  -122.8      (----*----)
W      -510.1  -119.5   271.1     (-----------*----------)
X      -225.5   -53.7   118.2             (---*----)
Y      -201.1   -31.7   137.7             (----*----)
                              --------+---------+---------+--------
                                   -350         0       350
```

Treat = O subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
P      -326.7   -48.0  230.80           (-------*-------)
Q      -321.6   -42.8  235.93           (-------*-------)
S      -453.5  -127.9  197.62       (--------*--------)
T      -320.0   -62.4  195.21           (------*-------)
U      -355.6   -98.2  159.31         (------*-------)
V      -621.5  -351.9  -82.31  (-------*-------)
W      -599.5  -162.7  274.01   (-----------*------------)
X      -357.1   -96.9  163.27         (------*-------)
Y      -333.5   -75.0  183.57         (-------*------)
                              --------+---------+---------+--------
                                   -350         0       350
```

Treat = P subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
Q      -163.0     5.1   173.2              (----*----)
S      -317.7   -79.9   157.8           (------*------)
T      -144.4   -14.4   115.6               (---*--)
U      -179.9   -50.2    79.6              (---*--)
V      -456.3  -303.9  -151.5       (---*----)
W      -490.7  -114.8   261.1     (----------*---------)
X      -184.0   -48.9    86.1              (---*--)
Y      -158.9   -27.0   104.9              (---*---)
                              --------+---------+---------+--------
                                   -350         0       350
```

Treat = Q subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
S      -322.8   -85.1   152.7           (------*-----)
T      -149.5   -19.5   110.5                (--*---)
```

```
U      -185.1   -55.3    74.4              (--*---)
V      -461.4  -309.0  -156.7       (---*----)
W      -495.8  -119.9   256.0      (----------*---------)
X      -189.1   -54.1    81.0              (--*---)
Y      -164.0   -32.1    99.7              (---*---)
                                --------+---------+---------+--------
                                     -350         0       350
```

Treat = S subtracted from:

```
Treat   Lower  Center    Upper  --------+---------+---------+--------
T      -147.0    65.5  278.042               (-----*-----)
U      -182.6    29.8  242.110              (-----*-----)
V      -450.8  -224.0    2.917       (------*-----)
W      -446.6   -34.8  376.945       (-----------*-----------)
X      -184.6    31.0  246.637              (-----*-----)
Y      -160.7    52.9  266.597              (------*-----)
                                 --------+---------+---------+--------
                                      -350         0       350
```

Treat = T subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
U      -109.8   -35.8    38.2               (-*-)
V      -398.4  -289.5  -180.7         (--*--)
W      -460.8  -100.4   260.1       (---------*---------)
X      -117.4   -34.5    48.3               (-*-)
Y       -90.2   -12.6    65.0               (--*-)
                                --------+---------+---------+--------
                                     -350         0       350
```

Treat = U subtracted from:

```
Treat   Lower  Center   Upper  --------+---------+---------+--------
V      -362.3  -253.7  -145.1         (--*--)
W      -425.0   -64.6   295.8       (---------*---------)
X       -81.2     1.3    83.8                (-*-)
Y       -54.1    23.2   100.4                (--*-)
                                --------+---------+---------+--------
                                     -350         0       350
```

Treat = V subtracted from:

```
Treat   Lower  Center  Upper  --------+---------+---------+--------
W      -180.0   189.1  558.3             (---------*----------)
X       140.1   255.0  369.8                      (--*---)
Y       165.8   276.9  388.0                       (--*--)
                                --------+---------+---------+--------
                                     -350         0       350
```

Treat = W subtracted from:

```
Treat   Lower  Center  Upper  --------+---------+---------+--------
X      -296.5   65.85  428.2           (---------*---------)
Y      -273.4   87.77  448.9           (----------*---------)
                                --------+---------+---------+--------
                                     -350         0       350
```

Treat = X subtracted from:

```
Treat   Lower  Center  Upper  --------+---------+---------+--------
Y      -63.89   21.92  107.7                  (--*-)
                          --------+---------+---------+--------
                               -350         0       350
```

Tukey Simultaneous Tests
Response Variable TH - 15YR
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
B	167.40	40.77	4.106	0.0083
C	38.76	43.34	0.894	1.0000
D	340.59	41.30	8.247	0.0001
E	297.72	42.20	7.054	0.0001
F	113.69	41.71	2.726	0.4745
G	165.77	40.86	4.057	0.0101
H	241.68	41.18	5.869	0.0001
I	271.66	40.68	6.678	0.0001
J	196.71	48.64	4.044	0.0106
K	123.36	46.27	2.666	0.5221
L	128.19	48.64	2.636	0.5468
M	245.66	57.79	4.251	0.0046
O	288.91	79.13	3.651	0.0445
P	240.93	49.74	4.844	0.0004
Q	246.06	49.74	4.947	0.0002
S	160.99	68.11	2.364	0.7556
T	226.54	40.04	5.658	0.0001
U	190.74	39.98	4.770	0.0005
V	-62.97	45.69	-1.378	0.9995
W	126.16	105.51	1.196	0.9999
X	192.01	41.30	4.649	0.0008
Y	213.93	40.51	5.281	0.0001

Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-128.6	27.52	-4.674	0.0007
D	173.2	24.18	7.162	0.0001
E	130.3	25.69	5.072	0.0002
F	-53.7	24.87	-2.160	0.8763
G	-1.6	23.43	-0.070	1.0000
H	74.3	23.98	3.098	0.2219
I	104.3	23.10	4.513	0.0015
J	29.3	35.28	0.831	1.0000
K	-44.0	31.93	-1.379	0.9995
L	-39.2	35.28	-1.111	1.0000
M	78.3	47.10	1.661	0.9925
O	121.5	71.70	1.695	0.9903
P	73.5	36.78	1.999	0.9386
Q	78.7	36.78	2.139	0.8861
S	-6.4	59.31	-0.108	1.0000
T	59.1	21.96	2.693	0.5009
U	23.3	21.86	1.068	1.0000
V	-230.4	31.09	-7.411	0.0001
W	-41.2	100.05	-0.412	1.0000

X	24.6	24.18	1.018	1.0000
Y	46.5	22.81	2.040	0.9256

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	301.8	28.31	10.663	0.0001
E	259.0	29.61	8.746	0.0001
F	74.9	28.89	2.593	0.5808
G	127.0	27.66	4.591	0.0011
H	202.9	28.13	7.213	0.0001
I	232.9	27.39	8.503	0.0001
J	157.9	38.22	4.132	0.0075
K	84.6	35.16	2.406	0.7255
L	89.4	38.22	2.340	0.7721
M	206.9	49.35	4.193	0.0059
O	250.1	73.19	3.418	0.0934
P	202.2	39.61	5.104	0.0001
Q	207.3	39.61	5.233	0.0001
S	122.2	61.11	2.000	0.9383
T	187.8	26.43	7.104	0.0001
U	152.0	26.35	5.768	0.0001
V	-101.7	34.39	-2.958	0.3052
W	87.4	101.13	0.864	1.0000
X	153.2	28.31	5.414	0.0001
Y	175.2	27.14	6.453	0.0001

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	-42.9	26.53	-1.62	0.9948
F	-226.9	25.73	-8.82	0.0001
G	-174.8	24.34	-7.18	0.0001
H	-98.9	24.87	-3.98	0.0138
I	-68.9	24.03	-2.87	0.3667
J	-143.9	35.89	-4.01	0.0122
K	-217.2	32.61	-6.66	0.0001
L	-212.4	35.89	-5.92	0.0001
M	-94.9	47.56	-2.00	0.9396
O	-51.7	72.00	-0.72	1.0000
P	-99.7	37.37	-2.67	0.5218
Q	-94.5	37.37	-2.53	0.6316
S	-179.6	59.67	-3.01	0.2726
T	-114.1	22.93	-4.97	0.0002
U	-149.8	22.84	-6.56	0.0001
V	-403.6	31.78	-12.70	0.0001
W	-214.4	100.27	-2.14	0.8862
X	-148.6	25.07	-5.93	0.0001
Y	-126.7	23.75	-5.33	0.0001

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-184.0	27.16	-6.78	0.0001
G	-132.0	25.84	-5.11	0.0001
H	-56.0	26.34	-2.13	0.8912
I	-26.1	25.55	-1.02	1.0000

J	-101.0	36.93	-2.74	0.4671
K	-174.4	33.75	-5.17	0.0001
L	-169.5	36.93	-4.59	0.0011
M	-52.1	48.35	-1.08	1.0000
O	-8.8	72.52	-0.12	1.0000
P	-56.8	38.37	-1.48	0.9984
Q	-51.7	38.37	-1.35	0.9996
S	-136.7	60.30	-2.27	0.8180
T	-71.2	24.52	-2.90	0.3424
U	-107.0	24.43	-4.38	0.0027
V	-360.7	32.94	-10.95	0.0001
W	-171.6	100.65	-1.70	0.9896
X	-105.7	26.53	-3.98	0.0133
Y	-83.8	25.29	-3.31	0.1262

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	52.1	25.02	2.081	0.9105
H	128.0	25.54	5.011	0.0002
I	158.0	24.72	6.390	0.0001
J	83.0	36.36	2.283	0.8084
K	9.7	33.12	0.292	1.0000
L	14.5	36.36	0.399	1.0000
M	132.0	47.92	2.754	0.4525
O	175.2	72.24	2.426	0.7114
P	127.2	37.82	3.365	0.1092
Q	132.4	37.82	3.500	0.0726
S	47.3	59.96	0.789	1.0000
T	112.8	23.66	4.770	0.0005
U	77.0	23.56	3.270	0.1424
V	-176.7	32.31	-5.469	0.0001
W	12.5	100.44	0.124	1.0000
X	78.3	25.73	3.044	0.2524
Y	100.2	24.45	4.100	0.0085

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	75.9	24.14	3.145	0.1977
I	105.9	23.27	4.551	0.0013
J	30.9	35.39	0.874	1.0000
K	-42.4	32.06	-1.323	0.9997
L	-37.6	35.39	-1.062	1.0000
M	79.9	47.18	1.693	0.9904
O	123.1	71.75	1.716	0.9887
P	75.2	36.89	2.038	0.9262
Q	80.3	36.89	2.177	0.8679
S	-4.8	59.37	-0.080	1.0000
T	60.8	22.14	2.745	0.4594
U	25.0	22.03	1.133	1.0000
V	-228.7	31.21	-7.329	0.0001
W	-39.6	100.09	-0.396	1.0000
X	26.2	24.34	1.078	1.0000
Y	48.2	22.98	2.096	0.9046

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	30.0	23.83	1.258	0.9999
J	-45.0	35.76	-1.258	0.9999
K	-118.3	32.46	-3.645	0.0454
L	-113.5	35.76	-3.174	0.1836
M	4.0	47.46	0.084	1.0000
O	47.2	71.93	0.656	1.0000
P	-0.7	37.24	-0.020	1.0000
Q	4.4	37.24	0.117	1.0000
S	-80.7	59.59	-1.354	0.9996
T	-15.1	22.72	-0.667	1.0000
U	-50.9	22.62	-2.252	0.8271
V	-304.7	31.62	-9.633	0.0001
W	-115.5	100.22	-1.153	1.0000
X	-49.7	24.87	-1.997	0.9392
Y	-27.8	23.54	-1.179	1.0000

Treat = I subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
J	-75.0	35.18	-2.13	0.8896
K	-148.3	31.82	-4.66	0.0008
L	-143.5	35.18	-4.08	0.0093
M	-26.0	47.02	-0.55	1.0000
O	17.2	71.65	0.24	1.0000
P	-30.7	36.68	-0.84	1.0000
Q	-25.6	36.68	-0.70	1.0000
S	-110.7	59.25	-1.87	0.9696
T	-45.1	21.79	-2.07	0.9145
U	-80.9	21.69	-3.73	0.0339
V	-334.6	30.97	-10.81	0.0001
W	-145.5	100.02	-1.45	0.9988
X	-79.7	24.03	-3.31	0.1258
Y	-57.7	22.65	-2.55	0.6162

Treat = J subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
K	-73.3	41.51	-1.767	0.9839
L	-68.5	44.14	-1.552	0.9970
M	49.0	54.06	0.906	1.0000
O	92.2	76.45	1.206	0.9999
P	44.2	45.35	0.975	1.0000
Q	49.4	45.35	1.088	1.0000
S	-35.7	64.97	-0.550	1.0000
T	29.8	34.44	0.866	1.0000
U	-6.0	34.37	-0.174	1.0000
V	-259.7	40.86	-6.355	0.0001
W	-70.6	103.51	-0.682	1.0000
X	-4.7	35.89	-0.131	1.0000
Y	17.2	34.98	0.492	1.0000

Treat = K subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
L	4.8	41.51	0.116	1.0000

M	122.3	51.94	2.355	0.7619
O	165.5	74.96	2.208	0.8516
P	117.6	42.80	2.747	0.4579
Q	122.7	42.80	2.867	0.3678
S	37.6	63.21	0.595	1.0000
T	103.2	31.00	3.328	0.1213
U	67.4	30.93	2.179	0.8670
V	-186.3	38.01	-4.902	0.0003
W	2.8	102.42	0.027	1.0000
X	68.6	32.61	2.105	0.9008
Y	90.6	31.61	2.865	0.3690

Treat = L subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
M	117.5	54.06	2.173	0.8697
O	160.7	76.45	2.102	0.9019
P	112.7	45.35	2.486	0.6655
Q	117.9	45.35	2.599	0.5760
S	32.8	64.97	0.505	1.0000
T	98.3	34.44	2.856	0.3756
U	62.6	34.37	1.820	0.9773
V	-191.2	40.86	-4.678	0.0007
W	-2.0	103.51	-0.020	1.0000
X	63.8	35.89	1.778	0.9827
Y	85.7	34.98	2.451	0.6926

Treat = M subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
O	43.2	82.57	0.524	1.0000
P	-4.7	55.05	-0.086	1.0000
Q	0.4	55.05	0.007	1.0000
S	-84.7	72.08	-1.175	1.0000
T	-19.1	46.47	-0.411	1.0000
U	-54.9	46.43	-1.183	1.0000
V	-308.6	51.42	-6.002	0.0001
W	-119.5	108.11	-1.105	1.0000
X	-53.7	47.56	-1.128	1.0000
Y	-31.7	46.88	-0.677	1.0000

Treat = O subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
P	-48.0	77.15	-0.622	1.0000
Q	-42.8	77.15	-0.555	1.0000
S	-127.9	90.09	-1.420	0.9992
T	-62.4	71.29	-0.875	1.0000
U	-98.2	71.26	-1.378	0.9995
V	-351.9	74.61	-4.717	0.0006
W	-162.7	120.87	-1.346	0.9996
X	-96.9	72.00	-1.346	0.9996
Y	-75.0	71.55	-1.048	1.0000

Treat = P subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Q	5.1	46.52	0.110	1.0000
S	-79.9	65.80	-1.215	0.9999
T	-14.4	35.97	-0.400	1.0000
U	-50.2	35.91	-1.398	0.9993
V	-303.9	42.17	-7.207	0.0001
W	-114.8	104.03	-1.103	1.0000
X	-48.9	37.37	-1.309	0.9998
Y	-27.0	36.50	-0.740	1.0000

Treat = Q subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
S	-85.1	65.80	-1.293	0.9998
T	-19.5	35.97	-0.543	1.0000
U	-55.3	35.91	-1.540	0.9973
V	-309.0	42.17	-7.329	0.0001
W	-119.9	104.03	-1.153	1.0000
X	-54.1	37.37	-1.446	0.9989
Y	-32.1	36.50	-0.880	1.0000

Treat = S subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
T	65.5	58.81	1.115	1.0000
U	29.8	58.77	0.506	1.0000
V	-224.0	62.79	-3.567	0.0587
W	-34.8	113.96	-0.306	1.0000
X	31.0	59.67	0.520	1.0000
Y	52.9	59.13	0.895	1.0000

Treat = T subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
U	-35.8	20.47	-1.749	0.9858
V	-289.5	30.12	-9.610	0.0001
W	-100.4	99.76	-1.006	1.0000
X	-34.5	22.93	-1.506	0.9980
Y	-12.6	21.48	-0.587	1.0000

Treat = U subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
V	-253.7	30.05	-8.443	0.0001
W	-64.6	99.74	-0.648	1.0000
X	1.3	22.84	0.055	1.0000
Y	23.2	21.38	1.085	1.0000

Treat = V subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
W	189.1	102.16	1.851	0.9725

X	255.0	31.78	8.023	0.0001
Y	276.9	30.75	9.005	0.0001

Treat = W subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
X	65.85	100.27	0.6567	1.000
Y	87.77	99.95	0.8781	1.000

Treat = X subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Y	21.92	23.75	0.9231	1.000

Species: Lodgepole Pine

General Linear Model: TH - 15YR versus Treat

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Factor  Type   Levels  Values
Treat   fixed      25  A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S,
                       T, U, V, W, X, Y


Analysis of Variance for TH - 15YR, using Adjusted SS for Tests

Source    DF    Seq SS    Adj SS  Adj MS      F      P
Treat     24  13970981  13970981  582124  74.32  0.000
Error   1396  10933830  10933830    7832
Total   1420  24904811


S = 88.5000   R-Sq = 56.10%   R-Sq(adj) = 55.34%


Unusual Observations for TH - 15YR

 Obs  TH - 15YR      Fit  SE Fit  Residual  St Resid
  50    635.900  409.370  10.086   226.530      2.58  R
  51    589.400  409.370  10.086   180.030      2.05  R
  54     95.400  409.370  10.086  -313.970     -3.57  R
  70    171.800  409.370  10.086  -237.570     -2.70  R
  83    215.300  409.370  10.086  -194.070     -2.21  R
 138     49.900  306.540   9.434  -256.640     -2.92  R
 163    104.000  306.540   9.434  -202.540     -2.30  R
 164    534.600  306.540   9.434   228.060      2.59  R
 182    488.200  306.540   9.434   181.660      2.06  R
 187    217.600  462.255  11.063  -244.655     -2.79  R
 222    230.600  462.255  11.063  -231.655     -2.64  R
 251    286.000  462.255  11.063  -176.255     -2.01  R
 254    599.300  422.136  11.331   177.164      2.02  R
 257    618.900  422.136  11.331   196.764      2.24  R
 261    653.200  422.136  11.331   231.064      2.63  R
 291    153.400  422.136  11.331  -268.736     -3.06  R
 296    179.600  422.136  11.331  -242.536     -2.76  R
 305    185.800  422.136  11.331  -236.336     -2.69  R
 329    196.500  377.145  10.152  -180.645     -2.05  R
 332    190.000  377.145  10.152  -187.145     -2.13  R
 353    603.000  377.145  10.152   225.855      2.57  R
 369    154.200  377.145  10.152  -222.945     -2.54  R
 371    162.300  377.145  10.152  -214.845     -2.44  R
 372    148.000  377.145  10.152  -229.145     -2.61  R
 391    145.900  363.767  10.578  -217.867     -2.48  R
 415    157.500  363.767  10.578  -206.267     -2.35  R
 432    148.100  363.767  10.578  -215.667     -2.45  R
 448    863.000  363.767  10.578   499.233      5.68  R
 481    188.800  440.951   9.833  -252.151     -2.87  R
 483    177.700  440.951   9.833  -263.251     -2.99  R
 484    157.300  440.951   9.833  -283.651     -3.23  R
 485    219.000  440.951   9.833  -221.951     -2.52  R
 486    223.500  440.951   9.833  -217.451     -2.47  R
 491    634.500  440.951   9.833   193.549      2.20  R
 496    224.800  440.951   9.833  -216.151     -2.46  R
 502    676.000  440.951   9.833   235.049      2.67  R
 544    622.900  393.946  11.722   228.954      2.61  R
```

549	587.800	393.946	11.722	193.854	2.21	R
550	571.100	393.946	11.722	177.154	2.02	R
551	583.900	393.946	11.722	189.954	2.17	R
560	154.000	393.946	11.722	-239.946	-2.74	R
621	0.000	312.709	15.645	-312.709	-3.59	R
648	519.700	338.379	12.909	181.321	2.07	R
706	257.000	340.994	20.860	-83.994	-0.98	X
707	313.300	340.994	20.860	-27.694	-0.32	X
708	171.700	340.994	20.860	-169.294	-1.97	X
709	352.900	340.994	20.860	11.906	0.14	X
710	328.000	340.994	20.860	-12.994	-0.15	X
711	320.200	340.994	20.860	-20.794	-0.24	X
712	199.300	340.994	20.860	-141.694	-1.65	X
713	361.100	340.994	20.860	20.106	0.23	X
714	290.000	340.994	20.860	-50.994	-0.59	X
715	350.000	340.994	20.860	9.006	0.10	X
716	327.500	340.994	20.860	-13.494	-0.16	X
717	395.100	340.994	20.860	54.106	0.63	X
718	353.000	340.994	20.860	12.006	0.14	X
719	352.000	340.994	20.860	11.006	0.13	X
720	380.000	340.994	20.860	39.006	0.45	X
721	378.800	340.994	20.860	37.806	0.44	X
722	542.700	340.994	20.860	201.706	2.35	RX
723	465.300	340.994	20.860	124.306	1.45	X
724	468.400	387.054	24.545	81.346	0.96	X
725	317.000	387.054	24.545	-70.054	-0.82	X
726	326.500	387.054	24.545	-60.554	-0.71	X
727	411.800	387.054	24.545	24.746	0.29	X
728	470.200	387.054	24.545	83.146	0.98	X
729	306.300	387.054	24.545	-80.754	-0.95	X
730	362.000	387.054	24.545	-25.054	-0.29	X
731	405.900	387.054	24.545	18.846	0.22	X
732	290.600	387.054	24.545	-96.454	-1.13	X
733	347.600	387.054	24.545	-39.454	-0.46	X
734	401.100	387.054	24.545	14.046	0.17	X
735	476.600	387.054	24.545	89.546	1.05	X
736	447.700	387.054	24.545	60.646	0.71	X
756	592.800	388.558	17.356	204.242	2.35	R
762	587.400	388.558	17.356	198.842	2.29	R
768	134.800	379.532	15.178	-244.732	-2.81	R
771	111.000	379.532	15.178	-268.532	-3.08	R
772	120.500	379.532	15.178	-259.032	-2.97	R
773	140.000	379.532	15.178	-239.532	-2.75	R
774	130.000	379.532	15.178	-249.532	-2.86	R
786	591.400	379.532	15.178	211.868	2.43	R
788	600.200	379.532	15.178	220.668	2.53	R
796	561.400	379.532	15.178	181.868	2.09	R
884	110.000	365.633	9.488	-255.633	-2.91	R
889	172.200	365.633	9.488	-193.433	-2.20	R
894	166.900	365.633	9.488	-198.733	-2.26	R
899	106.000	365.633	9.488	-259.633	-2.95	R
910	149.000	365.633	9.488	-216.633	-2.46	R
978	156.600	360.085	8.850	-203.485	-2.31	R
1074	365.400	95.024	10.288	270.376	3.08	R
1075	310.600	95.024	10.288	215.576	2.45	R
1076	309.500	95.024	10.288	214.476	2.44	R
1077	403.100	95.024	10.288	308.076	3.50	R
1144	393.000	95.024	10.288	297.976	3.39	R
1145	383.400	95.024	10.288	288.376	3.28	R
1147	341.200	95.024	10.288	246.176	2.80	R
1148	324.800	86.415	10.812	238.385	2.71	R
1160	357.200	86.415	10.812	270.785	3.08	R
1203	283.900	86.415	10.812	197.485	2.25	R

1272	185.200	391.286	8.289	-206.086	-2.34	R
1300	607.400	391.286	8.289	216.114	2.45	R
1367	193.800	380.579	8.895	-186.779	-2.12	R
1407	143.700	380.579	8.895	-236.879	-2.69	R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.

Grouping Information Using Tukey Method and 95.0% Confidence

Treat	N	Mean	Grouping
D	64	462.25	A
H	81	440.95	A B
E	61	422.14	A B C
B	77	409.37	A B C D
I	57	393.95	B C D E
L	28	393.03	A B C D E F
X	114	391.29	C D E
O	26	388.56	A B C D E F
N	13	387.05	A B C D E F G H
Y	99	380.58	C D E
P	34	379.53	B C D E F
F	76	377.14	C D E F
R	33	373.91	C D E F
T	87	365.63	D E F
S	31	364.96	C D E F G H
G	70	363.77	D E F
U	100	360.09	E F
Q	23	341.92	D E F G H
M	18	340.99	C D E F G H
K	47	338.38	E F G H
J	32	312.71	F H
C	88	306.54	G H
V	74	95.02	I
W	67	86.41	I
A	21	76.58	I

Means that do not share a letter are significantly different.

Tukey 95.0% Simultaneous Confidence Intervals
Response Variable TH - 15YR
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Lower	Center	Upper	-------+---------+---------+---------
B	253.15	332.794	412.44	(--*--)
C	151.39	229.964	308.54	(--*--)
D	304.32	385.678	467.04	(--*---)
E	263.70	345.560	427.42	(--*--)
F	220.81	300.569	380.33	(--*--)
G	206.69	287.191	367.69	(--*---)
H	285.15	364.374	443.60	(---*--)
I	234.78	317.369	399.96	(---*--)
J	145.27	236.133	326.99	(--*---)
K	176.88	261.803	346.72	(--*---)
L	223.06	316.452	409.85	(---*--)
M	160.50	264.418	368.34	(----*---)
N	196.30	310.478	424.65	(---*----)
O	217.06	311.982	406.90	(--*---)
P	213.16	302.956	392.75	(--*---)
Q	167.70	265.346	363.00	(---*---)

```
R      207.02  297.333  387.65                          (---*---)
S      196.94  288.382  379.82                          (---*--)
T      210.40  289.057  367.72                          (---*--)
U      205.85  283.509  361.17                          (--*--)
V      -61.55   18.448   98.44                 (--*--)
W      -71.07    9.839   90.75                (--*---)
X      237.88  314.710  391.54                            (--*--)
Y      226.27  304.003  381.73                           (--*--)
                                  -------+---------+---------+---------
                                      -250         0       250
```

Treat = B subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
C      -153.3  -102.8   -52.3            (-*-)
D        -1.8    52.9   107.6                  (-*-)
E       -42.7    12.8    68.2                (--*-)
F       -84.5   -32.2    20.1               (-*-)
G       -99.0   -45.6     7.8              (-*-)
H       -19.9    31.6    83.1                 (-*-)
I       -72.0   -15.4    41.1               (-*--)
J      -164.7   -96.7   -28.6            (--*--)
K      -130.9   -71.0   -11.1              (-*--)
L       -87.7   -16.3    55.1               (--*--)
M      -153.1   -68.4    16.3             (--*---)
N      -119.3   -22.3    74.7              (---*---)
O       -94.2   -20.8    52.6               (--*--)
P       -96.5   -29.8    36.8               (--*-)
Q      -144.3   -67.4     9.4             (--*--)
R      -102.8   -35.5    31.9               (--*-)
S      -113.2   -44.4    24.4             (--*--)
T       -94.4   -43.7     6.9               (-*-)
U       -98.3   -49.3    -0.2               (-*-)
V      -367.0  -314.3  -261.7    (-*--)
W      -377.0  -323.0  -268.9    (-*-)
X       -65.8   -18.1    29.6               (-*-)
Y       -78.0   -28.8    20.4               (-*-)
                                -------+---------+---------+---------
                                    -250         0       250
```

Treat = C subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
D       102.6   155.7   208.9                      (-*-)
E        61.7   115.6   169.5                    (--*-)
F        19.9    70.6   121.3                   (-*-)
G         5.4    57.2   109.0                  (-*-)
H        84.6   134.4   184.2                     (-*-)
I        32.4    87.4   142.4                   (-*--)
J       -60.6     6.2    73.0                (-*--)
K       -26.6    31.8    90.3                 (-*--)
L        16.3    86.5   156.7                    (-*--)
M       -49.2    34.5   118.1                (--*---)
N       -15.6    80.5   176.6                 (---*---)
O         9.8    82.0   154.2                   (--*--)
P         7.7    73.0   138.3                   (--*--)
Q       -40.4    35.4   111.1                (--*--)
R         1.3    67.4   133.4                   (--*-)
S        -9.2    58.4   126.0                   (-*--)
T        10.2    59.1   108.0                   (-*-)
U         6.3    53.5   100.8                   (-*-)
```

```
V      -262.5  -211.5  -160.5        (--*-)
W      -272.6  -220.1  -167.7        (-*-)
X        38.8    84.7   130.7                    (*-)
Y        26.6    74.0   121.4                   (-*-)
                                -------+---------+---------+---------
                                    -250         0       250
```

Treat = D subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
E       -98.0   -40.1    17.8               (-*--)
F      -140.0   -85.1   -30.2             (--*-)
G      -154.4   -98.5   -42.5             (-*-)
H       -75.4   -21.3    32.8                (-*-)
I      -127.2   -68.3    -9.4              (-*--)
J      -219.6  -149.5   -79.5          (--*--)
K      -186.0  -123.9   -61.7            (-*--)
L      -142.5   -69.2     4.1             (--*--)
M      -207.6  -121.3   -34.9           (--*---)
N      -173.6   -75.2    23.2            (---*---)
O      -148.9   -73.7     1.5             (--*--)
P      -151.4   -82.7   -14.1             (--*-)
Q      -199.0  -120.3   -41.7           (--*--)
R      -157.7   -88.3   -19.0             (-*--)
S      -168.1   -97.3   -26.5            (--*--)
T      -149.9   -96.6   -43.3             (-*-)
U      -154.0  -102.2   -50.4             (-*-)
V      -422.5  -367.2  -312.0  (-*--)
W      -432.4  -375.8  -319.3  (-*-)
X      -121.5   -71.0   -20.4              (-*-)
Y      -133.6   -81.7   -29.8              (-*-)
                                -------+---------+---------+---------
                                    -250         0       250
```

Treat = E subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
F      -100.6   -45.0    10.6              (-*-)
G      -115.0   -58.4    -1.7             (--*-)
H       -36.0    18.8    73.7                 (-*-)
I       -87.8   -28.2    31.4              (--*-)
J      -180.0  -109.4   -38.8            (--*-)
K      -146.6   -83.8   -21.0             (--*-)
L      -103.0   -29.1    44.7               (--*--)
M      -167.9   -81.1     5.6            (---*--)
N      -133.9   -35.1    63.7              (---*---)
O      -109.4   -33.6    42.2               (--*--)
P      -111.8   -42.6    26.6               (-*--)
Q      -159.4   -80.2    -1.0             (--*--)
R      -118.1   -48.2    21.7              (--*--)
S      -128.5   -57.2    14.2              (--*--)
T      -110.5   -56.5    -2.5               (-*-)
U      -114.6   -62.1    -9.5              (--*-)
V      -383.1  -327.1  -271.2    (-*-)
W      -393.0  -335.7  -278.5   (--*-)
X       -82.2   -30.9    20.5                (-*-)
Y       -94.2   -41.6    11.1               (-*-)
                                -------+---------+---------+---------
                                    -250         0       250
```

Treat = F subtracted from:

Treat	Lower	Center	Upper	-------+---------+---------+---------
G	-67.0	-13.4	40.2	(-*--)
H	12.1	63.8	115.5	(--*-)
I	-39.9	16.8	73.5	(--*-)
J	-132.6	-64.4	3.7	(-*--)
K	-98.8	-38.8	21.3	(-*--)
L	-55.6	15.9	87.4	(--*-)
M	-121.0	-36.2	48.7	(---*--)
N	-87.2	9.9	107.0	(--*---)
O	-62.1	11.4	84.9	(-*--)
P	-64.4	2.4	69.1	(--*--)
Q	-112.2	-35.2	41.8	(--*--)
R	-70.7	-3.2	64.2	(--*--)
S	-81.1	-12.2	56.8	(--*-)
T	-62.3	-11.5	39.3	(-*-)
U	-66.3	-17.1	32.2	(-*-)
V	-335.0	-282.1	-229.3	(-*-)
W	-344.9	-290.7	-236.5	(-*--)
X	-33.8	14.1	62.1	(-*)
Y	-45.9	3.4	52.8	(-*-)
				-------+---------+---------+---------
				-250 0 250

Treat = G subtracted from:

Treat	Lower	Center	Upper	-------+---------+---------+---------
H	24.4	77.2	130.0	(-*-)
I	-27.5	30.2	87.9	(-*--)
J	-120.1	-51.1	18.0	(--*--)
K	-86.4	-25.4	35.6	(-*-)
L	-43.1	29.3	101.6	(--*--)
M	-108.3	-22.8	62.7	(--*---)
N	-74.4	23.3	121.0	(---*---)
O	-49.5	24.8	99.1	(--*--)
P	-51.9	15.8	83.4	(--*-)
Q	-99.6	-21.8	55.9	(--*--)
R	-58.2	10.1	78.5	(-*--)
S	-68.6	1.2	71.0	(--*--)
T	-50.1	1.9	53.8	(-*-)
U	-54.1	-3.7	46.7	(-*-)
V	-322.7	-268.7	-214.8	(-*-)
W	-332.6	-277.4	-222.1	(-*-)
X	-21.6	27.5	76.6	(-*-)
Y	-33.7	16.8	67.3	(-*-)
				-------+---------+---------+---------
				-250 0 250

Treat = H subtracted from:

Treat	Lower	Center	Upper	-------+---------+---------+---------
I	-102.9	-47.0	8.9	(-*-)
J	-195.8	-128.2	-60.7	(--*--)
K	-161.9	-102.6	-43.2	(-*-)
L	-118.8	-47.9	23.0	(--*--)
M	-184.3	-100.0	-15.7	(--*--)
N	-150.6	-53.9	42.8	(---*---)
O	-125.3	-52.4	20.5	(--*--)
P	-127.5	-61.4	4.7	(--*-)
Q	-175.5	-99.0	-22.6	(--*--)

```
R      -133.9   -67.0    -0.2              (-*--)
S      -144.3   -76.0    -7.7             (--*--)
T      -125.3   -75.3   -25.4              (-*-)
U      -129.2   -80.9   -32.5              (-*-)
V      -398.0  -345.9  -293.9   (-*-)
W      -408.0  -354.5  -301.1   (-*-)
X       -96.7   -49.7    -2.6               (-*-)
Y      -108.8   -60.4   -11.9               (-*-)
                                -------+---------+---------+---------
                                    -250         0       250
```

Treat = I subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
J      -152.7   -81.2    -9.8            (--*--)
K      -119.3   -55.6     8.2             (--*-)
L       -75.6    -0.9    73.7               (--*--)
M      -140.4   -53.0    34.5            (---*--)
N      -106.3    -6.9    92.5              (---*---)
O       -82.0    -5.4    71.2               (--*--)
P       -84.5   -14.4    55.7               (-*--)
Q      -131.9   -52.0    27.9             (--*--)
R       -90.8   -20.0    50.7              (--*--)
S      -101.2   -29.0    43.2              (--*--)
T       -83.4   -28.3    26.8               (-*-)
U       -87.6   -33.9    19.8              (--*-)
V      -355.9  -298.9  -241.9    (-*-)
W      -365.8  -307.5  -249.2   (--*-)
X       -55.1    -2.7    49.8                (-*-)
Y       -67.2   -13.4    40.4               (-*--)
                                -------+---------+---------+---------
                                    -250         0       250
```

Treat = J subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
K       -48.5    25.7    99.8                (--*--)
L        -3.4    80.3   164.0                  (--*---)
M       -67.0    28.3   123.6               (---*---)
N       -32.1    74.3   180.8                 (---*---)
O        -9.6    75.8   161.3                  (--*--)
P       -12.9    66.8   146.5                 (---*--)
Q       -59.2    29.2   117.7                (--*---)
R       -19.1    61.2   141.5                 (--*---)
S       -29.3    52.2   133.8                 (--*--)
T       -14.0    52.9   119.8                 (--*--)
U       -18.3    47.4   113.1                 (--*--)
V      -286.1  -217.7  -149.2       (-*--)
W      -295.8  -226.3  -156.8      (--*--)
X        13.9    78.6   143.3                   (-*--)
Y         2.1    67.9   133.7                  (--*-)
                                -------+---------+---------+---------
                                    -250         0       250
```

Treat = K subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
L       -22.6    54.6   131.9                (--*--)
M       -87.1     2.6    92.3              (--*---)
N       -52.7    48.7   150.1               (---*---)
```

```
O       -28.9    50.2   129.3                  (--*--)
P       -31.7    41.2   114.0                  (--*--)
Q       -78.8     3.5    85.9                (--*--)
R       -37.9    35.5   109.0                 (--*--)
S       -48.3    26.6   101.4                 (--*--)
T       -31.3    27.3    85.8                  (-*-)
U       -35.5    21.7    78.9                  (-*-)
V      -303.7  -243.4  -183.0       (-*--)
W      -313.5  -252.0  -190.4      (--*-)
X        -3.2    52.9   109.0                   (-*-)
Y       -15.1    42.2    99.5                  (--*-)
                                -------+---------+---------+---------
                                    -250         0       250
```

Treat = L subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
M      -149.8   -52.0    45.7            (---*---)
N      -114.6    -6.0   102.6             (----*---)
O       -92.6    -4.5    83.6              (---*--)
P       -96.1   -13.5    69.1              (--*---)
Q      -142.2   -51.1    39.9            (---*---)
R      -102.2   -19.1    64.0              (--*---)
S      -112.4   -28.1    56.3              (--*--)
T       -97.7   -27.4    42.9              (--*--)
U      -102.1   -32.9    36.2              (--*-)
V      -369.8  -298.0  -226.2    (--*--)
W      -379.4  -306.6  -233.8    (--*--)
X       -70.0    -1.7    66.5               (--*--)
Y       -81.7   -12.4    56.8               (--*-)
                                -------+---------+---------+---------
                                    -250         0       250
```

Treat = M subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
N       -71.7    46.1   163.8               (----*----)
O       -51.6    47.6   146.8                (---*---)
P       -55.8    38.5   132.8                (---*--)
Q      -100.9     0.9   102.7              (---*---)
R       -61.9    32.9   127.7                (--*---)
S       -71.9    24.0   119.8               (---*---)
T       -59.1    24.6   108.4                (--*--)
U       -63.7    19.1   101.9               (---*--)
V      -331.0  -246.0  -160.9      (--*---)
W      -340.5  -254.6  -168.7     (---*--)
X       -31.8    50.3   132.3                  (--*--)
Y       -43.3    39.6   122.5                 (---*--)
                                -------+---------+---------+---------
                                    -250         0       250
```

Treat = N subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
O      -108.4     1.5   111.4              (---*---)
P      -113.0    -7.5    98.0             (----*---)
Q      -157.4   -45.1    67.1            (---*----)
R      -119.1   -13.1    92.8             (---*----)
S      -129.0   -22.1    84.8             (---*---)
T      -117.6   -21.4    74.8             (---*---)
```

```
U      -122.4   -27.0    68.4              (---*---)
V      -389.3  -292.0  -194.7    (---*---)
W      -398.7  -300.6  -202.6    (---*---)
X       -90.5     4.2    98.9               (---*---)
Y      -101.9    -6.5    89.0               (---*---)
                                -------+---------+---------+---------
                                    -250         0       250
```

Treat = O subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
P       -93.3    -9.0    75.3               (---*--)
Q      -139.2   -46.6    46.0            (---*---)
R       -99.5   -14.6    70.2               (--*---)
S      -109.6   -23.6    62.4               (--*--)
T       -95.2   -22.9    49.4               (--*--)
U       -99.7   -28.5    42.7               (--*--)
V      -367.3  -293.5  -219.8    (--*--)
W      -376.9  -302.1  -227.4    (--*--)
X       -67.6     2.7    73.0                (--*--)
Y       -79.3    -8.0    63.3                (--*--)
                                -------+---------+---------+---------
                                    -250         0       250
```

Treat = P subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
Q      -125.0   -37.6    49.7             (--*---)
R       -84.7    -5.6    73.4               (--*--)
S       -94.9   -14.6    65.8              (--*---)
T       -79.3   -13.9    51.5               (-*--)
U       -83.7   -19.4    44.8               (-*--)
V      -351.5  -284.5  -217.5     (--*-)
W      -361.2  -293.1  -225.0     (-*--)
X       -51.5    11.8    75.0                (-*--)
Y       -63.3     1.0    65.4               (--*--)
                                -------+---------+---------+---------
                                    -250         0       250
```

Treat = Q subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
R       -55.9    32.0   119.9                (--*---)
S       -66.0    23.0   112.1               (---*--)
T       -52.1    23.7    99.6                (--*--)
U       -56.7    18.2    93.0                (--*--)
V      -324.1  -246.9  -169.7      (--*--)
W      -333.7  -255.5  -177.3      (--*--)
X       -24.6    49.4   123.3                 (--*--)
Y       -36.2    38.7   113.5                 (--*--)
                                -------+---------+---------+---------
                                    -250         0       250
```

Treat = R subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
S       -89.9    -9.0    72.0             (---*--)
T       -74.4    -8.3    57.9              (--*-)
U       -78.8   -13.8    51.1              (-*--)
```

```
V      -346.6  -278.9  -211.2     (--*--)
W      -356.3  -287.5  -218.7     (--*-)
X       -46.6    17.4    81.3                (--*-)
Y       -58.4     6.7    71.7                (-*--)
                              -------+---------+---------+---------
                                  -250         0       250
```

Treat = S subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
T       -67.0     0.7    68.3               (--*--)
U       -71.4    -4.9    61.6               (--*-)
V      -339.2  -269.9  -200.7     (--*--)
W      -348.8  -278.5  -208.3     (--*--)
X       -39.2    26.3    91.9                (--*--)
Y       -51.0    15.6    82.2                (--*-)
                              -------+---------+---------+---------
                                  -250         0       250
```

Treat = T subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
U       -53.0    -5.5    41.9                (-*-)
V      -321.8  -270.6  -219.4      (-*-)
W      -331.8  -279.2  -226.6      (-*-)
X       -20.4    25.7    71.7                 (-*-)
Y       -32.6    14.9    62.5                 (-*)
                              -------+---------+---------+---------
                                  -250         0       250
```

Treat = U subtracted from:

```
Treat   Lower  Center   Upper  -------+---------+---------+---------
V      -314.7  -265.1  -215.4      (-*-)
W      -324.7  -273.7  -222.6      (-*-)
X       -13.1    31.2    75.5                 (-*-)
Y       -25.4    20.5    66.4                 (-*-)
                              -------+---------+---------+---------
                                  -250         0       250
```

Treat = V subtracted from:

```
Treat   Lower   Center   Upper  -------+---------+---------+---------
W      -63.17   -8.609   45.95               (--*-)
X      247.96  296.262  344.56                           (-*-)
Y      235.84  285.554  335.27                          (-*-)
                               -------+---------+---------+---------
                                   -250         0       250
```

Treat = W subtracted from:

```
Treat  Lower  Center  Upper  -------+---------+---------+---------
X      255.1   304.9  354.7                           (-*-)
Y      243.0   294.2  345.3                           (-*-)
                            -------+---------+---------+---------
                                -250         0       250
```

Treat = X subtracted from:

Treat	Lower	Center	Upper	-------+---------+---------+---------
Y	-55.15	-10.71	33.74	(-*)
				-------+---------+---------+---------
				-250 0 250

Tukey Simultaneous Tests
Response Variable TH - 15YR
All Pairwise Comparisons among Levels of Treat
Treat = A subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
B	332.794	21.79	15.2747	0.0001
C	229.964	21.49	10.6993	0.0001
D	385.678	22.26	17.3289	0.0001
E	345.560	22.39	15.4329	0.0001
F	300.569	21.82	13.7762	0.0001
G	287.191	22.02	13.0426	0.0001
H	364.374	21.67	16.8134	0.0001
I	317.369	22.59	14.0482	0.0001
J	236.133	24.85	9.5008	0.0001
K	261.803	23.23	11.2703	0.0001
L	316.452	25.55	12.3867	0.0001
M	264.418	28.43	9.3017	0.0001
N	310.478	31.23	9.9410	0.0001
O	311.982	25.97	12.0152	0.0001
P	302.956	24.56	12.3340	0.0001
Q	265.346	26.71	9.9338	0.0001
R	297.333	24.70	12.0356	0.0001
S	288.382	25.01	11.5296	0.0001
T	289.057	21.52	13.4338	0.0001
U	283.509	21.24	13.3457	0.0001
V	18.448	21.88	0.8431	1.0000
W	9.839	22.13	0.4445	1.0000
X	314.710	21.02	14.9748	0.0001
Y	304.003	21.26	14.2978	0.0001

Treat = B subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
C	-102.8	13.81	-7.45	0.0001
D	52.9	14.97	3.53	0.0751
E	12.8	15.17	0.84	1.0000
F	-32.2	14.31	-2.25	0.8586
G	-45.6	14.62	-3.12	0.2356
H	31.6	14.09	2.24	0.8638
I	-15.4	15.46	-1.00	1.0000
J	-96.7	18.61	-5.19	0.0001
K	-71.0	16.38	-4.33	0.0038
L	-16.3	19.53	-0.84	1.0000
M	-68.4	23.17	-2.95	0.3429
N	-22.3	26.54	-0.84	1.0000
O	-20.8	20.07	-1.04	1.0000
P	-29.8	18.22	-1.64	0.9963
Q	-67.4	21.03	-3.21	0.1899
R	-35.5	18.41	-1.93	0.9702
S	-44.4	18.82	-2.36	0.7957
T	-43.7	13.85	-3.16	0.2146

U	-49.3	13.42	-3.67	0.0476
V	-314.3	14.41	-21.82	0.0001
W	-323.0	14.79	-21.84	0.0001
X	-18.1	13.05	-1.39	0.9997
Y	-28.8	13.45	-2.14	0.9098

Treat = C subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
D	155.7	14.54	10.71	0.0001
E	115.6	14.74	7.84	0.0001
F	70.6	13.86	5.09	0.0002
G	57.2	14.17	4.04	0.0127
H	134.4	13.63	9.86	0.0001
I	87.4	15.05	5.81	0.0001
J	6.2	18.27	0.34	1.0000
K	31.8	15.99	1.99	0.9567
L	86.5	19.20	4.50	0.0018
M	34.5	22.89	1.50	0.9990
N	80.5	26.30	3.06	0.2699
O	82.0	19.75	4.15	0.0081
P	73.0	17.87	4.08	0.0106
Q	35.4	20.73	1.71	0.9934
R	67.4	18.06	3.73	0.0393
S	58.4	18.48	3.16	0.2136
T	59.1	13.38	4.42	0.0027
U	53.5	12.94	4.14	0.0085
V	-211.5	13.96	-15.15	0.0001
W	-220.1	14.35	-15.34	0.0001
X	84.7	12.56	6.75	0.0001
Y	74.0	12.97	5.71	0.0001

Treat = D subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
E	-40.1	15.84	-2.53	0.6706
F	-85.1	15.01	-5.67	0.0001
G	-98.5	15.31	-6.43	0.0001
H	-21.3	14.80	-1.44	0.9995
I	-68.3	16.12	-4.24	0.0057
J	-149.5	19.16	-7.80	0.0001
K	-123.9	17.00	-7.29	0.0001
L	-69.2	20.05	-3.45	0.0961
M	-121.3	23.61	-5.14	0.0001
N	-75.2	26.92	-2.79	0.4616
O	-73.7	20.58	-3.58	0.0645
P	-82.7	18.78	-4.40	0.0028
Q	-120.3	21.52	-5.59	0.0001
R	-88.3	18.97	-4.66	0.0009
S	-97.3	19.37	-5.02	0.0002
T	-96.6	14.57	-6.63	0.0001
U	-102.2	14.17	-7.21	0.0001
V	-367.2	15.11	-24.31	0.0001
W	-375.8	15.47	-24.30	0.0001
X	-71.0	13.82	-5.13	0.0002
Y	-81.7	14.19	-5.75	0.0001

Treat = E subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
F	-45.0	15.21	-2.96	0.3385
G	-58.4	15.50	-3.77	0.0347
H	18.8	15.00	1.25	1.0000
I	-28.2	16.30	-1.73	0.9922
J	-109.4	19.32	-5.66	0.0001
K	-83.8	17.18	-4.88	0.0004
L	-29.1	20.20	-1.44	0.9995
M	-81.1	23.74	-3.42	0.1063
N	-35.1	27.03	-1.30	0.9999
O	-33.6	20.73	-1.62	0.9968
P	-42.6	18.94	-2.25	0.8600
Q	-80.2	21.65	-3.70	0.0428
R	-48.2	19.12	-2.52	0.6796
S	-57.2	19.52	-2.93	0.3585
T	-56.5	14.78	-3.82	0.0283
U	-62.1	14.38	-4.32	0.0041
V	-327.1	15.30	-21.37	0.0001
W	-335.7	15.66	-21.44	0.0001
X	-30.9	14.04	-2.20	0.8855
Y	-41.6	14.41	-2.88	0.3909

Treat = F subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
G	-13.4	14.66	-0.91	1.0000
H	63.8	14.13	4.51	0.0018
I	16.8	15.51	1.08	1.0000
J	-64.4	18.65	-3.46	0.0953
K	-38.8	16.42	-2.36	0.7948
L	15.9	19.56	0.81	1.0000
M	-36.2	23.20	-1.56	0.9982
N	9.9	26.56	0.37	1.0000
O	11.4	20.11	0.57	1.0000
P	2.4	18.26	0.13	1.0000
Q	-35.2	21.06	-1.67	0.9950
R	-3.2	18.45	-0.18	1.0000
S	-12.2	18.86	-0.65	1.0000
T	-11.5	13.90	-0.83	1.0000
U	-17.1	13.47	-1.27	0.9999
V	-282.1	14.45	-19.52	0.0001
W	-290.7	14.83	-19.60	0.0001
X	14.1	13.11	1.08	1.0000
Y	3.4	13.50	0.25	1.0000

Treat = G subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
H	77.2	14.44	5.34	0.0001
I	30.2	15.79	1.91	0.9726
J	-51.1	18.89	-2.70	0.5337
K	-25.4	16.69	-1.52	0.9988
L	29.3	19.79	1.48	0.9992
M	-22.8	23.39	-0.97	1.0000
N	23.3	26.73	0.87	1.0000
O	24.8	20.33	1.22	1.0000
P	15.8	18.50	0.85	1.0000

Q	-21.8	21.27	-1.03	1.0000
R	10.1	18.69	0.54	1.0000
S	1.2	19.09	0.06	1.0000
T	1.9	14.21	0.13	1.0000
U	-3.7	13.79	-0.27	1.0000
V	-268.7	14.76	-18.21	0.0001
W	-277.4	15.13	-18.34	0.0001
X	27.5	13.44	2.05	0.9418
Y	16.8	13.82	1.22	1.0000

Treat = H subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
I	-47.0	15.30	-3.07	0.2636
J	-128.2	18.48	-6.94	0.0001
K	-102.6	16.23	-6.32	0.0001
L	-47.9	19.40	-2.47	0.7188
M	-100.0	23.06	-4.33	0.0038
N	-53.9	26.44	-2.04	0.9445
O	-52.4	19.95	-2.63	0.5965
P	-61.4	18.08	-3.40	0.1134
Q	-99.0	20.91	-4.74	0.0007
R	-67.0	18.28	-3.67	0.0484
S	-76.0	18.69	-4.07	0.0114
T	-75.3	13.66	-5.51	0.0001
U	-80.9	13.23	-6.11	0.0001
V	-345.9	14.23	-24.31	0.0001
W	-354.5	14.61	-24.26	0.0001
X	-49.7	12.86	-3.86	0.0246
Y	-60.4	13.26	-4.55	0.0015

Treat = I subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
J	-81.2	19.55	-4.16	0.0080
K	-55.6	17.44	-3.19	0.2001
L	-0.9	20.42	-0.04	1.0000
M	-53.0	23.93	-2.21	0.8782
N	-6.9	27.20	-0.25	1.0000
O	-5.4	20.94	-0.26	1.0000
P	-14.4	19.18	-0.75	1.0000
Q	-52.0	21.86	-2.38	0.7823
R	-20.0	19.36	-1.04	1.0000
S	-29.0	19.75	-1.47	0.9993
T	-28.3	15.08	-1.88	0.9778
U	-33.9	14.69	-2.31	0.8288
V	-298.9	15.60	-19.17	0.0001
W	-307.5	15.95	-19.28	0.0001
X	-2.7	14.36	-0.19	1.0000
Y	-13.4	14.71	-0.91	1.0000

Treat = J subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
K	25.7	20.28	1.27	0.9999
L	80.3	22.90	3.51	0.0813
M	28.3	26.07	1.08	1.0000

N	74.3	29.11	2.55	0.6543
O	75.8	23.37	3.25	0.1718
P	66.8	21.80	3.07	0.2675
Q	29.2	24.19	1.21	1.0000
R	61.2	21.96	2.79	0.4663
S	52.2	22.30	2.34	0.8062
T	52.9	18.30	2.89	0.3852
U	47.4	17.97	2.64	0.5889
V	-217.7	18.72	-11.63	0.0001
W	-226.3	19.02	-11.90	0.0001
X	78.6	17.70	4.44	0.0024
Y	67.9	18.00	3.77	0.0340

Treat = K subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
L	54.6	21.13	2.59	0.6285
M	2.6	24.53	0.11	1.0000
N	48.7	27.73	1.76	0.9904
O	50.2	21.63	2.32	0.8202
P	41.2	19.92	2.07	0.9365
Q	3.5	22.52	0.16	1.0000
R	35.5	20.10	1.77	0.9895
S	26.6	20.48	1.30	0.9999
T	27.3	16.02	1.70	0.9937
U	21.7	15.65	1.39	0.9997
V	-243.4	16.51	-14.74	0.0001
W	-252.0	16.84	-14.96	0.0001
X	52.9	15.34	3.45	0.0971
Y	42.2	15.68	2.69	0.5432

Treat = L subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
M	-52.0	26.74	-1.95	0.9664
N	-6.0	29.70	-0.20	1.0000
O	-4.5	24.10	-0.19	1.0000
P	-13.5	22.59	-0.60	1.0000
Q	-51.1	24.90	-2.05	0.9405
R	-19.1	22.74	-0.84	1.0000
S	-28.1	23.07	-1.22	1.0000
T	-27.4	19.23	-1.42	0.9996
U	-32.9	18.92	-1.74	0.9914
V	-298.0	19.64	-15.18	0.0001
W	-306.6	19.92	-15.40	0.0001
X	-1.7	18.67	-0.09	1.0000
Y	-12.4	18.94	-0.66	1.0000

Treat = M subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
N	46.1	32.21	1.43	0.9995
O	47.6	27.14	1.75	0.9906
P	38.5	25.80	1.49	0.9991
Q	0.9	27.85	0.03	1.0000
R	32.9	25.93	1.27	0.9999
S	24.0	26.23	0.91	1.0000

T	24.6	22.92	1.08	1.0000
U	19.1	22.66	0.84	1.0000
V	-246.0	23.26	-10.58	0.0001
W	-254.6	23.50	-10.84	0.0001
X	50.3	22.45	2.24	0.8645
Y	39.6	22.68	1.75	0.9911

Treat = N subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
O	1.5	30.06	0.05	1.0000
P	-7.5	28.86	-0.26	1.0000
Q	-45.1	30.71	-1.47	0.9993
R	-13.1	28.98	-0.45	1.0000
S	-22.1	29.24	-0.76	1.0000
T	-21.4	26.32	-0.81	1.0000
U	-27.0	26.09	-1.03	1.0000
V	-292.0	26.61	-10.97	0.0001
W	-300.6	26.82	-11.21	0.0001
X	4.2	25.91	0.16	1.0000
Y	-6.5	26.11	-0.25	1.0000

Treat = O subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
P	-9.0	23.06	-0.39	1.0000
Q	-46.6	25.33	-1.84	0.9825
R	-14.6	23.21	-0.63	1.0000
S	-23.6	23.53	-1.00	1.0000
T	-22.9	19.78	-1.16	1.0000
U	-28.5	19.48	-1.46	0.9993
V	-293.5	20.18	-14.55	0.0001
W	-302.1	20.45	-14.78	0.0001
X	2.7	19.23	0.14	1.0000
Y	-8.0	19.50	-0.41	1.0000

Treat = P subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Q	-37.6	23.89	-1.57	0.9979
R	-5.6	21.63	-0.26	1.0000
S	-14.6	21.98	-0.66	1.0000
T	-13.9	17.90	-0.78	1.0000
U	-19.4	17.57	-1.11	1.0000
V	-284.5	18.34	-15.52	0.0001
W	-293.1	18.63	-15.73	0.0001
X	11.8	17.29	0.68	1.0000
Y	1.0	17.59	0.06	1.0000

Treat = Q subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
R	32.0	24.04	1.33	0.9999
S	23.0	24.36	0.95	1.0000
T	23.7	20.75	1.14	1.0000

U	18.2	20.47	0.89	1.0000
V	-246.9	21.13	-11.69	0.0001
W	-255.5	21.39	-11.95	0.0001
X	49.4	20.23	2.44	0.7405
Y	38.7	20.49	1.89	0.9764

Treat = R subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
S	-9.0	22.14	-0.40	1.0000
T	-8.3	18.09	-0.46	1.0000
U	-13.8	17.77	-0.78	1.0000
V	-278.9	18.53	-15.05	0.0001
W	-287.5	18.82	-15.27	0.0001
X	17.4	17.49	0.99	1.0000
Y	6.7	17.79	0.37	1.0000

Treat = S subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
T	0.7	18.51	0.04	1.0000
U	-4.9	18.19	-0.27	1.0000
V	-269.9	18.93	-14.26	0.0001
W	-278.5	19.22	-14.49	0.0001
X	26.3	17.93	1.47	0.9993
Y	15.6	18.21	0.86	1.0000

Treat = T subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
U	-5.5	12.97	-0.43	1.0000
V	-270.6	14.00	-19.34	0.0001
W	-279.2	14.38	-19.41	0.0001
X	25.7	12.60	2.04	0.9451
Y	14.9	13.01	1.15	1.0000

Treat = U subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
V	-265.1	13.57	-19.53	0.0001
W	-273.7	13.97	-19.59	0.0001
X	31.2	12.13	2.57	0.6393
Y	20.5	12.55	1.63	0.9964

Treat = V subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
W	-8.609	14.92	-0.5769	1.0000
X	296.262	13.21	22.4244	0.0001
Y	285.554	13.60	20.9969	0.0001

Treat = W subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
X	304.9	13.62	22.38	0.0001
Y	294.2	14.00	21.01	0.0001

Treat = X subtracted from:

Treat	Difference of Means	SE of Difference	T-Value	Adjusted P-Value
Y	-10.71	12.16	-0.8807	1.000

Appendix 12 – 2012 Treatment Regime Photos

- Available upon request

APPENDIX F:

TREE PLOTS ROOT DEVELOPMENT STUDY

(MCDOUGALL 2015)

Investigation of Conifer Root Development

Mount Polley 1998-2000 Waste Rock Conifer Trials

March 2015

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Executive Summary

In May 2014 an investigation was made of conifer root development and surface layer development at a tree trial established between 1998 and 2000 on a waste rock dump at the Mount Polley Mining Corporation (MPMC) mine site. The objective of the study was to visually assess the effectiveness of amendments used on the waste rock in enhancing tree rooting and surface layer development in the approximately 15 years since trees were planted on the site.

The tree trial was established in two phases. In 1998 and 1999 a trial consisting of 13 different soil treatments was established on the top of the East Dump. Treatments included overburden placed on top of the waste rock at 0, 15, 25, 40 or 65 cm depth, and biosolids at 75 or 150 dry tonnes per hectare plus overburden at 15 cm. One plot was amended with tailings in combination with overburden and biosolids and tree fertilization was done in another. Select plots were seeded with domestic or native grasses and were planted to a mix of 30% Douglas fir and 70% lodgepole pine at 2000 stems per hectare. In 2000 the trial was expanded to include 13 more treatments on a slope of the East Dump below the 1998-9 trial. Treatments on this site included overburden at 0, 15 and 30 cm depth with and without biosolids at 50 dry tonnes per hectare, and plots either dry-seeded or hydro-seeded with domestic grasses. Plots were planted with the same tree species and density as the 1998-9 plots.

In this investigation, the rooting depth as well as the root density and size of one fir and one pine tree were assessed on 16 plots of the tree trial, and surface layer materials were observed. This represented a total of 14 different treatments with a combination of overburden or overburden plus tailings with depths ranging from 0 to 65 cm and biosolids from 50 to 150 dry tonnes per hectare, and included plots on the flat dump top and on the waste rock slope.

Rooting Depth

Waste rock: the root systems of both fir and pine trees growing on waste rock alone extended up to 30 cm into the waste rock, but root systems were very small and poorly developed.

Overburden: In general, the root systems of both fir and pine trees on the tree trial site extended to the depth of overburden placed on the site provided that the overburden was a minimum of 25 cm in depth. When overburden was 25, 40 or 65 cm deep, roots of both species extended to the depth of overburden. When overburden was 15 cm deep, root systems extended throughout the overburden and 10 to 15 cm into the waste rock below. This suggests that these species need a minimum rooting depth of 25 to 30 cm for normal root development and if this is provided by the overburden, they will not send roots into the waste rock. If the overburden layer is insufficient, they will extend roots a short distance into the waste rock.

Biosolids: Biosolids in combination with 15 cm of overburden substantially increased the rooting depth on the plots located on the dump top but did not impact rooting depth on the waste rock slope. The reasons for this are not known, but it is possibly due to downward leaching of nutrients. Biosolids amendment of waste rock (without overburden) significantly increased root density but not rooting depth.

Tailings: One plot in the tree trial was amended with both tailings and overburden. This plot was also amended with biosolids. Roots of both species were found well distributed throughout the tailings and the overburden. Because the plot had been amended with biosolids, it was not possible to determine whether the combination of tailings and overburden would have been as effective as a rooting medium without biosolids.

Flat vs. slope: With a similar depth of overburden, there was no difference in rooting depth between flat and slope. The exception to this was the presence of biosolids which seemed to increase rooting depth on the flat but not on the slope.

Root abundance and size

Root abundance and size were estimated on a 10 by 10 cm area of roots at the 0 to 10 cm depth and at the 10 to 30 cm depth of soil. The most abundant size of root was identified at each depth and the number of roots of that size visually estimated. A number of different comparisons were made to assess whether root abundance and size varied with treatment or site factors.

The assessment did not identify any significant differences in root abundance or size with depth of overburden, location on the site (slope vs. flat), depth of sampling or tree species. Very fine roots (<1mm in size) were the most abundant roots throughout the site. There was slightly more variability in root abundance in the surface layer than in the deeper layer. Trees on the slope may have had slightly more roots and a slightly smaller root size than those on the flat. Trees on plots amended with biosolids may have had slightly more roots and of a slightly larger size than those on plots amended with overburden only. Trees on the plot amended with tailings may have had slightly more roots and of a smaller size than trees on plots with equivalent depth of overburden and without biosolids.

Composition and depth of surface materials

Waste rock (control) plots: on control plots (trees planted into waste rock) the surface layer was virtually non-existent. There was also very little ground cover vegetation on control plots.

Overburden-amended plots: on all plots amended with overburden, the surface layer consisted of a 1 cm or less layer of needles and moss, typical of a young forest floor. There were also areas on most plots with no surface cover where rock was visible. On many plots, the trees at 15 years of age had grown to provide a closed canopy on the site. On these plots understory vegetation consisted of moss with a small amount of grass, herbs and small shrubs. The exception to this was in areas of the plots on the waste rock slope where significant tree mortality had occurred leaving large gaps. In these areas, the plot vegetation was predominately grasses and the surface layer was a 1-2 cm layer of thatch more typical of a young grassland soil.

Biosolids-amended plots: on the biosolids-amended plots on the waste rock slope, the surface layer was a 2-3 cm brown organic layer consisting of grass thatch, significantly deeper than on non-biosolids plots. On the surface-applied biosolids plots on the dump top, there was a dramatic 3-10 cm deep black organic surface layer composed of a thick thatch of tree roots growing throughout the biosolids and overburden. It appears that biosolids amendment accelerates the process of formation of a surface layer, probably by significantly increasing the rate of growth of all vegetation on the site.

Findings relevant to tree establishment on waste rock

- Root systems of trees planted directly into waste rock with no amendment (overburden, tailings or biosolids) are very small and poorly developed. This is clearly not a suitable growing medium for conifers.
- Waste rock does not appear to be a physical or chemical barrier to tree root growth. On several plots, tree roots extended well into the waste rock. This was only observed on plots where the overburden layer was 15 cm deep or less, and on the dump top plots that had been amended with biosolids plus 15 cm of overburden. It seems to be the lack of moisture and nutrients in the waste rock that discourages root growth.
- Overburden is an excellent rooting medium for the trees on site. The root systems of both species fully exploited the whole depth of overburden. This was observed at all depths of overburden, 15, 25, 30, 40 and 65 cm.
- Tailings in combination with overburden and biosolids also provided an excellent root growing medium, equivalent to overburden. Trees utilized the whole depth of overburden + tailings for root growth. It is not known whether tailings without biosolids and/or overburden would be an equally good rooting medium.
- The trees on the tree trial site appeared to require a minimum rooting depth of 25 to 30 cm for normal root development. Where overburden was less than 25-30 cm, tree roots were found extending into the waste rock. Where overburden was greater than 25 cm to the maximum depth used in the trial, 65 cm, tree roots were found primarily in the overburden with only a few very fine roots extending into the waste rock.
- Biosolids were very effective at enhancing root growth. When applied to bare waste rock, biosolids at 50 dry tonnes per hectare provided the same amount of rooting enhancement as did 15 to 30 cm of overburden. Biosolids also appeared to increase rooting depth on the flat dump top.
- There was no difference in root abundance and size (with the obvious exception of trees on control plots) with differing depths of overburden, between tree species or on flat vs. sloping waste rock. Amendment with biosolids may have produced slightly higher root abundance and size. Amendment with a combination of tailings plus biosolids may have produced slightly higher root abundance and smaller root size.
- Amendment with biosolids appears to enhance the development of the surface layer, but also increases grass growth which has potential to cause higher tree mortality.

Contents

Executive Summary 2
1. Introduction 7
2. Background 7
3. Sampling Methods 8
4. Rooting Depth of Trees 9
4.1 General observations on rooting depth 9
4.2 Rooting depth by species – fir and pine 9
4.3 Rooting depth on waste rock (control) plots 13
4.4 Rooting depth on overburden plots 15
4.5 Rooting depth on biosolids-amended vs. non-amended plots 16
4.6 Rooting depth on flat vs. sloping areas 18
4.6 Rooting depth on tailings-amended plot 19
4.7 Fine vs. coarse roots 20
4.8 Conclusions about rooting depth 20
5. Root Abundance and Size 24
5.1 Root abundance and size by depth: 0-10 cm vs. 10-30 cm depth 26
5.2. Root abundance and size by species: Fir vs. Pine 27
5.3 Root abundance and size by site position: Dump top vs. Waste Rock Slope 28
5.4 Root abundance and size differences with depth of overburden: Thin vs. thick (<20 vs. >20 cm) 29
5.5 Root abundance and size with and without amendment with biosolids 30
5.6 Root abundance and size with and without tailings 31
5.7 Conclusions about root abundance and density 31
6. Surface Materials 32
7. Conclusions 35
8. Findings relevant to future tree plantings on waste rock dumps 36
References 38

List of Tables

Table 1a. Rooting Depth and Description of Surface Layer – Phase I 1998/9 Plots 21

Table 1b. Rooting Depth and Description of Surface Layer – Phase II 2000 Plots 22

Table 2. Root Abundance and Size in Tree Trial Plots 25

Table 3. Root Abundance and Size Class Codes 25

List of Figures

Figure 1. Rooting Depth of Fir and Pine Trees – 1998/9 Trial 23

Figure 2. Rooting Depth of Fir and Pine Trees – 2000 Trial 23

Figures 3 and 4. Root Abundance and Size by Depth: 0-10 cm vs 10-30 cm 26

Figures 5 and 6. Root Abundance and Size by Species: Fir vs. Pine 27

Figures 7 and 8. Root Abundance and Size by Site Position: Dump Top vs. Waste Rock Slope 28

Figures 9 and 10. Root Abundance and Size by Depth of Overburden: <20 vs. >20 cm 29

Figures 11 and 12. Root Abundance and Size with and without Biosolids 30

Figures 13 and 14. Root Abundance and Size with and without Tailings 31

List of Photographs

Photographs 1 and 2. Typical Rooting Depth with 25 cm Overburden 11

Photographs 3 and 4. Typical Rooting Depth with 15 cm Overburden 12

Photographs 5 and 6. Rooting Depth of Fir on Control Plot with and without Biosolids 14

Photographs 7 and 8. Comparison of Rooting Depth with 15 and 65 cm overburden 15

Photographs 9 and 10. Comparison of Rooting Depth with 15 cm overburden +/- biosolids 17

Photographs 11 and 12. Comparison of Upslope and Downslope Roots of Fir 18

Photographs 13 and 14. Rooting on Tailings-amended site 19

Photographs 15 and 16. Surface Materials on Overburden +/- Biosolids – Phase I 33

Photographs 17 and 18. Surface Materials on Overburden +/- Biosolids – Phase II 34

1. Introduction

This report describes a project undertaken in May 2014 to assess root development of trees and soil surface layer development at a conifer trial established between 1998 and 2000 on a waste rock dump at the Mount Polley Mining Corporation (MPMC) mine site. Mount Polley is a copper and gold mine owned by Imperial Metals and located approximately 56 km northeast of Williams Lake and 8 km from Likely B.C. The tree trials were designed to provide information on the effectiveness of overburden at varying depths, different soil amendments including biosolids, fertilizer and tailings, and different seed mixes and application methods, in enhancing the growth of conifers on the mine's waste rock dumps. The objective of the investigation which this report summarizes was to visually assess the development of roots of conifers with the different treatments used on the waste rock and, to a lesser extent, to examine surface soil development in the approximately 15 years since trees were planted on the site.

Root abundance and size are a measure of the health of a tree and the productivity of a soil. In general, bigger trees tend to have bigger root systems, and productive soils provide the physical conditions to supply water and nutrients, and the biological environment to support those larger root systems and trees. Conversely, tree growth can be reduced where soil conditions such as compacted (root restricting) layers, lack of nutrients, poor aeration or limited water holding capacity prevent roots from exploring an adequate soil volume, or from obtaining the water and nutrients required for growth. Evaluation of the soil rooting patterns, especially regarding the depth of rooting, can provide insight into the factors affecting tree performance on reclaimed soils.

The relationships among soil factors, root growth and above-ground tree productivity have been studied for many years. Early investigations concluded that effective soil depth available for rooting was one of the principle factors affecting forest productivity in Montana (Cox et al. 1960), and the Northwestern US (Steinbrenner 1970). More recently, Meyer et al. (2007) discussed the close relationship between soil depth and productivity in California forests, and Grant et al. (2013) provided an evaluation of how soil conditions that affect root distribution played an important role in forest productivity in Australia. These studies and reports generally show that where tree roots have access to soils that are sufficiently deep to meet the tree demand for water and nutrients, productivity is higher than where soil conditions of one kind or another limit root development. Therefore, evaluating tree growth response on reclaimed mine soils requires some consideration of the soil conditions and rooting characteristics of the trees.

2. Background

Between 1998 and 2000, a tree trial was established on a portion of the East Dump, a waste rock dump at Mount Polley. The trial was designed to compare conifer growth on waste rock which had been amended with various depths of overburden with and without fertilizer, municipal biosolids and tailings (Meister 2008). Two species, Interior Douglas fir (*Pseudotsuga menziesii*) and lodgepole pine (*Pinus contorta*) were planted on the site. The trial was established in two phases as follows:

Phase 1: established in 1998 and 1999 on a flat area on top of the dump. This trial consisted of 13 different soil treatments (identified as A-M) with 2-3 replicates of each treatment for a total of 36 plots laid out in a square with 3 m un-amended buffers between each plot. Treatments included overburden placed on top of the waste rock at 0, 15, 25, 40 or 65 cm depth, biosolids at 75 and 150 dry tonnes per hectare plus 15 cm of overburden and a tailings + overburden amended treatment (20 cm of each).

Plots were seeded with domestic or native grasses, or left unseeded, and were planted to a mix of 30% fir and 70% pine at 2000 stems per hectare.

Phase 2: established in 2000 on a waste rock slope of the East Dump below the 1998-9 trial. This trial consisted of 13 treatments (identified as N-Z) with one replicate of each treatment for a total of 13 plots. Treatments included overburden at 0, 15 and 30 cm depth with and without biosolids at 50 dry tonnes per hectare, and plots either dry-seeded or hydro-seeded with domestic grasses. Plots were planted with the same tree species and density as the 1998-9 plots. Plot Z was subsequently destroyed during mining activities, leaving 12 plots along the slope.

Ron Meister of Forestmeister Services designed the tree trial and has assessed tree growth on trial plots three times since planting, in 2006, 2007 and 2012. His 2007 and 2012 assessment reports have been referenced throughout this report to relate his findings on tree growth on the site to rooting depth and density observations from this study.

Waste rock: The waste rock on the flat area where Phase I of the tree trial was established is described as having a fines content of 28% at the surface and declining to 10% fines at the 30 to 50 cm depth. This indicates that the waste rock is composed primarily of coarse fragments >2mm in size with slightly more fines at the surface than at depth (Meister 2008). Meister also suggests that the waste rock on the slope where Phase II was established would likely have less fines due to less compaction by heavy equipment on the site and a larger proportion of larger fragments than on the dump top where haul truck traffic would have severely compacted the site.

Overburden (OB): The overburden used in both phases of the trial came from the Bell Pit soil stockpiles. The material was highly variable in particle size and coarse fragment content. It had an approximate particle size analysis of 60% sand, 30% silt and 10% clay (Meister 2008).

Biosolids (BS): The biosolids originated from Metro Vancouver's Annacis Island Wastewater Treatment Plant and met Class B regulatory standards.

Fertilizer: one treatment was amended with chemical fertilizer in the form of an RTI Bio-Pak at the rate of 1 10 g bag per seedling (Meister 2008). This treatment was not assessed.

Tailings: one treatment was amended with tailings sourced from the mine site.

3. Sampling Methods

Of a total of 25 treatments in the tree trial, 16 were selected to be assessed for tree rooting depth and density, and surface soil development. There were several replicates of the treatments in the 1998-9 trial; one replicate of each treatment (the most representative or "average") was selected for assessment. Table 1 (page 19-20) lists the plots assessed and their combination of treatments. The treatments excluded from this assessment were similar to other plots in depth of overburden or composition of seeded groundcover species.

To expose roots, an excavator was used to dig a pit 50 to 80 cm deep beside one pine tree and one fir tree on each plot. To avoid edge effects, trees in the centre of each plot were selected for root assessment. On some plots, both trees were accessible with one pit. On two of the plots, there were no fir trees present. Pit excavation was coordinated by MPMC staff.

The roots of a total of 16 pine trees and 14 fir trees were examined.

The root development assessment was conducted on May 28, 2014. It consisted of a root density assessment conducted on each tree using standard density assessment techniques and measurement of rooting depth. Rooting depth was determined by simple measurement of the depth to the main root mass and the approximate maximum rooting depth. Root abundance and size were assessed on one randomly selected 10 by 10 cm area of roots (100 cm^2) in the 0 to 10 cm depth and in the 10 to 30 cm depth from one fir tree and one pine tree on each plot. The depth and composition of the surface vegetative layer was assessed. Photos were taken of roots and surface materials in each plot.

Note: Rooting depth was determined visually and is therefore a subjective assessment based on the roots that were visible when the assessment was done. The assessment was done on the approximately 25% of the roots of an individual tree that were exposed by the excavation. The overburden layer on top of the waste rock varied sometimes from the prescribed depth, probably due to variability during placement and to settlement of material over time. There was also variability in the coarseness of overburden between plots. Because of the inherent variability in overburden depth and quality around the site and the subjective assessment of rooting depth which was based only on the visible roots, rooting depths should be considered best estimates.

4. Rooting Depth of Trees

4.1 General observations on rooting depth

Rooting depth for each assessed plot is summarized in Tables 1a and 1b and in Figures 1 and 2 (Pages 21-23).

There were three main observations made of the rooting depth of trees on site:

- The majority of the roots of both fir and pine were in the top 25 to 30 cm of material on site. This generally corresponded with the depth of overburden on the site or, on plots with shallow overburden, the depth of overburden plus approximately 10 cm of waste rock. A few trees had roots to 40 cm; these were generally located on plots that had been amended with 40 cm or more of overburden or with a heavy application of biosolids. One treatment had been amended with 65 cm of overburden; on this plot, roots extended to 50 to 60 cm and were well distributed throughout the depth of overburden.
- While on most plots the bulk of the roots were located in the top 25 to 30 cm of material, on all plots there were a few very fine roots (<1 mm) extending into the waste rock to 50-60 cm. Very few roots larger than 2 mm in size were found below the overburden layer.
- Coarse (large) roots (> 5mm) including taproots were generally found within the top 15-25 cm of material and were mostly growing horizontally.

4.2 Rooting depth by species – fir and pine

Fir

Two plots had no fir trees (R & S) therefore only 14 sets of fir roots were examined.

Of the 14 sets of fir roots examined, 7 of the trees (50%) had roots primarily in the top 25-30 cm of soil, and a further 30% (5 trees) had roots primarily to 40 cm depth, in general corresponding to the depth of

overburden and the top few centimetres of waste rock. Most trees also had a few very fine roots (<1 mm) extending deeper, to at least 50 cm (Photos 1 and 3).

Three trees had roots extending beyond 40 cm (20%) (treatments D, E and I). The tree on the plot with 65 cm of overburden (treatment I) had roots distributed throughout 50 cm of overburden. The trees growing on two of the plots amended with biosolids in the Phase I area (treatments D and E) had roots extending to 50-60 cm despite only 15 cm of overburden on the plots.

McMinn (1963) suggests that this species normally has a taproot extending down well into the subsoil but when boulders, bedrock or other obstructions occur close to the soil surface, root systems can be shallow and taproots will divide and proliferate. Under these circumstances, distinct taproots are missing. This was observed on all plots except two suggesting that the waste rock is almost always a deterrent to downward movement of the taproot, causing it to grow horizontally and to branch. The exceptions to this were the two biosolids-amended plots located on the flat top of the dump where fir roots were present to 50-60 cm of material despite the plots being amended with only 15 cm of overburden (although the bulk of the roots were still within the top 30 cm). This is in contrast to all other plots where, below the overburden layer, there were only a few very fine roots and no larger roots. The reason for deeper rooting on these biosolids plots is not known, however on these two plots the waste rock appeared to contain fewer large rocks than on some plots and so may have been more easily penetrated by roots. It is also possible that nutrients from the biosolids moved into the subsoil with precipitation, and tree roots moved down to access them.

Pine

Of the 16 sets of pine roots examined, 11 of the trees (69%) had roots primarily in the top 25-30 cm of soil, corresponding to the extent of the overburden layer or extending into the top few centimetres of waste rock (Photos 2 and 4). All trees had very few very fine roots below this depth to a maximum depth of 60-70 cm.

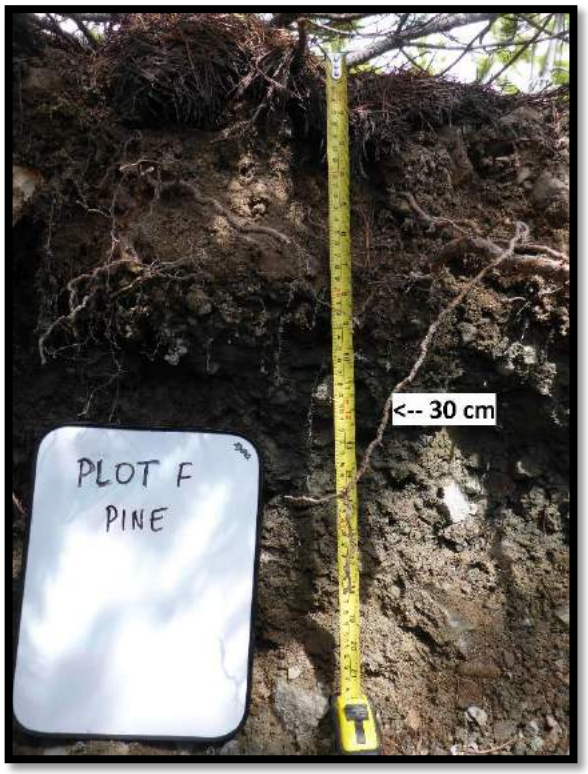
All of the trees on the slope (Phase II area) had the majority of their roots in the 25-30 cm depth. All of the plots on the waste rock dump slope had been amended with overburden at 30 cm or less.

Four trees had roots extending to 40 cm (treatments D, E, H and L), all in the flat Phase l area. Two of these trees were on plots with 40 cm of overburden and two were biosolids-amended treatments. One tree (treatment I) had a good distribution of roots to 60 cm; this treatment had been amended with 65 cm of overburden.

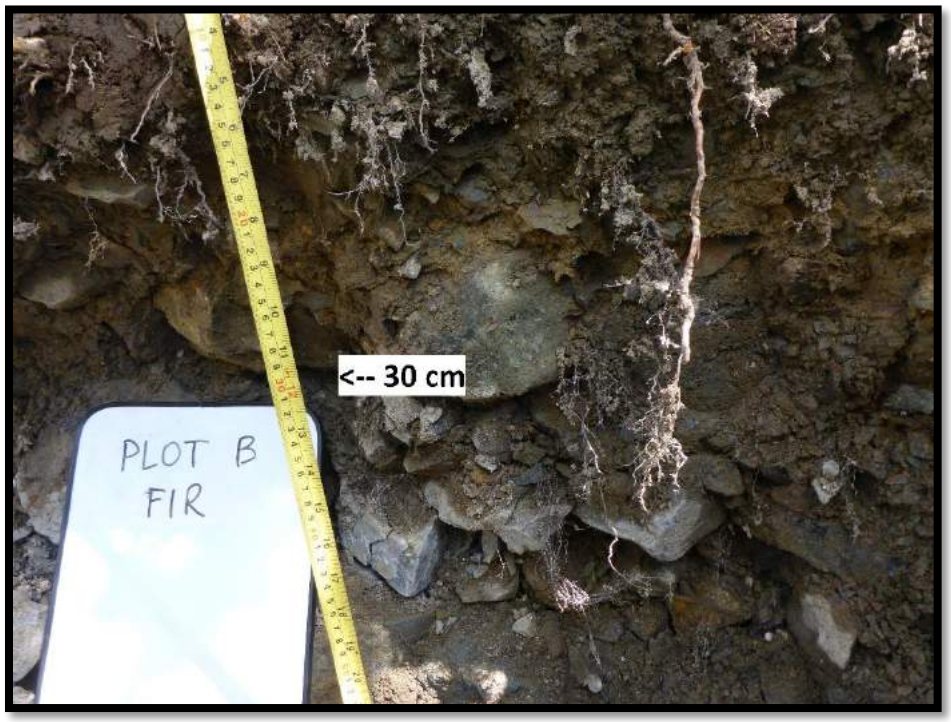
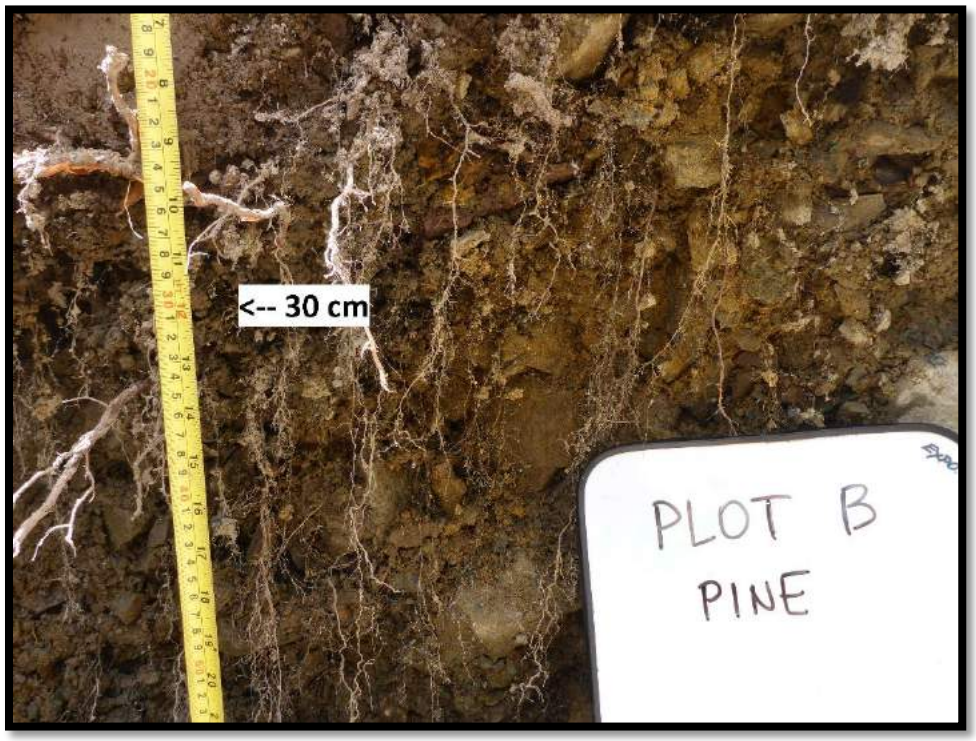
Lotan (1983) in '*The Ecology and Regeneration of Lodgepole Pine'* describes the roots of lodgepole pine as 'highly variable in form, depending in large measure on soil type'. He further suggests that where roots encounter an obstruction such as a clay hardpan or water table, the taproot may die or grow horizontally. This was observed on all plots except one of the control plots, suggesting that the waste rock is generally an obstruction that prevents downward growth of the taproot. This was the general rule with one exception: the root system of the pine tree on one control plot (treatment V on the slope) had a taproot that extended straight down deeper than 60 cm. The waste rock on this plot did not appear to contain such a large proportion of large rocks as were observed on most plots, and the rock did not appear to be compacted, perhaps allowing the tap root to penetrate the rock. It may also be

that the absence of overburden on the control plot forced roots to move down into the waste rock in search of moisture and nutrients which was not necessary on plots with adequate overburden.

Photos 1 and 2. Typical rooting depth of fir and pine on plots with 25 cm of overburden

	
Typical rooting depth of fir (Plot F: 25 cm of overburden over waste rock)	Typical rooting depth of pine (Plot F: 25 cm of overburden over waste rock)

Photos 3 and 4. Typical rooting depth of fir and pine on plots with 15 cm of overburden

	Typical rooting depth: fir tree on waste rock with 15 cm of overburden
	Typical rooting depth: pine tree on waste rock with 15 cm overburden

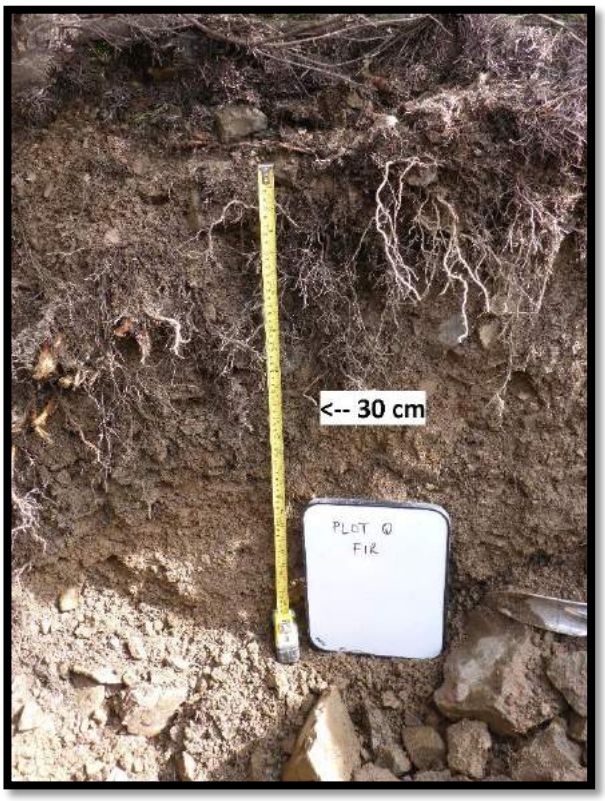
4.3 Rooting depth on waste rock (control) plots

Two control plots were assessed - one on the flat and one on the slope. These plots were not amended with overburden or biosolids. Trees were planted directly into waste rock.

The trees growing on control plots were very stunted relative to trees on plots amended with overburden and/or biosolids (Photo 5). The root systems of trees on control plots were also very stunted, consisting of one thin taproot <1 cm in diameter) and a small network of fine roots. Fine roots extended 30 cm into the waste rock. One fir tree had a taproot extending >60 cm into the waste rock while other taproots were growing horizontally. In comparison, trees on plots amended with overburden and/or biosolids had a dense network of coarse and fine roots throughout the top 30 cm or more of surface material (Photo 6).

Meister (2014) concluded from assessment of tree growth on the tree trial site that trees require a minimum amount of soil-like material for normal growth; trees growing directly in waste rock were significantly shorter and survival was lower than trees on all of the overburden-amended plots. Tree growth was better when waste rock was amended with biosolids than on waste rock alone. The poor root growth of trees on plots with no amendment further demonstrates that, to achieve normal growth, trees planted on waste rock require the site to be amended with some type of nutrient and moisture-holding material. Overburden and biosolids appear to provide similar functions in promoting tree growth.

Photos 5 and 6. Rooting depth of fir tree on control plot (no overburden or biosolids) and on waste rock plot amended with biosolids.

	
Control (trees planted into waste rock with no amendment) (Plot V, fir on waste rock slope)	Trees planted into waste rock and amended with 50 dt/ha biosolids (Plot Q, fir on waste rock slope with no overburden)

4.4 Rooting depth on overburden plots

Overburden was applied at depths of 15, 25, 40 and 65 cm on the Phase I dump top and at 15 and 30 cm on the waste rock slope. Rooting depth and density were similar between the 15 and 25-30 cm overburden depths, with roots generally extending to the 25-30 cm depth on plots (Photo 7). When overburden was deeper than 25-30 cm in depth, roots extended to the depth of overburden (Photo 8). There was no difference in rooting depth on the dump top or the waste rock slope with a similar overburden depth.

This finding would suggest that a deeper layer of overburden is desirable because it allows deeper rooting and presumably, therefore, growth of more roots overall which would allow the tree to access more area for moisture and nutrient uptake. This supports Meister's assessment of tree growth on the plots which found that, at 10 and 15 years of growth, tree survival and growth was better with overburden at 40 or 65 cm depth than at 15 or 25-30 cm depth (Meister 2008 and 2014).

Photos 7 and 8. Comparison of rooting depth with 15 and 65 cm of overburden

	
15 cm overburden over waste rock – roots extended to 30 cm (Plot B, fir)	65 cm of overburden over waste rock – roots extended to depth of overburden (Plot I, fir)

4.5 Rooting depth on biosolids-amended vs. non-amended plots

There were several different biosolids treatments. On the flat dump top (Phase I area), there were two biosolids treatments, 75 dry tonnes and 150 dry tonnes per hectare combined with 15 cm of overburden (treatments D & E respectively), and a third treatment with 75 dry tonnes per hectare of biosolids plus 20 cm of overburden and 20 cm of tailings (treatment M). Meister (2008) indicated that the biosolids on these plots were tilled into the top 15 cm of overburden but it was subsequently learned that on plots D and E the biosolids were surface-applied the year after tree planting and were not incorporated.

On the waste rock slope (Phase II area), there were 3 biosolids plots, each at 50 dry tonnes per hectare of biosolids with 0, 15 or 30 cm of overburden (treatments Q, R and S respectively). These treatments were paired with plots without biosolids but with the same amount of overburden. On these plots the biosolids were apparently incorporated into the top 15 cm of overburden or waste rock before trees were planted.

The trees on the biosolids-amended plots in the Phase I area (on the flat dump top) were deeper rooted than trees on similar plots without biosolids (Figures 1 and 2). This was especially noticeable in the rooting depth of firs where roots extended to 50-60 cm vs. a typical rooting depth of 30 cm on plots that were amended with 15 cm of overburden and no biosolids (Photos 9 and 10). This was observed to a lesser degree with the roots of pine trees.

The presence of biosolids on the plots on the slope did not appear to increase rooting depth; on these plots there did not appear to be any difference between biosolids-amended and non-amended plots in rooting depth. However, two of the plots amended with biosolids in this area had no fir trees; there was high mortality of fir on all slope plots, especially on those amended with biosolids. This was the species whose rooting depth was apparently impacted more positively by the presence of biosolids.

Meister (2008) noted that in the Phase I area of the trial (1998-9 plots) fir trees growing on plots with 15 cm of overburden plus biosolids showed significantly better growth than those on plots amended with overburden only at either 15 or 25 cm depth. In 2012, when the trees were 15 years old, fir tree growth on plots with 40 cm or more of overburden was equivalent to growth on plots with 15 cm of overburden plus biosolids. The increased rooting depth of trees on plots amended with biosolids may be partly responsible for this.

The results of this study suggest that in flat areas, particularly for fir trees, the presence of biosolids on the site enhances rooting depth. Trees on biosolids-amended plots with 15 cm of overburden had roots extending to the same depth as trees on plots amended with 40 or 65 cm of overburden. It is not clear what factor or factors push the roots deeper on biosolids-amended plots but it may be the presence of nutrients leached from the biosolids into the waste rock.

Meister did not observe this growth improvement in trees on the 2000 plots on the waste rock slope (Phase II area). On those plots, tree growth was not significantly better on plots with biosolids vs. paired plots without biosolids. This was corroborated in observations of tree rooting depth. There was no difference noted in tree rooting depth on plots with and without biosolids with either 15 or 30 cm of overburden. The exception to this was the control plots in this area. Tree roots were significantly more abundant on plot Q which was amended with biosolids but no overburden vs. plot V on which trees were planted directly into waste rock without amendment (photos 5 and 6).

It is not known why biosolids enhanced tree rooting depth and tree growth on the flat area of the waste rock dump but not on the waste rock slope. There are several differences between these two areas which may have contributed to this including: higher biosolids application rate on 1998-9 plots, biosolids incorporated into surface materials on slope vs. applied a year later and left unincorporated in flat area, harsher growing conditions on the slope vs. the flat due to increased exposure, possible loss of nutrients from runoff on sloping area vs. nutrient infiltration on the flat area, and greater grass growth on sloping area vs. flat area leading to increased competition.

Photos 9 and 10. Comparison of rooting depth with 15 cm of overburden with and without biosolids.

	
15 cm overburden over waste rock (Plot B, fir)	15 cm overburden + biosolids over waste rock (Plot D, fir)

4.6 Rooting depth on flat vs. sloping areas

Trees on the waste rock slope had an abundance of very large roots growing upslope from the tree in the overburden layer and fewer roots downslope. Downslope roots were much finer than upslope roots (Photos 11 and 12). On the flat dump top, this was not observed. It is not known whether this is the result of the relatively thin layer of overburden on slope plots or a normal adaptation of trees to growing on a slope.

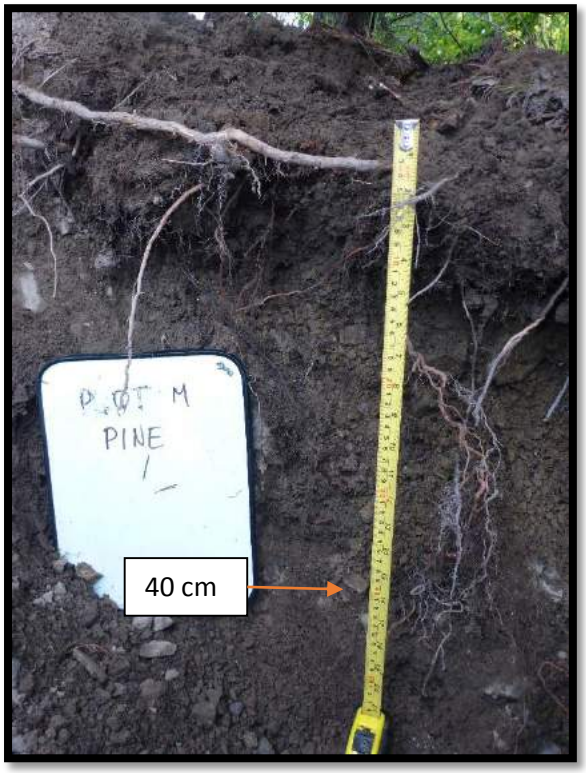
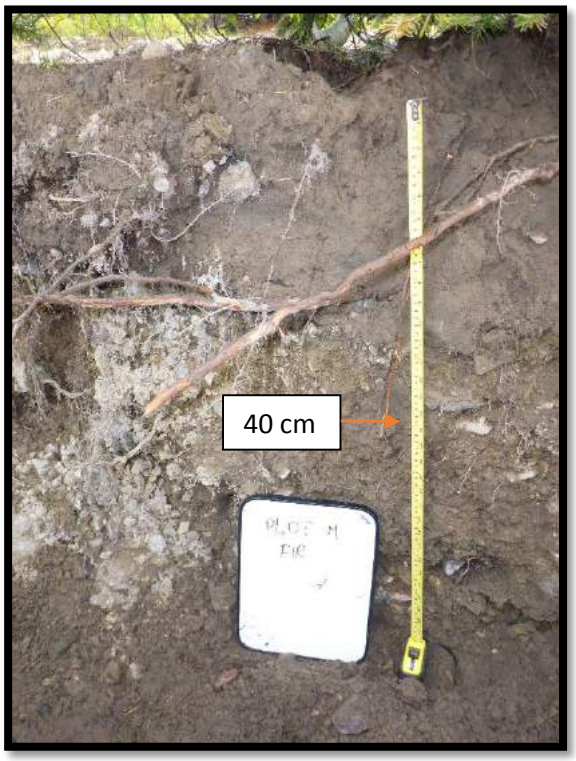
Photos 11 and 12. Comparison of upslope and downslope roots of fir tree on Plot U on waste rock slope.

	Upslope roots of fir tree on Plot U (15 cm overburden).
	Downslope roots of fir tree on Plot U (15 cm of overburden).

4.6 Rooting depth on tailings-amended plot

Plot M (on the dump top) was amended with 20 cm of tailings as well as 20 cm of overburden and 75 dry tonnes per hectare of biosolids. On this plot, fir roots extended to 40 cm while pine roots were found mostly in the top 25 cm of material (Photos 13 and 14). Rooting depth on this plot was similar to that observed on plots H and L which had both been amended with 40 cm of overburden. Roots of both species were well distributed throughout both the tailings layer (top 20 cm of surface material) and the overburden (20-40 cm layer). Based on these observations and measurements, the tailings in combination with biosolids and overburden appears to be an excellent rooting medium for both species of trees.

Photos 13 and 14. Rooting of fir and pine on Plot M (tailings + overburden + biosolids).

	
20 cm tailings + 20 cm overburden + 75 dt/ha biosolids over waste rock (Plot M, pine)	20 cm tailings + 20 cm overburden + 75 dt/ha biosolids over waste rock (Plot M, fir)

4.7 Fine vs. coarse roots

Coarse roots (>5 mm in diameter) were almost exclusively found within the top 30 cm of surface material, and were sometimes confined to the top 15-20 cm of material on plots where the overburden layer was only 15 cm deep. The exception to this was on control plots where fine and coarse roots extended into the waste rock but overall root growth was very poor. The biosolids-amended plots on the dump top also had coarse roots extending deeper into the waste rock.

The majority of fine and very fine roots were found in the overburden layer but where the overburden layer was less than 25 cm, were also found in the top 10 cm of waste rock. A few very fine roots were found on most plots to a depth of 50 cm or deeper.

4.8 Conclusions about rooting depth

In general, tree roots extended to the depth of overburden on site when overburden was 25 to 65 cm deep. This applied to the one plot amended with tailings as well. Where the overburden layer was shallow (15 cm), tree roots grew throughout the overburden and into the top 10 to 15 cm of waste rock for a total rooting depth of 25 to 30 cm (Table 1, Figures 1 and 2). The exception to this was the two biosolids- amended plots on the dump top; these plots had been amended with 15 cm of overburden only but tree roots extended a further 30 to 45 cm into the waste rock, a condition not observed on any plots amended with only overburden or on biosolids-amended plots on the slope. On the control plots, roots also extended into the waste rock although overall root development was poor.

The main conclusion from these observations is that, in general, tree roots do not extend into the waste rock if there is a layer of overburden on top of the waste rock at least 25-30 cm deep (in the trial a minimum layer of 15 cm of overburden was applied so it is not known how tree roots would respond if the layer was thinner than 15 cm). It appears to be the lack of nutrients and moisture within the waste rock itself that inhibits root growth and not its physical or chemical composition; on several plots it was observed that tree roots were growing well down into the waste rock suggesting that they will grow into the waste rock under certain circumstances. On the control plots where trees were planted directly into waste rock, roots extended 25-30 cm into the waste rock. Trees on plots amended with 15 cm of overburden plus a surface application of biosolids had roots extending significantly further into the waste rock as compared with plots with the same amount of overburden but no biosolids. This suggests that roots may have been seeking nutrients from the biosolids that may have moved into the waste rock. It appears that if the trees are able to get sufficient water and nutrients from the overburden layer they will not put roots into the waste rock layer where moisture and nutrient holding capacity is low.

There was significant variability in the size and shape of rock fragments in the waste rock, and there may also have been variability in degree of compaction of the waste rock which may have impacted rooting. As well, a limited number of root systems were examined which may have skewed observations.

Table 1a. Rooting Depth and Description of Surface Layer on Tree Trial Plots – Phase 1 1998/9

Plot ID	Description of treatments on plot	Rooting depth (cm)		Comments on rooting depth	Surface layer description
		Fir	Pine		
1998/9 Plots on Waste Rock Dump Top					
A	Control – 0 cm overburden (trees planted into waste rock)	25	25	Roots in 10-25 cm zone	No surface organic layer
B	15 cm overburden + domestic grasses	30	30	v. fine pine roots below 30 cm, no fir roots below 40 cm	<1 cm surface organic layer consisting of needles and moss
G	15 cm overburden + native grasses	30	30	A few fine roots to 55 cm	<1 cm layer of needles and moss on surface
F	25 cm overburden + domestic grasses	25	25	v. few roots below overburden layer	<1 cm layer of needles and organics on surface
H	40 cm overburden + domestic grasses	40	40		1 cm layer of needles and moss on surface
L	40 cm overburden + domestic grasses	40	40	A few fine roots found 10 cm into waste rock but most within overburden layer.	1 cm organic layer at surface
I	65 cm overburden + domestic grasses	50	60	A few fine roots to 65 cm	1 cm layer of needles and moss on surface
D	15 cm overburden + 75 dt/ha biosolids + domestic grasses (biosolids not incorporated)	60	40	A few fine roots observed deeper than main mass of roots	3-7 cm black organic layer on top of overburden with 1 cm needle layer on surface.
E	15 cm overburden + 150 dt/ha biosolids + domestic grasses (biosolids not incorporated)	50	40	A few fine roots to 60 cm	3 cm black organic layer on top of overburden with 1 cm needle layer on surface.
M	20 cm overburden + 20 cm tailings + 75 dt/ha biosolids + domestic grasses	40	25	Most roots in tailings/overburden layer; a few fine roots down to 70 cm.	1-3 cm brown organic layer with 1 cm needle layer at surface.

Table 1b. Rooting Depth and Description of Surface Layer on Tree Trial Plots – Phase II 2000

Plot ID	Description of treatments on plot	Rooting depth (cm)		Comments on rooting depth	Surface layer description
		Fir	Pine		
Year 2000 Plots on Waste Rock Slope					
V	0 cm overburden + domestic grasses (control plot – trees planted into waste rock)	30	30	Pine tap root extended to >60 cm, fine roots only to 30 cm.	No surface organic layer
U	15 cm overburden + domestic grasses	30	30	Several large roots in top 30 cm of soil.	1-2 cm surface organic layer, grass root mass in areas without trees, moss in treed areas.
T	30 cm overburden + domestic grasses	40	25	A few fine roots to 45 cm but most within top 25 cm	1 cm surface organic layer
Q	0 cm overburden + 50 dt/ha biosolids + domestic grasses (biosolids incorporated)	30	30	Fir: a few fine roots below 30 cm. Pine: most roots in surface 15 cm, a few large (>2 cm)roots deeper.	2-3 cm surface organic layer consisting of grass root mass.
R	15 cm overburden + 50 dt/ha biosolids + domestic grasses (biosolids incorporated)	No fir on plot	30	A few fine roots to 55 cm but most within top 30 cm	2-3 cm surface organic layer consisting of grass root mass
S	30 cm overburden + 50 dt/ha biosolids + domestic grasses (biosolids incorporated)	No fir on plot	25	A few fine roots to 45 cm but most with top 25 cm	2-3 cm surface organic layer consisting of grass root mass.

Figure 1. Rooting Depth of Fir and Pine Trees on Selected Plots from the 1998/9 Tree Trial

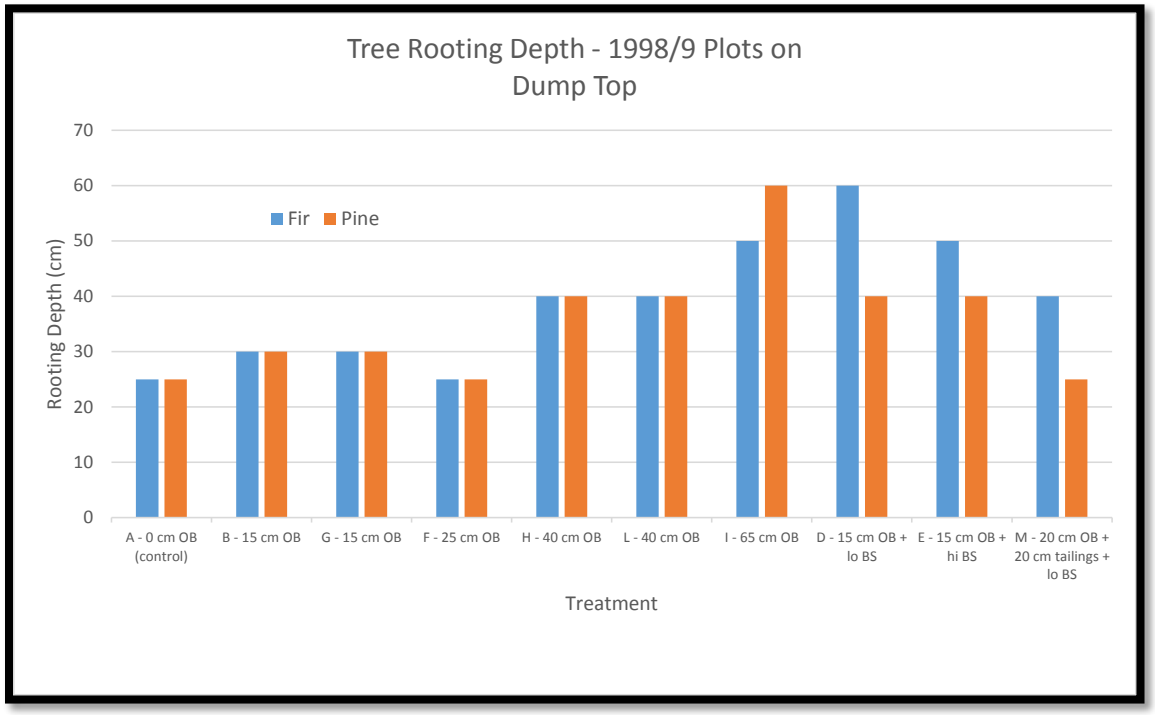
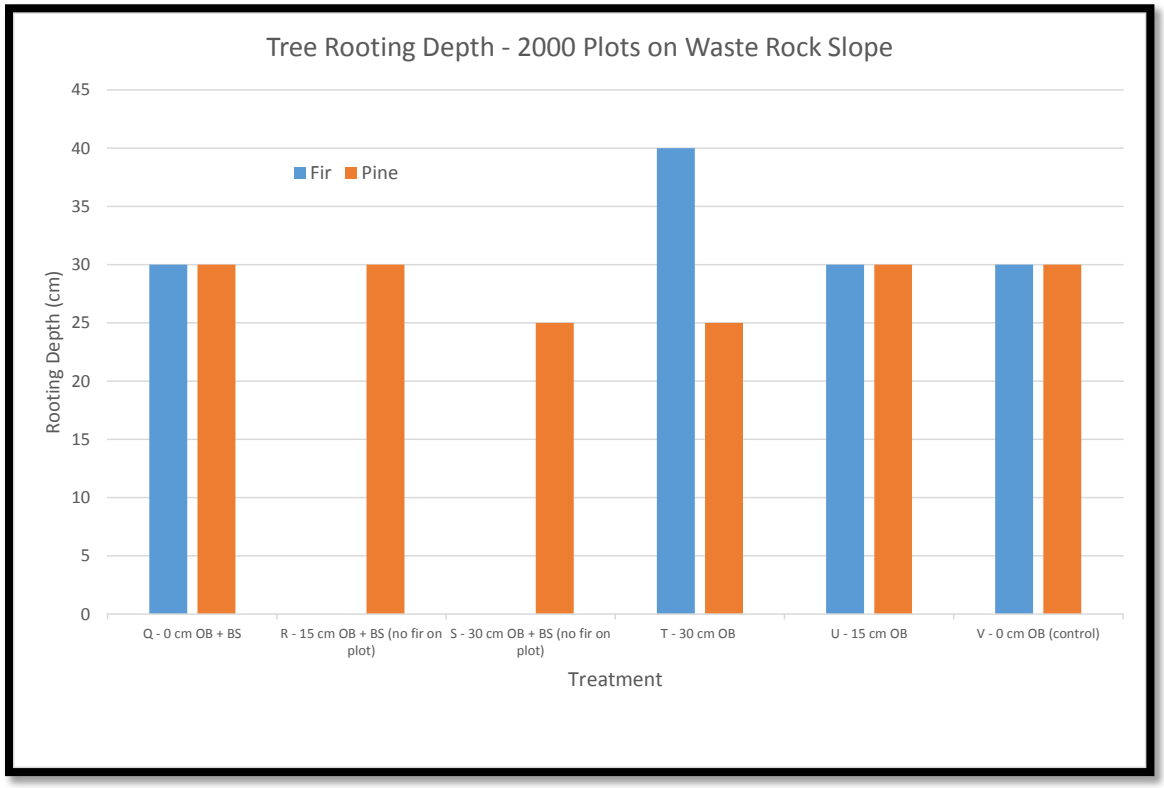


Figure 2. Rooting Depth of Fir and Pine Trees on Selected Plots from the 2000 Waste Rock Slope Tree Trial



5. Root Abundance and Size

Root abundance and size are a measure of the health of a tree. These parameters were assessed to determine whether there were measurable differences in root density and size between treatments and within the site.

Root abundance and size were assessed on one randomly selected 10 by 10 cm area of roots (100 cm^2) in the 0 to 10 cm depth and in the 10 to 30 cm depth from one fir tree and one pine tree on each plot. Roots of sufficient density to measure were found only to the 30 cm depth on all plots. Below that depth, root density was so low that it was not deemed necessary to conduct the assessment.

Several comparisons were made with the root density and size measurements to see if there was variation between treatments and with varying site conditions. The comparisons are:

- Depth from soil surface – 0-10 cm vs. 10-30 cm
- Species – fir vs. pine
- Site position effect – dump top vs. waste rock slope
- Depth of overburden – shallow (<20 cm) vs. deep (>20 cm)
- Presence of biosolids – with and without biosolids
- Presence of tailings – comparable plots with and without tailings

Results of the comparisons are discussed on the following pages. Data is shown in Table 2 and in a series of graphs that accompany each comparison.

Table 2. Most Common Root Abundance and Size in Pine and Fir Trees on Tree Trial Plots

Plot ID	Amendments on Plot	Pine		Fir	
		0-10 cm	10-30 cm	0-10 cm	10-30 cm
1998/9 Plots on Waste Rock Dump Top					
A	Control – 0 cm overburden (trees planted into waste rock)	FV	PV	FV	PV
B	15 cm overburden	PV	PV	FF	FV
G	15 cm overburden	PV	PV	AV	PV
F	25 cm overburden	PF	FV	PF	PV
H	40 cm overburden	FV	FC	FF	FF
L	40 cm overburden	PV	PV	AV	PV
I	65 cm overburden	PV	PV	FF	FF
D	15 cm overburden + 75 dt/ha biosolids	FF	PV	PM	PF
E	15 cm overburden + 150 dt/ha biosolids	PC	PV	PM	FM
M	20 cm overburden + 20 cm tailings + 75 dt/ha biosolids	PV	PV	PV	PF
Year 2000 Plots on Waste Rock Slope					
V	Control – 0 cm overburden (trees planted into waste rock)	FV	PV	X	PF
U	15 cm overburden	PV	PV	AV	PV
T	30 cm overburden	PV	PV	AV	FF
Q	0 cm overburden + 50 dt/ha biosolids	PV	FV	PF	PV
R	15 cm overburden + 50 dt/ha biosolids	AV	PV	N/A	N/A
S	30 cm overburden + 50 dt/ha biosolids	AV	PV	N/A	N/A

Note: First letter is root abundance, second letter is root size

Table 3. Root Abundance and Size Class Codes

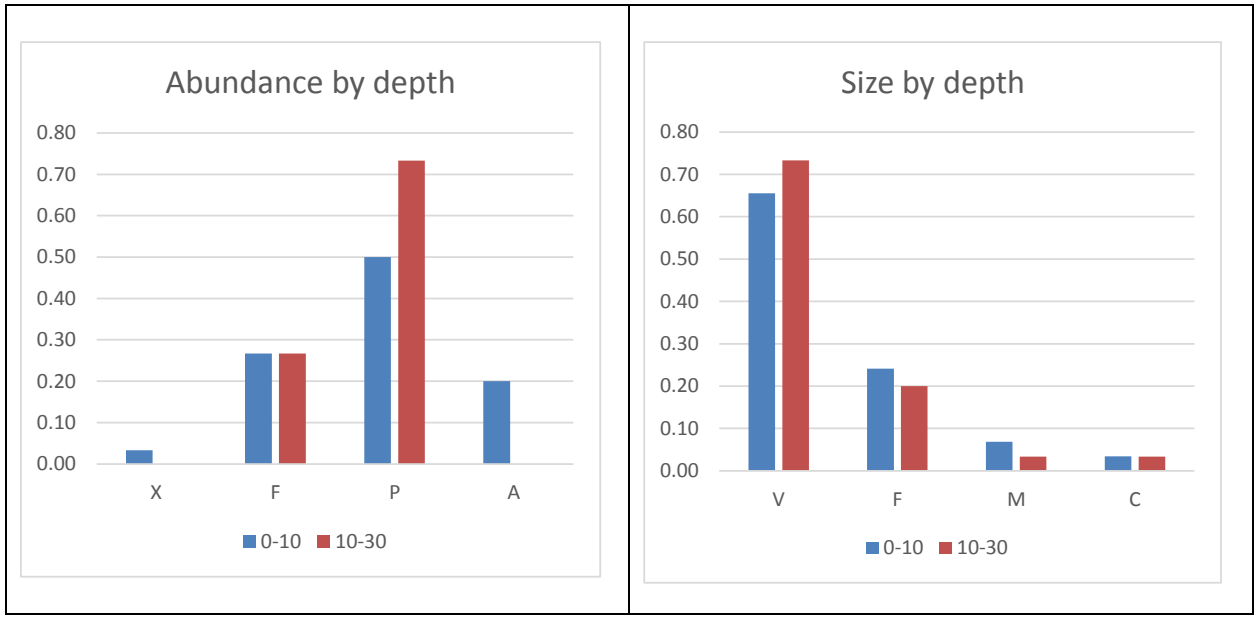
	Root Size			
Root Abundance	**V** Very Fine (<1 mm)	**F** Fine (1-2 mm)	**M** Medium (3-5 mm)	**C** Coarse (>5 mm)
X None	0	0	0	0
F Few	<10	<10	1	1
P Plentiful	10-100	10-100	2-10	2-5
A Abundant	>100	>100	>10	>5

5.1 Root abundance and size by depth: 0-10 cm vs. 10-30 cm depth

The following observations were made about root abundance and size variability with depth in test pits (Figures 3 and 4).

- Root abundance was more variable in the surface layer.
- Very fine roots were the most common size.
- Upper and lower layers had similar sized roots.

Figures 3 and 4. Root Abundance and Size by Depth: 0-10 cm vs. 10-30 cm



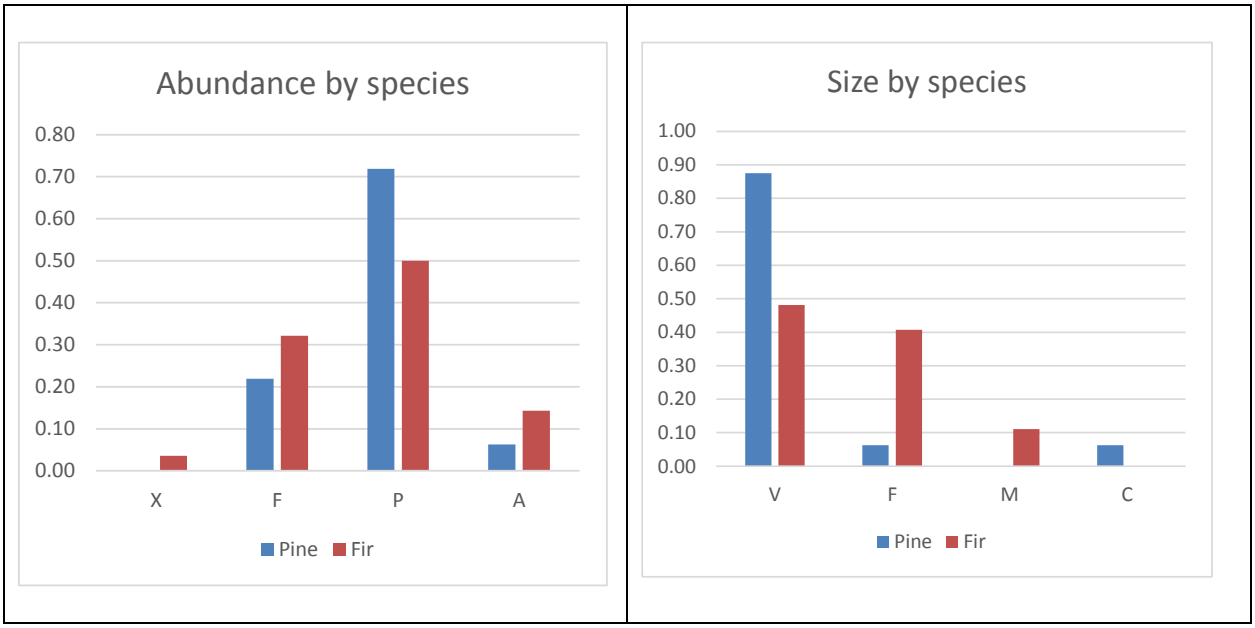
Note: Y axis is the proportion of the total # of observations in each category (0.5 = 50%).
Root abundance: X none, F few, P plentiful, A abundant.
Root size: V very fine, F fine, M medium, C coarse
See Table 3 for root abundance and size class codes.

5.2. Root abundance and size by species: Fir vs. Pine

The following observations were made about root abundance and size variability between fir and pine trees on site (Figures 5 and 6):

- Pine and fir had roughly similar root abundance.
- Root abundance was more variable in fir.
- Pine had more very fine roots than fir.
- Fir had a wider range of root sizes than pine.

Figures 5 and 6. Root Abundance and Size by Species: Fir vs. Pine



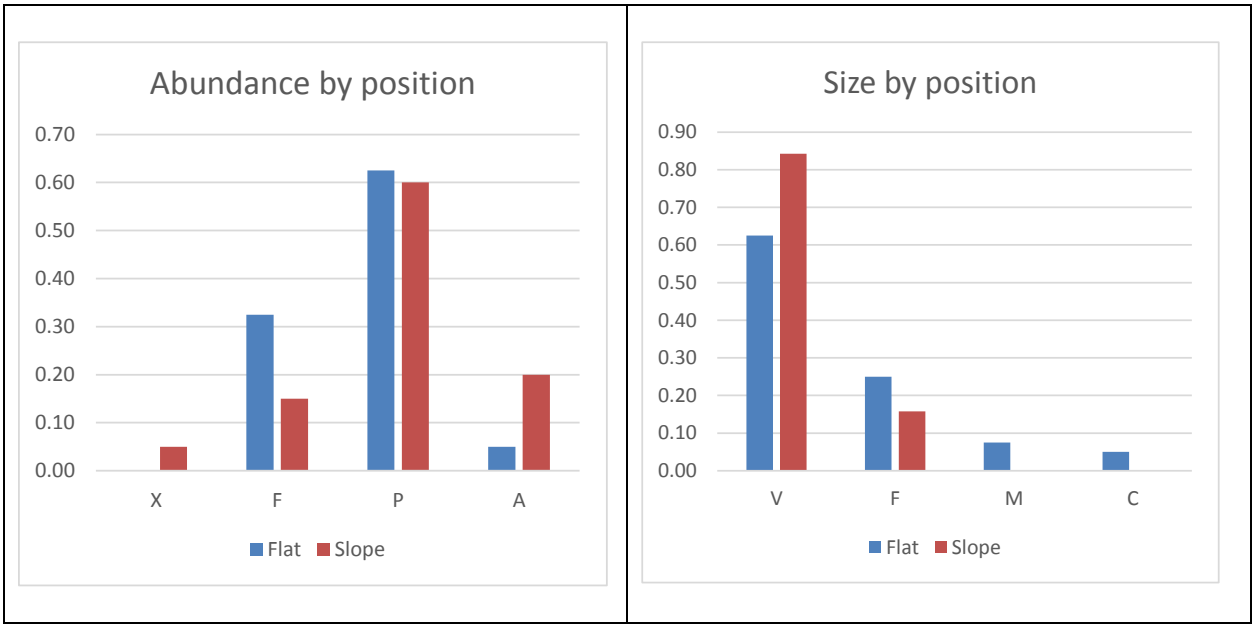
Note: Y axis is the proportion of the total # of observations in each category (0.5 = 50%).
Root abundance: X none, F few, P plentiful, A abundant.
Root size: V very fine, F fine, M medium, C coarse
See Table 3 for root abundance and size class codes.

5.3 Root abundance and size by site position: Dump top vs. Waste Rock Slope

The following observations were made about root abundance and size differences between trees on the flat dump top and those on the waste rock slope (Figures 7 and 8):

- Trees on the slope may have had slightly more roots than those on the flat.
- Trees on the slope had a slightly smaller root size.

Figures 7 and 8. Root Abundance and Size by Species: Dump Top vs. Waste Rock Slope

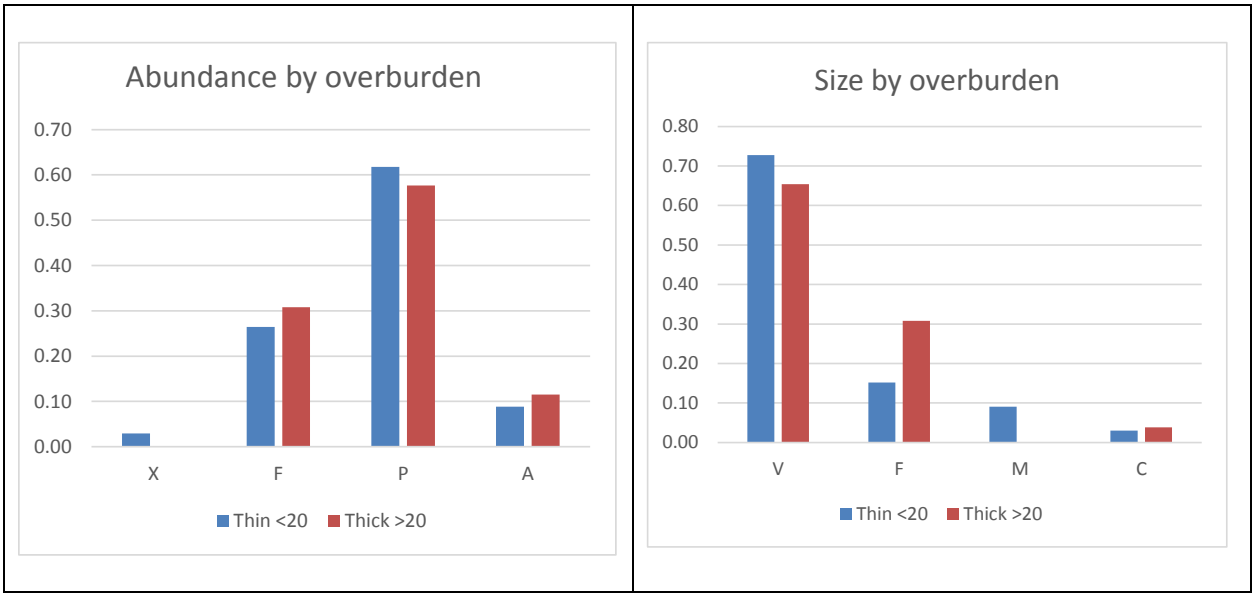


Note: Y axis is the proportion of the total # of observations in each category (0.5 = 50%).
Root abundance: X none, F few, P plentiful, A abundant.
Root size: V very fine, F fine, M medium, C coarse
See Table 3 for root abundance and size class codes.

5.4 Root abundance and size differences with depth of overburden: Thin vs. thick (<20 vs. >20 cm)

There was no apparent trend in root abundance or root size between thin and thick layers of overburden (Figures 9 and 10).

Figures 9 and 10. Root Abundance and Size by Depth of Overburden: Thin (<20 cm) vs. Thick (>20 cm)



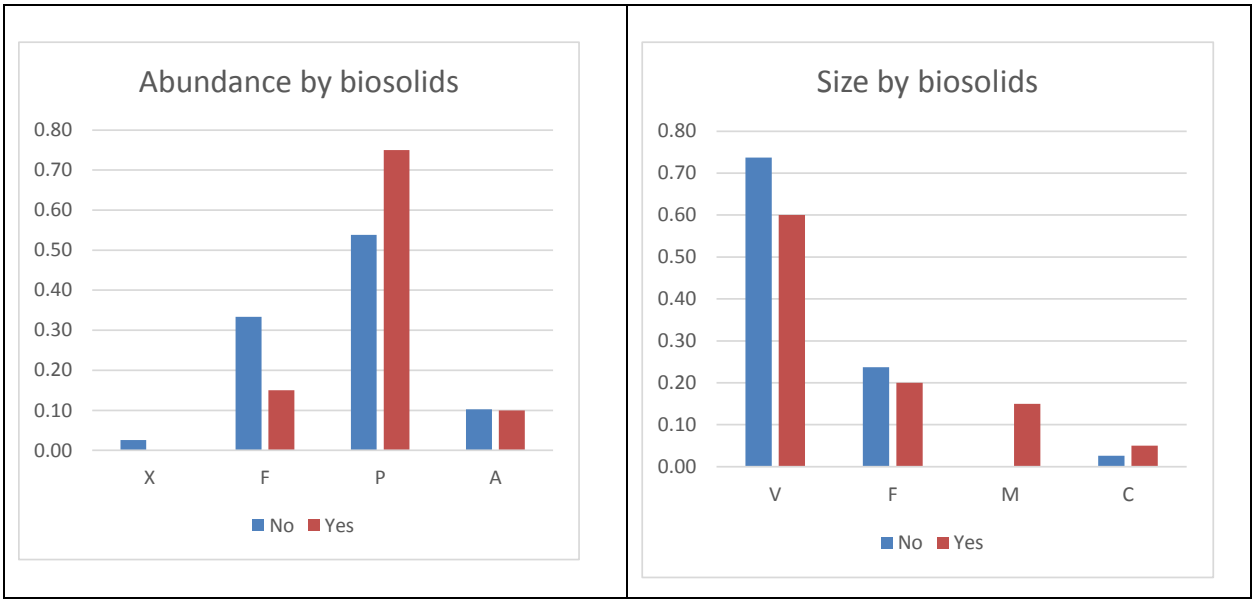
Note: Y axis is the proportion of the total # of observations in each category (0.5 = 50%).
Root abundance: X none, F few, P plentiful, A abundant.
Root size: V very fine, F fine, M medium, C coarse
See Table 3 for root abundance and size class codes.

5.5 Root abundance and size with and without amendment with biosolids

The following observations were made on root abundance and size with and without biosolids on plots (Figures 11 and 12).

- Plots receiving biosolids may have slightly more roots.
- Plots receiving biosolids may have slightly bigger roots.

Figures 11 and 12. Root Abundance and Size on Plots with and without Biosolids



Note: Y axis is the proportion of the total # of observations in each category (0.5 = 50%).
Root abundance: X none, F few, P plentiful, A abundant.
Root size: V very fine, F fine, M medium, C coarse
See Table 3 for root abundance and size class codes.

5.6 Root abundance and size with and without tailings

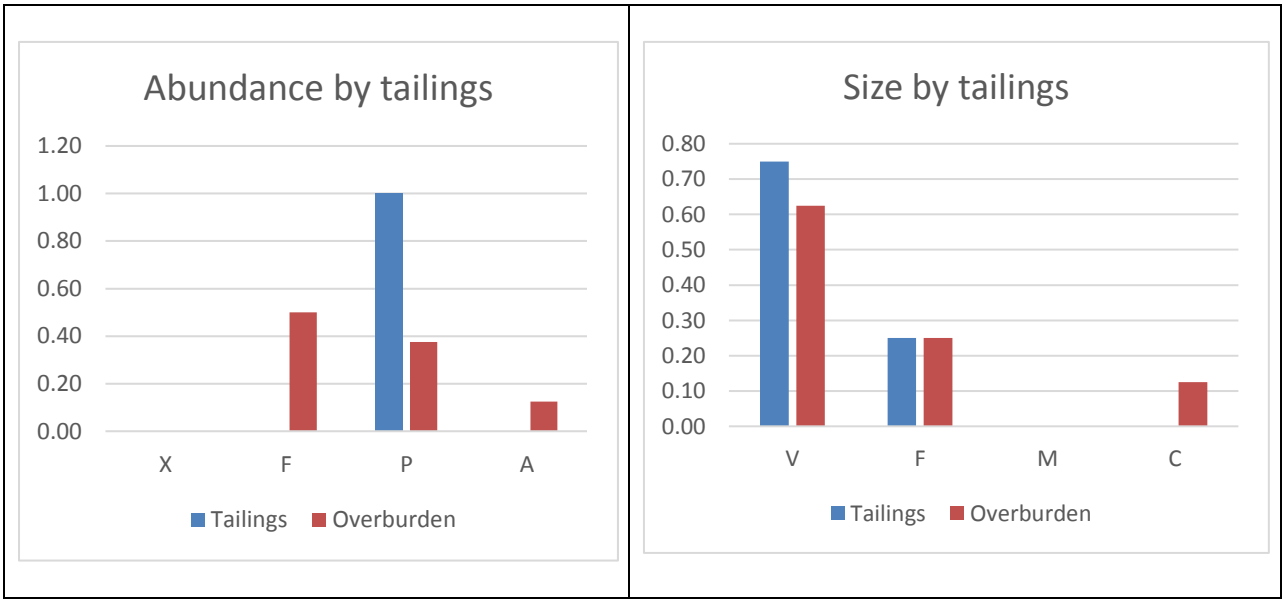
One plot (M) was amended with a combination of 20 cm tailings, 20 cm overburden and 75 dry tonnes per hectare of biosolids. Root abundance and size on this plot were compared with two plots amended with 40 cm of overburden (H and L) but no biosolids.

The following observations were made on root abundance and size with and without tailings on plots (Figures 13 and 14).

- The plot amended with tailings had slightly more roots than plots with an equivalent depth of overburden.
- The plot amended with tailings had slightly more very fine roots and fewer coarse roots than the plots with an equivalent depth of overburden.

It should be noted that this comparison is based on one plot amended with tailings, and that the plot also was amended with biosolids. The combination of tailings and biosolids are likely to have contributed to the higher root abundance and smaller root size on the plot as compared with overburden alone.

Figures 13 and 14. Root Abundance and Size on Plot with Tailings and Overburden



Note: Y axis is the proportion of the total # of observations in each category (0.5 = 50%).
Root abundance: X none, F few, P plentiful, A abundant.
Root size: V very fine, F fine, M medium, C coarse
See Table 3 for root abundance and size class codes.

5.7 Conclusions about root abundance and density

The root abundance and size assessment did not identify any significant differences in root abundance or size with depth of overburden, location on the site (slope vs. flat), depth of sampling or between tree species. Very fine roots (<1mm in size) were the most abundant roots throughout the site. There was slightly more variability in root abundance in the surface layer than in the deeper root layer. Trees on

the slope may have had slightly more roots and a slightly smaller root size than those on the flat. Trees on plots amended with biosolids may have had slightly more roots and of a slightly larger size than those on plots amended with overburden only.

It should be noted that the one obvious difference in rooting density was between the control plots and all other plots. On control plots, the overall root density was much lower than on all other plots. This was not identified during the root density and size assessment because only one measurement was made per depth on each plot.

6. Surface Materials

Phase I area (1998/9 plots on dump top): the plots in this area with the exception of the control plot (treatment A) had almost closed canopies so there was very little grass, shrub or herb cover on the plots (Table 1). The surface material on all overburden-amended plots was a 1 cm layer or less of needles, moss and organics, typical of a young forest floor (Photo 15). There was very little thatch observed such as develops on a site with a permanent grass stand.

On the biosolids plots, especially treatments D and E, there was a 3-10 cm black organic layer made up of roots and vegetative material with a 1 cm or deeper layer of needles on top of it (Photo 16). On these plots biosolids had been applied as a surface layer. On the plot that had been amended with biosolids plus overburden and tailings, there was a 1-3 cm brown organic layer at the surface, suggesting that the biosolids had been incorporated on this plot.

On the control plot (treatment A) there was virtually no surface layer (Photo 5).

Phase II area (2000 plots on waste rock slope): the plots in this area that had received biosolids (treatments Q, R and S) had a noticeably deeper (2-3 cm) surface organic layer than non-biosolids plots and the layer was composed primarily of grass thatch (Table 1 and Photo 17). Plots amended with overburden only (treatments T and U) had a 1-2 cm deep surface layer of organic matter, consisting of grass thatch in areas without trees and moss and needles in areas with trees (Photo 18). The plots that had been amended with biosolids had had significantly greater tree mortality than those without. The plots had all been seeded with domestic grasses as ground cover. The grasses apparently have flourished more on the biosolids plots because of the nutrients contained in the biosolids and the spaces created by tree mortality. This appears to be the reason that the surface organic layer is much better developed on biosolids-amended plots in this area.

The presence of a surface layer dominated by grasses on some plots should not negatively impact the ability of the site to support trees in the future. The grass thatch represents an important reservoir of organic material and nutrients that will contribute to the formation of soil on the site. The main concern with a dense surface grass layer is the difficulty tree seedlings have in establishing on such a site due to competition from the grass for nutrients and moisture. Short-term vegetation control on this type of site may be required until tree seedlings grow tall enough to out-compete the grass.

Photos 15 and 16. Surface materials on overburden and biosolids-amended plots in Phase I area (dump top)

	Surface layer: Plot B -15 cm overburden: 1-2 cm layer of needles at the surface.
	Surface layer: Plot D - 15 cm overburden + 75 dt/ha biosolids: 10 cm layer of black organics with a 1 cm needle and moss layer on the surface.

Photos 17 and 18. Surface materials on overburden and biosolids amended plots in Phase II area (waste rock slope)

	
Plot S – 30 cm overburden plus 50 dt/ha biosolids with thick grass stand on surface.	Plot T – 30 cm overburden with 1-2 cm moss, grass and needles on surface.

7. Conclusions

Rooting depth

The rooting depth of fir and pine trees was assessed on 16 plots of the tree trial. This represented a total of 14 different treatments with a combination of several different depths of overburden ranging from 0 to 65 cm, several rates of biosolids ranging from 50 to 150 dry tonnes per hectare and one depth of tailings (20 cm), and included plots on the flat dump top and on the waste rock slope.

Waste rock: the root systems of both fir and pine trees growing on waste rock alone extended up to 60 cm into the waste rock, but root systems were very small and poorly developed.

Overburden: In general, the root systems of both fir and pine trees on the tree trial site extended to the depth of overburden placed on the site provided that the overburden was a minimum of 25 cm in depth. When overburden was 15 cm deep, root systems extended through the overburden and 10 to 15 cm into the waste rock below. This suggests that these species need a minimum rooting depth of 25 to 30 cm for normal root development and if this is provided by the overburden, they will not send roots into the waste rock. If the overburden layer is insufficient, they will extend roots a short distance into the waste rock.

Biosolids: Biosolids in combination with 15 cm of overburden substantially increased the rooting depth on the plots located on the dump top, but did not impact rooting depth on the waste rock slope. The reasons for this are not known. Biosolids amendment of waste rock (without overburden) significantly increased root production but not rooting depth.

Tailings: One plot in the tree trial was amended with both tailings and overburden. This plot was also amended with biosolids. Roots of both species were found well distributed throughout the tailings and the overburden. Because the plot had been amended with biosolids, it was not possible to determine the effectiveness of the combination of tailings and overburden as a rooting medium without the contribution of nutrients from the biosolids.

Fir vs. pine trees: There was no significant difference in the rooting pattern between species. Fir trees appeared to root slightly deeper than pine trees on the biosolids-amended plots on the dump top but not on the waste rock slope.

Flat vs. slope: With a similar depth of overburden, there was no difference in rooting depth between trees growing on the flat or slope. The exception to this was the presence of biosolids which seemed to increase rooting depth on the flat but not on the slope.

Root abundance and size

Root abundance and size were estimated on a 10 by 10 cm area of roots at the 0 to 10 cm depth and at the 10 to 30 cm depth of soil. The most abundant size of root was identified at each depth and the number of roots of that size visually estimated. A number of different comparisons were made to assess whether root abundance and size varied with treatment or site factors.

The results did not identify any significant differences in root abundance or size with depth of overburden, location on the site (slope vs. flat), depth of sampling or species. Very fine roots (<1mm in size) were the most abundant roots throughout the site. There was slightly more variability in root

abundance in the surface layer than in the deeper sampling layer. Trees on the slope may have had slightly more roots and a slightly smaller root size than those on the flat. Trees on plots amended with biosolids may have had slightly more roots and of a slightly larger size than those on plots amended with overburden only. The plot amended with tailings plus biosolids appeared to have slightly more roots than plots with an equivalent depth of overburden without biosolids, and roots appeared to be of smaller size.

Composition of soil surface materials

Waste rock (control) plots: on control plots (trees planted into waste rock) the surface layer was virtually non-existent. There was also very little ground cover vegetation on control plots.

Overburden-amended plots: on all plots amended with overburden, the surface layer consisted of a 1 cm or less layer of needles and moss, typical of a young forest floor. There were also areas on most plots with no surface cover where rock was visible. On many plots, the trees at 15 years of age had grown to provide a closed canopy on the site. On these plots understory vegetation consisted of moss with a small amount of grass, herbs and small shrubs. The exception to this was in areas of the plots on the waste rock slope where significant tree mortality had occurred leaving large gaps. In these areas, the plot vegetation was predominately grasses and the surface layer was a 1-2 cm layer of thatch more typical of a young grassland soil.

Biosolids-amended plots: on the biosolids-amended plots on the waste rock slope, the surface layer was a 2-3 cm brown organic layer consisting of grass thatch, significantly deeper than on non-biosolids plots. On the surface-applied biosolids plots on the dump top, there was a dramatic 3-10 cm black organic surface layer composed of a thick thatch of tree roots. It appears that biosolids amendment speeds the process of formation of a surface layer, probably by significantly increasing the rate of growth of all vegetation on the site.

8. Findings relevant to future tree plantings on waste rock dumps

1. Root systems of trees planted directly into waste rock with no amendment (overburden or biosolids) are very small and poorly developed. This is clearly not a suitable growing medium for conifers.
2. Waste rock does not appear to be a physical or chemical barrier to tree root growth. On several plots tree roots extended well into the waste rock. It seems to be the lack of moisture and nutrients in the waste rock that discourages root growth.
3. Overburden is the preferred rooting medium for the trees on site. Trees planted on sites with 25 cm or more of overburden had roots primarily in the overburden. Tree roots exploited the whole depth of overburden, even at the deepest depth of 65 cm. Trees planted on sites with 15 cm of overburden had roots throughout the overburden and extending 10 to 15 cm into the waste rock below. This suggests that the trees on site required a minimum rooting depth of 25 to 30 cm for normal root development and that this can be provided by overburden or a combination of overburden and waste rock.
4. Tailings in combination with overburden and biosolids also provided an excellent root growing medium, equivalent to overburden. Trees utilized the whole depth of overburden + tailings for

root growth. It is not known whether tailings without biosolids and/or overburden would be an equally good rooting medium.

5. Biosolids are also very effective at enhancing rooting of trees. If overburden is unavailable, biosolids at a minimum of 50 dry tonnes per hectare provide a similar degree of rooting enhancement as does 15 to 30 cm of overburden.
6. There was no difference in root abundance and size (with the obvious exception of trees on control plots) with differing depths of overburden, between tree species or on flat vs. sloping waste rock. Amendment with biosolids may have produced slightly higher root abundance and size. Amendment with tailings may have produced slightly higher root abundance and roots of smaller size than overburden alone; this plot was also amended with biosolids which may have contributed to the enhanced rooting.
7. Amendment with biosolids appears to enhance the development of the surface layer, but also increases grass growth which has potential to cause higher tree mortality.

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APPENDIX G:

2014 ABR SUMMARY REPORT

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Annual Anaerobic Biological Reactor Review

2014

INTRODUCTION

In 2008, a partnership was established between Mount Polley Mining Corporation (MPMC) and Sue Baldwin of the University of British Columbia (UBC) Chemical and Biological Engineering Department, with support from Genome BC, to collaborate on the project *The development of genomic tools for monitoring and improving passive mitigation of mine drainage*.

To implement this project, a 100 gallon per minute (GPM) anaerobic biological reactor (ABR) was commissioned and constructed at Mount Polley Mine in December 2009. The objective of this ABR is to passively reduce metal and sulphate concentrations through biological activity, thereby providing a better opportunity for meeting water quality discharge requirements. The ABR feed flow is the East Main Toe Drain (MTD) which collects seepage through the Main Embankment of the Tailings Storage Facility (TSF). From the ABR outflow, water passes through a polishing pond before returning to the Main Embankment Seepage Collection Pond (MESCP), from where it is pumped back into the TSF.

TIMELINE

2009

The ABR was commissioned on December 16th, 2009. It was constructed by laying eleven (11) perforated inflow pipes on the bottom of the northwest half of the excavated pond (Figure 1). The pipes and the bottom of the pond were then covered with layers of organic material (manure, woodchips, and straw), which act as a carbon and energy source for microbes. The organic material was sealed in by rocks, which maintain the layer structure and provide microbe habitat, and the rocks were covered with water to act as an oxygen barrier (Figure 2). The system was activated with an inflow of approximately 100 GPM.

2010

The system was active with an estimated 100 GPM until August 11th, when it was shut down for just over one month. From September 20th to the end of October, approximately 10 GPM was reporting to the ABR, with 100 GPM once again flowing through most of November.

2011

The ABR continued to be active at 100 GPM until September, when a propane heating system was commissioned at the ABR inflow, and the inflow was reduced to a rate of 4 GPM. Heat was applied to increase the temperature of inflow water from 7°C to 20°C in hopes of promoting the activity of remedial microbes. The heating system ran until mid-November before being shut off and winterized. After the heating system was shut off, inflow was increased to 50 GPM.

2012

The ABR flow rate was regulated at 50 GPM from January through May, and then was restored to 100 GPM in June. After signing on to Phase II of the project with UBC, MPMC began ABR modifications with the aim of improving metal and sulphate reduction performance. Phase II preparation work involved re-directing the toe-drain feed flow to the MESCP in July and pumping down the ABR in August and September. Upon conclusion of dewatering in October, Phase II modifications to the ABR were completed: a containment berm around the up-flow water intake system was constructed to increase retention time (Figure 3); and the ABR was filled with hay, gravel, woodchips and manure to replenish the microbial content and carbon sources. Re-filling of the ABR commenced in November at a flow rate of 100 GPM.

2013

In 2013, modifications were made to the ABR based on the hypothesis that sulphate is being converted into other forms in the anaerobic environment of the ABR, but reverting back to sulphate upon contact with oxygen, due to a lack of elements or compounds in the water for sluphides to bind to. For this reason, the outlet pipe was modified to draw water from the bottom of the ABR, with the goal of having non-oxygenated water flowing out of the ABR for sampling purposes (Figure 4). In late summer, installation of booms to reduce wind mixing and potentially support a cover in the future was completed. For outflow pipe alterations, on April 9th the inflow was turned down three “notches” and flow through the ABR stopped. The inflow was turned on again in mid-April, and ran at an average of 50 GPM for the remainder of the year.

2014

In 2014, a plan was in place to change the feed water of the ABR to water from the MESCP to allow water with higher metals content to pass through the ABR, because the toe drain water goes through a filtering process when it passes through the TSF seepage system, and is not necessarily representative of typical mine contact water. Increased concentrations of metal ions (specifically iron) were anticipated to improve removal of sulphides, and reduce re-oxidation of suphides into sulphate. After the TSF breach on August 4, 2014 resources were redistributed to breach response measures and the planned work was not completed.

The ABR ran at an average of 66 US GPM based on six (6) flow measurements taken in July through November. It was temporarily turned off from approximately May 29 the July 3, 2014. Discussion of 2014 monitoring and results is included in the following sections.

SAMPLE LOCATIONS

To monitor effects of the ABR on water chemistry, samples are taken at the inflow (ABR-IN or East MTD), within the pond (ABR-INTERFACE), and at the outflow (ABR-OUT). Refer to Figure 5 for a map of sampling locations. All samples are sent to ALS Laboratory in Burnaby for analysis.

From April 2011 to 2013, ABR-IN has been sampled from an inflow port, providing more accurate inflow data then previous samples, which were collected by drawing down the MESCP and sampling the toe drain input below the TSF Main Embankment. Installation of the Hazeltine Creek discharge system in 2013 allowed for the East MTD to be sampled in the winter months when the ABR-IN sample port is shut off and winterized. Ten (10) ABR-IN samples were collected in 2014.

Previously, during non-freezing periods, ABR-OUT was accessed through the gate on the South East side of the ABR and the samples taken in front of the outlet culvert. Since the outlet pipe design change in 2013, all samples are now collected from the winter sampling location on the other side of the Gavin Lake Forest Service Road at the outlet pipe outflow. Eleven (11) ABR-OUT samples were collected in 2014.

ABR-Interface samples are taken at four (4) locations within the body of water in the ABR in the area of the pond where the inflow piping is situated (refer to Figure 5). In 2014 a sample was taken at the bottom of each ABR-Interface location in August, with an extra sample taken at ABR-Interface-4 bottom in January. In addition to samples, in situ parameter profiles are taken at interface locations to measure the changes in pH, conductivity, temperature, and dissolved oxygen through the water column. In 2014, no sampling was completed at the interface or the outflow polishing pond (Duck Pond).

RESULTS AND DISCUSSION

ABR-IN and ABR-OUT

Results for individual samples taken in 2014 at ABR-IN and ABR-OUTare presented in Tables 1 and 2, respectively. A comparison of average results for key parameters at ABR-IN and ABR-OUT is presented in Table 3. Highlighted cells indicate an increase in a parameter, and red text indicates exceedance of a BC Water Quality Guideline for Aquatic Life (BCWQG). Parameters of interest are reviewed below.

- Sulphate*:* Sulphate levels at ABR-OUT were consistently lower than levels at ABR-IN, with an average decrease of 41 mg/L (8%) to an average outflow value of 475 mg/L. All result but one result at ABR-OUT were above the hardness based BCWQG of 429 mg/L.

- Nitrate: Nitrate levels at ABR-OUT were consistently lower than levels at ABR-IN, with and average decrease of 1.48 mg/L (88%). All results were below the BCWQG.

- Phosphorus (Total): ABR-OUT reported consistently higher values of total phosphorus, with an average increase 0.016 mg/L (49%) to an average outflow value of 0.049. It is of note that ABR-OUT total phosphorus concentrations were lower than ABR-IN levels from May through October, with levels being higher during the winter months. There is no BCWQG for aquatic life in creeks; however, the average total phosphorus concentration in the discharge receiving environment of Hazeltine Creek prior to the TSF breach was 0.02 mg/L.

Noted increases through the system in phosphorus and iron (and in past years manganese) may potentially related to a process observed in the hypolimnion (lower anoxic layer) of lakes, where phosphorus bound to iron (and manganese) is released from sediments in anaerobic conditions when Fe^{3+} is reduced to Fe^{2+}, which forms soluble complexes. As Fe^{2+} moves from the sediments into the water column, phosphorus also follows into its dissolved form. This process can be promoted by the presence of sulphates, which can be reduced into hydrogen sulphide in anaerobic conditions and then form complexes with iron, replacing the phosphorus and creating iron sulphide. The phosphorus is then released from the sediment and enters the water column[1].

- Aluminum (Dissolved): All results at the inflow and outflow were below the lab method detection limit (MDL) except January 23rd at ABR-OUT. This results in an average decrease of 0.0002 mg/L (10.9%). All results were below the BCWQG.

- Cadmium (Total): Four (4) cadmium results were above the MDL, and all remaining inflow and outflow results were below the MDL. An average decrease of 0.00006 mg/L (81%) was calculated and all results were below BCWQG.

- Copper (Total): Copper levels were consistently lower at ABR-OUT than ABR-IN, resulting in an average decrease of 0.0047 mg/L (81%). All results were below the BCWQG.

- Iron (Total): Iron concentrations were consistently lower at ABR-IN than ABR-OUT. An average increase of 0.029 mg/L (64%) was observed.

- Molybdenum (Total): Molybdenum concentrations were consistently lower at ABR-OUT than at ABR-IN, with an average decrease of 0.099 mg/L (46%). All results were below the BCWQG.

[1] Wetzel, R. G. (2001). *Limnology, Third Edition: Lake and River Ecosystems* (3 edition.). San Diego: Academic Press.

- Selenium (Total): Selenium results were consistently lower at ABR-OUT and ABR-IN, with an average decrease of 0.0047 mg/L (71%). This results in a decrease from above the BCWQG at ABR-IN to below the guideline at ABR-OUT.

ABR Interface

Result from 2014 ABR interface samples are presented in Table 4 and dissolved oxygen profile results from ABR-INTERFACE-4 are presented in Figure 6. Field test results indicate that:

1. A reducing environment is present at the bottom of the ABR interface sample locations (dissolved oxygen levels are very low), but not at the surface (dissolved oxygen levels are high) during non-freezing months.
2. A reducing environment is present through the majority of the water column at ABR interface sample locations when the pond is frozen over.
3. Sulphides are present at the interface, which means that sulphate reducing bacteria are present, and sulphate is being reduced to sulphides.
4. Sulphate levels are slightly lower in ABR interface samples than at ABR-IN, but sulphate is not being reduced to the desired level and/or sulphate is being reduced, but is re-oxidizing immediately upon contact with oxygen, before field tests are able to be conducted.

Winter Conditions

In situ and lab results for ABR-OUT (refer to Table 2) showing the presence of sulphides only during winter indicate that when an ice cover is on the ABR, sulphate reducing bacteria (which function better in an anaerobic environment) convert higher levels of sulphate to sulphides. A strong sulphur smell observed in winter suggests that some of the sulphides created are released as H_2S gas. The low sulphate field test results from January 2014 in ABR-INTERFACE-4 bottom samples preserved with zinc acetate, which binds with suphides, further indicates that sulphate is being reduced. However, similar concentrations of sulphate at ABR-IN and ABR-OUT year round supports the hypothesis that sulphides are re-oxidizing upon contact with oxygen and sulphate is not permanently removed from the water as desired.

Comparison with 2010 – 2013 Results

Refer to Table 5 for a comparison of ABR results from 2010 to 2014. Over this period, change in concentration of many parameters due to ABR activity has remained relatively constant. This includes sulphate, nitrate, arsenic (total), magnesium (total), and selenium (total). Larger fluctuations have been observed for total manganese with no evident trends. General trends of improvements in reduction of total copper, and molybdenum have been noted since 2010. Manganese levels did not show increases like last year, and phosphorus levels did not increase through the system as much as in 2013.

Results for a number of parameters including dissolved aluminum, total cadmium, total iron, total lead, total nickel, and total zinc are typically below or close to the MDL, making trends difficult to detect.

CONCLUSIONS AND RECOMMENDATIONS

Results from 2014 monitoring indicate that all water quality parameters at the outflow of the ABR meet BCWQG for aquatic life, except for sulphate. They suggest that in the reducing environment at the bottom of the ABR and through the water column in winter when the ABR is covered with ice, sulphate reducing bacteria are reducing sulphate to sulphides, however a lack of iron or other metals for sulphides to complex with results in reoxidation to sulphate upon contact with oxygen. The lack of available iron may also be resulting in an increase of phosphorus through the system, because in the anaerobic conditions iron bound to phosphorus in the bottom sediments is reduced and becomes soluble. The soluble iron is then available to complex with sulphides that are present, while phorphorus remains in the water column.

Recommendations to improve sulphate reduction in the ABR are to:

- Create a cover on the ABR (potentially using the booms installed in 2013 as anchors to develop a vegetative cover) and prevent oxygen from entering the system, creating an anaerobic environment year round, similar to when ice forms over the system, to promote activity of suphate reducing bacteria.
- Change the ABR water source to site contact water with higher levels of metals, and/or install a port to allow addition of iron into the system (at appropriate levels based on stoichiometric calculations). This is expected to provide more metal ions to bind to sulphides, preventing re-oxidation into sulphate.

TABLES AND FIGURES

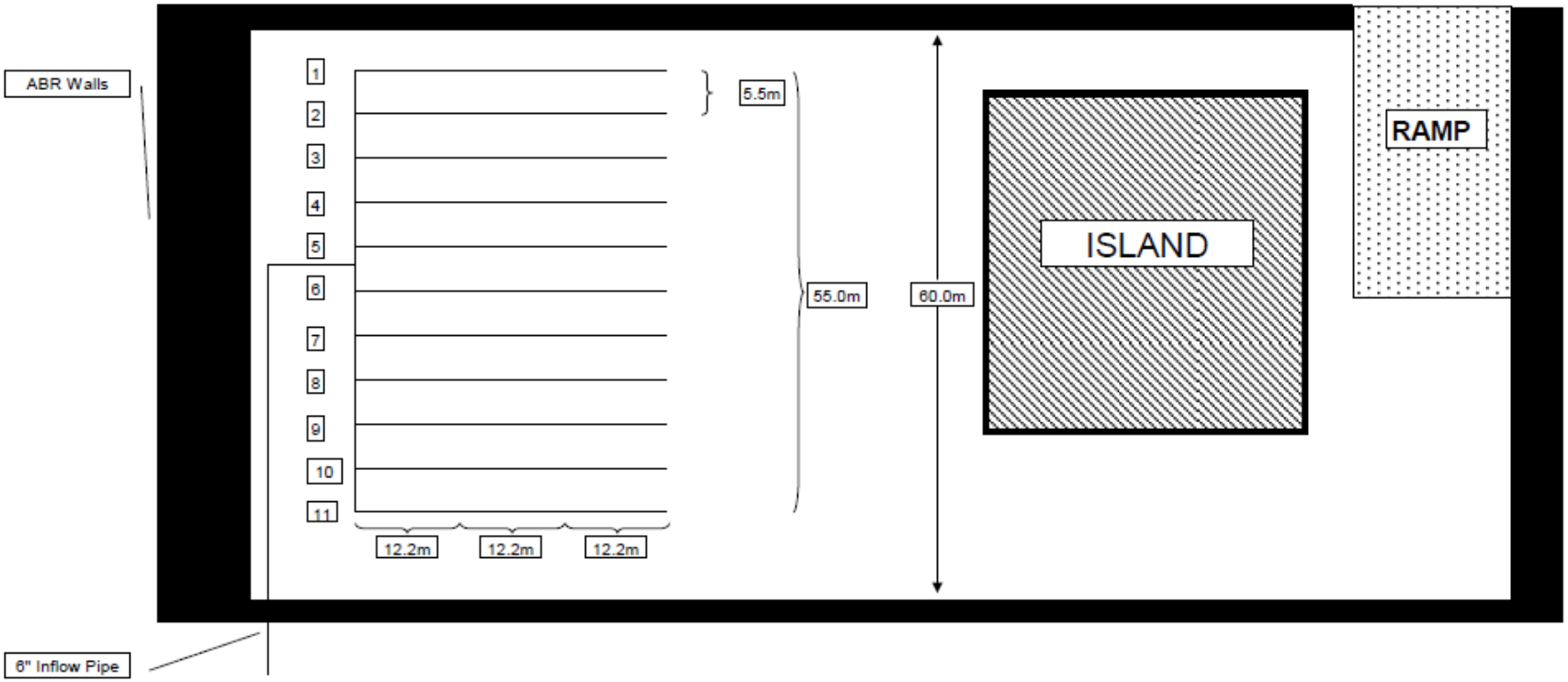


Figure 1: ABR piping layout design

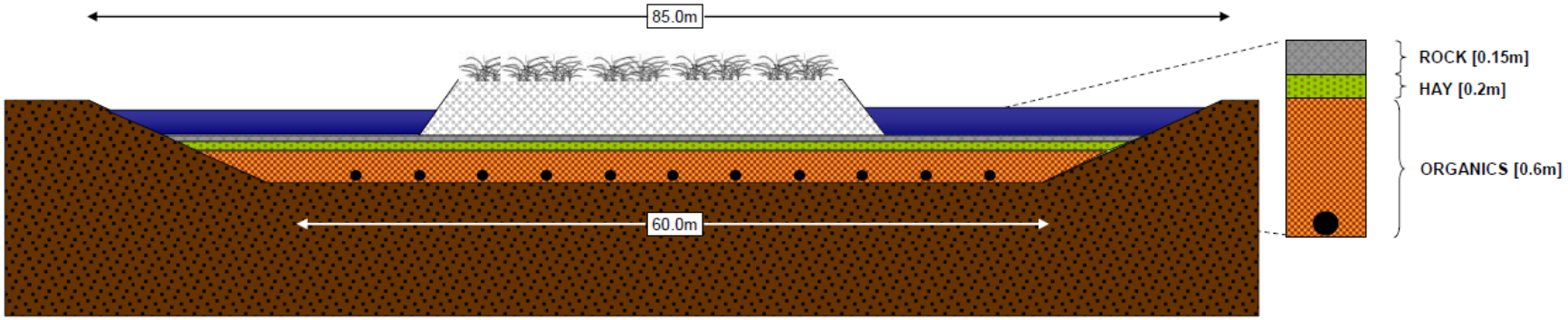


Figure 2: ABR material layering design

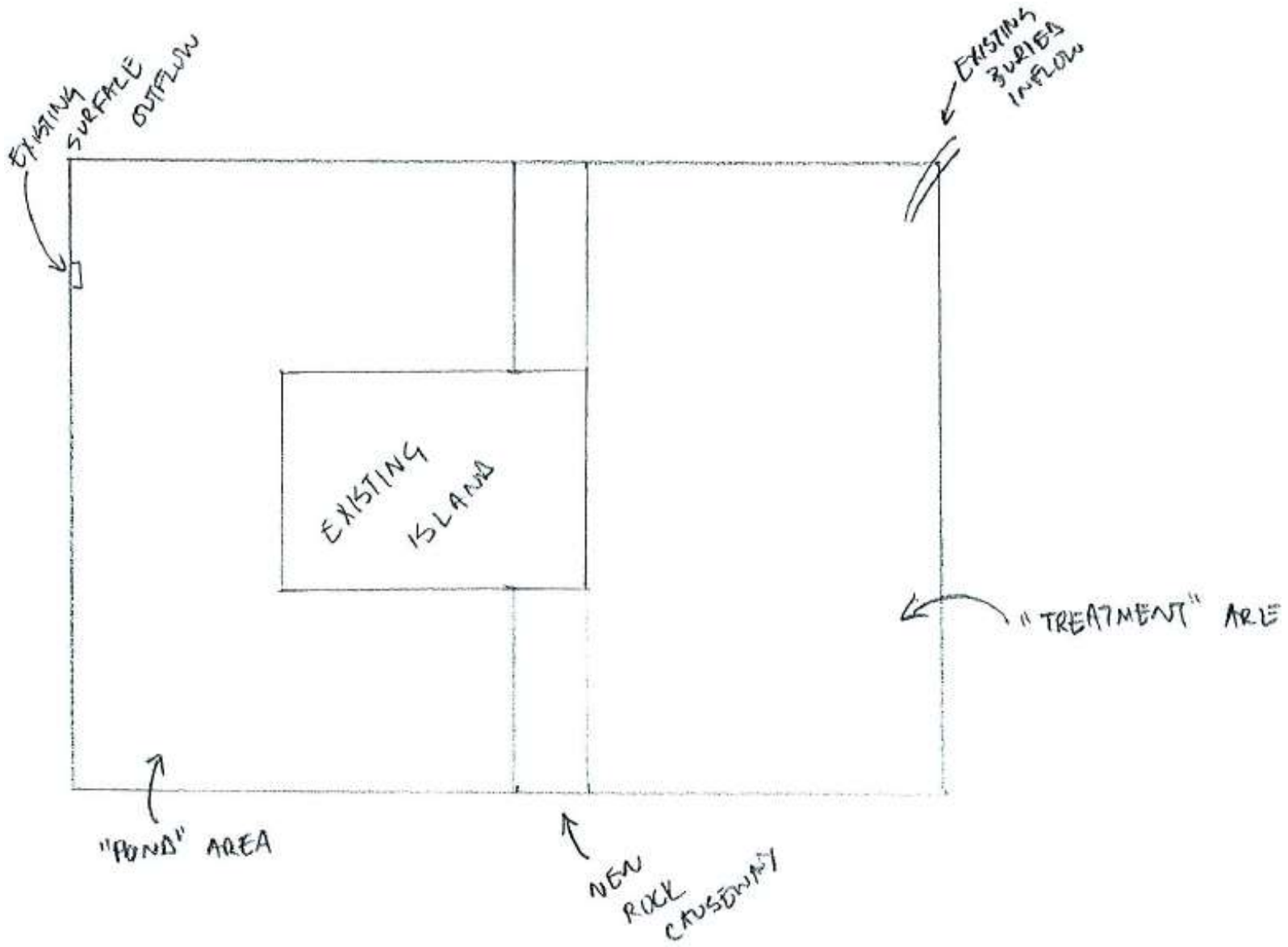


Figure 3: ABR containment berm design

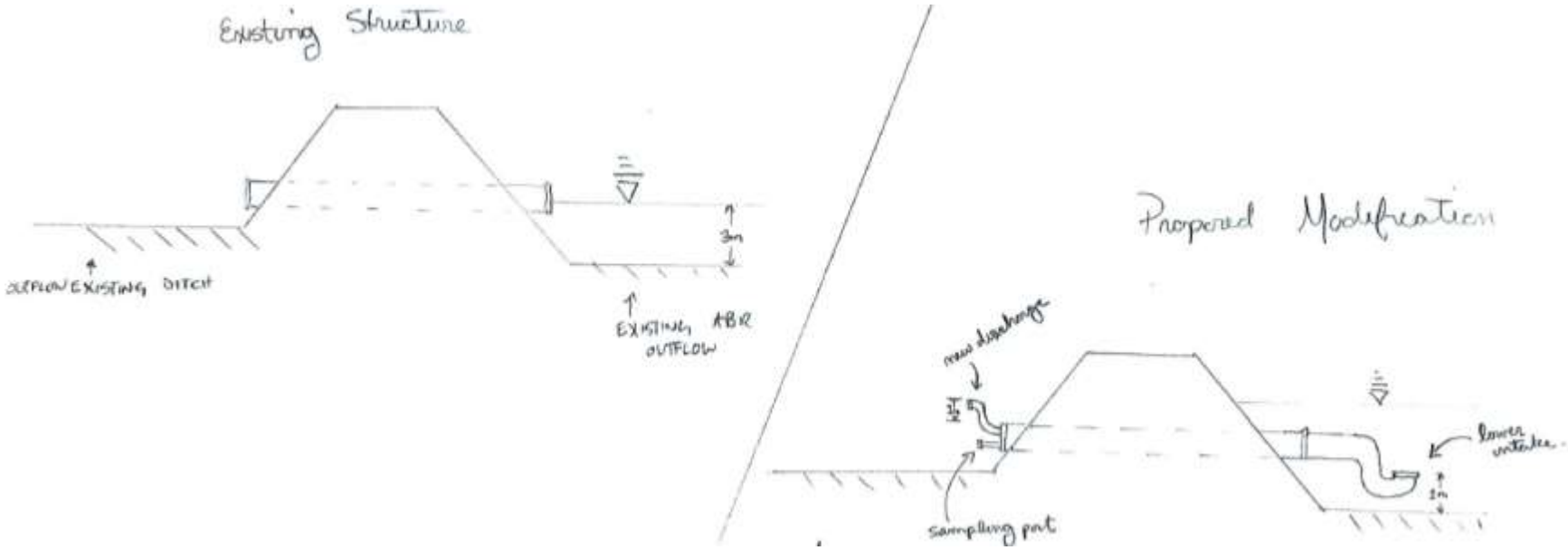


Figure 4: ABR discharge structure modifications



Figure 5: ABR sample locations

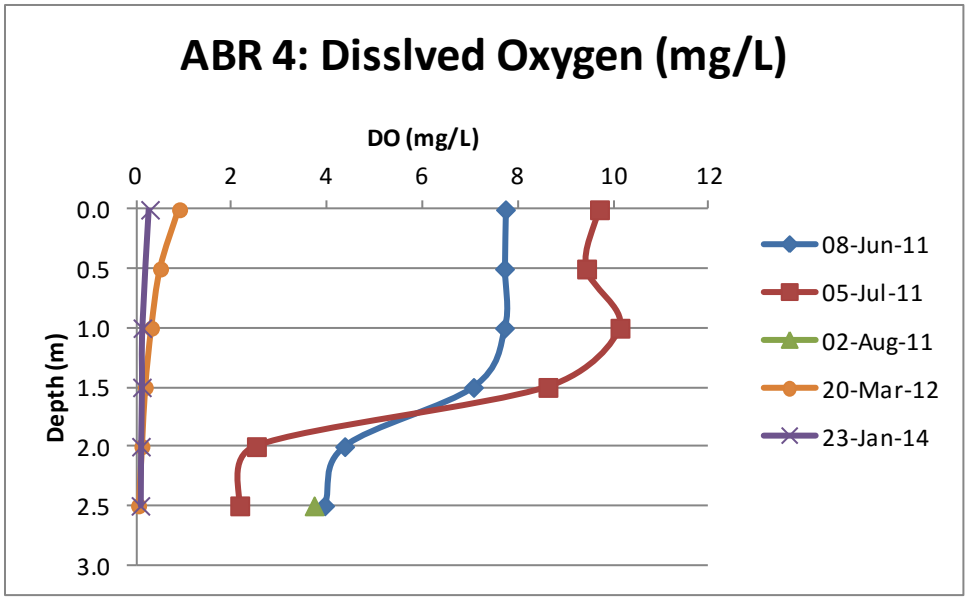


Figure 6: Dissolved oxygen field readings from ABR-INTERFACE-4

Table 1: ABR-IN 2014 sample results

Parameter	7-Jan-14	11-Feb-14	4-Mar-14	3-Apr-14	1-May-15	3-Jun-14	28-Aug-14	15-Oct-14	5-Nov-14	8-Dec-14
Sulfate (SO_4) (mg/L)	526	532	528	532	523	513	509	503	503	488
Nitrate (as N) (mg/L)	1.67	1.84	1.86	1.92	1.89	2.26	1.85	1.51	1.24	0.871
Phosphorus (Total) (mg/L)	0.0315	0.0353	0.0322	0.0308	0.0326	0.0259	0.0352	0.0326	0.0288	0.0415
Aluminum (Dissolved) (mg/L)		0.0031	0.0015	0.0015	0.0015	0.0032	0.0015	0.0015	0.0015	0.0015
Arsenic (Total) (mg/L)	0.00173	0.00164	0.0016	0.0017	0.00168	0.00197	0.00178	0.00184	0.00186	0.00233
Cadmium (Total) (mg/L)	0.00006	0.000055	0.00006	0.000105	0.000175	0.000065	0.00006	0.000034	0.000046	0.000058
Copper (Total) (mg/L)	0.00353	0.00374	0.0035	0.0151	0.00362	0.011	0.00464	0.0044	0.00434	0.00414
Iron (Total) (mg/L)	0.015	0.015	0.015	0.051	0.015	0.112	0.034	0.030	0.032	0.126
Lead (Total) (mg/L)	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025
Magnesium (Total) (mg/L)	23.5	23.7	22.6	23.9	22.5	22.2	22.7	21.4	21.6	19.7
Manganese (Total) (mg/L)	0.622	0.632	0.599	0.592	0.620	0.505	0.591	0.564	0.568	0.565
Molybdenum (Total) (mg/L)	0.213	0.215	0.223	0.210	0.215	0.214	0.227	0.208	0.217	0.197
Nickel (Total) (mg/L)	0.00025	0.00054	0.00062	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025	0.00025
Selenium (Total) (mg/L)	0.00642	0.00736	0.00729	0.00762	0.00792	0.00881	0.00714	0.00542	0.00469	0.00355
Zinc (Total) (mg/L)	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0129	0.0144	0.0126	0.0015

Note: Values below MDL are represented as 0.5*MDL

Table 2: ABR-OUT 2014 sample results

Parameter	7-Jan-14	23-Jan-14	18-Feb-14	4-Mar-14	3-Apr-14	1-May-14	8-Jul-14	14-Aug-14	28-Aug-14	14-Oct-14	5-Nov-14
Sulphate (SO_4) (mg/L)	464	463	493	462	498	395	483	483	515	496	474.0
Sulphate (in situ) mg/L)		100									
Sulfides (mg/L) - Preserved with Zn-Acetate	8.2	11.9	10.3	8.3	7.8	0.01	0.01	0.01	0.01	0.01	0.01
Sulphides (in situ) (mg/L)		3	5.5 - 6	6		0	0		0	0	
Nitrate (as N) (mg/L)	0.075	0.025	0.025	0.025	0.025	1.91	0.136	0.025	0.025	0.025	0.025
Phosphorus (Total) (mg/L)	0.0837	0.0829	0.0758	0.076	0.0615	0.0192	0.0197	0.0253	0.0228	0.0229	0.0444
Aluminum (Dissolved) (mg/L)	0.0015	0.0033	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015
Arsenic (Total) (mg/L)	0.00117	0.00117	0.00107	0.00116	0.00111	0.001	0.00128	0.00147	0.00108	0.00092	0.00105
Cadmium (Total) (mg/L)	0.00002	0.000025	0.000015	0.00002	0.000015	<0.00010	0.000025	0.000005	0.000005	0.000005	0.000005
Copper (Total) (mg/L)	0.00057	0.00089	0.00054	0.00077	0.00133	0.00221	0.00238	0.00076	0.00053	0.00081	0.00148
Iron (Total) (mg/L)	0.052	0.05	0.039	0.044	0.075	0.09	0.139	0.083	0.053	0.089	0.089
Lead (Total) (mg/L)	0.000025	0.000025	0.000025	0.000025	0.000025	0.000025	0.000051	0.000025	0.000025	0.000025	0.000025
Magnesium (Total) (mg/L)	21.8	21.9	21.2	22.8	23.3	19.1	22.2	23.6	24	21.5	22.4
Manganese (Total) (mg/L)	0.948	0.909	0.768	0.778	0.745	0.283	0.308	0.501	0.253	0.329	0.216
Molybdenum (Total) (mg/L)	0.113	0.105	0.129	0.123	0.121	0.16	0.119	0.0848	0.094	0.103	0.111
Nickel (Total) (mg/L)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Selenium (Total) (mg/L)	0.001	0.000	0.000	0.000	0.001	0.010	0.003	0.002	0.002	0.001	0.002
Zinc (Total) (mg/L)	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015

Note: Values below MDL are represented as 0.5*MDL

* Preserved with An-Acetate

Table 3: Comparison of 2014 ABR-IN and ABR-OUT average results

Parameter	BCWQG 30-day Average	BCWQG Max	ABR-IN	ABR-OUT	Decrease	% Reduction
Sulfate (SO_4) (mg/L)	429	-	516	475	41	7.9
Nitrate (as N) (mg/L)	3.0	32.8	1.691	0.211	1.480	87.5
Phosphorus (Total) (mg/L)	-	-	0.0326	0.0486	-0.0159	-48.8
Aluminum (Dissolved) (mg/L)	0.05	0.10	0.0019	0.0017	0.0002	10.9
Arsenic (Total) (mg/L)	-	5.0	0.0018	0.0011	0.0007	37.4
Cadmium (Total) (mg/L)	0.605*	2.52*	0.00007	0.00001	0.00006	80.5
Copper (Total) (mg/L)	0.016*	0.041*	0.00580	0.00112	0.00469	80.8
Iron (Total) (mg/L)	-	1.0	0.045	0.073	-0.029	-64.0
Lead (Total) (mg/L)	0.023*	0.045*	0.00003	0.00003	0.00000	-9.5
Magnesium (Total) (mg/L)	-	-	22.4	22.2	0.2	1.0
Manganese (Total) (mg/L)	2.4*	5.1*	0.586	0.549	0	6.3
Molybdenum (Total) (mg/L)	1.0	2.0	0.214	0.115	0.099	46.3
Nickel (Total) (mg/L)	-	0.15	0.00032	0.00025	0.00007	20.9
Selenium (Total) (mg/L)	-	0.0020	0.0066	0.0019	0.0047	70.6
Zinc (Total) (mg/L)	0.249*	0.275*	0.005	0.002	0.004	70.2

Note: Values below MDL are used in calculations as 0.5*MDL

*calculation based on average ABR-OUT hardness of 412 mg/L

Table 4: ABR-Interface bottom 2014 results

Parameter	ABR-Interface-1 26-Aug-14	ABR-Interface-2 26-Aug-14	ABR-Interface-3 26-Aug-14	ABR-Interface-4 23-Jan-14	ABR-Interface-4 26-Aug-14
Sulphate (SO_4) (mg/L)	512	508	510	484	504
Sulphate (in situ) (mg/L)	442	423	399	375	50/90*
Sulfides (mg/L) - Preserved with Zn-Acetate					13.4
Sulfides (in situ) (mg/L)	0	60	180	40-50	3
Nitrate (as N) (mg/L)	0.025	0.102	0.025	0.025	0.025
Phosphorus (Total) (mg/L)	0.155	0.0614	0.0742	0.0595	0.0217
Aluminum (Dissolved) (mg/L)	0.0015	0.0015	0.0015	0.0015	0.0015
Arsenic (Total) (mg/L)	0.00535	0.00115	0.00093	0.00108	0.00098
Cadmium (Total) (mg/L)	0.0001	0.000025	0.000025	0.000025	0.000005
Copper (Total) (mg/L)	0.109	0.0031	0.00123	0.00218	0.00025
Iron (Total) (mg/L)	7.27	0.155	0.106	0.063	0.034
Lead (Total) (mg/L)	0.00193	0.000025	0.000025	0.000055	0.000077
Magnesium (Total) (mg/L)	25.1	22.1	22	21.6	22.2
Manganese (Total) (mg/L)	0.794	0.494	0.643	0.707	0.624
Molybdenum (Total) (mg/L)	0.575	0.151	0.131	0.139	0.144
Nickel (Total) (mg/L)	0.00677	0.00025	0.00025	0.00025	0.00025
Selenium (Total) (mg/L)	0.0274	0.00401	0.002	0.00063	0.00225
Zinc (Total) (mg/L)	0.0573	0.0015	0.0015	0.0074	0.0015

Note: Values below MDL are represented as 0.5*MDL

* Preserved with Zn-Acetate

Table 5: Comparison of ABR results from 2010 to 2014

	2010		2011		2012		2013		2014	
Parameter (mg/L)	**Decrease**	**% Reduction**	**Decrease**	**% Reduction**	**Decrease**	**% Reduction**	**Decrease**	**% Reduction**	**Decrease**	**% Reduction**
Sulphate (Dissolved)	71.0	14.9	-28.2	-6.0	59.0	12.3	65	12.9	41	7.9
Nitrate (as N)	1.9	98.4	1.2	97.9	0.8	92.1	1.343	97.9	1.480	87.5
Phosphorus (Total)	0.000	0.0	0.024	42.9	-0.001	-2.2	-0.1694	-487.7	-0.0159	-48.8
Aluminum (Dissolved)	0.0002	12.0	0.0004	19.6	-0.0004	-20.7	-0.0008	-44.4	0.0002	10.9
Arsenic (Total)	-0.0005	-32.2	0.0004	22.8	0.0008	34.6	-0.0008	-48.1	0.0007	37.4
Cadmium (Total)	0.00005	26.2	0.00004	63.8	0.00004	55.7	0.00004	61.0	0.00006	80.5
Copper (Total)	-0.0007	-23.3	0.0022	50.9	0.0015	33.9	0.00440	64.7	0.00469	80.8
Iron (Total)	-0.139	-929.3	-0.054	-119.6	-0.011	-8.9	-0.112	-102.9	-0.029	-64.0
Lead (Total)	-0.000003	-5.2	0.000263	91.3	0.000263	87.1	0.00005	51.8	0.00000	-9.5
Magnesium (Total)	0.61	3.0	-1.76	-8.2	0.39	1.8	-1.3	-6.2	0.2	1.0
Manganese (Total)	-0.091	-13.3	0.310	28.5	-0.067	-7.6	-0.8	-133.3	0.037	6.3
Molybdenum (Total)	0.049	29.7	0.047	25.3	0.052	28.4	0.108	53.4	0.099	46.3
Nickel (Total)	-0.0013	-230.4	0.0005	54.8	0.0007	66.1	-0.00010	-20.1	0.00007	20.9
Selenium (Total)	0.0022	70.7	0.0008	44.8	0.0015	60.7	0.0048	84.7	0.0047	70.6
Zinc (Total)	0.0008	34.8	0.0021	44.9	0.0024	32.1	0.009	86.1	0.004	70.2

APPENDIX H:

2012 NEZ DUMP RECLAMATION ASSESSMENT

Mount Polley Mining Corporation
August 2012

NEZ Dump Reclamation Assessment – Year 2

Background information

The NEZ Dump is an 80 ha area at Mount Polley Mine, just west of Polley Lake. In September 2010, re-vegetation reclamation research was initiated on 5 ha of this eastern aspect site. Three reclamation treatment units (refer to Figure 1) were established to determine the effectiveness of different soil treatments, seeding rates, and fertilizer rates for re-vegetation. The varying parameters of each treatment unit are described in Table 1.

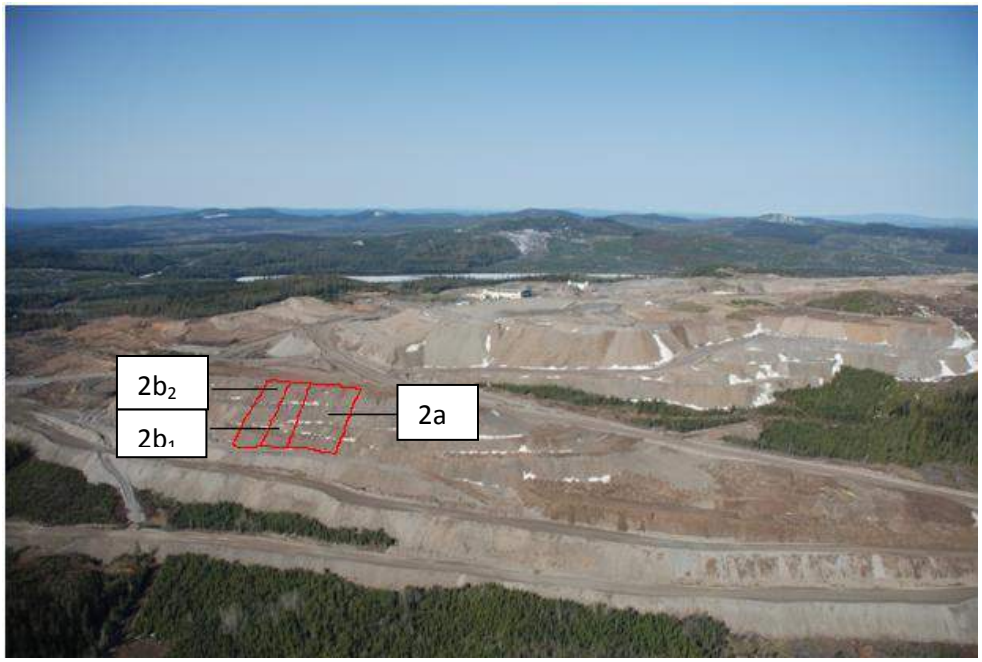


Figure 1. Mount Polley NEZ Dump (May 2008)

Table 1. NEZ Dump reclamation treatment unit parameters

Treatment Unit	Total Hectares	Seed Mixture	Seed Rate (kg/ha)	Fertilizer Rate (kg/ha)	Biosolid Application
2a	2.5	Native	45	283	No
$2b_1$	1.25	Native	34	0	Yes
$2b_2$	1.25	Native	34	71	Yes

Before seeding, biosolids were applied to $2b_1$ and $2b_2$, and then 0.4 m of till was spread on each treatment unit. Unfortunately the till cover was applied on top of the biosolids and not mixed in, so it is unlikely the biosolids will have had an immediate effect on plant growth.

Each treatment unit was hand-seeded with a native seed mixture containing eight (8) grasses (Mountain Brome, Native Red Fescue, Rocky Mountain Fescue, Wheat Grass-Blue Bunch, Blue Wild Rye, June Grass, and Tickle Grass) and two (2) forbs (Fireweed, and Lupins). Individual hand-seed trial plots of each of the nine (9) native seed types were also established in September 2010 on each treatment unit to investigate the re-vegetative success of each species (Figure 2).

It is also important to note that above average precipitation was recorded during spring and early summer in 2011 and 2012 at MPMC, which may have influenced plant growth on the site.

In 2012, fertilizer was applied to the portion of $2b_1$ that lacks soil coverage to increase performance of the vegetation there. A granular fertilizer was applied at a rate of 100 kg/ha to that area. While the vegetation is relatively sparse in this area, it is present and reasonably healthy.



Figure 2. Newly planted NEZ Dump re-vegetation test plots

2012 Tree Planting

Trees and shrubs were planted May and June of 2012 in all 3 treatment units. Live stake willow trials were also completed. Planting targets involved uniform planting coverage with higher density "biodiversity islands" dispersed throughout the planting units. Conifers were planted at a uniform 1800 stems per hectare (SPH) with an additional 200 SPH planted in "biodiversity islands". The deciduous trees and shrubs were planted primarily in the "biodiversity islands" with a minor representation throughout the rest of the treatment units. Table 2 provides details on the quantities of each species planted.

Table 2. Quantities of each tree and shrub species planted on the NEZ Dump in Spring 2012

Species	Quantity	Stems per Ha	Status/Comments
Lodgepole Pine	6500	1300	Very good survival in all units
Douglas Fir	3500	700	Good survival in all units, minor sun scald
Paper Birch	500	100	Moderate suvival overall, good survival in 2a and $2b_1$ poor survival in Unit $2b_2$
Trembling Aspen	500	100	Moderate suvival overall, good survival in 2a and $2b_1$ poor survival in Unit $2b_2$
Black Cottonwood	1000	200	Moderate suvival overall, good survival in 2a and $2b_1$ poor survival in Unit $2b_2$
Sitka Alder	500	100	Moderate suvival overall, good survival in 2a and $2b_1$ poor survival in Unit $2b_2$
Saskatoon	500	100	Moderate suvival overall, good survival in 2a and $2b_1$ poor survival in Unit $2b_2$
Wood Rose	500	100	Moderate suvival overall, good survival in 2a and $2b_1$ poor survival in Unit $2b_2$
Willow (local, live staked)	200	40	Moderate survival in trials in Unit 2a, considerable sun scald on new growth

Grasses and Forbes Assessment: July 2012

For each of the nine plots on the three treatment units, the percentage of ground covered, the percentage of other unplanted species present, and the vigor of the planted species (0= poor, 5- very good) were documented. Photos were taken of each plot, and any additional observations were noted. General observations including growth success, invasive and non-planted species, and growth patterns were also made for the three treatment units. Results were compared with findings of 2011 Assessment.

Treatment Unit 2a

Treatment unit 2a (2.5 ha) had a seeding rate of 45 kg/ha and a fertilizer application rate of 283 kg/ha. Biosolids were not incorporated into the soil.

Ground coverage was roughly 70%, and grasses grew to a height of approximately 0.75 m (Figure 3). The plant species had a slight yellow hue, and were overall less vigorous than the other treatment units (Figure 4). Differences in growth success on this treatment unit may also be attributed to the lack of underlying biosolids, and/or the differences in soil observed in the 2011 assessment; soil in 2b appeared to be smoother and more till-like than in 2a. It is also possible that the higher seed rate may have stifled growth.

Invasive species observed include oxeye daisy, yellow hawkweed, Canadian thistle, and sow thistle. Native species present that were not originally planted include equisetum, aslike clover, and cow-parsnip.

Refer to Table 3 for the individual seed plot results. Since July 2011, in the native seed plots there have shown no specific trends for changes in % cover, % other species, and vigor.



Figure 3. Treatment unit 2a ground cover



Figure 4. Transition from treatment unit 2a to 2b

Treatment Unit $2b_1$

Treatment unit $2b_1$ (1.25 ha) had a seeding rate of 34 kg/ha and no fertilizer was applied. Biosolids were applied below the soil.

It is difficult to accurately assess the re-vegetative success of this treatment unit, as it appears that the till may have been pushed over the upper portion of the treatment unit, while the till intended for the lower portion was left in berms and not applied to the lower portion (Figure 5). The variable growth success may also be partially attributed to soil variability, as no fertilizer was applied to supplement available soil nutrients.

The soil berms and portion of the $2b_1$ with the native seed plots has full coverage and good vigour, with grasses reaching heights of greater than 1 m high. The portion "without till" had approximately 60% coverage and 0.5 m high growth and an average vigor of "3" on the 0 to 5 scale. For the purposes of comparison with other treatment units, the upper portion of the unit that received a till cover will be used.

Invasive species observed include Canadian thistle, sow thistle, yellow hawkweed. Native species present that were not originally planted include raspberries, a pink and yellow columbine, a yellow pea species, and aslike clover.

Refer to Table 4 for the individual seed plot results. Since July 2011, increases in % cover and vigor have been observed in the seed plots, while % other species shows no specific trend.

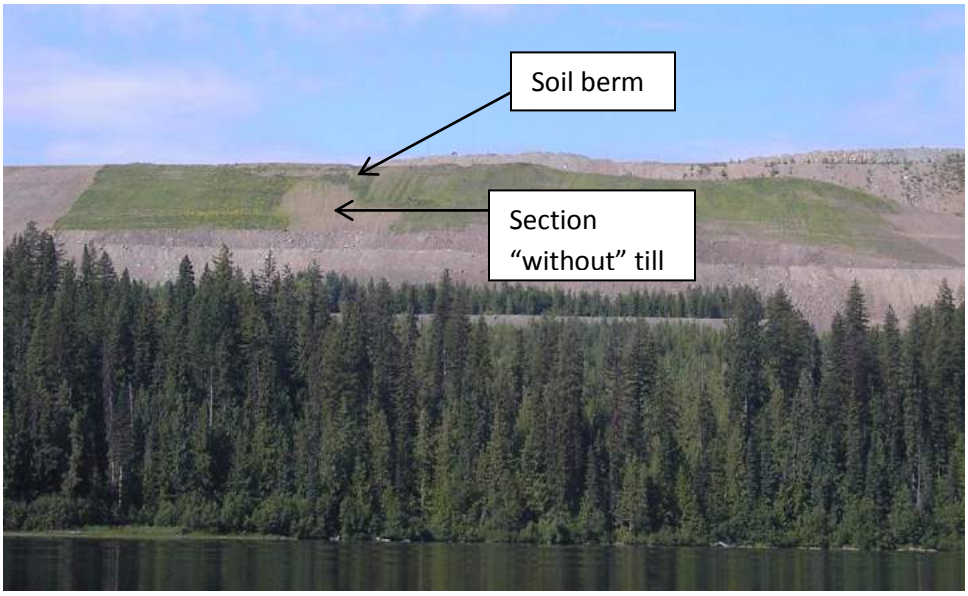


Figure 5. NEZ Dump reclamation $2b_1$ soil distribution (August 2011)

Treatment Unit $2b^2$

Treatment unit $2b^2$ (1.25 ha) had a seeding rate of 34 kg/ha and a fertilizer application rate of 71 kg/ha. Biosolids were applied beneath the soil.

This treatment unit shows impressive growth, with very good vigor, growth to greater than 1 m high, and more or less complete coverage (Figure 6). Moving forward, this may be a concern as there is potential that the thriving grasses and forbs may out-compete the recently planted tree and shrub species.

Invasive species observed include yellow hawkweed, Canadian thistle, sow thistle, and dandelions. Native species present that were not originally planted include aslike clover, raspberries, and cow parsnip.

Refer to Table 5 for the individual seed plot results. Since July 2011, increases and % cover and vigor have been observed in the seed plots, while % other species shows no specific trend.



Figure 6. Treatment unit $2b_2$ growth

Table 3. Treatment Unit 2a Individual Seed Plot Results

						Changes from 2011		
Plot	Species	% Cover	% Other Species	Vigor (0-5)	Notes	Cover	Other Species	Vigor
1	Mountain Brome	50	15	3		decrease	increase	decrease
2	Native Red Fescue	70	10	3		decrease	increase	decrease
3	Rocky Mountain Fescue	75	10	4		decrease	same	same
4	Wheat Grass - Blue Bunch	70	5	3.5		same	decrease	same
5	Blue Wild Rye	90	0	4	some seeded and dried out already	increase	decrease	same
6	June Grass	60	60	3	clover, fireweed, lupin, equisetum	increase	increase	increase
7	Tickle Grass	65	50	4	plot split down middle half clover, half grass	increase	increase	increase
8	Fireweed	50	80	3		increase	increase	increase
9	Lupin	90	<5	5	one fireweed	increase	decrease	increase

Table 4. Treatment Unit 2b[1] Individual Seed Plot Results

						Changes from 2011		
Plot	Species	% Cover	% Other Species	Vigor (0-5)	Notes	Cover	Other Species	Vigor
1	Mountain Brome	80	0	5	starting to flower (yellow)	same	decrease	increase
2	Native Red Fescue	90	10	4		increase	decrease	same
3	Rocky Mountain Fescue	100	15	5		increase	decrease	increase
4	Wheat Grass - Blue Bunch	90	20	5	pink and yellow columbine	increase	decrease	increase
5	Blue Wild Rye	85	35	4.5	lupin, raspberry	increase	increase	increase
6	June Grass	70	50	4	lots of fireweed	increase	increase	increase
7	Tickle Grass	70	80	4	raspberry, thistle (sow?)	same	increase	same
8	Fireweed	80	30	5		increase	same	increase
9	Lupin	80	30	5	grasses, fireweed, yellow hawkweed (invasive?)	increase	same	increase

Table 5. Treatment Unit 2b[2] Individual Seed Plot Results

						Changes from 2011		
Plot	Species	% Cover	% Other Species	Vigor (0-5)	Notes	Cover	Other Species	Vigor
1	Mountain Brome	90	0	4.5		increase	decrease	increase
2	Native Red Fescue	95	10	4.5	thistle, raspberry, fireweed, cow parsnip	increase	increase	increase
3	Rocky Mountain Fescue	90	20	5		increase	increase	increase
4	Wheat Grass - Blue Bunch	100	0	5		increase	decrease	increase
5	Blue Wild Rye	80	20	5		increase	decrease	increase
6	June Grass	70	50	4.5	raspberries, fireweed	increase	increase	increase
7	Tickle Grass	80	70	4.5	dandelions, lupins, fireweed	same	increase	increase
8	Fireweed	75	30	4	most not flowering yet	increase	increase	increase
9	Lupin	90	50	4	thistle, fireweed, grasses	increase	same	increase

Tree Survival Survey - August 17, 2012

A formal survival survey was completed on Aug. 17th focusing on the planted conifers. The survey was based on common methodologies found in the forest industry. 5 plots per treatment Unit were established. Detailed results are in Appendix A.

The overall success has been moderate/good with respect to survival on all species. Units 2a and $2b_1$ are performing very well. There is a noticeable difference in survival rates for the deciduous trees and shrubs in unit $2b_2$, specifically poorer survival. Unit $2b_2$ is characterized by rockier soils and heavy grass coverage. These trees and shrubs appear to have died as a result of drought. It is likely that the combined effects of the soils inability to retain moisture, heavy grass competition and hot dry weather contributed to these results. It is important to note that the conifers in this unit are doing well. There is a marginally higher rate of sun scald on the Douglas Fir, but overall survival has been good to date.

On Treatment Units 2a and $2b_1$, overall survival is very good with few problems observed. The planted Black Cottonwood, Paper Birch, Saskatoon, Alder and Rose appear to be performing moderately well overall. Each stratum is well stocked and no major stocking problems are foreseen. On 2b2 overall survival is poor to fair. Most of the Lodgepole Pine are doing well, but additional mortality should be expected over the short term due to rodent damage.

The live stake willow trials have been a moderate success. Stakes were planted from May 1st to June 25th. The initial success was impressive, with a survival rate of 89%. The onset of hot weather in mid-July dramatically affected the new foliage and branches though. Much of the new growth has been set back, though it appears that many viable buds still remain on the branches and a degree of recovery is expected. It is likely that the willow stakes' limited root development restricted the uptake of moisture and reduced their capacity for drought mitigation. Virtually all of the stakes planted after May 31 have not survived, likely as a result of drought/dehydration. The stakes that were planted the earliest in the season are performing the best.

Discussion

Successful plant growth was observed at all sites, as were wildlife (including ladybugs, butterflies, mice, and various insects); indicating that re-vegetation is proceeding and habitats are developing. Plant growth was denser and more vigorous on contoured and ridged areas, indicating that such areas provide improved microsites.

Overall, ground coverage, vigor, and vegetation height appeared to be the greatest on $2b_2$, and poorest on 2a (with the exception of the lower portion of $2b_1$ that did not receive a till cover). The 2b treatment units showed improved coverage and vigor from 2011, which is potentially because the plant roots have

extended into the layer of biosolids, while 2a (which did not have biosolids applied), has not shown these trends. Lower growth success at 2a may also be a function of variability of soil applied across the slope.

By combining results from the three groups of native seed plots, and analyzing results by species, each species can be ranked in its ability to provide ground coverage, out-compete non-planted species, and its vigor. Table 5 shows these results and combines them into overall rankings based on the sum of the species rankings in all three categories.

Table 5. Native species rankings

	Species Ranking				
Species	**Cover**	**% Planted**	**Vigor**	**Rankings Sum**	**Overall Rank**
Mountain Brome	6	1	5	12	4
Native Red Fescue	4	3	8	15	6
Rocky Mountain Fescue	1	4	1	6	1
Wheat Grass - Blue Bunch	2	2	3	7	2
Blue Wild Rye	4	5	3	12	4
June Grass	9	8	8	25	9
Tickle Grass	7	9	5	21	7
Fireweed	8	7	7	22	8
Lupin	2	6	1	9	3

The tall grasses, in particular Rocky Mountain Fescue and Wheat Grass – Blue Bunch were the most successful species, which agrees with field observations. Tickle Grass and June Grass were the least successful grasses. Forbe growth (fireweed and lupins) cannot necessarily be compared with that of the grasses, and while lupins were successful in the plots, fireweed was observed to be prominent species across the treatment units.

With regards to tree planting, limiting factors on 2a and $2b_1$ appeared to be minor sun scald and drought on Douglas Fir and Alder, minor planting errors, and considerable drought damage on the Trembling Aspen. On $2b_2$, there was major drought damage on the Fdi, and very few planted deciduous shrubs were observed. This is likely due to competition from the heavy grass cover, and this treatment unit may be rockier, with less moisture holding capacity. Considerable rodent damage was observed on the Lodgepole Pine, likely due to the heavy grass cover which increases rodent habitat.

Recommendations

For New Reclamation Sites

For soil application, 0.4 m of till appears sufficient. Reclamation sites with a rougher surface, contours and debris will exhibit more successful plant growth. Soil variability plays a key factor in re-vegetative success, so it is recommended that a tracking system be devised so that soil is either used immediately for reclamation (ensuring soil microbes, bacteria, and viable seeds remain in the soil), or it is stockpiled and seeded. Minimal disturbance and re-handling of soil is recommended, to prevent compaction

(which decreases pore space and increases bulk density). Additionally, prior to soil use, in situ physical tests and/or soil samples can help prevent application of till that is not appropriate for growth.

Based on these results a seeding rate of 34 kg/ha is plentiful. A lower seeding rate may be advantageous, as it would provide coverage and erosion control without competing with tree and shrub growth. 71 kg/ha of fertilizer appears to provide a good nutrient supply for the first year of growth for situations when biosolids are not incorporated into the soil, while biosolids may provide a longer term nutrient source.

For maximum growth, the native seed mix should be adjusted, and June Grass and Tickle Grass should be removed, however, for general reclamation use, these species provide biodiversity and will be less likely to exclude young trees and shrubs.

For the NEZ Dump

Due to the grass and forb growth success on the NEZ Dump, chemical or repeated mechanical treatment around trees and shrubs may be necessary so that they are not out-competed by the grasses (particularly on treatment unit $2b_2$).

A second formal survival survey should be completed in 2013 survival survey for all Treatment Units, and $2b_2$ survival should be closely monitored to see if fill planting is required to meet the stocking standards.

Appendix A

Treatment Unit 2a

MPMC Survival Survey Summary

Location/Block: NEZ	**Date:** Aug. 17, 2012	**Surveyor:** GH (201102), KM
Area (Ha): 5	**History:** Waste Rock Dump. Sloped 2010, soil 2010, grass seeded 2010, planted 2012	

Stratum Information:

Stratum: 2a		**Area (Ha):** 2.5
BGC Zone and Sub Zone: ICH mk3		**Site Series:** 02
Site Index, Method and Species: 18/BEC/Pli		**Slope and Aspect:** +/- 50% -E-
Inventory Label: Pli70Fdi30-1/1-0.1/0.2-18/E-1-2120(12)		**Silviculture Label:** Pli70Fdi30-1-0.1-18/E-1200(12)
Total Trees: 2120	**Total Conifers:** 2080	**Total Well Spaced:** 1200/1480 with no max.

Survival Information (ocular estimate from plots and walkthrough):

Species	Good %	Fair %	Poor %	Dead %
Fdi	52	29	14	5
Pli	51	47	1	1
Sx	-	-	-	-

Sample Information (based on plot averages per species, sample "typical" trees only):

Species	Height	Leader	Age
Fdi	17	17	1
Pli	11	11	1
Sx	-	-	-

Limiting Factors (e.g. forest health, planting errors):

-Minor sun scald and drought on Fdi and planted Alder.
- Minor planting errors.
- Considerable drought damage is evident on the planted At.

Comments:

Overall survival appears to be very good in this TU. Very few problems were observed.
The planted Act, Ep, Saskatoon, Alder and Rose appear to be performing moderately well overall.
This stratum is well stocked and no major stocking problems are foreseen.

Recommendations:

1) Survival Survey summer/ Fall 2013.



Figures 2. Overview of Treatment Unit 2a



Figure 3. Overview of Treatment Unit 2a



Figure 4. Typical planted Pine



Figure 5. Typical planted Fir

Treatment Unit $2b_1$

MPMC Survival Survey Summary

Location/Block: NEZ	**Date:** Aug. 17, 2012	**Surveyor:** GH (201102), KM
Area (Ha): 5	**History:** Waste Rock Dump. Sloped 2010, soil 2010, grass seeded 2010, planted 2012	

Stratum Information:

Stratum: 2b1		**Area (Ha):** 1.25
BGC Zone and Sub Zone: ICH mk3		**Site Series:** 02
Site Index, Method and Species: 18/BEC/Pli		**Slope and Aspect:** +/- 50% –E-
Inventory Label: Pli70Fdi30-1/1-0.1/0.2-18/E-1-2000(12)		**Silviculture Label:** Pli73Fdi27-1-0.1-18/E-1200(12)
Total Trees: 2000	**Total Conifers:** 1880	**Total Well Spaced:** 1200/1320 with no max.

Survival Information (ocular estimate from plots and walkthrough):

Species	Good %	Fair %	Poor %	Dead %
Fdi	67	16	6	11
Pli	48	49	2	1
Sx	-	-	-	-

Sample Information (based on plot averages per species, sample "typical" trees only):

Species	Height	Leader	Age
Fdi	16	13	1
Pli	13	13	1
Sx	-	-	-

Limiting Factors (e.g. forest health, planting errors):

-Minor sun scald and drought on Fdi and planted Alder.
- Minor planting errors.
- Considerable drought damage is evident on the planted At.

Comments:

Overall survival appears to be very good in this TU, much the same as 2a. Very few problems were observed.
The planted Act, Ep, Saskatoon, Alder and Rose appear to be performing moderately well overall.
This stratum is well stocked and no major stocking problems are foreseen.

Recommendations:

1) Survival Survey summer/ Fall 2013.



Figure 6. Overview of 2b1



Figure 5. Overview of 2b1



Figure 7. Typical planted Pine



Figure 8. Typical planted Fir

Treatment Unit 2b²

MPMC Survival Survey Summary

Location/Block: NEZ	**Date:** Aug. 17, 2012.	**Surveyor:** GH (201102), KM
Area: 5	**History:** Waste Rock Dump. Sloped 2010, soil and bio-solids 2010, grass seeded 2010, planted 2012	

Stratum Information:

Stratum: 2b2		**Area:** 1.25
BGC Zone and Sub Zone: ICH mk		**Site Series:** 02
Site Index, Method and Species: 18/BEC/Pli		**Slope and Aspect:** +/- 50/ -E-
Inventory Label: Pli90Fdi10-1/1-0.1/0.2-18/E-1-1040(12)		**Silviculture Label:** Pli96Fdi4-1-0.1-18/E-880(12)
Total Trees: 1040	**Total Conifers:** 1040	**Total Well Spaced:** 880/920 with no max.

Survival Information (ocular estimate from plots and walkthrough):

Species	Good %	Fair %	Poor %	Dead %
Fdi	19	3	3	75
Pli	45	29	3	23
Sx	-	-	-	-

Sample Information (based on plot averages per species, sample "typical" trees only):

Species	Height	Leader	Age
Fdi	18	18	1
Pli	12	12	1
Sx	-	-	-

Limiting Factors (e.g. forest health, planting errors):

- Major drought damage on the Fdi. Likely due to very coarse soils and considerable grass coverage.

- Very few planted deciduous and shrubs were observed. It is expected that these components have suffered major drought damage as well. The visibility was poor due to heavy grass cover and there is a possibility that more of these components survived but were not observed during the survey.

- Considerable rodent damage was observed on the Pli.

Comments:

Overall survival is not that great. Most of the Pli are doing well. More mortality should be expected over the short term due to rodent damage.

Recommendations:

1) Fill plant with 100% Pine Spring/Summer 2013. Target 2000 SPH. 880 WS x 1.25 Ha =1100, 2000-1100= 900 Total Trees required.
2) Survival Survey 2013.



Figure 9. Overview of $2b_2$



Figure 10. Overview of $2b_2$



Figure 11. Typical Pine



Figure 12. Rodent damage



Figure 13. Rodent damage

APPENDIX I:

2014 NORTH BELL DUMP RECLAMATION ASSESSMENT

Mount Polley Mining Corporation
2014 North Bell Dump Reclamation Update

Reclamation Summary (2011 – 2014)

2011 Reclamation

Between July and October 2011, 11.59 ha the North Bell Dump (NBD) defined as Parcels 1 – 10 was re-sloped to a 2:1 ratio for long term stability, and 20 cm of manufactured soil containing a 1:2:1 mixture of biosolids, soil, and rock, respectively, was applied. Coarse woody debris was then scattered across the slope. Parcels 1 – 9 of the dump face were subsequently hydroseeded between October 27 and November 8, 2011 by the contractor Any Season Holdings Inc. Parcel 10 (southern-most parcel) was hand seeded on November 14, 2011.

The native seed mix applied to the NBD is outlined in Table 1. The seeding was done on snow without the use of mulch or adhesive at an application rate of 30 kg/ha.

Table 1 Native seed mixture applied to the NBD

Seed	%
Mountain Brome	20
Native Red Fescue	10
Rocky Mountain Fescue	15
Wheatgrass, Bluebunch	25
Blue Wildrye	25

2012 Reclamation

In spring 2012, a 1.30 ha Parcel 10 area adjacent to the 2011 reclamation called the South Triangle was re-sloped. Glacial till was then spread to a depth of 20 to 40 cm across the surface. This area was the hydro-seeded with native seed mix (35 kg/ha), fertilizer (18-19-18, 75 kg/ha), and fiber mulch. Unsuccessful vegetation growth over the 2012 season led to the decision to re-seed the area by hand on October 23 with the native seed mix at approximately 35 kg/ha.

From June 13 to 20, approximately 2.2 ha of the dump's toe had glacial till cast over it. This work was completed by Peterson Contracting.

The hauling of waste rock to the top of the North Bell Dump ceased in July and sloping began shortly afterwards. Re-contouring was completed on the north and south portions of the dump and areas were designated for "features" to add terrain diversity to the slope (Figure 1). Shallow gullies and ridges were shaped.

Work continued with the preparation of staging areas for the eventual stockpiling, mixing and spreading of biosolids. Class A Annacis biosolids from Metro Vancouver were accepted from May 30 to July 31. The biosolids were mixed with an excavator rented from Peterson Contracting at a ratio of 3:1 till to

biosolids from June 28 to October 3. The till used was from the stockpiles atop the North Bell Dump. This material was applied to a 2.21 ha are entitled Phase 1 (on North end of the dump) at a uniform depth of 20 cm, with a final application rate of 138 /ha. Mixed biosolids were also applied to a 2.87 ha area entitled Phase 2 (on the South portion of the dump). The soil was applied using a horizontal windrow method to increase micro-topography (Figure 2), with an average depth of 20 cm. The final application rate was 135 dt/ha. These two parcels were hand-seeded between October 17 and 22 at a rate of 35 kg/ha. The seed mix for Parcel 1 is presented in Table 2, while the seed mix for Parcel 2 is the same as Table 1, except lupine seed was planted as well.

The map in Figure 3 shows the location of all the NBD reclamation sites.



Figure 1 Creation of a swale on the NBD



Figure 2 Horizontal windrows on Phase 2 of the NBD

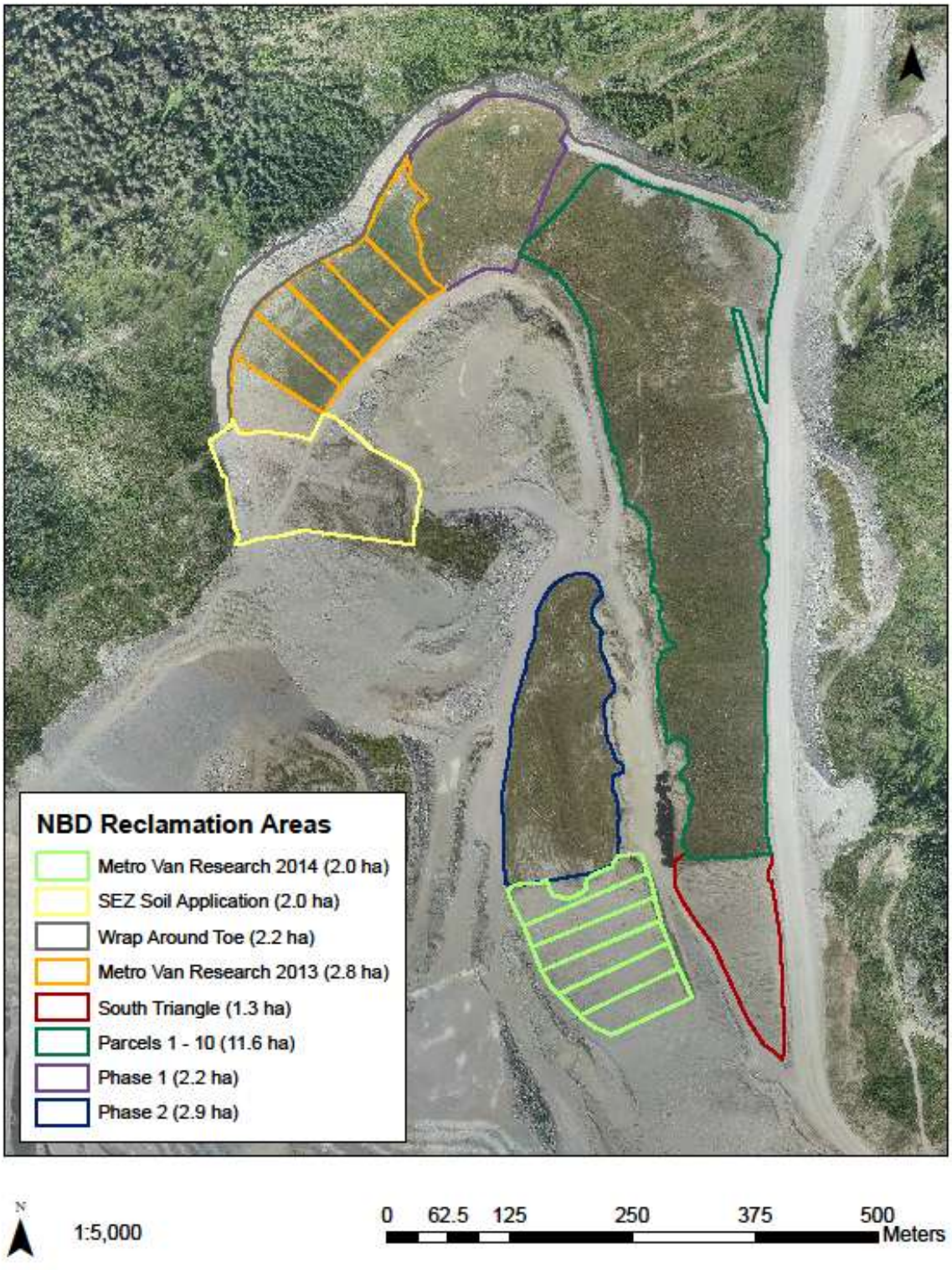


Figure 3 Map of the NBD reclamation areas

Table 2 Native grasses and forbes mix hand-seeded on Parcel 1

Species	%
Mountain Brome	20
Native Red Fescue	10
Rocky Mountain Fescue	15
Wheatgrass, Bluebunch	25
Blue Wildrye	25
Junegrass	3
Ticklegrass	1
Lupinus polyphyllus	0.97
Fireweed	0.03

2013 Reclamation

In 2013, a variety of deciduous native species were planted on Parcels 1 – 10 and the South Triangle. 1000 black cottonwood (800 plug seedlings and 200 seedlings in 6 inch pots) and 800 Sitka alder were planted on the 1.3 ha South Triangle. Biodiversity islands were planted on Parcels 1 – 10, containing a total of 3800 black cottonwood, 1160 saskatoon, 1160 paper birch, 1160 prickly rose, 1100 trembling aspen, and 1000 Sitka alder.

Unfortunately the trees, ordered from Peels Nursery, did not arrive until June 23. While an effort was made to plant the trees quickly (both by the Mount Polley Environmental Department and Torrent Reforestation), 2013 was an extremely dry summer and survival was extremely poor on Parcels 1 – 10. Due to less competition from grasses and forbes, the survival of the trees on the South Triangle was significantly better. A summary of results from 2014 survival surveys on the South Triangle is provided in the next section.

Mechanical removal of invasive species (scentless camomile, oxeye daisy, and Canadian thistle) was pursued throughout the summer.

Reclamation using biosolids was continued in 2013 in a joint research project with Metro Vancouver. This trial tested an alternative biosolids application method, and was designed to explore reclamation prescriptions that promote primary succession of shrubs and trees, with this vegetation not being out-competed by dense grass growth (caused by the biosolids nutrient flush). Biosolids were applied at a rate of 107 dt/ha to 2.34 ha. They were spread with a bull dozer evenly over the 20 cm till cap on the sloped waste dump, and then incorporated by an excavator moving horizontally across the slope with a rake attachment. This work was completed by Peterson Contracting in October. An additional 0.47 ha control area with only 20 cm of till applied was prepared. Due to early snowfall, the area was not able to be seeded.

Soil that was stripped from the expanding SERDS dump in August 2012 was spread out on a 1.99 ha area adjacent to the Metro Vancouver research parcels.

2014 Reclamation

Hand seeding of the Metro Vancouver research parcels was completed June 9 as per the prescriptions outlined in Table 3.

Planting of trees and shrubs was completed on Parcels 1-10, the South Triangle, and the Metro Vancouver 2013 research parcels by Cariboo Enviro Tech May 27 through June 4 at the planting prescriptions shown in Table 4.

Establishment of a second Metro Vancouver research parcel was conducted on a resloped area adjacent to the 2012 Phase 2 reclamation area. 20 cm of till was applied to a 2.0 ha area by Peterson Contracting in July and August 2014, with biosolids being applied to the surface and bladed in in October 2014. The area is broken into 6 parcels (Parcels 7 – 12), which follow the same prescriptions as six parcels of the 2013 trial plots (Table 3). Seeding was completed by hand in November 2014.

A report summarizing design of the 2013 and 2014 Metro Vancouver research areas, and results of soil composition testing in the 2013 plots is attached to this report.

Table 3 Metro Vancouver research project treatment unit prescriptions

Parcel	Soil Application	Ground Cover	Tree/Shrubs
1	Till	-	Lodgepole Pine and Douglas-fir will be planted at 70/30 at 1600 sph. Black cottonwood - 200 sph Paper birch - 50 sph Trembling aspen - 50 sph Sitka alder - 200 sph Saskatoon - 50 sph Prickly rose - 50 sph Scoulers willow - 50 sph
2	Till + Biosolids	Forbe mixture (~35 g fireweed = 75g/ha, 500 g lupine = 1 kg/ha, 52.9 g Dryas drummondii = 113 g/ha, 2.3 kg june grass, yarrow, pearly everlasting mix = 4.9 kg/ha)	
3	Till + Biosolids	Fireweed (~35 g) = 75g/ha	
4	Till + Biosolids	-	
5	Till + Biosolids	Native blend @ 5 kg/ha	
6	Till + Biosolids	Native blend @10 kg/ha	

Table 4 Trees and shrubs planted on the NBD in 2004

Location	Area	Stems Per Ha	Lodgepole Pine	Douglas Fir	Western Red Cedar	Hybrid Spruce	Black Cottonwood	Paper Birch	Trembling Aspen	Sitka Alder	Saskatoon	Rose	Willow	Huckleberry	Soopolalie
NBD Parcels 1-10	11.6	Conifers -1634 Deciduous - 455	12474 (1075 SPH)	5226 (451 SPH)	630 (54 SPH)	630 (54 SPH)	700 (60 SPH)	390 (34 SPH)	390 (34 SPH)	2000 (172 SPH)	390 (34 SPH)	390 (34 SPH)	920 (79 SPH)	140 (biodiversity islands)	100 (test plot)
NBD South Triangle	1.3	Conifers 2000 Desiduous - 77	1820 (1400 SPH)	780 (600 SPH)			2013: 1000 (769 SPH)			2013: 800 (615 SPH)					100 (test plot)
NBD Biosolids Research Parcels	2.8	Conifers - 1600 Deciduous - 650	3136 (1120 SPH)	1344 (480 SPH)			560 (200 SPH)	140 (50 SPH)	140 (50 SPH)	560 (200 SPH)	140 (50 SPH)	140 (50 SPH)	140 (50 SPH)	140 (50 SPH)	

Results – 2014 Assessments

Parcels 1-10 Survival Survey

Location/Block: Parcels 1-10		Date: September 9, 2014	Surveyor: GH
Total Area (ha): 11.6	History: Re-contoured 2011, Soil application 2011, Grass seeding 2011, Shrubs Planted in 2013, 2014, Conifers Planted 2014		

Stratum Information:

Stratum: A		Area: 11.6
BGC Zone and Sub Zone: ICH mk3		Site Series: 02
Site Index, Method and Species: 18/SIBEC/PLI		Slope and Aspect: ~30-40% -E- -NE- -N-
Inventory Label: Pli8Fdi2-2/2-0.2/0.3-18/E-1-700(14)		Silviculture Label: Pli83Fdi17-2-0.2-18/E-1-460(14)
Total Trees: 700	Total Conifers: 700	Total Well Spaced: 460 (460 using M Value)

Survival Information (ocular estimate from plots and walkthrough):

Species	Good %	Fair %	Poor %	Dead %
Douglas Fir	11	3	23	63
Lodgepole Pine	22	14	9	55
Western Red Cedar	-	-	1	99
Hybrid Spruce	-	-	1	99
Saskatoon	5	5	20	70
Black Cottonwood	5	15	30	50
Sitka Alder	5	5	20	70
Prickly Rose	45	30	10	20

Sample Information (based on plot averages per species, sample "typical" trees only):

Species	Height (m)	Leader (cm)	Age
Fdi	0.25	2	2
Pli	0.20	9	2

Limiting Factors (e.g. forest health, planting errors):

Drought has caused major mortality throughout this stratum. Drought effects appear to be exasperated by the heavy grass cover, the relatively porous soils and the exposed slope. 54% of the total planted stems in the plots were dead and an additional 12% were unacceptable due to drought stress. 34% of the total planted stems were found to acceptable.
Heavy herbaceous cover is likely to present drought problems and veg press problems in the future.

Comments:

- Stocking in this stratum is sparse.
- Overall survival is poor in all species. Small areas of stocked ground can be found, but are too small and dispersed to merit stratification.
- No planting errors were observed.
- No live spruce or cedar was observed.
- Very few planted deciduous and shrubs were observed, it is expected that these seedlings have also succumbed to drought stress.
- Vegetation hazard is expected to be moderate to high until target species emerge from the herbaceous cover.

Photos from the survival survey are shown in Figure 4 to Figure 7.

Recommendations:

1. Complete a second year survival survey in fall 2015.
2. Wait for the conifers to emerge from the vegetation or for vegetation die back, then consider replanting in the future.



Figure 4 Overview of NBD Parcels 1 - 10



Figure 5 NBD Parcels 1-10 typical pine and fir (note the drought stress)



Figure 6 NBD Parcels 1-10 drought killed fir and pine



Figure 7 NBD Parcels 1-10 good pine

Good p***ine***

South Triangle Survival Survey

Location/Block: South Triangle	Date: September 9, 2014	Surveyor: GH
Total Area (ha): 1.3	History: Re-contoured 2012, Soil application 2012, Grass seeding 2012, Shrubs Planted in 2013, Trees Planted 2014	

Stratum Information:

Stratum: A		Area: 1.3
BGC Zone and Sub Zone: ICH mk3		Site Series: 02
Site Index, Method and Species: 18/SIBEC/PLI		Slope and Aspect: ~30% -E-
Inventory Label: Pli7Fdi3-2/2-0.2/0.3-18/E-1-2080(14)		Silviculture Label: Pli63Fdi37-2-0.2-18/E-1200(14)
Total Trees: 2080	Total Conifers: 1600	Total Well Spaced: 1520 (1200 using M Value)

Survival Information (ocular estimate from plots and walkthrough):

Species	Good %	Fair %	Poor %	Dead %
Douglas Fir	39	53	7	1
Lodgepole Pine	12	52	35	1
Black Cottonwood	20	65	12	3
Sitka Alder	60	33	5	2
Soopolalie	10	55	30	5

Sample Information (based on plot averages per species, sample "typical" trees only):

Species	Height (m)	Leader (cm)	Age
Fdi	26	4	2
Pli	15	7	2

Limiting Factors (e.g. forest health, planting errors):

- Nutrient deficient soils appear to be the main limiting factor at this site. Nutrient deficiency is unlikely to affect seedling survival but will likely reduce productivity considerably. Long term mortality may occur as a result of nutrient related pathology (i.e. susceptibility to disease).
- There may be a high risk of winter desiccation due to lack of cover and the location being an exposed and windy slope.
- Drought may cause minor mortality in the immediate future, until established vegetation develops substantial root systems.

Comments:

- Overall survival is excellent in all species.
- Performance is moderate to date for most species.
- No dead conifers were observed.
- All planted species are represented in this stratum.
- Long-term vegetation hazard is expected to be low.
- Very little ground cover has established and consists primarily of scattered grasses.
- Overall the alder is performing very well.
- Overall the cottonwood is performing moderately.
- Overall the soopolalie is performing moderately.

Photos from the survival survey are shown in Figure 8 to Figure 11.

Recommendations:

1. Complete a second year survival survey in fall 2015.



Figure 8 Overview of the NBD South Triangle



Figure 9 NBD South Triangle typical fir and pine trees



Figure 10 NBD South Triangle typical alder and soopalalie



Figure 11 NBD South Triangle typical cottonwood

Phase 1and 2

A walkthrough assessment of these parcels was completed on July 31, 2014. Observations of Phase 1 were:

- Coarse woody debris cover: <5% large placed boulders and logs
- Surface: minimal surface roughening, but larger topographic features (mid slope plateau)
- Average vegetation height: 80 cm
- Cover (all species): 90%
- Cover (species specific):
    - Planted native grasses: 60-65%
    - Prickly lettuce (*Lactuca serriola*) 15%
    - Clover (red/aslike): 5%
    - Clover (yellow): <1%
    - Canada thistle: <5%
    - Oxeye daisy: <1%
- Average vegetation vigour (0-5): 4

Observations of Phase 2 were:

- Coarse woody debris cover: <1%
- Surface: horizontal windrows and topographic features (plateaus and modulating slopes)
- Average vegetation height: 80 cm
- Cover (all species): 95%

- Cover (species specific):
    - Planted native grasses: 65%
    - Prickly lettuce (*Lactuca serriola*) 20-25%
    - Oxeye daisy: 5% (in patches)
    - Canada thistle: <5%
    - Annual Hawksbeard: <5%
- Average vegetation vigour (0-5): 4

In general these parcels show vigorous ground cover growth. Planting of trees and shrubs is scheduled for 2015, and there is potential that this vegetation may compete with trees and shrubs; however, in contrast to Parcels 1 to10, Phase 1 is north facing and Phase 2 had extensive surface roughening, and moisture retention is anticipated to be better. It is recommended that tree planters target moist microsites, and that survival surveys be carried out in 2015. Establishment of an overstory by planting trees and shrubs is also a long-term invasive species management approach that is anticipated to provide competition through creation of shade.

2013 Metro Vancouver Research Plots

A report prepared by Metro Vancouver summarizing findings to date on the 2013 Metro Vancouver Research Plots is being completed and will be submitted provided as Attachment 2 to this report when it is complete.

Adjacent to 2013 Metro Vancouver Research Plots

A walkthrough assessment of the area on which soil salvaged from the expanding SERDS was directly placed in 2013 (adjacent to the 2013 Metro Vancouver research parcels) was completed on July 31, 2014. Observations were:

- Coarse woody debris cover: ~5%
- Surface: rough, vertical windrows, some gaps in soil coverage, high rock content in till
- Average vegetation height: 25cm
- Cover (all species): 70% (top) 40% (mid slope, above road), 20-30% (lower slope, below road)
- Cover (species specific):
    - Clover (red/aslike): 35%
    - Canada thistle: <5%
    - Timothy: <5%
    - Oxeye daisy: <5% (more at top of slope)
- Average vegetation vigour (0-5): 3

Recommendations:

- Monitor vegetation growth in 2015, and apply the native seed mixture (Table 2) if coverage from ingress and natural establishment is minimal

- Bring in equipment to address areas without soil cover (minimize equipment traffic on areas with establishing vegetation).
- Consider planting with trees and shrubs in 2016.

Summary

Recommendations for future reclamation based on findings to date include:

- Hand-seeding is as effective as hydroseeding for re-vegetation, and is more cost effective.
- During the design phase, the reclamation surface should be designed with access for to prevent the need for makeshift road construction, which causes soil compaction. Any access roads should be ripped up and seeded as reclamation activities conclude. Slopes should also be designed with consideration of equipment constraints, and the inability to "push" soil long distances.
- Conduct surface roughening and application of coarse woody debris to create more diverse microsites and help dry waste rock dumps retain moisture.
- Tree and shrub survival and success are better on parcels without extensive ground cover; this ground cover provides competition for moisture and nutrients. On plots where biosolids or soil nutrient amendments are incorporated, decrease application rates of native grass and forbe to less than 30 kg/ha mixtures. Monitor results from the Metro Vancouver research trials for selection of ground cover species that compete less with tree and shrub growth.
- Continue to monitor presence of invasive species closely, and implement treatment programs as necessary.
- Continue the tree and shrub planting program to promote development of early successional stages of forest development. Creation of a shade and overstory will help out compete invasive species.

APPENDIX J:

MOUNT POLLEY TREE TRIAL 2014 PROGRESS REPORT

(METRO VANCOUVER 2015)

Mount Polley North Bell Dump Tree Trial

2014 progress report

PREPARED BY:
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Table of Contents

BACKGROUND 2

OVERBURDEN (GLACIAL TILL) CAPPING LAYER QUALITY (PLOTS 7-12) 2

PRE-APPLICATION NUTRIENT STATUS AND QUALITY OF OVERBURDEN: 2

TRACE ELEMENT CONTENT OF OVERBURDEN: 3

Table 1a: Pre-application Quality and Nutrient data of Overburden on plots 7-12 on North Bell Dump Tree Trial Site 3

Table 1b: Trace metal concentration of Pre-application overburden used on North Bell Dump tree trial site plots 7 - 12 - September, 2014 3

2014 SOIL MONITORING (PLOTS 1-6) 4

SOIL AMMONIUM-N RESULTS: 4

SOIL PH: 4

Table 2a: Soil Ammonium-N and Nitrate-N levels and soil pH by plot - Spring (May) 2014 4

Ammonium-N 4

Table 2b: Soil Ammonium-N and Nitrate-N levels and soil pH by plot - October 2014 5

SOIL NUTRIENT LEVELS AND QUALITY PARAMETERS: 5

Table 3: Quality and Nutrient status of Plots 1-6 - October, 2014 6

TREE AND SHRUB SURVIVAL SURVEY & GROUND COVER GROWTH ASSESSMENT (PLOTS 1-6) 6

YEAR 1 VEGETATION ASSESSMENT 6

YEAR 1 SURVIVAL SURVEY ASSESSMENT 7

Table 4: 2014 Mount Polley Reclamation Vegetation Assessment - North Bell Dump 2013 Research Plots 8

NEXT STEPS 9

References 10

Appendix A 11

Vegetation Assessment Photographs 12

Appendix B 19

North Bell Dump research Plot locations 20

MPMC – Trial Plot Prescriptions 21

Appendix C 22

MPMC Survival Survey Summary Biosolids Plots 23

MPMC Survival Survey Summary Control Plot 1 24

Background

The North Bell Dump at Mount Polley Mining Corporation (MPMC), has been undergoing a tree trial since 2013. The goal of this trial is to determine the optimal ground cover vegetation mix that would help inhibit wind, water erosion and invasive species without smothering the trees during the first few years of planting. Metro Vancouver biosolids were used as the soil amendment for the research plots, as biosolids contain nutrients and organic matter that can augment the deficient soils being used in mine site reclamation. Results from a previous tree trial using biosolids indicated that the ammonia content of biosolids applied sites may potentially damage the roots of seedlings. Also, concerns were expressed by MPMC based on research and progressive reclamation results about the high nutrient content of biosolids causing rapid growth of the understory, and smothering young trees within the first few years of planting. A Report written by Ruth McDougall, Professional Agrologist, discusses the trial design and initial overburden and soil sampling analysis (Mcdougall 2014).

There are two research parcels on the North Bell Dump, plots 1-6 (2.8 ha) and plots 7-12 (2.0 ha). A photo of the plot areas can be found in appendix B. Plots 1 and 7 are the control plots with no biosolids applied. In 2013, soil was applied to plots 1-6 and it was seeded with prescribed native grasses and forbes blends in the fall. A mix of trees and shrubs were then planted in late May and early June, and plots were seeded with ground cover in June 2014. The plot prescriptions are detailed in the survival survey assessment written by Mount Polley Environmental Staff, Gabriel Holmes (see appendix B); and other plot treatment details are discussed in McDougall (2014). A vegetation assessment on plots 1-6 was completed in July of 2014 by another of Mount Polley's Environmental Staff, Katie McMahen.

This report will discuss the activities that occurred in 2014. This includes additional soil nutrient sampling on plots 1-6, pre-application overburden (described as glacial till sub-soil) sampling of plots 7-12, a formal tree and shrub survival survey and a ground cover and vegetation assessment of plots 1 -6.

Overburden (glacial till) capping layer quality (Plots 7-12)

Details on the source, description and application of the overburden is within McDougall (2014). Details on the overburden quality of plots 1-6 are also included in McDougall (2014).

Pre-application nutrient status and quality of overburden:

On September 9, 2014 overburden samples were collected and sent to ALS Environmental laboratory for analysis. Samples were collected in the same manner outlined in McDougall (2014) The September sampling analysis data are summarized in Table 1a. The results show minimal variability in nutrient or trace metal content. Overburden pH ranged from 8.3-8.5 for plots 8-12, which is slightly higher than the optimum for plant growth, but of no concern. However, plot 7, the control (no biosolids applied) had a pH of 7.4. McDougall (2014) noted that free NH_3 as opposed to ammonium (NH_4+) is the cause of root damage, since the positive charge of NH_4+ enables binding to soil particles. The concentrations of ammonia and the effect on root damage is an area of concern, which will be monitored through soil sampling and analysis.

TRACE ELEMENT CONTENT OF OVERBURDEN:

All trace metal elements, with the exception of copper, were well below the CSR and OMRR Soil Standards for Agricultural sites (Table 1b). Copper concentrations in all 6 samples exceeded the soil standard, which is expected considering the nature of the mineral deposits at Mount Polley.

Table 1a: Pre-application Quality and Nutrient data of Overburden on plots 7-12 on North Bell Dump Tree Trial Site

Parameter	Units	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12
Quality Parameters							
pH	mk/kg	7.38	8.38	8.34	8.41	8.44	8.51
Nutrients							
Phosphorus	mk/kg	1440	1330	1450	1470	1360	1380
Potassium	mk/kg	1590	1430	1310	1410	1480	1440
Calcium	mk/kg	19200	16900	18600	19400	19200	17700
Magnesium	mk/kg	10700	10100	10400	10600	10400	10300
Sodium	mk/kg	460	380	550	450	350	380
Micronutrients							
iron	mk/kg	43900	40600	40700	42400	42100	40400
Manganese	mk/kg	10700	10100	10400	10600	10400	10300

Table 1b: Trace metal concentration of Pre-application overburden used on North Bell Dump tree trial site plots 7 - 12 - September, 2014

Parameter	Units	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	CSR standards - Agricultural sites
Metals								
Arsenic	mk/kg	15	14.1	8.34	8.41	8.44	8.51	25
Cadmium	mk/kg	0.43	0.40	0.41	0.45	0.38	0.40	9
Chromium	mk/kg	24	22.5	20.5	23	23.5	22.4	50
Cobalt	mk/kg	19.7	17.1	17.3	17.8	17.3	16.8	40
Copper	mk/kg	***656***	***591***	***671***	***728***	***612***	***644***	150
Lead	mk/kg	11.2	10.3	10.3	11.1	10.5	10.3	350
Mercury	mk/kg	0.11	0.11	0.22	0.13	0.11	0.10	0.6
Molybdenum	mk/kg	4.01	3.7	3.54	3.51	3.58	3.41	5
Nickel	mk/kg	18.9	16.3	15.9	17.3	16.9	16.1	150
Selenium	mk/kg	1.08	0.99	0.93	1.18	0.91	0.88	2
Zinc	mk/kg	107	96.8	104	106	101	104	200

2014 Soil Monitoring (Plots 1-6)

Details on the soil quality of plots 1-6 are also included in McDougall (2014).

The spring (May) soil monitoring results from plots 1-6 are reviewed in McDougall (2014). As outlined in the trial design, additional soil sampling for ammonia was to be conducted after biosolids application. This occurred on October 22, 2014. The same sampling methodology described in McDougall (2014) was used. This includes one composite sample of surface material consisting of 10-12 randomly collected subsamples to a depth of 15cm (6 inches). The samples were analyzed at ALS Environmental laboratory in their Saskatoon location.

Soil Ammonium-N results:

Tables 2a and 2b show the laboratory results for soil ammonium-N (NH_4+), from May and October 2014 respectively. The NH_4+ concentrations ranged from 1-7 ppm, which is less than the concentrations of the samples taken in May 2014, which ranged from 2-97ppm. NH_4+ slowly converts to nitrate in soil, and this transition is driven by soil moisture and temperature. The Nitrate concentrations ranged from 2-46ppm in October 2014, with plot 4 having the highest concentration at >46ppm, which is opposite of the May 2014 sampling results where plot 4 had the lowest Nitrate concentration of 5.6ppm. However, in both May and October plot 4 had the highest concentration of NH_4+ at 97ppm and 7 ppm, respectively. The decreased concentrations of NH_4+ reduces the likelihood of free ammonia developing and negatively impacting the tree roots.

Soil pH:

Soil pH in plots 2-6, which are the plots with applied biosolids, ranged from 6.9-7.5. This pH is near neutral, indicating a low likelihood of free ammonia being present since at pH near neutral (6.5-7.5), soil contains 1% free ammonia and 99% NH_4+. The neutral pH and the low concentrations of NH_4+, which have mostly converted to Nitrate, reduces the risk of free ammonia forming and damaging the roots of planted trees.

Table 2a: Soil Ammonium-N and Nitrate-N levels and soil pH by plot - Spring (May) 2014

Plot	Ammonium-N			Nitrate-N	pH
	Pounds per acre	Kilograms per hectare	Milligrams per kg or ppm*	Milligrams per kg or ppm*	pH units
1 (no biosolids)	4	4.5	2	1	8.3
2	26	29	16	35	7.4
3	19	21	12	43	7.5
4	156	175	97	5.6	7.2
5	51	57	32	34	7.2
6	66	74	41	44	7.3

**converted from kg/ha data assuming soil bulk density of 1200kg/m³*

Table 2b: Soil Ammonium-N and Nitrate-N levels and soil pH by plot - October 2014

Plot	Ammonium-N			Nitrate-N	pH
	Pounds per acre	Kilograms per hectare	Milligrams per kg or ppm*	Milligrams per kg or ppm*	pH units
1 (no biosolids)	2	2.2	1	2	8.3
2	7	8	4	20	7.4
3	7	8	4	41	7.5
4	12	13	7	>46	6.9
5	7	8	4	41	7
6	10	11	6	37	6.9

**converted from kg/ha data assuming soil bulk density of 1200kg/m³*

Soil Nutrient Levels and Quality Parameters:

Table 3 shows the soil nutrient and quality data from the post-biosolids application soil sampling of plots 1-6 in October 2014. The results in Table 3 are comparable to the May 2014 post-application results in McDougall (2014) and are all within the moderate to optimal nutrient range. However, there are some changes in the concentrations in each plot. It is interesting to note that the copper concentration in plot 4 increased two-fold from 39.1 in May to 87ppm in October. During the post-application inspection of biosolids incorporation, Janelle Hunt (Metro Vancouver) and Gabriel Holmes (Mount Polley Mining Corporation) observed a heavy application rate at the base and middle section of plot 4. Additional details and photos can be found in the operational report (Hunt, 2013). This may explain the increase in the copper concentration in Plot 4. Overall, the concentration level of the macronutrients were similar to the May 2014 analysis, with the exception of Nitrate in plot 4, which was described in the previous section. The difference in the concentration of Nitrate in plot 4 may be due to the heavier application rate administered in this area. Also, there was a minimal decline in the concentrations of chloride and potassium from May to October 2014. As for the micronutrients, Iron and Manganese concentrations are lower than the concentrations in the May 2014 results. The soil pH and electric conductivity (EC) are within the normal range (6 -7.5 units for pH and < 3 dS/m for EC) (Mcdougall, 2015), which is also the optimal range for tree and vegetation growth. Organic matter content decreased compared to the May 2014 sampling results. The decrease in soil nutrient concentrations and organic matter is expected to be a result of root nutrient uptake, which is beneficial for vegetation growth.

Table 3: Quality and Nutrient status of Plots 1-6 - October, 2014

Parameter	Units	PLOT 1	PLOT 2	PLOT 3	PLOT 4	PLOT 5	PLOT 6
Quality Parameters							
pH (1:2 soil:water)	pH units	8.3	7.4	7.5	6.9	7	6.9
EC (1:2 soil:water)	dS/m	0.1	0.2	0.4	1.1	0.7	0.5
Organic matter (%)	%	0.8	2.9	2.2	3.2	3.8	3.6
Nutrients (mg/kg)							
Nitrate-N	mg/kg	2	20	41	>46	41	37
Phosphorus	mg/kg	9	>34	>34	>34	>32	>32
Potassium	mg/kg	116	134	118	154	117	135
Sulphate-S	mg/kg	4	9	>27	>27	>26	>26
Chloride	mg/kg	2	4	3	5	4	4
Micronutrients							
Copper	mg/kg	38	87	74	87	89	95
Manganese	mg/kg	6	16	15	29	22	27
Zinc	mg/kg	2	25	21	42	37	42
Boron	mg/kg	0.62	0.44	0.81	0.68	0.68	0.75
Iron	mg/kg	32	129	106	168	153	180

Tree and Shrub Survival Survey & Ground Cover Growth Assessment (Plots 1-6)

Year 1 Vegetation Assessment

As outlined in the trial design, a ground cover and growth assessment was to be completed in summer 2014 as part of the on-going tree trial site work. Katie McMahen completed a vegetation assessment on plots 1-6 on July 31, 2014. Plot 1 is the control plot where no biosolids were applied, whereas plots 2-6 received biosolids. The results are shown in Table 4. Plot treatments, amendments and the planting plan are outlined as per Mcdougall (2014) in Appendix B.

The assessment was completed using standard vegetation monitoring techniques; and the impacts were assessed by visual observation of the height and density of the ground cover. Each plot was assessed in sections and identified by numbers (i.e. upper slope =1 mid-slope=2 and the flat bottom = 3; thus, the upper, mid and bottom slope of plot 1 would be 1.1, 1.2 and 1.3 respectively). The percent coverage of all species for the biosolids amended plots 2-6 ranged from 25% - 90% with the bottom slope of plots 2 and 3 having the lowest coverage of 25% and 30% respectively. The upper and mid slope of plot 2 showed the highest coverage at 90%, followed by the upper and mid slope of plot 4 at 80%. The average plant vigor on a scale of 0-5 was approximately 4, which indicates that sufficient nutrients are available in the biosolids-amended overburden. The high percent coverage and vigor of all species is positive in terms of the initial growth of vegetation. However, the low proportion of observed seeded species may be due to the fact that the heavy snowfall in fall 2013 required seeding to be postponed till June 2014.

As a result, seeds in the glacial till stockpiles flourished in the high nutrient environment, and there competitiveness over the seeded species may have been exasperated by not seeding until the end of June. Mount Polley mine site typically has higher success with fall seeding. This is because the plants can establish as soon as the snow has melted, which will give a longer time to form before the weather becomes hot and dry. Overall, there were several weed species that dominated the majority of the vegetative cover, which may have been present within the soils at the time of application. The majority of the weed species observed are not in the Regional Strategic Plan for the Cariboo Regional District; however they are not anticipated to be highly competitive in the long-term. Further assessment in the following years will be needed to measure long-term success.

Photos of a few of the vegetation found on the plots can be seen in appendix A. The control plot 1, which was only applied with glacial till, had no non-planted vegetation observed. Whereas the biosolids applied areas, parcels 2-6, all had abundant ground cover observed. This can be attributed to biosolids, since all the plots were supplied with the same low nutrient glacial till. Plots 2-6 were dominated by species that were not planted. For example in plot 2 the forb mix (Lupine, Drummond's Avens, Junegrass and Pearly Everlasting) that was planted was not the dominant species observed. Rather, the ground cover consisted primarily of Yellow Mustard, Prickly Lettuce, Pineappleweed, Morning Glory, Annual Hawksbeard and Yarrow. This ground cover mixture dominated plots 3 to 6, and as seen in the plot prescriptions table in Appendix B, these species were not part of the intended mixture.

Year 1 Survival Survey Assessment

A formal survival survey was completed by Gabriel Holmes on September 23, 2014 of plots 1-6. Results are shown in Appendix C. The survey was completed based on common methodologies found in the forest industry and the focus was mainly on the planted conifers, deciduous and shrubs. Based on ocular assessments, the conifer survival was excellent; and performance was noted as moderate. Holmes (2014) also noted some limiting factors, with respect to poor spacing, heavy herbaceous competition and as aforementioned, weed presence. A second year survival survey is recommended for fall 2015. Methodology and details can be found in Holmes (2014).

Table 4: 2014 Mount Polley Reclamation Vegetation Assessment - North Bell Dump 2013 Research Plots

Plot	1. 1/2/3	2.1/2	2.3	3.1/2	3.3	4.2/1	4.3	5.1/2	5.3	6.1/2	6.3
Site Condition (slope position/angle, aspect)	NW Aspect	Slope, NW	Flat, NW Slope above/below	Slope (NW)	Flat (NW slope above/below	NW Slope	Flat (NW slope above/below)	NW Slope	Flat (NW slope above/below)	Slope	Flat (NW slope above/below)
Ground Surface											
Surface Roughening	minimal	minimal	minimal	minimal	minimal	minimal	minimal	minimal	minimal	minimal	minimal
Coarse Woody Debris (% cover, types)	Large rocks	Larger rocks (more at the bottom)	rock placement	minimal-some rock placement	Odd small piece; lots of rock vegetation	minimal - minor rocky placement	some rock placement	some rock placement	some rock placement	rock placement	rock placement
Understorey Vegetation											
%Cover (all species)	<1	90%	25%	50%	30%	80%	70%	50% - 80%	50%	75%	70%
Average Height (m)	0	0.6	0.6	0.6	0.45	.2-.5	0.5	0.45	0.3	0.3	0.4
Vigor (0-5)	0		3	4	3	4	4				3
Species Specific (% Cover)		%	%	%	%	%	%	%	%	%	%
Perennial sowthistle	N/A	15	5	10	5 to 10	20	10 to 20	5 to 10	5	5	10
Pineapple weed		20	5	10	5	20	10	15	10	10	15
Polygonum aviculture		20									15
Lactua serriola		15	5	5	5 to 10	0	10	5 to 10	5	5 to 10	10
Canada thistle		<5	<5				<5	<5	<5	<5	<1
Annual Hawksbeard		5	<5	<5	<5						<5
Oxeye daisy		5	5	<5		5	<5		<5	1	<1
Clover		<5		<5							
fireweed		<1	<1	<1	<1		<1				
grasses		5		5 to 10	<5	<1		5	<5	5	
scentless chamomile			<1								
Timothy			<1								
Lupine			<1								
raspberry			<1								<1
Persicaria maculosa				<1			<5	<5		5	5
Curly dock				5			5 to 10	5	5	5	5
Crawlers				5	5	20	30	10 to 30	20	30	
Alsike clover			<5		<5	<1	<5	<5	<5		<5
Dandelion					<1						
Young Lactua serriola											<1
Wildlife Value											
Habitat Types present	rock (cover)		rock; minor leg coverage	rock habitats; veg cover	Veg cover; rocks	Veg cover; rocks	Veg cover; rocks	Veg cover; rocks	Veg cover; rocks	Veg cover; rocks	Veg cover; rocks

NEXT STEPS

Overall there is a positive outlook on the survival of vegetation on the parcels. Also, the reduced ammonia concentrations limit the chance of root damage, which was an initial area of concern.

Although survival was excellent, the abundant weed presence should be monitored, and assessed for impact on vegetation.

Next steps include:

- Second year survival survey on plots 1-6 in fall 2015
- Formal tree and shrub trial survey of spring 2015 planted areas in fall 2015.
- Ground cover growth assessment in summer 2015 on plots 1-6.
- Ground cover growth assessment in summer 2015 on plots 7-12 should be completed as a comparison to plots 1-6.
- Additional soil sampling for ammonia in fall 2015

References

Holmes, G. 2015. NBD Biosolids Research Parcels 1-6 Survival Survey Assessment – Year 1. Mount Polley Mining Corporation, September 2014.

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Appendix A

Vegetation Assessment Photographs



Plot 1 (Glacial till only) – Flat (<1% cover)



Plot 1 – Flat – Plant species identified as Curly dock



Plot 2 (Biosolids applied) – upper – mid Slope (90% cover)



Plot 3 (Biosolids applied) – Flat (30% cover)



Plot 4 (Biosolids applied) – mid to upper slope (80%)



Plot 4 – Flat (70% cover)



Plot 5 (Biosolids applied) – Flat (50% cover) – Plant species identified as Polygonum, aviculare (knotweed)



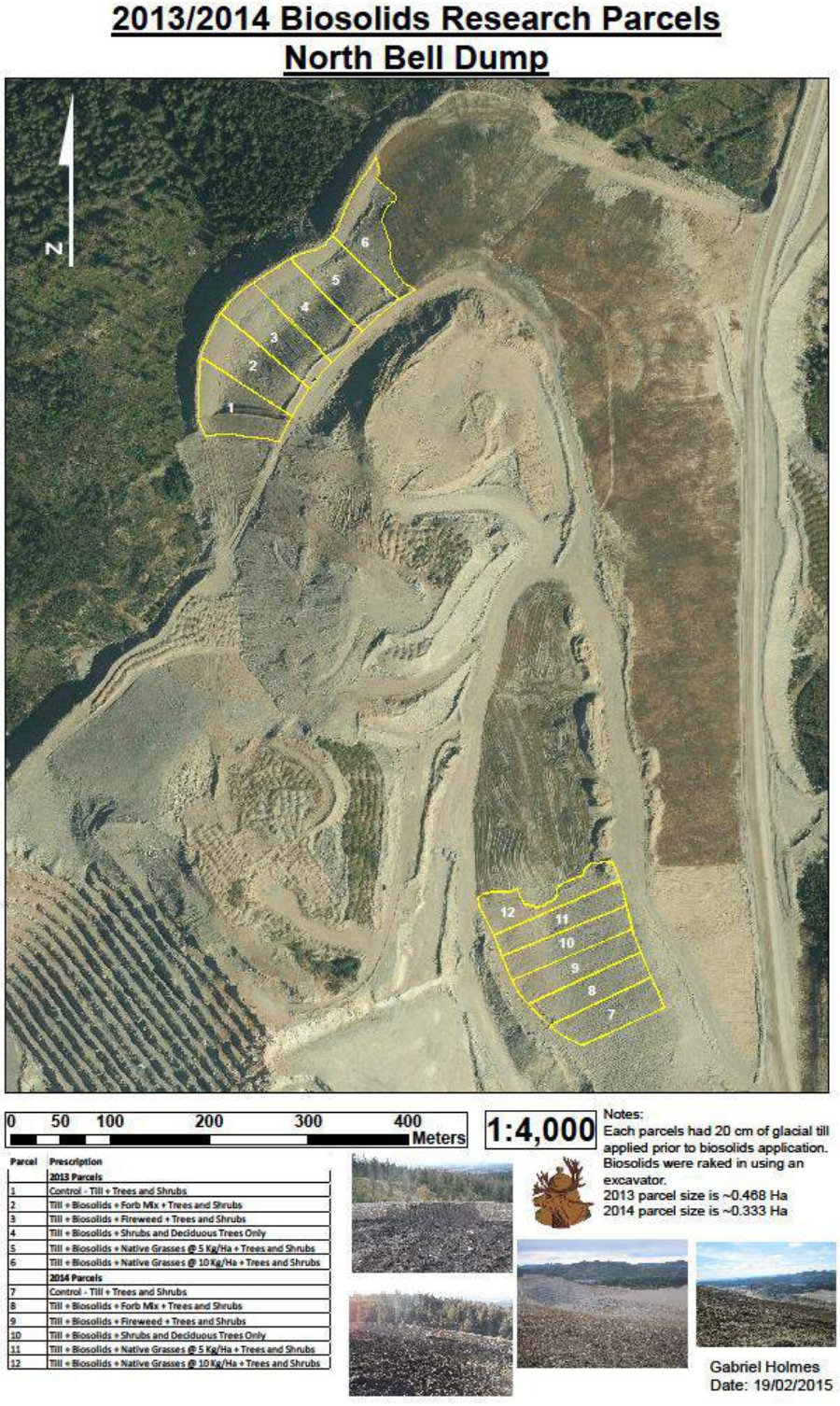
Plot 6 (Biosolids Applied) – Mid to upper slope (75% cover)



Plot 6 – Flat (% cover) – plant species identified as Lactuca serriola, a tall common weed on disturbed sites

Appendix B

North Bell Dump research Plot locations



Parcel	Prescription
	2013 Parcels
1	Control - Till + Trees and Shrubs
2	Till + Biosolids + Forb Mix + Trees and Shrubs
3	Till + Biosolids + Fireweed + Trees and Shrubs
4	Till + Biosolids + Shrubs and Deciduous Trees Only
5	Till + Biosolids + Native Grasses @ 5 Kg/Ha + Trees and Shrubs
6	Till + Biosolids + Native Grasses @ 10 Kg/Ha + Trees and Shrubs
	2014 Parcels
7	Control - Till + Trees and Shrubs
8	Till + Biosolids + Forb Mix + Trees and Shrubs
9	Till + Biosolids + Fireweed + Trees and Shrubs
10	Till + Biosolids + Shrubs and Deciduous Trees Only
11	Till + Biosolids + Native Grasses @ 5 Kg/Ha + Trees and Shrubs
12	Till + Biosolids + Native Grasses @ 10 Kg/Ha + Trees and Shrubs

Plot map

MPMC – Trial Plot Prescriptions

Parcel	Area (Ha)	Soil Application	Ground Cover	Tree/Shrubs
1	0.467	Till	-	Lodgepole Pine and Douglas-fir will be planted at 70/30 at 1600 sph. Black cottonwood - 200 sph Paper birch - 50 sph Trembling aspen - 50 sph Sitka alder - 200 sph Saskatoon - 50 sph Prickly rose - 50 sph Scoulers willow - 50 sph Huckleberry – 50 sph
2	0.469	Till + Biosolids	Forbe mixture (~35 g fireweed = 75g/ha, 500 g lupine = 1 kg/ha, 52.9 g Dryas drummondii = 113 g/ha, 2.3 kg june grass, yarrow, pearly everlasting mix = 4.9 kg/ha)	
3	0.468	Till + Biosolids	Fireweed (~35 g) = 75g/ha	
4	0.469	Till + Biosolids	-	
5	0.473	Till + Biosolids	Native blend @ 5 kg/ha	
6	0.468	Till + Biosolids	Native blend @10 kg/ha	

- Glacial Till: 20 cm uniform application
- Biosolids: 107 dt/ha
- Native blend: junegrass, tickle grass, mountain brome, native red fescue, Rocky Mountain fescue, blue wild rye, wheatgrass (bluebunch), lupine, fireweed

Appendix C

MPMC Survival Survey Summary Biosolids Plots

Location/Block: NBD Research Parcels 1 - 6	**Date: September 23, 2014**	**Surveyor: GH**
Total Area (ha): 2.8	***History: Re-contoured 2013, Soil application 2013, Grass seeding 2013, Planted 2014***	

Stratum Information:

Stratum: A (with biosolids, parcels 2-6)		**Area: 2.347**
BGC Zone and Sub Zone: ICH mk3		**Site Series: 02**
Site Index, Method and Species: 18/SIBEC/PLI		**Slope and Aspect: ~30% -NW-**
Inventory Label: Pli7Fdi3-2/2-0.2/0.3-18/E-1-1520(14)		**Silviculture Label: Pli69Fdi31-2-0.2-18/E-1360(14)**
Total Trees: 1520	**Total Conifers: 1400**	**Total Well Spaced: 1360 (1120 using M Value)**

Survival Information (ocular estimate from plots and walkthrough):

Species	Good %	Fair %	Poor %	Dead %
Douglas Fir	55	43	1	1
Lodgepole Pine	44	52	3	1
Black Cottonwood	80	10	8	2
Paper Birch			10	90
Trembling Aspen	70	15	5	10
Sitka Alder	80	14	3	3
Saskatoon	10	70	5	15
Prickly Rose	53	40	5	2
Scoulers Willow	60	44	5	1
Black Huckleberry			10	90

Sample Information (based on plot averages per species, sample "typical" trees only):

Species	Height (m)	Leader (cm)	Age
Fdi	0.27	6	2
Pli	0.21	9	2

Holmes, G. 2015. NBD Biosolids Research Parcels 1-6 Survival Survey Assessment – Year 1. Mount Polley Mining Corporation, September 2014.

MPMC Survival Survey Summary Control Plot 1

Location/Block: NBD Research Parcels 1 - 6	**Date: September 23, 2014**	**Surveyor: GH**
Total Area (ha): 2.8	***History: Re-contoured 2013, Soil application 2013, Grass seeding 2013, Planted 2014***	

Stratum Information:

Stratum: B (no biosolids, parcel 1)		**Area: 0.453**
BGC Zone and Sub Zone: ICH mk3		**Site Series: 02**
Site Index, Method and Species: 18/SIBEC/PLI		**Slope and Aspect: ~30% -NW-**
Inventory Label: Pli7Fdi3-2/2-0.2/0.2-18/E-1-2000(14)		**Silviculture Label: Pli74Fdi26-2-0.2-18/E-1560(14)**
Total Trees: 2000	**Total Conifers: 1720**	**Total Well Spaced: 1560 (1200 using M Value)**

Survival Information (ocular estimate from plots and walkthrough):

Species	Good %	Fair %	Poor %	Dead %
Douglas Fir	1	97	1	1
Lodgepole Pine	34	59	6	1
Black Cottonwood	5	83	10	2
Paper Birch			10	90
Trembling Aspen	1	66	30	3
Sitka Alder	4	84	10	2
Saskatoon	1	36	60	3
Prickly Rose	5	74	20	1
Scoulers Willow	3	76	20	1
Black Huckleberry	-		10	90

Sample Information (based on plot averages per species, sample "typical" trees only):

Species	Height (m)	Leader (cm)	Age
Fdi	0.23	4	2
Pli	0.17	7	2

Holmes, G. 2015. NBD Biosolids Research Parcels 1-6 Survival Survey Assessment – Year 1. Mount Polley Mining Corporation, September 2014.

APPENDIX K:

MPMC SEDIMENT AND EROSION CONTROL PLAN

Mount Polley Mine
Environmental Management Plan:

Sediment and Erosion Control Management Plan

Last Update: April 30, 2015

Document Revision Control

Rev. No.	Revision	Date	Approved
0	Original	2010	RM
1	Incorporation of available best practices	July 7, 2014	CH
2	Minor update	February 12, 2015	KM
3	Inclusion of site-specific components	April 30, 2015	KM

Table of Contents

1 Introduction 1
1.1 Legislation and Best Management Practices 1
1.2 Environmental Protection and Mitigation 2
2 Surface Development/Construction Projects 2
2.1 Pre-Project Planning 2
2.1.1 Stabilization and Treatment Methods 3
2.1.2 Runoff Collection Ditches 4
2.1.3 Sediment Control Ponds 4
2.2 Construction 4
2.2.1 Soil Salvage 5
2.3 Post-Construction 5
3 Mine Operations 5
3.1.1 Collection of Mine Contact Water 5
3.1.2 Emergency Release of Water 6
3.1.3 Adaptive Management 6
4 Decommissioning and Reclamation 6
5 Monitoring and Inspections 7
5.1 Water Monitoring (Site Infrastructure and Receiving Environment) 9
5.1.1 Inspections 9
5.1.2 Contact Water Monitoring 9
5.1.3 Receiving Environment Monitoring 10
5.1.4 Emergency Release of Water 11
5.2 Reclamation Areas 12
5.3 Construction Projects 12
5.3.1 General Monitoring 12
5.3.2 Event-based Monitoring 13
7 References 15

Appendices

Appendix A – Water Management Inspection Checklist
Appendix B – Bi-annual Water Management Inspection Checklist
Appendix C – Water Release Report Form
Appendix D – Reclamation Re-vegetation Assessment Form

1 INTRODUCTION

Erosion results in the loss of soil particles, mineral nutrients and organic matter that support vegetation, and in turn, wildlife. Eroded materials entering adjacent watercourses may adversely affect water quality, fish and fish habitat. This "Sediment and Erosion Control Plan" (the Plan) is a tool to provide direction for the management of surface erosion at Mount Polley Mine. The Plan addresses existing and potential surface erosion impacts associated with mine expansion (construction activities), operation, and decommissioning phases, and applies to all Mount Polley personnel and contractors. The main objective of this Plan is to minimize erosion and intercept potential sediments as close to the source as possible. Erosion and sediment control measures and best management practices (BMPs) are incorporated in the Plan as approaches to prevent erosion and the introduction of sediment into natural water bodies and watercourses. Guidelines for monitoring the efficacy of measures in this Plan are also outlined. This Plan is a "live" document that is to be updated as site conditions and operations, as well as industry BMPs, evolve.

1.1 Legislation and Best Management Practices

The following lists the federal and provincial regulatory requirements with regards to surface erosion prevention and sediment control. The guidance in the subsequent sections is designed to help works proceed in accordance with these regulations:

- BC *Water Act*
- BC *Environmental Management Act*
- Canada *Fisheries Act*

The following are examples of BMPs and guidelines applicable to surface erosion prevention and sediment control. These documents may be used as resource when developing project specific environmental management plans (EMPs). This Plan is designed to incorporate BMPs from these resources:

- "Environmental Best Management Practices for Urban and Rural Land Development in British Columbia" (Draft) (MWLAP, 2004)
- "Best Management Practices Guide for Storm water: Appendix H Construction Site Erosion and Sediment Control Guide" (Dayton and Knight, 1999)
- "Standards and Best Practices for Instream Works" (MWLAP, 2004)
- "Developing a Mining Erosion and Sediment Control Plan Version 1.0" (BC Ministry of Environment [MOE], 2015).
- "Land Development Guidelines for the Protection of Aquatic Habitat" (DFO, 1993)

1.2 Environmental Protection and Mitigation

The general approach applied in this document is reducing sediment sources and minimizing contact between sediment sources and water. Where avoidance is not possible, mitigation measures are adopted to reduce erosion. Sediment and erosion control measures are, and will continue to be, used during construction, operation, and decommissioning activities at the Mount Polley Mine site. Such activities may include clearing vegetation and stripping topsoil, stockpiling topsoil, and constructing roads, infrastructure, tailings and water diversion structures. Potential hazards from these activities, in the absence of planned mitigation measures, include increased surface erosion from disturbed areas, increased sediment load to downstream receiving environments, and siltation or erosion of downstream watercourses or water bodies.

The subsequent sections discuss short- and long-term procedures for sediment retention and erosion control measures for work with potential for land surface disturbance.

2 SURFACE DEVELOPMENT/CONSTRUCTION PROJECTS

This section provides general guidelines to be followed for future construction projects and/or surface development on the mine site.

2.1 Pre-Project Planning

The guidance documents referenced in Section 1.1 and, when necessary, qualified consulting professionals, are available to support planning of a specific project. Prior to starting any new construction work, the following should be considered:

- Design of projects to minimize the amount of ground cleared and disturbed.
- Design of projects to minimize disturbance adjacent to receiving environment watercourses and water bodies.
- Planning of works such that areas adjacent to waterways and drainage lines remain undisturbed or protected from erosion for as long as practicable.
- Planning of work to minimize the use of heavy equipment and have equipment conduct work as efficiently as possible.
- Planning of interim water and runoff management strategies to reduce erosion and identify available mitigation techniques in the event that sediment mobilizes (refer to the following subsections).
- Planning of long-term erosion control measures to be implemented after project completion (Section 2.3).
- Identification of monitoring and inspection requirements for during and after the project (Section 5).
- Design of project criteria, construction plans, and mitigation for stream and other watercourse crossings to meet or exceed all standards and codes established by relevant authorities for the project.
- Obtaining the appropriate approvals prior to conducting works in and around watercourses and water bodies, ensure works are being conducted in accordance with the regulated in stream work windows, or as otherwise agreed with relevant agencies. Permitting, notification, and reporting requirements for projects will vary baedon on their location and proximity to natural waterbodies and water courses. These permits and notifications may include:
    - DFO Project Review;

- Section 9 approval (Water Act);
- MOE approval; and
- Ministry of Energy and Mines (MEM) approval.

If the project has potential to impact natural watercourses or water bodies (i.e., if the work is outside site contact water collection systems and/or is adjacent to natural waterways), a site-specific EMP for project work should be developed. The EMP should include, at minimum:

- A summary of how information requirements in the bullets above have or are being implemented.
- Details of drainage patterns over the area, both clean water and potential construction runoff.
- Locations of adjacent environmentally sensitive areas that could be impacted.
- Details of existing or planned erosion and sedimentation control methods to filter or collect construction runoff.
- The locations of spill kits and extra sediment and erosion control materials.
- The location of any existing or planned drainage diversions.
- A general outline of the planned work.
- The location of any existing or planned required pumping or sediment ponds.
- An inspection and monitoring schedule.
- A revision number and date.

For projects requiring an EMP, appropriate training and awareness to involved supervisors, workers (employees and contractors) regarding their legal responsibilities of complying with general water quality related legislation should be conducted. Workers are to be made aware of the required mitigation measures for a task, in addition to any requirements contained in any public or private approvals and agreement documents.

The following subsections outline potential sediment and erosion control techniques that may be implemented.

2.1.1 Stabilization and Treatment Methods

Sediment control measures are to be planned and, if required, installed prior to any clearing or earthwork activities. Stabilization measures are put in place to prevent or reduce the mobilization of sediment by stabilizing the source (e.g., exposed soils). Typical interim measures that may be used to stabilize areas that have the potential to be sources of sediment to water bodies or watercourses include:

- Non-vegetative cover (e.g., gravel and straw);
- Rip-rap placement;
- Slope modification to reduce erosive energy (e.g., flattening or benching);
- Surface ripping and roughening to promote infiltration;
- Diversion berms and drains (in particular to intercept upstream runoff);
- Chute construction;
- Sandbags;
- Buffer zones; and
- Erosion blankets.

While pro-active stabilization measures are used to avoid the presence of sediment laden water, treatment measures may be necessary when it is not possible to completely prevent the mobilization of sediment. Typical treatment measures that may be used to manage sediment in contact water include the following:

- Check dams or weir drop structures;
- Outlet protection;
- Sediment retention ponds, sediment traps and sediment basins;
- Silt fence or similar barrier, such as straw; and
- Swales.

2.1.2 Runoff Collection Ditches

Runoff collection ditches may be either temporary or permanent structures. Permanent surface runoff control works should be sized to convey runoff from a 1 in 10 year 24-hour flood flow and to withstand a 1 in 200 year 24 hour event without significant damage as per MOE Permit 11678.

Site-specific sections of ditch may depend on topography, excavation material (till or bedrock) and design discharge. Different material gradations or design approaches may be used for armoring depending on site specific conditions and material availability. Any convergences with other ditches or streams should be armored.

Some initial flushing, erosion and self-armoring is expected following construction. Appropriate measures should be taken for ditches discharging into the receiving environment, for example construction of small ponds with rock overflow weirs or temporary collection of this water in mine contact water systems until it is of appropriate quality to discharge. With aging, erosion and sediment runoff will be controlled to be comparable to natural conditions; however, inspections and monitoring (refer to Section 5) are required to confirm appropriate sediment control.

2.1.3 Sediment Control Ponds

A sediment control pond is used to detain runoff from a disturbed area so that sediment can settle out of the water column. Sediment control ponds should be designed according to the “Guidelines for the Design, Size, and Operation of Sedimentation Ponds used in Mining” (MOE, 2002), where applicable.

2.2 Construction

Construction should comply with the plans developed in the pre-construction phase (Section 2.1) so that work is conducted in a manner that avoids or minimizes erosion and the discharge of silt, sediment or other deleterious substances into any watercourse. Changes to the construction plan are to be reviewed by the appropriate Environmental and Engineering staff prior to implementation to allow sediment and erosion control plans to be revised accordingly.

Monitoring is to be carried out as per Section 5 of this document. Actions and maintenance that may be required based on monitoring observations include:

- Correcting deficiencies of the erosion and sediment control measures as soon as they are observed.
- Removal of any sediment and debris accumulation that compromises the effectiveness of the erosion and sediment control measures.
- Implementation of additional stabilization and treatment measures listed in Section 2.2.

Additional measures recommended for all stages of construction include:

- Monitor weather forecasts for upcoming rainfall or other climatic conditions that may affect the construction works and surrounding environment.
- Suspend work in areas adjacent to natural water bodies or watercourses during heavy precipitation or runoff conditions.
- Follow the project EMP (especially for pumping, diversion, or relocation of water undertaken) and revise it if the project work plan changes.
- Refer to the site Emergency Response Plan in the event of a major incident.

2.2.1 Soil Salvage

Under the MEM permit M-200, surficial soils are required to be stripped from the areas to be disturbed in advance of construction of works including waste rock dumps, waste or ore stockpiles, and roads. Stockpiles are often required to store salvaged soils for later use in reclamation. Stockpile locations should have minimal exposure to wind, southwest sun, and runoff pathways. Stockpiles should be promptly seeded with a native seed mixture containing grasses, and/or forbes. If stockpiles have the potential to impact natural watercourses or water bodies, temporary erosion and control measures should be installed and maintained until a vegetative cover is established.

Refer to the MPMC Soil Management Plan for additional details on the site protocol for soil salvage.

2.3 Post-Construction

When a project is completed, long-term sediment retention and erosion control measures should be implemented. These measures may include elements of the stabilization and treatment options in Section 2.1.1, as well as:

- Restricting access to areas being rehabilitated.
- Establishing a vegetative cover.
- Armoring areas receiving surface runoff.
- Slope modification to reduce erosive energy, such as flattening or benching.
- Surface ripping and roughening to promote infiltration.
- Diversion berms and drains (in particular to intercept upstream runoff).

Any interim measures should remain in place until long-term controls are established. When monitoring and inspections (as described in Section 5) find long-term measures are sufficient, interim or temporary erosion and sediment control features may be reclaimed.

3 MINE OPERATIONS

Sediment and erosion control practices for new disturbances at the mine site are to follow the procedures outlined in Sections 2.1 to 2.3, but measures are also to be implemented and maintained on a site-wide scale.

3.1.1 Collection of Mine Contact Water

Collection of runoff from disturbed areas on site that may impact water quality in the receiving environment is to be carried out across the mine site. Thus, runoff from disturbed areas that potentially

contains sediments is not directly released to the environment. Water from these collection systems is stored on site, and is not permitted to be discharged to the environment unless specific regulatory requirements are met. These requirements include maximum allowable total suspended solids and turbidity levels, necessitating removal of suspended sediments through active or passive treatment prior to discharge.

To minimize the volume of contact water collected and stored at the site, upstream ditches to divert non-site contact water may be constructed. As water from these works enters the receiving environment, for construction of new diversion ditches, an EMP should be developed and followed for construction, and the guidelines in Sections 2.1 to 2.3 followed.

Inspection and monitoring requirements for site water collection systems and diversion ditches are outlined in Section 5.

3.1.2 Emergency Release of Water

If emergency release of water from a site water collection systems should occur, sediment and erosion control material are to be installed as required to avoid the displacement of sediment as water moves over land. These materials are stored in the Environmental C-Can located beside the Leach Pad, and the Environmental Department staff is available to guide proper installation. The Mount Polley Emergency Response Plan and Water Management Inspection Manual outline in more detail response protocol for such events, and Section 5 outlines required event-based monitoring.

3.1.3 Adaptive Management

This Plan is designed to be updated as sediment and erosion control science and BMPs develop over time. It is also designed to be adapted for operational changes and water management needs at the mine site. Continuous improvements that may be carried out include (but are not limited to):

- Changes to the design of works to eliminate deficiencies that are noted during inspections and require regular maintenance.
- Implementation of mitigation measures in response to water quality trends noted in the receiving environment.
- Implementation of measures that reduce treatment needs prior to discharging water.
- Implementation of measures to reduce maintenance costs.
- Implementation of measures to reduce environmental risk.

Measures in place to identify areas where improvements and/or maintenance are required are described in Section 5.

4 DECOMMISSIONING AND RECLAMATION

At closure, MPMC is responsible for leaving the mine site in compliance with all regulations, including site runoff water quality and re-vegetation to meet end land use objectives. Re-vegetation shall be undertaken of all disturbed areas, along with the following measures:

- Grade and contour any disturbed areas to promote drainage and conform to adjacent topography.
- Apply soil in a rough manner to create micro topography.
- Apply coarse woody debris to the reclamation site if it is not already incorporated into the soil.

- Seed and/or plant disturbed areas with a suitable mixture of grass, legumes and woody species to establish ground cover and stabilization in a timely manner.
- On disturbed areas with potential to impact natural water bodies or watercourses, maintain temporary stabilization measures, such as geotextile or mulch until a vegetative cover is established.

Detailed soil application and revegetation plans that include methods for reducing erosion are included in the site Reclamation and Closure Plan. Monitoring and inspections requirements for reclaimed sites are included in Section 5.

5 MONITORING AND INSPECTIONS

Site monitoring and inspections of sediment and erosion control systems are based on associated risk to the environment. Figure 1 identifies environmentally sensitive areas (i.e. receiving environment waterways) adjacent to the Mount Polley Mine footprint that could potentially be impacted by sedimentation. It also shows the location of contact water conveyance structures, areas undergoing progressive reclamation and soil stockpile locations, which are potential sources of sediment. Table 1 relates potential sediment sources to these sensitive areas and assigns a level of risk based on sensitivity of the receiving environment (receiver size, fish bearing status, etc.) and erosion potential. Note that Hazeltine Creek and adjacent areas impacted by the August 4, 2015 TSF breach are outside of the scope of this document.

Based on the risk matrix and site conditions, water management works appear to be the largest risk to receiving environment systems, because:

- Reclamation areas and soil stockpiles on site (with the exception of two (2) active soil stockpiles below the Southeast Rock Disposal Site (SERDS) and one (1) active stripping location in the WX Zone) have all been seeded or inspected to confirm natural revegetation is underway. Further, site specific observations from annual reclamation inspections and soil stockpile surveys indicate that erosion of these sites is rare.
- Mine site hydrology systems are snowmelt dominated, and periods of high flow are experienced annually during freshet, meaning that:
    - There is higher potential for in-ditch erosion;
    - There is higher potential for erosion by surface runoff that reports to collection ditches; and
    - Risk of an emergency release of water is elevated.
- Collection ditches are located downstream of disturbed areas on site, and thus are collect and convey any turbid water that is generated on sites.

Thus, water management inspections are the primary focus of the monitoring program. In the following subsections, monitoring and inspection requirements, roles and responsibilities, and reporting protocol are outlined. Protocol is broken into the following areas:

1. Water Monitoring;
2. Reclamation areas (soil stockpiles and progressive reclamation sites); and
3. Construction projects.

Table 1. Mount Polley Sediment and Erosion Control Risk Matrix

Receiving Environment Area	Area Sensitivity	Primary Potential Source(s)	Secondary Potential Sources(s)[1]	Erosion Potential[2]	Risk[3]
6km Creek	- Not fish bearing in upper reaches - Variable forest buffer	- Access Road - Junction Zone Ditch or 9km Sump	- NW PAG Stockpile soil stockpiles - NW PAG Stockpile access roads - Failure of NW Sump	- Established gravel ditch bottom - Upstream area mostly covered with waste rock - Soil stockpiles revegetating - Two high traffic road crossings	Medium
Mine Drainage Creek	- Not fish bearing - Connected to Bootjack Lake	- West Ditch Sump - West Ditch	- Waste Haul Road - Helipad reclamation parcel - Crusher Access Road - Ore Switchback Road - Ore switchback soil stockpile	- Some erodible ditch sections - Portion of runoff into ditch filters through rock haul road - Reclamation parcel revegetating - One active soil stripping location	Medium
W20 Creek	- Fish bearing (very low productivity) - Variable forest buffer	- West Ditch - West Ditch Access Road	- Light Vehicle Tailings Road - Waste Haul Road - Above Waste Haul Road reclamation parcel	- Some erodible ditch sections - Majority of runoff into ditch filters through rock haul road - Reclamation parcel revegetating	Medium
Bootjack Lake	- Fish bearing, - Medium sized receiver - Variable forest buffer	- NW Sump - NW Ditch - West Ditch Sump - West Ditch - West Ditch Access Road - Mine Drainage Creek - W20 Creek	- Waste Haul Road - Helipad reclamation parcel - Crusher Access Road - Ore Switchback Road - Ore switchback soil stockpile - Light Vehicle Tailings Road - Waste Haul Road - Above Waste Haul Road reclamation parcel	- Some erodible ditch sections - Soil stockpiles and reclamation parcels revegetating - One active soil stripping location - Portion of runoff into ditches filters through rock dumps or haul roads	Medium
North Dump Creek	- Not fish bearing in upper reaches - Variable forest buffer	- Joe's Creek Coffer Dam - Joe's Creek Pipeline - Gavin's Ditch (clean water diversion) - Wight Pit Ditch (clean water diversion) - Wight Pit Haul Road	- North Bell Dump reclamation areas and soil stockpiles - Access Road - NEZ Dump reclamation area and soil stockpiles - East Dump reclamation areas and soil stockpiles	- Coffer Dam/Pipeline water very low turbidity/suspended solids - Established ditch substrates - Reclamation area/stockpile revegetation underway - Two moderate use road crossings	Medium
Bootjack Creek	- Not fish bearing - Connected to Polley Lake	- Bootjack Creek Sump - Tailings Access Road Ditch - SERDS Ditch	- Tailings Access Road - Tailings Access Road soil stockpiles - SERDS access roads - Southeast Zone soil stockpiles	- Some erodible ditch sections - Portion of runoff into ditches filters through waste rock roads/dumps - Three high use road crossings	Medium
Polley Lake	- Fish bearing, - Large sized receiver - Forest buffer	- Wight Pit Ditch (clean water diversion) - Long Ditch - North Dump Creek - Bootjack Creek	- North Bell Dump reclamation areas and soil stockpiles - Access Road - NEZ Dump reclamation area and soil stockpiles - East Dump reclamation areas and soil stockpiles - Tailings Access Road - Tailings Access Road soil stockpiles - SERDS access roads - Southeast Zone soil stockpiles	- Upstream reclamation areas and soil stockpiles revegetating - Some Erodible sections of Ditch Upstream of Bootjack and North Dump Creeks	Low
Hazeltine Creek[4]	- Not fish bearing - Undergoing rehabilitation - Sedimentation ponds constructed at outflow	- Polley Lake - Long/SERDS Ditch (combined) - Central Collection Sump - Breach Sump and Ditch - Perimeter Till Borrow Pit - Edney Creek	- TSF and associated infrastructure - TSF Perimeter Embankment soil stockpiles - TSF Ditch (clean water diversion) - TSF South Seepage Pond - TSF South Toe Drain Ditch - TSF Main Seepage Pond - ABR/Main Seepage Pond Ditch	- High volume water transfers - Water has time to settle in the TSF settling pond and Perimeter Embankment Till Borrow Pit - Central Collection Sump and Breach Sump/Ditch recently constructed - South Till Borrow area revegetation is progressing	Medium (risk will increase as rehabilitation progresses and when fish barriers are removed)
Edney Creek	- Fish bearing - Forest/wetland buffer	- TSF Ditch (clean water diversion) - TSF South Seepage Pond - TSF South Toe Drain Ditch - TSF Main Seepage Pond - ABR/Main Seepage Pond Ditch - South Till Borrow reclamation area	- TSF and associated infrastructure - South and Main Embankment soil stockpiles	- Few erodible ditch sections - Water in ABR and seepage ponds very low turbidity/suspended solids - South Till Borrow area revegetation is progressing	Low

Notes:

1) Secondary sources are potential sources of sediment that are upstream of (i.e. potentially contribute to) primary sources

2) Historic turbidity and TSS data in relevant water collection infrastructure were considered when assessing erosion potential

3) Based on combination of area sensitivity and erosion potential

4) Sediment and erosion control in Hazeltine Creek beyond the mine footprint related to the TSF breach is managed under a separate program

5.1 Water Monitoring (Site Infrastructure and Receiving Environment)

5.1.1 Inspections

Daily inspections of site water containment infrastructure are completed as per the Water Management Inspection Manual to verify the collection system is working as designed. As per this document, inspections are completed on day shift and night shift during high risk periods (i.e. freshet). The inspection form template is included as Appendix A. Completed forms are provided to the Environmental Department for review and filing at the end of each seven (7) day set. Note that protocol and triggers are in place for immediate notifications to occur if deficiencies are observed. Daily inspections are the responsibility of Mill Maintenance, and the Environmental and Engineering Departments are responsible for updating the Water Management Inspection Manual, which is a component of the site Operation Maintenance and Surveillance (OMS) Manual.

Thorough inspections of all site water management infrastructure (sumps, ditches, culverts, etc.) are completed in spring after freshet and in fall prior to freeze up, as per Permit 11678. This is the responsibility of the Environmental Department. Results are documented in the inspection form (refer to the template provided as Appendix B) and filed internally.

Inspection results are used to inform upgrades of water management structures. Noted deficiencies, including areas of sedimentation or erosion, are compiled and prioritized in a projects list which is provided to the Engineering Department to address, based on the identified levels of urgency.

As per the Water Management Inspection Manual, supplemental inspections are to be completed by Mill Maintenance during high risk periods (i.e. precipitation and/or snowmelt runoff events), with support from Mine Operations, the Environmental Department, and the Engineering Department. Aside from the frequency changes, the inspection procedure is consistent with the one previously described. Inspection reports from high flow periods provide feedback on the functioning of site water collection systems under conditions when erosion potential is higher. Noted deficiencies are incorporated into project planning for continuous improvements along with findings from routine inspections as described above.

5.1.2 Contact Water Monitoring

Routine monitoring of mine site contact water conveyed through various infrastructure components is also completed as per *Mines Act* Permit M-200. This sampling program is outlined in the site OMS Manual, which is regularly updated to account for operational changes at the mine site. All routine samples collected on site are analysed for physical parameters (including total suspended solids and turbidity), anions, nutrients, and total and dissolved metals. Monitoring locations and frequency (at the time of this update) are shown in Figure 1.

These sample results are included in the Annual Environmental and Reclamation Report to MOE and the MEM, which is written and submitted by the Environmental Department.

Results from these samples are used, along with inspection results, to identify potential upgrade opportunities for site water conveyance structures as described in Section 5.1.1

5.1.3 Receiving Environment Monitoring

The Environmental Department conducts water quality monitoring in receiving environment water bodies and watercourses as required under *Environmental Management Act* Permit 11678. In addition to regular sampling (e.g., monthly, quarterly), a five (5) week intensive turbidity and total suspended solids monitoring program is conducted in spring and fall in receiving environment streams that could potentially be impacted by erosion from the mine. This includes the following creeks downstream of inflows from runoff diversion ditches:

- North Dump Creek;
- Bootjack Creek;
- Edney Creek; and
- Hazeltine Creek (temporarily suspended due to the TSF breach).

This sample program is outlined in the Annual Monitoring Plan which is revised and submitted to MOE each January by the Environmental Department. The Annual Monitoring Plan is also referenced in the site OMS Manual, which is regularly updated to account for operational changes at the mine site. All routine samples collected on site are analysed for physical parameters (including total suspended solids and turbidity), anions, nutrients, and total and dissolved metals. Monitoring locations and frequency (at the time of this update) are shown in Figure 1.

Results from monitoring completed as part of the Annual Monitoring Plan are submitted to MOE quarterly, which is the responsibility of the Environmental Coordinator, and are also included in the Annual Environmental and Reclamation Report, which is submitted to MOE and MEM annually, and is the responsibility of the Environmental Department.

Results from routine or freshet/fall rainy period monitoring of receiving environment or general observations from carrying out other work at the mine site may indicate increased sedimentation from mine-related sources. Table 3 outlines the triggers for further monitoring and required follow up actions if elevated suspended sediment levels are observed or measured.

Table 3. Event-based monitoring protocol for receiving environment waterways

Trigger	Actions and Responsibilities
Receiving environment waterway or waterbody is observed to have a "cloudy" appearance	- Observer to report observation to the Environmental Coordinator (or member of the Environmental Department if Environmental Coordinator cannot be reached) - Environmental Coordinator or their delegate from the Environmental Department is to carry out in situ monitoring at this site, following the turbidity triggers and associated protocol below.
80-100% of BC Water Quality Guideline for Protection of Aquatic Life for turbidity observed in scheduled construction monitoring	- Environmental Technician to notify Environmental Coordinator. - Environmental Technician to organize investigation into the sediment source, with support from the Environmental Coordinator and other relevant workers, depending on the specific scenario. If the investigation indicates this sedimentation is not related to mine activities: - Document the findings. - Report any illegal activities. - Closely monitor this site until conditions have returned to normal or, it is established that the sedimentation will continue. If the investigation indicates that sedimentation is related to a mine activities: - Take actions to control the source. - Increase frequency of receiving environment turbidity monitoring. - Closely monitor the site until the sediment source is being appropriately managed and turbidity readings return to below the BC Water Quality Guideline.
⩾100% of BC Water Quality Guideline for Protection of Aquatic Life for turbidity observed in scheduled construction monitoring	- Environmental Technician to notify Environmental Coordinator. - Environmental Technician to organize investigation into the sediment source, with support from the Environmental Coordinator and other relevant workers, depending on the specific scenario. If the investigation indicates this sedimentation is not related to mine activities: - Document the findings. - Report any illegal activities. - Closely monitor this site until conditions have returned to normal or, it is established that the sedimentation will continue. If the investigation indicates that sedimentation is related to a mine activities: - Stop any construction or mine activities that may contribute to or exacerbate erosion. - Take actions to control the source. - Increase frequency of receiving environment turbidity monitoring. - Closely monitor the site until the sediment source is being appropriately managed and turbidity readings return to below the BC Water Quality Guideline.

5.1.4 Emergency Release of Water

In the event that an emergency release of water from the site collection system occurs, the protocol in the Water Management Inspection Manual outlining responsibilities, notification requirements, documentation (refer to the form in Appendix C), and actions to carry out. One key action is the installation of sediment and erosion control materials and/or structures.

Monitoring associated with an emergency release of water is the responsibility of the Environmental Department, and should include the following:

- Assessment of the spatial extent of the release and if the release reached receiving environment waterways or water bodies;
- Monitoring of water released (visual observations, flow measurements/estimates, field parameters including turbidity, and/or sampling, based on the observed location, conditions and size of the release); and

- Monitoring (visual observations, field parameters including turbidity, and sampling) of downstream waterways or waterbodies into which water was released.

Reporting to Emergency Management BC and follow up reporting to provincial regulatory agencies will likely require this information, in addition to the information required to be collected as per the Water Management Inspection Manual (refer to the form in Appendix C).

5.2 Reclamation Areas

Formal and/or informal inspections of reclamation areas are conducted annually to document the progression of revegetation. Soil stockpiles are also inspected annually as part of the soil stockpile inventory tracking program. During these inspections, erosion concerns are documented in the site Reclamation Field Notebook or on printed forms, such as the Reclamation Vegetation Assessment Form included as Appendix D. Results from reclamation assessments are included in the Annual Environmental and Reclamation Report, and planned reclamation prescriptions are updated accordingly for any identified erosion concerns.

A regular seeding program is another component of the reclamation program. Each spring and fall, when conditions are ideal for seeding, a list of areas that require seeding is developed based on planned reclamation, and results of site inspections. Areas included include progressive reclamation sites, recent disturbances from known operational activity, areas where erosion has been observed (and seeding is a reasonable mitigation method), and any previously seeded areas where growth was poor. Areas seeded are reported in the Annual Environmental and Reclamation Report. Note that this does not preclude seeding that occurs at other times of year associated with specific construction projects.

Supplemental investigations of soil stockpiles and reclamation areas are carried out if an investigation into a sediment source is being conducted. Results are documented in the current Environmental Department field notebook, and are presented in the Annual Environmental and Reclamation Report with relevant water quality discussions.

Monitoring and inspections of reclamation areas outlined in this section are the responsibility of the Mount Polley Environmental Department. Monitoring and inspections of reclamation sites post-closure are not included in this program, and are components of the site Reclamation and Closure Plan.

5.3 Construction Projects

5.3.1 General Monitoring

Monitoring should be carried out in accordance with project specific EMPs developed as per Section 2.1 and regulatory permits and legislation.

If the project has the potential to impact natural water courses, and requires an EMP, a designated, designated environmental monitor should oversee the project full time. The monitor's daily tasks are to be defined in the EMP, and should include:

- Visual inspections of erosion and sedimentation controls;
- Visual inspections of equipment for leaks;
- Visual inspections of spill kits to confirm appropriate supplies are available;

- Visual inspections of potential sources, such as soil stockpiles, new disturbances, and active construction areas;
- Monitoring of the weather forecast and current conditions; and
- Documentation of the above.

If a project does not have the potential to impact natural water courses, and EMP is not developed, monitoring is still expected and BMPs for sediment and erosion control should still be applied. Inspections should be conducted by a designated, qualified member of the Mount Polley Environmental or Engineering Department for the tasks outlined above.

In active construction areas where activities could impact stream water quality, additional monitoring may be required beyond routine sampling described in Section 5.1. Monitoring may include in situ turbidity testing and/or full suite water quality sampling (same parameters as listed for routine samples in Section **Error! Reference source not found.**). Results should be compared against pre-construction data and the BC Water Quality Guidelines for Freshwater Aquatic Life. Downstream monitoring site(s) should be located at a sufficient distance to ensure mixing of construction runoff and ambient stream water. An upstream control site of sufficient distance to be isolated from any construction-related impacts may be monitored simultaneously and compared to downstream monitoring results. Monitoring requirements and sampling frequency depend on the specific project and a monitoring plan should be included in the project EMP.

5.3.2 Event-based Monitoring

A detailed event-based monitoring program for the receiving environment should be included in project EMPs. Table 4 provides recommended protocol to incorporate.

Table 4. Recommended event-based monitoring protocol for a construction project

Trigger	Actions and Responsibilities
80-100% of BC Water Quality Guideline for Protection of Aquatic Life* for turbidity observed in scheduled construction monitoring	- Environmental Monitor to notify Environmental Coordinator and construction supervisor. With support from the Environmental Coordinator and construction supervisor (and any workers they designate), the Environmental Monitor is to: - Inspect all sediment and erosion control works and construction areas to identify the source. - Take actions to control the source. - Increase frequency of receiving environment turbidity monitoring.
⩾100% of BC Water Quality Guideline for Protection of Aquatic Life* for turbidity observed in scheduled construction monitoring	- Environmental Monitor to notify Environmental Coordinator and construction supervisor. - Construction supervisor to stop all local construction work. With support from the Environmental Coordinator and construction supervisor (and any workers they designate), the Environmental Monitor is to: - Inspect all sediment and erosion control works and construction areas to identify the source. - Take actions to control the source. - Increase frequency of receiving environment turbidity monitoring. Work is not to recommence until the sediment source is being appropriately managed and turbidity readings return to below the BC Water Quality Guideline.
Rainfall (or snowmelt) ≤ 10 mm/h or 25 mm/d	During minor rainfall or snowmelt runoff events, the Environmental Monitor is to: - Increase the frequency of receiving environment turbidity monitoring and follow the turbidity triggers and associated protocol above. - Increase the frequency of visual inspections of potential sediment sources (soil stockpiles, sediment ponds, etc.).
Rainfall (or snowmelt) ⩾10 mm/h or 25 mm/d	During major rainfall or snowmelt runoff events, the Environmental Monitor is to: - Notify the Environmental Coordinator and construction supervisor. - Increase the frequency of receiving environment turbidity monitoring and follow the turbidity triggers and associated protocol above. - Increase the frequency of visual inspections of high risk areas (soil stockpiles, sediment ponds, etc.). Environmental Coordinator and/or construction supervisor are to consider full work stop in the area based on conditions.

*Upstream monitoring site may be used as “background” reference

7 REFERENCES

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Waterways
Environmentally Sensitive Areas
Surface Water Monitoring Sites
Frequency
Monthly
Quarterly
Bi-Annually
Annually
Lake Monitoring Site
Water Collection Systems
Type
Clean Water Ditch
Contact Water Ditch
Pipeline
Sumps and Ponds
Soil Stockpiles
Progressive Reclamation Sites
Boundary Pit Sump
6km Creek
Junction Zone Ditch
6km Sump
NW Sump
NW Ditch
Springer Pit Sump
Cariboo Pit Sump
Mill to Springer West Ditch
North Dump Creek
Joe's Creek Coffer Dam
P1
Gavins Ditch
Wright Pit to Mill
Long Ditch
Polley Lake
Mill Site Sump
Mine Drainage Creek
Bootjack Lake
Tailings Reclaim Line
W20 Creek
SERDS Ditch
Bootjack Creek Sump
SERDS Sump
Long Ditch Sumps
Bootjack Creek
P2
Central Collection Sump
Breach Sump
TSF Settling Pond
Hazeltine Creek
Upstream 1
Till Borrow Pit
Upstream 2
TSF Clean Water Ditch
ABR
South Seepage Pond
Main Seepage Pond
3 Corner Ditch
Edney Creek
Figure 1: Mount Polley Mine Sediment and Erosion Control Plan Map
Date: 27/04/2015
N
0 250 500 1,000 1,500 2,000
Meters

Daily TSF/Water Management Inspection Checklist

Inspector: _____ Date: _____

Shift (Crew, D or N):_____ Weather Condition (ex. hot, windy): _____

Pumps/Pipes/Sumps	Time Checked	Inspection Gauge Readings	Fire Extinguisher OK?	# Starts
Upstream 1				
TSF Settling Pond				
CCS		RED YELLOW BLACK	Y / N	
Breach Sump (CCS to Till Borrow)				
South Seepage Collection Pond		RED YELLOW BLACK	Y / N	
Main Seepage Collection Pond		RED YELLOW BLACK	Y / N	
Perimeter Embankment Till Borrow		RED YELLOW BLACK		
9km Sump		RED YELLOW BLACK	Y / N	
NW PAG Sump		RED YELLOW BLACK	Y / N	
Mine Drainage Creek Sump		RED YELLOW BLACK	Y / N	
Bootjack Creek Sump		RED YELLOW BLACK	Y / N	
SERDS Sump		RED YELLOW BLACK		
West Ditch Culverts (light vehicle, TAR)				
Wight Pit Dewatering				
Joe's Creek Pipe			Y / N	
Long Ditch Sumps (Upper and Lower)		RED YELLOW BLACK		
Long Ditch/SERDS Outflow Pipes				
Cariboo Pit				
Springer Pit Sump			Y / N	
Springer Pit Dewatering Outflow				

Is the TSF Generating Dust?

No Minor Moderate Major

Is the Polley Lake Plug Generating Dust?

No Minor Moderate Major

ADDITIONAL COMMENTS/OBSERVATIONS (ex. erosion):

_____

_____

_____

WINTER IS COMING REMEMBER TO DRAIN BACK UP DIESEL PUMPS AFTER TESTING

Bi-Annual Water Management Inspections

Location	Initials	Date	OK	Not OK	Photo (Y/N)	Comments/Actions Required
Junction Zone Ditch (lower section)						
Junction Zone Ditch (upper section)						
9km Sump						
Northwest Ditch						
Northwest Sump						
Waste Haul Road Culvert						
West Ditch						
Mine Drainage Creek Sump						
Bootjack Lake Dam						
Orica Site Settling Pond						
Orica Ditch						
Bootjack Cr Culverts at TAR and TSF Road						
Bootjack Creek Sump						
TAR Ditch						
SERDS Ditch						
SERDS Culverts at TSF Road						
SERDS Culverts at TAR						
SERDS Sump						
SERDS Ditch Pipeline						
Wight Pit Clean Water Ditch (N)						
Wight Pit Clean Water Ditch (SW)						
SEZ Ditch						
Gavin's Ditch						
Access Road Culverts						
Joe's Creek Coffer Dam						
Joe's Creek Pipeline						
Long Ditch						
Long Ditch Sump (Upper)						
Long Ditch Pipeline						
Long Ditch Sump (Lower)						
Bootjack Creek Bridge Crossing						
Mill Site Ditch						
Mill Site Sump						
Crusher Site Ditch						
Tailings Ditch (Mill to Booster Station)						
Tailings Ditch (Booster Station to 5 Corner)						
Tailings Ditch (5 corner to TSF)						
Central Collection Sump						
Breach Sump						
Breach Sump Ditch						
Perimeter Embankment Till Borrow Pit						
Hazeltine Discharge Pipeline						
ABR						
Main Seepage Pond						
Main Seepage Pond Ditch						
Ditch below 3 Corner						
South Toe Drain Ditch						
South Seepage Pond						
South Seepage Pond Pipeline						
Borrow Pit Ditch & Settling Pond across from Horsefly-Gavin FSR						
Horsefly-Gavin FSR under permit obligation with MOF (W7 to W8z)						
TSF Clean Water Ditch						

Water Management Incident Report Form

Please complete and forward to the Environmental Department.

DATE OF REPORT	
DATE AND TIME INCIDENT DISCOVERED	
NAME(S) OF PERSON/PEOPLE REPORTING INCIDENT	
LOCATION OF INCIDENT	
IS WATER RELEASING TO ENVIRONMENT?	
If yes, what time did it start releasing, and at what rate is the water flowing?	
If no, at what rate is it approaching release?	
DESCRIPTION OF HOW/WHY INCIDENT OCCURRED	
HAS THE PROBLEM BEING FIXED? HOW?	
If yes, what time did the water stop releasing to the environment (if released)?	
If no, describe actions being taken to fix problem (record timeline of events).	

DESCRIPTION OF MEASURES TAKEN TO PROTECT ENVIRONMENT (ex. sediment and erosion control materials)	
PREVENTATIVE MEASURES TAKEN TO ENSURE INCIDENT DOES NOT OCCUR AGAIN	
SUPERVISOR NAME	
SUPERVISOR SIGNATURE	
FOLLOW UP REQUIRED?	
Environmental Department: Name: _____ Sign: _____	Comments:

MOUNT POLLEY RECLAMATION RE-VEGETATION ASSESSMENT FORM

Date: _____ Transect: _____
Assessor(s): _____ Plot: _____
Reclamation Site: _____ Plot Size: _____
Site Conditions (slope position, slope angle, aspect): _____

Ground Surface

Surface Roughening (present, description):	
Coarse Woody Debris (% cover, types):	

Understorey Vegetation

General

% Cover (all species)	
% Cover (invasive species)	
Average Height (m)	
Vigor (0 - 5)	

Species Specific

Species	# Species	% Cover	Height (m)	Vigor (0 - 5)	Planted/Ingress/Invasive

Trees/Shrubs

Species	# Present	Average Height (m)		Vigour (0 - 5)	Planted/Ingress

Wildlife Value

Wildlife Observations:	
Habitat Types Present:	

Comments

(ex. erosion, variation across plot)

APPENDIX L:

SITE WIDE WATER BALANCE AND WATER QUALITY MODEL

(GOLDER 2015)

CARIBOO-SPRINGER PIT PHASE 4 WATER MANAGEMENT PLAN

(GOLDER 2015)

SPRINGER PIT WATER LEVEL PREDICTIONS AND MODEL VERIFICATION

(GOLDER 2015)

TECHNICAL MEMORANDUM

DATE September 29, 2015 **REFERENCE No.** 1411734-075-TM-Rev0-6000

TO Luke Moger and Katie McMahen
Mount Polley Mining Corporation

CC Jerry Vandenberg

FROM Kristina Skeries, Skya Fawcett, Johanna Richards and Rob Millar **EMAIL** Kristina_Skeries@golder.com; Skya_Fawcett@golder.com; Johanna_Richards@golder.com; Robert_Millar@golder.com

MOUNT POLLEY SITE WIDE WATER BALANCE AND WATER QUALITY MODEL – CLOSURE AND POST-CLOSURE FOR RESTRICTED OPERATIONS

1.0 INTRODUCTION

Mount Polley Mine is an open pit copper/gold mine owned and operated by Mount Polley Mining Corporation (MPMC) and is located in south-central British Columbia, about 56 kilometres (km) northeast of Williams Lake (Figure 1). The Mount Polley property is located on the eastern edge of the Fraser Plateau physiographic sub-division, characterized by rolling topography and moderate relief. The mine is situated on a ridge straddling the Polley Lake/Hazeltine Creek and the Bootjack Lake/Morehead Creek watersheds. These watersheds are both contained within the Quesnel River drainage basin. Elevations range from 950 meters above sea level (masl) at Polley Lake to 1,266 masl at the summit of Mount Polley.

The Mount Polley Mine initially operated from 1997 to 2001 when it was placed on care and maintenance. It re-opened in 2005 after improved metal prices and delineation of new ore reserves (MPMC 2009). The Mount Polley site includes a crusher and mill (including office spaces), waste rock disposal sites, seepage collection ponds, haul roads, access roads, and various small buildings and small storage areas. Golder Associates Ltd. (Golder) has worked collaboratively with MPMC to develop options for short-term water management at the Mount Polley Mine. To this end, Golder (2015a) developed a site-wide water balance for the MPMC mine site using GoldSim™ simulation software (GoldSim 2010). That water balance was modified to represent closure conditions and forms the basis of this technical memorandum.

In August 2015, MPMC retained Golder to evaluate the quantity and quality of effluent at closure following one year of restricted operations, consistent with their present *Mines Act* Permit M-200. The objectives of this study were to:

- Expand the water balance and water quality models that were developed for short-term water management to include other site facilities and extend them forward in time to generate mine water quantity and quality predictions.

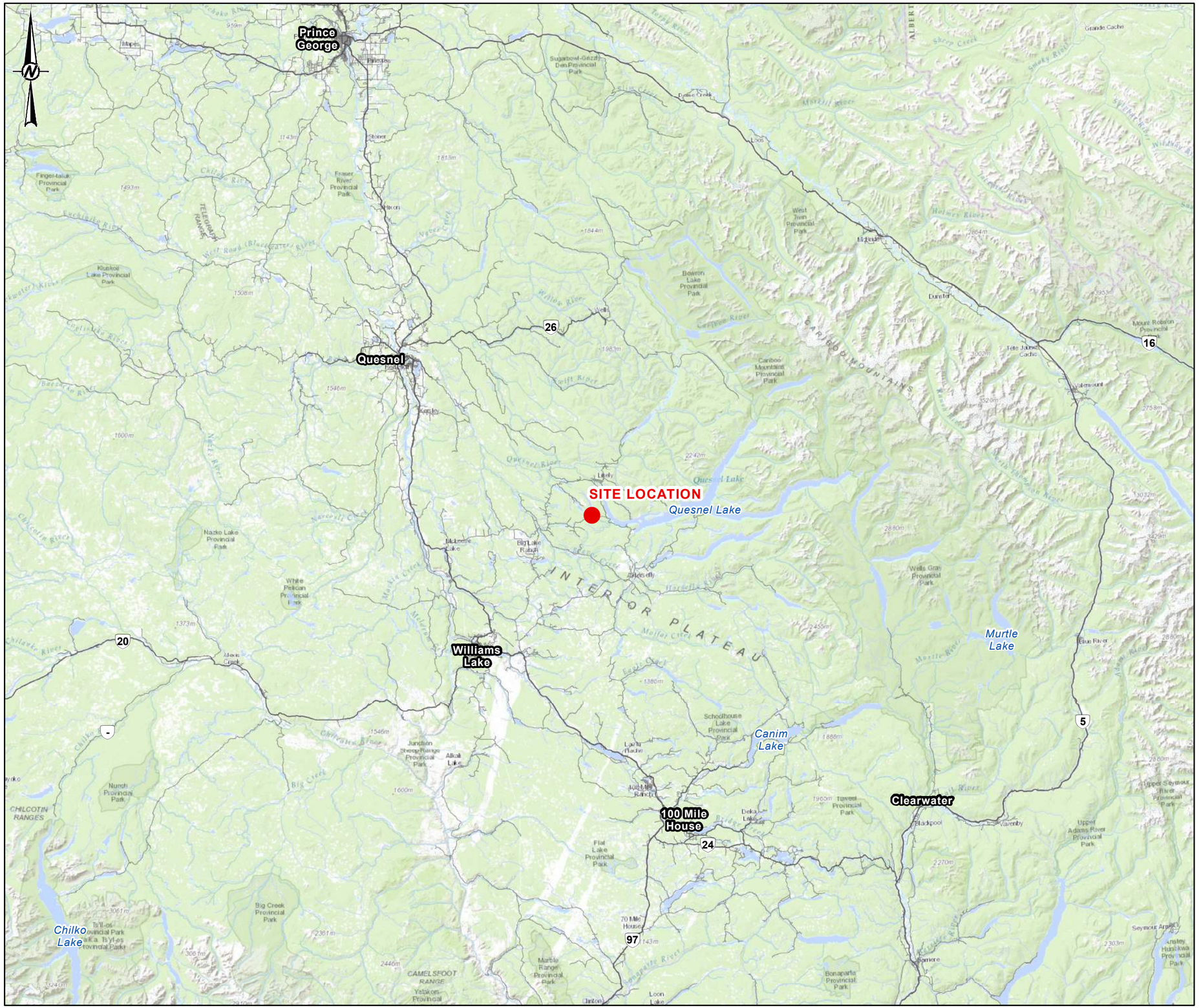
CANADA'S BEST MANAGED COMPANIES Platinum member

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- Where gaps exist in the present closure plan, develop conservative assumptions to be included in the model and recommendations for follow-up tasks to verify and refine the assumptions.

This work is presented in this technical memorandum as follows:

- Summary of Climate and Hydrology (Section 2);
- Water Management under Closure Conditions (Section 3);
- Water Balance (Section 4);
- Water Quality (Section 5); and
- Summary and Recommendations (Section 6).


Prince George
Quesnel
SITE LOCATION
Quesnel Lake
Williams Lake
100 Mile House
Clearwater
Murtle Lake
Canim Lake
Chilko Lake
26
16
20
97
24
5
CARIBOO MOUNTAINS
INTERIOR PLATEAU
CHILCOTIN RANGES
CAMELSFOOT RANGE
Grande Cache
Dunster
Valemount
Tête Jaune Cache
Blue River
Wells Gray Provincial Park
Bonaparte Provincial Park
Loon Lake
Clinton
Ashcroft
Cache Creek
Barriere
Seymour Arm
Sugarbowl-Grizzly Den Provincial Park
Fraser River Provincial Park
Bowron Lake Provincial Park
Caribou Mountain Provincial Park
West Twin Provincial Park
Moore Robson Provincial
Kluskoil Lake Provincial Park
Nazko Lake Provincial Park
White Pelican Provincial Park
Big Creek Provincial Park
Junction Sheep Range Provincial Park
Schoolhouse Lake Provincial Park
Flat Lake Provincial Park
Marble Range Provincial Park
Tweedsmuir Provincial Park
Upper Adams River Provincial Park
Upper Seymour River Provincial Park
Finger-Isaluk Provincial Park
Nuchi Provincial Park
Tsil-os Provincial Park
Ts'il-os Provincial Park
Yalakom Provincial
Stoner
Dome Creek
Loos
Hixon
Willow River
Carp Lake
Quesnel River
Swift River
Likely
Horsefly
Alkali Lake
Lac la Hache
Deka Lake
Bridge Lake
Big Lake Ranch
McLeese Lake
Marble Canyon
Meffer Creek
Bridge River
Fraser River
Blackpool
Kersley
Soda Creek
Alexis Creek
Chilcotin River
Taseko River
Nazko River
Euchiniko River
Mitchell River
Sheep Creek
Sukunka River
Smoky River
Wolverine River
Holmes River
Murtle River
Azure River
Adams River
Eagle River
Bonaparte River
Thompson River
Kamloops Lake
Mount Olie
Mount Tom Ellis
Mount Tom Hill
Mount Tom Sauter
Mount Tom Wells
Mount Tom Wilson
Mount Tom Wright
Mount Tom Yates
Mount Tom Zimmerman
Mount Tom Zinn
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Mount Tom Zwicky
Mount Tom Zwicky

2.0 CLIMATE AND HYDROLOGY

This section provides an overview of climate and hydrology at Mount Polley. A more detailed description may be found in the Mount Polley Site Wide Water Balance Report (Golder 2015a).

Climate of the study area is greatly influenced by the Quesnel Highlands, which borders the Fraser Plateau to the east. Precipitation typically reports as rainfall in the spring, summer and fall and as snowfall in the winter. Prevailing winds are from the northwest in the winter months and from the south and southwest during the summer months.

The mine site experiences high summer precipitation due to summer storms, with the lowest precipitation occurring in February. Precipitation typically occurs as snowfall starting in November, and accumulates until March. Average annual precipitation at Mount Polley is estimated to be 670 mm. Estimated average, 1:200-year dry and 1:200-year wet precipitation depths are shown in Table 1.

Table 1: Long-Term Precipitation at the Mount Polley Mine Site (1974 – 2015)

Month	Precipitation (mm)		
	Average	1:200-Year Dry	1:200-Year Wet
January	50.8	26.9	82.9
February	37.5	19.8	61.1
March	42.8	22.7	69.8
April	49.5	26.2	80.7
May	53.5	28.3	87.3
June	78.2	41.4	128
July	58.9	31.2	96
August	52.2	27.6	85.1
September	48.2	25.5	78.6
October	58.2	30.8	94.9
November	53.5	28.3	87.3
December	85.6	45.3	140
Annual	**669**	**354**	**1092**

(a) No precipitation data available for 1994. Includes Likely station data (1974 – 1993).

Mount Polley is drained by three main watersheds: the Hazeltine Creek (30.2 square kilometres [km^2]) at Quesnel Lake, the Edney Creek (87.4 km^2) at Quesnel Lake, and the Morehead Lake (62.7 km^2) watersheds. The Hazeltine Creek watershed includes Polley Lake and conveys all water from Polley Lake, the east side of Mount Polley and the area surrounding the Tailings Storage Facility (TSF). The Morehead Creek watershed includes the Bootjack Lake catchment area (11.2 km^2).

3.0 MINE WATER MANAGEMENT – CLOSURE AND POST-CLOSURE

Mount Polley Mine is currently operating under restricted operations, with an average mill rate of 11,000 tonnes per day (tpd). The mine received a permit amendment from the British Columbia Ministry of Energy and Mines (MEM) to operate under these conditions until July 2016. Therefore, if the mine does not receive a permit to operate under resumed operations, closure would commence July 9, 2016.

The mine development plan for Mount Polley includes the following stages:

- **Restricted Operations:** currently permitted to continue until July 8, 2016. Activities are mainly focused on mining Cariboo Pit, along with construction activities as needed.
- **Closure**: assumed to start August 1, 2016, lasting approximately ten years. Activities are mainly focused on:
  - treatment of offsite water discharges through a Veolia™ plant before discharge to the environment, consistent with the Short-term Water Management Plan;
  - reclamation of affected areas on the mine site;
  - back-flooding of Springer, Cariboo and Wight Pits; and
  - deposition of the Potentially Acid Generating (PAG) stockpile into the Springer Pit.
- **Post-Closure:** assumed to start August 1, 2026. Activities are mainly focused on monitoring, as required. Additionally, a transition to passive treatment systems would take place during this time.

3.1 Water Management Considerations

The summary of the Mine reclamation and closure plan presented in this section is focused on the activities affecting water management on the mine. Water management during the Mount Polley Mine closure phase would mainly consist of back-flooding of the pits, and reclamation of the waste rock storage areas. The reader is referred to the MPMC Reclamation and Closure Plan reports for a complete description of the conceptual closure plans (MPMC 2013 and MPMC 2015a).

3.1.1 Pits

Upon closure, groundwater and runoff will be allowed to accumulate in Springer, Cariboo and Wight Pits, submerging any PAG materials stored in the pits.

3.1.2 Waste Rock Storage Areas

The rock dump storage areas will be re-contoured, covered in a growth medium, and re-vegetated. The PAG material in the Temporary NW PAG Stockpile will be mined and deposited in the Springer Pit.

3.1.3 Tailings Storage Facility

Waste characterization studies have confirmed that the tailings solids will not be acid generating (Golder 2015d). The tailings beaches will be reclaimed as a mosaic of forested and wetland habitats, with a gradual transition towards a pond and artificial wetland above the outflow spillway.

3.1.4 Buildings and Haul Roads

The mill site area, as well as haul roads, will be reclaimed after closure. Some access roads may remain on site as necessary to facilitate transportation within the mine site.

3.1.5 Ditches

The Long Ditch is expected to remain in place in perpetuity. The area surrounding this ditch will be vegetated with grasses and shrubs. The South-East Rock Disposal Site (SERDS) Ditch will also likely remain in perpetuity, and will continue to convey flow to the Long Ditch. The clean water diversion ditch upstream of the TSF, which diverts water to the Edney Creek system to the south of the TSF, will also remain in perpetuity.

3.1.6 Discharge of Treated Effluent

The current discharge application (presently under review by the British Columbia Ministry of Environment [MoE], the MEM, and others) proposes that treated mine water will be discharged through a diffuser to Quesnel Lake via Hazeltine Creek, commencing in October 2015. This represents a short-term approach prior to development of a long-term pipeline and diffuser. The preferred option will be determined as part of the long-term water management strategy, for which the draft Technical Assessment Report is to be developed by June 30, 2016. For the purposes of the 2015 Reclamation and Closure Plan, it is assumed that site discharges that are acceptable for release to the receiving environment will be passively released to the downstream waterbodies. Site discharges requiring treatment will be treated and released according to the water management plan that is permitted and operational at the time of closure. Conservative predictions have been made regarding water quality, and the requirement to treat will be confirmed through monitoring and assessment as the closure phase progresses.

4.0 WATER BALANCE

A site-wide operational and predictive water balance model was developed by Golder (2015a) using GoldSim™ simulation software (Version 11.1). GoldSim allows dynamic, complex interactions within the water system to be represented through a visual, modular framework. All input parameters and functions are defined by the user and are built as individual objects or elements linked together by mathematical expressions.

The Mount Polley closure site water balance model has been developed with the following objectives:

- Simulate the site water management during the final year of operations and into closure and post-closure, including:
  - water accumulation in the site storage systems;
  - water transfers (both pumped and gravity); and
  - overflows from the water storage facilities to the environment.
- Provide the foundation for a water quality module.

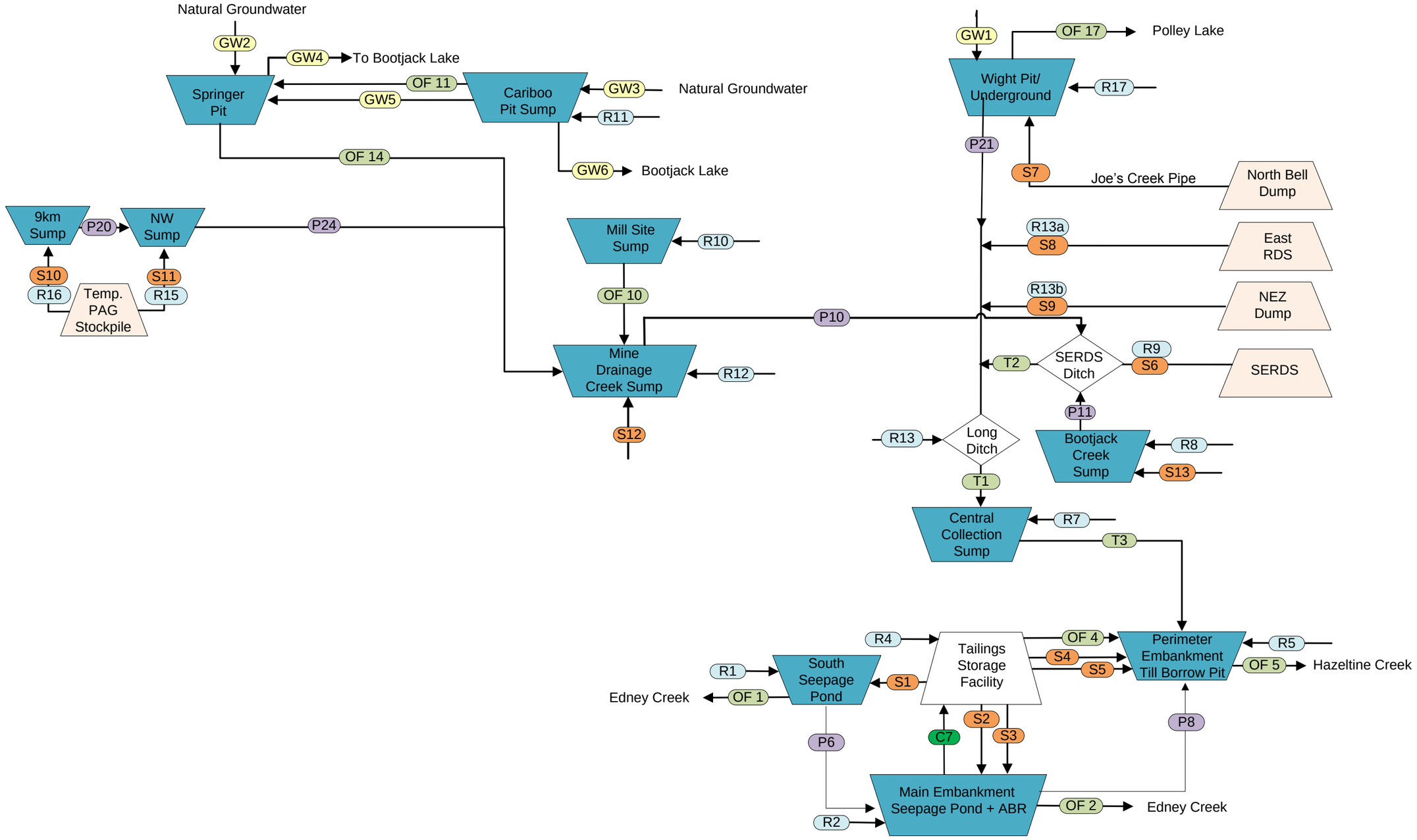
4.1 General Assumptions

General assumptions applied to model development are:

- the model is run on a monthly timestep;
- seepage losses from the ponds or sumps are assumed to be negligible;
- direct precipitation, evaporation and seepage loss from ditches are assumed to be negligible;
- precipitation occurs as snow from December to February and as rain in all other months. While precipitation occurs as a mixture of snow and rain during November and March, the current assumption yields an adequate model calibration; and
- snowmelt occurs in the months of March, April and May as a percentage of the maximum snowpack at the end of February (5% in March, 90% in April and 5% in May).

4.2 Model Scope and Flow Diagram

The scope and structure of the water balance has been outlined in a conceptual process flow diagram (Figure 2 and Figure 3). A description of the closure model flows are presented in Attachment 1. The water management facilities that have been included within the water balance are presented in Golder (2015a), along with a description of all flows and facilities on the mine site during restricted operations.



Runoff (R)
Seepage Flow (S)
Pumped Flows (P)
Groundwater Flows (GW)
Transfer Flows (T) / Overflow (OF)
Flow Path

Note:

- Evaporation and Direct Precipitation are modeled for all ponds, but are not shown on this diagram.
- Temporary PAG Stockpile will be reclaimed as of August 2026

Golder Associates

CLIENT: Imperial Metals Ltd.
Mount Polley Mining Corporation

DRAWN: JFR DATE: Sept 25, 2015

CHECKED: RM DATE: Sept 29, 2015

SCALE: Not to Scale

PROJECT No: 1411734/6000

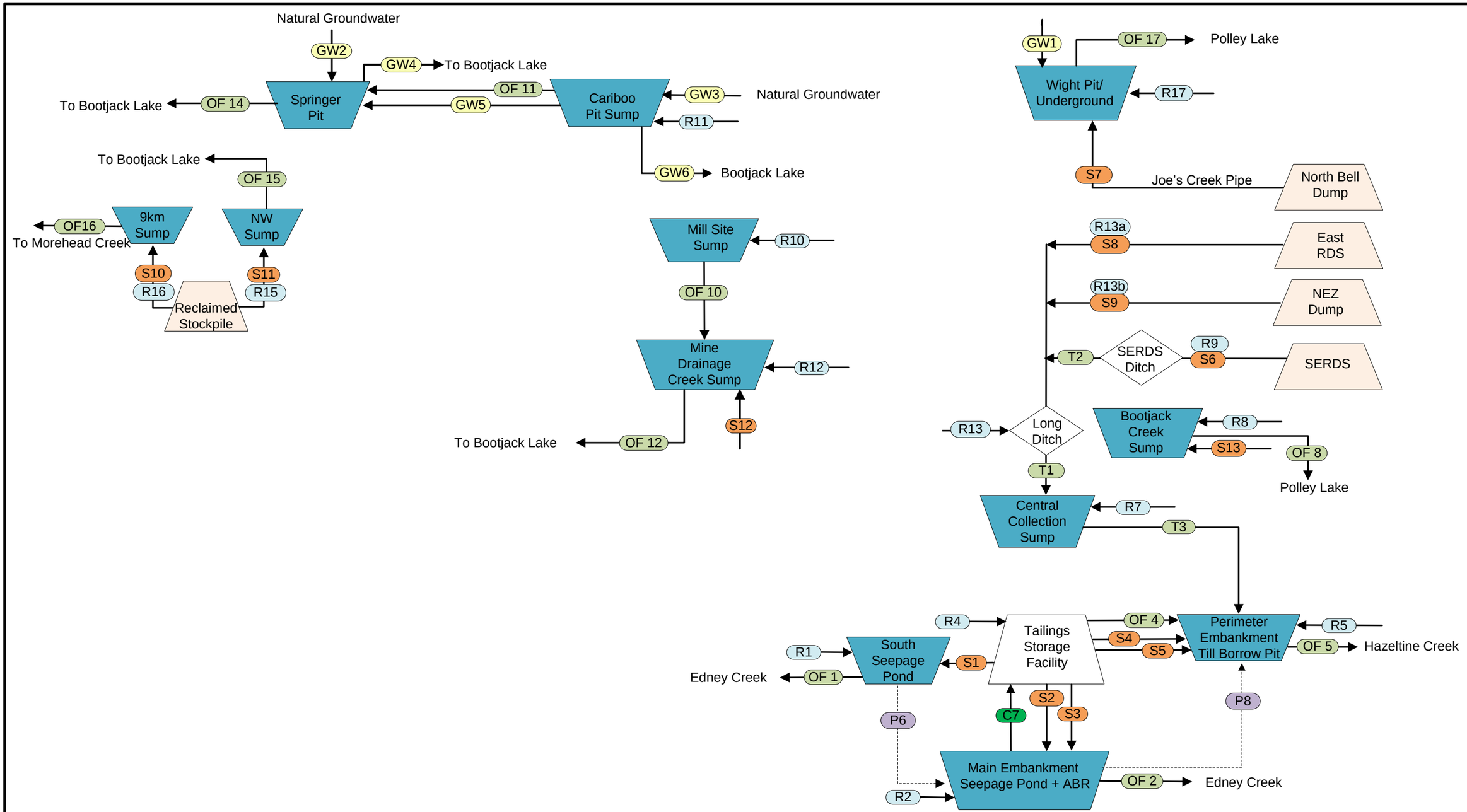
TITLE

Site Wide Water Balance

Restricted Operations Closure Conditions

FIGURE No: 2

REV No: 0



Runoff (R)
Seepage Flow (S)
Pumped Flows (P)
Groundwater Flows (GW)
Transfer Flows (T) / Overflow (OF)
Flow Path
Optional Flow Path during Post-closure - Not active in model

Note:

- Evaporation and Direct Precipitation are modeled for all ponds, but are not shown on this diagram.
- Temporary PAG Stockpile will be reclaimed as of August 2026

Golder Associates

CLIENT	Imperial Metals Ltd. Mount Polley Mining Corporation		
DRAWN	JFR	DATE	Sept 25, 2015
CHECKED	RM	DATE	Sept 29, 2015
SCALE	Not to Scale	PROJECT No	1411734/6000
FIGURE No	3	REV No	0

TITLE

Site Wide Water Balance
Restricted Operations Post-Closure Conditions

4.2.1 Model Flow Logic

Table 2 describes the primary flows during closure. All pumped flows will be terminated as of closure (August 1, 2016 in the model), with the exception of the following:

- Mine Drainage Creek Sump to SERDS Ditch (P10);
- Bootjack Creek Sump to SERDS Ditch (P11);
- 9 km Sump to NW Sump (P20);
- NW Sump to Mine Drainage Creek Sump (P24);
- South Seepage Pond to Main Embankment Seepage Pond (P6);
- Main Embankment Seepage Pond to Perimeter Embankment Till Borrow Pit (P8); and
- Wight Pit/ Underground to Long Ditch (P21).

Table 2: Primary Mine Water Flows

Flow Group	Component	Flow Label	Closure
Pumped Flows	Mine Drainage Creek Sump to SERDS Ditch	P10	Operational until Post-Closure (assumed to start August 1, 2026).
	Bootjack Creek Sump to SERDS Ditch	P11	
	9km Sump to NW Sump	P20	
	NW Sump to Mine Drainage Creek Sump	P24	
	Wight Pit/ Underground to Long Ditch	P21	
Seepage	From TSF	S1, S2, S3, S4, S5	Flows continue in perpetuity.
	Joe's Creek Pipe (from North Bell Dump)	S7	Flow continues in perpetuity. North Bell Dump will be reclaimed.
	From Temporary NW PAG Stockpile	S10, S11	Flows continue in perpetuity. PAG waste rock will be deposited in the Springer Pit during closure.
	From Non-Acid Generating waste rock storage areas	S6, S8, S9	Flows continue in perpetuity. Waste rock storage areas will be reclaimed during closure.
	From Haul Roads	S12, S13	Flows continue in perpetuity. Haul roads will be reclaimed during closure.
Groundwater Flows	Springer Pit Groundwater Inflow	GW2	Flows continue in perpetuity.
	Springer Pit Groundwater Outflow	GW4	
	Cariboo Pit Groundwater Inflow	GW3	
	Wight Pit Groundwater Inflow	GW1	

Table 2: Primary Mine Water Flows

Flow Group	Component	Flow Label	Closure
Ditch Flows	Long Ditch	T1	Flows continue in perpetuity.
	SERDS Ditch	T2	
Environmental Discharges to Hazeltine Creek	From Perimeter Embankment Till Borrow Pit	OF5	Discharge allowed during post-closure.
Environmental Discharges to Edney Creek	From South Seepage Pond	OF1	Discharge allowed during post-closure.
	From Main Embankment Seepage Pond	OF2	
Environmental Discharges to Polley Lake	From Bootjack Creek Sump	OF8	Discharge allowed during post-closure.
	From Wight Pit	OF17	
Environmental Discharges to Bootjack Lake	From Mine Drainage Creek Sump	OF12	Discharge allowed during post-closure.
	From Springer Pit	OF14	
	From 9km Sump	OF16	
	From NW Sump	OF15	

4.2.2 Temporary NW PAG Stockpile

The Temporary NW PAG Stockpile will consist of up to 9.25 Mm^3 of material upon closure. This material will be deposited into the Springer Pit during the closure period. Because the details of these material transfers have not yet been developed, conservative assumptions have been made regarding storage and runoff. Specifically, the material is assumed to be placed in the Springer Pit immediately in August 2016 because that is the most conservative estimate regarding storage.

4.2.3 Springer Pit Dewatering

In the short-term, a discharge diffuser system, with a maximum capacity of 0.6m^3/s, will discharge water from the Springer Pit (via the West and SERDS Ditches and Hazeltine Creek) and runoff from the Polley Lake/Hazeltine Creek watershed into Quesnel Lake. Due to the the contribution of Polley Lake/Hazeltine Creek, the discharge rate from the Springer Pit will be constrained in keeping within the maximum capacity of the diffuser. Dewatering in the water balance model is currently assumed to start October 15, 2015 and continue until December 31, 2016, consistent with the short-term discharge application.

4.2.4 Groundwater Flows

Hydrogeological modelling was carried out for the Springer, Cariboo and Wight Pits during closure by Golder (2015b,c). Cariboo and Springer Pits are hydraulically connected, meaning that the groundwater flows into and out of the pits are driven by the water elevations in both pits. Table 3 shows the groundwater inputs used for the model for Cariboo and Springer Pits (based on the calibrated hydrogeological model results), with a varying Cariboo Pit water elevation and a constant Springer Pit elevation (1,050 m; spillover elevation). Table 4 shows the groundwater inputs with a varying Springer Pit water elevation and a constant Cariboo Pit elevation (1,094 m; spillover elevation).

Table 3: Groundwater Flows for Springer and Cariboo Pits –Springer Pit Lake Elevation at 1,050 m

Springer Pit			Cariboo Pit		
Pit Lake Elevation (m)	Groundwater Flow (m^3/day)		Pit Lake Elevation (m)	Groundwater Flow (m^3/day)	
	Into the Lake	Out of the Lake		Into the Lake	Out of the Lake
1,050	550	180	1,078	20	140
	970	130	1,100	20	720
	1,460	90	1,120	0	1,450

Table 4: Groundwater Flows for Springer and Cariboo Pits – Cariboo Pit Lake Elevation at 1,094 m

Cariboo Pit			Springer Pit		
Pit Lake Elevation (m)	Groundwater Flow (m^3/day)		Pit Lake Elevation (m)	Groundwater Flow (m^3/day)	
	Into the Lake	Out of the Lake		Into the Lake	Out of the Lake
1,094	0	610	990	1,110	0
	0	600	1,010	1,060	0
	0	590	1,020	1,010	0
	0	580	1,030	950	10
	0	550	1,040	900	60
	0	480	1,050	790	150

Table 5 shows the groundwater inflows and outflows to Wight Pit between 880 m (near the Pit bottom) to 926 m (spillover elevation), for the calibrated hydrogeological model.

Table 5: Groundwater Flows for Wight Pit

Water Elevation (m)	Groundwater Inflow (m^3/day)	Groundwater Outflow (m^3/d)
802	2,559	0
900	2,542	0
910	2,140	0
920	840	0
950	574	518

4.2.5 Reclamation Logic and Hydrology

The model simulates the reclamation of the mine facilities as a step-function, meaning that the model assumes that the hydrology changes within one time-step to reflect the reclamation process. Table 6 shows the simulation time at which the hydrology of the primary facilities change to reflect reclamation.

Table 6: Reclamation Timing for Primary Facilities within the Water Balance Model

Facility	Simulation Time when Hydrology Changes (Reclamation Occurs)	Comments
TSF Beach	Not applicable	The TSF beach will be reclaimed with wetland and vegetation, but the model assumes the same hydrologic characteristics as during operations. It is assumed that the hydrologic behaviour of the beach (such as response to storm events) would not change, particularly if a substantial part of the beach is reclaimed as wetlands. This is consistent with the 2012 MPMC Reclamation and Closure Plan Update (MPMC 2013), and will require ongoing work and discussion as the closure plan is refined.
Non Acid Generating Rock Dump Areas	August 1, 2016	Reclamation of these areas will begin as of closure, so the runoff coefficients in the model switch from Waste Rock to Undisturbed Catchment values (Table 7) on August 1, 2016.
PAG Stockpile	August 1 , 2026	As mentioned in Section 4.2.2, the details of the PAG material transfers have not yet been developed. However, the possibility exists that MPMC will deposit the PAG material over a period following closure. The model currently assumes that the PAG material will be deposited into the Springer Pit in August 2016. However, for a more conservative approach to assessing the hydrology and run-off/ seepage water quality from the Temporary NW PAG Stockpile area, the runoff-coefficients for the Temporary NW PAG Stockpile area are changed from Waste Rock to Undisturbed catchment values (Table 7) on August 1, 2026.
Mill Site and Haul Roads	August 1, 2026	Reclamation of these areas would take place over a period. Hydrologic characteristics in the model therefore change August 1, 2026.

Table 7 shows the runoff coefficients used during operations and closure for the land types.

Table 7: Runoff Coefficients for Land Types during Operations and Closure

Catchment Type	Operations			Closure		
	Dry	Winter	Freshet	Dry	Winter	Freshet
Tailings Beach	0.3	0.6	0.9	0.3	0.6	0.9
Disturbed Areas	0.0	0.3	0.9	0.35	0.4	0.42
Rock Disposal Site Areas (Waste Rock)	0.0	0.1	0.6	0.35	0.4	0.42
Open Pits	0.5	0.75	0.9	0.5	0.75	0.9
Undisturbed Catchments	0.35	0.4	0.42	0.35	0.4	0.42
Haul Roads and Access Roads	0.0	0.15	0.9	0.35	0.4	0.42
Mill Site Area	0.0	0.1	0.1	0.35	0.4	0.42

Table 8 shows the baseflow rates used during operations and closure.

Table 8: Baseflow Rates during Operations and Closure

Baseflow Source	Baseflow Rate (m/year)	
	Operations	Closure
Haul Road	0.10	0.14
Rock Storage Areas	0.30	0.28

4.3 Results

4.3.1 Mine Water Accumulation

This section describes the accumulation of water in the following primary mine facilities:

- Springer Pit;
- Wight Pit;
- Cariboo Pit;
- TSF; and
- Perimeter Embankment Till Borrow Pit.

Results are shown for average climate inputs as the water quality during closure/post-closure was assessed using average climate conditions. Lastly, results are shown from July 1, 2015 to December 31, 2070, as this was the period during which water quality was assessed.

4.3.1.1 Springer Pit

Figure 4 shows the total volume and overflow rate of the Springer Pit, while Figure 5 shows the water elevation in the pit. The water volume in the pit as of July 1, 2015 was 7 Mm^3 (corresponding elevation of 1016 m). The model simulates deposition of 9.25 Mm^3 of PAG material into the Springer Pit on August 1, 2016. A 25% porosity was assumed for this material, meaning that 2.3 Mm^3 of capacity was available for water within the PAG material.

Due to the modeling assumptions, an initial outflow was projected from the Springer Pit upon the addition of the PAG material to the pit. However, as dewatering continues until the end of 2016, the water level in the pit will be continually drawn down, until it starts to increase in 2017. The maximum outflow rate from the Springer Pit after dewatering has ended is 0.08 m^3/s, and this overflow is projected to start in March 2021. This discharge will be directed to the Mine Drainage Creek sump during closure (August 2016 to 2026), and will then discharge to Bootjack Creek as of post-closure.

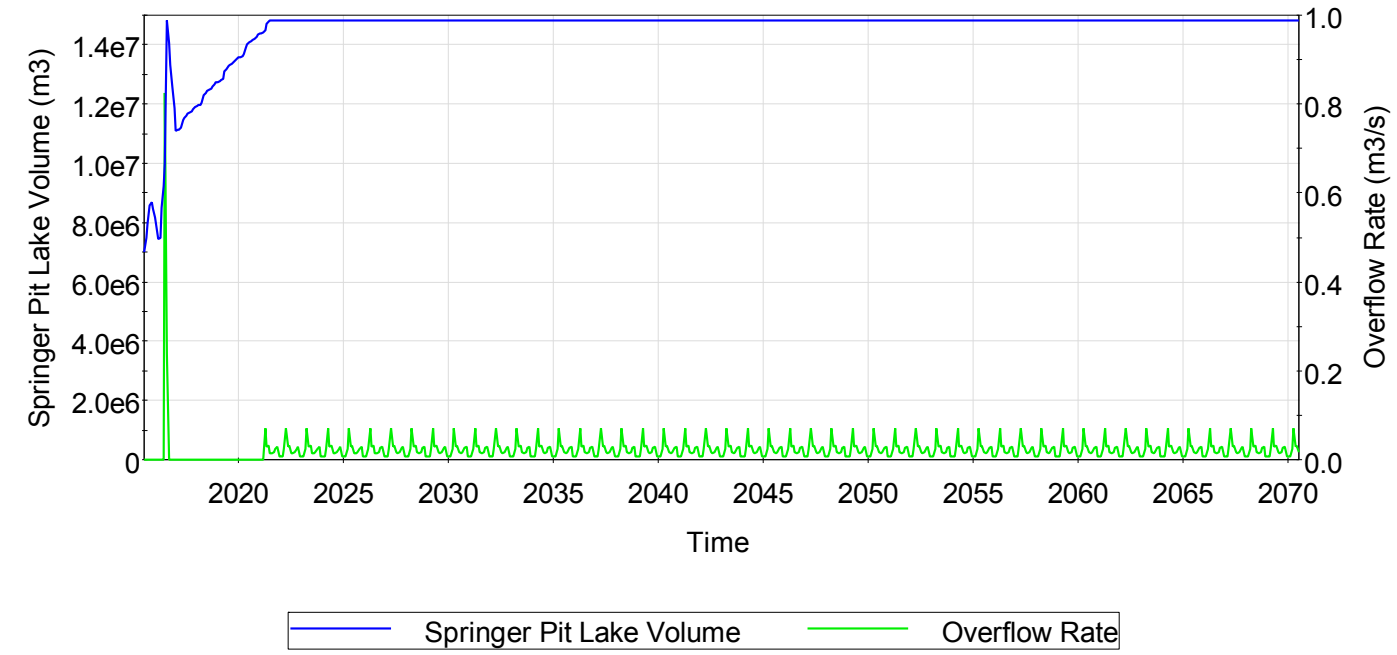


Figure 4: Springer Pit Total Volume and Overflow Rate During the Last Year of Restricted Operations through Post-Closure

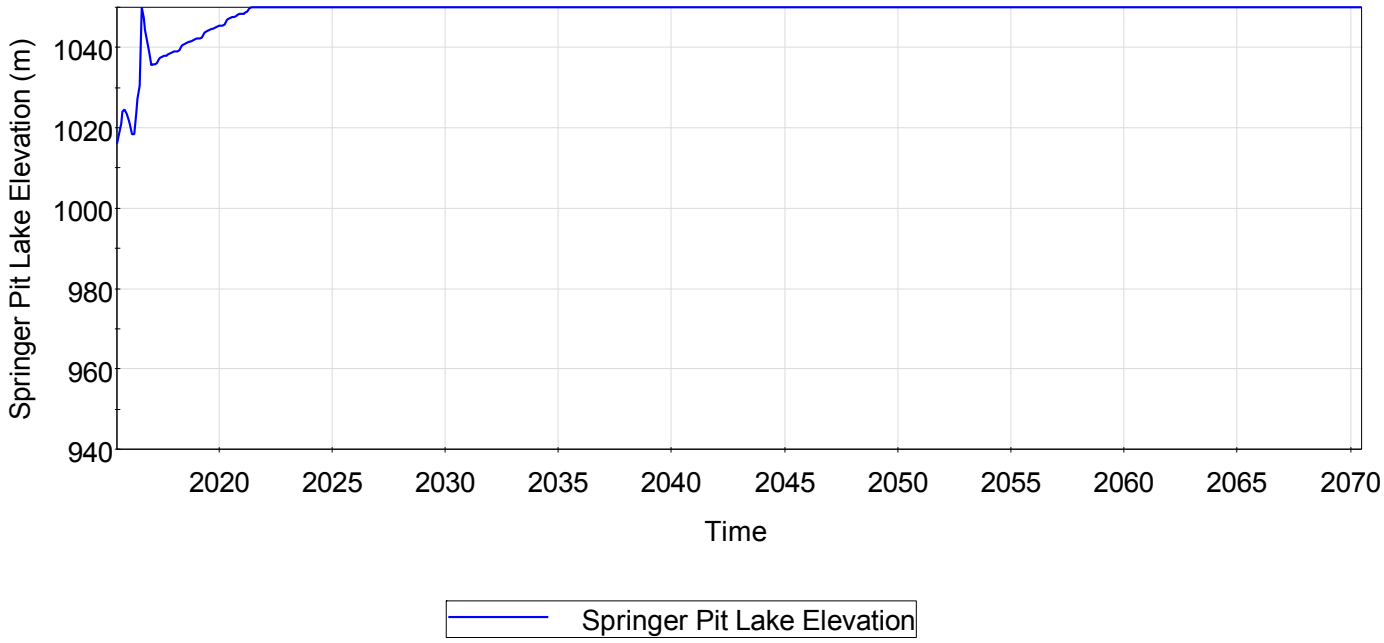


Figure 5: Springer Pit Elevation during the Last Year of Restricted Operations through Post-Closure

4.3.1.2 Wight Pit

Figure 6 shows the volume and overflow rate for the Wight Pit. As mentioned in Section 4.2.1, dewatering of the Wight Pit to the Long Ditch is assumed to continue for approximately 10 years after closure. Once dewatering stops, the pit starts to fill and is projected to overflow in November 2032. The peak overflow rate experienced is estimated to be approximately 0.03 m^3/s, and it will discharge to Polley Lake.

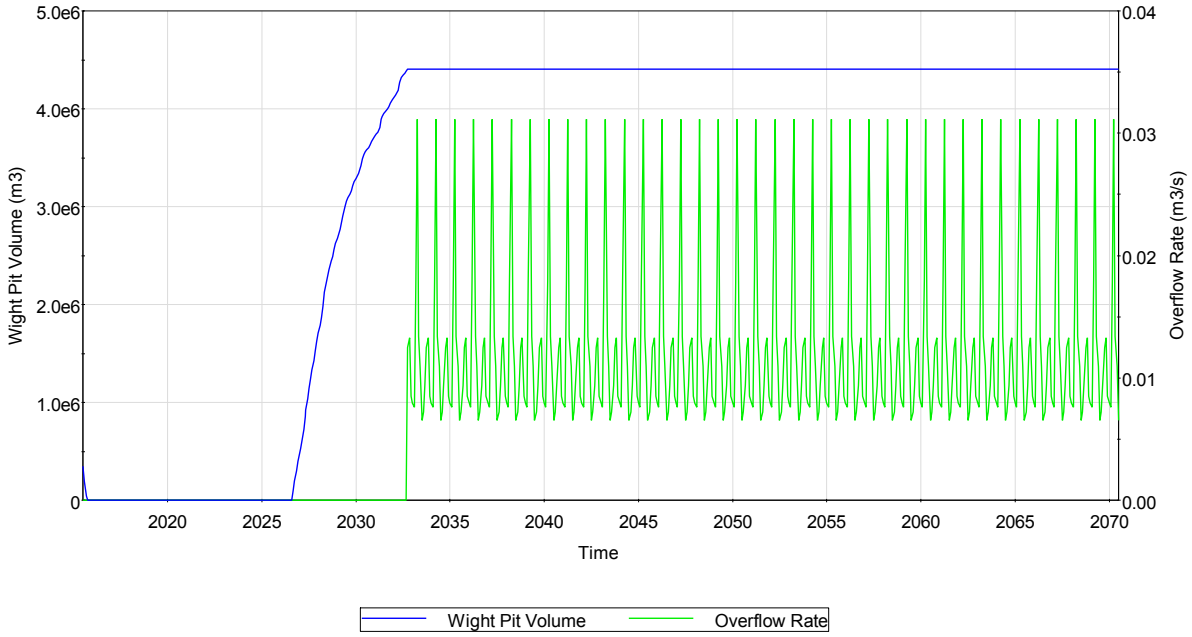


Figure 6: Wight Pit Volume and Overflow Rate during the Last Year of Restricted Operations through Post-Closure

4.3.1.3 Cariboo Pit

Figure 7 shows the volume and overflow rate for the Cariboo Pit. In 2016, there is an increase in groundwater inflow into the pit due to the sudden increase in volume and elevation in the Springer Pit upon the assumed deposition of the PAG material. Although the model generated these increases, the groundwater response is expected to be more subdued. Subsequent to this deposition, the peak overflow from the Cariboo Pit is estimated to be 0.01 m^3/s, directed towards the Springer Pit.

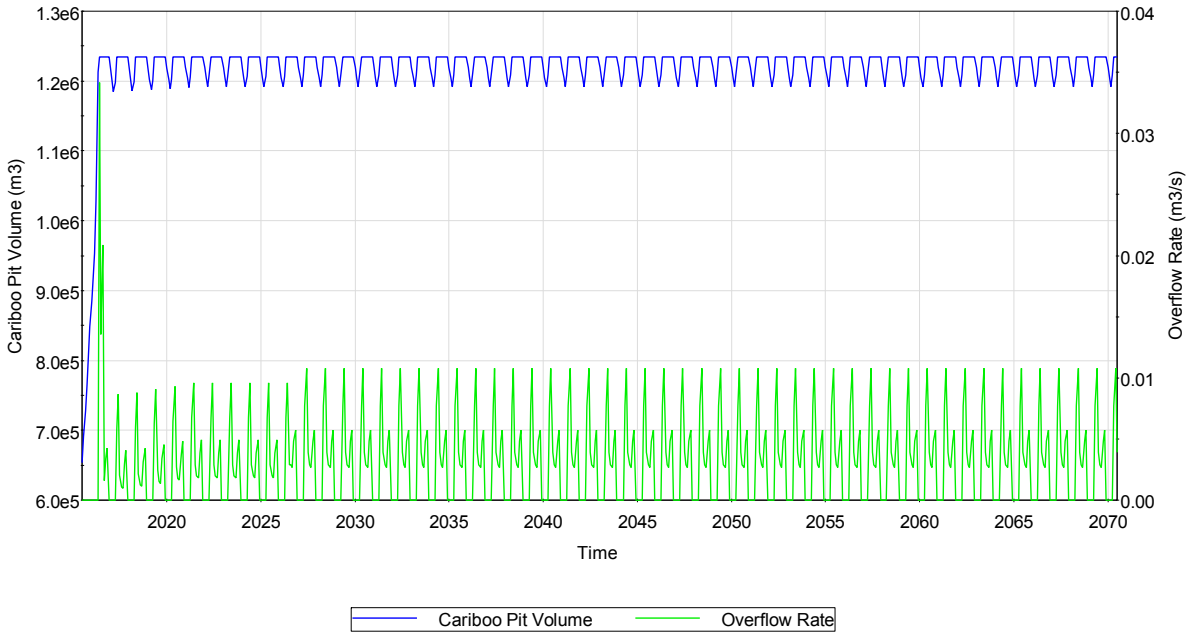


Figure 7: Cariboo Pit Volume and Overflow Rate during the Last Year of Restricted Operations through Post-Closure

4.3.1.4 Tailings Storage Facility

Figure 8 shows the volume in the TSF. The TSF does not overflow under average climate conditions.

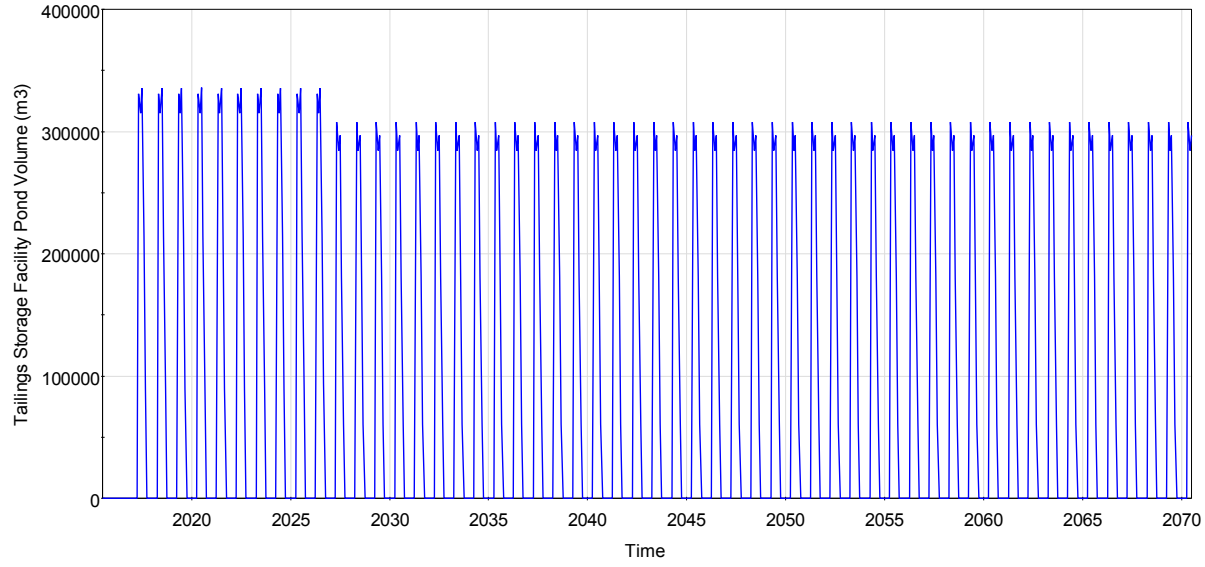


Figure 8: TSF Volume during the Last Year of Restricted Operations through Post-Closure

4.3.1.5 Perimeter Embankment Till Borrow Pit

The Perimeter Embankment Till Borrow Pit functions as a key facility during closure as all of the mine water from site will be collected there before treatment and discharge. The current capacity of the Perimeter Embankment Till Borrow Pit is 190,000 m^3; however, this may be increased depending upon results of the future water quality modelling and assessment of treatment options.

The Perimeter Embankment Till Borrow Pit is projected to start to discharge to the environment September 2016 (note that this water may be treated for some time). Figure 9 shows the volume in the Perimeter Embankment Till Borrow Pit as well as the overflow rate. Environmental discharge from the Perimeter Embankment Till Borrow Pit decreases in 2026 after decommissioning of the pumps.

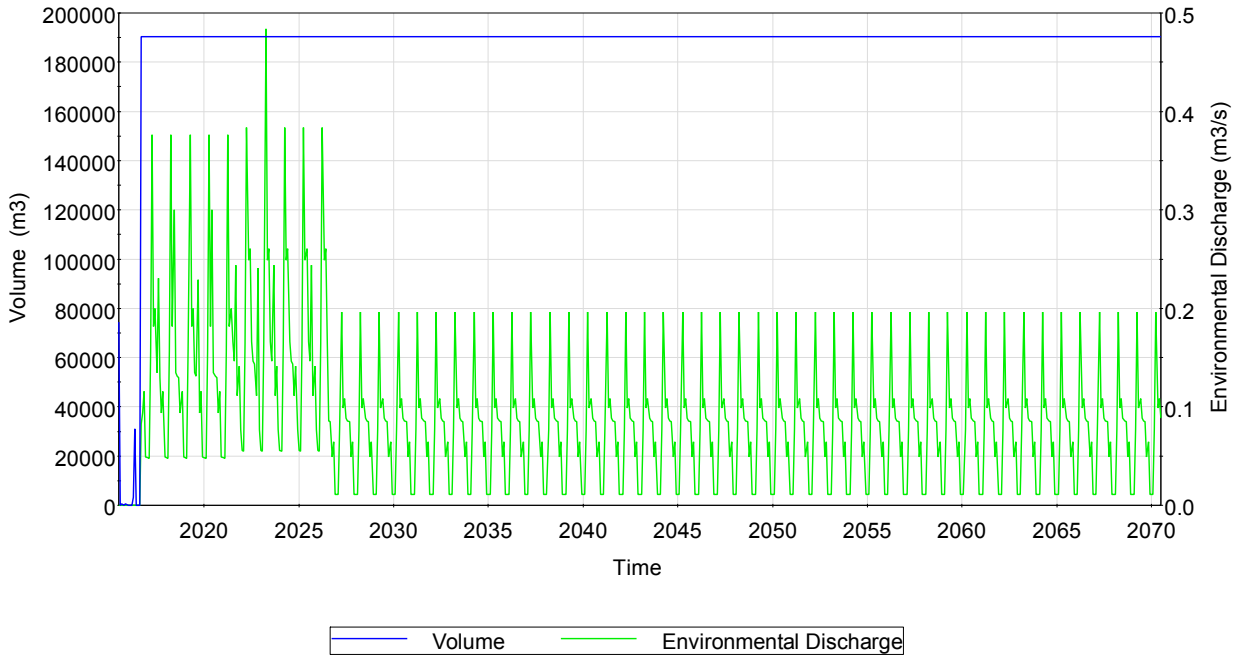


Figure 9: Volume and Environmental Discharge for Perimeter Embankment Till Borrow Pit for the Last Year of Restricted Operations through Post-closure

4.3.2 Environmental Discharges

This section describes the total simulated environmental discharges to the receiving water bodies during closure for:

- Edney Creek;
- Hazeltine Creek;
- Polley Lake;
- Bootjack Lake; and
- Morehead Creek.

4.3.2.1 Edney Creek Environmental Discharges

The South Embankment Seepage Pond and the Main Embankment Seepage Ponds are the sources of environmental discharge to Edney Creek. Figure 10 shows this discharge during the last year of operations into closure/ post-closure. The rate of discharge during freshet conditions is approximately 28 L/s under average climate conditions. Overflow from these ponds does not start until after closure.

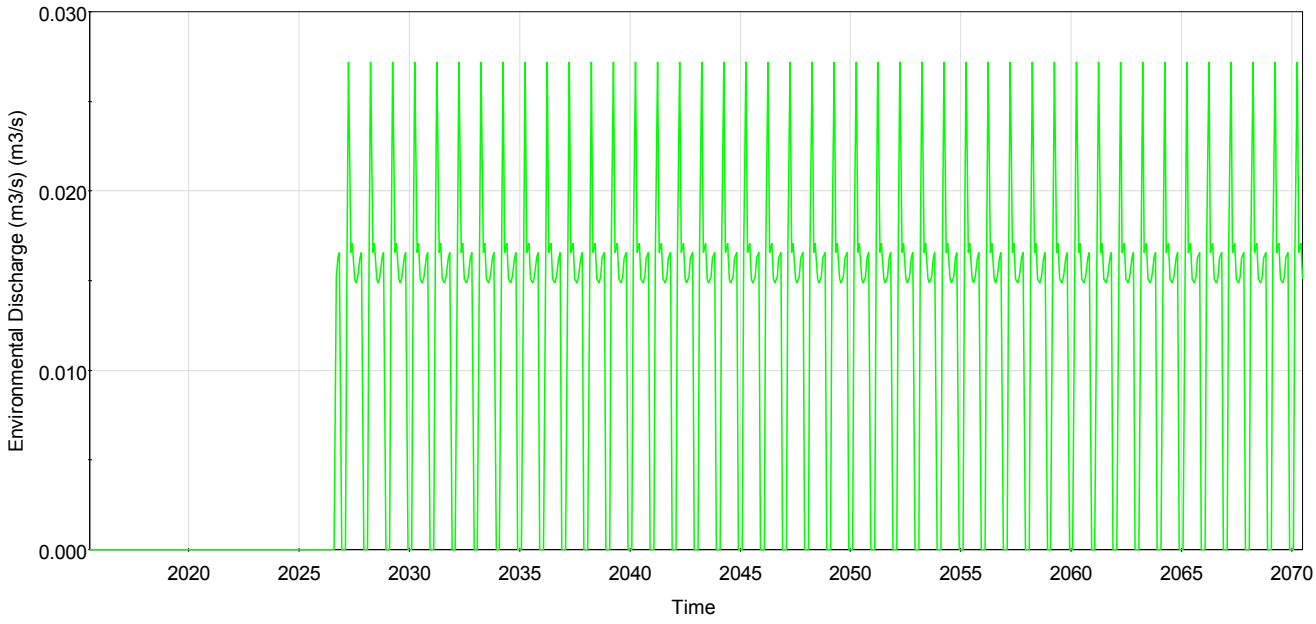


Figure 10: Environmental Discharge to Edney Creek

4.3.2.2 Hazeltine Creek Environmental Discharges

The Perimeter Embankment Till Borrow Pit will discharge to the receiving environment upon closure. The combined inflow is shown in Figure 11. Environmental discharge from the Perimeter Embankment Till Borrow Pit decreases in 2026 after the Springer Pit, NW Sump, 9km Sump, Mine Drainage Creek Sump and the Wight Pit discharge to Bootjack Lake.

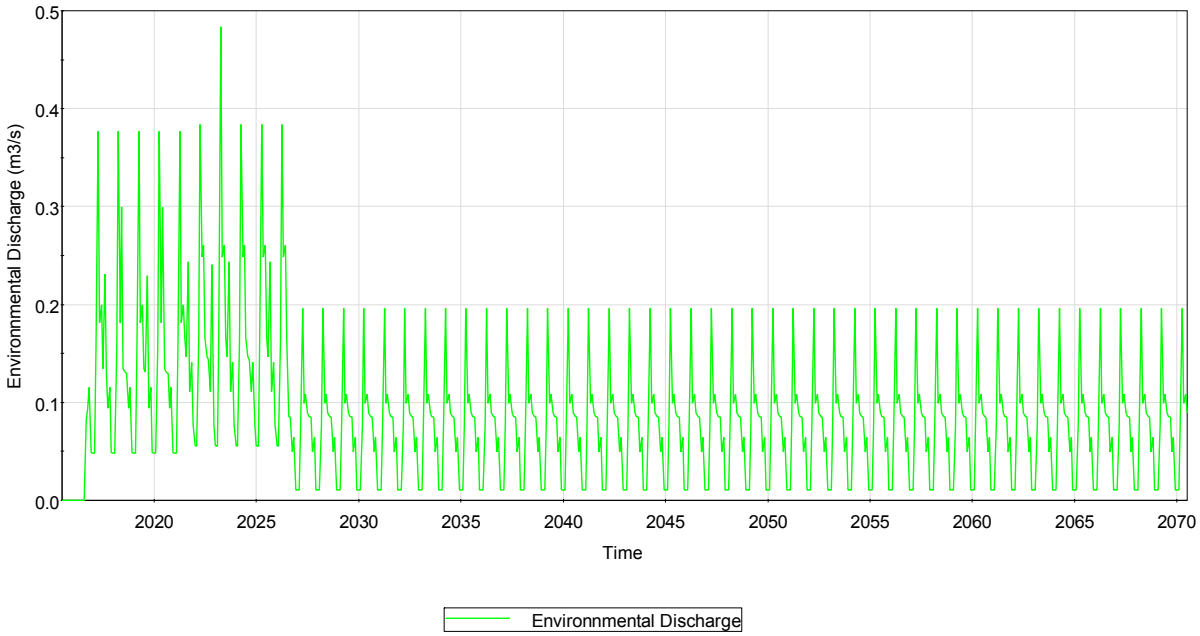


Figure 11: Environmental Discharge to Hazeltine Creek

4.3.2.3 Polley Lake Environmental Discharges

Bootjack Creek Sump and Wight Pit are the only sources of discharge to Polley Lake, and do not start to overflow until August 1, 2026 (post-closure). Under average climate conditions, the discharge to Polley Lake does not exceed 38 L/s (Figure 12). Environmental discharge from Bootjack Sump commences in 2026 after decommissioning of the pump to the SERDS Ditch (P11) and reclamation of disturbed areas within the sump's catchment. Environmental discharge from the Wight Pit commences in 2032 once the pit fills up with water subsequent to the decommissioning of the pump to Long Ditch (P21) in 2026.

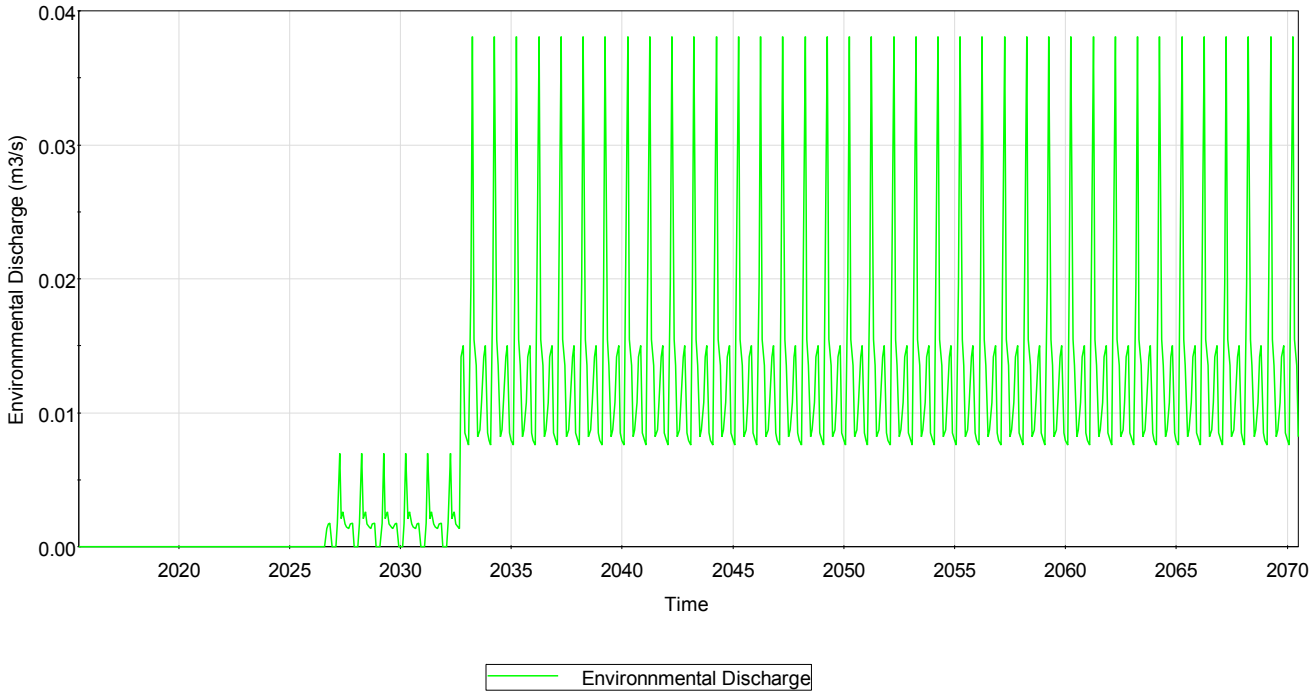


Figure 12: Environmental Discharge to Polley Lake

4.3.2.4 Bootjack Lake Environmental Discharges

The Springer Pit, 9km Sump, NW Sump and Mine Drainage Creek Sump all discharge to Bootjack Lake upon post-closure (August 1, 2026). Under average climate conditions, the discharge to Bootjack Lake does not exceed 13 L/s (Figure 13). Environmental discharge to Bootjack Lake commences in 2026 after decommissioning of the pumps at NW Sump, and the Mine Drainage Creek Sump, as well as the re-routing of the Springer Pit overflow to Bootjack Lake.

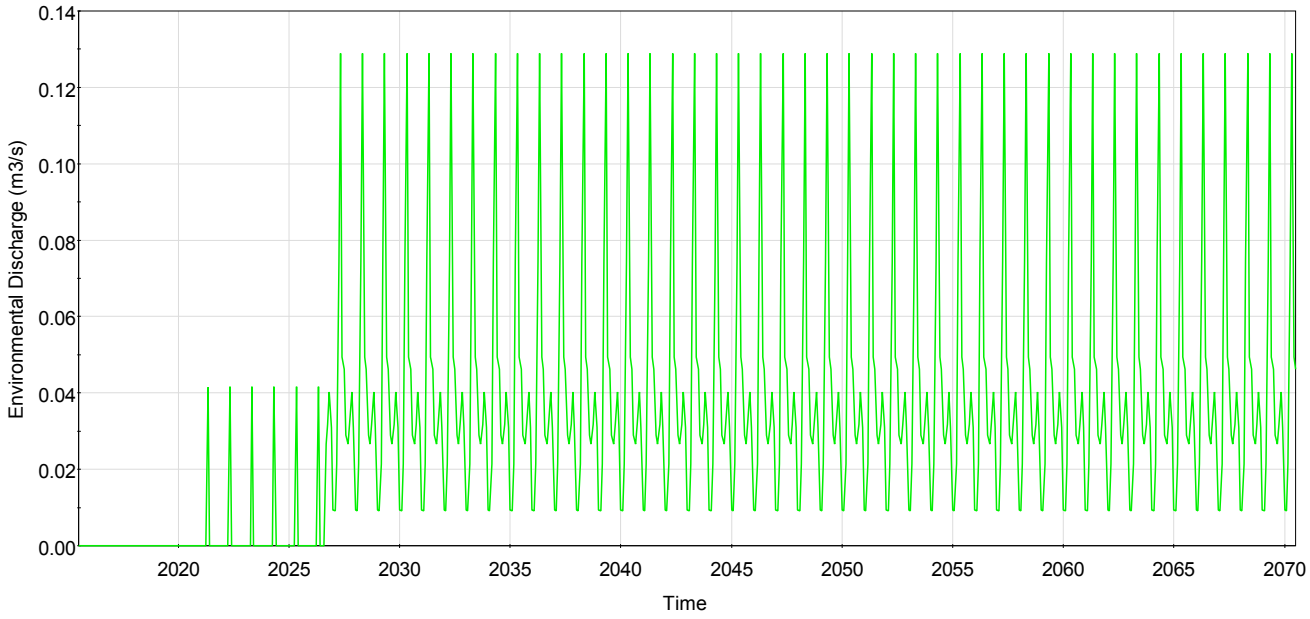


Figure 13: Environmental Discharge to Bootjack Lake

4.3.2.5 Morehead Creek Environmental Discharges

The 9km Sump will discharge to the Morehead Creek watershed (Figure 14). Environmental discharge takes place as of 2026 as of the decommissioning of the pump from the 9 km Sump to the NW Sump. Environmental discharge does not exceed 28L/s under average climate conditions.

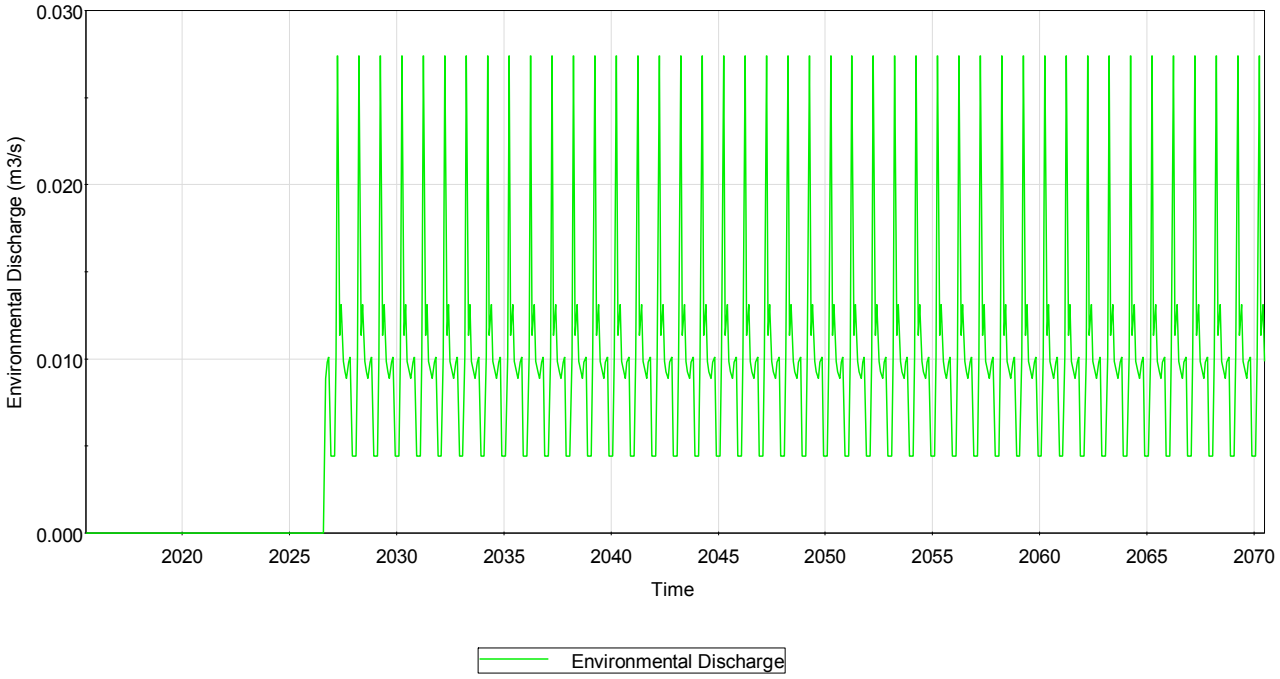


Figure 14: Environmental Discharge to Morehead Creek Watershed

4.3.3 Ditch Flows

This section presents the simulated flows in the major ditches on the mine site: the SERDS Ditch and the Long Ditch. During closure, the flows in Long Ditch approach 0.3 m^3/s during freshet, while flows in the SERDS Ditch approach 0.16 m^3/s (Figure 15).

In both the SERDS Ditch and Long Ditch, flows are higher during closure than post-closure (2026) as outflows from the Springer Pit, NW Sump, 9km Sump and the Mine Drainage Creek Sump are redirected as of post-closure. In addition, flows from the Wight Pit into Long Ditch also cease as of post-closure.

Therefore, the flows in Long Ditch are projected to decrease by approximately 60%, approaching 0.11 m^3/s during freshet. Flows in the SERDS Ditch are projected to decrease by approximately 70%, approaching 0.05 m^3/s during freshet.

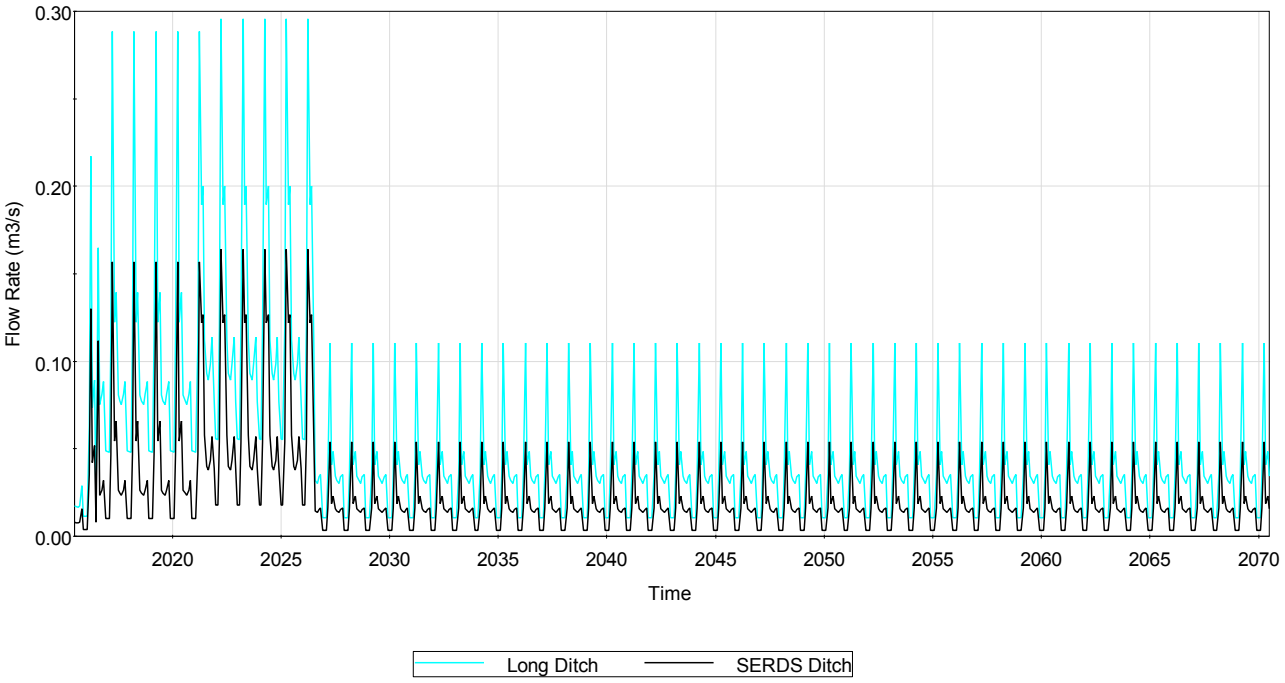


Figure 15: Flow Rates in Long Ditch and SERDS Ditch under Average Climate Conditions

5.0 WATER QUALITY

This section presents the water quality predictions for the Springer, Cariboo, and Wight Pits, as well as the TSF and all water bodies that will discharge to the receiving environment post-closure. These predictions were made in support of the Reclamation and Closure Plan for the Mount Polley Mine. The analysis builds on previous modeling work which included the development of a site-wide water quality model to predict discharge quality from the Springer Pit, before and after treatment (Golder 2015a). The foundation for the water quality model is the site-wide water balance model described in Section 4.0.

5.1 Model Approach

The water quality model was applied to the following nodes: Springer Pit, Cariboo Pit, Wight Pit, the TSF, and all waterbodies that will discharge to the environment post-closure (Table 9). The water balance and water quality models were dynamically coupled in GoldSim so that the water quality model reflects exactly what is in the water management plan. In the water quality model, concentrations at each node were estimated by accounting for storage volumes and mass inflows and outflows.

Table 9: Sources of Discharge to the Environment in Post-Closure

Discharge Point	Medium	Receiving Water
9 Km Sump	Overflow	Bootjack Lake
NW Sump	Overflow	Morehead Creek
Springer Pit	Overflow	Bootjack Lake
	Groundwater	Bootjack Lake
Cariboo Pit	Groundwater	Bootjack Lake
Mine Drainage Creek Sump	Overflow	Bootjack Lake
Wight Pit	Overflow	Polley Lake
Bootjack Creek Sump	Overflow	Polley Lake
South Seepage Pond	Overflow	Edney Creek
Main Embankment Seepage Pond	Overflow	Edney Creek
Perimeter Embankment/Till Borrow Pit	Overflow	Hazeltine Creek

The water quality model simulated concentrations on a monthly time step from July 2015 to July 2070. The model was run stochastically for 1,000 realizations. In each realization, a unique value is calculated based on values that are randomly sampled from a statistical probability distribution that is derived for each input (described in Golder, 2015a). Following each simulation, the median and 95th percentile concentrations for each time step were calculated from the 1,000 realizations to assess a range of conditions and their associated probability. In this context, a 95th percentile prediction indicates the maximum concentration that is likely to be reached over the duration of the simulation, with a 95% likelihood that concentrations will be at or below that concentration for the entire duration. Stated in the converse, it suggests that there is a 5% probability that a given concentration will be exceeded for one month or more under the modelled scenario.

Modelled constituents were chosen by screening monitored site water quality data against BC water quality guidelines (BC MoE 2015), in conjunction with an outlier analysis as described in Golder (2015a). Based on this screening process, thirty nine constituents were included in the water quality model. These constituents are listed in Table 10.

Table 10: Water Quality Model Constituent List

Category	Constituent
Physical Parameters	Total Dissolved Solids
Major Ions	Chloride, Sulphate, Calcium, Magnesium
Nutrients	Ammonia, Nitrate, Nitrite, Total Phosphorus
Total and Dissolved Metals and Metalloids	Aluminum, Antimony, Arsenic, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Manganese, Molybdenum, Selenium, Silver, Vanadium, Zinc

Notes: Other water quality parameters such as pH and temperature are assumed based on historical site monitoring.

Each flow that could influence the water quality at each node was assigned an input source term based on site water quality monitoring data and geochemical data. The water quality model is designed to consider all processes at each node that may materially affect water quality.

5.1.1 Inputs and Assumptions

Assumptions relevant to the model inputs are included in Table 11. In addition, all the assumptions provided in Section 4.1 and the source term derivation attachment (Attachment 4), are relevant to the water quality model.

The data and approach used to estimate future water quality are commensurate with industry best practices (Vandenberg et al. 2011; MEND 2009; INAP 2009) and are believed to provide a reasonable approximation of the system, as currently understood, within the context of the assumptions used in the model.

Table 11: Model Inputs and Assumptions

Flow Description	End-of-Mine		Closure and Post-Closure	
	Water Quality Model Input	Notes and Assumptions	Water Quality Model Input	Notes and Assumptions
Baseline Inputs				
Direct Precipitation	Pristine	Assumed to be pristine water carrying no load of any modelled constituents, this input provides dilution capacity only.	No change from End-of-Mine	
Runoff - Undisturbed Areas	Derived from historical water quality data from stations W4 and W5.	"Undisturbed" is defined as being vegetated.	No change from End-of-Mine	
Runoff - Disturbed Areas	Derived from historical water quality data from stations W4 and W5.	"Disturbed" is defined as exposed soil (i.e., cleared of trees).	No change from End-of-Mine	
Baseline Groundwater	Stochastic term developed from groundwater monitoring data around site. Sites used were: ■ GW95R-1 ■ GW96-7 ■ GW96-8 ■ GW05-01 ■ GW11-1 ■ GW12-1 ■ GW12-2 ■ GW12-4 ■ GW12-5 ■ GS15-1 ■ GW15-2	These monitoring points represented groundwater within proximity of the Springer Pit, Wight Pit, and Cariboo Pit, that did not show significant mine impact. Dataset was combined to provide a reasonable range of values that would be used to develop stochastic inputs.	No change from End-of-Mine	
Mine Facilities				
Runoff - Haul Roads	Oxide Waste Rock source term	Haul roads runoff assumed to be constructed using oxide waste rock.	Undisturbed Areas Runoff	Haul roads assumed to be reclaimed at closure
Seepage - Haul Roads	Oxide Waste Rock source term	Haul roads runoff assumed to be constructed using oxide waste rock.	No change from End-of-Mine	
Runoff - Mill Site	Oxide Waste Rock source term	Mill site assumed to be constructed using oxide waste rock.	Undisturbed Areas Runoff	Mill site assumed to be reclaimed at closure
Runoff - Exposed Pond	Oxide Waste Rock and Disturbed Areas Runoff	Oxide Waste Rock when pond is lined with waste rock; Disturbed Areas Runoff term when pond is not lined with waste rock.	No change from End-of-Mine	
Runoff - Pit Walls	Breccia, Monzonite, and Diorite source terms (rock types exposed on pit wall surfaces)	It was assumed that the proportion of breccia, monzonite, and diorite exposed on the pit walls were equal (33.3% each).	No change from End-of-Mine	
Runoff - Tailings Beach	TSF Draindown source term	Water chemistry is expected to be dominated by process water (Attachment 4).	No change from End-of-Mine	It is assumed that the tailings remain saturated at closure, consistent with the closure plan to reclaim the tailings beaches into wetland environments. The assumption that there will be no change in chemistry from End-of-Mine is a conservative assumption as process water will become depleted over time and the runoff may be dominated by water in contact with wetland vegetation rather than the tailings.
Pumped flow from Mill to the Springer Pit (P2)	TSF Supernatant Water Quality data from the water quality site E1.	It is assumed the E1 data is representative of mill process water.	Pumps are turned off at closure	

Flow Description	End-of-Mine		Closure and Post-Closure	
	Water Quality Model Input	Notes and Assumptions	Water Quality Model Input	Notes and Assumptions
Runoff in contact with South Seepage Pond liner (R1)	Natural Areas Runoff	Lined with till	No change from End-of-Mine	
Runoff and Seepage - Temporary NW PAG Stockpile	Sulphide Waste Rock	Attachment 4	PAG Flush source term (1 month), followed by Undisturbed Areas Runoff	PAG rock is moved into the Springer Pit at which time stored oxidation products are flushed. The amount of stored loads that reports to the Springer Pit when the PAG stockpile is moved is equal to three years of stored oxidation products minus the amount of oxidation products that reported to runoff and seepage over the three year period. After the PAG rock is moved (2016) the area is assumed to be reclaimed.
North Bell Dump Runoff	Oxide Waste Rock source term	Attachment 4	Undisturbed Areas Runoff	Waste rock dumps assumed to be reclaimed (covered) at closure
North Bell Dump Seepage	Oxide Waste Rock source term	Attachment 4	No change from End-of-Mine	
Runoff - SERDS, East RDS, and NEZ Dump	Sulphide Waste Rock source term	It is assumed that all permanent dumps are non-Potentially Acid Generating. Contact water is assumed to remain non-acidic with chemistry reflecting dissolution of natural weathering products created prior to mining, and sulphide oxidation and acid neutralization (Attachment 4).	Undisturbed Areas Runoff	Waste rock dumps assumed to be reclaimed (covered) at closure
Seepage - SERDS, East RDS, and NEZ Dump	Sulphide Waste Rock source term	It is assumed that all permanent dumps are non-Potentially Acid Generating. Contact water is assumed to remain non-acidic with chemistry reflecting dissolution of natural weathering products created prior to mining, and sulphide oxidation and acid neutralization (Attachment 4).	No change from End-of-Mine	

Site water quality data, provided by MPMC, were used to represent baseline water quality inputs (disturbed and undisturbed areas runoff, and groundwater), initial conditions at each model node, and process water from the mill. For each baseline water quality model input, statistical distributions were assigned to each modelled constituent. Available water quality data were compiled and used to represent these waters. A standardized process was used to develop a statistical distribution for each constituent and is described in Golder (2015a).

Source terms for the mine facilities were provided by SRK using methods described in Attachment 4. The source terms were utilized in the model as recommended by Attachment 4 with a few exceptions:

1) SRK provided a TSF "post-draindown" term which was meant to be applied to tailings runoff and seepage when the tailings became de-saturated. However, the closure plan for the TSF beaches is to reclaim them to a wetland environment. Therefore, it is assumed the tailings will remain saturated.

2) SRK provided a "PAG flush" term which was applied to the Temporary NW PAG Stockpile material that reports to the Springer Pit at closure. The source term was calculated assuming the Temporary NW PAG stockpile would weather at surface for 10 years after End-of-Mine. Following the receipt of the source terms and consultation with MPMC it was decided that the Temporary NW PAG stockpile be transferred to the Springer Pit in the first year after End-of-Mine (2016). The earlier placement of material has two advantages: first, it allows materials to be placed in the Springer Pit before the pit is full of water, which eliminates the need to dewater twice, and second, it reduces the amount of weathering that will occur in the PAG materials. Therefore, only three years (2013-2016) of accumulated oxidation products will report to the Springer Pit when the rock is submerged rather than ten years. The schedule for placing PAG material in the Springer Pit will be refined as part of subsequent Reclamation and Closure Plans.

3) SRK provided a porewater constraint term for the PAG Backfill. It is recommend this term be used to calculate the diffusive flux of constituents from the PAG backfill porewater to the overlying water column for the next water quality model submission (Section 6).

Stochastic inputs were developed using the source terms provided using two methods. For all the source terms with the exception of the TSF Draindown term, upper and lower bounds were provided. The upper bound was treated as the maximum and the lower bound as the minimum and a uniform probability distribution was applied (i.e., there was an equal probability the model run would choose the maximum, minimum, and any value in between). For the TSF Draindown terms P5, P50, and P95 values were provided. Based on these values the distribution type (normal or log normal) was determined, and mean, max, and standard deviation values were calculated (Table 12).

Table 12: Distribution Types and Statistics Developed for the TSF Draindown Terms

Parameter	Units	Distribution	Mean	Standard Deviation	Maximum
Physical Parameters					
Total Dissolved Solids	mg/L	Normal	891	157	1180
Nutrients					
Ammonia	mg/L	Log Normal	0.095	0.077	0.21
Nitrate	mg/L	Log Normal	4.2	3.7	9.7
Nitrite	mg/L	Normal	0.15	0.091	0.32
Phosphorus	mg/L	Log Normal	0.021	0.015	0.043

Table 12: Distribution Types and Statistics Developed for the TSF Draindown Terms

Parameter	Units	Distribution	Mean	Standard Deviation	Maximum
Major Ions					
Calcium	mg/L	Normal	161	35	217
Magnesium	mg/L	Log Normal	26	7.6	37
Chloride	mg/L	Normal	18	2.9	30
Sulphate	mg/L	Normal	534	74	661
Metals					
Aluminum	mg/L	Log Normal	0.61	0.72	1.5
Antimony	mg/L	Log Normal	0.00082	0.00049	0.0015
Arsenic	mg/L	Normal	0.0016	0.00031	0.0024
Boron	mg/L	Log Normal	0.18	0.075	0.28
Cadmium	mg/L	Normal	0.000075	0.000042	0.00014
Chromium	mg/L	Log Normal	0.0011	0.0011	0.0024
Cobalt	mg/L	Log Normal	0.00069	0.00054	0.0014
Copper	mg/L	Log Normal	0.013	0.012	0.028
Iron	mg/L	Log Normal	0.72	0.84	1.7
Manganese	mg/L	Normal	0.45	0.28	0.92
Molybdenum	mg/L	Normal	0.18	0.023	0.23
Selenium	mg/L	Normal	0.015	0.011	0.032
Silver	mg/L	Log Normal	0.000012	0.0000087	0.000022
Vanadium	mg/L	Log Normal	0.0022	0.0017	0.0046
Zinc	mg/L	Log Normal	0.0068	0.0064	0.014

Furthermore, the Attachment 4 source terms included only dissolved constituents. The total fraction for the metals was determined by calculating the ratio of total to dissolved concentrations, for each constituent, using observed data in the Springer Pit between February, 2011 and February, 2015. The median of the ratios was calculated for each constituent (Table 13). The total to dissolved ratio was then multiplied by the dissolved source terms to attain an estimate of the total fraction.

Table 13: Median Ratio of Total to Dissolved Concentrations

Parameter	Ratio of Total to Dissolved Concentration
Aluminum	36
Antimony	1.0
Arsenic	1.1
Boron	1.0
Cadmium	1.1
Chromium	1.0
Cobalt	1.4
Copper	1.4

Parameter	Ratio of Total to Dissolved Concentration
Iron	7.2
Manganese	1.1
Molybdenum	1.0
Selenium	1.0
Silver	2.0
Vanadium	1.3
Zinc	1.4

5.1.2 Model Limitations

In natural systems and complex man-made systems, observed conditions will almost certainly vary with respect to forecasted conditions. Water quality modelling requires the use of many assumptions due to the uncertainty related to determining the physical and geochemical characteristics of a complex system. The prediction of water quality is based on several inputs (surface flows and groundwater flows, and baseline water quality), all of which have inherent variability and uncertainty. The water quality model represents an attempt to incorporate natural and site processes, and combine them with flows to develop predictions for water quality along with associated probabilities.

Given the inherent uncertainties, the water quality model should be viewed as a tool to aid in the design of monitoring programs and mine planning, development of mitigation strategies, and identification of potential risks rather than to provide absolute concentrations. Conservative assumptions have been incorporated where uncertainty is known to exist, so that predicted concentrations under modelled scenarios are likely to exceed actual future concentrations.

The following key assumptions have been made in the water quality modelling:

- Measured water quality constituents that were lower than the analytical detection limit were set equal to half the detection limit (as is the convention for water quality related calculations and modelling).
- The pit lakes and TSF are fully mixed systems. No stratification is considered in either system over the modelled timeframe. All inputs are mixed with existing pit lake water to calculate predicted water quality.
- All constituents are assumed to behave conservatively. That is, they are assumed to not settle, precipitate, sorb, degrade, or undergo any other process that would reduce concentrations. This assumption is likely to have negligible effects on major ion predictions, but may lead to overestimation of some nutrients and metals.

5.2 Results

The maximum concentrations from the median and 95th percentile of the 1,000 realizations are presented (Table 14) and discussed below. Maximum concentrations are shown for three periods: “end-of-mine” (July 2015 to July 2016), “early closure” (July 2016 to July 2021), and “long-term” (July 2069 to July 2070). These date ranges differ from the date ranges presented in Section 4.0 because they are more reflective of trends in water chemistry over the closure time frame. Results for other sources of discharge to the environment in post-closure are included in Attachment 2. The results are screened against the Metal Mining Effluent Regulations (Schedule 4) limits, as well as the B.C. maximum water quality guidelines for the protection of aquatic life. Only the short-term B.C. guidelines were used for comparison because the effluent concentrations predicted herein do not represent ambient conditions to which aquatic species will be exposed for prolonged durations. An assessment of receiving environment conditions that includes long-term exposures will be included as part of subsequent submissions, such as the draft Long-term Water Management Plan that will be submitted to MoE by June 30, 2016.

Time series for untreated Springer, Cariboo, and Wight Pits and the TSF water quality are included in Attachment 3. Time series show trends in concentrations for all modelled constituents during the modelled period: July 2015 to July 2070. Median water quality for each time step based on all 1,000 realizations is shown as a black line. The light green area indicates the predicted range between the 25th and 75th percentile results,

while the dark green range indicates the predicted range between the 5th and 95th percentile results. Parameters with the highest variability in source data have greater variability in results.

The early closure chemistry varies across the different pits, but in general copper is elevated in all pits, and arsenic and iron are elevated in the Springer and Wight Pits. Ammonia is flagged as being elevated in the Wight Pit, and nitrite is flagged as being elevated in the Cariboo and Wight Pits; however, there is high uncertainty associated with these constituent predictions because the assumption of conservative behaviour is not appropriate for the nitrogen species (i.e., predictions err on the high side). Selenium is elevated in the Springer Pit in early closure, but returns to baseline concentrations in the long-term.

With the exception of selenium, copper, iron, and molybdenum in the Wight Pit, all mine-related parameters decrease substantially in the pits over time. Mine-related parameters increase slightly from 2026 to 2070 in the Wight Pit, because during this period, the proportion of contact water (North Bell Dump seepage and pit wall runoff) is greater compared to the early closure period when dilution by groundwater was significant. Only copper in the Springer Pit and iron in the Cariboo and Wight pits are identified as potentially exceeding the B.C. maximum daily guideline for the protection of freshwater aquatic life in the long term. Selenium is elevated in all pits in the early closure period and remains elevated in the Wight Pit in the long-term.

The TSF predictions show elevated arsenic, copper, and iron in the early closure period and iron in the long-term closure period. Selenium is elevated in both the early and long-term closure periods. There is substantial uncertainty associated with the TSF predictions, largely owing to the variability inherent in the tailings runoff and seepage source term.

Table 14: Summary of Predicted Springer Pit, Cariboo Pit, Wight Pit, and the Tailings Storage Facility for the Year of Restricted Operations, Short and Long-Term Post-Closure

Part A

Parameter	Units	BC Water Quality Guidelines[a]		Metal Mining Effluent Regulations[b]	Springer Pit						Cariboo Pit					
					Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]		Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]	
		Maximum	notes		Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value
Physical Parameters																
Hardness	mg/L (as $CaCO_3$)	-	-	-	623	735	1228	1386	118	143	656	806	561	641	178	222
Total Dissolved Solids	mg/L	-	-	-	987	1155	1749	2018	130	174	988	1252	842	968	156	256
Major Ions																
Calcium	mg/L	-	-	-	197	237	407	454	39	47	208	256	177	202	59	72
Chloride	mg/L	600	A	-	16	21	18	23	0.33	1.2	10	14	7.1	9.3	0.49	0.95
Magnesium	mg/L	-	-	-	32	37	51	61	4.9	6.4	33	40	29	33	7.6	10
Sulphate	mg/L	-	-	-	577	684	734	903	31	49	559	711	436	510	43	80
Nutrients																
Ammonia	mg/L (as N)	1.26 - 1.26	A, c	-	0.16	0.3	0.17	0.32	0.0021	0.0064	0.043	1.1	0.036	0.51	0.0037	0.015
Nitrate	mg/L (as N)	32.8	A	-	11	12	12	14	0.076	0.51	7.8	11	8.3	11	0.2	1.5
Nitrite	mg/L (as N)	0.06 - 0.06	A, d	-	0.27	0.32	0.32	0.37	0.00085	0.0032	0.042	**0.64**	0.03	**0.31**	0.0016	0.008
Total Phosphorus	mg/L	-	-	-	0.022	0.057	0.83	1.07	0.012	0.019	0.021	0.095	0.021	0.057	0.015	0.026
Total Metals																
Aluminum	mg/L	-	-	-	2.2	5.3	199	255	0.5	0.65	0.23	0.62	0.4	0.7	0.41	0.85
Antimony	mg/L	-	-	-	0.0014	0.0025	0.0038	0.0048	0.00011	0.00017	0.0017	0.0046	0.00099	0.0023	0.0001	0.00015
Arsenic	mg/L	0.005	A	0.5	0.0022	0.0035	**0.028**	**0.033**	0.00047	0.00077	0.0022	0.0034	0.0016	0.0023	0.00042	0.00062
Boron	mg/L	1.2	A	-	0.16	0.2	1.2	**1.2**	0.051	0.11	0.18	0.28	0.15	0.27	0.05	0.065
Cadmium	mg/L	no total WQG, see dissolved WQG	-	-	0.00013	0.00022	0.00102	0.0014	0.000046	0.00006	0.00013	0.00023	0.00009	0.00014	0.000039	0.000074
Chromium	mg/L	-	-	-	0.00054	0.0016	0.0029	0.004	0.0002	0.00075	0.0003	0.0017	0.00034	0.0014	0.00029	0.0019
Cobalt	mg/L	0.11	A	-	0.0034	0.0041	0.0047	0.0065	0.00026	0.0005	0.00053	0.0008	0.00056	0.00083	0.00023	0.0008
Copper	mg/L	0.0131 - 0.0155	A, e	0.3	**0.11**	**0.28**	**0.3**	**0.5**	**0.015**	**0.017**	0.054	**0.24**	0.035	**0.12**	0.014	0.022
Iron	mg/L	1	A	-	**1.1**	**2.7**	**15**	**19**	0.42	0.51	0.58	**1.0**	0.64	**1.1**	0.37	0.65
Manganese	mg/L	1.8 - 2.1	A, f	-	0.82	1.1	0.97	1.3	0.012	0.083	0.19	0.32	0.21	0.35	0.012	0.035
Molybdenum	mg/L	2	A	-	0.17	0.2	0.34	0.4	0.017	0.022	0.17	0.22	0.12	0.14	0.016	0.018
Selenium	mg/L	-	-	-	0.063	0.075	0.2	0.28	0.0065	0.0072	0.044	0.068	0.048	0.066	0.0049	0.0064
Silver	mg/L	0.003 - 0.003	A, g	-	0.000017	0.000031	0.00066	0.00076	0.00001	0.000019	0.00001	0.000027	0.000013	0.000031	0.000013	0.000039
Vanadium	mg/L	-	-	-	0.0039	0.0082	0.084	0.11	0.00062	0.001	0.0024	0.0061	0.0017	0.0034	0.00083	0.0013
Zinc	mg/L	0.05 - 0.07	A, h	0.5	0.014	0.02	0.078	0.085	0.0056	0.0063	0.0036	0.0079	0.0049	0.0066	0.0049	0.0063
Dissolved Metals																
Aluminum	mg/L	0.1	A, i	-	0.062	0.13	5.4	7.0	0.025	0.14	0.0081	0.015	0.034	0.26	0.044	0.37
Antimony	mg/L	-	-	-	0.0014	0.0022	0.0038	0.0049	0.00011	0.00017	0.0017	0.0049	0.0010	0.0025	0.000099	0.00015
Arsenic	mg/L	-	-	-	0.0019	0.0027	0.026	0.03	0.00045	0.00079	0.0019	0.004	0.0015	0.0026	0.00038	0.00055
Boron	mg/L	-	-	-	0.15	0.19	1.1	1.2	0.051	0.11	0.17	0.27	0.15	0.26	0.049	0.064
Cadmium	mg/L	0.0007 - 0.0009	A, j	-	0.00012	0.00021	0.0009	0.0012	0.000042	0.000059	0.00012	0.0002	0.000081	0.00013	0.000037	0.000078
Chromium	mg/L	-	-	-	0.00034	0.00082	0.0027	0.0032	0.00018	0.00048	0.00029	0.0012	0.00031	0.00089	0.00027	0.0011
Cobalt	mg/L	-	-	-	0.0024	0.0029	0.0033	0.0046	0.00019	0.00036	0.00036	0.00061	0.00039	0.00064	0.00015	0.0004
Copper	mg/L	-	-	-	0.069	0.086	0.2	0.25	0.011	0.014	0.022	0.074	0.017	0.042	0.011	0.021
Iron	mg/L	0.35	A	-	0.13	0.22	**2.0**	**2.6**	0.075	0.17	0.083	0.14	0.098	0.29	0.08	**0.37**
Manganese	mg/L	-	-	-	0.76	0.96	0.9	1.1	0.0095	0.086	0.17	0.32	0.2	0.35	0.0073	0.02
Molybdenum	mg/L	-	-	-	0.17	0.2	0.34	0.39	0.016	0.022	0.17	0.22	0.12	0.14	0.015	0.018

Table 14: Summary of Predicted Springer Pit, Cariboo Pit, Wight Pit, and the Tailings Storage Facility for the Year of Restricted Operations, Short and Long-Term Post-Closure

Part A

Parameter	Units	BC Water Quality Guidelines[a]		Metal Mining Effluent Regulations[b]	Springer Pit						Cariboo Pit					
					Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]		Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]	
		Maximum	notes		Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value
Selenium	mg/L	-	-	-	0.064	0.071	0.2	0.28	0.0064	0.0071	0.043	0.07	0.046	0.067	0.0049	0.0063
Silver	mg/L	-	-	-	0.0000078	0.000011	0.00033	0.00038	0.0000065	0.000014	0.0000073	0.000017	0.0000092	0.000023	0.0000094	0.00003
Vanadium	mg/L	-	-	-	0.0028	0.0059	0.064	0.084	0.0005	0.00088	0.0018	0.0044	0.0013	0.0027	0.00069	0.0011
Zinc	mg/L	-	-	-	0.009	0.011	0.054	0.058	0.0041	0.0048	0.0026	0.0049	0.0037	0.0045	0.0038	0.0049

Notes:
A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage
a) BC Water Quality Guidelines (BC WQG) for the protection of freshwater aquatic life.
b) Metal Mining Effluent Regulations (MMER) Schedule 4, maximum authorized monthly mean concentration
c) pH and temperature dependent ammonia guideline: values selected from Table 3 in BC WQG based on maximum temperature and observed pH values in Springer Pit
d) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6
e) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000
f) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54
g) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness ≤100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness ≤100 mg/L, at hardness > 100 mg/L = 0.0015
h) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000
i) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH ≥6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH^2))
j) hardness dependent dissolved Cd guideline: max BC WQG (mg/L) = (exp(1.03*ln(hardness)-5.274))/1000
k) July 1, 2015 to July 1, 2016
l) July 1, 2016 to July 1, 2021
m) July 1, 2069 to July 1, 2070

123	Indicates concentration exceeding the BC maximum WQ Guideline
123	Indicates concentration exceeded MMER guideline

Table 14: Summary of Predicted Springer Pit, Cariboo Pit, Wight Pit, and the Tailings Storage Facility for the Year of Restricted Operations, Early Closure, and Long-Term
Part B

Parameter	Units	BC Water Quality Guidelines[a]		Metal Mining Effluent Regulations[b]	Wight Pit						Tailings Storage Facility					
					Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]		Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]	
		Maximum	notes		Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value
Physical Parameters																
Hardness	mg/L (as $CaCO_3$)	-	-	-	586	949	326	423	345	426	575	860	540	688	513	669
Total Dissolved Solids	mg/L	-	-	-	860	1243	480	600	508	607	1009	1433	925	1131	886	1102
Major Ions																
Calcium	mg/L	-	-	-	193	284	104	133	109	133	204	300	172	216	164	211
Chloride	mg/L	600	A	-	5.0	7.1	2.2	6.7	2.5	5.6	26	36	17	22	18	22
Magnesium	mg/L	-	-	-	25	59	16	22	18	23	26	33	27	36	25	35
Sulphate	mg/L	-	-	-	463	690	179	244	210	264	622	884	551	638	527	621
Nutrients																
Ammonia	mg/L (as N)	1.26 - 1.26	A, c	-	0.24	**3.4**	0.015	0.022	0.018	0.024	0.24	0.57	0.067	0.16	0.066	0.16
Nitrate	mg/L (as N)	32.8	A	-	8.1	20	4.9	5.0	6.2	6.3	6.0	9.1	5.0	9.1	2.9	7.7
Nitrite	mg/L (as N)	0.06 - 0.06	A, d	-	0.028	**0.29**	0.01	0.013	0.012	0.016	0.12	0.22	0.14	0.25	0.14	0.26
Total Phosphorus	mg/L	-	-	-	0.026	0.17	0.022	0.062	0.019	0.045	0.019	0.07	0.018	0.036	0.019	0.037
Total Metals																
Aluminum	mg/L	-	-	-	1.1	1.7	0.98	1.1	0.53	0.53	10	34	12	39	13	41
Antimony	mg/L	-	-	-	0.0012	0.0019	0.00028	0.00053	0.00027	0.00048	0.0018	0.0031	0.00066	0.0013	0.00066	0.0013
Arsenic	mg/L	0.005	A	0.5	0.0026	**0.0083**	0.0011	0.0031	0.00097	0.0021	0.0032	**0.0063**	0.0016	0.0021	0.0017	0.0022
Boron	mg/L	1.2	A	-	0.64	**1.2**	0.12	0.47	0.11	0.31	0.14	0.22	0.16	0.26	0.16	0.26
Cadmium	mg/L	no total WQG, see dissolved WQG	-	-	0.00023	0.00045	0.000097	0.00012	0.00006	0.000088	0.000076	0.00034	0.000085	0.00014	0.000086	0.00014
Chromium	mg/L	-	-	-	0.00096	0.0017	0.00033	0.00096	0.00025	0.00064	0.00066	0.0032	0.00076	0.0019	0.00083	0.002
Cobalt	mg/L	0.11	A	-	0.0014	0.004	0.00064	0.0011	0.0006	0.001	0.00074	0.0036	0.00078	0.0016	0.00073	0.0017
Copper	mg/L	0.0131 - 0.0155	A, e	0.3	0.035	0.072	**0.03**	0.033	0.019	0.022	0.039	**0.52**	0.015	0.033	0.014	0.033
Iron	mg/L	1	A	-	**1.5**	**2.0**	**1.0**	**1.2**	0.89	**1.3**	**2.7**	**7.9**	**3.0**	**9.2**	**3.1**	**9.5**
Manganese	mg/L	1.8 - 2.1	A, f	-	0.35	0.78	0.18	0.5	0.22	0.46	0.48	0.81	0.51	0.89	0.48	0.88
Molybdenum	mg/L	2	A	-	0.14	0.32	0.051	0.074	0.053	0.073	0.2	0.26	0.18	0.21	0.18	0.21
Selenium	mg/L	-	-	-	0.06	0.062	0.037	0.039	0.043	0.045	0.029	0.041	0.028	0.04	0.015	0.029
Silver	mg/L	0.003 - 0.003	A, g	-	0.000034	0.00063	0.000019	0.000025	0.000013	0.000013	0.000018	0.000051	0.00002	0.000038	0.000021	0.000041
Vanadium	mg/L	-	-	-	0.0023	0.016	0.001	0.0028	0.00075	0.0021	0.006	0.016	0.0022	0.0047	0.0023	0.005
Zinc	mg/L	0.05 - 0.07	A, h	0.5	0.02	0.047	0.011	0.013	0.0064	0.0086	0.0058	0.022	0.0065	0.016	0.0067	0.017
Dissolved Metals																
Aluminum	mg/L	0.1	A, i	-	0.03	0.037	0.036	0.11	0.016	0.023	0.29	0.91	0.34	1.1	0.37	1.1
Antimony	mg/L	-	-	-	0.0012	0.0019	0.00027	0.00055	0.00027	0.0005	0.0019	0.0034	0.00065	0.0013	0.00065	0.0013
Arsenic	mg/L	-	-	-	0.0019	0.0048	0.0012	0.0033	0.00097	0.0022	0.0025	0.0045	0.0015	0.002	0.0016	0.0021
Boron	mg/L	-	-	-	0.63	1.2	0.13	0.48	0.11	0.32	0.14	0.21	0.15	0.24	0.16	0.25
Cadmium	mg/L	0.0007 - 0.0009	A, j	-	0.00012	0.00032	0.000087	0.00011	0.000054	0.000082	0.000078	0.00034	0.000074	0.00012	0.000075	0.00013
Chromium	mg/L	-	-	-	0.00043	0.0012	0.00031	0.00088	0.00025	0.0006	0.00063	0.0016	0.00073	0.0018	0.00079	0.002
Cobalt	mg/L	-	-	-	0.001	0.002	0.00047	0.001	0.00045	0.00091	0.0005	0.001	0.00052	0.0012	0.00048	0.0012
Copper	mg/L	-	-	-	0.024	0.079	0.021	0.025	0.013	0.017	0.0098	0.059	0.01	0.023	0.0097	0.024
Iron	mg/L	0.35	A	-	0.22	0.3	0.16	0.26	0.14	0.23	**0.38**	**1.2**	**0.43**	**1.3**	**0.44**	**1.4**
Manganese	mg/L	-	-	-	0.27	0.67	0.17	0.53	0.21	0.47	0.43	0.73	0.47	0.81	0.43	0.8
Molybdenum	mg/L	-	-	-	0.14	0.32	0.049	0.072	0.052	0.07	0.2	0.26	0.17	0.21	0.17	0.21

Table 14: Summary of Predicted Springer Pit, Cariboo Pit, Wight Pit, and the Tailings Storage Facility for the Year of Restricted Operations, Early Closure, and Long-Term
Part B

Parameter	Units	BC Water Quality Guidelines[a]		Metal Mining Effluent Regulations[b]	Wight Pit						Tailings Storage Facility					
					Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]		Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]	
		Maximum	notes		Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value
Selenium	mg/L	-	-	-	0.059	0.062	0.037	0.039	0.043	0.045	0.03	0.041	0.028	0.04	0.016	0.029
Silver	mg/L	-	-	-	0.000012	0.000016	0.000011	0.000016	0.000008	0.000008	0.0000096	0.000017	0.000011	0.00002	0.000011	0.000022
Vanadium	mg/L	-	-	-	0.0018	0.003	0.00083	0.003	0.00061	0.0021	0.0044	0.012	0.0016	0.0037	0.0017	0.0039
Zinc	mg/L	-	-	-	0.016	0.04	0.0083	0.01	0.0048	0.0069	0.0041	0.0098	0.0045	0.011	0.0047	0.012

Notes:
A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage
a) BC Water Quality Guidelines (BC WQG) for the protection of freshwater aquatic life.
b) Metal Mining Effluent Regulations (MMER) Schedule 4, maximum authorized monthly mean concentration
c) pH and temperature dependent ammonia guideline: values selected from Table 3 in BC WQG based on maximum temperature and observed pH values in Springer Pit
d) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6
e) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000
f) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54
g) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness ≤100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness ≤100 mg/L, at hardness > 100 mg/L = 0.0015
h) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000
i) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH ≥6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH^2))
j) hardness dependent dissolved Cd guideline: max BC WQG (mg/L) = (exp(1.03*ln(hardness)-5.274))/1000
k) July 1, 2015 to July 1, 2016
l) July 1, 2016 to July 1, 2021
m) July 1, 2069 to July 1, 2070

123	Indicates concentration exceeding the BC maximum WQ Guideline
123	Indicates concentration exceeded MMER guideline

6.0 SUMMARY AND RECOMMENDATIONS

Reclamation for most of the mine site is assumed to take place upon closure (August 2016). Most pumping will cease at this point, with the exception of the pumps P10 (Mine Drainage Creek Sump to SERDS Ditch), P11 (Bootjack Creek Sump to SERDS Ditch), P20 (9KM Sump to NW Sump), P21 (Wight Pit/Underground to Long Ditch, and P24 (NW Sump to Mine Drainage Creek Sump).

The PAG material in the Temporary NW PAG Stockpile will be transferred to Springer Pit for subaqueous disposal upon closure. Due to the modeling assumptions, an initial outflow is projected to occur from Springer Pit upon the addition of the PAG material to the pit. However, according to the model, as dewatering continues until the end of 2016, the water level in the pit will be continually drawn down, until it starts to increase in 2017. Overflow from the Springer Pit is estimated to start in April, 2021. The TSF does not overflow under average climate conditions.

Concentrations of most constituents decrease in the pits and in the TSF over time. Copper in the Springer Pit and iron in the Wight and Cariboo pits and the TSF were identified as constituents of potential concern in the long-term closure period. MPMC has committed to treating effluent sources until relevant criteria can be met in the receiving environment. Also, the modelling predictions will be refined in subsequent closure plans.

The following recommendations can be carried out as part of future, more detailed Reclamation and Closure Plans:

- Refine reclamation transition:
  - The model currently treats the reclamation process as a step-function, meaning that the hydrologic and water quality characteristics change within one model timestep (one month). In reality however, the reclamation process will be a gradual process during closure. Therefore, the model can be updated to reflect this gradual process. Progressive and gradual reclamation applies to:
    - Cover placement on waste rock dumps;
    - Transition of the PAG waste rock into the Springer Pit; and
    - Evolution of the wetland environment in the TSF.
  - The potential for the tailings to de-saturate at closure should be further examined. While the report issued by the Independent Expert Engineering Investigation and Review Panel (2015) on the Mount Polley Tailings Storage Facility Breach recommended the promotion of unsaturated conditions in tailings to physically stabilize the dam, there are implications for chemical stability. As discussed in Wilson and Robertson (2015) the principles outlined in the best available technology (BAT) for physical stability contradict the BAT principles for chemical stability. The trade off in risk should be assessed in subsequent submissions.

- Refine source terms:
  - Assuming the tailings remain saturated at closure, the source term applied to both runoff and seepage from the TSF beaches at closure may be overly conservative because process water will become depleted over time and the runoff is likely to be dominated by contact with wetland vegetation and not tailings.
  - The assumption that pit wall exposures include equal proportions of breccia, monzonite, and diorite should be refined.
  - Data to represent process water from the mill were low. MPMC has been collecting samples since resumed operations in August 2015. The process water term should be evaluated once the process water database is populated.
  - Assess the potential impact of diffusion of constituents from the submerged PAG in the Springer Pit to the overlying water column on Springer Pit water quality results.
- A receiving environment model should be completed to assess the concentration of constituents. This is already planned as part of the Long-Term Water Management Plan, due to MoE June 30, 2016.

7.0 CLOSURE

We trust this report satisfies your current requirements. If you have any questions or require further assistance, please do not hesitate to contact the undersigned.

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Attachments
Attachment 1 – Water Balance Model Inputs
Attachment 2 – Water Quality Results for Sources of Discharges to the Environment at Closure
Attachment 3 – Time Series Results
Attachment 4 – SRK Source Terms

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ATTACHMENT 1
Water Balance Model Inputs

1.0 FLOW INVENTORY FOR CLOSURE/ POST-CLOSURE

A description of the model flows is provided in Table A1 to Table A4. Direct precipitation, runoff and environmental discharge flows are numbered according to their associated elements, and are therefore not described herein.

Table A1: Description of Process Flows

Flow ID	From	To	Comment
P6	South Seepage Pond	Main Embankment Seepage Pond	Optional during closure. Not active in closure model.
P8	Main Embankment Seepage Pond	Perimeter Embankment Till Borrow Pit	Optional during closure. Not active in closure model.
P10	Mine Creek Drainage Sump	South-east Rock Disposal Site (SERDS) Ditch	Via SERDS Ditch
P11	Bootjack Creek Sump	SERDS Ditch	Via SERDS Ditch
P20	9 km Sump	NW Sump	
P21	Wight Pit	Long Ditch	Via Long Ditch
P24	NW Sump	Mine Drainage Creek Sump	

Table A2: Description of Seepage Flows

Flow ID	From	To	Comment
S1	Tailings Storage Facility (TSF)	South Seepage Pond	
S2	TSF	Main Embankment Seepage Pond	Via South Toe Drain
S3	TSF	Main Embankment Seepage Pond	Via Main Toe Drain/ Foundation Drain
S4	TSF	Perimeter Embankment Till Borrow Pit	Via Perimeter Drain
S5	TSF	Perimeter Embankment Till Borrow Pit	Freshet Event seepage collection
S6	SERDS	SERDS ditch	Baseflow from waste rock dump
S7	North Bell Dump	Wight Pit	Baseflow from waste rock dump via Joe's Creek Pipe
S8	EAST RDS	Long Ditch	Baseflow from waste rock dump
S9	NEZ Dump	Long Ditch	Baseflow from waste rock dump
S10	Temp PAG Stockpile	9 km Sump	Baseflow from waste rock dump
S11	Temp PAG Stockpile	NW Sump	Baseflow from waste rock dump
S12	Seepage from Waste Haul Road	Mine Drainage Creek Sump	Seepage from haul roads
S13	Seepage from Tailings Access Road	Bootjack Creek Sump	Seepage from haul roads

Table A3: Description of Gravity Driven Flows (Transfer [T] and Overflow [OF])

Flow ID	From	To	Comments
T1	Long Ditch	Central Collection Sump	
T2	SERDS Ditch	Central Collection Sump	Via Long Ditch
T3	Central Collection Sump	Perimeter Embankment Till Borrow Pit	
T4	Polley Lake	Hazeltine Creek	
OF1	South Seepage Pond	Edney Creek	
OF2	Main Embankment Seepage Pond	Hazeltine Creek	
OF4	Tailings Storage Facility	Perimeter Embankment Till Borrow Pit	
OF5	Perimeter Embankment Till Borrow Pit	Hazeltine Creek	
OF8	Bootjack Creek Sump	Polley Lake	
OF10	Mill Site Sump	Mine Drainage Creek Sump	
OF11	Cariboo Pit Sump	Springer Pit	
OF12	Mine Drainage Creek Sump	Bootjack Lake	
OF14	Springer Pit	Mine Drainage Creek Sump (Closure) Bootjack Creek (Post-closure)	
OF15	NW Sump	Bootjack Lake	
OF16	9km Sump	Bootjack Lake	

Table A4: Description of Groundwater Flows

Flow ID	From	To
GW1	Groundwater Aquifer	Wight Pit
GW2	Groundwater Aquifer	Springer Pit
GW3	Groundwater Aquifer	Cariboo Pit
GW4	Springer Pit	Bootjack Lake

1.1 Maximum Pumping Rates

Table A5: Assumed Maximum Pumping Rates for Operational Flows

Flow ID	From	To	Assumed Flow Rate (m^3/s)
P10	Mine Creek Drainage Sump	SERDS Ditch	N/A [(a)]
P11	Bootjack Creek Sump	SERDS Ditch	0.1
P20	9 km Sump	NW Sump	0.1
P21	Wight Pit	Long Ditch	0.13
P24	NW Sump	Mine Drainage Creek Sump	N/A [(f)]

1.2 Tailings Storage Facility Seepage Flows

MPMC staff has measured post breach seepage flows from the TSF, and these are presented in Table A6.

Table A6: Seepage Flows from TSF

Flow ID	Description	Flow Rate (m^3/s)
S1	From TSF to South Seepage Pond	0.00095
S2	From TSF to Main Embankment Seepage Pond via South Toe Drain	0.006
S3	From TSF to Main Embankment Seepage Pond via Main Toe/ Foundation Drain	0.0061
S4	From TSF to Perimeter Embankment Till Borrow Pit via Perimeter Drain	0
S5	From TSF to Perimeter Embankment Till Borrow Pit via Toe Drains	0.049

2.0 STORAGE CHARACTERIZATION

Measured stage-storage-area curves were only available for the following storage elements:

- Tailings Storage Facility;
- Perimeter Embankment Till Borrow Pit;
- Cariboo Pit;
- Wight Pit; and
- Springer Pit.

The storage characteristics of these elements are summarized in Table A7. These stage-storage curves were provided by personal communication with the MPMC staff (MPMC 2015b,c,d).

Table A7: Observed Storage Characteristics for Primary Water Management Facilities during Closure/ Post Closure

Storage Element	Maximum Pond Area (m^2)	Depth (m)	Capacity (Mm^3)	Initial Pond Volume (m^3) [(a)]
Tailings Storage Facility [(a)]	864,640	20	2.3	230
Perimeter Embankment Till Borrow Pit	43,630	7	0.19	51,880
Wight Pit	162,000	125	4.48	346,950
Cariboo Pit	32,450	55	1.07	650,000
Springer Pit	280,480	110	14.8	7,000,000

(a) As of July 1, 2015

ATTACHMENT 2
Water Quality Results for Sources of Discharges to the Environment at Closure

Parameter	Units	BC Water Quality Guidelines[a]		Metal Mining Effluent Regulations[b]	9 Km Sump					
					Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]	
		Maximum	notes		Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value
Physical Parameters										
Hardness	mg/L (as $CaCO_3$)	-	-	-	1774	1796	1473	1494	164	213
Total Dissolved Solids	mg/L	-	-	-	2780	2846	2286	2345	134	247
Major Ions										
Calcium	mg/L	-	-	-	546	554	454	461	53	68
Chloride	mg/L	600	A	-	22	26	18	21	0.55	1.1
Magnesium	mg/L	-	-	-	100	100	82	83	7.5	10.4
Sulphate	mg/L	-	-	-	1690	1713	1382	1402	37	78
Nutrients										
Ammonia	mg/L (as N)	1.26 - 1.26	A, c	-	0.38	0.44	0.31	0.36	0.0042	0.0166
Nitrate	mg/L (as N)	32.8	A	-	**52**	**53**	**42**	**43**	0.231	1.69
Nitrite	mg/L (as N)	0.06 - 0.06	A, d	-	**2.54**	**2.93**	**2.07**	**2.38**	0.00177	0.0091
Total Phosphorus	mg/L	-	-	-	0.028	0.074	0.03	0.03	0.013	0.025
Total Metals										
Aluminum	mg/L	-	-	-	3.3	3.3	3	3	0.1	0.6
Antimony	mg/L	-	-	-	0.0009	0.0009	0.0007	0.0008	0.00006	0.00011
Arsenic	mg/L	0.005	A	0.5	0.0012	0.0018	0.001	0.001	0.00032	0.00054
Boron	mg/L	1.2	A	-	0.15	0.16	0.1	0.1	0.04	0.06
Cadmium	mg/L	no total WQG, see dissolved WQG	-	-	0.00061	0.00068	0.0005	0.0006	0.000013	0.000052
Chromium	mg/L	-	-	-	0.00037	0.0024	0.0004	0.0021	0.00029	0.00215
Cobalt	mg/L	0.11	A	-	0.0283	0.0335	0.0231	0.0272	0.00009	0.00073
Copper	mg/L	0.0174 - 0.022	A, e	0.3	**0.71**	**0.88**	**0.58**	**0.72**	0.006	0.015
Iron	mg/L	1	A	-	**3.2**	**5.1**	**3**	**4**	0.11	0.43
Manganese	mg/L	2.3 - 2.9	A, f	-	7.42	10.1	6.04	8.3	0.009	0.035
Molybdenum	mg/L	2	A	-	0.5	0.55	0.41	0.45	0.008	0.011
Selenium	mg/L	-	-	-	0.324	0.341	0.26	0.28	0.0005	0.0022
Silver	mg/L	0.003 - 0.003	A, g	-	0.00004	0.000078	0.00003	0.00004	0.00001	0.000039
Vanadium	mg/L	-	-	-	0.0021	0.0064	0.002	0.0	0.0007	0.0013
Zinc	mg/L	0.09 - 0.13	A, h	0.5	0.096	0.122	0.079	0.10	0.0017	0.0032
Dissolved Metals										
Aluminum	mg/L	0.1	A, i	-	0.091	0.17	0.1	0.4	0.04	0.41
Antimony	mg/L	-	-	-	0.0009	0.0009	0.0007	0.0008	0.00005	0.00011
Arsenic	mg/L	-	-	-	0.0011	0.0013	0.001	0.001	0.00029	0.00048
Boron	mg/L	-	-	-	0.15	0.15	0.1	0.1	0.039	0.06
Cadmium	mg/L	0.001 - 0.0013	A, j	-	0.00054	0.0006	0.00044	0.0005	0.000014	0.00006
Chromium	mg/L	-	-	-	0.00037	0.00057	0.0003	0.0012	0.00026	0.0012
Cobalt	mg/L	-	-	-	0.0202	0.0241	0.0165	0.0196	0.00005	0.00033
Copper	mg/L	-	-	-	0.497	0.616	0.4	0.5	0.006	0.017
Iron	mg/L	0.35	A	-	**0.45**	**0.72**	**0.4**	**0.6**	0.048	**0.38**
Manganese	mg/L	-	-	-	6.89	9.17	5.6	7.5	0.0046	0.019
Molybdenum	mg/L	-	-	-	0.49	0.54	0.4	0.44	0.008	0.011
Selenium	mg/L	-	-	-	0.321	0.336	0.26	0.27	0.0005	0.0021
Silver	mg/L	-	-	-	0.000020	0.000025	0.00002	0.00003	0.0000079	0.000031
Vanadium	mg/L	-	-	-	0.0016	0.0017	0.001	0.002	0.0006	0.00101
Zinc	mg/L	-	-	-	0.0673	0.085	0.055	0.069	0.0015	0.0028

Notes:

A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage

a) BC Water Quality Guidelines (BC WQG) for the protection of freshwater aquatic life.

b) Metal Mining Effluent Regulations (MMER) Schedule 4, maximum authorized monthly mean concentration

c) pH and temperature dependent ammonia guideline: values selected from Table 3 in BC WQG based on maximum temperature and observed pH values in Springer Pit

d) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6

e) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000

f) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54

g) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness ≤100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness ≤100 mg/L, at hardness > 100 mg/L = 0.0015

h) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000

i) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH ≥6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH^2))

j) hardness dependent dissolved Cd guideline: max BC WQG (mg/L) = (exp(1.03*ln(hardness)-5.274))/1000

k) July 1, 2015 to July 1, 2016

l) July 1, 2016 to July 1, 2021

m) July 1, 2069 to July 1, 2070

123	Indicates concentration exceeding the BC maximum WQ Guideline
123	Indicates concentration exceeded MMER guideline

Parameter	Units	BC Water Quality Guidelines[a]		Metal Mining Effluent Regulations[b]	NW Sump					
					Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]	
		Maximum	notes		Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value
Physical Parameters										
Hardness	mg/L (as $CaCO_3$)	-	-	-	1774	1796	1550	1570	164	213
Total Dissolved Solids	mg/L	-	-	-	2780	2846	2413	2471	134	247
Major Ions										
Calcium	mg/L	-	-	-	546	554	477	484	53	68
Chloride	mg/L	600	A	-	22	26	18.9	22.5	0.55	1.08
Magnesium	mg/L	-	-	-	100	100	87	88	7.5	10
Sulphate	mg/L	-	-	-	1690	1713	1461	1481	37	78
Nutrients										
Ammonia	mg/L (as N)	1.26 - 1.26	A, c	-	0.38	0.4	0.328	0.38	0.0042	0.017
Nitrate	mg/L (as N)	32.8	A	-	**51.6**	**53**	**44.5**	**46**	0.23	1.7
Nitrite	mg/L (as N)	0.06 - 0.06	A, d	-	**2.543**	**2.93**	**2.189**	**2.52**	0.0018	0.0091
Total Phosphorus	mg/L	-	-	-	0.028	0.074	0.026	0.033	0.013	0.025
Total Metals										
Aluminum	mg/L	-	-	-	3.3	3.35	2.86	2.94	0.1	0.6
Antimony	mg/L	-	-	-	0.0009	0.0009	0.00077	0.0008	0.00006	0.00011
Arsenic	mg/L	0.005	A	0.5	0.0012	0.0018	0.0011	0.0013	0.00032	0.00054
Boron	mg/L	1.2	A	-	0.15	0.16	0.14	0.14	0.04	0.057
Cadmium	mg/L	no total WQG, see dissolved WQG	-	-	0.00061	0.00068	0.000526	0.00059	0.000013	0.000052
Chromium	mg/L	-	-	-	0.00037	0.0024	0.00036	0.0021	0.00029	0.0021
Cobalt	mg/L	0.11	A	-	0.02834	0.03348	0.02443	0.02882	0.00009	0.00073
Copper	mg/L	0.0174 - 0.022	A, e	0.3	**0.71**	**0.88**	**0.611**	**0.76**	0.006	0.015
Iron	mg/L	1	A	-	**3.2**	**5.1**	**2.77**	**4.4**	0.11	0.43
Manganese	mg/L	2.3 - 2.9	A, f	-	7.42	10.15	6.39	8.73	0.009	0.035
Molybdenum	mg/L	2	A	-	0.5	0.55	0.43	0.48	0.008	0.011
Selenium	mg/L	-	-	-	0.324	0.341	0.279	0.293	0.0005	0.0022
Silver	mg/L	0.003 - 0.003	A, g	-	0.00004	0.000078	0.000036	0.000045	0.00001	0.000039
Vanadium	mg/L	-	-	-	0.0021	0.0064	0.0019	0.002	0.0007	0.0013
Zinc	mg/L	0.09 - 0.13	A, h	0.5	0.0963	0.1223	0.0832	0.1055	0.0017	0.0032
Dissolved Metals										
Aluminum	mg/L	0.1	A, i	-	0.0905	0.157	0.084	0.41	0.04	0.41
Antimony	mg/L	-	-	-	0.0009	0.0009	0.00076	0.0008	0.000054	0.00011
Arsenic	mg/L	-	-	-	0.0011	0.0013	0.001	0.0012	0.00029	0.00048
Boron	mg/L	-	-	-	0.15	0.15	0.13	0.14	0.039	0.057
Cadmium	mg/L	0.001 - 0.0013	A, j	-	0.00054	0.0006	0.000467	0.00052	0.000014	0.00006
Chromium	mg/L	-	-	-	0.00037	0.0005	0.00035	0.0012	0.00026	0.0012
Cobalt	mg/L	-	-	-	0.02023	0.02414	0.01742	0.02077	0.00005	0.00033
Copper	mg/L	-	-	-	0.497	0.616	0.428	0.531	0.006	0.017
Iron	mg/L	0.35	A	-	**0.448**	**0.72**	**0.403**	**0.63**	0.048	**0.38**
Manganese	mg/L	-	-	-	6.89	9.17	5.93	7.89	0.0046	0.019
Molybdenum	mg/L	-	-	-	0.49	0.54	0.42	0.47	0.008	0.011
Selenium	mg/L	-	-	-	0.321	0.336	0.276	0.289	0.0005	0.0021
Silver	mg/L	-	-	-	0.000020	0.000025	0.0000188	0.000031	0.0000079	0.000031
Vanadium	mg/L	-	-	-	0.0016	0.0017	0.0015	0.0016	0.0006	0.001
Zinc	mg/L	-	-	-	0.0673	0.0851	0.0581	0.0735	0.0015	0.0028

Notes:

A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage

a) BC Water Quality Guidelines (BC WQG) for the protection of freshwater aquatic life.

b) Metal Mining Effluent Regulations (MMER) Schedule 4, maximum authorized monthly mean concentration

c) pH and temperature dependent ammonia guideline: values selected from Table 3 in BC WQG based on maximum temperature and observed pH values in Springer Pit

d) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6

e) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000

f) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54

g) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness ≤100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness ≤100 mg/L, at hardness > 100 mg/L = 0.0015

h) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000

i) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH ≥6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH^2))

j) hardness dependent dissolved Cd guideline: max BC WQG (mg/L) = (exp(1.03*ln(hardness)-5.274))/1000

k) July 1, 2015 to July 1, 2016

l) July 1, 2016 to July 1, 2021

m) July 1, 2069 to July 1, 2070

123	Indicates concentration exceeding the BC maximum WQ Guideline
123	Indicates concentration exceeded MMER guideline

Parameter	Units	BC Water Quality Guidelines[a]		Metal Mining Effluent Regulations[b]	Mine Drainage Creek Sump					
					Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]	
		Maximum	notes		Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value
Physical Parameters										
Hardness	mg/L (as $CaCO_3$)	-	-	-	810	823	1222	1379	205	252
Total Dissolved Solids	mg/L	-	-	-	1151	1184	1740	2008	199	307
Major Ions										
Calcium	mg/L	-	-	-	252	257	405	452	66	80
Chloride	mg/L	600	A	-	11.2	17.9	17.7	22.9	1.0	1.5
Magnesium	mg/L	-	-	-	44	44	51	61	10	13
Sulphate	mg/L	-	-	-	627	639	730	898	75	114
Nutrients										
Ammonia	mg/L (as N)	1.26 - 1.26	A, c	-	0.05	0.5	0.173	0.321	0.007	0.019
Nitrate	mg/L (as N)	32.8	A	-	21.0	21	21.0	21.4	1.5	2.9
Nitrite	mg/L (as N)	0.06 - 0.06	A, d	-	0.039	0.25	0.318	0.367	0.004	0.011
Total Phosphorus	mg/L	-	-	-	0.055	0.28	0.821	1.061	0.014	0.025
Total Metals										
Aluminum	mg/L	-	-	-	0.7	5.0	197.61	253.4	0.12	0.6
Antimony	mg/L	-	-	-	0.0005	0.0027	0.00381	0.00479	0.00008	0.00013
Arsenic	mg/L	0.005	A	0.5	0.0015	0.0039	**0.0282**	**0.0325**	0.00034	0.0006
Boron	mg/L	1.2	A	-	0.15	0.2	1.16	1.2	0.04	0.06
Cadmium	mg/L	no total WQG, see dissolved WQG	-	-	0.00006	0.00007	0.001013	0.00135	0.000016	0.000053
Chromium	mg/L	-	-	-	0.0013	0.0058	0.00284	0.0040	0.00029	0.00207
Cobalt	mg/L	0.11	A	-	0.0012	0.0034	0.00464	0.0065	0.00015	0.0008
Copper	mg/L	0.0174 - 0.022	A, e	0.3	**0.032**	**0.101**	**0.297**	**0.498**	0.008	0.016
Iron	mg/L	1	A	-	**1.8**	**6.6**	**14.7**	**19.3**	0.23	0.5
Manganese	mg/L	2.3 - 2.9	A, f	-	0.67	0.86	0.97	1.25	0.05	0.08
Molybdenum	mg/L	2	A	-	0.12	0.12	0.343	0.396	0.015	0.018
Selenium	mg/L	-	-	-	0.125	0.132	0.202	0.279	0.008	0.01
Silver	mg/L	0.003 - 0.003	A, g	-	0.000017	0.00008	0.00066	0.000756	0.00001	0.000038
Vanadium	mg/L	-	-	-	0.004	0.018	0.0835	0.1106	0.00072	0.0013
Zinc	mg/L	0.09 - 0.13	A, h	0.5	0.016	0.04	0.078	0.085	0.0018	0.0033
Dissolved Metals										
Aluminum	mg/L	0.1	A, i	-	0.034	0.31	5.359	6.97	0.039	0.393
Antimony	mg/L	-	-	-	0.0005	0.003	0.00376	0.00484	0.00008	0.00013
Arsenic	mg/L	-	-	-	0.0008	0.0017	0.0256	0.0294	0.00031	0.0005
Boron	mg/L	-	-	-	0.14	0.2	1.11	1.15	0.04	0.06
Cadmium	mg/L	0.001 - 0.0013	A, j	-	0.00006	0.00007	0.000899	0.0012	0.000016	0.000061
Chromium	mg/L	-	-	-	0.00026	0.001	0.00266	0.00321	0.00026	0.00116
Cobalt	mg/L	-	-	-	0.0008	0.0011	0.00331	0.0046	0.0001	0.00036
Copper	mg/L	-	-	-	0.019	0.022	0.194	0.249	0.007	0.017
Iron	mg/L	0.35	A	-	0.28	**0.47**	**1.97**	**2.63**	0.06	**0.38**
Manganese	mg/L	-	-	-	0.61	0.78	0.9	1.14	0.04	0.06
Molybdenum	mg/L	-	-	-	0.12	0.12	0.337	0.387	0.014	0.018
Selenium	mg/L	-	-	-	0.123	0.13	0.201	0.276	0.008	0.01
Silver	mg/L	-	-	-	0.000009	0.000026	0.000328	0.000379	0.000008	0.0000304
Vanadium	mg/L	-	-	-	0.0011	0.002	0.06357	0.0834	0.00062	0.001
Zinc	mg/L	-	-	-	0.006	0.017	0.054	0.057	0.0016	0.0029

Notes:

A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage

a) BC Water Quality Guidelines (BC WQG) for the protection of freshwater aquatic life.

b) Metal Mining Effluent Regulations (MMER) Schedule 4, maximum authorized monthly mean concentration

c) pH and temperature dependent ammonia guideline: values selected from Table 3 in BC WQG based on maximum temperature and observed pH values in Springer Pit

d) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6

e) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000

f) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54

g) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness ≤100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness ≤100 mg/L, at hardness > 100 mg/L = 0.0015

h) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000

i) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH ≥6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH^2))

j) hardness dependent dissolved Cd guideline: max BC WQG (mg/L) = (exp(1.03*ln(hardness)-5.274))/1000

k) July 1, 2015 to July 1, 2016

l) July 1, 2016 to July 1, 2021

m) July 1, 2069 to July 1, 2070

123	Indicates concentration exceeding the BC maximum WQ Guideline
123	Indicates concentration exceeded MMER guideline

Parameter	Units	BC Water Quality Guidelines[a]		Metal Mining Effluent Regulations[b]	Bootjack Creek Sump					
					Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]	
		Maximum	notes		Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value
Physical Parameters										
Hardness	mg/L (as $CaCO_3$)	-	-	-	1093	1097	1092	1096	335	376
Total Dissolved Solids	mg/L	-	-	-	1589	1608	1588	1607	402	494
Major Ions										
Calcium	mg/L	-	-	-	340	341	340	341	106	118
Chloride	mg/L	600	A	-	10	10	10	10	2	3
Magnesium	mg/L	-	-	-	59	60	59	60	17	19
Sulphate	mg/L	-	-	-	878	886	877	885	192	225
Nutrients										
Ammonia	mg/L (as N)	1.26 - 1.26	A, c	-	0.07	0.09	0.074	0.08	0.017	0.03
Nitrate	mg/L (as N)	32.8	A	-	29.8	30.2	29.7	30.2	5.7	6.9
Nitrite	mg/L (as N)	0.06 - 0.06	A, d	-	0.05	**0.24**	0.05	0.07	0.01	0.02
Total Phosphorus	mg/L	-	-	-	0.06	0.17	0.028	0.034	0.016	0.026
Total Metals										
Aluminum	mg/L	-	-	-	1	3	1	1	0	1
Antimony	mg/L	-	-	-	0.0006	0.0007	0.00065	0.0007	0.00017	0.0002
Arsenic	mg/L	0.005	A	0.5	0.0011	0.0016	0.0008	0.0008	0.0004	0.0006
Boron	mg/L	1.2	A	-	0.13	0.15	0.13	0.15	0.06	0.07
Cadmium	mg/L	no total WQG, see dissolved WQG	-	-	0.000082	0.00012	0.000082	0.00009	0.000025	0.00006
Chromium	mg/L	-	-	-	0.00125	0.0032	0.00029	0.0016	0.00029	0.0018
Cobalt	mg/L	0.11	A	-	0.00163	0.0028	0.00163	0.0021	0.00039	0.0009
Copper	mg/L	0.0174 - 0.022	A, e	0.3	**0.099**	**0.2**	0.036	0.038	0.012	0.019
Iron	mg/L	1	A	-	**2.5**	**4.5**	**2.5**	**4.5**	0.6	1.0
Manganese	mg/L	2.3 - 2.9	A, f	-	0.95	1.56	0.94	1.22	0.18	0.24
Molybdenum	mg/L	2	A	-	0.17	0.17	0.17	0.17	0.04	0.04
Selenium	mg/L	-	-	-	0.177	0.188	0.177	0.188	0.033	0.035
Silver	mg/L	0.003 - 0.003	A, g	-	0.000035	0.000061	0.000021	0.000033	0.000012	0.000036
Vanadium	mg/L	-	-	-	0.0035	0.009	0.0013	0.0014	0.0008	0.0013
Zinc	mg/L	0.09 - 0.13	A, h	0.5	0.0528	0.201	0.0057	0.007	0.0024	0.004
Dissolved Metals										
Aluminum	mg/L	0.1	A, i	-	0.07	0.19	0.03	0.3	0.04	0.3
Antimony	mg/L	-	-	-	0.0006	0.0006	0.00064	0.0006	0.00016	0.0002
Arsenic	mg/L	-	-	-	0.0008	0.0014	0.0008	0.0008	0.0004	0.0005
Boron	mg/L	-	-	-	0.12	0.14	0.12	0.14	0.05	0.07
Cadmium	mg/L	0.001 - 0.0013	A, j	-	0.000073	0.00009	0.000073	0.00008	0.000025	0.00006
Chromium	mg/L	-	-	-	0.00044	0.0011	0.00026	0.0009	0.00026	0.001
Cobalt	mg/L	-	-	-	0.00117	0.0015	0.00117	0.0015	0.00027	0.0005
Copper	mg/L	-	-	-	0.0815	0.134	0.025	0.026	0.0094	0.018
Iron	mg/L	0.35	A	-	**0.35**	**0.6**	**0.35**	**0.6**	0.12	**0.4**
Manganese	mg/L	-	-	-	0.87	1.11	0.87	1.11	0.17	0.21
Molybdenum	mg/L	-	-	-	0.16	0.17	0.16	0.17	0.04	0.04
Selenium	mg/L	-	-	-	0.175	0.185	0.175	0.185	0.033	0.035
Silver	mg/L	-	-	-	0.0000161	0.000029	0.000011	0.000025	0.000008	0.000028
Vanadium	mg/L	-	-	-	0.0015	0.003	0.001	0.001	0.0007	0.001
Zinc	mg/L	-	-	-	0.027	0.0983	0.0039	0.005	0.002	0.003

Notes:

A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage

a) BC Water Quality Guidelines (BC WQG) for the protection of freshwater aquatic life.

b) Metal Mining Effluent Regulations (MMER) Schedule 4, maximum authorized monthly mean concentration

c) pH and temperature dependent ammonia guideline: values selected from Table 3 in BC WQG based on maximum temperature and observed pH values in Springer Pit

d) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6

e) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000

f) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54

g) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness ≤100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness ≤100 mg/L, at hardness > 100 mg/L = 0.0015

h) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000

i) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH ≥6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH^2))

j) hardness dependent dissolved Cd guideline: max BC WQG (mg/L) = (exp(1.03*ln(hardness)-5.274))/1000

k) July 1, 2015 to July 1, 2016

l) July 1, 2016 to July 1, 2021

m) July 1, 2069 to July 1, 2070

123	Indicates concentration exceeding the BC maximum WQ Guideline
123	Indicates concentration exceeded MMER guideline

Parameter	Units	BC Water Quality Guidelines[a]		Metal Mining Effluent Regulations[b]	South Seepage Pond					
					Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]	
		Maximum	notes		Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value
Physical Parameters										
Hardness	mg/L (as $CaCO_3$)	-	-	-	663	835	690	894	500	656
Total Dissolved Solids	mg/L	-	-	-	1129	1370	1190	1476	874	1090
Major Ions										
Calcium	mg/L	-	-	-	211	262	220	281	160	206
Chloride	mg/L	600	A	-	23	27	23	30	18	22
Magnesium	mg/L	-	-	-	33	44	34	47	25	34
Sulphate	mg/L	-	-	-	671	773	710	832	525	617
Nutrients										
Ammonia	mg/L (as N)	1.26 - 1.26	A, c	-	0.08	0.19	0.088	0.22	0.066	0.16
Nitrate	mg/L (as N)	32.8	A	-	6.4	12	5.3	11	2.9	7.6
Nitrite	mg/L (as N)	0.6 - 0.6	A, d	-	0.18	0.43	0.19	0.34	0.14	0.26
Total Phosphorus	mg/L	-	-	-	0.022	0.042	0.025	0.049	0.018	0.036
Total Metals										
Aluminum	mg/L	-	-	-	14	46	17	54	13	41
Antimony	mg/L	-	-	-	0.0011	0.0015	0.00088	0.0017	0.00065	0.0013
Arsenic	mg/L	0.005	A	0.5	0.0019	0.0025	0.0022	0.0029	0.0017	0.0022
Boron	mg/L	1.2	A	-	0.19	0.3	0.21	0.35	0.16	0.26
Cadmium	mg/L	no total WQG, see dissolved WQG	-	-	0.00012	0.00018	0.00011	0.00019	0.000084	0.00014
Chromium	mg/L	-	-	-	0.00087	0.0022	0.0011	0.0026	0.00079	0.002
Cobalt	mg/L	0.11	A	-	0.00097	0.002	0.00099	0.0022	0.00072	0.0016
Copper	mg/L	0.049 - 0.0636	A, e	0.3	0.018	0.039	0.019	0.043	0.014	0.032
Iron	mg/L	1	A	-	**3.6**	**11**	**4.1**	**13**	**3.1**	**9.5**
Manganese	mg/L	6.1 - 7.8	A, f	-	0.63	1.1	0.64	1.2	0.47	0.88
Molybdenum	mg/L	2	A	-	0.21	0.25	0.23	0.28	0.17	0.21
Selenium	mg/L	-	-	-	0.035	0.051	0.03	0.042	0.015	0.029
Silver	mg/L	0.003 - 0.003	A, g	-	0.000023	0.000045	0.000027	0.000053	0.00002	0.000039
Vanadium	mg/L	-	-	-	0.0026	0.0055	0.003	0.0065	0.0022	0.0049
Zinc	mg/L	0.34 - 0.46	A, h	0.5	0.0077	0.019	0.0088	0.022	0.0065	0.017
Dissolved Metals										
Aluminum	mg/L	0.1	A, i	-	0.39	1.2	0.48	1.5	0.36	1.1
Antimony	mg/L	-	-	-	0.0011	0.0015	0.00087	0.0017	0.00065	0.0013
Arsenic	mg/L	-	-	-	0.0018	0.0023	0.0021	0.0027	0.0016	0.0021
Boron	mg/L	-	-	-	0.18	0.29	0.21	0.33	0.15	0.25
Cadmium	mg/L	0.0031 - 0.0041	A, j	-	0.00011	0.00016	0.000099	0.00017	0.000073	0.00013
Chromium	mg/L	-	-	-	0.00084	0.0021	0.001	0.0026	0.00076	0.0019
Cobalt	mg/L	-	-	-	0.00064	0.0014	0.00065	0.0015	0.00047	0.0012
Copper	mg/L	-	-	-	0.013	0.028	0.013	0.031	0.0093	0.023
Iron	mg/L	0.35	A	-	**0.5**	**1.6**	**0.58**	**1.8**	**0.43**	**1.4**
Manganese	mg/L	-	-	-	0.57	0.97	0.59	1.1	0.43	0.79
Molybdenum	mg/L	-	-	-	0.21	0.25	0.23	0.28	0.17	0.21
Selenium	mg/L	-	-	-	0.036	0.05	0.03	0.042	0.016	0.029
Silver	mg/L	-	-	-	0.000013	0.000023	0.000015	0.000028	0.000011	0.00002
Vanadium	mg/L	-	-	-	0.0019	0.0044	0.0022	0.0051	0.0016	0.0039
Zinc	mg/L	-	-	-	0.0054	0.013	0.0062	0.016	0.0045	0.012

Notes:

A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage

a) BC Water Quality Guidelines (BC WQG) for the protection of freshwater aquatic life.

b) Metal Mining Effluent Regulations (MMER) Schedule 4, maximum authorized monthly mean concentration

c) pH and temperature dependent ammonia guideline: values selected from Table 3 in BC WQG based on maximum temperature and observed pH values in Springer Pit

d) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6

e) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000

f) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54

g) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness ≤100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness ≤100 mg/L, at hardness > 100 mg/L = 0.0015

h) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000

i) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH ≥6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH^2))

j) hardness dependent dissolved Cd guideline: max BC WQG (mg/L) = (exp(1.03*ln(hardness)-5.274))/1000

k) July 1, 2015 to July 1, 2016

l) July 1, 2016 to July 1, 2021

m) July 1, 2069 to July 1, 2070

123	Indicates concentration exceeding the BC maximum WQ Guideline
123	Indicates concentration exceeded MMER guideline

Parameter	Units	BC Water Quality Guidelines[a]		Metal Mining Effluent Regulations[b]	Main Embankment Seepage Pond					
					Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]	
		Maximum	notes		Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value
Physical Parameters										
Hardness	mg/L (as $CaCO_3$)	-	-	-	18218	21125	684	785	411	527
Total Dissolved Solids	mg/L	-	-	-	28769	32847	1071	1213	684	847
Major Ions										
Calcium	mg/L	-	-	-	5752	6617	216	246	131	166
Chloride	mg/L	600	A	-	402	489	14	18	13	17
Magnesium	mg/L	-	-	-	936	1117	35	42	20	27
Sulphate	mg/L	-	-	-	16469	18198	610	671	399	468
Nutrients										
Ammonia	mg/L (as N)	1.26 - 1.26	A, c	-	**1.8**	**3.6**	0.066	0.13	0.051	0.12
Nitrate	mg/L (as N)	32.8	A	-	**278**	**366**	11	14	2.3	5.8
Nitrite	mg/L (as N)	0.6 - 0.6	A, d	-	**3.0**	**5.3**	0.11	0.21	0.11	0.2
Total Phosphorus	mg/L	-	-	-	0.62	0.96	0.023	0.036	0.016	0.03
Total Metals										
Aluminum	mg/L	-	-	-	242	772	10	33	9.5	31
Antimony	mg/L	-	-	-	0.017	0.029	0.00063	0.0011	0.0005	0.00098
Arsenic	mg/L	0.005	A	0.5	**0.039**	**0.049**	0.0014	0.0019	0.0013	0.0017
Boron	mg/L	1.2	A	-	**4.1**	**6.0**	0.15	0.22	0.13	0.2
Cadmium	mg/L	no total WQG, see dissolved WQG	-	-	0.0023	0.0033	0.000083	0.00012	0.000066	0.00011
Chromium	mg/L	-	-	-	0.019	0.043	0.00072	0.0017	0.0007	0.0017
Cobalt	mg/L	0.11	A	-	0.026	0.044	0.00099	0.0016	0.00057	0.0013
Copper	mg/L	0.049 - 0.0636	A, e	0.3	0.56	0.9	0.021	0.033	0.012	0.026
Iron	mg/L	1	A	-	**79**	**197**	**2.8**	**7.6**	**2.3**	**7.1**
Manganese	mg/L	6.1 - 7.8	A, f	-	16	23	0.59	0.86	0.36	0.66
Molybdenum	mg/L	2	A	-	**4.5**	**5.2**	0.16	0.19	0.13	0.16
Selenium	mg/L	-	-	-	1.6	1.9	0.063	0.072	0.011	0.021
Silver	mg/L	0.003 - 0.003	A, g	-	0.00058	0.00098	0.000022	0.000036	0.000018	0.000034
Vanadium	mg/L	-	-	-	0.054	0.1	0.002	0.0041	0.0018	0.0038
Zinc	mg/L	0.34 - 0.46	A, h	0.5	0.17	0.36	0.0063	0.014	0.0053	0.013
Dissolved Metals										
Aluminum	mg/L	0.1	A, i	-	7.2	21	0.3	0.89	0.29	0.85
Antimony	mg/L	-	-	-	0.017	0.029	0.00062	0.0011	0.00049	0.00098
Arsenic	mg/L	-	-	-	0.036	0.046	0.0013	0.0017	0.0012	0.0016
Boron	mg/L	-	-	-	4.0	5.7	0.15	0.21	0.13	0.19
Cadmium	mg/L	0.0031 - 0.0041	A, j	-	0.002	0.003	0.000074	0.00011	0.000059	0.0001
Chromium	mg/L	-	-	-	0.018	0.04	0.00068	0.0016	0.00066	0.0016
Cobalt	mg/L	-	-	-	0.018	0.031	0.00068	0.0011	0.00038	0.00089
Copper	mg/L	-	-	-	0.4	0.66	0.015	0.024	0.0088	0.019
Iron	mg/L	0.35	A	-	**11**	**29**	**0.41**	**1.1**	**0.35**	**1.0**
Manganese	mg/L	-	-	-	15	21	0.55	0.78	0.32	0.59
Molybdenum	mg/L	-	-	-	4.4	5.1	0.16	0.18	0.13	0.16
Selenium	mg/L	-	-	-	1.6	1.9	0.063	0.071	0.012	0.022
Silver	mg/L	-	-	-	0.00033	0.00054	0.000012	0.00002	0.000011	0.00002
Vanadium	mg/L	-	-	-	0.041	0.082	0.0015	0.0032	0.0014	0.003
Zinc	mg/L	-	-	-	0.12	0.25	0.0045	0.0097	0.0038	0.009

Notes:

A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage

a) BC Water Quality Guidelines (BC WQG) for the protection of freshwater aquatic life.

b) Metal Mining Effluent Regulations (MMER) Schedule 4, maximum authorized monthly mean concentration

c) pH and temperature dependent ammonia guideline: values selected from Table 3 in BC WQG based on maximum temperature and observed pH values in Springer Pit

d) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6

e) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000

f) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54

g) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness ≤100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness ≤100 mg/L, at hardness > 100 mg/L = 0.0015

h) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000

i) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH ≥6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH^2))

j) hardness dependent dissolved Cd guideline: max BC WQG (mg/L) = (exp(1.03*ln(hardness)-5.274))/1000

k) July 1, 2015 to July 1, 2016

l) July 1, 2016 to July 1, 2021

m) July 1, 2069 to July 1, 2070

123	Indicates concentration exceeding the BC maximum WQ Guideline
123	Indicates concentration exceeded MMER guideline

Parameter	Units	BC Water Quality Guidelines[a]		Metal Mining Effluent Regulations[b]	Perimeter Pond/Till Borrow					
					Restricted Operations[k]		Short-Term Post-Closure[l]		Long-Term Post-Closure[m]	
		Maximum	notes		Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value	Maximum Median Predicted Value	Maximum 95th Predicted Value
Physical Parameters										
Hardness	mg/L (as $CaCO_3$)	-	-	-	19770	23750	872	1004	775	813
Total Dissolved Solids	mg/L	-	-	-	32765	38141	1368	1562	1175	1243
Major Ions										
Calcium	mg/L	-	-	-	6290	7492	276	322	241	253
Chloride	mg/L	600	A	-	546	**677**	22	27	12	14
Magnesium	mg/L	-	-	-	987	1225	45	49	42	44
Sulphate	mg/L	-	-	-	19297	21956	799	919	695	720
Nutrients										
Ammonia	mg/L (as N)	1.26 - 1.26	A, c	-	**3.4**	**7.8**	0.2	0.35	0.15	0.17
Nitrate	mg/L (as N)	32.8	A	-	**178**	**295**	16	17	19	20
Nitrite	mg/L (as N)	0.6 - 0.6	A, d	-	**4.9**	**8.0**	**0.5**	**0.57**	**0.91**	**1.0**
Total Phosphorus	mg/L	-	-	-	0.75	1.3	0.28	0.36	0.019	0.026
Total Metals										
Aluminum	mg/L	-	-	-	350	1131	65	84	6.2	19
Antimony	mg/L	-	-	-	0.029	0.046	0.0018	0.0022	0.00047	0.00071
Arsenic	mg/L	0.005	A	0.5	**0.058**	**0.074**	**0.01**	**0.012**	0.001	0.0013
Boron	mg/L	1.2	A	-	**5.9**	**8.6**	0.47	0.54	0.11	0.15
Cadmium	mg/L	no total WQG, see dissolved WQG	-	-	0.0025	0.004	0.00043	0.00054	0.00023	0.00026
Chromium	mg/L	-	-	-	0.029	0.062	0.0014	0.0023	0.00056	0.0017
Cobalt	mg/L	0.11	A	-	0.024	0.047	0.0057	0.0067	0.01	0.012
Copper	mg/L	0.049 - 0.0636	A, e	0.3	0.52	1.0	**0.18**	**0.33**	**0.25**	**0.31**
Iron	mg/L	1	A	-	**87**	**264**	**5.8**	**8**	**1.9**	**4.7**
Manganese	mg/L	6.1 - 7.8	A, f	-	15	26	1.5	2.0	2.7	3.6
Molybdenum	mg/L	2	A	-	**5.8**	**6.8**	0.24	0.27	0.21	0.23
Selenium	mg/L	-	-	-	0.85	1.2	0.11	0.14	0.12	0.12
Silver	mg/L	0.003 - 0.003	A, g	-	0.00063	0.0011	0.00023	0.00026	0.000022	0.000036
Vanadium	mg/L	-	-	-	0.074	0.14	0.029	0.038	0.0015	0.0027
Zinc	mg/L	0.34 - 0.46	A, h	0.5	0.25	0.52	0.037	0.042	0.035	0.045
Dissolved Metals										
Aluminum	mg/L	0.1	A, i	-	10	30	1.8	2.3	0.2	0.57
Antimony	mg/L	-	-	-	0.028	0.045	0.0018	0.0023	0.00046	0.0007
Arsenic	mg/L	-	-	-	0.051	0.063	0.009	0.011	0.00094	0.0012
Boron	mg/L	-	-	-	5.9	8.4	0.45	0.52	0.1	0.14
Cadmium	mg/L	0.0031 - 0.0041	A, j	-	0.0022	0.0036	0.00038	0.00048	0.00021	0.00024
Chromium	mg/L	-	-	-	0.023	0.054	0.0012	0.0017	0.00053	0.0012
Cobalt	mg/L	-	-	-	0.015	0.034	0.0041	0.0049	0.0072	0.0086
Copper	mg/L	-	-	-	0.32	0.68	0.12	0.14	0.18	0.22
Iron	mg/L	0.35	A	-	**13**	**39**	**0.8**	**1.1**	0.3	**0.72**
Manganese	mg/L	-	-	-	13	23	1.4	1.9	2.5	3.3
Molybdenum	mg/L	-	-	-	5.7	6.7	0.23	0.26	0.2	0.22
Selenium	mg/L	-	-	-	0.84	1.2	0.11	0.14	0.11	0.12
Silver	mg/L	-	-	-	0.00036	0.0006	0.00011	0.00013	0.000013	0.000025
Vanadium	mg/L	-	-	-	0.051	0.11	0.022	0.028	0.0012	0.0021
Zinc	mg/L	-	-	-	0.17	0.36	0.026	0.028	0.025	0.031

Notes:

A = approved guideline, W = working guideline, Min = Minimum concentration requirement based on life stage

a) BC Water Quality Guidelines (BC WQG) for the protection of freshwater aquatic life.

b) Metal Mining Effluent Regulations (MMER) Schedule 4, maximum authorized monthly mean concentration

c) pH and temperature dependent ammonia guideline: values selected from Table 3 in BC WQG based on maximum temperature and observed pH values in Springer Pit

d) chloride dependent nitrite guideline: BC Max WQG (mg/L) = 0.06 at Cl <2 mg/L, at Cl 2-4 mg/L = 0.12, at Cl 4-6 mg/L = 0.18, at Cl 6-8 mg/L = 0.24, at Cl 8-10 = 0.30, at Cl >10 = 0.6

e) hardness dependent Cu guideline: BC Max WQG (mg/L) = (0.094(hardness)+2)/1000

f) hardness dependent Mn guideline: BC Max WQG (mg/L) = 0.01102*(hardness)+0.54

g) hardness dependent Ag guideline: BC Max WQG (mg/L) = 0.0001 at hardness ≤100 mg/L, at hardness >100 mg/L = 0.003; BC 30-d WQG (mg/L) = 0.00005 at hardness ≤100 mg/L, at hardness > 100 mg/L = 0.0015

h) hardness dependent Zn guideline: BC Max WQG (mg/L) = (33+0.75(hardness-90))/1000

i) pH dependent dissolved Al guideline: BC Max WQG (mg/L) = 0.1 at pH ≥6.5, at pH <6.5 = EXP(1.209-2.426*(pH)+0.286*(pH^2))

j) hardness dependent dissolved Cd guideline: max BC WQG (mg/L) = (exp(1.03*ln(hardness)-5.274))/1000

k) July 1, 2015 to July 1, 2016

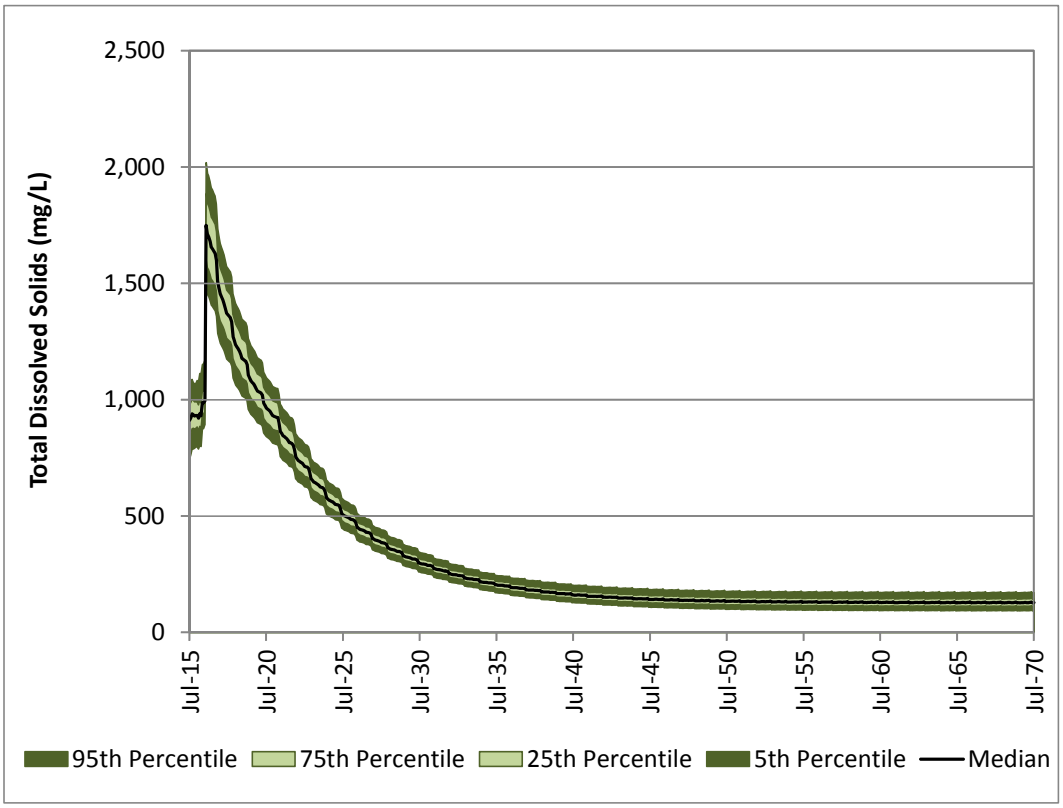
l) July 1, 2016 to July 1, 2021

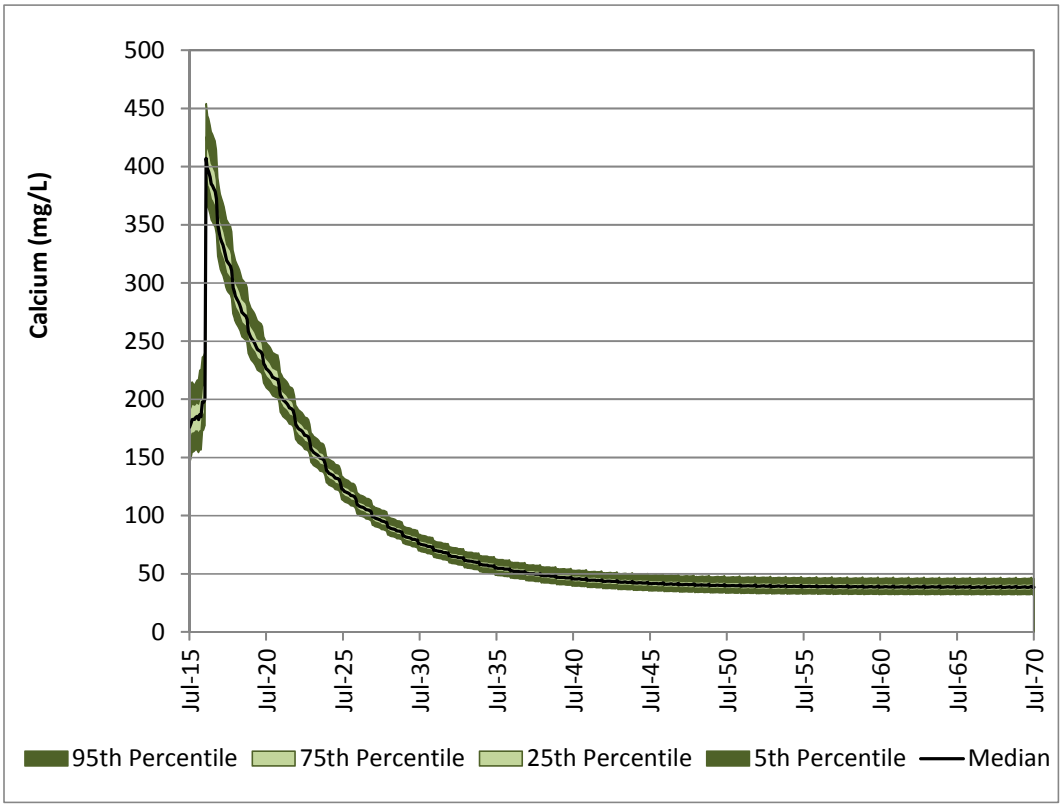
m) July 1, 2069 to July 1, 2070

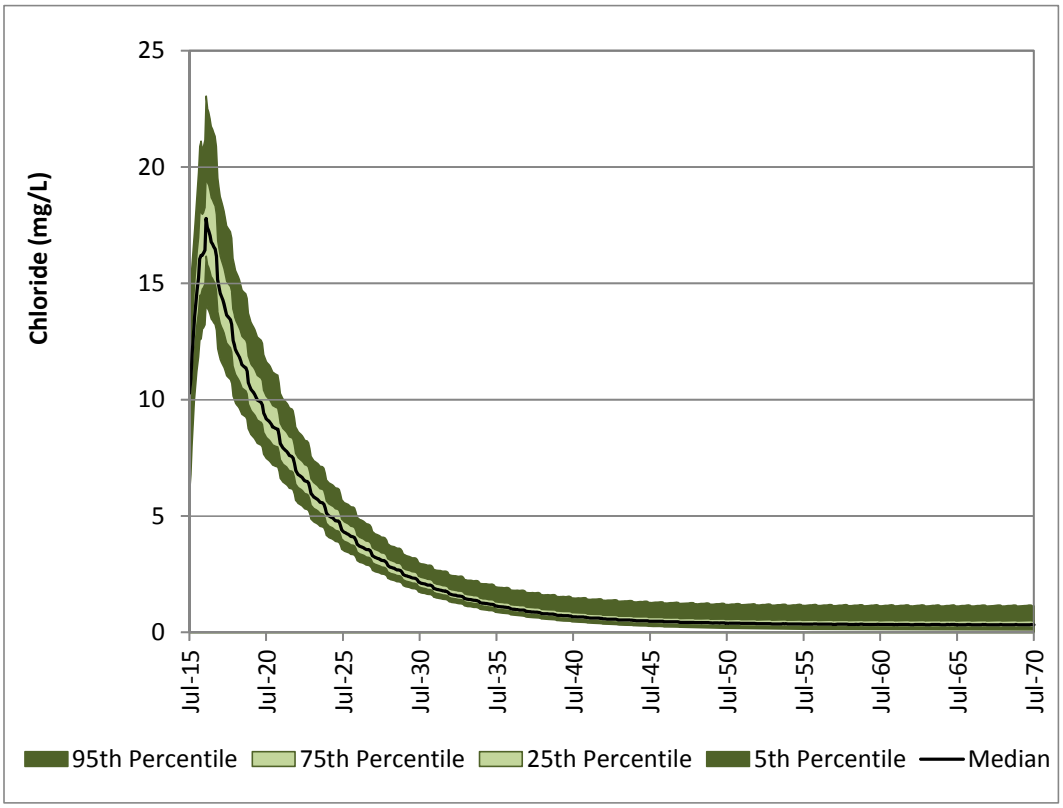
123	Indicates concentration exceeding the BC maximum WQ Guideline
123	Indicates concentration exceeded MMER guideline

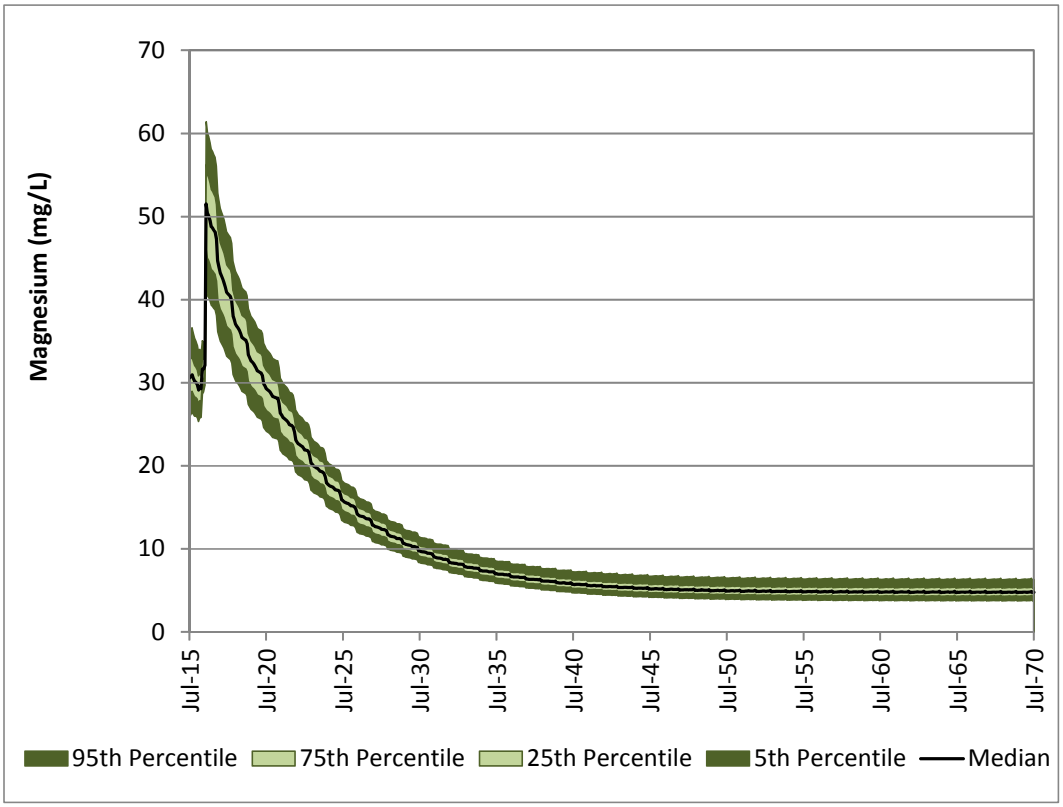
ATTACHMENT 3
Time Series Results

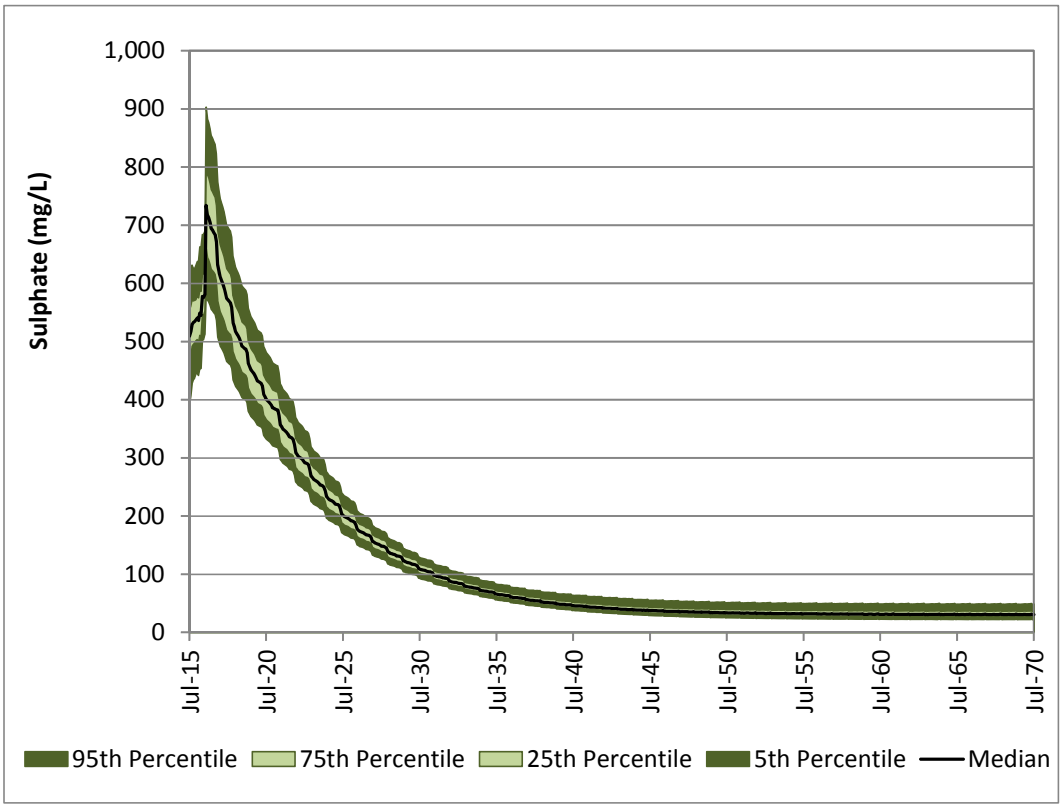
ATTACHMENT 3.1
Time Series Results for Springer Pit

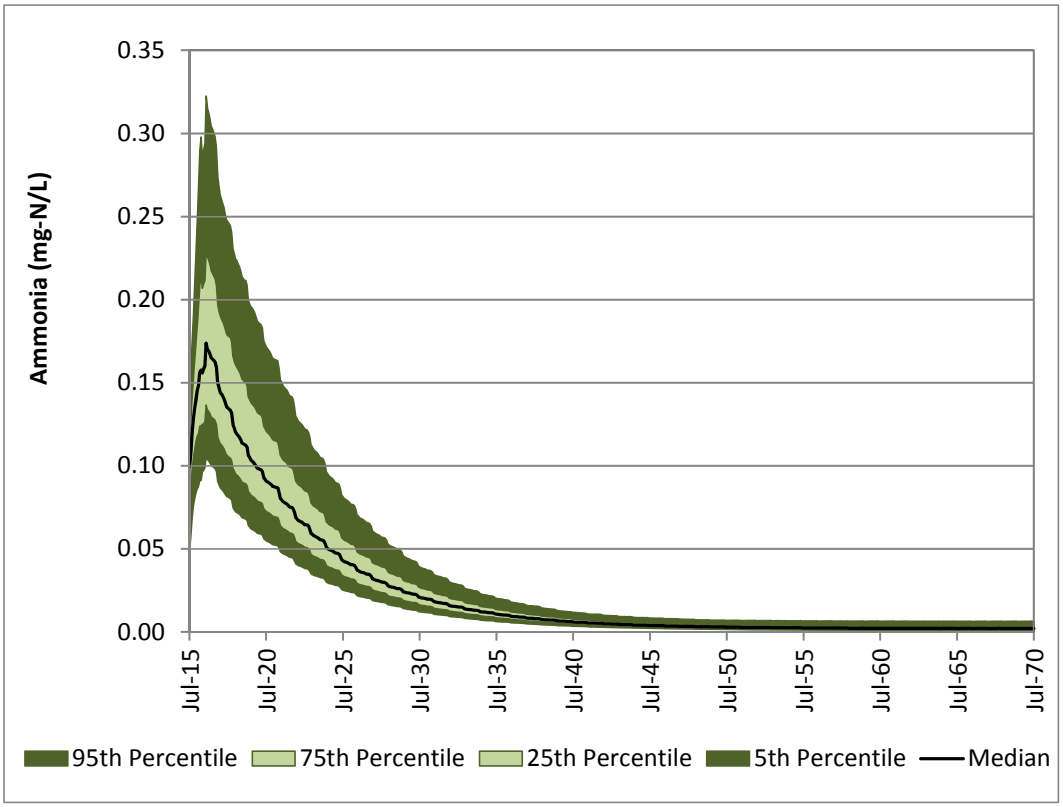

Total Dissolved Solids (mg/L)
2,500
2,000
1,500
1,000
500
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

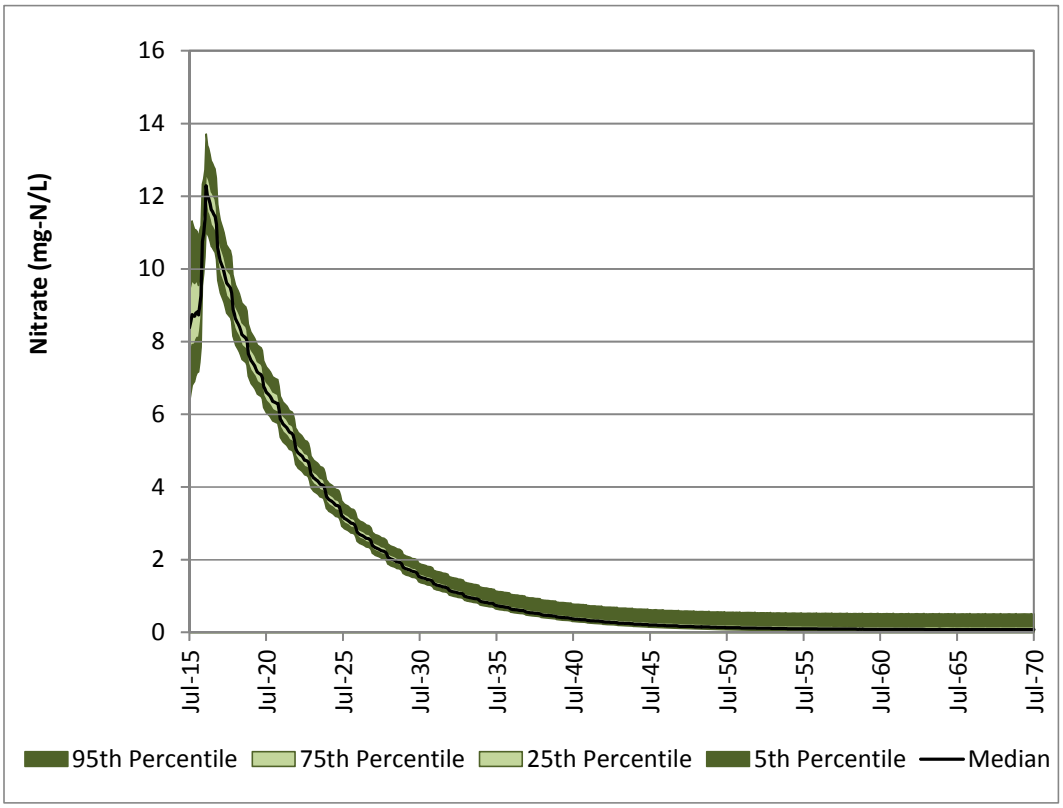

Calcium (mg/L)
500
450
400
350
300
250
200
150
100
50
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

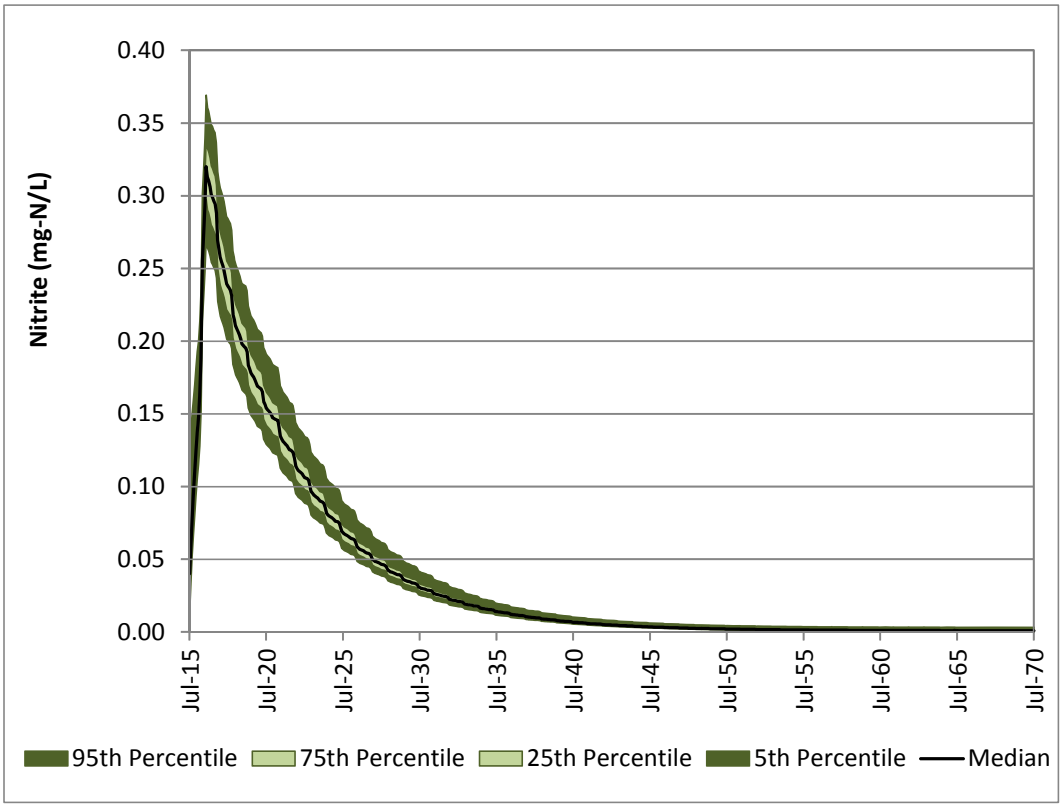

Chloride (mg/L)
25
20
15
10
5
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

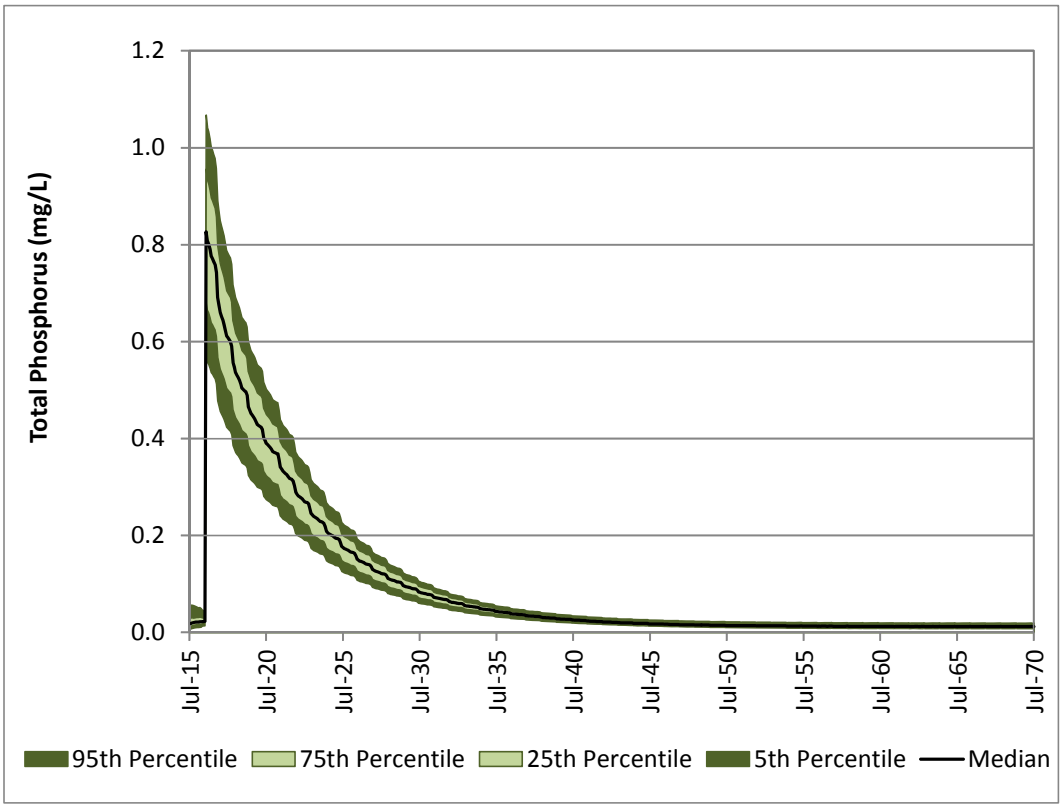

Magnesium (mg/L)
70
60
50
40
30
20
10
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

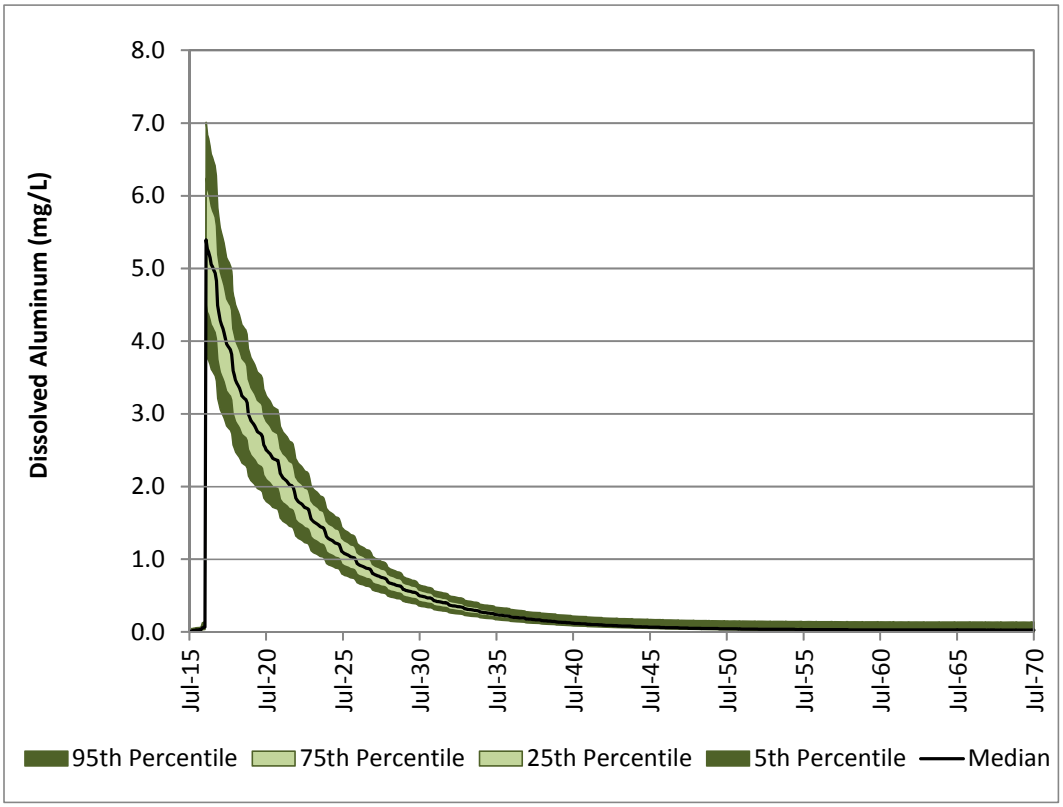

Sulphate (mg/L)
1,000
900
800
700
600
500
400
300
200
100
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

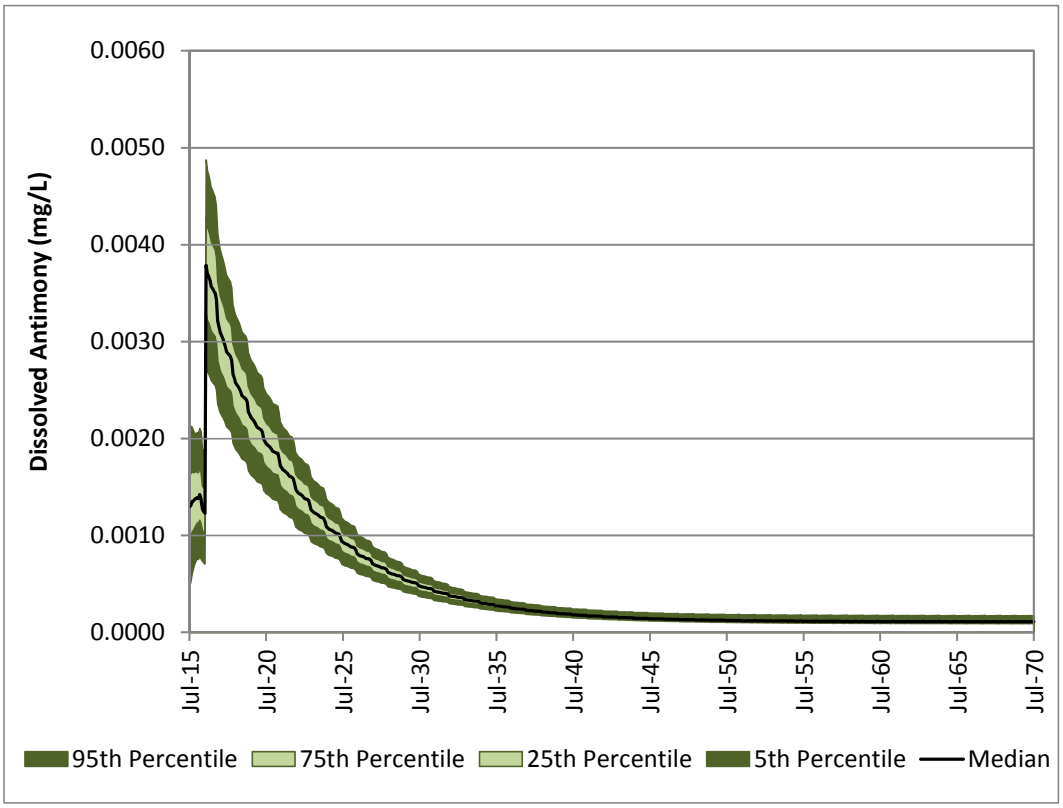

Ammonia (mg-N/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

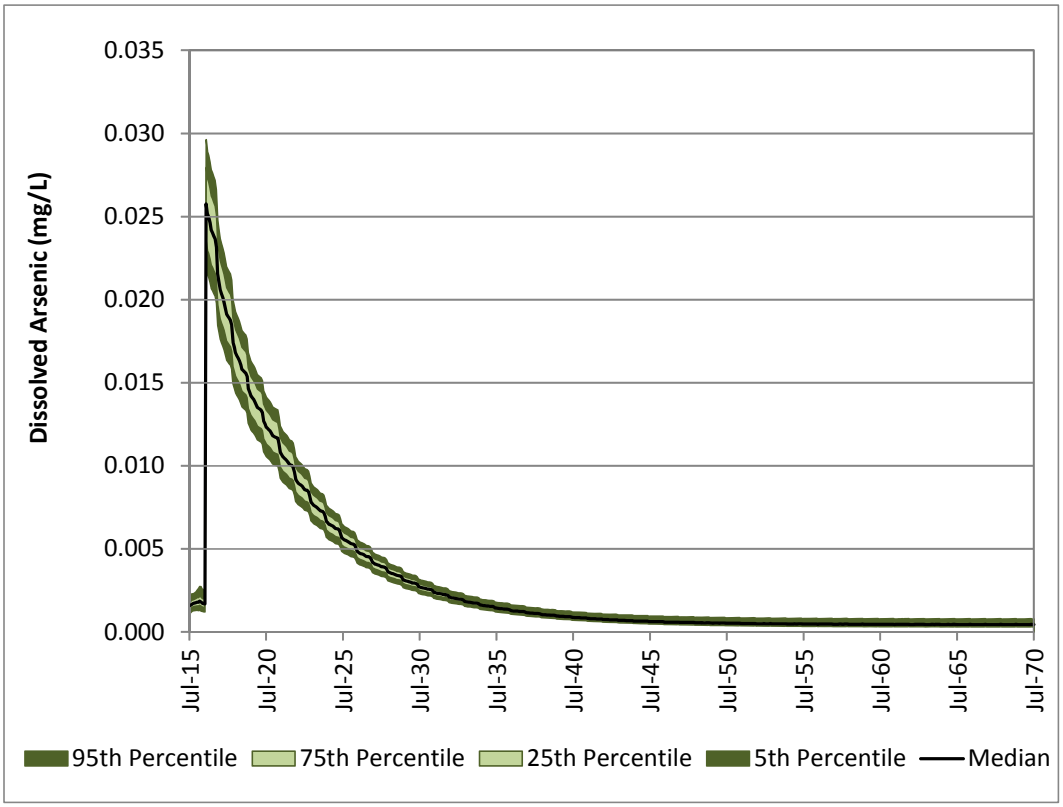

Nitrate (mg-N/L)
16
14
12
10
8
6
4
2
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

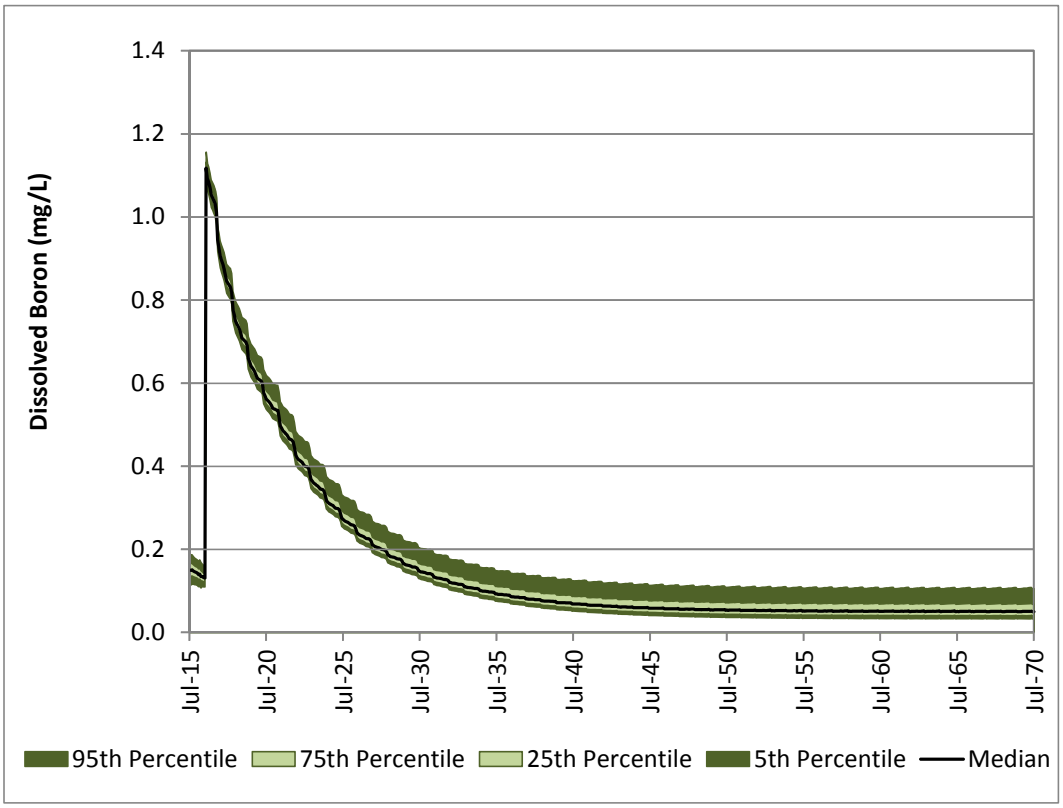

Nitrite (mg-N/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

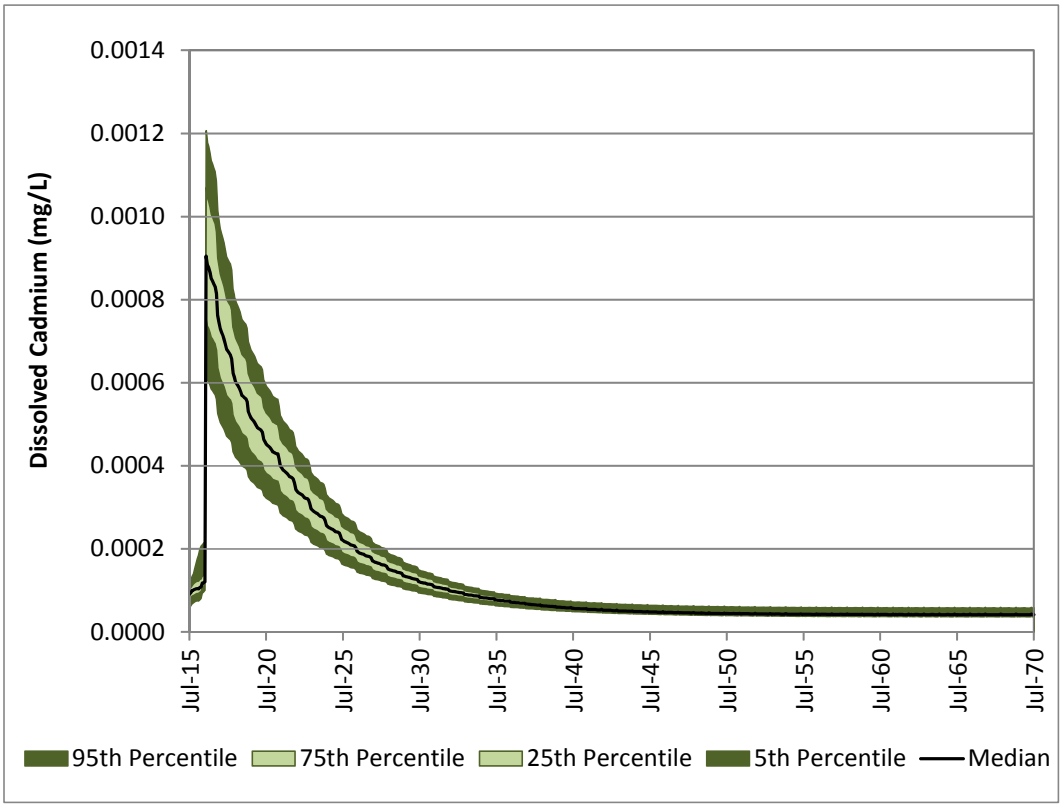

Total Phosphorus (mg/L)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

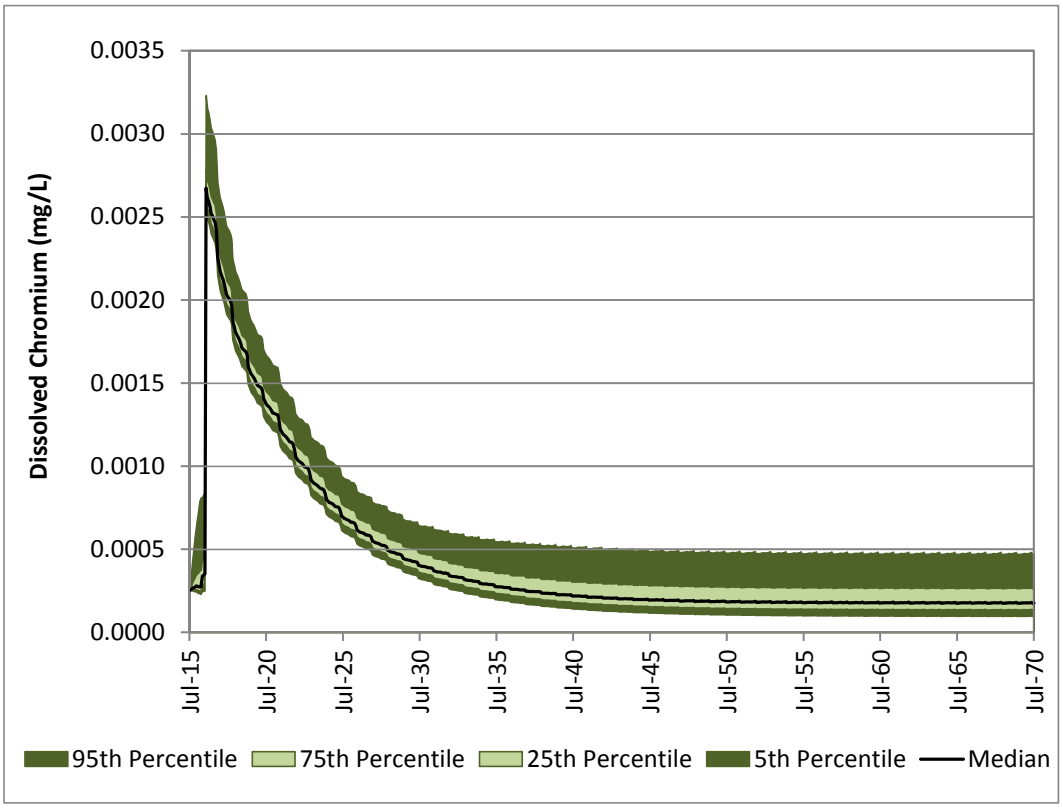

Dissolved Aluminum (mg/L)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

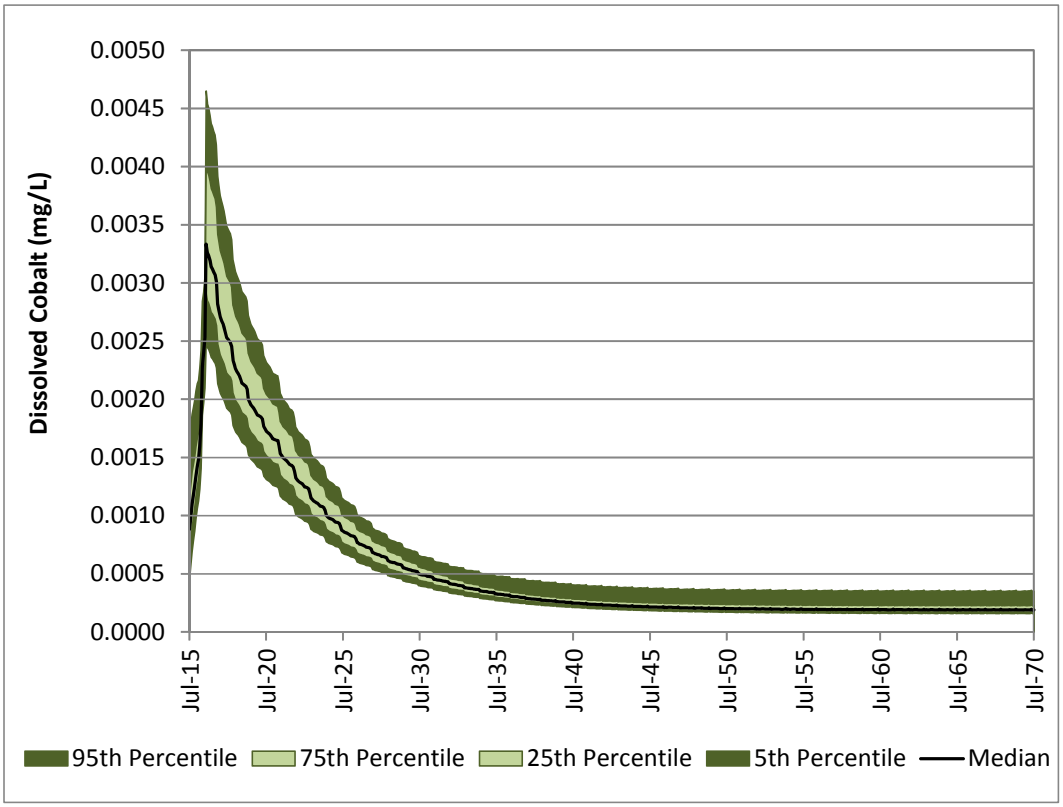

Dissolved Antimony (mg/L)
0.0060
0.0050
0.0040
0.0030
0.0020
0.0010
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

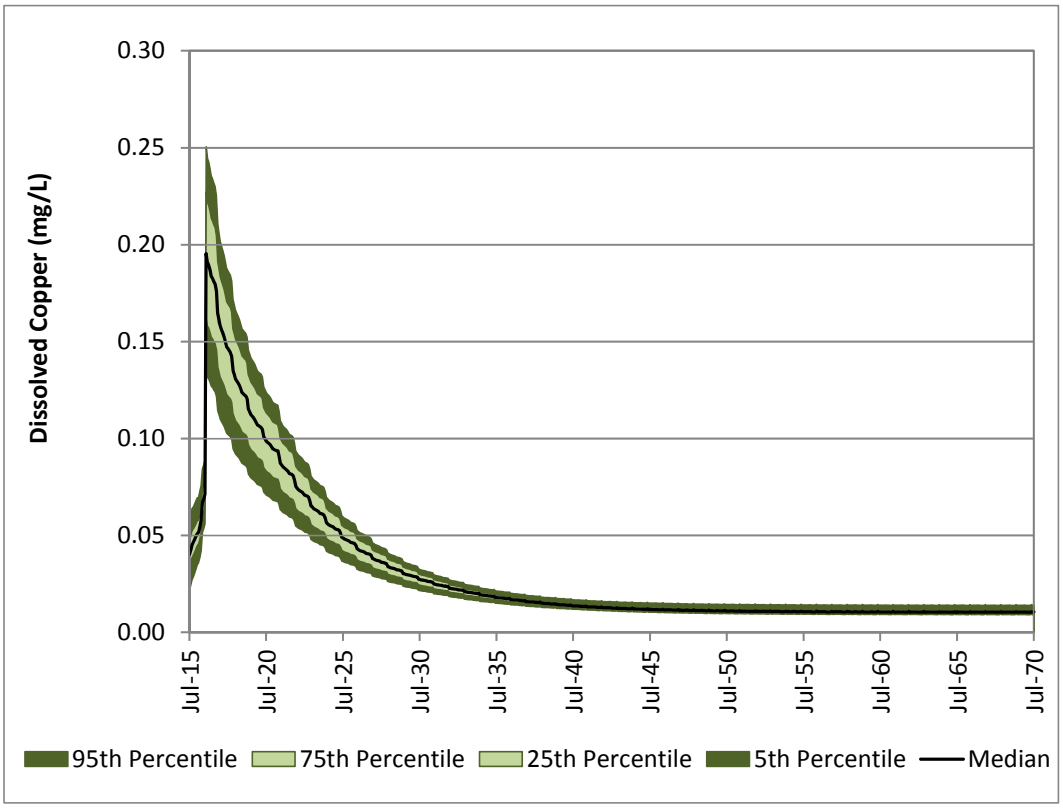

Dissolved Arsenic (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

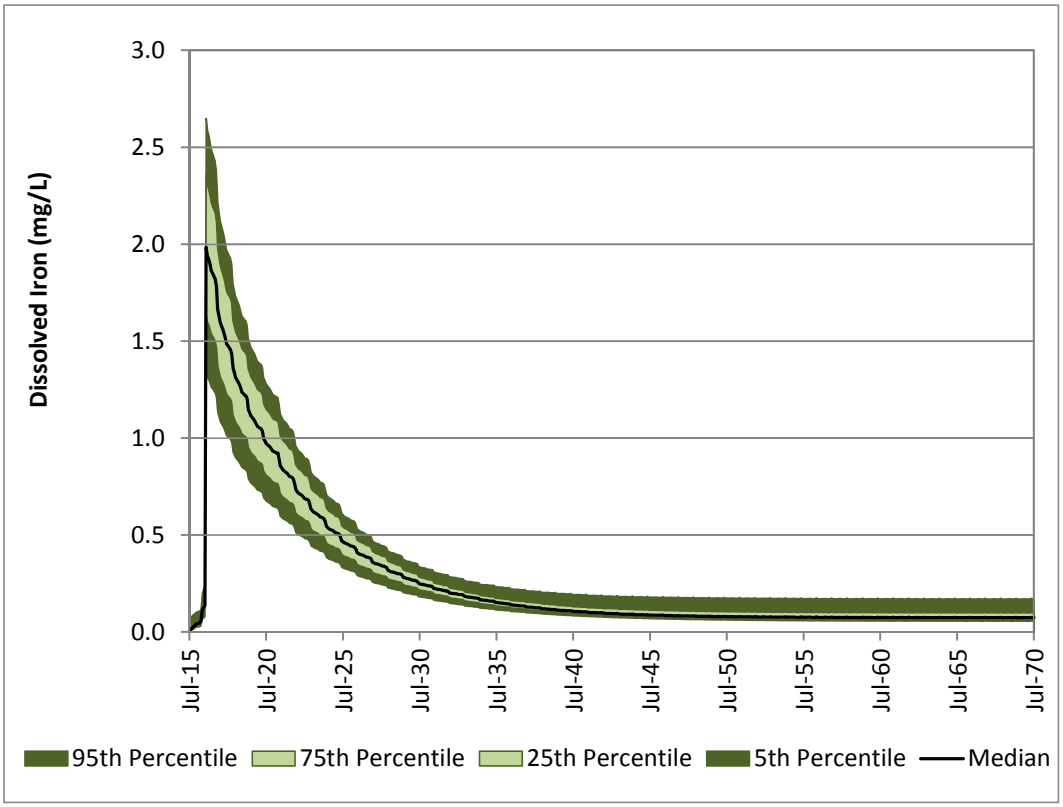

Dissolved Boron (mg/L)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

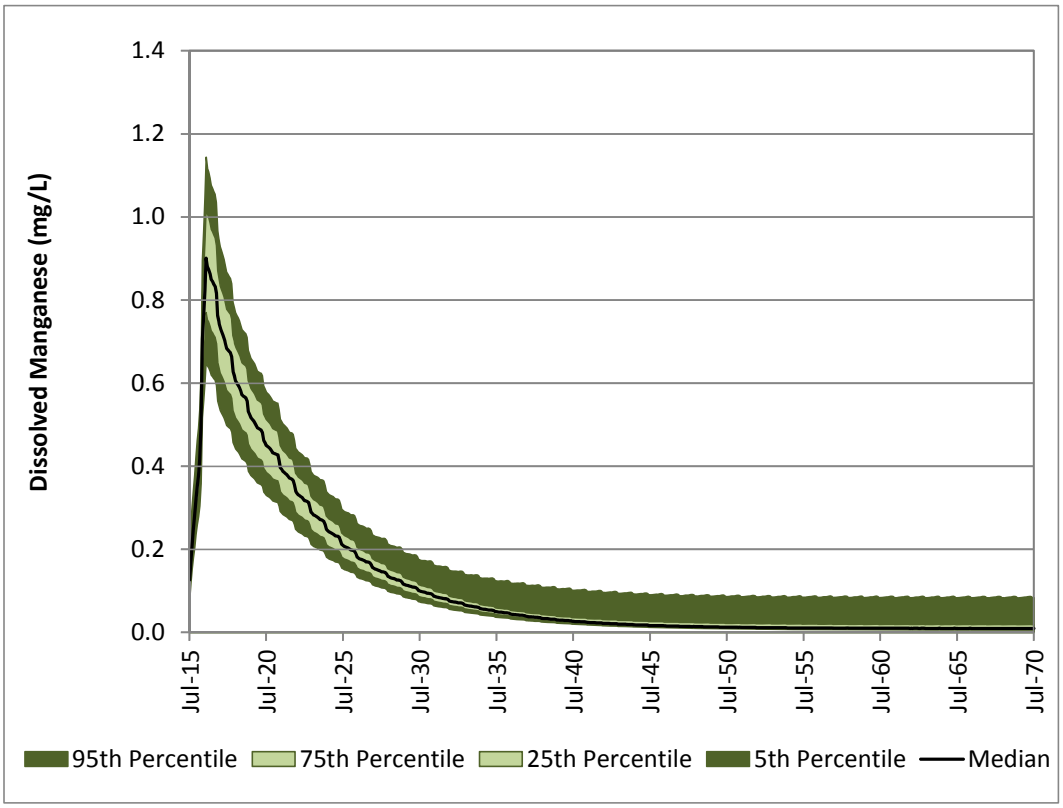

Dissolved Cadmium (mg/L)
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

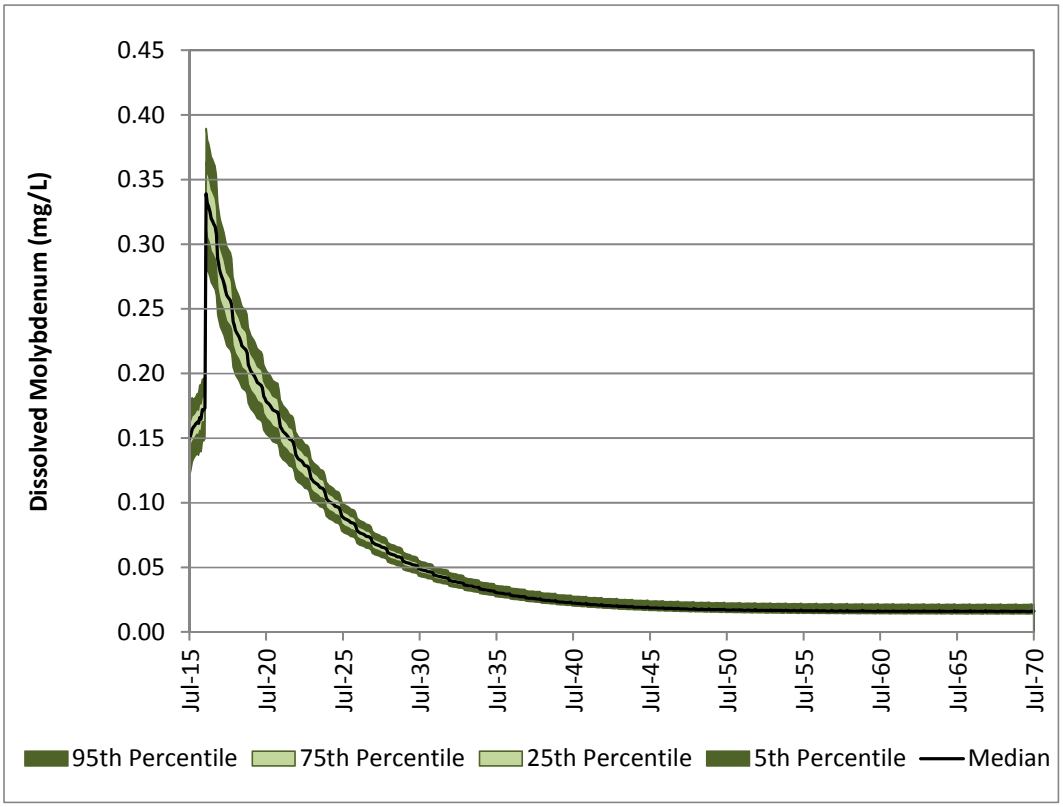

Dissolved Chromium (mg/L)
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

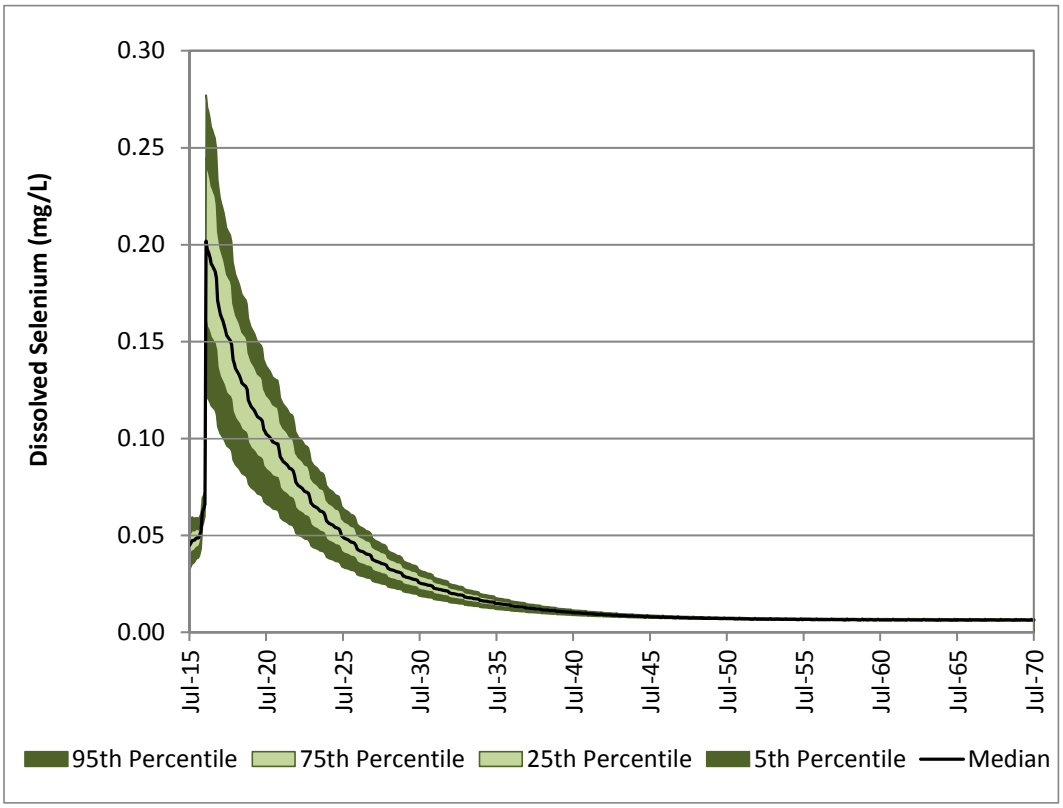

Dissolved Cobalt (mg/L)
0.0050
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

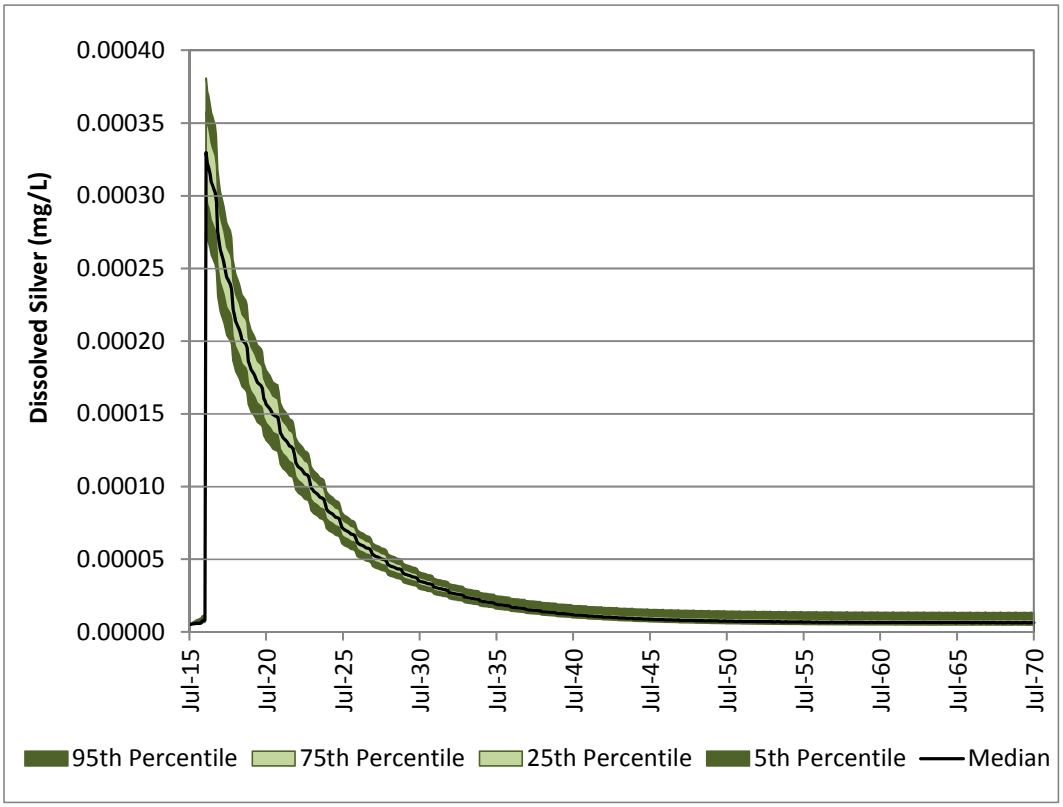

Dissolved Copper (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

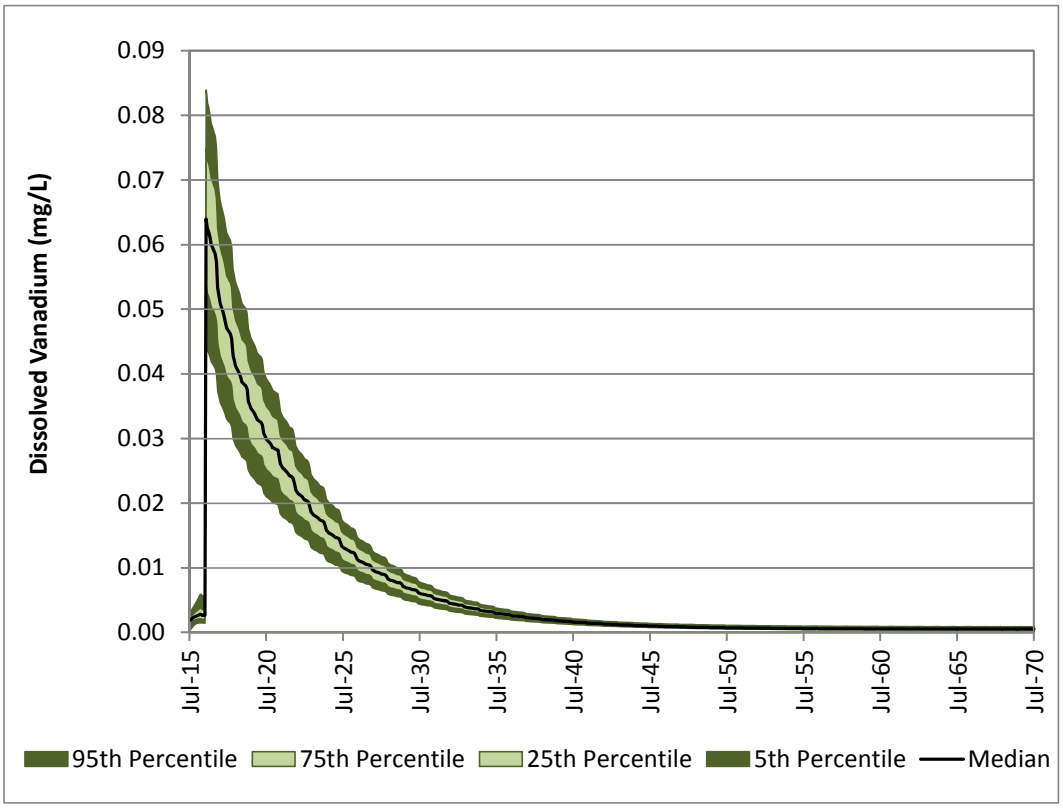

Dissolved Iron (mg/L)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

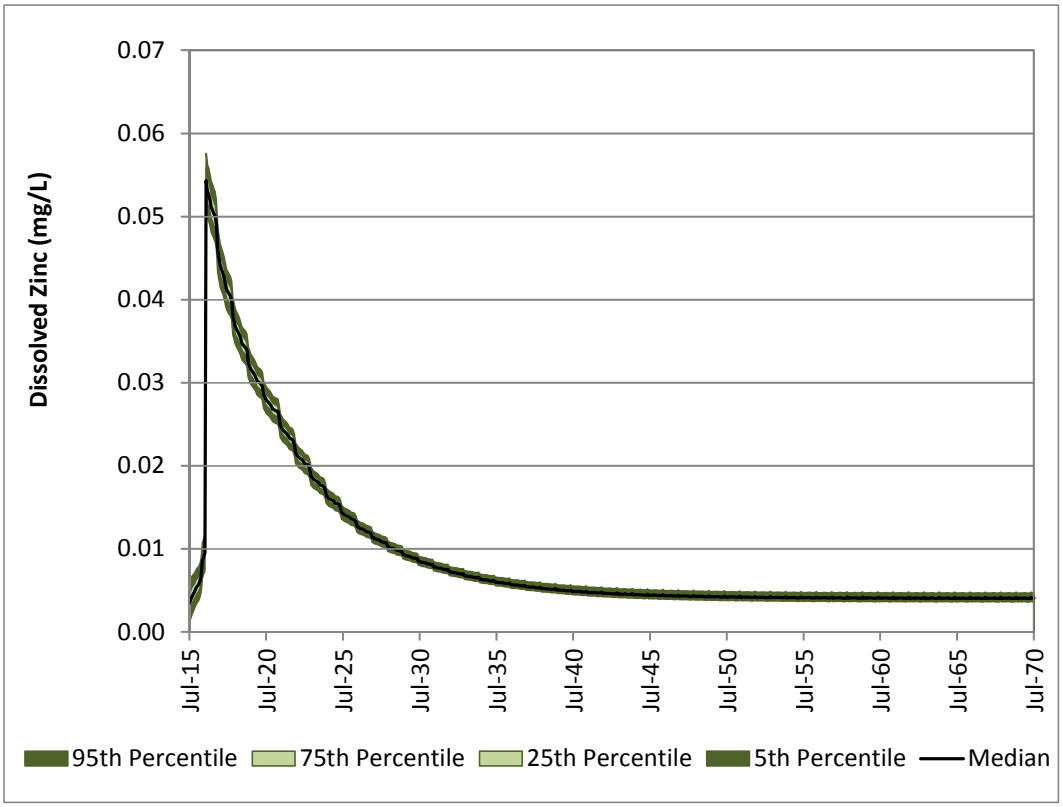

Dissolved Manganese (mg/L)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

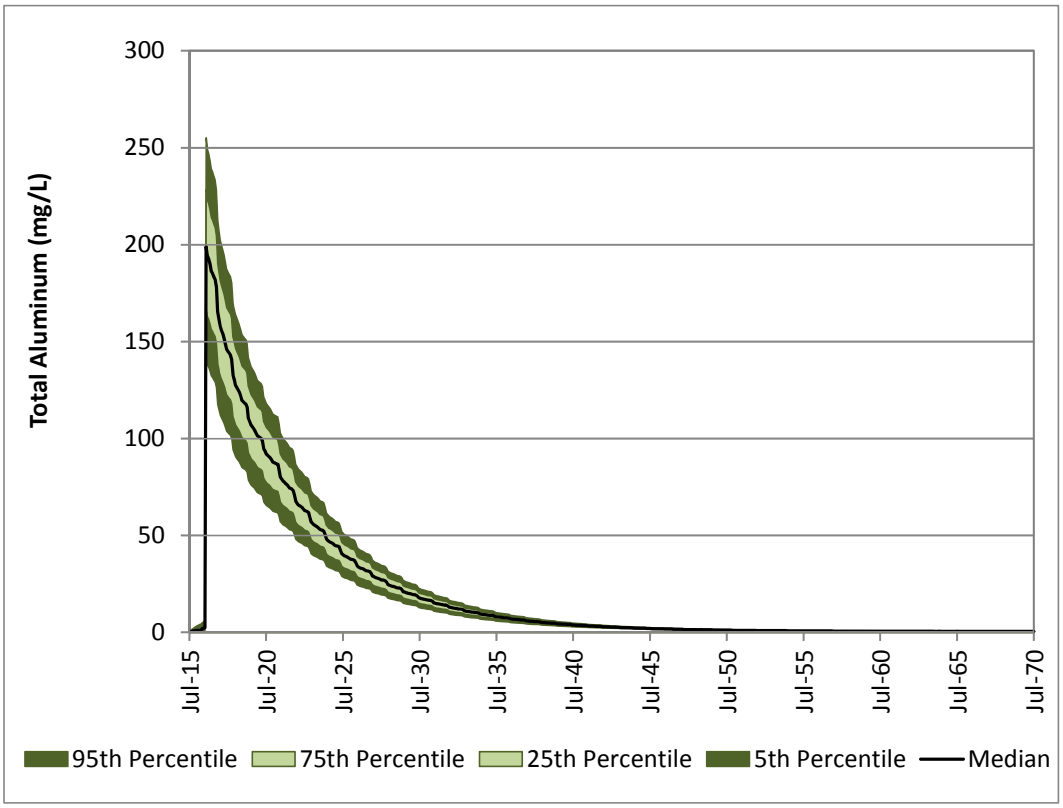

Dissolved Molybdenum (mg/L)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

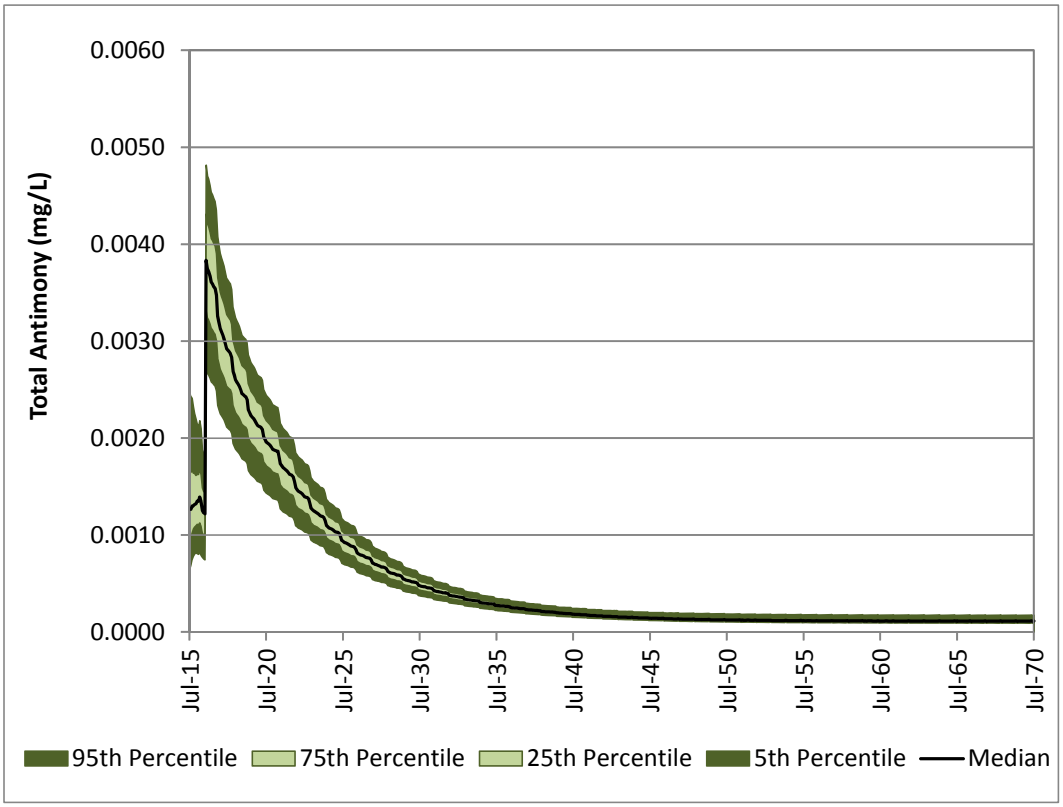

Dissolved Selenium (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

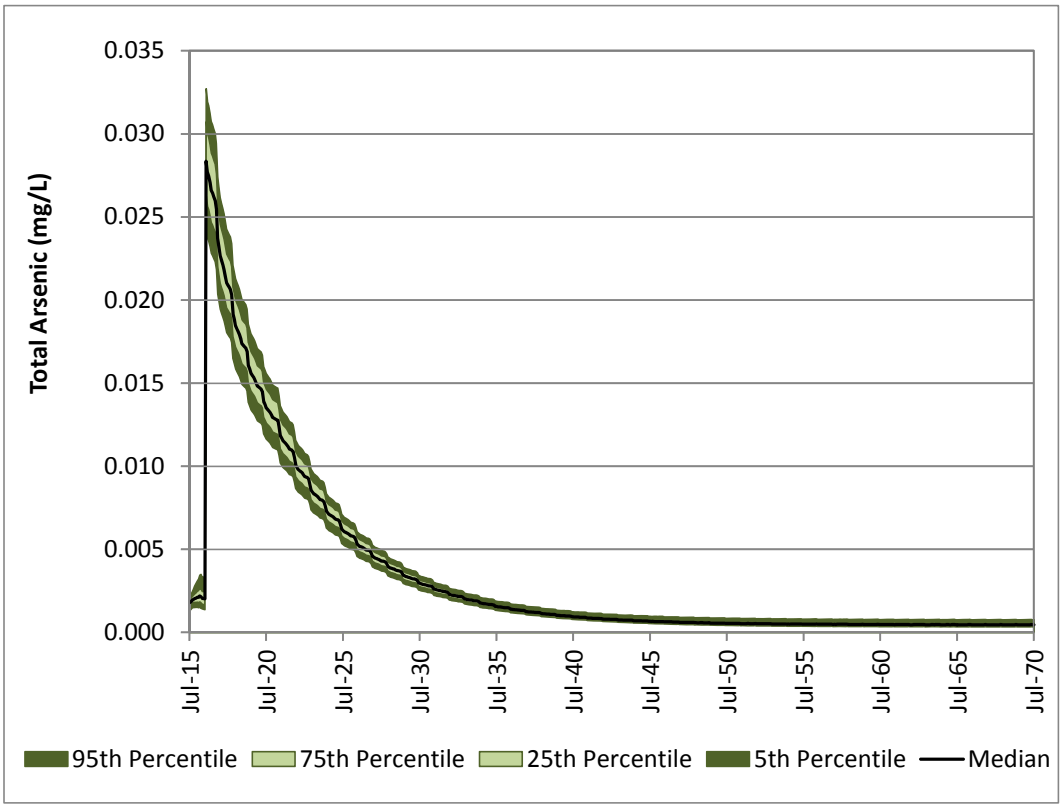

Dissolved Silver (mg/L)
0.00040
0.00035
0.00030
0.00025
0.00020
0.00015
0.00010
0.00005
0.00000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

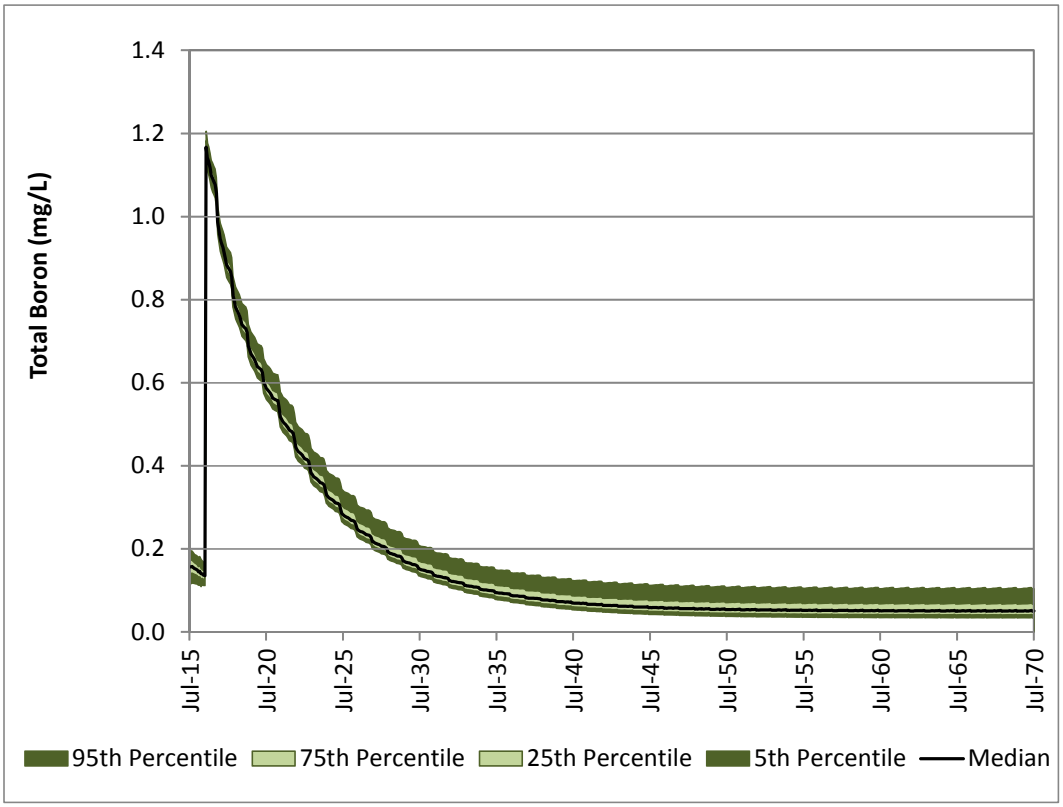

Dissolved Vanadium (mg/L)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

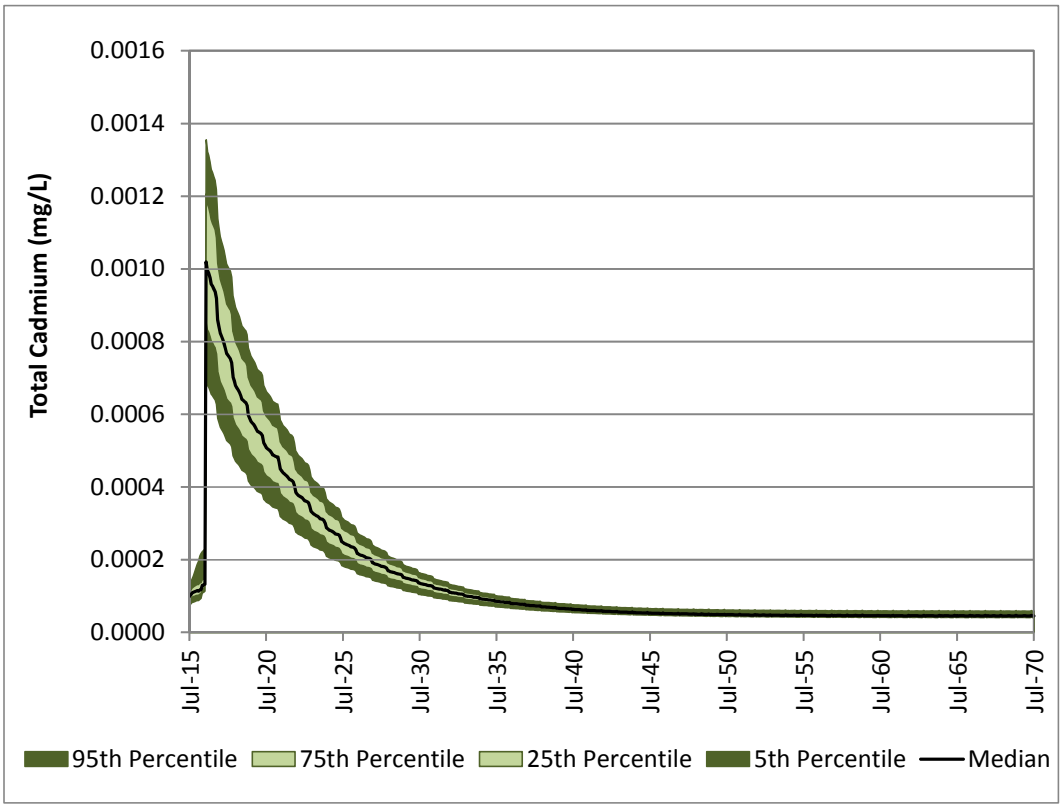

Dissolved Zinc (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

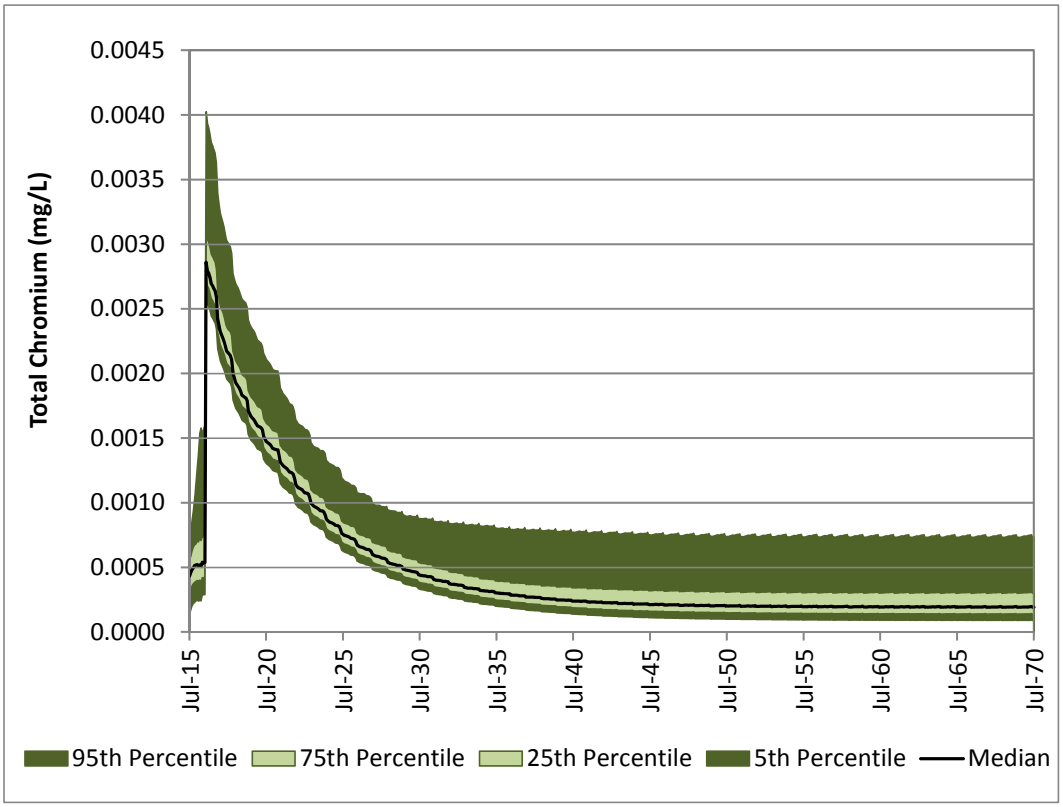

Total Aluminum (mg/L)
300
250
200
150
100
50
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

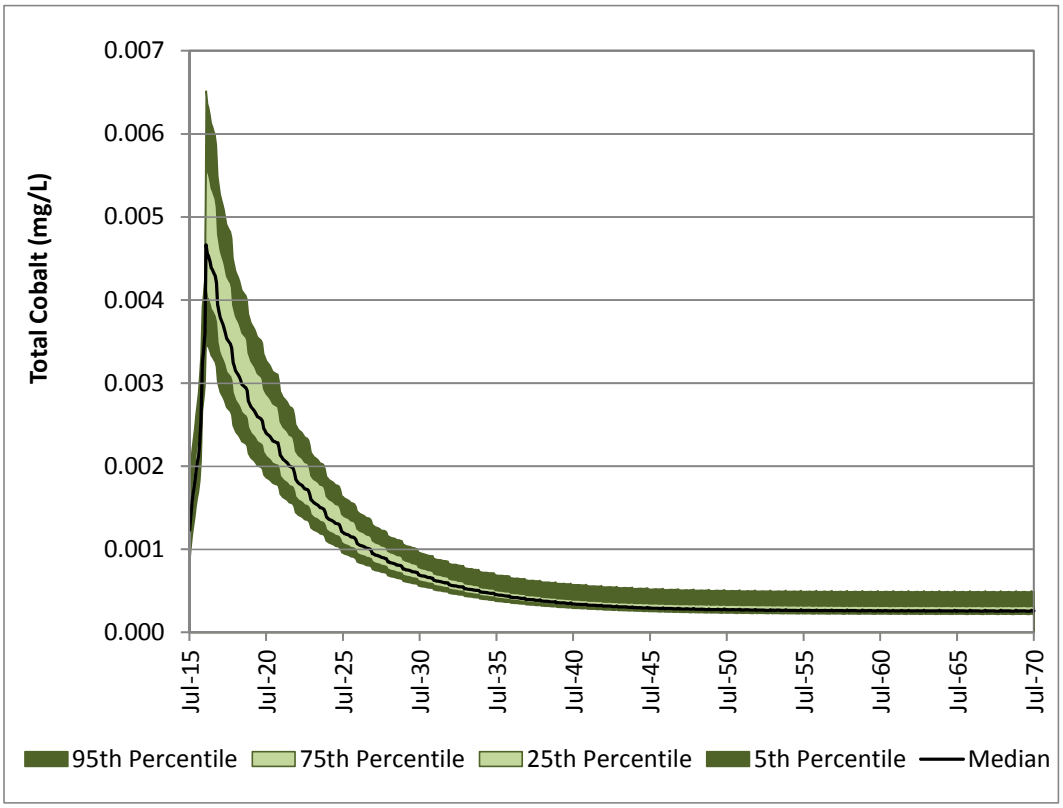

Total Antimony (mg/L)
0.0060
0.0050
0.0040
0.0030
0.0020
0.0010
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

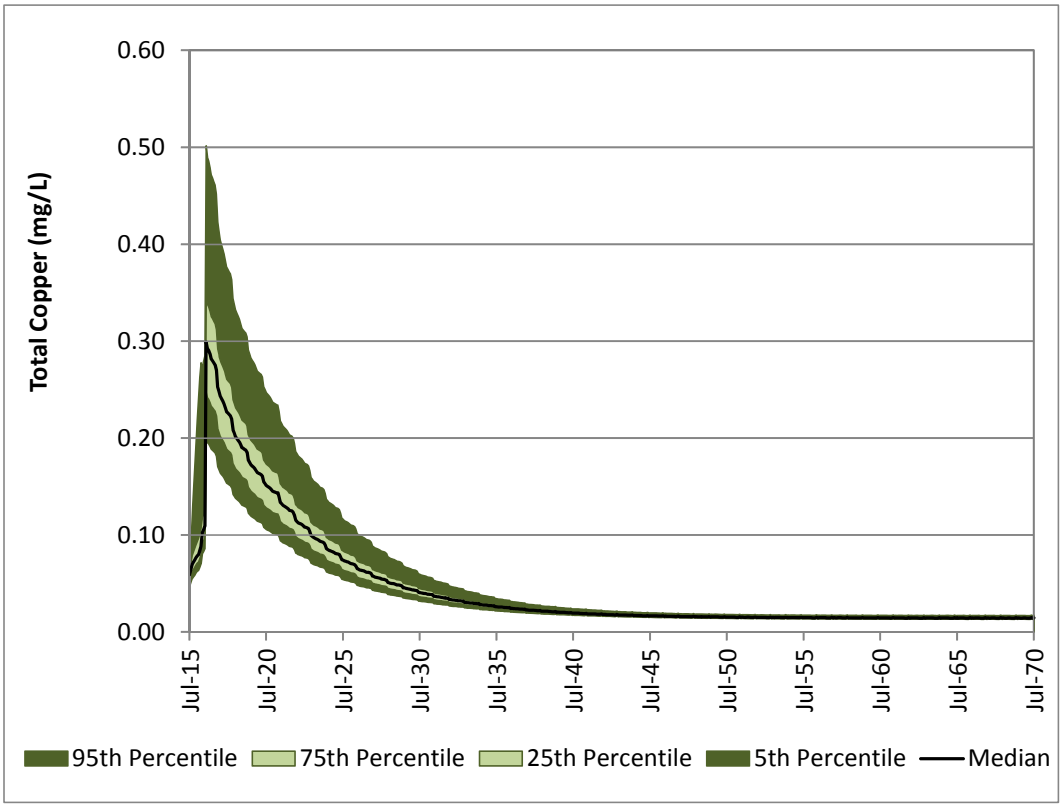

Total Arsenic (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

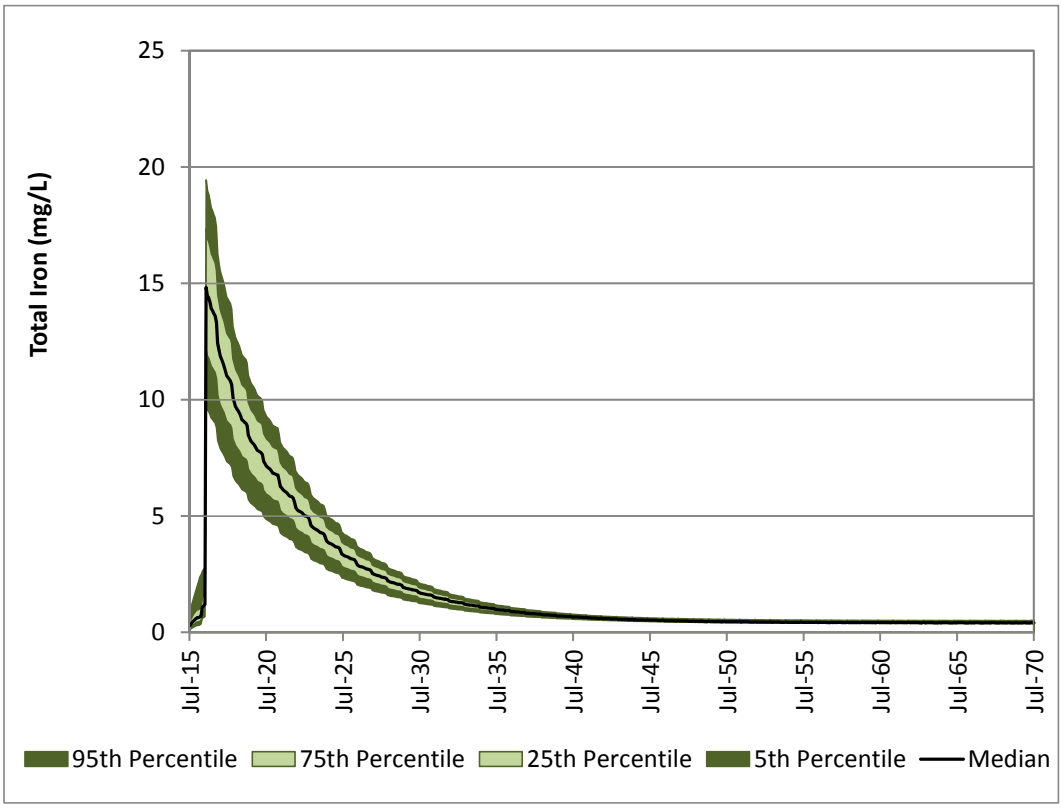

Total Boron (mg/L)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

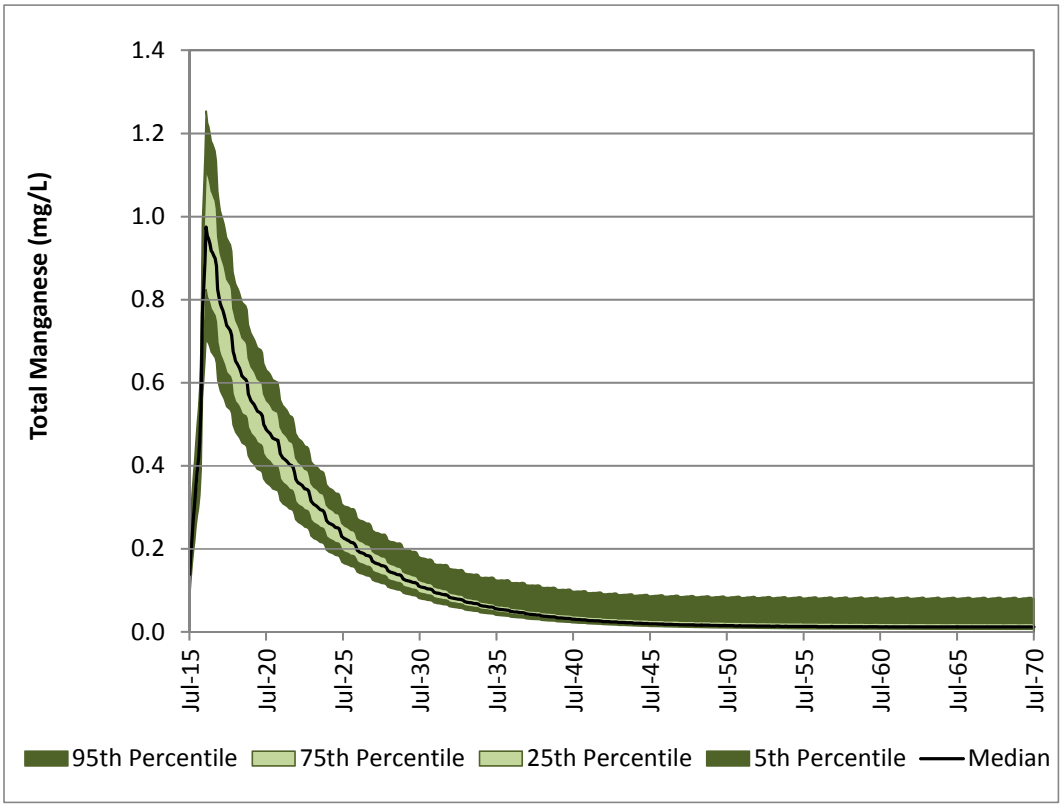

Total Cadmium (mg/L)
0.0016
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

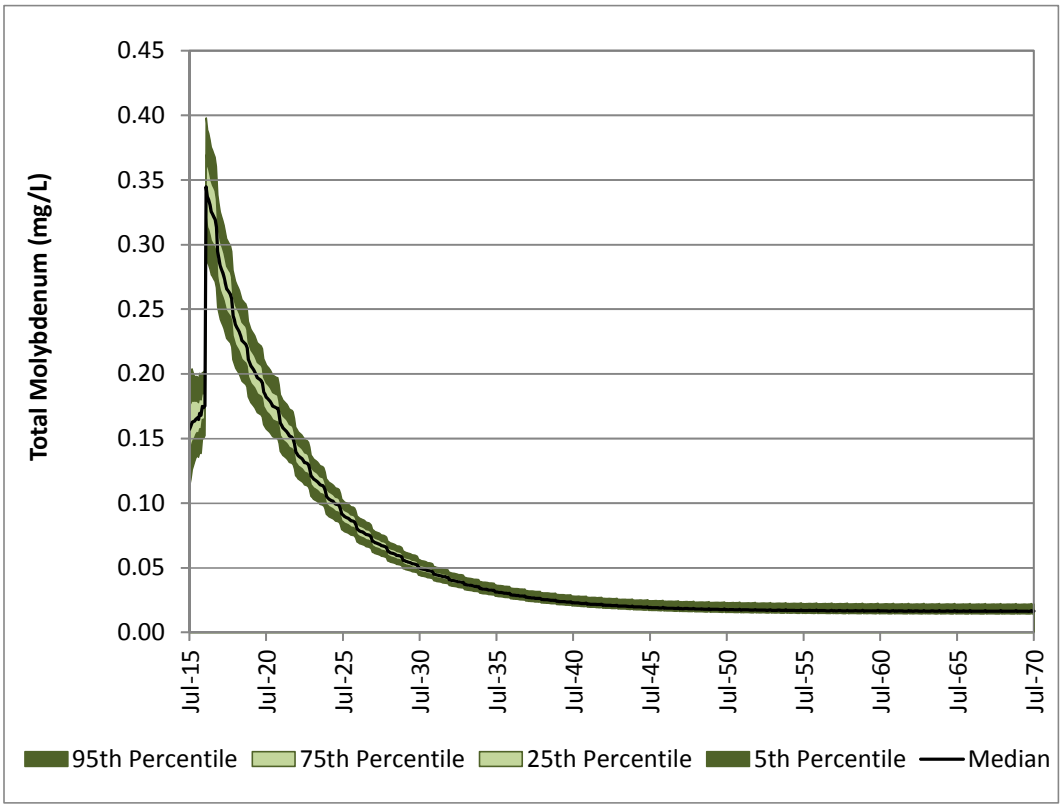

Total Chromium (mg/L)
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

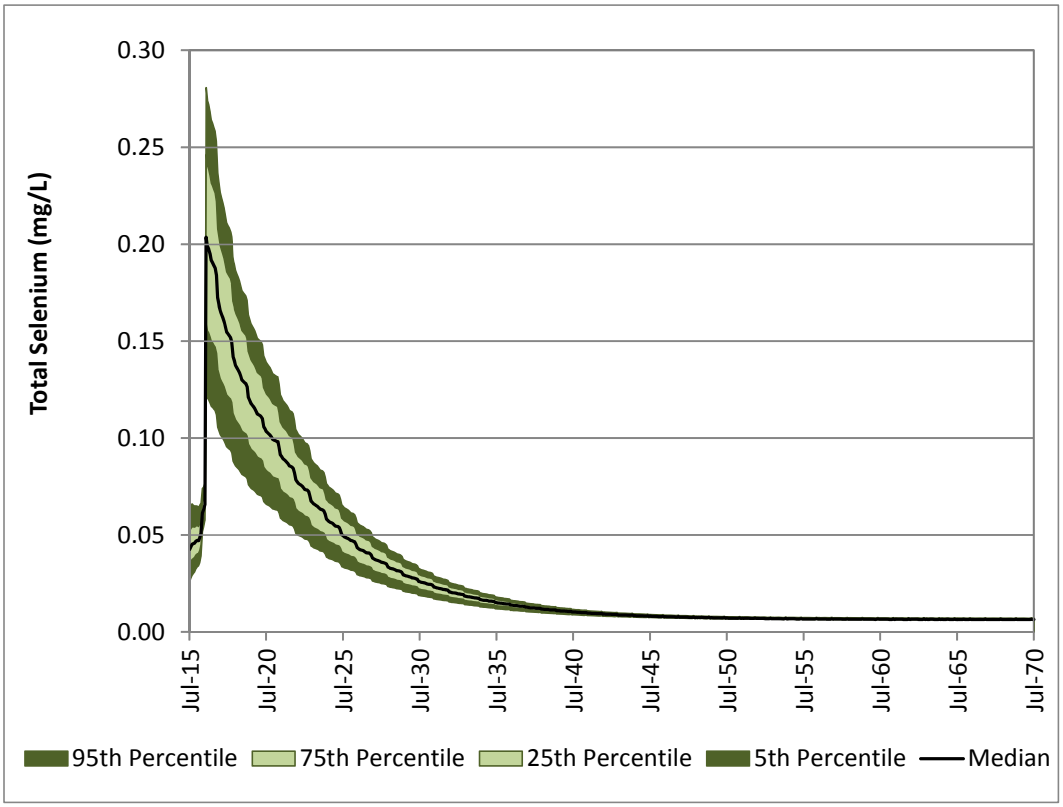

Total Cobalt (mg/L)
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

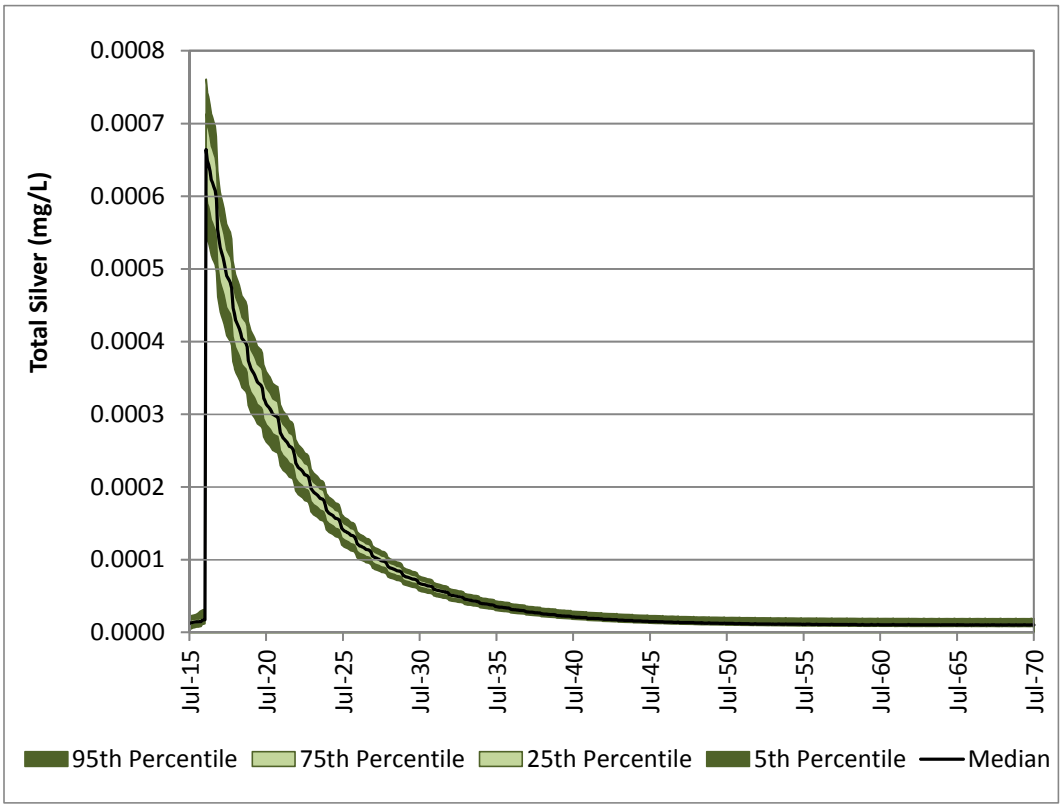

Total Copper (mg/L)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

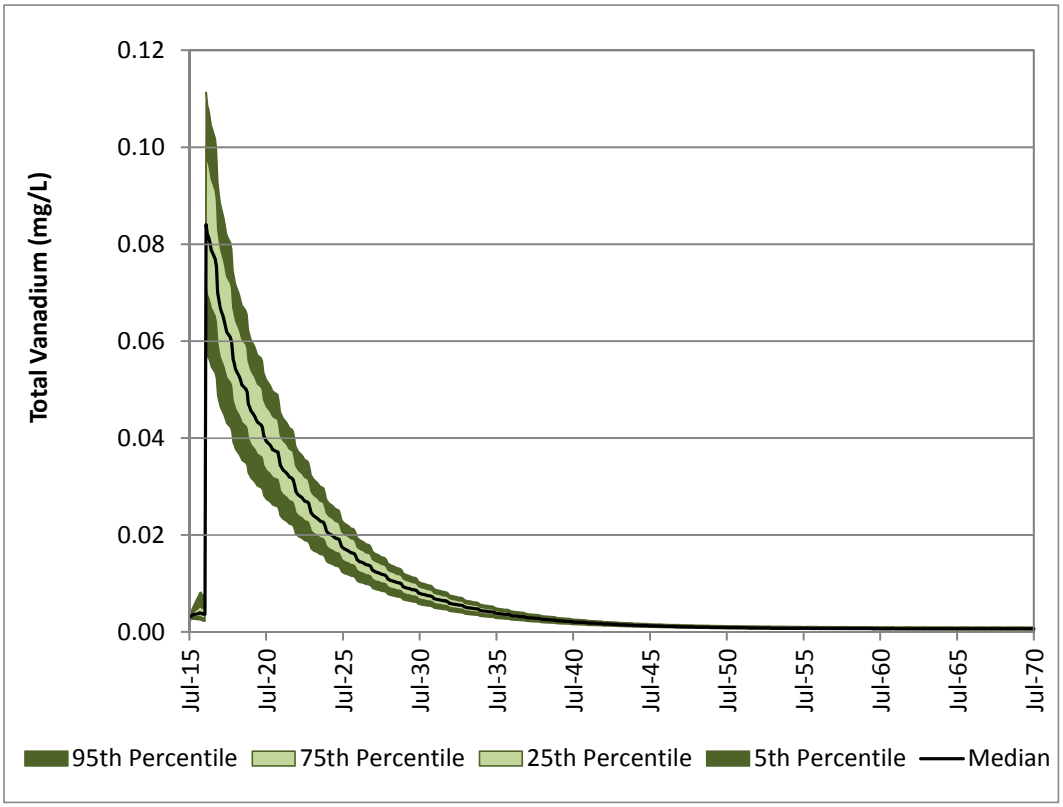

Total Iron (mg/L)
25
20
15
10
5
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

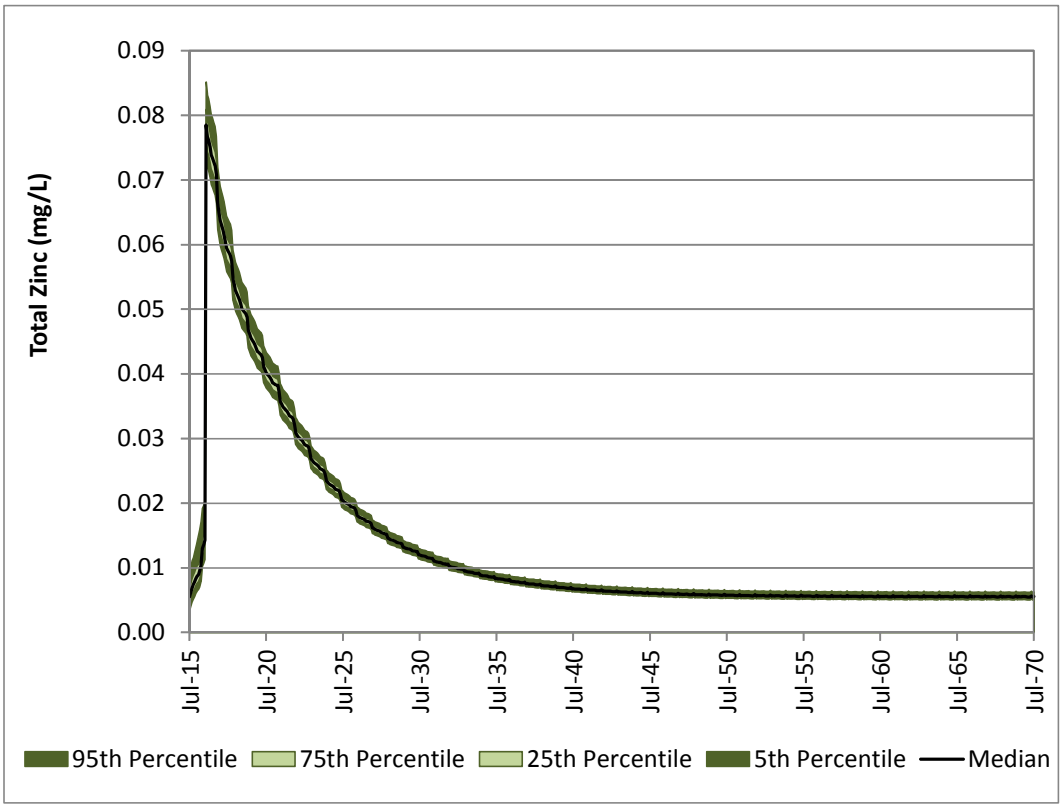

Total Manganese (mg/L)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median


Total Molybdenum (mg/L)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median


Total Selenium (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

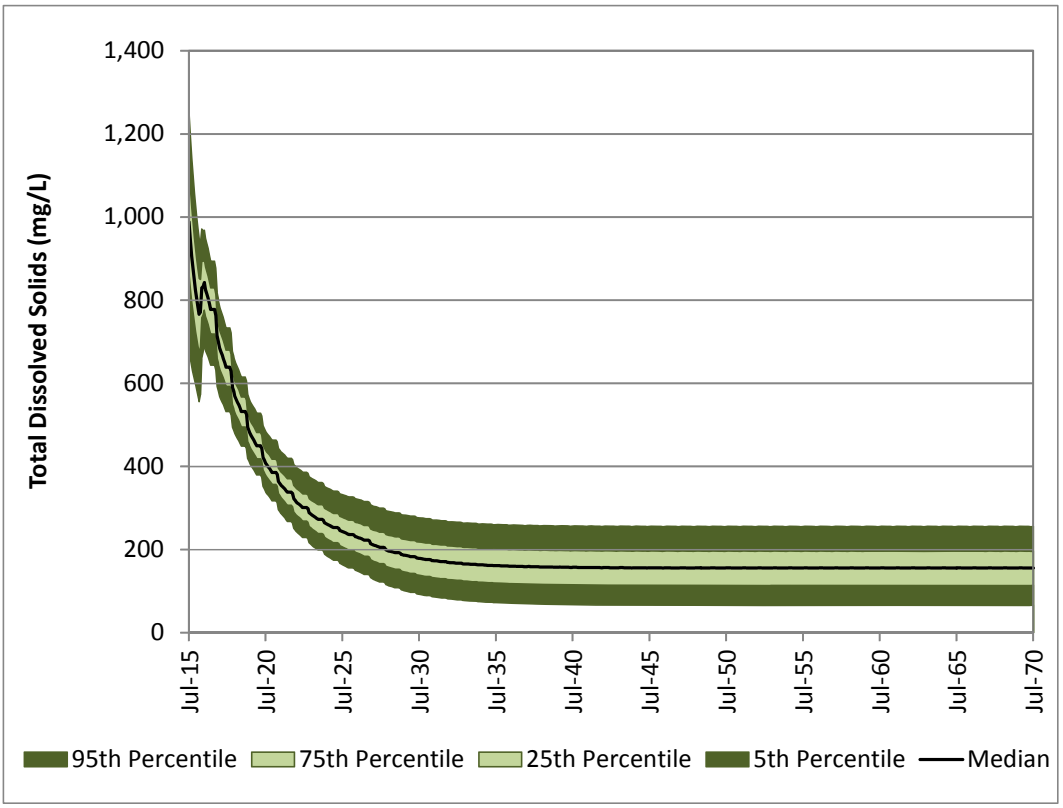

Total Silver (mg/L)
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

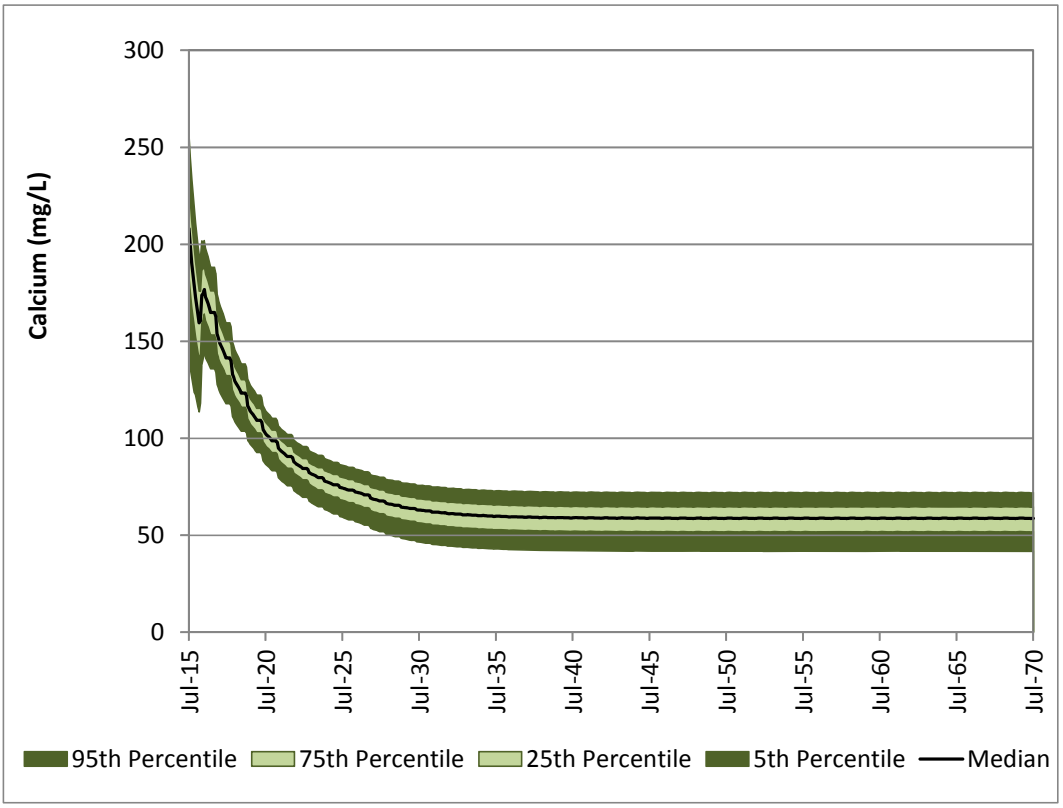

Total Vanadium (mg/L)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

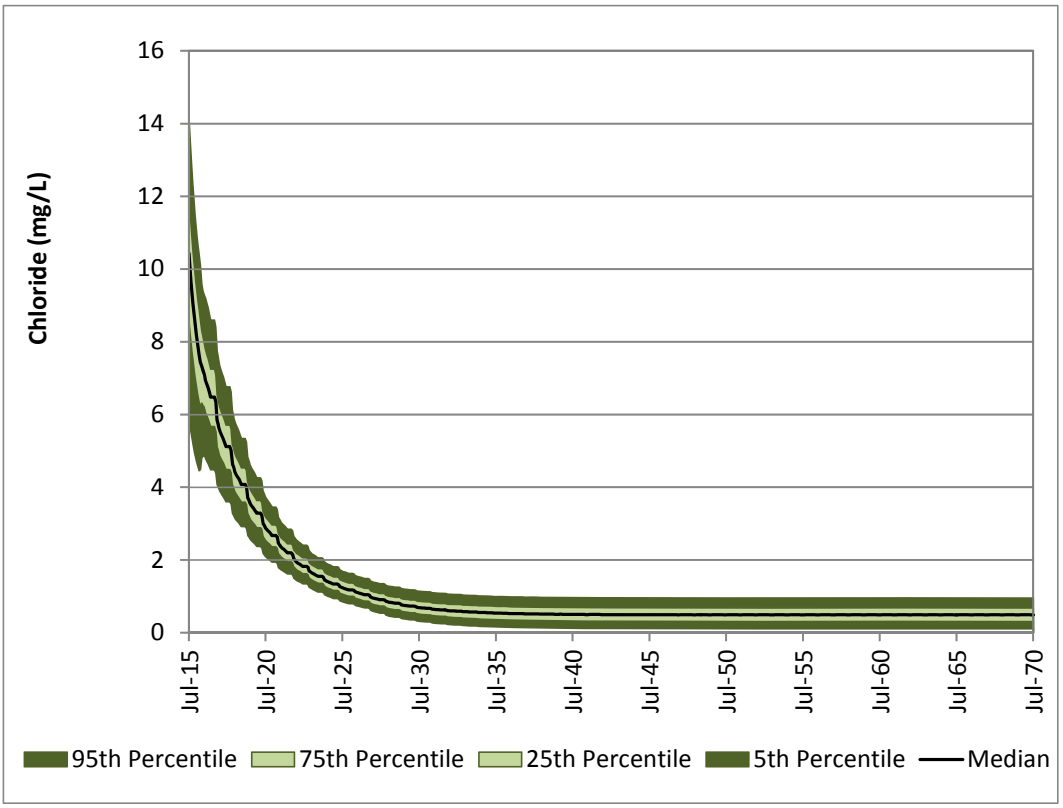


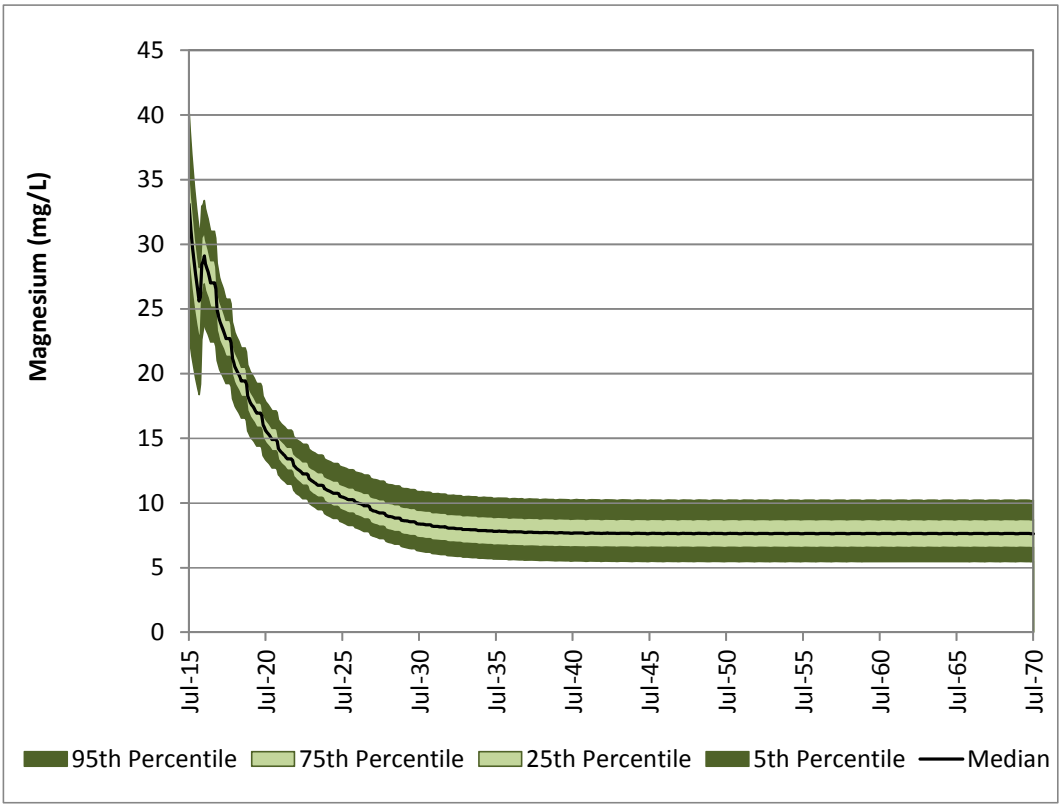
\\golder.gds\gal\burnaby\active_2014\1421\1411734 mount polley\07 deliverables\1411734-12000-site wide water balance\closure\september 29, 2015 report\attachment 3 - time series results\attachment 3.1 -springerpit.docx

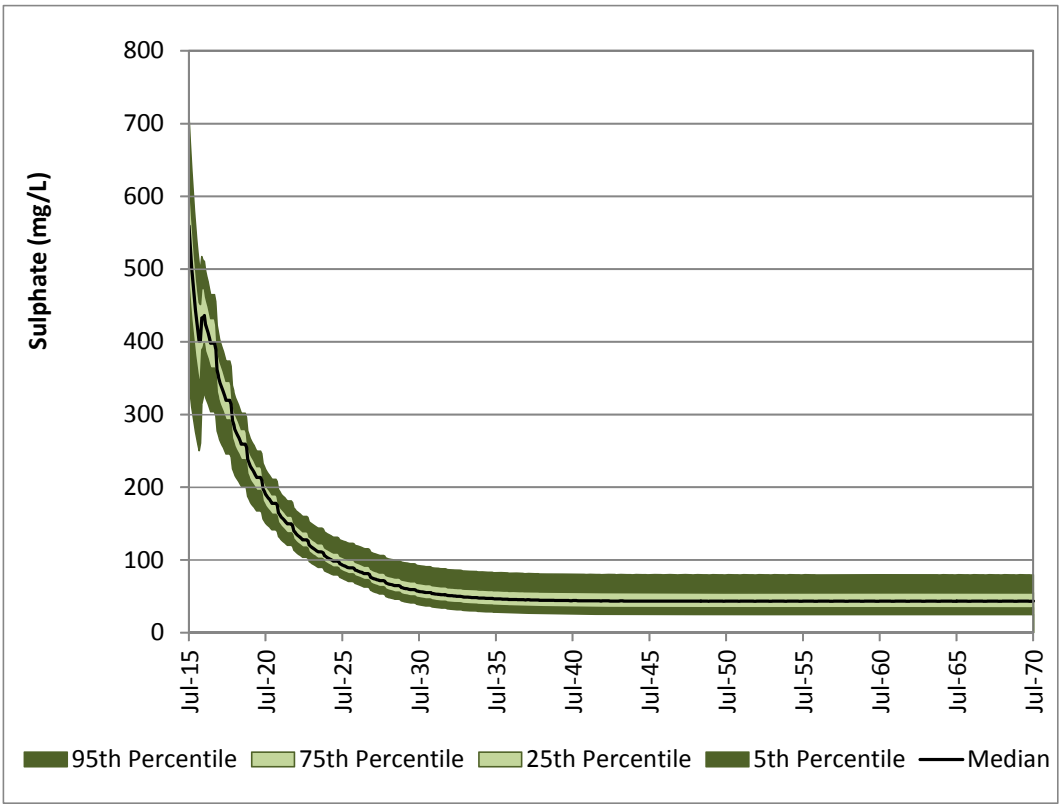
ATTACHMENT 3.2
Time Series Results for Cariboo Pit

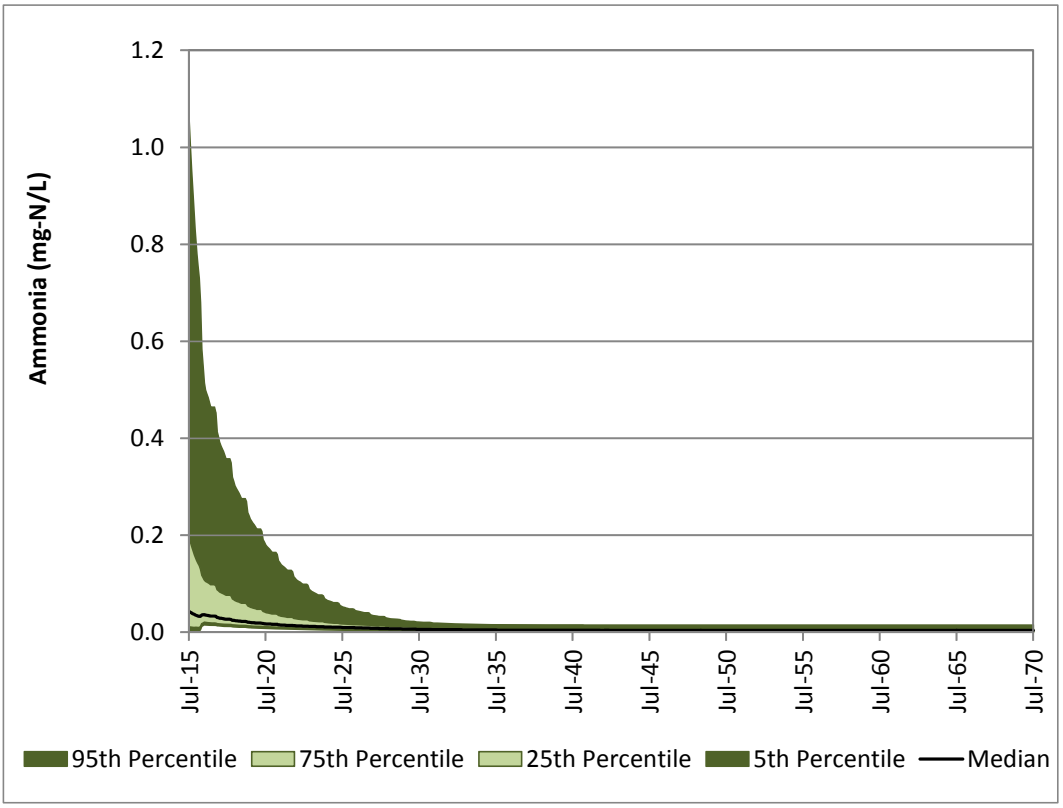

Total Dissolved Solids (mg/L)
1,400
1,200
1,000
800
600
400
200
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

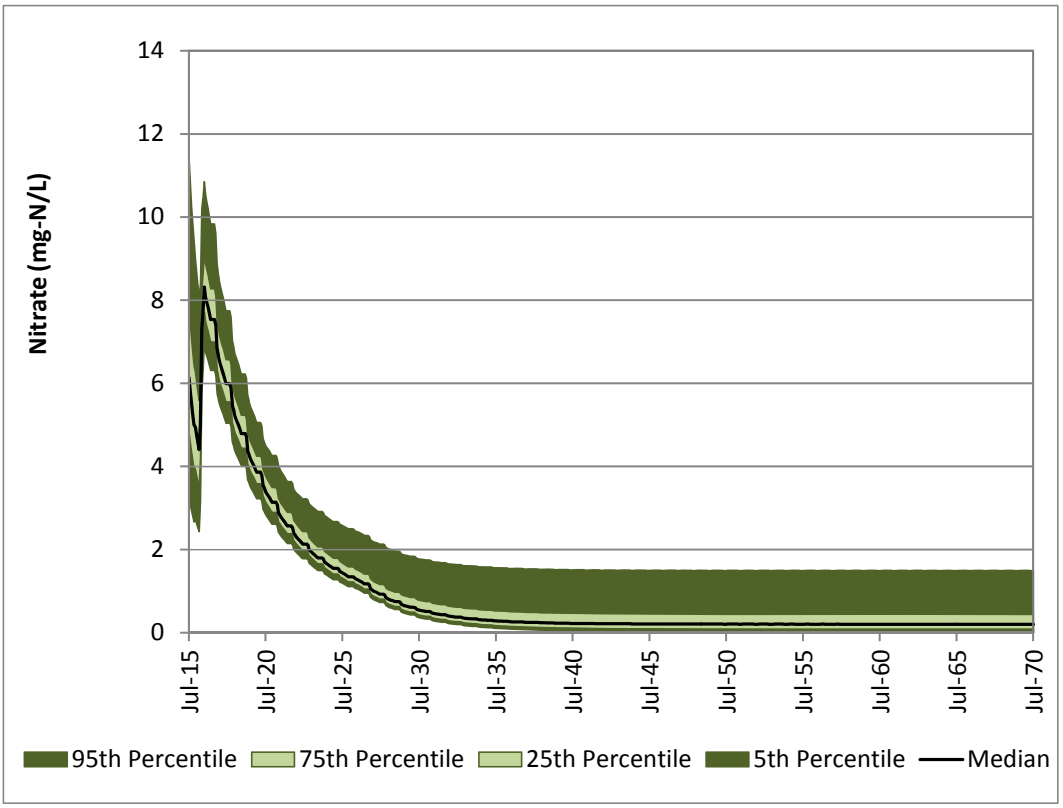

Calcium (mg/L)
300
250
200
150
100
50
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

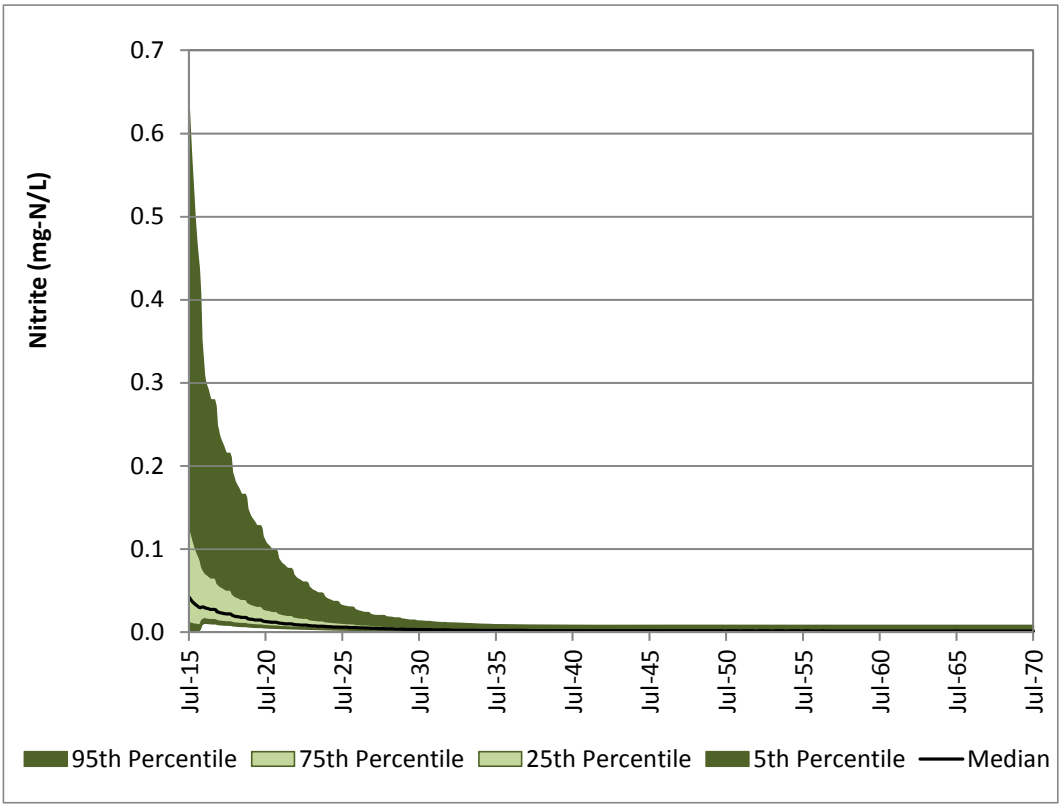

Chloride (mg/L)
16
14
12
10
8
6
4
2
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

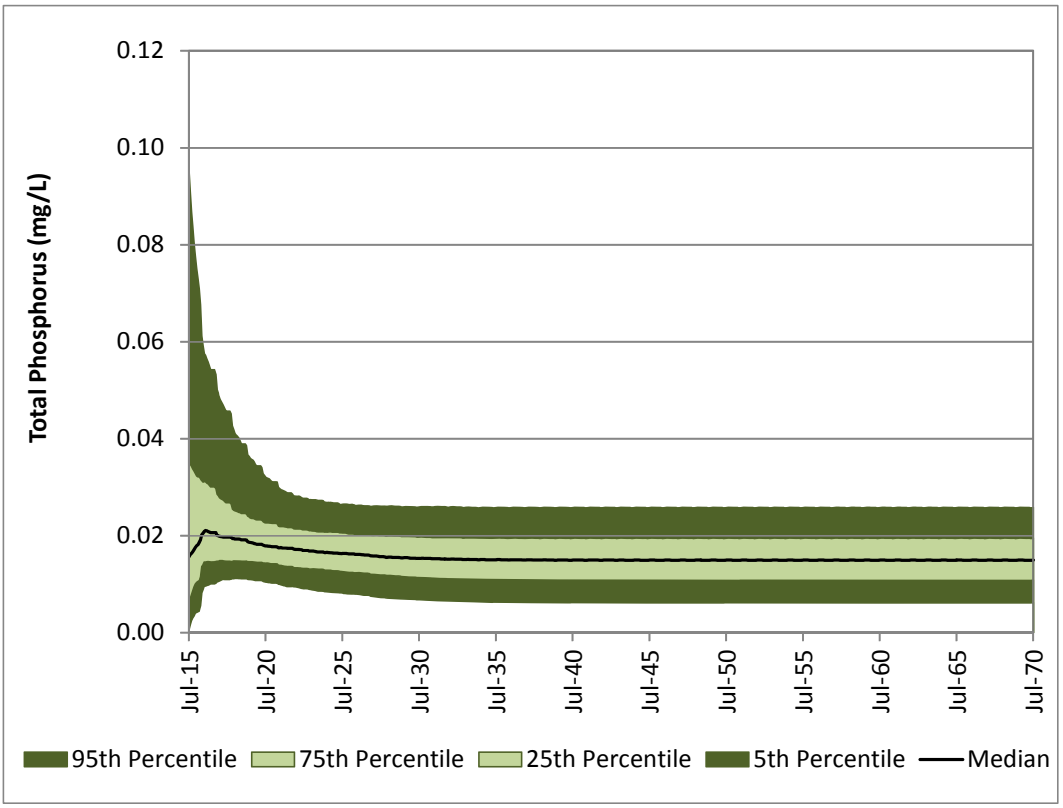

Magnesium (mg/L)
45
40
35
30
25
20
15
10
5
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

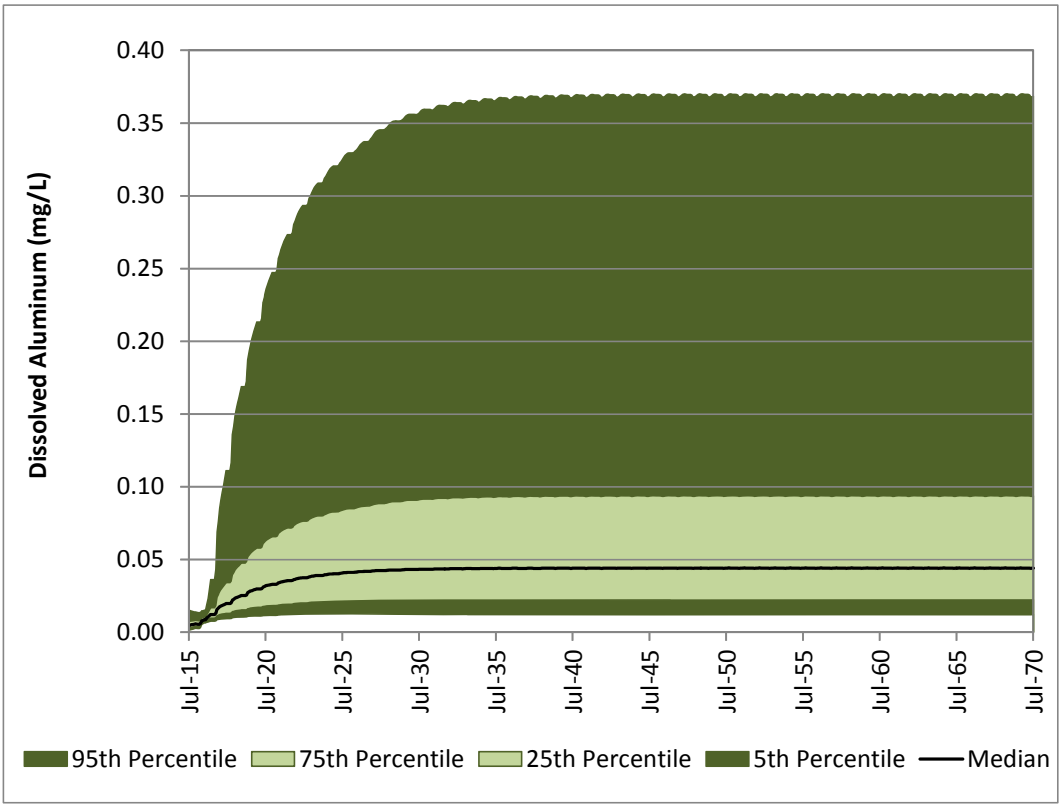

Sulphate (mg/L)
800
700
600
500
400
300
200
100
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

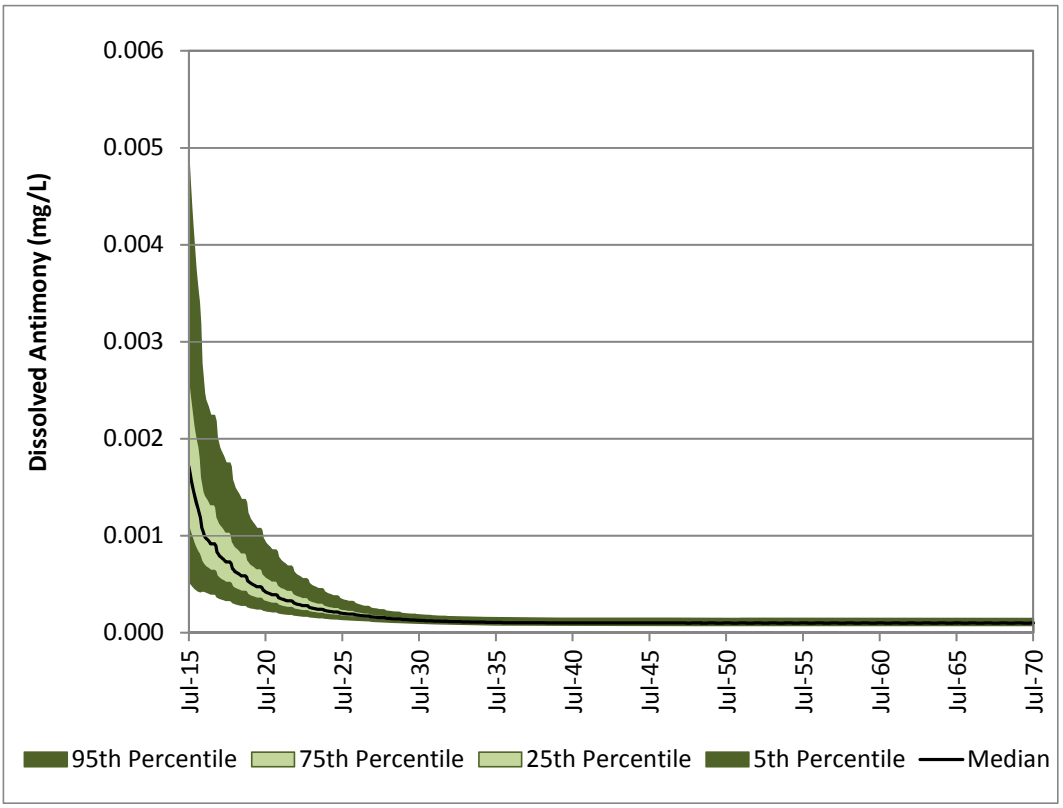

Ammonia (mg-N/L)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

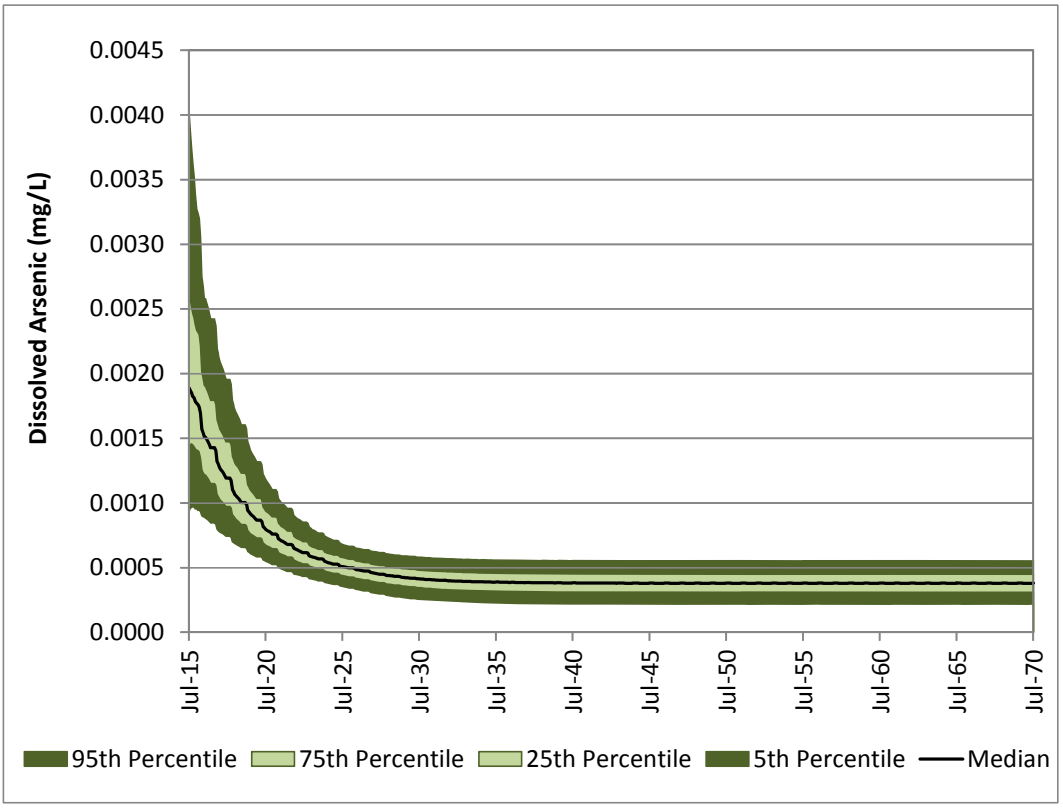

Nitrate (mg-N/L)
14
12
10
8
6
4
2
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

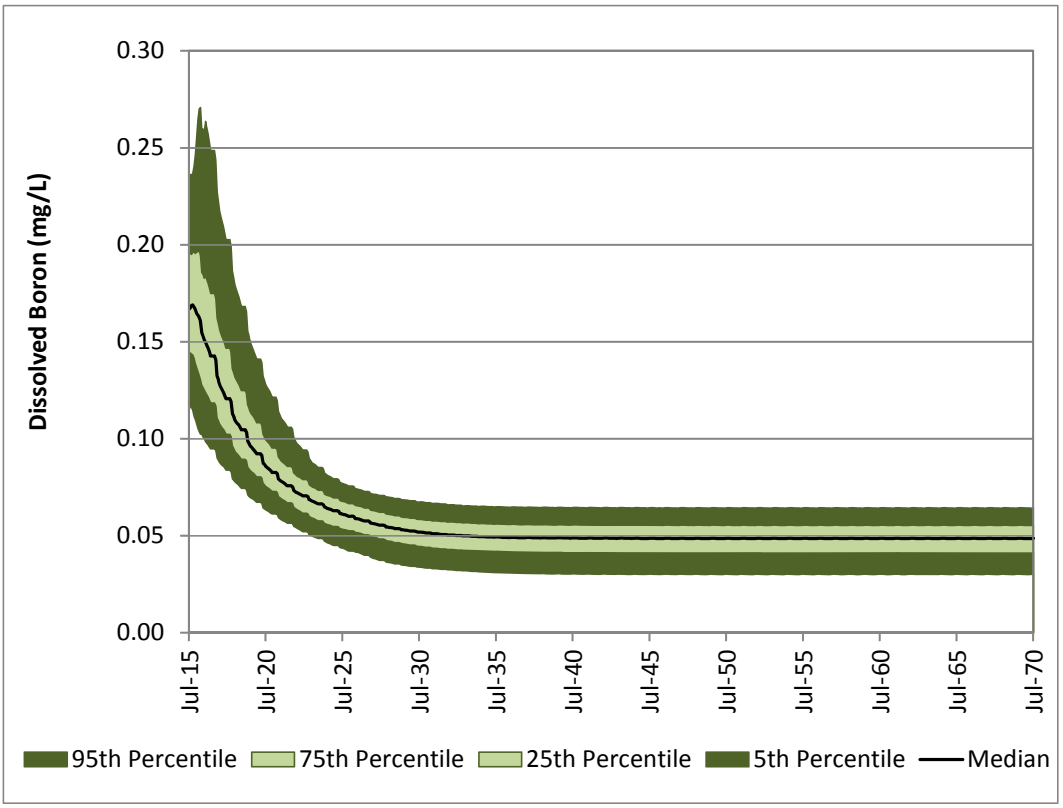

Nitrite (mg-N/L)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

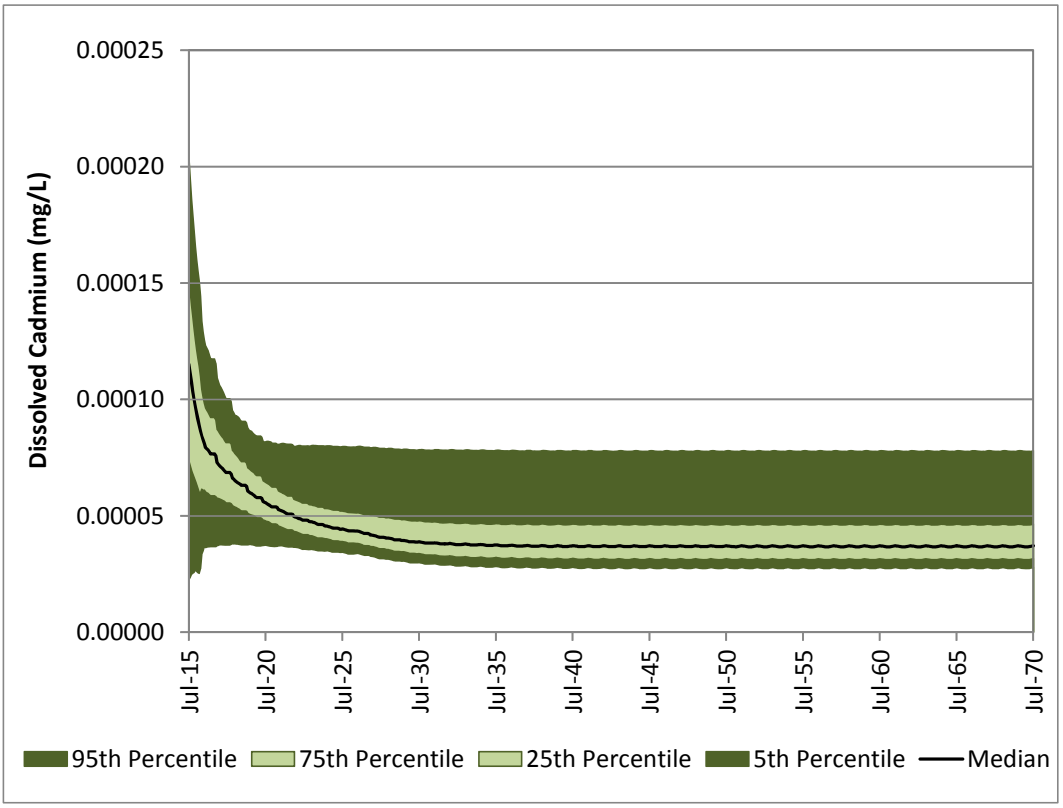

Total Phosphorus (mg/L)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

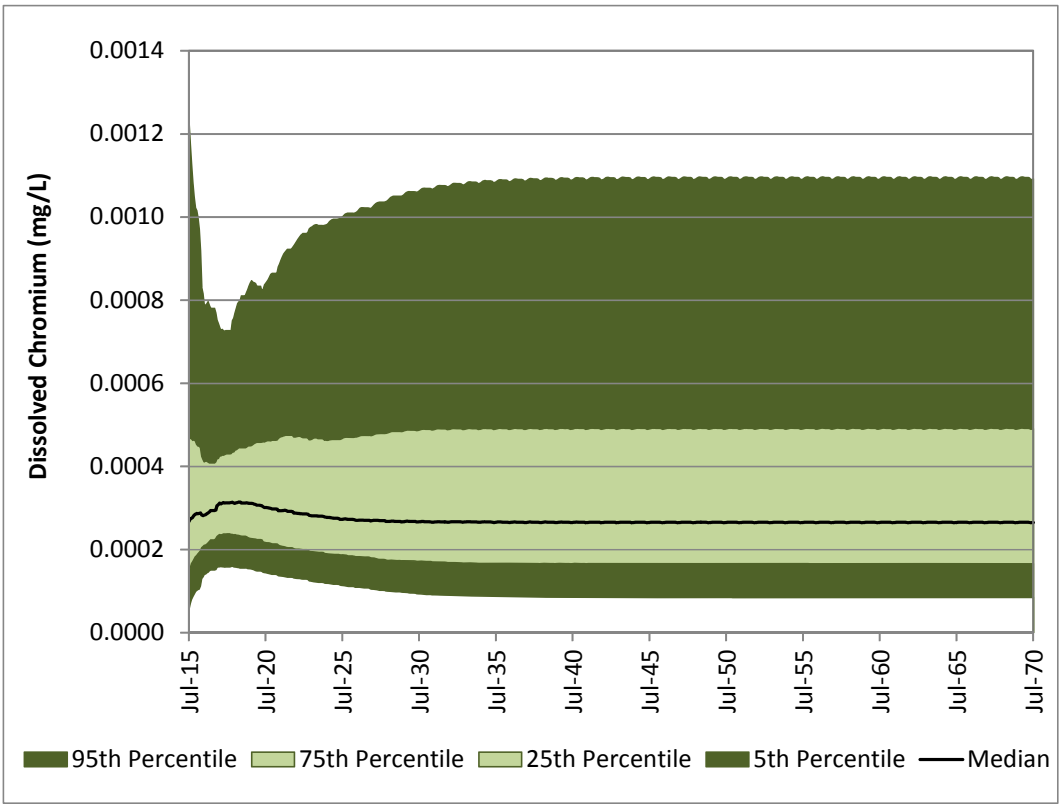

Dissolved Aluminum (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

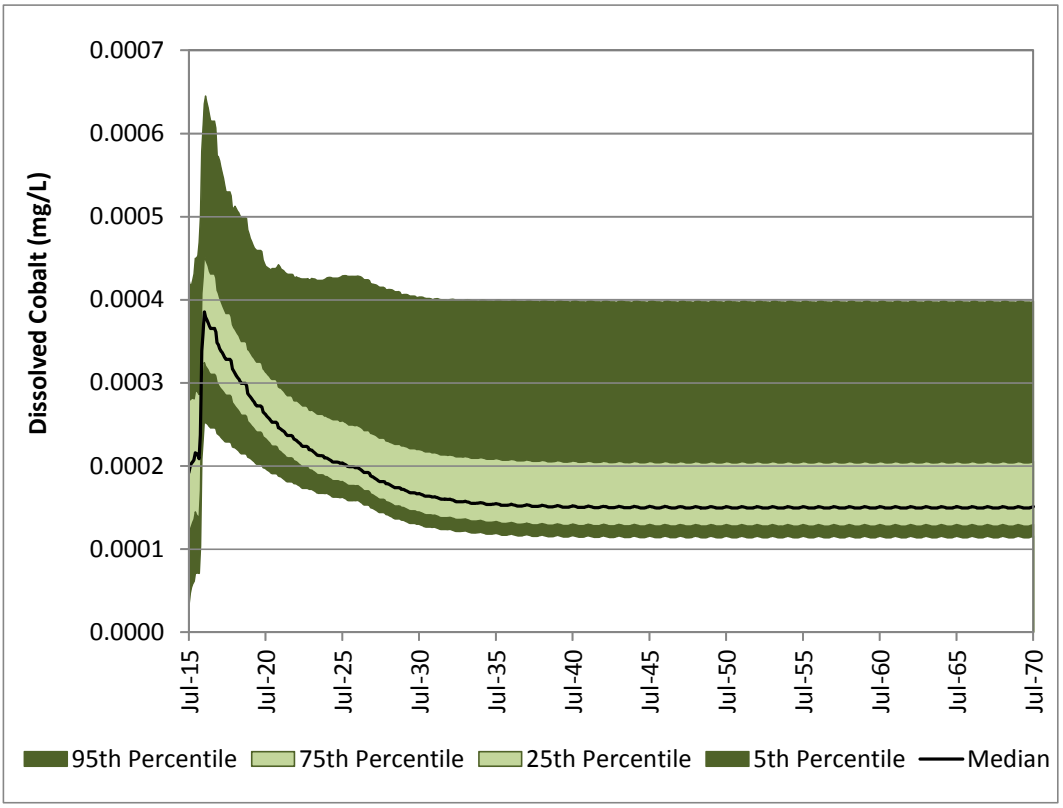

Dissolved Antimony (mg/L)
0.006
0.005
0.004
0.003
0.002
0.001
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

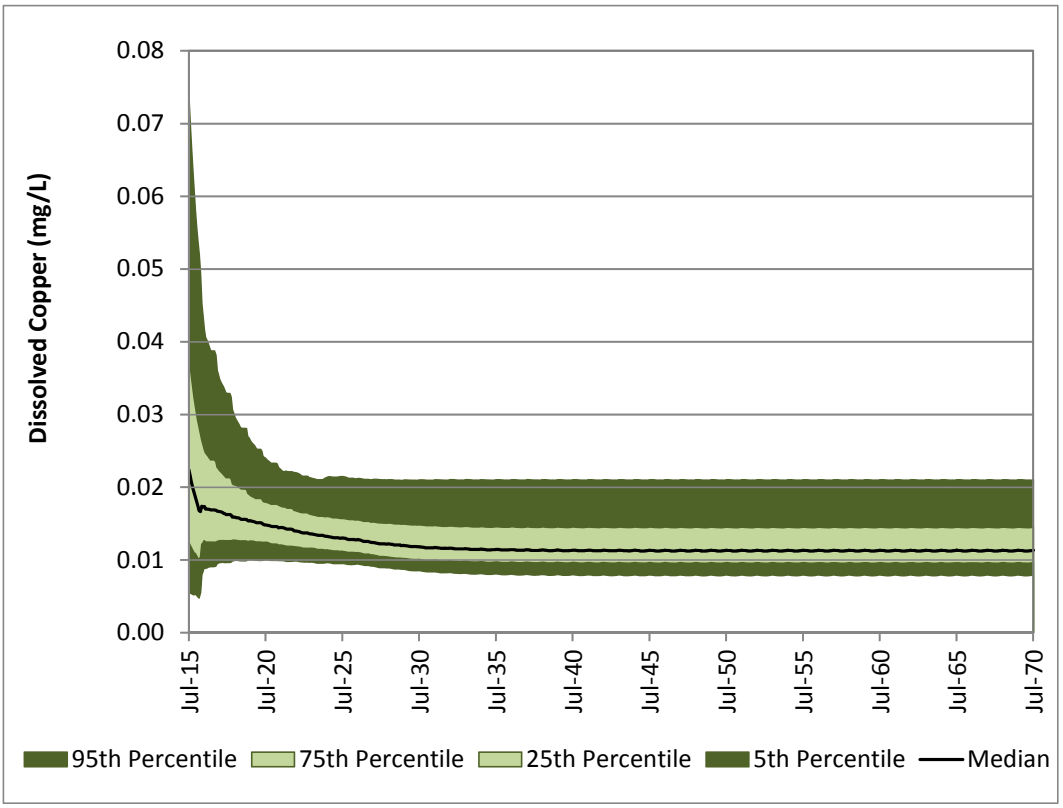

Dissolved Arsenic (mg/L)
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

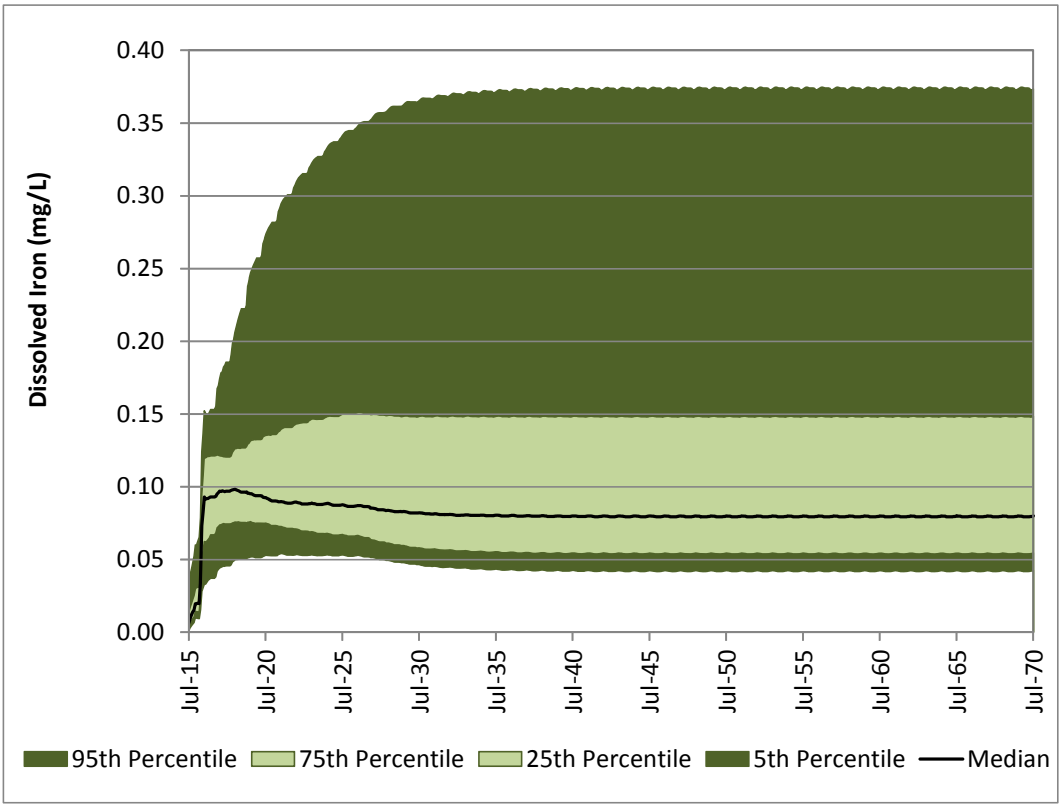

Dissolved Boron (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

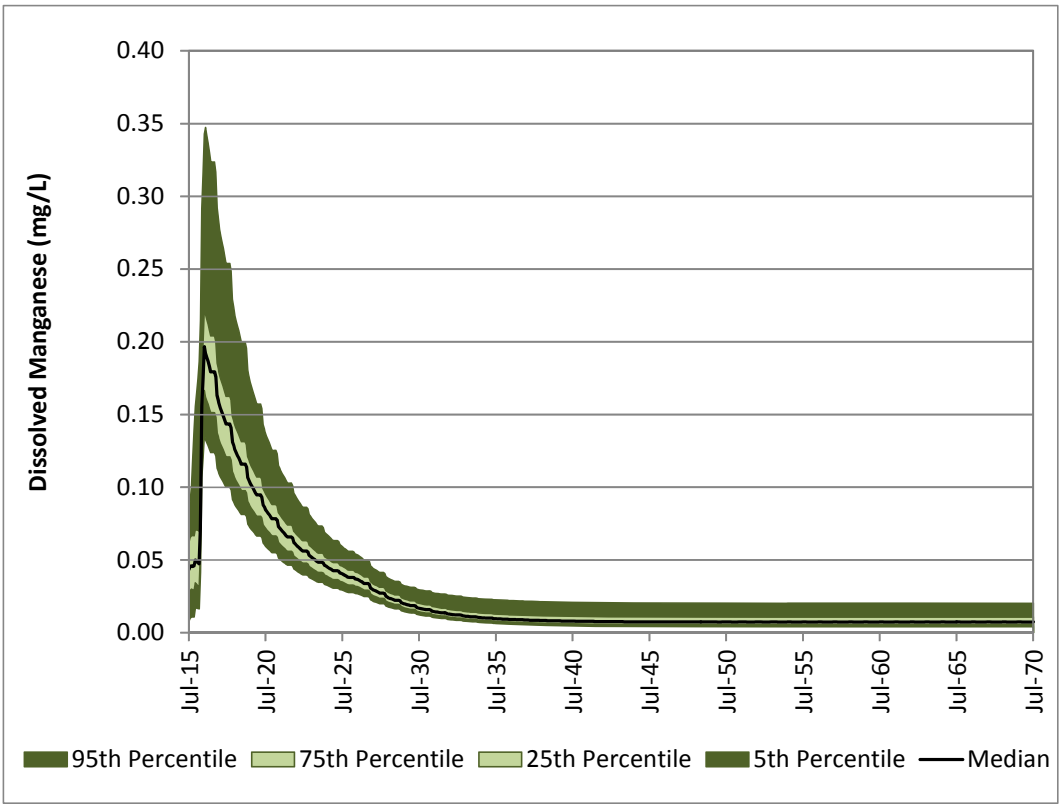

Dissolved Cadmium (mg/L)
0.00025
0.00020
0.00015
0.00010
0.00005
0.00000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

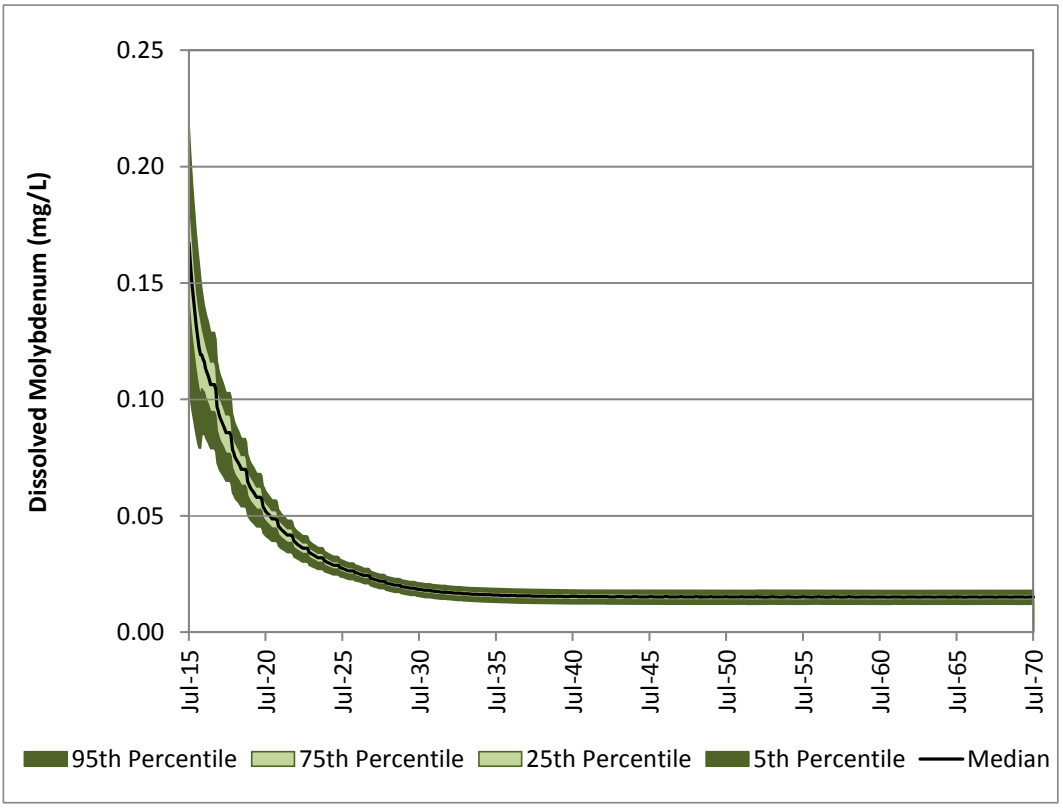

Dissolved Chromium (mg/L)
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

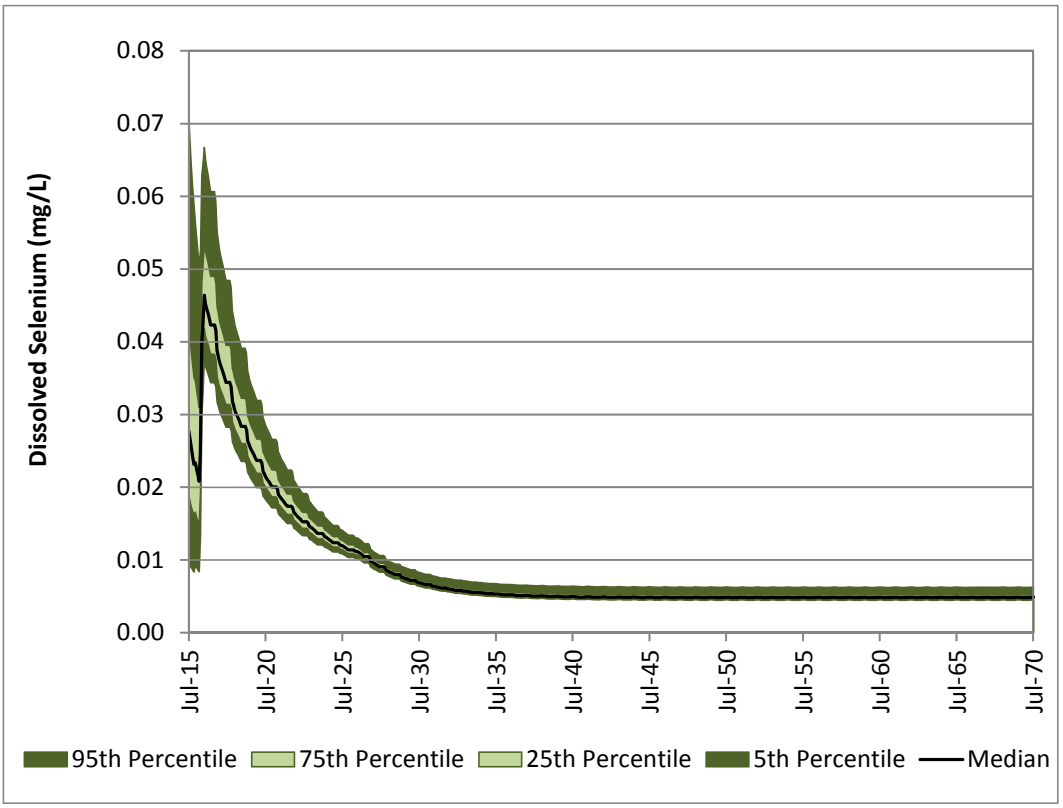

Dissolved Cobalt (mg/L)
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

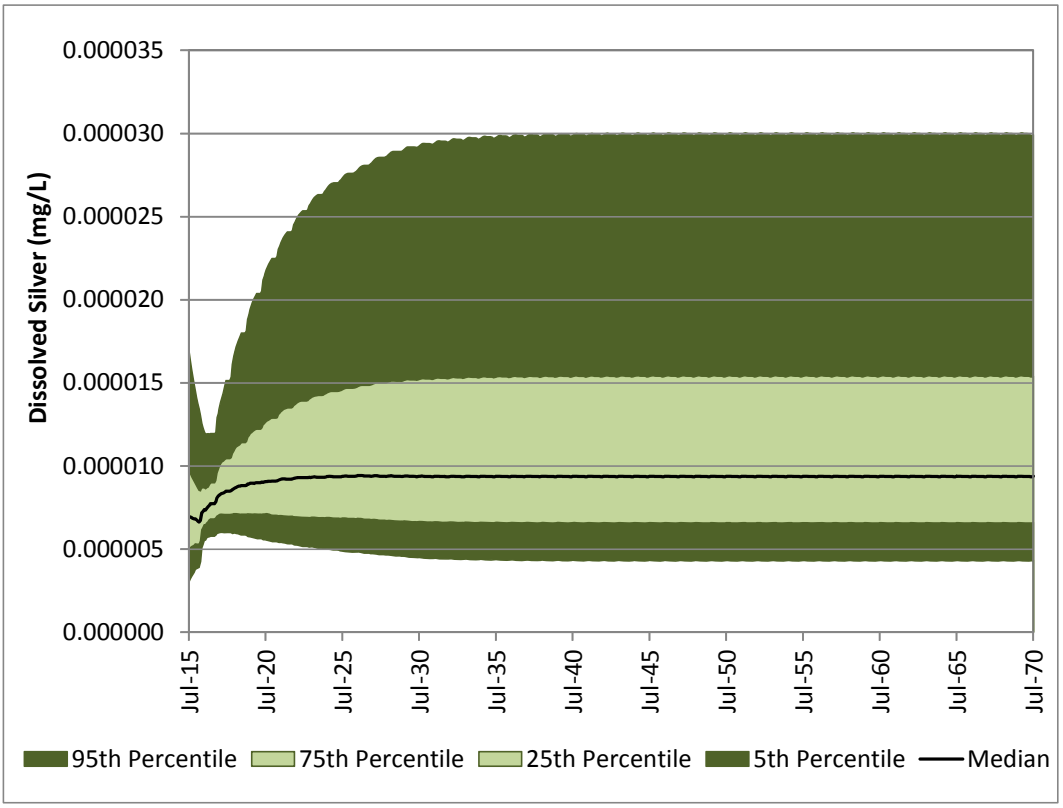

Dissolved Copper (mg/L)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

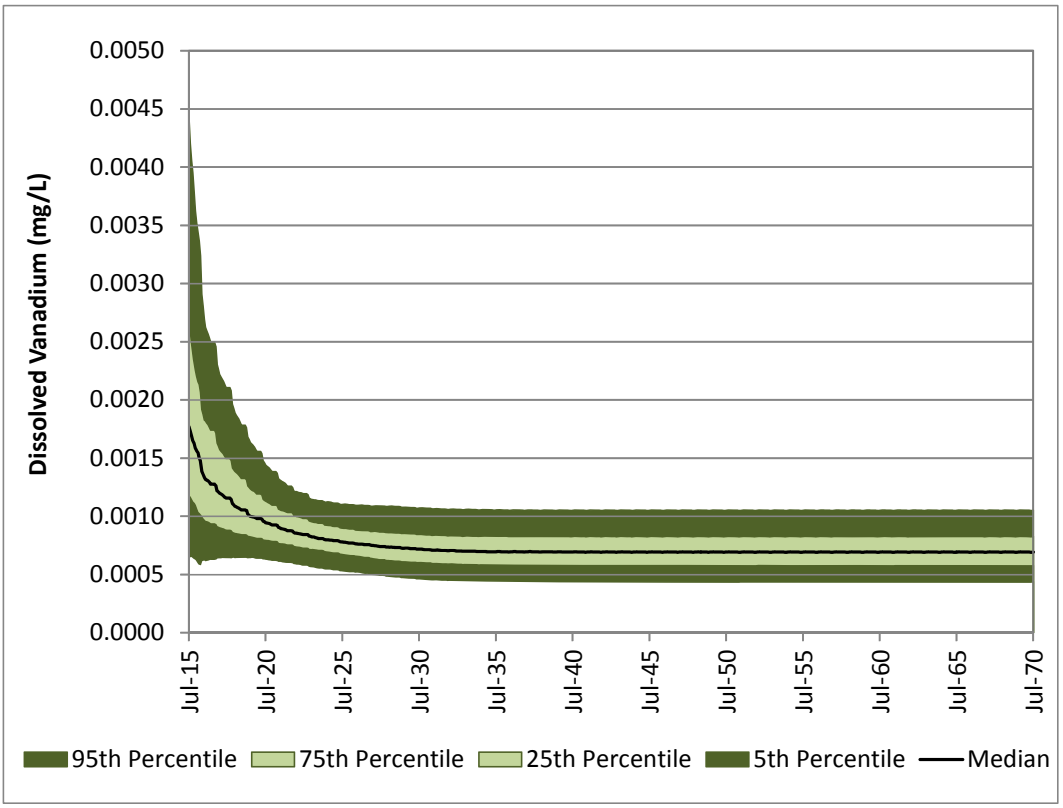

Dissolved Iron (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

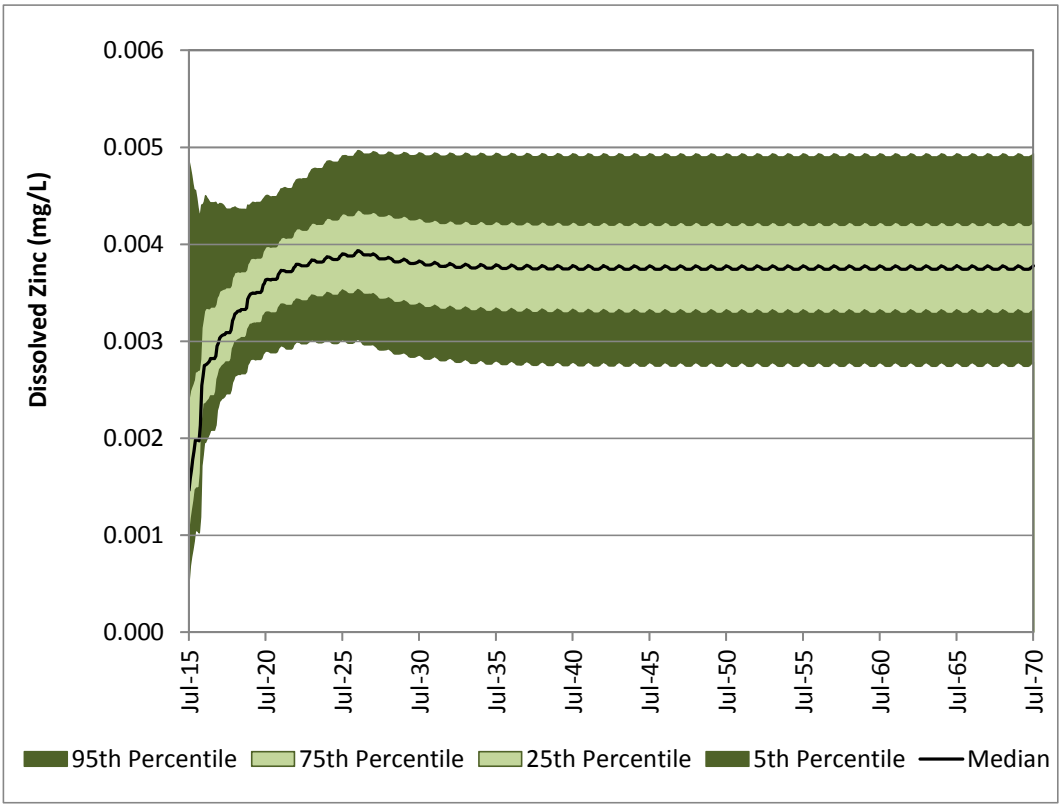

Dissolved Manganese (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

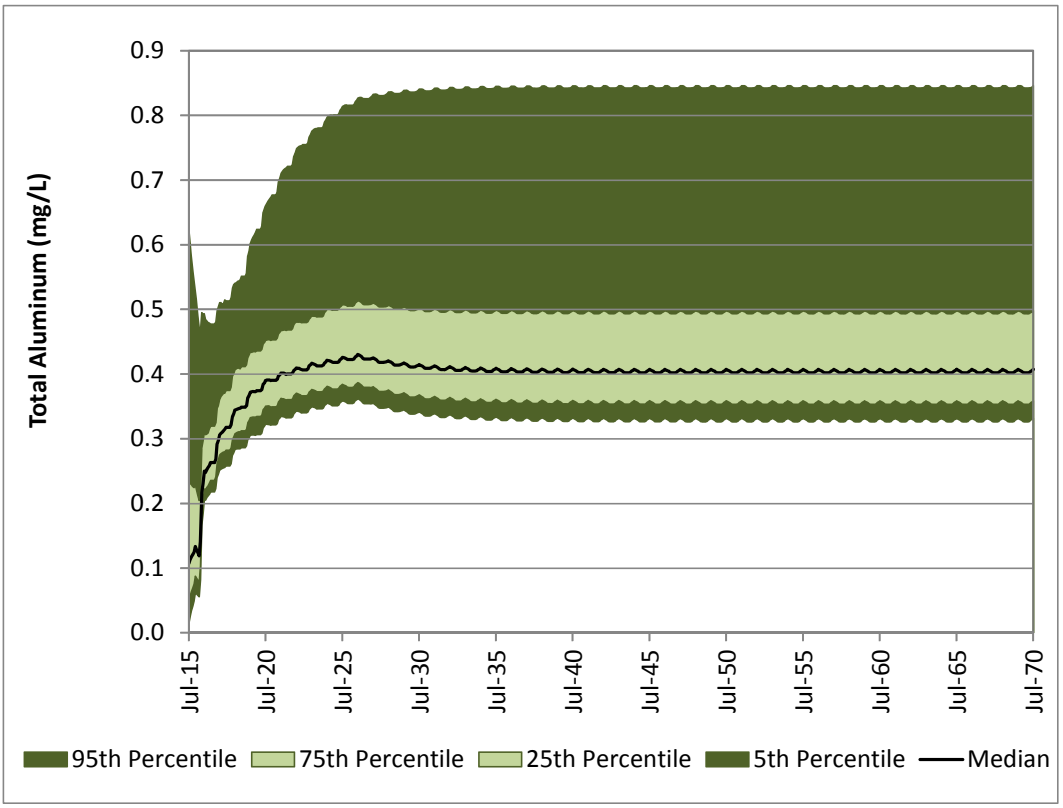

Dissolved Molybdenum (mg/L)
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

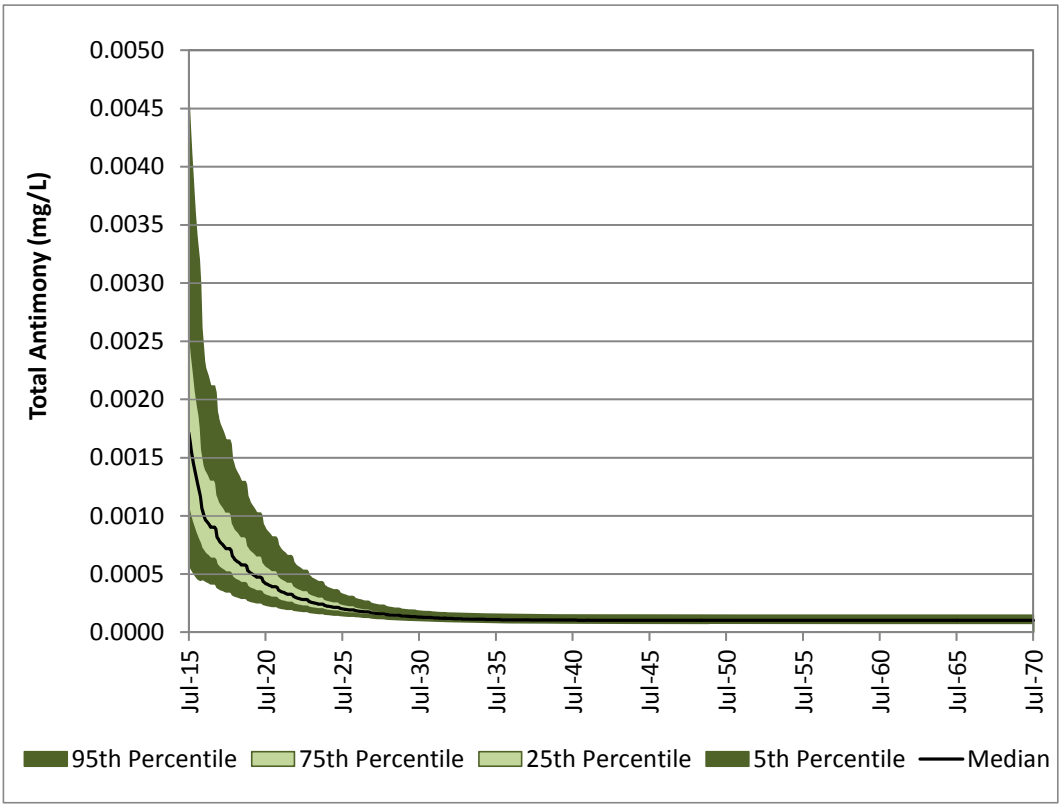

Dissolved Selenium (mg/L)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

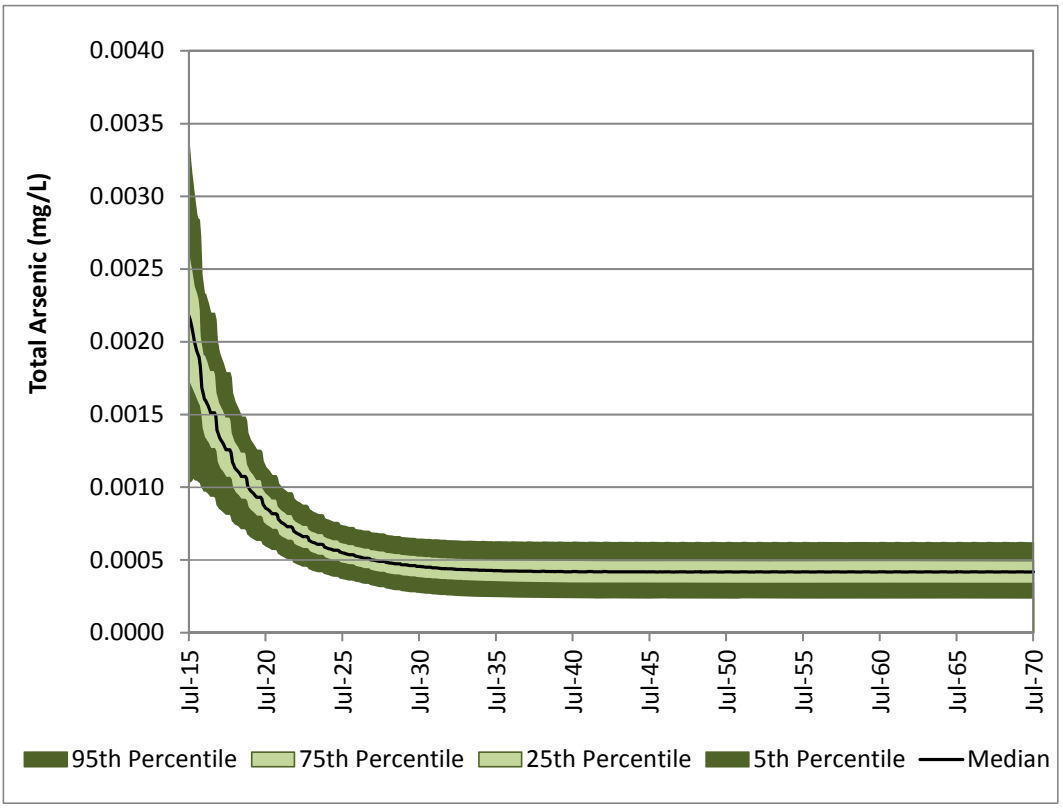

Dissolved Silver (mg/L)
0.000035
0.000030
0.000025
0.000020
0.000015
0.000010
0.000005
0.000000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

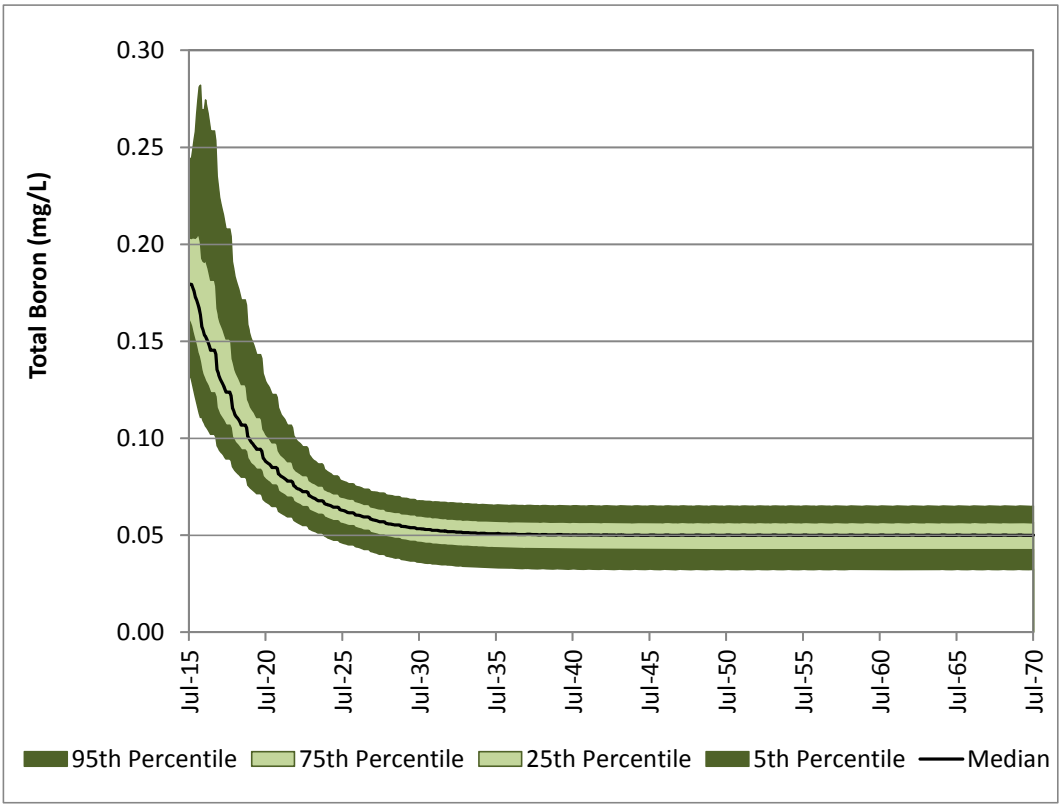

Dissolved Vanadium (mg/L)
0.0050
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

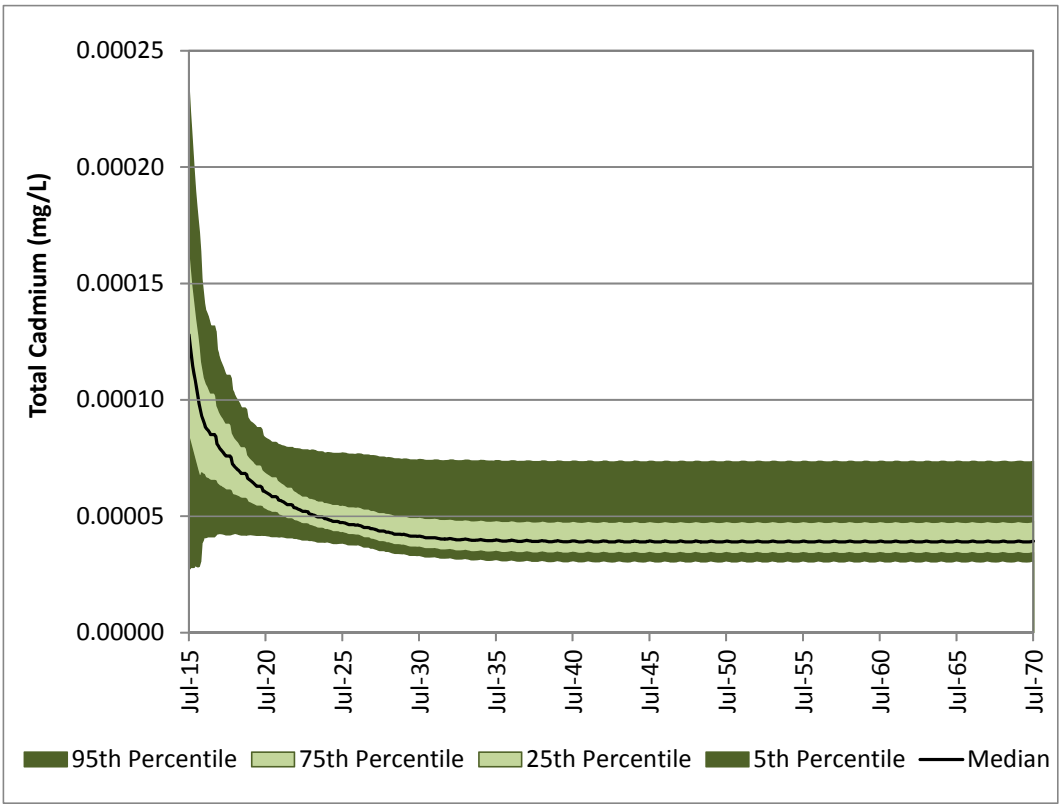

Dissolved Zinc (mg/L)
0.006
0.005
0.004
0.003
0.002
0.001
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

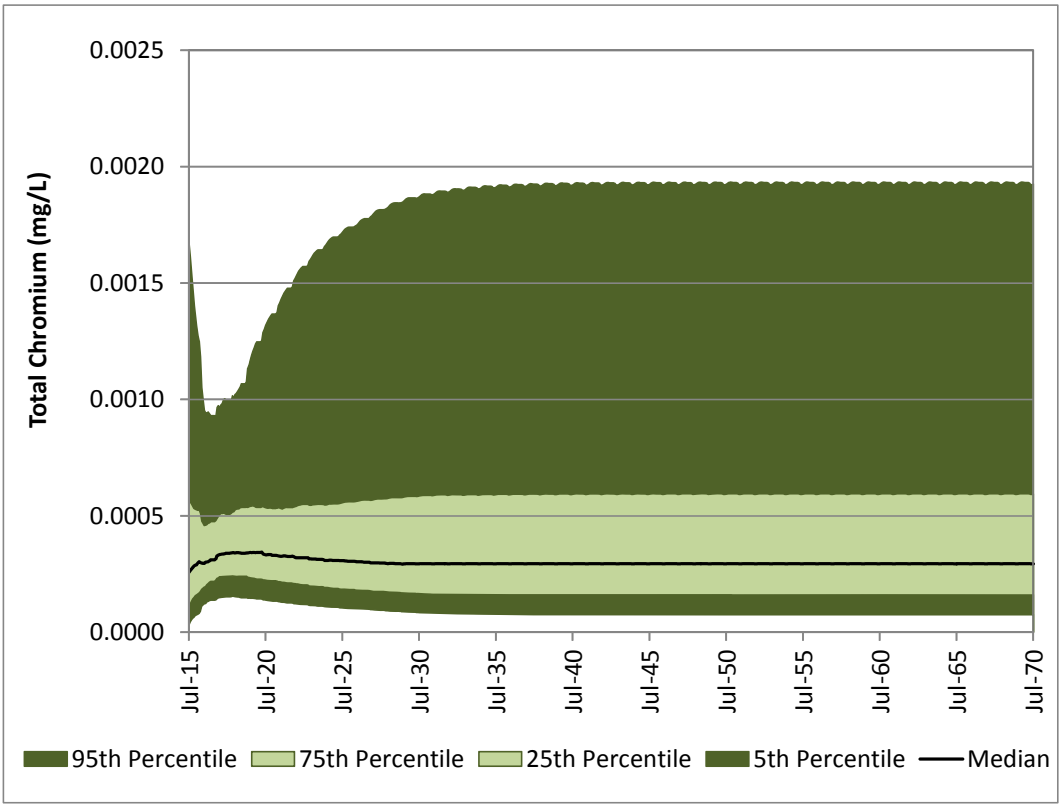

Total Aluminum (mg/L)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

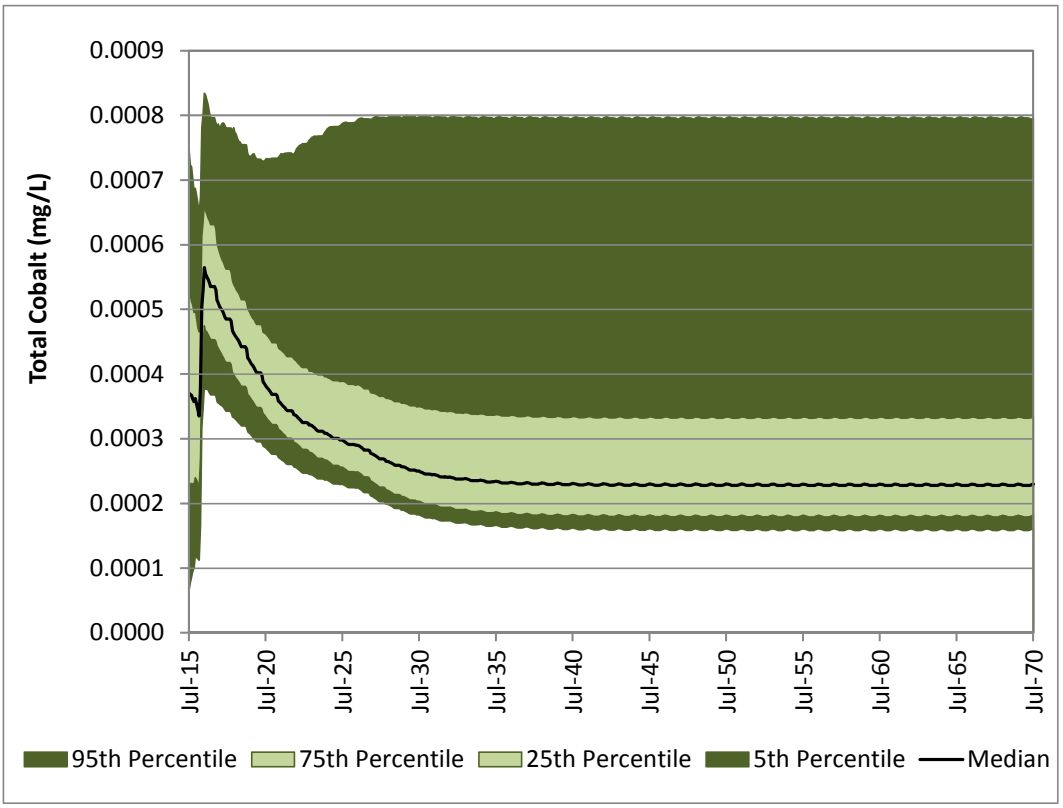

Total Antimony (mg/L)
0.0050
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

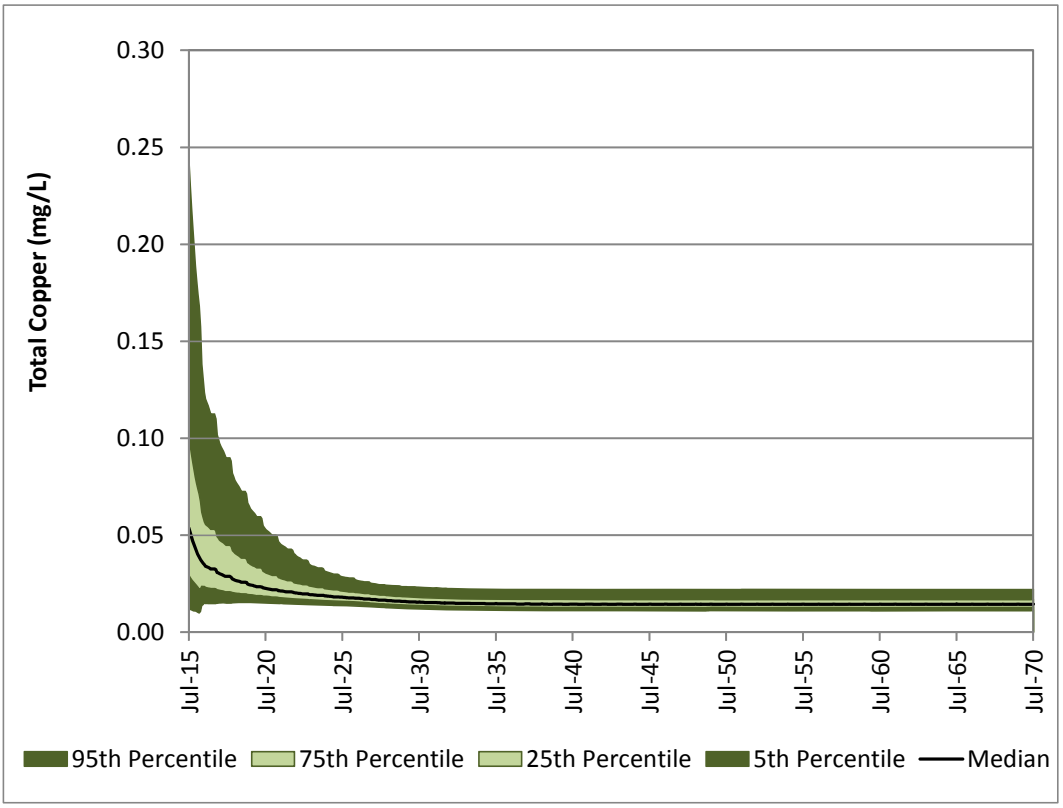

Total Arsenic (mg/L)
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

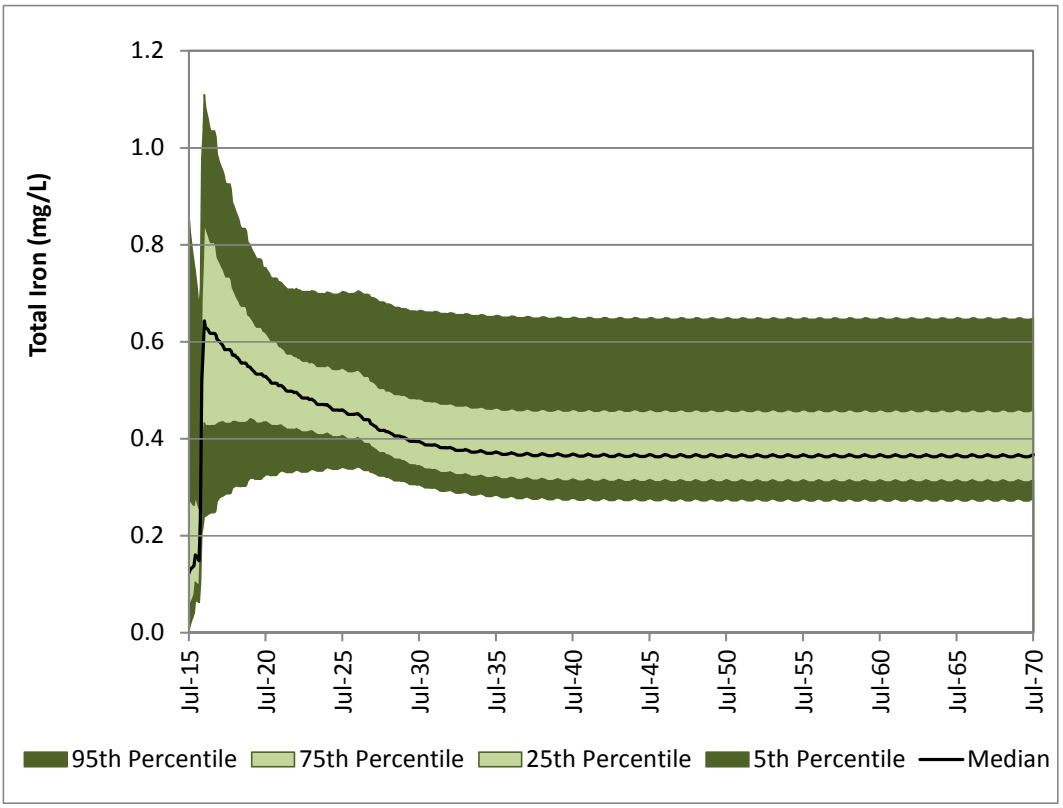

Total Boron (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

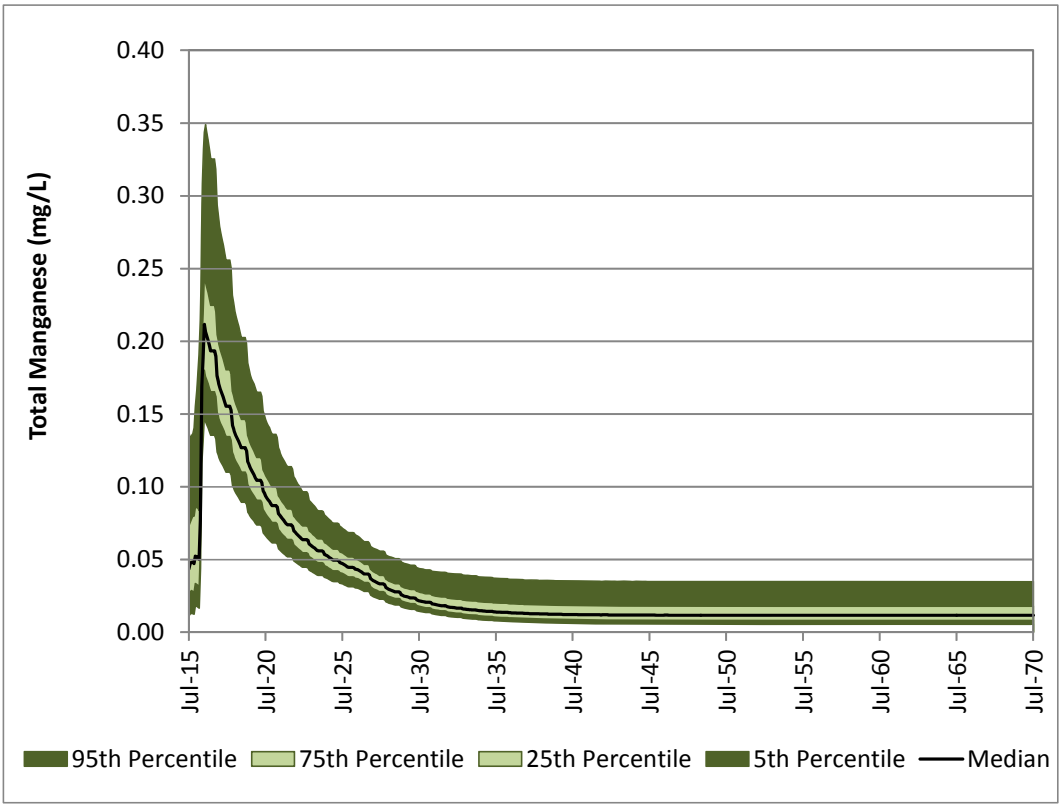

Total Cadmium (mg/L)
0.00025
0.00020
0.00015
0.00010
0.00005
0.00000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

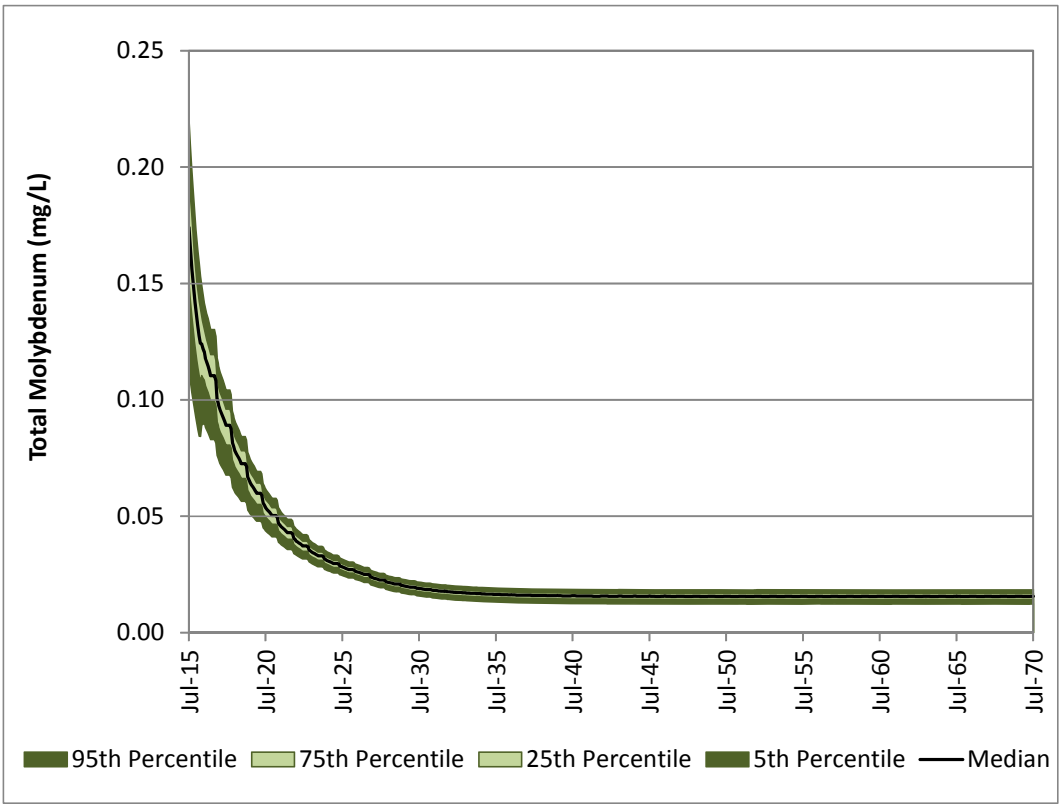

Total Chromium (mg/L)
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

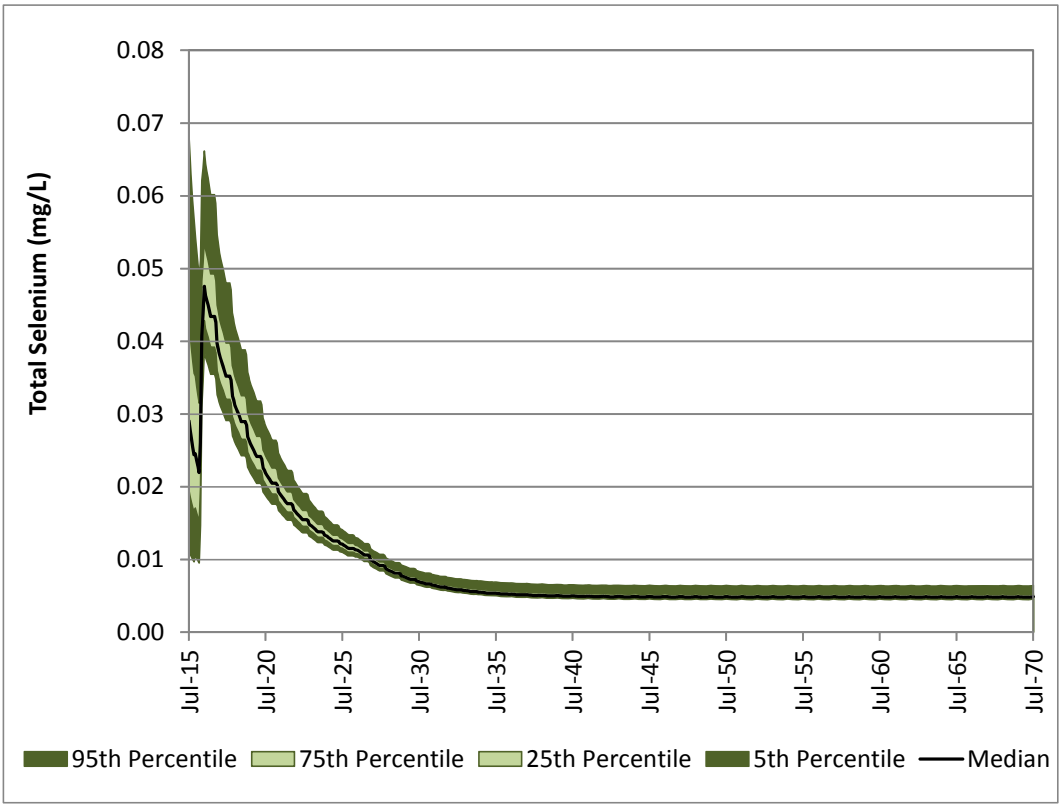

Total Cobalt (mg/L)
0.0009
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

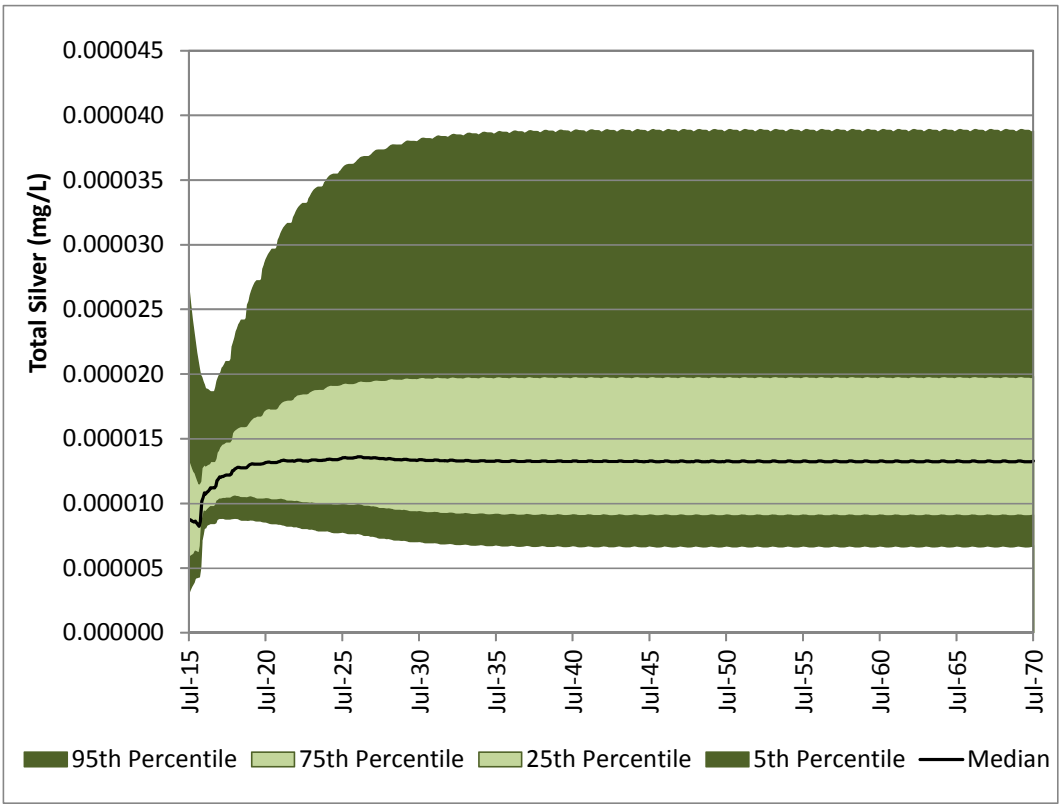

Total Copper (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

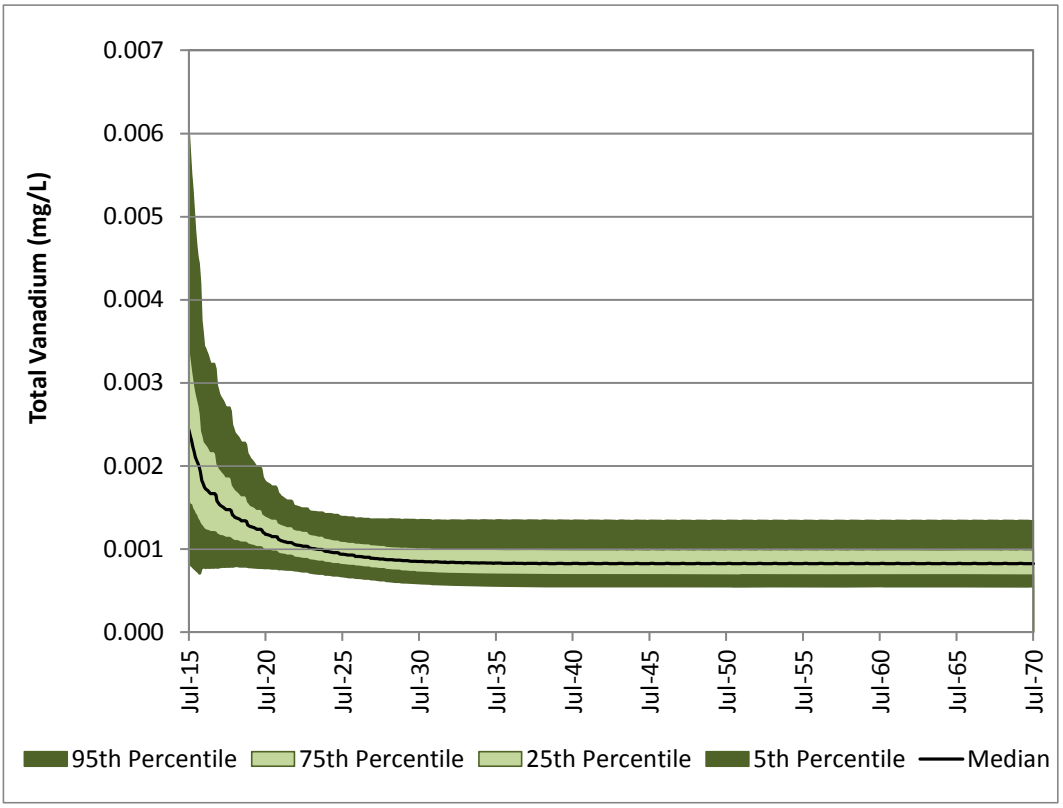

Total Iron (mg/L)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

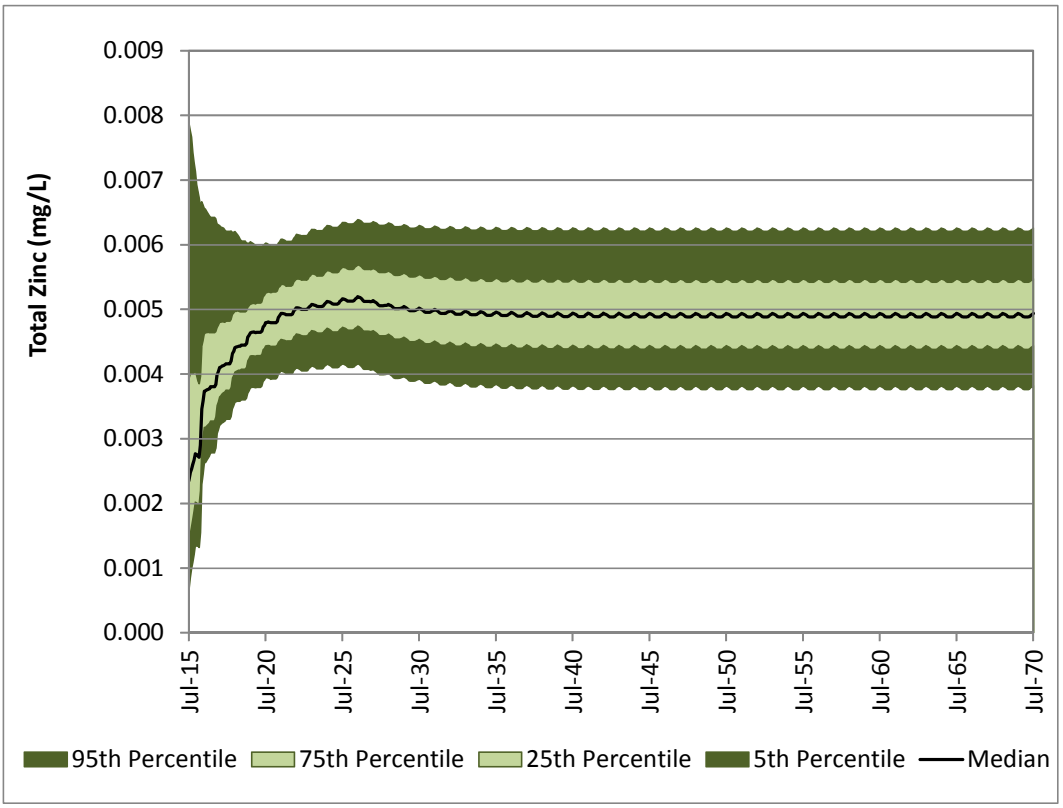

Total Manganese (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median


Total Molybdenum (mg/L)
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median


Total Selenium (mg/L)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

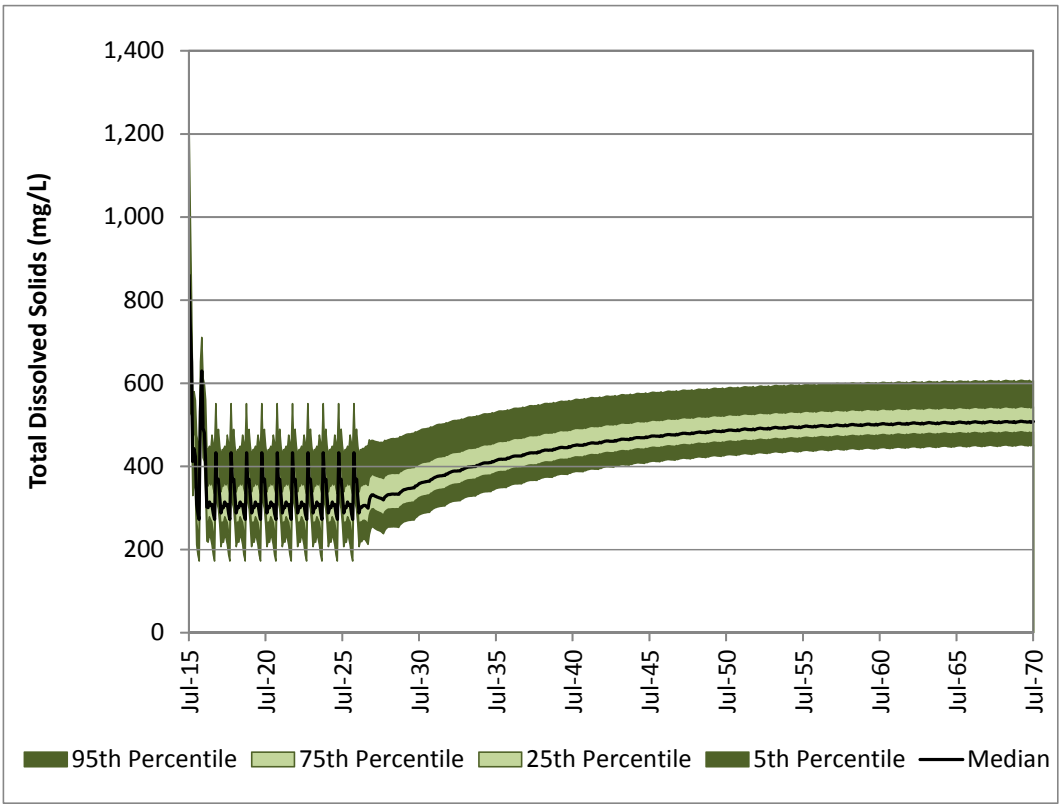

Total Silver (mg/L)
0.000045
0.000040
0.000035
0.000030
0.000025
0.000020
0.000015
0.000010
0.000005
0.000000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

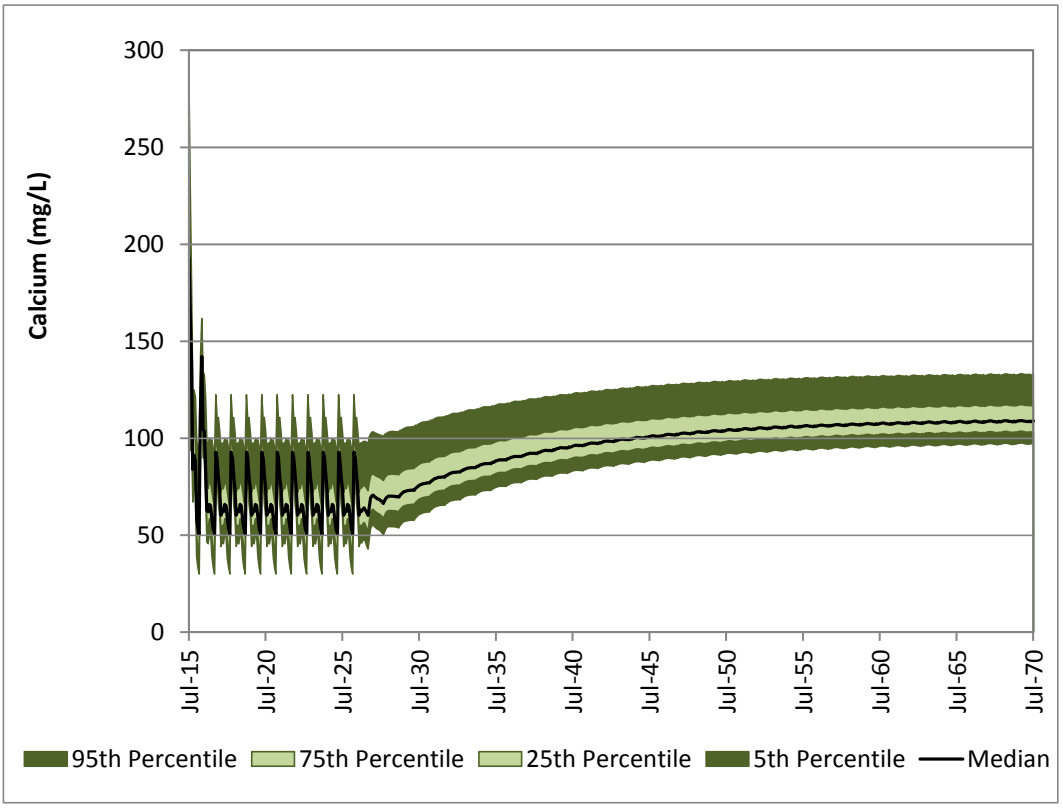

Total Vanadium (mg/L)
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

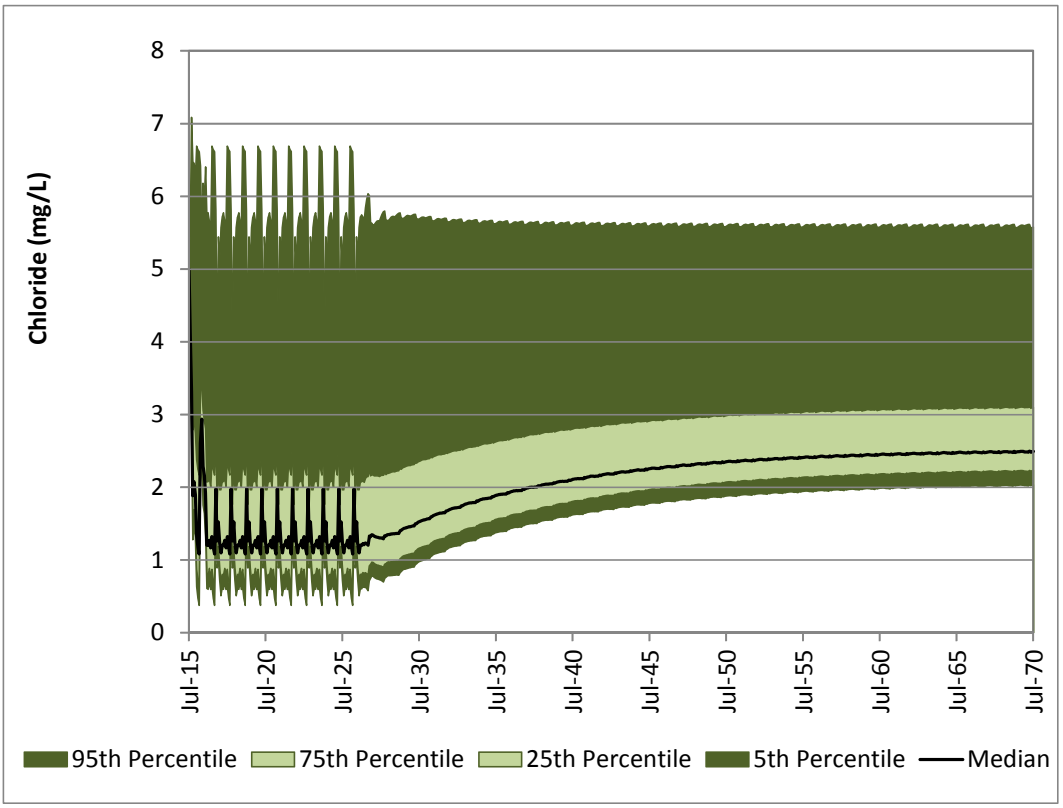


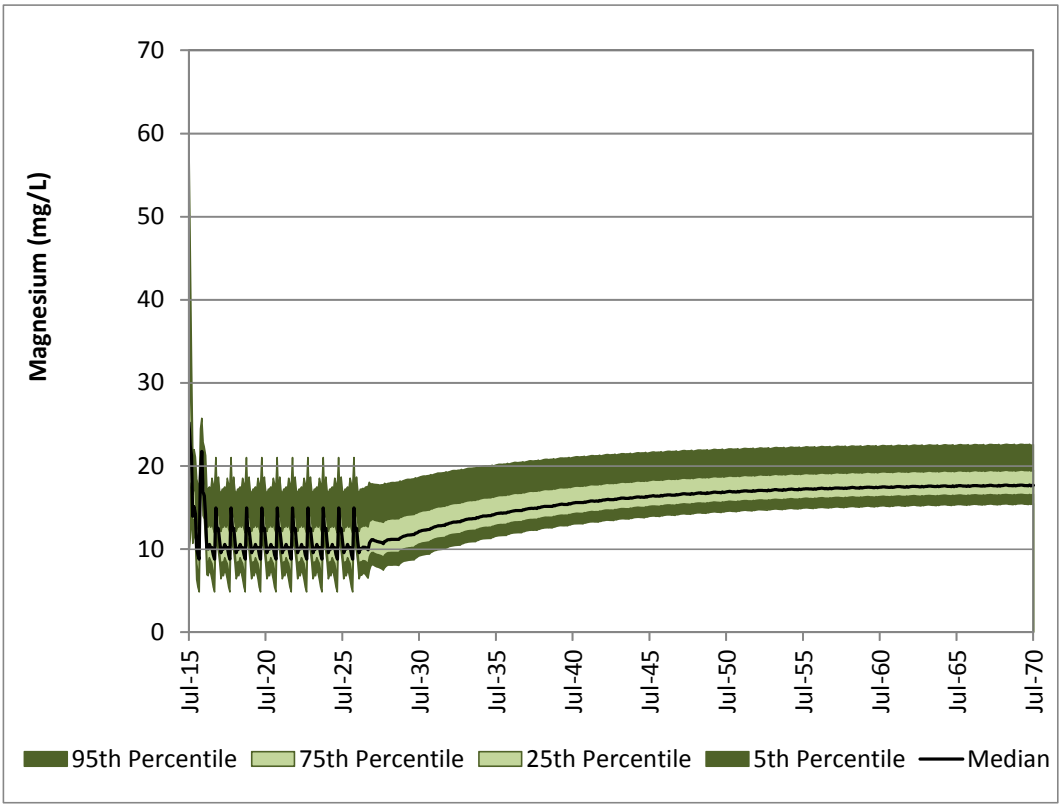
\\golder.gds\gal\burnaby\active_2014\1421\1411734 mount polley\07 deliverables\1411734-12000-site wide water balance\closure\september 29, 2015 report\attachment 3 - time series results\attachment 3.2 - cariboopit.docx

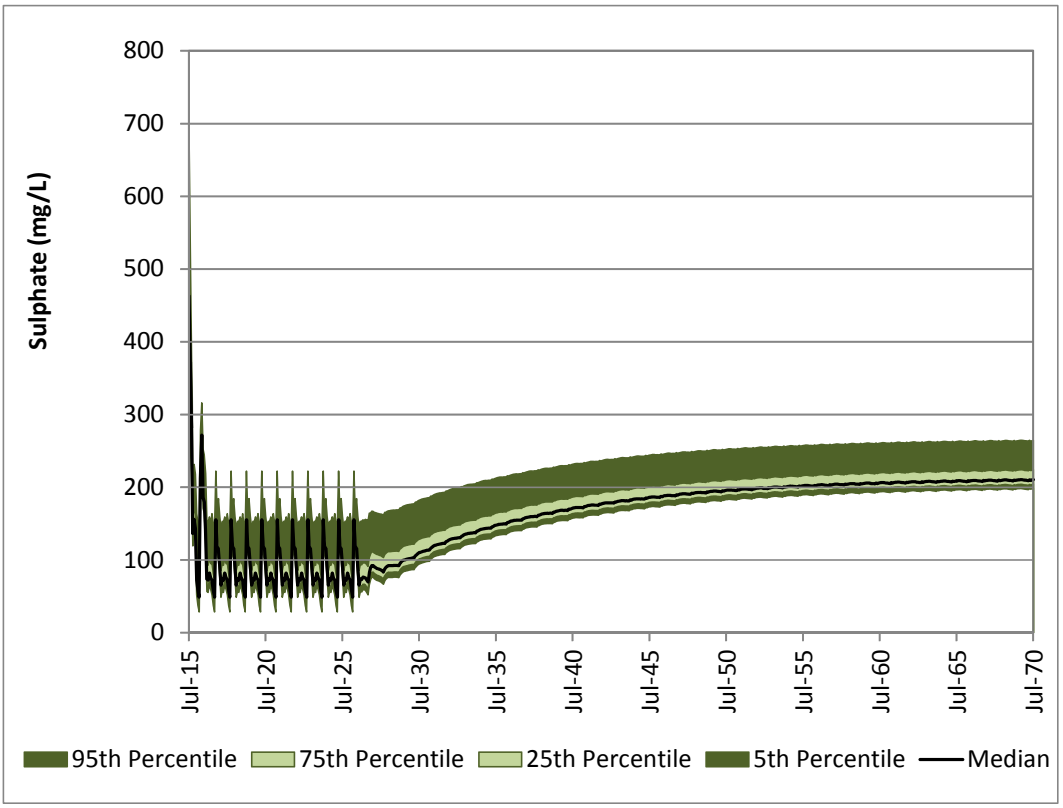
ATTACHMENT 3.3
Time Series Results for Wight Pit

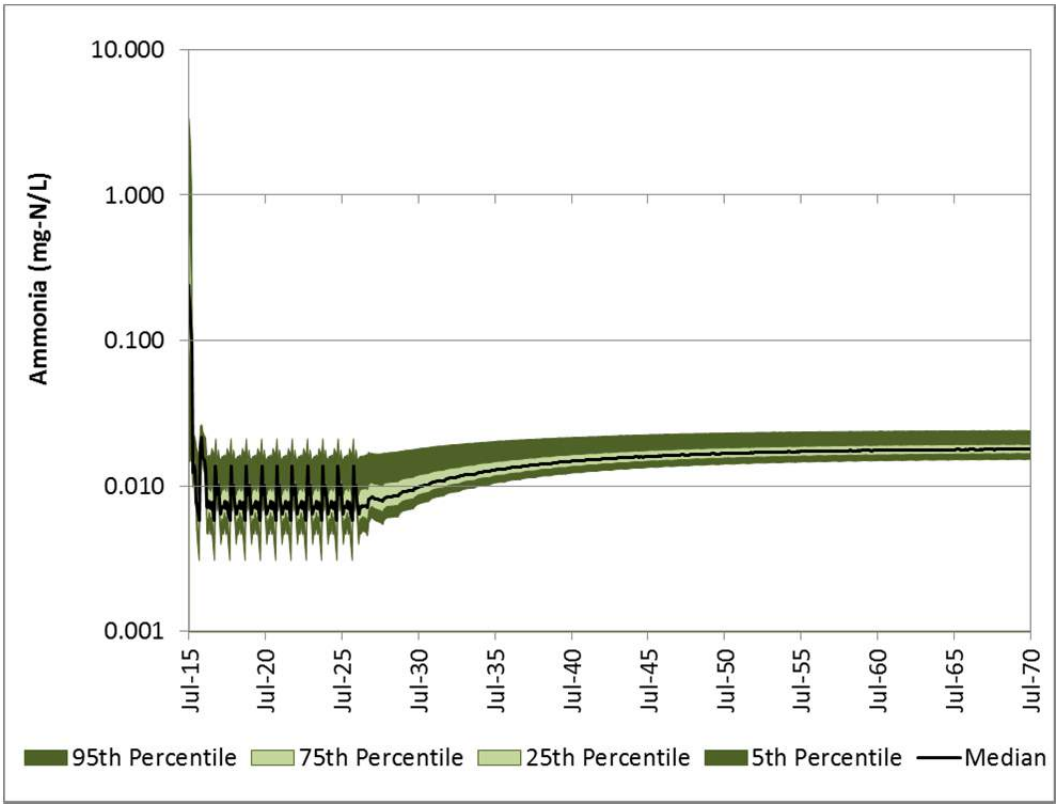

Total Dissolved Solids (mg/L)
1,400
1,200
1,000
800
600
400
200
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

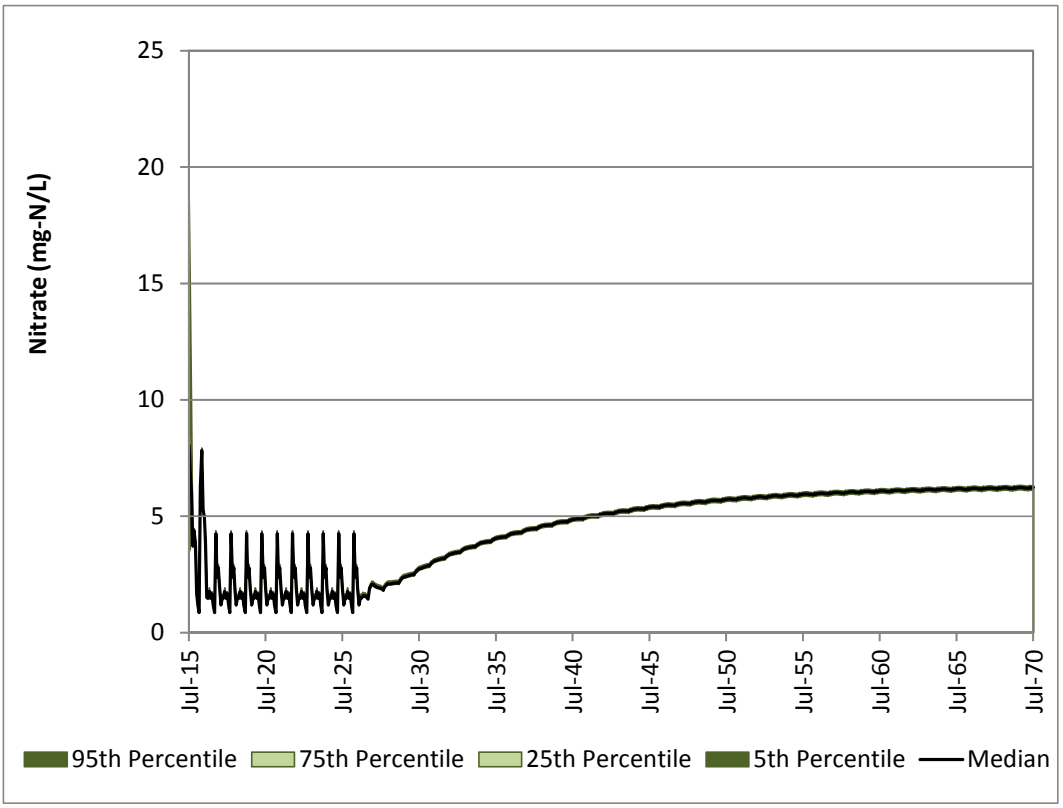

Calcium (mg/L)
300
250
200
150
100
50
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

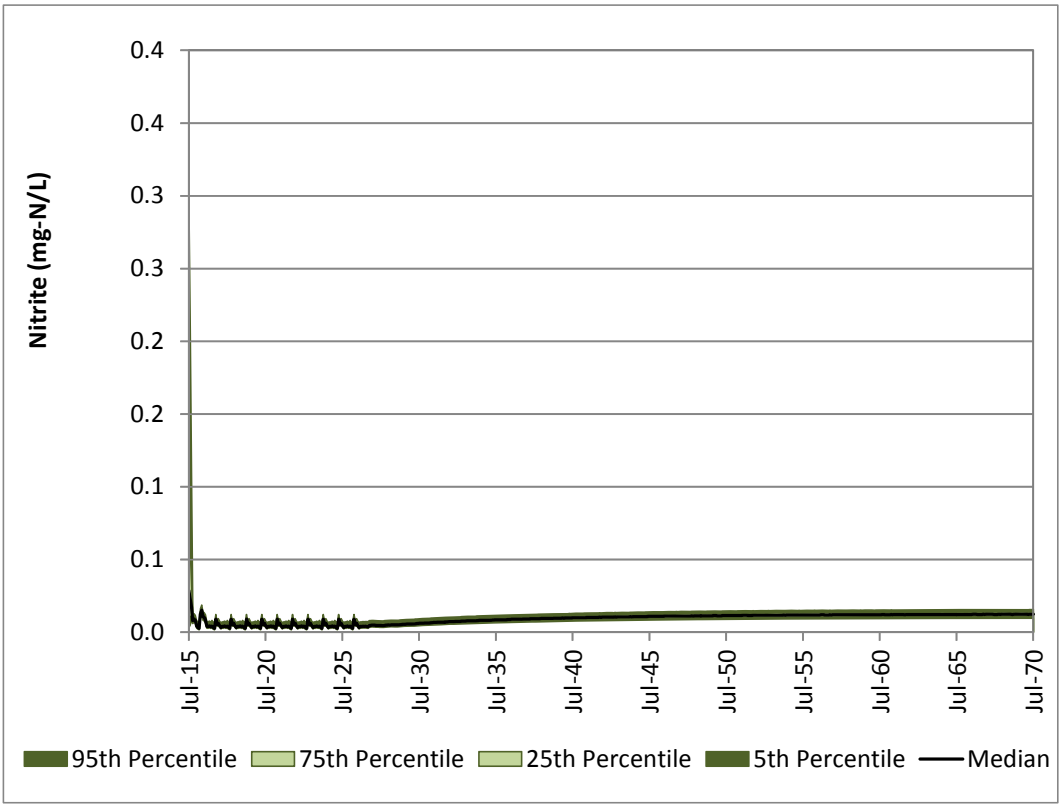

Chloride (mg/L)
8
7
6
5
4
3
2
1
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

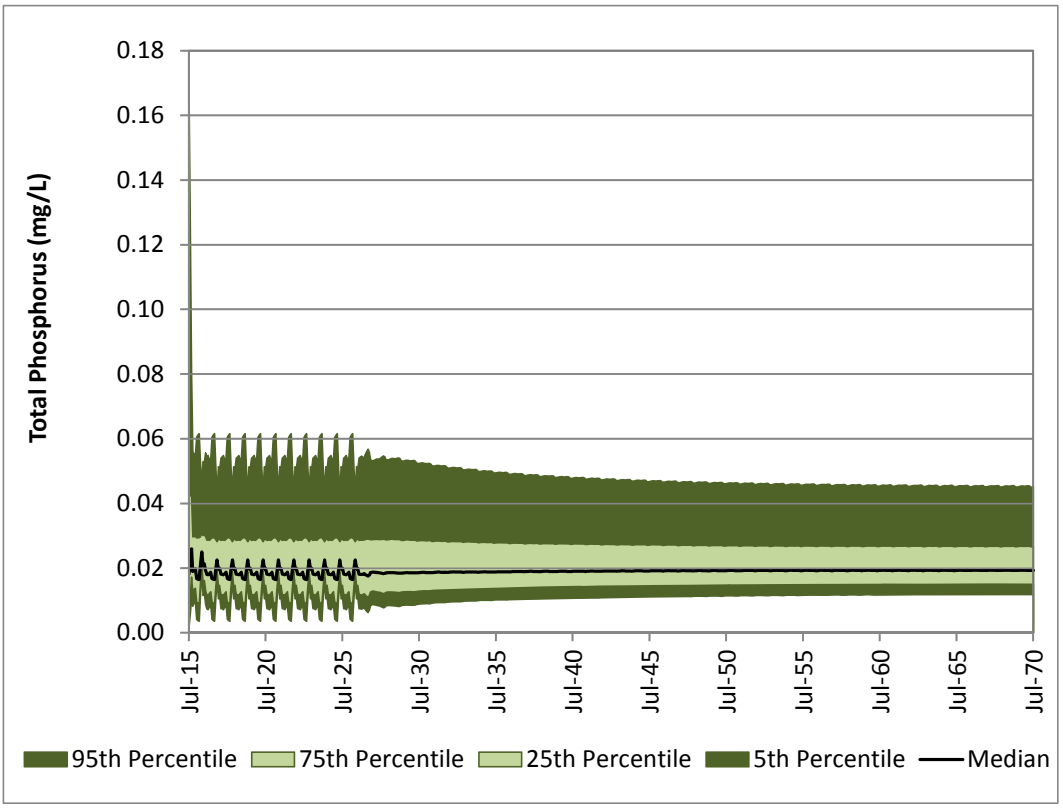

Magnesium (mg/L)
70
60
50
40
30
20
10
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

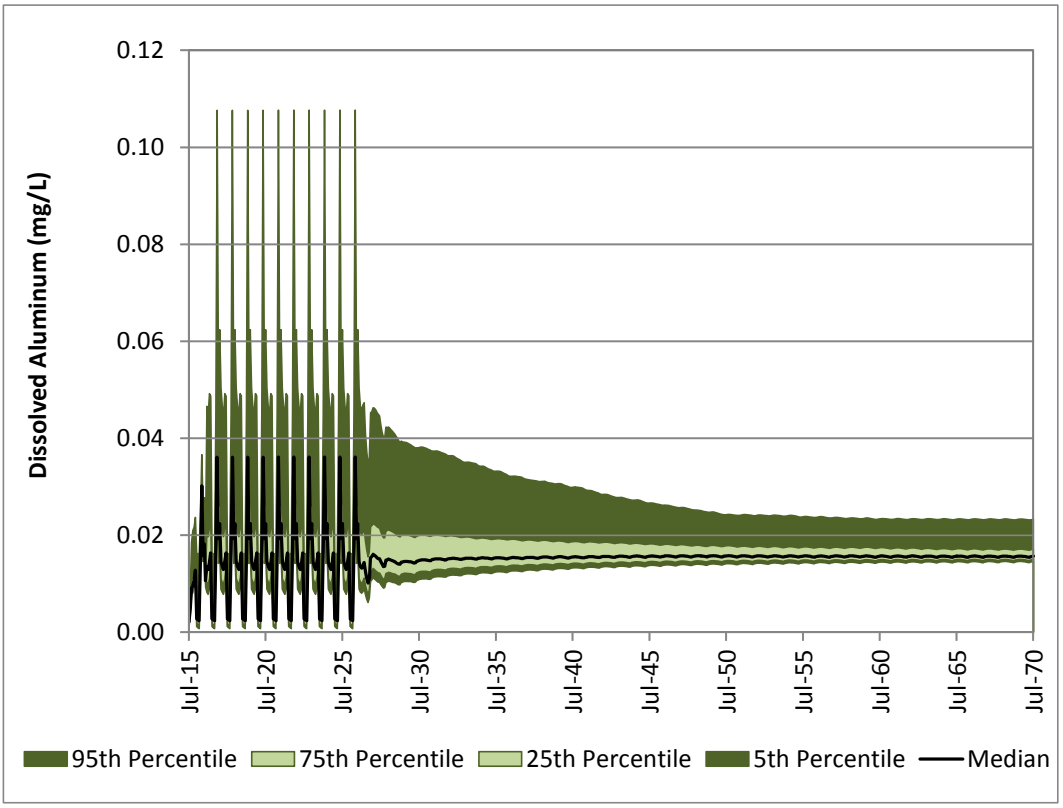

Sulphate (mg/L)
800
700
600
500
400
300
200
100
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

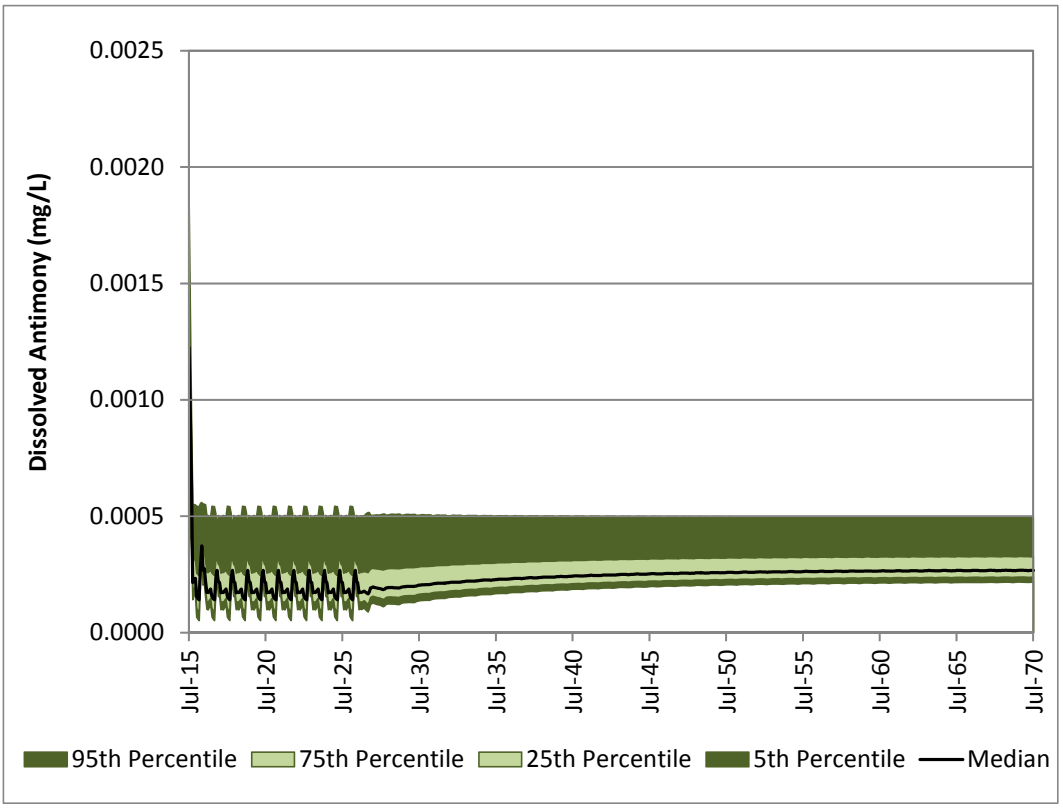

Ammonia (mg-N/L)
10.000
1.000
0.100
0.010
0.001
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

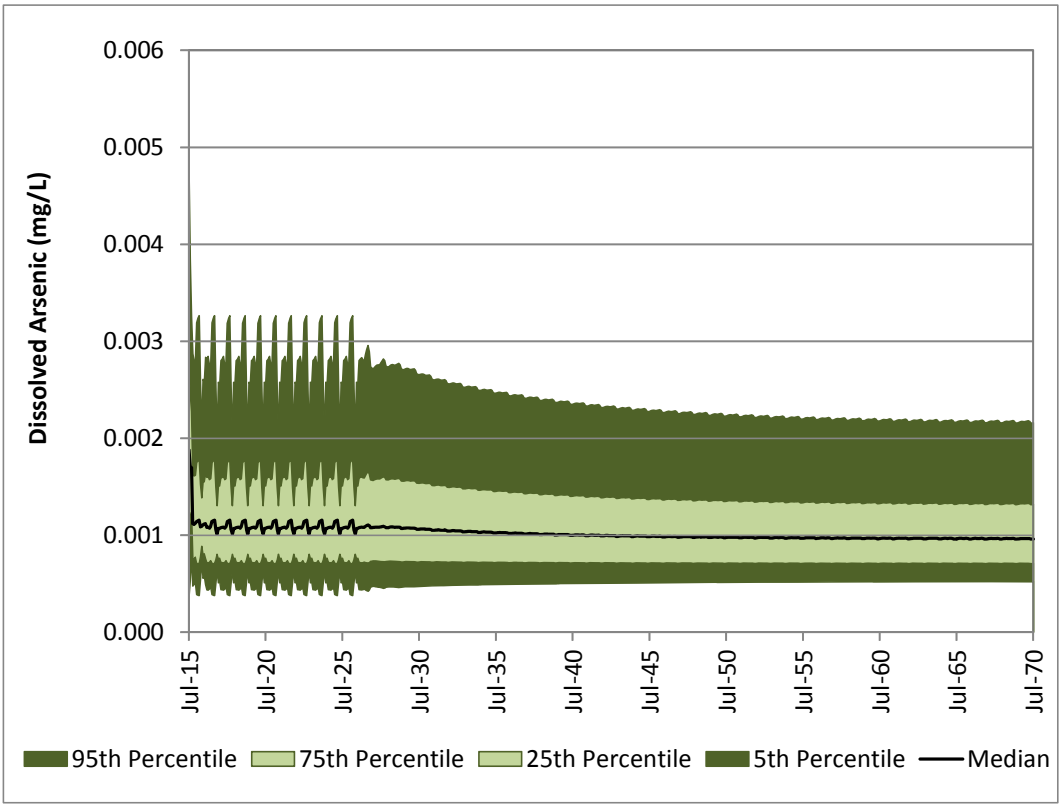

Nitrate (mg-N/L)
25
20
15
10
5
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

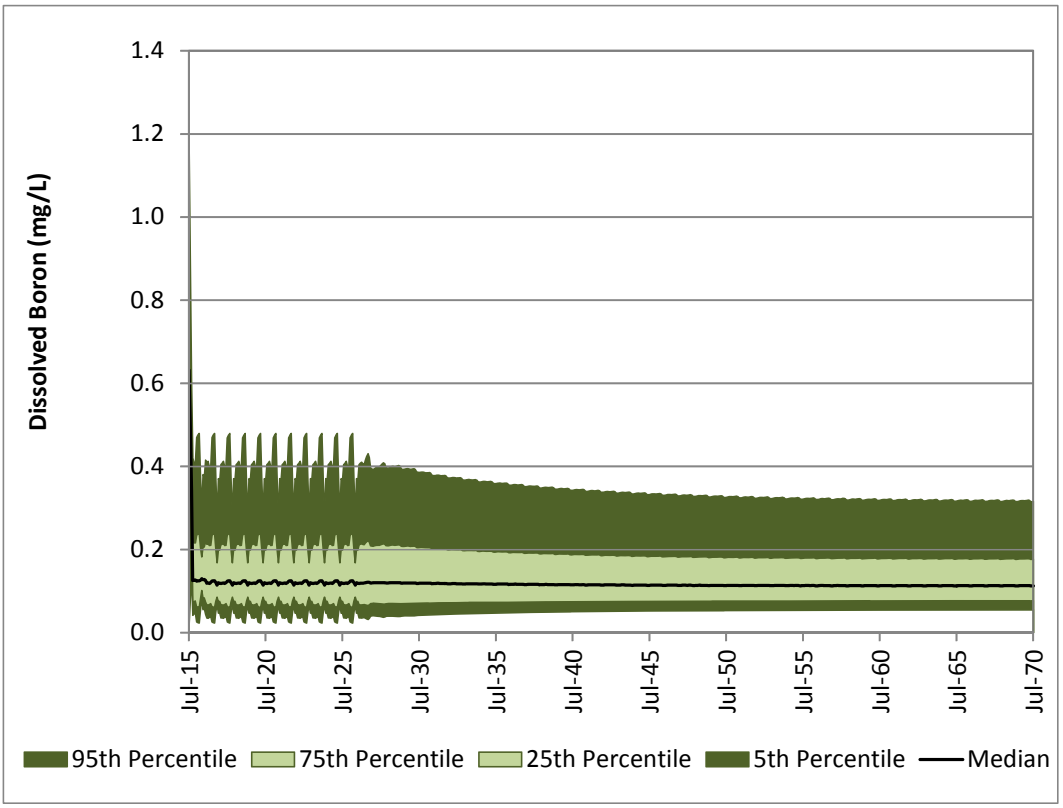

Nitrite (mg-N/L)
0.4
0.4
0.3
0.3
0.2
0.2
0.1
0.1
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

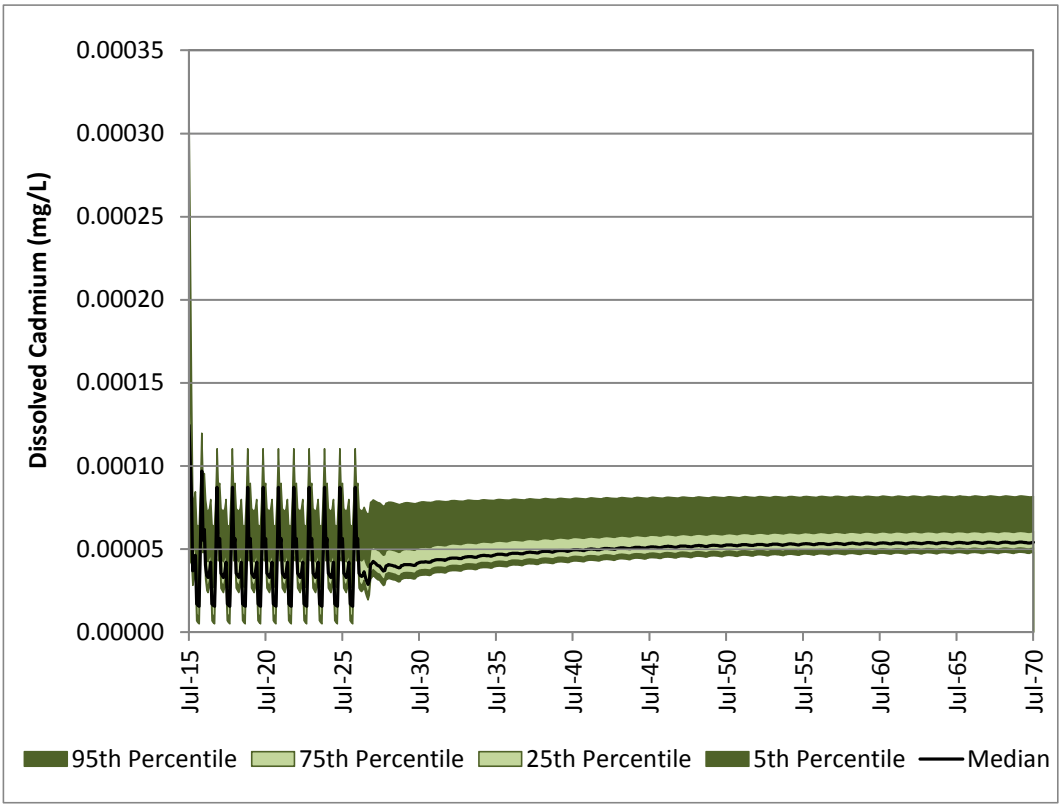

Total Phosphorus (mg/L)
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

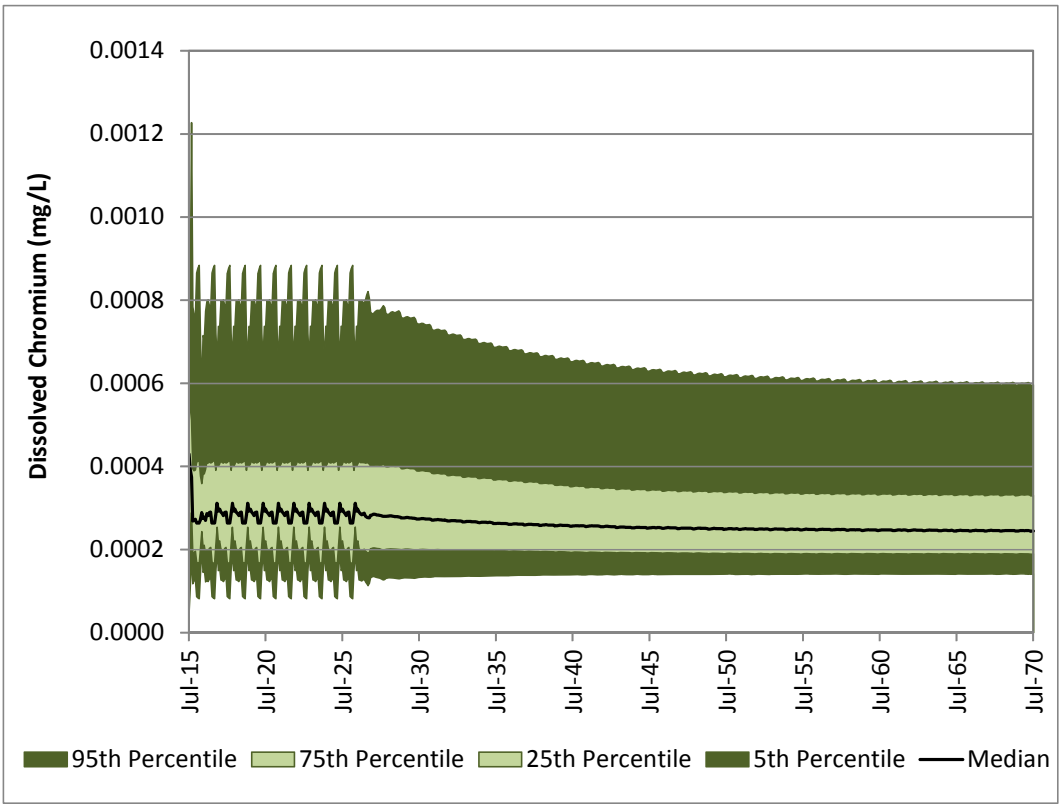

Dissolved Aluminum (mg/L)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

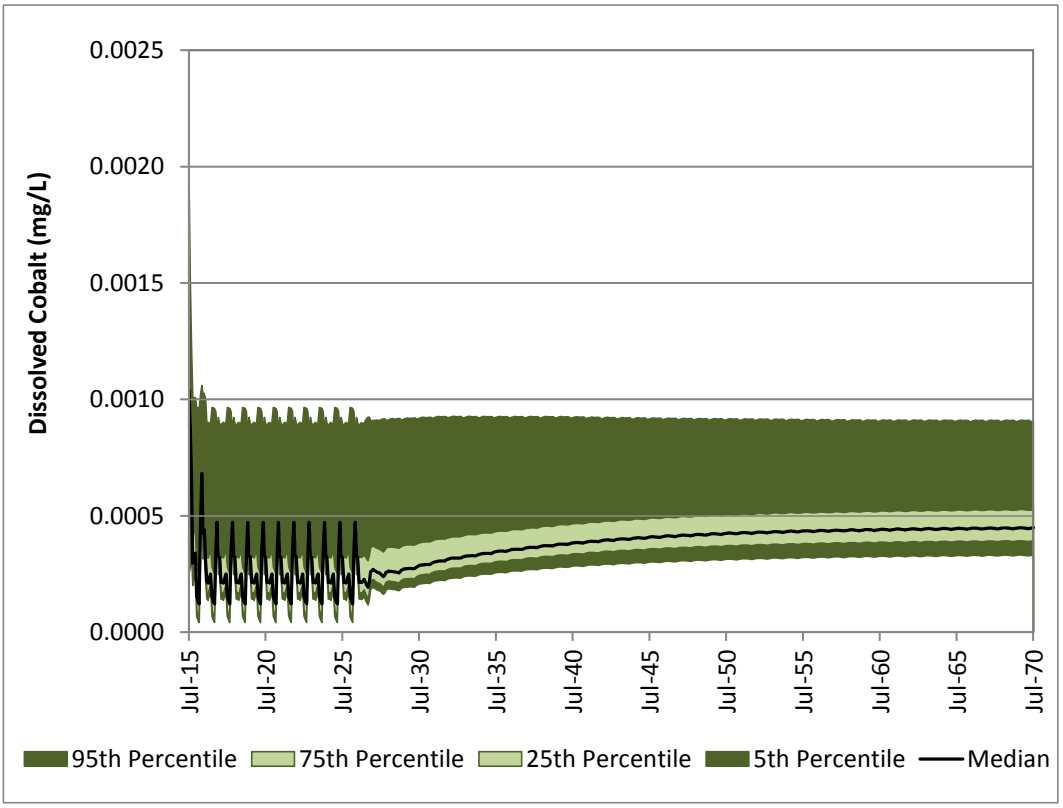

Dissolved Antimony (mg/L)
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

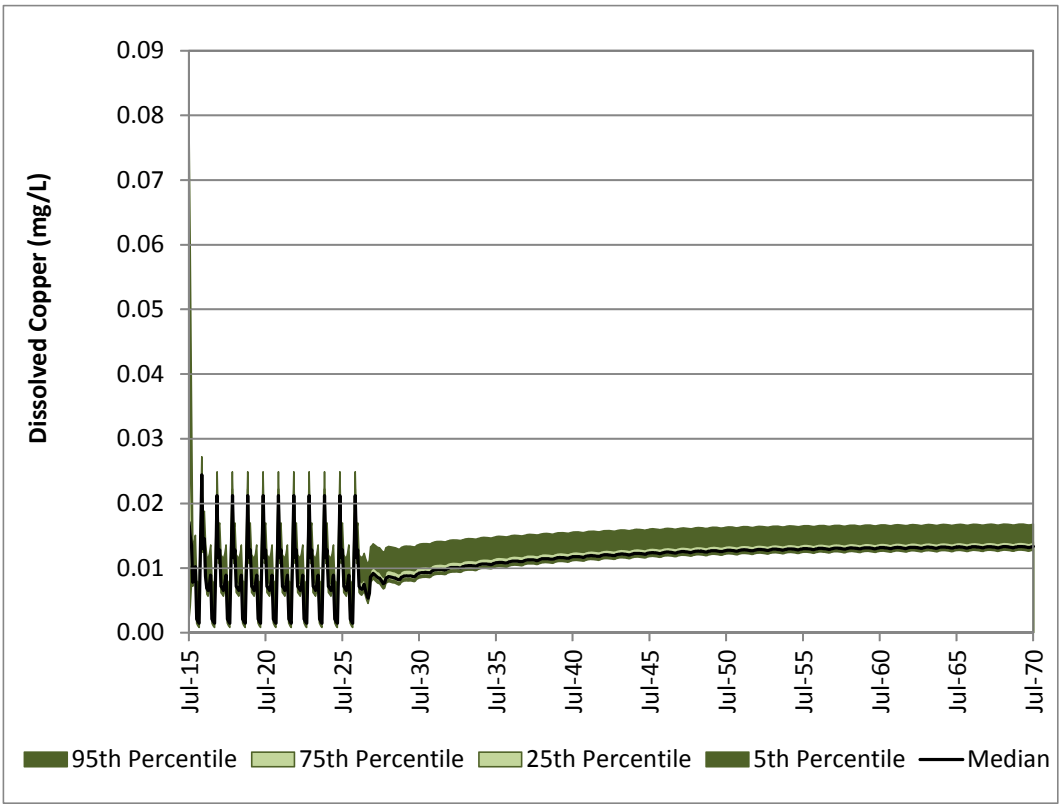

Dissolved Arsenic (mg/L)
0.006
0.005
0.004
0.003
0.002
0.001
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

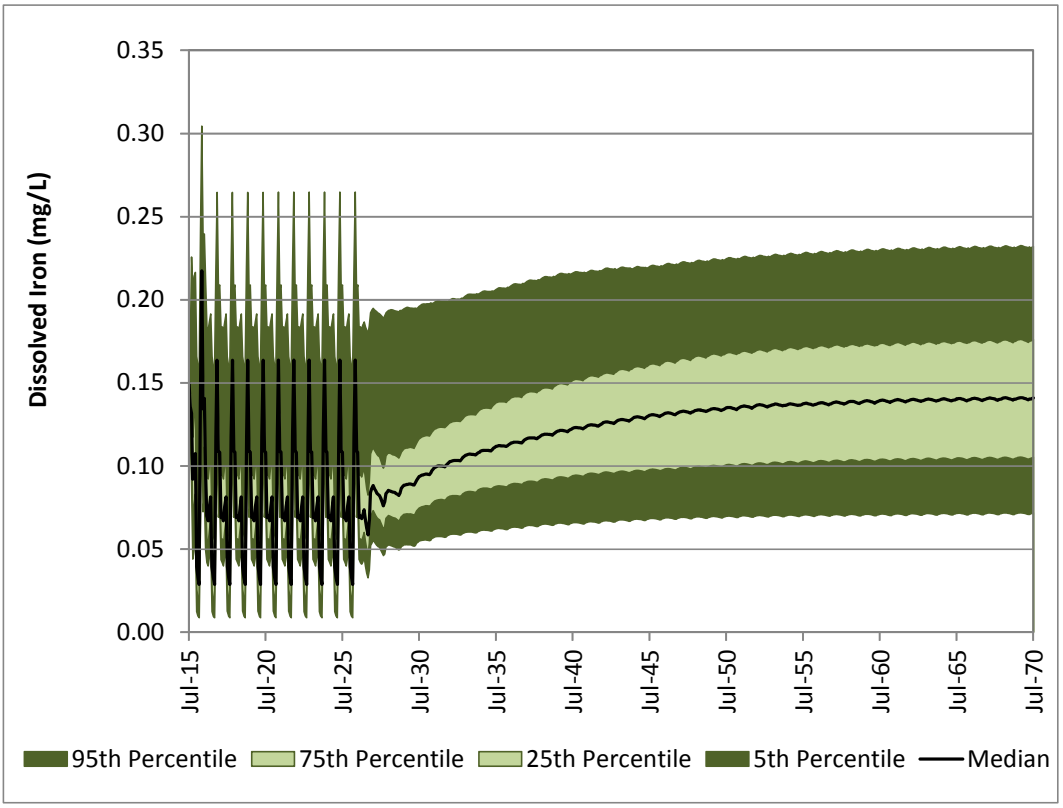

Dissolved Boron (mg/L)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

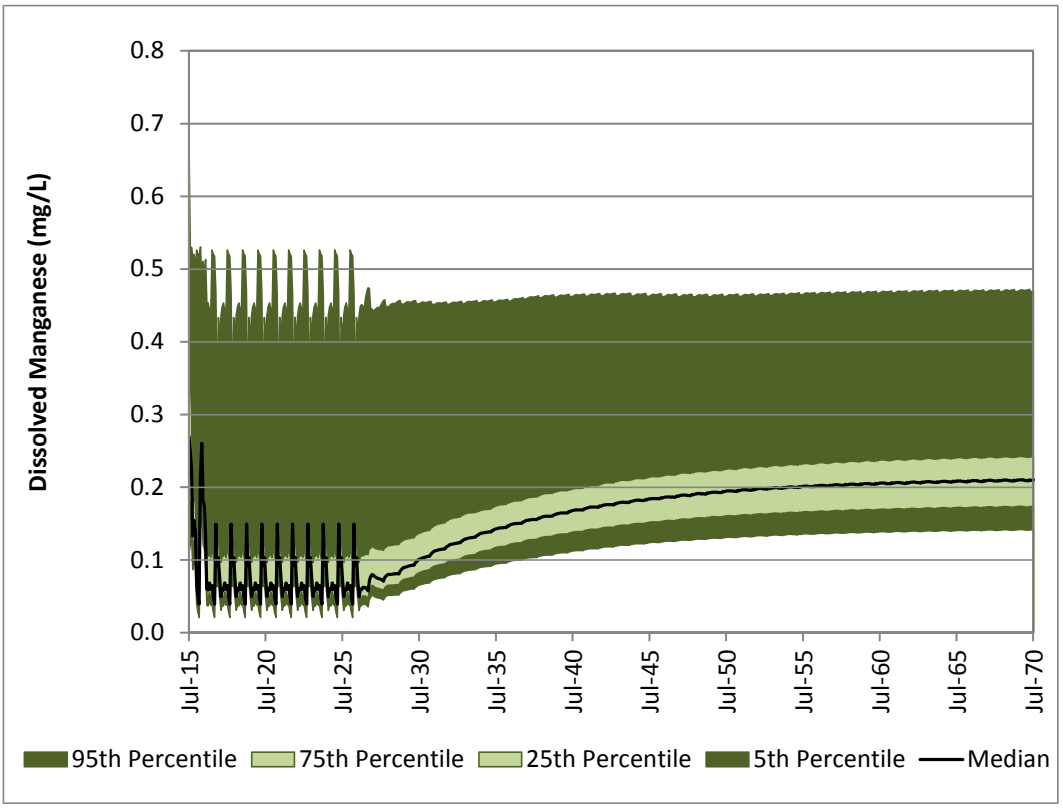

Dissolved Cadmium (mg/L)
0.00035
0.00030
0.00025
0.00020
0.00015
0.00010
0.00005
0.00000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

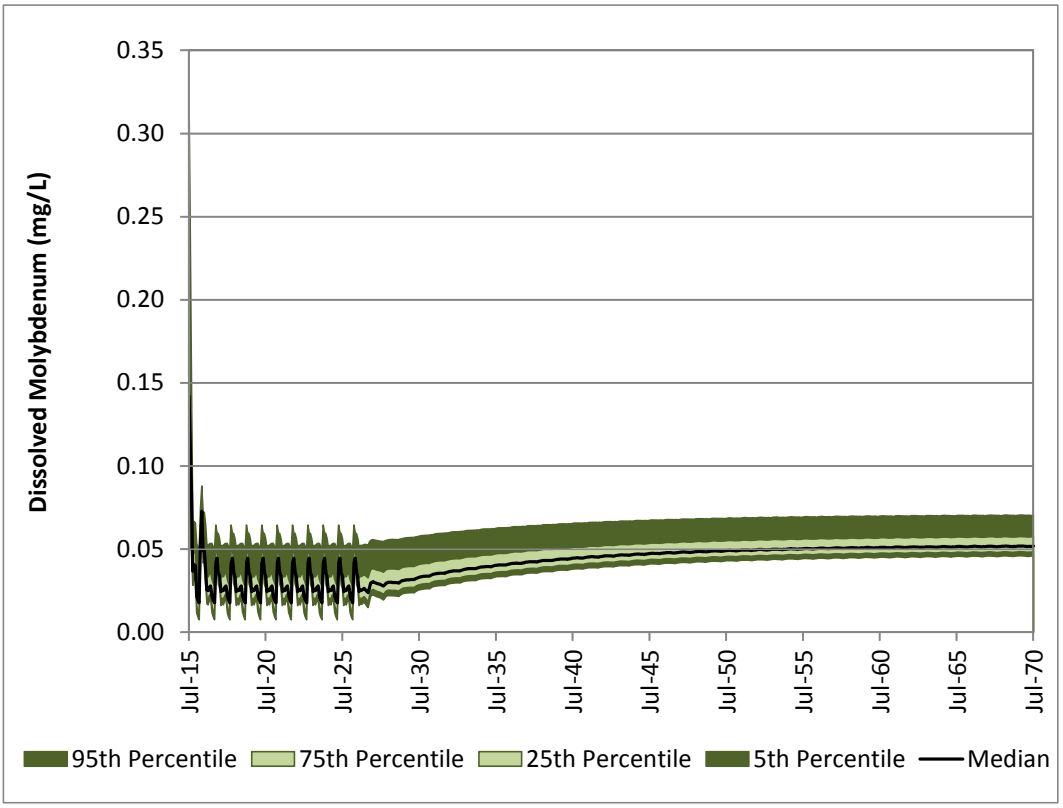

Dissolved Chromium (mg/L)
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

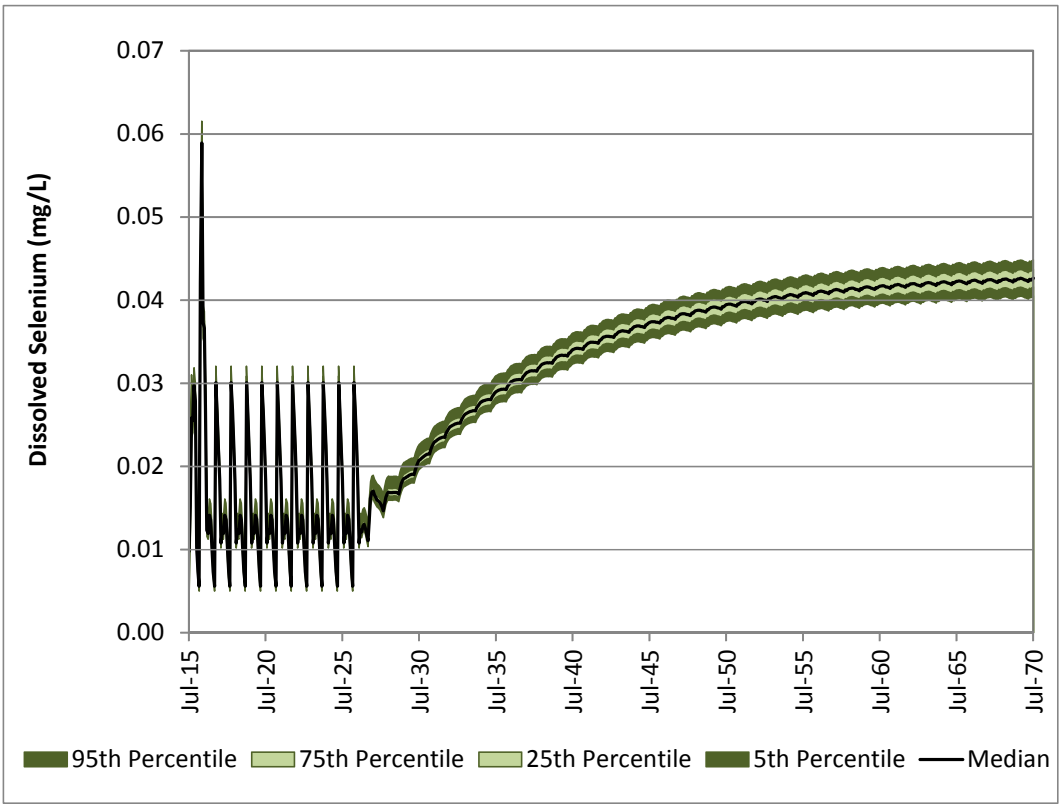

Dissolved Cobalt (mg/L)
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

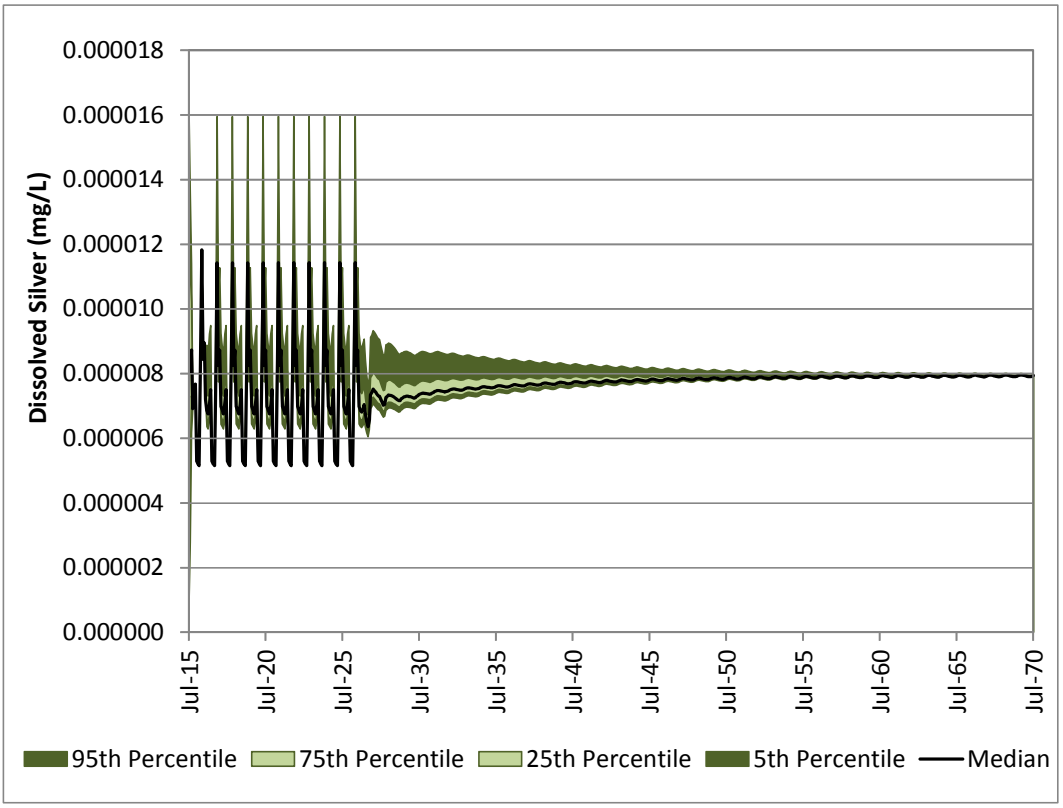

Dissolved Copper (mg/L)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

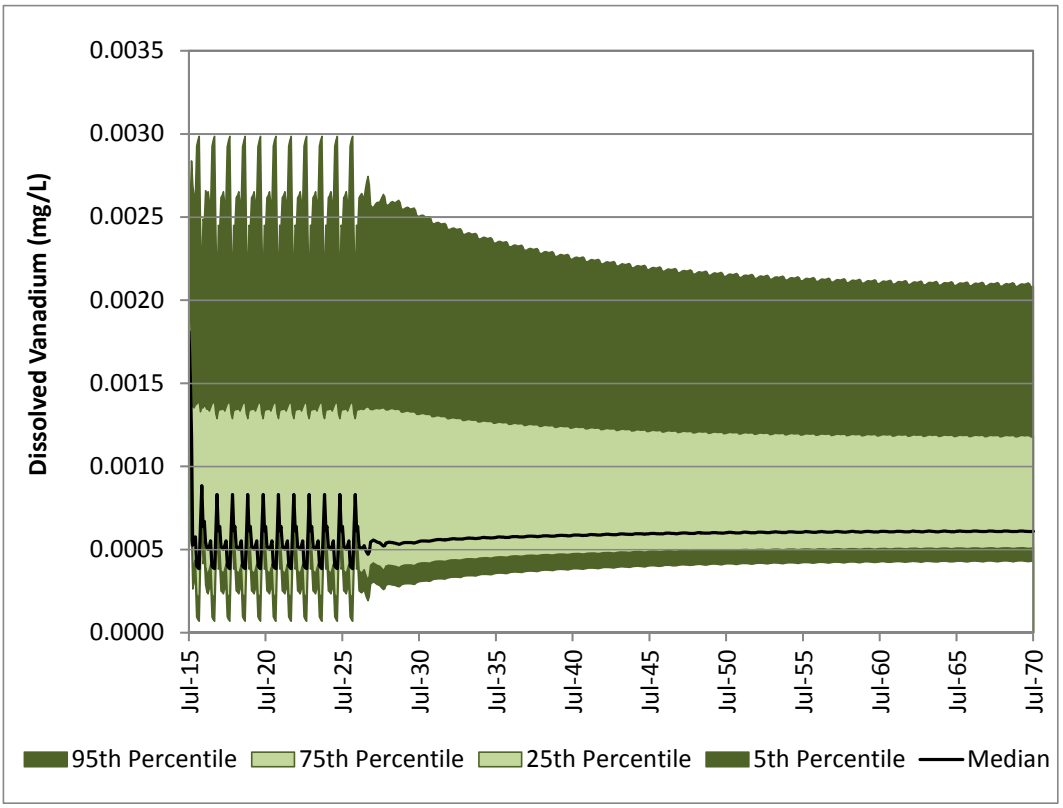

Dissolved Iron (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

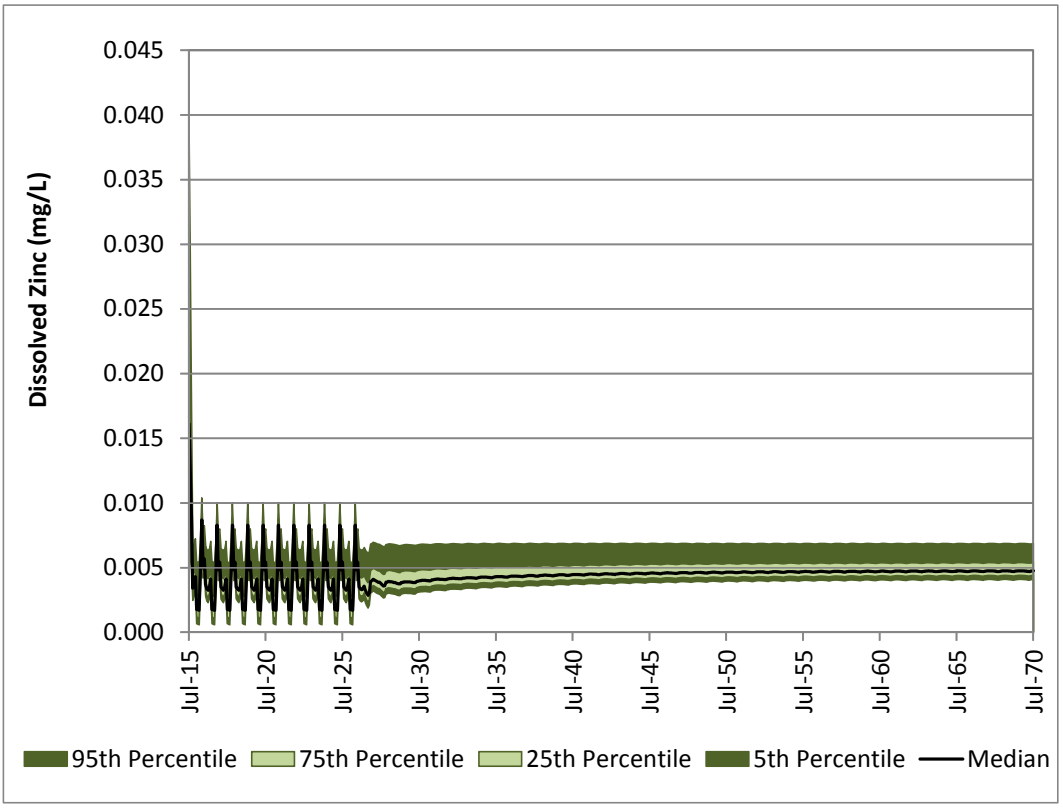

Dissolved Manganese (mg/L)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

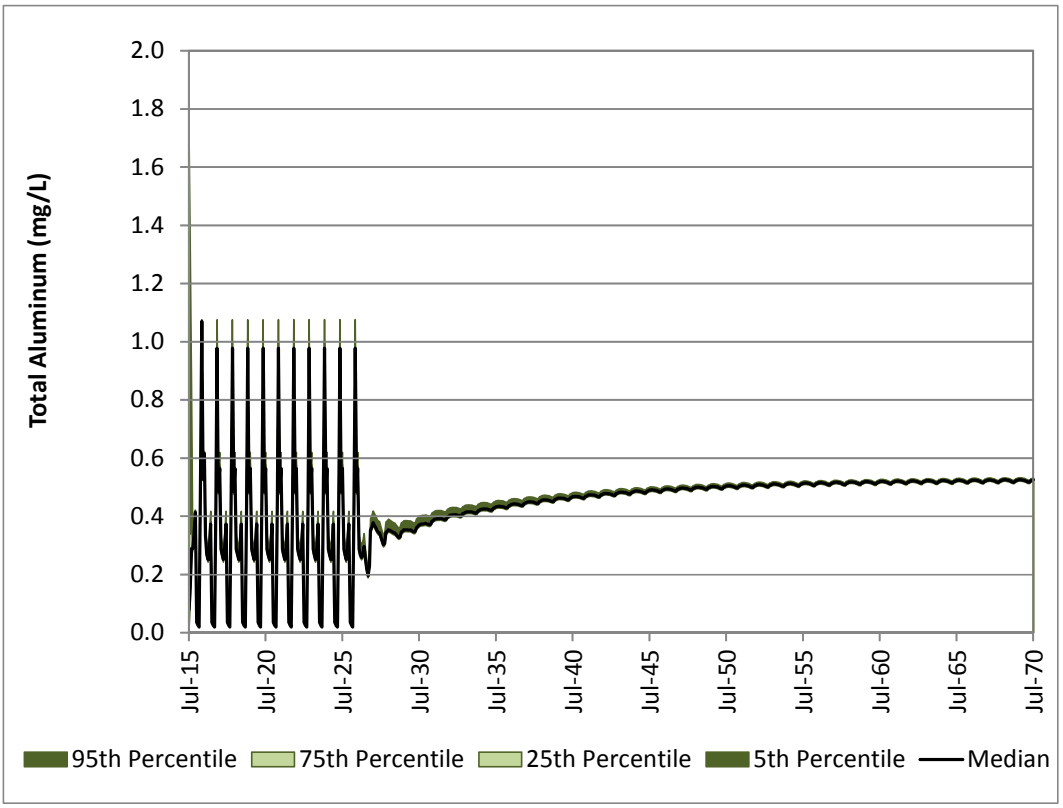

Dissolved Molybdenum (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

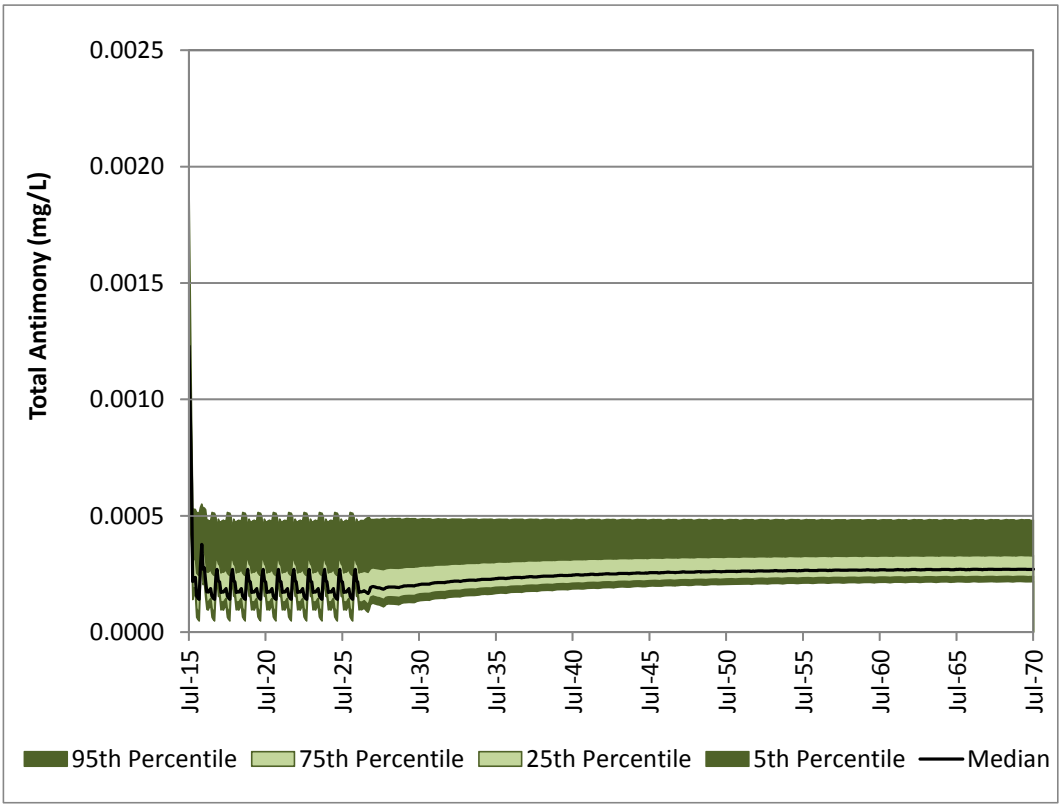

Dissolved Selenium (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

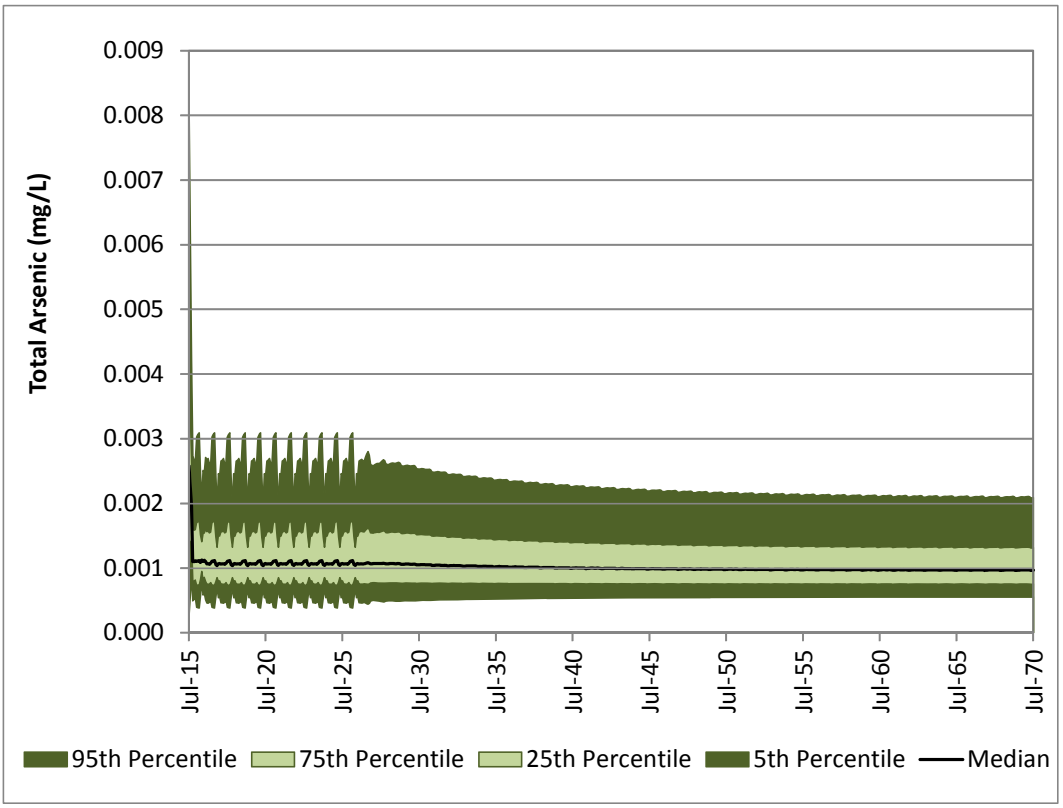

Dissolved Silver (mg/L)
0.000018
0.000016
0.000014
0.000012
0.000010
0.000008
0.000006
0.000004
0.000002
0.000000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

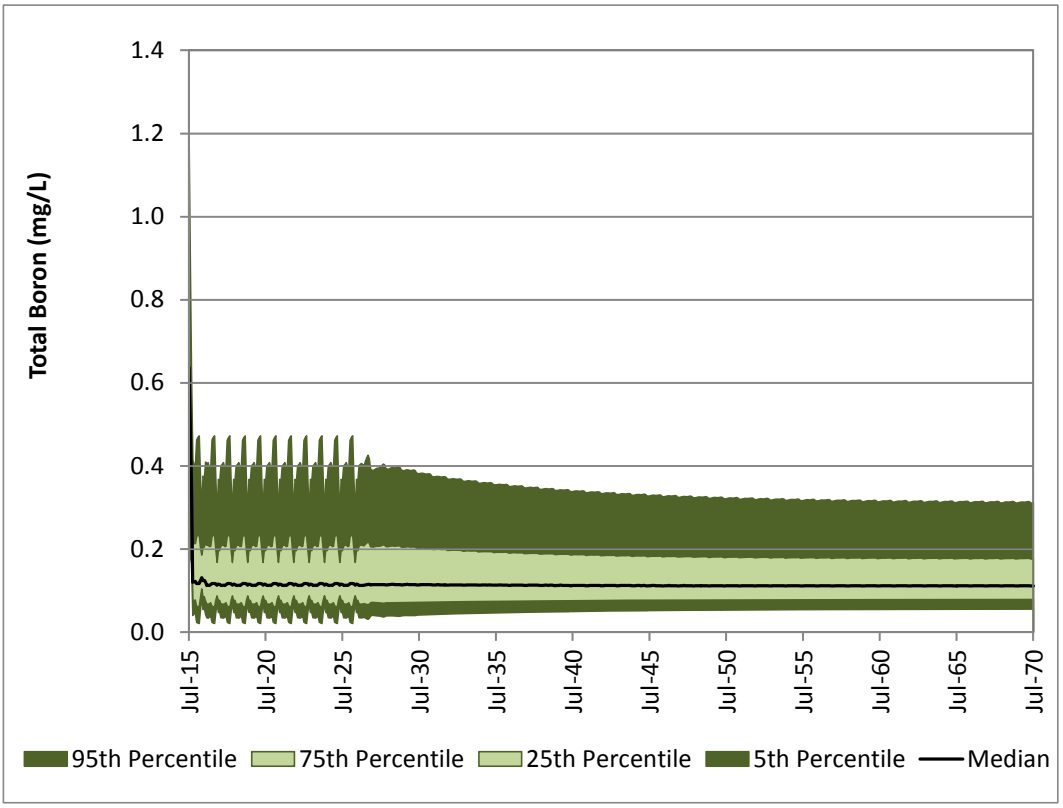

Dissolved Vanadium (mg/L)
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

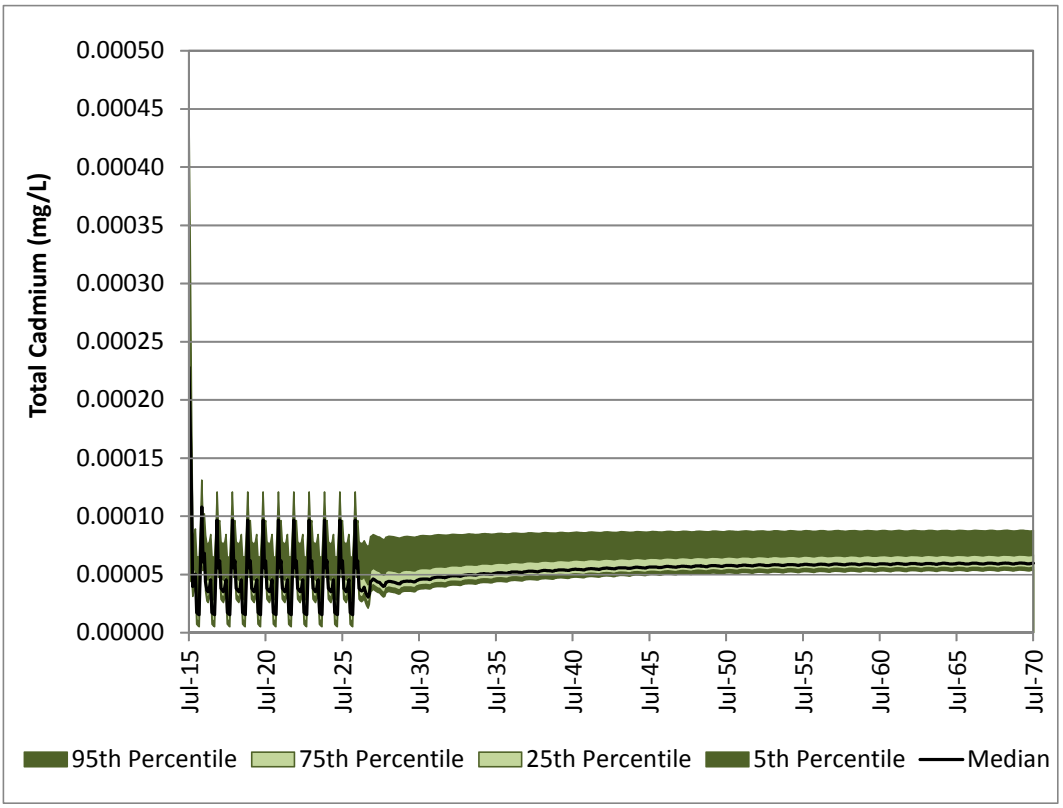

Dissolved Zinc (mg/L)
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

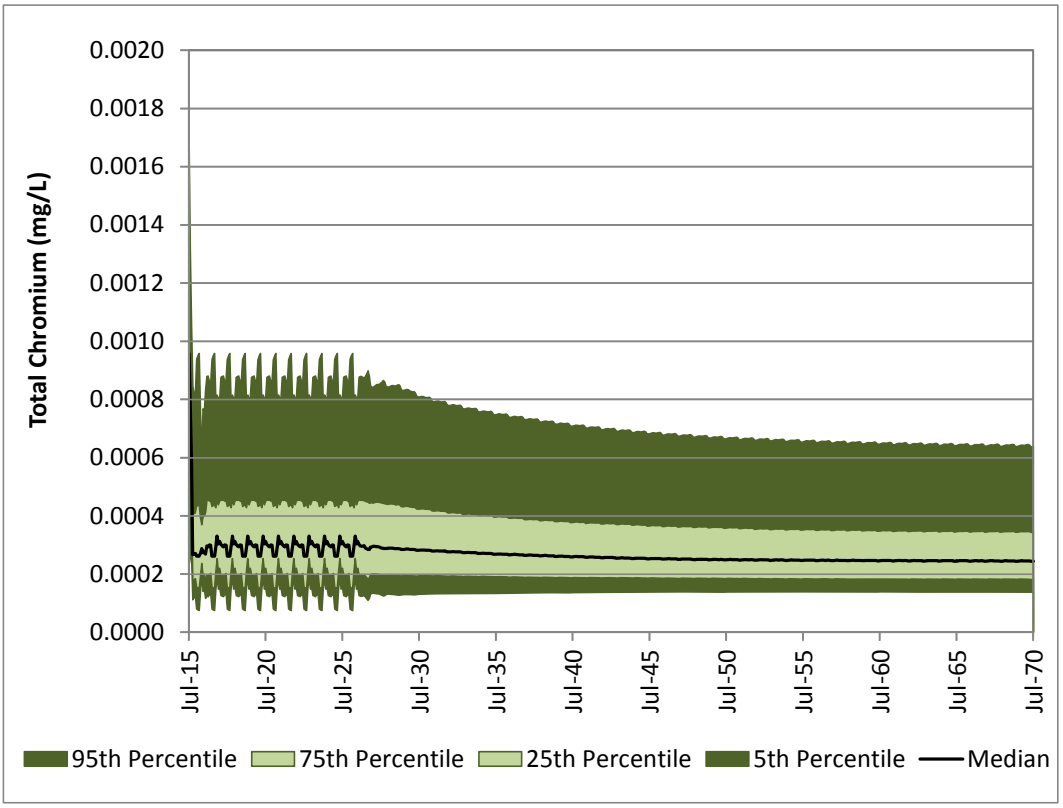

Total Aluminum (mg/L)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

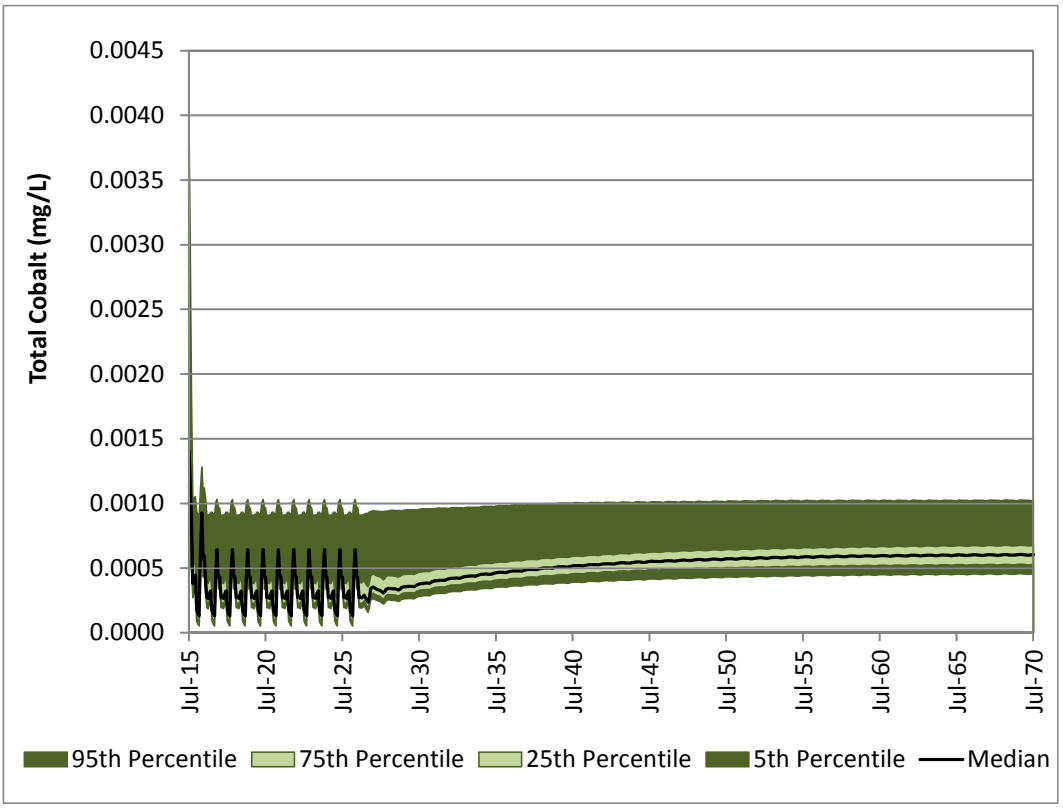

Total Antimony (mg/L)
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

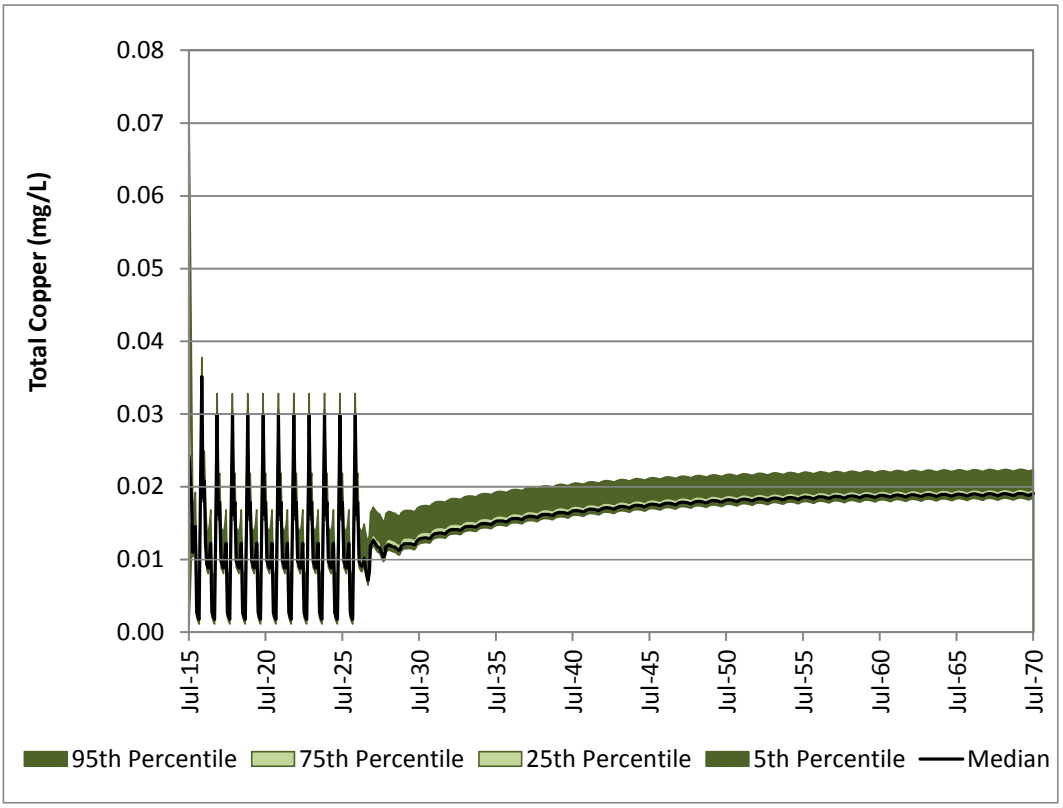

Total Arsenic (mg/L)
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

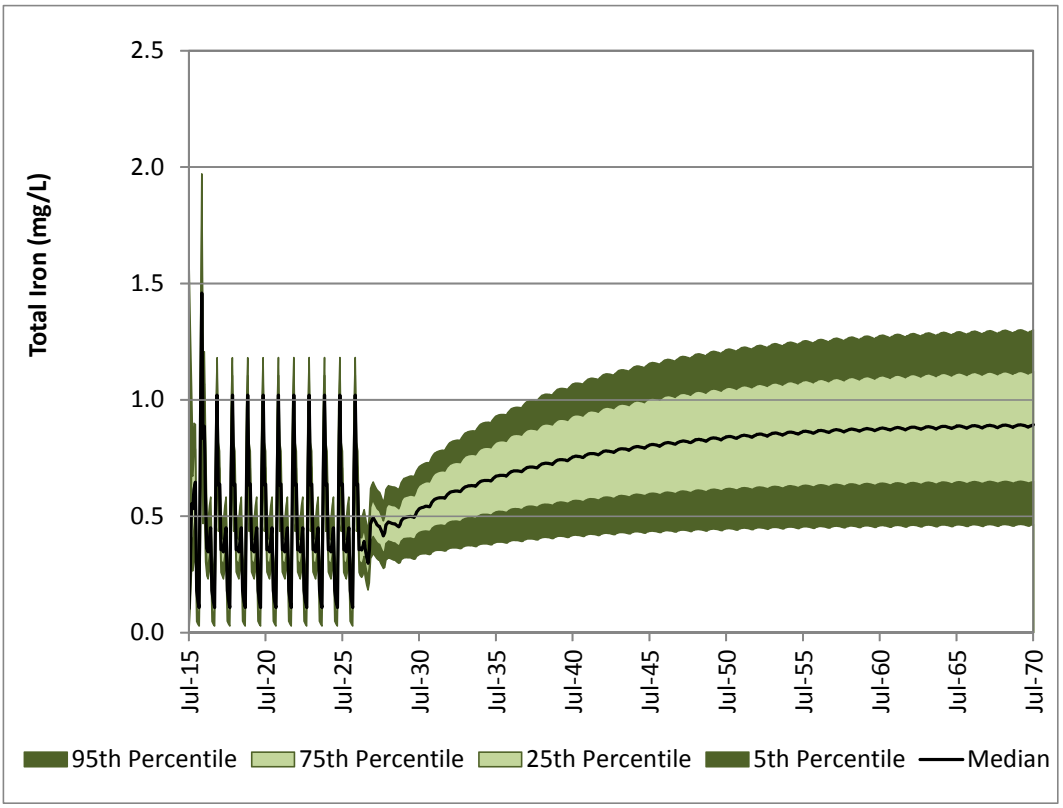

Total Boron (mg/L)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

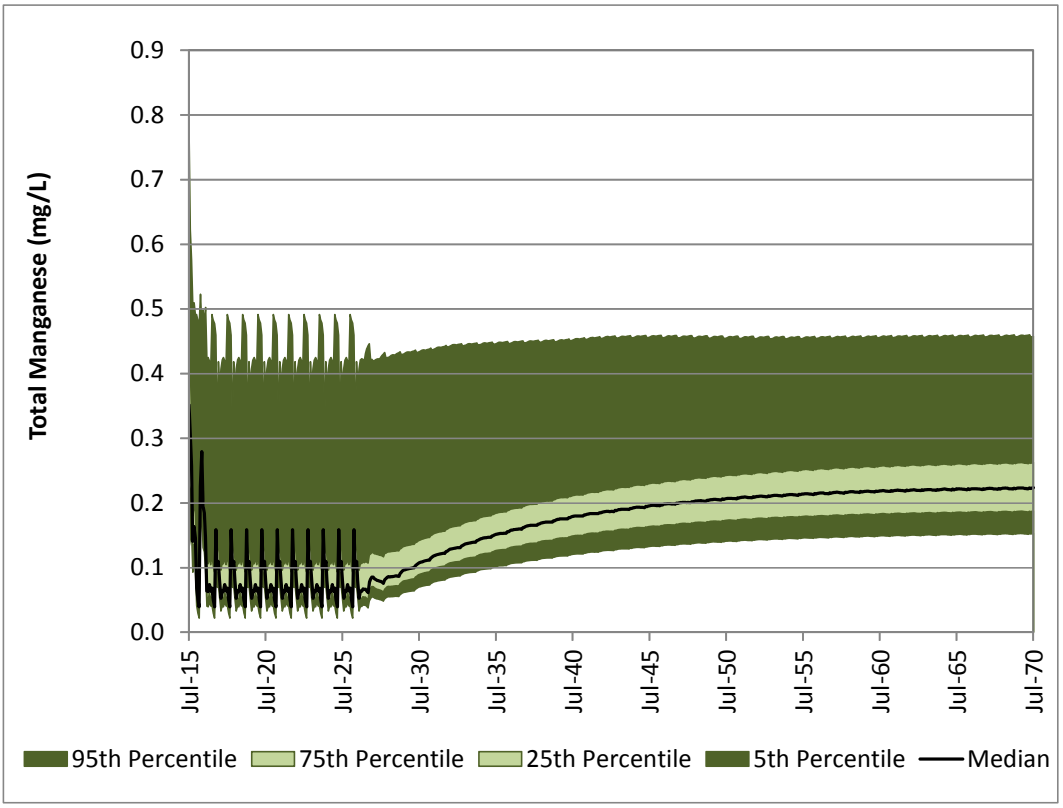

Total Cadmium (mg/L)
0.00050
0.00045
0.00040
0.00035
0.00030
0.00025
0.00020
0.00015
0.00010
0.00005
0.00000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

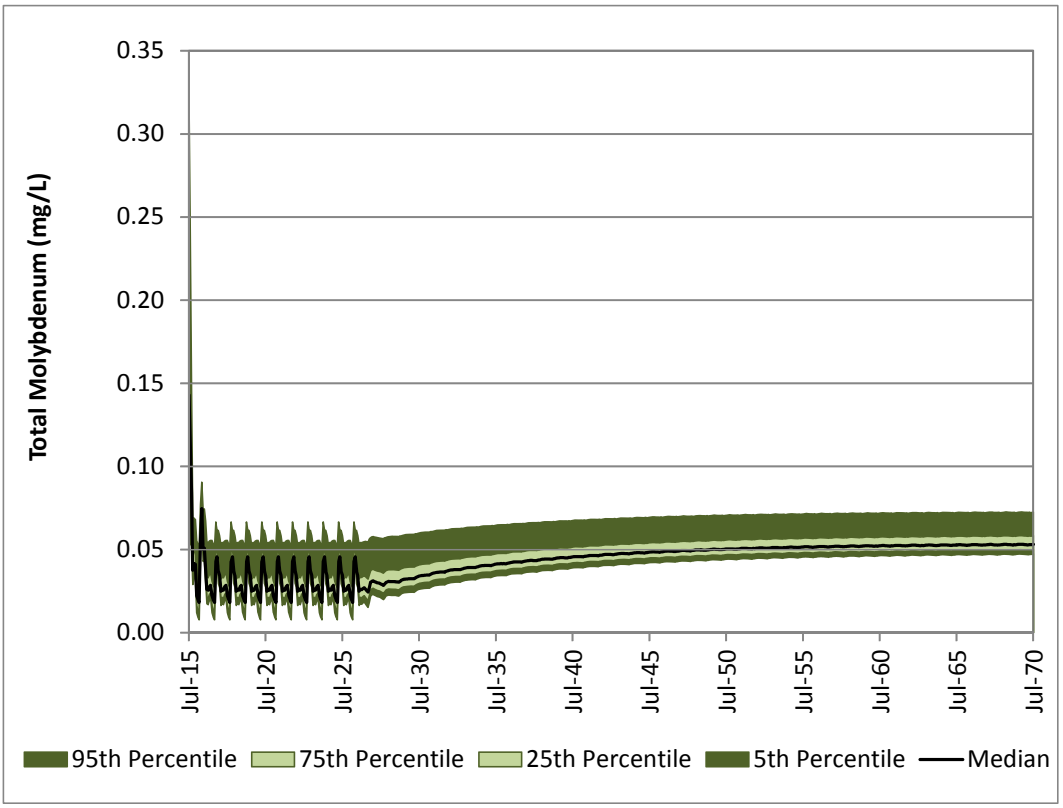

Total Chromium (mg/L)
0.0020
0.0018
0.0016
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

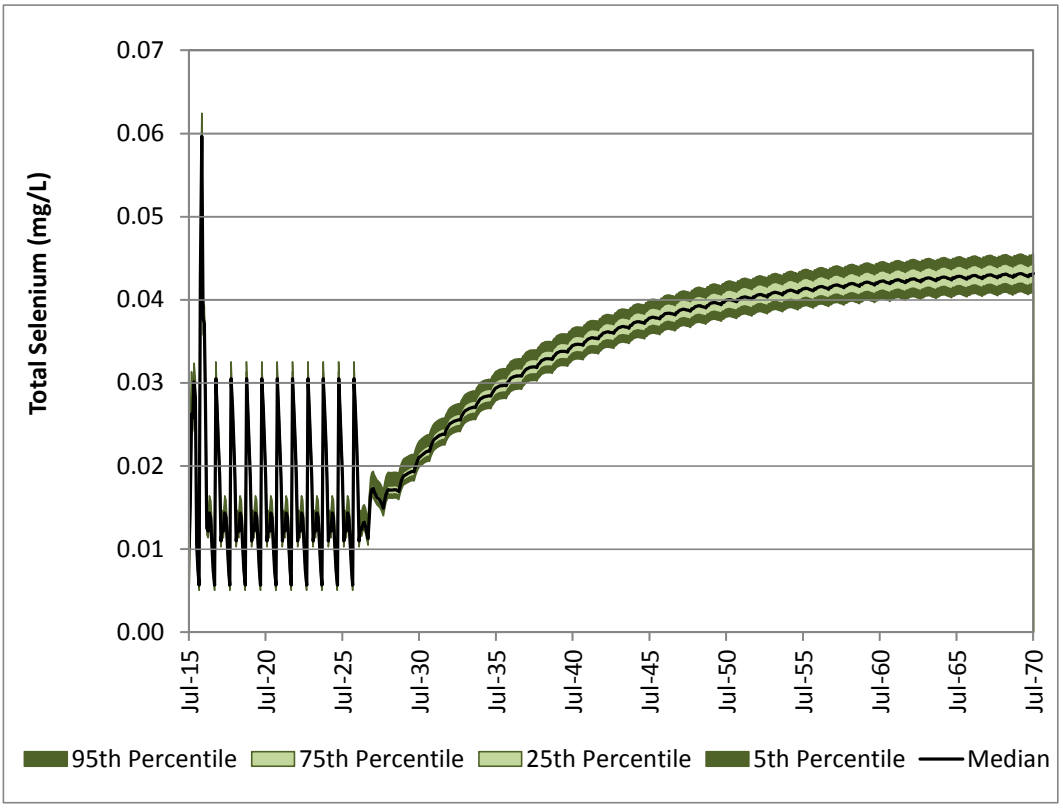

Total Cobalt (mg/L)
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

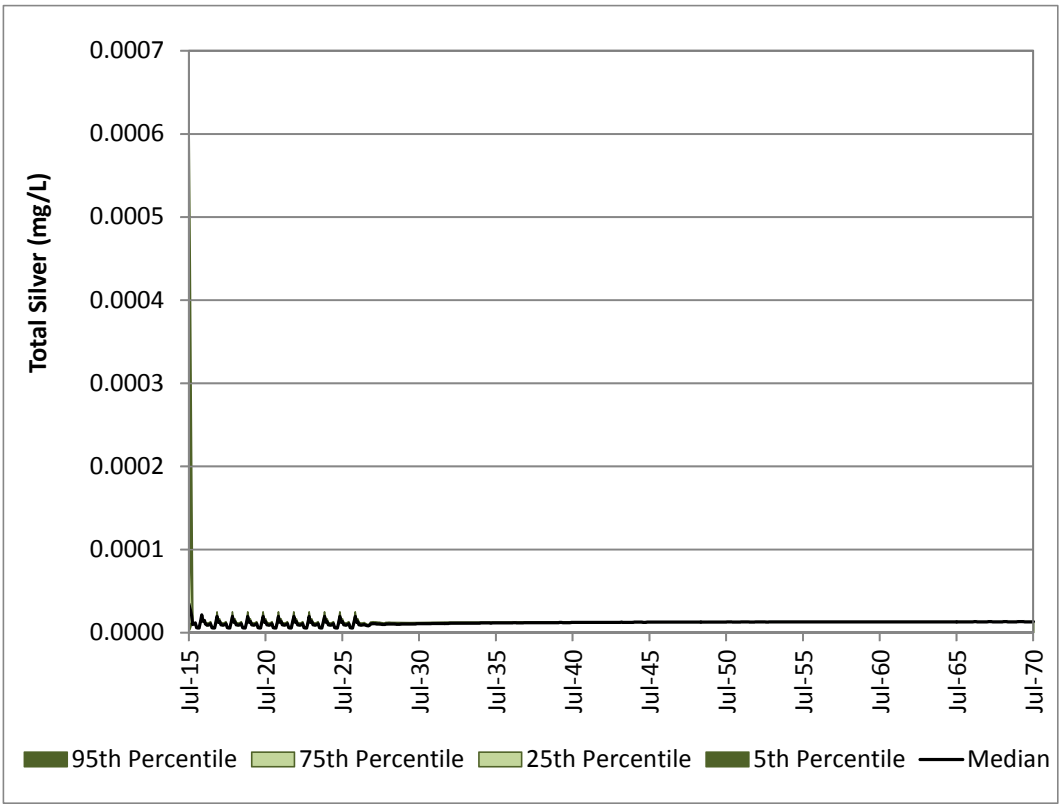

Total Copper (mg/L)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

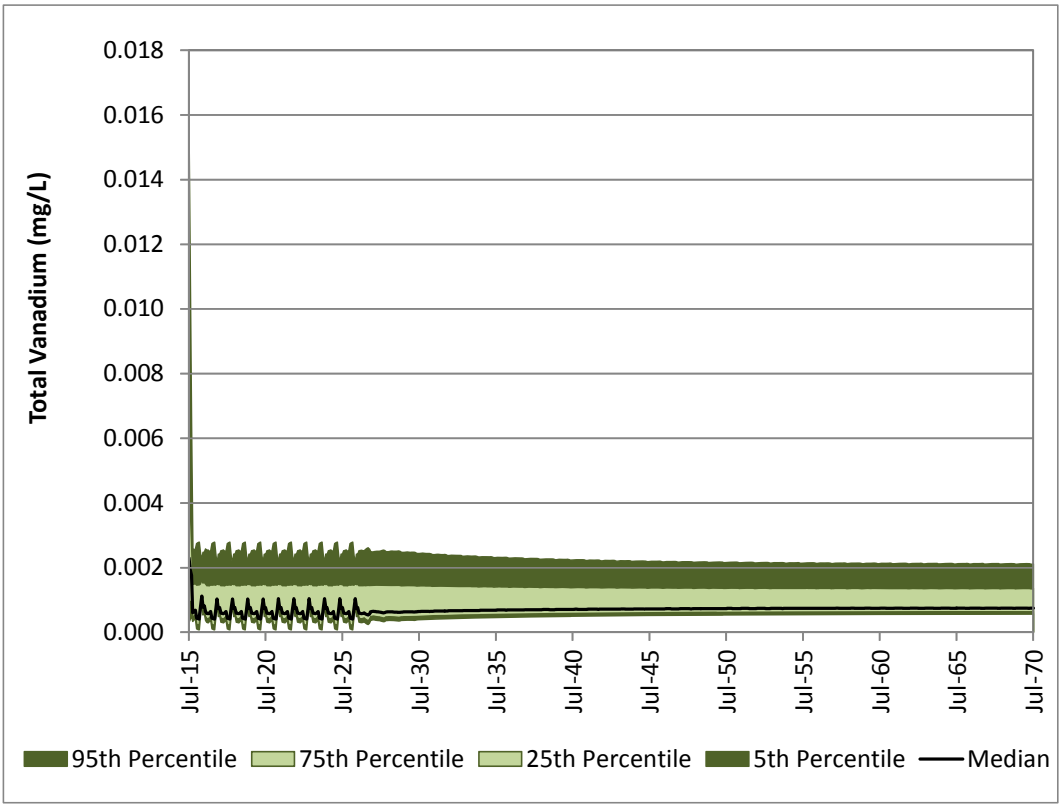

Total Iron (mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

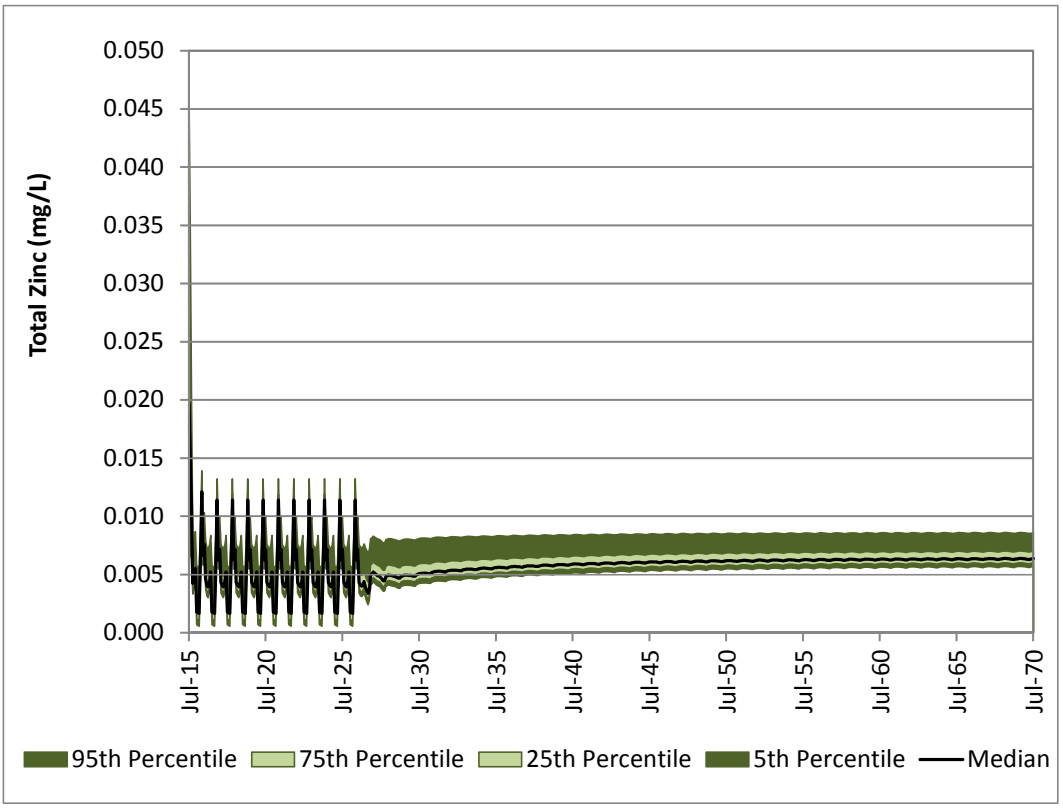

Total Manganese (mg/L)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median


Total Molybdenum (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median


Total Selenium (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

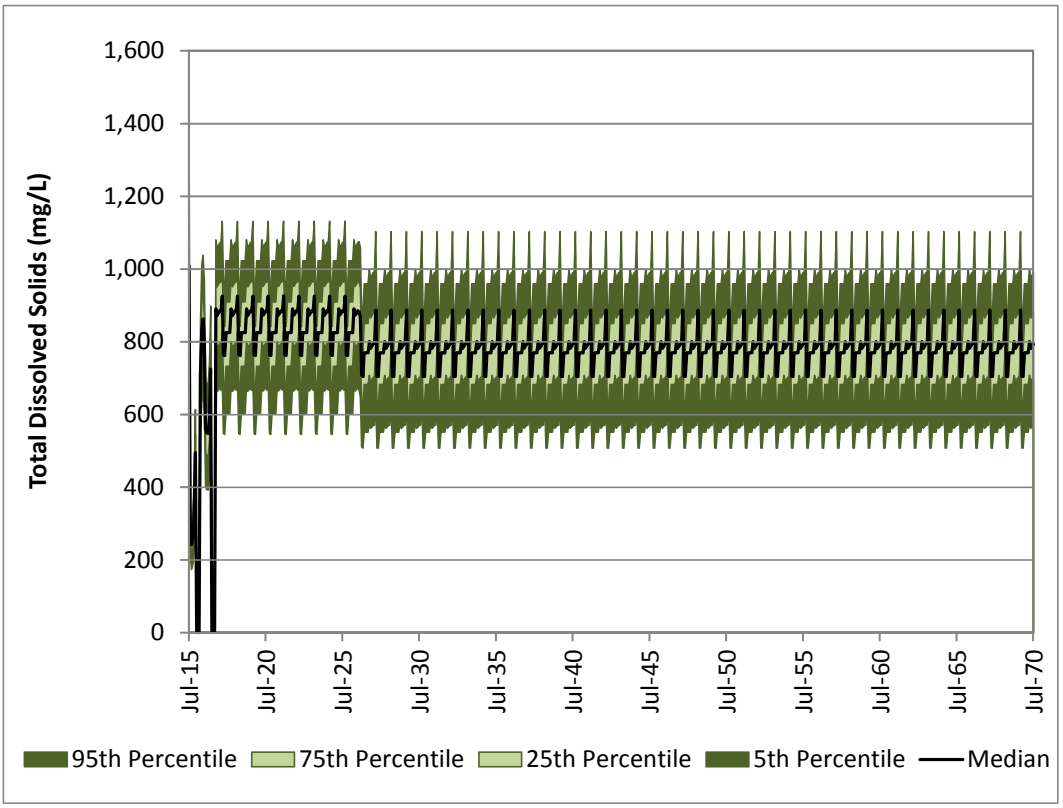

Total Silver (mg/L)
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

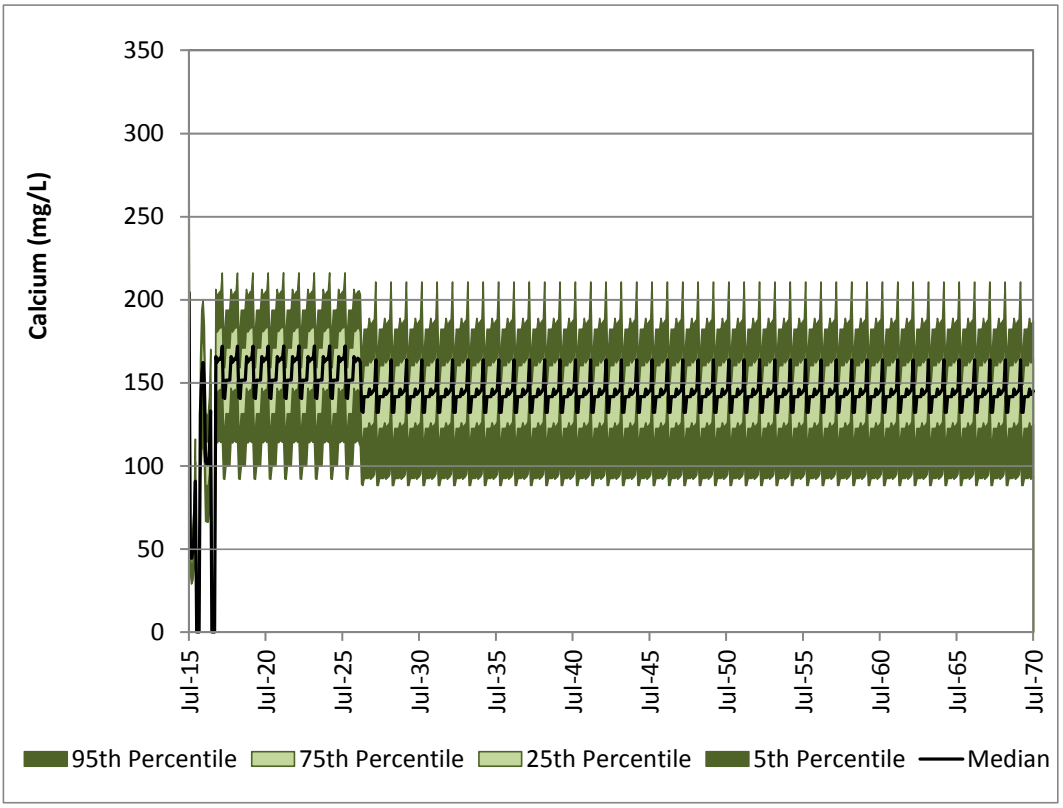

Total Vanadium (mg/L)
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

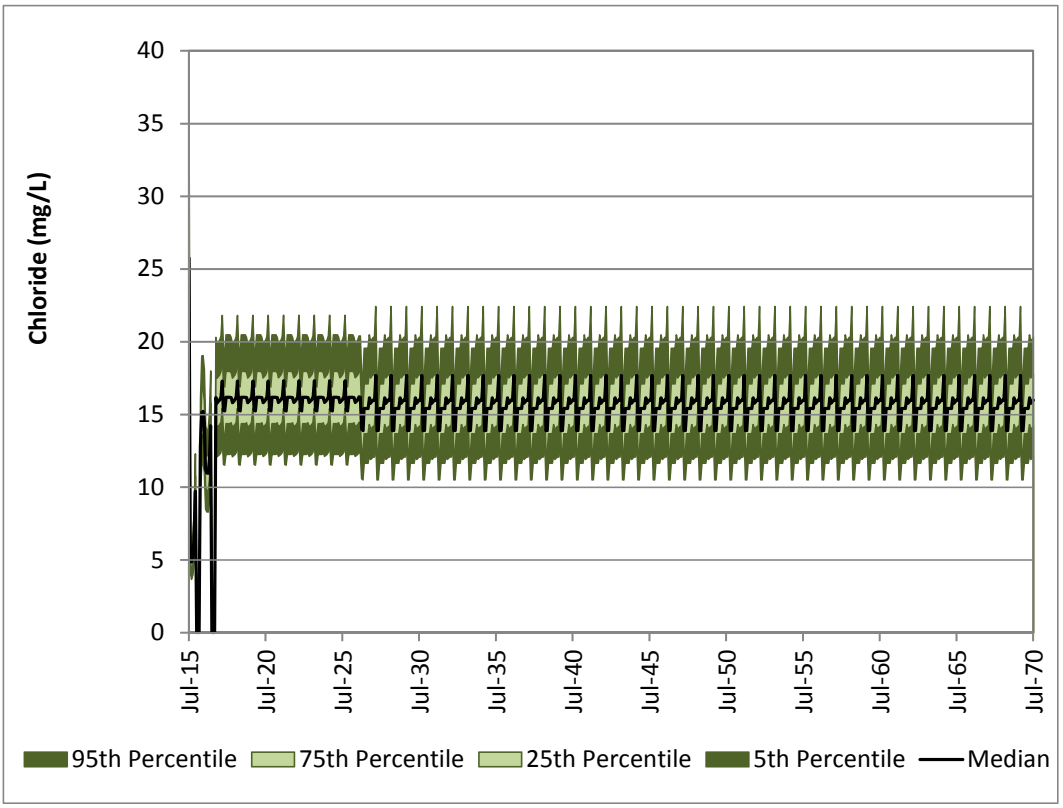


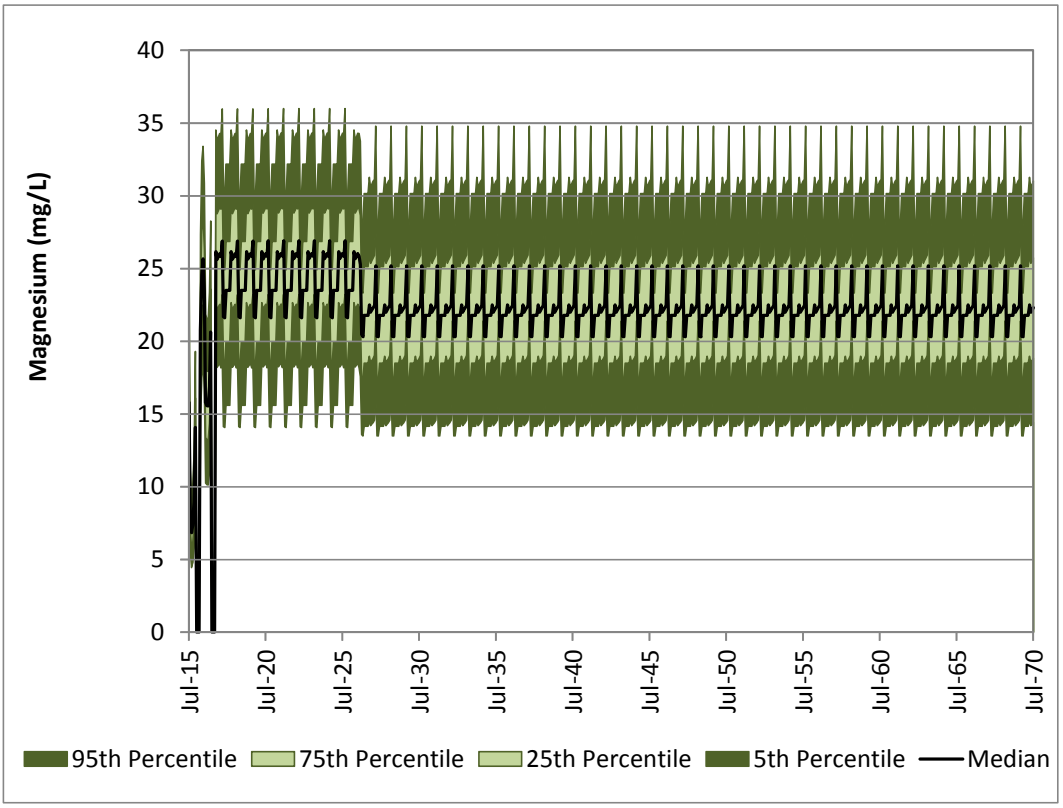
\\golder.gds\gal\burnaby\active_2014\1421\1411734 mount polley\07 deliverables\1411734-12000-site wide water balance\closure\september 29, 2015 report\attachment 3 - time series results\attachment 3.3 - wightpit.docx

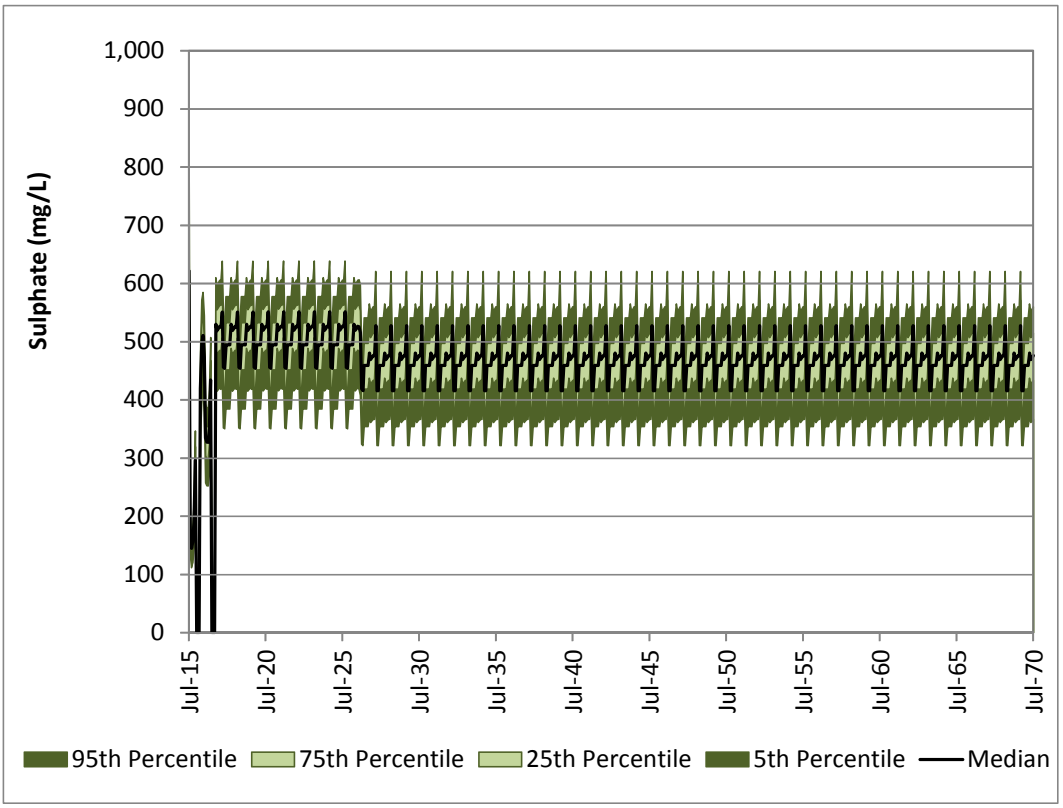
ATTACHMENT 3.4
Time Series Results for the Tailings Storage Facility

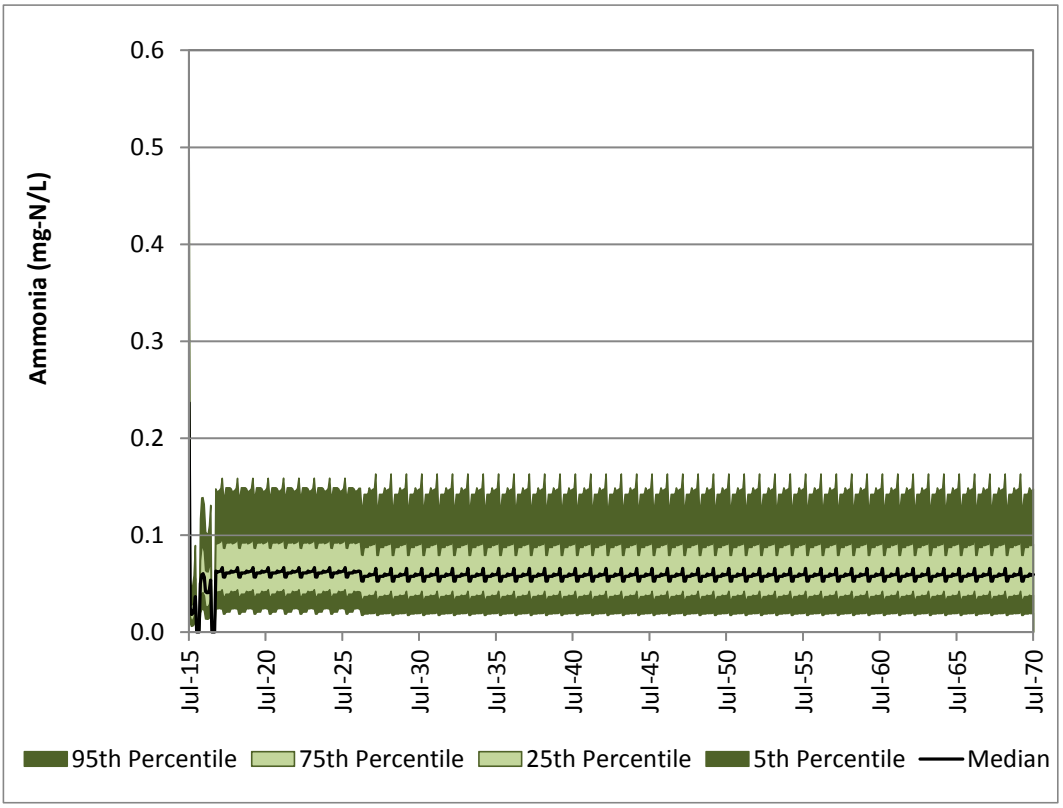

Total Dissolved Solids (mg/L)
1,600
1,400
1,200
1,000
800
600
400
200
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

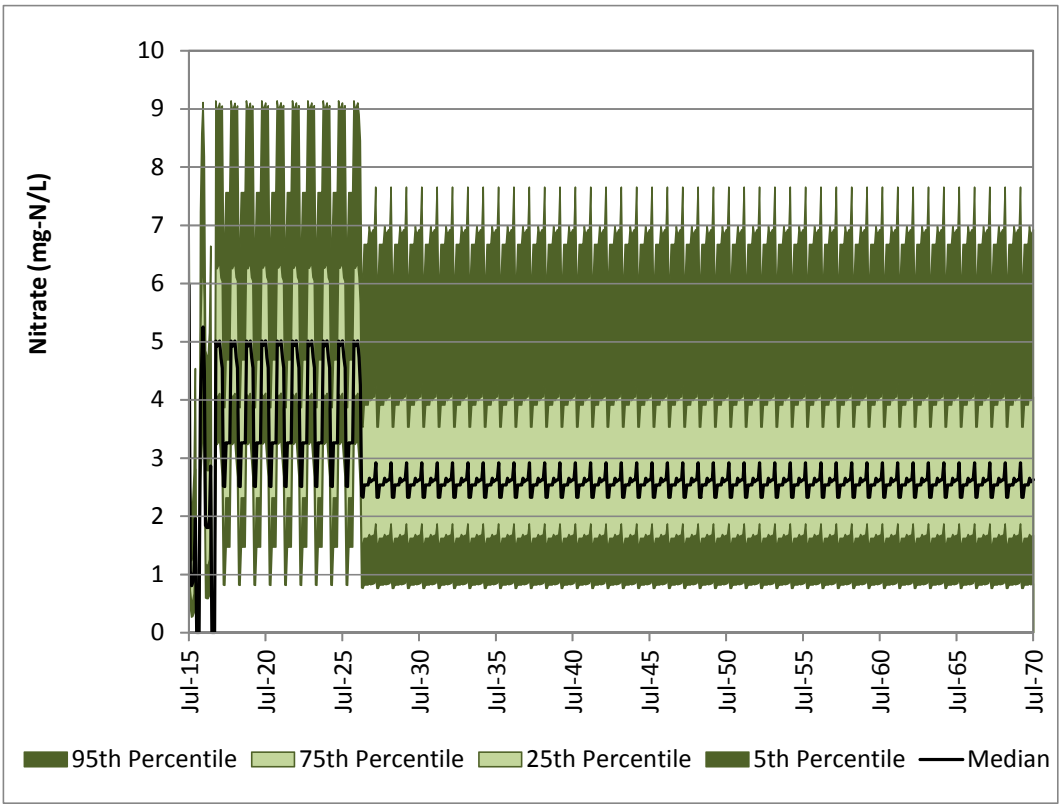

Calcium (mg/L)
350
300
250
200
150
100
50
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

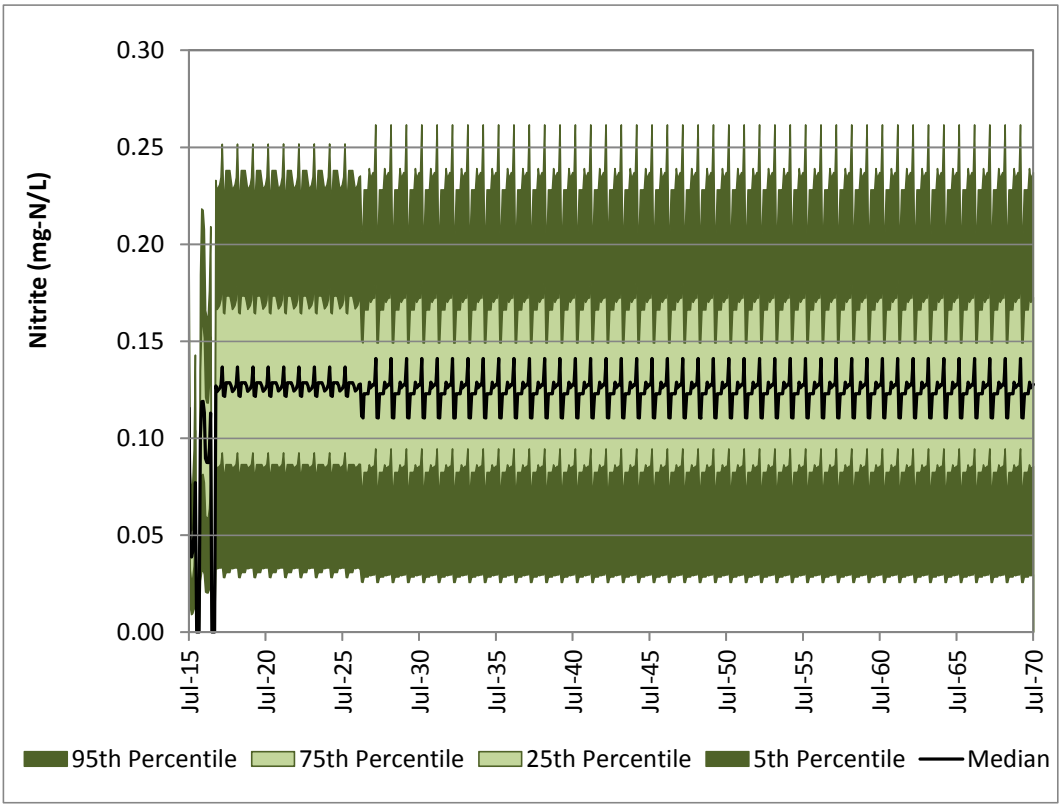

Chloride (mg/L)
40
35
30
25
20
15
10
5
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

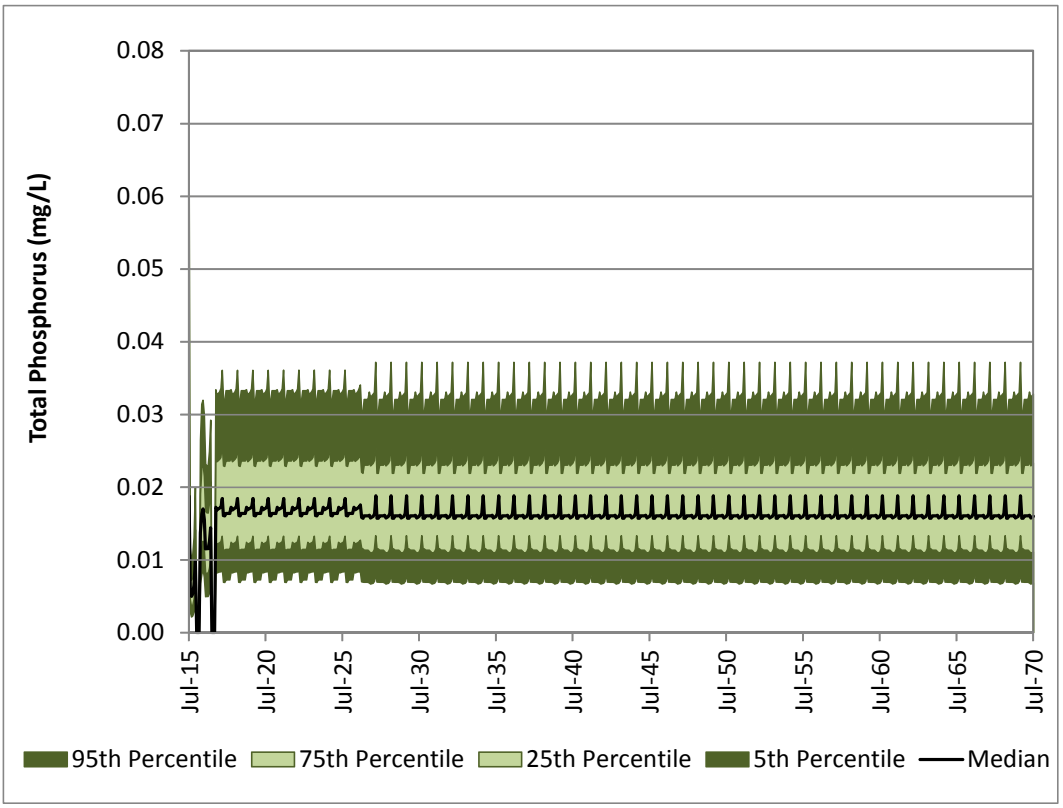

Magnesium (mg/L)
40
35
30
25
20
15
10
5
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

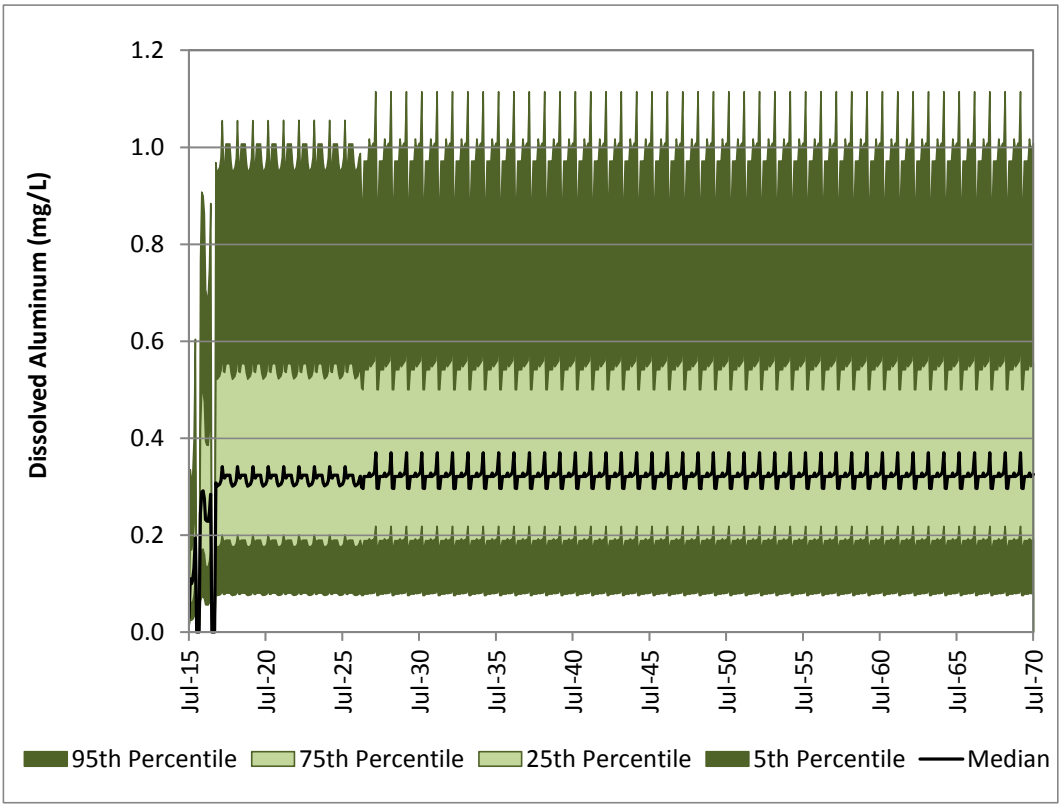

Sulphate (mg/L)
1,000
900
800
700
600
500
400
300
200
100
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

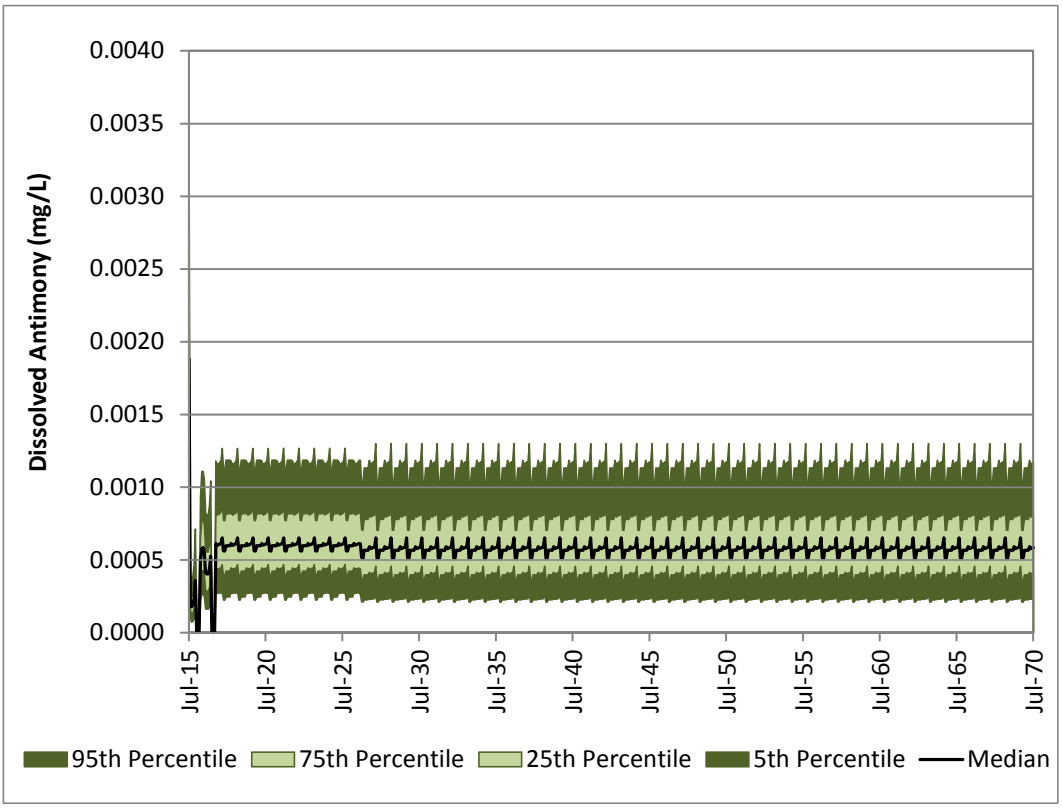

Ammonia (mg-N/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

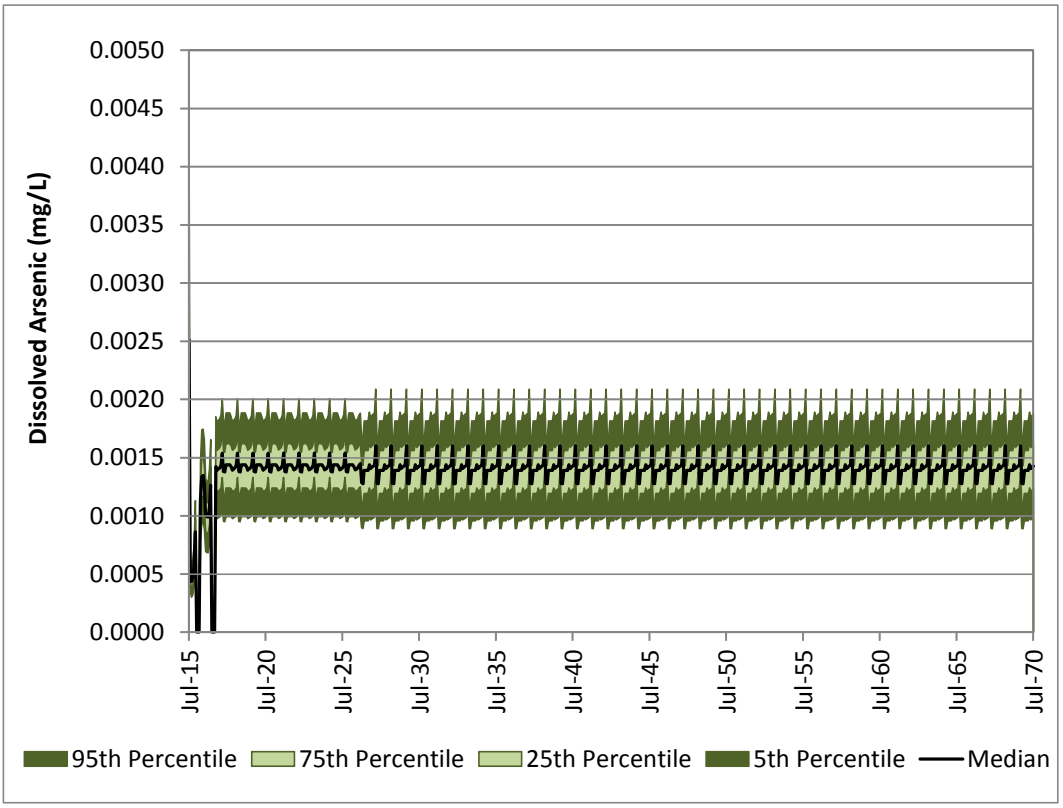

Nitrate (mg-N/L)
10
9
8
7
6
5
4
3
2
1
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

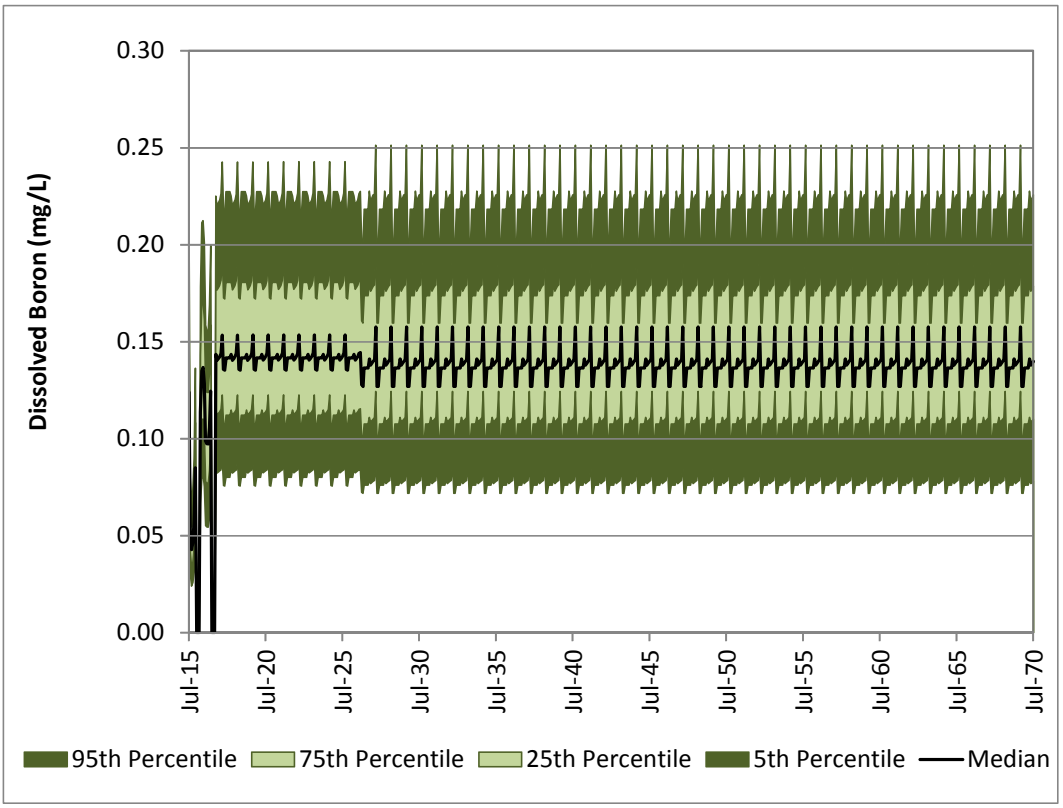

Nitrite (mg-N/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

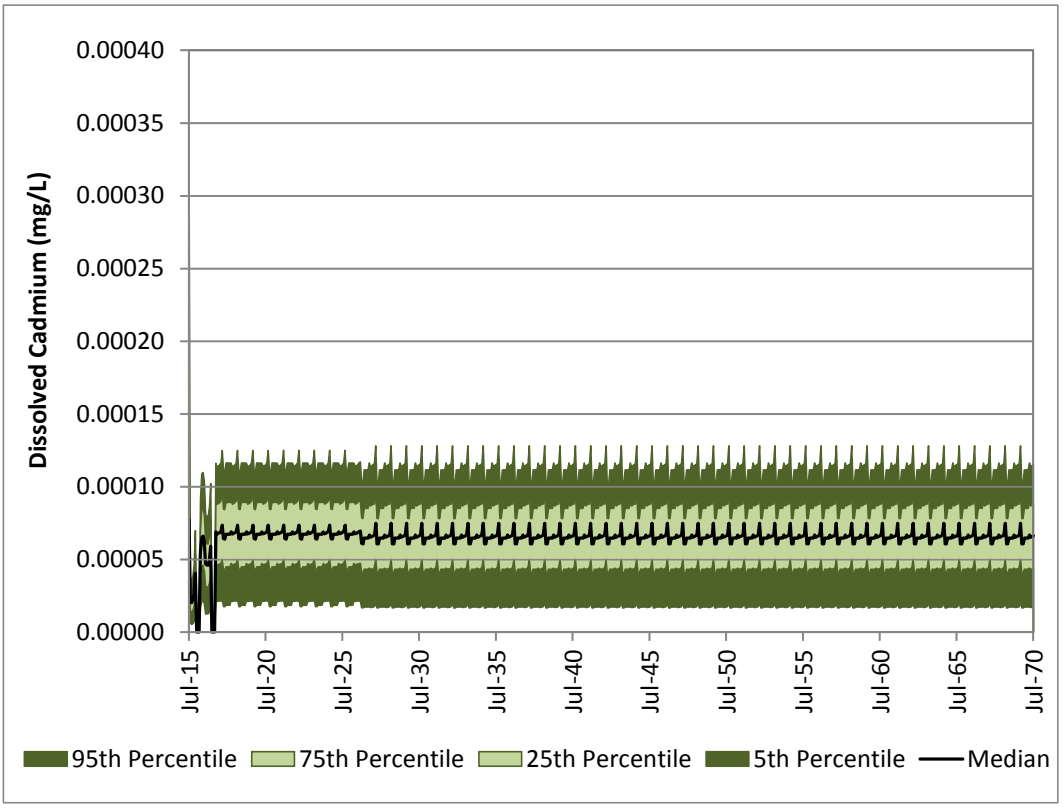

Total Phosphorus (mg/L)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

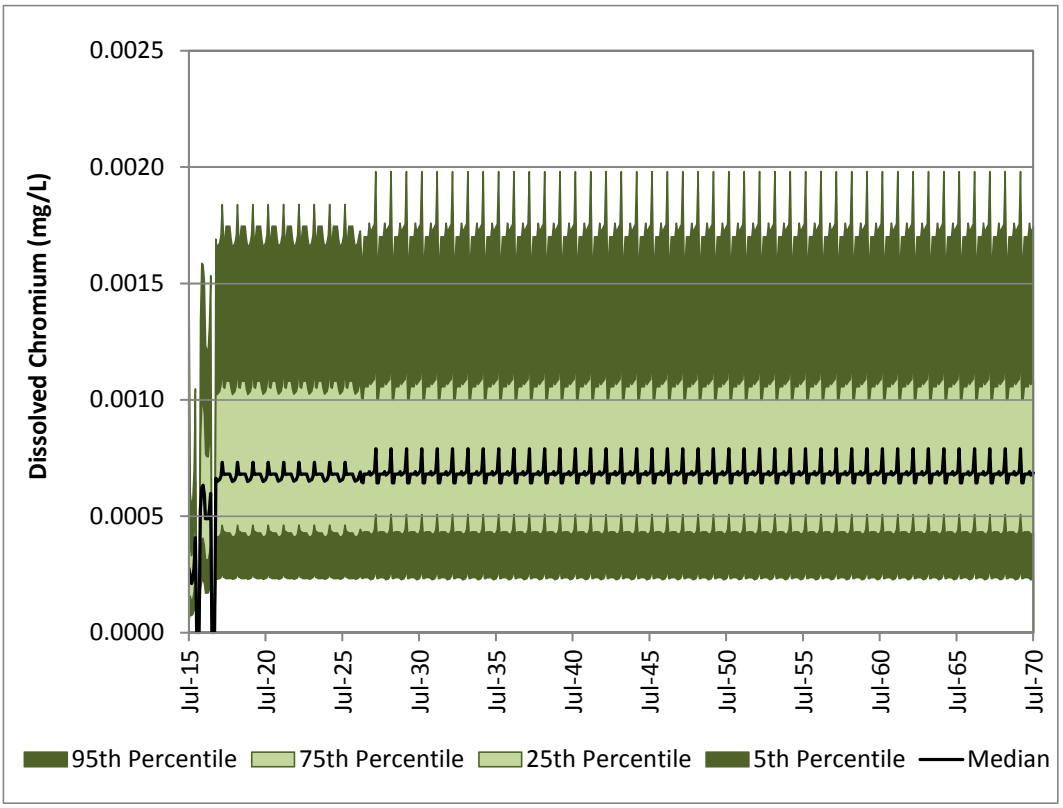

Dissolved Aluminum (mg/L)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

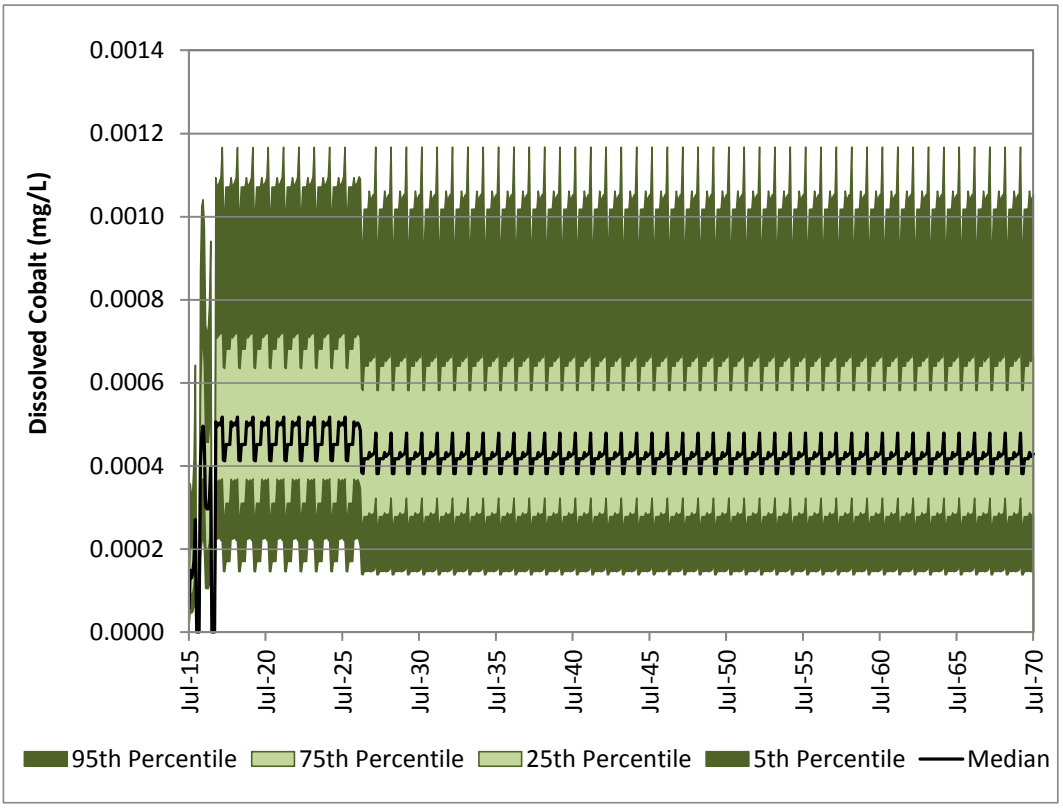

Dissolved Antimony (mg/L)
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

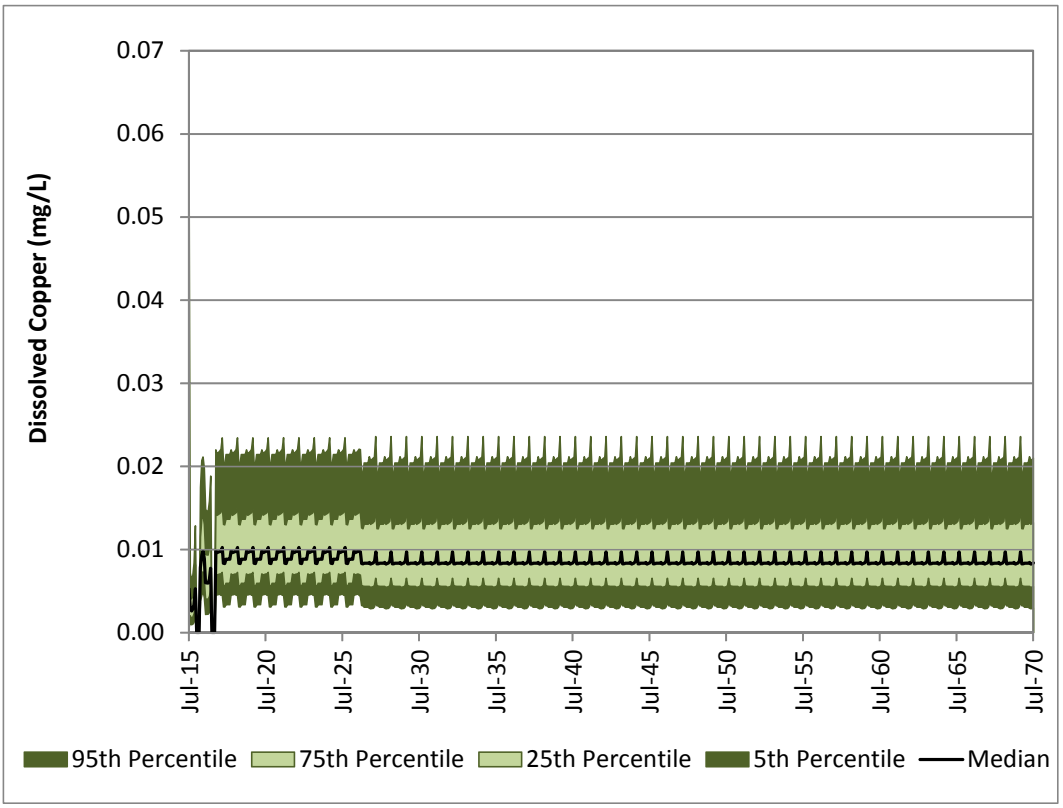

Dissolved Arsenic (mg/L)
0.0050
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

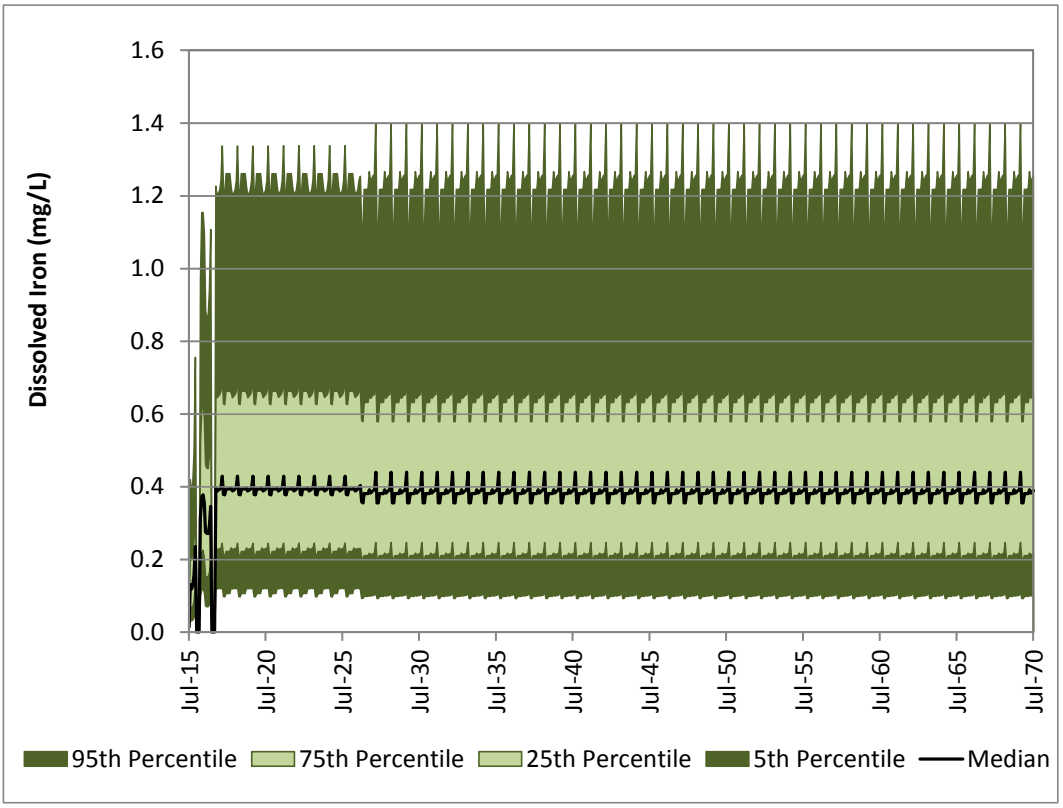

Dissolved Boron (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

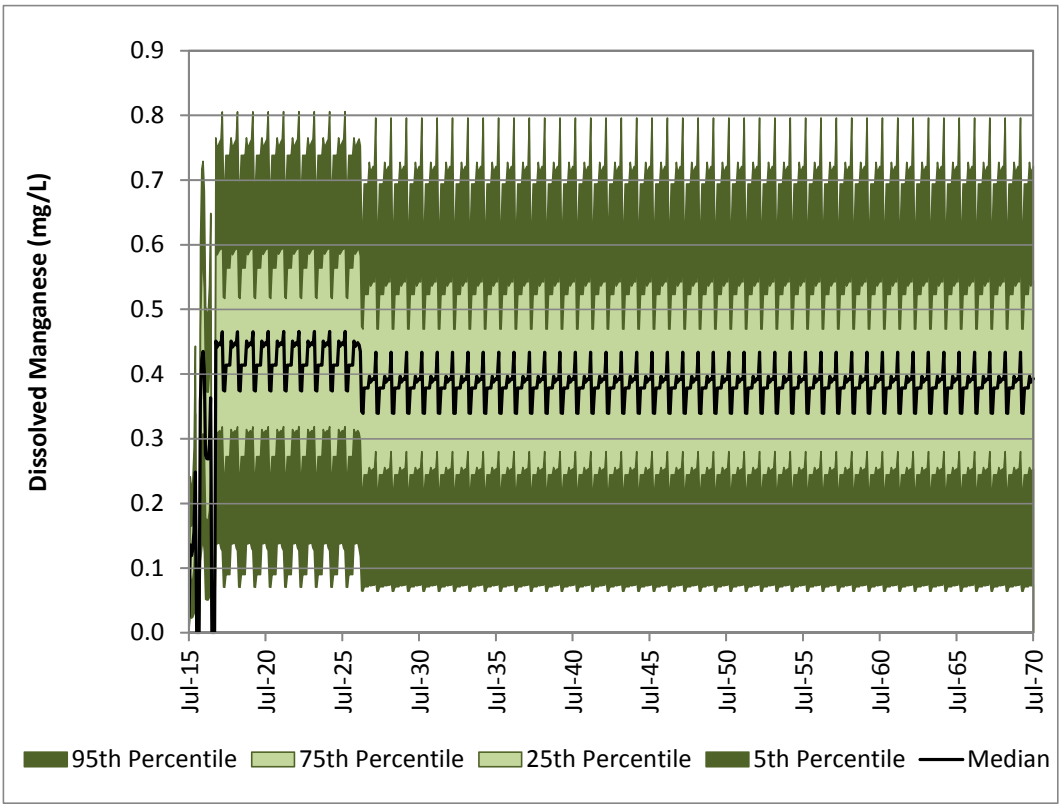

Dissolved Cadmium (mg/L)
0.00040
0.00035
0.00030
0.00025
0.00020
0.00015
0.00010
0.00005
0.00000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

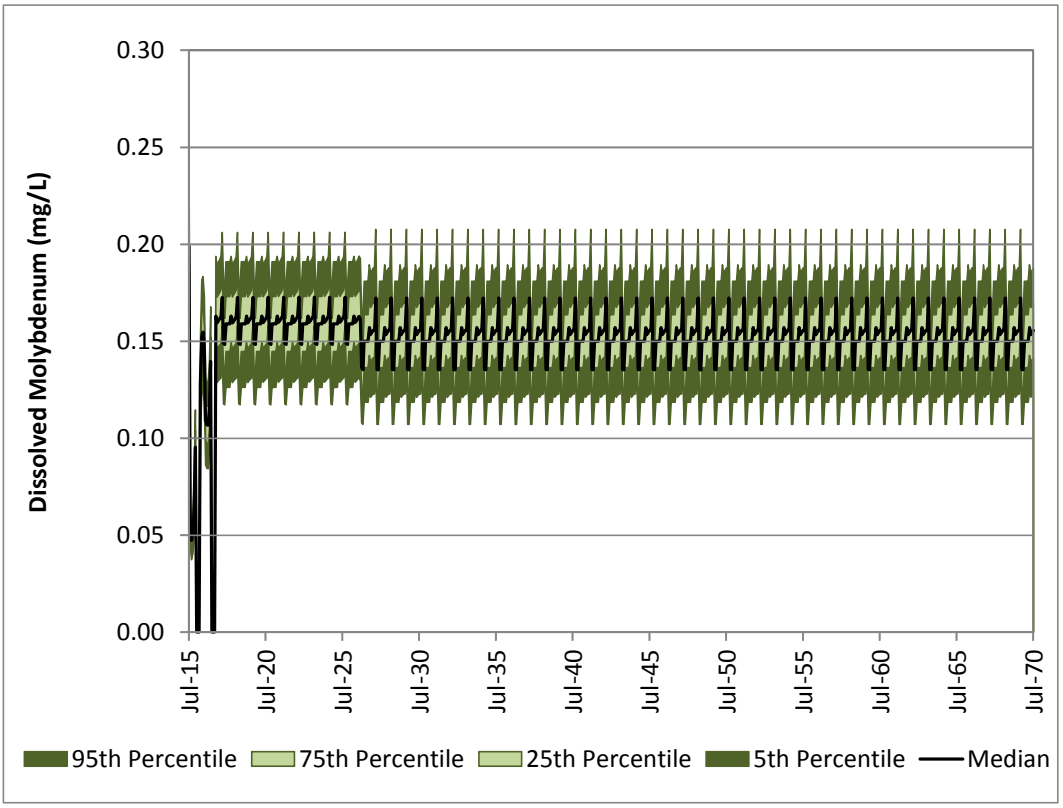

Dissolved Chromium (mg/L)
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

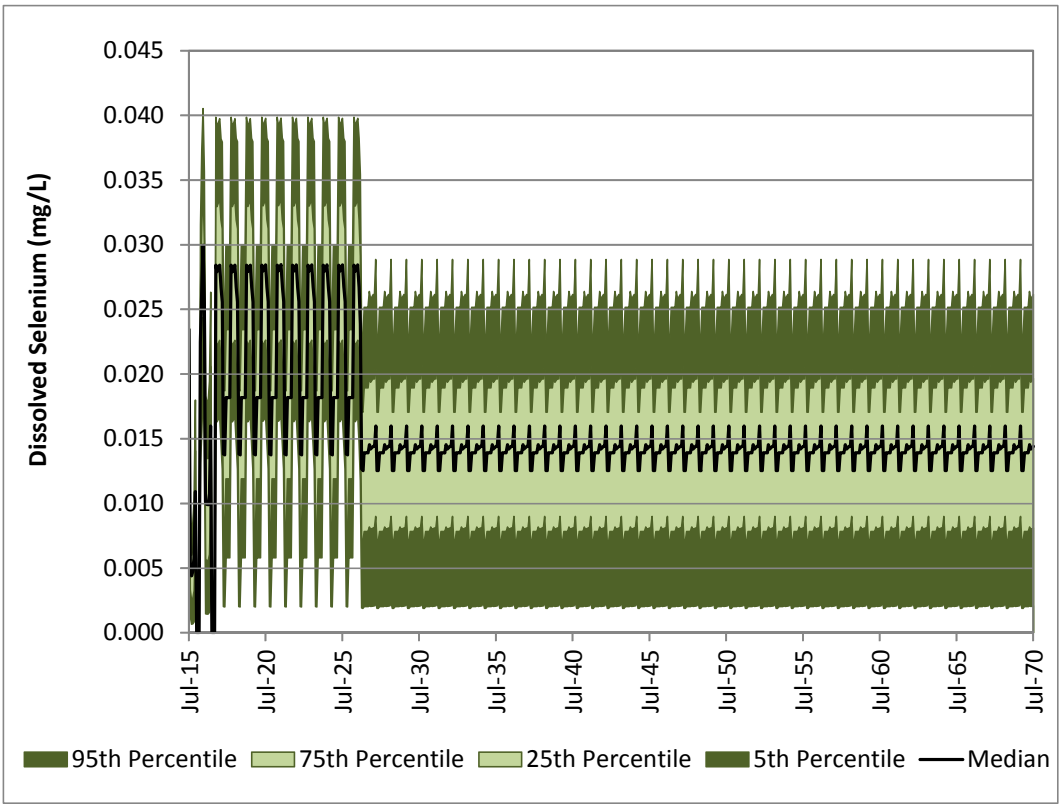

Dissolved Cobalt (mg/L)
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

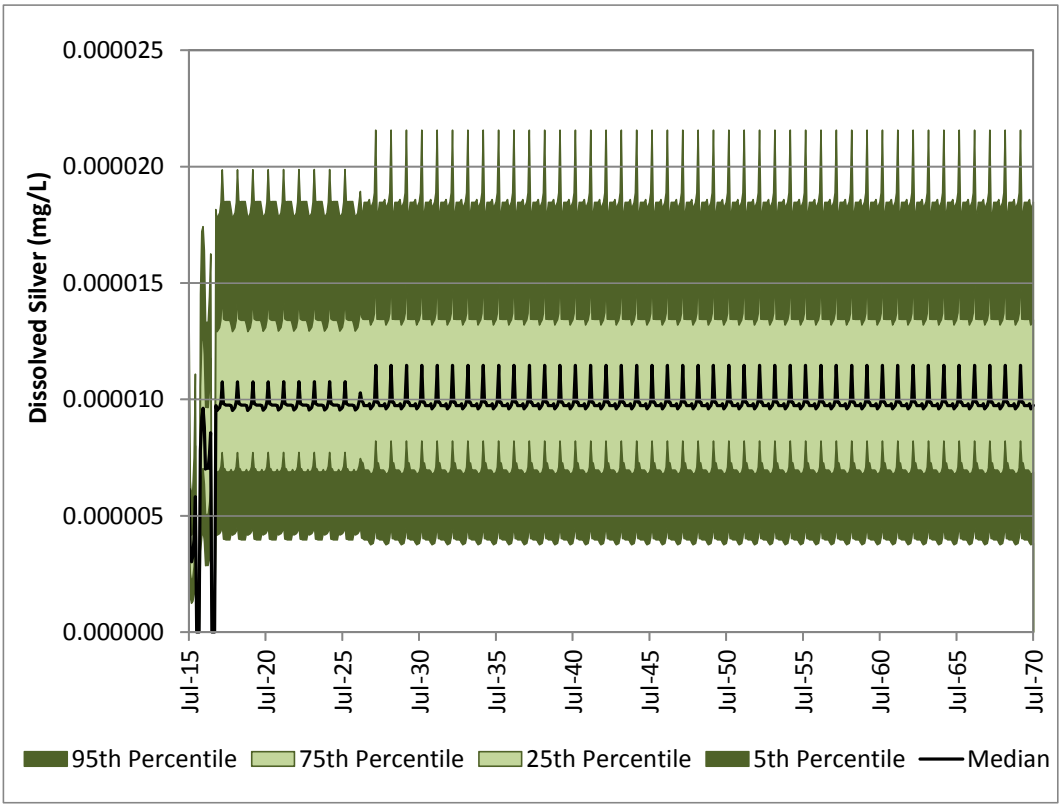

Dissolved Copper (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

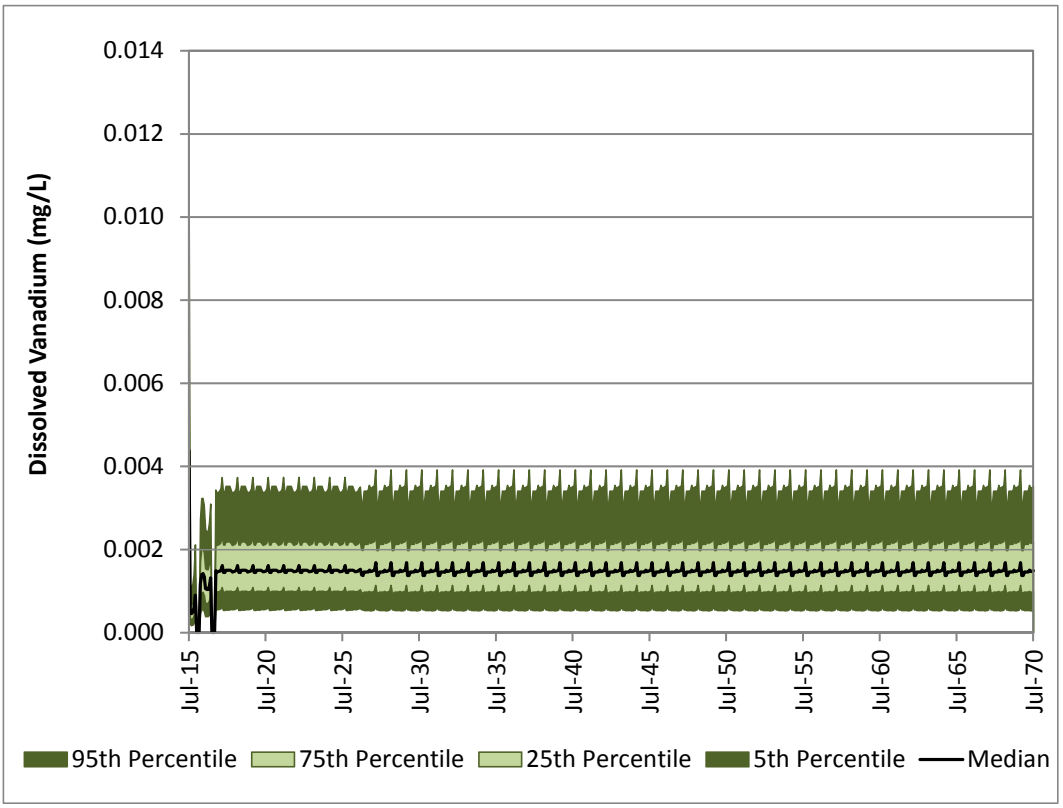

Dissolved Iron (mg/L)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

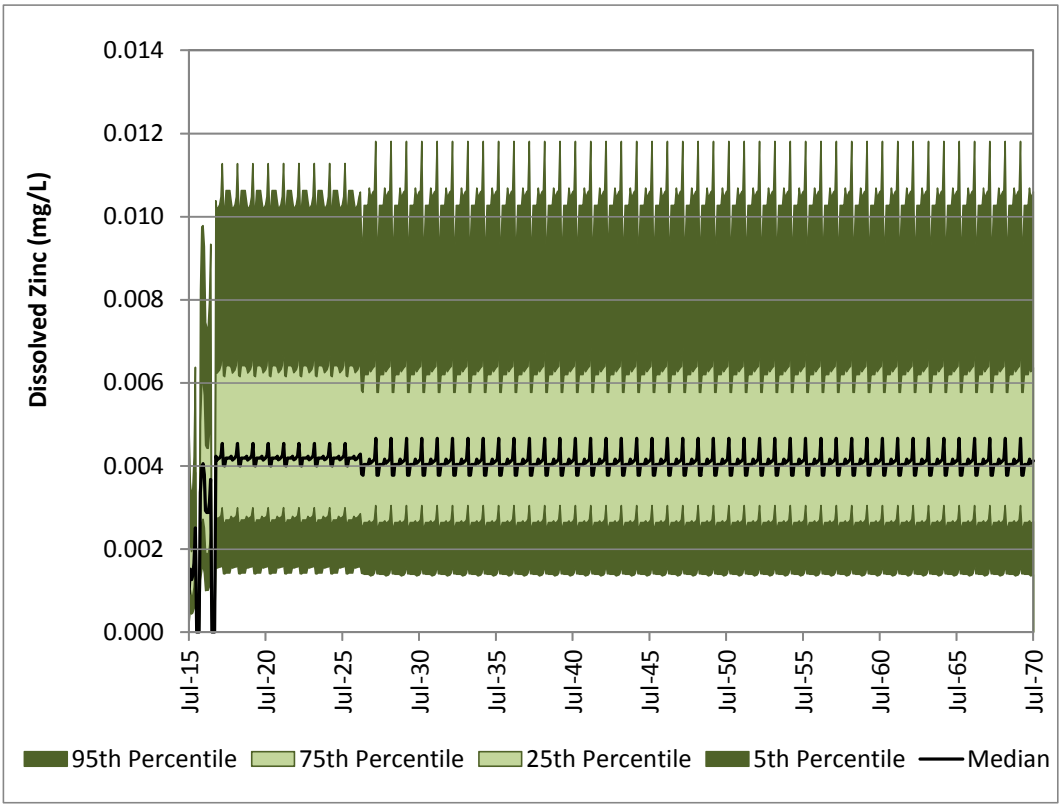

Dissolved Manganese (mg/L)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

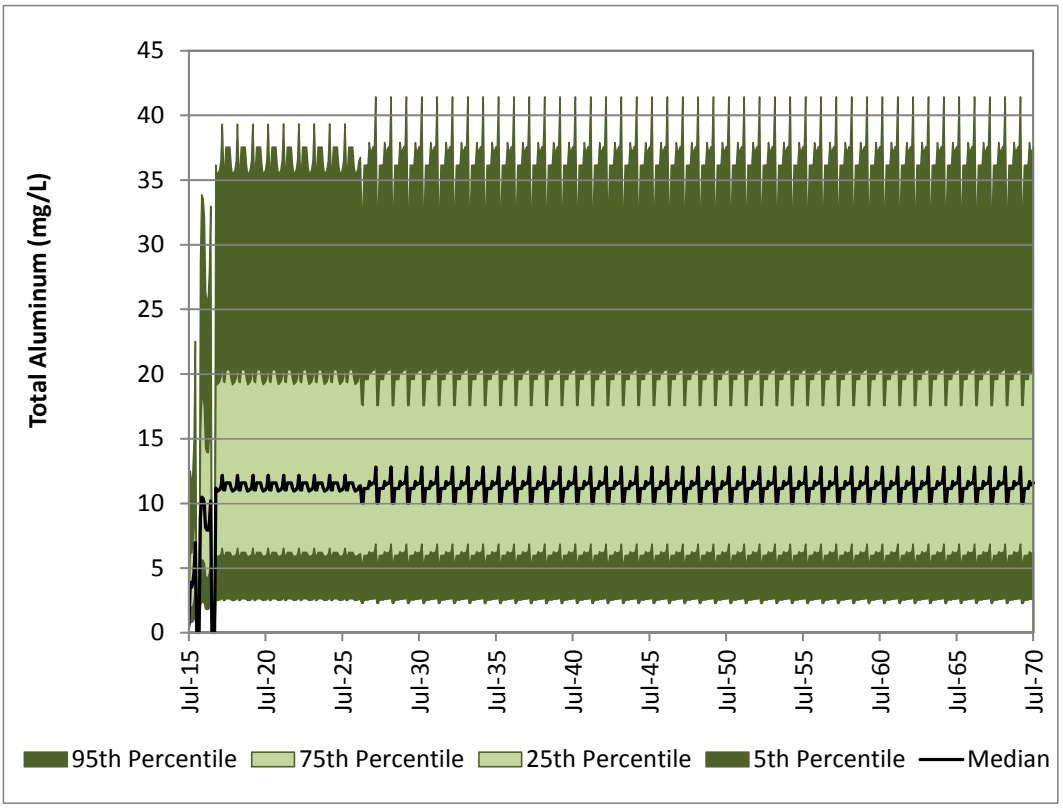

Dissolved Molybdenum (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

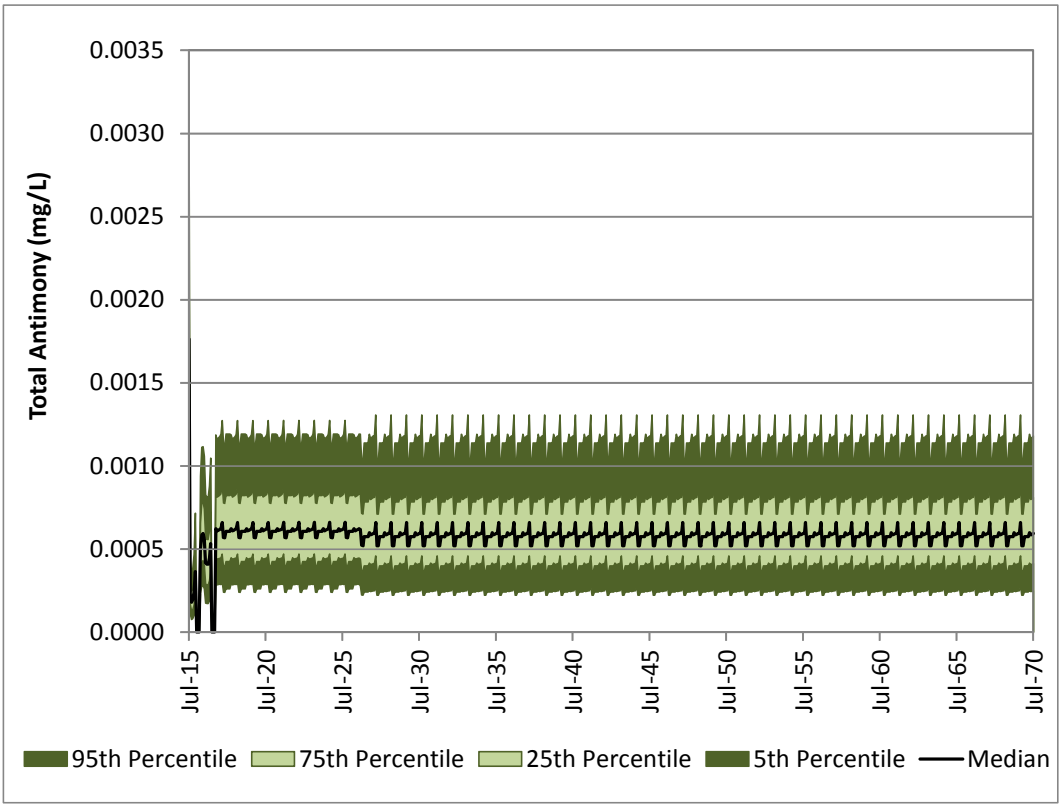

Dissolved Selenium (mg/L)
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

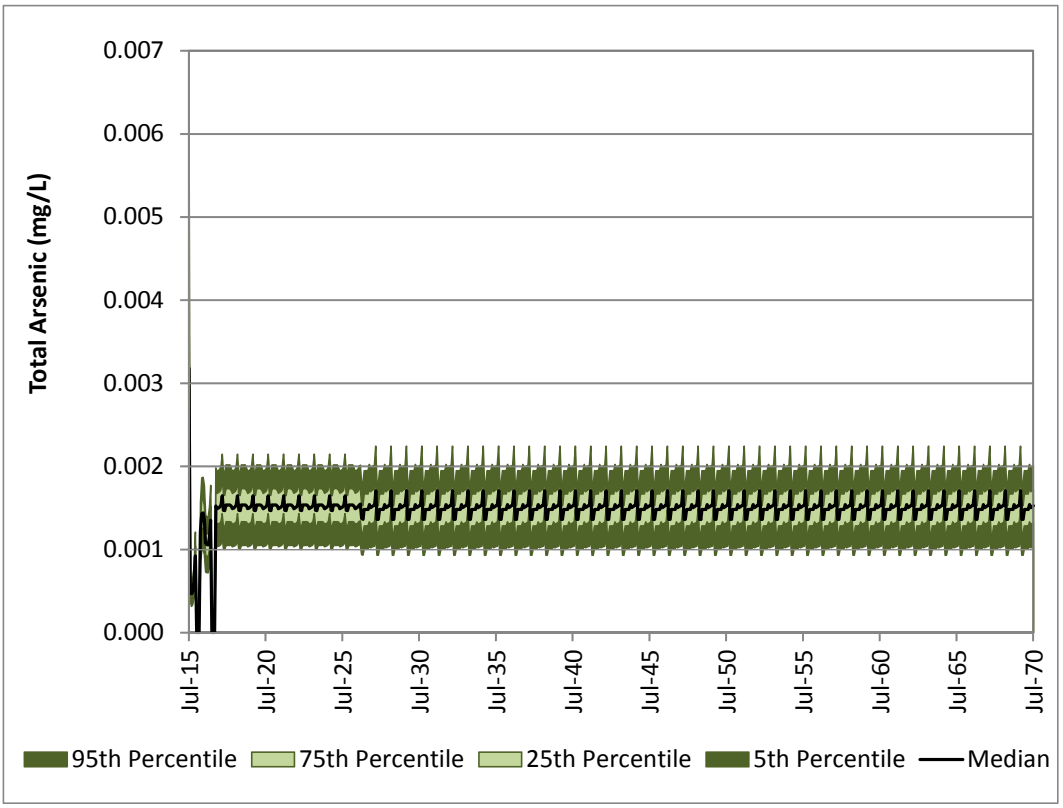

Dissolved Silver (mg/L)
0.000025
0.000020
0.000015
0.000010
0.000005
0.000000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

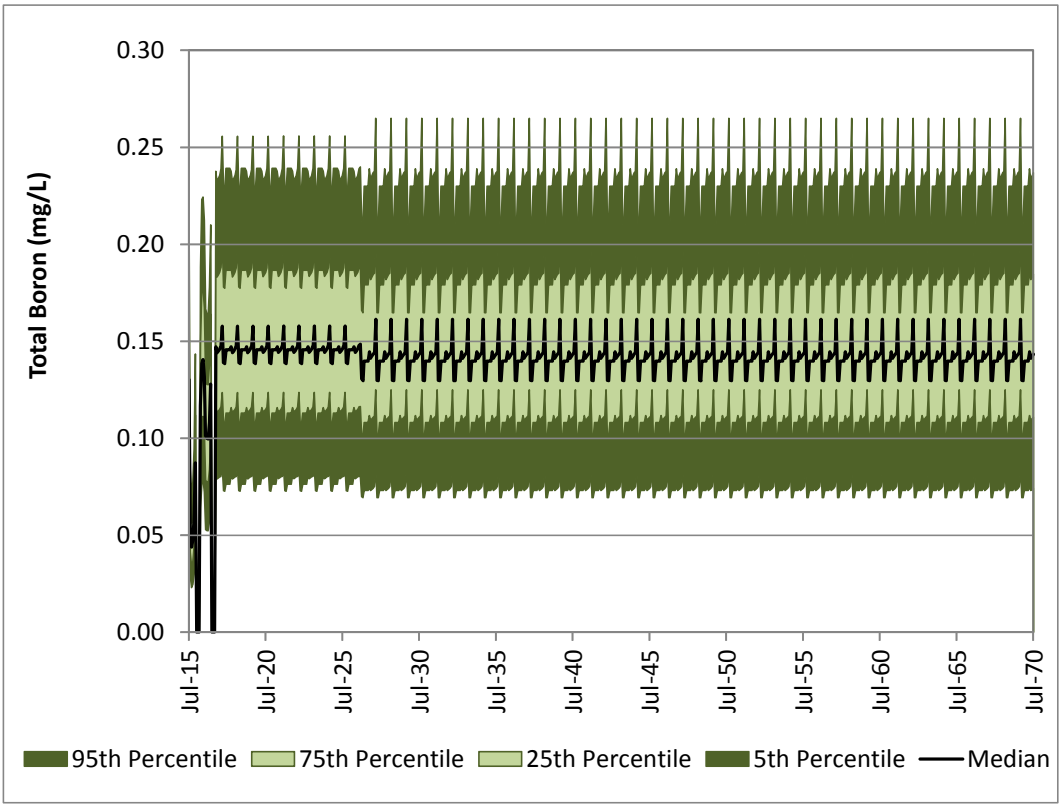

Dissolved Vanadium (mg/L)
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

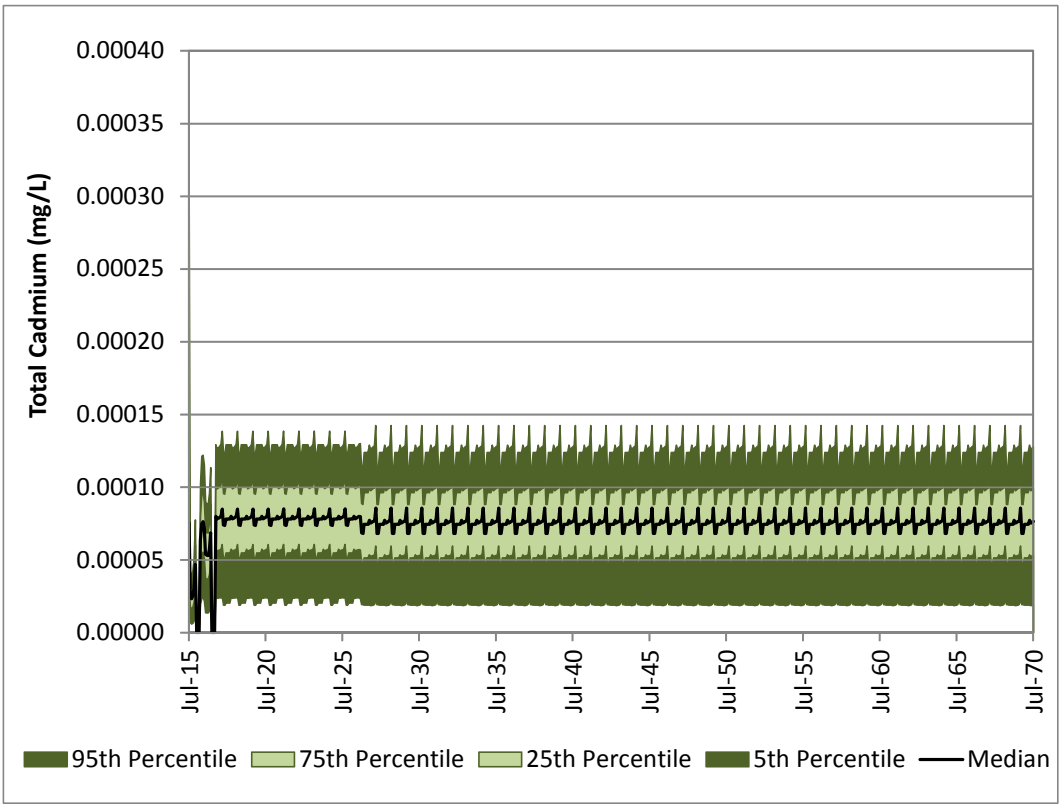

Dissolved Zinc (mg/L)
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

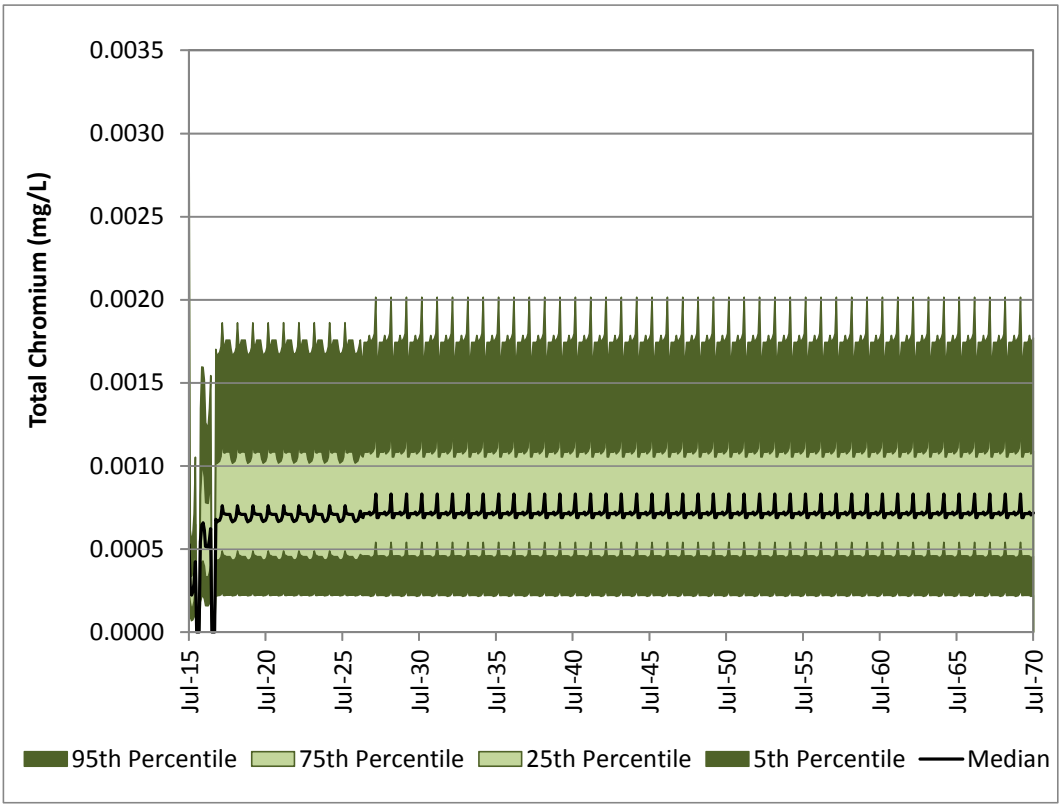

Total Aluminum (mg/L)
45
40
35
30
25
20
15
10
5
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

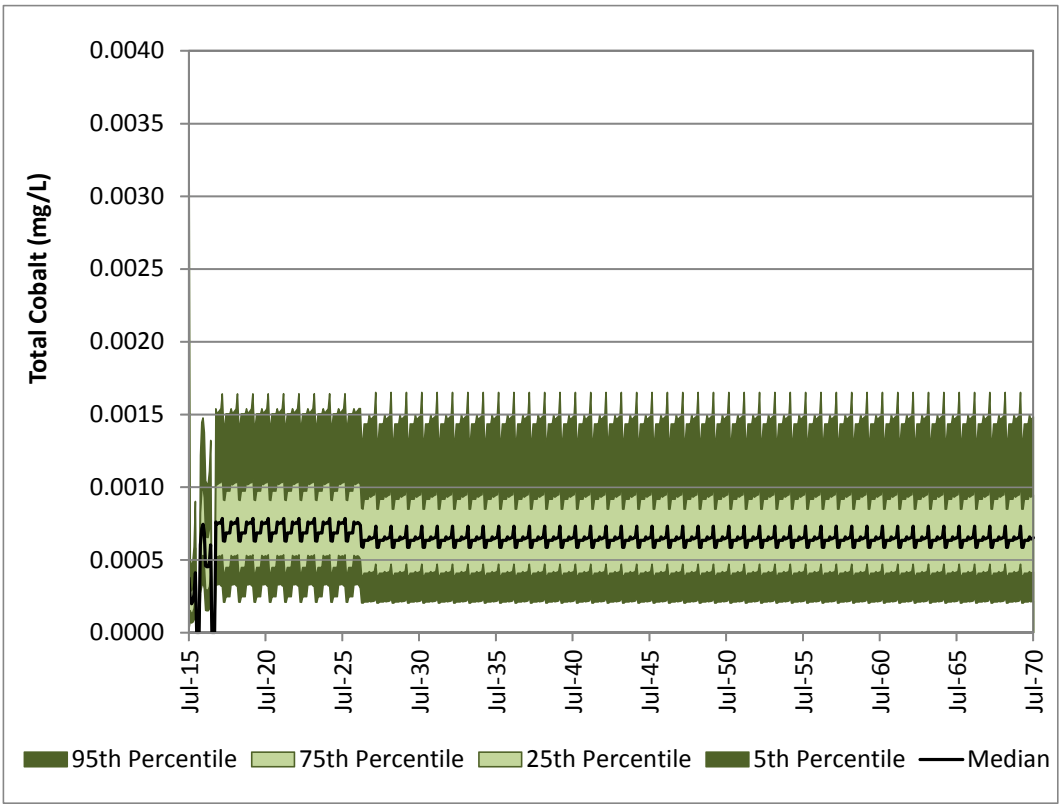

Total Antimony (mg/L)
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

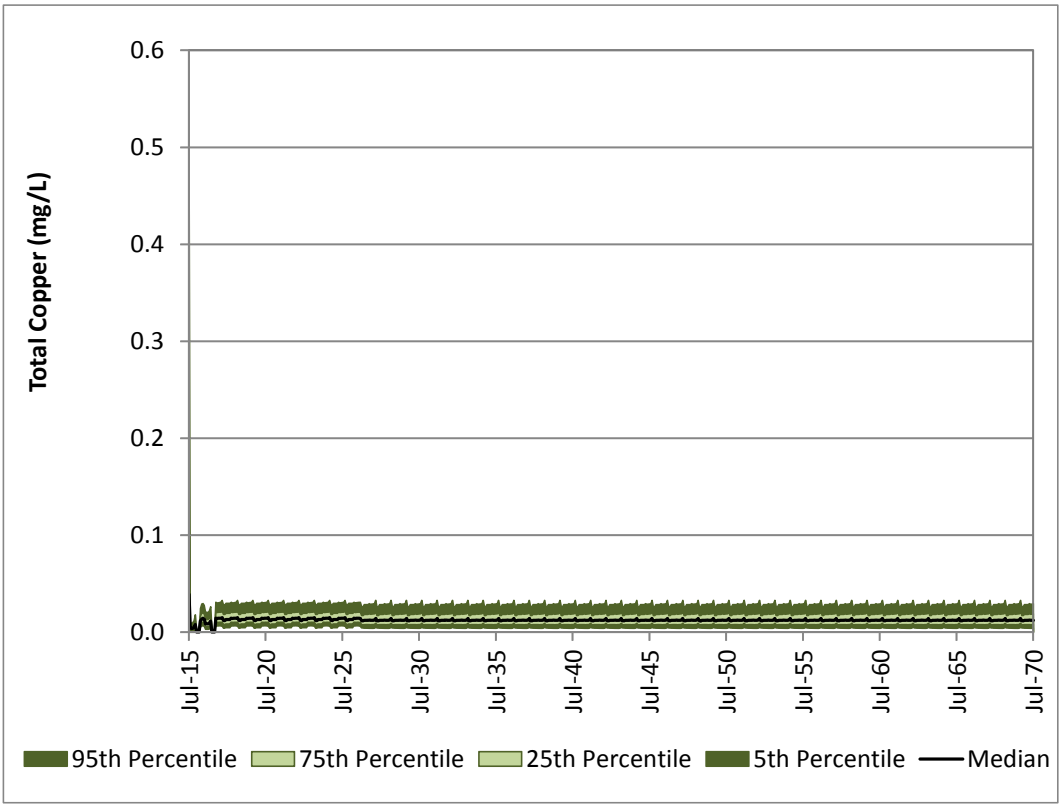

Total Arsenic (mg/L)
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

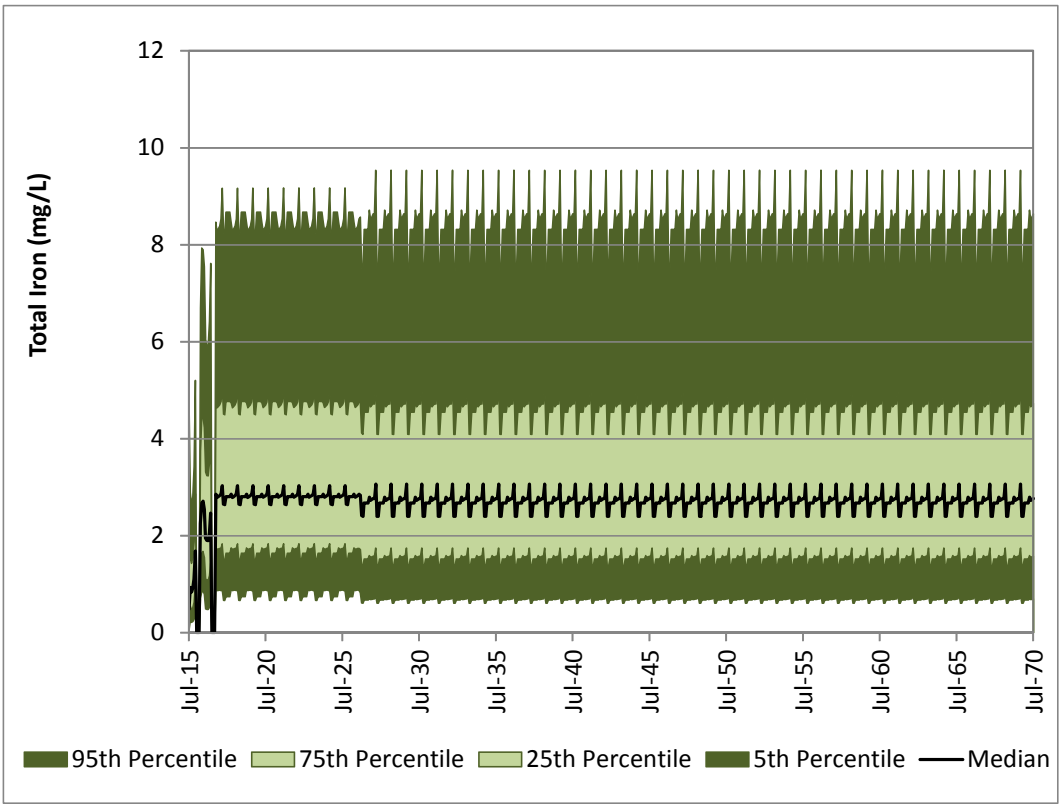

Total Boron (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

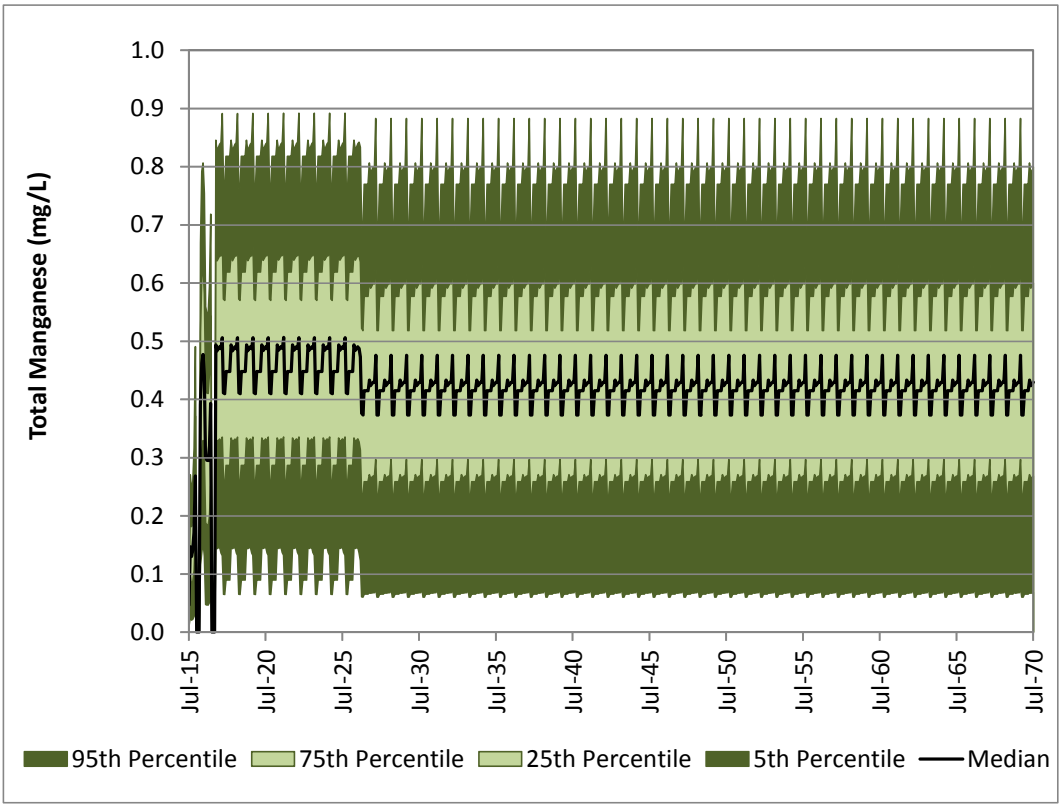

Total Cadmium (mg/L)
0.00040
0.00035
0.00030
0.00025
0.00020
0.00015
0.00010
0.00005
0.00000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

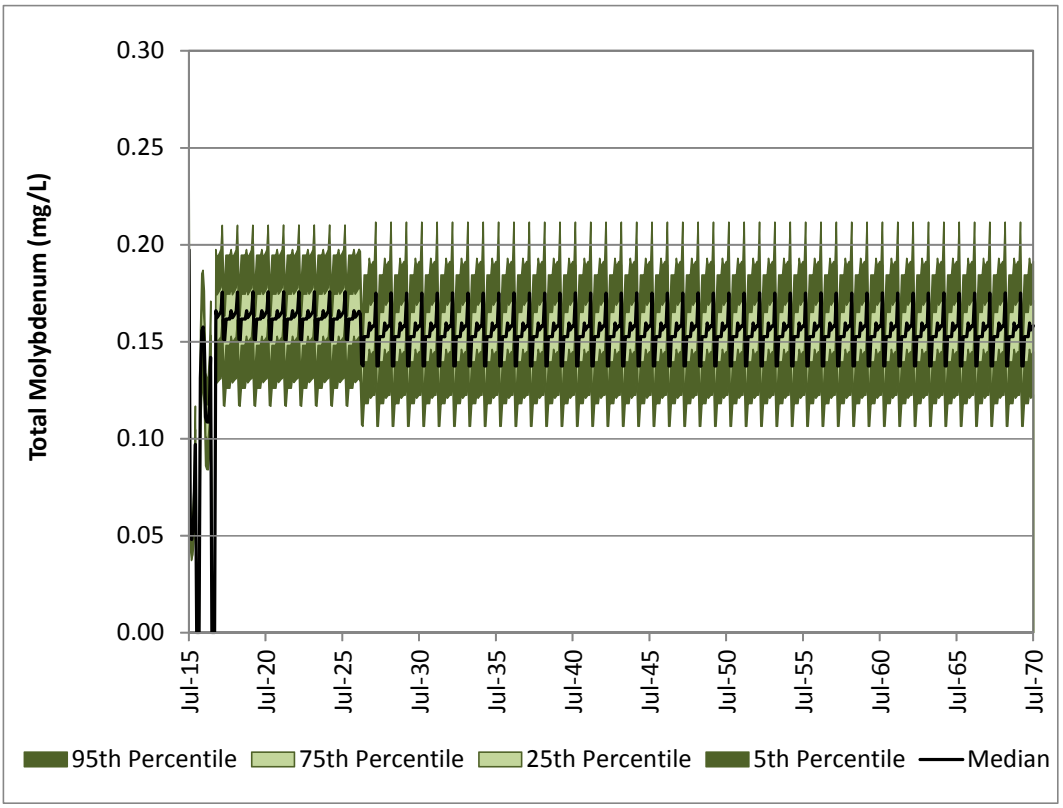

Total Chromium (mg/L)
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

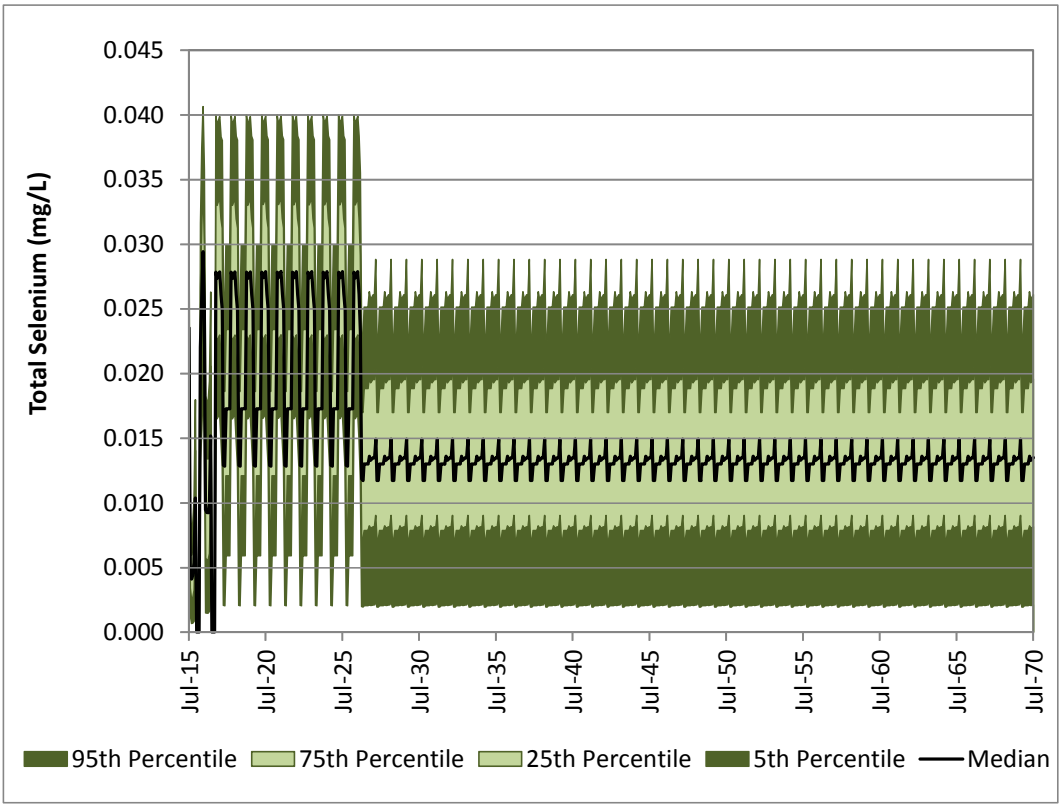

Total Cobalt (mg/L)
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

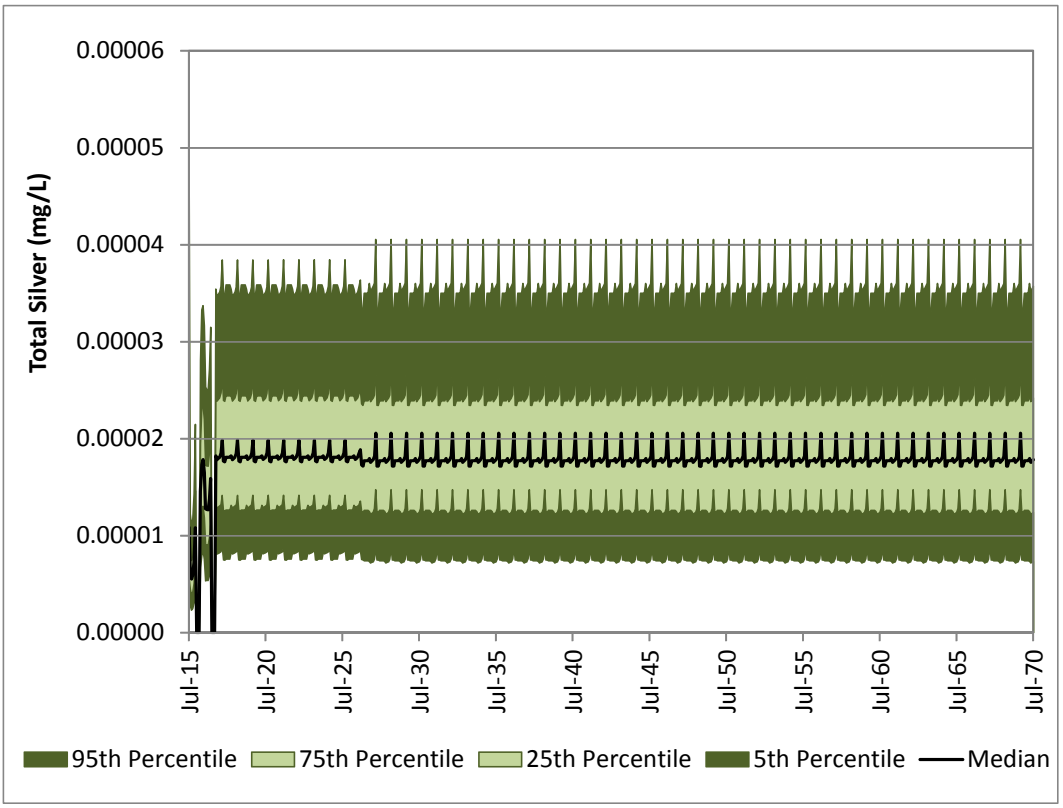

Total Copper (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

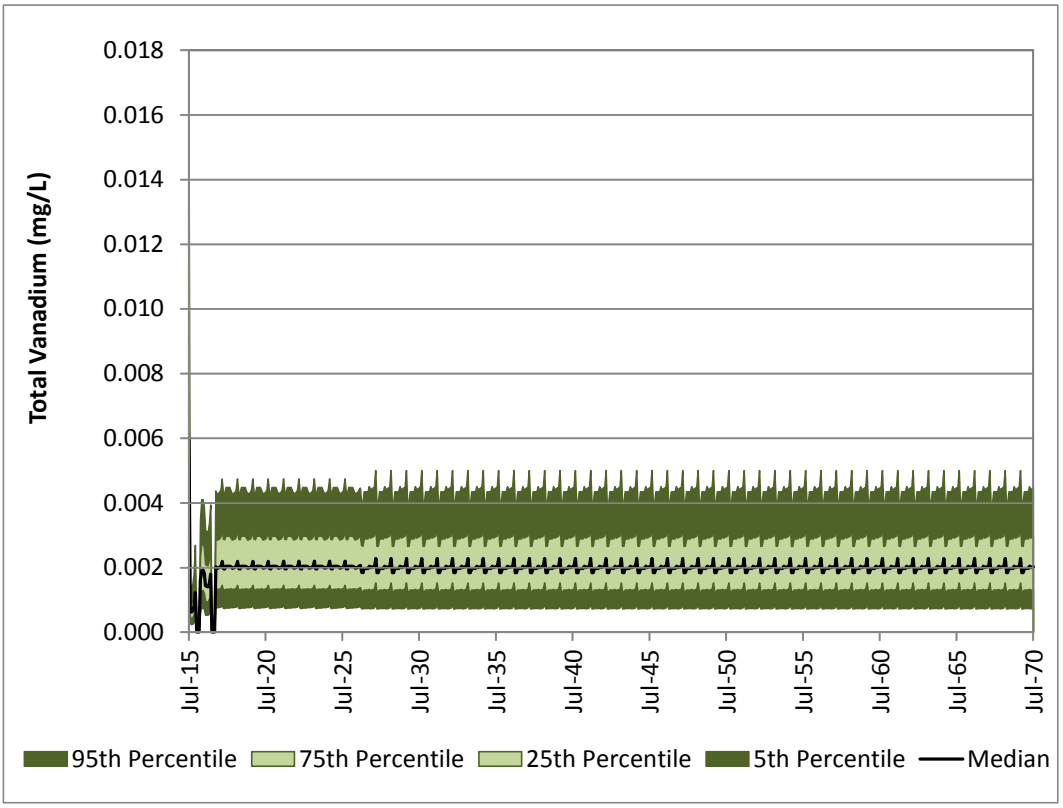

Total Iron (mg/L)
12
10
8
6
4
2
0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median

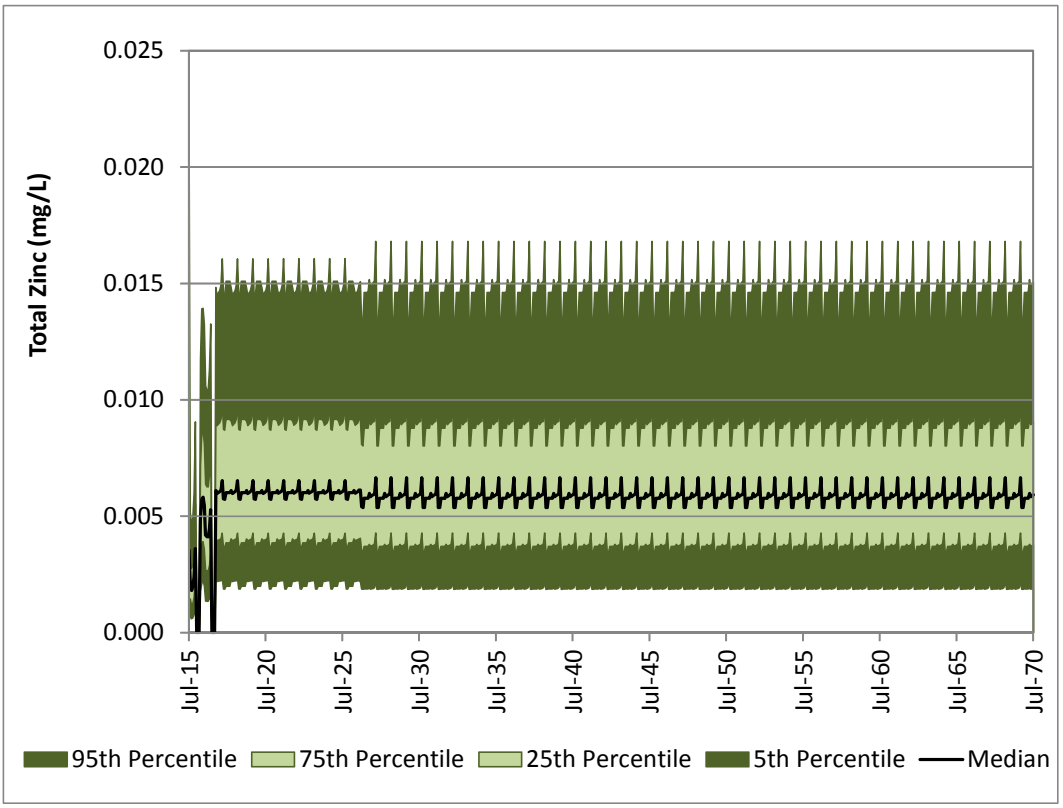

Total Manganese (mg/L)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median


Total Molybdenum (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median


Total Selenium (mg/L)
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median


Total Silver (mg/L)
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median


Total Vanadium (mg/L)
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Jul-15
Jul-20
Jul-25
Jul-30
Jul-35
Jul-40
Jul-45
Jul-50
Jul-55
Jul-60
Jul-65
Jul-70
95th Percentile
75th Percentile
25th Percentile
5th Percentile
Median



\\golder.gds\gal\burnaby\active_2014\1421\1411734 mount polley\07 deliverables\1411734-12000-site wide water balance\closure\september 29, 2015 report\attachment 3 - time series results\attachment 3.4 - tsf.docx

ATTACHMENT 4
SRK Source Terms

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Memo

To:	Katie McMahen, MPMC	**Client:**	MPMC
From:	Stephen Day	**Project No:**	1CI008.005
Cc:	Chris Kennedy, SRK Michael Herrell, Golder Jerry Vandenberg, Golder Skya Fawcett, Golder	**Date:**	September 18, 2015
Subject:	Scoping Level Source Term Water Chemistry Predictions for Mount Polley Closure Plan, DRAFT		

1 Introduction

As requested by Golder Associates, this memorandum describes scoping level source term water chemistry predictions for the Mount Polley Mine closure plan. These source terms are described as "scoping" because the schedule for delivery of the closure plan required by BC Ministry of Energy and Mines did not allow sufficient time for a thorough assessment of site data.

Source terms for selected elements are provided in Table 1. The file containing all source terms is provided separately:

- Closure_Source_terms_Output_1CI008005_SD_20150901.xlsx.

Sources for which terms are required are:

- Waste rock dumps, waste rock stockpiles and ore stockpiles;
- Re-handled PAG waste rock;
- Pit walls;
- Sulphur stockpiles;
- Magnetite stockpiles; and
- Tailings.

No terms were developed for the sulphur and magnetite stockpiles because geochemical data were not available. Both are probably small sources relative to other components of the site but this should be confirmed.

2 Terminology

A “source term” is the predicted concentration of pore water in contact with mine waste. It does not include the effects of dilution by non-contact water, or other contact waters. For example, a waste rock pore water source term does not include dilution by groundwater, surface water at a seep sampling location and runoff from the surface of the dump (bare or reclaimed).

All source terms described here are for “dissolved elements” resulting from chemical weathering. The effect of suspended matter resulting from physical weathering and erosion will need to be added separately to obtain total concentrations.

All source terms are described as “maximum annual” for a given statistic. Seasonal variation was not considered but lower concentrations may be expected during high infiltration events.

Golder requested that statistical distributions be used to describe the uncertainty in source terms. Where monitoring data are used directly, these distributions can be derived from the data themselves. SRK described distributions using 5^{th}, 50^{th} and 95^{th} percentiles. However, when source terms are derived by interpretation and the data do not exist to construct distributions, SRK represented these distributions as one value (for terms derived from small datasets) and two values (larger datasets). For the latter, the two values should be assumed to be equally probable.

3 Methods

3.1 Waste Rock Dumps and Stockpiles, and Ore Stockpiles

Waste rock has been generated by mining of several open pits and will remain as permanent features at closure. Potentially acid rock drainage (ARD) generating (PAG) waste rock from Springer Pit was stockpiled separately for subsequent subaqueous disposal in the Springer Pit at closure. Ore stockpiles are located near the ore processing plant.

For the purpose of these source terms, it is assumed that all permanent dumps are non-PAG. Contact water is assumed to remain non-acidic with chemistry reflecting dissolution of natural weathering products (oxides) created prior to mining, sulphide oxidation and acid neutralization, and limited solubility under non-acidic conditions of secondary minerals generated by chemical weathering processes.

Using this conceptual model, the current seepage from the waste rock dumps can be assumed to be a reasonable analog for future waste rock seepage chemistry. The exception to this assumption is that the influence of final reclamation measures is only partially reflected in current conditions. Soil covers may reduce oxidation rates by limiting oxygen availability and entry mechanisms, increase CO_2 in pore gas due to reduced exchange with the atmosphere and reduce infiltration. These effects can all influence seepage chemistry and will be considered as the source terms are refined.

An initial review of seepage water chemistry data obtained since 2013 showed distinctive spatial variations. The Southeast Rock Disposal Site (SERDS), Northeast Zone Dump (NEZ) and

Temporary PAG Stockpile seeps have higher sulphate concentrations and similar major cation chemistry. The Waste Haul Road (WHR) and Boundary Dump seeps have similar lower sulphate concentrations but show different major ion chemistry. For this reason, three waste rock source terms were developed for SERDS, NEZ and PAG group (termed "sulphide"), WHR (termed "oxide") and Boundary Dump (termed "Boundary"). These terms also show distinctive selenium concentrations (highest for oxide, lowest for Boundary).

Due to the time limitation, a detailed review of trends was not completed. Instead, the objective of the method was to estimate highest likely concentrations assuming typical mineral solubility constraints for the prevailing non-acidic pH conditions. This eliminates the need to consider trends because it is assumed that even an upward trend would not surpass well-established solubility controls. In general this was achieved as follows:

- Major ion chemistry was reviewed to determine if sulphate concentrations were constrained by gypsum solubility and, if not, what the expected maximum sulphate concentration could be. The NEZ seeps had high end sulphate concentrations of 1100 mg/L compared to theoretical gypsum solubility of about 1700 mg/L for these waters. The difference is assumed to represent dilution.
- The ratio of theoretical limit to high end monitored values was calculated (1.4 for NEZ).
- Values for the 95th and 99th percentiles for concentrations of all the observed seep data grouped as indicated above were calculated.
- The sulphate ratio obtained above was used to "correct" the observed concentrations for dilution.

For WHR data, the correction was not applied assuming that water chemistry is influenced by natural oxide materials and therefore that sulphate concentrations will not eventually reach the gypsum control. High end concentrations are near 500 mg/L compared to the calculated sulphate solubility limit for these seeps of about 1900 mg/L.

In summary, the terms can be applied as follows:

- "Sulphide" Term: East side waste rock dumps, Temporary PAG Stockpile and ore stockpiles.
- "Oxide" Term: West side waste rock dumps, excluding the Temporary PAG Stockpile.
- "Boundary" Term: Boundary waste rock dump.

Other locations where waste rock is used, for example, for infrastructure and re-construction of the tailings dam should be assigned a term appropriate for its geochemical composition.

3.2 Re-Handled PAG Waste Rock

It is assumed that weathering products will be flushed from re-handled PAG waste rock when it is placed in the Springer Pit. However, due to the non-acidic conditions, flushing is expected to occur slowly reflecting the low solubility of weathering products. The source term therefore incorporates two components:

1. The total inventory of weathering products accumulated in the stockpile over a 10 year period.
2. Solubility limits for water in contact with the backfill.

The first component was calculated using weathering rates indicated mainly by humidity cells. Three HCTs were used with the rate range based on the average and maximum for each parameter. Rates were scaled to cooler site conditions using a factor of 0.1. These scaled rates were then multiplied by 10 years to obtain the inventory expressed in mg/t.

Nitrogen forms, fluoride and chloride were not determined for the humidity cells. Ammonia, nitrite and chloride were assumed to have been flushed or degraded before backfilling. For nitrate, column tests on waste rock samples were used to estimate residual nitrate. For fluoride, the same columns were used to estimate a leaching rate.

Solubility limits (in mg/L) were those determined for waste rock.

3.3 Pit Walls

Pit wall source terms were calculated using humidity cells data scaled as described above. The scaling factor used was 0.03 over a reactive thickness of 2 m to account for bench rubble. Concentrations were calculated using an assumed infiltration of 405 mm/year which was estimated assuming 90% of total annual precipitation (450 mm/year).

Ammonia, nitrate and nitrite were all assumed to yield a negligible contribution. Fluoride concentrations were based on solubility limits indicated by waste rock.

3.4 Tailings

For the purpose of closure planning, it is assumed the tailings will slowly drain down overtime resulting in de-saturation of the tailings mass. Earlier water chemistry is expected to be dominated by process water with a slow transition to water chemistry influenced by weathering of the tailings.

The source term for earlier water chemistry was based on the tailings monitoring dataset. These data showed that chemistry at seepage collection locations tracked with process water chemistry though at slightly lower concentrations presumably reflecting the effect of dilution by groundwater. The distribution was calculated from recent data (August 2011 to present) following a peak in sulphate concentrations in the pond in 2010.

No specific data were available to estimate long term concentrations. The recommended source term is that for sulphide waste rock with the exception of ions released from blasting residues which were set to have concentrations of zero.

4 Conclusions

Scoping level source terms have been provided for major facilities as part of assessment of closure. These source terms will be refined to reflect the composition of sources, additional interpretation of water chemistry data and trends, and updated to include the magnetite and sulphur stockpiles.

SRK Consulting (Canada) Inc.

Stephen Day, PGeo
Corporate Consultant (Geochemistry)

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Table 1. Summary of Selected Source Terms

Source	Phase or Type	Statistic	Units	Alkalinity	NO_3 (as N)	SO_4	Al	As	Cd	Ca	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	Se	Zn
TMF	Draindown	P5	mg/L	60	0.032	430	0.0015	0.0003	0.0009	0.00002	120	0.00013	0.0016	0.015	0.000025	18	0.069	0.13	0.00025	0.0013
	Draindown	P50	mg/L	83	2.3	510	0.016	0.00053	0.0017	0.00006	150	0.00035	0.0045	0.052	0.000025	22	0.36	0.19	0.00025	0.0095
	Draindown	P95	mg/L	120	8.4	640	1.2	0.0013	0.0023	0.00013	210	0.0012	0.024	1.4	0.00057	34	0.82	0.22	0.0023	0.028
	Post Draindown	Low	mg/L	200	50	1700	0.089	0.0008	0.00091	0.00047	540	0.016	0.35	0.13	0.000074	99	4.3	0.43	0.0081	0.3
	Post Draindown	High	mg/L	280	53	1700	0.092	0.00094	0.0013	0.00061	550	0.024	0.63	0.75	0.000074	100	9.5	0.55	0.017	0.34
Waste Rock	Sulphide	Low	mg/L	200	50	1700	0.089	0.0008	0.00091	0.00047	540	0.016	0.35	0.13	0.000074	99	4.3	0.43	0.0081	0.3
	Sulphide	High	mg/L	280	53	1700	0.092	0.00094	0.0013	0.00061	550	0.024	0.63	0.75	0.000074	100	9.5	0.55	0.017	0.34
	Oxide	Low	mg/L	220	28	820	0.015	0.0006	0.00072	0.000065	320	0.00074	0.022	0.038	0.00005	56	0.55	0.15	0.0019	0.16
	Oxide	High	mg/L	240	29	840	0.016	0.00061	0.00074	0.000073	320	0.0015	0.025	0.62	0.00005	56	1.1	0.16	0.0026	0.18
	Boundary	Low	mg/L	210	2.4	1600	0.024	0.00051	0.005	0.00018	640	0.0012	0.022	0.61	0.0004	98	0.97	0.13	0.00061	0.012
	Boundary	High	mg/L	220	2.4	1600	0.063	0.00057	0.0067	0.00018	640	0.0013	0.023	0.76	0.00041	99	0.99	0.13	0.0015	0.016
Pit Wall	Breccia	All	mg/L	280	0	66	0.092	0.00094	0.0013	0.00059	150	0.00063	0.049	0.36	0.000074	21	0.04	0.14	0.0011	0.13
	Diorite	All	mg/L	130	0	250	0.092	0.00029	0.0013	0.000098	150	0.0026	0.13	0.75	0.000074	2.5	0.057	0.086	0.0011	0.0035
	Monzonite	All	mg/L	260	0	19	0.092	0.0004	0.0013	0.00011	82	0.00027	0.018	0.079	0.000074	7.8	0.0069	0.045	0.00094	0.0038
	Average	All	mg/L	220	0	110	0.092	0.00054	0.0013	0.00026	130	0.0012	0.064	0.4	0.000074	11	0.035	0.089	0.001	0.046
PAG Backfill	Flush	Low	mg/t	650000	5400	280000	4500	2.1	25	0.67	320000	2.9	160	1500	3.6	27000	88	230	2.6	120
	Flush	High	mg/t	960000	5600	630000	8900	4.4	35	1.5	380000	6.6	320	3300	7.4	55000	140	350	2.8	330
	PW Constraint	All	mg/L	280	1000000	1700	0.092	0.00094	0.0013	0.00061	550	0.024	0.63	0.75	0.000074	100	9.5	0.55	0.017	0.34

Source: P:\01_SITES\Mt_Polley\1CI008.005_2015_ReStart_Source_Terms\200_Closure_Source_terms\[Closure_Source_terms_1CI008005_SD_REV00.xlsx]

November 2, 2015

MOUNT POLLEY MINING CORPORATION

Cariboo-Springer Pit Phase 4 Water Management Plan (TSF 970 m Design)

Submitted to:
Mount Polley Mining Corporation
PO Box 12
Likely, BC
V0L 1N0

Attention: Don Parsons and Luke Moger

REPORT

Reference Number: 1411734-094-R-Rev0-12000

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Golder Associates

Executive Summary

Mount Polley Mining Corporation (MPMC) has retained Golder Associates Ltd. (Golder) to complete the detailed design for the raise of the tailings storage facility (TSF) at the Mount Polley Mine to an elevation of 970 m and feasibility design of the embankments to an elevation of 984 m. This water management plan addresses the 970 m raise, which is required for the Cariboo-Springer Pit Phase 4 mine plan.

The mining operations were suspended following a breach of the TSF Perimeter Embankment at Corner 1 on August 4, 2014. No tailings have been deposited in the TSF since. MPMC resumed restricted operations in August 2015, with the tailings being deposited within Springer Pit. MPMC is seeking regulatory approval to return to full operations using the TSF in 2016.

A site wide water balance has been developed by Golder (2015a) to support short- and long-term water management planning for the Mount Polley Mine (Mine). Subsequently, a site-wide water management plan (SWWMP) has been developed, and has been presented in this document. The SWWMP represents the long-term water management during mine life, closure and post-closure.

This report presents the SWWMP in conjunction with the site-wide water balance (SWWB).

The work presented in this report is as follows:

- a brief summary of the physical setting at the Project site (Section 2.0);
- an overview of the climate and hydrology at site (Section 3.0);
- an overview of surface and groundwater considerations (Section 4.0);
- a presentation of the mine water management objectives and considerations (Section 5.0);
- a presentation of the SWWB model (Section 6.0);
- SWWB results (Section 7.0);
- a high level summary of the mine water management infrastructure design (Section 8.0);
- a qualitative overview of changes to water quality, relative to the previously submitted Year-1 Reclamation and Closure Plan (Section 9.0);
- a high level summary of the monitoring plan (Section 10.0); and
- closure.

Study Limitations

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Table of Contents

EXECUTIVE SUMMARY ..... **i**

STUDY LIMITATIONS ..... **ii**

1.0 INTRODUCTION **1**

2.0 BACKGROUND **2**

3.0 CLIMATE AND HYDROLOGY **6**

3.1 Climate 6

3.1.1 Temperature 7

3.1.2 Precipitation 7

3.1.3 Evaporation 8

3.2 Site Drainage and Hydrology 9

3.2.1 Pit Groundwater Hydrology 11

4.0 WATER MANAGEMENT AT THE MINE **12**

4.1 Surface Water Management 12

4.2 Groundwater Management 12

5.0 MOUNT POLLEY MINE WATER MANAGEMENT OVERVIEW **13**

5.1 Objectives 13

5.2 Mine Water Management Plan 13

5.2.1 Restricted Operations Phase 14

5.2.2 Resumed Operations Phase 14

5.2.3 Closure Phase and Post-Closure 16

5.2.3.1 Tailings Storage Facility 17

5.2.3.2 Pit Lakes 17

6.0 SITE WIDE WATER BALANCE MODEL **18**

6.1 Model Software 18

6.2 Model Objectives 18

6.3 General Assumptions 19

6.4 Model Scope and Flow Diagram 19

6.5 Climate Inputs 26

6.5.1 Deterministic Climate Inputs 26
6.5.2 Stochastic Climate Inputs 26
6.6 Hydrology Inputs 27
6.6.1 Runoff Parameters 27
6.6.2 Catchment Areas 28
6.7 Storage Capacities 29
6.8 Flow Derivation and Logic 31
6.8.1 Pumped Flows 31
6.8.1.1 Operational Pumping Rules – Restricted and Resumed Operations 31
6.8.1.2 Operational Pumping Rules – Closure/ Post Closure 31
6.8.1.3 Mill Process Flows – Restricted Operations 33
6.8.2 Tailings Storage Facility Seepage Flows 34
6.8.3 Consumption Flows 34
6.8.4 Pit Groundwater Flows 34
6.9 Model Simulation 36
7.0 RESULTS 37
7.1 Tailings Storage Facility 37
7.2 Central Collection Sump 38
7.3 Perimeter Embankment Till Borrow Pond 39
7.4 Springer Pit 40
7.5 Required Pumping Capacities for TSF Water Management 42
8.0 DESIGN OF MINE WATER MANAGEMENT INFRASTRUCTURE 46
9.0 WATER QUALITY 47
10.0 MONITORING PLAN 48
11.0 CLOSURE 49
REFERENCES 50

TABLES

Table 1: Local and Regional Climate Stations for the Mount Polley Mine 6
Table 2: Local Snow Course Sites at the Mount Polley Mine 7
Table 3: Likely Climate Station Monthly Temperatures (1974 – 1993) 7

Table 4: Long-Term Precipitation at the Mount Polley Mine Site (1974 – 2015)[(a)] 8
Table 5: Estimated Monthly and Annual Lake Evaporation (1997 – 2015) [(a)] 9
Table 6: Tailings Deposition Monthly to December 2016 15
Table 7: Tailings Deposition Quarterly to Q4 2021 16
Table 8: Primary Mine Water Flows 25
Table 9: Stochastic Climate Generator Statistics 27
Table 10: Seasonal Runoff Coefficients 28
Table 11: Catchment Areas for Storage/Conveyance Elements 28
Table 12: Maximum Capacities for Major Storage Facilities 29
Table 13: Primary Mine Water Flows 32
Table 14: Mill Process Flows - Production during Restricted and Resumed Operations 33
Table 15: Pit Groundwater Flows (Golder 2015b) 35
Table 16: Groundwater Flows for Wight Pit 35

FIGURES

Figure 1: Project Location 4
Figure 2: Mine Site Layout 5
Figure 3: Mount Polley Mine - Major Catchment Areas 10
Figure 4: Conceptual Flow Diagram - Restricted Operations 21
Figure 5: Conceptual Flow Diagram - Resumed Operations 22
Figure 6: Conceptual Flow Diagram – Closure 23
Figure 7: Conceptual Flow Diagram – Post-Closure 24
Figure 8: Mount Polley Site Wide Water Balance - Catchment Areas 30
Figure 9: TSF Water Volumes throughout the Mine Life and into Closure 37
Figure 10: TSF Water Elevations throughout the Mine Life and into Closure 38
Figure 11: CCS Water Volumes throughout the Mine Life and into Post-Closure 39
Figure 12: Perimeter Embankment Till Borrow Pond Water Volumes 40
Figure 13: Springer Pit Water Elevations 41
Figure 14: Springer Pit Water Volumes - PAG Deposition 42
Figure 15: Simulated Pumping Rates for P3 (Pump from TSF to CCS) 43
Figure 16: Simulated Pumping Rates for P4 (Pump from CCS to TSF) 43
Figure 17: Simulated Pumping Rates for P5 (Pump from Perimeter Embankment Till Borrow Pond to TSF) 44
Figure 18: Simulated Pumping Rates for P33 (Make-up Water from Polley Lake to TSF). 45

APPENDICES

APPENDIX A
Model Inputs

1.0 INTRODUCTION

Mount Polley Mining Corporation (MPMC) has retained Golder Associates Ltd. (Golder) to complete the detailed design for the raise of the tailings storage facility (TSF) at the Mount Polley Mine (the Mine) to an elevation of 970 m and a feasibility design of the embankment to 984 m. This water management plan addresses the 970 m raise, which is required for the Cariboo-Springer Pit Phase 4 mine plan.

The mining operations were suspended following a breach of the TSF Perimeter Embankment at Corner 1 on August 4, 2014. No tailings have been deposited in the TSF since. MPMC resumed restricted operations in August 2015, with the tailings being deposited within Springer Pit. MPMC is seeking regulatory approval to return to full operations, with use of the TSF in 2016.

A number of documents have been completed or are under development related to water management at the Mine. The short-term water management Technical Assessment Report in support of resumed restricted operations is provided in Golder (2015c). An operational water management plan and design basis is currently being developed and is to be submitted to the Chief Inspector of Mines by December 31, 2015. A long-term water management plan that extends for the estimated remaining mine life is under development. The draft Technical Assessment Report in support of the long term water management plan is due to be submitted to the Regional Director, Environmental Protection, British Columbia Ministry of Environment by June 30, 2016.

This report presents the water balance and water management plan in support of detailed design for the construction of the Corner 1 Perimeter Embankment to an elevation of 970 m and the raise of the remaining embankments by approximately 2 m to a crest elevation of 970 m (Golder 2015d). The methods and assumptions used in this water balance are consistent with the documents mentioned above, except where noted.

The work presented in this report is as follows:

- a brief summary of the physical setting at the Project site (Section 2.0);
- an overview of the climate and hydrology at site (Section 3.0);
- an overview of surface and groundwater considerations (Section 4.0);
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- a qualitative overview of changes to water quality, relative to the previously submitted Year-1 Reclamation and Closure Plan (Section 9.0);
- a high level summary of the monitoring plan (Section 10.0); and
- closure.

2.0 BACKGROUND

The Mount Polley Mine (the Mine) is a copper and gold mine operated by MPMC. The site is located 56 km northeast of Williams Lake, British Columbia. Mount Polley began production in 1997 and operated until October 2001, when operations were suspended for economic reasons. In March 2005, the mine restarted production and it had been in continuous operation up to the time of the breach. Ore was crushed and processed by selective flotation to produce a copper-gold concentrate. The mill throughput rate was approximately 6 to 8 million tonnes per year.

The project location is shown on Figure 1, while the mine site layout is shown on Figure 2. The mine is located between Polley Lake and Bootjack Lake. The TSF is located about 3 km southeast of the mill. The TSF includes one embankment that is approximately 4.8 km in length. The embankment is subdivided into three sections; referred to as the Main Embankment, Perimeter Embankment and South Embankment. The embankment has incorporated a staged expansion design utilizing modified centerline and centerline construction methods.

The Mine operates with an annual water surplus. During its first stage of development (1997 – 2001), the Mine recycled water from the TSF for re-use in the milling process. It was not necessary for the mine to discharge water during the initial period of operation. When the mine re-opened in 2005, a surplus of water was present and a permit amendment was sought to enable discharge of treated surplus water into Hazeltine Creek (MPMC 2009). This amendment, issued in 2013 for Permit 11678 under the BC *Environmental Management Act*, imposed certain limits for effluent quality, non-toxicity requirements and target levels for specific analytes in Hazeltine Creek, as well as the following volume limits:

- a maximum annual discharge of 1.4 million m^3 (Mm^3) per year could be discharged; and
- a permitted discharge amount was not to exceed 35% of the daily flow of Hazeltine Creek.

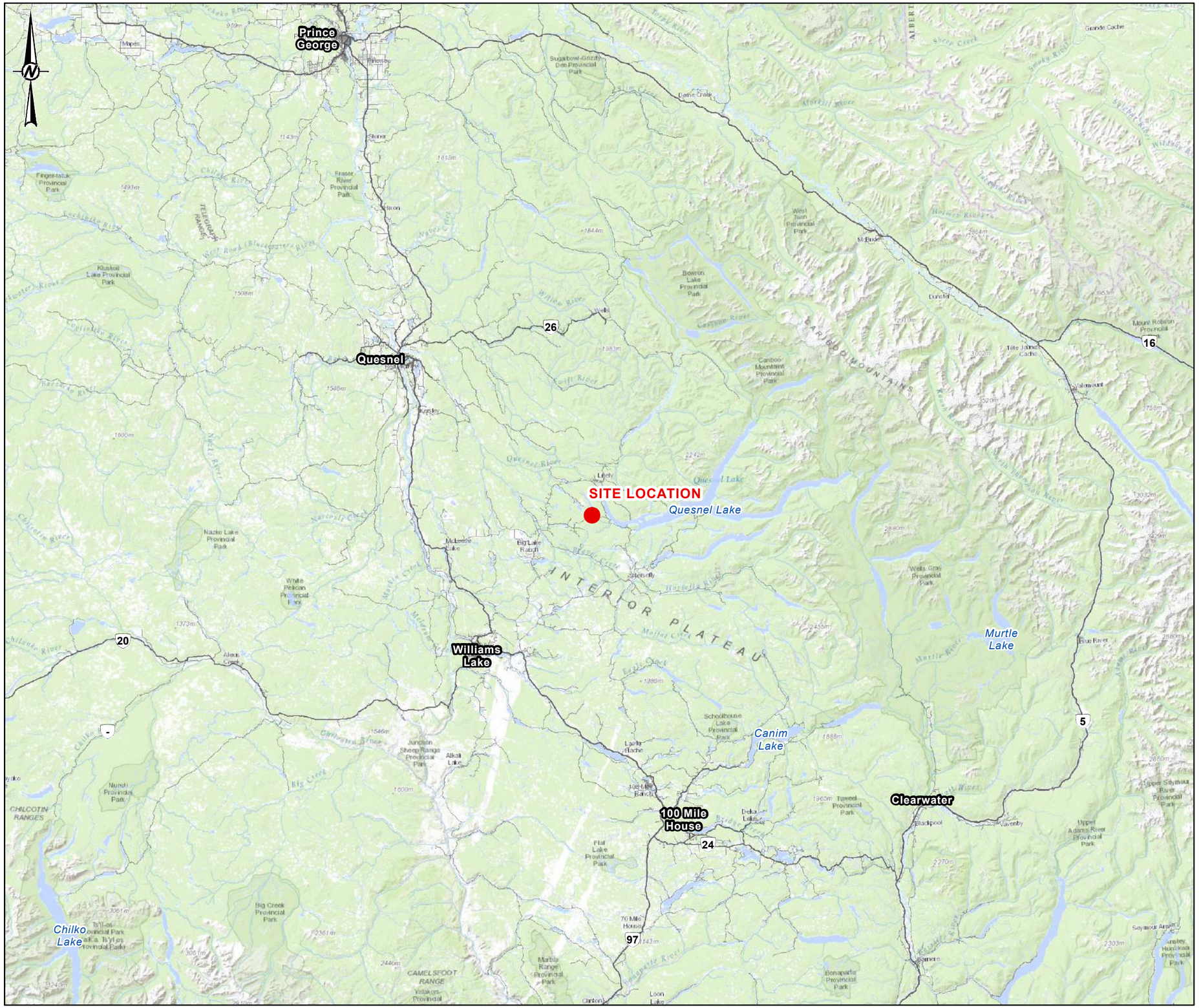
The mine has continued to expand its operation, resulting in an increased mine footprint, as well as an increase in the contact water to be managed. To address the increased contact water volumes, MPMC was actively pursuing an interim measure using a reverse osmosis (RO) plant with discharge of treated water to Polley Lake. The reject water from the RO plant was to be directed to the TSF. The proposed application of RO was intended for a short period (approximately four years) and not intended as a suitable technology post-closure.

During operations, prior to the TSF dam breach on August 4, 2014, contact water flowed or was pumped to the TSF and was recycled to the mill as process water. The embankment raise construction to a crest elevation of about 967 m was completed in November 2013. The 2013 construction is documented by AMEC (2014). On August 4, 2014, a breach of the Perimeter Embankment of the TSF occurred, at Corner 1 near station 4+300, releasing tailings, water and embankment materials to the downstream environment. At the time of the failure on August 4, 2014, placement of fill on the embankments to raise the crest to an elevation of 970 m was nearing completion.

The 2015 Freshet Management Embankment (Freshet Embankment) was constructed to a top of cut-off wall elevation of 950 m through the breach area. The Freshet Embankment was designed and constructed to allow capture and temporary storage of the 2015 freshet flows, so that the water could be managed after the peak inflows reduced. The construction of a buttress along the Perimeter Embankment was also completed, as part of the 2015 Freshet Management (Golder 2015a). The December 17, 2014 amendment of the *Mines Act* Permit M-200 allows operation of the TSF for water management for a period of one year from the date of the permit amendment and requires a permit amendment prior to the 2016 freshet to address requirements for longer term use. A further amendment of the *Mines Act* Permit M-200 dated July 9, 2015 authorizes the current restricted mining operations at the Mine, including deposition of tailings into Springer Pit.

Following the breach, MPMC is pumping mine contact water to the Springer Pit, which has a finite capacity. It is estimated that once water in Springer Pit reaches approximately 1,030 metres above sea level (masl), the pit water will begin to exfiltrate to the groundwater and discharge towards Bootjack Lake (Golder, 2015a).

Currently, there is no discharge from the Mine. A draft *Environmental Management Act* permit amendment to discharge treated mine effluent at a maximum rate of 0.3 m^3/s to Quesnel Lake via the Hazeltine Creek channel has recently been received by MPMC. Treatment infrastructure and a temporary diffuser to Quesnel Lake are in place and commissioned, and MPMC is awaiting approval from the British Columbia Ministry of Environment before discharge can commence.



LEGEND

- SITE LOCATION
- ROAD
- WATERCOURSE
- WATERBODY



0 25 50

1:1,250,000 KILOMETRES

REFERENCES

1. INSET MAP DATA OBTAINED FROM GEOBASE®.
2. BASEMAP OBTAINED FROM ESRI. USED UNDER LICENCE, ALL RIGHTS RESERVED.
3. ROAD, WATERCOURSE AND WATERBODY DATA OBTAINED FROM IHS INC.
4. DATUM: NAD 1983 UTM ZONE 10N

CLIENT
MOUNT POLLEY MINING CORPORATION
IMPERIAL METALS

PROJECT
MINE WATER MANAGEMENT PLAN

TITLE
PROJECT LOCATION

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-02
DESIGNED	JR
PREPARED	RH
REVIEWED	JR
APPROVED	RGM

PROJECT NO.	CONTROL	REV.	FIGURE
14-11734	1000	0	01

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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LEGEND

- CLIMATE STATION
- CONTACT WATER COLLECTION DITCH
- NON - CONTACT WATER DIVERSION DITCH
- CONTOUR (10m)

0 750 1,500

1:30,000 METRES

REFERENCES

1. CONTOURS AND PROJECT IMAGERY OBTAINED FROM SNC LAVALIN (2014)
2. WATER CATCHMENT AREAS INTERPOLATED BY GOLDER ASSOCIATES LTD.
3. BASE IMAGERY SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY
4. DATUM: NAD 1983 UTM ZONE 10N

CLIENT
MOUNT POLLEY MINING CORPORATION
IMPERIAL METALS

PROJECT
MINE WATER MANAGEMENT PLAN

TITLE
MINE SITE LAYOUT

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-02
DESIGNED	JR
PREPARED	RH
REVIEWED	JR
APPROVED	RGM

PROJECT NO.	CONTROL	REV.	FIGURE
14-11734	1000	0	02

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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3.0 CLIMATE AND HYDROLOGY

3.1 Climate

The Mine is located in the Cariboo region of British Columbia, approximately 56 km northeast of Williams Lake. This region experiences high spatial climate variation due to its topographical complexity. MPMC has operated climate stations on site since 1995, although records are not continuous. From 1995 through 2012, Mount Polley maintained one climate station at the Mill Site that measured and recorded rainfall and temperature. In 2012, this was replaced with two stations: one near the Mill Site and one adjacent to the TSF. These new stations measure and record wind speed and direction, relative humidity, solar radiation, temperature and rainfall. The details of these stations are shown in Table 1. The location of the Mine weather stations are shown in (Figure 2).

The climate of the Mine site was characterized using the Environment Canada (EC) station in the nearby town of Likely as well as three onsite climate stations.

Table 1: Local and Regional Climate Stations for the Mount Polley Mine

Station Name	ID	Northing (m N) [a]	Easting (m E)	Elevation (masl) [b]	Data Type	Period of Record
Likely	1094616	5828785	599332	724	Temperature, Rainfall, Snowfall, Total Precipitation	1974 - 1993
Mill Site Weather Station	N/A	5822420	592495	1,181	Rainfall, Temperature	1995 - 2012
Weather Station #1 (near Mill)	N/A	5822420	592792	1,171	Rainfall, Temperature, Relative Humidity, Solar Radiation, Wind Speed, Wind Direction	2012 - 2015
Weather Station #2 (TSF)	N/A	5819955	594059	964	Rainfall, Temperature, Relative Humidity, Solar Radiation, Wind Speed, Wind Direction	2012 - 2015

N/A = not applicable.

a) UTM Coordinate system - Zone 10U.

b) Metres above sea level (masl). Elevation for on-site climate stations measured with handheld GPS device.

During the winter, snowpack is measured at four snow course sites at minimum frequency of once per month, with more frequent measurements typically being taken during the melt phase. The details of these stations are provided in Table 2, while their locations are shown in Figure 2.

Table 2: Local Snow Course Sites at the Mount Polley Mine

Station Name	ID	Northing (m N) [a]	Easting (m E)	Approximate Elevation (masl) [b]	Period of Record
Snow Course # 1 (near Mill)	N/A	5823182	592792	1,171	1997 – 2010, 2015
Snow Course # 2 (near TSF)	N/A	5819976	594092	964	1997 – 2015
Snow Course # 3	N/A	5823895	593632	976	2012 – 2015
Snow Course # 4	N/A	5823537	590835	1,112	2015 – 2015

a) UTM Coordinate system - Zone 10U.

b) Elevation measured by handheld GPS device.

3.1.1 Temperature

The town of Likely is located approximately 9 km northeast of the mine site at an elevation of 724 masl. The elevation of the mine ranges from about 920 masl to 1,200 masl, and therefore the average temperatures are generally 0.3ºC to 1.0ºC cooler than recorded at Likely.

Monthly values for the Likely climate station are shown in Table 3. Temperatures at Likely are generally mild to cold, with average monthly temperatures ranging from 15.1ºC in July to -6.6ºC in January.

Table 3: Likely Climate Station Monthly Temperatures (1974 – 1993)

Month	Temperature (ºC)		
	Average	Maximum	Minimum
January	-6.6	-2.9	-11.1
February	-4.5	0.6	-9.4
March	-0.8	5.8	-6.0
April	4.0	11.3	-2.1
May	9.1	16.3	2.3
June	12.8	19.8	6.0
July	15.1	22.7	8.1
August	15.1	22.3	7.8
September	10.7	17.3	4.0
October	4.7	10.6	0.1
November	-1.3	2.4	-4.8
December	-5.6	-2.1	-9.2
Annual	4.4	10.3	-1.2

3.1.2 Precipitation

Long-term precipitation time series representative of the climate conditions at the Mine were derived using the long-term regional data from the Likely station (1974 – 1993) and available local data from the three on-site climate stations (1995 to 2015).

The mine site experiences high summer precipitation due to summer storms, with the lowest precipitation occurring in February. Precipitation typically occurs as snowfall starting in November, and accumulates until March. Average annual precipitation at Mount Polley is estimated to be 670 mm. Estimated 1:200-year dry, average, and 1:200-year wet precipitation depths are shown in Table 4.

Table 4: Long-Term Precipitation at the Mount Polley Mine Site (1974 – 2015)[(a)]

Month	Precipitation (mm)				
	Average	1:200-Year Dry	1:25-Year Dry	1:25-Year Wet	1:200-Year Wet
January	50.8	26.9	33.3	72.0	82.9
February	37.5	19.8	24.5	53.1	61.1
March	42.8	22.7	28.0	60.7	69.8
April	49.5	26.2	32.4	70.2	80.7
May	53.5	28.3	35.1	75.8	87.3
June	78.2	41.4	51.3	111	128
July	58.9	31.2	38.6	83.4	96.0
August	52.2	27.6	34.2	73.9	85.1
September	48.2	25.5	31.5	68.3	78.6
October	58.2	30.8	38.1	82.5	94.9
November	53.5	28.3	35.1	75.8	87.3
December	85.6	45.3	56.1	121.3	140
Annual	**669**	**354**	**438**	**948**	**1092**

a) No precipitation data available for 1994. Includes Likely station data (1974 – 1993).

The 1:25 year dry and wet, as well as the 1:200 year dry and wet precipitation values were determined by distributing the average annual precipitation (derived based on Likely and on-site stations) among the months based on average percentage of precipitation for each month.

3.1.3 Evaporation

Currently, at the Mine there are two climate stations that measure and record precipitation (rain), temperature, wind speed and direction, solar radiation, and relative humidity every 30 minutes. Lake (open water) evaporation is calculated based on measured climate parameters such solar radiation, wind and temperature, using the Penman equation (Penman 1984). Lake evaporation estimates have been derived for the period 2005 to 2012. Lake evaporation shows a typical seasonal profile, with no evaporation in the winter months and maximum evaporation in the summer months. Average annual lake evaporation at Mount Polley is estimated to be 404 mm. Estimated average monthly and annual lake evaporation values are provided in Table 5.

Table 5: Estimated Monthly and Annual Lake Evaporation (1997 – 2015) [(a)]

Month	Lake Evaporation (mm)
January	0
February	0
March	0
April	0
May	52.0
June	94.3
July	102
August	88.8
September	48.1
October	18.2
November	0.3
December	0
Annual	404

a) Derived from data measured at on-site climate stations, pro-rated to long-term data from Likely Climate Station

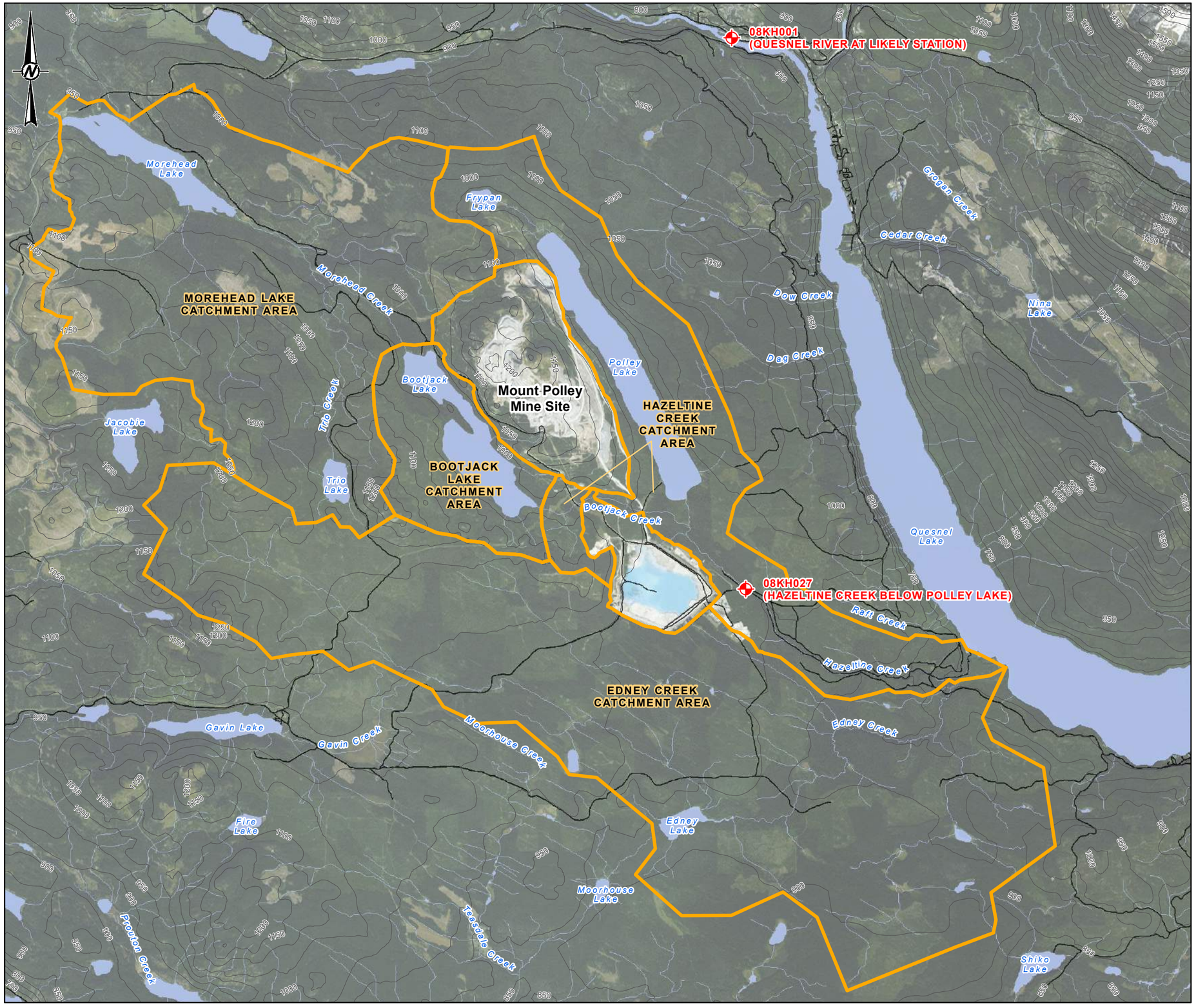
3.2 Site Drainage and Hydrology

Mount Polley is drained by three main watersheds: the Hazeltine Creek (30.2 square kilometres [km^2]) at Quesnel Lake, the Edney Creek (87.4 km^2) at Quesnel Lake, and the Morehead Lake (62.7 km^2) watersheds (Figure 3). The Hazeltine Creek watershed includes Polley Lake and conveys all water from Polley Lake, the east side of Mount Polley and the area surrounding the TSF. The Morehead Creek watershed includes the Bootjack Lake catchment area (11.2 km^2).

Both the Hazeltine Creek and the Morehead Creek watersheds were significantly altered by historical water diversions. Bootjack Creek, a small remnant of which now flows into Polley Lake, historically conveyed water from Bootjack Lake to Hazeltine Creek. In 1913, flow from Bootjack Lake was reversed by damming the east end of Bootjack Lake and digging a new outlet westward to Morehead Creek. Around the same time, a control structure was also built at the outlet of Polley Lake (Hazeltine Creek), and Hazeltine Creek water was diverted to the Bullion Pit to support hydraulic mining. Flow from Polley Lake to Hazeltine Creek was restored with the abandonment of mining at the Bullion Pit during World War II. However, the flow from Bootjack Lake to Hazeltine Creek was never restored.

Prior to the breach of the TSF, Edney Creek and Hazeltine Creek converged just prior to discharging into Quesnel Lake. The mouths of the two creeks have now been separated, and Edney Creek and Hazeltine Creek now both discharge directly into Quesnel Lake.

Mount Polley has maintained a hydrological monitoring station on upper Hazeltine Creek that was originally installed by the Water Survey of Canada (08KH027). In general, the hydrology of Hazeltine Creek (and by extension, the Mount Polley area), can be described as snowmelt driven, with the majority of annual runoff occurring during the spring snowmelt in April and May freshet (KP 2014). Annual average flow at the upper Hazeltine Creek station (assessed in 2009) was 0.19 cubic meters per second (m^3/s), and ranges from 0.05 m^3/s in the winter (December through February) to 0.74 m^3/s in April (KP 2014). Greatest observed flow was approximately 3.1 m^3/s in April 1996 (KP 2014). Flow gauges are also located on Edney Creek and Morehead Creek, although the data record is too short to estimate long-term flows.



LEGEND

- ENVIRONMENT CANADA HYDROMETRIC STATIONS
- WATER CATCHMENT AREA
- CONTOUR (50m)
- ROAD
- WATERCOURSE
- WATERBODY

0 2 4

1:80,000 KILOMETRES

REFERENCES

1. CONTOURS, ROAD, WATERCOURSE AND WATERBODY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. WATER CATCHMENT AREAS INTERPOLATED BY GOLDER ASSOCIATES LTD.
3. BASE IMAGERY SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY
4. DATUM: NAD 1983 UTM ZONE 10N

CLIENT
MOUNT POLLEY MINING CORPORATION
IMPERIAL METALS

PROJECT
MINE WATER MANAGEMENT PLAN

TITLE
MOUNT POLLEY MINE - MAJOR CATCHMENT AREAS

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-02
DESIGNED	JR
PREPARED	RH
REVIEWED	JR
APPROVED	RGM

PROJECT NO.	CONTROL	REV.	FIGURE
14-11734	1000	0	**03**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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3.2.1 Pit Groundwater Hydrology

A hydrogeological assessment has been conducted to predict the quantity of long-term groundwater seepage from both Springer and Cariboo Pits towards Bootjack Lake for the Phase 4 Cariboo-Springer Pit mine plan (Golder 2015b). The analysis considered placement of waste rock in the pit prior to the pit lake formation.

Currently, all mine water and tailings are being deposited and stored in Springer Pit. Dewatering is expected to commence in the near future, after an approval to discharge treated mine water has been received by MPMC. Tailings deposition in Springer Pit is scheduled to continue until April 2016. Prior to resumed operation in Springer Pit, the pit will be dewatered and tailings that were deposited will be transferred to the TSF. Springer Pit and Cariboo Pit will be mined to the ultimate depths of approximately 878 m and 938 m elevation, respectively.

During closure, Springer Pit and Cariboo Pit will be allowed to flood. Once the pit lake level is above approximately 1,028 m elevation, the pit lakes in these two pits will merge and form a single pit lake. The spillover elevation for this pit lake is approximately 1,050 m elevation. Potentially Acid Generating (PAG) materials will be placed in the Springer Pit up to an elevation of approximately 1,028 m to mitigate acid generation and metal leaching, in accordance with standard mine waste handling practices (MEND 2015).

The results from the hydrogeological model indicate that under steady-state conditions, groundwater inflow to the Springer Pit Lake is projected to gradually decrease from approximately 500 m^3/day at a pit lake elevation of 878 m, to 250 m^3/day for a pit lake elevation of 1,050 m elevation (Golder 2015b). Groundwater inflow to the Cariboo Pit is expected to gradually decrease from 590 m^3/day at a pit lake elevation of 938 m, to 320 m^3/day at an elevation of 1,050 m. Model results also show that groundwater outflow from Springer Pit Lake towards Bootjack Lake water is expected to occur once the pit lake level reaches approximately 1,030 m. Likewise, groundwater outflow from the Cariboo Pit Lake to Bootjack Lake is expected to occur once the pit lake reaches approximately 1,050 m.

Hydrogeological modelling was also carried out for the Wight Pit by Golder (2015c). The results from the hydrogeological model indicate that under steady-state conditions, groundwater inflow to the Wight Pit is projected to gradually decrease from 2,560 m^3/day at an elevation of 950 m, to 574 m^3/day at an elevation of 802 m.

4.0 WATER MANAGEMENT AT THE MINE

4.1 Surface Water Management

A network of channels, ponds, and pumping systems is operated by MPMC for managing surface water at the site. Surface water at the Mine is segregated by contact and non-contact water:

- Non-contact water: water that has not been physically or chemically altered by mining and milling activities. Non-contact water is understood as runoff originating from areas unaltered by mining activity that does not come into contact with mining areas. It is typically diverted to the maximum extent practical and allowed to discharge directly to the receiving environment (Figure 2).
- Contact water: water that may have been physically or chemically altered by mining and milling activities. This water generally requires treatment before releasing to the environment. To the extent practical, contact water is recirculated for internal use to reduce the amount of fresh water supply from natural sources.

The contact/non-contact water systems are managed to minimize mixing of these waters. Examples include the following:

- keeping runoff originating from areas unaltered by mining activities (non-contact water) separate from areas altered by mining activities (contact water), and diverting it to the natural conveyance channels;
- managing runoff from waste rock dumps and other disturbed areas that could contain sediment; and
- managing stormwater in the active pits, waste rock stockpiles, and other areas that could contribute contaminants to site water.

After approval has been received to discharge excess mine water, MPMC will discharge treated mine water to the environment to a maximum rate of 0.3 m^3/s.

4.2 Groundwater Management

Groundwater inflows to Springer Pit, Cariboo Pit, and the underground workings are currently collected and mixed with mine surface water for use as process water, or to be treated and discharged.

5.0 MOUNT POLLEY MINE WATER MANAGEMENT OVERVIEW

5.1 Objectives

The main objective of this MWMP is to define the water management practices that will help prevent the accumulation of contact water at the Mine, and to prevent unplanned and/or non-compliance releases of untreated contact water to the environment. The following strategies are proposed to meet this objective:

- to the extent practical, reduce the volume of non-contact water by diverting non-contact water away from disturbed areas;
- treat and discharge excess mine water so that minimal water accumulates with minimal carry-over from year to year, for conditions up to the 1 in 200-year wet conditions;
- maintain a minimum pond volume of one million m^3 (1 Mm^3) in the TSF for operation of reclaim pumps; and
- maintain adequate tailings beaches, with the goal of a minimum of 100 m long beaches.

There will be minimal storage of mine water on site; however, during the freshet (April through June) and extreme storm events, the volume of mine water runoff will exceed the discharge and treatment capacity. Therefore, temporary detention of the freshet and extreme storm runoff volume will be necessary to equalise the flows to the water treatment facility.

5.2 Mine Water Management Plan

This section provides a description of the proposed mine water management plan for the main mining phases:

- **Restricted operations** will extend from present until April 2016. Use of the TSF has not been authorized, and tailings and mine water will continue to be deposited in Springer Pit. Mining and milling shall cease if the Springer Pit Lake reaches an elevation of 1,030 masl (*Mines Act* Permit M-200).
- **Resumed operations** will extend from May 2016 until Q2 2020. Resumed Operations will include:
  - Resumption of full mining and milling activities, which will include deepening of the Cariboo and Springer pits.
  - Tailings will be deposited in the TSF.
  - Springer Pit will be dewatered.
  - Tailings previously deposited in Springer Pit will be removed and transferred to the TSF.
- **Closure/post-closure phase—**The Closure Phase will extend from July 2020 to July 2030, and will include closure and reclamation activities as identified in the Reclamation and Closure Plan. The post-closure period will continue indefinitely after the Closure Phase. Pit lakes will develop in the Springer/Cariboo Pit.

A summary of tailings deposition during Restricted Operations and Resumed Operations phases are presented in Table 6 and Table 7. A total of 36 Mt of tailings solids are to be deposited in the TSF under the current mine plan, and includes tailings to be transferred from Springer Pit.

Water management infrastructure is shown in Figure 2.

5.2.1 Restricted Operations Phase

Currently, all mine contact water is pumped to, and tailings are deposited in, the Springer Pit for temporary storage. Contact water from roads, haul roads, waste rock dumps and other mine areas north of Bootjack Creek either collects in sumps (NW, 9km, Mine Drainage Creek, Mill Site, Wight Pit, Cariboo Pit) or flows directly to the South-east Rock Dump Site (SERDS), West, and Long ditches (Figure 2). The water that collects in the sumps is either pumped directly to Springer Pit, or to the SERDS, West, or Long ditches, which flow to the Central Collection Sump (CCS). Water in the TSF is currently pumped to the CCS. All water in the CCS is currently pumped to the Springer Pit.

As of October 1, 2015, the water level in the Springer Pit was 1020.36 m. Under the existing *Mines Act* mine permit M-200, mining and milling operations shall cease when the Springer Pit Lake level reaches 1,030 m. A draft *Environmental Management Act* permit has been received by MPMC, and discharge of treated mine water at a maximum rate of 0.3 m^3/s is expected to be approved in the near future.

The current mine permit authorizes mining and processing of up to four million tonnes (4 Mt) for up to one year from the date of permit issuance (July 9, 2015).

5.2.2 Resumed Operations Phase

Under Resumed Operations, the TSF will be operational from May 2016, and tailings deposition in Springer Pit will cease. Outside of the TSF, mine contact water will either flow or be pumped to the SERDS and Long ditches, which flow to the CCS. Water from the CCS reports by gravity to the Perimeter Embankment Till Borrow Pond where it will be treated and discharged. When the inflows to the CCS exceed the discharge rate (typically during the freshet period), excess contact water will be pumped to the TSF for temporary detention. At other times, water from the TSF will be pumped to the CCS for use in processing or treatment prior to discharge.

Mine water inflows into the TSF consist of:

- water pumped with the tailings slurry, at approximately 35% solids by weight;
- precipitation and run-off into the TSF;
- excess water pumped from the water management structures for temporary storage in the TSF, during the freshet and high flow events; and
- water pumped from Polley Lake to the TSF to provide make-up water to meet process requirements and to maintain the minimum pond volume in the TSF necessary for operation of the reclaim pumps. This would typically be required during the winter and extreme dry years.

Springer Pit will be dewatered progressively over time. In addition, over the period Q4 2017 to Q3 2018, tailings which have been previous deposited in Springer Pit will be pumped as a slurry, or mined and hauled, to the TSF (Table 7). Predictions for Springer Pit dewatering are given in Section 6.9.

Table 6: Tailings Deposition Monthly to December 2016

Phase	Period	Tailings Solids Deposited (tonnes)	
		Springer Pit	TSF
Restricted Operations	Year to Sep-15	596,000	N/A
	Oct-15	347,000	N/A
	Nov-15	327,000	N/A
	Dec-15	559,000	N/A
	Jan-16	558,000	N/A
	Feb-16	522,000	N/A
	Mar-16	558,000	N/A
	Apr-16	540,000	N/A
Resumed Operations	May-16	N/A	682,000
	Jun-16	N/A	660,000
	Jul-16	N/A	682,000
	Aug-16	N/A	682,000
	Sep-16	N/A	660,000
	Oct-16	N/A	678,000
	Nov-16	N/A	608,000
	Dec-16	N/A	620,000

Table 7: Tailings Deposition Quarterly to Q4 2021

Phase	Period	Direct to TSF (tonnes)	Transferred from Springer Pit (tonnes)
Resumed Operations	2017 Q1	1,862,000	N/A
	2017 Q2	2,002,000	N/A
	2017 Q3	2,024,000	N/A
	2017 Q4	1,902,000	138,000
	2018 Q1	1,862,000	900,000
	2018 Q2	2,001,000	1,900,000
	2018 Q3	2,024,000	1,100,000
	2018 Q4	1,902,000	N/A
	2019 Q1	1,862,000	N/A
	2019 Q2	2,002,000	N/A
	2019 Q3	2,024,000	N/A
	2019 Q4	1,902,000	N/A
	2020 Q1	1,862,000	N/A
	2020 Q2	1,477,000	N/A

N/A = not applicable.

5.2.3 Closure Phase and Post-Closure

An updated Mine Reclamation and Closure Plan has been prepared by Mount Polley (MPMC 2015a). The following objectives to the closure and reclamation have been identified:

- long-term preservation of water quality within and downstream of decommissioned operations;
- long-term stability of the TSF;
- removal of all access roads, ponds, ditches, pipelines, structures and equipment not required following mine closure;
- long-term stabilization of all exposed materials that are susceptible to erosion;
- establishment of a self-sustaining vegetative cover consistent with existing forestry, grazing and wildlife needs; and
- natural integration of disturbed lands into the surrounding landscape and restoration of the natural appearance of the area.

The following sections provide an overview of the closure and post-closure management strategies for the TSF and the pits. More detail regarding the closure and post-closure management of the mine facilities may be found in the Mine Reclamation and Closure Plan (MPMC 2015a).

5.2.3.1 Tailings Storage Facility

The surface of the TSF will be converted into a forested and wetlands site. Approximately 15% of the surface area of the TSF basin will be covered with water, with the remainder of the area being vegetated with indigenous species of trees, shrubs and grasses. The pond level within the TSF will be controlled by an overflow spillway constructed at an abutment. The spillway will be sized to manage the Probable Maximum Flood (PMF). The downstream embankment slopes will be pushed down to a slope of 2H:1V and these slopes and the 3H:1V buttress slopes will be covered with selected overburden materials and seeded with grasses and legumes to provide a stable vegetation mat that resists erosion. The seepage collection ponds and recycle pumps will be retained after closure until monitoring results indicate that the water quality from the TSF is suitable for direct release to the environment.

The tailings deposition plan will be to maintain the supernatant pond at the centre of the facility, against the natural topography. Within the last year of deposition, prior to closure, the deposition plan will change to push the pond closer to Corner 5 where the spillway is located, and at the same time reduce the pond volume. The operational spillway will limit the size of the pond and maintain the majority of the tailings unsaturated.

The tailings conveyance system will be removed immediately following cessation of operations. The reclaim barge, pumps and pipeline will be utilized for supplementary flooding of the open pits, as required, and will then be removed. Once open pit flooding is complete, the surface water diversion channel will be regraded to allow natural run-off through the tailings area.

5.2.3.2 Pit Lakes

Approximately 191 ha of the mine property is projected to be open pits at closure, which includes Springer Pit, Wight Pit, Cariboo Pit and Boundary Pit. All of the pits will be allowed to flood during closure, creating pit lakes.

Little or none of the upper pit walls can be reclaimed due to steep terrain and poor access, and as permitted under Section 10.7.14 of the *Health, Safety and Reclamation Code for Mines in British Columbia,* they will not be re-vegetated. If any benches are safely accessible by foot at closure, they will be broadcast-seeded with a native grasses and forbs seed mixture, and potentially fertilized. If access allows, these areas will then be hand-planted with seedlings which grow naturally on colluvial veneers and steep droughty sites in the region, such as of lodgepole pine, black cottonwood, sitka alder, and common juniper.

As described in Section 3.2.1, upon completion of mining operations, the Springer Pit will be allowed to flood and will spill over to the Cariboo Pit, and the two pits will form a single pit lake once filled. Upon completion of underground operations (portal located in the bottom of the Wight Pit), the Wight Pit will be allowed to fill to the spillover elevation into Polley Lake of 926 masl.

The Boundary Pit is a small pit (0.4 ha of area that will not be reclaimed) and observations through the operating period of the mine life indicate that the water exists in a roughly steady state (does not overflow).

6.0 SITE WIDE WATER BALANCE MODEL

6.1 Model Software

An Excel-based, deterministic site wide water balance model (SWWBM) was originally developed by Knight Piésold (KP 2004) for water management at the Mine. Over time, the model has been adapted by MPMC as the Mine has developed. The Excel-based water balance was designed to track and predict overall mine water accumulation, and MPMC has previously used the Excel-based site water balance for operational and planning purposes.

A new site-wide operational and predictive water balance model has been developed by Golder using GoldSim™ (Version 11.1). GoldSim allows dynamic, complex interactions within the water system to be represented through a visual, modular framework. All input parameters and functions are defined by the user and are built as individual objects or elements linked together by mathematical expressions. GoldSim is widely used for mine water quantity studies. The GoldSim model now supersedes the Excel-based model. The Excel-based water balance was converted to GoldSim because of the following GoldSim capabilities:

- deterministic and probabilistic simulations can be run within the model, allowing statistics and probabilities to be assigned to the model outputs;
- simulation periods can be varied within the same model;
- the model framework can be easily adjusted to account for changing/future conditions on the mine site, allowing the model to be used as an operational and planning tool; and
- water quantity and water quality modules can be directly linked, allowing both models to be updated simultaneously when evaluating various sensitivity scenarios of alternate water management strategies.

Hydrological parameters such as runoff coefficients, seepage flows and snow pack accumulation and melt have been largely retained from the Excel-based model.

6.2 Model Objectives

The Mount Polley SWWBM has been developed for the Mine with the following objectives:

- simulate current and future site water management, including a transition from Restricted Operations to Resumed Operations, and into Closure;
- determine water detention requirements in the TSF;
- develop strategies and assess timelines for Springer Pit dewatering;
- determine pumping capacities between the TSF, Springer Pit, the CCS, the Perimeter Embankment Till Borrow, and other major facilities at the Mine;
- provide support for assessment of water treatment and discharge options; and
- couple with a water quality module to assess site and discharge water quality during operations and into Closure.

The following sections present an overview of the SWWBM inputs and assumptions.

6.3 General Assumptions

General assumptions applied to model development are as follows:

- no seepage is lost from the ponds or sumps (i.e., all ponds and sumps are assumed to be lined);
- direct precipitation, evaporation and seepage loss from ditches are assumed to be negligible;
- precipitation occurs as snow from December to February and as rain in all other months; and
- snowmelt occurs in the months of March, April and May as a percentage of the maximum snowpack at the end of February (5% in March, 90% in April and 5% in May).

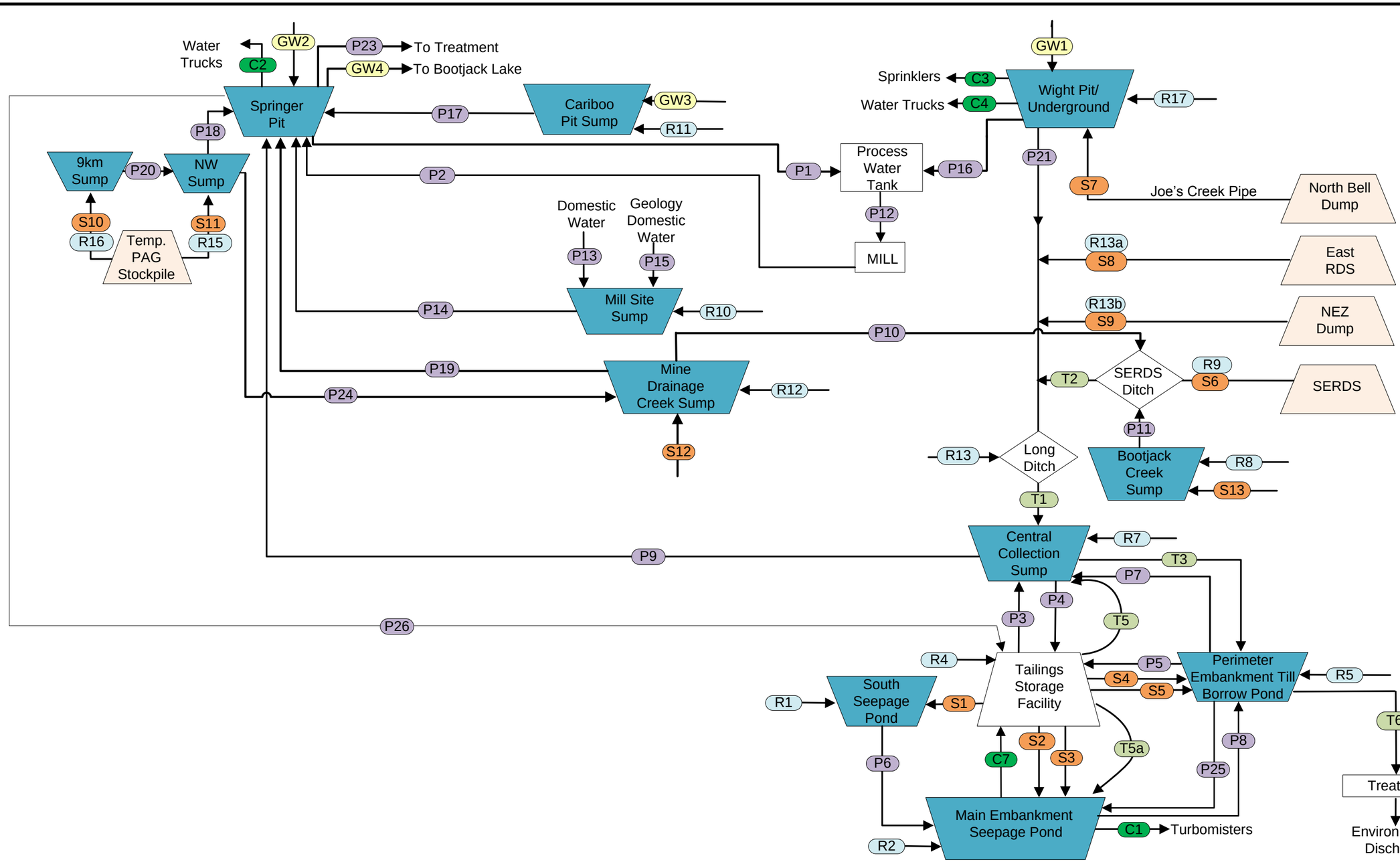
6.4 Model Scope and Flow Diagram

The scope and structure of the SWWBM has been outlined in conceptual process flow diagrams for each phase of mine life: Restricted Operations (Figure 4), Resumed Operations (Figure 5), Closure (Figure 6) and post-closure (Figure 7). The flow diagrams illustrate the water circuit system at the Mine, including the operational storage and conveyance of water. The water management facilities which have been included within the SWWBM include:

- South Seepage Pond;
- Main Embankment Seepage Pond;
- TSF;
- Perimeter Embankment Till Borrow Pit;
- CCS;
- Bootjack Creek Sump;
- SERDS Ditch;
- Mill Site Sump;
- Cariboo Pit Sump;
- Mine Drainage Creek Sump;
- Long Ditch;
- Springer Pit;
- NW Sump;
- 9 km Sump;
- Wight Pit; and
- Mill.

The following flow types are represented in the model:

- direct precipitation and evaporation;
- runoff;
- seepage (includes baseflows);
- water consumption flows (turbomisters, sprinklers and water trucks);
- pumped flows between facilities; and
- transfer flows (gravity flows between facilities).



Runoff (R)
Seepage Flow (S)
Water consumption (C)
Pumped Flows (P)
Groundwater Flows (GW)
Transfer Flows (T)
Flow Path

Note: Evaporation and Direct Precipitation are modelled for all ponds, but are not shown on this diagram

Golder Associates

CLIENT: Imperial Metals Ltd.
Mount Polley Mining Corporation

DRAWN: JFR DATE: October 29, 2015

CHECKED: RGM DATE: October 30, 2015

SCALE: Not to Scale

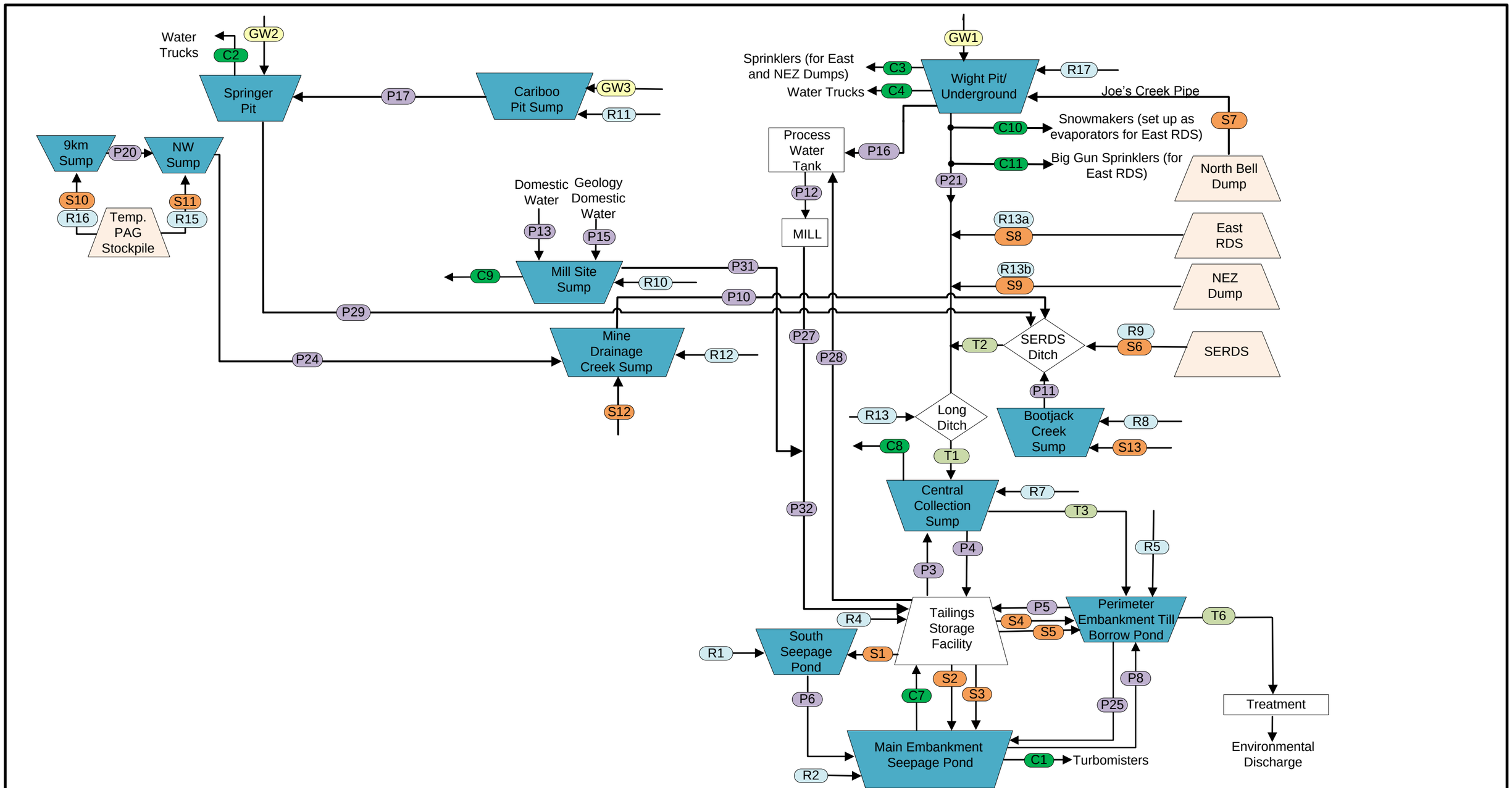
PROJECT No: 1411734/12000

TITLE

Site Wide Water Balance
Restricted Operations

FIGURE No: 4

REV No: 0



Runoff (R)
Seepage Flow (S)
Water consumption (C)
Pumped Flows (P)
Groundwater Flows (GW)
Transfer Flows (T)
Flow Path

Note: Evaporation and Direct Precipitation are modelled for all ponds, but are not shown on this diagram

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CLIENT: Imperial Metals Ltd.
Mount Polley Mining Corporation

DRAWN: JFR DATE: October 29, 2015

CHECKED: RGM DATE: October 30, 2015

SCALE: Not to Scale

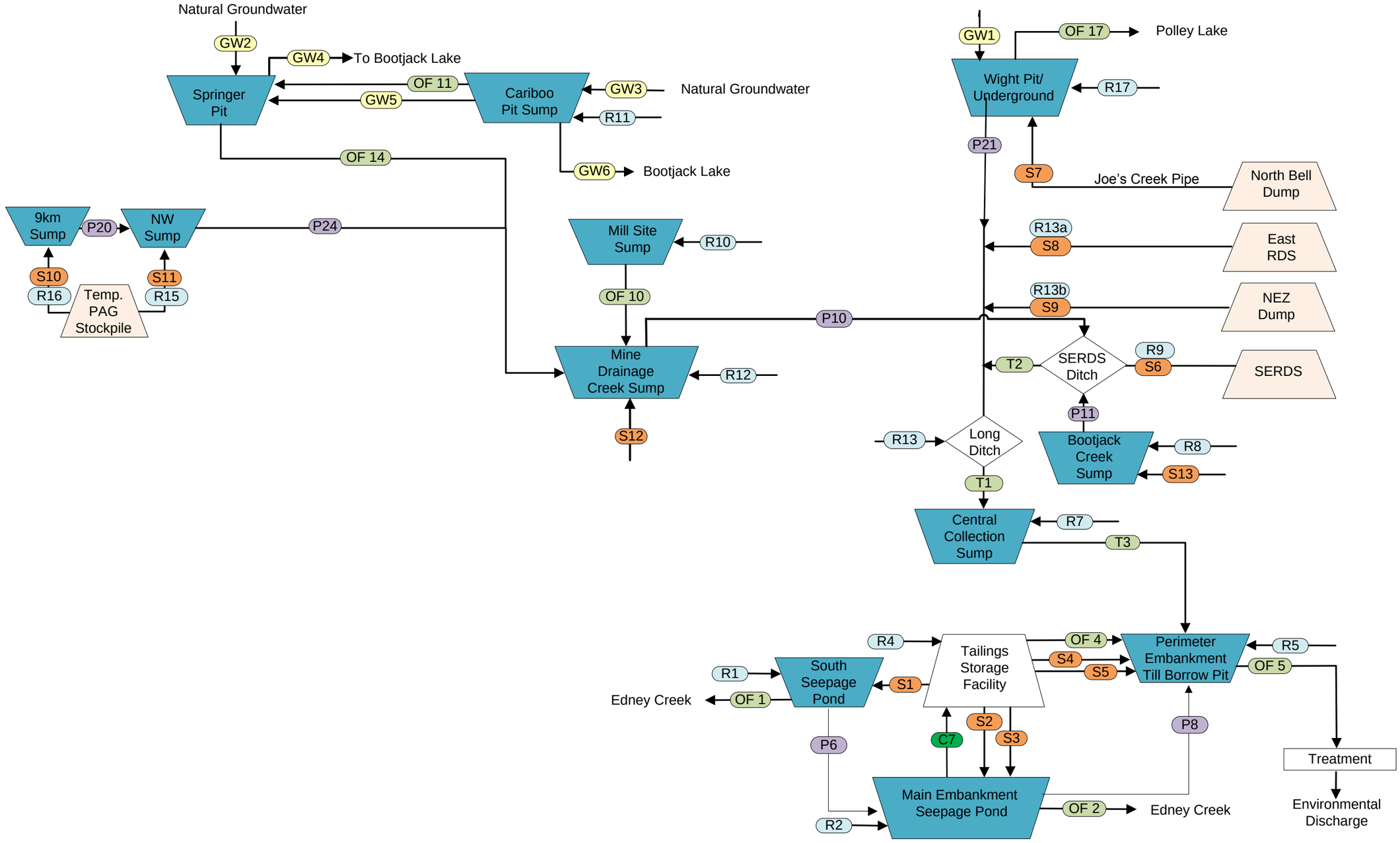
PROJECT No: 1411734/12000

TITLE

Site Wide Water Balance
Resumed Operations

FIGURE No: 5

REV No: 0



Runoff (R)
Seepage Flow (S)
Pumped Flows (P)
Groundwater Flows (GW)
Transfer Flows (T) / Overflow (OF)
Flow Path

Note:

- Evaporation and Direct Precipitation are modeled for all ponds, but are not shown on this diagram.
- Temporary PAG Stockpile will be rehandled to Springer Pit starting Q4 2018

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CLIENT: Imperial Metals Ltd.
Mount Polley Mining Corporation

DRAWN: JFR DATE: October 29, 2015

CHECKED: RGM DATE: October 30, 2015

SCALE: Not to Scale

PROJECT No: 1411734/12000

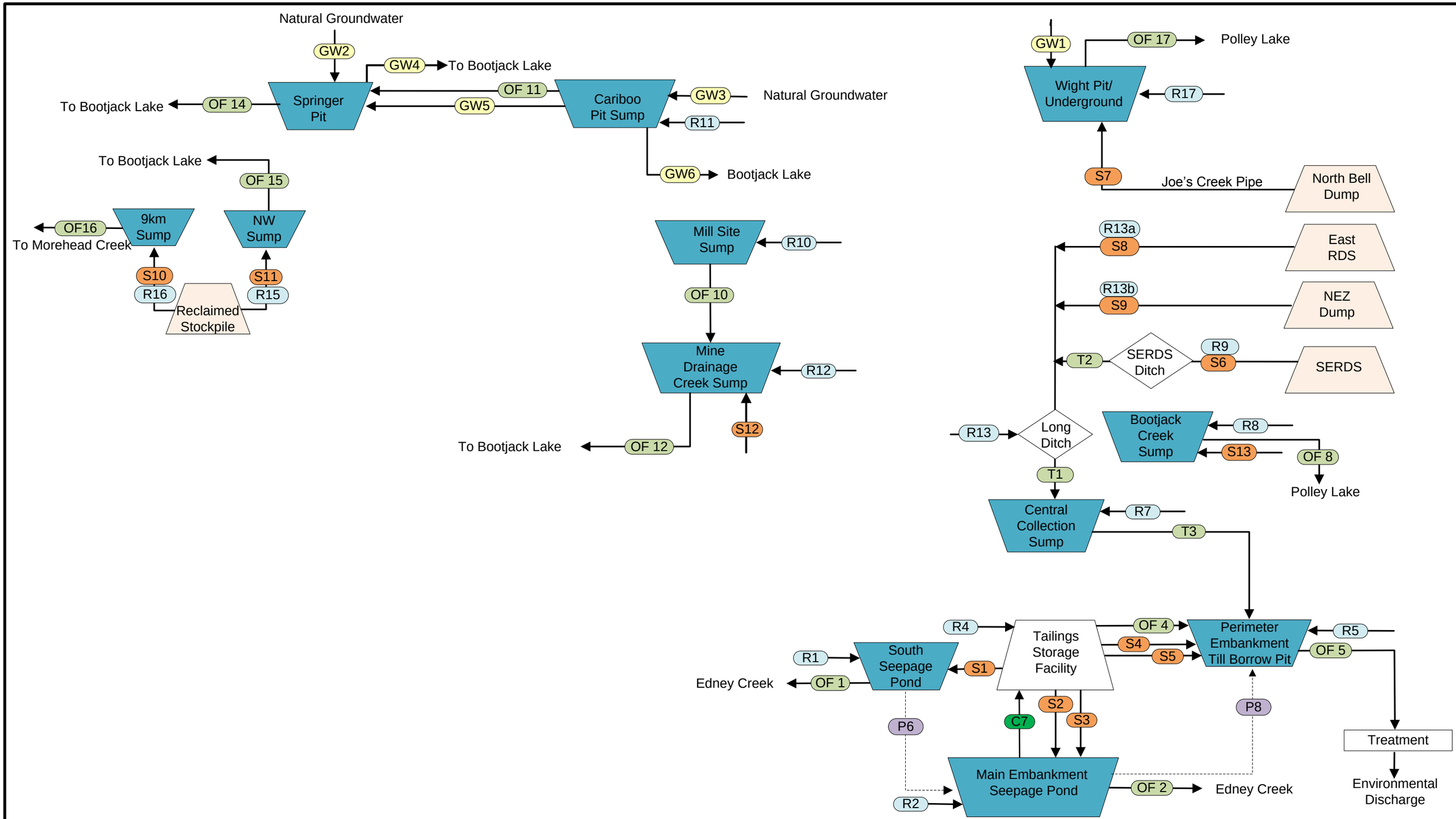
TITLE

Site Wide Water Balance

Resumed Operations Closure Conditions

FIGURE No: 6

REV No: 0



Runoff (R)
Seepage Flow (S)
Pumped Flows (P)
Groundwater Flows (GW)
Transfer Flows (T) / Overflow (OF)
Flow Path
Optional Flow Path during Post-closure - Not active in model

Note:

- Evaporation and Direct Precipitation are modeled for all ponds, but are not shown on this diagram.
- Temporary PAG Stockpile will be rehandled to Springer Pit starting Q4 2018

Golder Associates

CLIENT	Imperial Metals Ltd. Mount Polley Mining Corporation		
DRAWN	JFR	DATE	October 29, 2015
CHECKED	RGM	DATE	October 30, 2015
SCALE	Not to Scale	PROJECT No	1411734/12000
FIGURE No	7	REV No	0

TITLE

Site Wide Water Balance
Resumed Operations Post-Closure Conditions

The SERDS Ditch and the Long Ditch have been included in the model as conveyance elements. They do not store water; however, the model tracks the various inflows to these elements and transfers the cumulated flows to the CCS. No routing of flows takes place as the model is run on a monthly time step.

The primary flows in the model are summarized in Table 8.

Table 8: Primary Mine Water Flows

Flow Group	Component	Flow Label
Hydrology	Precipitation	N/A[(a)]
	Evaporation	N/A[(a)]
	Runoff	All flows labelled R[(b)]
Consumption	Sprinklers	C3,C7
	Turbomisters	C1, C6
	Water Truck Usage	C2, C4, C5
Seepage (from Tailings Storage Facility)	South Seepage Pond Inflow	S1
	Perimeter Toe Drain	S4
	Main Toe Drain	S3
	South Toe Drain	S2
	Freshet Embankment Drain	S5
	Tailings Drainage	T5
Groundwater Flows	Springer Pit Groundwater Inflow	GW2
	Springer Pit Groundwater Outflow	GW4
	Cariboo Pit Groundwater Inflow	GW3
	Wight Pit Groundwater Inflow	GW1
Pumped Flows – Inflows to Springer Pit	Tailings Slurry from the Mill	P2
	Pumped flow from Central Collection Sump	P9
	Pumped flow from Mill Site Sump	P14
	Pumped flow from Cariboo Pit Sump	P17
	Pumped flow from NW Sump to Springer Pit	P18
	Pumped flow from Mine Drainage Creek Sump	P19
Pumped Flows – Pit Dewatering	Springer Pit lake Dewatering	P23
Pumped Flows – Mill Site and Process Flows	Mill Water Requirement	P12
	Geology Domestic Water Effluent to Mill	P15
	Mill Domestic Water into Mill Site Sump	P13
Pumped Flows – Make-up Water to TSF	Polley Lake	P33

N/A = not applicable.

a) Evaporation and direct precipitation flows not shown on process flow diagram.

b) No flows were assigned specifically for snowpack. Instead, snowpack was accumulated in the model and applied to the runoff flows as snowmelt.

6.5 Climate Inputs

6.5.1 Deterministic Climate Inputs

The model features a deterministic mode, which allows the user to select from six pre-defined climate scenarios, as well as one custom (manual) input. The pre-defined climate scenarios are as follows:

- average annual precipitation data, derived based on long-term EC and local data (as described in Section 3.1);
- current climate conditions: measured precipitation and evaporation data up to the end of September 2015, with average precipitation and evaporation used for subsequent months;
- 1:25-year wet and dry annual precipitation (Table 4); and
- 1:200-year wet and dry annual precipitation (Table 4).

A manual climate condition can be defined by the user to simulate actual weather forecasts or extreme events. Annual average lake evaporation is used for the deterministic mode, and snowpack is accumulated within the model based on the assumption that snow accumulates from December to February, with a 5%, 90% and 5% melting in March, April and May respectively.

6.5.2 Stochastic Climate Inputs

GoldSim has stochastic elements, allowing uncertainty to be represented in model input data. GoldSim uses the Monte Carlo method to sample stochastic elements for probabilistic simulations. A stochastic generator was developed within GoldSim to probabilistically simulate natural climatic variation at the Mine. The stochastic generator operates on a monthly basis, and generates random sequences of monthly precipitation over the simulation period (one such random sequence is called a 'realisation').

The benefits of the stochastic generator are as follows:

- The model generates precipitation inputs for each realisation that are randomly drawn from a seasonally representative distribution.
- The statistics (i.e., mean and standard deviation) of stochastically generated values are representative of those of observed data.
- The approach can be used to generate multiple sequences of precipitation, each being equally likely as those that have occurred historically. GoldSim can then collate results for each rainfall sequence scenario to produce probabilistic results. As many time series can be generated, more extreme weather conditions (both wet and dry) can be simulated and tested in the water balance model than are available in the measured historical precipitation data.

Details on the development of the stochastic climate inputs can be found in Golder (2015a).

Table 9 shows a summary of the precipitation depths generated by the stochastic generator and compared with the values obtained from frequency analysis of the historic annual data. A regression analysis was done between the stochastically generated annual precipitation and the historical annual precipitation, resulting in a coefficient of determination of 0.996.

Table 9: Stochastic Climate Generator Statistics

Climate Scenario	Stochastically Generated Annual Precipitation (mm)	Historical Annual Precipitation (mm)
Average	668	670
1:200-year Dry	419	354
1:25-year Dry	482	438
1:25-year Wet	918	948
1:200-year Wet	1,086	1,091

6.6 Hydrology Inputs

The following sections describe the processes and inputs which define the hydrology in the model.

6.6.1 Runoff Parameters

Runoff in the SWWBM is estimated using seasonal runoff coefficients. Runoff coefficients represent the proportion of rainfall for runoff or seepage, and accounts for losses due to evaporation, storage and infiltration. The runoff coefficients account for the following seasons:

- dry: July to October;
- winter: November to February; and
- freshet: March to June.

The runoff coefficients are defined for six catchment types:

- exposed tailings;
- disturbed areas (cleared areas – not including pit surfaces, roads or rock dump storage);
- rock disposal sites;
- open pits;
- undisturbed catchments; and
- haul and access roads.

The seasonal runoff coefficients for each catchment type are presented in Table 10. The runoff coefficients were determined from the Knight Piésold water balance model (KP 2004) and revised based on site runoff measurements.

Table 10: Seasonal Runoff Coefficients

Catchment Type	Dry	Winter	Freshet
Exposed Tailings	0.3	0.6	0.9
Disturbed Areas	0.0	0.3	0.9
Rock Disposal Site Areas	0.0	0.1	0.6
Open Pits	0.5	0.75	0.9
Undisturbed Catchments	0.35	0.4	0.42
Haul Roads and Access Roads [(a)]	0.0	0.15	0.9
Mill Site Area [(a,b)]	0.0	0.1	0.1

a) Defined subsequent to the Knight Piésold Water Balance Report (KP 2004).

b) Calibrated parameter.

A constant baseflow seepage depth of 0.025 m/month for rock dump storage areas is included in the SWWBM to provide flows during the dry and winter months. Calibration of the water balance model is provided in Golder (2015a).

6.6.2 Catchment Areas

To model runoff, direct precipitation and evaporation, the catchment areas for each storage element were defined in the model. Delineated catchments are shown in Figure 8; catchment areas are shown in Table 11. Further details regarding land type breakdown for each catchment are presented in the Short Term Technical Assessment Report (Golder 2015a). A total area of 2,892,440 m^2 or 22% of the total mine area reports directly to the TSF.

Table 11: Catchment Areas for Storage/Conveyance Elements

Storage/ Conveyance Element	Total Reporting Area (m^2)
South Seepage Pond	385
Main Embankment Seepage Pond + ABR	376,935
TSF Upstream Catchment	622,790
TSF Facility	2,269,650
Perimeter Embankment Till Borrow Pit (includes Breach Sump)	524,330
Central Collection Sump	438,550
Bootjack Creek Sump	175,160
SERDS Ditch	1,537,590
Mill Site Sump	1,630

Storage/ Conveyance Element	Total Reporting Area (m^2)
Cariboo Pit Sump	1,320,350
Mine Drainage Creek Sump	1,115,930
Long Ditch	2,494,010
Springer Pit	651,890
North-West (NW) Sump	330,160
9 km Sump	698,840
Wight Pit	413,910
Total Reporting Area (m^2)	**12,972,110**

6.7 Storage Capacities

Storage curves were available for the following major storage elements:

- Springer Pit;
- Cariboo Pit;
- TSF; and
- Perimeter Embankment Till Borrow Pond.

Details regarding the stage storage curves can be found in the Technical Assessment Report (Golder 2015a). The maximum capacities for the facilities listed above are presented in Table 12. The CCS capacity will remain at 51,000 m^3 during the 970 m TSF embankment raise.

Table 12: Maximum Capacities for Major Storage Facilities

Storage Facility	Maximum Capacity (Mm^3)
Springer Pit[(a)]	14.8
Cariboo Pit [(a)]	5.2
Combined Springer/Cariboo Pit (End of Mine Life)	30.3
Tailings Storage Facility – Current Layout	2.1
Tailings Storage Facility – 970 m Embankment Raise	9.5
Perimeter Embankment Till Borrow Pond	0.17
CCS (Current Volume – to continue during 970 m Embankment Raise)	0.051

a) Represents current individual pit volumes (i.e., before pits are combined or further mined).



LEGEND

- WATER CATCHMENT AREA
- WATER COLLECTION DITCH
- CONTOUR (10m)

0 750 1,500

1:30,000 METRES

REFERENCES

1. CONTOURS AND PROJECT IMAGERY OBTAINED FROM SNC LAVALIN (2014)
2. WATER CATCHMENT AREAS INTERPOLATED BY GOLDER ASSOCIATES LTD.
3. BASE IMAGERY SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY
4. DATUM: NAD 1983 UTM ZONE 10N

CLIENT
MOUNT POLLEY MINING CORPORATION
IMPERIAL METALS

PROJECT
MINE WATER MANAGEMENT PLAN

TITLE
WATER CATCHMENT AREAS

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-02
DESIGNED	JR
PREPARED	RH
REVIEWED	JR
APPROVED	RGM

PROJECT NO.	CONTROL	REV.	FIGURE
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6.8 Flow Derivation and Logic

This section describes the model logic for pumped, seepage (from the TSF), groundwater, consumption and transfer flows. The derivation of runoff flows were discussed in Section 6.6. Details regarding the definition of all flows in the model are found in Technical Assessment Report (Golder 2015a).

6.8.1 Pumped Flows

Maximum pumping rates for each pumped flow are shown in Appendix A. With the exception of flows P13, P15, P16 and P19 (measured), all maximum pumping rates have been assumed. Although pump specifications were available for several pumps on site, not enough information was available to determine the energy losses of the pumping systems. Therefore assumed maximum pumping capacities were based on Golder's engineering judgement. The assumed pumping rates would not materially affect the results of Springer Pit water level, or the predicted dates of reaching critical elevations under any scenario.

6.8.1.1 Operational Pumping Rules – Restricted and Resumed Operations

In general, all water management facilities are pumped dry within the SWWMB. However, certain facilities have special operational pumping logic to deal with high flows. These are:

- Mine Drainage Creek Sump – All water is pumped into the SERDS Ditch (P10), which then flows to the CCS.
- Wight Pit – The Wight Pit has a maximum pumping capacity to the Mill Process Water Tank of approximately 0.09 m^3/s (P16). If inflow rates exceed this, all the water is then diverted into the Long Ditch (P21).
- Perimeter Embankment Till Borrow Pond – Water is sent to the Main Embankment Seepage Pond (provided that this pond is below freeboard elevation) to provide flow for the turbomisters and sprinklers on the TSF (P25). All excess water is then pumped to the CCS to be pumped to Springer Pit (P7). There is approximately 170,000 m^3 of contingency storage in the Perimeter Embankment Till Borrow Pond. If this contingency storage is depleted, the CCS is full and the pumps to the Springer Pit are operating at maximum capacity, water is pumped to the TSF for temporary detention (P5).

6.8.1.2 Operational Pumping Rules – Closure/ Post Closure

All pumped flows will be terminated as of closure (August 1, 2016 in the model), with the exception of the following:

- 9 km Sump to NW Sump (P20);
- NW Sump to Mine Drainage Creek Sump (P24);
- Mine Drainage Creek Sump to SERDS Ditch (P10);
- Bootjack Creek Sump to SERDS Ditch (P11);

- Wight Pit/ Underground to Long Ditch (P21);
- South Seepage Pond to Main Embankment Seepage Pond (P6); and
- Main Embankment Seepage Pond to Perimeter Embankment Till Borrow Pond (P8).

Table 13 describes the timing for the primary mine flows during closure/post closure.

Table 13: Primary Mine Water Flows

Flow Group	Component	Flow Label	Closure
Pumped Flows	9km Sump to NW Sump	P20	Operational until post-closure (assumed to start August 1, 2026).
	NW Sump to Mine Drainage Creek Sump	P24	
	Mine Drainage Creek Sump to SERDS Ditch	P10	
	Bootjack Creek Sump to SERDS Ditch	P11	
	Wight Pit/ Underground to Long Ditch	P21	
	South Seepage Pond to Main Embankment Seepage Pond	P6	
	Main Embankment Seepage Pond to Perimeter Embankment Till Borrow Pond	P8	
Seepage	From TSF	S1, S2, S3, S4, S5	Flows continue in perpetuity.
	Joe's Creek Pipe (from North Bell Dump)	S7	Flow continues in perpetuity. North Bell Dump will be fully reclaimed.
	From Temporary NW PAG Stockpile	S10, S11	Flows continue in perpetuity. PAG waste rock will be deposited in the Springer Pit during closure. Stockpile pad will be reclaimed during closure.
	From Non-Acid Generating waste rock storage areas	S6, S8, S9	Flows continue in perpetuity. Waste rock storage areas will be reclaimed during closure.
	From Haul Roads	S12, S13	Flows continue in perpetuity. Haul roads will be reclaimed during closure.
Groundwater Flows	Springer Pit Groundwater Inflow	GW2	Flows continue in perpetuity; inflow rates vary according to water level in pits (i.e., decrease with increasing water levels according to hydrogeological model; Table 15).
	Springer Pit Groundwater Outflow	GW4	
	Cariboo Pit Groundwater Inflow	GW3	
	Wight Pit Groundwater Inflow	GW1	

Flow Group	Component	Flow Label	Closure
Ditch Flows	Long Ditch	T1	Flows continue in perpetuity.
	SERDS Ditch	T2	
Environmental Discharge	From Perimeter Embankment Till Borrow Pond	OF5	Discharge allowed during post-closure.
	From South Seepage Pond	OF1	Discharge allowed during post-closure.
	From Main Embankment Seepage Pond	OF2	
	From Bootjack Creek Sump	OF8	Discharge allowed during post-closure.
	From Wight Pit	OF17	
	From Mine Drainage Creek Sump	OF12	Discharge allowed during post-closure.
	From Springer Pit	OF14	
	From 9km Sump	OF16	
	From NW Sump	OF15	

6.8.1.3 Mill Process Flows – Restricted Operations

The mill process flows, predicted by MPMC for the proposed limited mining of 4 Mt of high-grade ore from Cariboo Pit, are shown in Table 14. The total volume of tailings solids to be deposited in Springer Pit is approximately 1.51 Mm^3.

Table 14: Mill Process Flows - Production during Restricted and Resumed Operations

Month	Tailings Solids	Tailings Solids	Interstitial Water	Process Water
	(t)	(m^3)	(m^3)	(m^3)
2015 Q3	596,000	225,000	207,000	1,192,000
2015 Q4	1,232,000	465,000	428,000	2,464,000
2016 Q1	618,000	233,000	215,000	1,236,000
2016 Q2	1,882,000	710,000	654,000	3,764,000
2016 Q3	2,024,000	764,000	703,000	4,049,000
2016 Q4	1,905,000	719,000	662,000	3,811,000
2017 Q1	1,862,000	703,000	647,000	3,723,000
2017 Q2	2,002,000	755,000	695,000	4,004,000
2017 Q3	2,024,000	764,000	703,000	4,048,000
2017 Q4	1,902,000	718,000	661,000	3,805,000
2018 Q1	1,862,000	703,000	647,000	3,723,000
2018 Q2	2,001,000	755,000	695,000	4,003,000
2018 Q3	2,024,000	764,000	703,000	4,047,000
2018 Q4	1,902,000	718,000	661,000	3,804,000

Month	Tailings Solids	Tailings Solids	Interstitial Water	Process Water
	(t)	(m^3)	(m^3)	(m^3)
2019 Q1	1,862,000	703,000	647,000	3,724,000
2019 Q2	2,002,000	755,000	695,000	4,004,000
2019 Q3	2,024,000	764,000	703,000	4,048,000
2019 Q4	1,902,000	718,000	661,000	3,804,000
2020 Q1	1,862,000	703,000	647,000	3,725,000
2020 Q2	1,477,000	557,000	513,000	2,954,000

6.8.2 Tailings Storage Facility Seepage Flows

Seepage flows from the TSF (S1 to S5) have been measured for post-breach conditions by MPMC staff, and constant seepage rates based on these measurements have been applied in the model. Seepage from the TSF has been defined to flow year-round in the SWWBM. The seepage rates are presented in Appendix A.

6.8.3 Consumption Flows

Consumption flows were calculated by MPMC staff, and are modelled according to the following logic:

- turbomisters operate from May to October;
- sprinklers operate from July to October; and
- water trucks withdraw water from July through October.

Consumption flow rates are presented in Appendix A.

6.8.4 Pit Groundwater Flows

A hydrogeological assessment has been conducted to predict the quantity of long-term groundwater seepage from Springer Pit towards Bootjack Lake (Golder 2014). The model has been updated to include the Phase 4 pit shells for the Springer and Cariboo pits. The pits coalesce above approximately 1,028 m. The spillover elevation from Springer Pit is approximately 1,050 m.

The results from the hydrogeological model indicate that under steady-state conditions, combined groundwater inflow to the pit lake is predicted to gradually decrease from approximately 1090 m^3/day at a pit lake elevation of 870 m, to 570 m^3/day for a pit lake elevation of 1,050 m elevation (Table 15). Model results also show that groundwater outflow from the pit lake towards Bootjack Lake water is predicted to occur once the pit lake level reaches approximately 1,030 m. Combined outflow is predicted to gradually increase to 180 m^3/day once the pit lake level is at 1,050 m.

Table 15: Pit Groundwater Flows (Golder 2015b)

Pit Lake Elevation (m)	Groundwater Flows (m^3/d)			
	Springer Pit		Cariboo Pit	
	Into the Lake	Out of the Lake	Into the Lake	Out of the Lake
Base Case				
870	500	0		
940	490	0	590	0
960	480	0	590	0
980	450	0	570	0
1,000	410	0	530	0
1,020	320	0	450	0
1,030	300	60	420	0
1,040	270	150	380	0
1,050	250	250	320	10
Upper Bound				
1,050	420	580	500	50
Lower Bound				
1,050	170	180	220	10

Table 16 shows the groundwater inflows and outflows to Wight Pit between 880 m (near the Pit bottom) to 926 m (spillover elevation), for the calibrated hydrogeological model.

Table 16: Groundwater Flows for Wight Pit

Water Elevation (m)	Groundwater Inflow (m^3/d)	Groundwater Outflow (m^3/d)
802	2,559	0
900	2,542	0
910	2,140	0
920	840	0
950	574	518

6.9 Model Simulation

The simulation was carried out from October 1, 2015 to December 31, 2024, in order to capture the following mine life stages:

- restricted operations: August 2015 to June 2016 (expected);
- resumed operations: June 2016 to May 2020; and
- closure/post-closure: June 2020 onwards.

The model was run with probabilistic climate inputs for the purposes of this assessment. For each facility, water levels relating to the mean, 90th and 99.5th percentile climate conditions are shown. These results correspond to average, 1 in 10-year Wet, and 1 in 200-year Wet conditions, respectively. The model currently assumes that the CCS and Perimeter Embankment Till Borrow Pond would provide the required external detention volume.

7.0 RESULTS

7.1 Tailings Storage Facility

Temporary detention of water will be necessary to manage the large runoff volumes generated during the freshet (April to June, inclusive). The inflows during the freshet will exceed treatment and discharge capacities, and the detention volume is required to prevent spills from the CCS and to equalize the flow for treatment. Because of the large freshet volumes, it will be necessary to utilise the TSF for temporary detention; however, a principal objective of the water management plan is to not accumulate water on site (including the TSF), and to not carry over water from year to year, even under extreme wet conditions. The water balance has been used to assess the required detention volume external to the TSF, while also assessing the corresponding detention volume required in the TSF under average to extreme-wet conditions. Figure 9 shows the water volume in the TSF throughout the mine life, while Figure 10 shows the corresponding elevations.

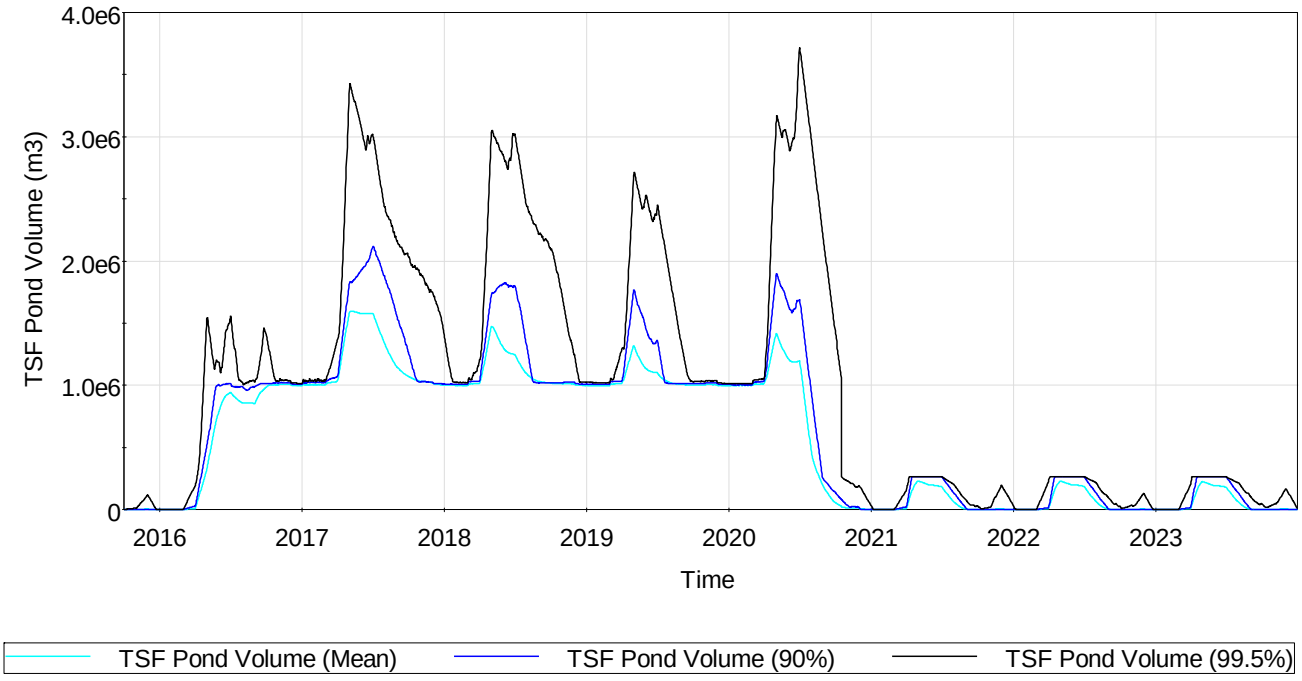


Figure 9: TSF Water Volumes throughout the Mine Life and into Closure

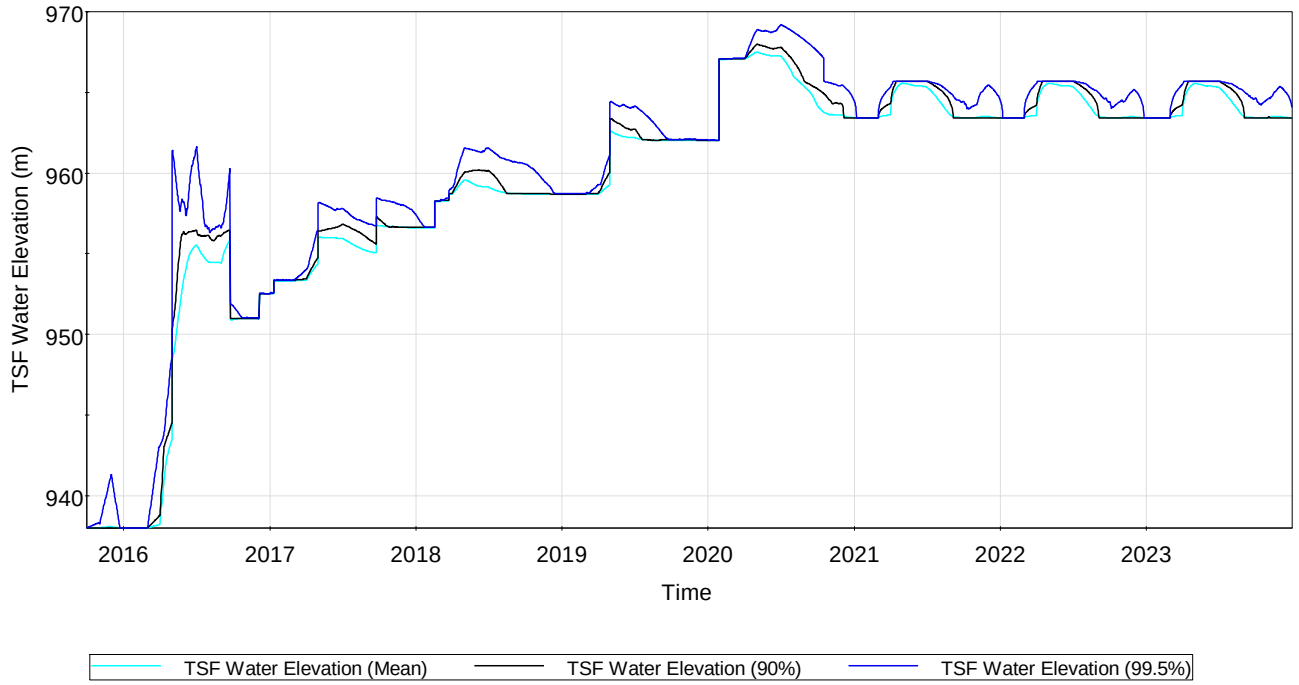


Figure 10: TSF Water Elevations throughout the Mine Life and into Closure

Under average climate conditions, the peak TSF volume is within the normal operating range and would not exceed 1.5 Mm^3 (including the 1.0 Mm^3 minimum operating volume). During the 90% (1 in 10 year) freshet, a peak volume of approximately 2.0 Mm^3 is expected, while for the 99.5% (1 in 200 year) freshet, a peak volume of approximately 3.3 Mm^3 is expected within the TSF on or around July 1.

As of closure, the water in the TSF is pumped and treated until the water volume reaches the spillway invert of 965.7 m. Under average climate conditions, this is projected to occur by November 2020. After this point, there are no active controls on the water volume, and changes in water volume are driven solely by catchment inflows and seepage outflows. Discharge from the TSF during closure would pass through a treatment system before being discharged to the environment. The type of treatment system, and the design and location are to be developed for the long-term water management plan, which is being prepared for submission prior to June 30, 2016.

7.2 Central Collection Sump

Water in the CCS overflows through an open channel to the Perimeter Embankment Till Borrow Pond. Therefore, both the CCS and Perimeter Embankment Till Borrow Pond act together as external storage for the TSF. To represent this process, the pond was allowed to reach the full capacity in the model and then all overflow was directed to the Perimeter Embankment Till Borrow Pond. As mentioned previously, the capacity in the CCC will remain at 51,000 m^3 until closure. Under average climate conditions, no water is sent to the Perimeter Embankment Till Borrow Pond (Figure 11). After closure, water is allowed to accumulate in the CCS where it would then discharge through the culverts and open ditches to the Perimeter Embankment Till Borrow Pond.

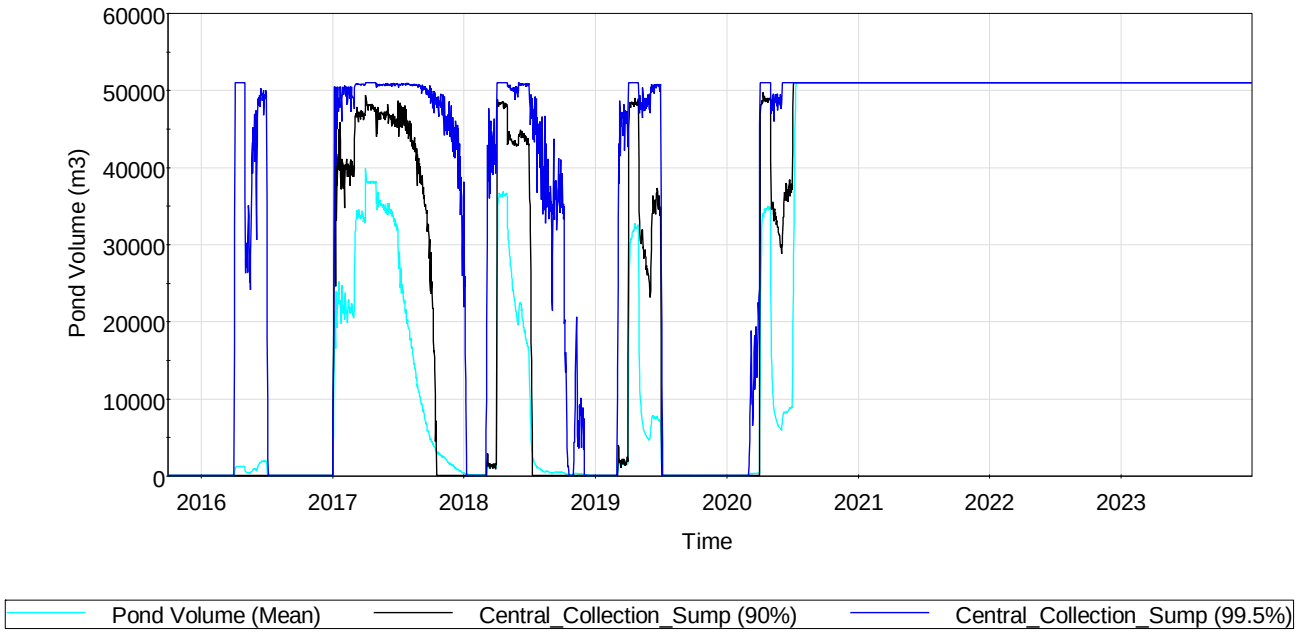


Figure 11: CCS Water Volumes throughout the Mine Life and into Post-Closure

7.3 Perimeter Embankment Till Borrow Pond

Water flows from the CCS to the Perimeter Embankment Till Borrow Pond by gravity through an open channel, with culverts under the plug access road (PAR).

Culverts and a rock drain may be required at the base of the Corner 1 Perimeter Embankment Buttress. Depending upon the final design, the buttress extension may cover the existing inflow ditch to the Till Borrow Pond (Golder 2015d).

A combined capacity of 2.3 m^3/s would be required in the rock drains and culverts, if water in the CCS is also managed by pumping excess water to the TSF for temporary detention during the storm event. Further studies are needed to verify the required capacity of the culvert and rock drains, and to assess their design and construction specifications.

The current maximum capacity of the Perimeter Embankment Till Borrow Pond is 170,000 m^3. When the water volume in the Perimeter Embankment Till Borrow Pond exceeds 150,000 m^3, pumps to the TSF are activated in order to avoid overflow. Under average climate conditions during operations, the volume in the pond approaches 80,000 m^3 during the freshet. Once operations are completed, the pond will be allowed to fill and is assumed to discharge to the environment after treatment. There are no occurrences of overflow under the simulated conditions.

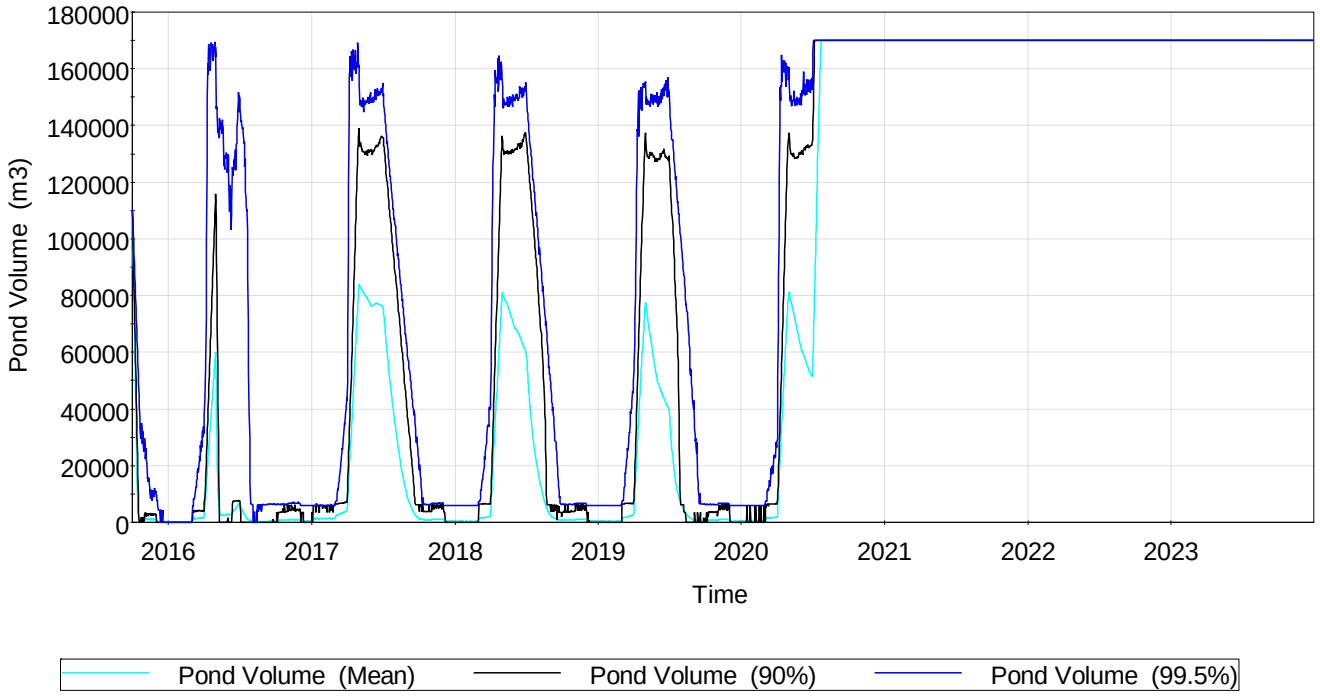


Figure 12: Perimeter Embankment Till Borrow Pond Water Volumes

7.4 Springer Pit

As of October 1, 2015, the water level in the Springer Pit was 1020.36 m. After approval to discharge has been received, the accumulated water in Springer Pit will be treated and discharged. The predicted drawdown of Springer Pit is limited until the TSF is operating under Resumed Operations (Figure 13). Springer Pit is expected to be dewatered before the end of 2018 (Figure 13). Note that the elevations shown in Figure 13 account for total volume in the pit (free water and tailings), and so under the current dewatering pumping logic, the pit is dewatered with all tailings removed by the end of Q3 2018. However, there are still tailings in the pit.

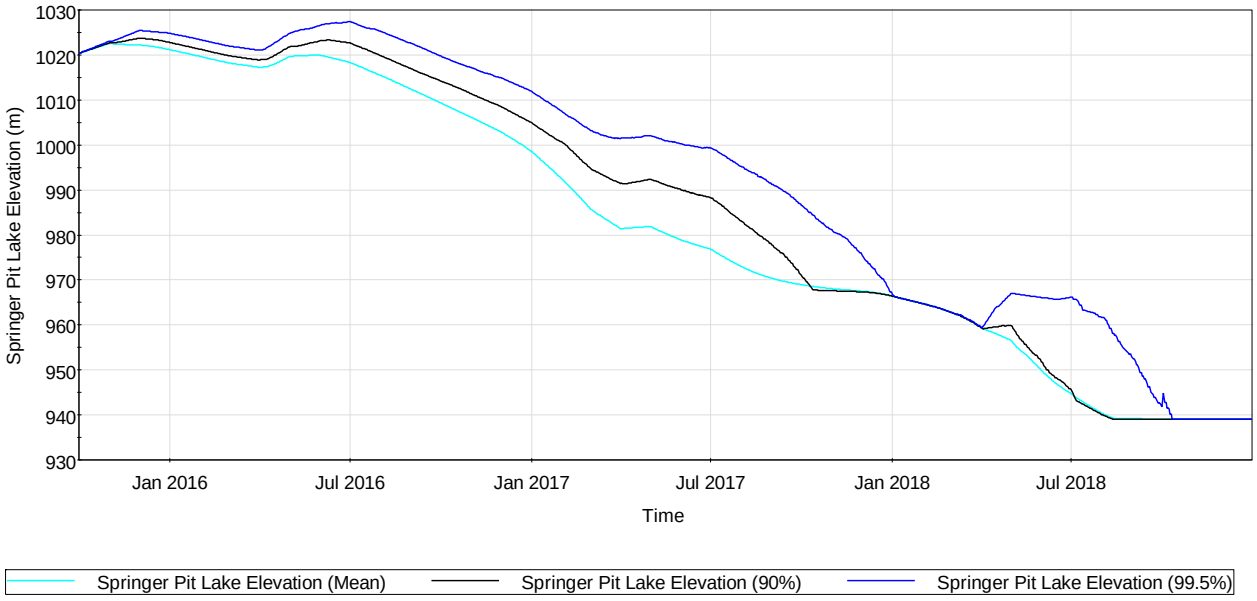


Figure 13: Springer Pit Water Elevations

The elevations shown in Figure 13 account for total volume in the pit (free water and tailings), and so under the current dewatering pumping logic, the pit is fully dewatered by January 2018, with tailings being progressively removed until the end of Q3 2018 (Table 7). Current water pumping logic shows water accumulating in the base of Springer Pit during extreme wet freshet years (Figure 13). This accumulation can likely be reduced with further optimization of the pumping logic and operational water management.

PAG rock will gradually be deposited in Springer Pit starting in Q4 2018 after Springer Pit has been dewatered. Upon deposition of the PAG material, dewatering of the Pit will cease, and water would be allowed to accumulate in the Pit. However, the water elevation would not exceed the PAG elevation until well into closure (Figure 14). This aspect of water management may be refined to minimize the release of oxidation by-products from PAG materials as part of the long-term water management plan.

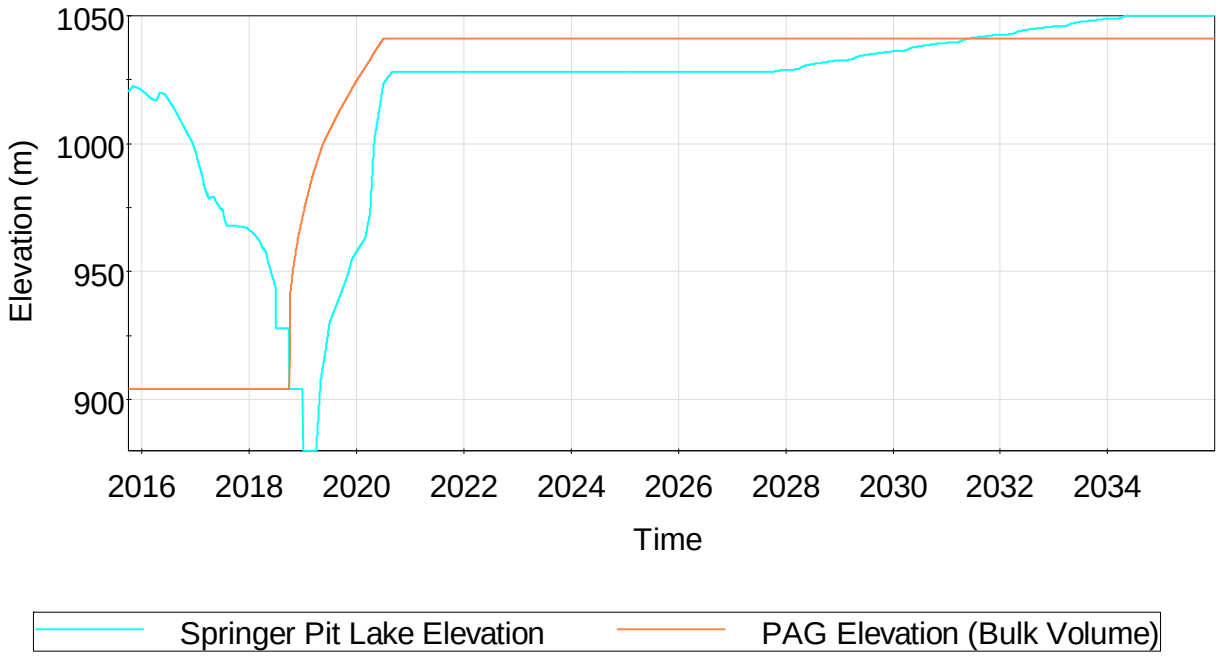


Figure 14: Springer Pit Water Volumes - PAG Deposition

7.5 Required Pumping Capacities for TSF Water Management

There are a few key pumping systems which will need to be operational in order to manage water in the TSF:

- P3 – Pump from TSF to CCS;
- P4- Pump from CCS to TSF;
- P5- Pump from Perimeter Embankment Till Borrow Pond to TSF; and
- P33 – Pump from Polley Lake to TSF (make-up water).

P3 requires a pump capacity of 0.11 m^3/s (1,750 GPM). This allows the drawdown in the TSF during wet years to occur gradually, so that the TSF water volume is at the minimum operational water volume (1 Mm^3) just before freshet. The pumping rates for P3 for mean climate conditions are shown in Figure 15.

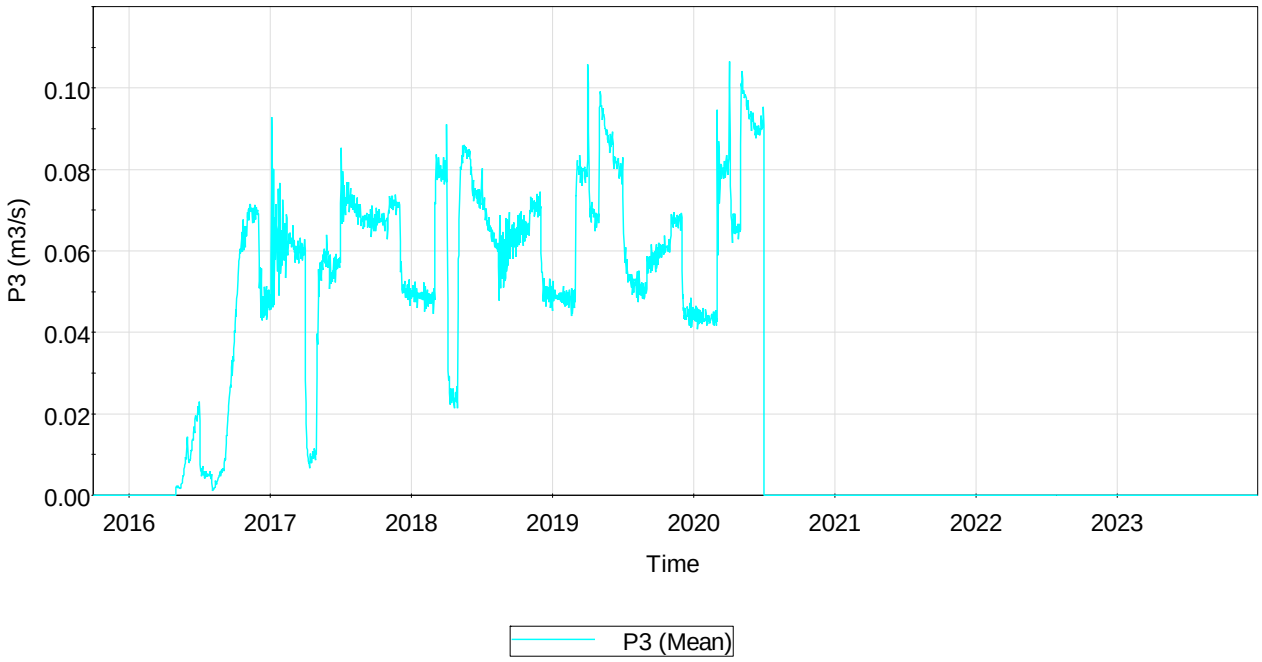


Figure 15: Simulated Pumping Rates for P3 (Pump from TSF to CCS)

P4 requires a pump capacity of 0.3 m^3/s (4,755 GPM) in order to facilitate the dewatering of Springer Pit during operations. P4 also allows the CCS to act as a source of make-up water for processing requirements. The pumping rates for P4 for mean climate conditions are shown in Figure 16.

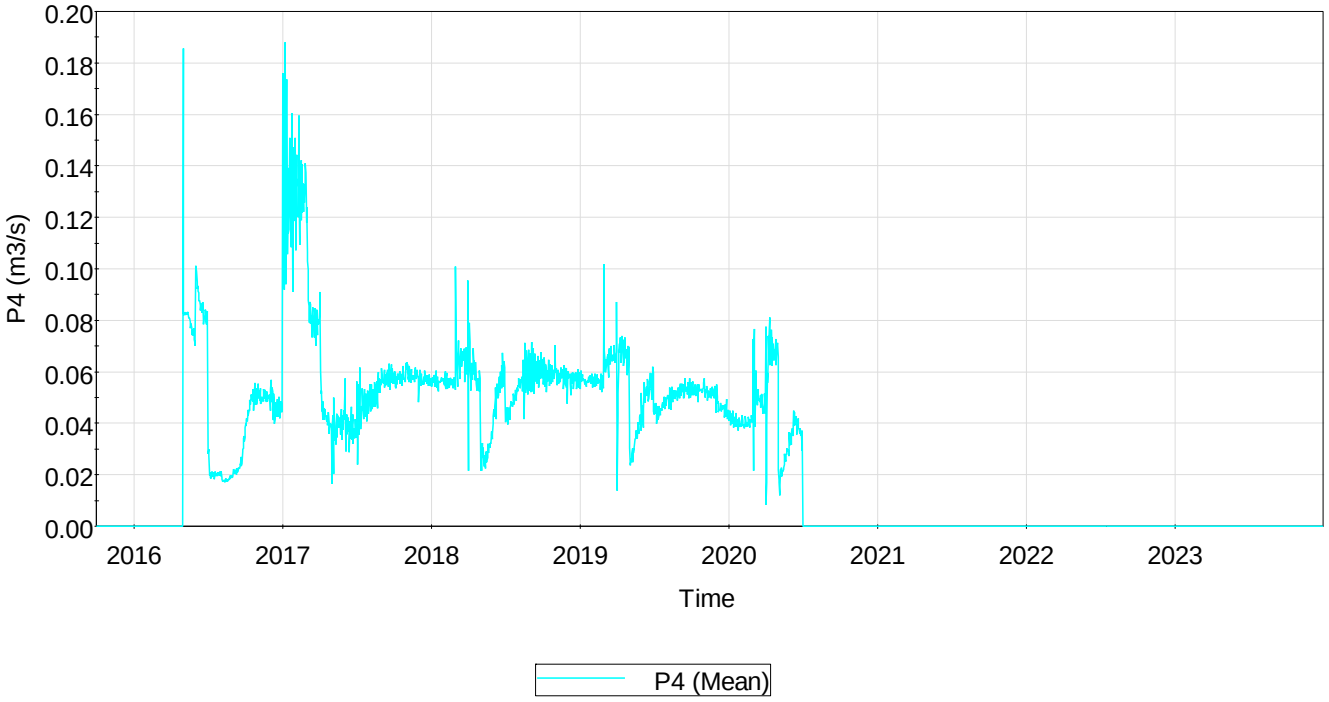


Figure 16: Simulated Pumping Rates for P4 (Pump from CCS to TSF)

P5 requires a pump capacity of 0.38 m^3/s (6,000 GPM) during extreme (99.5th percentile) storm conditions. However, for climate conditions relating to events less extreme than, or relating to, the 90th percentile events, a pumping capacity of 0.16 m^3/s (2,500 GPM) is sufficient. The pumping rates for P5 under mean climate conditions are shown in Figure 17.

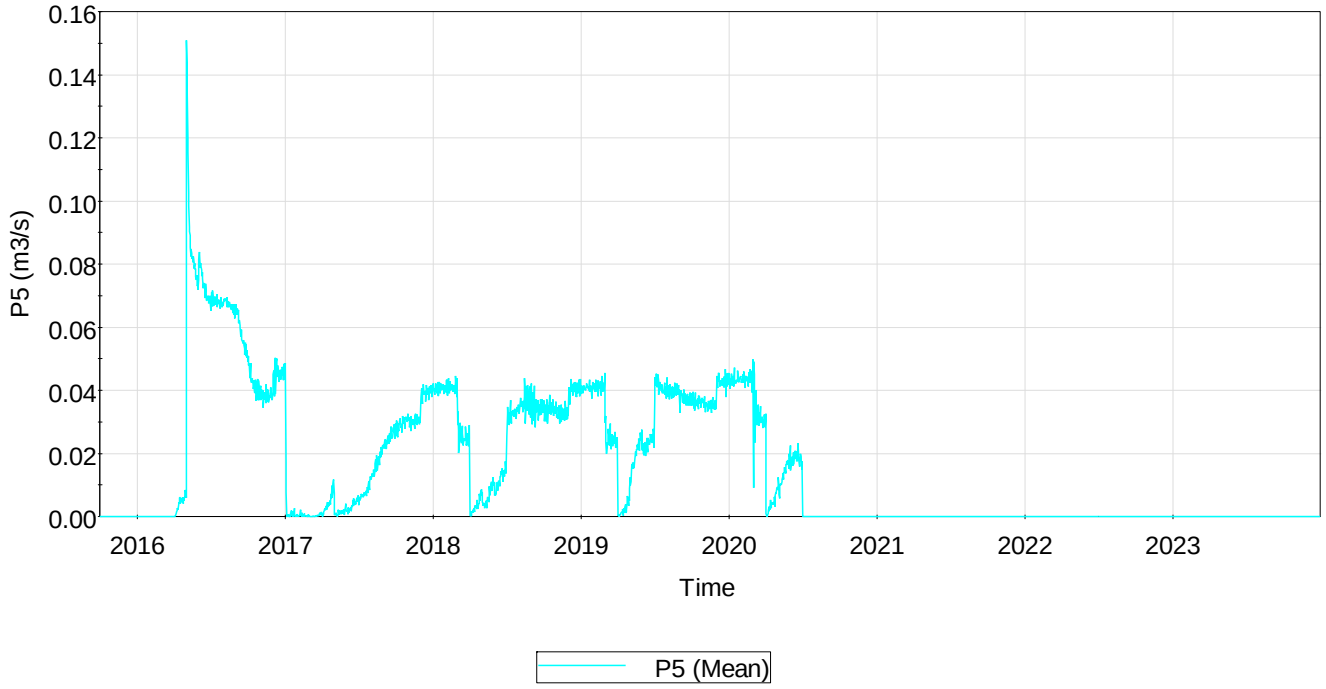


Figure 17: Simulated Pumping Rates for P5 (Pump from Perimeter Embankment Till Borrow Pond to TSF)

Lastly, P33 requires a pumping capacity of 0.1 m^3/s (1,585 GPM). The pumping rates for P5 under mean climate conditions are shown in Figure 18.

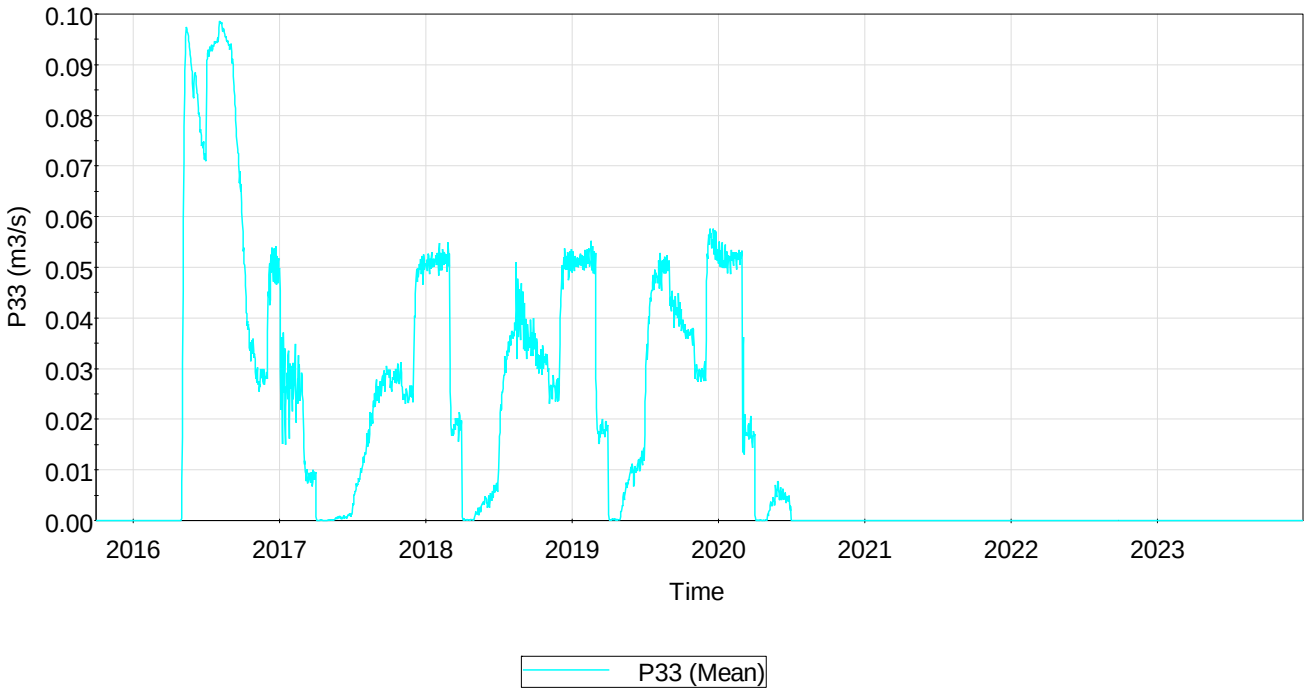


Figure 18: Simulated Pumping Rates for P33 (Make-up Water from Polley Lake to TSF).

8.0 DESIGN OF MINE WATER MANAGEMENT INFRASTRUCTURE

During the Restricted and Resumed Operations phases, the existing water management infrastructure including ponds, ditches, culverts, pipelines and pumping systems at the Mine will be used (Figure 2). A review of the infrastructure is currently underway, and upgrades are being implemented to improve water management and water quality. For example, the SERDS ditch has recently being armoured with rock to reduce channel erosion, which is expected to significantly reduce suspended sediment concentrations. The armoured ditch is being sized with a capacity to pass the 1:200-year peak flow.

Design of the closure spillway is presented in the TSF to 970 m design report (Golder, 2015d).

An operational water management plan and design basis will be submitted to the Chief Inspector of Mines by December 31, 2015. The operational water management plan will include:

- review of design criteria and operational requirements of the diversion and collection ditch, pipe and pumping system;
- ongoing maintenance requirements to maintain sufficient capacity and performance of the water management system to convey design flows; and
- recommendation for upgrading existing water management structures that do not meet Provincial standards.

9.0 WATER QUALITY

The following aspects of an extended mine life were qualitatively and semi-quantitatively evaluated to determine potential changes to the water quality predictions presented for the restricted operations water quality model (Golder, 2015):

- the Springer and Cariboo pits will be larger, which will result in larger pit wall exposures and longer subaerial exposure periods;
- more PAG rock will be stored at surface during operations and closure and deposited into the pit at closure; and
- the PAG rock stored at surface will be subaerially exposed for a longer period of time.

All three of these aspects of an extended mine life will result in increased loading of mine-related constituents. However, despite the larger volume of PAG material, the larger pits offer more assimilative capacity because the overlying water cap will be much larger. Deterministic model runs using the revised pit shells and PAG volumes suggest that, in the post-closure period, many constituent concentrations are higher relative to the post-closure predictions presented in the restricted operations model. However, consistent with the restricted operations model, only copper was flagged as a potential constituent of concern in the post-closure period.

In the restricted operations model runs, there was uncertainty related to the model input for process water due to a lack of process water data. Since the development of the restricted operations model, three process water samples were collected by MPMC and the data were provided to Golder for this evaluation. A review of the process water data and comparison to the model input revealed that the median model input values were within the range of previously assumed process water concentrations, or were conservatively higher than the assumed process water values, with the exception of ammonia and nitrate. Therefore, the additional samples result in a reduction of uncertainty regarding the predictions presented in Golder (2015).

The median model input values for ammonia and nitrate were 0.24 mg/L and 8.3 mg/L, respectively, while the maximum measured values in process water were 0.47 mg/L and 9.5 mg/L, respectively. The model inputs are stochastic, and observed values are represented in the restricted operations predictions, just in the upper percentile ranges rather than at the median.

Changes to water quality around the TSF were not evaluated in terms of the extended mining schedule. The quality of seepage waters is expected to be similar to previously measured and reported water quality at those locations. As noted in the Year-1 Reclamation and Closure Plan Water Quantity and Water Quality report (Golder 2015), the greatest influence on water quality in the TSF will be the relative proportion of unsaturated and saturated tailings where constituent loading from unsaturated tailings is expected to be significantly greater than from saturated tailings. Sufficient information to fully evaluate this effect is not yet available; additional data are being collected by MPMC, SRK and Golder, and the TSF closure strategy will be evaluated as part of the long-term water management plan.

10.0 MONITORING PLAN

Water quantity and quality monitoring is an important part of the MWMP to confirm compliance with discharge criteria, to define and promptly implement strategies to limit impacts in the unlikely event that non-compliant discharge is recognized.

The current water quality monitoring plan for the mine is described in the *Reclamation and Closure Plan Update 2015* (MPMC, 2015). Monitoring results are compiled and analyzed each year and submitted in MPMC's Annual Environmental and Reclamation Report. Results provide verification that mine water management and discharge systems are functioning as designed and not causing adverse impacts on the receiving environment.

Monitoring programs are updated annually, as required by *Environmental Management Act* Permit 11678, with third party Qualified Professional reviews occurring every three years. Updates to monitoring plans are reported each year in the Annual Environmental and Reclamation Report, and are also incorporated into Operation, Maintenance and Surveillance (OMS) Manual updates.

11.0 CLOSURE

The reader is referred to the Study Limitations, which precedes the text and forms an integral part of this report.

We trust the above meets your present requirements. If you have any questions or requirements, please contact the undersigned.

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APPENDIX A

Model Inputs

1.0 FLOW INVENTORY

A description of the model flows is provided in Table A1 to Table A5. Direct precipitation, runoff and environmental discharge flows are numbered according to their associated elements, and are therefore not described herein.

Table A1: Description of Process Flows

Flow ID	From	To	Comment
P1	Springer Pit	Mill Process Water Tank	Not applicable for current conditions; required for start-up
P2	Mill	Springer Pit	Not applicable for current conditions; required for start-up
P3	Tailings Storage Facility (TSF)	Central Collection Sump	
P4	Central Collection Sump	TSF	
P5	Perimeter Embankment Till Borrow Pit	TSF	
P6	South Seepage Pond	Main Embankment Seepage Pond	
P7	Perimeter Embankment Till Borrow Pit	Central Collection Sump	
P8	Main Embankment Seepage Pond	Perimeter Embankment Till Borrow Pit	
P9	Central Collection Sump	Springer Pit	Via Booster Station
P10	Mine Creek Drainage Sump	South-east Rock Disposal Site (SERDS) Ditch	Via SERDS Ditch
P11	Bootjack Creek Sump	SERDS Ditch	Via SERDS Ditch
P12	Mill Process Tank	Mill	
P13	Mill Domestic Water	Mill Site Sump	
P14	Mill Site Sump	Springer Pit	
P15	Geology/ Domestic Water	Mill Site Sump	
P16	Wight Pit	Mill Process Water Tank	
P17	Cariboo Pit	Springer Pit	
P18	NW Sump	Springer Pit	
P19	Mine Drainage Creek Sump	Springer Pit	
P20	9 km Sump	NW Sump	
P21	Wight Pit	Long Ditch	Via Long Ditch
P23	Springer Pit	Treatment	Pit Lake Dewatering (Proposed)
P24	NW Sump	Mine Drainage Creek Sump	Not currently operational
P25	Perimeter Embankment Till Borrow Pit	Main Embankment Seepage Pond	
P26 [(a)]	Springer Pit	TSF	Emergency Discharge to TSF

Flow ID	From	To	Comment
P27	Mill	TSF	Tailings Slurry (operational as of Resumed Operations)
P28	TSF	Process Water Tank	Mill Process Water (operational as of Resumed Operations)
P29	Springer Pit	SERDS Ditch	Operational Dewatering (operational as of Resumed Operations)
P31	Mill Site Sump	TSF	Tie-in to tailings slurry pipeline (operational as of Resumed Operations)
P32	Mill Site Sump and Mill	TSF	Combined slurry and domestic water (operational as of Resumed Operations)

There is no P22 or P30 flow currently built into the model.

a) Current model logic dictates that emergency discharge from Springer Pit to the TSF takes place once the pit lake elevation reaches 1049 m (1 m below spill elevation) during operations.

Table A2: Description of Seepage Flows

Flow ID	From	To	Comment
S1	Tailings Storage Facility (TSF)	South Seepage Pond	
S2	TSF	Main Embankment Seepage Pond	Via South Toe Drain
S3	TSF	Main Embankment Seepage Pond	Via Main Toe Drain/ Foundation Drain
S4	TSF	Perimeter Embankment Till Borrow Pit	Via Perimeter Drain
S5	TSF	Perimeter Embankment Till Borrow Pit	Freshet Event seepage collection
S6	SERDS	SERDS Ditch	Baseflow from waste rock dump
S7	North Bell Dump	Wight Pit	Baseflow from waste rock dump via Joe's Creek Pipe
S8	EAST RDS	Long Ditch	Baseflow from waste rock dump
S9	NEZ Dump	Long Ditch	Baseflow from waste rock dump
S10	Temp PAG Stockpile	9 km Sump	Baseflow from waste rock dump
S11	Temp PAG Stockpile	NW Sump	Baseflow from waste rock dump
S12	Seepage from Waste Haul Road	Mine Drainage Creek Sump	Seepage from haul roads
S13	Seepage from Tailings Access Road	Bootjack Creek Sump	Seepage from haul roads

Table A3: Description of Transfer Flows

Flow ID	From	To	Comments
T1	Long Ditch	Central Collection Sump	
T2	SERDS Ditch	Central Collection Sump	Via Long Ditch
T3	Central Collection Sump	Till Burrow	
T4	Polley Lake	Hazeltine Creek	
T5	TSF	Central Collection Sump	Tailings dewatering in TSF
T5a	TSF	Main Embankment Seepage Pond	Tailings dewatering in TSF. T5 was redirected to the Main Embankment Seepage Pond as of May 2015.
T6	Perimeter Embankment Till Borrow Pond	Treatment	Environmental Discharge

Table A4: Description of Consumption Flows

Flow ID	From	To
C1	Main Embankment Seepage Collection Pond	Turbomisters
C2 [(a)]	Springer Pit	Water Trucks
C3	Wight Pit	Sprinklers
C4	Wight Pit	Water Trucks
C5	Main Embankment Seepage Collection Pond	Water Trucks
C6	TSF	Turbomisters (in summer)
C7	Main Embankment Seepage Collection Pond	Sprinklers on TSF

a) C2 currently not operational in SWWBM and is acting as a placeholder in the model.

Table A5: Description of Groundwater Flows

Flow ID	From	To
GW1	Groundwater Aquifer	Wight Pit
GW2	Groundwater Aquifer	Springer Pit
GW3	Groundwater Aquifer	Cariboo Pit
GW4	Springer Pit	Bootjack Lake

2.0 STOCHASTIC CLIMATE INPUTS

Monthly precipitation values were log-transformed, and the distribution of the values fit to a normal distribution. The arguments for the normal distribution are the mean and standard deviation. The monthly means and standard deviations of the log-transformed monthly precipitation values were therefore determined. The standard deviations were adjusted based on trial and error so that the annual mean of the stochastically generated results agreed with the mean of the historical data. Table A6 shows the input arguments (mean and standard deviations) used to define the normal distribution stochastic element in GoldSim.

Table A6: Stochastic Generator Normal Distribution Input Arguments

Month	Means of the Log Transformed Monthly Precipitation Depths [(a)]	Adjusted Standard Deviation of the Log Transformed Monthly Precipitation Depths [(a)]
January	1.60	0.23
February	1.48	0.21
March	1.54	0.22
April	1.61	0.23
May	1.70	0.24
June	1.87	0.27
July	1.65	0.24
August	1.63	0.23
September	1.72	0.25
October	1.72	0.25
November	1.67	0.24
December	1.84	0.26

a) Unitless.

3.0 CATCHMENT AREAS – MINE WATER MANAGEMENT FACILITIES

Table A7 shows the catchment areas based on land type for the mine water management facilities.

Table A7: Catchment Areas Based on Land Type for Mine Water Management Facilities

Element	Rock Dump Storage Areas (m^2)	Disturbed Areas (m^2)	Pit Walls	Haul and Access Roads (m^2)	Undisturbed Areas (m^2)	Mill Site Areas	Maximum Pond Area (m^2)
South Seepage Pond	0	0	0	0	0	0	385
Main Embankment Seepage Pond + ABR	214,910	124,490	0	0	0	0	37,550
TSF Upstream Catchment	0	63,800	0	238,430	320,560	0	0
Perimeter Embankment Till Borrow Pit	100,540	193,080	0	96,350	65,060	0	69,310
Central Collection Sump	0	122,210	0	67,920	226,600	0	21,830
Bootjack Creek Sump	0	70,050	0	103,990	0	0	1,130
SERDS (includes Mill Site Area)	401,240	313,060	165,460	383,920	383,920	273,920	0
Mill Site Sump	0	0	0	0	0	0	1,630
Cariboo Pit Sump	1,092,420	0	98,500	0	0	129,440	0
Mine Drainage Creek Sump	437,190	114,980	137,340	111,140	111,140	314,170	1,130
Long Ditch	1,792,060	237,890	0	261,430	202,650	0	0
Springer Pit	0	156,100	495,790	0	0	0	0
NW Sump	205,920	60,210	63,800	0	0	0	240
Nine KM Sump	497,430	60,740	0	0	140,280	0	400
Wight Pit	0	0	412,570	0	0	0	1,340
Total Area (m^2)	4,741,710	1,516,610	1,373,460	1,263,180	1,450,210	717,530	134,945

4.0 FLOW RATES

4.1 Tailings Storage Facility Seepage Flows

MPMC staff has measured post breach seepage flows from the TSF, and these are presented in Table A8.

Table A8: Seepage Flows from TSF

Flow ID	Description	Flow Rate (m^3/s)
S1	From TSF to South Seepage Pond	0.00095
S2	From TSF to Main Embankment Seepage Pond via South Toe Drain	0.006
S3	From TSF to Main Embankment Seepage Pond via Main Toe/ Foundation Drain	0.0061
S4	From TSF to Perimeter Embankment Till Borrow Pit via Perimeter Drain	0
S5	From TSF to Perimeter Embankment Till Borrow Pit via Toe Drains	0.049

4.2 Consumption Flows

The flow parameters for the turbomisters are shown in Table A9 and Table A10. Moving the turbomisters from their current locations would not materially change the model results.

Table A9: Operational Days per Month for Turbomisters

Flow ID	From	Hours per Day					
		May	June	July	August	September	October
C1	Main Embankment Seepage Collection Pond	10	10	15	15	12	10
C6	TSF	N/A	N/A	N/A	N/A	N/A	N/A

C6 currently not operational in SWWBM as turbomisters have not yet been placed on the TSF.

Table A10: Operational Flow Rates for Turbomisters

Flow ID	From	Evaporation Rates (m^3/hr)	
		May, June and October	July to September
C1	Main Embankment Seepage Collection Pond	5.5	12.7
C6	TSF	N/A	N/A

The flow parameters for the Sprinklers are shown in Table A11 and Table A12.

Table A11: Operational Hours per Month for Sprinklers

Flow ID	From	Hours per Month					
		May	June	July	August	September	October
C3 [a]	Wight Pit	40	40	120	120	120	40
C7 [b]	Main Embankment Seepage Collection Pond	40	40	120	120	120	40

a) Combined hours per month for East RDS and NEZ Dumps.

b) Sprinkler Demand unknown at this time, and the consumption hours for C3 were applied to C7.

Table A12: Operational Flow Rates for Sprinklers

Flow ID	From	Evaporation Rates (m^3/hr)	
		May, June and October	July to September
C3 [a]	Wight Pit	11.4	22.7
C7 [b]	Main Embankment Seepage Collection Pond	11.4	22.7

The flow parameters for water trucks are shown in Table A13 and Table A14 below.

Table A13: Operational Days per Month for Water Trucks

Flow ID	From	Days per Month					
		May	June	July	August	September	October
C2	Springer Pit	N/A	N/A	N/A	N/A	N/A	N/A
C4	Wight Pit	10	5	20	20	15	10
C5	Main Embankment Seepage Collection Pond	10	5	20	20	15	10

C2 currently not operational in SWWBM.

Table A14: Operational Flow Rates for Water Trucks

Flow ID	From	To	Flow Rates (m^3/day)
C2	Springer Pit	Water Trucks	N/A
C4	Wight Pit	Water Trucks	818
C5	Main Embankment Seepage Collection Pond	Water Trucks	455

4.3 Groundwater Flow Rates – Cariboo and Wight Pit

Lastly, groundwater rates for Cariboo and Wight Pit have also been measured and are presented in Table A15.

Table A15: Measured Groundwater Flows into Cariboo and Wight Pits

Flow ID	Description	Flow Rate (m^3/s)
GW1	Groundwater inflow into Wight it	0.028
GW3	Groundwater inflow into Cariboo Pit	0.011

4.4 Transfer Flows

The flow rates for the transfer flows were defined in the model as described in Table A16.

Table A16: Definitions of Transfer Flows in SWWBM

Flow ID	From	To	Flow Definition
T1	Long Ditch	Central Collection Sump	Flow rates determined by runoff and baseflow from the Long Ditch catchment.
T2	SERDS Ditch	Central Collection Sump	Flow rates determined by runoff and baseflow from the SERDS ditch catchment.
T3	Central Collection Sump	Till Borrow	Modelled as the overflow rate from the CCS.
T4	Polley Lake	Hazeltine Creek	Modelled as the overflow rate from Polley Lake.
T5	TSF	Central Collection Sump	Defined as described in Section 5.7.

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Golder Associates

TECHNICAL MEMORANDUM

DATE October 13, 2015 **REFERENCE No.** 1411734-090-TM-Rev0-12000

TO Luke Moger
Mount Polley Mining Corporation

CC

FROM Rob Millar, Lee Nikl **EMAIL** Robert_Millar@golder.com, Lee_Nikl@golder.com

SPRINGER PIT WATER LEVEL PREDICTIONS AND MODEL VALIDATION

This technical memorandum describes a validation of the Mount Polley Mine site wide water balance that was developed and calibrated for the short-term discharge technical assessment report (TAR) and ongoing operations and planning at Mount Polley.

The comparison between simulated and measured water elevation in Springer Pit is shown in Figure 1. The simulation starts on April 1, 2015, and the initial Springer Pit lake level, and the observed site precipitation and snowpack depths from April through September have been used for the simulation. Daily water level measurements are available for Springer Pit.

The water balance model over predicts the Springer Pit water level over the period of the simulation. On September 30 the model was predicting a Springer pit water elevation of 1029.01 m, compared to an observed elevation of 1020.36 m. This represents an additional 1.8 million m^3 (Mm^3). The deviation between simulated and observed water accumulation occurred primarily between April and the end of June, as indicated by the diverging lines in Figure 1. From July onwards, the simulated and observed lines are essentially parallel, indicating the model is reasonably predicting the observed inflow volumes.

The divergence of the water balance model predictions from the observed values during the spring is attributed to the unusual weather conditions experienced in 2015 (Table 1). The lack of snowpack in April and the persistent dry conditions in May and June were outside of the range of historic data used to calibrate the water balance model. Total rainfall and snowmelt between April through June was 70% below average, and 30% less than the 1:200-y Dry conditions (Table 1). During the extreme dry conditions during the spring of 2015, the runoff coefficients and other hydrologic parameters in the model are overestimating runoff. On return to more normal weather conditions from July through September, the water balance predictions track the observed changes in water level in Springer Pit (Figure 1).

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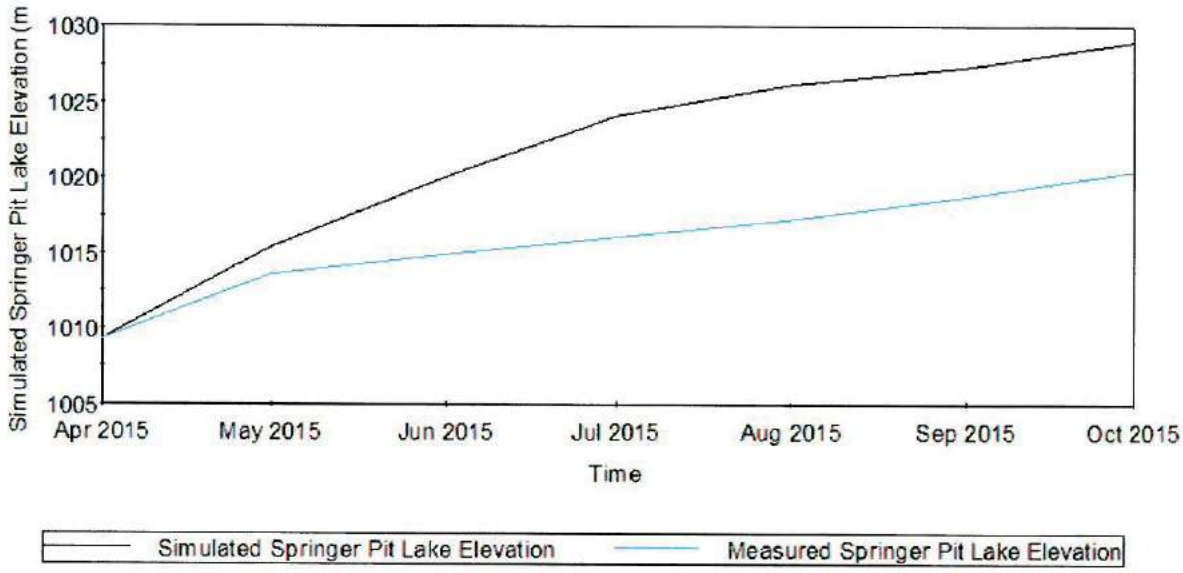


Figure 1: Comparison between simulated and measured Springer Pit lake elevations (m).

Table 1: Combined Monthly Rain plus Snowmelt (mm).

Month	2015 Observed[(a)]	Average Historic	1:200-y Dry Historic
April	20.4	206.0	106.6
May	36.2	53.5	28.3
June	48.2	78.2	41.4
July	63.8	58.9	31.2
August	20.8	52.2	27.6
September	61.6	48.2	25.5
Apr - Jun	104.8	337.7	176.3
Jul - Sep	146.2	159.3	84.3

(a) There was no snowmelt in April 2015, as the snowpack had melted by March.

In conclusion, the Mount Polley site wide water balance model provides good estimates of site water volumes and Springer Pit inflows for average conditions, with greater uncertainty under extreme conditions that fall outside of those used for model calibration. For extreme dry conditions the water balance model over predicts site water volumes.

If you have any questions please contact either Robert Millar or Lee Nikl.

PROFESSIONAL GEOSCIENTIST PROVINCE OF BRITISH COLUMBIA Dr. R. G. MILLAR # 25722

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Oct 13, 2015

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APPENDIX M:

MPMC SOIL MANAGEMENT PLAN

MOUNT POLLEY MINING CORPORATION
IMPERIAL METALS CORPORATION

Soil Management Plan

Purpose

To identify, salvage, store, and redistribute all suitable growth material in accordance with Ministry of Energy and Mines (MEM) Permit M-200 with the goal of achieving closure land use and capability objectives.

Introduction

As required under MEM Permit M-200, all surficial soil identified through soil surveys as being appropriate for plant growth shall be salvaged and stored in suitable manor for use in reclamation programs. Soil shall be replaced on all mine facility areas (excluding pits) to pre-determined depths based on soil and site parameters.

Responsibilities

Environmental Superintendent/Coordinator

- Supervise Environmental Technicians/Technologists to ensure soil handling and management on site is carried out as per the requirements of Permit M-200 and this Plan.
- Ensure that a soil stockpile and soil management updated is provided to MEM in the Annual Environmental and Reclamation Report.

Environmental Technician/Technologists

- Coordinate with and supervise Mine Operations to ensure soil handling and management procedures are followed.
- Provide a soil stockpile and soil management data update to MEM in the Annual Environmental and Reclamation Report.

Mine Operations Planner/Engineer

- Ensure that all material suitable for reclamation is stripped prior to expansion of mine works.
- Notify the Environmental Department of planned disturbances that will require soil salvaging.
- Assign appropriate equipment for handling soil.
- Assign areas for soil to be stockpiled or directly placed.

Mine Operations

- Supervisors: Coordinate with Environmental Technician/Technologist and only allow operations to proceed when weather and soil moisture conditions are appropriate
- Employees: Follow instructions from Environmental Technician/Technologist and Mine Operations Supervisors.

Soil Handling and Management

Prior to Commencement of Mine Development

Site-specific soil surveys must be completed for areas scheduled for disturbance by a qualified individual and submitted to the MEM Chief Inspector for approval.

The following survey procedure is recommended:

1. Pre-stratify the area according to landforms and materials using aerial photographs. Confirm stratification with a walk-through.
2. Select soil pit locations at representative sites or on a predetermined systematic grid. Soil pit density ranges from one pit per half hectare to 1 pit per two hectares, depending on site variability.
3. Expose the soil profile by machine excavation, road cuts, and hand-dug holes.
4. Describe the soil and site characteristics at each profile location. Identify the following soil morphological attributes to determine soil suitability for reclamation:
    - Terrain classification
    - Soil classification and humus form
    - Horizon depths
    - Colour
    - Texture
    - Percent coarse fragments (by volume)
    - Root abundance and size
    - Soil structure and consistency
    - Drainage class
    - Rooting depth
    - Root restricting layer
5. Sample soils at select, representative sites to provide additional soil quality data.
6. Compile all soil survey information into a report and recommend depths for salvage of soil appropriate for reclamation.

Site soil and landform inventories completed to date include:

- Southeast Dump, Boundary Pit and West PAG Projects (2010)
- Wight Pit Rock Waste Dump Extension Project (2006)
- Southeast Pit Project, Wight Pit to Tailings Pond Road, and Southeast Pit to Tailings Pond Road (2005)
- Northeast Extension Project (2004)
- Springer Pit (2001)
- Baseline Soil Survey and Agricultural Assessment of proposed Tailings Storage Facility, open pit, and waste rock dumps (1995)

Soil Salvage

Salvage Materials and Depths

Soil will be salvaged to the depth pre-determined in the site-specific survey; however, in general, soils are to be salvaged to the effective rooting depth.

C horizon material underlying the topsoil horizons can be used to supplement more suitable reclamation material and for contouring. If the decision is made to strip this material (whether for use in reclamation or to create a geotechnically stable surface for mine works), the strata will be delineated prior to salvaging, and the material will be stored in separate stockpiles from the topsoil.

Organic soils from wetlands are recognized by their black colour and mucky texture. Organic soils, which occur in depths up to 2 m, will be salvaged and stockpiled separately from the topsoil.

When possible, non-merchantable coarse woody debris is to be salvaged and stockpiled or directly applied to reclamation site.

Procedure

A qualified individual should train and oversee equipment operators to ensure salvage operations are completed.

Non-merchantable coarse woody debris is to be salvaged first and stockpiled, and/or mixed in with topsoil piles. Organic matter (grass, plants, chipped woody material) is to be incorporated into the topsoil piles by salvaging plant materials on the surface with the topsoil. To minimize compaction caused by equipment, use single lift operations rather than repeatedly driving over the surface scraping off thin layers. With a single pass, a bulldozer or backhoe can push the soil into a pile for storage (or for loading into a truck by an excavator or backhoe for transport). If suitable soil is still visible after the initial scraping (can generally be identified by marked presence of roots), another pass will be required to salvage all available soil materials. Soil inventory and strata delineation information collected prior to stripping activities starting on a new site will guide the stripping procedure and depths.

Avoid handling soil if it is too wet or dry to prevent degradation of the physical structure. If the soil sticks to the equipment, wait until the soil has dried to a friable state. If the soil is too dry and hard to handle, resembling flour, add water until the soil is wetted to a loose, friable condition.

In shallow soils, rock rubble from the fractured bedrock surface may become incorporated into the stockpile, reducing topsoil quality. To prevent this, machine blades must be raised to avoid the rubble while still removing the soil.

Desired volumes of C horizon material are to be stripped after and stored in separate stockpiles.

Soil Stockpiling

When possible, use soil immediately for reclamation (allowing microbes, bacteria, and viable seeds to remain in the soil). If this is not possible:

1. Carefully select the storage location, because once stockpiled, the soil should not be disturbed again until final reclamation. Minimize exposure to wind, southwest sun, and water/flooding.
2. Pile the soil in a manner that maximizes surface area, and minimizes soil depth. When possible, the maximum depth should be the height of a pile dumped from a haul truck (~2.5 m).

3. Promptly seed stockpiles with an approved native or weed free seed mix as designed by a qualified profession to control wind and water erosion and maintain microbial activity. Weed control may be necessary on soil stockpiled for longer periods if stockpiles are not seeded sufficiently to reduce ingress of weeds, or if stockpiles have been located in an area where weeds are present or have the potential to seed from offsite populations.
4. Take a representative sample of the stockpile to assess soil quality.
5. Place signs on the stockpiles to avoid accidental disturbance.
6. Enter stockpile date, location, soil volume, and date seeded into the Soil Stockpile Inventory spreadsheet.
7. Add stockpile locations to site maps and plans for Mine Operations to avoid disturbance or loss of stockpiles.

Soil Quality

A soil quality sampling program of site soil stockpiles was completed in September 2013 to assess the variability and suitability for reclamation (refer to Appendix A for sample guidelines). Results are included as Appendix B. All new soil stockpiles are to be sampled upon creation, and a site wide soil stockpile sampling program is to be carried out every 5 years.

Findings

General findings based on analytical results are:

- pH has increased from a baseline average of approximately 5.5 to between 6 and 8.
- Soil is deficient in Nitrogen.
- Soil has marginal to deficient phosphorus and organic matter levels.
- Soil is marginal to deficient for potassium; however, concentrations are similar to levels in baseline soil samples.
- Micronutrients levels are sufficient for copper, iron, manganese, and zinc.
- Micronutrient levels are marginal to deficient for boron and chloride.
- Nutrient loss increases with stockpile storage time and depth of soil stockpiles
- Metal levels of the 23 soil stockpiles sampled are compared with available guidelines in Appendix B. Guidelines were only exceeded for copper; however, baseline samples of soil test pits in 1995 had an average copper concentration of 350 ppm, indicating that soils in the area naturally have elevated copper levels.

Recommendations

- Incorporate woody debris when salvaging soil and, when possible, lay coarse woody debris on reclamation sites as long term organic matter and carbon inputs.
- Include nitrogen fixing species in revegetation prescriptions.
- When possible, carry out direct placement of soil and pursue progressive reclamation to avoid nutrient loss.
- For soil that has been stockpiled, incorporation of soil amendments is recommended. For reasons detailed below, biosolids are the recommended soil amendment (although fertilizer applications may be required over time after biosolids nutrients are exhausted). If biosolids are not available for use, the following fertilizer application is recommended, based results of the stockpile soil quality assessment and on agricultural guidelines for grass cover:
    - Average nutrient requirements of stockpiled soil are: 52 mg/kg of nitrogen, 13 mg/kg of phosphorus, and 19 mg/kg of potassium, which corresponds to a need for 61.9-15.7-22.5 (nitrogen-phosphorus-potassium) fertilizer at 187 kg/ha.
    - Average micronutrient requirements are: 0.2 mg/kg of boron and 7 mg/kg of chloride.

As shown in Appendix B, the biosolids Mount Polley Mining Corporation (MPMC) receives from Metro Vancouver for use in reclamation contain sufficient levels of potassium and phosphorus to ameliorate deficiencies. Routine monitoring does not test for boron or chloride; however, these results show that in general, metal and anion levels are elevated. Biosolids also contain an average of 11 mg/kg of Nitrate-N, which does not entirely account for soil deficiencies; however, as described below, large inputs of nitrogen are not recommended, as it may cause a detrimental nutrient flush.

These recommendations are supported by site research, which has shown that biosolids improve tree growth (with no significant difference between application rates of 75 and 150 dt/ha), while teabag fertilizer caused increased tree growth over two years, but was actually detrimental in the long term (Meister, 2007). Fertilizer has been shown to improve grass and forbes growth on the NEZ Dump trials and can be used to increase herbaceous growth to build up organic matter in the soil. Caution should be taken when using soil amendments because, as found in site research trials, the initial nutrient flush can increase competition from herbaceous vegetation (causing tree mortality). Results from ongoing site specific research will provide guidance on when soil amendments are necessary, and what types and quantities to use. This will include long-term considerations, as soil amendments are typically only a short-term nutrient source.

Soil Placement

Soil placement should only occur under appropriate moisture conditions, as described in the soil salvage section. Soil should be placed to minimum depth of 15 cm, which has been shown by site research to be sufficient for seedling establishment; however, tree growth was shown to improve with increased soil cover up to 40 cm (Meister, 2007). Thus, when material is available, and especially on undesirable substrates, such as waste rock dumps, soil should be applied at greater than 15 cm. Stockpiled soil quantities and disturbed areas requiring reclamation are to be assessed annually to determine appropriate replacement depths. Progressive reclamation sites and site research projects are to be continually monitored to provide guidance on appropriate soil depths.

Little evidence of soil erosion has been noted on progressive reclamation sites at Mount Polley; however, surface roughening and landform design efforts initiated on the North Bell Dump are to be continued, and widely applied across the site.

When possible, apply coarse woody debris to all sites (when not incorporated in salvaged soil) to help retain moisture, prevent erosion, create desirable microsites, and act as a long term organic matter source.

Reporting

The following information will be provided each year in the MPMC Annual Environmental and Reclamation Report:

- An update of soil management and handling activities, including erosion and sediment control measures, and soil replacement depths on reclamation sites.
- An updated soil stockpile inventory, including stockpile volumes and locations.
- An updated conceptual plan for allocation of existing reclamation materials, including prescribed site-specific replacement depths (based on available volumes of suitable soil, characteristics of ground to be covered, and revegetation species requirements).

References

- Ministry of Mines Permit M-200
- Mount Polley Mining Corporation Annual Reclamation Research Report (Meister 2007)

Appendix A

Soil Sampling Procedure

At each site:

1. Take a photo of the stockpile to document characteristics, including size and vegetative cover.
2. Collect a composite sample from a minimum of three locations that are representative of the different sections of the stockpile. Record the GPS coordinates for each location.
3. For each sample, use a new (clean), labelled plastic sample bag.
4. At each sample location, dig a profile using a shovel or mini back-hoe to greater than 1 m depth (from all surfaces of the stockpile). Take a sample from 0.3 m and 1.0 m depths (this of the more biologically active surface soils, and the "dead zone" below approximately 1.0 m). Ensure that equal volumes are sampled at every location and depth so that the composite is representative (minimum sample volume is approximately 500 mL).
5. Store samples in the refrigerator until ready for shipment to the lab. Ship in coolers with ice packs.
6. Request lab analysis for parameters including, but not limited to:
    - Texture
    - pH
    - Electrical conductivity
    - Total nitrogen
    - Available phosphorus
    - Organic matter
    - Micronutrients including sulphur and potassium

Appendix B

Soil Stockpile Sample Results

Table B.1 2013 soil stockpile sample results

		Soil Test Characteristics						Soil Test Nutrient Levels (mg/kg)																				Fertilizer Recommendations (mg/kg)					
Location	Soil Climatic Zone	Texture	pH (1S:2W)	EC (1S:2W - mS/cm)	EC (Calc. Sat Extr - mS/cm)	Salinity Rating	Organic Matter (%)	NO_3-N		P		K		SO_4-S		Cu		Mn		Zn		B		Fe		Cl		N	P2O5	K2O	S	B	Cl
Mill Site	Dark Gray	Clay Loam	6.8	0.1	0.2	Non Saline	2.2	1	Deficient	2	Deficient	79.5	Marginal	12	Sufficient	70	Excess	5.1	Sufficient	0.75	Sufficient	0.2	Deficient	91	Sufficient	3	Deficient	52.5	18.75	10	2.5	0.125	8.75
SERDS	Dark Gray	Clay Loam	6.0	0.1	0.2	Non Saline	4.4	1.5	Deficient	>27	Marginal	70.5	Deficient	4	Marginal	1.25	Sufficient	24.7	Excess	1.05	Sufficient	0.2	Deficient	123.5	sufficient	5	Marginal	52.5	8.75	7.5	0	0.125	3.75
SEZ 2	Dark Gray	Loam	6.5	0.3	0.7	Non Saline	6.4	1.5	Deficient	26.5	Marginal	109.5	Sufficient	>24	Sufficient	82.5	Excess	21.75	Excess	1.6	Sufficient	0.4	Marginal	98.5	Sufficient	6.5	Marginal	52.5	8.75	7.5	0	0.125	3.75
Perimeter Embankment 1	Dark Gray	Clay Loam	6.4	0.2	0.4	Non Saline	4.4	4.5	Deficient	4	Deficient	53.5	Deficient	19	Sufficient	3.85	Sufficient	55	Excess	0.85	Sufficient	0.2	Deficient	141	Sufficient	4.5	Marginal	57.5	11.25	27.5	6.25	0.25	3.75
PAG Dump	Dark Gray	Clay Loam	7.1	0.3	0.7	Non Saline	3.2	1	Deficient	13	Marginal	96	Marginal	>21.5	Sufficient	144	Excess	7.4	Sufficient	1.2	Sufficient	0.6	Sufficient	69.5	Sufficient	5	Marginal	45	18.75	42.5	0	0.25	3.75
NW Sump Road	Dark Gray	Clay Loam	6.2	0.1	0.2	Non Saline	1.7	1	Deficient	>27	Marginal	91.5	Marginal	5	Marginal	9.8	Sufficient	20.3	Excess	0.85	Sufficient	0.15	Deficient	99.5	Sufficient	3	Deficient	52.5	11.25	10	0	0	3.75
North Bell Dump Till	Dark Gray	Clay Loam	8.3	0.2	0.4	Non Saline	0.9	1	Deficient	8.5	Deficient	101	Marginal	>21.5	Sufficient	25.5	Excess	5.55	Sufficient	0.7	Sufficient	0.25	Deficient	13.5	Sufficient	2	Deficient	52.5	8.75	10	3.75	0.25	8.75
Springer North	Dark Gray	Clay Loam	7.9	0.1	0.2	Non Saline	1.0	1	Deficient	13.5	Marginal	59	Deficient	3	Deficient	102.5	Excess	5.95	Sufficient	1.1	Sufficient	0.1	Deficient	61.5	Sufficient	1.5	Deficient	52.5	13.75	10	0	0.25	8.75
North Bell Dump Top	Dark Gray	Clay Loam	7.5	0.2	0.4	Non Saline	2.6	2	Deficient	>27	Marginal	75.5	Deficient	>21.5	Sufficient	18.05	Excess	25.95	Excess	0.8	Sufficient	0.15	Deficient	47	Sufficient	4.5	Marginal	52.5	11.25	42.5	6.25	0.25	8.75
Access Road km 12	Dark Gray	Clay Loam	7.6	0.1	0.2	Non Saline	1.5	1	Deficient	20	Marginal	63	Deficient	3	Deficient	33.35	Excess	6.05	Sufficient	0.6	Marginal	0.1	Deficient	58.5	Sufficient	1.5	Deficient	50	8.75	10	0	0.25	3.75
EAST RDS	Dark Gray	Clay Loam	8.0	0.1	0.2	Non Saline	1.3	1	Deficient	3.5	Deficient	45.5	Deficient	4	Marginal	10.4	Sufficient	5.85	Sufficient	0.5	Marginal	0.15	Deficient	35.5	Sufficient	1.5	Deficient	52.5	8.75	27.5	0	0.25	8.75
Ore Switchback	Dark Gray	Clay Loam	6.9	0.1	0.2	Non Saline	3.6	1.5	Deficient	>27	Marginal	86.5	Marginal	14.5	Sufficient	9.85	Sufficient	21.6	Excess	1.75	Sufficient	0.3	Marginal	86	Sufficient	5	Marginal	52.5	18.75	42.5	3.75	0.25	8.75
NEZ Dump	Dark Gray	Clay Loam	7.0	0.2	0.4	Non Saline	2.5	2.5	Deficient	23.5	Marginal	69.5	Deficient	>21.5	Sufficient	156.5	Excess	7.35	Sufficient	1.7	Sufficient	0.15	Deficient	191	Excess	1.5	Deficient	52.5	8.75	10	0	0.125	3.75
Highway to Heaven	Dark Gray	Clay Loam	6.9	0.2	0.4	Non Saline	2.6	1	Deficient	13	Marginal	79	Marginal	15.5	Sufficient	92.5	Excess	16.75	Sufficient	0.8	Sufficient	0.15	Deficient	187.5	Excess	1.5	Deficient	50	8.75	27.5	0	0.25	8.75
Wight Pit Till	Dark Gray	Clay Loam	7.7	0.3	0.7	Non Saline	0.9	1	Deficient	10	Deficient	60.5	Deficient	>21.5	Sufficient	15.05	Sufficient	4.35	Sufficient	0.85	Sufficient	0.15	Deficient	36.5	Sufficient	1	Deficient	52.5	11.25	10	0	0.25	8.75
Wrap Around Road	Dark Gray	Clay Loam	7.4	0.2	0.4	Non Saline	1.9	1	Deficient	8	Deficient	79.5	Marginal	17	Sufficient	60	Excess	6.45	Sufficient	0.85	Sufficient	0.1	Deficient	119	Sufficient	1.5	Deficient	52.5	13.75	27.5	0	0.25	8.75
Till Borrow	Dark Gray	Clay Loam	6.6	0.1	0.2	Non Saline	3.3	1	Deficient	5	Deficient	78.5	Marginal	0.5	Deficient	2.1	Sufficient	16.3	Sufficient	1.1	Sufficient	0.15	Deficient	157.5	Excess	3.5	Deficient	52.5	13.75	8.75	0	0.25	8.75
Perimeter Embankment 2	Dark Gray	Clay Loam	6.2	0.1	0.2	Non Saline	3.8	7.5	Deficient	6.5	Deficient	81.5	Marginal	5.5	Marginal	2.65	Sufficient	7.35	Sufficient	0.8	Sufficient	0.25	Deficient	197	Excess	2.5	Deficient	52.5	18.75	10	6.25	0.25	8.75
South Till Borrow	Dark Gray	Clay Loam	6.6	0.1	0.2	Non Saline	5.2	1.5	Deficient	9.5	Deficient	85.5	Marginal	1	Deficient	2.4	Sufficient	65	Excess	0.55	Marginal	0.15	Deficient	210	Excess	3.5	Deficient	40	13.75	10	3.75	0.25	8.75
Main Embankment	Dark Gray	Clay Loam	7.5	0.2	0.4	Non Saline	2.2	1	Deficient	1	Deficient	76.5	Deficient	12	Sufficient	3.25	Sufficient	12.3	Sufficient	0.4	Marginal	0.15	Deficient	105.5	Sufficient	3	Deficient	52.5	13.75	8.75	6.25	0.25	8.75
TSF Corner 1	Dark Gray	Clay Loam	6.9	0.1	0.2	Non Saline	1.6	1.5	Deficient	2.5	Deficient	53.5	Deficient	5	Marginal	5.3	Sufficient	14.65	Sufficient	0.3	Marginal	0.1	Deficient	123.5	Sufficient	2.5	Deficient	52.5	18.75	10	2.5	0.25	8.75
TRR	Dark Gray	Clay Loam	6.0	0.1	0.2	Non Saline	3.1	1	Deficient	9.5	Deficient	54	Deficient	3.5	Deficient	1.25	Sufficient	17.05	Sufficient	2.3	Sufficient	0.3	Marginal	175.5	Excess	2.5	Deficient	52.5	18.75	42.5	3.75	0.25	8.75
Cariboo Stockpile		Sandy Loam	7.5				2.1	<1.0	Deficient	10.1	Marginal	92	Marginal	14.6	Sufficient	491	Excess	910	Excess	93.8	Excess			35800	Excess								
AVERAGE			7.0	0.2	0.3		2.7	1.7		10.0		75.7		8.2		58.4		55.8		5.0		0.2		1662.1		3.0		52	13	19	2	0.2	7
1995 Test Pits (Average)			5.7		0.2		2.5			30.0		73.0				305		778		89		19		39556									
1997 Test Pits (Average)			5.3		0.4		4.4			26.7		99.8																					
2006 Test Pits (Average)			6.0		0.2		2.8			27.9		91.0																					

Table B.2 Comparison of 2013 soil stockpile sample results with soil guidelines for metal levels

Parameter	Canadian Soil Quality Guidelines	BC Contaminated Sites Regulation Guideline	Average Soil Stockpile Concentration (ppm)	Number of Sample Exceeding the Guideline
Copper	63		58.4	7
Zinc	200		5	0
Boron	2		0.2	0
Manganese		1800	55.8	0

ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	MILL SITE
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

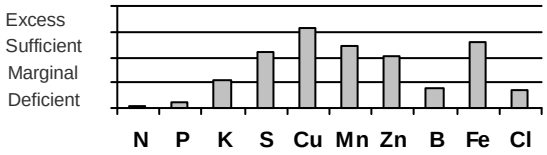
Sample ID 1380605 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	6.8	0.1	0.2	Non Saline	2.2										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	2	4	159	24	140	10.2	1.5	0.4	182	6



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	40-45	15-25	0-10	0-0	0-0	0-0	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	35-40	15-25	0-10	0-0	0-0	0-0	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	20-25	15-25	0-10	0-0	0-0	0-0	0-0.5	0-0	0-15

No Goal Submitted

☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	SEZ 2
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

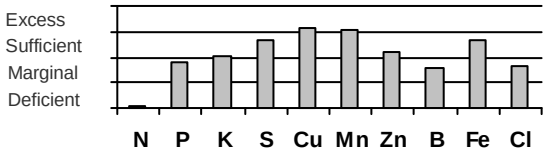
Sample ID 1380606 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Loam	6.5	0.3	0.7	Non Saline	6.4										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	3	53	219	>48	165	43.5	3.2	0.8	197	13



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NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	20-25	10-20	0-0	0-0	0-0	0-0	0-0.5	0-0	0-15
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	15-20	10-20	0-0	0-0	0-0	0-0	0-0.5	0-0	0-15
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	5-10	10-20	0-0	0-0	0-0	0-0	0-0.5	0-0	0-0

No Goal Submitted

☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	SERDS
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

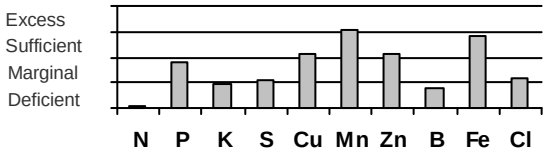
Sample ID 1380607 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	6.0	0.1	0.2	Non Saline	4.4										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P	K	SO_4-S	Cu	Mn	Zn	B	Fe	Cl
0-6	3	>54	141	8	2.5	49.4	2.1	0.4	247	10



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	5-10	50-60	0-10	0-0	0-0	0-0	0-0.5	0-0	0-0
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	20-25	50-60	10-15	0-0	0-0	0-0	0.5-0.5	0-0	0-15
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	15-20	50-60	5-10	0-0	0-0	0-0	0.5-0.5	0-0	0-15

No Goal Submitted

☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	PER EMBANKMENT OUTER
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

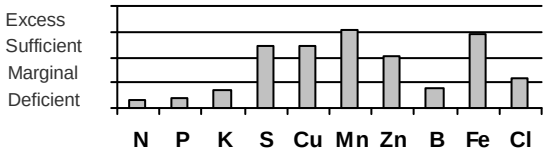
Sample ID 1380608 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	6.4	0.2	0.4	Non Saline	4.4										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	9	8	107	38	7.7	110	1.7	0.4	282	9



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NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	95-105	40-45	80-90	0-0	0-0	0-0	0-0	0.5-0.5	0-0	0-15
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	85-95	35-40	80-90	0-0	0-0	0-0	0-0	0.5-0.5	0-0	0-15
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	65-75	20-25	80-90	0-0	0-0	0-0	0-0	0-0.5	0-0	0-0

No Goal Submitted ☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	PAG DUMP
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

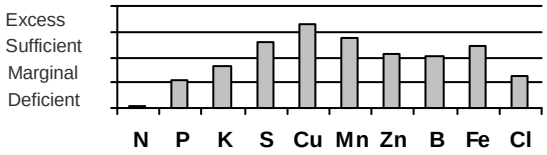
Sample ID 1380609 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	7.1	0.3	0.7	Non Saline	3.2										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	2	26	192	>43	288	14.8	2.4	1.2	139	10



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	25-30	15-25	0-0	0-0	0-0	0-0	0-0	0-0	0-15
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	20-25	15-25	0-0	0-0	0-0	0-0	0-0	0-0	0-15
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	10-15	15-25	0-0	0-0	0-0	0-0	0-0	0-0	0-0

No Goal Submitted

☐ Irrigation

Other Recommendations And Comments

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	NW SUMP RD
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

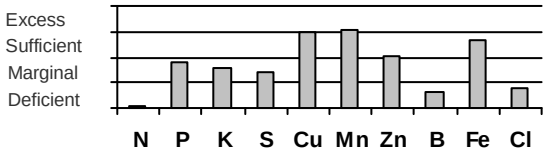
Sample ID 1380610 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	6.2	0.1	0.2	Non Saline	1.7										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	2	>54	183	10	19.6	40.6	1.7	0.3	199	6



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	20-25	15-25	10-15	0-0	0-0	0-0	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	15-20	15-25	5-10	0-0	0-0	0-0	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	5-10	15-25	0-10	0-0	0-0	0-0	0-0.5	0-0	0-15

No Goal Submitted

☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	NBD
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

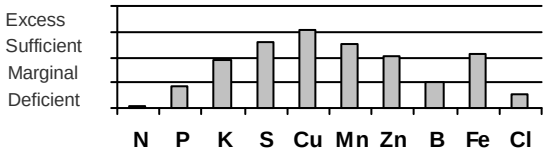
Sample ID 1380721 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	8.3	0.2	0.4	Non Saline	0.9										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	2	17	202	>43	51.0	11.1	1.4	0.5	27	4



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	30-35	15-25	0-0	0-0	0-0	0-0	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	25-30	15-25	0-0	0-0	0-0	0-0	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	15-20	15-25	0-0	0-0	0-0	0-0	0-0.5	0-0	0-15

No Goal Submitted ☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	SPRINGER NORTH
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

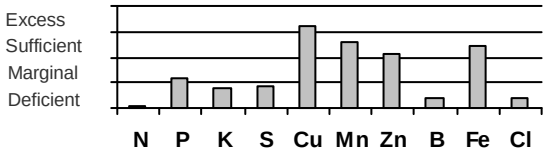
Sample ID 1380722 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	7.9	0.1	0.2	Non Saline	1.0										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	2	27	118	6	205	11.9	2.2	0.2	123	3



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	25-30	80-90	15-20	0-0	0-0	0-0	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	20-25	80-90	10-15	0-0	0-0	0-0	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	10-15	80-90	5-10	0-0	0-0	0-0	0-0.5	0-0	0-15

No Goal Submitted

☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	NBD TOP
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

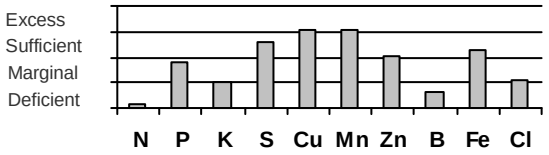
Sample ID 1380723 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	7.5	0.2	0.4	Non Saline	2.6										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	4	>54	151	>43	36.1	51.9	1.6	0.3	94	9



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	105-115	20-25	15-25	0-0	0-0	0-0	0-0	0.5-0.5	0-0	0-15
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	95-105	15-20	15-25	0-0	0-0	0-0	0-0	0.5-0.5	0-0	0-15
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	75-85	5-10	15-25	0-0	0-0	0-0	0-0	0-0.5	0-0	0-0

No Goal Submitted ☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	ACCESS ROAD KM 12
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

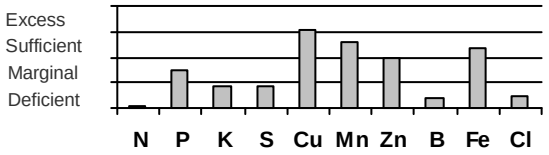
Sample ID 1380724 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	7.6	0.1	0.2	Non Saline	1.5										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	2	40	126	6	66.7	12.1	1.2	0.2	117	3



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NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	20-25	50-60	15-20	0-0	0-0	0-0	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	15-20	50-60	10-15	0-0	0-0	0-0	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	5-10	50-60	5-10	0-0	0-0	0-0	0-0.5	0-0	0-15

No Goal Submitted

☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	EAST RDS
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

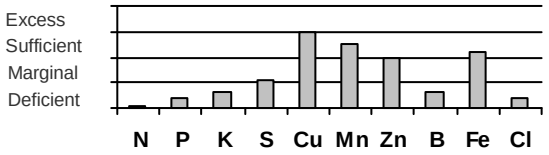
Sample ID 1380725 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	8.0	0.1	0.2	Non Saline	1.3										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	2	7	91	8	20.8	11.7	1.0	0.3	71	3



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NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	40-45	80-90	10-15	0-0	0-0	2-6	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	35-40	80-90	5-10	0-0	0-0	0-4	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	20-25	80-90	0-10	0-0	0-0	0-2	0-0.5	0-0	0-15

No Goal Submitted

☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	WX ZONE
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

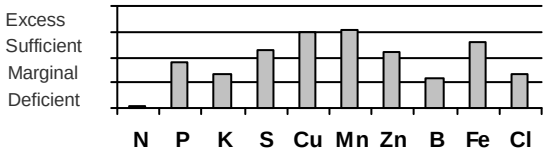
Sample ID 1380726 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	6.9	0.1	0.2	Non Saline	3.6										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	3	>54	173	29	19.7	43.2	3.5	0.6	172	10



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	20-25	15-25	0-0	0-0	0-0	0-0	0-0.5	0-0	0-15
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	15-20	15-25	0-0	0-0	0-0	0-0	0-0.5	0-0	0-15
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	5-10	15-25	0-0	0-0	0-0	0-0	0-0.5	0-0	0-0

No Goal Submitted

☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

Loginnum: L116660

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	NEZ DUMP
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

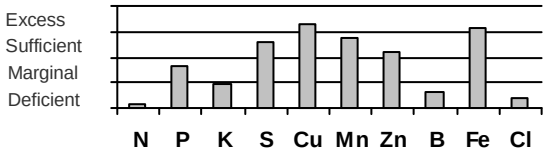
Sample ID 1380727 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	7.0	0.2	0.4	Non Saline	2.5										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	5	47	139	>43	313	14.7	3.4	0.3	382	3



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	105-115	20-25	50-60	0-0	0-0	0-0	0-0	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	95-105	15-20	50-60	0-0	0-0	0-0	0-0	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	75-85	5-10	50-60	0-0	0-0	0-0	0-0	0-0.5	0-0	0-15

No Goal Submitted

☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	HIGHWAY TO HEAVEN
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

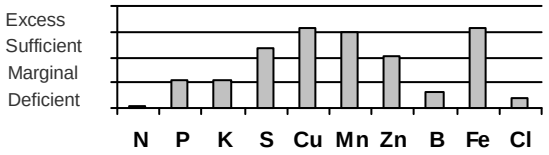
Sample ID 1380728 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	6.9	0.2	0.4	Non Saline	2.6										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	2	26	158	31	185	33.5	1.6	0.3	375	3



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	25-30	15-25	0-0	0-0	0-0	0-0	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	20-25	15-25	0-0	0-0	0-0	0-0	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	10-15	15-25	0-0	0-0	0-0	0-0	0-0.5	0-0	0-15

No Goal Submitted ☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	WIGHT PIT TILL
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

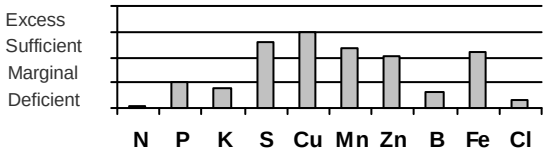
Sample ID 1380729 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	7.7	0.3	0.7	Non Saline	0.9										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	2	20	121	>43	30.1	8.7	1.7	0.3	73	2



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	30-35	50-60	0-0	0-0	0-0	0-0	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	25-30	50-60	0-0	0-0	0-0	0-0	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	15-20	50-60	0-0	0-0	0-0	0-0	0-0.5	0-0	0-15

No Goal Submitted ☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	WRAP AROUND ROAD
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

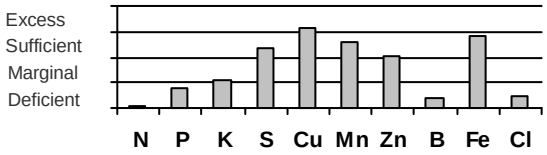
Sample ID 1380730 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	7.4	0.2	0.4	Non Saline	1.9										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	2	16	159	34	120	12.9	1.7	0.2	238	3



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	30-35	15-25	0-0	0-0	0-0	0-0	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	25-30	15-25	0-0	0-0	0-0	0-0	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	15-20	15-25	0-0	0-0	0-0	0-0	0-0.5	0-0	0-15

No Goal Submitted ☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	TILL BORROW
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

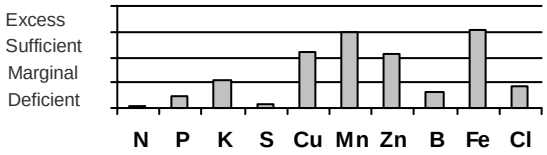
Sample ID 1380731 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	6.6	0.1	0.2	Non Saline	3.3										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P	K	SO_4-S	Cu	Mn	Zn	B	Fe	Cl
0-6	2	10	157	1	4.2	32.6	2.2	0.3	315	7



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	40-45	15-25	15-20	0-0	0-0	0-0	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	35-40	15-25	10-15	0-0	0-0	0-0	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	20-25	15-25	5-10	0-0	0-0	0-0	0-0.5	0-0	0-15

No Goal Submitted ☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	PERIMETER EMBANKMENT
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

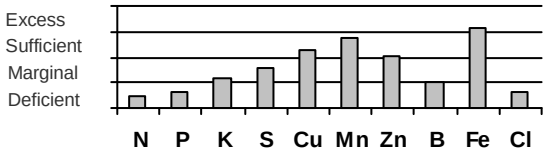
Sample ID 1380732 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	6.2	0.1	0.2	Non Saline	3.8										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	15	13	163	11	5.3	14.7	1.6	0.5	394	5



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	85-95	30-35	15-25	10-15	0-0	0-0	0-0	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	75-85	25-30	15-25	5-10	0-0	0-0	0-0	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	55-65	15-20	15-25	0-10	0-0	0-0	0-0	0-0.5	0-0	0-15

No Goal Submitted

☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	SOUTH TILL BORROW
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

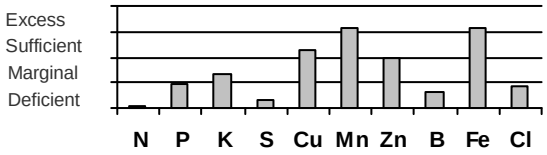
Sample ID 1380733 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	6.6	0.1	0.2	Non Saline	5.2										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	3	19	171	2	4.8	130	1.1	0.3	420	7



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	30-35	15-25	15-20	0-0	0-0	0-0	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	25-30	15-25	10-15	0-0	0-0	0-0	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	15-20	15-25	5-10	0-0	0-0	0-0	0-0.5	0-0	0-15

No Goal Submitted ☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	MAIN EMBANKMENT
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

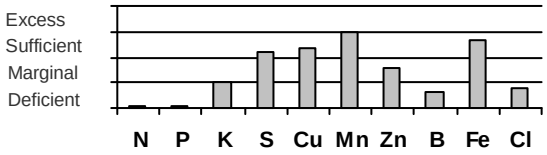
Sample ID 1380734 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	7.5	0.2	0.4	Non Saline	2.2										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	2	2	153	24	6.5	24.6	0.8	0.3	211	6



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	40-45	15-25	0-10	0-0	0-0	2-6	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	35-40	15-25	0-10	0-0	0-0	0-4	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	20-25	15-25	0-10	0-0	0-0	0-2	0-0.5	0-0	0-15

No Goal Submitted

☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

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ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	TSF CORNER 1
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

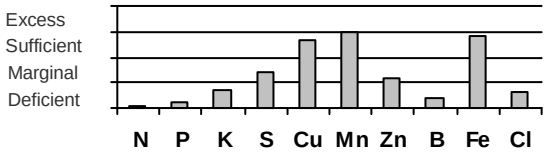
Sample ID 1380735 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	6.9	0.1	0.2	Non Saline	1.6										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	3	5	107	10	10.6	29.3	0.6	0.2	247	5



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	40-45	80-90	10-15	0-0	0-0	2-6	0.5-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	35-40	80-90	5-10	0-0	0-0	0-4	0.5-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	20-25	80-90	0-10	0-0	0-0	0-2	0-0.5	0-0	0-15

No Goal Submitted

☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

Loginnum: L116660

Printed:14-Sep-13 02:32 PM

ALS Laboratory Group Agricultural Services

Phone: 1-800-667-7645

SOIL TEST REPORT

Dealer / Crop Consultant:

MOUNT POLLEY MINING CORP

BOX 12

LIKELY,BC V0L 1N0

Phone: 250-790-2215

Fax: --

Email:kmcmahen@mountpolley.com,chughes

Client Information:

MOUNT POLLEY MINING CORP

Sample / Field Information:

Crop Year	2014
Field Name	TRR
Legal Location	83 18 W6
Soil Climatic Zone	Dark Gray
GPS Reference	
Acres	
Previous Crop	
Yield	
Stubble Management	Spread
Rotation	Continuous

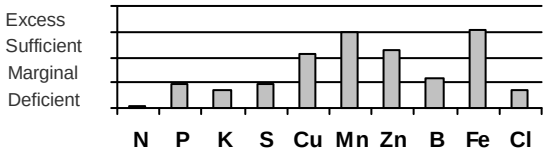
Sample ID 1380736 Date Sampled 08-SEP-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-6	Clay Loam	6.0	0.1	0.2	Non Saline	3.1										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-6	2	19	108	7	2.5	34.1	4.6	0.6	351	5



ALS Laboratory Group

NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: _____ ☑ Typical: 3.0 inches

Wheat, CWRS	N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
46 bu/ac 8.7 in. of ppt - 25% chance of this ppt. 11.0% Protein.	110-120	30-35	80-90	10-15	0-0	0-0	0-0	0-0.5	0-0	15-20
36 bu/ac 6.5 in. of ppt - 50% chance of this ppt. 12.0% Protein.	100-110	25-30	80-90	5-10	0-0	0-0	0-0	0-0.5	0-0	15-20
24 bu/ac 3.8 in. of ppt - 75% chance of this ppt. 13.0% Protein.	80-90	15-20	80-90	0-10	0-0	0-0	0-0	0-0.5	0-0	0-15

No Goal Submitted

☐ Irrigation

Other Recommendations And Comments

B recommendations are for annual broadcast application of an inorganic salt and based on limited research. Consult label directions for foliar application.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

Loginnum: L116660

Printed:14-Sep-13 02:32 PM

MOUNT POLLEY MINING CORP.
ATTN: Katie McMahen
PO Box 12
Likely BC V0L 1N0

Date Received: 12-JAN-13
Report Date: 23-JAN-13 16:12 (MT)
Version: FINAL

Client Phone: 250-790-2215

Certificate of Analysis

Lab Work Order #: L1257355

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Comments:

Can Dang
Senior Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1257355-1				
Description	soil/sediment				
Sampled Date	10-JAN-13				
Sampled Time	01:00				
Client ID	CARIBOO STOCKPILE				
Grouping **Analyte**					
MANURE					
Organic / Inorganic Carbon C:N Ratio	41.3:1				

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1257355-1				
	Description	soil/sediment				
	Sampled Date	10-JAN-13				
	Sampled Time	01:00				
	Client ID	CARIBOO STOCKPILE				
Grouping	**Analyte**					
SOIL						
Physical Tests	Bulk Density (kg/m3)	1270				
	Loss on Ignition @ 375 C (%)	2.4				
	Moisture (%)	16.9				
	Organic Matter (%)	2.1				
	pH (1:2 soil:water) (pH)	7.51				
	Porosity (%)	52.0				
Particle Size	% Gravel (>2mm) (%)	9.82				
	% Sand (2.0mm - 0.063mm) (%)	50.3				
	% Silt (0.063mm - 4um) (%)	27.3				
	% Clay (<4um) (%)	12.6				
	Texture	Sandy loam				
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.031				
Anions and Nutrients	Total Nitrogen by LECO (%)	0.042				
Organic / Inorganic Carbon	Total Carbon by Combustion (%)	1.3				
	Total Organic Carbon (%)	1.17				
Plant Available Nutrients	Cation Exchange Capacity (meq/100g)	9.44				
	Available Nitrate-N (mg/kg)	<1.0				
	Available Phosphate-P (mg/kg)	10.1				
	Available Potassium (mg/kg)	92				
	Available Sulfate-S (mg/kg)	14.6				
Metals	Aluminum (Al) (mg/kg)	19600				
	Antimony (Sb) (mg/kg)	0.44				
	Arsenic (As) (mg/kg)	13.3				
	Barium (Ba) (mg/kg)	132				
	Beryllium (Be) (mg/kg)	0.65				
	Bismuth (Bi) (mg/kg)	<0.20				
	Cadmium (Cd) (mg/kg)	0.359				
	Calcium (Ca) (mg/kg)	12400				
	Chromium (Cr) (mg/kg)	25.6				
	Cobalt (Co) (mg/kg)	17.6				
	Copper (Cu) (mg/kg)	491				
	Iron (Fe) (mg/kg)	35800				
	Lead (Pb) (mg/kg)	10.5				
	Lithium (Li) (mg/kg)	17.0				
	Magnesium (Mg) (mg/kg)	9420				

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1257355-1				
	Description	soil/sediment				
	Sampled Date	10-JAN-13				
	Sampled Time	01:00				
	Client ID	CARIBOO STOCKPILE				
Grouping	**Analyte**					
SOIL						
Metals	Manganese (Mn) (mg/kg)	910				
	Mercury (Hg) (mg/kg)	0.102				
	Molybdenum (Mo) (mg/kg)	3.05				
	Nickel (Ni) (mg/kg)	19.0				
	Phosphorus (P) (mg/kg)	1260				
	Potassium (K) (mg/kg)	970				
	Selenium (Se) (mg/kg)	0.43				
	Silver (Ag) (mg/kg)	0.24				
	Sodium (Na) (mg/kg)	250				
	Strontium (Sr) (mg/kg)	112				
	Thallium (Tl) (mg/kg)	0.050				
	Tin (Sn) (mg/kg)	<2.0				
	Titanium (Ti) (mg/kg)	926				
	Uranium (U) (mg/kg)	0.619				
	Vanadium (V) (mg/kg)	113				
	Zinc (Zn) (mg/kg)	93.8				

Reference Information

Additional Comments for Sample Listed:

Samplenum	Matrix	Report Remarks	Sample Comments
L1257355-1	Soil	Note: Analysis performed on a disturbed sample results do not reflect field conditions.	

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-LECO-SK	Soil	Total Carbon by combustion method	SSSA (1996) P. 973-974

The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.

C-TOT-ORG-LECO-SK	Soil	Organic Carbon by combustion method	SSSA (1996) p. 973

Total Organic Carbon (C-TOT-ORG-LECO-SK, C-TOT-ORG-SK)

Total C and inorganic C are determined on separate samples. The total C is determined by combustion and thermal conductivity detection, while inorganic C is determined by weight lass after addition of hydrochloric acid. Organic C is calculated by the difference between these two determinations.

Reference for Total C:
Nelson, D.W. and Sommers, L.E. 1996. Total Carbon, organic carbon and organic matter. P. 961-1010 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

Reference for Inorganic C:
Loeppert, R.H. and Suarez, D.L. 1996. Gravimetric Method for Loss of Carbon Dioxide. P. 455-456 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

C:N-CALC-AG-SK	Manure	Carbon:Nitrogen Ratio(Total)-Calculation	Calculation
CEC-SK	Soil	Cation Exchange Capacity (NH4OAC Extn)	CSSS(1978) 3.321/Comm Soil Sci 17(7)

Soil exchange sites are saturated with ammonium, then displaced with sodium. Ammonium in the extract is determined colorimetrically.

DENSITY-BULK-SK	Soil	Bulk Density - Disturbed Soil	CSSS 50.2-Wt./Vol Density

The disturbed sample is dried at 35C and ground to pass a 2 mm screen using a flail grinder. A known volume of the sry soil is weighed to determine bulk density.

HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS	EPA 200.2/245.7

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by atomic fluorescence spectrophotometry (EPA Method 245.7).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis of the digested extract is by collision cell inductively coupled plasma - mass spectrometry (modifed from EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

MOISTURE-VA	Soil	Moisture content	ASTM D2974-00 Method A

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

N-TOT-LECO-SK	Soil	Total Nitrogen by combustion method	SSSA (1996) P. 973-974

The sample is ignited in a combustion analyzer where nitrogen in the reduced nitrous oxide gas is determined using a thermal conductivity detector.

N-TOTKJ-COL-SK	Soil	Total Kjeldahl Nitrogen	CSSS (1993) 22.2.3

The soil is digested with sulfuric acid in the presence of CuSO4 and K2SO4 catalysts. Ammonia in the soil extract is determined colrimetrically at 660 nm.

NO3-AVAIL-SK	Soil	Available Nitrate-N	Method = Alberta Ag (1988)

Reference Information

Available Nitrate and Nitrite are extracted from the soil using a dilute calcium chloride solution. Nitrate is quantitatively reduced to nitrite by passage of the sample through a copperized cadmium column. The nitrite (reduced nitrate plus original nitrite) is then determined by diazotizing with sulfanilamide followed by coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. The resulting water soluble dye has a magenta color which is measured at colorimetrically at 520nm.

Reference:
Recommended Methods of Soil Analysis for Canadian Prairie Agricultural Soils. Alberta Agriculture (1988) p. 19 and 28

OM-LOI-SK Soil Organic Matter by LOI at 375 deg C. CSSS (1978) p. 160

The dry-ash method involves the removal of organic matter by combustion at 375 degrees C for a minimum of 16 hours. Samples are dried prior to combustion.

Reference: McKeague, J.A. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1978) method 4.23

PH-1:2-VA Soil pH in Soil (1:2 Soil:Water Extraction) BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

PO4/K-AVAIL-SK Soil Plant Available Phosphorus and Potassium Comm. Soil Sci. Plant Anal, 25 (5&6)

Plant available phosphorus and potassium are extracted from the soil usng Modified Kelowna solution. Phosphorous in the soil extract is determined colorimetrically at 880 nm, while potassiumis determined by flame emission at 770 nm.

PSA-PIPET+GRAVEL-SK Soil Particle size - Sieve and Pipette SSIR-51 METHOD 3.2.1

Particle size distribution is determined by a combination of techniques. Dry sieving is performed for coarse particles, wet sieving for sand particles and the pipette sedimentation method for clay particles.

Reference:

Burt, R. (2009). Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States Department of Agriculture Natural Resources Conservation Service.

SO4-AVAIL-SK Soil Available Sulfate-S REC METH SOIL ANAL - AB. AG(1988)

Plant available sulfur in the soil is extracted with a weak calcium chloride solution. Total S in the extract is then determined by ICP-OES.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

Chain of Custody / Analytical Request Form

Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # _____

Page 1 of 1

Report to:		Report Format / Distribution	Service Requested: (rush - subject to availability)
Company:	MOUNT POLLEY MINING CORP.	☐ Standard ☑ Other	◉ Regular (Default)
Contact:	Katie McMahen	☑ PDF ☑ Excel ☐ Ogita: ☐ Fax	○ Priority (2-3 Business Days) - 50% Surcharge
Address:	PO BOX 12, Likely, BC, V0L 1N0	Email 1: on file	○ Emergency (1 Business Day) - 100% Surcharge
		Email 2:	○ For Emergency < 1 Day, ASAP or Weekend - Contact ALS
Phone:	250-790-2216 Fax:		
Invoice To:	Same as Report ? ◉ Yes ○ No	**Client / Project Information:**	**Analysis Request**
Company:		Job #:	Please indicate below Filtered, Preserved or both (F, P, F/P)
Contact:		PO / AFE:	
Address:		Legal Site Description:	
Phone:	Fax:	Quote #:	
Lab Work Order # (lab use only)	[redacted]	ALS Contact: Can Dang	Sampler: Katie McMahen

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH	Total Metals	Particle Size	TOC / TKN / C:N / CEC	Physical Parameters (see no	Plant Available Nutrients	Organic Matter	% Moisture Content	Number of Containers
	Cariboo Stockpile	10-Jan-13	1:00	Soil/Sediment	X	X	X	X	X	X	X	X	1

L1257355-COFC

Special Instructions / Regulations / Hazardous Details

Please analyse for physical parameters: texture, % sand/silt/clay, bulk density. Not sure if it is possible to analyze for all the parameters requested. Please contact kmcmahen@mountpolley.com with questions.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)		SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)		
Released by:	Date & Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date & Time:	Observations: Yes / No ? If Yes attach SIF
Katie McMahen	10/01/2013 16:00	[signature]	[signature]	10:30	6.13			

METRO VANCOUVER'S BIOSOLIDS COMPOSITION

	BC Organic Matter Recycling Regulation		Annacis I. WWTP (Routine QC Station)			
			Numbers of Samples Collected	Dewatered Biosolids (Class A)		
				Period:	15-Apr-13	- 15-Oct-13
	Class A Biosolids	Class B Biosolids		Mean	Min	Max
Physical Parameters						
Total Solids (%)			32	26.5	23.4	30.3
Volatile Solids (%)			6	70.3	69.1	72.1
Electrical Conductivity (ds/m)			6	6.07	5.50	6.60
Bulk Density						
pH			6	8.1	7.8	8.4
Macronutrients (mg/kg dw)						
Total Kjeldahl Nitrogen (TKN)			6	52,633	49,400	55,300
Ammonia distillation			6	9,560	9,040	10,100
Nitrate/Nitrite-N			0	0.0	0.0	0.0
Nitrate/Nitrite-N (Available)			5	11.0	11.0	11.0
Phosphorus (Total)			31	24,568	22,600	29,200
Phosphorus (Available)			5	2,680	1,900	3,500
Potassium (Total)			20	1,730	1,550	2,050
Potassium (Available)			5	1,282	1,110	1,470
Calcium (Total)			27	23,756	21,900	25,500
Magnesium (Total)			27	6,132	5,460	6,990
Total Trace Elements (mg/kg)						
Aluminum			27	7,701	6,650	8,730
Arsenic	**75**	**75**	27	5.2	4.0	7.0
Barium			14	318	294	343
Cadmium	**20**	**20**	27	2.4	2.0	3.4
Chromium		**1,060**	27	64	42	99
Cobalt	**150**	**150**	27	4.3	3.7	4.9
Copper		**2,200**	27	894	759	1,030
Iron			27	33,137	28,500	37,600
Lead	**500**	**500**	27	56	36	71
Manganese			27	349	315	395
Mercury	**5**	**15**	27	1.8	1.0	3.2
Molybdenum	**20**	**20**	27	13.9	10.7	19.5
Nickel	**180**	**180**	27	26	18	38
Selenium	**14**	**14**	27	7.0	6.1	9.0
Silver			27	6.8	4.6	9.7
Zinc	**1,850**	**1,850**	27	1312	1090	1550
Bacteriology (MPN/g)						
Fecal Coliform - discrete	**<1,000**		79	125	19	820

APPENDIX N:

MPMC INVASIVE PLANT MANAGEMENT PLAN

MOUNT POLLEY MINING CORPORATION

INVASIVE PLANT MANAGEMENT PLAN

1.0 Overview

Due to the area of disturbed ground that is created during mining operations, development of an invasive plant management and control program is necessary to prevent weed species from becoming a management problem on the mine site and associated disturbances that impacts reclamation efforts and/or hinders regional invasive plant management strategies.

The Invasive Species Council of British Columbia defines invasive plants as any non-native plant species that has the potential to pose undesirable or detrimental impacts on people, animals or ecosystems. Invasive plants can establish quickly and easily on both disturbed and un-disturbed sites, and causing widespread negative economic, social, and environmental impacts (ISCBC, 2015).

any invasive alien plant species that has the potential to pose undesirable or detrimental impacts on humans, animals or ecosystems (Ministry of Forests, 2005).

Under the *Weed Control Act* (RSBC 1996), noxious weeds may meet one or more of the following criteria:

- they aggressively invade natural resources and agricultural crops or are detrimental to them;
- they are poisonous or injurious to livestock;
- they are exceptionally difficult to control by standard methods; and
- there is a need to enforce control to prevent expansion of new invaders.

This Act also states that every occupier shall control, in accordance with the regulations, noxious weeds growing or located on land and premises, and on any other property located on land and premises occupied by him.

"*Invasive plant species (weeds) can turn productive reclaimed areas into non-productive wastelands in a very short time."* (Polster, 2003)

The prevention of the establishment of invasive plants or noxious weeds in the Mount Polley Mine area will be addressed by MPMC through Implementation of this Invasive Plant Management Plan that will be conducted over the mine project life, including closure.

2.0 Purpose

The purpose of this plan is:

- to control and reduce the spread of invasive plant species;

- to educate the mine management and personal about the potential costs of infestation, both monetary and environmental; and

- evaluate the effectiveness of weed management.

3.0 Objectives

The program will include visual monitoring of all disturbed lands at MPMC by environmental staff to detect the establishment of weed species. The monitoring will be conducted on both re-vegetated and un-vegetated disturbed areas to survey for noxious weeds and invasive plants. More formal weed surveys will be conducted annually in late spring/early summer so that plant eradication measures can be undertaken prior to seed dispersal in late summer/early fall. The program will include:

- surveying and mapping of infestation locations, with a focus on reclamation areas and soil stockpiles;
- identification of weed species present;
- assessment of the degree of weed growth, distribution, and density present at the infestation sites;
- implementation of control measures;
- assessment of success, and follow-up as required; and
- reporting/record keeping.

4.0 Prevention and Control

The primary goal involved in managing weed infestations on the project area is to carry out mining activities in a manner that prevents the introduction or spread of weed plants and supports the ability to establish desired species during site reclamation activities.

Mining activities that can facilitate the introduction or spread of weeds include:

- removal of native vegetation during clearing operations in a manner that exposes soil and thereby removes competition for weed plants, and creates a seed bed which will allow weed seed to establish;
- topsoil salvage and stockpiling which results in exposed soils at both the stockpiles and the salvage areas;
- road and powerline construction and maintenance activities that disturb sites and create exposed soil;
- movement of machinery related to the above activities that may be carrying weed seeds, thereby spreading seed between disturbance sites; and

- long-term exposure of disturbed ground (e.g., inactive waste rock dumps, exposed ground in plantsite areas).

MPMC will adopt the following best management practices (BMPs) for preventing weed establishment on mine disturbed ground:

- Minimize soil disturbance during all phases of the mining operation in order to limit the availability of exposed, un-vegetated ground to weed seed deposition.
- Establish a vegetation cover as soon as possible after ground disturbance, as follows:
    - seed ground disturbed due to construction or mining activity with a rapidly establishing agronomic seed mix for erosion protection and weed control;
    - seed soil stockpiles; water management features such as ditches and sediment pond berms; borrow pits; road edges; powerline access roads and power pole installation sites; inactive sections of mill site areas, storage and equipment yards; and generally any disturbed ground where weed infestation is a concern;
    - where warranted, seed areas that are inactive for some time and that are capable of supporting vegetation with interim weed control seed mixtures to prevent weed establishment. Active mine areas do not require weed control as weed species do not have a chance to become established;
    - specify high quality grade seed in the reclamation and interim weed control seed mixtures. Low quality grade seed may contain a higher portion of weed seed in the seed lot. As a minimum, ensure the seed used for re-vegetation is of the grade Common #1 Forage Mixture (or better) or Canada No. 1 Ground Cover Mixture.
    - Monitor seeded sites to confirm that adequate colonization with desirable species has occurred.
- Work with contractors and equipment operators to reduce weed seed delivery to disturbance sites, as follows:
    - refrain from driving through areas infested with weeds;
    - before moving equipment or vehicles from a weed infestation area to a non-infested area, inspect the undercarriage and remove attached plants or wash the undercarriage to dislodge any mud, dirt or plant parts prior to leaving infested area;
    - where possible, limiting road maintenance to the road surface to retain the vegetated areas along roads;
    - keep equipment yards and vehicle storage facilities free of invasive plants; and
    - train personnel on preventing the spread of weeds by checking and removing seeds from clothing and equipment.

- Liaise with the Cariboo Chilcotin Coast Invasive Plant Committee (CCCIPC) to keep informed of invasive plant species and management strategies in the region.

If the above prevention measures fail and weed plants establish on disturbance sites, physical, chemical and biological methods will be utilized to control or eradicate the weed infestations.

Any sites documented to have weeds present will be monitored in subsequent years to check that treatment measures have been successful. The MPMC Environmental Department that is a representative on the CCCIPC and management strategies will be developed in accordance with the Cariboo Chilcotin Regional Strategic Plan updated each year by the CCCIPC, which considers the provincial and regional noxious weeds list (Table 1; Ministry of Agriculture 2013). Note that some species in the region are designated as "established", and management options are not implemented because control of these species is not currently possible. As such, MPMC will not actively manage these species, unless they are directly impeding reclamation efforts, and will focus efforts on species listed in the "new invaders" and "containment" categories.

The strategies for managing weeds include:

- hand weeding or pulling, if plants are hand-pulled, propagules are to be removed from the site and disposed of in a way that does not allow the spread of seeds (i.e., burned not composted);
- mowing or cutting;
- burning;
- biological control; and
- herbicide spraying .

Biological control agents are natural organisms that can be used to reduce weed populations. Typically, they are insects, nematodes, fungi or viruses that infect or invade the weed plants and weaken the target weed by decreasing seed production and reducing weed density.

In the event that weed populations do become established on the mine site, that pose a threat to humans, animals or ecosystems MPMC will utilize one or a combination of the above-listed methods to control these infestations. Use of herbicides will only be as a last resort.

Table 1: Noxious Weeds in B.C.

Provincial Weeds: These weeds are classed as noxious within all regions of British Columbia.	Regional Weeds: These weeds are designated as noxious within the boundaries of the Cariboo Regional District.
Annual Sowthistle (*Sonchus oleraceus*)	blueweed *(Echium vlugare)*
Bohemian Knotweed (*Fallopia x bohemica*)	burdock *(Arctium* spp.*)*
Bur Chervil (*Anthriscus caucalis*)	orange hawkweed *(Hieracium aurantiacum)*
Canada Thistle (*Cirsium arvense*)	oxeye daisy *(Chrysanthemum leucanthemum))*
Common Reed (*Phragmites australis* subsp. *australis*)	
Crupina (*Crupina vulgaris*)	
Common Toadflax (*Linaria vulgaris*)	
Dalmatian Toadflax (*Linaria dalmatica*)	
Dense-flowered Cordgrass (*Spartina densiflora*)	
Diffuse Knapweed (*Centaurea diffusa*)	
Dodder (*Cuscuta* spp.)	
English Cordgrass (*Spartina anglica*)	
Flowering Rush (*Butomus umbellatus*)	
Garlic Mustard (*Alliaria petiolata*)	
Giant Hogweed (*Heracleum mantegazzianum*)	
Giant Knotweed (*Fallopia sachalinensis*)	
Giant Mannagrass / Reed Sweetgrass (*Glyceria maxima*)	
Gorse (*Ulex europaeus*)	
Himilayan Knotweed (*Polygonum polystachyum*)	
Hound's-tongue (*Cynoglossum officinale*)	

5.0 References

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APPENDIX O:

MOUNT POLLEY FUGITIVE DUST MANAGEMENT PLAN

(GOLDER 2015)

SUMMARY OF PARTICULATE MONITORING JULY 7 TO SEPTEMBER 29, 2015

(GOLDER 2015)

May 26, 2015

REPORT ON

Fugitive Dust Management Plan Mount Polley

Submitted to:
Mount Polley Mining Corporation
Box 12
Likely, BC
V0L 1N0

Attention: Luke Moger

REPORT

Reference Number: 1411734-023-R-Rev1-1000

Distribution:

1 Electronic Copy - Mount Polley Mining Corporation
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Golder Associates

Version Control

Version Number	Document Title	Date	MoE Response	Date
0	Mount Polley Mining Corporation 2015 Tailings Storage Facility Dust Control Plan	January 23, 2015	Review of the Mount Polley Dust Control Plan (Appendix A)	February 22, 2015
1	Fugitive Dust Management Plan – Mount Polley	May 12, 2015		

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Table of Contents

STUDY LIMITATIONS ..... **ii**

1.0 INTRODUCTION **1**

2.0 FACILITY DESCRIPTION **3**

2.1 Existing Meteorology 3

2.1.1 Temperature 4

2.1.2 Precipitation 6

2.1.3 Wind 7

2.2 Existing Dustfall Monitoring 11

2.3 Particulate Monitoring 15

2.4 Receptors 15

2.5 New Conditions (Tailings and Plug) 16

3.0 RESPONSIBILITIES **17**

3.1 Senior Management Representative: Mine Manager 17

3.2 Accountable Facility Representative: Mine Operations Manager 17

3.3 Operations Supervisor: Mill Maintenance Superintendent 17

3.4 Facility Personnel and Contractors 17

3.5 Environmental Coordinator 18

4.0 FUGITIVE DUST EMISSIONS MANAGEMENT **19**

4.1 PLAN – Identification and Classification of Fugitive Dust Emissions 19

4.1.1 Identification of the Sources of Fugitive Dust Emissions 19

4.1.2 Fugitive Dust Management Practices 22

4.2 DO – Implementation of the Dust Management Plan 25

4.3 CHECK – Inspection, Maintenance and Documentation 25

4.4 ACT – Dust Management Plan Review and Continuous Improvement 26

5.0 CLOSURE **27**

TABLES

Table 1: Station #1, Frequency of Winds above 5.4 m/s 10
Table 2: Station #2, Frequency of Winds above 5.4 m/s 10
Table 3: Airborne Particulate Station Description 11
Table 4: Sensitive Receptor Locations 15
Table 5: Main Sources and Factors Contributing to Fugitive Dust 20
Table 6: Description of Preventative Procedures and Control Measures for Fugitive Dust Emissions at the Facility 22
Table 7: Summary Table of Mitigation 24
Table 8: Wet Suppression Efficiency (Environment Canada 2014) 24

FIGURES

Figure 1: Station #1 Monthly Temperature (September 2012-March 2015) 4
Figure 2: Station #2 Monthly Temperature (November 2012-March 2015) 4
Figure 3: Old Station Monthly Temperature (2006-2012) 5
Figure 4: Average, Maximum and Minimum Monthly Temperature from the Three Meteorological Stations at Mount Polley Mine from 1995 to 2014 5
Figure 5: Monthly Average, Maximum and Minimum Rainfall from the Three Meteorological Stations at Mount Polley Mine from 1995 to 2015 6
Figure 6: Monthly Average, Maximum and Minimum Snow Cover from the Three Meteorological Stations at Mount Polley Mine from 1995 to 2015 6
Figure 7: Station #1 Monthly Wind Roses (2012- 2015) 7
Figure 8: Station #2 Monthly Wind Roses (2012-2015) 8
Figure 9: Total Dustfall at A1 12
Figure 10: Total Dustfall at A2 12
Figure 11: Total Dustfall at A3 13
Figure 12: Total Dustfall at A4 13
Figure 13: Total Dustfall at A5 14
Figure 14: Total Dustfall at A6 14

APPENDICES

APPENDIX A
Ministry of Environment Comments on Dust Control Plan

APPENDIX B
The Daily Water Management Check List

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by Mount Polley Mining Corporation (MPMC) to prepare a fugitive dust management plan (the Plan) for the Mount Polley Mine Tailings Storage Facility (TSF) and the plug area. The TSF and plug area will henceforth be referred to as the Facility. The Mount Polley Mine is located approximately 100 km northeast of the city of Williams Lake, British Columbia (BC), near the town of Likely BC.

The purpose of this dust management plan is to:

- identify the sources of fugitive dust emissions associated with the Facility;
- describe how fugitive dust can be controlled from each significant source and describe the best management practices (BMPs) in place at the Facility;
- provide a schedule by which the Plan will be implemented;
- describe how the Plan will be implemented, including the training of personnel;
- describe inspection and maintenance procedures; and
- describe methods of monitoring and record-keeping to verify and document ongoing compliance with the Plan.

The Plan is structured as follows:

- Section 2.0 provides an overview of the Facility, the existing meteorological conditions, monitoring programs and sensitive receptors;
- Section 3.0 identifies the responsibilities for each employment level as they relate to the Plan; and
- Section 4.0 describes the fugitive dust control measures that are implemented at the Facility. This section follows the Plan, Do, Check, and Act (PDCA) cycle according to the International Standards Organization (ISO) guidelines. The PDCA cycle is described below:
  - Section 4.1 **PLAN** - identifies the emission sources at the Facility;
  - Section 4.2 **DO** - documents the schedule for implementation of the management practices;
  - Section 4.3 **CHECK** - describes the monitoring procedures and a record keeping system; and
  - Section 4.4 **ACT** - describes the management practice review and update procedures in order to promote its continuous improvement.

A Plan was originally developed by MPMC to meet the requirements of the BC Ministry of Environment (MoE) *Status Report on Accepted and Outstanding Mitigation and Remediation Activities* letter dated November 21, 2014. The purpose of the letter was to provide MPMC a status report regarding activities undertaken in response to the Mount Polley Tailing Storage Facility breach and the related requirements of the Pollution Abetment Order 107461 dated August 5, 2014. This version of the Plan (revision 1) has been revised to:

- Incorporate written feedback from MoE provided in the memorandum "Re: Review of the Mount Polley Dust Control Plan" dated February 22, 2015 from Ralph Adams, MoE Air Quality Meteorologist, to Arvind Saraswat.
- Incorporate comments from Ralph Adams (MoE Air Quality Meteorologist), Arvind Saraswat (MoE Air Quality Section Head) and Hubert Bunce (MoE Environmental Protection Director Mount Polley) made in a conference call with MPMC representatives on March 10, 2015.
- Account for operational and physical changes to the Mount Polley Mine site.

2.0 FACILITY DESCRIPTION

The TSF at Mount Polley consists of three dams: the Main Embankment; the Perimeter Embankment; and the South Embankment. During the TSF breach which occurred on August 4, 2014, water (both supernatant and interstitial) was released from the TSF, resulting in much of the tailings within the TSF being exposed to the elements (no longer submerged).

The breach of the Mount Polley TSF resulted in the deposition of tailings between Polley Lake and Hazeltine Creek (known as the Polley Lake Tailings Plug or Polley Lake Sediment Plug), interrupting the flow of water from the previous Polley Lake outlet channel to Hazeltine Creek. The Polley Lake Tailings Plug covers an approximate 900 m long section of Hazeltine Creek south of Polley Lake. Prior to the breach, the area immediately south of Polley Lake contained a wetland. The materials deposited in the Polley Lake Tailings Plug area are observed to include the following:

- tailings (sandy silt or silty sand);
- dam construction materials (gravel, rock fill and till);
- organic matter transported by the tailings flow (including trees and wood debris); and
- reworked organic and inorganic materials from the wetland.

Under current conditions, the exposed tailings are retaining moisture, though it is anticipated that the exposed tailings surface may dry in the summer. Dried and exposed tailings combined with high winds could cause the particulates to become airborne, which may potentially affect onsite and offsite air quality. It is known that fine particulate matter, when airborne, is a health concern and MPMC has therefore contracted Golder to develop this Plan in advance of summer conditions to reduce the risk of such health concerns from arising.

In addition to the exposed tailings in the TSF and those deposited in the Polley Lake Tailings Plug Area, other identified potential sources for fugitive dust emissions at the Facility are construction emissions related to the disturbance of waste rock during TSF remediation activities.

2.1 Existing Meteorology

MPMC has two (2) meteorological monitoring stations on site that have been operating since 2012. The first station (Station #1) is located southwest of the Polley Mountain summit, at an elevation of 1,171 masl (metres above sea level) near the Mill Site. The second station (Station #2) is located northwest of the TSF, along the access road to the old rock quarry. Station #2 is located atop a topographical rise at an elevation of 964 masl. The two (2) stations are approximately 3.5 km apart, with an elevation difference of approximately 200 m.

These stations monitor and record rainfall, temperature, relative humidity, wind speed, wind direction, and solar radiation every 30 minutes. From 1995 to 2012, a single meteorological station located northwest of the TSF was in operation. This station monitored rainfall and temperature only. Data from the three (3) stations are presented in the following sections.

2.1.1 Temperature

Figure 1 to Figure 3 show the monthly temperature plots from each of the three (3) meteorological stations. Figure 4 presents the accumulated average, maximum and minimum temperatures from all three (3) stations between 1995 and 2015; the three (3) stations had different operational periods over 1995 and 2015, however the amalgamated temperature (Figure 4) is expected to demonstrate the long term meteorological conditions at the Facility. They indicate hourly temperatures peak during the summer months (June through September) to approximately 18 degrees Celsius (°C). Average temperatures measured at the three (3) stations were very similar; summertime temperatures were observed to be slightly lower (2°C) at the old station, which was active from 2006 to 2012.

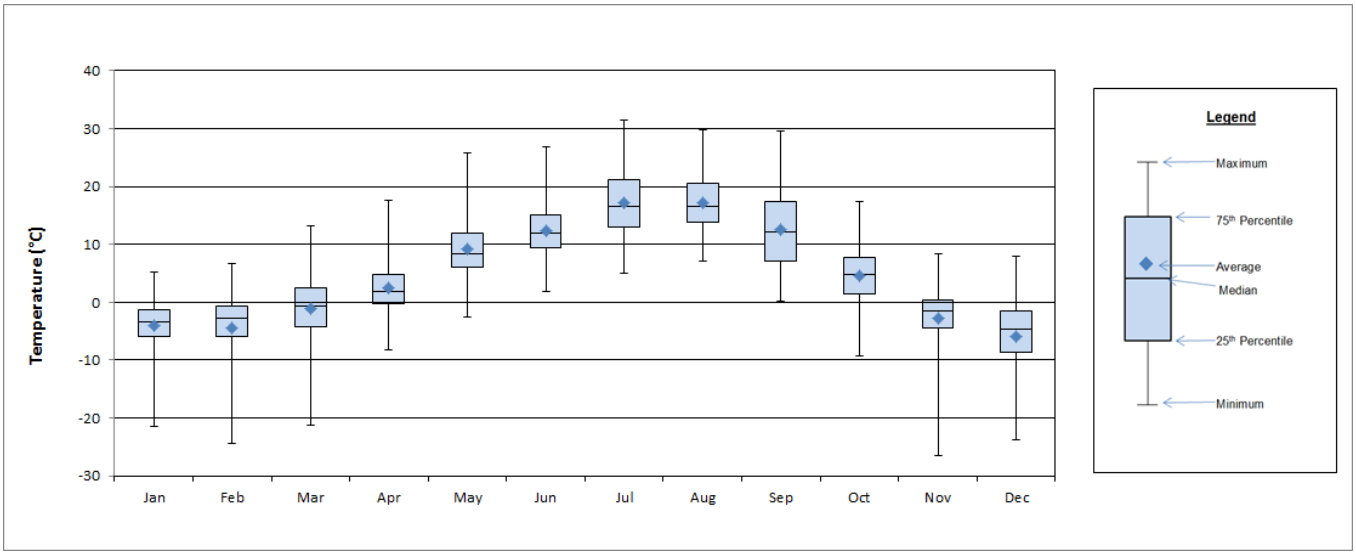


Figure 1: Station #1 Monthly Temperature (September 2012-March 2015)

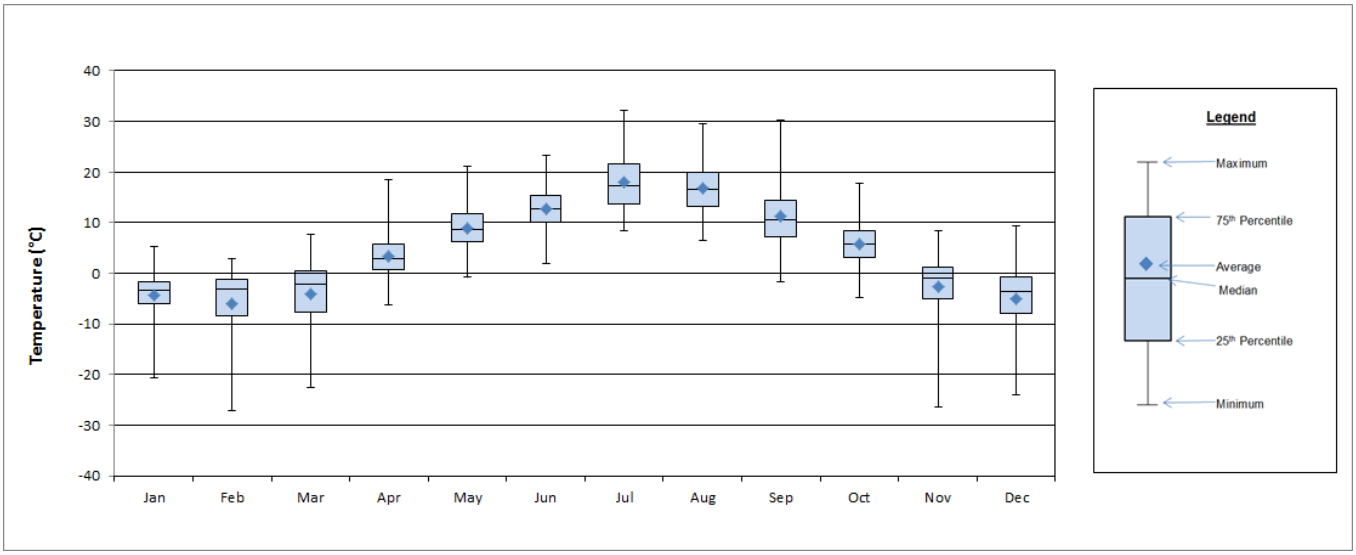


Figure 2: Station #2 Monthly Temperature (November 2012-March 2015)

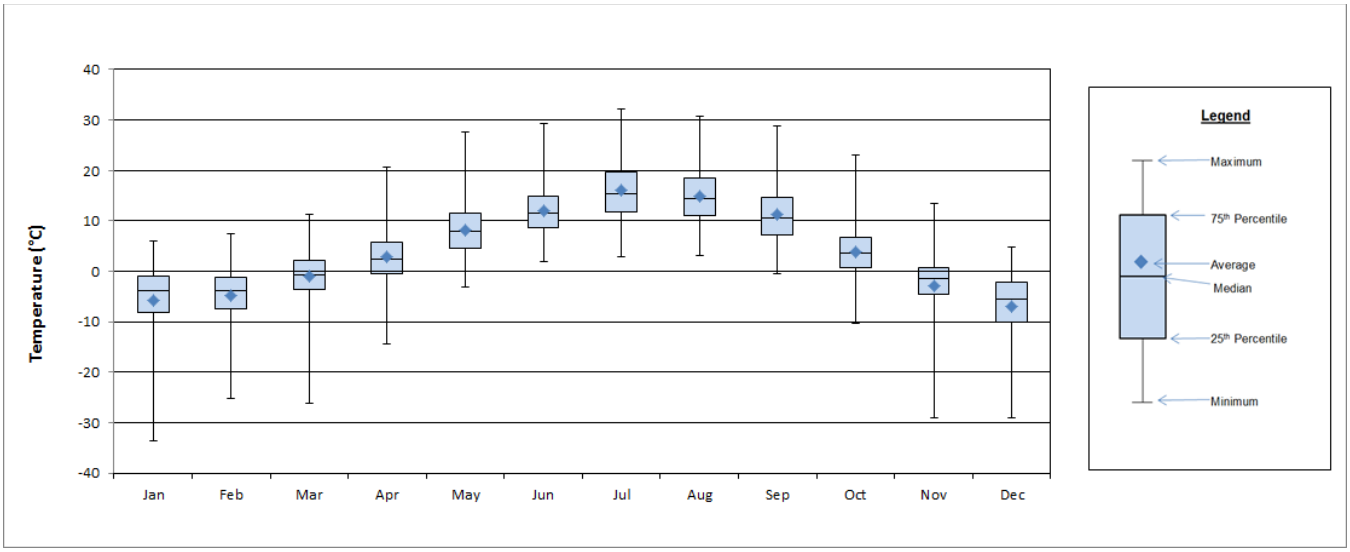


Figure 3: Old Station Monthly Temperature (2006-2012)

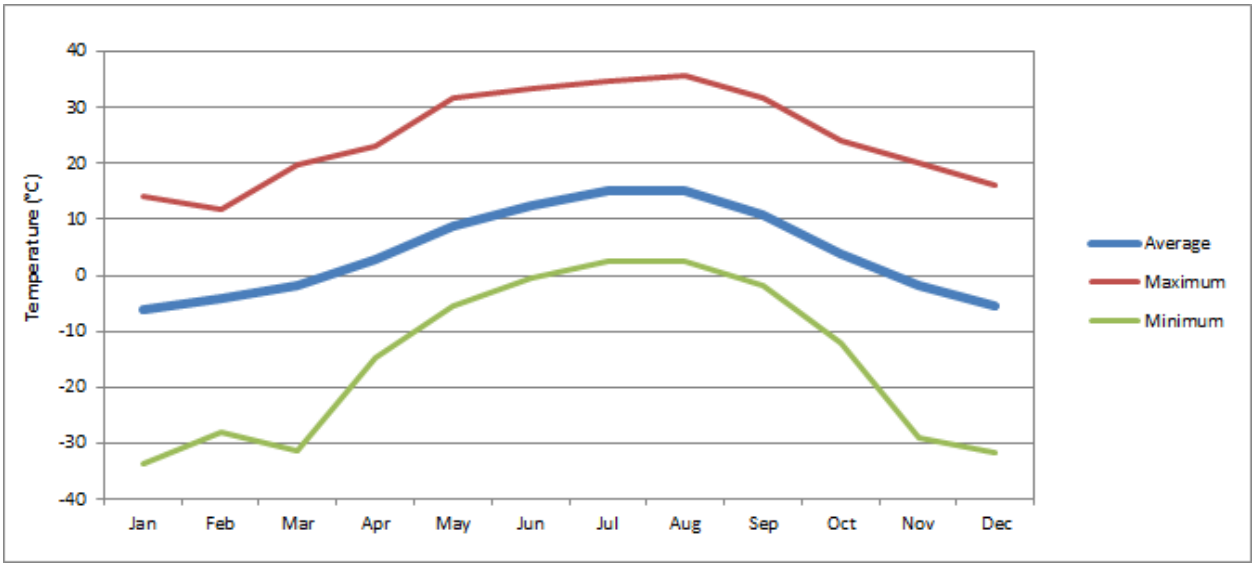


Figure 4: Average, Maximum and Minimum Monthly Temperature from the Three Meteorological Stations at Mount Polley Mine from 1995 to 2014

Dust generation will be low during freezing conditions, observed at this site between November and March. There is potential for dust generation when the temperatures are above zero, between April and October. During summer months (June, July, and August) the warmer temperatures may result in the accelerated drying of wet surfaces; therefore, dust controls measures relying on watering during summer months should be monitored regularly.

2.1.2 Precipitation

Figure 5 illustrates the monthly average, maximum and minimum rainfall measured at the three (3) meteorological sites active at the Mount Polley Mine from 1995 to 2015. It is observed that rainfall measured at Mount Polley Mine peaked in the spring and early summer (April through July) and again in the fall (October). Rainfall will act as a natural dust suppressor during non-freezing months.

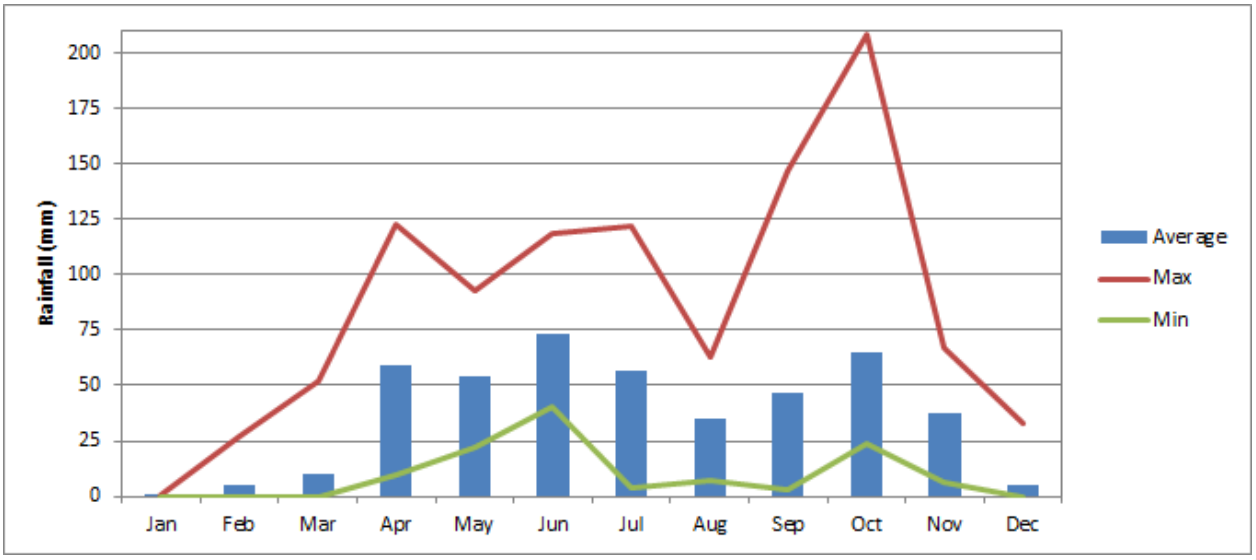


Figure 5: Monthly Average, Maximum and Minimum Rainfall from the Three Meteorological Stations at Mount Polley Mine from 1995 to 2015.

Snow cover will act as dust suppression in the freezing months. Average snow depth was measured on site. It is observed in Figure 6 that from 1995 to 2015, snow cover was present from November to April when rainfall was low.

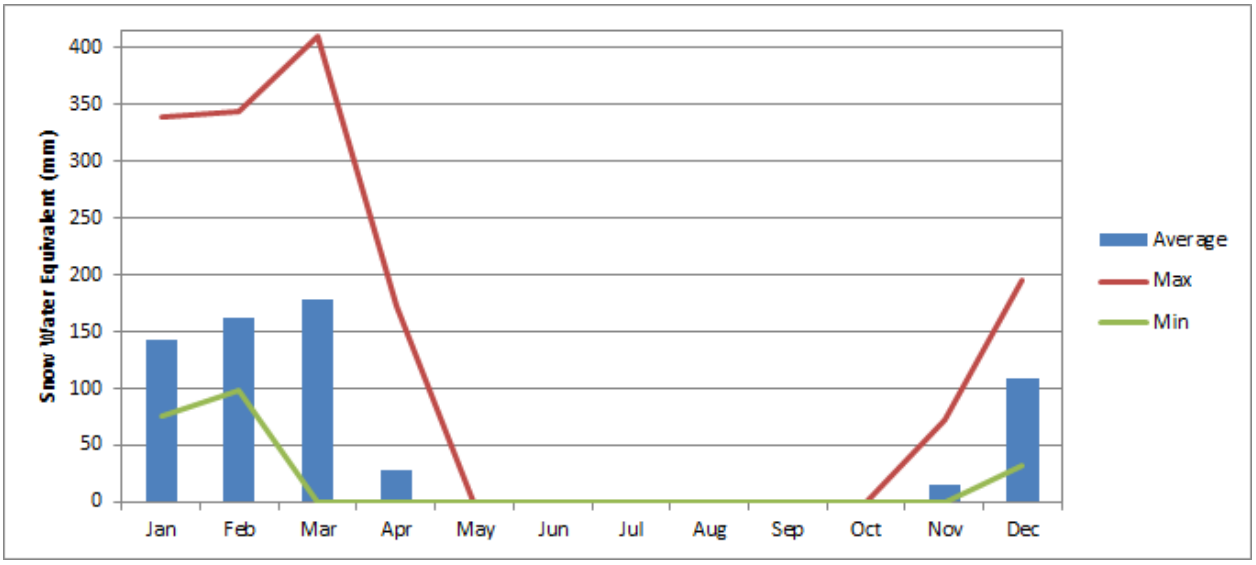


Figure 6: Monthly Average, Maximum and Minimum Snow Cover from the Three Meteorological Stations at Mount Polley Mine from 1995 to 2015.

2.1.3 Wind

A wind rose depicts the relative frequency of wind direction on a 16-point compass, with north, east, south, and west directions going clockwise, whose value is listed adjacent to each of the compass points. Each ring on the wind rose represents a frequency of 5% of the total. The length of the shaded bars on each wind rose petal represents the frequency of wind recorded from a given direction within a certain speed range.

Wind rose plots depicting the relative frequency of mean hourly wind speed and direction at Station #1 and Station #2 are shown in Figure 7 and Figure 8, respectively.

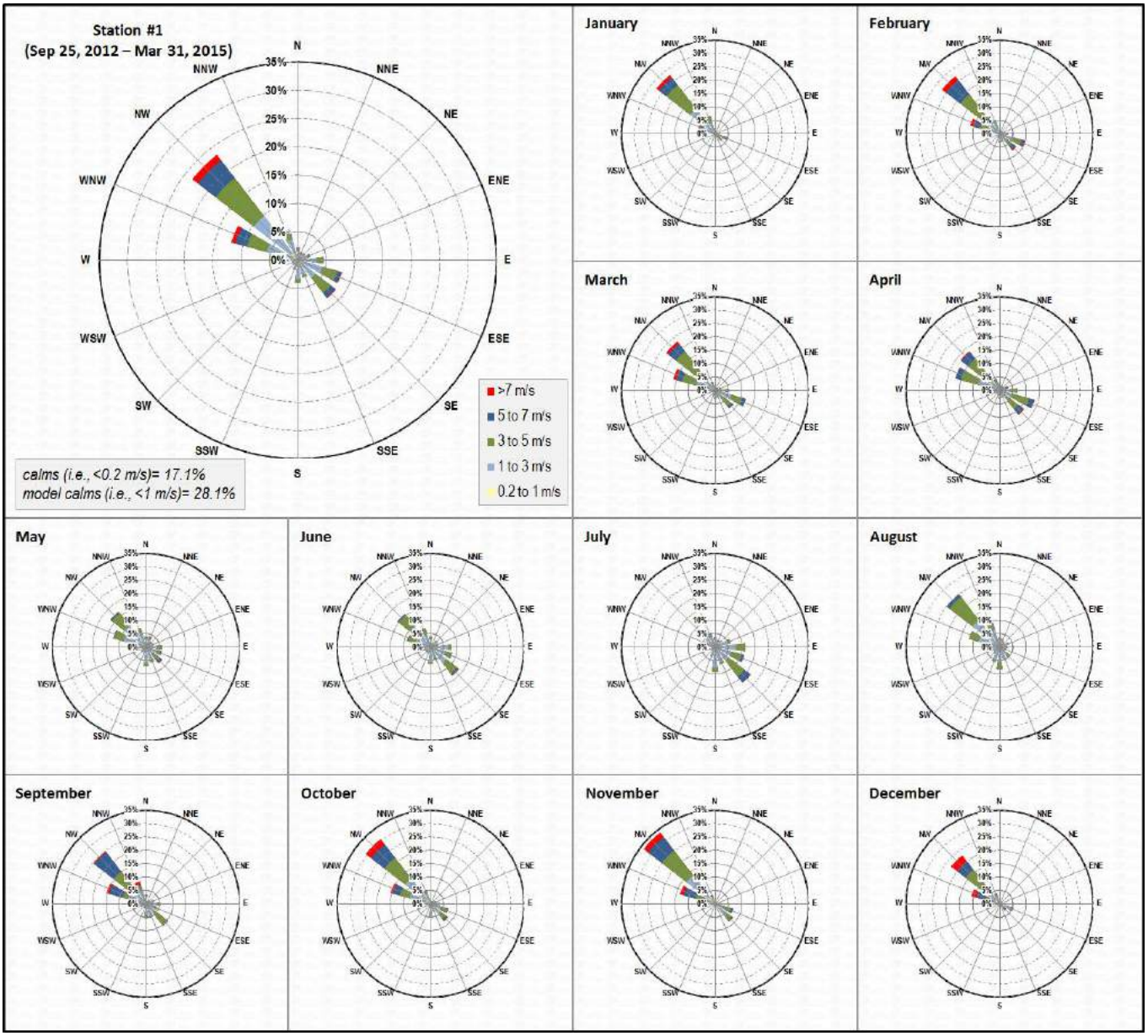


Figure 7: Station #1 Monthly Wind Roses (2012- 2015)

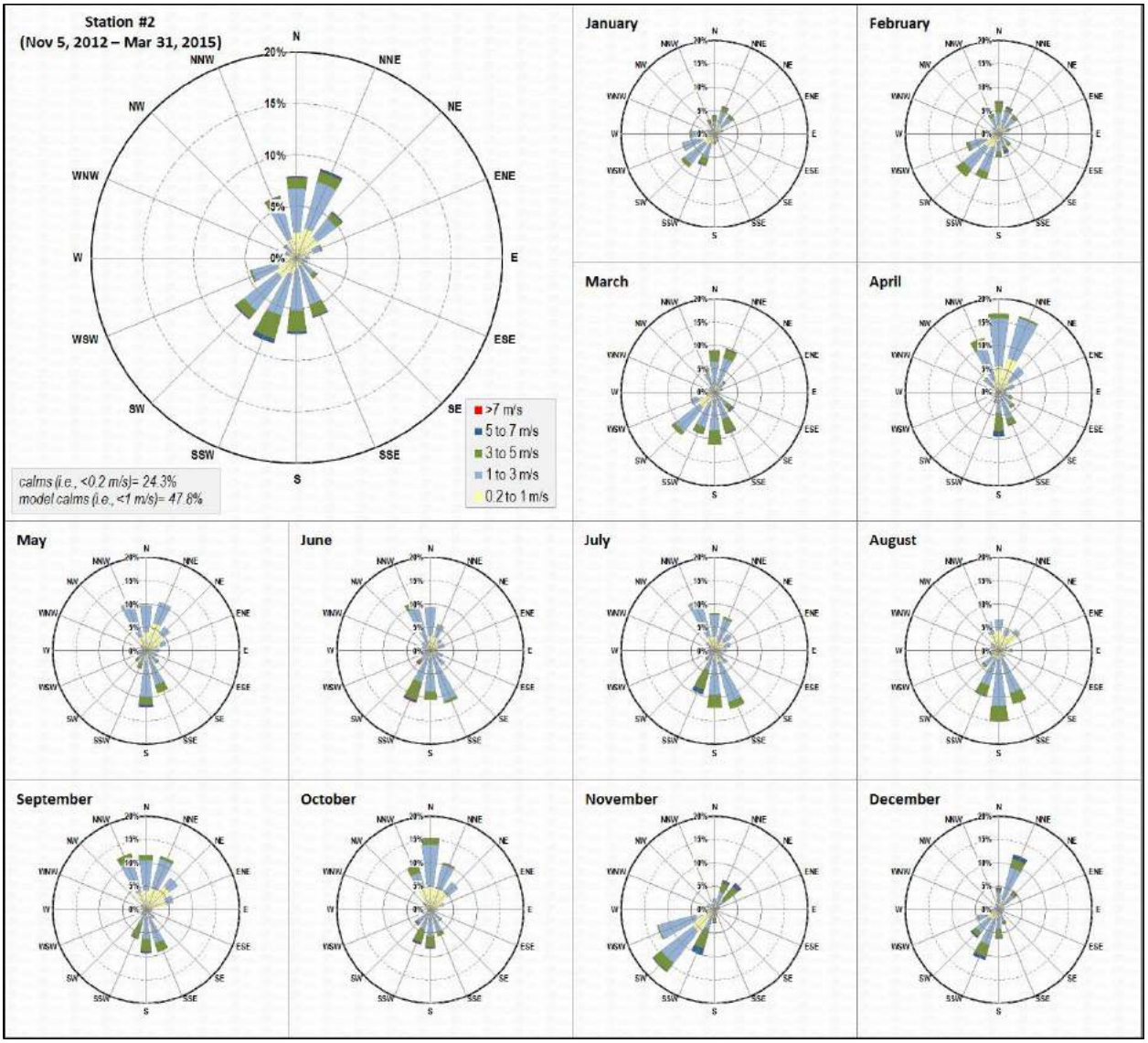


Figure 8: Station #2 Monthly Wind Roses (2012-2015)

The Station #1 wind roses indicate that the predominant wind direction is from the northwest, with a predominance of winds below 3 meters per second (m/s). Figure 7 also indicates that 28.1% of winds measured were below 1 m/s. Within atmospheric modelling programs this would generally be defined as calm periods. Monthly wind roses in Figure 7 indicate that summer months are calmer, with predominant wind directions from the northwest and southeast.

The Station #2 wind roses indicate that the predominant wind direction is from the north-north-east and south-south-west, with a predominance of winds below 3 metres per second (m/s). Figure 8 also indicates that a high percentage (47.6%) of winds measured were below 1 m/s. Monthly wind roses provided in Figure 8 indicate that the predominant wind direction during the summer months is from the north and south.

As previously described, Station #1 is located closer to the Mount Polley summit (elevation 1,171 masl) while Station #2 is located further down in the valley (elevation 964 masl). This means that due to the difference in elevation, and the surrounding terrain features, the wind patterns are expected to be different. For example, lower wind speeds are observed at locations with more obstacles such as forest and terrain. As the wind roses in Figure 7 and Figure 8 suggest, Station #2 observes a higher percentage of calm winds along with a higher percentage of lower wind speeds than Station #1. The wind flow near Station #2 is expected to be hindered by the surrounding forested area. As previously mentioned, Station #2 is located along a valley slope at a local topographical rise; therefore, the location is expected to experience mountain breeze and valley breeze. Mountain breeze and valley breeze are terrain induced wind patterns which are caused by the heating of ground surface. During the daytime, land is heated, which drives the air upwards along the slope, which is called a valley breeze. During the night, cooled air is submerged (sinks) along the slope, which is called a mountain breeze. Station #2 wind roses in Figure 8 suggests that there are two (2) predominant winds, which agree with the direction of the terrain slope. As Figure 7 suggests, higher wind speeds are observed at Station #1 relative to Station #2, since Station #1 is located near the summit of Mt. Polley, there are less obstacles which hinder the wind flow. In addition, due to past project activities on site, the area surrounding Station #1 is clear, which means less obstacles to hinder the wind flow.

It is expected that the wind patterns observed at Station #1 would be representative of fugitive dust emission sources at higher elevations (pits, dumps and mill site) while the wind patterns at Station #2 would be representative of sources at lower elevations (TSF and plug).

It is expected that when winds reach a threshold velocity, fugitive emissions would result from wind erosion. When no source tested data is available, the United States Environment Protection Agency (US EPA) (1988) has used a threshold velocity of 5.4 m/s for aggregate material stockpiles (coal and other exposed materials). Table 1 and Table 2 present the frequency in which hourly wind speeds were greater than 5.4 m/s at Station #1 and Station #2 from 2012 to 2015. A dash indicates no available data in that month.

Table 1: Station #1, Frequency of Winds above 5.4 m/s

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	—	—	—	—	—	—	—	—	11.94%	9.95%	17.92%	4.30%
2013	3.63%	13.39%	8.20%	8.19%	4.84%	0.83%	4.57%	0.67%	10.42%	3.36%	4.17%	3.76%
2014	4.84%	14.43%	9.14%	10.83%	1.08%	2.78%	2.42%	0.00%	—	23.52%	8.06%	18.82%
2015	9.68%	12.35%	11.16%	—	—	—	—	—	—	—	—	—

Table 2: Station #2, Frequency of Winds above 5.4 m/s

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	—	—	—	—	—	—	—	—	—	—	3.19%	3.90%
2013	0.40%	1.04%	—	—	—	—	—	—	0.14%	1.08%	0.28%	0.13%
2014	0.27%	2.08%	1.21%	0.69%	0.13%	0.97%	0.81%	0.00%	0.28%	0.81%	1.11%	1.75%
2015	1.21%	0.30%	0.81%	—	—	—	—	—	—	—	—	—

Table 1 shows that at Station #1 in May, June, July and August, the frequency of wind speeds greater than 5.4 m/s occurs less than 5% of the time, whereas the rest of the year observes higher frequency of winds greater than 5.4 m/s. This trend can also be seen from the wind rose in Figure 7. Similarly, Table 2 shows that at Station #2 in May, June, July, and August there are fewer occurrences of winds greater than 5.4 m/s than the rest of the year. This trend can also be seen from the wind rose in Figure 8. Figure 4 shows the on-site monthly temperature trend, where the temperatures in November to March are expected to be below freezing. Conversely, between the months of April to October the temperature is expected to be warmer. This suggests that during the drier conditions in summer months, the dust is less likely to be transported by strong winds in this region.

2.2 Existing Dustfall Monitoring

Six (6) airborne particulate stations have been monitoring dustfall at Mount Polley since November 2011. These air quality monitoring stations provide the fixed, volatile, and total dustfall measured in milligrams per decimetre squared per day (mg/dm^2/d) over a monthly period. Data from these stations are compared against the BC Ambient Air Quality Objectives, for which the lower and upper limits are 1.7 mg/dm^2/d and 2.9 mg/dm^2/d, respectively.

Station names and locations are presented in Table 3. Figure 9 to Figure 14 present the monthly dustfall data compared to the lower BC Ambient Air Quality Objective. The majority of the dustfall data were measured prior to the breach in August 2014, and therefore represent the sources of dust from the Mine (rather than the tailings in the TSF, which were previously submerged).

Table 3: Airborne Particulate Station Description

Station Name and Description	Easting (m)	Northing (m)	Distance from TSF (km)	Direction from TSF
A1 - By W12 (6 km Creek water monitoring station)	588,221	5,826,043	10	Northwest
A2 - At Cabin on Bootjack Lake	589,906	5,823,978	7	Northwest
A3 - Near New Access Road	590,471	5,825,114	8	Northwest
A4 - Polley Lake Boat Launch	595,241	5,821,259	2	North
A5 - By W7 (Hazeltine Creek water monitoring station)	597,010	5,819,075	2	East
A6 - Polley Lake Cabin	593,170	5,826,290	7	North

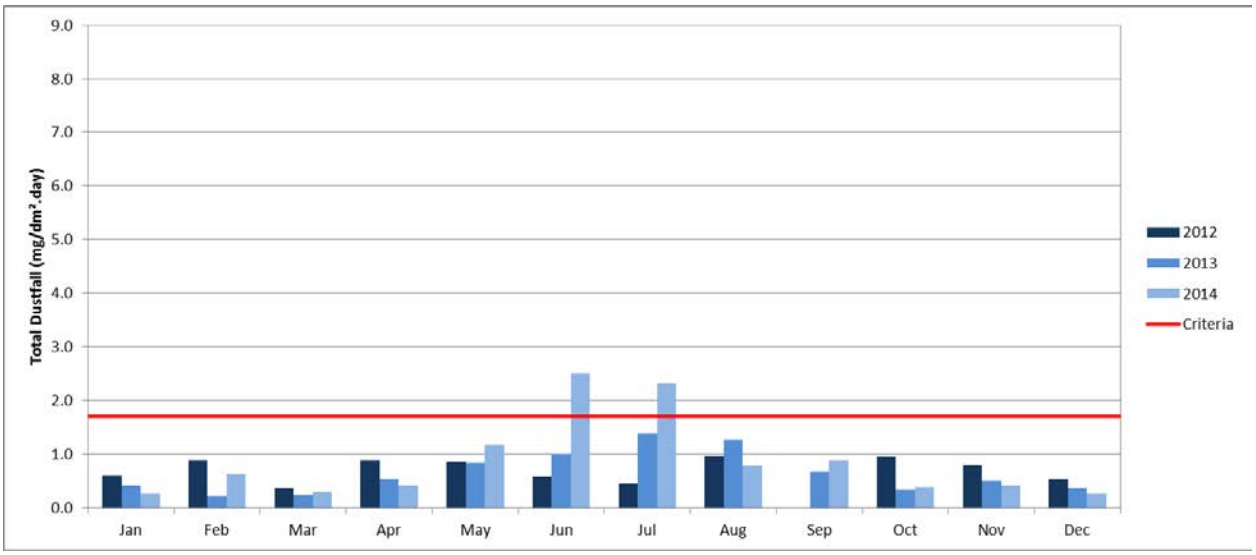


Figure 9: Total Dustfall at A1

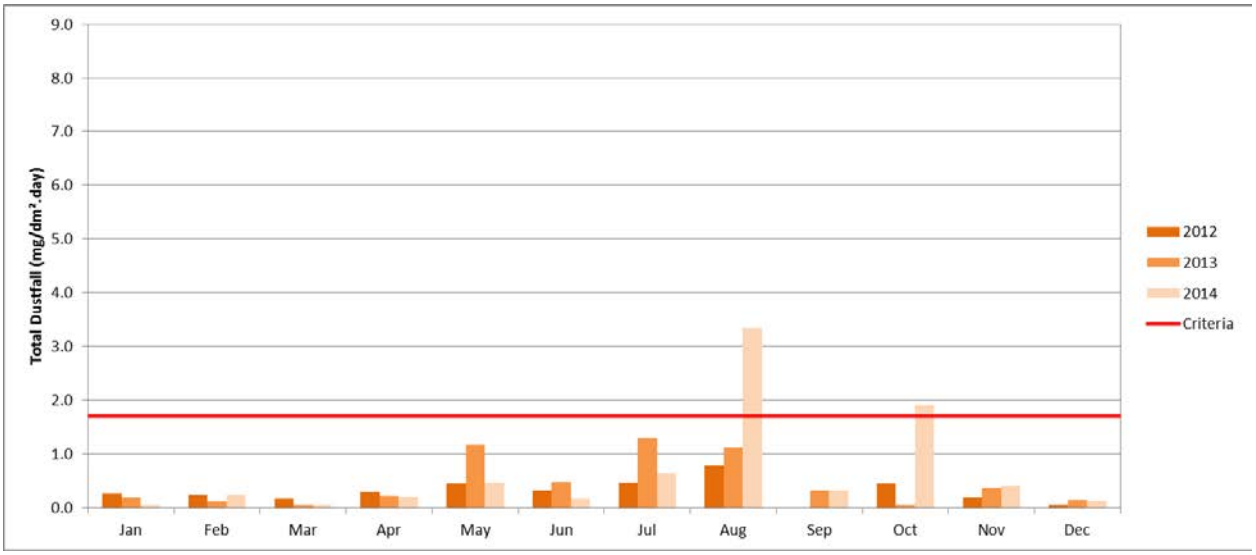


Figure 10: Total Dustfall at A2

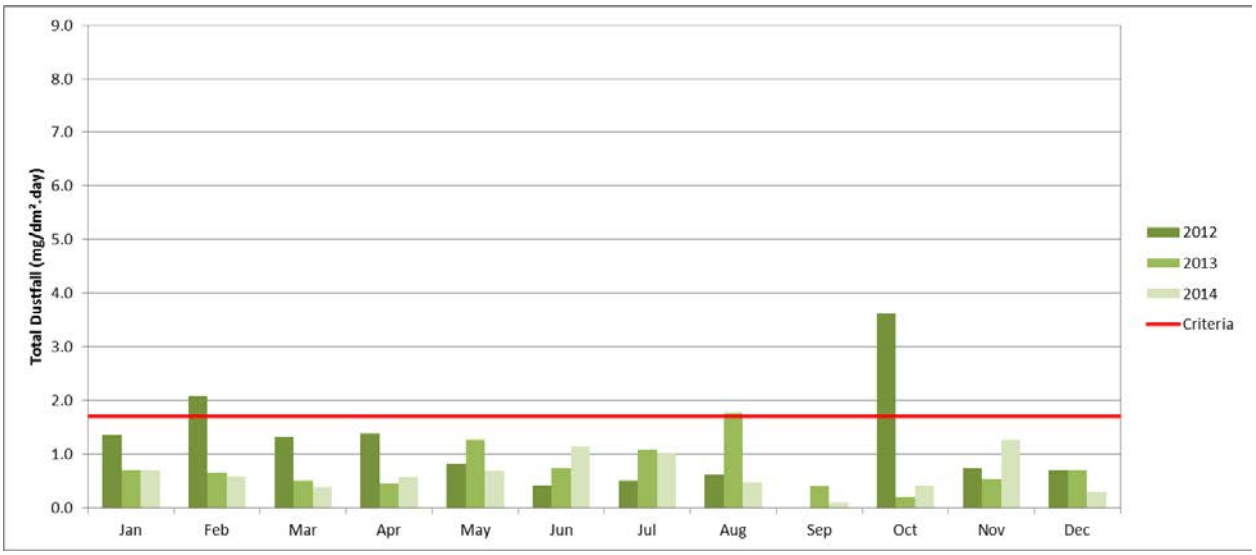


Figure 11: Total Dustfall at A3

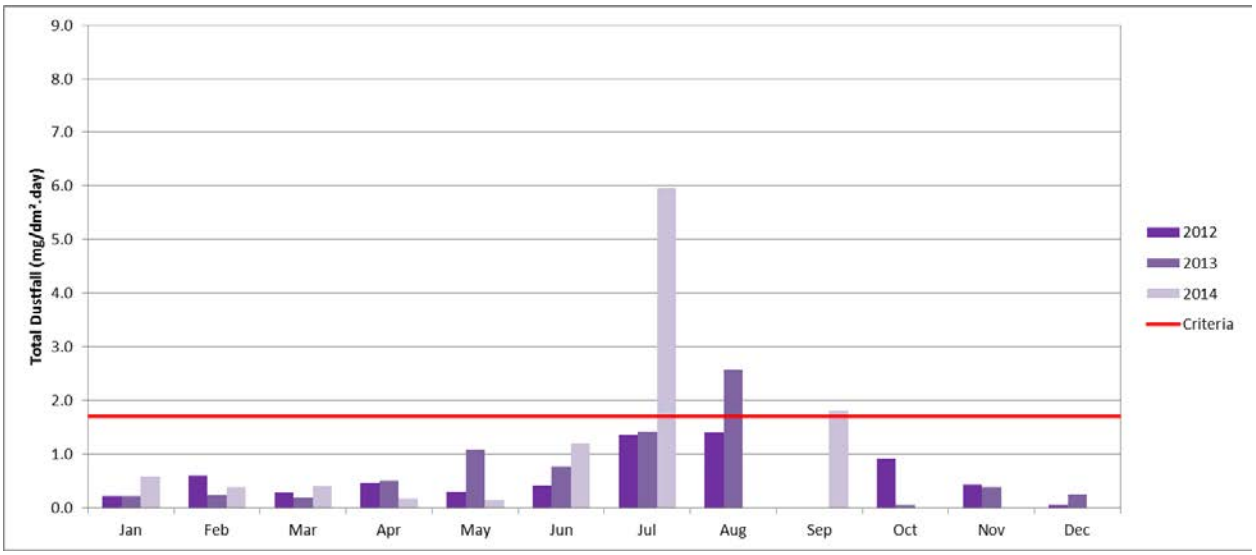


Figure 12: Total Dustfall at A4

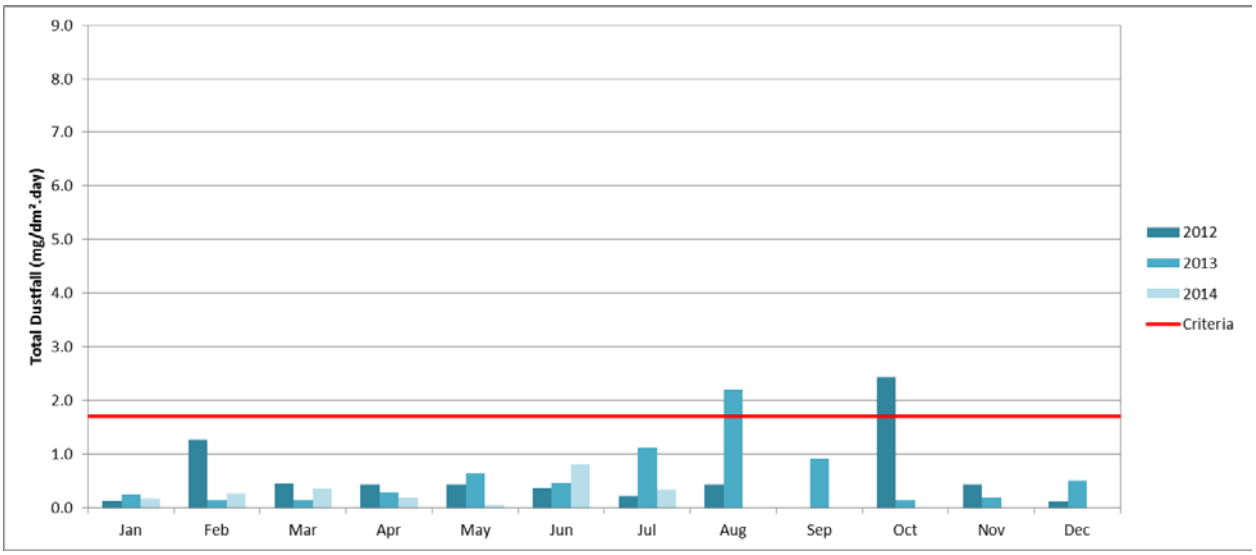


Figure 13: Total Dustfall at A5

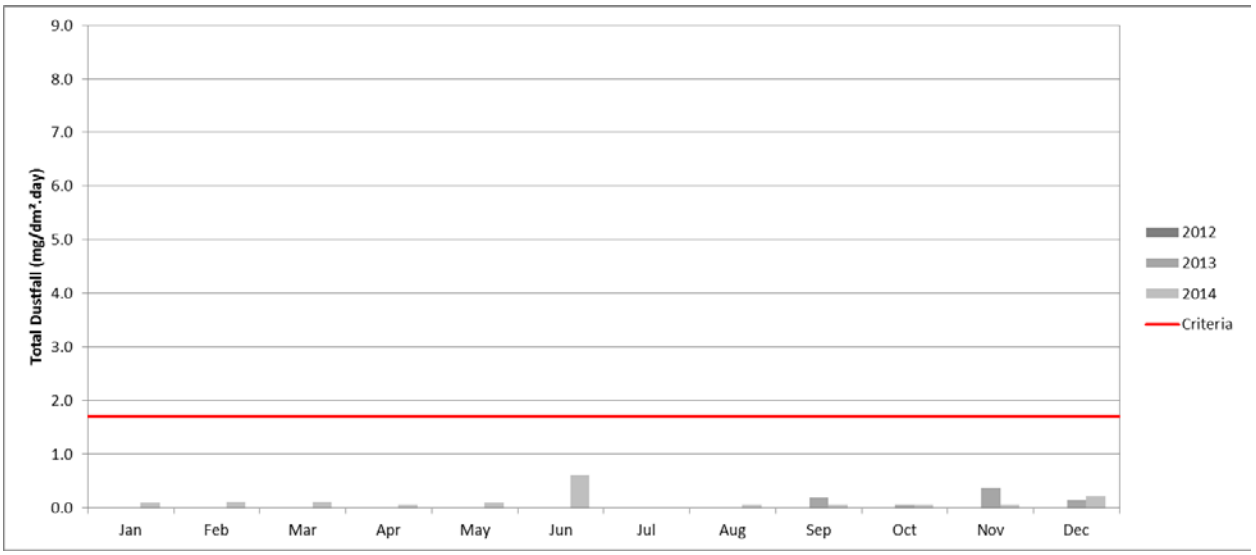


Figure 14: Total Dustfall at A6

Over the past three (3) calendar years, exceedances of the lower dust deposition objective were observed at each of the dust monitoring locations with the exception of station A6.

Dustfall readings (Figure 9 to Figure 14) demonstrate strong year to year variability. For station A1 (Figure 9) dustfall peaked in summers of 2013 and 2014; however, for 2012 some of the lowest dustfall readings were in summer. Dustfall concentrations were observed to be much lower at monitor A6, which is located across Polley Lake.

2.3 Particulate Monitoring

Particulate matter is generally defined into three (3) size fractions:

- particulates of all size classes are referred to as total suspended particulate (TSP);
- particulates with a diameter of 10 µm or less are referred to as PM_{10}; and
- particulates with a diameter of 2.5 µm or less are referred to as $PM_{2.5}$.

Exposure to respirable (PM_{10}) and fine particulate matter ($PM_{2.5}$) aggravates a number of respiratory illnesses. Smaller particles are generally thought to be of greater concern to human health than larger particles.

The deposition of TSP is generally considered dustfall. Deposition of PM_{10} and $PM_{2.5}$ are limited relative to TSP and these smaller particles can generally travel farther distances than TSP. Currently there is no monitoring of TSP, PM_{10} and $PM_{2.5}$ at the Facility.

2.4 Receptors

The following table summarizes offsite sensitive receptors near the Facility, arranged by least distance from the Facility, that may be affected by fugitive dust. There are a number of recreational areas within 10 km of the Facility and the nearest town site is the community of Likely located 12 km north-east of the TSF.

Table 4: Sensitive Receptor Locations

Receptor Description	Receptor Name	Easting (m)	Northing (m)	Distance from TSF (km)	Direction from TSF
Recreation	Polley Lake Campsite	596,031	5,821,197	2	North
Recreation	Polley Lake	595,508	5,821,029	2	North
Recreation	Bootjack Lake	592,240	5,820,738	3	Northwest
Recreation	Raft Creek Campsite	601,094	5,818,449	5	East
Recreation	Bootjack Mountain	589,454	5,820,753	6	West Northwest
Recreation	Quesnel Lake	599,055	5,823,901	6	Northeast
Recreation	Campsite at Bootjack lake	590,183	5,823,874	7	Northwest
Residence	Cedar Creek Rd Residences by Quesnel Lake	599,755	5,824,847	7	Northeast
Residence	Cabins at Polley Lake	593,105	5,826,365	7	North Northwest
Residence	Residential Dwelling	592,076	5,826,547	8	North Northwest
Recreation	Cedar Point Provincial Park	598,954	5,826,215	8	Northeast
Recreation	Gavin Lake	587,195	5,816,268	8	Southwest
Recreation	Mount Jacobie	586,318	5,821,558	9	Northwest
Residence	Likely Road Residences by Quesnel Lake	598,207	5,829,330	11	Northeast
Recreation	Jacobie Lake	584,757	5,822,835	11	Northwest

Receptor Description	Receptor Name	Easting (m)	Northing (m)	Distance from TSF (km)	Direction from TSF
Town Site	Town of Likely	596,739	5,830,494	12	Northeast
Recreation	Morehead Lake	586,301	5,826,856	12	Northwest
Recreation	Prior Lake	589,673	5,829,819	12	North northwest
Recreation	Little Lake	586,936	5,830,106	14	Northwest
Residence	Dwelling by Little Lake	586,878	5,830,576	14	Northwest
Recreation	Morehead Lake Cabins and Campsite	582,824	5,828,888	16	Northwest

Based on the predominant wind directions at the TSF, winds blowing northerly and southerly, it is expected that dustfall stations A4 and A5 (A5 being lost during the breach), located approximately 2 km from the TSF, would be representative of the dust effects from the TSF. Based on dustfall data from A4 and A5 (Figure 12 and Figure 13) that are within 2 km of the TSF it is possible that receptors near to the Facility (receptors less than 2 km from the TSF like Polley Lake) may experience exceedances in ambient air quality objectives under certain meteorological conditions.

2.5 New Conditions (Tailings and Plug)

The dust management plan was developed based on new operational and physical conditions at the Facility. The breach in the TSF in August 2014 resulted in the drying of tailings in the TSF and the deposition of material (outlined in Section 2.0) in the Polley Lake Tailings Plug. These new conditions require development of a dust management plan. If site conditions change, the dust management plan may need to be updated. Generally, it is the fine (silt) fraction of material that would result in fugitive dust due to material disturbance (i.e., wind erosion off of the TSF and Polley Lake Tailings Plug). This section describes the how the size fraction of the TSF and Polley Lake Tailings Plug area were determined. In a review of the National Ambient Air Quality Standards (NAAQS), the US EPA determined that size-fractionated particle mass, rather than particle composition, was the most appropriate approach for addressing health concerns of ambient particulate matter (EPA 2008). Therefore, only particulate size fraction analyses were included in this report.

Particle size analysis of the tailings at the TSF was undertaken in December 2014. The results indicate that 47% of the tailings would be characterized as silt or clay, with a grain size less than 0.05 mm. Coarse and fine particulate matter is comprised of particulates with aerodynamic diameters of 10 µm (0.001 mm) and 2.5 µm (0.0025 mm). Therefore, coarse and fine particulate matter is a subset of fugitive dust, which is comprised of material with a grain size less than 0.05 mm.

Particle size of the material deposited in the Polley Lake Tailings Plug below the embankment failure was measured in September 2014. The results indicate that 50% of the tailings would be characterized as silt or clay. The particulate size analysis demonstrates that the tailings and Polley Lake Tailings Plug material contain a 47% and 50% of fines which makes them more susceptible to fugitive emissions as a result of material disturbance.

3.0 RESPONSIBILITIES

The following sections detail the responsibilities held by each of the employment levels at the Facility as they pertain to this Plan.

3.1 Senior Management Representative: Mine Manager

The Senior Management Representative, or designate, is responsible for:

- putting in place the required resources to execute the Plan.

3.2 Accountable Facility Representative: Mine Operations Manager

The Accountable Facility Representative, or designate, is responsible for:

- reviewing the effectiveness of the current dust control measures at the Facility;
- scheduling and coordinating the implementation of fugitive dust control measures; and
- training of site personnel and contractors on the Plan and best management practices to be implemented.

3.3 Operations Supervisor: Mill Maintenance Superintendent

The Operations Supervisors are responsible for:

- providing feedback on the effectiveness of the current dust control measures at the Facility;
- implementing fugitive dust control measures;
- maintaining documentation of schedules and logs; and
- completing (or having a delegate completed) daily dustfall observations as part of the daily water management inspection checklist (Appendix B).

3.4 Facility Personnel and Contractors

All Facility Personnel and Contractors are responsible for:

- providing feedback on the effectiveness of the current dust control measures at the Facility; and
- following the dust control procedures that are currently in place.

3.5 Environmental Coordinator

The environmental coordinator is responsible for:

- providing feedback on the effectiveness of the current dust control measures at the Facility;
- conducting internal audits of the dust control measures at the Facility;
- coordinating external audits of the dust control measures at the Facility; and
- coordinating dust sampling programs.

4.0 FUGITIVE DUST EMISSIONS MANAGEMENT

This section describes the fugitive dust control measures that are implemented at the Facility. This section follows the Plan, Do, Check, and Act (PDCA) cycle as described below:

- Section 4.1 **PLAN** - identifies the emission sources at the Facility.
- Section 4.2 **DO** - documents the schedule for implementation of the management practices.
- Section 4.3 **CHECK** - describes the monitoring procedures and a record keeping system.
- Section 4.4 **ACT** - describes the review and update procedures to promote continuous improvement.

4.1 PLAN – Identification and Classification of Fugitive Dust Emissions

4.1.1 Identification of the Sources of Fugitive Dust Emissions

Fugitive dust emissions occur due to mechanical disturbances of granular materials exposed to the air. Dust generated from these open sources is termed “fugitive” as it is not discharged to the atmosphere in a confined flow stream, such as through an exhaust pipe or stack (US EPA 1995).

Mechanical disturbances are often created from such activities as vehicle movement, crushing, and material transfer activities, but can also be created from wind action, which promotes lifting of fine particles from sources such as open fields and stockpiles. Therefore, some fugitive dust emissions occur or are intensified during certain operations and/or by natural means (wind action).

Factors that would affect the quantity of fugitive dust emitted from a source include the material’s particulate size distribution, moisture content, and frequency of the mechanical and natural disturbances. Precipitation and evaporation conditions can affect the moisture content of the material being disturbed and therefore, have an influence on the amount of fugitive dust emitted. Precipitation acts to prevent emissions through cohesive bonding of small particles, while evaporation elevates the potential for dust emissions.

Once dust is emitted (suspended in air), it will disperse from the source according to various factors such as wind speed and direction, precipitation rates, and particle size distribution (OMoE 2005). Higher wind speeds increase the potential distance travelled by the particulates, while precipitation can facilitate particulate deposition (wet deposition). Particles that are less than 2.5 microns in diameter can travel further before settling and are of higher concern as they have the potential to present a health problem to humans if inhaled.

Particle size distribution of the tailings is discussed in Section 2.5.

Main sources of activities which contribute to fugitive dust emissions from the Facility are summarized in Table 5.

Table 5: Main Sources and Factors Contributing to Fugitive Dust

Process/Activity	Causes	Factors that may Produce Fugitive Dust Emissions
Tailings Storage Facility	■ Wind erosion off of surface of facility from dried material.	■ Fines content of tailings. ■ Surface moisture content of tailings. ■ Precipitation and snow cover (natural control measures). ■ Wind speed and wind direction. ■ Vegetation cover- control measure. ■ Sprinklers/application of water- control measures. ■ Surface treatment- control measures.
Polley Lake Tailings Plug Area	■ Wind erosion off of surface of facility for dried material.	■ Fines content of tailings. ■ Surface moisture content of tailings. ■ Precipitation and snow cover (natural control measures). ■ Wind speed and direction. ■ Vegetation cover- control measure. ■ Surface treatment- control measure.
Material Handling	■ Disturbance of material (waste rock) caused by loading/unloading (dumping into haul trucks and dumping onto stockpiles/dumps). ■ Wind erosion of material from material being handled.	■ Drop height of loading/unloading activities. ■ Moisture content of material (waste rock). ■ Fines content of material (waste rock). ■ Wind speed.
Dozing Activity	■ Disturbance of material (waste rock) caused by machinery. ■ Wind erosion of material from material being dozed.	■ Height of material being dozed. ■ Fines content in material handled. ■ Moisture content in the material. ■ Speed of dozing machinery. ■ Vehicle weight. ■ Wind speed.
Grading	■ Disturbance of surface material caused by grading machinery.	■ Surface fines content. ■ Surface material moisture content. ■ Vehicle weight. ■ Speed of grading machinery.

Process/Activity	Causes	Factors that may Produce Fugitive Dust Emissions
Hauling	■ Disturbance of granular material on the road surface caused by motion of vehicles. ■ Wind erosion on the road surface.	■ Surface fines content. ■ Surface material moisture content. ■ Wind speed. ■ Vehicle weight and speed.

4.1.2 Fugitive Dust Management Practices

Control measures to reduce fugitive dust emissions should take into account the sources of the dust emission, the dispersion conditions and the location of sensitive areas in order to avoid significant impacts of dust emissions on receptors.

Control measures tend to impact one (1) or more factors affecting the generation and/or dispersion of fugitive dust emissions. These control measures can be classified as follows:

- **Preventative Procedure**: Measure pertaining to the design and installation of structures and the operating procedures which are implemented on a regular basis in order to prevent the generation of dust and/or the dispersion of dust generated from reaching sensitive areas.
- **Reactive Control Measures**: Measures which are implemented in the event of unexpected circumstances which can lead to the generation of dust and/or the dispersion of dust generated reaching sensitive areas.

Table 6: Description of Preventative Procedures and Control Measures for Fugitive Dust Emissions at the Facility

Preventative Procedure/ Control Measure	Emission Source Effected	Description	Application Frequency
Visual Inspection	TSF and Plug	Daily visual inspections of the TSF and Plug.	Daily during non-frozen periods. If inspection indicates potential for dust emissions another follow up inspection will be made for later that day.
Wet Suppression	TSF and unpaved access roads (excluding the mine and ore stockpile area)	Fugitive dust generated from the TSF is controlled by using water.	Daily observations (water management inspections, when wind speeds measured over 3.6 m/s are observed and/or incidents).
Progressive Reclamation	TSF and Plug Area	Growth media and vegetation applied progressively as either broadcast seeding, hydroseeding, heli-seeding or natural re-vegetation.	Progressive Reclamation.
Use of Dedicated Routes / Areas	Unpaved Access Roads (excluding the Mine and Ore Stockpile Area)	Haul traffic has designated routes. Have a procedure that all vehicles comply with these routes.	When necessary.
Controlled Loading and Unloading Techniques	Dust from Material Handling	Trucks are loaded/unloaded in a slow and controlled manner to minimize drop height and avoid spillage.	When necessary based on daily observations, inspections and/or incidents

Fugitive dust may be emitted from the TSF and Plug area under strong wind conditions (wind speeds >5.4 m/s). If wind erosion from the TSF is observed, it can be readily controlled by stabilizing the affected surfaces by use of chemical suppressants or regular watering. Control measures that have been implemented to reduce wind erosion from the TSF include:

- In September 2014, the exposed tailings in the TSF, the Polley Lake Tailings Plug area and the Hazeltine corridor were heli-seeded with a grass blend spread at 60 kg/hectare. The grass blend (by weight) consisted of 1% Rocky Mountain fescue, 10% annual ryegrass and 89% fall rye. These hearty grass species are expected to overwinter and re-grow in the spring. Because the heli-seeded grasses had a short growing season in fall 2014, the growth that occurred may not be sufficient to prevent wind erosion.
- Installation of eleven (11) water sprayers along the Main Embankment of the TSF. Each has a spray radius of 65-70 m and are adjacent to each other. Water is being pumped from the Main Embankment Seepage Collection Pond below the Main Embankment. One (1) grid sprayer, composed of thirteen (13) sprayers has been installed.
- Three (3) additional dustfall monitoring stations were installed, details of the monitor are listed below:
  - Monitor A7 located at 592,969 m easting, 5,818,320 m northing (UTM Zone 10) south-west of the TSF;
  - Monitor A8 located at 596,911 m easting, 5,817,991 m northing (UTM Zone 10) south-east of the TSF; and
  - Monitor A9 located at 596,020 m easting, 5,821,407 m northing (UTM Zone 10) north-east of the TSF.

Planned control measures to be implemented at a later date to reduce wind erosion from the TSF include:

- Installation of additional water cannons, snowmakers and sprayers to periodically wet the TSF, thereby increasing the moisture content of the surface material which will result in greater surface cohesion and a reduction from fugitive windblown dust.
- MPMC is looking as a contingency option of using a chemical dust suppressant (lignosulfonate or similar) on the TSF area. It has been demonstrated that lignosulfonate has a 96% control efficiency at reducing fugitive dust two (2) weeks after application and a 47% control efficiency at reducing fugitive dust six weeks after application (Turner et. al 1984). Guidance on application rates will be determined based on consultation with the vendor. Typical lignosulfonate application rates on roads range between 0.3-0.5 gallons per square yard.

Winter temperatures, below freezing, will prohibit the use of water as a dust suppressant. However, snow cover will act as dust suppressant in the winter months. Based on Figure 4, the average temperature is below freezing from November to March, where there is snow cover present, as seen in Figure 6.

Table 7 summarizes the fugitives dust emission activities and processes along with the proactive and reactive mitigation practices that can be implemented to control fugitive dust.

Table 7: Summary Table of Mitigation

Source	Proactive Mitigation Practices	Reactive Mitigation Practices
TSF	■ Water cannons, snowmakers and sprayers as a dust suppressant on TSF. ■ Rain/snow cover as a natural dust suppressant during winter. ■ Progressive reclamation.	■ Wet suppression. ■ Visual inspection of nearby sensitive receptor locations (<2 km) during dust events. ■ Lignosulfonate application (contingency option).
Polly Lake Tailings Plug Area	■ Rain/snow cover as a natural dust suppressant during winter. ■ Progressive reclamation (including ongoing removal and/or capping of tailings).	■ Wet suppression. ■ Visual inspection of nearby sensitive receptor locations (<2 km) during dust events.

The effectiveness of watering practices for the TSF and the Plug area are expected to be the same as stockpiles. From Environment Canada (2014), wet suppression effectiveness rates are a function of the amount of water applied and range between 50-95 % efficiency (Table 8).

Table 8: Wet Suppression Efficiency (Environment Canada 2014)

Efficiency (%)	Application Rate (Litre/m^2)
50	1.591
60	2.232
70	3.172
80	4.748
85	6.077
90	8.306
95	13.337

It is expected that there are 151 days during the year where there are either subfreezing ground conditions (based on average monthly temperature, Figure 4) or days where there is at least 1 cm of snow on the ground (Horsefly Lake Gruhs Lake Environment Canada Climate normal) which would act as a natural dust control measure. Furthermore, it is expected that during the non-freezing period there are approximately 98 days where there is at least 0.254 mm of rainfall (Station #1 and Station #2). Therefore, using the precipitation adjustment factor published by Environment Canada (2014) for stockpiles it is expected that precipitation and snow cover would have approximately 68% percent effectiveness at controlling fugitive dust on an annual basis.

The effectiveness of vegetation cover to control fugitive dust has been observed to vary with the type and amount of cover. In the south west regions of the United States vegetation cover, which were sparse, resulted in dust control effectiveness of 25% whereas dense vegetation cover can result in dust control effectiveness of up to 100% (US EPA 1984). Visual inspections can be undertaken at receptor locations near (within 2 km of the Facility) during dust events (i.e., wind events >5.4 m/s).

4.2 DO – Implementation of the Dust Management Plan

Dust generating activities performed on-site should meet the requirements of this Plan.

4.3 CHECK – Inspection, Maintenance and Documentation

Routine inspections at the operations should be performed to firstly check that the proactive and reactive mitigation practises are being implemented, and secondly, that the mitigation practices are effectively reducing fugitive dust emissions. Daily Inspections are incorporated into MPMC's water management checklist, and Joint Occupational Health Safety and Environment Committee (JOHSEC) site tours that incorporate Health, Safety, Environment and Quality (HSEQ). Outstanding or overdue inspection findings are reviewed monthly by the JOHSEC committee.

Routine audits are also performed by MPMC. Audits include review of the daily observation checklists to confirm that the mitigation (control) measures were implemented to reflect the observations recorded. A template of the daily inspection checklist can be found in Appendix B.

Conformity with the proactive and reactive mitigation measures should be documented through a monthly inspection program and also through workplace observations by MPMC's employees and its contractors and/or through audits. Each incident/non-conformance to MPMC procedures or company policy should be documented as a non-conformance incident.

It is expected that all deficiencies identified in inspections will be addressed as soon as practicable. Reasonable corrective action will be undertaken and documented. Reviews of the non-conformance should be done quarterly as a method for continual improvement.

The Operations Supervisor should be responsible for recordkeeping the information listed above.

The MPMC Environmental Department carries out monitoring for airborne particulates. As mentioned in Section 2.2, six (6) airborne particulate stations have been operating at Mount Polley since November 2011; one (1) station (A5) located near the TSF was lost due to the breach. Three (3) new stations near the TSF have been installed; one (1) is west of the TSF near to Gavin Lake road (A7), one (1) is southeast of the TSF (A8) in the South Till Borrow area, and one (1) is northeast of the TSF (A9) at the Polley Lake campground. The air quality monitoring stations are continuous sampling devices from which samples are retrieved every 28 to 32 days, in accordance with regulatory requirements.

The annual and monthly wind roses for Station #2 (the station with representative winds at the TSF and plug area) demonstrates that the predominant wind directions during the summer months are from the north and south (with more southerly winds). Due to the strong predominance of southerly and northerly winds, one (1) additional dustfall monitor is recommended, one (1) station (A9) north-north-east of the TSF and Polley Lake Tailings Plug. Gavin Lake Road station (A8) is recommended to be moved south of the TSF. In the summer months, due to the warmer, dryer conditions, four (4) Dust Track samplers will be installed to measure both $PM_{2.5}$ and PM_{10} concentrations. The four (4) Dust Tracks will be co-located with dust monitors A4, A7, A9 and A8. The Dust Tracks will run on batteries where batteries are expected to last for 1-2 weeks. Batteries will be charged and replaced by one (1) of the Facility's technicians. It is expected that batteries will be replaced every week which means that there may be small gaps in the monitoring. Continuous monitoring of $PM_{2.5}$ and PM_{10} concentrations will not be feasible if access to power is not possible. Data from the Dust Tracks will be analysed

to assess the potential effect the TSF and the Polley Lake Tailings Plug have on the surrounding environment. The Dust Track data, collected over the summer, will be used to establish a long-term monitoring program and will assist in identifying the most suitable long term monitoring equipment.

Dustfall data collected during the summer of 2015 can be compared against pre-breach dustfall data and the BC Ambient Air Quality Objectives, for the lower and upper limits are 1.7 mg/dm^2/d and 2.9 mg/dm^2/d, respectively. These data will be part of annual regulatory reporting to MoE and will directly inform MPMC on the success of dust mitigation efforts, the need to implement additional measures and the need to reduce/increase monitoring.

Concentrations of PM_{10} and $PM_{2.5}$ will be compared against BC air quality objectives. Similar to the dustfall monitoring the concentration data will be part of annual regulatory reporting to MOE and will directly inform MPMC on the success of dust mitigation efforts or the need to implement additional measures.

4.4 ACT – Dust Management Plan Review and Continuous Improvement

Inspections and monitoring procedures will assist MPMC personnel with the maintenance of an effective dust management plan. The dust management plan should be monitored and updated, as follows:

- when there are significant changes in the fugitive dust emissions sources;
- periodically, every five years (minimum);
- when there are verified complaints associated with fugitive dust emissions from the Facility; and
- when there are visible dust emissions occurring more frequently and/or at a higher rate (excluding seasonal conditions).

Review of the dust management plan is intended to evaluate the effectiveness of the proactive and reactive dust control practices and focus on the identification of improvement opportunities that can reduce the risk of complaints or health concerns related to fugitive dust emissions.

5.0 CLOSURE

The fugitive dust management plan is a tool that will assist MPMC in controlling fugitive dust emissions from the Mount Polley Facility. The management plan follows the PLAN (identify the emission sources), DO (implementation of the management practices), CHECK (describes the management practice procedures, recordkeeping system, and monitoring along with monitoring analysis) and ACT (describes the management practices review and updates) cycle. The PDCA cycle allow for continual improvement for the control of fugitive dust over the lifetime of the mine.

We trust the above meets your present requirements. If you have any questions or requirements, please contact the undersigned.

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

Jeffrey Ramkellawan, M.Sc., P.Eng.
Air Quality Specialist

ORIGINAL SIGNED

Sean Capstick, P.Eng.
Principal, Atmospheric Services

JR/MR/rs/jc/bb

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APPENDIX A

Ministry of Environment Comments on Dust Control Plan

Ministry of Environment

Environmental Protection
Thompson & Cariboo Regions
1259 Dalhousie Drive
Kamloops BC V2C 5Z5

Phone: (250) 371-6200
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MEMORANDUM

To: Arvind Saraswat
Air Quality Section Head
Monitoring, Compliance & Stewardship
Surrey
Via email

File:
Date: 22nd February, 2015

From: Ralph Adams
Air Quality Meteorologist
Southern Region
Kamloops

RE: REVIEW OF THE MOUNT POLLEY DUST CONTROL PLAN.

Arvind:

I have now reviewed the Dust Control Plan submitted by Mount Polley Mining Corporation. In summary, there are serious shortcomings to the plan and the plan, in my opinion, requires revision before it can be accepted.

In particular, the plan does not include dust from the tailings deposited in Hazeltine Creek. The plan makes no mention of acute health effects due to the inhalable and respirable dust that may be generated, nor are these included in the monitoring programme. There is no discussion or analysis of the existing dustfall data or historical meteorological measurements to determine when dusting events would be likely and if there are potential receptors in the areas that may be affected by dust from the tailings. The description of the monitoring plan is inadequate, and although it is stated that the monitoring plan establishes triggers for the implementation of additional mitigation, there is no description or discussion of the triggers.

Some detailed comments follow.

These comments refer to two documents:

- *Mount Polley Mining Corporation 2015 Tailings Storage Facility Dust Control Plan*. The document is dated January 23rd, 2015 and was supplied as a pdf file named MPMC_Dust Control Plan_Final.pdf. The document is not signed, but the pdf file properties indicate it was authored by Eric LeNeve.

- Letter from Shelly Metcalfe, Mining Authorizations Section Head, Ministry of Environment to Jack Love at Mount Polley Mining Corporation dated August 21st, 2014.

I think it would be easiest to explain my concerns with the submitted plan if I first outlined the general principles that that are used to develop and evaluate dust control plans. For the purposes of this summary, I define "dust" as finely divided crustal material that may become entrained into the atmosphere and then transported. The usual sources of dust at mine facilities include: construction and maintenance or roads and facilities, drilling and blasting, haul roads, ore and waste handling, crushing and processing, waste rock dumps and tailings storage facilities. The dust may be entrained either by winds from exposed surfaces, by processes which generate finely divided particles such as blasting and crushing, or by entrainment by equipment operating in, or moving over dust bearing material such as construction and haul roads.

The size distribution of the particles is important as it determines both the distance the particle is likely to be transported, and the effect it will have on various receptors. The most basic division based on size is to divide particle sizes into TSP (total suspended particulate), PM10 (inhalable particulate) and PM2.5 (respirable particulate). The upper size range for TSP is not well defined, but in general, TSP particles are small enough to become entrained and stay suspended in the atmosphere for considerable time and may transported considerable distances. PM10, which is a subset of TSP, consists of particles that are less than 10 microns in effective diameter. This size is important as these particles are inhalable by humans and are deposited in the throat and upper airways, finally PM2.5 particles (a subset of PM10) are less than 2.5 microns in diameter and carry the most significant health risk as they penetrate into the deepest part of the lungs.

An effective dust control plan should include estimates of the emission of these size fractions and the potential effect on all receptors. In general, the PM10 and PM2.5 are associated with human health effects through inhalation, and larger particles are associated with ecosystem health due to deposition to soil and vegetation.

In my opinion, the most serious shortcomings in the proposed plan is that human health impacts are not addressed, and that the plan only deals with tailings remaining in the breached TSF, not those deposited in Hazeltine Creek and elsewhere. In the case of hazeltine Creek I note that in the letter from Shelley Metcalfe to Jack Love, it is stated that,

> *"The scope of the Plan needs to include dust control – in the tailings storage facility and offsite (e.g. deposits in Hazeltine Creek)."* Page 2.

The only mention of Hazeltine Creek in the plan is in the background section and it is stated that tailings will be removed or covered with vegetation and mulch and should not be a concern. This should be expanded to include estimates of potential dust entrainment in the coming months from the deposits, where the potential effects would occur and which receptors are effected, a timeline for determining which mitigations strategy will

be used, and a monitoring plan that includes all size fractions of dust, and how the monitoring will trigger additional mitigation.

For the TSF, I suggest a similar approach. I would like to add that one of the objectives of the dust control plan is to demonstrate to the public and health professionals (e.g. IHA) that the potential effects of dust associated with the tailings breach have been investigated (both ecosystem and human health effects) and describe in detail how any potential effects will be mitigated. I have made some specific suggestions below that I think will supply more complete information to stakeholders and the public:

Existing Mitigation Measures.

- The statement is made that rainfall averages 60mm per month in summer at the site and that this may be sufficient to prevent dust events. It is also stated that additional mitigation procedures may be required for hot dry periods when evaporation exceeds rainfall. This is very important to the overall plan and should be described in more detail. See my comments below regarding the meteorological monitoring.
- There is also a statement that includes "the monitoring program that establishes the triggers for the implementation of further mitigation measures." This is a key component of the plan, but I can find no details on what the triggers are or how they were determined.

Management Plan: Water Canons, Snowmakers and Sprinklers.

- In this section it is stated that water canon, snowmakers and sprinklers will be used, the discussion should be expanded to include information about the range of the various systems, and how the large area of the TSF will be treated using equipment mounted on the periphery.

Meteorological Monitoring.

- It is stated in the proposed plan that there are two existing meteorological stations on the site. However, the only data that is shown is two polar plots for the period June to September in 2013 and 2014. These are not windroses as stated in the document. Windroses supply very much more information and they should be supplied for both stations.
- In addition the existing weather data could be used to estimate the occurrence of dusting conditions based on rainfall, temperature etc. The current document implies that dusting is only expected in the June to September period. This should be discussed in detail.

Airborne Particulate Monitoring.

- In the airborne particulate monitoring section it states that a total of 4 dustfall sites will be used. The rationale behind using only 4 canisters and the choice of locations should be described.
- No summary of existing dustfall data is included in this section.

- The dustfall canisters in the proposed plan only collect particles much larger than PM10, they cannot be used be used for assessment of human health impacts, only ecosystem health.
- I note that the dustfall objectives referenced have been rescinded, and are currently used only for information. These rescinded objectives do not indicate a threshold below which there is no concern.

Given that we appear to be entering an early spring, and dust advisories are already being issued for interior communities, I think the most important issue that has to be addressed is potential adverse health effects to human receptors, that is, the local population. In addition, ambient monitoring of PM10 and/or PM2.5 should be initiated in Likely (the closest community) as soon as possible. Given the urgency, I suggest that a meeting be arranged with all involved to resolve these issues quickly and put in place the needed short-term monitoring.

Sincerely,



Ralph Adams P.Ag.

APPENDIX B

The Daily Water Management Check List

Daily TSF/Water Management Inspection Checklist (Mill Maint./Surface Crew)

Inspector: _____ Date: _____ Shift (Crew, D or N):_____ Weather Condition: _____

General Notes for Inspectors:

- Take photographs of the TSF, pipeworks and associated structures **regularly** (and all unusual observations and events) for use as a photographic record of the storage facility. Photographs are to be taken from the same locations and in the same direction each time so that changes over time can be identified from a series of photographs.
- Please put checklists in Enviro mailbox at the end of set
- INSPECTION GAUGE COLOUR = IGC
- Circle options that are relevant (some may have two options that are applicable at once)
- Any irregularities at sumps/pumps/pipes please note in comments and observations for associated section
- **Report all breaches to the Environmental Department immediately**
- **Contact Environmental Supervisor immediately if inspection gauges is yellow or red**

Tailings Pond

TSF Pumps: Upstream 1: Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF

Breach pumps: Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF

Leakage in TSF pipelines: YES NO If YES, Where & Severity:_____ Picture taken of leakage: YES NO

Condition of Tailings Pond @ Sprinklers: GOOD ERODED SINKHOLES Other: _____

Explain choice:_____

Dust Generating from TSF: YES NO If YES, how severe: MINIMAL SOME EXTREME Sprinklers: Time Checked:_____ #'s on:_____ Time Checked:_____ #'s on:_____

Comments/Observations on Tailings Pond:_____

_____

Tailings Discharge Pipeline (not required for 2015)

Tailings pipeline pressure gauge readings @ booster station: _____

Leakage on pipeline: YES NO If YES, Where & Severity:_____ Picture taken of leakage: YES NO

Comments/Observations on Tailings Pipeline:_____

_____

Sediment Ponds (TSF Settling, CCS, Mill Site)

Mill Site Pond: Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF

TSF Settling Pond: Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF

CCS: Time Checked:_____ ON OFF IGC: RED YELLOW BLACK IGC Missing: YES NO Time Checked:_____ ON OFF IGC: RED YELLOW BLACK

Time Checked:_____ ON OFF IGC: RED YELLOW BLACK Time Checked:_____ ON OFF IGC: RED YELLOW BLACK

Leakage in Sediment pipelines: YES NO If YES, Where & Severity:_____ Picture taken of leakage: YES NO

Comments/Observations (Any Inspection Gauges Missing) on Sediment Ponds:_____

_____

Seepage Collection Ponds (Main, South, Till Borrow)

South Seepage: Time Checked: _____ ON OFF IGC: RED YELLOW BLACK IGC Missing: YES NO Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

Time Checked: _____ ON OFF IGC: RED YELLOW BLACK Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

Main Seepage: Time Checked: _____ ON OFF IGC: RED YELLOW BLACK IGC Missing: YES NO Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

Time Checked: _____ ON OFF IGC: RED YELLOW BLACK Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

Till Borrow: Time Checked: _____ ON OFF IGC: RED YELLOW BLACK IGC Missing: YES NO Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

Time Checked: _____ ON OFF IGC: RED YELLOW BLACK Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

Comments/Observations (Any Inspection Gauges Missing) on Seepage Ponds:_____

_____

West Ditch System

9K Sump: Time Checked: _____ ON OFF IGC: RED YELLOW BLACK IGC Missing: YES NO Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

Time Checked: _____ ON OFF IGC: RED YELLOW BLACK Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

NW Sump: Time Checked: _____ ON OFF IGC: RED YELLOW BLACK IGC Missing: YES NO Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

Time Checked: _____ ON OFF IGC: RED YELLOW BLACK Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

Mine Drainage: Time Checked: _____ ON OFF IGC: RED YELLOW BLACK IGC Missing: YES NO Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

Time Checked: _____ ON OFF IGC: RED YELLOW BLACK Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

Bootjack Sump: Time Checked: _____ ON OFF IGC: RED YELLOW BLACK IGC Missing: YES NO Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

Time Checked: _____ ON OFF IGC: RED YELLOW BLACK Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

SERDS Sump: Time Checked: _____ ON OFF IGC: RED YELLOW BLACK IGC Missing: YES NO Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

Time Checked: _____ ON OFF IGC: RED YELLOW BLACK Time Checked: _____ ON OFF IGC: RED YELLOW BLACK

West Ditch Culvert under Light Duty Road: Time Checked:_____ Time Checked:_____ Time Checked:_____ Time Checked:_____

West Ditch Culvert under TAR: Time Checked:_____ Time Checked:_____ Time Checked:_____ Time Checked:_____

Leakage on pipelines/culverts: YES NO If YES, Where & Severity:_____ Picture taken of leakage: YES NO

Comments/Observations (Any Inspection Gauges Missing) on West Ditch System:_____

_____

Long Ditch System

Lower Wight Pit Pump: Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF

Upper Wight Pit Pump: Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF

Joe's Creek Pipe: Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF

Long Ditch Sumps: Time Checked:_____ Time Checked:_____ Time Checked:_____ Time Checked:_____

Long Ditch/SERDS Pipe Outlets: Time Checked:_____ Time Checked:_____ Time Checked:_____ Time Checked:_____

Leakage on pipelines/culverts: YES NO If YES, Where & Severity:_____ Picture taken of leakage: YES NO

Comments/Observations on Long Ditch System:_____

_____

Cariboo Pit & Springer Pit Systems

Cariboo Pit Pump: Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF Time Checked:_____ ON OFF

Leakage on pipelines: YES NO If YES, Where & Severity:_____ Picture taken of leakage: YES NO

Comments/Observations on Cariboo Pit & Springer Pit System:_____

_____

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Golder Associates

TECHNICAL MEMORANDUM

DATE	October 22, 2015	**REFERENCE No.**	1411734-091-TM-Rev1-1500
TO	Ralph Adams, Air Quality Meteorologist Ministry of Environment		
FROM	Taishi Baba, Jeffrey Ramkellawan, and Rachel Wyles	**EMAIL**	tbaba@golder.com; jramkellawan@golder.com; rwyles@golder.com

CONTINUOUS PARTICULATE MONITORING AT MOUNT POLLEY SEPTEMBER 17 TO 29, 2015: SUMMARY OF PARTICULATE MONITORING JULY 7 TO SEPTEMBER 29, 2015

Golder Associates Ltd. (Golder) was retained by Mount Polley Mining Corporation (MPMC) to prepare *Fugitive Dust Management Plan Mount Polley* (Dust Management Plan) (Golder 2015a), and to provide interpreted summaries of bi-weekly/monthly monitoring data for the period of July through September, 2015. To date, four technical memoranda have been to submitted to the BC Ministry of Environment (MOE), the last dated September 24, 2015. This is the final memorandum, which summarizes monitoring data from September 17 to 29, 2015 and also presents a summary of the data for the entire summer monitoring period from July 7 to September 29, 2015. This memorandum also provides recommended updates to the Dust Management Plan, in consideration of the monitoring data and seasonal conditions observed at the site over the summer monitoring period.

The current commitment to undertake continuous monitoring until October has been fulfilled and the DustTRAK monitors have now been removed from site due to on site temperatures approaching zero degrees, which is the lower end of the operational range of the monitors. The BC MOE were in agreement with the removal of the monitors.

The memorandum presents the following:

1) A summary of the following for the September monitoring period:
   a) the visual dust observations at the Tailing Storage Facility (TSF) and Plug area;
   b) particulate monitoring data; and
   c) meteorological observations including wind and rainfall data.
2) A summary of the particulate, dustfall and rainfall data for the summer monitoring period.
3) Recommended updates to the Dust Management Plan for the TSF/Plug area.

The raw monitoring data will be forwarded as a separate email attachment to Mr. Ralph Adams (BC MOE), as has been done with the monitoring data to date.

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1.0 SEPTEMBER MONITORING PERIOD

This section presents a summary of the monitoring and meteorological data for the period September 19 through 29, 2015.

1.1 Visual Observations at the TSF and Plug Area

Visual inspections of Hazeltine Creek and the breach area are undertaken daily and logged using the TSF/Water Management Inspection Checklist (Attachment 1). Visual observations are provided for September 15 to 29, 2015. No dust generation was noted for the monitoring period.

1.2 Particulate Data

The 24-hour average concentrations from DustTRAK Stations A4, A7, A8, and A9 are presented in Figure 1 through Figure 3. For context, PM_{10} and $PM_{2.5}$ concentration data from Quesnel Senior Secondary and Williams Lake Columneetza School (BC MOE 2015) are plotted on Figure 2 and Figure 3. Quesnel Senior Secondary is a shared BC MOE and National Air Pollution Surveillance Program (NAPS) station located 76 km northwest of Mount Polley, and Williams Lake Columneetza School is a BC MOE station located 60 km southwest of Mount Polley. TSP is not monitored in the BC MOE air quality network; therefore, no additional data are plotted on Figure 1.

The red lines on Figure 1 through Figure 3 represent the BC Ambient Air Quality Objectives (AAQO) (BC MOE 2014) for the 24-hour averaging period for TSP, PM_{10}, and $PM_{2.5}$, respectively. The AAQO have been established by the BC MOE as indications of good air quality; concentrations are frequently measured above the AAQO values at many monitoring stations throughout BC. DustTRAK stations (A4, A7, A8, and A9) are located on an industrial site (a mine) where industrial activities will influence the monitored data, and therefore are not considered compliance measurement locations. The criteria are included for reference purposes only; if the monitored values are above the relevant AAQO, then further assessment may be necessary. For example the $PM_{2.5}$ air quality objective is based on the 24-hour 98th percentile concentration from a year of data, short term (daily) monitored values above the AAQO may be recorded; however, the area may still be considered to have good air quality.

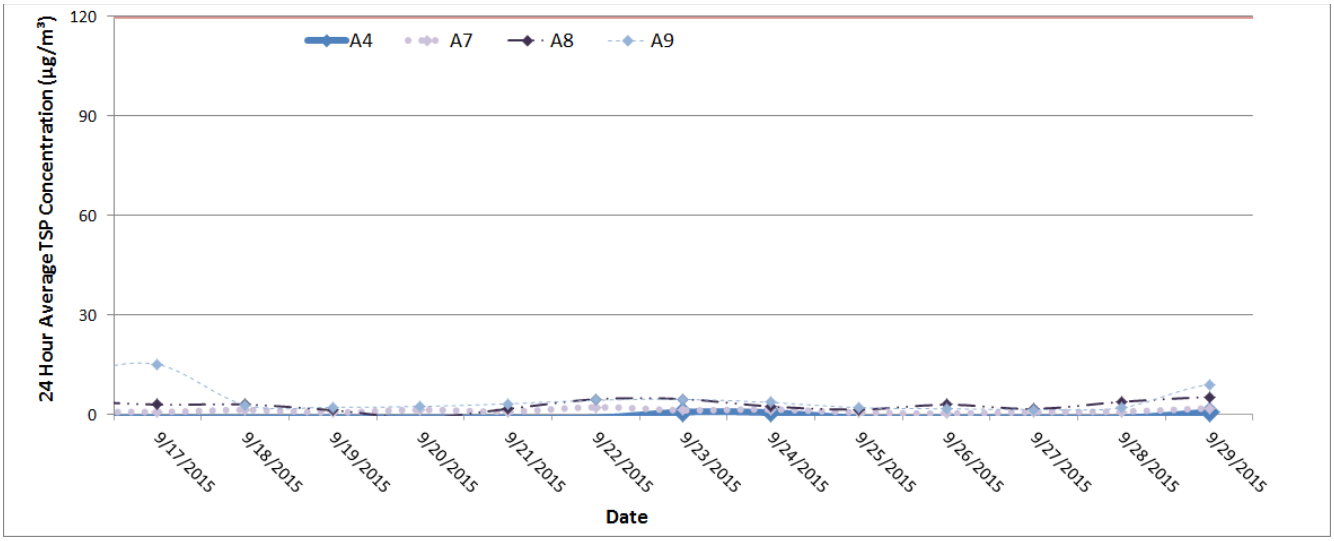


Figure 1: 24-Hour Average TSP Concentrations at MPMC Stations

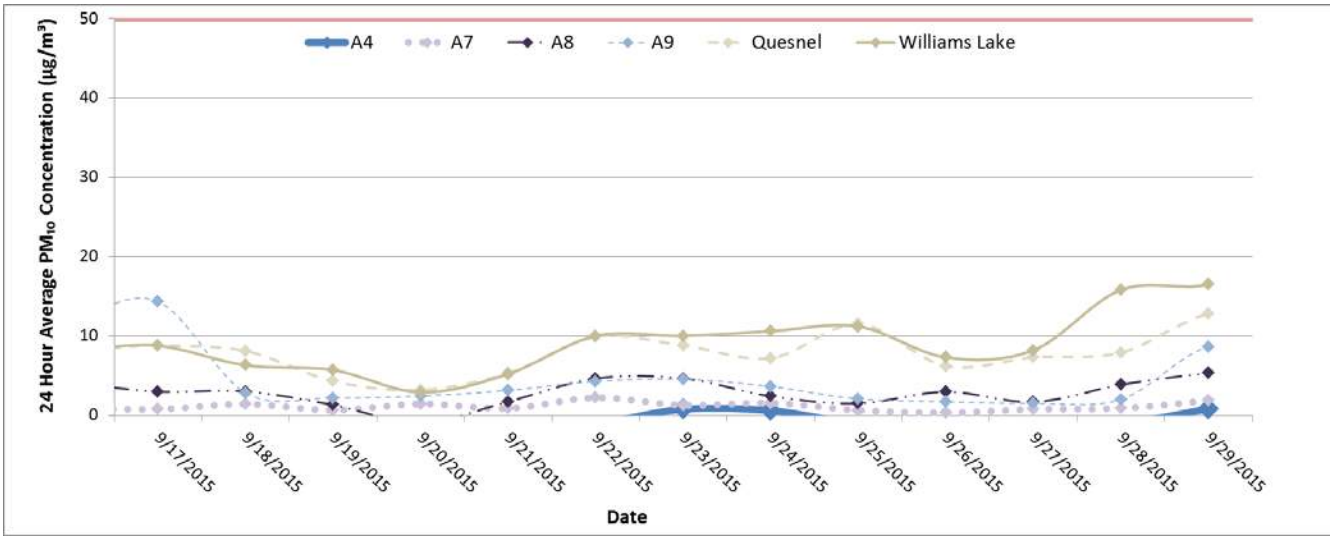


Figure 2: 24-Hour Average PM_{10} Concentrations at MPMC and Surrounding BC MOE Stations

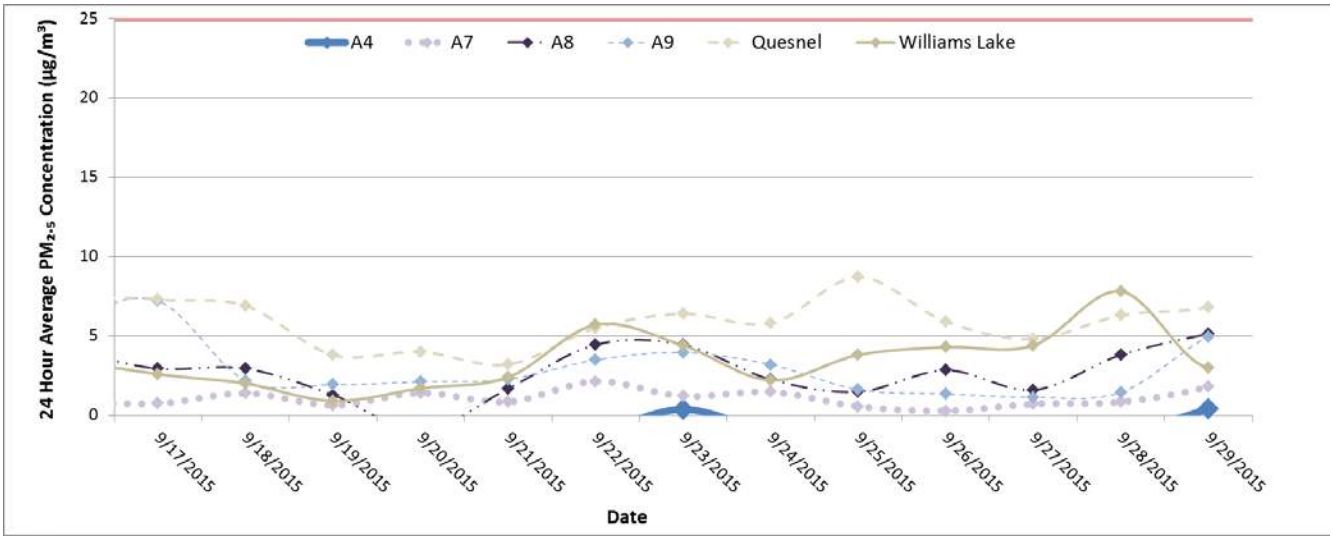


Figure 3: 24-Hour Average $PM_{2.5}$ Concentrations at MPMC and Surrounding BC MOE Stations

As shown in Figures 1 through 3, the monitored values are consistently below the AAQO for TSP, PM_{10} and $PM_{2.5}$ throughout the September 17 to 29, 2015 monitoring period at the Mount Polley Mine site as well as at Quesnel and Williams Lake (TSP is not available for the latter two stations).

Regional forest fires may result in elevated particulate concentration readings at the DustTRAK and BC MOE monitors. The BC Wildfire Service website provides a list of active wildfires within BC (BC Wildfire Service 2015a). During the monitoring period (September 17 to 29, 2015) no forest fires of note were reported in the Cariboo region (BC Wildfire Service 2015b). However, three small forest fires, all 80 to 150 km east of MPMC (BC Wildfire Service 2015a), were active at some point during the monitoring period. One forest fire, approximately 120 km east of the site, may have been of sufficient size (33 hectares) to influence ambient particulate concentrations. However, the other two fires were likely too small (0.009 hectares) to influence ambient air quality in the vicinity of the site.

A summary of the 2-minute (as collected), hourly average and 24-hour average monitoring data for each DustTRAK station is contained in Attachment 2 of this memorandum. A summary of the data for each time averaging period is presented as box and whisker plots.

A MS Excel file which contains data downloaded from the A4, A7, A8, and A9 DustTRAKs will be forwarded as a separate email attachment to BC MOE.

1.3 Meteorological Conditions

This section outlines the wind and rainfall patterns observed on site during the September 17 to 29, 2015 monitoring period.

1.3.1 Winds

Wind data from Meteorological Station #2 (meteorological station adjacent to the TSF) is illustrated in a wind rose (Figure 4). The wind rose shows a predominance of southerly winds during the monitoring period. There was a high predominance (67%) of calms, periods with wind speed less than 1 m/s, for the September 17 to 29, 2015 monitoring period. Calm periods from the previous bi-weekly and monthly monitoring reports ranged between 43.8 and 54.8%. This high predominance of calms indicates stagnant wind conditions during the monitoring period.

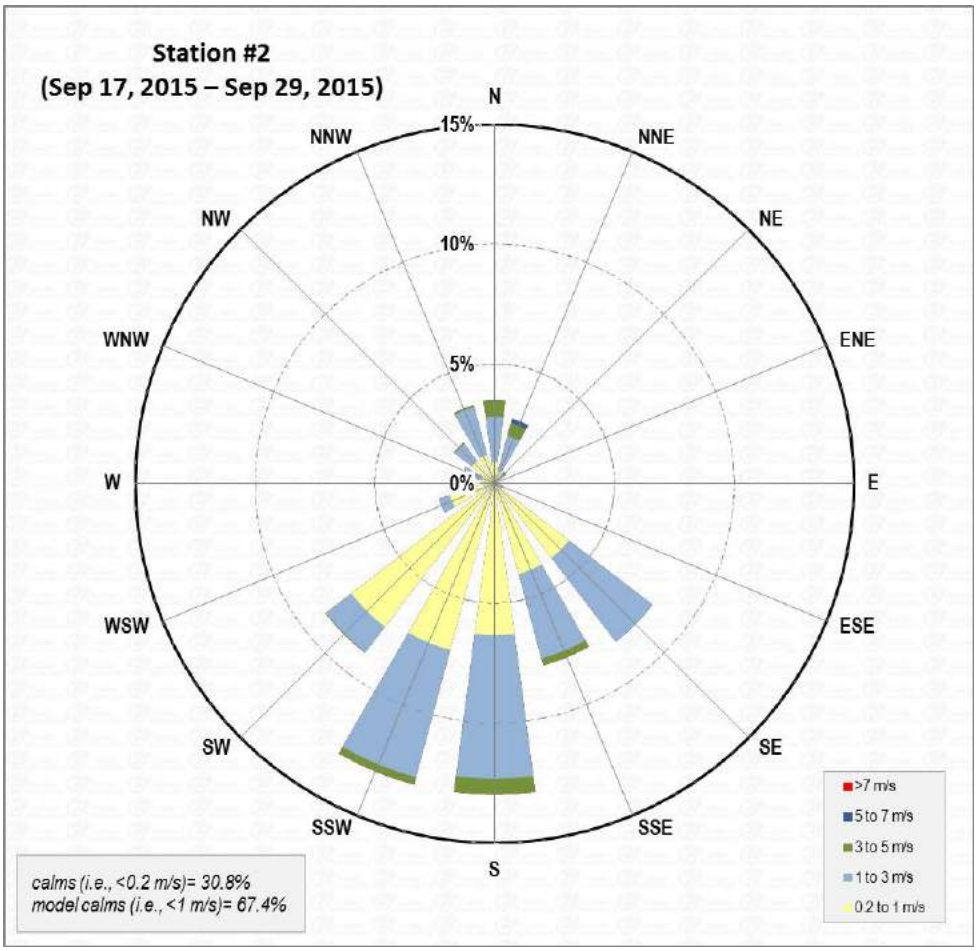


Figure 4: Wind Rose Data for September 17 to 29, 2015 at Meteorological Station #2

1.3.2 Rainfall

Rain acts as a natural dust suppressant, rainfall may mitigate wind erosion effects off of the TSF and Plug area. Rainfall data measured at Meteorological Station #1 (near the Mill area) are summarized in Figure 5. Measureable rainfall was recorded onsite for seven days during the September 17 to 29, 2015 monitoring period.

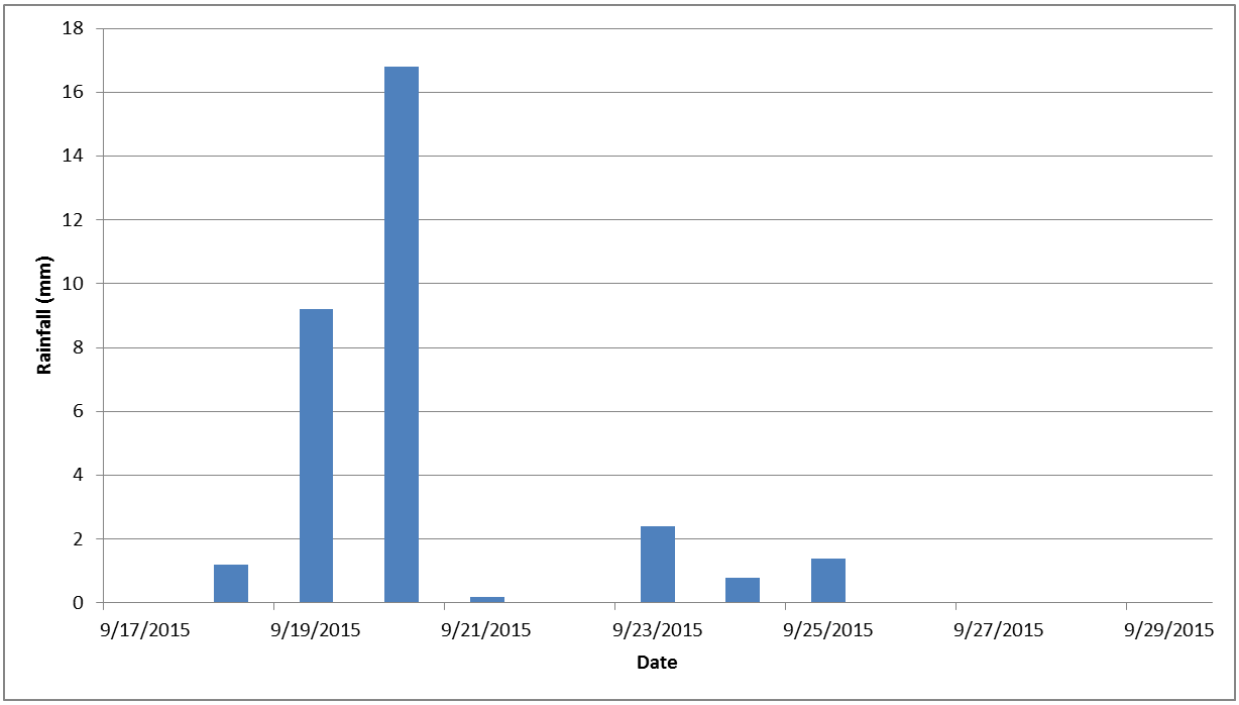


Figure 5: Daily Rainfall for September 17 to 29, 2015 at Station #1

2.0 SUMMER MONITORING PERIOD

This section presents the particulate concentration, dustfall and rainfall data monitored over the summer period (July 7 to September 29, 2015).

2.1 Particulate Data

The 24-hour particulate concentrations for the summer monitoring period are summarized in Figure 6 to Figure 8.

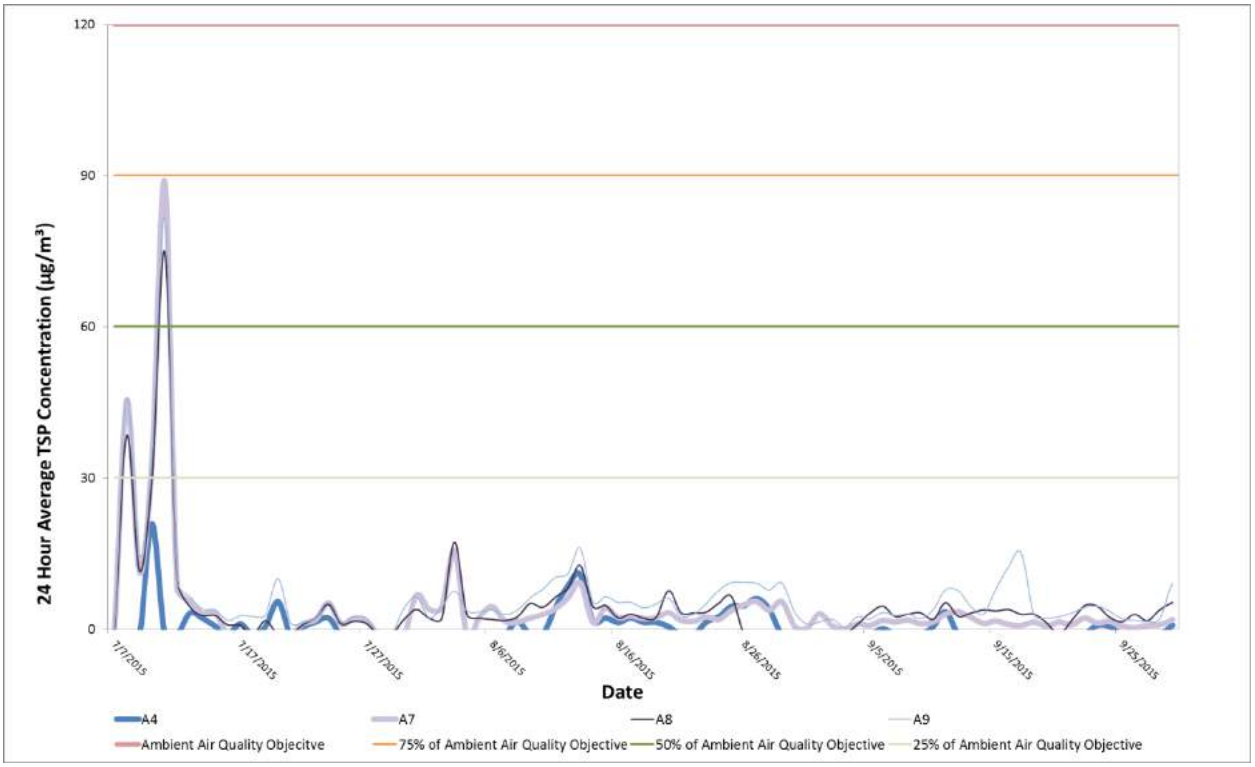


Figure 6: 24-Hour Average TSP Concentrations at MPMC Stations July 7 to September 29, 2015

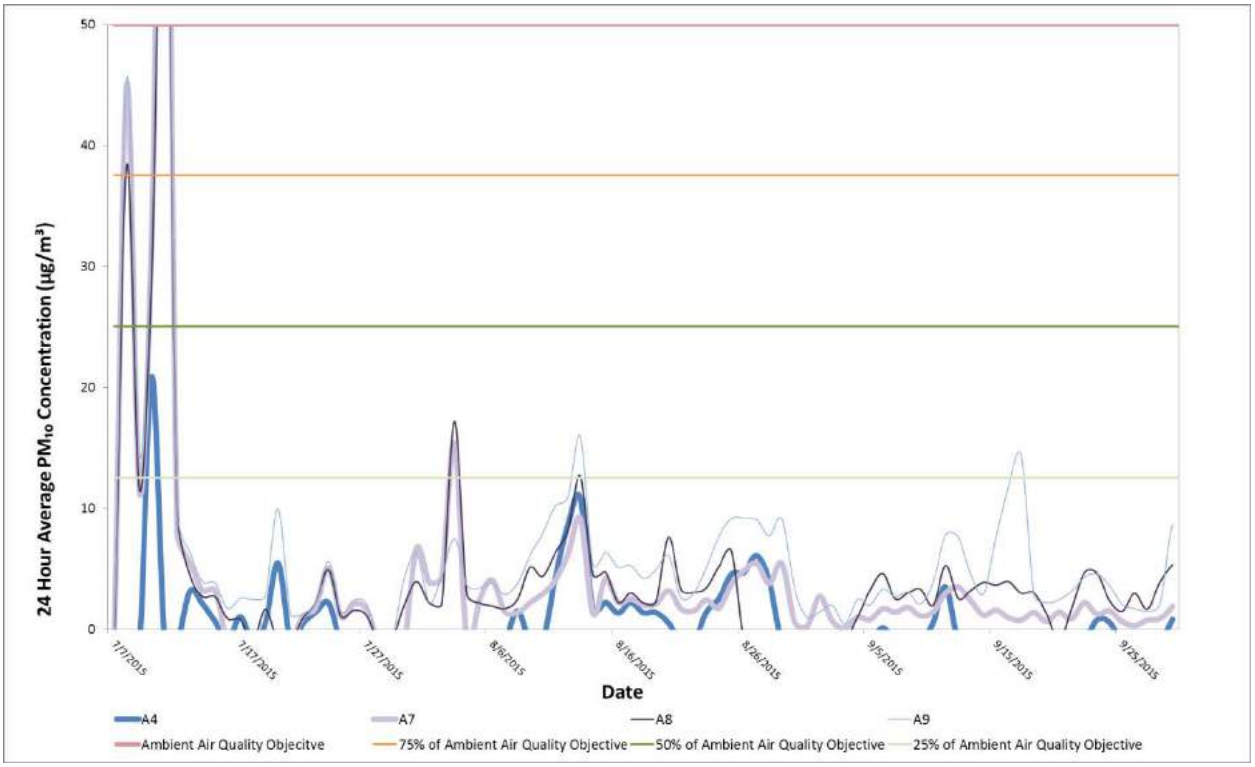


Figure 7: 24-Hour Average PM_{10} Concentrations at MPMC Stations, July 7 to September 29, 2015

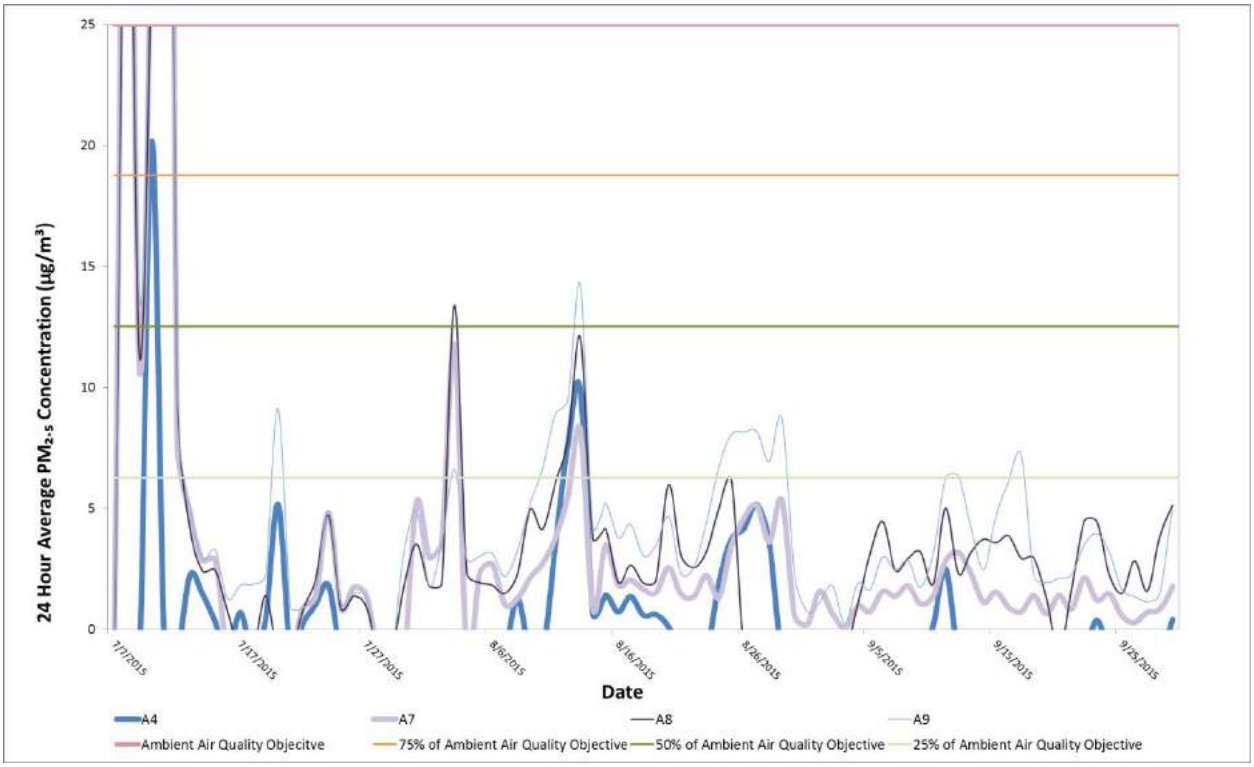


Figure 8: 24-Hour Average $PM_{2.5}$ Concentrations at MPMC Stations, July 7 to September 29, 2015

For each station it is observed that at least 94% of 24-hour TSP, PM_{10} and $PM_{2.5}$ concentrations are below 50% of the relevant AAQO. Of the 82 days monitored, only 3 days were found to have PM_{10} and $PM_{2.5}$ concentrations greater than the AAQO. However, as noted in the July 29, 2015 bi-weekly monitoring memorandum (Golder 2015b) the exceedances in the AAQO are most likely a result of regional forest fires rather than a result of site activities.

2.2 Dustfall

Dustfall was monitored at the site at eight locations, four of which are in the vicinity of the TSF/Plug area (A4, A7, A8 and A9), as illustrated in Figure 9. The remaining four stations are located in the northern section of the mine, in excess of 3 km from the TSF/Plug area. Despite the distance from the TSF/Plug area, data from these stations have been included here for comparison purposes. For context, dustfall data have been compared to the BC AAQO for dustfall. Since the monitoring locations in the vicinity of the TSF/Plug area are located on an industrial site (a mine) where industrial activities will influence the monitored data, they therefore are not considered compliance measurement locations and hence comparison to the criteria is presented for reference purposes only. The AAQO for mining operations is a range of values between 1.7 and 2.9 mg/dm^2/day; however, MPMC waste discharge permit PA-15087 (BC MOE 1997), specifies a Ministry objective of 2.9 mg/dm^2/day (upper dustfall AAQO) to be used for comparison.

Monitored dustfall values are presented in Table 1; the stations located in the vicinity of the TSF/Plug area are highlighted in grey.



LEGEND

- DUSTFALL MONITORING STATION
- CONTINUOUS PARTICULATE MONITORING STATION (DustTRAK)
- METEOROLOGICAL STATION
- TOWN
- ROAD
- WATERCOURSE
- WATERBODY

Station ID	Description	Station Location (UTM10)	
		Easting (m)	Northing (m)
A1	Dustfall	588,221	5,826,043
A2	Dustfall	589,906	5,823,978
A3	Dustfall	590,471	5,825,114
A4	Dustfall and DustTRAK	595,215	5,821,275
A5	Lost during breach	597,010	5,819,075
A6	Dustfall	593,170	5,826,290
A7	Dustfall and DustTRAK	595,146	5,818,104
A8	Dustfall and DustTRAK	596,807	5,817,945
A9	Dustfall and DustTRAK	595,744	5,820,806
Station #1	Meteorological Station	592,792	5,823,182
Station #2	Meteorological Station	594,059	5,819,955

0 1 2 3

1:60,000 KILOMETRES

REFERENCES

1. TOWN, ROAD, WATERCOURSE AND WATERBODY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. SITE IMAGERY OBTAINED FROM SNC LAVALIN LTD, DATE 2014. BASE IMAGERY © 20100411 ESRI AND ITS LICENSORS. SOURCE: DIGITAL GLOBE, WV01.
PROJECTION: NAD 1983 UTM ZONE 10N

CLIENT
MOUNT POLLEY MINING CORPORATION
IMPERIAL METALS

PROJECT
CUMULATIVE ENVIRONMENTAL IMPACT ASSESSMENT

TITLE
AIR QUALITY MONITORING AND METEOROLOGICAL STATION LOCATIONS

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-10-19
DESIGNED	TB
PREPARED	CD
REVIEWED	JR
APPROVED	RW

PROJECT NO.	CONTROL	REV.	FIGURE
14-11734	1500 / 1000	0	9

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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Table 1: Summer Dustfall Data for 2015 (mg/dm^2/day)

Station	July	August	September	Summer Average
A1	1.60	0.52	0.18	0.77
A2	1.16	0.28	0.26	0.57
A3	0.30	0.13	0.14	0.19
A4	1.10	0.60	0.88	0.86
A6	0.10[(a)]	0.10[(a)]	0.13	0.11
A7	1.26	2.86	0.43	1.52
A8	1.09	0.48	0.10[(a)]	0.56
A9	0.50	0.21	0.18	0.30

(a) Deposition monitored at or below detection limit of 0.10 mg/dm^2/day

Dustfall values are generally low and are consistently below the upper dustfall AAQO and the Ministry objective (waste discharge permit PA-15087) of 2.9 mg/dm^2/day.

For five dustfall monitoring stations, historical data was available from summer months from previous years for comparison. However, only one station (A4) in the vicinity of the TSF/Plug area had historical data. Historical data for this station is presented in Figure 10.

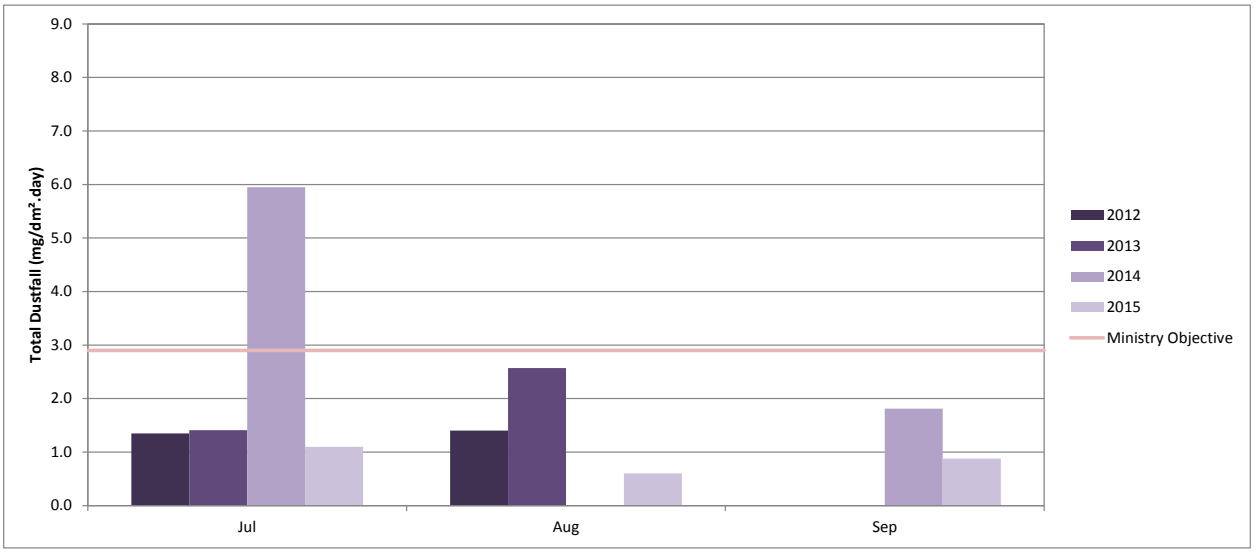


Figure 10: Summer Dustfall Data - Station A4

In general, the data shows that dustfall levels are lower in 2015 than in the same months in previous years.

For the dustfall stations with historical data that are located in the northern area of the site (A1, A2, A3 and A6), the year to year data are plotted in Figure 11 to Figure 14.

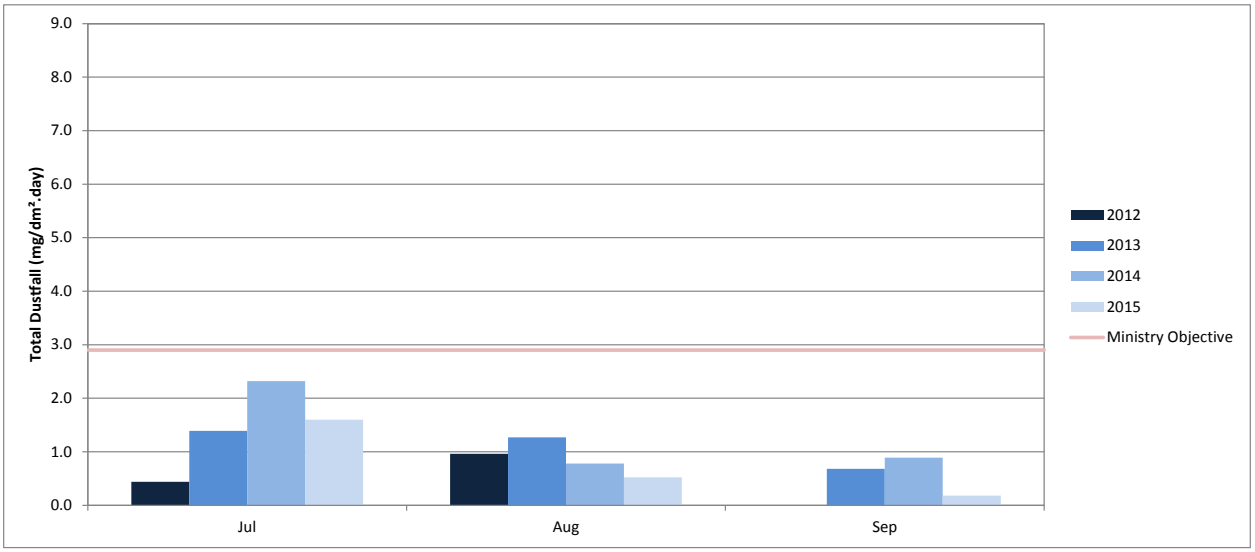


Figure 11: Summer Dustfall Data - Station A1

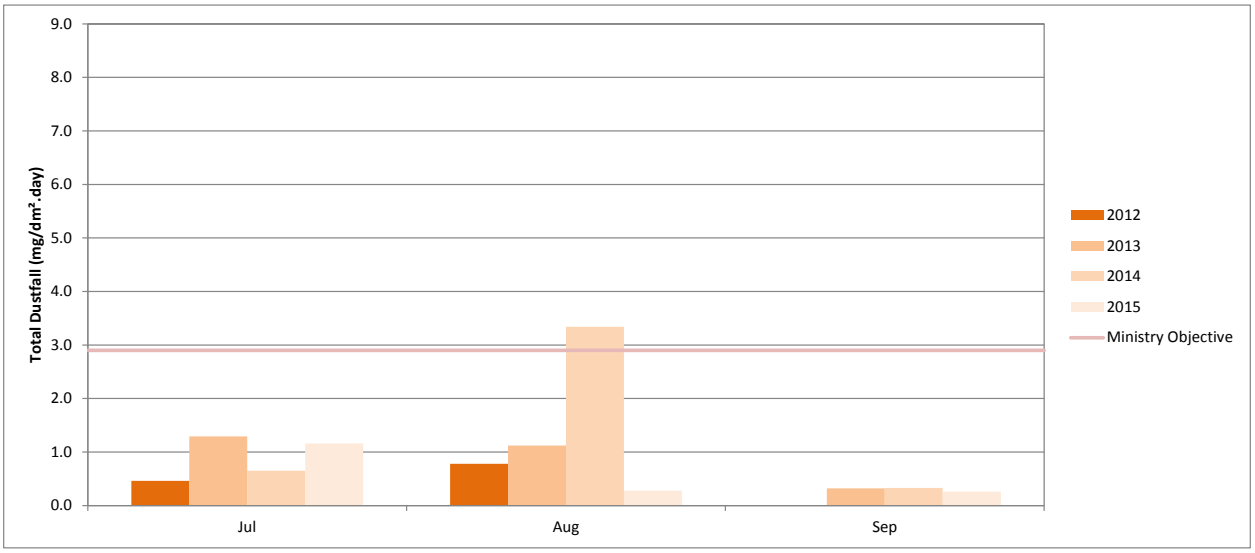


Figure 12: Summer Dustfall Data - Station A2

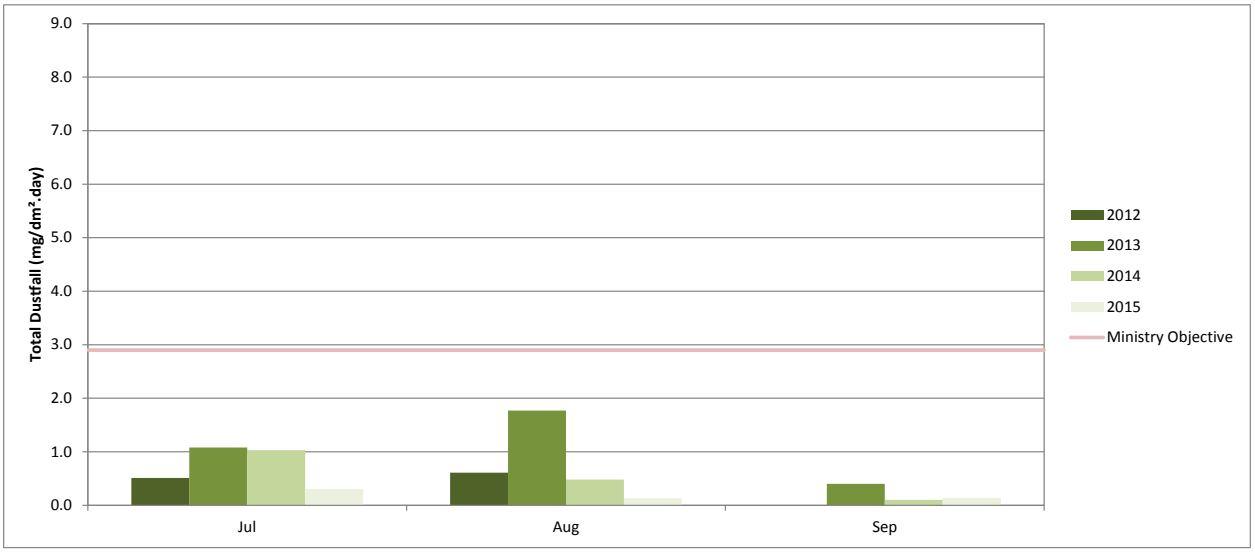


Figure 13: Summer Dustfall Data - Station A3

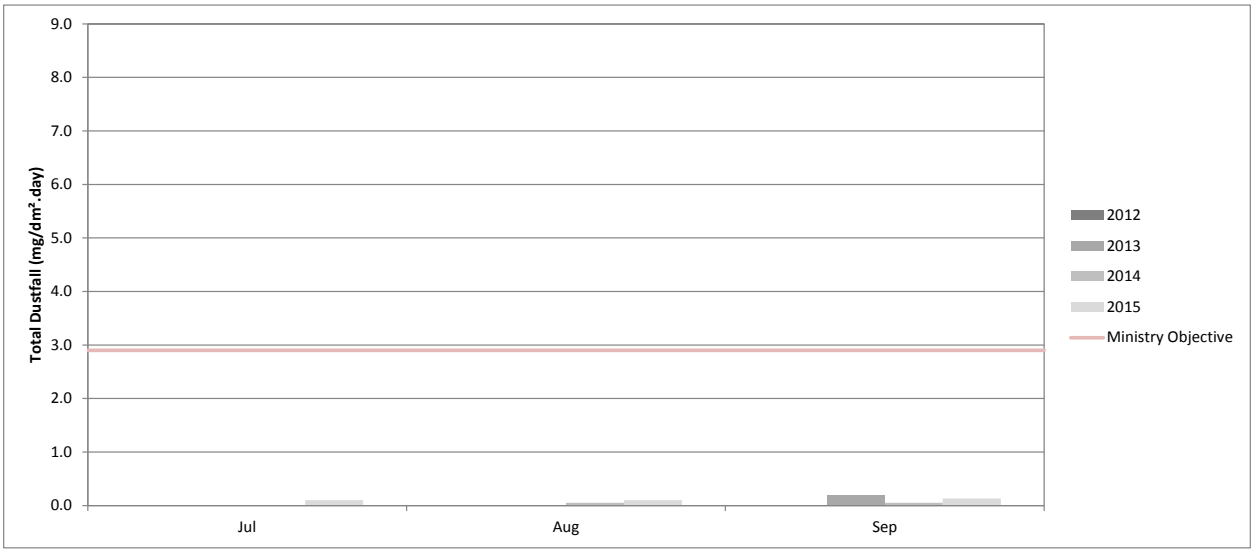


Figure 14: Summer Dustfall Data - Station A6

Similar to the pattern observed in A4, generally dustfall levels in 2015 are lower than in previous years.

2.3 Rainfall

Rainfall acts as a natural dust suppressant, reducing wind erosion effects off of the TSF and Plug area. Monthly rainfall amounts measured at Meteorological Station #2 are presented in Table 2. For comparison purposes the monthly 20 year average (1994-2015) rainfall at Mount Polley Mine is provided along with monthly rainfall (historical average) from Environment Canada's Likely station.

Table 2: Monthly Rainfall Data (mm)

Month	Mount Polley Mine Site Station #2 2015	Mount Polley Mine Site 1996-2015	Likely 1974-1993
July	63.8	56.7	59.7
August	20.8	35.3	67.2
September	61.6	46.5	51.6
Total Rainfall	146.2	138.5	178.5

During the summer monitoring period (July to September 2015) 146 mm of rainfall was recorded at the site. Between July and September the Mount Polley Mine on average receives approximately 139 mm of rainfall (based on data from 1996 to 2014). This indicates that the total summer 2015 rainfall amount is consistent with the long term averages.

However, August 2015 was a relatively dry month compared to longer term averages. August received 15 mm less rainfall than the 20 year average, which equates to approximately 40% less rainfall in 2015 than the longer term 20 year average. The historical 20 year average data from the Likely station shows that on average there are 14 days with measurable rainfall (>0.2 mm of rainfall) in August. In August 2015 there were only 6 days with measurable rainfall, which also indicates that August 2015 was a relatively dry month.

3.0 UPDATES TO DUST MANAGEMENT PLAN

The following section outlines the recommended updates to the *Fugitive Dust Management, Plan Mount Polley* (Golder 2015a) for the TSP/Plug area (referred as Dust Management Plan), and presents the supporting rationale.

Recommendation #1: Fugitive dust emissions management is continued as outlined in the dust management plan.

Rationale: The continuous monitoring data during the summer period of 2015 indicate that the dust management measures (as outlined in the dust management plan) appear to be effective at managing dust in the TSF and Plug area. The monitored results show that of the 82 days monitored, only 3 days were found to have PM_{10} and $PM_{2.5}$ concentrations greater than the AAQO; however, these exceedances are most likely attributable to local and regional forest fires.

Recommendation #2: Monitoring requirements outlined in the dust management plan are amended to ongoing dustfall monitoring, as required by permit conditions. There is no further requirement for monitoring using DustTRAKs.

Rationale: The continuous monitoring data during the summer period indicates that the dust management measures (as outlined in the dust management plan) appear to be effective at managing dust in the TSF and Plug area. Despite August 2015 being a dry month when compared to historical averages, particulate concentration data showed fugitive dust control measures were effective in the TSF and Plug area. It is expected that there are around 108 days during the year where there are either subfreezing ground conditions or days were there is at least 1 cm of snow on the ground (Likely station). Therefore winter conditions will act as natural dust suppression for many months of the year (November to March).

Dustfall monitoring and associated annual reporting to the MOE will continue, and will be used to inform MPMC on the ongoing success of dust mitigation efforts.

Recommendation #3: The dustfall monitoring network in the area of the TSF/Plug area is updated based on dustfall and particulate monitoring results. Dustfall monitoring will continue at stations A7 and A9. However, monitoring is no longer required at stations A4 and A8.

Rationale: There are currently two dustfall stations located to the north of the TSF, A4 and A9, one station is considered adequate to characterize dustfall to the north of the TSF area. It is recommended that monitoring continue at A9 since it is closer to the TSF area, it is located between the TSF and Polley Lake. In addition the DustTrack particulate monitoring for the summer 2005 showed generally higher concentrations at the A9 location than at the A4 location. At both locations A4 and A9, the dustfall values were lower than AAQO and the Ministry objective (waste discharge permit PA-15087) of 2.9 mg/dm^2/day throughout the summer monitoring period.

There are currently two dustfall stations located to the south of the TSF, A7 and A8, one station is considered adequate to characterize dustfall to the south of the TSF area. It is recommended that monitoring continue at A7 since it is immediately south of the TSF area along the south bank wall. In addition, the highest dustfall reading for the summer of 2015 was for August 2015 at dustfall station A7. At both locations A7 and A8, the dustfall values were lower than AAQO and the Ministry objective (waste discharge permit PA-15087) of 2.9 mg/dm^2/day throughout the summer monitoring period.

Recommendation #4: The TSF/Plug area dust management plan is modified at a future date, prior to the TSF/Plug area becoming operational.

Rationale: Ongoing activities on site are generally the same as those considered as emission sources in the current dust management plan. Significant changes in the fugitive dust emissions sources in the TSF/Plug area are not expected until permitting has been completed, and the area becomes operational. It is anticipated that fugitive emissions from the TSF/Plug area will decrease once operational due to the removal and revegetation of tailings material from the Plug area, and water covering part of the TSF area.

4.0 CLOSURE

We trust that this memorandum meets your present needs. Please do not hesitate to contact us should you have any questions or comments regarding the above.

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

Taishi Baba, B.Sc.
Air Quality Specialist

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Rachel Wyles, M.Eng., P.Eng.
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TB/JR/RW/kp/bb

Attachments: Attachment 1: Daily Inspection Observations for the TSF and Plug Area
Attachment 2: TSP, PM_{10} and $PM_{2.5}$ Concentrations at A4, A7, A8, and A9

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ATTACHMENT 1
Daily Inspection Observations for the TSF and Plug Area

	
No Dust Generation (**No**)	Minimal or Sporadic Dust Generation (**Minor**)
In between minimal or sporadic and major	
Moderate Dust Generation (**Moderate**)	Major Dust Generation (**Major**)

Important Information to Document:

- Date and time.
- Source of dust (ex., sand cells, traffic along embankment, TSF surface along Main embankment) – photos are helpful, if possible.
- Weather conditions, including wind (ex., calm, light breeze, windy) and precipitation (ex., hot and sunny, dry, heavy rain last night).

Table 1: Summary of Visual Inspections at TSF and Plug Area

Date	Approximate Time	Area Inspected		Comment
		Tailings Storage Facility	Plug Area	
15/Sep/15	8:38	No	No	
15/Sep/15	11:20	No	No	
15/Sep/15	19:32	No	No	
15/Sep/15	21:52	No	No	
16/Sep/15	1:37	No	No	
16/Sep/15	5:22	No	No	
16/Sep/15	8:45	No	No	
16/Sep/15	11:56	No	No	
16/Sep/15	15:30	No	No	
16/Sep/15	19:44			Dust level not noted
16/Sep/15	21:47			Dust level not noted
17/Sep/15	12:47			Dust level not noted
17/Sep/15	2:50			Dust level not noted
17/Sep/15	4:33			Dust level not noted
17/Sep/15	7:20	No	No	
17/Sep/15	11:22	No	No	
17/Sep/15	15:20	No	No	
17/Sep/15	19:11	No	No	
17/Sep/15	22:12			Dust level not noted
17/Sep/15	23:02			Dust level not noted
18/Sep/15	1:40			Dust level not noted
18/Sep/15	5:12			Dust level not noted
18/Sep/15	7:20	No	No	
18/Sep/15	11:25	No	No	
18/Sep/15	14:00	No	No	
18/Sep/15	19:26	No	No	
18/Sep/15	21:23	No	No	
18/Sep/15	23:33	No	No	
19/Sep/15	1:39	No	No	
19/Sep/15	4:25			Dust level not noted
19/Sep/15	7:26	No	No	
19/Sep/15	12:03	No	No	
19/Sep/15	15:59			Dust level not noted
19/Sep/15	19:09			Dust level not noted
19/Sep/15	21:31	No	No	
20/Sep/15	12:07	No	No	

Date	Approximate Time	Area Inspected		Comment
		Tailings Storage Facility	Plug Area	
20/Sep/15	2:15			Dust level not noted
20/Sep/15	4:49	No	No	
20/Sep/15	7:35	No	No	
20/Sep/15	12:26	No	No	
20/Sep/15	15:55	No	No	
20/Sep/15	19:46	No	No	
20/Sep/15	21:39			Dust level not noted
20/Sep/15	23:51			Dust level not noted
21/Sep/15	2:14			Dust level not noted
21/Sep/15	4:51			Dust level not noted
21/Sep/15	7:44	No	No	
21/Sep/15	13:22	No	No	
21/Sep/15	15:08	No	No	
21/Sep/15	19:04	No	No	
21/Sep/15	21:34	No	No	
21/Sep/15	23:36	No	No	
22/Sep/15	1:46			Dust level not noted
22/Sep/15	4:22	No	No	
22/Sep/15	18:57	No	No	
22/Sep/15	21:27	No	No	
22/Sep/15	23:14	No	No	
23/Sep/15	1:42	No	No	
23/Sep/15	4:37	No	No	
23/Sep/15	9:12	No	No	
23/Sep/15	13:38	No	No	
23/Sep/15	16:06	No	No	
23/Sep/15	19:49	No	No	
23/Sep/15	22:11	No	No	
24/Sep/15	3:22	No	No	
24/Sep/15	5:39	No	No	
24/Sep/15	8:12	No	No	
24/Sep/15	12:06			Dust level not noted
24/Sep/15	14:16	No	No	
24/Sep/15	20:52	No	No	
24/Sep/15	23:04	No	No	
25/Sep/15	2:44	No	No	
25/Sep/15	5:29	No	No	

Date	Approximate Time	Area Inspected		Comment
		Tailings Storage Facility	Plug Area	
25/Sep/15	8:24	No	No	
25/Sep/15	11:42	No	No	
25/Sep/15	13:46	No	No	
25/Sep/15	16:39	No	No	
25/Sep/15	19:07	No	No	
25/Sep/15	22:20	No	No	
26/Sep/15	2:15	No	No	
26/Sep/15	6:09	No	No	
26/Sep/15	8:48	No	No	
26/Sep/15	10:52	No	No	
26/Sep/15	11:49	No	No	
26/Sep/15	14:01	No	No	
26/Sep/15	15:50	No	No	
26/Sep/15	19:50	No	No	
26/Sep/15	21:36	No	No	
27/Sep/15	0:51	No	No	
27/Sep/15	4:20	No	No	
27/Sep/15	8:34	No	No	
27/Sep/15	11:16	No	No	
27/Sep/15	13:15	No	No	
27/Sep/15	16:08	No	No	
27/Sep/15	20:36	No	No	
27/Sep/15	22:43	No	No	
28/Sep/15	2:29	No	No	
28/Sep/15	5:15	No	No	
28/Sep/15	7:20	No	No	
28/Sep/15	19:33	No	No	
28/Sep/15	23:08	No	No	
29/Sep/15	2:17	No	No	
29/Sep/15	4:54	No	No	
29/Sep/15	19:48	No	No	
29/Sep/15	22:05	No	No	
30/Sep/15	1:25	No	No	
30/Sep/15	5:26	No	No	

Daily TSF/Water Management Inspection Checklist

Inspector: _____ Date: _____

Shift (Crew, D or N):_____ Weather Condition (ex. hot, windy): _____

TSF Area

Pumps/Pipes/Sumps	Time Checked	Inspection Gauge Readings
Upstream 1		
TSF Settling Pond		
CCS		RED YELLOW BLACK
South Seepage Pond		RED YELLOW BLACK
Main Seepage Pond		RED YELLOW BLACK
Till Borrow Pond		RED YELLOW BLACK
9KM Sump		RED YELLOW BLACK
NW Sump		RED YELLOW BLACK
Mine Drainage Creek		RED YELLOW BLACK
Bootjack Creek Sump		RED YELLOW BLACK
SERDS Sump		RED YELLOW BLACK
West Ditch Culverts		
Wight Pit Pumps		
Joe's Creek Pipe		
Long Ditch Sumps		
Long Ditch/SERDS Pipe Outlets		
Cariboo Pit Pumps		
Springer Pipes		

Is the TSF Generating Dust?

No Minor Moderate Major

Is the Polley Lake Plug Generating Dust?

No Minor Moderate Major

ADDITIONAL COMMENTS:

_____

_____

_____

_____

_____

ATTACHMENT 2
TSP, PM_{10} and $PM_{2.5}$ Concentrations for A4, A7, A8, and A9

1.0 DUSTTRAK PARTICULATE DATA

This attachment outlines the particulate concentrations observed at DustTRAK stations A4, A7, A8, and A9.

Daily, hourly, and 2-minute data for TSP, $PM_{10,}$ and $PM_{2.5}$ are summarized using a simplified box and whisker plot. The simplified box and whisker plot has been used to present trends and statistical data. The box on the figures represents the bounds of the middle (50th percentile) of the 1 hour data points, with the top of the box representing the 1 hour 75th percentile concentration and the bottom of the of box representing the 1 hour 25th percentile concentration. The green diamond represents the 24-hour average concentration. The "whiskers" extend up to the maximum hourly and down to the minimum hourly concentration. The upper dotted grey line represents the 2-minute maximum data, and the lower dotted grey line represents the minimum 2-minute data; the upper dashed green line represents the 75th percentile for the 2-minute data and the lower dashed green line represents the 25th percentile of the 2-minute data. The legend for Figure 2 through Figure 13 is illustrated in Figure 1.

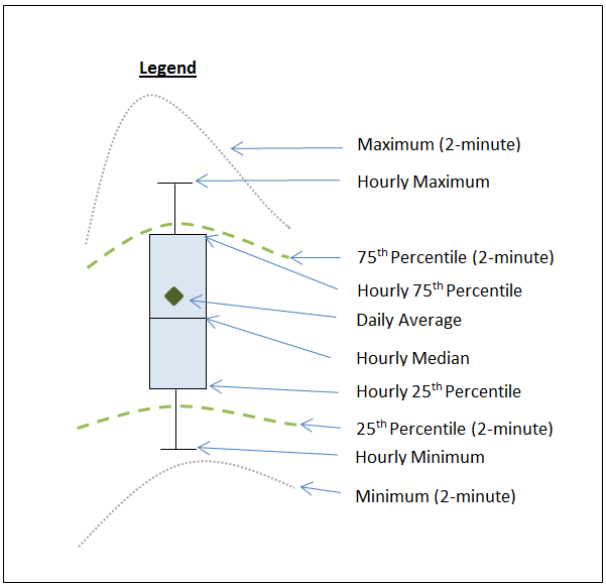


Figure 1: Simplified Box-Whisker Plot Legend

The raw monitored data were screened against the criteria listed below; data that met the following criteria were removed and not presented in the following sections and within the main technical memorandum:

- 2-minute concentrations less than zero;
- data outside of the instrument's monitoring range (0 to 150,000 µg/m^3 for TSP, PM_{10} and $PM_{2.5}$);
- errors indicated within the raw data file including:
  - flow error;
  - laser error; and
  - filter error.

- less than 75% data completeness for hourly and 24-hour averaged values:
  - any hour with less than 23 samples of 2-minute data were was excluded from the hourly dataset (23 samples of 2-minute data over an hour represents a 75% complete hourly dataset); and
  - any 24-hour period with less than 540 samples of 2-minute data were excluded from the 24-hour dataset (540 samples of 2-minute data over 24-hours represents a 75% complete 24-hour dataset).

1.1 A4

Monitored concentrations of TSP, PM_{10}, and $PM_{2.5}$ at A4 are shown in Figure 2 to Figure 4.

Many days' worth of TSP, $PM_{10,}$ and $PM_{2.}5$ concentration data from DustTRAK station A4 met the criteria listed in Section 1.0. Specifically, the 2-minute concentrations were less than zero and hourly and 24-hour data had data completeness of less than 75%. Dates that met the criteria listed in Section 1.0 included September 17 to 22, and 25 to 28, 2015 for TSP and PM_{10}.

Of the valid data, 24-hour concentrations for TSP, PM_{10}, and $PM_{2.5}$ were below BC's ambient air quality objectives (BC AAQO).

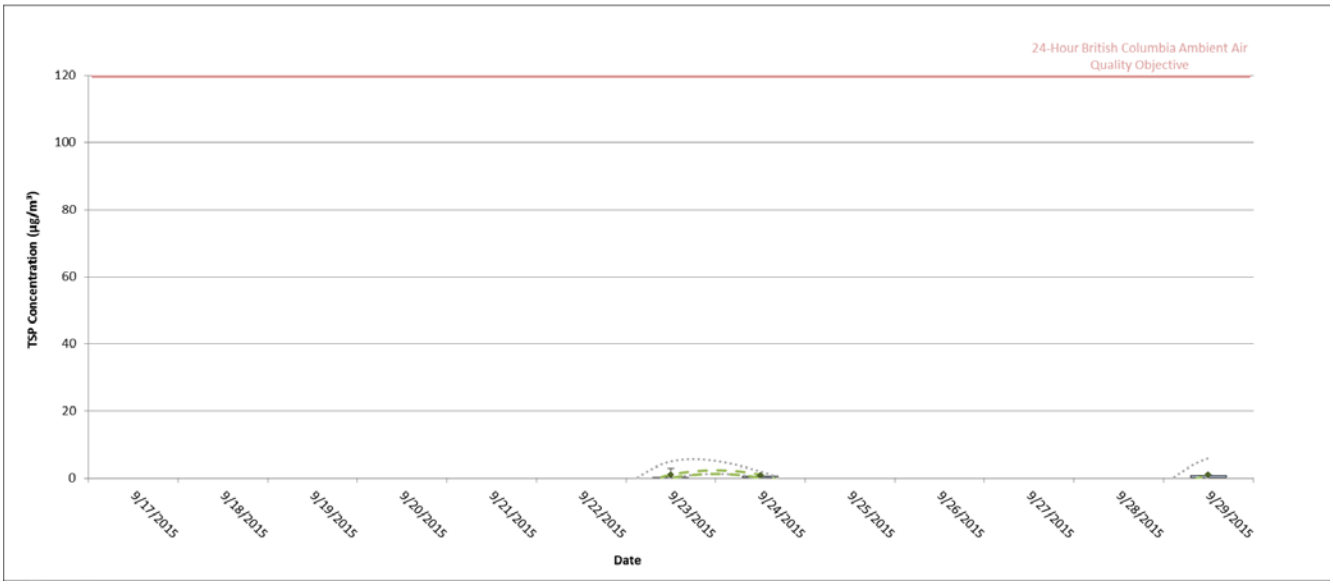


Figure 2: TSP Concentrations at A4, September 17 to 29, 2015

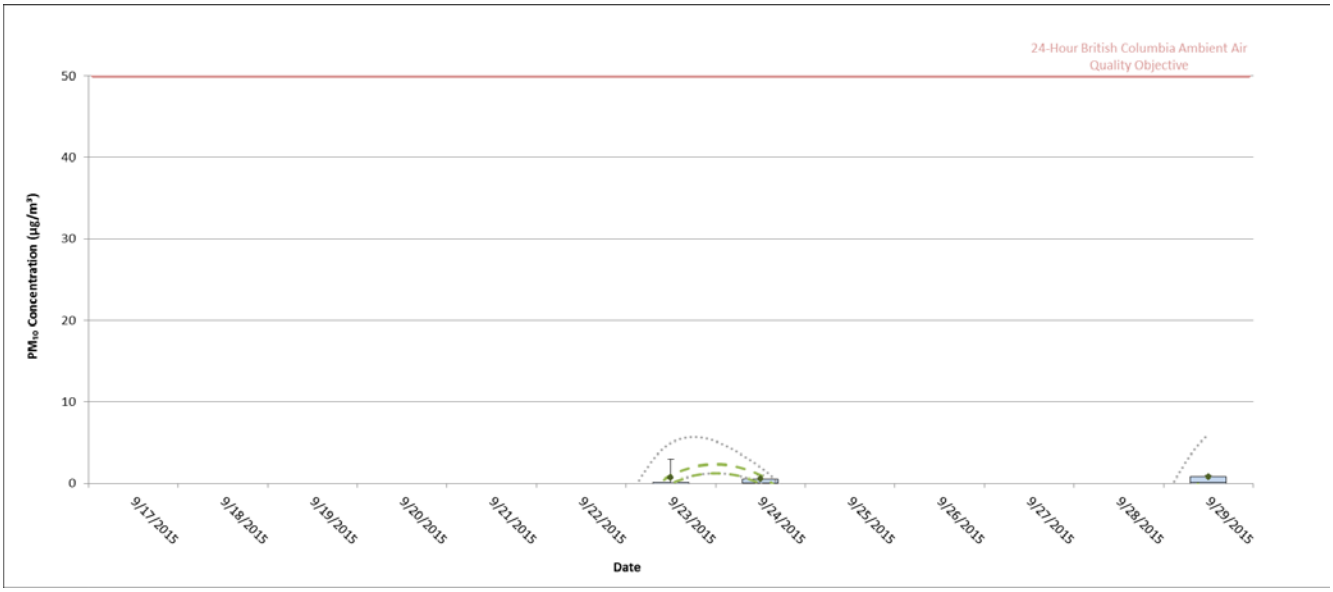


Figure 3: PM_{10} Concentrations at A4, September 17 to 29, 2015

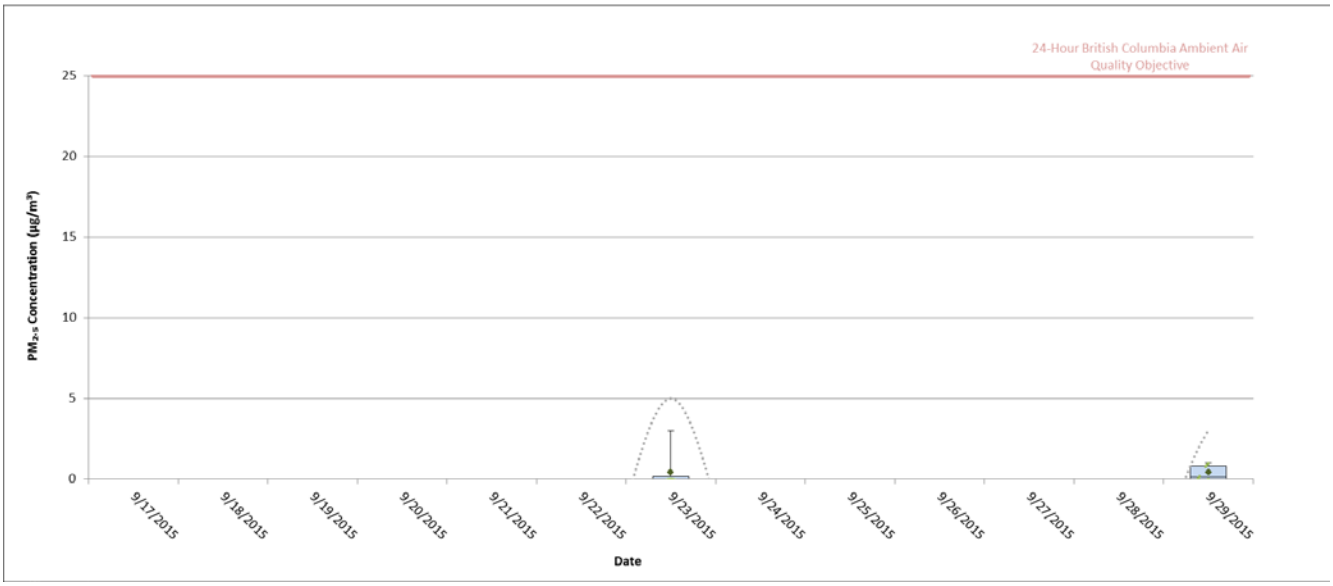


Figure 4: $PM_{2.5}$ Concentrations at A4, September 17 to 29, 2015

1.2 A7

Monitored concentrations of TSP, PM_{10}, and $PM_{2.5}$ measured at A7 are illustrated in Figure 5 to Figure 7.

All monitoring data was considered valid during the September 17 to 29, 2015 monitoring period.

TSP, PM_{10}, and $PM_{2.5}$ 24-hour concentrations were below BC's AAQO throughout the monitoring period.

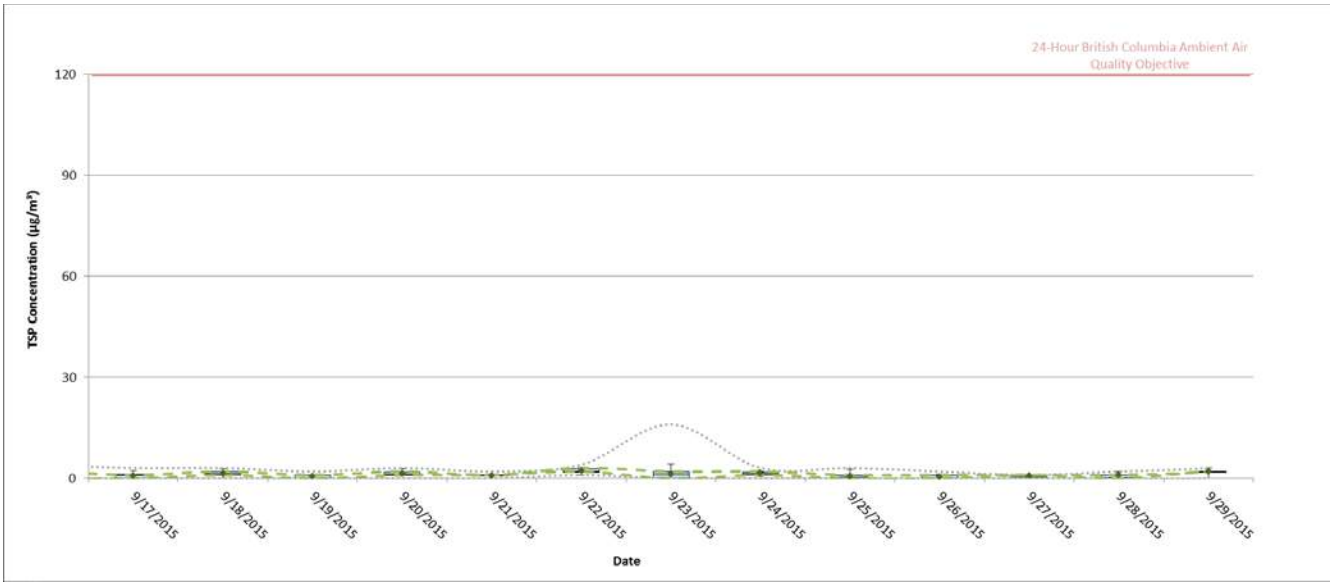


Figure 5: TSP Concentrations at A7, September 17 to 29, 2015

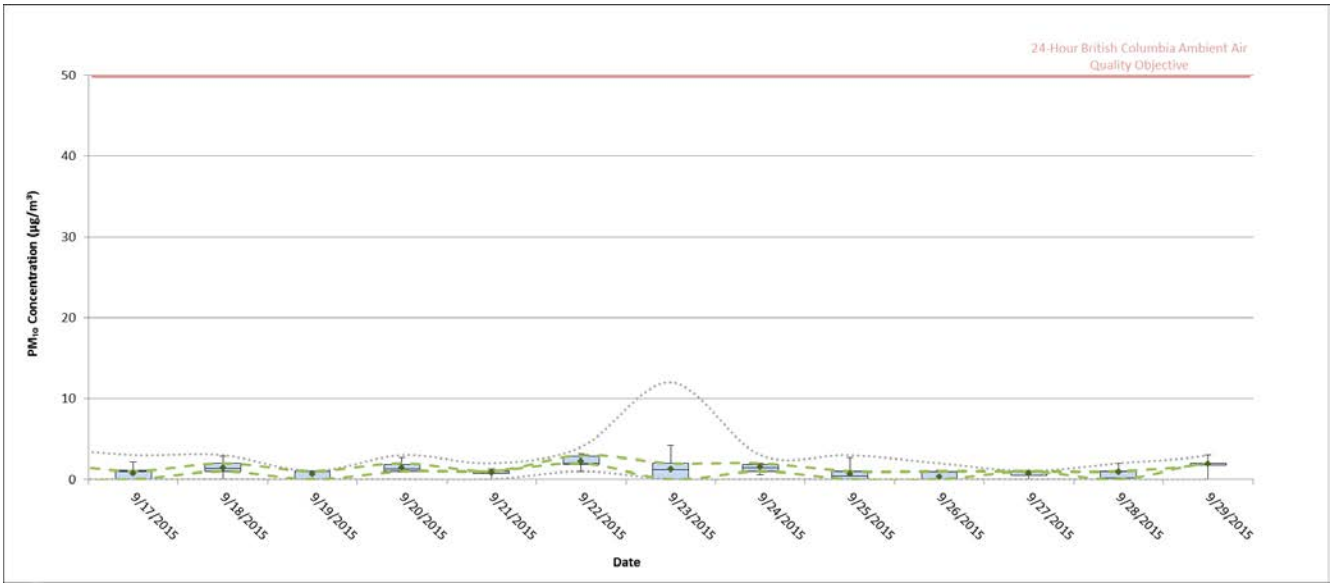


Figure 6: PM_{10} Concentrations at A7, September 17 to 29, 2015

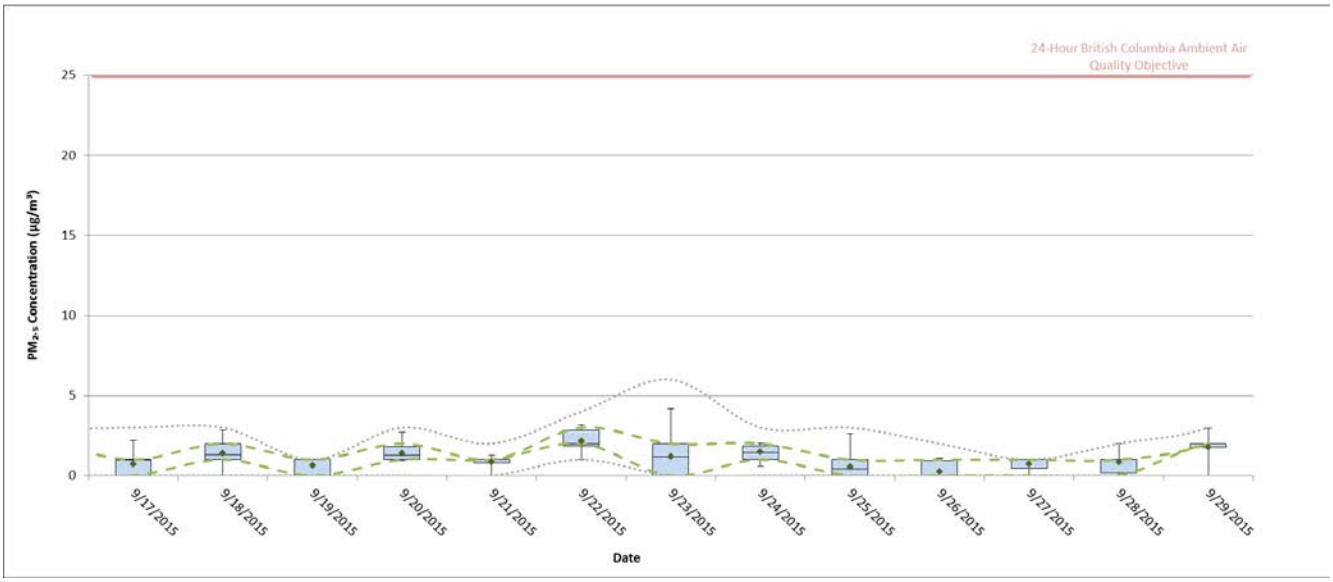


Figure 7: $PM_{2.5}$ Concentrations at A7, September 17 to 29, 2015

1.3 A8

Monitored concentrations of TSP, PM_{10}, and $PM_{2.5}$ measured at A8 are illustrated in Figure 8 to Figure 10.

Concentration data on September 20, 2015 data met the criteria listed in Section 1.0.

Of the valid data, TSP, PM_{10}, and $PM_{2.5}$ 24-hour concentrations were below BC's AAQO for all days monitored.

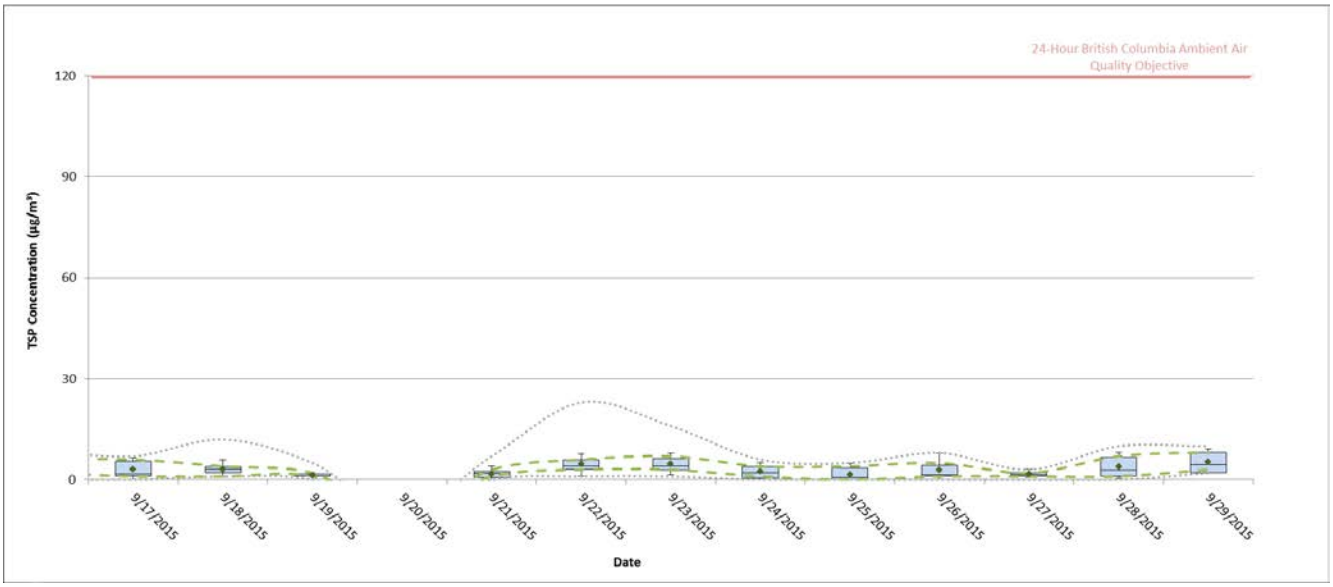


Figure 8: TSP Concentrations at A8, September 17 to 29, 2015

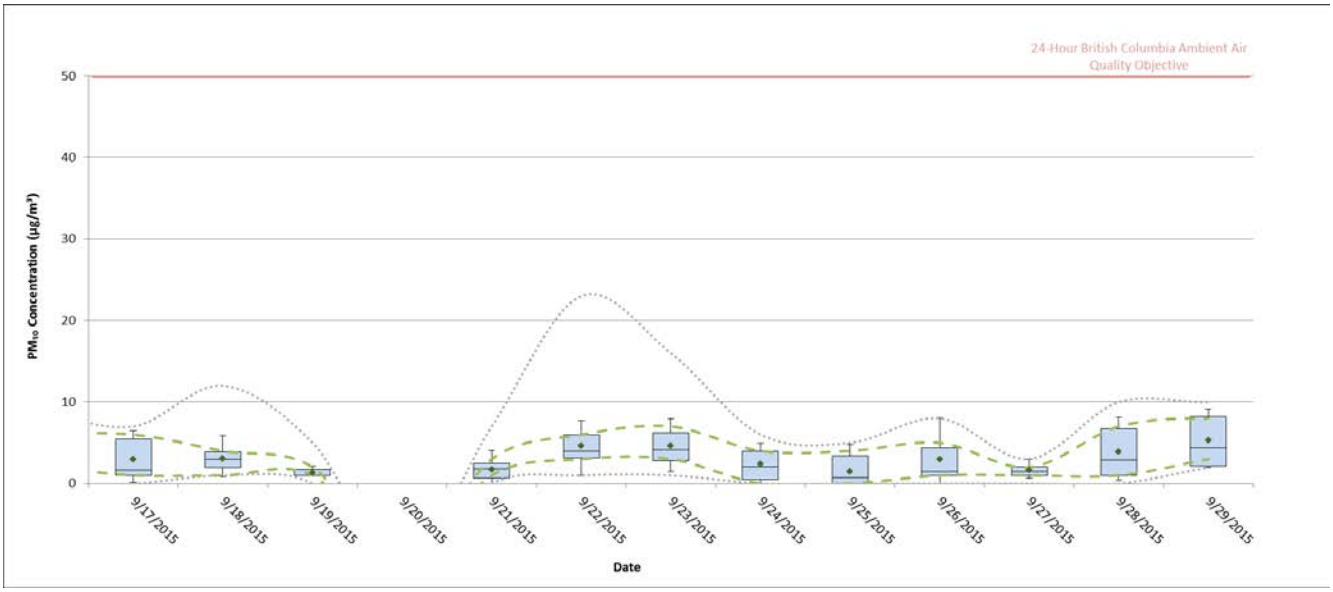


Figure 9: PM_{10} Concentrations at A8, September 17 to 29, 2015

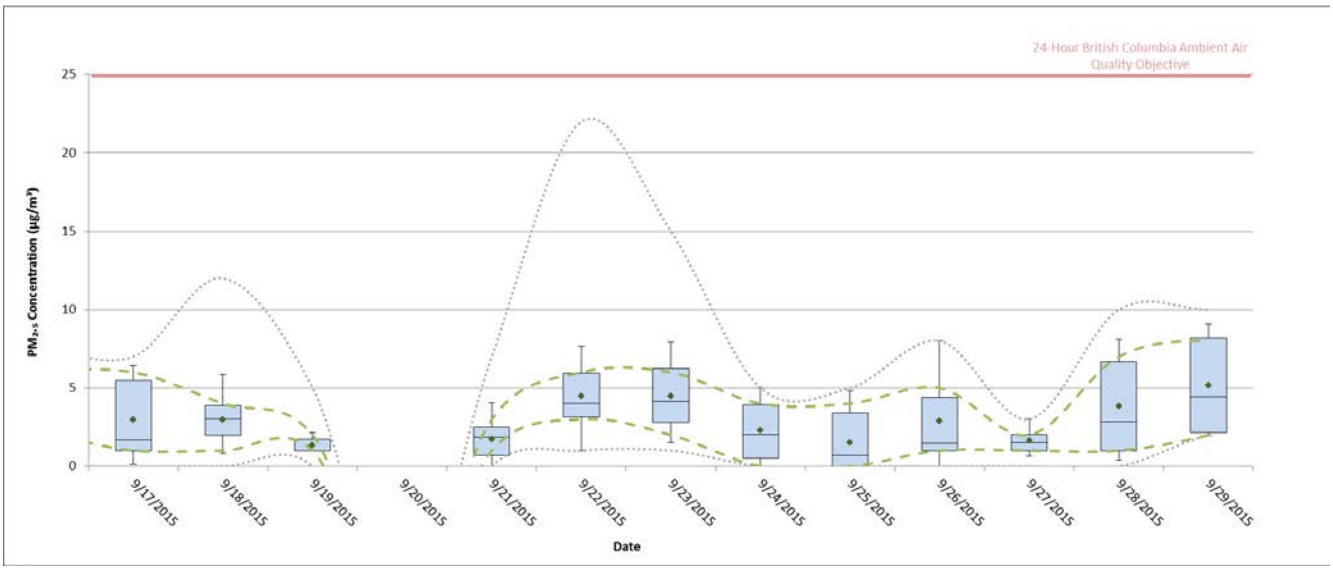


Figure 10: $PM_{2.5}$ Concentrations at A8, September 17 to 29, 2015

1.4 A9

Concentration patterns for TSP, PM_{10}, and $PM_{2.5}$ measured at A9 are illustrated in Figure 11 to Figure 13.

All data were considered to be valid during the September 17 to September 29, 2015 monitoring period.

TSP, PM_{10}, and $PM_{2.5}$ 24-hour concentrations were below BC's AAQO for all days monitored.

Short-term 2-minute TSP concentrations (greater than 120 µg/m³) were measured on September 17, and 29, 2015 for a period of 50, and 22 minutes. Short-term PM_{10} 2-minute concentrations (greater than 50 µg/m³) were monitored on September 17, 18, and 29, 2015 for a period of 130, 4, and 34 minutes respectively. Short term 2-minute $PM_{2.5}$ concentrations (greater than 25 µg/m³) were monitored on September 17, 18, and 29, 2015 for a period of 128, 4, and 32 minutes respectively.

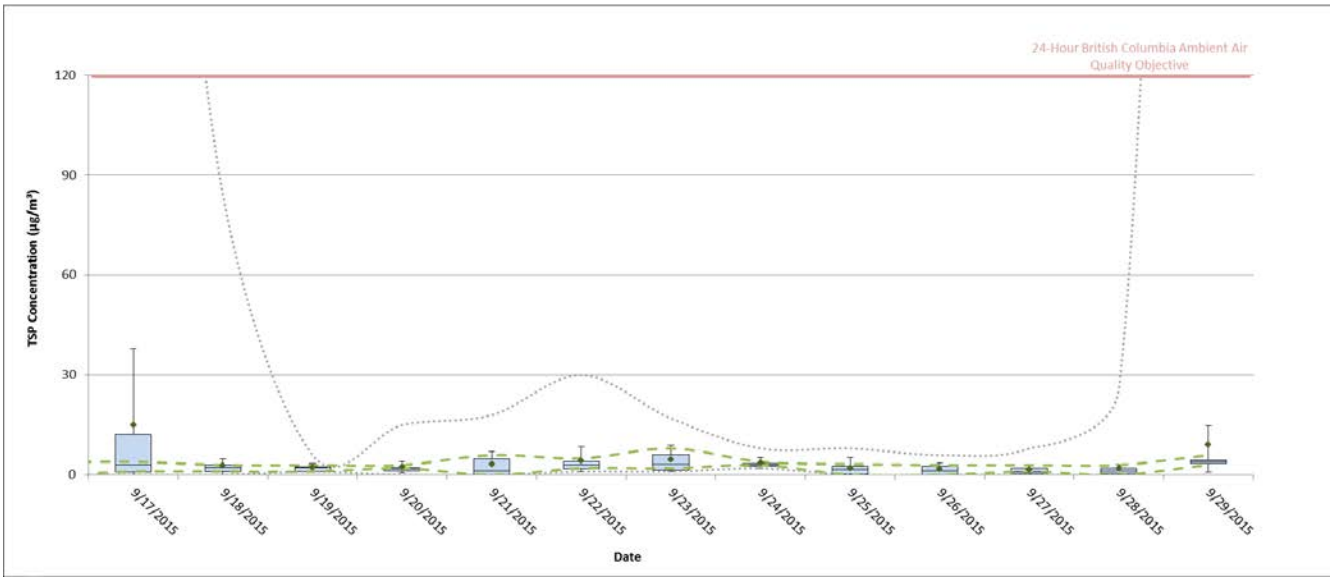


Figure 11: TSP Concentrations at A9, September 17 to 29, 2015

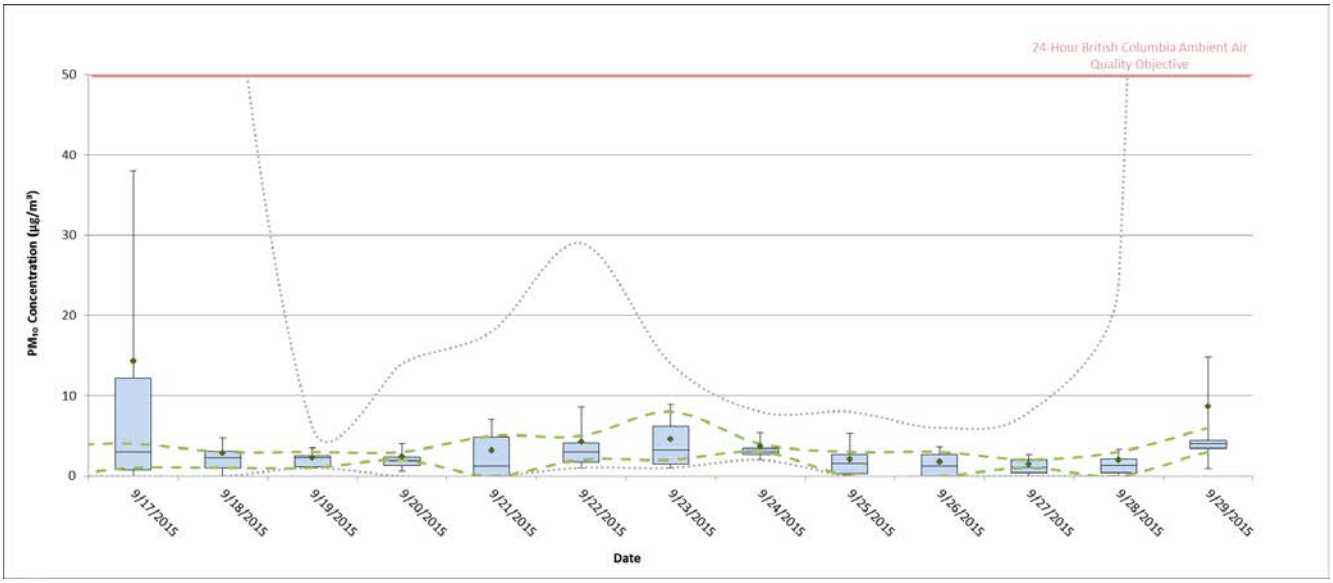


Figure 12: PM_{10} Concentrations at A9, September 17 to 29, 2015

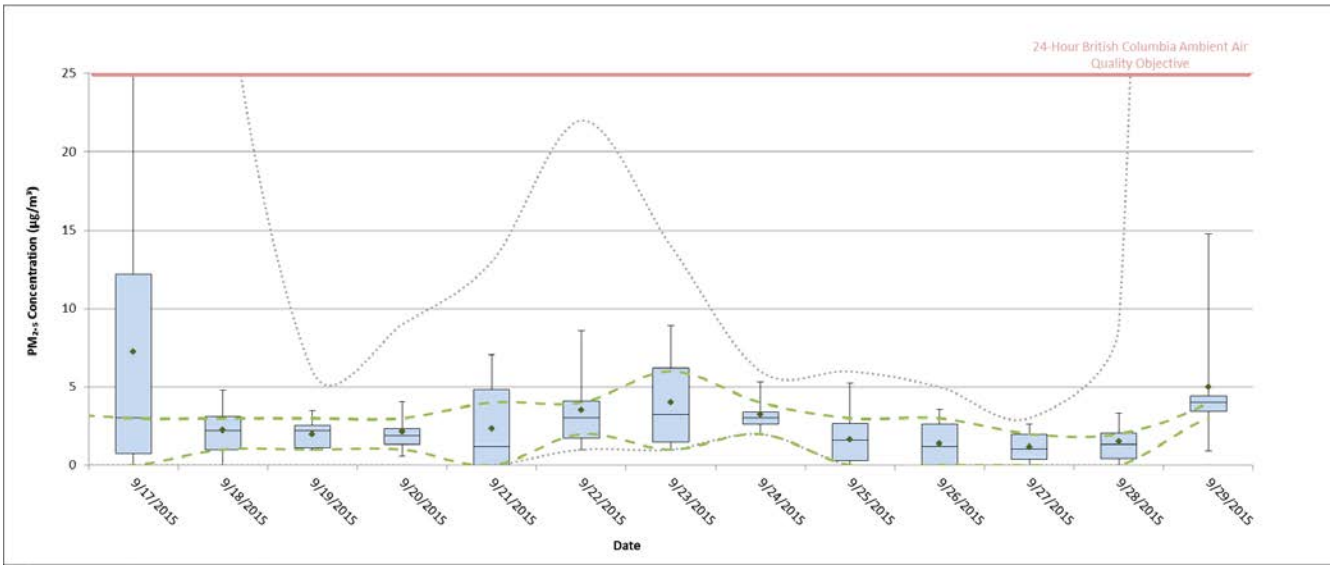


Figure 13: $PM_{2.5}$ Concentrations at A9, September 17 to 29, 2015

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APPENDIX P:

CONTAMINATED SITE ASSESSMENT PLAN

(GOLDER 2015)

September 30, 2015 Reference No. 1411734-085-L-Rev0-15000-6000

Katie McMahen
Mount Polley Mining Corporation
Box 12
Likely, BC V0L 1N0

CONTAMINATED SITE ASSESSMENT PLAN

Dear Ms. McMahen:

This letter provides an outline of the conceptual contaminated sites assessment (CSA) plan for closure of the Mount Polley Mine ("the Site") required by the BC Ministry of Energy and Mines in a permit amendment issued to Mount Polley Mining Corporation on July 9, 2015. Specifically, the CSA plan to address potential contamination on closure of the mine will follow the technical guidance and protocols outlined in the Contaminated Sites Regulation (http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/laws-regulations-compliance), and tailored to the conditions of the Site. The CSA work will be conducted in consultation with a Contaminated Sites Approved Professional

Stage I Preliminary Site Investigation

MPMC has identified the activities or areas of potential environmental concern (APECs) associated with mining operations and the contaminants of potential concern (COPC) associated with these APECs (Table 1, Figure 1). On closure of the mine, or areas of the mine, each of the APECs will be inspected for visual signs of contamination. Photos of each APEC will be taken to include in documentation. Interviews will be held with MPMC personnel familiar with the APECs to determine standard practice for each APEC and records of spills or other historical activities that could have resulted in contamination. This process is consistent with a Stage I Preliminary Site Investigation. MPMC will track each APEC recording site inspections, interviews and photos of those closed, such that documentation can be supplied, if requested. The estimated costs associated with the Stage I PSI are outlined in Table 2.

Stage II Preliminary Site Investigation and Detailed Site Investigation

If there is evidence of contamination associated with the APEC, soil will be sampled and analyzed for the COPCs associated with the APEC in accordance with the guidelines and protocols for a Stage II Preliminary Investigation (Stage II PSI). If contamination is found, step out soil samples will be collected to delineate soil contamination in a Detailed Site Investigation (DSI). Depending on the extent of soil contamination found, an investigation of groundwater quality may be needed. If the COPCs are listed on Schedule 11 of the CSR, it may be necessary to conduct an investigation of soil vapour. The estimated costs associated with a Detailed Site Investigation are dependent on the results of the PSI, and are therefore difficult to predict. For planning purposes, an estimate is provided in Table 3.

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Using Site Knowledge

MPMC has conducted many detailed site investigations related to contamination, contaminant fate and transport, as well as restoration work including site-specific assessments of geochemistry and contaminant toxicity as part of their exploration work and work related to the tailings dam failure. Reclamation plans have been developed for both terrestrial and aquatic areas surrounding the mine. This work should be consulted if contamination is found related to the mine APECs, as this work provides valuable context for data interpretation.

Following delineation of contamination, a remediation plan will be developed to address contamination such that it meets the requirements of the BC *Environmental Management Act*. It is anticipated that the remediation plan will build off of studies conducted and lessons learned and successes from the remediation and restoration work conducted for the tailings dam failure.

The plan provides an outline of the CSA plan required in the July 9, 2015 permit amendment issued to MPMC. The cost associated with the stages of investigation are difficult to determine as it will depend the extent of contamination encountered. For planning purposes, MPMC should expect the costs to be similar to those estimated in this report. As APECs are investigated and closed, the costs should be updated such that they provide a meaningful budgeting tool moving forward.

Yours very truly,

GOLDER ASSOCIATES LTD.





Reidar Zapf-Gilje, Ph.D., P.Eng.
Contaminated Sites Expert

Trish Miller, M.Sc., R.P.Bio.
Principal, Senior Environmental Scientist

RZG/TAM/ch

Attachments: Table 1: Areas of Potential Environmental Concern (APECs) and Contaminants of Potential Concern (COPC) for the Operational Areas of the Mount Polley Mine
Table 2: Stage 1 PSI Scope and Cost
Table 3: Scope of Work and Estimated Costs for a Stage II Preliminary Site Investigation (Stage II PSI) and Detailed Site Investigation (DSI) for Budget Planning Purposes

Figure 1 – CSR Conceptual Plan APECs

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Area	~Size(m^2)	Material(s) Stored/Used	COPC(s)
Fuel Island (light vehicle)	170	Diesel, gasoline	Hydrocarbons
Waste Disposal Area (adjacent to light vehicle fuel island)	90	Batteries, hydrocarbon contaminated waste, used paint, plastic jug recycling	Glass cleaner (Isopropyl alcohol; propoxy propanol; cipropylene glycol; monomethyl ether; monobutyl ether; ammonia),washer fluid (methanol), hydrocarbons, acid batteries (lead; lead sulphate; figer glass separator, ABS), aerosol paint cans/paint cans (liquified petroleum gas; acetone; toluene; limestone; xylene; titanium dioxide; aliphatic hydrocarbon; talc; naphtha, petrolume hydrogreated light; ethylbenzne; barium sulfate; mineral spirits; aliphatic hydrocarbon, and similar)
Fuel Island	1,600	Diesel	Hydrocarbons
Outside maintenance shop + wash bay	8,200	**Lube Products**, **Welding Products,** diesel	See list below
Maintenance laydown	17,700	**Lube Products**, diesel	See list below
Light vehicle maintenance shop + weld barn	1,100	**Lube Products**, **Welding Products,** diesel	See list below
Warehouse	1,400	waste hydrocarbons/contained hydrocarbon products, mill reagents, cleaning products, lube products	See lists below
Crusher Yard	6,500	**Lube Products**, diesel	See list below
Crusher Area	38,400	Ore	Metals (copper, sulphur, iron, silica, aluminua); liquid heat (diethylene glycol; non-hazardous ingredients held as trade secret); belt dressing and conditioner (N-hexane; petroleum gases, liquified, sweetened; polybutylene resin), Nordbak products (aluminum oxide, fibrous; epoxy resin; silicon carbide; silicon dioxide; magnesium oxide; treated fumed silica; neopentyl glycol diglycidyl ether; silicon carbine; aliphatic amines; amine adduct; amine reacted fatty acid; alkyl phenol; triethylenetetramine; lisane derivative; quartz; calcium carbonate epichlorohydrin-4-4'isopropylidene diphenol resin, butyl 2,3-epoxypropyl ether; triphenyl phosphite
Temporary PAG Stockpile	428,400	Potentially acid generating rock	Metals
#1 Ore Stockpile	55,500	Ore	Metals
Cariboo Ore Stockpile	39000	Ore	Metals
Sulphur Pile	5,200	Sulphur compounds	Sulphur compounds
Heap Leach (test facility)	24,000	Sulphur compounds	Metals, sulphur compounds
Underground Operation and Maintenance Area	6,000	Blasting products	?
Magnetite Plant	33,600	Magnetite	Metals (iron oxide)
Concentrate Sheds	2,600	Ore, magnetite	Metals (copper, sulphur, iron, silica, alumiuna)
Orica Site	14,400	Blasting products	Fortan Extra System (Dry product: Ammonium nitrate; petrolium distillates, hydrotreated light; mineral oil. Wet product: ammonium nitrate; diesel fuel; mineral oil)

Cleaning Products	Hazardous Constituents (from MSDS)
ACTION DSC	Didecyl Dimethyl Ammonium Chloride; sodium carbonate; ethyl acoho
ALL PURPOSE WASHROOM CLEANER	Organic acid salt
AQUARESS HAND & BODY SHAMPOO	Water, Sodium Laureth Sulfate, Cocamide DEA, Sodium Chloride, Citric Acid, Diazolidinyl Urea, Glycol Distearate, Tetrasodium EDTA, Fragrance, Cocamide MEA, Laureth-10, Magnesium Nitrate, Methylchloroisothiazolinone, Magnesium Chloride, Methylisothiazolinone, Blue 1 (CI 42090
BLEACH-SODIUM HYPOCHLORITE	Sodium Hypochlorite
BORAXO POWDERED HAND SOAP	Sodium Borate Decahydrate (Borax); sodium soap
CITRUS AIR	Ethanol; D-Limonene; propylene glycol; isobutane; propane
CITRUSOLV-HF	Distillates (petroleum), hydrotreated light; (R)-p-mentha-1,8-diene
CLEAN SPRAY	Ethylene glycol mono butyl ether; tetrapotassium pyrophosphate; tetrasodium salt of ethylenediaminetetraacetic acid
COMPARE	No hazardous ingredients listed on MSDS
COMET DISINFECTANT CLEANER WITH CHLORINOL	Dipropylene glycol N-butyl ether; citric acid
ENGINE DEGREASER	Diethylene gloycol monoethyl ether; ethanol; propane; butane; citrus terpenes; ethanol
FAST ORANGE PUMICE CLEANER	Pumic; ethoxylated C11-C16 alcohol; D-limonene
FLOOR SWEEP-CANOLA OIL BASED	No hazardous ingredients listed on MSDS
GLASS CLEANER WITH AMMONIA	Isopropyl alcohol; propoxy propanol; cipropylene glycol; monomethyl ether; monobutyl ether; ammonia
KLINGER BOWL CLEANER	Citric acid
KRYSTAL GREEN	Ethylene glycol mono butyl ether; monoethanolamine
LEMINEE 23 CLEANER-DISINF.	Alcohols, C12-15, ethoxylated; soda ash; alkyl dimethylbenzylammonium chloride; alkyl dimethyl ethylbenzylammonium chloride; ethyl alcohol
LIQUID HAND SOAP-6000	No hazardous ingredients listed on MSDS
MULTI-KLEEN	2-propanol; 2-propanol; Alcohol Ethoxylate; caustic potash (45%); sodium metasilicate; sodium tripolyphosphate
MULTI-KLEEN-INDUSTRIAL	Sodium metasilicates; 2-butoxyethanol; Alcohol Ethoxylated; sodium tripolyphosphates
NEUTRAL FLOOR CLEANER	Sodium lauriminodipropionate; alcohols C12-C13 ethoxylated; dipropylene glycol monomethyl ether; alcohol ethoxylate (C9-C11)
ORDERLY-DISINFECTAND	Di-(C8-10)-alkyl dimethyl ammonium chlorides; alkyl dimethyl benzyl ammonium chlorides; ethanol; alcohol ethoxylate
PINOSAN	Alkyl dimethyl ammonium chlorides; Didecyl dimethyl ammonium chloride
PLEDGE	Hydrocarbons, C16-C20, n-alkanes, isoalkanes, cyclics,<2% aromatics; white mineral oil (petroleum)
SHOWER SHINE	Phosphoric acid; ethoxylated nonionic detergent; lauryl dimethylamine oxide
STAIN REMOVER AND DEODORIZER-SR (unbelievable)	No hazardous ingredients listed on MSDS
STRATE FLUSH	Hydrochloric acid
SUNLIGHT DISH SOAP	Magnesium oxide; ethyl alcohol; dodecylbenzene sulfonic acid
SUPER-CLEAN DEGREASER (DETERGENT)	Sodium metasilicate; sodium hydroxide; surfactant, glycol blend
SUPER 90 FLOOR FINISH	No hazardous ingredients listed on MSDS
TOUGH GUY LAUNDRY DETERGENT	Sodium carbonate
TOUGH GUY NEUTRAL CLEANER	No hazardous ingredients listed on MSDS
TRISODIUM PHOSPHATE-TSP	Trisodium phosphate dodecahydrate
URINAL BLOCKS	1,4-Dichlorobenzene
VELVA SHEEN	1,8-p-menthadiene; isoparaffinic hydrocarbon; propane/N-butane

Lube Products	Hazardous Constituents (from MSDS)
2-CYCLE MOTOR OIL	Distillates, petroleum, solvent-refined heavy paraffinic; petroleum distillates, hydrotreated light
ANTIFREEZE/COOLANT 50/50	CH_2OHCH_2OH
ANTIFREEZE/COOLANT HEAVY DUTY	CH_2OHCH_2OH
ANTIFREEZE/COOLANT-UNIVERSAL	CH_2OHCH_2OH
ANTIFREEZE - AIR BREAK	CH_3OH
ATF-SUPER	Distillates, petroleum, hydrotreated heavy paraffinic; distillates, petroleum, hydrotreated light paraffinic
ATF-TYPE F	Distillates, petroleum, hydrotreated heavy paraffinic; N-Phenyl-1-naphthylamine
BATTERY CLEANER	2-butyloxyethanol; sodium bicarbonate; detergent; liquefied petroleum gas
BEARING MOUNTS FOR CLOSE FITS	Methacrylate monomer; 2-hydroxyethyl methylate; coumarone-indene resin (mixture); poly(ethyl methacrylate); dimethylbenzyl hydroperoxide
BREAK CLEAN	Heptane; methanol; 2-propane
BREAK FLUID DOT 3 HEAVY DUTY	http://armoredautogroup.com/pdf/STP/STP-Heavy-Duty-Brake-Fluid,-DOT-3-(1-2011).pdf
COMPRESSOR OIL	Hydrotreated light paraffinic distillates, petroleum
FUEL-DIESEL	Diesel; distillates (petroleum), hydrotreated middle; distillates, hydrotreated light (may contain: alkyl nitrate, polyisobutenyl succinic anhydride nitrogen functionalized dispersant, and mixed cyclic amines)
FUEL-GASOLINE	Gasoline, toluene, ethanol, benzene
FULL SYNTHETIC MITOR OIL-KENDALL	Distillates, petroleum, hydrotreated heavy paraffinic
FULL SYNTHETIC MITOR OIL-HIGH PERFORMANCE	Distillates, petroleum, hydrotreated heavy paraffinic
GEAR LUBE-EXTRA DUTY	Residual oils, petroleum, solvent-refined; distillates, petroleum, solvent-dewaxed heavy paraffinic; residual oils, petroleum, solvent-dewaxed; distillates, petroleum, hydrotreated heavy paraffinic; residuum resins
GEAR LUBE-MOLYLUBE SF 100 SEMI-SYN. LIGHT	Graphite, hydrotreated light distillates (petroleum); carbon black; Stoddard solvent; silica, crystalline, quartz; mineral oil; molybdenum compounds; trymethylbenzne
GEAR LUBE- MOLYLUBE SF 100 SEMI-SYN ARCTIC	Distillates (petroleum), hydrotreated heavy naphthenic; distillates (petroleum), hydrotreated heavy paraffinic; distillates (petroleum), solvent-refined heavy paraffinic; hydrotreated light distillates (petroleum); Stoddard solvent
GEAR LUBE-MP	Lubricant base oil (light)
GEAR LUBE- TRITON SYN	1-Decene, homopolymer, hydrogenated
GEAR SHIELD NC	Bitumen; distillates (petroleum), hydrotreated light; distillates (petroleum), hydrotreated middle; zinc compounds
GEAR SHIELD-HEAVY	Heavy hydrotreated naphthenic distillates (petroleum); petroleum hydrocarbon; residual oils (petroleum), solvent dewaxed; petroleum asphalt; zinc oxide; 12 hydroxystearic acid; carbon black; inedible animal grease; lithium hydroxide monohydrate
GUARDOL ECT-MOTOR OIL (TITANIUM)	Lubricant base oil (petroleum); proprietary additives
GUARDOL QLT-MOTOR OIL	Distillates, petroleum, hydrotreated heavy paraffinic
HT/4 FLUID	Distillates, petroleum, hydrotreated heavy paraffinic; distillates, petroleum, solvent-refined heavy paraffinic; residual oils, petroleum, solvent-dewaxed; distillates, petroleum, solvent-dewaxed heavy paraffinic
HYDRAULIC/TRACTOR FLUID	Distillates, petroleum, hydrotreated heavy paraffinic; distillates, petroleum, solvent-dewaxed heavy paraffinic
HYDRAULIC OIL-MEGAFLOW AW	Distillates, petroleum, hydrotreated heavy paraffinic;
HYDRAULIC OIL-SUPER	Zinc compounds; lubricant base oil (petroleum)
KOPR-KOTE	Talc; graphite; copper; molybdenum disulphide
LUBRIPLATE CHAIN AND CABLE FLUID	Heavy and light hydrotreated naphthenic distillates (petroleum); carbon dioxide; 2-butoxyethanol; light distillate; aliphatic petroleum distillate
MAROK-ROCK DRILL OIL	Distillates, petroleum, hydrotreated light naphthenic
MEGAPLEX XD3	Lubricant base oil (petroleum); molybdenum disulfide; carbonic acid, calcium salt
MEGAPLEX XD5	Lubricant base oil (petroleum); molybdenum disulfide; zinc dialkyl dithiophosphate
MOLY LOW TEMP	Distillates, petroleum, hydrotreated light naphthenic; distillates, petroleum, hydrotreated heavy naphthenic; molybdenum (IV) sulfide
MULTIPLEX-RED	Phosphorodithioic acid, O,O-di-C1-14-alkyl esters, zinc salts; lubricating oils (petroleum), hydrotreated solvent-refined bright stock-based; alkyl Imidazoline; lubricant base (petroleum)
OMNIGUARD	Lubricant base (petroleum); calcium carbonate
OSBORN BLUE LAYOUT FLUID	Acetone; methyl ethyl ketone; liquified petroleum gas; ethyl acetate; xylene; butyl acetate; isopropyl alcohol; nitrocellulose
POLYTAC EP	Distillates, petroleum, hydrotreated heavy naphthenic; distillates, petroleum, solvent-refined heavy paraffinic; N-Phenyl-1-naphthylamine
PYROSHIELD 9011	Amines, C12-14-alkyl, reaction products
QUIK PENETRATING SOLVENT	Mineral spirits; white mineral oil; propane
REDTAC	Naphthenic acids, zinc salts; lubricating oils (petroleum)
SKF GREASE (LGEP 2)	Phosphorodithioic acid, O,O-di-C1-14-alkyl esters, zinc salts; lubricating oils (petroleum), hydrotreated solvent-refined bright stock-based
SOLVENT	Stoddard solvent
SUPER MOTOR OIL	Distillates, petroleum, hydrotreated heavy paraffinic
SUPER SYNTHETIC BLEND MOTOR OIL	Distillates, petroleum, hydrotreated heavy paraffinic
TRANSFORMER OIL	Distillates, petroleum, hydrotreated light naphthenic
TRITON 220	Synthetic lubricant base oil
UNIMIX 2-CYCLE OIL	Lubricant base oil (petroleum); hydrotreated distillate, light C9-C16
UNOBA EP	Lubricant base oil (petroleum); calcium carbonate; proprietary additives
VICTAULIC LUBRICANT	Fatty acids, tall-oil, potassium salts; 1,2-Propylene glycol; mica
WASHER FLUID	Methanol
WHITE LITHIUM GREASE	Hexane isomers; n-hexane; heavy napthenic petroleum distillates; liquefied petrolum gas

Chemial Products	Hazardous Constituents (from MSDS)
AERO 208 PROMOTER	phosphorodithioic acid, O,O-bis(methylpropyl) ester, sodium salt, phosphorodithioic acid, o,o-diethyl ester, sodium salt, sodium hydroxide
AERO 3477 PROMOTER	phosphorodithioic acid, O,O-bis(methylpropyl) ester, sodium hydroxide
AERO 7048 PROMOTER	phosphorodithioic acid, O,O-bis(methylpropyl) ester, sodium salt, carbamothioic acid, 2-propenyl-, O-(2-methylpropyl) ester, isobutanol, sec-butyl alcohol, sodium hydroxide
AERO 7279 PROMOTER (DISCONTINUED)	carbamothioic acid, 2-propenyl-, O-(2-methylpropyl) ester, isobutanol, phosphorodithioic acid, O,O-bis(2-methylpropyl) ester, sodium salt, nonylphenol ethoxylate, sec-butyl alcohol
AERO 5100 PROMOTER	modified thionocarbamate #1, sec-butyl alcohol, isobutanol, modified thionocarbamate #2
DANAFLOAT 262	carbamothioic acid, ethyl-, *O*-(1-methylethyl) ester, isopropanol
DANAFLOAT 262T (unavailable)	carbamothioic acid, ethyl-, O-(1-methylethyl) ester, isopropanol, 1-dodecanethiol
DANAFLOAT 468	phosphorodithioic acid, O,O-bis(methylpropyl) ester, sodium salt, phosphorodithioic acid, o,o-diethyl ester, sodium salt, sodium hydroxide
CARBON DIOXIDE	carbon dioxide
HELIUM	helium
HIGHT CALCIUM QUICKLIME	calcium oxide, crystalline silica quartz
IPAC 6832	no hazardous ingredents listed on MSDS
IRON CHIP ACCELERATOR	iron; iron oxide dust
LECOCEL II and II HP	tungsten, tin
LECOSORB	non-fibrous silicate
LIQUID HEAT	diethylene glycol; non-hazardous ingredients held as trade secret
MAGNETITE	iron oxide
MIBC	methyl isobutyl carbinol
POLYCLEAR 2529	anionic water-soluble polymer
POLYCLEAR 2528	anionic water-soluble polymer
POLYCLEAR 2532	long-chain polymer
POLYCLEAR 2530	long-chain polymer
POLYFROTH W22C FROTHER	polyoxyalkylene alkyl ether, methyl isobutyl carbinol
POTASSIUM AMYL XANTHATE 85%	potassium amyl xanthate
POTASSIUM AMYL XANTHATE 90%	potassium amyl xanthate
SODIUM HYDROSULFIDE 36% SOLUTION	sodium hydrosulfide, sodium carbonate, sodium sulfide, nonahydrate
SODIUM HYDROXIDE SOLUTIONS	sodium hydroxide
SULPHUR	sulphur
TMT 15	1,3,5-triazine-2,4,6(1H,3H,5H)-trithione, triosodium salt
VULTREX-TOOL JOINT COMPOUND-	zinc, talc, mixture of severely hydrotreated and hydrocracked base oil (petroleum

Welding Products	Hazardous Constituents (from MSDS)
Arcair Electrodes	Iron; manganese; copper; chromium; iron; molybdenum; nickel; silicon; niobium
Arcair Slice Cutting Rod	Nicel; steel
Hardfacing allyed electrode	Titanium dioxide; nickel; silicon dioxide; calcium fluride
ER70S2	Iron; carbon; copper; manganese; phosphorus; molybdenum; silicon; titanium; zirconium
Carbon ring	Sulfur dioxide; nitrogen
Welding rods	Iron; chromium; nickel; maganese; silicon; molybdenum; columbium; titanium dioxide; sodium fluoride; talc; calcium fluoride; crystalline silica respirable; silicon; molybdenum; titanium; cobalt; copper
Welding wire	Iron; manganese; titanium dioxide; nickel; calcium flouride
WIA Fabshield 4 Hobart	Metals (numberous)
Wearsheild BU	Iron; limestone and/or calcium carbonate; silicates; fluorides; silicon and/or silicon alloys and compounds; manganese and/or manganese alloys and compounds; chromium and chromium alloys and/or compounds; quartz; cellulose and other carbohydrates; iron oxides; carbon steel core wire
Wearhshield ME	Chromium and chromium alloys or compounds; titanium dioxides; mineral silicates; silicates; limestone and/or calcium carbonate; magnesite; fluride; cellulose and other carbohydrates; iron; silicon and/or silicon alloys and compounds; quartz
Acetylene	Acetylene
Blueshield	Argon

Stage 1 Preliminary Site Investigation Scope and Estimated Costs for Budget Planning Purposes

Task	Scope	Cost
Baseline report	MCMC collects information on all APECs, prepare working tables, figures and photos. Golder organizes report in CSR format and checks information in the field and through meetings with MCMC.	$25,000
Update reports	The Stage 1 PSI is updated when an APEC is decommissioned or at 5 year intervals. Estimated cost of $2,500/update	$25,000
Total		$50,000

Area	~Size(m^2)	Material(s) Stored/Used	Characteristics	Scope	Cost
Fuel Island (light vehicle)	170	Diesel, gasoline	AST with spill protection. No observed or reported spills. Likelihood of contamination is low.	> Limited soil sampling using hand dug pits or excavator test pits > no groundwater sampling > Reporting	$ 5,000
Waste Disposal Area (adjacent to light vehicle fuel island)	90	Batteries, hydrocarbon contaminated waste, used paint, plastic jug recycling	Potential for surface spills	> Soil sampling using hand dug test pits > No groundwater sampling > Reporting	$ 5,000
Fuel Island	1,600	Diesel	AST with spill protection. No observed or reported spills. Likelihood of contamination is low to moderate.	> Soil sampling using excavator test pits > Groundwater sampling > Reporting	$ 25,000
Outside maintenance shop + wash bay	8,200	**Lube Products**, **Welding Products,** diesel	Potential for surface spills	> Soil sampling using excavator test pits > Limited shallow groundwater sampling > Reporting	$ 25,000
Maintenance laydown	17,700	**Lube Products**, diesel	Potential for surface spills	> Soil sampling using excavator test pits > Limited shallow groundwater sampling > Reporting	$ 25,000
Light vehicle maintenance shop + weld barn	1,100	**Lube Products**, **Welding Products,** diesel	Potential for surface spills	> Soil sampling using excavator test pits > Limited shallow groundwater sampling > Reporting	$ 10,000
Warehouse	1,400	waste hydrocarbons contained hydrocarbon products, mill reagents, cleaning products, lube products	Indoor storage on concrete floor. Liklihood of contamination is neglible.	No sampling	$ -
Crusher Yard	6,500	**Lube Products**, diesel	Potential for surface spills	> Limited soil sampling using hand dug pits or excavator test pits > no groundwater sampling > Reporting	$ 25,000
Crusher Area	38,400	Ore	Potential for residual contamination of soil and shallow groundwater	> Limited soil sampling using hand dug pits or excavator test pits > limited shallow groundwater sampling > Reporting	$ 35,000
Temporary PAG Stockpile	428,400	Potentially acid generating rock	Potential for residual contamination of surface soil and groundwater after PAG stockpile has been backfilled into Springer Pit	> Soil sampling using excavator test pits > Groundwater sampling > Reporting	$ 50,000
#1 Ore Stockpile	55,500	Ore	Potential for residual contamination of surface soil and groundwater after ore stockpile has been removed.	> Limited soil sampling using hand dug pits or excavator test pits > limited shallow groundwater sampling > Reporting	$ 35,000
Cariboo Ore Stockpile	39000	Ore	Potential for residual contamination of surface soil and groundwater after ore stockpile has been removed.	> Soil sampling using excavator test pits > Groundwater sampling > Reporting	$ 35,000
Sulphur Pile	5,200	Sulphur compounds	Potential for residual contamination of surface soil and groundwater after sulphur pile has been removed.	> Soil sampling using excavator test pits > Groundwater sampling > Reporting	$ 25,000
Heap Leach (test facility)	24,000	Sulphur compounds	Potential for residual contamination of surface soil and groundwater after sulphur has been removed.	> Soil sampling using excavator test pits > Groundwater sampling > Reporting	$ 35,000
Underground Operation and Maintenance Area	6,000	Blasting products	Potential for residual contamination of surface soil and shallow groundwater.	> Limited soil sampling using hand dug pits or excavator test pits > limited shallow groundwater sampling > Reporting	$ 15,000
Magnetite Plant	33,600	Magnetite	Potential for residual contamination of surface soil and shallow groundwater.	> Limited soil sampling using hand dug pits or excavator test pits > limited shallow groundwater sampling > Reporting	$ 35,000
Concentrate Sheds	2,600	Ore, magnetite	Indoor storage on concrete floor. Liklihood of contamination is neglible.	No sampling	$ -
Orica Site	14,400	Blasting products	Potential for residual contamination of surface soil and shallow groundwater.	> Limited soil sampling using hand dug pits or excavator test pits > limited shallow groundwater sampling > Reporting	$ 25,000
					$ 410,000


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MPMC APECs
Draft for Discussion Purposes
Drawn by: KM
Date: 2015 08 20
Underground Operation
Temporary PAG Stockpiles
Sulphur Pile
Heap Leach
#1 Ore Stockpile
Fuel Island
Crusher Yard
Wash Bay and Maintenance Area
Crusher Area
Maintenance Laydown
Warehouse
Magnetite Plant
Cariboo Ore Stockpile
Orica Site
Sulphur Pile
Heap Leach
#1 Ore Stockpile
Fuel Island
Crusher Yard
Wash Bay and Maintenance Area
Ligth Vehicle Shop
Crusher Area
Maintenance Laydown
Warehouse
Concentrate Sheds
Fountain Tire
Magnetite Plant
Cariboo Ore Stockpile

APPENDIX Q:

GROUNDWATER SEEPAGE PREDICTIONS FOR THE SPRINGER PIT – RESTRICTED OPERATIONS

(GOLDER 2015)

GROUNDWATER SEEPAGE PREDICTIONS FOR THE PHASE 4 SPRINGER AND CARIBOO OPEN PITS

(GOLDER 2015)

TECHNICAL MEMORANDUM

DATE September 11, 2015 **PROJECT No.** 1411734-067-TM-Rev0-15000

TO Katie McMahen, P.Ag.
Mount Polley Mining Corporation

FROM Willy Zawadzki
Don Chorley

EMAIL wzawadzki@golder.com

GROUNDWATER SEEPAGE PREDICTIONS FOR THE SPRINGER OPEN PIT AT CLOSURE – MOUNT POLLEY MINE

1.0 INTRODUCTION

This technical memorandum presents predictions of groundwater seepage for the Springer Pit Lake at closure at the Mount Polley Mine that is operated by the Mount Polley Mining Corporation (MPMC). These predictions were made in support of the Reclamation and Closure Plan that is currently being prepared for the site. This plan assumes placement of tailings and potentially acid generating (PAG) waste rock in the Springer Pit; therefore, this assessment includes the effects of these materials on pit lake formation.

The analysis presented in this memorandum builds on the analysis that was completed in 2010 for the ultimate configuration of the Springer Pit that assumed no tailings/waste rock deposition in the pit (Golder, 2010) and on the additional analysis completed in 2014 as part of mine water management analyses that assumed the presence of tailings/waste rock in the pit (Golder, 2014). These analyses utilized a numerical groundwater model that considered hydrogeological data that were available at the time of these analyses. The updated analysis presented in this memorandum considers additional hydrogeological and hydrologic data collected at the site since 2014, in particular the hydrogeological investigations that were conducted along the southwest wall of the Springer Pit in the spring of 2015 (Golder, 2015).

This memorandum documents predictions of groundwater seepage from the Springer Pit Lake at closure. It is understood that the pit lake hydrology, quality of pit lake water and resulting seepage quality will be assessed by the concurrent studies conducted by MPMC and Golder.

2.0 CLOSURE PLAN

MPMC provided the closure plan for the mine site. From the perspective of assessing seepage from the Springer Pit Lake, the key assumptions in the plan are:

- Tailings will be placed in the Springer Pit to an elevation of approximately 984 m elevation;
- Waste rock will be placed on top of tailings in the Springer Pit to an elevation of approximately 1033 m elevation;
- Springer Pit will be allowed to flood. The spillover elevation is approximately 1050 m elevation;
- Cariboo Pit will be allowed to flood. The spillover elevation is approximately 1094 m elevation.

Figure 1 presents the current layout of mine facilities in relation to Bootjack Lake and Polley Lake.

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3.0 SEEPAGE PREDICTIONS AT CLOSURE

3.1 Updated Hydrogeological Model

The details of the numerical hydrogeological model that has been developed for the area adjacent to the Springer Pit have been documented in Golder (2010, 2014). These details are not repeated in this memorandum, except for the description of additional model calibration that was completed since the installation of new monitoring wells between Springer Pit and Bootjack Lake (Golder, 2015). The additional model calibration considered previous calibration targets and hydrogeological data collected in the new monitoring wells, as follows:

- **Dewatered Conditions:** steady state calibration to hydraulic heads measured in mid-2014 in the pre-2015 monitoring wells installed near the Springer Pit and corresponding estimates of groundwater inflow to this pit, prior to the formation of the pit lake; and
- **Pit Lake Conditions:** steady state calibration to hydraulic heads measured in July 2015 in the pre-2015 monitoring wells and new monitoring wells installed in 2015 (i.e. the conditions when the Springer Pit Lake level was approximately 1017.2 m elevation).

Steady-state calibration was considered reasonable because hydraulic heads in bedrock surrounding the Springer Pit are expected to equilibrate relatively fast due to low storage properties. In addition nearby presence of several water bodies provides a stabilizing effect on hydraulic heads and watertable elevations.

Minor modifications to the model input parameters were required to achieve sufficient match to all calibration targets. These modifications included an introduction of a more permeable zone extending east from the new monitoring well pair GW15-02 towards Cariboo Pit, within the approximate boundary of brecciated bedrock that is present in this area. The hydraulic conductivity within this zone was increased by a factor of 5 from the values adopted elsewhere for bedrock (Golder, 2014). This increase in hydraulic conductivity is reasonable considering the results of permeability testing that was completed in GW15-2 piezometers (Golder, 2015). The introduction of this zone was necessary to better match the hydraulic heads measured in GW15-2 wells.

Figure 2 presents the results of model calibration for the Dewatered Conditions whereas Figure 3 shows these results for the Pit Lake Conditions. In both calibration scenarios the model predicted hydraulic heads matched the hydraulic heads measured in the monitoring wells reasonably well, with the weighted root-mean-square error of less 5% for the Dewatered Conditions and less than 4% for the Pit Lake Conditions. The model predicted groundwater inflow to the Springer Pit in the Dewatered Conditions scenario was approximately 1100 m^3/day (200 USgpm), which is within the range of inflows estimated for this pit by MPMC. In additional to this base case calibration, a reasonable lower and upper bound calibration scenario was prepared using the same methodology as discussed in Golder (2014). In these lower and upper bound scenarios, the model predicted groundwater inflow to the Springer Pit was 700 m^3/day (130 USgpm) and 1900 m^3/day (350 USgpm), respectively. These values span the range of inflows estimated by MPMC.

3.2 Results

The calibrated hydrogeological model was used to simulate groundwater seepage near the Springer Pit Lake after closure for pit lake level elevations between 990 m and 1050 m. This latter elevation corresponds to the spillover elevation for this pit. As in previous analyses, tailings hydraulic conductivity was assumed to be 1×10^{-6} m/s (sensitivity analyses conducted in 2014 showed that predicted seepage is not significantly affected by this parameter) and waste rock hydraulic conductivity was assumed to be significantly higher than that of the surrounding rock mass. In all model simulations Cariboo Pit Lake level was set at the 1094 m, which represents its spillover elevation, whereas the Springer Pit Lake level was varied between 990 m elevation and 1050 m elevation to provide seepage quantities necessary for this pit lake water balance.

Figure 4 presents the groundwater flow conditions predicted by the base case model for the pit lake elevations between 990 m and 1050 m, whereas Table 1 shows the corresponding groundwater inflow and outflow. These results indicate that groundwater inflow to the pit lake is predicted to gradually decrease from approximately 1110 m^3/day (200 USgpm) 790 m^3/day (150 USgpm) as the pit lake level rises to 1050 m elevation. In agreement with the 2014 predictions, the model also shows that groundwater outflow from the pit lake towards Bootjack Lake would only occur once the pit lake level increases above approximately 1030 m elevation. This outflow was predicted to gradually increase to approximately 150 m^3/day (30 USgpm) once the pit lake level reaches 1050 m elevation.

The results of the hydrogeological model were also used to assess the interaction between the Springer Pit Lake and Cariboo Pit Lake that was required for the concurrent geochemical and hydrology studies. As presented in Table 1, groundwater outflow from the Cariboo Pit Lake was predicted to gradually decrease from approximately 610 m^3/day (110 USgpm) to 480 m^3/day (90 USgpm) as the pit lake level in the Springer Pit increased from 990 m to 1050 m elevation. The majority of this outflow was predicted to discharge to the Springer Pit Lake, whereas 16% to 27% percent of the total outflow (depending on the pit lake level) was predicted to discharge towards Bootjack Lake. Figure 5 presents predicted seepage pathways for the Springer Pit Lake and Cariboo Pit Lake when the water level in both lakes is at the spillover elevations.

Table 1: Predicted Groundwater Flows

Pit Lake Elevation (m)	Springer Pit Lake		Cariboo Pit Lake		
	Into the Lake	Out of the Lake	Into the Lake	Out of the Lake	% towards Bootjack Lake*
Base Case					
990	1110	0	0	610	16%
1010	1060	0	0	600	17%
1020	1010	0	0	590	18%
1030	950	10	0	580	19%
1040	900	60	0	550	21%
1050	790	150	0	480	27%
Lower Reasonable Bound					
1050	510	70	10	260	23%
Upper Reasonable Bound					
1050	1360	290	0	930	30%

***** This value represent predicted % of groundwater outflow from the Cariboo Pit Lake migrating towards Bootjack Lake. The remainder flows to Springer Pit Lake.

Table 1 also presents the predicted inflow and outflow of groundwater from the Springer Pit Lake for the sensitivity scenarios that represent lower and upper bound conditions that could reasonably be expected considering the uncertainty in the hydrogeological model. These results show that, once the pit lake elevation is at 1050 m, the groundwater inflow to the lake could range between 510 m^3/day and 1360 m^3/day. Groundwater outflow from the lake in these scenarios was predicted to range between 70 m^3/day and 290 m^3/day. The corresponding groundwater outflow from the Cariboo Pit Lake could range between 260 m^3/day and 930 m^3/day, with up to 30% of this predicted outflow discharging towards Bootjack Lake.

4.0 SUMMARY AND RECOMMENDATIONS

The hydrogeological analysis that utilized data collected from additional monitoring wells installed in 2015 shows that, for the assumed closure conditions at the Springer Pit, groundwater seepage from this pit would occur once the pit lake level is above 1030 m elevation. When the pit lake level is at the spillover elevation of 1050 m this seepage is predicted to be approximately 150 m^3/day (30 USgpm), and could range between 70 m^3/day and 290 m^3/day due to uncertainty in the hydrogeological conditions. Because of the steep hydraulic gradient that would develop between the pit lake and Bootjack Lake and a short travel distance, the migration of this seepage would be relatively quick (advective travel time of less than one year) with likely limited potential for natural attenuation.

It is recommended that MPMC continue to monitor groundwater conditions as the Springer Pit Lake levels increase. This monitoring should consist of daily water level readings in wells GW12-2a/b, GW15-1a/b, and GW15-2a/b and quarterly water quality sampling at these three locations. The information gathered at these locations should be periodically compared to the predictions discussed in this memorandum so that the hydrogeological model could be refined.

The effects of seepage from the Springer Pit on down-gradient receptors will depend on the pit lake water quality and characteristics of the receiving environment, which are both assessed as part of the concurrent geochemical and hydrology studies. If these studies indicate that these effects are not acceptable, seepage from the pit lake at closure could be reduced or if necessary eliminated by implementing one or the combination of the following mitigation measures:

- **Decreasing the spillover elevation:** The results of the hydrogeological analysis show that when the pit lake level is at 1040 m elevation the predicted seepage is reduced by approximately 60% from the seepage predicted for assumed spillover elevation of 1050 m, and that is essentially eliminated when the pit lake level is at 1030 m elevation. Thus lowering the spillover elevation, in combination with on-going monitoring, could be used to manage the quantity of groundwater seepage at closure such that it is reduced to an acceptable level. Note that sufficient water coverage over the PAG waste rock will be required during closure;
- **Installation of a low-permeability barrier:** Hydrogeological testing conducted near the Springer Pit suggests that the shallow bedrock, down to approximately 50 m below ground surface, is generally more permeable than the deep bedrock (Golder, 2014). It is thus anticipated that a significant portion of seepage from the Springer Pit Lake at closure would migrate through shallow bedrock. Grouting of the shallow bedrock along the southwest crest of the Springer Pit would create a low-permeability barrier that would reduce the seepage quantity; and

- **Passive collection system:** The elevation difference between the Springer Pit and Bootjack Lake is approximately 60 m. This difference is sufficient for the implementation of a passive seepage collection system. Such system would consist of a horizontal drainholes drilled from the lower portion of the slope between the pit lake and Bootjack Lake and terminating approximately 40 m to 50 m below the ground surface. These drainholes would target the pit lake seepage in the shallow and more permeable bedrock adjacent to the Springer Pit. Discharge from these drainholes would be conveyed to the mine water management system.

5.0 CLOSURE

We trust that the above information is sufficient for your needs at this time. Should you have any questions or require clarification, please contact the undersigned at 604-296-4200.

GOLDER ASSOCIATES LTD.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
W. ZAWADZKI
25898
Sept 11 2015
PROFESSIONAL GEOSCIENTIST

Willy Zawadzki, P.Geo.
Principal, Senior Hydrogeologist

Don Chorley, P.Geo.
Principal, Senior Hydrgeologist

WZ/DWC/ch

Attachments: Figure 1: Site Plan
Figure 2: Results of Model Calibration – Dewatered Conditions
Figure 3: Results of Model Calibration – Pit Lake Conditions
Figure 4: Predicted Hydrogeological Conditions Pit Lake Elevation 990 m to 1050 m
Figure 5: Predicted Seepage Pathways for Springer Pit Lake at 1050 m and Cariboo Pit Lake at 1094 m

Attachment 1: Study Limitations

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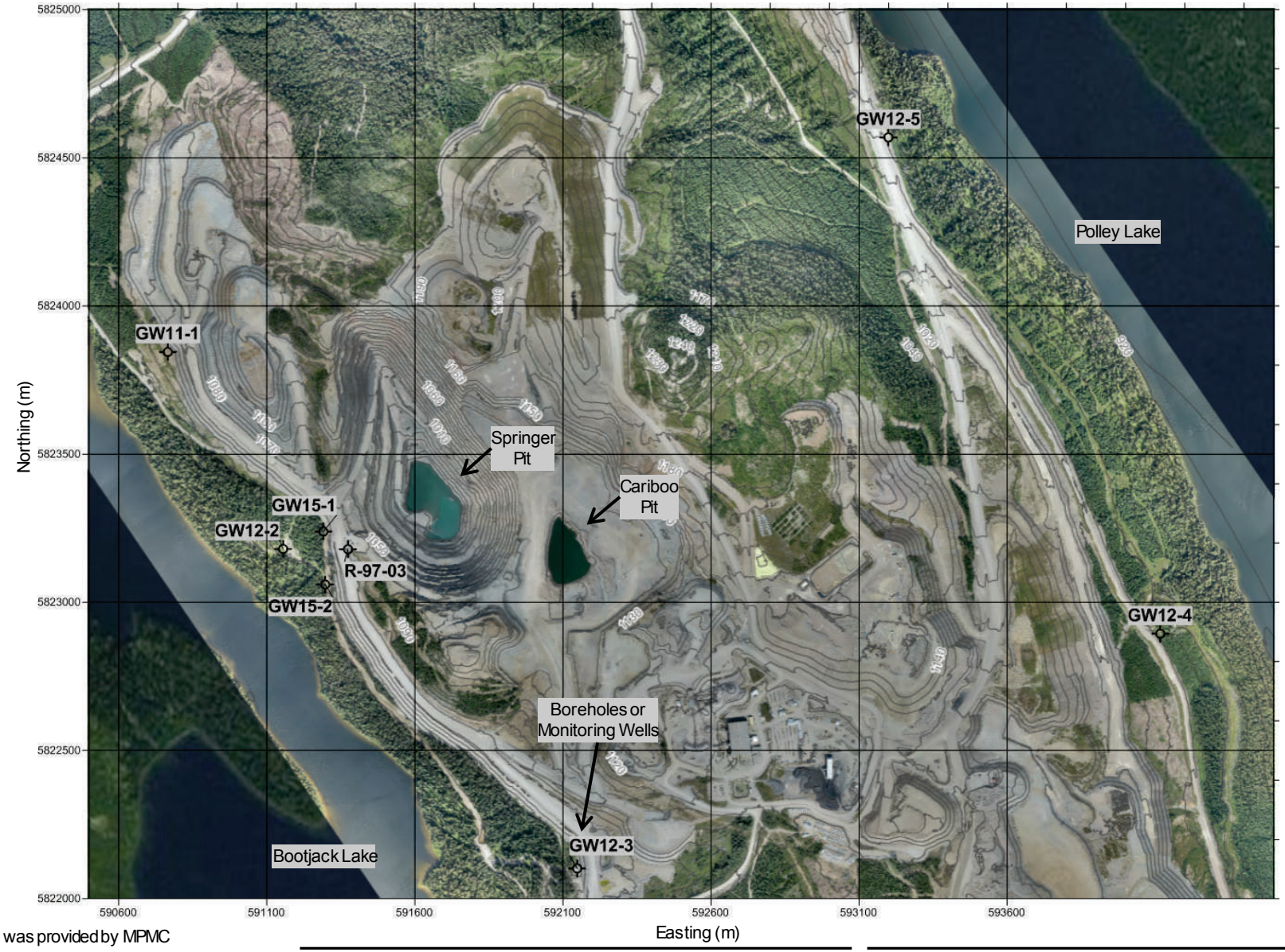
6.0 REFERENCES

Golder Associates Ltd. 2010. *Predictions of Pit Lake Formation for the Springer Open Pit – Mount Polley Mine.* submitted to Mount Polley Mining Corporation on August 19, 2010.

Golder Associates Ltd. 2014. *Updated Predictions of Pit Lake Formation for the Springer Open Pit – Mount Polley Mine*. submitted to Mount Polley Mining Corporation on December 16, 2014.

Golder Associates Ltd. 2015. *Hydrogeological Investigations near the Springer Pit Lake – Mount Polley Mine*. submitted to Mount Polley Mining Corporation on August 28, 2015.

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Notes:
Orthophoto was provided by MPMC

CLIENT
MOUNT POLLEY MINING CORPORATION
LIKELY, BC

PROJECT
GROUNDWATER SEEPAGE PREDICTIONS FOR THE SPRINGER OPEN PIT AT CLOSURE

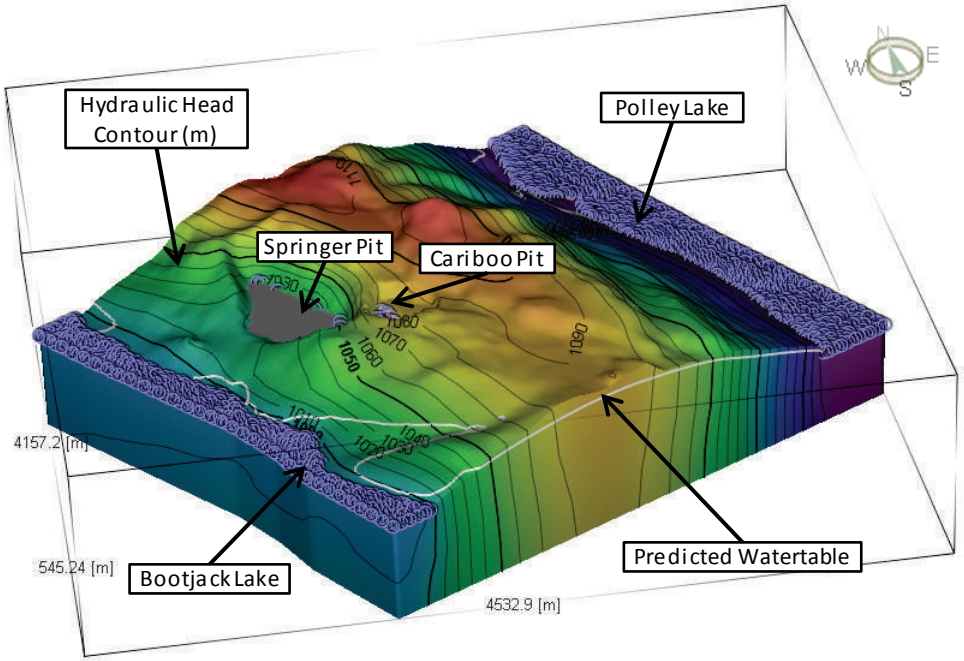
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Golder Associates

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APPROVED	DWC

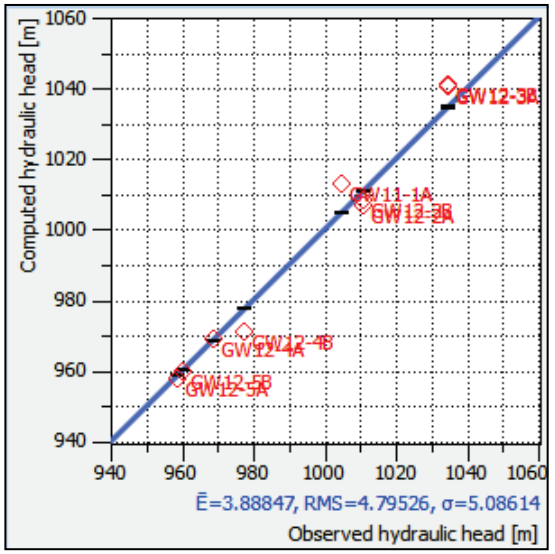
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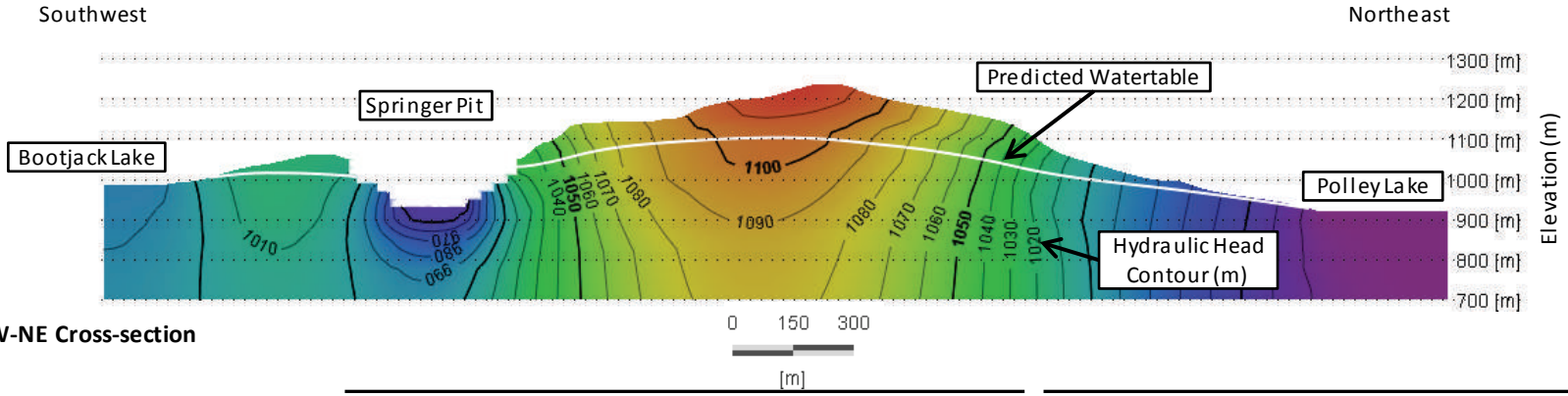
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A. Oblique View Looking NE



C. Comparison of Predicted vs. Observed Hydraulic Heads



B. SW-NE Cross-section

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GROUNDWATER SEEPAGE PREDICTIONS FOR THE SPRINGER OPEN PIT AT CLOSURE

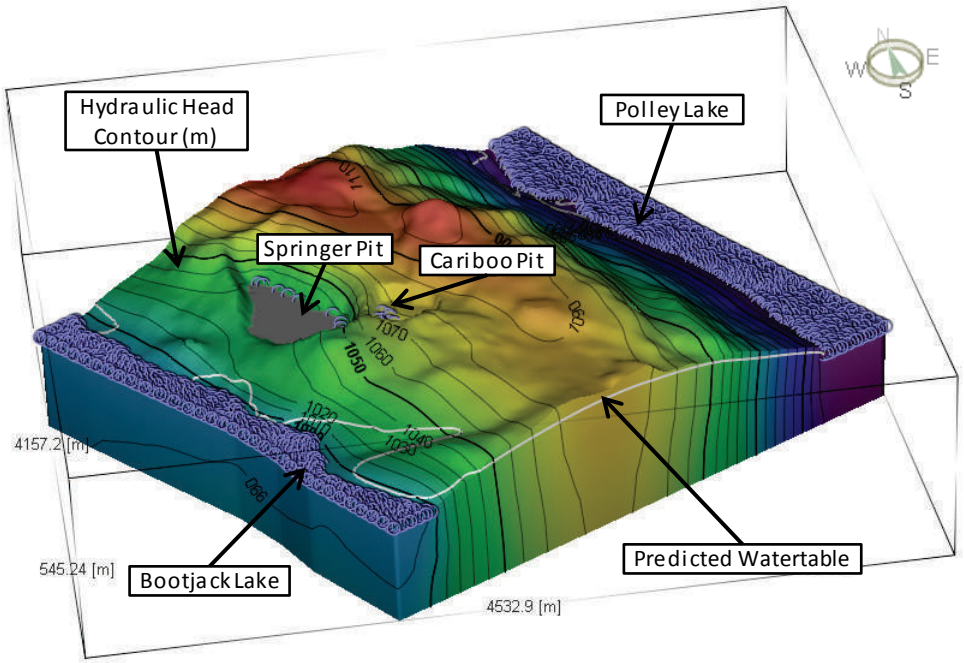
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Golder Associates

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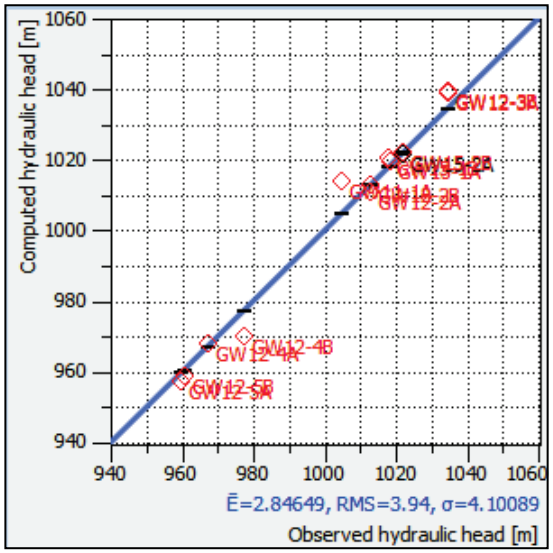
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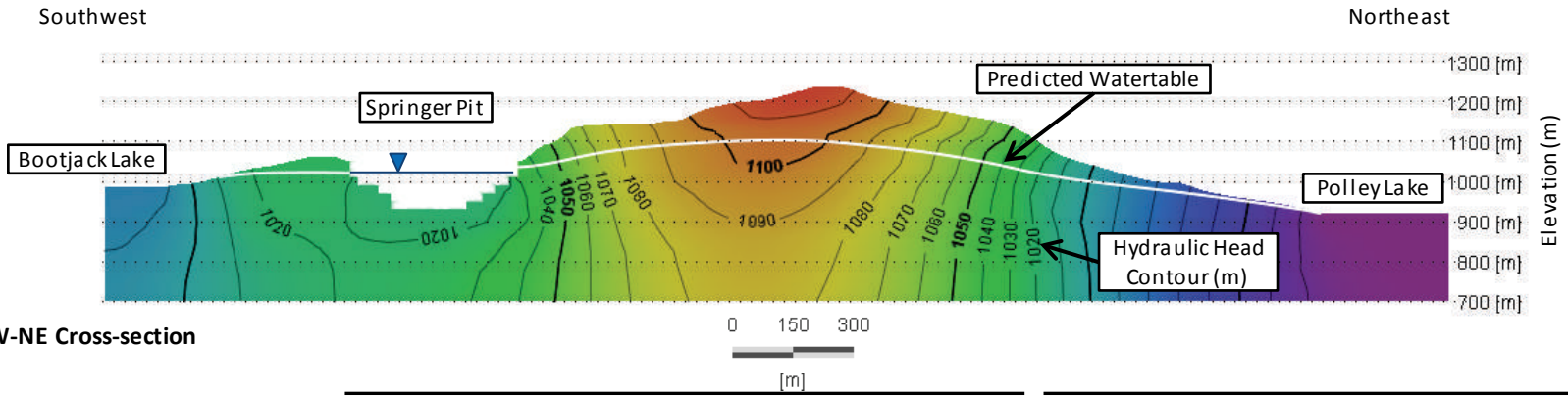
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A. Oblique View Looking NE



C. Comparison of Predicted vs. Observed Hydraulic Heads



B. SW-NE Cross-section

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PROJECT
GROUNDWATER SEEPAGE PREDICTIONS FOR THE SPRINGER OPEN PIT AT CLOSURE

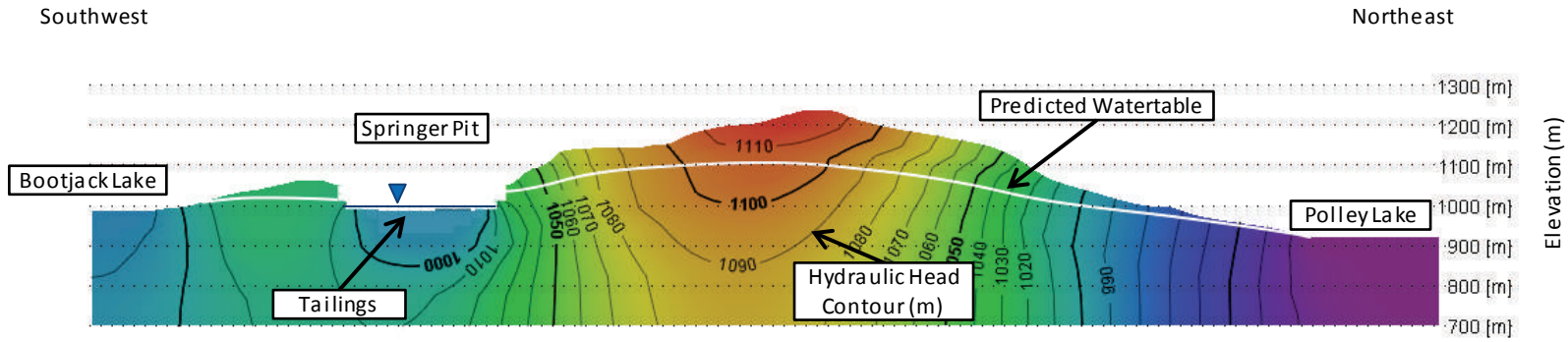
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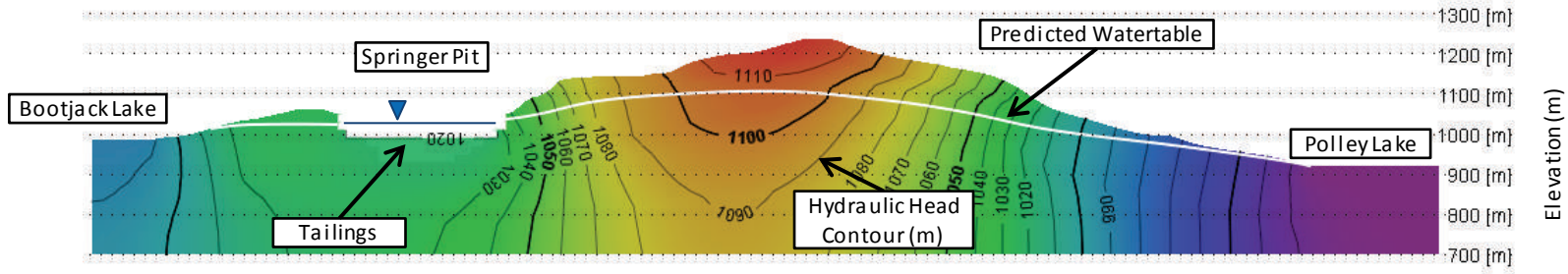
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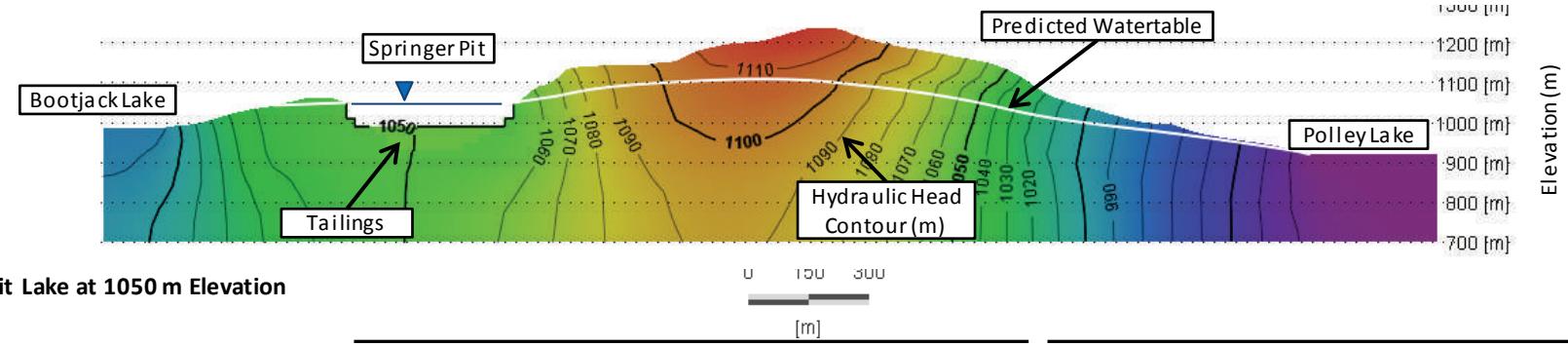
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A. Pit Lake at 990 m Elevation



B. Pit Lake at 1020 m Elevation



C. Pit Lake at 1050 m Elevation

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PROJECT
GROUNDWATER SEEPAGE PREDICTIONS FOR THE SPRINGER OPEN PIT AT CLOSURE

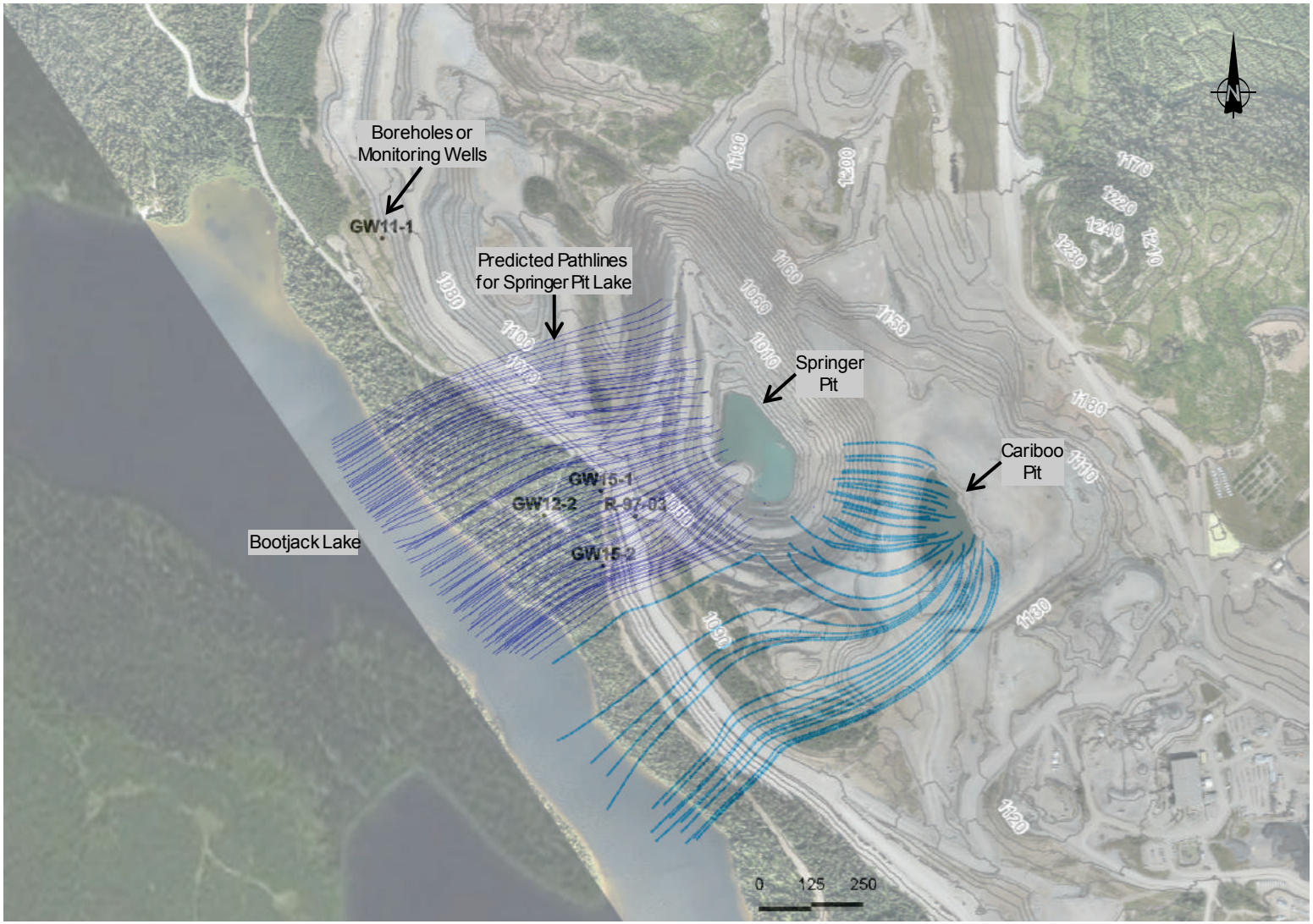
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PREDICTED HYDROGEOLOGICAL CONDITIONS PIT LAKE ELEVATION 990 M TO 1050 M

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LIKELY, BC

CONSULTANT
Golder Associates

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APPROVED	DWC

PROJECT
GROUNDWATER SEEPAGE PREDICTIONS FOR THE SPRINGER OPEN PIT AT CLOSURE

TITLE
PREDICTED SEEPAGE PATHWAYS FOR SPRINGER PIT LAKE AT 1050 M AND CARIBOO PIT LAKE AT 1094 M

PROJECT No.		Rev.	
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ATTACHMENT 1

Study Limitations

Study Limitations

This document has been prepared for the exclusive use of Mount Polley. The factual information, descriptions, interpretations, and comments contained herein are specific to the project described in this document and do not apply to any other project or site. Under no circumstances may this information be used for any other purposes than those specified in the scope of work unless explicitly stipulated in the text of this document or formally authorized by Golder. This document must be read in its entirety as some sections could be falsely interpreted when taken individually or out-of-context. As well, the final version of this document and its content supersedes any other text, opinion or preliminary version produced by Golder.

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Hydrogeologic/hydrologic investigations and groundwater modelling are dynamic and inexact sciences. They are dynamic in the sense that the state of any hydrological system is changing with time, and in the sense that the science is continually developing new techniques to evaluate these systems. They are inexact in the sense that groundwater systems are complicated beyond human capability to evaluate them comprehensively in detail, and we invariably do not have sufficient data to do so. A groundwater model uses the laws of science and mathematics to draw together the available data into a mathematical or computer-based representation of the essential features of an existing hydrogeologic system. While the model itself obviously lacks the detailed reality of the existing hydrogeologic system, the behaviour of a valid groundwater model reasonably approximates that of the real system. The validity and accuracy of the model depends on the amount of data available relative to the degree of complexity of the geologic formations, the site geochemistry, the fate and transport of the dissolved compounds, and on the quality and degree of accuracy of the data entered. Therefore, every groundwater model is a simplification of a reality and the models described herein are not an exception.

The professional groundwater modelling services performed as described in this document were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practising under similar conditions, subject to the quantity and quality of available data, the time limits and financial and physical constraints applicable to the services. Unless otherwise specified, the results of previous or simultaneous work provided by sources other than Golder and quoted and/or used herein are considered as having been obtained according to recognised and accepted professional rules and practices, and therefore deemed valid. This model provides a predictive scientific tool to evaluate the impacts on a real groundwater system of specified hydrological stresses and/or to compare various scenarios in a decision-making process. However and despite the professional care taken during the construction of the model and in conducting the simulations, its accuracy is bound to the normal uncertainty associated to groundwater modelling and no warranty, expressed or implied, is made.

TECHNICAL MEMORANDUM

DATE November 2, 2015 **REFERENCE No.** 1411734-093-TM-Rev0

TO Katie McMahen, P.Ag.
Mount Polley Mining Corporation

FROM Willy Zawadzki
Don Chorley

EMAIL wzawadzki@golder.com
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GROUNDWATER SEEPAGE PREDICTIONS FOR THE PHASE 4 SPRINGER AND CARIBOO OPEN PITS – MOUNT POLLEY MINE – REV 0

1.0 INTRODUCTION

This technical memorandum presents predictions of groundwater seepage for the Phase 4 pit extension of the Springer Open Pit and Cariboo Open Pit at the Mount Polley Mine that is operated by the Mount Polley Mining Corporation (MPMC). These predictions were made in support of the 4-Year Closure Plan that is currently being prepared for the site (Figure 1). This plan assumes mining of the Springer Pit to the ultimate depth of 878 m elevation and mining of the Cariboo Pit to the ultimate depth of 938 m elevation, and thereafter flooding of both pits. The plan does not include deposition of tailings in the open pits at closure.

The hydrogeological analysis presented in this memorandum builds on:

- The analysis that was completed in 2010 for the ultimate configuration of the Springer Pit that assumed no tailings/waste rock deposition in the pit (Golder, 2010);
- The additional analysis completed in 2014 as part of mine water management studies that assumed the presence of tailings/waste rock in the pit (Golder, 2014); and
- The analysis completed between May and September 2015 in support of the 1-Year Closure Plan (Golder, 2015a, 2015b, 2015c);

The above analyses utilized a numerical groundwater model that considered hydrogeological data that were available at the time each study was conducted. The latter study includes 2015 site investigations that were carried out in the area between Bootjack Lake and Springer Pit (Golder, 2015b). The details of groundwater model construction and calibration have been documented previously and are not repeated herein.

This memorandum documents predictions of groundwater seepage near the Springer Pit and Cariboo Pit for the 4-Year Closure Plan. It is understood that the pit lake hydrology, quality of pit lake water and resulting seepage quality will be assessed by the concurrent studies conducted by MPMC and Golder.

2.0 CLOSURE PLAN

MPMC provided the 4-Year Closure Plan for the mine site, including a pit shell for the Phase 4 extension of the Springer Pit and Cariboo Pit (Figure 2). From the perspective of assessing seepage near the Springer Pit and Cariboo Pit, the key assumptions in the plan are:

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- Springer Pit and Cariboo Pit will be mined to the ultimate depths of approximately 878 m and 938 m elevation, respectively;
- The ground elevation along the pit wall separating the Springer Pit and Cariboo Pit will be approximately 1028 m;
- Springer Pit and Cariboo Pit will be allowed to flood. Once the pit lake level is above approximately 1028 m elevation, the pit lakes in these two pits will merge and form a single pit lake. The spillway elevation for this pit lake is approximately 1050 m elevation;
- Potentially Acid Generating (PAG) materials will be placed in the Springer Pit up to an elevation of approximately 1028 m; and
- Tailings will not be deposited in the Springer Pit and Cariboo Pit.

3.0 SEEPAGE PREDICTIONS AT PHASE 4 CLOSURE

The seepage near the Phase 4 Springer Pit and Cariboo Pit was predicted by the numerical groundwater model using the same methods as described in Golder (2015c). The model mesh was modified to incorporate the extent of the Phase 4 open pits, and the model was then run for conditions representing the fully dewatered conditions at the end of mining and conditions representing rising pit lake levels up to the spillway elevation of 1050 m. In these model simulations it was assumed that the PAG materials that will be placed in the Springer Pit have hydraulic conductivity significantly higher than the surrounding rockmass, and thus offer no resistance to seepage entering or exiting the pit lake.

For comparison purposes, Figure 3 presents hydrogeological conditions for the existing Springer Pit in July 2015, when the pit lake water level was at approximately 1017.2 m, that were calculated during calibration of the groundwater model (Golder, 2015c). Figure 4 and Figure 5 present predictions for the Phase 4 pit extension for the fully dewatered pit (Figure 4 panel A) and increasing pit lake levels up to the spillway elevation of 1050 m (Figure 5 panel C). The corresponding seepage quantities predicted by the model are summarized in Table 1.

Table 1: Predicted Groundwater Flows

Pit Lake Elevation (m)	Springer Pit Lake (m^3/day)		Cariboo Pit Lake (m^3/day)	
	Into the Lake	Out of the Lake	Into the Lake	Out of the Lake
Base Case				
880	500	0	590*	0*
940	490	0	590	0
960	480	0	590	0
980	450	0	570	0
1000	410	0	530	0
1020	320	0	450	0
1030	300	60	420	0
1040	270	150	380	0
1050	250	250	320	10
Lower Reasonable Bound				
1050	170	180	220	10
Upper Reasonable Bound				
1050	420	580	500	50

*These values represent conditions when the Cariboo Pit is fully dewatered (i.e., the base of the Cariboo Pit is at ~938 m elevation).

Model results indicated that when the Phase 4 Springer Pit and Cariboo Pit are fully dewatered, the respective groundwater inflow to these pits would be approximately 500 m^3/day (90 USgpm) and 590 m^3/day (100 USgpm). When fully dewatered, both pits would act as strong groundwater sinks that would reverse groundwater flow between the Bootjack Lake and the pits such that seepage from the Bootjack Lake to the underlying bedrock would occur. As the pit lake level rises, the groundwater seepage into the pit lake was predicted to gradually decease to approximately 250 m^3/day (50 USgpm) in the Springer Pit and 320 m^3/day (60 USgpm) in the Cariboo Pit once the spillway elevation of 1050 m is reached.

In addition, as the pit lake level approaches the 1030 m elevation and then increases above this elevation, seepage of pit lake water into the subsurface was predicted to occur. For the Springer Pit, this seepage was calculated to gradually increase from approximately 60 m^3/day (10 USgpm) for the pit lake level of 1030 m to 250 m^3/day (50 USgpm) for the pit lake level of 1050 m. In the Cariboo Pit, seepage towards the Bootjack Lake of approximately 10 m^3/day (2 USgpm) was predicted to occur only when the pit lake level approaches 1050 m elevation. Figure 6 shows seepage pathways predicted for the conditions representing the pit lake at the spillway elevation. Uncertainty in the predicted seepage rates, as presented in Table 1, was quantified using the same approach as the one that was adopted in previous analyses (i.e. Golder, 2015c).

In general, the predicted seepage rates into the Springer Pit are lower than the rates that were reported in the previous analyses. These previous analyses were carried out on pit shells that did not include merging of the pit lakes, with spillway elevation of the Cariboo Pit Lake set at approximately 1094 m elevation (instead of the Phase 4 spillway at 1050 m). The assumed presence of a separate Cariboo Pit Lake with water level much higher than in the Springer Pit Lake resulted in a relatively significant cross-seepage from Cariboo Pit to the Springer Pit in these previous analyses. In the presence of merged pit lakes, as incorporated in the Phase 4 mine plan, this cross-seepage is non-existent and hence the predicted seepage into the Springer Pit is lower.

4.0 SUMMARY AND RECOMMENDATIONS

Groundwater seepage for the Phase 4 Springer Pit and Cariboo Pit was predicted using the existing groundwater model. When both pits are fully dewatered, the predicted groundwater inflow was approximately 500 m^3/day (90 USgpm) and 590 USgpm (100 USgpm), respectively. Once the lake level in both open pits reaches its spillway elevation of 1050 m, seepage from the pit lake towards the Bootjack Lake was calculated to be approximately 250 m^3/day (50 USgpm) for the Springer Pit and 10 m^3/day (2 USgpm) for the Cariboo Pit.

As was previously discussed in Golder (2015c), it is recommended that MPMC continue to monitor groundwater conditions as the Springer Pit lake levels change. This monitoring should consist of daily water level readings in wells GW12-2a/b, GW15-1a/b, and GW15-2a/b and quarterly water quality sampling at these three locations. Once the pit lake is dewatered and mining operations resume, this monitoring should also include measurements of groundwater inflow to the Springer Pit and Cariboo Pit, and observation of seepage conditions in the pit walls. This information should be periodically compared to the predictions discussed in this memorandum so that the hydrogeological model could be refined, if necessary.

The effects of seepage from the Springer Pit and Cariboo Pit lakes on down-gradient receptors will depend on the pit lake water quality and characteristics of the receiving environment, which are assessed as part of the concurrent geochemical and hydrology studies. If these studies indicate that these effects are not acceptable, seepage from the pit lake at closure could be reduced or if necessary eliminated by implementing one or the combination of the mitigation measures that were discussed in Golder (2015c).

5.0 CLOSURE

We trust that the above information is sufficient for your needs at this time. Should you have any questions or require clarification, please contact the undersigned at 604-296-4200.

GOLDER ASSOCIATES LTD.

Nov 2 2015 W. ZAWADZKI 25898

Willy Zawadzki, P.Geo.
Principal, Senior Hydrogeologist

Don Chorley, P.Geo.
Principal, Senior Hydrgeologist

WZ/DWC/asd

Attachments:
Figure 1: Site Plan
Figure 2: Phase 4 Springer Pit and Cariboo Pit
Figure 3: Results of Model Calibration – Pit Lake Conditions – July 2015
Figure 4: Predicted Hydrogeological Conditions – Open Pits Dewatered – Pit Lake Level 960 m – Pit Lake Level 980 m
Figure 5: Predicted Hydrogeological Conditions – Pit Lake Level 1000 m – Pit Lake Level 1030 m – Pit Lake Level 1050 m
Figure 6: Predicted Seepage Pathways for Springer Pit and Cariboo Pit Lake at 1050 m
Attachment 1: Study Limitations

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6.0 REFERENCES

Golder Associates Ltd. 2010. *Predictions of Pit Lake Formation for the Springer Open Pit – Mount Polley Mine.* submitted to Mount Polley Mining Corporation on August 19, 2010.

Golder Associates Ltd. 2014. *Updated Predictions of Pit Lake Formation for the Springer Open Pit – Mount Polley Mine*. submitted to Mount Polley Mining Corporation on December 16, 2014.

Golder Associates Ltd. 2015a. *Additional Prediction of Water Level and Seepage in the Springer Pit Lake for May 205 to December 2016 – Mount Polley Mine*. draft submitted to Mount Polley Mining Corporation on May 5, 2015.

Golder Associates Ltd. 2015b. *Hydrogeological Investigations near the Springer Pit Lake – Mount Polley Mine*. submitted to Mount Polley Mining Corporation on August 28, 2015.

Golder Associates Ltd. 2015c. *Groundwater Seepage Predictions for the Springer Pit at Closure – Mount Polley Mine*. submitted to Mount Polley Mining Corporation on September 11, 2015.



Notes:
Orthophoto was provided by MPMC

CLIENT
MOUNT POLLEY MINING CORPORATION
LIKELY, BC

PROJECT
GROUNDWATER SEEPAGE PREDICTIONS FOR THE PHASE 4 SPRINGER AND CARIBOO OPEN PITS

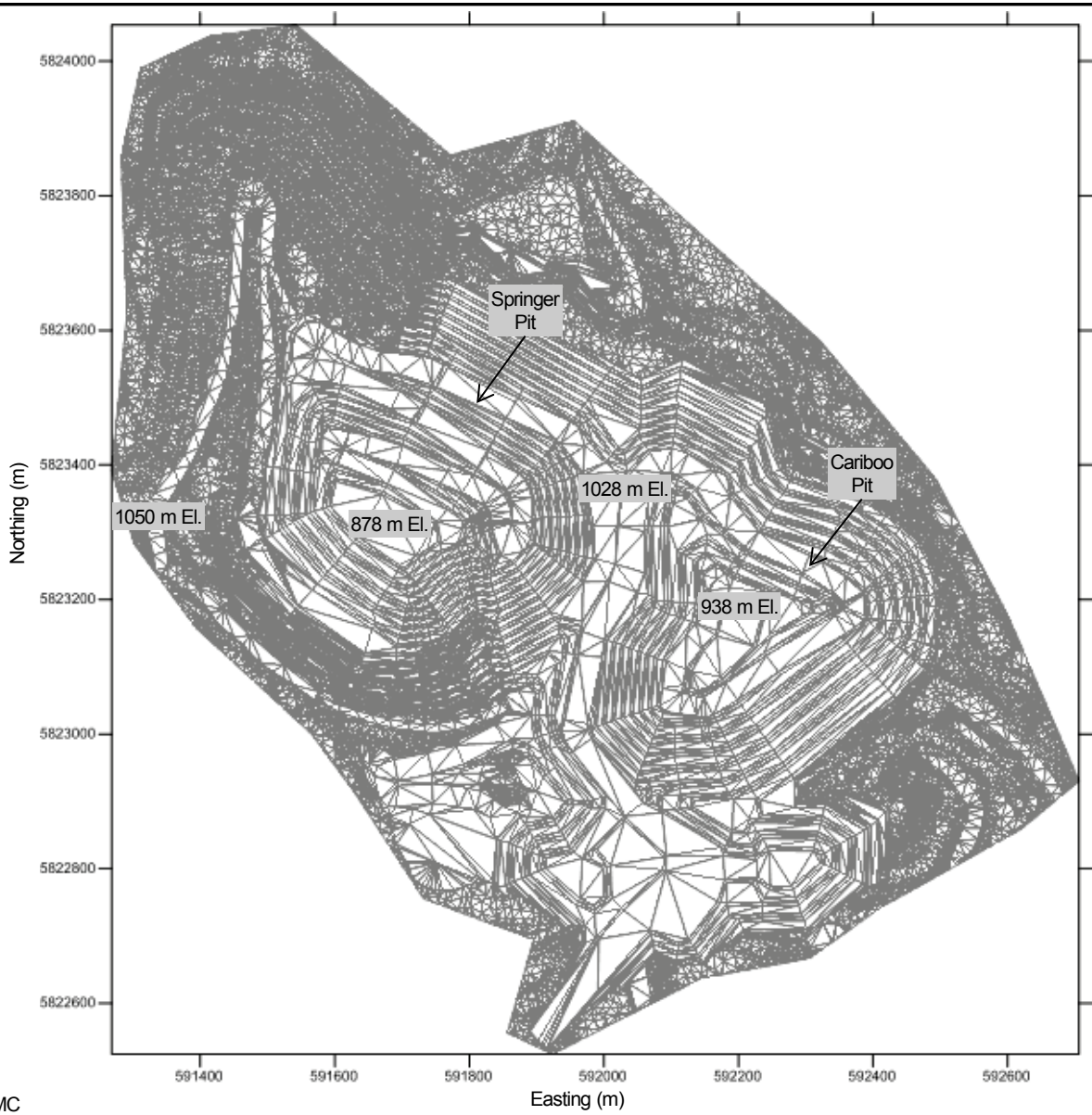
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Golder Associates

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APPROVED	DWC

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PROJECT No.		Rev.	
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Notes:
AutoCad drawing was provided by MPMC in file Total Pit Walls - Cariboo-SP4.dxf

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PROJECT
GROUNDWATER SEEPAGE PREDICTIONS FOR THE PHASE 4 SPRINGER AND CARIBOO OPEN PITS

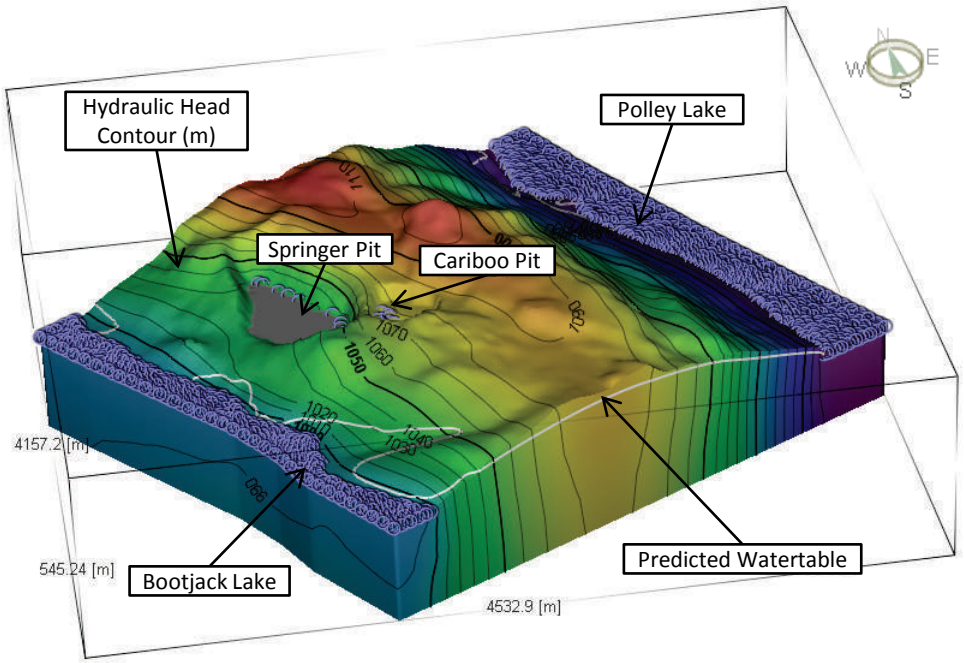
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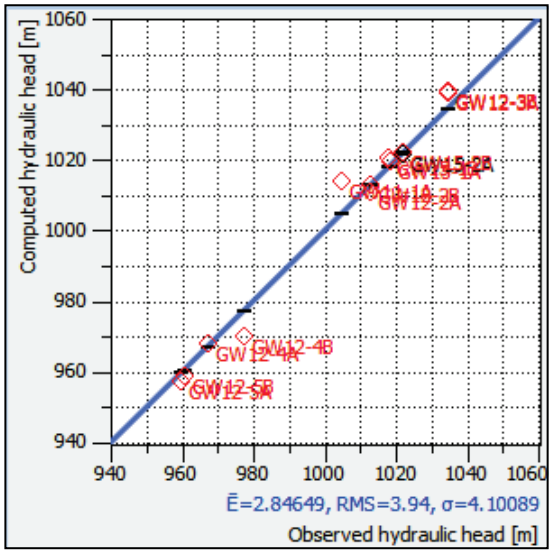
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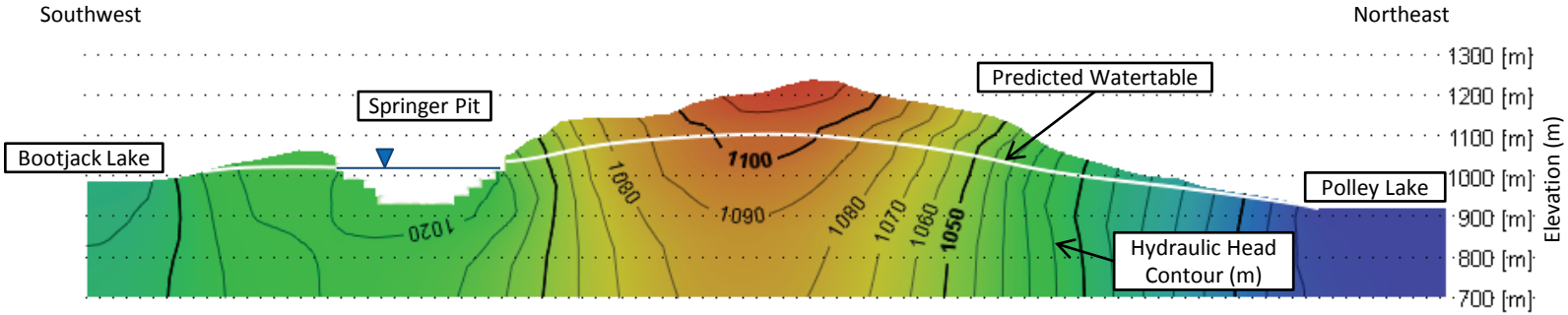
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A. Oblique View Looking Northeast



C. Comparison of Predicted vs. Observed Hydraulic Heads



B. SW-NE Cross-section

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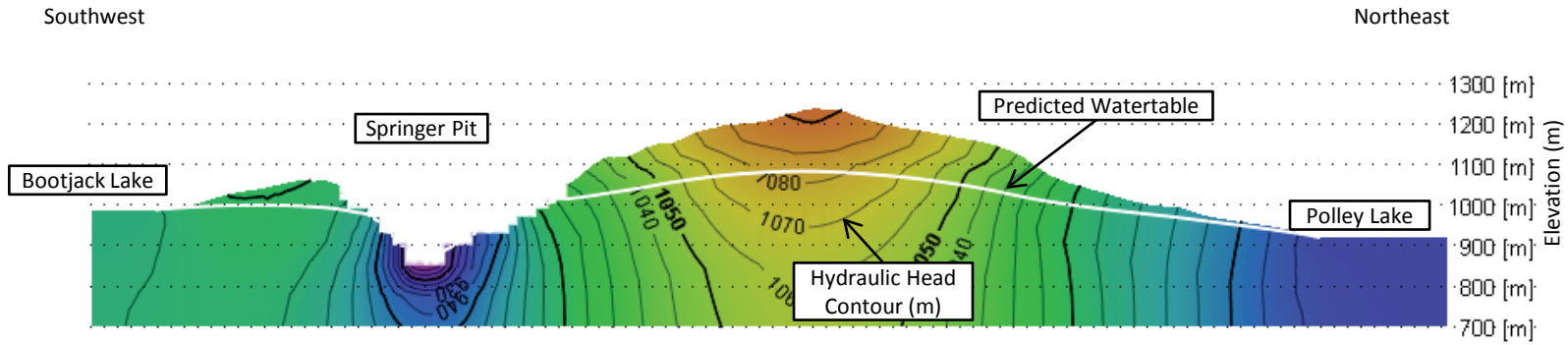
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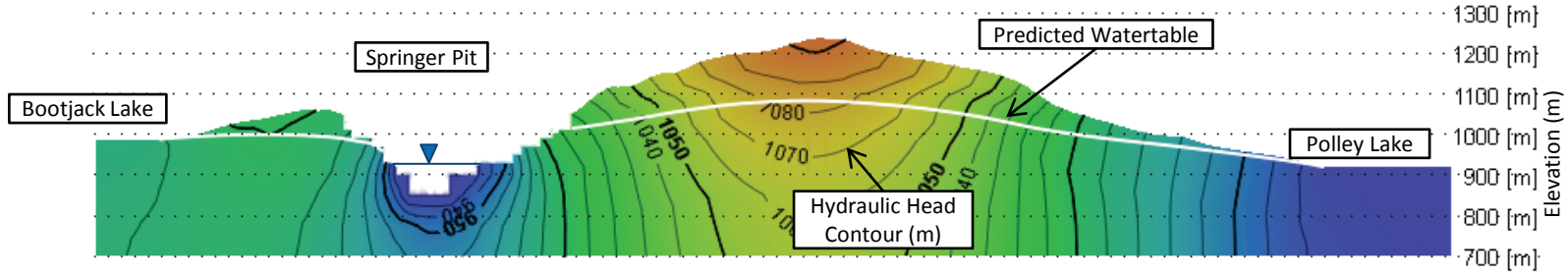
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Rev. **0**

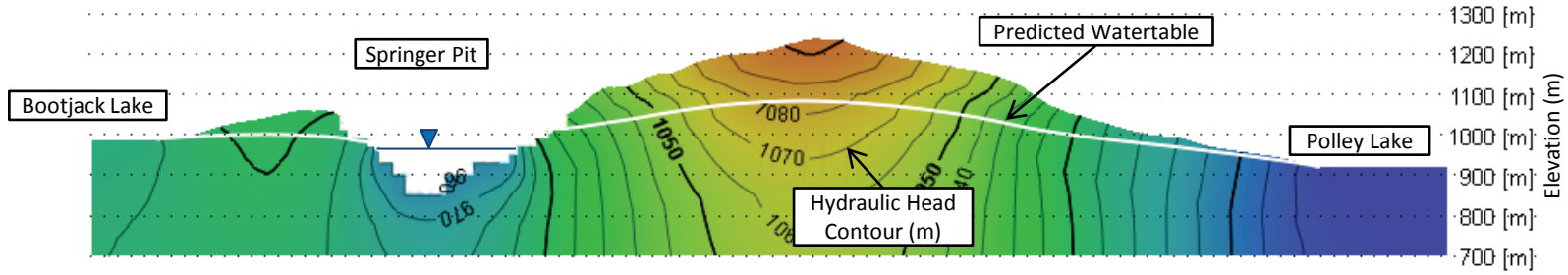
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A. Open Pits Fully Dewatered



B. Pit Lake at 920 m Elevation



C. Pit Lake at 960 m Elevation

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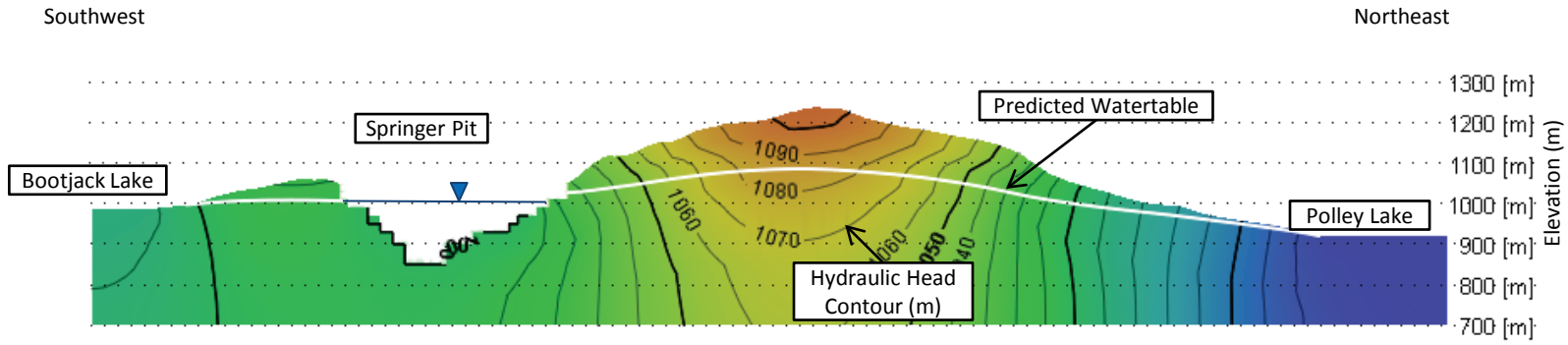
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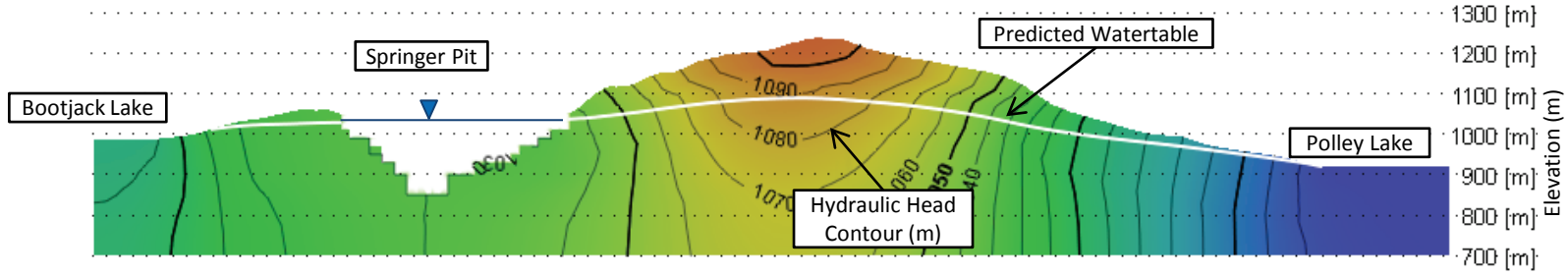
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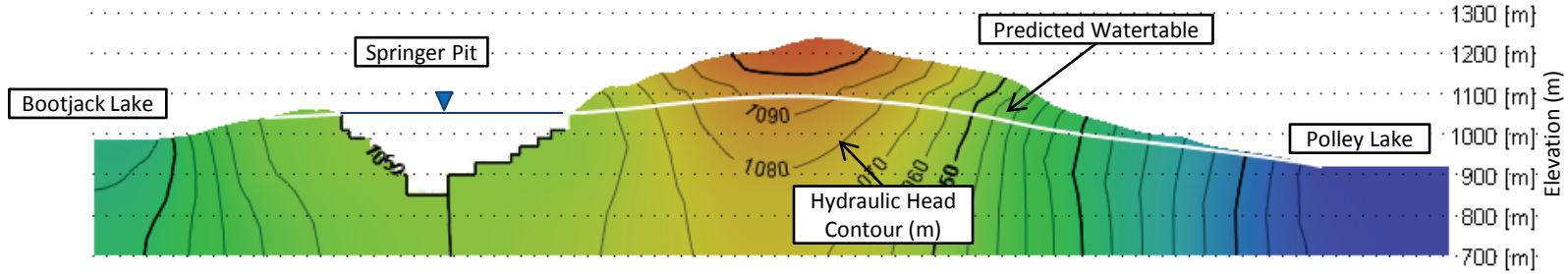
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A. Pit Lake at 1000 m Elevation



B. Pit Lake at 1030 m Elevation



C. Pit Lake at 1050 m Elevation

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LIKELY, BC

PROJECT
GROUNDWATER SEEPAGE PREDICTIONS FOR THE PHASE 4 SPRINGER AND CARIBOO OPEN PITS

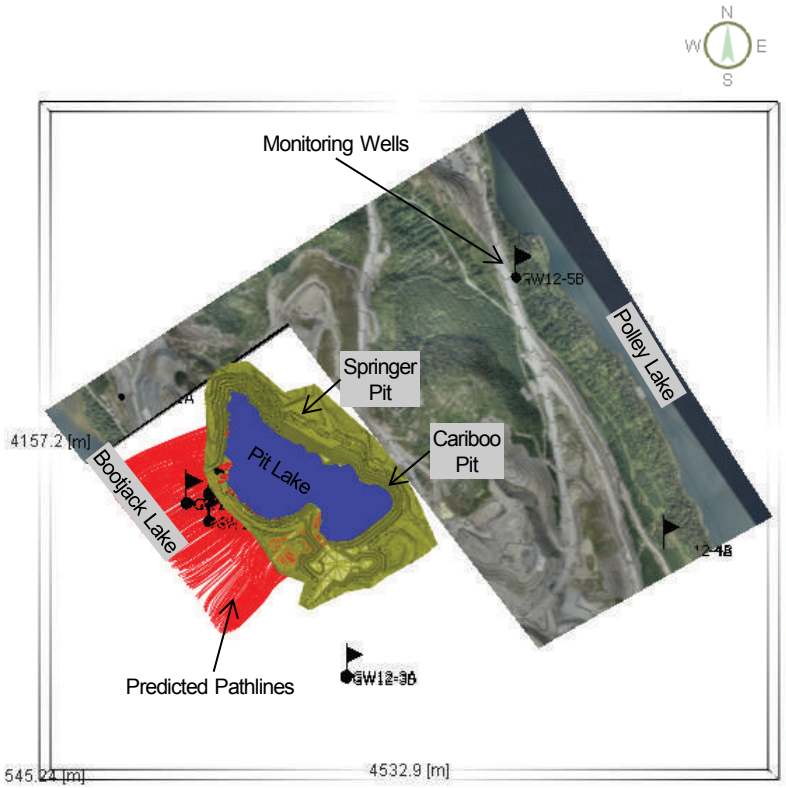
CONSULTANT
Golder Associates

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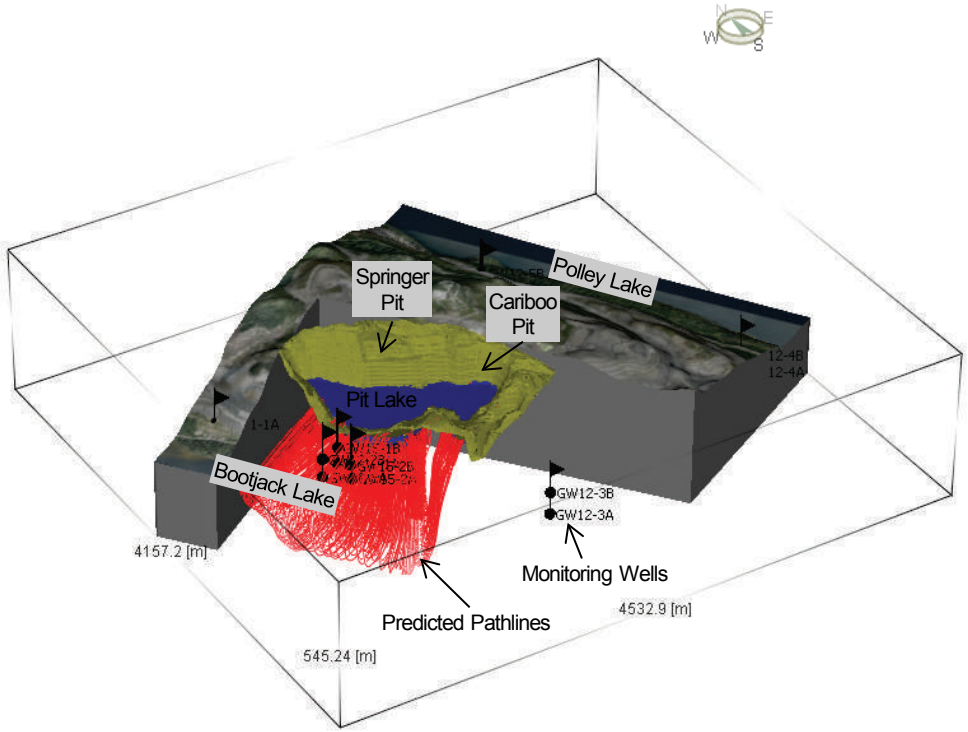
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PROJECT No. **1411734** **15000** Rev. **0**

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1 in
0



A. Top View



B. Oblique View Looking Northeast

Notes:
Orthophoto was provided by MPMC
Distances are in meters.

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PREPARED	WZ
DESIGN	WZ
REVIEW	DWC
APPROVED	DWC

PROJECT
GROUNDWATER SEEPAGE PREDICTIONS FOR THE PHASE 4 SPRINGER AND CARIBOO OPEN PITS

TITLE
PREDICTED SEEPAGE PATHWAYS FOR SPRINGER PIT AND CARIBOO PIT LAKE AT 1050 M

PROJECT No. **1411734** **15000** Rev. **0** **6**

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Study Limitations

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Hydrogeologic/hydrologic investigations and groundwater modelling are dynamic and inexact sciences. They are dynamic in the sense that the state of any hydrological system is changing with time, and in the sense that the science is continually developing new techniques to evaluate these systems. They are inexact in the sense that groundwater systems are complicated beyond human capability to evaluate them comprehensively in detail, and we invariably do not have sufficient data to do so. A groundwater model uses the laws of science and mathematics to draw together the available data into a mathematical or computer-based representation of the essential features of an existing hydrogeologic system. While the model itself obviously lacks the detailed reality of the existing hydrogeologic system, the behaviour of a valid groundwater model reasonably approximates that of the real system. The validity and accuracy of the model depends on the amount of data available relative to the degree of complexity of the geologic formations, the site geochemistry, the fate and transport of the dissolved compounds, and on the quality and degree of accuracy of the data entered. Therefore, every groundwater model is a simplification of a reality and the models described herein are not an exception.

The professional groundwater modelling services performed as described in this document were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practising under similar conditions, subject to the quantity and quality of available data, the time limits and financial and physical constraints applicable to the services. Unless otherwise specified, the results of previous or simultaneous work provided by sources other than Golder and quoted and/or used herein are considered as having been obtained according to recognised and accepted professional rules and practices, and therefore deemed valid. This model provides a predictive scientific tool to evaluate the impacts on a real groundwater system of specified hydrological stresses and/or to compare various scenarios in a decision-making process. However and despite the professional care taken during the construction of the model and in conducting the simulations, its accuracy is bound to the normal uncertainty associated to groundwater modelling and no warranty, expressed or implied, is made.

APPENDIX R:

SPRINGER PIT SPILLWAY CONCEPTUAL DESIGN

(GOLDER 2015)

TECHNICAL MEMORANDUM

DATE October 30, 2015 **REFERENCE No.** 1411734-095-TM-Rev0-15000

TO Katie McMahen
Mount Polley Mining Corporation

CC Luke Moger, Art Frye

FROM James Ogilvie and Allan Bronsro **EMAIL** jogilvie@golder.com; abronsro@golder.com

SPRINGER PIT SPILLWAY CONCEPTUAL DESIGN

1.0 INTRODUCTION

Mount Polley Mining Corporation (MPMC) has retained Golder Associates Ltd. (Golder) to develop a conceptual-level spillway design for the Springer Pit. The Springer Pit is located in the northwest part of the Mount Polley Mine site. The spillway is intended to operate after closure of the Springer Pit. The function of the spillway will be to safely discharge overflow from the Springer Pit caused by storm water runoff and other inflows from the surrounding catchment. This document reflects ultimate pit conditions following completion of the restricted operations and a return to full operations over a combined period of approximately four (4) years.

This document presents the data that Golder used to develop the spillway design.

2.0 DATA FOR DESIGN

2.1 Design Flows

Precipitation depths used to estimate inflows to Springer Pit for various return periods are presented in Table 1.

Table 1: 24-Hour Precipitation Depths

Return Period	Depth (mm)
2-year	34.2
10-year	46.8
25-year	52.5
100-year	60.7
200-year	64.7
1000-year	73.8
Probable Maximum Precipitation	188.1

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The total catchment area draining to the Springer Pit spillway is estimated to be 1.1 km^2. The design event for the Springer Pit was selected as the 1-in-200-year 24-hour rainfall plus the 1-in-2-year snowmelt. The flows to Springer Pit were calculated using Hydrologic Engineering Centre Hydrologic Modelling System (HEC-HMS) software (USACE 2010), and are presented below in Table 2. The Soil Conservation Service (SCS) curve number (CN) method (USDA 1986) was used to calculate catchment losses. A CN value of 95 and a lag time of 15 minutes were used for the HEC-HMS calculations.

The peak outflow was estimated by routing the inflow through the pit.

Table 2: Design Event Flows

Description	Flow (m^3/s)
Peak rainfall inflow	3.64
Peak snowmelt inflow	0.17
Peak combined inflow	3.81
Peak outflow	0.52

2.2 Design Elevations

Elevations used for the design are presented below in Table 3. All elevations are in MPMC's mine grid.

Table 3: Design Elevations

Description	Value (masl)
Spillway crest elevation	1050.0
Top of spillway channel	1050.5

3.0 DESIGN SUMMARY

A summary of the conceptual spillway design for the Springer Pit is provided in this section. The spillway design consists of a weir crest and a rock-lined, 40 m-long channel to convey flows, as shown on Drawings 100 through 300 in Attachment A.

The channel dimensions are shown below in Table 4.

Table 4: Spillway Channel Dimensions

Description	Value	Comment
Design flow depth	0.16 m	Calculated
Channel depth	0.5 m	Provides freeboard
Bottom width	3.0 m	Allows for vehicle passage across channel
Side slope	10H:1V	Allows for vehicle passage across channel

The spillway channel has been sized with constructability and vehicle passage along the existing haul road as main considerations. The wide channel base and gradually-sloped banks allow for vehicles using the existing haul road to cross the spillway channel safely when no water is flowing. The spillway channel has been sloped towards the Springer Pit to eliminate the risk of normal runoff from the haul road discharging into the environment. Additional design information is presented in the drawing package that was provided with this memorandum.

The outlet channel design does not include a specific termination point and is only intended to convey flows beyond the Springer Pit area. Golder recommends that the final discharge location for the spillway channel be confirmed at a later date and based on site conditions existing at the anticipated time of construction (i.e., water quality and closure scenario).

Golder understands that there are several scenarios that could apply for the closure of Springer Pit.

There are two potential discharge options for the case of permanent closure: Bootjack Lake or a temporary storage location (i.e., the Tailings Storage Facility (TSF) or the Perimeter Embankment Till Borrow Pit). The water quality in Springer Pit is an important factor in selecting one of these locations. If the water quality in Springer Pit, perhaps following enhancement with a passive treatment system, is suitable, the water could be discharged into Bootjack Lake. If it is not feasible to meet water quality targets, the water could be conveyed to and retained in a temporary storage location, where it would be treated and eventually discharged to Quesnel Lake.

If the closure of Springer Pit is temporary, the preferred option would be to pump the water into the West Ditch, which conveys water to the Central Collection Sump.

4.0 CLOSURE

We trust this document meets your present requirements. Please direct any questions, comments, or concerns to the undersigned.





James Ogilvie, P.Eng.
Water Resources Engineer

Allan Bronsro, MCIP, P.Eng.
Associate, Senior Water Resources Engineer

JMO/AB/pn
Attachments: A: Conceptual Design Drawings 100, 200, 300 Rev 2

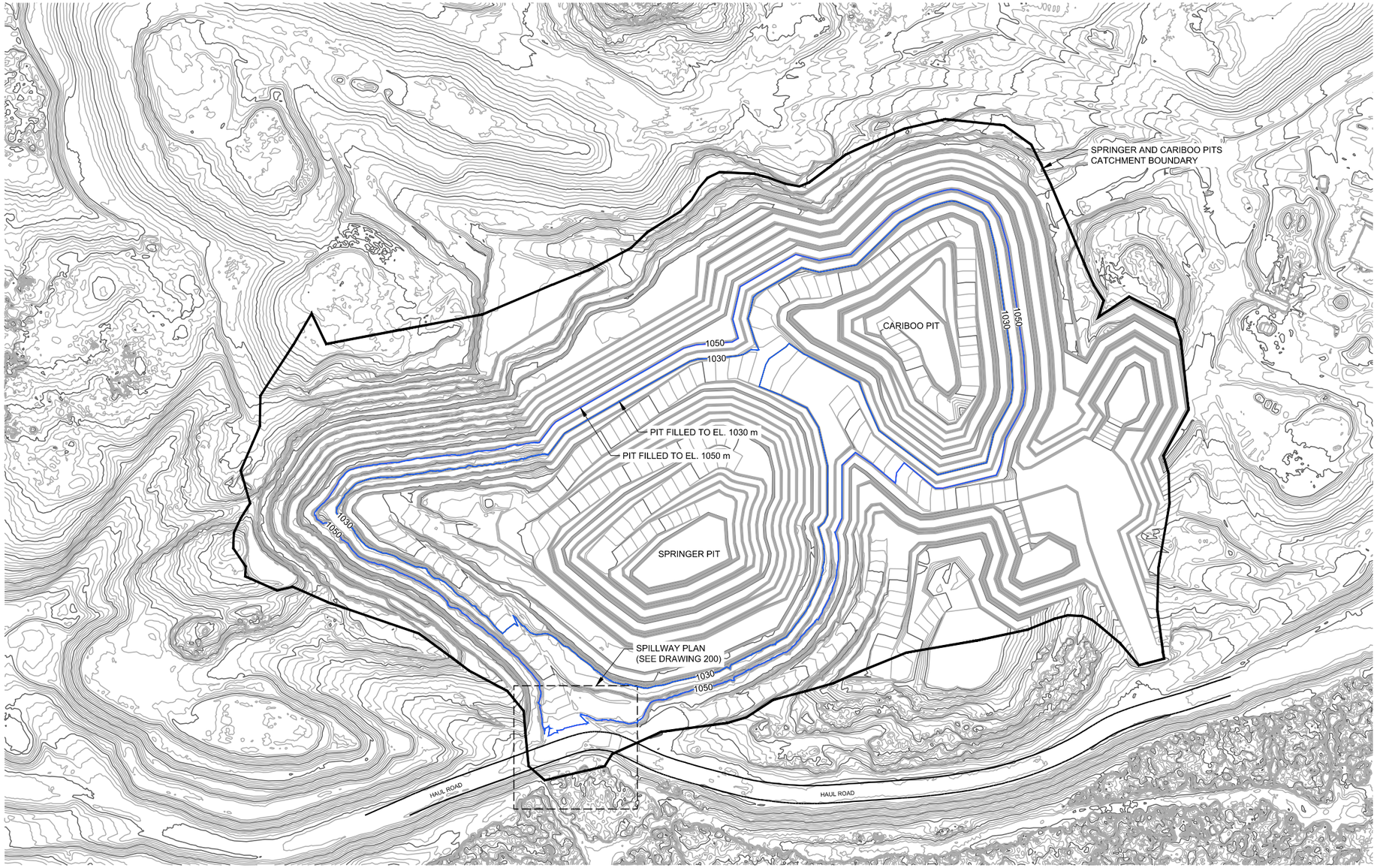
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Golder (Golder Associates Ltd.). 2015. *Site Wide Water Balance.* Prepared for Mount Polley Mining Corporation. Submitted May 29, 2015. Vancouver, BC. Ref. #1411734-031-R-Rev0-12000.

USACE (US Army Corps of Engineers). 2010. *Hydrologic Modeling System HEC-HMS*. Version 3.5, released August 2010.

USDA-SCS (United States Department of Agriculture- Soil Conservation Service). 1986. *Urban Hydrology for Small Watersheds*. TR-55, 164 p.



PLAN
SCALE 1:7500

NOTES
1. ALL UNITS IN METERS UNLESS OTHERWISE NOTED.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL 2 m MINOR AND 10 m MAJOR CONTOURS.

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CONCEPT ONLY

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1	2015-09-24	ISSUED FOR USE	BC	SH	JO	AB

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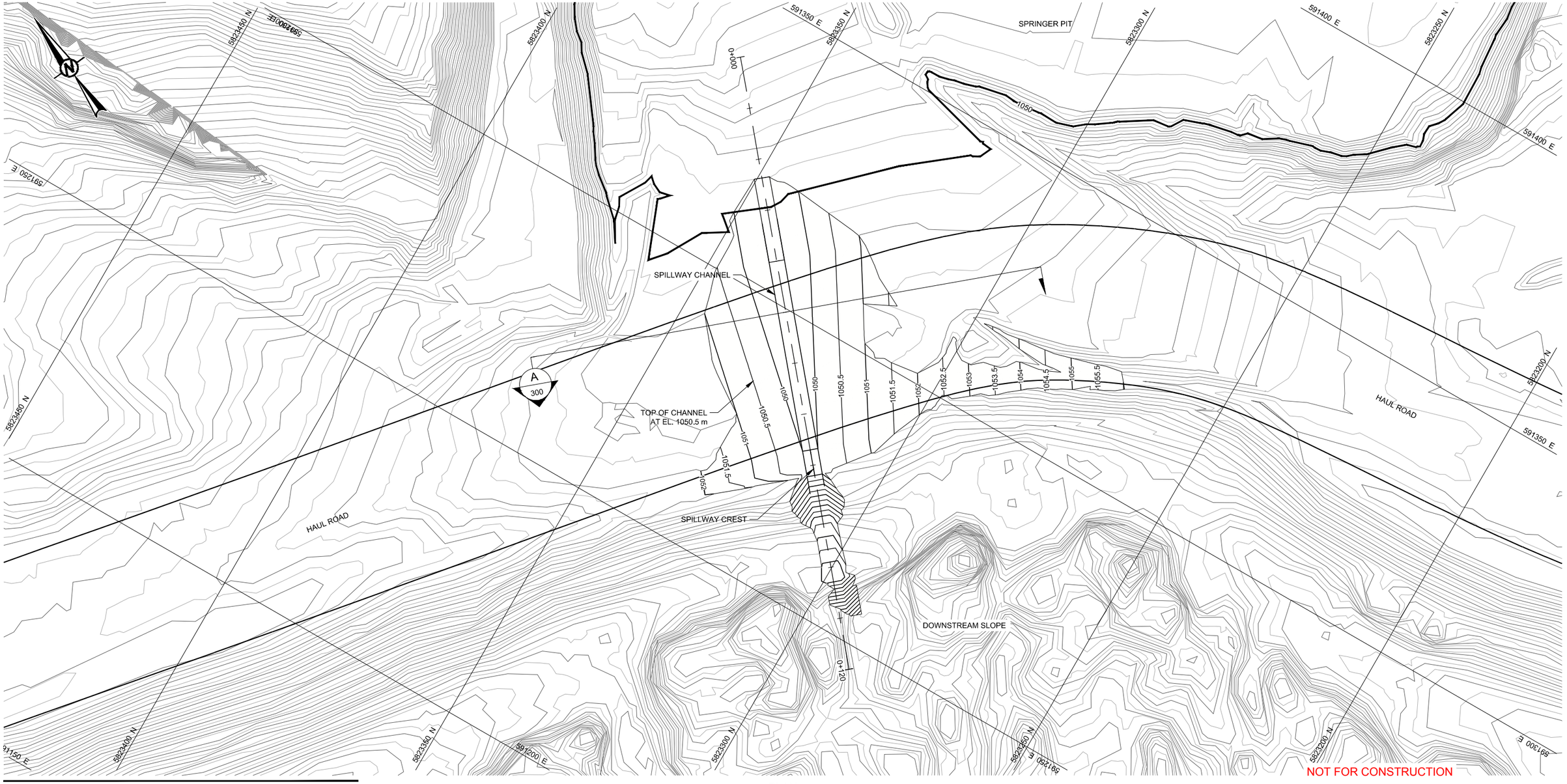
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SPRINGER PIT SPILLWAY
CONCEPTUAL DESIGN

TITLE
PROJECT PLAN

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NOTES

1. ALL UNITS IN METERS UNLESS OTHERWISE NOTED.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL 0.5 m MINOR AND 1 m MAJOR CONTOURS.

PLAN
SCALE 1:750

NOT FOR CONSTRUCTION

CONCEPT ONLY

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Rev.	YYYY-MM-DD	DESCRIPTION	PREPARED	DESIGN	REVIEW	APPROVED
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1	2015-09-24	ISSUED FOR USE	BC	SH	JO	AB

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PROJECT
SPRINGER PIT SPILLWAY
CONCEPTUAL DESIGN

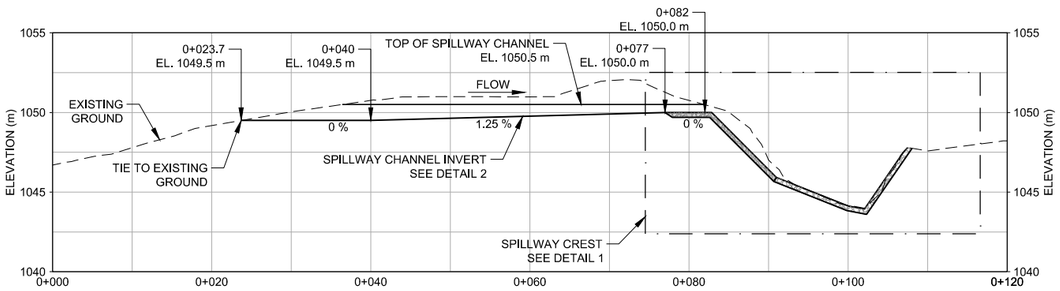
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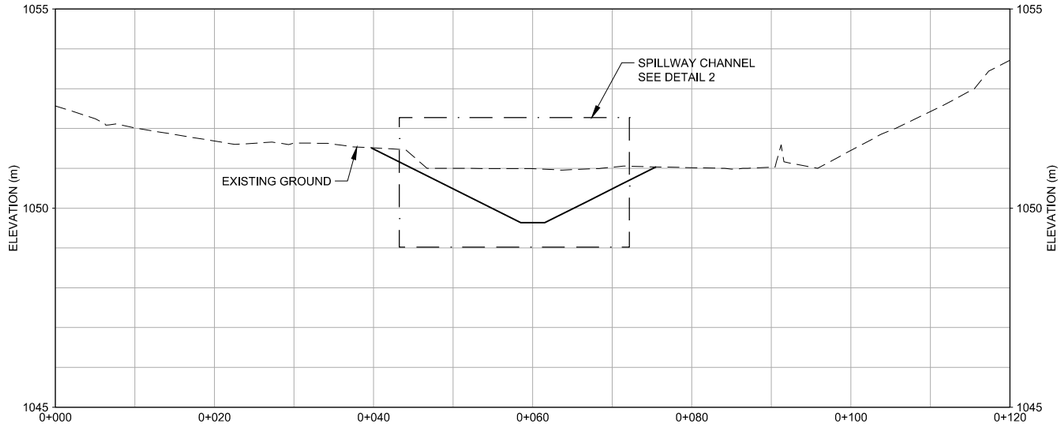
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SPILLWAY PROFILE

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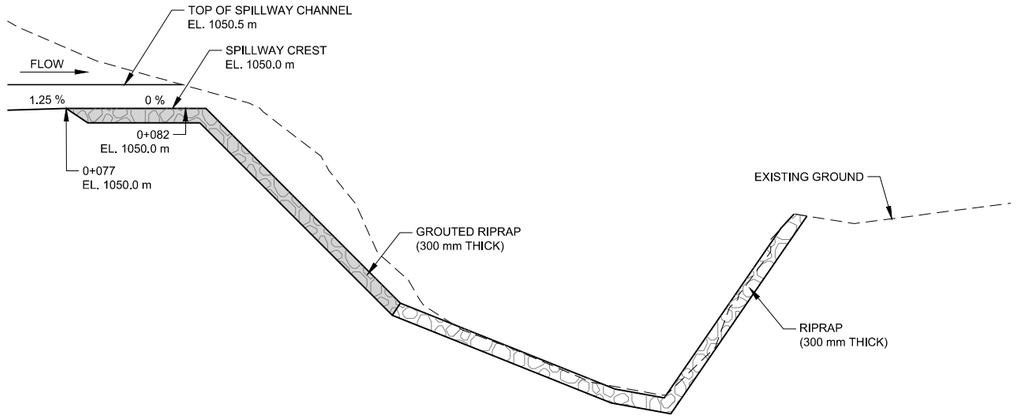


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SPILLWAY CHANNEL SECTION

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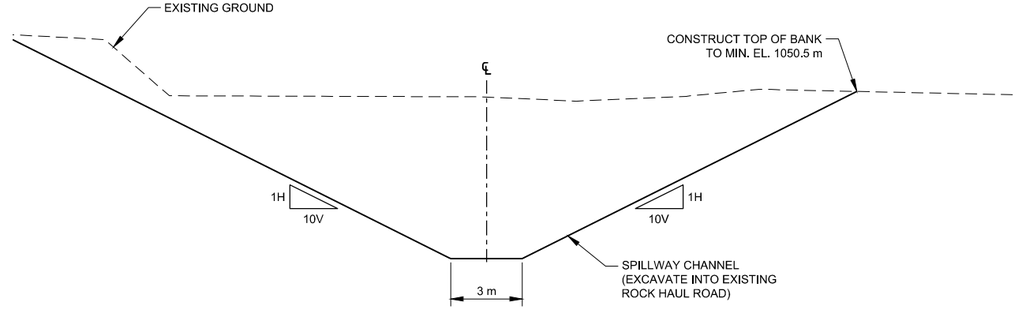


SCALE 1:250
VERT. SCALE 1:125

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SPILLWAY CREST DETAIL

0 5 10
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SCALE 1:250
VERT. SCALE 1:50

2

SPILLWAY CHANNEL TYPICAL DETAIL

0 5 10
1:250 METRES

NOTES

1. ALL UNITS IN METERS UNLESS OTHERWISE NOTED.
2. SPILLWAY CHANNEL SLOPED TO PROVIDE DRAINAGE BACK TO SPRINGER PIT.

NOT FOR CONSTRUCTION

CONCEPT ONLY

Rev.	YYYY-MM-DD	DESCRIPTION	PREPARED	DESIGN	REVIEW	APPROVED
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1	2015-09-24	ISSUED FOR USE	BC	SH	JO	AB

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PROJECT
SPRINGER PIT SPILLWAY
CONCEPTUAL DESIGN

TITLE
PROFILE, SECTIONS, AND DETAILS

PROJECT No.	PHASE	Rev.		DRAWING
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APPENDIX S:

RESULTS OF GEOTECHNICAL ASSESSMENT FOR THE SPRINGER PIT SLOPE STABILITY, MOUNT POLLEY MINE – RETURN TO FULL OPERATIONS

(GOLDER 2015)

TECHNICAL MEMORANDUM

DATE October 30, 2015 **REFERENCE No.** 1411734-092-TM-Rev0-15000

TO Luke Moger and Katie McMahen
Mount Polley Mining Corporation (MPMC)

CC Jerry Vandenberg, Rob Millar, and Willy Zawadzki

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RESULTS OF GEOTECHNICAL ASSESSMENT FOR THE SPRINGER PIT SLOPE STABILITY, MOUNT POLLEY MINE – RETURN TO FULL OPERATIONS

1.0 INTRODUCTION

This Technical Memorandum presents the results of a geotechnical assessment carried out to assess the slope stability of the Southwest Wall of the Springer Pit for Mount Polley Mining Corporation (MPMC). The assessment was carried out to demonstrate the long-term slope stability of the pit wall located between the Springer Pit and Bootjack Lake. The long-term slope stability conditions were assessed for the ultimate pit shell, which is proposed to be excavated over approximately four (4) years under the current restricted mine operations and a return to full operations utilizing the tailings storage facility.

The work was carried out in accordance with the Golder Associates Ltd. (Golder) proposed scope of work, presented in a Technical Memorandum referenced 1411734-050-TM-Rev0-6000 and dated August 12, 2015.

2.0 SPRINGER PIT DEVELOPMENT

Golder understands that MPMC requires a geotechnical assessment which demonstrates the long-term slope stability of the pit wall located between the Springer Pit and Bootjack Lake. The assessed pit wall is located along the southwest side of the Springer Pit, and forms an in situ bedrock pillar between the excavated pit and Bootjack Lake which is located to the west of the Springer Pit. The long-term slope stability conditions were assessed for the ultimate pit mining scenario. The ultimate pit mining scenario is understood to include the current restricted operations followed by a return to full mine operations utilizing the tailings storage facility.

Based on the ultimate pit shell data provided to Golder, the Southwest Wall of the proposed ultimate Springer Pit will be approximately 160 to 180 m in height, with an in situ bedrock pillar width of between 200 and 350 m. The ultimate Springer Pit will be pear shaped, and will be 1,400 m in length and approximately 800 m in width. Eight double benches will be excavated along the Southwest Wall of the ultimate Springer Pit, with a pit crest elevated at approximately 1,060 m.

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3.0 SPRINGER PIT ENGINEERING GEOLOGY

3.1 Geology

The Mount Polley copper-gold deposit is one of a series of porphyry copper deposits that occur in a belt of accreted Mesozoic-aged island arc terranes in the Canadian Cordillera. The deposit comprises three breccia-hosted Cu-Au ore zones associated with a series of monzodiorite to monzonite-breccia intrusions emplaced into during the Late Triassic. The Mount Polley deposit has been deformed by a number of structural events which have resulted in folding, faulting, and tilting (Wafforn 2013).

The mineralized rock in the centre of the Springer Pit consists of potassically altered breccia with angular clasts that range in composition from fine-grained volcanic rocks to monzodiorite (Wafforn 2013). The mineralized breccia zone is off-set and truncated by a series of steeply dipping, northwest and northeast trending faults. Along the west of the pit, the breccia is bounded by monzonite rocks.

The mineralized breccia is hosted in a diorite intrusive along the northeast side of the pit, and a monzonite intrusive along the southwest side of the pit.

A series of younger north–south trending, steeply dipping augite porphyry dykes are observed in the Springer Pit. These dykes are often chlorite and calcite altered, and commonly faulted.

3.2 Structural Geology

The rocks located in the Springer Pit are characterized by deformation associated with several pit continuous faults, described below:

- Polley Fault: a wide, steep, north–south trending, steeply east dipping zone of poor quality rock (Wafforn 2013).
- South Wishbone Fault: a northeast–southwest trending fault that truncates the mineralization breccia zone to the north.
- Springer Fault: a steep, north–south trending and steeply west dipping fault that is interpreted to be exposed in the central portion of the Springer Pit area. This fault is interpreted to terminate at the South Wishbone Fault and the South Boundary Fault, respectively, to the north and south (Wafforn 2013).
- South Boundary Fault: a northwest–southeast trending fault that truncates the mineralization breccia zone to the south. This fault is interpreted to cross the pit and to intersect the Southwest and Southeast Walls. This fault is interpreted to terminate at the Polley Fault.
- Northeast–southwest trending faults are interpreted to occur within the central portion of the Springer Pit area. These faults off-set the mineralized breccia zone and are shown to terminate on the South Boundary Fault to the south. To the north, these faults are shown to terminate on the various north–south trending faults, i.e., the Springer Fault, the Polley Fault.

The South Boundary Fault is interpreted to be orientated in a northwest to southeast direction, aligned sub-parallel to the West Wall. The fault has not been observed within the exposed bench faces and is not expected to affect the overall slope stability of the ultimate pit wall. Instabilities related to this fault are expected to be localized and restricted to one or two of the benches located toward the toe of the ultimate pit wall. Several northeast-southwest trending faults intersect the Southwest Wall at sub-perpendicular orientations resulting in localized raveling in the observed bench faces.

3.3 Intact Rock Strength

The intact rock strength of the monzonite rock types that are excavated in the Southwest Wall is based on estimates carried out during geotechnical mapping work (2014 site visit). The rock strengths are generally estimated in the *strong rock strength* range, approximately 50 to 100 MPa. Experience with similar rock types, including the results of laboratory testing, suggests that this is an appropriate strength range to use in the overall slope stability analyses, summarized in Section 4.0.

3.4 Discontinuity Characterisation

The rocks in the Springer Pit area are strongly-jointed and intersected by several faults. The stability performance of the pit walls is largely affected by the orientation of these structures with respect to the orientation of the excavated walls. Golder has previously carried out geotechnical mapping in the Springer Pit, which includes mapping work carried out during 2009, 2010 and 2014 site visits. The dominant structures observed in the Springer Pit are summarized in Table 1.

Table 1: Springer Pit Dominant Geologic Structures

Structure		Northeast Wall	East Wall	South Wall	West Wall
ID	Description				
J1	Steep (50° to 60°) east dipping joints/faults	√		√	√
J2	Moderate (30° to 40°) west-northwest dipping joints	√	√		
J3	Steep (60° to 80°) south-southeast dipping joints	√	√		√
J4	Moderate (30° to 40°) southwest dipping joints	√		√	√
J5	Steep, north-northwest dipping joints and faults		√	√	
FLT1	Continuous, steep, east dipping faults	√	√	√	√
FLT2	Shallow west-northwest dipping faults	√	√		

The joint surfaces are generally discontinuous and restricted to the bench faces. The intersections of these joints have formed wedges, resulting in rock fall and ravelling of the exposed bench faces. The mapped faults are continuous and can be observed over several of the exposed bench faces. However, the majority of the faults in the Southwest Wall are steeply dipping, and are not expected to affect the overall slope stability conditions.

3.5 Groundwater

The groundwater table in the area of the Springer Pit has been drawn down during excavation. Little seepage is observed on the pit walls, and the water table is likely located at shallow levels below the exposed pit walls. A pit lake is expected to form should there be no additional mining carried out following excavation of the ultimate pit and the natural groundwater table is re-established to a pre-mining elevation.

Slope stability analyses were carried out for dry conditions, for saturated pit walls, and for flooded pit conditions. A flooded pit water level at the proposed spillway elevation of 1,050 m was used in the two dimensional limit equilibrium slope stability modelling, discussed below.

4.0 SPRINGER PIT SLOPE STABILITY ASSESSMENT

The overall slope stability of the Southwest Wall was assessed using two-dimensional limit equilibrium methods for the ultimate pit mining scenario. In addition, the stability of the soil slope located on the east side of the Bootjack Lake was also assessed to demonstrate long-term stability conditions.

4.1 Existing Southwest Wall Stability

The walls in the existing Springer Pit have exhibited adequate overall stability to date. The monzonite rocks excavated along the Southwest Wall are massive and are considered to exhibit competent rock mass quality. The discontinuous joint surfaces and major faults are favourably oriented with respect to the Southwest Wall, with instabilities restricted to the bench scale structural failures and raveling. During the 2014 geotechnical site visit, the Southwest Wall was exhibiting adequate bench catchment in a double bench configuration. The bench faces were breaking back along steep easterly dipping structures (i.e., J1 joint surfaces). Monitoring data have not indicated any displacements along the Southwest Wall, and the wall was considered to exhibit adequate overall slope stability performance during the 2014 site visit.

4.2 Geotechnical Strength Parameters

Geotechnical strength parameters for the monzonite rock mass are based on geotechnical mapping work carried out in the Springer Pit. The generalized Hoek-Brown strength criterion is used to represent the rock mass strength of the monzonite rock. Soil and waste rock material parameters are based on the results of previous site investigations (Golder 2015) and studies carried out at the mine. A summary of the shear strength parameters used in analyses are presented in Table 2.

Table 2: Geotechnical Strength Parameters Modelled in Slope Stability Analyses

Material Name	Unit Weight (kN/m^3)	Strength Model	Shear Strength Parameters or Equations					
			Cohesion (kN/m^2)	Friction Angle (°)	UCS (MPa)	GSI	s	a
Till / Lacustrine Silts	19	Mohr-Coulomb	2	30				
Fault	24	Mohr-Coulomb	0	25				
Monzonite - Rock Mass	24	Generalized Hoek-Brown			75.0	55	0	0.506

4.3 Slope Stability Analysis

4.3.1 Southwest Wall

Overall slope stability analyses were carried out for the most critical section through the Southwest Wall (Figure 1-1). The section was selected to represent the greatest pit wall heights and thinnest bedrock pillar width between the excavated wall and Bootjack Lake.

Slope stability analyses were carried out for dry conditions, for saturated groundwater conditions (i.e., groundwater table) and for a flooded pit. A flooded pit water level at the proposed spillway elevation of 1,050 m was modelled to simulate potential groundwater conditions following the completion of the ultimate Springer Pit excavation.

A minimum Factor of Safety of 1.3 is considered acceptable for long-term overall slope stability conditions. The results of the analyses indicate that the Southwest Wall is expected to satisfy overall slope conditions for the ultimate pit mining scenario. The results of the overall slope stability analyses for the wall are summarised in Table 3, and presented in Attachment 1.

Table 3: Summary of Southwest Wall Overall Slope Stability Results

Mining Scenario	Failure Surface Type	Groundwater Conditions	Critical FOS	Relevant Figure
Ultimate Springer Pit	Circular	Dry	2.69	1-2
		Saturated	1.36	1-3
		Pit Lake	3.15	1-4
	Bi-Linear	Dry	2.82	1-5
		Saturated	1.81	1-6
		Pit Lake	2.83	1-7

4.3.2 Slope Along East Side of Bootjack Lake

The stability of the soil slope located along the east side of the Bootjack Lake was assessed to demonstrate long-term stability conditions. The soil foundation conditions modelled in the analyses were based on the materials encountered in the hydrogeological site investigations, which included three boreholes drilled into bedrock at depths between 44.2 m and 96.9 m (Golder 2015). The stability analyses were carried out to model the current slope foundation conditions. The location of the stability analysis cross section is presented in Figure 1-8, Attachment 1.

A minimum Factor of Safety of 1.3 is considered acceptable for long-term overall slope stability conditions. The results of the analysis indicate that the slope located along the east side of the Bootjack Lake is expected to satisfy overall slope conditions. The result of the slope stability analysis is summarised in Table 4, and presented in Figure 1-8 in Attachment 1.

Table 4: Summary of Bootjack Lake Northeast Slope Stability Results

Stability Conditions	Surface Failure	Groundwater Conditions	Critical FOS	Relevant Figure
Long Term	Bi-linear	Saturated	1.47	1-9

5.0 DISCUSSION OF RESULTS

The results of the stability analyses indicate that adequate long-term slope stability conditions are expected to be achieved in the Southwest Wall of the Springer Pit for the mine scenario evaluated, as summarised in Table 3. The results of the analyses exceeded the minimum recommended Factor of Safety of 1.3.

The lower Factor of Safety results are related to saturated groundwater conditions, where the groundwater table was modelled at the surface elevation of the excavation. These extreme groundwater conditions are unlikely to be encountered during mining as the near surface slope is expected to be well drained due to seepage along the joint sets.

The results of the stability analyses for the northeast slope of Bootjack Lake indicate that adequate long-term slope stability conditions are expected to be achieved, as summarised in Table 4. The stability analyses were carried out to model the current slope foundation conditions. Should MPMC modify the current foundation conditions (i.e., placement of additional waste rock near the existing access road), then additional stability assessment work should be performed to assess the overall long-term slope stability conditions.

In summary, the favourable pit slope stability performance observed in the existing pit, together with the results of the slope stability analyses, indicate that the Southwest Wall of the Springer Pit is expected to exhibit adequate stability performance for the proposed mining scenario, and that Bootjack Lake is not expected to be adversely affected by the excavation of the pit.

The Southwest Wall should be continued to be monitored with prisms and regular geotechnical inspections to assess the overall slope stability conditions. The frequency of monitoring should be increased if there is no excavation past the proposed mining scenario and a pit lake is to form.

6.0 CLOSURE

The information presented in this Technical Memorandum is intended to support mine planning and operations for MPMC. If you have any questions, please do not hesitate to contact the undersigned.

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

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ORIGINAL SIGNED

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Principal, Mining Geotechnical Engineer

EAS/AVC/kp/bb/jc/it

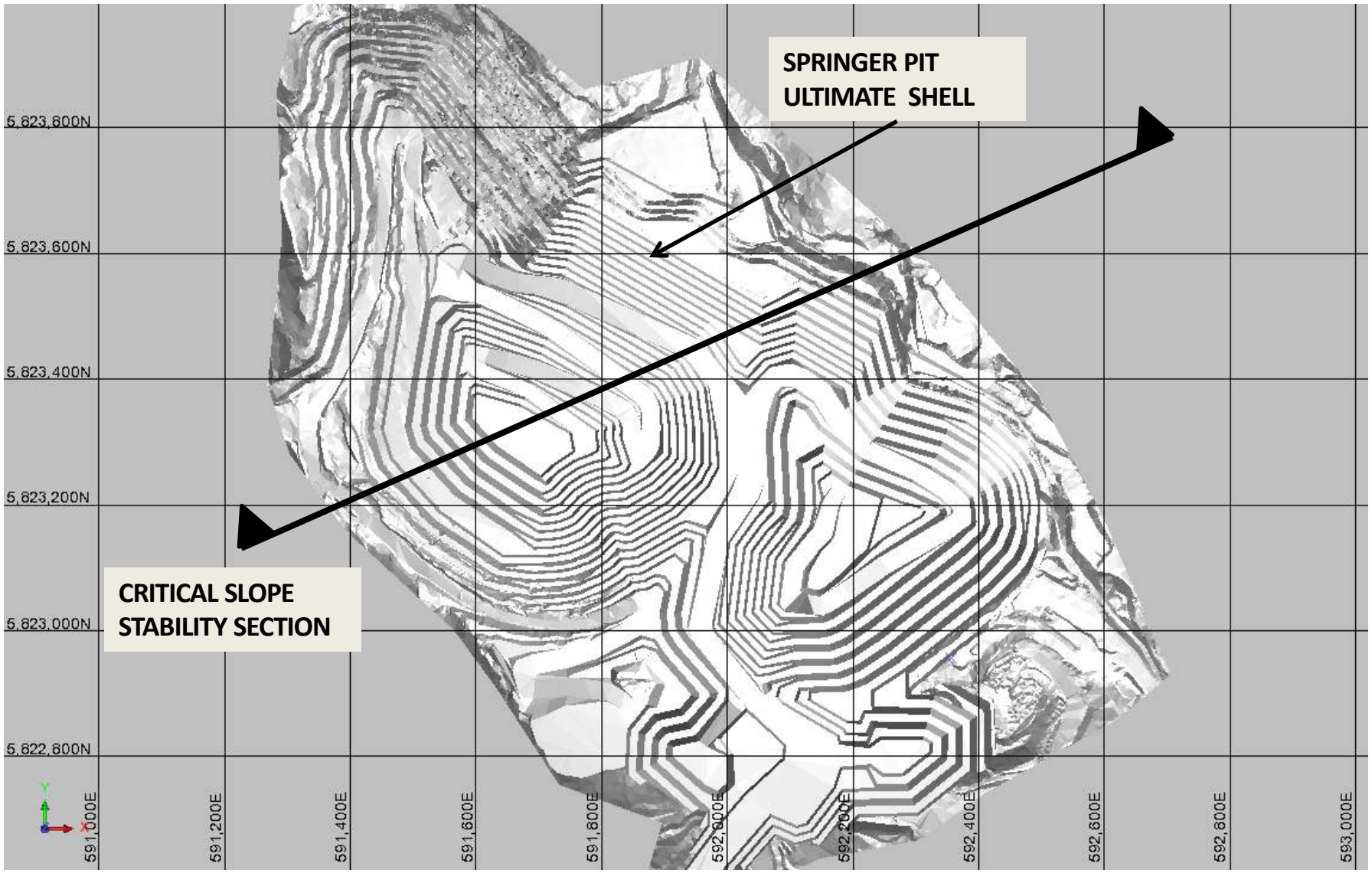
Attachment 1: Results of Slope Stability Analyses

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REFERENCES

Golder Associates Ltd. Technical Memorandum titled “Hydrogeological Investigations near the Springer Pit – Mount Polley Mine”. Referenced 1411734-051-TM-Rev0, and dated August 31, 2015. (Golder 2015).

Wafforn SR. 2013. Structural Geology of the Mount Polley Cu-Au District, South-Central British Columbia. Master of Science in Geology. Thesis. (Waffom 2013).



NOTES:

1. COORDINATES SHOWN IN MOUNT POLLEY MINE GRID.

CLIENT
MOUNT POLLEY MINE
LIKELY, B.C.

CONSULTANT
Golder Associates

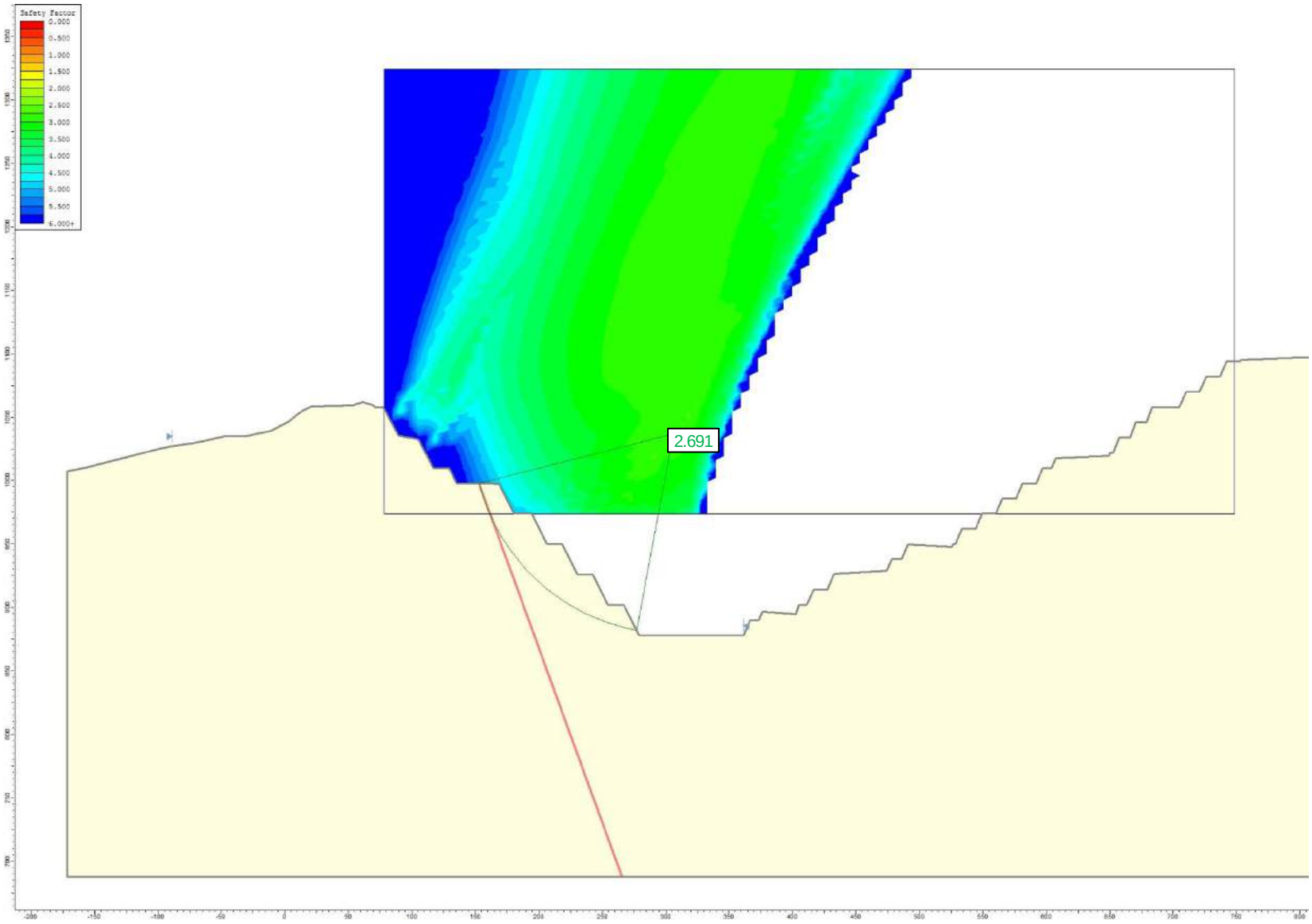
YYYY-MM-DD	2015-09-08
PREPARED	EAS
DESIGN	EAS
REVIEW	EAS
APPROVED	AVC

PROJECT
GEOTECHNICAL ASSESSMENT FOR THE SPRINGER PIT SLOPE STABILITY - RETURN TO FULL OPERATIONS, MOUNT POLLEY MINE

TITLE
SPRINGER PIT, YEAR 4 PIT SHELL SHOWING CRITICAL SECTION FOR PIT WALL STABILITY ANALYSES

PROJECT No.	PHASE	Rev.	FIGURE
1411734	15000	0	1-1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A



Material Name	Colour	Unit Weight (kN/m³)	Strength Model
Monzonite		24	Generalized Hoek-Brown
Lacustrine Silt		21	Mohr-Coulomb
Fault		24	Mohr-Colomb

CLIENT
MOUNT POLLEY MINE
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CONSULTANT
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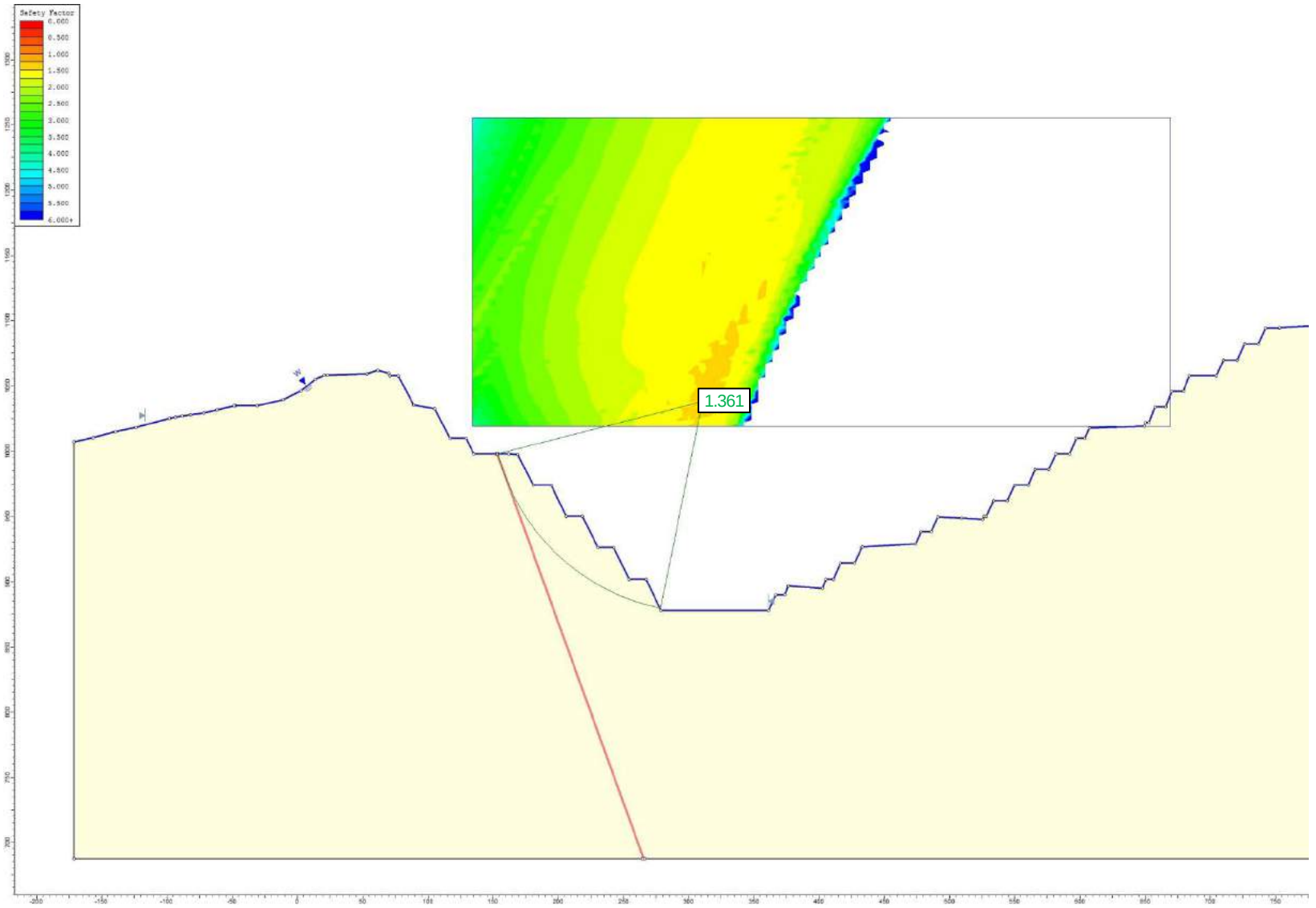
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PREPARED	EAS
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REVIEW	EAS
APPROVED	AVC

PROJECT
GEOTECHNICAL ASSESSMENT FOR THE SPRINGER PIT SLOPE STABILITY - RETURN TO FULL OPERATIONS,
MOUNT POLLEY MINE

TITLE
SPRINGER PIT, ULTIMATE PIT SHELL
CIRCULAR FAILURE SURFACE
DRY MODEL

PROJECT No.	PHASE	Rev.	FIGURE
1411734	15000	0	1-2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
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0



Material Name	Colour	Unit Weight (kN/m³)	Strength Model
Monzonite		24	Generalized Hoek-Brown
Lacustrine Silt		21	Mohr-Coulomb
Fault		24	Mohr-Colomb

CLIENT
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LIKELY, B.C.

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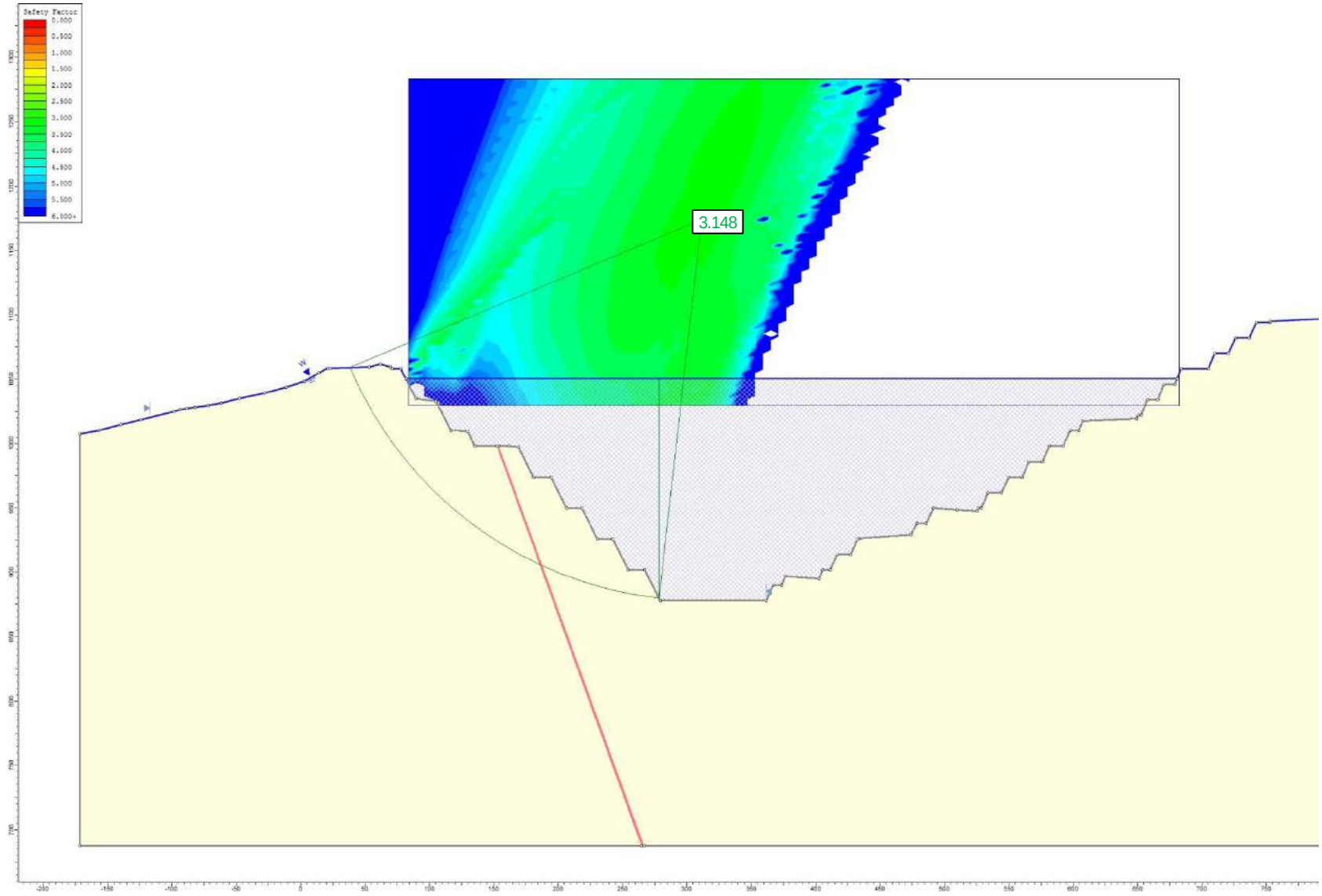
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PREPARED	EAS
DESIGN	EAS
REVIEW	EAS
APPROVED	AVC

PROJECT
GEOTECHNICAL ASSESSMENT FOR THE SPRINGER PIT SLOPE STABILITY - RETURN TO FULL OPERATIONS,
MOUNT POLLEY MINE

TITLE
SPRINGER PIT, ULTIMATE PIT SHELL
CIRCULAR FAILURE SURFACE
SATURATED GROUNDWATER CONDITIONS

PROJECT No.	PHASE	Rev.	FIGURE
1411734	15000	0	1-3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
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Material Name	Colour	Unit Weight (kN/m³)	Strength Model
Monzonite		24	Generalized Hoek-Brown
Lacustrine Silt		21	Mohr-Coulomb
Fault		24	Mohr-Colomb

CLIENT
MOUNT POLLEY MINE
LIKELY, B.C.

CONSULTANT
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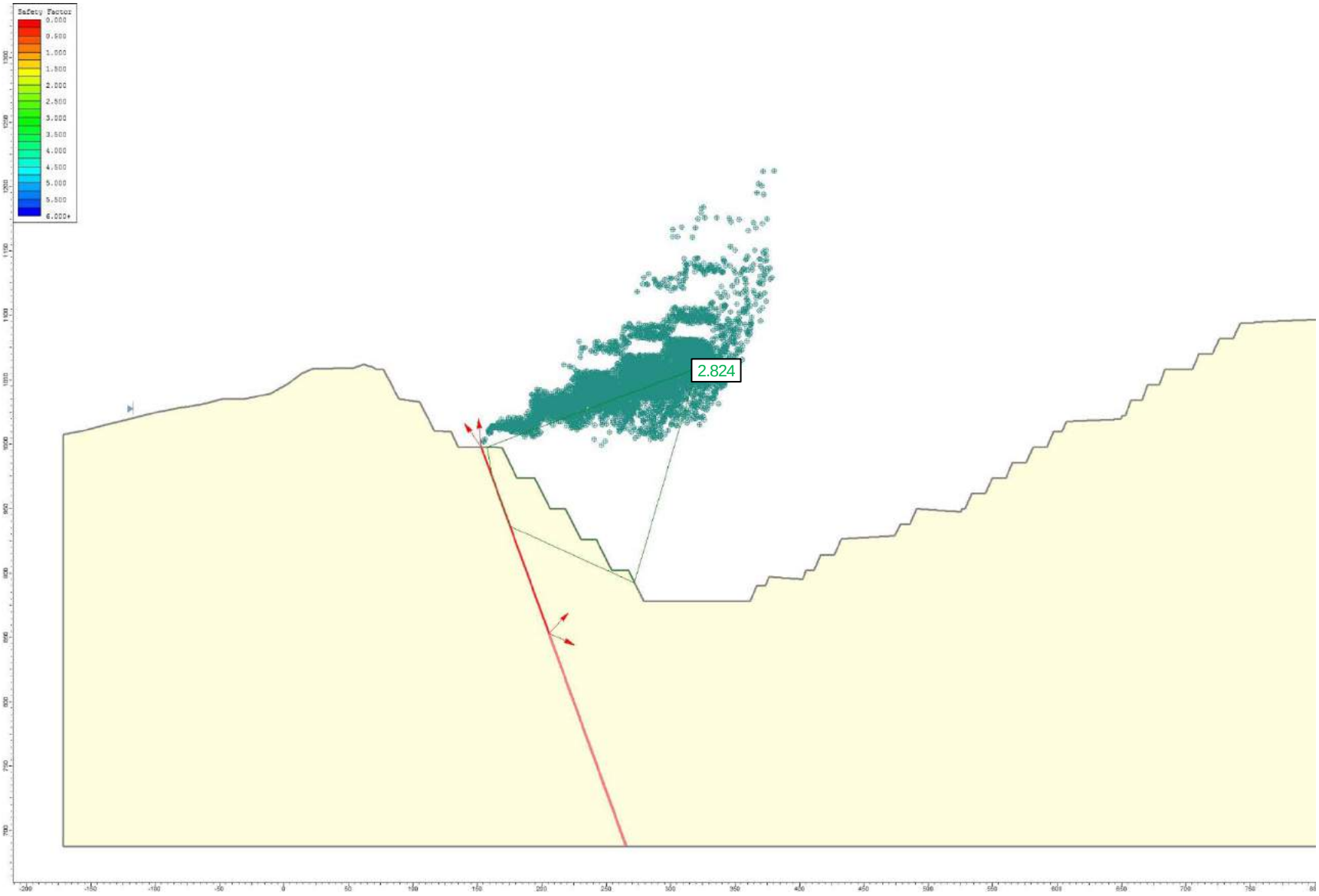
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DESIGN	EAS
REVIEW	EAS
APPROVED	AVC

PROJECT
GEOTECHNICAL ASSESSMENT FOR THE SPRINGER PIT SLOPE STABILITY - RETURN TO FULL OPERATIONS,
MOUNT POLLEY MINE

TITLE
SPRINGER PIT, ULTIMATE PIT SHELL
CIRCULAR FAILURE SURFACE
SATURATED GROUNDWATER CONDITIONS - PIT LAKE

PROJECT No.	PHASE	Rev.	FIGURE
1411734	15000	0	1-4

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1 in
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Lacustrine Silt		21	Mohr-Coulomb
Fault		24	Mohr-Colomb

CLIENT
MOUNT POLLEY MINE
LIKELY, B.C.

CONSULTANT
Golder Associates

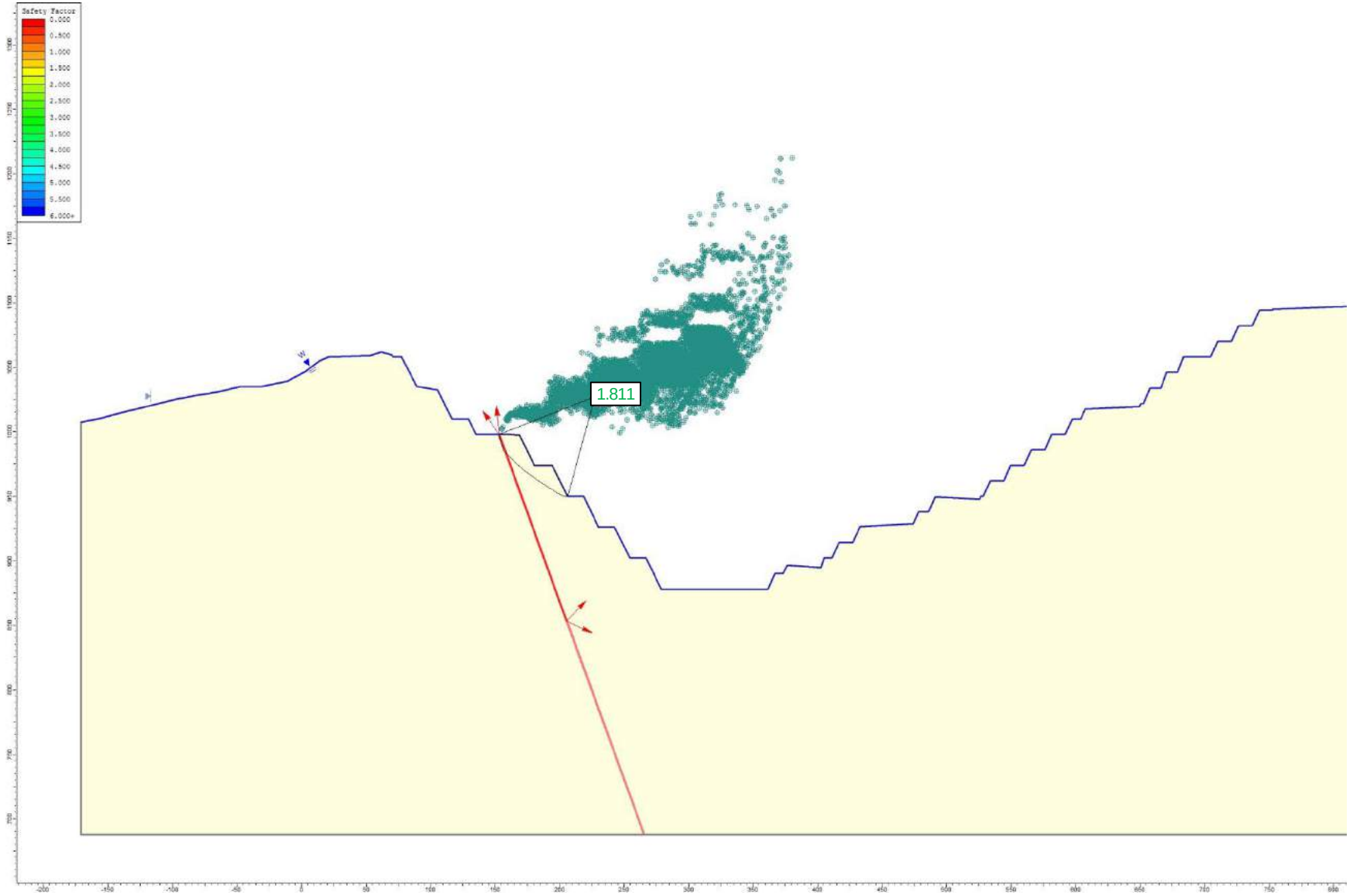
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PREPARED	EAS
DESIGN	EAS
REVIEW	EAS
APPROVED	AVC

PROJECT
GEOTECHNICAL ASSESSMENT FOR THE SPRINGER PIT SLOPE STABILITY - RETURN TO FULL OPERATIONS,
MOUNT POLLEY MINE

TITLE
SPRINGER PIT, ULTIMATE PIT SHELL
BILINEAR FAILURE SURFACE
DRY MODEL

PROJECT No.	PHASE	Rev.	FIGURE
1411734	15000	0	1-5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
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Monzonite		24	Generalized Hoek-Brown
Lacustrine Silt		21	Mohr-Coulomb
Fault		24	Mohr-Colomb

CLIENT
MOUNT POLLEY MINE
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Golder Associates

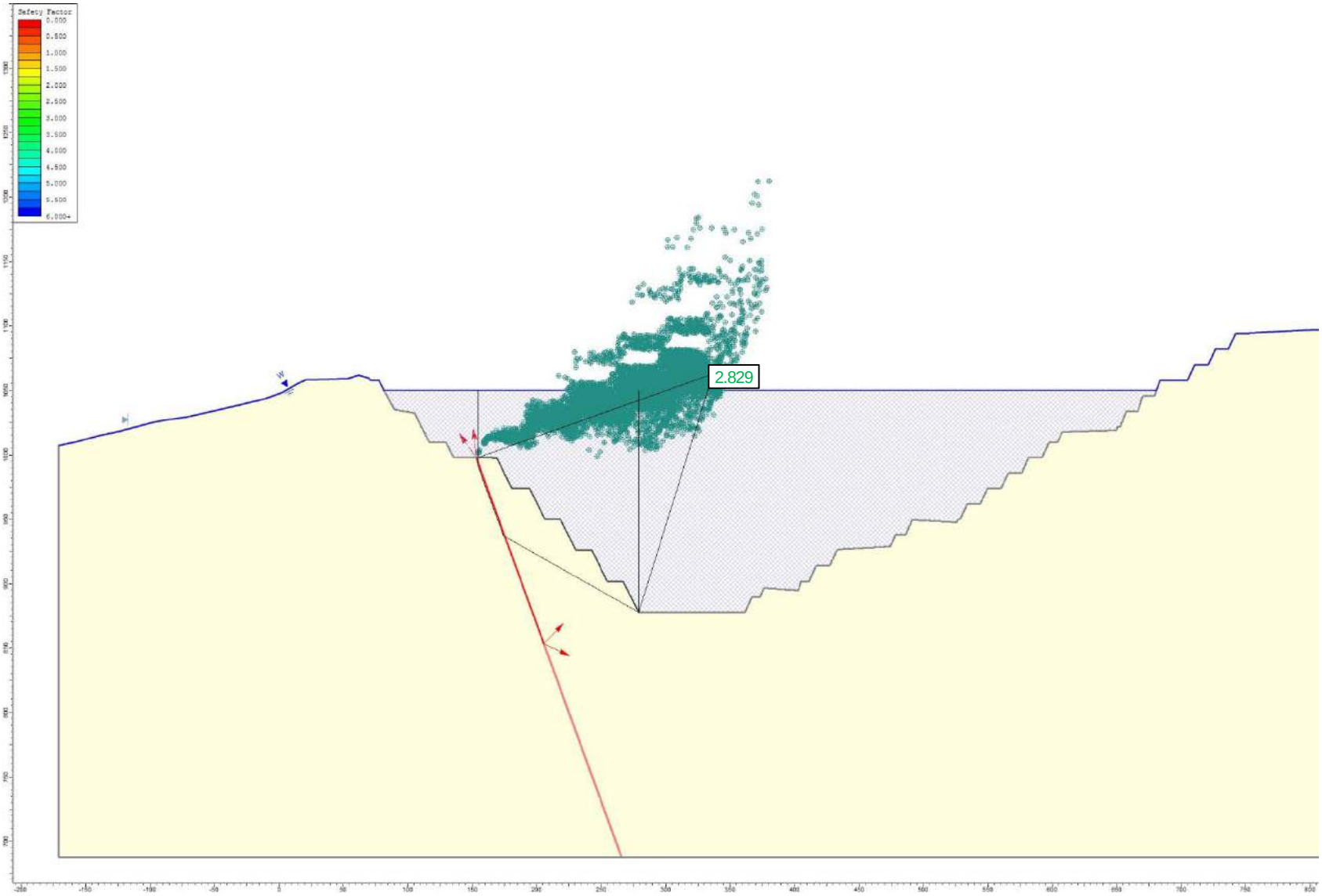
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APPROVED	AVC

PROJECT
GEOTECHNICAL ASSESSMENT FOR THE SPRINGER PIT SLOPE STABILITY - RETURN TO FULL OPERATIONS,
MOUNT POLLEY MINE

TITLE
SPRINGER PIT, ULTIMATE PIT SHELL
BILINEAR FAILURE SURFACE
SATURATED GROUNDWATER CONDITIONS

PROJECT No.	PHASE	Rev.	FIGURE
1411734	15000	0	1-6

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Monzonite		24	Generalized Hoek-Brown
Lacustrine Silt		21	Mohr-Coulomb
Fault		24	Mohr-Colomb

CLIENT
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CONSULTANT
Golder Associates

YYYY-MM-DD	2015-09-08
PREPARED	EAS
DESIGN	EAS
REVIEW	EAS
APPROVED	AVC

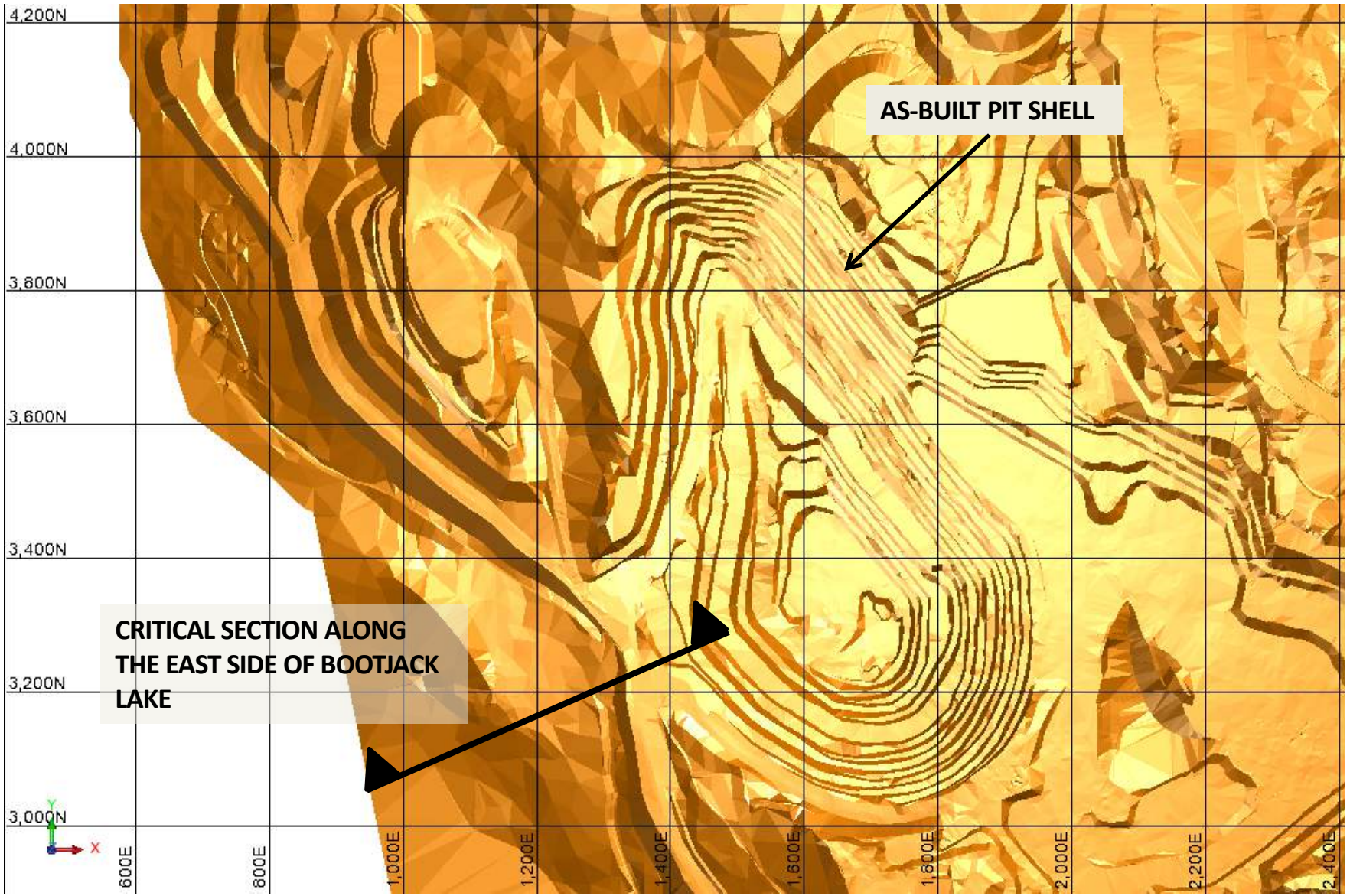
PROJECT
GEOTECHNICAL ASSESSMENT FOR THE SPRINGER PIT SLOPE STABILITY - RETURN TO FULL OPERATIONS,
MOUNT POLLEY MINE

TITLE
SPRINGER PIT, ULTIMATE PIT SHELL
BILINEAR FAILURE SURFACE
SATURATED GROUNDWATER CONDITIONS - PIT LAKE

PROJECT No.	PHASE	Rev.	FIGURE
1411734	15000	0	1-7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A
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\\golder.gds\gal\burnaby\Active_2014\1421\1411734 Mount Polley (confidential and solicitor-client privileged)\Ph 15000 Closure\2000 - Springer Slope Stability\Analyses\2008 Springer Pit Analyses\Slide\2015 Slide models



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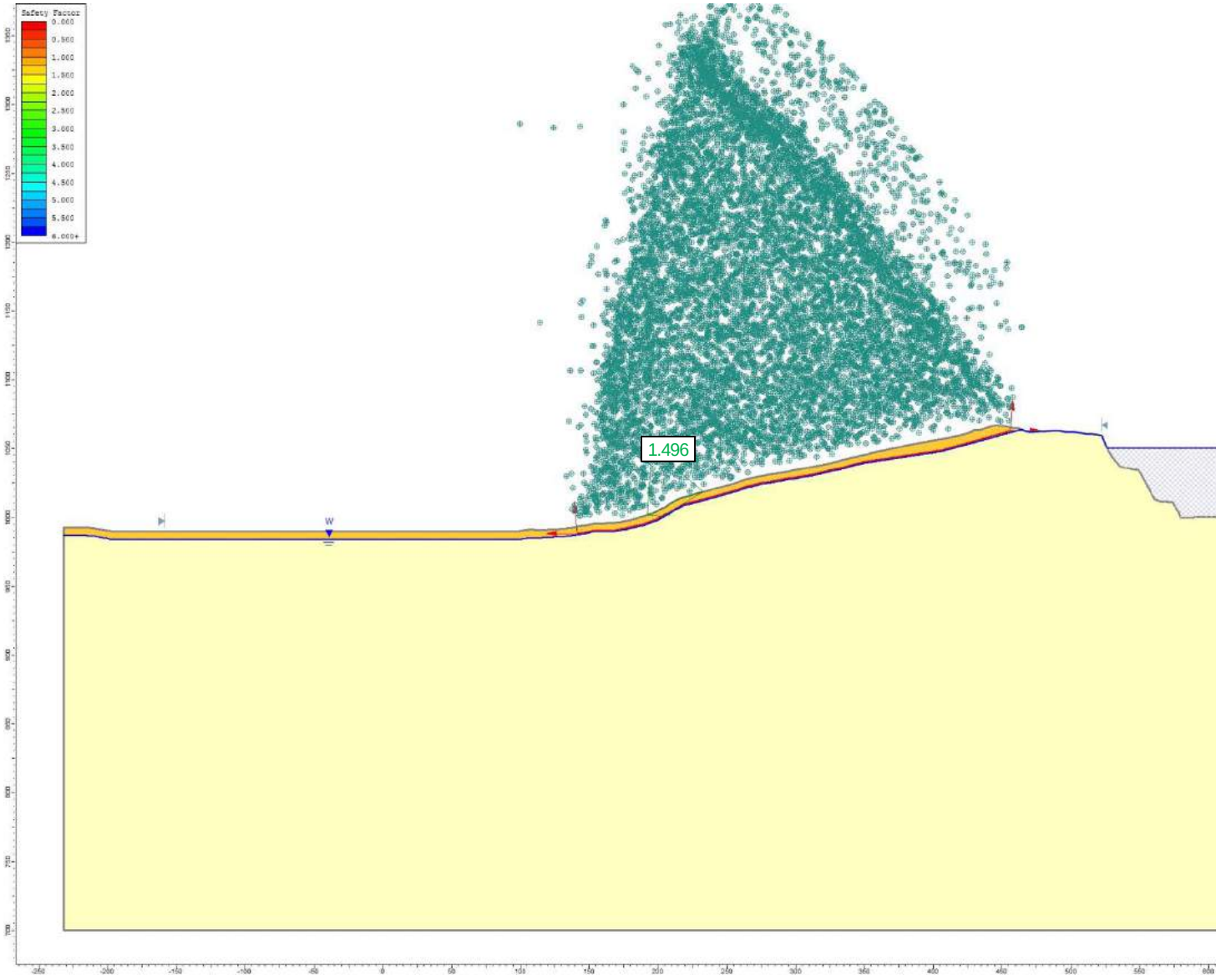
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REVIEW	EAS
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PROJECT
GEOTECHNICAL ASSESSMENT FOR THE SPRINGER PIT SLOPE STABILITY - RETURN TO FULL OPERATIONS, MOUNT POLLEY MINE

TITLE
LOCATION OF STABILITY SECTION ALONG EAST SIDE OF BOOTJACK LAKE

PROJECT No.	PHASE	Rev.	FIGURE
1411734	15000	0	1-8

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Material Name	Colour	Unit Weight (kN/m³)	Strength Model
Monzonite		24	Generalized Hoek-Brown
Lacustrine Silt		21	Mohr-Coulomb
Fault		24	Mohr-Colomb

CLIENT
MOUNT POLLEY MINE
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CONSULTANT
Golder Associates

YYYY-MM-DD	2015-09-08
PREPARED	EAS
DESIGN	EAS
REVIEW	EAS
APPROVED	AVC

PROJECT
GEOTECHNICAL ASSESSMENT FOR THE SPRINGER PIT SLOPE STABILITY - RETURN TO FULL OPERATIONS,
MOUNT POLLEY MINE

TITLE
BOOTJACK SLOPE, LONG TERM STABILITY CONDITIONS
BI-LINEAR FAILURE SURFACE
GLOBAL MINIMUM

PROJECT No.	PHASE	Rev.	FIGURE
1411734	15000	0	1-9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
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APPENDIX T:

PRELIMINARY PREDICTIONS OF GROUNDWATER SEEPAGE FOR THE WIGHT OPEN PIT AT CLOSURE

(GOLDER 2015)

TECHNICAL MEMORANDUM

DATE September 11, 2015 **PROJECT No.** 1411734-070-TM-Rev0-15000

TO Katie McMahen, P.Ag.
Mount Polley Mining Corporation

FROM Willy Zawadzki
Don Chorley

EMAIL wzawadzki@golder.com

PRELIMINARY PREDICTIONS OF GROUNDWATER SEEPAGE FOR THE WIGHT OPEN PIT AT CLOSURE – MOUNT POLLEY MINE

1.0 INTRODUCTION

This technical memorandum presents preliminary predictions of groundwater seepage for the Wight Pit Lake at closure at the Mount Polley Mine that is operated by the Mount Polley Mining Corporation (MPMC). These predictions were made in support of the Reclamation and Closure Plan that is currently being prepared for the site. This Plan assumes that the Wight Pit will be allowed to flood to a spillover elevation of approximately 926 m.

This memorandum documents preliminary predictions of groundwater seepage from the Wight Pit Lake at closure. It is understood that the Wight Pit Lake hydrology, quality of pit lake water and resulting seepage quality is assessed by the concurrent studies conducted by MPMC and Golder.

2.0 BACKGROUND

Surface mining of the Wight Pit occurred between 1999 and 2009. The pit floor reached an elevation of approximately 804 m; however, since the mining stopped the pit has been partially filled with waste rock with the pit bottom presently at an elevation of approximately 875 m in the northwest and approximately 912 m in the southeast, as presented on Figure 1. In the northwest, the pit crest is located at a distance of approximately 200 m from the Polley Lake shore and in the southeast this distance is about 80 m. At both locations the pit bottom is below the average level of Polley Lake of approximately 920 m.

Similar to the nearby Springer Pit, the majority of the Wight Pit walls were excavated in monzonite bedrock that was intruded by hydrothermal breccias. Three northwest-southeast striking faults intersect the pit, and these faults have been intruded by thick and presently weathered mafic dykes. In 2014, groundwater seepage was observed in the southeast corner of the pit along the east-west striking dyke that is exposed in the pit wall (Golder, 2014a).

The southeast corner of the pit also intersected a relatively thick sequence of overburden deposits of glacio-lacustrine and glacio-fluvial origin. In 2004, Golder conducted hydrogeological investigations in these deposits that included installation and testing of two pumping wells (Golder, 2004) and in 2005 Golder assisted in the installation and testing of two dewatering wells that became part of pit wall dewatering/depressurization system (Golder, 2005). The location of these wells is presented in Attachment 1. Interpretation of hydrogeological data collected during these investigations suggested that the overburden southeast from the pit is highly variable, ranging in texture from silt/clay to sand/gravel, with coarser sediments present at depth and directly overlying bedrock.

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MPMC provided information on the historical dewatering rates for the Wight Pit. In 2008, when the majority of the pit was mined out, MPMC estimated groundwater inflow to this pit to range between 950 m^3/day (175 USgpm) in winter and 1600 m^3/day (300 USgpm) during spring/summer. MPMC also indicated that in 2008 only one overburden dewatering well was operational; however, the dewatering records for this well are not available. In 2014, MPMC estimated that, during summer months, the groundwater inflow to the Wight Pit was approximately 1300 m^3/day (240 USgpm), and indicated that the dewatering wells were not active at this time.

3.0 PRELIMINARY ESTIMATES OF SEEPAGE AT CLOSURE

At present the hydrogeological data from the area of the Wight Pit is not sufficient for the development of a detailed hydrogeological model that could be used to estimate seepage near this pit during closure. Most importantly, current hydraulic head data from the overburden sediments and bedrock surrounding the dewatered pit are not available. However, the available information was considered sufficient for providing preliminary estimates of this seepage based primarily on the historical groundwater inflows to this pit and information from the nearby Springer Pit. These preliminary estimates relied on a simplified analytical model of groundwater seepage near the Wight Pit that was based on the following assumptions:

- Seepage in bedrock near the Wight Pit can be represented using the Thiem equation that describes radial flow of groundwater towards a circular sink under steady-state conditions. The portion of this seepage originating from the topographic high west of the pit was based on the effective radius to the inferred groundwater divide of approximately 700 m and hydraulic head near this divide of 1080 m elevation. The portion of this seepage originating from the east (i.e. from Polley Lake) was based on the effective radius to Polley Lake of 325 m and the Polley Lake level of 920 m;
- Seepage in the overburden along the southeast wall of the Wight Pit can be represented using Darcy's Law. The cross-sectional area for this seepage was estimated to be approximately 2000 m^2 based on Golder (2006) interpretation, and the effective distance between the seepage face along the pit wall and Polley Lake was assumed to be 80 m;
- Estimates of groundwater seepage to the Wight Pit in 2008 and 2014 ranging between 950 m^3/day (175 USgpm) and 1600 m^3/day (300 USgpm) were assumed to consist of 50% of inflow from bedrock and 50% inflow from the overburden, under the assumption that in 2008 only one dewatering well was operational (as indicated by MPMC) and that in 2014 the dewatering system was off. For the base case estimates of groundwater seepage, inflow to the dewatered pit originating from bedrock alone was thus assumed to be equal to 650 m^3/day (120 USgpm) or 50% of average inflow estimated in 2008 and 2014;
- Groundwater seepage from the overburden to the Wight Pit under dewatered conditions was assumed to be equivalent to the pumping rate of 1900 m^3/day (350 USgpm) that was utilized during testing of TW05-1 in 2005 (Golder, 2006).

The simplified analytical model was calibrated to the estimates of groundwater inflow during mining by adjusting hydraulic conductivity assigned to the overburden and bedrock. When these parameters for overburden and bedrock were set to 6×10^{-5} m/s and 2×10^{-7} m/s, respectively, the model calculated total inflow was 2,600 m^3/day (470 USgpm) and matched 700 m^3/day (120 USgpm) estimated to originate from bedrock and 1,900 m^3/day (350 USgpm) assumed to enter the pit from the overburden. The values of hydraulic conductivity adopted in the calibrated model are in good agreement with bulk hydraulic conductivity of bedrock estimated for the mine site (Golder, 2014b) and with results of overburden testing near the Wight Pit discussed in Golder (2004, 2006).

Following calibration, the simplified analytical model was used to predict groundwater seepage near the Wight Pit for the pit lake level ranging between 880 m (i.e. current pit bottom) to 926 m (i.e. spillover elevation). The results of these calculations are presented in Table 1. Groundwater inflow to the pit lake was predicted to gradually decrease as the pit lake level increases from approximately 2,600 m^3/day (470 USgpm) when the pit lake level is at 880 m elevation to about 600 m^3/day (100 USgpm) when the lake is at a spillover elevation of 926 m. Groundwater outflow from the pit lake was predicted to occur once the pit lake level is above the water level elevation of Polley Lake (i.e. approximately 920 m) and was calculated to reach approximately 500 m^3/day (90 USgpm) when the pit lake is at the spillover elevation. The majority of this outflow was calculated to occur via the overburden materials that are present in the southeast between the pit wall and Polley Lake.

Table 1: Predicted Groundwater Flows for Wight Pit Lake

Pit Lake Elevation (m)	Groundwater Flow (m^3/day)	
	Into the Lake	Out of the Lake
Base Case		
880	2600	0
900	2500	0
910	2100	0
920	800	0
926	600	500
Lower Reasonable Bound		
926	400	300
Upper Reasonable Bound		
926	700	800

Table 1 also presents a range of potential groundwater inflow and outflow from the Wight Pit Lake that could be expected considering the uncertainty in the understanding of hydrogeological conditions near the facility. This range was calculated by considering the estimated range of historical pit inflows and the results of testing conducted previously in the overburden. The analysis indicated that, for the pit lake level at spillover elevation, the groundwater inflow to the pit could range from 400 m^3/day to 700 m^3/day: whereas, the outflow from the pit towards Polley Lake could vary from 300 m^3/day to 800 m^3/day.

4.0 SUMMARY AND RECOMMENDATIONS

The simplified hydrogeological analysis that was carried out for the Wight Pit Lake indicates that groundwater inflow to this lake could range between approximately 2600 m^3/day (470 USgpm) when the pit lake level is at 880 m elevation and 600 m^3/day (110 USgpm) when the spillover elevation of 926 m is reached. Once the pit lake level is above the average water level in Polley Lake of 920 m, groundwater seepage from the pit lake towards Polley Lake would occur. When the Wight Pit Lake is at spillover elevation this outflow was calculated to be approximately 500 m^3/day (90 USgpm).

Due to limited hydrogeological data available for the Wight Pit, the above predictions should be considered only as preliminary estimates of actual groundwater fluxes that could occur at closure. At present there is lack of understanding of groundwater levels in the area surrounding the Wight Pit and the hydrogeological significance of faults intersecting the east pit wall. In the absence of this information more accurate predictions of these fluxes cannot be made. The following activities are recommended to address these data gaps so that the estimates of groundwater seepage could be refined:

- Borehole survey: During the 2004 and 2005 investigations, several boreholes and wells were completed between the crest of the Wight Pit and Polley Lake (Attachment 1). It is recommended that the condition of these boreholes be assessed for their suitability for hydraulic head monitoring and water quality sampling;
- Installation of monitoring wells: If the borehole survey finds that wells installed in 2004-2005 are no longer accessible and/or suitable for groundwater monitoring, two multi-level monitoring wells should be installed between the Wight Pit and Polley Lake. At each location the shallow piezometer should target the more permeable portion of the overburden and the deep piezometer should be completed in bedrock. One of the deeper installations should target the fault/dike structure that is present in the southeast corner of the pit;
- Seepage survey: A seepage survey, focusing on major structure identified along the pit walls, should be conducted. If practicable, quantitative measurements of groundwater seepage from the fault/dyke structure in the southeast corner of the pit (and other visible seepage) should be made to facilitate estimates of hydrogeological properties of this feature;
- Groundwater monitoring: Monitoring wells near the Wight Pit should be included in the groundwater monitoring program for the site. Hydraulic heads at these installations should be measured at least weekly and groundwater quality should be assessed on a quarterly basis. After one year of monitoring, the groundwater quality data should be assessed for seasonal variability and the monitoring frequency should be adjusted appropriately;
- The existing hydrogeological model should be expanded to include the Wight Pit and its calibration should be updated to include new data sources described above. The expanded model should be used to refine the predictions of groundwater seepage that could occur at closure.

5.0 CLOSURE

We trust that the above information is sufficient for your needs at this time. Should you have any questions or require clarification, please do not hesitate contact the undersigned at 604-296-4200.

GOLDER ASSOCIATES LTD.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
W. ZAWADZKI
25898
Sept 11 2015
GEOSCIENTIST

Willy Zawadzki, P.Geo.
Principal, Senior Hydrogeologist

Don Chorley, P.Geo.
Principal, Senior Hydrogeologist

WZ/DWC/ch

Attachments: Figure 1: Site Plan
Attachment 1: Location of Pumping Wells Completed in the Overburden
Attachment 2: Study Limitations

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6.0 REFERENCES

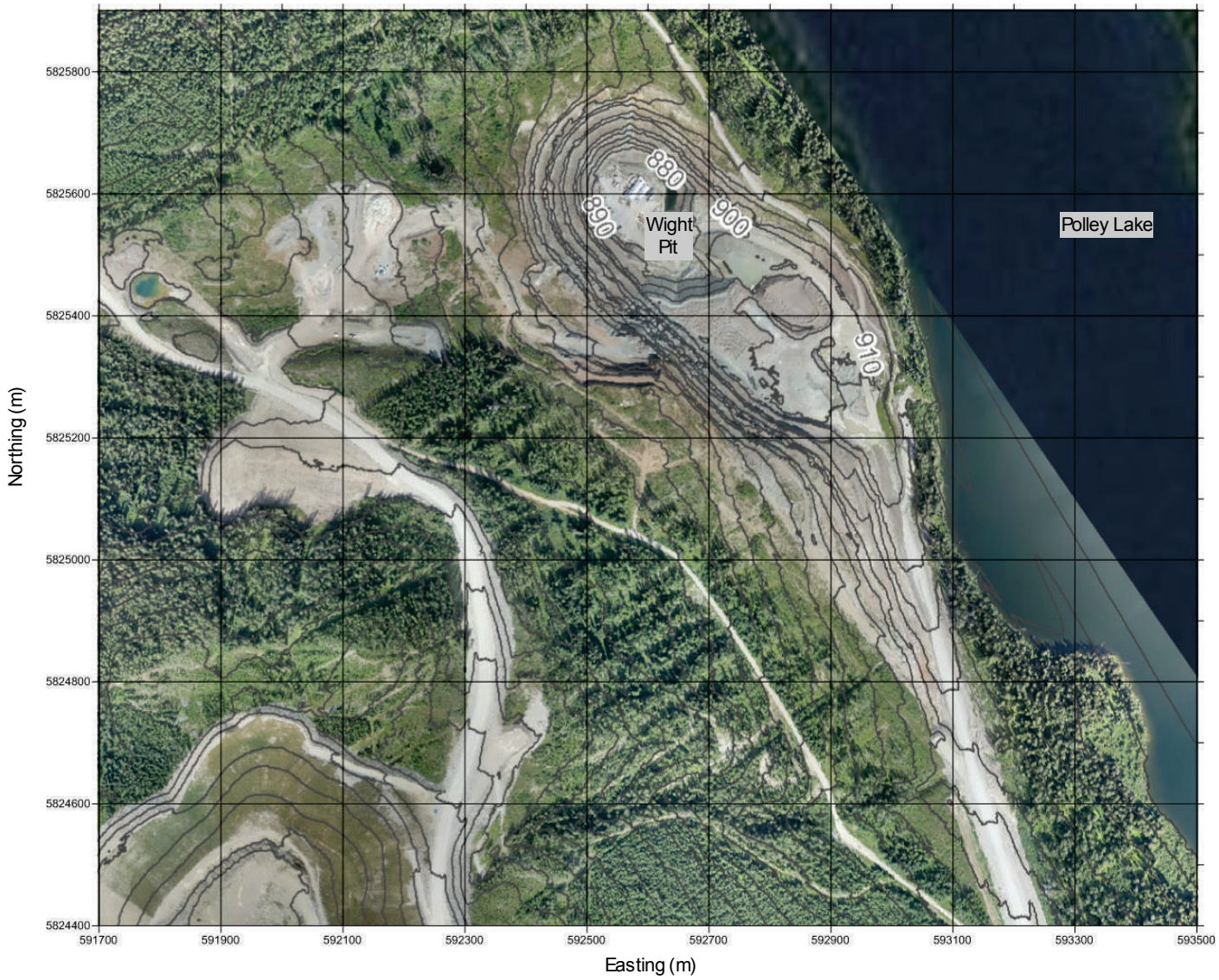
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MOUNT POLLEY MINING CORPORATION
LIKELY, BC

PROJECT
PRELIMINARY PREDICTIONS OF GROUNDWATER SEEPAGE FOR THE WIGHT OPEN PIT AT CLOSURE

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-09-03
PREPARED	WZ
DESIGN	WZ
REVIEW	DWC
APPROVED	DWC

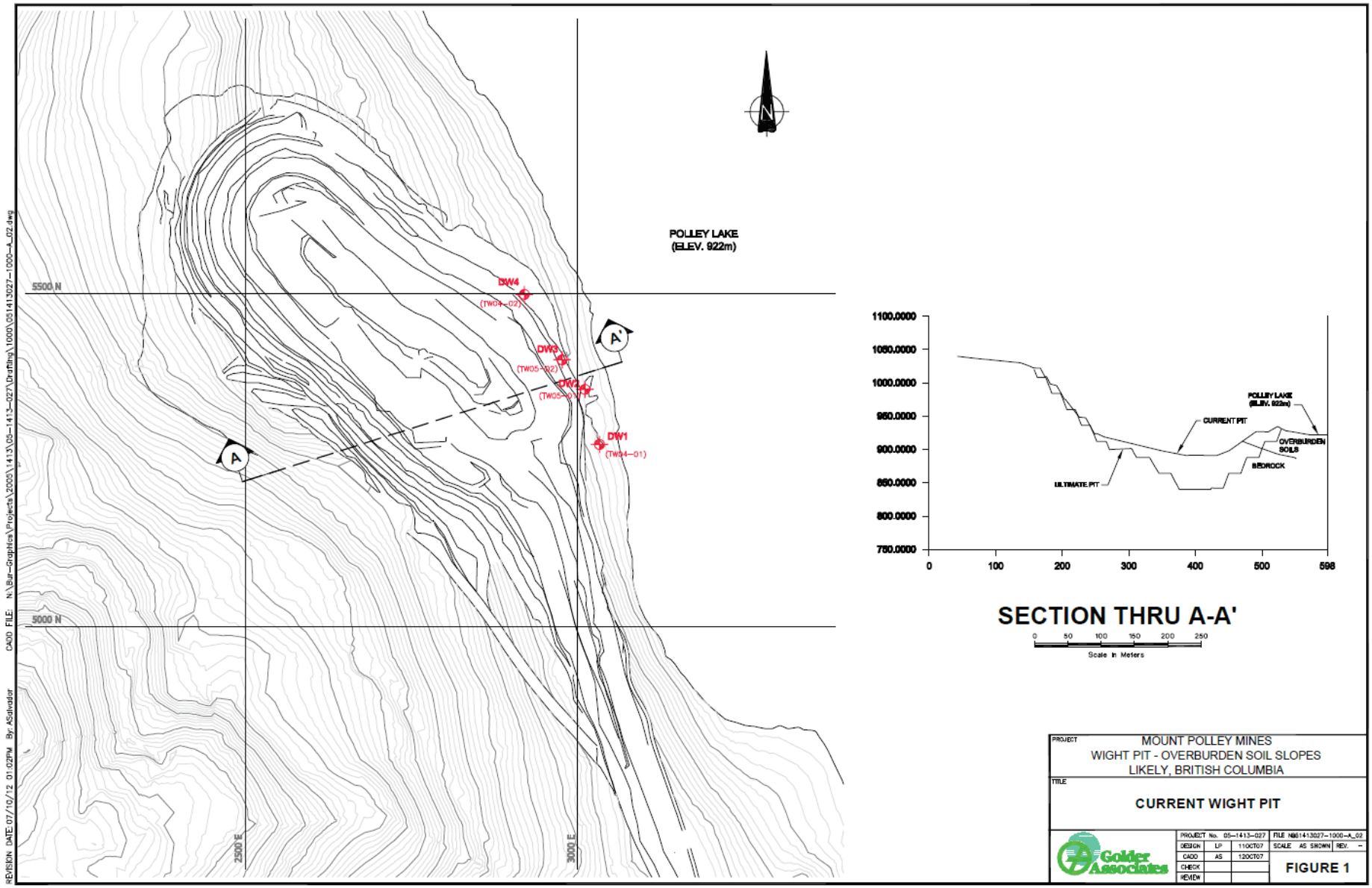
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ATTACHMENT 1

LOCATION OF PUMPING WELLS COMPLETED IN THE OVERBURDEN



Note: This figure is reproduced from Golder letter report to MPMC dated October 31, 2007.

ATTACHMENT 2
STUDY LIMITATIONS

Study Limitations

This document has been prepared for the exclusive use of Mount Polley. The factual information, descriptions, interpretations, and comments contained herein are specific to the project described in this document and do not apply to any other project or site. Under no circumstances may this information be used for any other purposes than those specified in the scope of work unless explicitly stipulated in the text of this document or formally authorized by Golder. This document must be read in its entirety as some sections could be falsely interpreted when taken individually or out-of-context. As well, the final version of this document and its content supersedes any other text, opinion or preliminary version produced by Golder.

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Hydrogeologic/hydrologic investigations and groundwater modelling are dynamic and inexact sciences. They are dynamic in the sense that the state of any hydrological system is changing with time, and in the sense that the science is continually developing new techniques to evaluate these systems. They are inexact in the sense that groundwater systems are complicated beyond human capability to evaluate them comprehensively in detail, and we invariably do not have sufficient data to do so. A groundwater model uses the laws of science and mathematics to draw together the available data into a mathematical or computer-based representation of the essential features of an existing hydrogeologic system. While the model itself obviously lacks the detailed reality of the existing hydrogeologic system, the behaviour of a valid groundwater model reasonably approximates that of the real system. The validity and accuracy of the model depends on the amount of data available relative to the degree of complexity of the geologic formations, the site geochemistry, the fate and transport of the dissolved compounds, and on the quality and degree of accuracy of the data entered. Therefore, every groundwater model is a simplification of a reality and the models described herein are not an exception.

The professional groundwater modelling services performed as described in this document were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practising under similar conditions, subject to the quantity and quality of available data, the time limits and financial and physical constraints applicable to the services. Unless otherwise specified, the results of previous or simultaneous work provided by sources other than Golder and quoted and/or used herein are considered as having been obtained according to recognised and accepted professional rules and practices, and therefore deemed valid. This model provides a predictive scientific tool to evaluate the impacts on a real groundwater system of specified hydrological stresses and/or to compare various scenarios in a decision-making process. However and despite the professional care taken during the construction of the model and in conducting the simulations, its accuracy is bound to the normal uncertainty associated to groundwater modelling and no warranty, expressed or implied, is made.

APPENDIX U:

TAILINGS STORAGE FACILITY 950 MASL SPILLWAY CONCEPTUAL DESIGN

(GOLDER 2015)

TECHNICAL MEMORANDUM

DATE September 28, 2015 **REFERENCE No.** 1411734-081-TM-Rev0-15000

TO Katie McMahen
Mount Polley Mining Corporation

CC Luke Moger, Art Frye

FROM James Ogilvie and Allan Bronsro **EMAIL** jogilvie@golder.com; abronsro@golder.com

TAILINGS STORAGE FACILITY 950 MASL SPILLWAY CONCEPTUAL DESIGN

1.0 INTRODUCTION

Mount Polley Mining Corporation (MPMC) has retained Golder Associates Ltd. (Golder) to develop a conceptual-level spillway design for the Tailings Storage Facility (TSF) as part of the Five Year Mine Plan and Reclamation Plan. The TSF is located on the southern edge of the Mount Polley Mine site. The main function of the spillway is to safely discharge overflow from the TSF caused by storm water runoff and other inflows from the surrounding catchment, and it is intended to operate after closure of the TSF, provided that the breach repair area remains at a minimum crest elevation of 950 masl (MPMC's tailings grid).

This document presents the data that Golder used to develop the spillway design.

2.0 DATA FOR DESIGN

2.1 Design Flows

Precipitation depths used to estimate inflows to the TSF for various return periods are presented in Table 1.

Table 1: 24-Hour Precipitation Depths

Return Period	Depth (mm)
2-year	34.2
10-year	46.8
25-year	52.5
100-year	60.7
200-year	64.7
1000-year	73.8
Probable Maximum Precipitation (PMP)	188.1

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The total catchment area draining to the TSF is estimated to be 2.99 km^2 (Golder 2015). The design event for the TSF was selected as the 24-hour-PMP rainfall event plus the 1-in-2-year snowmelt. The flows to the TSF were calculated using Hydrologic Engineering Centre Hydrologic Modelling System (HEC-HMS) software (USACE 2010). The Soil Conservation Service (SCS) curve number (CN) method (USDA 1986) was used to calculate catchment losses. A CN value of 95 and a lag time of 5 minutes were used for the direct TSF catchment, and a CN value of 87 and a lag time of 15 minutes were used for the catchment upstream of the TSF.

Flows resulting from the design event, as calculated in HEC-HMS, are presented below in Table 2.

Table 2: Design Event Flows

Description	Value (m^3/s)
PMP inflow	33.6
1-in-2-year snowmelt inflow	0.2
Total peak design inflow	33.8
Total peak design outflow	3.9

2.2 Freeboard

The freeboard for a water-containing structure can be defined as the minimum vertical distance between the still pool reservoir level and the crest of the containing structure (CDA 2007). This distance needs to be maintained at all times to prevent overtopping of the containing structure by large waves resulting from the sum of wind, and wave set-up and run-up.

There are two freeboard values that need to be considered as follows:

- *Normal freeboard* is the difference in elevation between the dam crest and the maximum operating water level of the facility.
- *Minimum freeboard* is the difference in elevation between the dam crest and the maximum still pool water level that would result from the peak design inflow.

The normal and minimum freeboard requirements for the TSF were calculated for the spillway. The freeboard calculations follow the procedures and equations discussed in CDA (2007). Wind speeds, pond depth, and dam slope geometry were considered to determine the greatest wave uprush value for the normal and minimum freeboard scenarios.

The freeboard calculation values and the corresponding normal and minimum freeboards for the TSF 950 masl spillway are shown below in Table 3.

Table 3: Spillway Freeboard Values

Description	Normal	Minimum
Design wind speed	30.3 m/s (1-in-1,000 year)	25.2 m/s (1-in-10-year)
Fetch length	1.25 km	1.25 km
Average water depth	5 m	5 m
Water depth at toe of berm	15 m	15 m

Description	Normal	Minimum
Berm slope	0.4 m/m	0.4 m/m
Berm surface condition	Smooth impermeable	Smooth impermeable
Wave setup	0.05 m	0.03 m
Wave run-up	2.13 m	1.63 m
Wave uprush (setup and run-up)	2.18 m	1.66 m
Design Freeboard	2.50 m*	1.66 m

**To prevent discharge over spillway during normal conditions*

2.3 Design Elevations

Elevations used for the design of the spillway are presented below in Table 4. All elevations are in MPMC's tailings grid.

Table 4: Spillway Design Elevations

Description	Elevation (masl)
TSF crest elevation	950.0
TSF spillway crest elevation	947.5
Normal operating water level	947.5
Maximum water level	948.34

3.0 DESIGN SUMMARY

The spillway design consists of a grouted riprap weir crest and a 170 m-long channel to convey flows downstream of the TSF's landside toe. The spillway is located on top of the TSF breach repair, which is at the north end of the dam. Flatter channel side slopes (10H: 1V) have been provided to allow vehicle passage along the access road. The channel dimensions are shown below in Table 5. The design also includes cutting back the haul road to the north of the TSF to meet original grade on the downstream side of the TSF.

Table 5: Spillway Channel Dimensions

Description	Value
Bottom width	2.0 m
Channel side slope	2H:1V
Channel side slope at road crossings	10H:1V
Depth	0.8 m

3.1 Design Drawings

Additional design information is presented in the drawing package provided with this memorandum.

4.0 CLOSURE

We trust this document meets your present requirements. Please direct any questions, comments, or concerns to the undersigned.





James Ogilvie, P.Eng., M.Eng.
Water Resources Engineer

Allan Bronsro, P.Eng., M.Sc.
Associate, Senior Water Resources Engineer

Attachment: TSF 950m Spillway Conceptual Design Drawings Rev. 0

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NOTES

1. ALL UNITS IN METERS UNLESS OTHERWISE NOTED.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL 2 m MINOR AND 10 m MAJOR CONTOURS.

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PROJECT
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CONCEPTUAL DESIGN

TITLE
950 MASL SPILLWAY
PROJECT PLAN

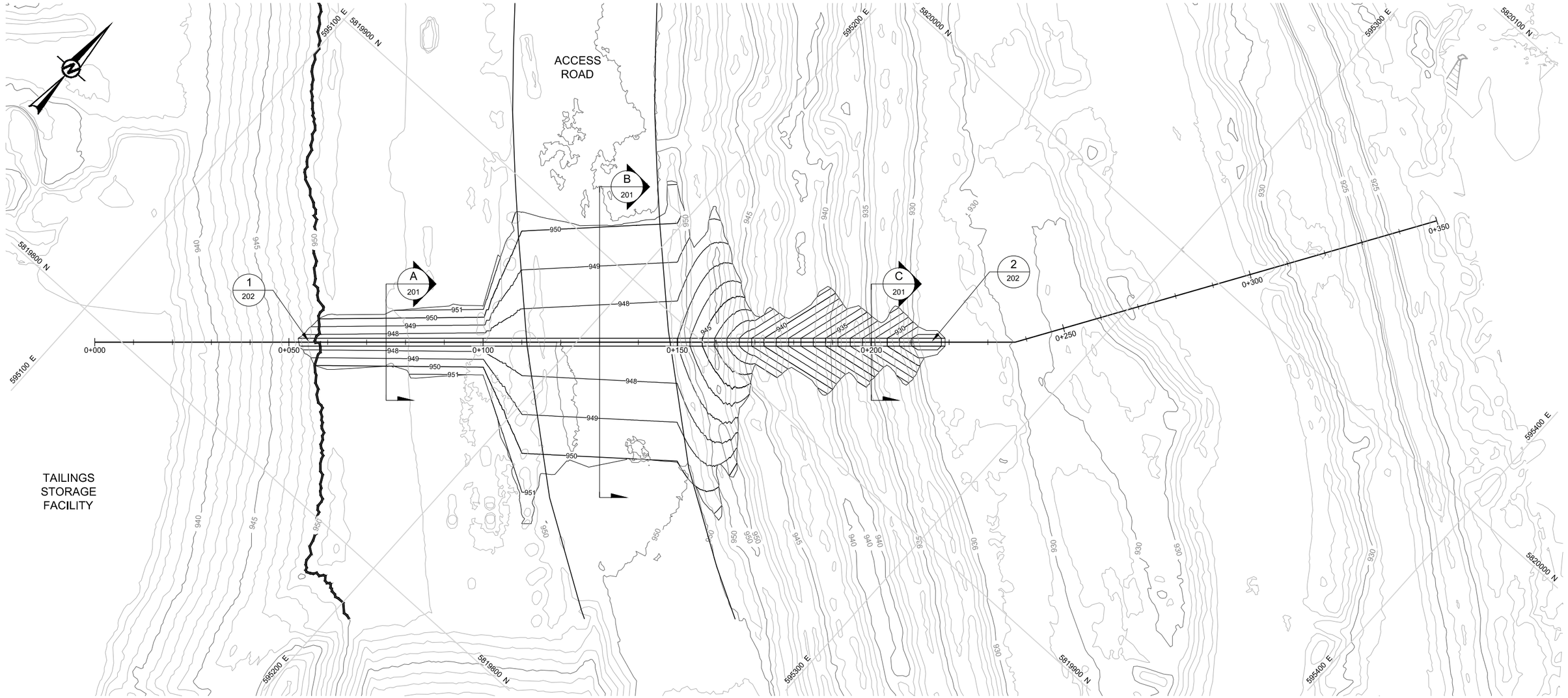
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CONCEPTUAL DESIGN

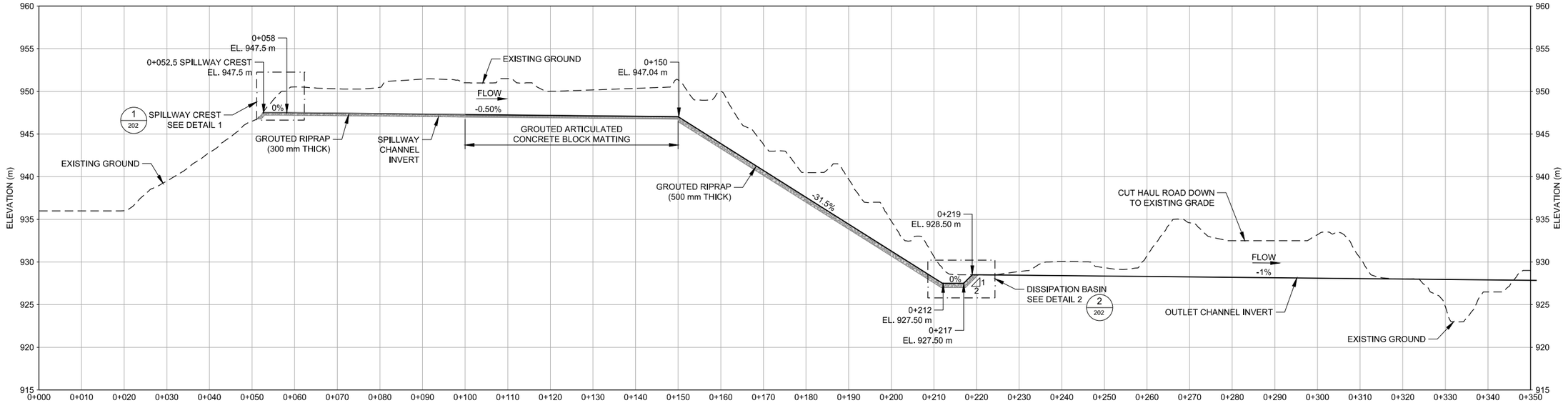
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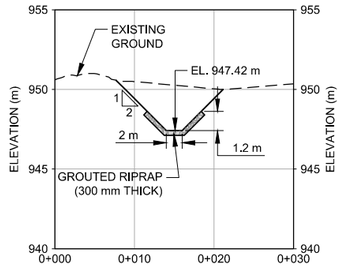
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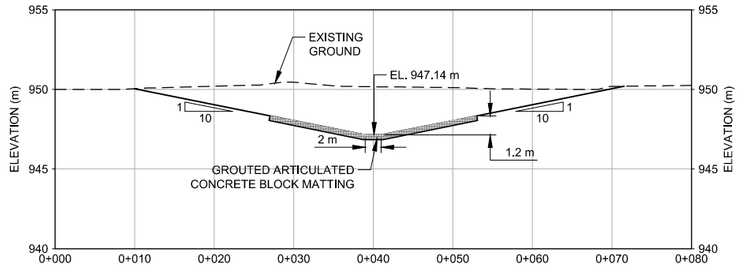
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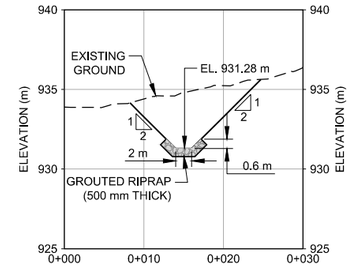
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SCALE 1:750 VERT. SCALE 1:375 — C 200 — TSF SLOPE CHANNEL SECTION

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950 MASL SPILLWAY
PROFILE AND SECTIONS

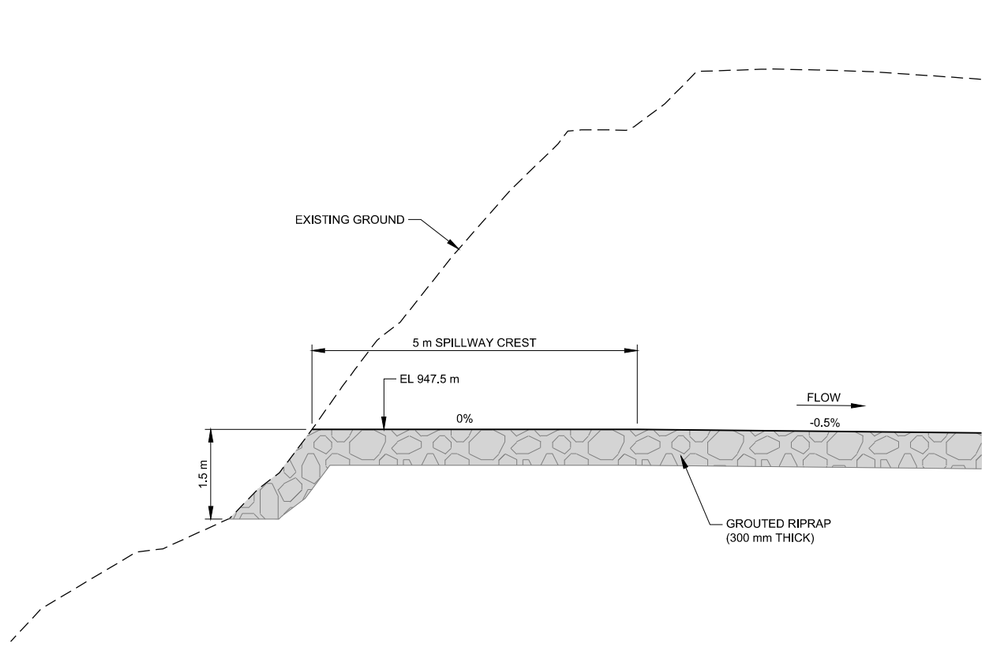
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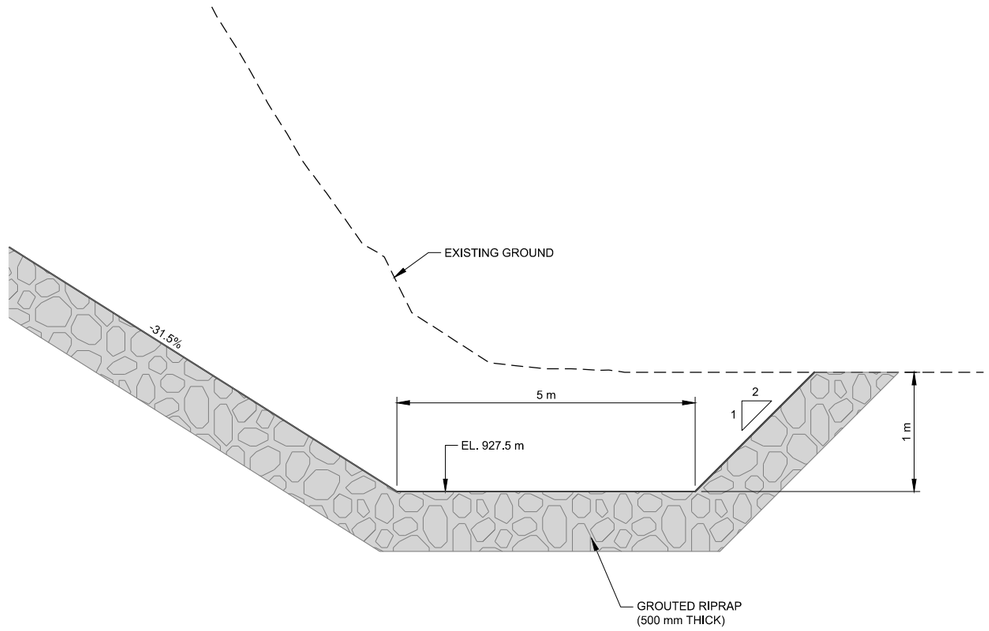
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SCALE 1:100 / VERT. SCALE 1:50 — 2/200 — DISSIPATION BASIN DETAIL

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NOTES
1. ALL UNITS IN METERS UNLESS OTHERWISE NOTED.

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MOUNT POLLEY MINING CORPORATION

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[+1] (604) 296 4200
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PROJECT
TSF SPILLWAY
CONCEPTUAL DESIGN

TITLE
950 MASL SPILLWAY
DETAILS

PROJECT No.	PHASE	Rev.		DRAWING
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APPENDIX V:

REVIEW OF GROUNDWATER CHARACTERIZATION AND MONITORING PROGRAM

(GOLDER 2015)

TECHNICAL MEMORANDUM

DATE September 22, 2015 **PROJECT No.** 1411734-074-TM-Rev0-15000

TO Katie McMahen, P.Ag.
Mount Polley Mining Corporation

FROM Willy Zawadzki
Don Chorley

EMAIL wzawadzki@golder.com
don_chorley@golder.com

REVIEW OF REVIEW GROUNDWATER CHARACTERIZATION AND MONITORING PROGRAM AT MOUNT POLLEY MINE

1.0 INTRODUCTION

This technical memorandum presents a review of the groundwater characterization and monitoring program at the Mount Polley Mine that is operated by the Mount Polley Mining Corporation (MPMC). The review was requested by MPMC to support the preparation of the Reclamation and Closure Plan for the site. As requested by MPMC the focus of this review is the area adjacent to the Springer Pit, Cariboo Pit and Wight Pit and does not include the area adjacent to the Tailings Management Facility (TSF). Review of the groundwater characterization and monitoring program for this facility is currently in progress and will be reported on under a separate cover.

2.0 GROUNDWATER CHARACTERIZATION

2.1 Historical Field Programs

The collection of hydrogeological data near the open pits at the Mount Polley Mine began before the start of mining and continues to this date. Figure 1 shows the location of key mine facilities. The following list provides a summary of groundwater investigations programs that has been completed at the site to date:

- In 1989 nine piezometers were installed by Imperial Metals Corporation as part of the diamond drilling and groundwater investigation program for the Cariboo and Springer Pits (KP, 1990). The program also included packer testing in selected boreholes. All piezometers that were installed in 1989 are no longer active;
- In 1995 Knight Piesold installed seven monitoring wells near Bootjack Lake and Polley Lake to monitor groundwater flow between the mine facilities and these water bodies (KP, 1996). Monitoring well GW95-R5 is still accessible whereas the remaining wells installed in 1995 are no longer active. In 1996 additional monitoring wells were installed primarily near the TSF, and one well GW96-7 was completed south of the mill site in the area adjacent to the open pits. This well is still active;
- In 2004 Golder installed piezometers in four boreholes completed in bedrock and four boreholes completed in the overburden as part of geotechnical assessment for the Wight Pit (Golder, 2004). In addition, two test dewatering wells were installed and tested in the area between this pit and Polley Lake. These installations are no longer active;

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- In 2005 Golder assisted MPMC in the installation and testing of two dewatering wells between Wight Pit and Bootjack Lake (Golder, 2006). One of these wells, GW05-1 (formerly TW05-1), is included in the MPMC monitoring program; whereas, the other well is no longer active;
- In 2011 MPMC installed two monitoring wells at the site. One of these wells (GW11-1) is located west of the Springer Pit and is currently active;
- In 2012 Amec installed five nested monitoring wells (a shallow well and a deep well) and conducted permeability testing along the shore of Bootjack Lake and Polley Lake (Amec, 2013). All GW12 series wells are presently active; and
- In 2015 Golder installed two two-level monitoring wells and conducted permeability testing in the area between the Springer Pit and Bootjack Lake (Golder, 2015a). All GW15 series wells are presently active.

Figure 1 presents the locations of monitoring wells that are active and are part of MPMC groundwater monitoring program.

2.2 Site Conceptual Model

The conceptual understanding of groundwater conditions near the Springer Pit, Cariboo Pit and Wight Pit has been previously discussed by Golder (2001) as part of the hydrogeological studies for the Cariboo Pit; by Golder (2006) as part of the assessment for the Wight Pit; by Amec (2013) as part of their data review; and by Golder (2010 and 2014) in support of pit lake studies for the Springer Pit. The following is a summary of a combined conceptual model for the conditions that existed prior to mining, the conditions that developed during mining, and conditions that will exist after mine closure.

The area adjacent to the open pits at the Mount Polley mine is located on a topographic high bounded to the northeast by Polley Lake and to the southwest by Bootjack Lake (Figure 1). This topographic high is underlain by monzonite bedrock that has been intruded by hydrothermal breccias. During testing, bedrock hydraulic conductivity was found to generally decrease with depth from approximately mid-10^{-7} m/s to 10^{-6} m/s near the bedrock top to 10^{-8} m/s at greater depth. These values indicate that the bedrock at the site has a low and at greater depth very low capacity to transmit groundwater (Powers and Corwin, 2007). The area is intersected by northwest-southeast striking faults that in the area of the Cariboo and Springer Pits appear to be well healed and not conductive, whereas in the area of the Wight Pit are associated with seepage that was observed in the southeast wall of this pit. The bedrock in the area of Springer and Cariboo Pits is overlain by discontinuous and relatively thin (i.e. few meters) layer of overburden of glacio-lacustrine and glacio-fluvial origin, primarily silt/clay. Near the Wight Pit a thicker zone of overburden was identified between the southeast crest of the pit and Polley Lake, with coarser and more permeable sand/gravel sediments present at depth directly above bedrock.

2.2.1 Pre-Mining

Figure 2 presents a conceptual cross-section that shows groundwater conditions that existed before open pits were mined. Recharge to groundwater from precipitation along the topographic high resulted in a watertable that mounded relatively close to the ground surface and was a subdued replica of topography. At higher elevations, near the present location of Cariboo Pit, the watertable was approximately 30 m below the ground surface and at lower elevations the watertable was within a few meters of the ground surface. The majority of groundwater flow occurred in bedrock with discharge directed southwest towards Bootjack Lake and northeast towards Polley Lake, both acting as strong hydrogeologic boundaries. Perched groundwater conditions might have existed within pockets of lower-permeability overburden along the topographic highs, and a more continuous flow system (fully saturated) was likely active in the thicker overburden zone near the current location of Wight Pit southeast wall.

2.2.2 Operational

Figure 3 shows a conceptual cross-section that depicts groundwater conditions that have developed during mining. Once the floor of each open pit was lowered below the watertable, the pits started to act as sinks for groundwater flow with groundwater directed in a radial pattern towards the pit walls. Near the Springer and Cariboo Pits, the inflow occurred primarily through bedrock with majority of this inflow originating from precipitation-driven recharge along the topographic highs. Due to the relatively close proximity of the Wight Pit to Polley Lake, groundwater inflow to this pit also included recharge from Polley Lake that occurred primarily through the overburden unit and to a lesser degree through bedrock. Groundwater inflow to the Springer Pit (700 m^3/day to 1600 m^3/day in 2014) and Wight Pit (950 m^3/day to 1600 m^3/day in 2008) that MPMC observed was relatively low and in reasonable agreement with permeability testing conducted near these pits (Golder, 2015b and 2015c).

2.2.3 Closure

The conceptual cross-section presented on Figure 4 shows groundwater conditions that are expected to develop after mine closure. At closure, tailings that are capped by waste rock will be deposited in the Springer Pit, and waste rock will be placed in the Wight Pit and Cariboo Pit. Once the open pits are flooded to their spillover elevation, the watertable along the topographic high is expected to recover to near pre-mining conditions; except in the immediate vicinity of the open pits where locally the watertable will remain depressed on the upgradient side of each pit and some local mounding is expected on the downgradient side. The pits lakes will act as "flow-through lakes" with groundwater discharging to the pit lakes from the upgradient direction and discharging from the pit lakes towards lower ground. Groundwater discharge from the Springer Pit Lake and the Wight Pit Lake will be directed towards Bootjack Lake and Polley Lake, respectively. A portion of groundwater discharge from the Cariboo Pit Lake is expected to be directed towards the Springer Pit Lake with the remainder of this seepage migrating towards Bootjack Lake.

3.0 CURRENT GROUNDWATER MONITORING PROGRAM

MPMC provided their report that included the results of 2014 groundwater monitoring program (MPMC, 2015). The program has been ongoing since 1995 with the objectives to monitor direction, quantity and quality of groundwater seepage near the mine facilities. Monitoring changes in groundwater quality focused on 9 Parameters of Interest (POIs) that included:

- Physical Parameters: hardness;
- Anions: sulphate;
- Nutrients: nitrate; and
- Dissolved Metals: aluminum, arsenic, cadmium, copper, molybdenum, and selenium.

In 2014, groundwater conditions near the Springer Pit, the Cariboo Pit and Wight Pit were monitored at 15 locations that are presented on Figure 1. Table 1 provides a summary of the monitoring program and its recent findings.

Well ID	Well Depth (m)	Location	Recent Trends
95R-5	79.2	E of NE Zone Dump	Arsenic increased; other POIs decreased
GW96-7	14.12	S of Mill Site	Hardness, sulphate, molybdenum decreased; other POIs similar to historical trends
GW05-01		Near Wight Pit	Sulphate, copper, molybdenum increased; other POIs similar to historical trends
GW11-1a	15.85	W of Potentially Acid Generating (PAG) Stockpile	Hardness, nitrate, copper increased; other POIs similar to historical trends
GW11-1b	8.23	W of PAG Stockpile	Nitrate increased; other POIs similar to historical trends
GW12-1a	99.6	N of PAG Stockpile	Sulphate, aluminum, arsenic increased; other POIs similar to historical trends
GW12-1b	24.4	N of PAG Stockpile	Nitrate, aluminum, arsenic increased; other POIs similar to historical trends
GW12-2a	100.6	W of Springer Pit	Aluminum, arsenic and molybdenum increased; other POIs similar to historical trends
GW12-2b	30.2	W of Springer Pit	Aluminum and molybdenum increased; other POIs similar to historical trends
GW12-3a	99.7	S of Cariboo Pit	Nitrate, cadmium, copper and selenium increased; other POIs similar to historical trends
GW12-3b	16.1	S of Cariboo Pit	Nitrate, arsenic, and selenium increased; other POIs similar to historical trends
GW12-4a	100.6	E of NE Zone Dump	Arsenic, molybdenum increased; other POIs similar to historical trends
GW12-4b	36.3	E of NE Zone Dump	Hardness, nitrate and molybdenum increased; other POIs similar to historical trends
GW12-5a	100.4	S of Wight Pit	Arsenic increased; other POIs similar to historical trends
GW12-5b	12.7	S of Wight Pit	Copper increased; other POIs similar to historical trends

Notes: Based on Table 5.2 and Section 5.2.3 in MPMC 2015.

In addition to the water quality sampling, groundwater levels are measured bi-annually in all monitoring wells listed in Table 1 to facilitate evaluations of changes in groundwater flow directions and quantities during the mine life.

In the spring of 2015 MPMC commenced groundwater quality monitoring near the Springer Pit in the GW15 series wells. Water quality sampling at these location are conducted on a monthly basis. MPMC also monitors groundwater levels at these locations and nearby GW12-2a/b monitoring wells on a daily basis.

With the exception of the area surrounding the Wight Pit, the location of monitoring wells and monitoring frequency are considered sufficient for monitoring of groundwater conditions at the mine site during operation. These wells are positioned downgradient of the key mine facilities such that changes in groundwater conditions that could occur in response to mine operation could be detected. Monitoring frequency is considered adequate for assessing seasonal changes in groundwater quality and hydraulic gradients.

At present, groundwater conditions near the Wight Pit are assessed based on the information from monitoring well GW05-1. This well was installed in the overburden as part of the pit dewatering efforts in 2005 (Golder, 2006) and has since been used as a water supply source for the mine underground operation. Groundwater quality data collected from this well may be affected by water recharge from Polley Lake while the well is being pumped, although due to lack of water level readings from this well this cannot be assessed at present. As such, GW05-1 water quality data may not be representative of groundwater conditions in the overburden near this pit. In addition, data on groundwater conditions in bedrock adjacent to the Wight Pit is not available. It may be possible to re-condition some of the older installations that were completed near this pit along the shore of Polley Lake in bedrock and overburden, which is something that MPMC is currently pursuing based on recommendations previously provided by Golder (2015b).

4.0 CONCEPTUAL GROUNDWATER MONITORING PROGRAM AT CLOSURE

As indicated in the hydrogeological conceptual model that was presented in Section 2, seepage from the pit lakes that will form in the Springer Pit, Cariboo Pit and Wight Pit will affect groundwater conditions at the site after closure. Monitoring of this seepage will be required such that its effects on the receiving environment could be assessed, and, if necessary, an appropriate mitigative strategy could be implemented. With these objectives in mind, the following conceptual plan for groundwater monitoring at closure is proposed.

4.1.1 Springer Pit Lake

At closure, groundwater monitoring at the GW15 series wells and GW12-2a/b should continue on a quarterly basis, and the groundwater levels should be monitored daily. This information should be assessed as it becomes available in conjunction with the hydrologic assessment of water quality in the Springer Pit Lake and Bootjack Lake, and if necessary used to implement seepage mitigation that was discussed in Golder (2015c).

At later times, once the quality and quantity of seepage is well characterized and the effect of optional mitigation is well understood, the frequency of groundwater monitoring could be reduced. As a minimum, annual water quality sampling and groundwater level monitoring should continue for a period of five years or until such time that groundwater quality and quantity trends have stabilized and their effect on the receiving environment is within acceptable limits.

4.1.2 Cariboo Pit Lake

A significant portion of the seepage that will originate from the Cariboo Pit at closure is expected to report to the nearby Springer Pit Lake, and as such monitoring in this lake and downgradient monitoring wells will capture its effects. However, a portion of the seepage from Cariboo Pit is expected to by-pass the Springer Pit Lake and migrate directly towards Bootjack Lake. At present, groundwater conditions along this seepage pathway are not monitored.

If the water quality studies indicate that the water quality in the Cariboo Pit Lake at closure is of concern, it will be necessary to assess the quantity and quality of seepage along the flowpath between the pit lake and Bootjack Lake. This will require an installation of a nested monitoring well (with a shallow and deep well in each borehole) at two possible locations, as presented on Figure 5. Groundwater quality and level monitoring should be conducted at this location on a quarterly basis until this seepage pathway is characterized and its potential effects on the receiving environment well understood. The monitoring frequency could then be revised.

4.1.3 Wight Pit Lake

At closure, seepage from the Wight Pit Lake is expected to migrate towards Polley Lake through the overburden that is present along its southeast wall, and to a lesser degree through bedrock (Golder, 2015b). If the water quality studies for that pit lake indicate that its quality could be of concern, seepage monitoring at closure could be conducted in monitoring well GW05-1, once this well is modified to allow both water quality and level monitoring; by monitoring in previously installed wells that could be adapted for this purpose, and if necessary in new nested piezometers that could be installed between the pit wall and the shore of Polley Lake. An approximate location of these monitoring locations is shown on Figure 6. Groundwater quality and level monitoring for this seepage pathway should be conducted on a quarterly basis until this pathway is characterized and its potential effects on the receiving environment well understood, and at that time the monitoring frequency could be adjusted.

4.1.4 Other Facilities adjacent to the Open Pits

Groundwater quality and levels downgradient of other mine facilities that are nearby the open pits (i.e. North Zone Dump, Mill Site, PAG Stockpile) are monitored by monitoring wells listed in Table 1, with the exception of wells GW12-2a/b, which only monitors seepage between the Springer Pit and Bootjack Lake. At closure, it is recommended that bi-annual monitoring at these locations continue until such time that the groundwater quality and level trends stabilize and potential effects on the receiving environment are well understood. At such time and if these effects are within the acceptable levels, the monitoring frequency could be revised.

4.1.5 Contingency Planning

Seepage mitigation measures would be implemented at the site if it is determined that water quality in the pit lakes and associated seepage quantities are of concern. As discussed in Golder (2015c), these measures could rely on lowering the pit lake levels to reduce seepage quantity, installation of low-permeability barriers to contain the seepage, and/or implementation of passive interception systems. Detailed evaluation of these options is being developed as part of on-going water quality and water balance assessments. Additionally, active water treatment will be employed as necessary through the closure period to ensure that offsite water discharges remain protective of the receiving environment.

5.0 CLOSURE

We trust that the above information is sufficient for your needs at this time. Should you have any questions or require clarification, please do not hesitate contact the undersigned at 604-296-4200.

GOLDER ASSOCIATES LTD.

PROFESSIONAL ENGINEER OF BRITISH COLUMBIA W. ZAWADZKI Sept 22 2015 25898 GEOSCIENTIST

Willy Zawadzki, P.Geo.
Principal, Senior Hydrogeologist

Don Chorley, P.Geo.
Principal, Senior Hydrogeologist

WZ/DWC/ch

Attachments: Figure 1: Site Plan and Location of Groundwater Monitoring Stations Included in the MPMC Monitoring Program
Figure 2: Conceptual Hydrogeological Model – Pre-Mining Conditions
Figure 3: Conceptual Hydrogeological Model – Conditions during Mining
Figure 4: Conceptual Hydrogeological Model – Conditions during Closure
Figure 5: Additional Monitoring Locations – Cariboo Pit
Figure 6: Additional Monitoring Locations – Wight Pit

Attachment 1: Study Limitations

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6.0 REFERENCES

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NOTES:

Based on site plan provided
by MPMC in file MPMC GW Wells Map.pdf
The actual location of well
GW05-1 is currently being investigated.

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LIKELY, BC

PROJECT
REVIEW GROUNDWATER CHARACTERIZATION AND MONITORING PROGRAM

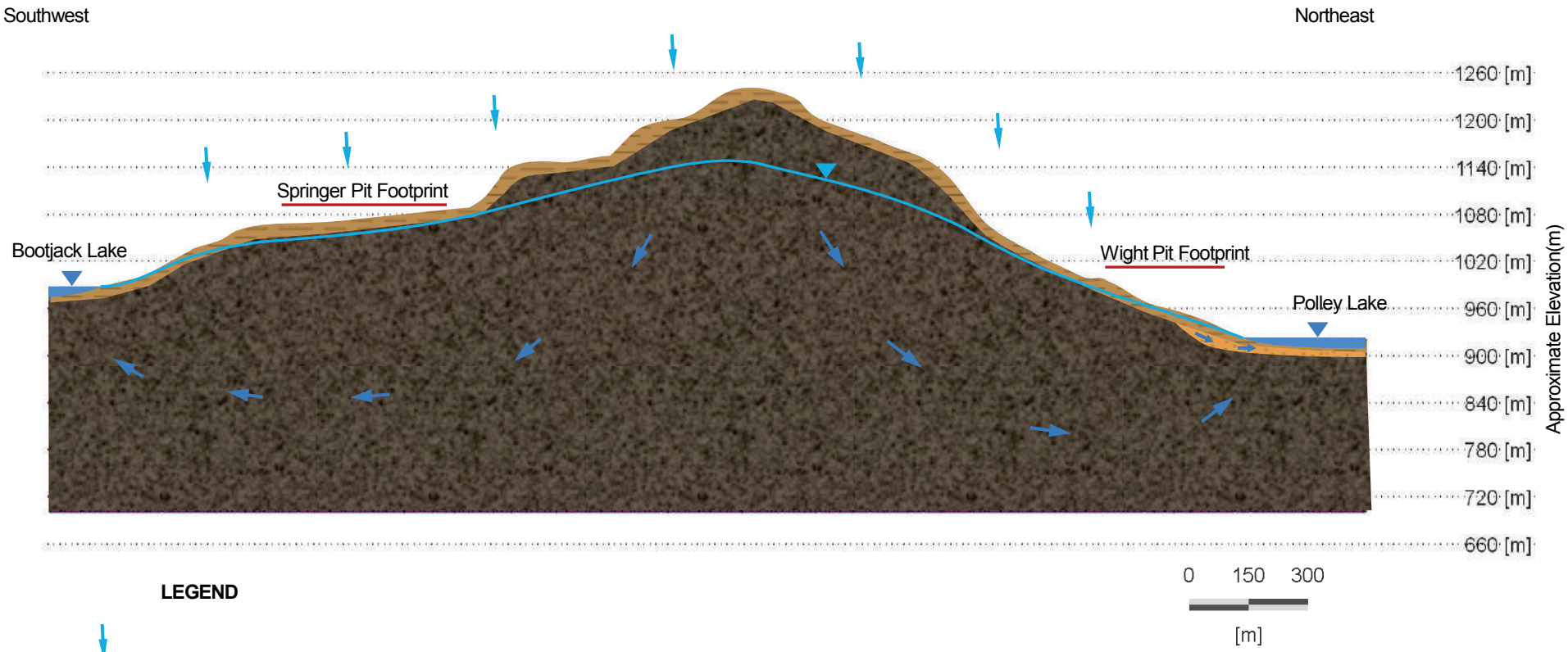
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SITE PLAN AND LOCATION OF GROUNDWATER MONITORING STATIONS INCLUDED IN THE MPMC MONITORING PROGRAM

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- Watertable
- Inferred Groundwater Flow Direction
- Bedrock
- Overburden (discontinuous silts/clays)
- Overburden (sand and gravel)

NOTES:
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Scale is approximate and vertical exaggeration is 2:1.
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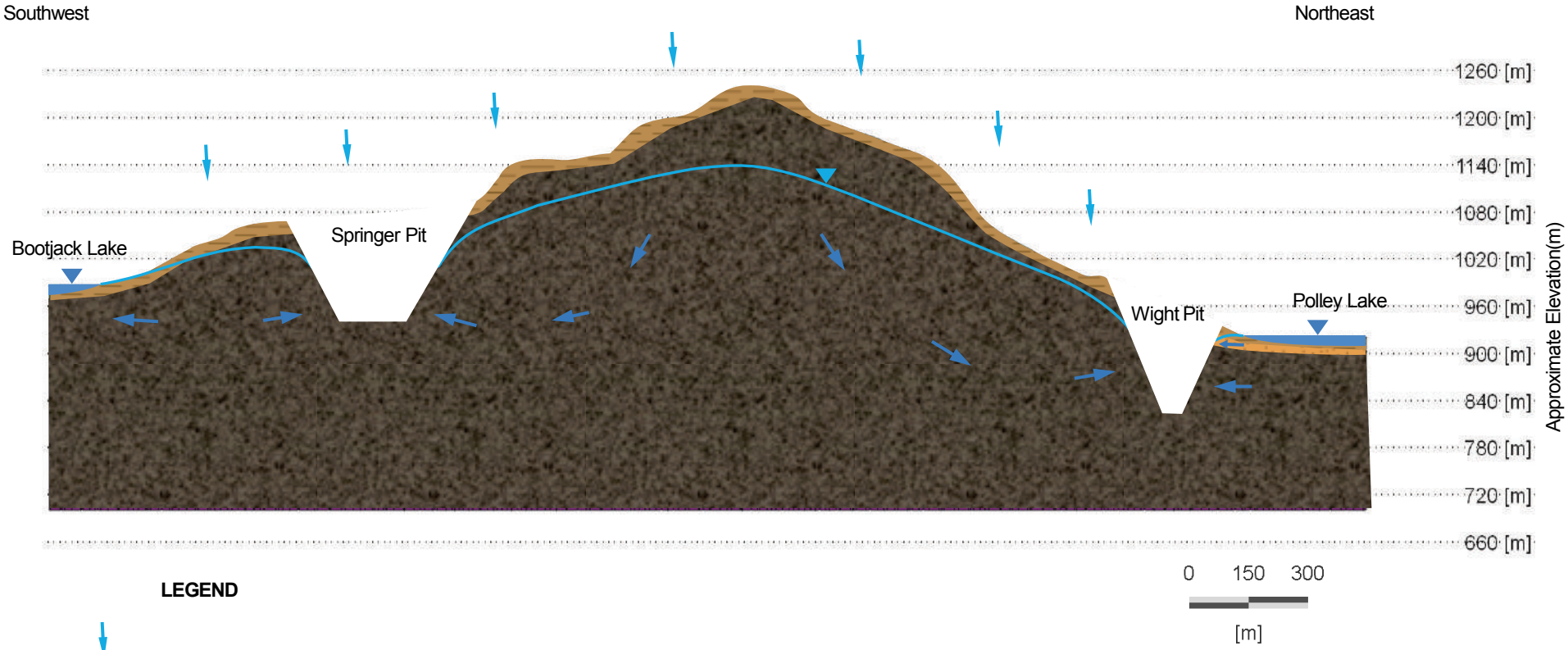
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PROJECT
REVIEW GROUNDWATER CHARACTERIZATION AND MONITORING PROGRAM

TITLE
CONCEPTUAL HYDROGEOLOGICAL MODEL PRE-MINING CONDITIONS

PROJECT No. **1411734** **15000** Rev. **0** **2**

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LEGEND

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- Watertable
- Inferred Groundwater Flow Direction
- Bedrock
- Overburden (discontinuous silts/clays)
- Overburden (sand and gravel)

NOTES:
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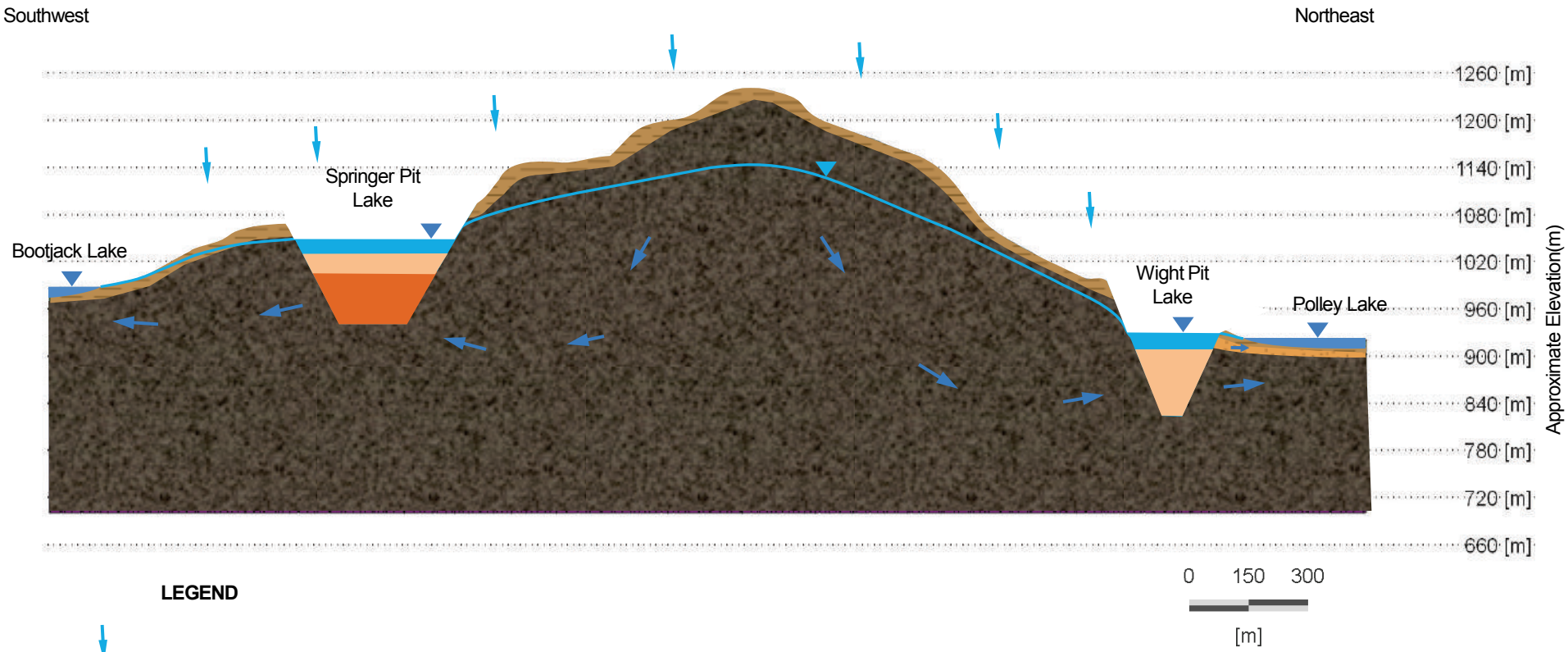
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TITLE
CONCEPTUAL HYDROGEOLOGICAL MODEL CONDITIONS DURING MINING

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LEGEND

- Recharge from Direct Precipitation
- Watertable
- Inferred Groundwater Flow Direction
- Bedrock
- Overburden (discontinuous silts/clays)
- Overburden (sand and gravel)
- Tailings
- Waste Rock

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PROJECT
REVIEW GROUNDWATER CHARACTERIZATION AND MONITORING PROGRAM

TITLE
CONCEPTUAL HYDROGEOLOGICAL MODEL CONDITIONS AT CLOSURE

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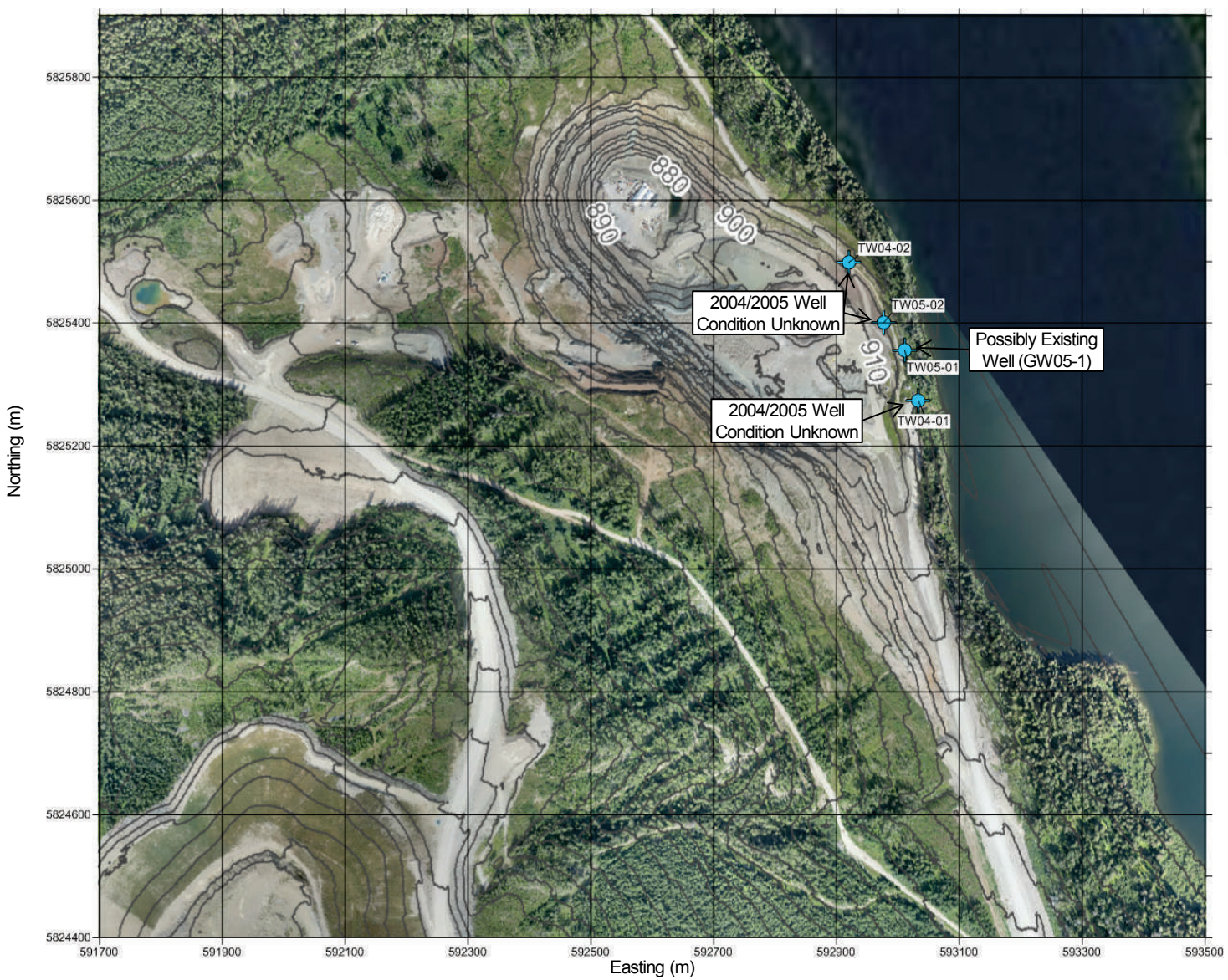
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PROJECT
REVIEW GROUNDWATER CHARACTERIZATION AND MONITORING PROGRAM

TITLE
ADDITIONAL MONITORING LOCATIONS
CARIBOO PIT

PROJECT No.		Rev.	
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CONSULTANT
Golder Associates

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PREPARED	WZ
DESIGN	WZ
REVIEW	DWC
APPROVED	DWC

TITLE
ADDITIONAL MONITORING LOCATIONS WIGHT PIT

PROJECT No.		Rev.	
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APPENDIX W:

VEGETATION METAL UPTAKE SAMPLING PLAN

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Vegetation Metal Uptake Monitoring Plan

Document Revision Control

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0	Original	September 25, 2014	KM

1 INTRODUCTION

As part of the Mount Polley Mining Corporate (MPMC) reclamation program, vegetation is sampled and analyzed for metal content. This work is conducted to investigate if vegetation growing on reclamation sites at the mine has different levels of metal uptake when compared with baseline and reference site data, and to assess if elevated metal levels (if encountered) are of concern for wildlife species. This vegetation metal uptake plan:

- Summarizes available historic data and monitoring conducted to date for baseline, reference, and progressive reclamation sites;
- Provides an overview of monitoring to be conducted at closure of the Mount Polley Mine site;
- Describes sampling methods and associated quality assurance / quality control (QA/QC) measures; and,
- Projects sampling program costs.

1.1 Summary of Historic Data

Baseline vegetation sampling at the Mount Polley Property was conducted for the purpose of documenting the pre-impact metal levels in vegetation at or near the mine site. Sampling was conducted in 1989, 1995, and 2006 in areas including the Central and West Pits (now the Cariboo and Springer Pits), the Mill Site, and the Tailings Storage Facility (TSF). These programs targeted wildlife forage species and species were selected based on their importance in the diet of ungulates and other herbivores. Vegetation that appeared browsed was also sampled.

In recent years, sampling of progressive reclamation sites has been carried out to monitor vegetation metal levels with varying reclamation prescriptions.

- In 2007, clover on the East Rock Disposal Site (RDS) research tree plots was sampled.
- In 2012, composite samples of ground cover (grasses and forbes) on the North Bell Dump Parcels 1 – 10 reclamation area and the East RDS research tree plots were collected, along with a composite ground cover sample in a new control east of the TSF. On the Northeast Zone (NEZ) dump reclamation area, samples of nine species in the native species trial plots on three treatment units were sampled.
- In 2014, composite samples of groundcover and composite samples of deciduous tree and shrub leaves were taken at four of the baseline sites that have not been disturbed by mining activity and at two new control sites located north and southeast of the mine site. Composite samples of deciduous tree and shrub leaves were collected on the East RDS research tree plots (ground cover composites were collected in 2012). Composite groundcover samples were collected on the three NEZ Dump treatment units (deciduous trees and shrubs are still being established).

Reclamation prescriptions for these reclamation areas are provided in Table 1 and details on the East RDS research tree plot prescriptions are provided in Table 2.

Table 3 summarizes samples that have been collected to date, including year, species sampled, and location. Compiled sample results are provided in Appendix A. Sample locations are shown in Figure 1.

Table 1 Summary of prescriptions for progressive reclamation areas where vegetation metal uptake sampling has been conducted

Site Specifications				Soil				Revegetation			Progressive Reclamation Timeline				
Site	**Parcel(s)**	**Area**	**End Land Use Objectives**	**Soil Stockpile Source**	**Volume (m^3)**	**Application Depth (cm)**	**Ammendments**	**Grass Seed Mix[1]**	**Shrub & Deciduous Tree Planting**	**Conifer Tree Planting**	**Re-Contour**	**Soil and Ammendment Application**	**Seeding**	**Shrub & Deciduous Tree Planting**	**Conifer Planting**
North Bell Dump	Parcels 1-10	11.59	Wildlife, forestry	Wight Till	10,600	20	Biosolids (122 dt/ha)	Native grasses (30 kg/ha) (hydroseeded w ith fibre mulch, except southern-most Parcel 10 hand seeded at 35 kg/ha)	Black cottonw ood - 60 sph Paper birch - 34 sph Trembling aspen - 34 sph Sitka alder - 172 sph Saskatoon - 34 sph Prickly rose - 34 sph Scoulers w illow - 79 sph Soopolalie - 100 stem trial plot	Lodgepole pine - 1075 sph Douglas fir - 451 sph Western red cedar - 54 sph Hybrid spruce - 54 sph	2011	2011	2011	2013 - poor survival 2014 - re-plant	2014
East RDS	Tree Plots[5]	2.13	Wildlife, forestry	Bell Pit Stockpile	Not Calculated	0 - 65	Amendment Tested: Fertilizer (RTI Bio Pack's, 10g/bag) Biosolids (50 - dt/ha) Tailings (20cm)	Domistic grasses (20kg/ha - 40 kg/ha) Native grasses/forbes (40 kg/ha) - tw o different mixtures	-	Lodgepole pine - 1400 sph Douglas fir - 600 sph	2000	1998 - 2000	1998 - 2000	-	1998 - 2000
NEZ Dump	Parcel 2 (a/b)	5.13	Wildlife, forestry	Wight Till	20,000	40	2a: fertilizer (238 kg/ha) 2b1: biosolids 2b2: fertilizer (71 kg/ha), biosolids	Native grasses/forbes (handseeded) 2a: 45 kg/ha 2b: 34 kg/ha	Paper birch - 100 sph Trembling aspen - 100 sph Black cottonw ood - 200 sph Sitka alder - 100 sph saskatoon - 100 sph w ood rose - 100 sph Willow live stakes - 40 sph	Lodgepole pine - 1300 sph Douglas fir - 700 sph	2010	2010	2011	2012	2012

Notes:

1) Native grasses/forbes: mountain brome, native red fescue, Rocky Mountain fescue, w heat grass - blue bunch, blue w ild rye, june grass, tickle grass, firew eed.
Native grasses: mountain brome, native red fescue, Rocky Mountain fescue, w heat grass - blue bunch, blue w ild rye.

5) Refer to summary reports on the tree plots for detailed information on the treatment units and research design

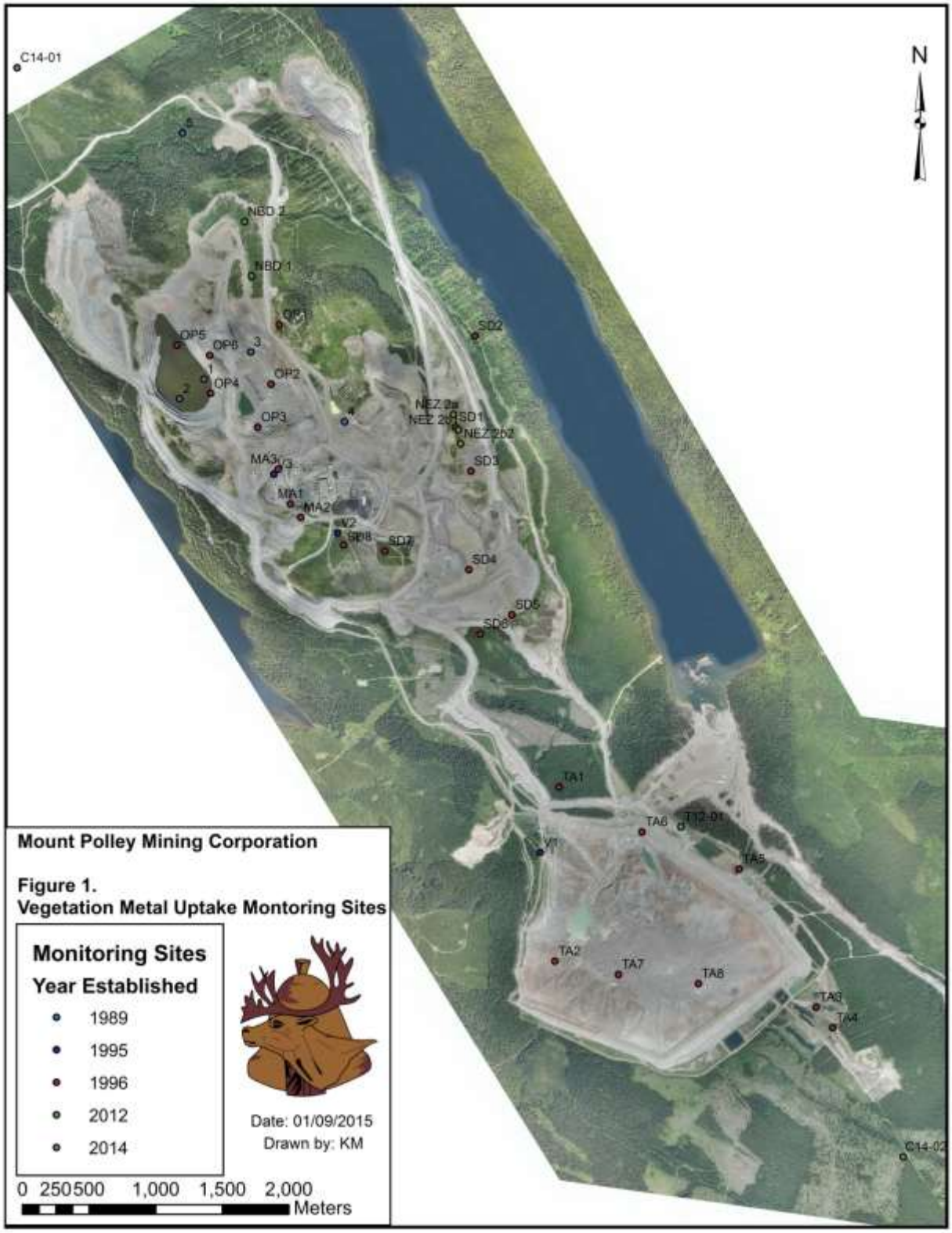
Table 2 East RDS research tree plot prescriptions (1998: A - I_1; 1999: I_2 - M)

Treatment Regime	Soil added (cm)	Fertilizer – tea bag (#/plot)	Fertilizer – biosolids (dT/ha)	70:30 Lodgepole pine: Douglas-fir (stems/ha)	Domestic grasses (Kg/ha)	Native grasses (Kg/ha)
A control	0			2000	40	
B	15			2000	40	
C	15	1 / tree		2000	40	
D	15		75	2000	40	
E	15		150	2000	40	
F	25			2000	40	
G	15			2000		40
H	40			2000	40	
I_1	65			2000		40
I_{2+3}	65			2000	40	
J	15			2000	40	
K	25			2000	40	
L	40			2000	40	
M	20	20	75	2000	40	

Table 3 Summary of historic vegetation metal sampling

Conifer Trees						
Western Red Cedar (*Thuja plicata*)	3 - Central Pit 4 - Mill Site					
Subalpine fir (*Abies lasiocarpa*)		V1 - Tailings North V3 - Central Pit	Mill Area 3[3] Open Pit 6[3]			
Deciduous Trees and Shrubs						
Black cottonwood (*Populus balsamifera*)			Tailings Area 6[3]			
Western Mountain ash (*Sorbus acuparia*)		V3 - Central Pit[t]	Mill Area 6[3]			
Trembling aspen (*Populus tremuloides*)			Open Pit 3[3]			
Paper birch (*Betula papyrifera*)			Tailings Area 7[3] Southeast Dump 8[3]			
Sitka alder (*Alnus Crispa*)	1 - West Pit 2 - West Pit 3 - Central Pit 4 - Mill Site 5 - N of Mine		Tailings Area 3[3]			
Red osier dogwood (*Cornus sericea*)			Tailings Area 7[3]			
Willow (*Salix scouleriana*)	1 - West Pit [d] 5 - N of Mine	V1 - Tailings North[t] V2 - Mill South[t]				
Sitka sillow (*Salix sitchensis*)	2 - West Pit[d] 4 - Mill Site					
Variable willow (*Salix commutata)*		V1 - Tailings North[t] V3 - Central Pit[t]				
Willow (*Salix sp*)	3 - Central Pit[d]	V1 - Tailings North[t]	Open Pit 1[3] Tailings Area 1[3]			
Douglas maple (*Acer glabrum* **)**			Open Pit 5[3]			
Prickly rose (*Rosa acicularis*)		V1 - Tailings North V2 - Mill South	Southeast Dump 5[3]			
Baldhip rose (*Rosa gymnocarpa*)		V2 - Mill South				
Red elderberry (*Sambucus racemosa*)			Southeast Dump 2[3]			
Mountain Bilberry (*Vaccinium membranaceum*)	1 - West Pit 3 - Central Pit					
Black twinberry (*Lonicera involucrata*)			Tailings Area 2[3]			
Highbush cranberry *(Viburnum edule*)			Tailings Area 5[3]			
Black huckleberry (*Vaccinium membranaceum*)		V2 - Mill South	Southeast Dump 4[3]			
Black gooseberry (*Ribes lacustre*)			Tailings Area 8[3]			
Saskatoon (*Amelanchier alnifolia*)		V3 - Central Pit[t]	Southeast Dump 3[3]			
Raspberry (*Rubus idaeus strigosus*)		V3 - Central Pit[t]				
Thimbleberry (*Rubus parviflorus*)			Open Pit 4[3]			
Falsebox (*Paxistima myrsinites*)		V3 - Central Pit[t]	Tailings Area 4[3]			
Birch-leaved spirea (*Spiraea betulifolia*)			Southeast Dump 7[3]			
Composite - deciduous leaves						C14-01 C14-02 Open Pit 1[3] V2 - Mill South[3] Tailings Area 5[3] Southeast Dump 2[3] Tree Plots A-M[c]
Grasses, Forbes & Other						
Wheelers blue grass (*Poa nervosa*)	2 - West Pit 5 - N of Mine					
Timothy (*Phleum pratense*)	4 - Mill Site	V1 - Tailings North[t]				
Northern reed grass (*Calamgrostis inexpansa*)	5 - N of Mine					
Red top (*Agrostis stonlonifera*)	5 - N of Mine					
Aslike clover (*Trifolium hybridum*)	2 - West Pit 4 - Mill Site 5 - N of Mine[d]		Mill Area 1[3]			
Common horsetail (*Equisetum arvense*)		V1 - Tailings North				
Pumpelly Brome (*Bromus inermis*)		V1 - Tailings North				
Witches hair (*Alectoria sarmentosa*)		V1 - Tailings North V3 - Central Pit				
Red clover (*Trifolium pratense*)		V1 - Tailings North V3 - Central Plt		Tree Plots A-M[c]		
Rye grass (*Elymus sp*)			Mill Area 2[3]			
Fringed aster (*Aster ciliolatus*)			Southeast Dump 1[3]			
Fireweed (*Chamerion angustifolium*)			Open Pit 2[3]		NEZ 2a NEZ 2b1 NEZ 2b2	
Lupine (*Lupinus polyphyllus*)					NEZ 2a NEZ 2b1 NEZ 2b2	
Mountain brome (*Bromus marginatus*)					NEZ 2a NEZ 2b1 NEZ 2b2	
Native red fescue (*Festuca rubra*)					NEZ 2a NEZ 2b1 NEZ 2b2	
Rocky Mountain fescue (*Festuca saximontana*)					NEZ 2a NEZ 2b1 NEZ 2b2	
Bluebunch wheatgrass (*Pseudoroegneria spicata*)					NEZ 2a NEZ 2b1 NEZ 2b2	
Blue wildrye (*Elymus glaucus*)					NEZ 2a NEZ 2b1 NEZ 2b2	
June grass (*Koeleria cristata*)					NEZ 2a NEZ 2b1 NEZ 2b2	
Tickle grass/hair bentgrass (*Agrostis scabra*)					NEZ 2a NEZ 2b1 NEZ 2b2	
Composite - grasses and forbes					T12-01 Tree Plots A-M[3] NBD Plot 1[5] NBD Plot 2[5]	C14-01 C14-02 Open Pit 1[3] V2 - Mill South[3] Tailings Area 5[3] Southeast Dump 2[3] NEZ2a[3] NEZ 2b1[3] NEZ 2b2[3]

Notes:
d = duplicate
t = twigs (only leaves samples if not specified otherwise)
3 = triplicate samples collected
5 = five sampes collected
c = composite of triplicate research plots


C14-01
N
NBD 2
NBD 1
OP1
OP5
OP6
3
OP4
OP2
OP3
SD2
NEZ 2a
NEZ 2b
SD1
NEZ 2b2
SD3
MA3
MA1
MA2
V2
SD8
SD7
SD4
SD5
SD6
TA1
TA6
T12-01
V1
TA5
TA2
TA7
TA8
TA3
TA4
C14-02
Mount Polley Mining Corporation
Figure 1.
Vegetation Metal Uptake Montoring Sites
Monitoring Sites
Year Established
1989
1995
1996
2012
2014
Date: 01/09/2015
Drawn by: KM
0 250500 1,000 1,500 2,000
Meters

2 MONITORING PROGRAM

2.1 Objectives

The objective of this monitoring program is to investigate if metal uptake by vegetation in progressive reclamation sites at the Mount Polley Mine varies from metal uptake in vegetation in applicable baseline and reference sites, and if any elevated metal levels encountered are of concern for wildlife or the successful reclamation of the area.

This plan is intended to meet the following Ministry of Energy and Mine's condition in MPMC's Permit M-200 (July 9, 2015 amendment):

> *The Permittee shall develop and submit to the Chief Inspector with the September 30, 2015 Five Year Mine Plan and Reclamation Plan, a detailed monitoring program and associated cost estimate, designed to assess metal uptake in vegetation to ensure that appropriate reclamation plans are developed toward successful reclamation. The scope of the program shall include analysis of soil and vegetation.*

2.2 Monitoring Program Design

This monitoring program to be implemented at closure is designed to: i) determine if the concentrations of metals in vegetation growing in reclamation areas of the mine are different than baseline concentrations, and ii) to determine if the concentrations of metals in vegetation growing in reclamation areas of the mine are associated with adverse effects to wildlife or ecosystem reclamation. Sample sites in reclamation areas have been selected to represent the different reclamation and soil amendment approaches used in progressive reclamation. Sample locations, rationale for their selection, and species to be sampled are outlined in Table 4.

Reclamation units selected for sampling are the:

- TSF;
- Southeast RDS (SERDS);
- East RDS research tree plots;
- NEZ Dump Parcels 2a, 2b1 and 2b2;
- North Bell Dump Parcels 1 - 10; and,
- Temporary Potentially Acid Generating (PAG) Stockpile base (following placement of PAG rock in the Springer Pit to be submerged).

These areas cover the range of projected reclamation prescriptions and soil amendments, as well as mine substrates (tailings and waste rock). Prior to sample collection, sample locations will be pre-selected using grids or transects to avoid site selection bias in the field. Results from these major reclamation units will be applicable to adjacent smaller areas which will be reclaimed using the same materials and prescriptions.

Species were selected based on the following criteria:

- Sampled in baseline monitoring programs;
- Planted at or naturally ingress into reclamation sites;
- Wildlife browse species; and
- Prevalent in reference areas adjacent to the mine site.

If a trend develops in sample results that indicates vegetation concentrations in reclaimed areas are not different from baseline or reference areas, and/or are not above risk-based criteria, sampling will be discontinued. It is anticipated that sampling will be carried out in year 5 and year 10 following closure.

Table 4 Vegetation metal uptake monitoring program

Area Type	Specific Area	Site ID	Year Established	Species	Number of Samples	Rationale
Reclamation Sites	East RDS research tree plots	A - M	2007	Willow (deciduous foliage); Red or aslike clover (forbe); Timothy (grass) [as available]	1 (plots in triplicate)	Represent reclamation sites with a range of soil depths and amendments (none, biosolids, tailings, fertilizer)
	North Bell Dump Parcels 1-10	NBD Plot 1	2012		1	Represent reclamaiton sites where biosolids were used as a soil amendment
		NBD Plot 2	2012		1	
		NBD Plot 3	-		1	
	NEZ Dump	Treatment Unit 2a	2014		3	Represent reclamation sites where varying levels of fertilizer and/or biosolids were used
		Treatment Unit 2b1	2014		3	
		Treatment Unit 2b2	2014		3	
	Tailings Storage Facility	Representative sites	-		3	Large-scale reclamation of tailings
	SERDS	Representative sites	-		3	Large-scale waste dump reclamation (closure prescription)
	Temporary PAG Stockpile	Representative sites	-		3	Large-scale waste dump reclamation (closure prescription)

2.3 Sampling Methods

Sampling methods are detailed in the MPMC Environmental QA/QC Manual; the Work Method MPMC-WORK-018: Vegetation Sampling is provided as Appendix B.

Duplicate samples are to be taken with 10% of samples. Vegetation is to be split into two sample bags, with soil samples being collected from the same location. The relative percent difference data quality objective of greater than 40% for concentrations greater than or equal to five times the method detection limit (MDL) will be used to indicate differences between original and duplicate samples.

Samples will be shipped to a certified laboratory (typically ALS Environmental in Burnaby, BC) for analysis. Parameters that will be analyzed for and the associated method detection limits are provided in Table 5.

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Table 5. Metal parameters to be analyzed and associated method detection limits

Parameter	Tissue MDL (mg/kg)	Soil MDL (mg/kg)
Physical Tests		
Moisture		0.25
pH (1:2 soil:water)		0.1
Leachable Anions & Nutrients		
Total Available Nitrogen		2.2
Oxidation Reduction Potential		-990
Anions & Nutrients		
Total Nitrogen		0.020
Organic/Inorganic Carbon		
Total Carbon		0.1
Organic Carbon		0.1
Plant Available Nutrients		
Available Ammonium-N		1.0
Available Nitrate-N		1.0
Nitrate+Nitrite-N		2.0
Nitrate-N		2.0
Nitrite-N		0.50
Available Phosphate-P		2.0
Available Potassium		20
Available Sulphate-S		3.0
Metals		1.0
Antimony (Sb)-Total	0.010	0.10
Arsenic (As)-Total	0.020	0.050
Barium (Ba)-Total	0.050	0.50
Beryllium (Be)-Total	0.010	0.20
Cadmium (Cd)-Total	0.0050	0.050
Chromium (Cr)-Total	0.050	0.10
Cobalt (Co)-Total	0.020	0.50
Copper (Cu)-Total	0.10	50
Lead (Pb)-Total	0.020	5.0
Molybdenum (Mo)-Total	0.020	0.50
Nickel (Ni)-Total	0.20	0.50
Thallium (Tl)-Total	0.0020	2.0
Tin (Sn)-Total	0.10	1.0
Uranium (U)-Total	0.0020	0.050
Vanadium (V)-Total	0.10	0.20
Zinc (Zn)-Total	0.50	1.0

2.4 Data Analysis

Vegetation data interpretation will include the following (where applicable), with statistical comparisons being made where possible:

- Comparison of results with historic data to evaluate if concentrations of metals in vegetation are changing over time at sample locations;
- Comparison of vegetation data from reference sites and/or baseline data with reclamation site data to determine if concentrations of metals in vegetation are influenced by reclamation measures;
- Comparison of vegetation data from different reclamation sites to investigate differences resulting from varying soil treatments and spatial trends;
- To establish acceptable concentrations of metals in vegetation to enable an efficient evaluation of tissue data over time; and
- To link the vegetation monitoring work to other work Mount Polley is developing in ecosystem reclamation.

Where results for reclamation sites are significantly different from reference and baseline data, the results will be compared to the results of the Terrestrial Ecological Risk Assessment conducted for the forest area along Hazeltine Creek. This work is currently characterizing an acceptable concentration range for metals in vegetation in the local area, which will enable a streamlined data evaluation process moving forward. If vegetation data from reclaimed areas indicate higher concentrations than those established to be acceptable, additional investigations will be conducted to determine the significance of measured concentrations to the terrestrial ecosystem.

2.5 Cost Estimate

Proposed costs associated with this conceptual closure monitoring plan, including personnel for sample collection and data analysis, and analytical costs are provided in Table 6.

Table 6 Vegetation metal uptake monitoring cost estimate

Samples (#)		102
Soil Analysis - Metals	$	200
Vegetation Analysis- Metals	$	140
Sampling Hours		30
Sampler Wage	$	25
Data Analysis Hours (basic)		40
Analytical Wage (basic)	$	35
Data Analysis Hours (advanced)		10
Analytical Wage (advanced)	$	200
TOTAL	$	36,830

Appendix A:

Historic Vegetation Metal Uptake Sample Results

1989: 1 - West Pit

Element	Detection limit	Alder	Bilberry	Willow	(Dup) Willow
Arsenic	0.010	0.040	0.040	0.035	0.030
Cadmium	0.025	0.030	0.065	6.000	6.000
Chromium	0.050	0.650	0.550	0.600	0.500
Cobalt	0.500	<	<	<	<
Copper	0.500	17.400	7.030	12.000	11.700
Iron	0.750	87.000	70.500	74.000	73.000
Lead	0.050	0.350	0.200	0.200	0.300
Manganese	0.250	251.000	1971.000	351.000	358.000
Mercury	0.005	0.015	0.025	0.015	0.020
Molybdenum	0.250	2.500	0.200	0.650	0.650
Nickel	0.050	16.500	1.300	3.500	3.450
Silver	0.050	<	<	<	<
Zinc	0.250	43.200	48.600	128.000	126.000

Measured as mg per dry kg

1989: 2 - West Pit

Element	Detection limit	Alder	Clover	Blue Grass	(Dup) Willow
Arsenic	0.010	0.025	0.250	0.045	0.075
Cadmium	0.025	<	0.045	0.025	3.200
Chromium	0.050	0.450	2.250	2.100	0.800
Cobalt	0.500	<	<	<	<
Copper	0.500	23.900	36.300	12.600	17.800
Iron	0.750	79.000	945.000	99.000	257.000
Lead	0.050	0.050	0.300	0.150	0.250
Manganese	0.250	150.000	175.000	82.900	205.000
Mercury	0.005	0.020	0.030	0.025	0.035
Molybdenum	0.250	10.500	57.000	35.700	2.250
Nickel	0.050	1.800	2.550	1.950	2.250
Silver	0.050	<	<	<	<
Zinc	0.250	46.100	49.500	67.100	189.000

Measured as mg per dry kg

1989: 3 - Central Pit

Element	Detection limit	Alder	Bilberry	Cedar	Willow	Willow (dup)
Arsenic	0.010	0.250	0.075	0.015	0.015	0.020
Cadmium	0.025	<	0.13	0.04	2.95	2.75
Chromium	0.050	0.35	0.80	0.45	0.65	0.60
Cobalt	0.500	<	<	<	<	<
Copper	0.500	22.0	13.0	2.48	9.65	9.21
Iron	0.750	109	109	38.8	72.0	73.0
Lead	0.050	0.20	0.40	0.10	0.20	0.20
Manganese	0.250	166	2705	86.2	166	162
Mercury	0.005	0.015	0.045	0.020	0.030	0.035
Molybdenu	0.250	8.30	<	3.95	0.35	0.40
Nickel	0.050	2.25	1.70	1.80	3.05	3.10
Silver	0.050	<	<	<	<	<
Zinc	0.3	31.1	45.5	10.1	87.6	87.6

Measured as mg per dry kg

1989: 4 - Mill Site

Element	Detection limit	Alder	Cedar	Clover	Timothy	Willow
Arsenic	0.010	0.020	0.025	0.085	0.055	0.035
Cadmium	0.025	0.120	0.070	0.300	1.350	<
Chromium	0.050	0.150	0.300	0.850	1.050	0.400
Cobalt	0.500	<	<	<	<	<
Copper	0.500	13.200	3.020	14.100	2.870	8.510
Iron	0.750	72.000	63.000	237.000	86.500	90.000
Lead	0.050	0.150	0.100	0.350	0.100	0.250
Manganese	0.250	767.000	184.000	403.000	175.000	600.000
Mercury	0.005	0.025	0.015	0.110	0.020	0.035
Molybdenum	0.250	2.050	5.450	3.600	2.000	1.000
Nickel	0.050	3.850	4.200	5.500	1.000	3.500
Silver	0.050	<	<	<	<	<
Zinc	0.250	56.200	19.700	46.000	15.700	124.000

Measured as mg per dry kg

1989: 5 - North of Mile

Element	Detection limit	Clover	(Dup) Clover	Blue Grass	Red Top	Willow	Alder	Northern Reed Grass
Arsenic	0.010	0.120	0.140	0.070	0.030	0.020	<	0.055
Cadmium	0.025	<	<	0.070	0.065	0.340	<	<
Chromium	0.050	0.900	1.050	6.500	1.450	0.250	0.150	0.500
Cobalt	0.500	<	<	<	<	<	<	<
Copper	0.500	14.500	15.0	4.900	3.020	4.650	10.600	1.730
Iron	0.750	320.000	326.0	200.000	49.300	85.500	67.500	44.000
Lead	0.050	0.150	0.15	0.150	0.10	<	0.100	0.100
Manganese	0.250	286.000	297.0	157.000	182.000	61.400	110.000	100.000
Mercury	0.005	0.030	0.030	0.030	0.030	0.060	0.025	0.030
Molybdenum	0.250	1.250	1.05	2.200	1.400	1.900	5.800	2.000
Nickel	0.050	1.200	1.20	1.800	0.500	0.950	0.250	0.200
Silver	0.050	<	<	<	<	<	<	<
Zinc	0.250	29.700	33.1	28.900	13.900	93.800	39.000	8.050

Measured as mg per dry kg

1995: V1 - Tailings North

Element	Common Horsetail	Prickly Rose	Subalpine Fir*	Pumpelly Brome	Witches Hair*	Red Clover	Willow Sp. Leaves	Willow Sp. Twigs	Scoulers Willow Leaves	Scoulers Willow Twigs*	Variable Willow Leaves	Variable Willow Twigs	Timothy
Physical Tests Moisture %	84	75	59.9	60	63.6	80.6	75.8	50.4	81.4	49.4	76.2	49	60.7
Arsenic	0.33	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	<0.05	0.06	0.05
Copper	5.9	3.8	2.25	2.8	1.35	10.5	3.5	4.7	7	6.85	6.7	8.5	2.5
Lead	0.2	0.1	0.1	0.1	0.9	0.2	0.05	0.05	0.15	0.1	0.15	<0.05	1
Molybdenum	7.9	5.2	<0.5	11.3	<0.5	11.8	3	<0.5	4.1	<0.5	5.5	<0.5	9.2
Selenium	<0.05	0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.75	0.2	<0.05
Zinc	28.7	14	46.9	17.5	49.6	40.1	14.7	26.5	109	72.6	245	89.5	18.6

Measured as mg per dry kg

1995: V2 - Mill South

Element	Huckleberry Browsed	Baldhip Rose	Prickly Rose	Scoulers Willow Leaves	Scoulers Willow Twigs	Subalp. Fir*	Falsebox Leaves	Falsebox Twigs	Saskat. Berry Leaves
Physical Tests Moisture %	76.1	74.6	72	78.5	18.5	28.3	68.2	42.7	73.4
Arsenic	0.19	0.06	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	0.19
Copper	8.8	4.2	3.6	5	3	3.1	4.4	6.7	9.7
Lead	0.25	0.25	0.35	0.25	0.1	0.15	0.15	0.45	0.4
Molybdenum	0.9	3.1	1.8	0.5	<0.5	<0.5	0.8	1.1	5.7
Selenium	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc	9.3	15.5	11.3	219	104	41.65	25	93	96.5

Measured as mg per dry kg

1995: V2 - Mill South

Element	Saskat. Berry Twigs	Douglas Maple Leaves*	Douglas Maple Twigs	Variable Willow Leaves	Variable Willow Twigs	WMtn. Ash Leaves	WMtn. Ash Twigs	Witches Hair
Physical Tests Moisture %	27.1	80.9	24.6	82.7	29.9	53.8	25.7	64.7
Arsenic	<0.05	<0.05	<0.05	0.42	0.18	0.18	<0.05	<0.05
Copper	4.5	4.35	2.2	20.9	11.3	7.9	3.6	1.9
Lead	0.15	0.325	0.1	0.4	0.2	0.3	0.2	0.1
Molybdenum	<0.5	4.5	<0.5	0.6	<0.5	2.4	<0.5	<0.5
Selenium	<0.05	<0.05	<0.05	0.13	0.06	0.06	<0.05	0.06
Zinc	32.9	135	27.8	126	85.9	44.4	93.6	17.5

Measured as mg per dry kg

1995: V3 - Central Pit

Element	Wmtn. Ash Leaves	Wmtn. Ash Twigs	Huckleberry Leaves	Huckleberry Twigs	Falsebox Leaves	Falsebox Twigs	Saskat. Leaves
Physical Tests Moisture %	70.5	50.1	82.9	48.2	64.1	46.3	78.3
Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Copper	3.3	3.8	5.9	5.2	7.5	9.7	6.4
Lead	0.6	0.1	1.05	0.2	0.2	0.25	0.3
Molybdenum	0.7	<0.5	<0.5	<0.5	<0.5	0.9	0.6
Selenium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc	38.6	69.4	18.9	46.7	33.2	70.6	71.8

Measured as mg per dry kg

1995: V3 - Central Pit

Element	Saskat. Twigs	Var. Willow Leaves	Var. Willow Twigs	Sub Alp. Fir	Red Clover	Witches Hair	Red Rasp. Leaves	Red Rasp. Twigs
Physical Tests Moisture %	31.3	75	46.6	50.5	78.7	64.8	34.9	52
Arsenic	<0.05	<0.05	<0.05	0.05	0.06	<0.05	0.05	0.07
Copper	4.4	7.5	7.8	3.9	12	2.9	4.55	4.3
Lead	0.4	0.15	0.1	0.1	0.15	1.05	0.25	0.1
Molybdenum	<0.5	<0.5	<0.5	<0.5	1	<0.5	0.65	<0.5
Selenium	<0.05	<0.05	<0.05	<0.05	0.05	0.05	<0.05	<0.05
Zinc	52.1	121	110.7	48.8	71.5	21.3	26.9	53.1

Measured as mg per dry kg

1996: TA - Tailings Area

Element	TA1			TA2			TA3			TA4		
	Willow Species B			Black Twinberry			Sitka Alder			Falsebox		
	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Arsenic	0.28	0.23	0.21	0.34	0.35	0.35	0.17	0.17	0.16	0.14	0.1	0.1
Copper	5.5	6.25	6.45	9.95	9.15	9.05	8	8.3	8.1	5.4	6.8	6.7
Lead	0.06	0.27	0.28	0.35	0.39	0.38	0.3	0.34	0.34	0.16	0.21	0.21
Molybdenu	0.65	0.82	0.72	0.25	0.45	0.42	0.25	0.41	0.44	0.65	0.55	0.45
Selenium	<0.1	<0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1
Zinc	121	145	143	118	122	116	26.1	31.5	31.5	32	36.5	37.5

Measured as mg per dry kg

1996: TA - 7

Element	TA5			TA6			TA7			TA7			TA8		
	High Bush Cranberry			Black Cottonwood			Paper Birch			Red Osier Dogwood			Black Gooseberry		
	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Arsenic	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.1	0.12	0.09	0.07	0.08	0.06	0.26	0.3	0.29
Copper	4.35	4.05	3.95	3.65	5.15	4.7	6.6	5.7	5.75	3.7	3.15	3.05	5.2	5.75	5.85
Lead	0.09	0.14	0.14	0.52	0.11	0.07	0.3	0.35	0.37	0.3	0.3	0.31	0.35	0.54	0.49
Molybdenu	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.95	0.25	0.26	1.45	1.75	1.77	1	1.3	1.22
Selenium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1
Zinc	18.6	22.6	21.2	136	141	151	268	236	235	17	19.9	20.3	21.1	29.5	29.5

Measured a

1996: MA - Mill Area

Element	MA1			MA2			MA3		
	Alsike Clover			Rye Grass			Subalpine Fir		
	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Arsenic	1.47	1.06	1.38	0.35	0.26	0.26	0.08	0.07	0.09
Copper	38	33.5	40.7	10.4	9.2	9.05	12.7	8.25	7.35
Lead	1.33	1.16	1.33	0.19	0.19	0.18	0.15	0.96	0.17
Molybdenu	5.8	5.27	5.22	0.67	0.7	0.68	<0.25	<0.25	<0.25
Selenium	<0.1	0.2	0.2	0.2	0.3	0.3	<0.1	0.1	0.1
Zinc	93.5	106	111	25.8	29.5	29.7	42.9	55	55.5

Measured as mg per dry kg

1996: SD - Southeast Dump

Element	SD1			SD2			SD3			SD4		
	Fringed Aster			Red Elderberry			Black Huckleberry			Saskatoon Berry		
	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Arsenic	0.2	0.18	0.19	0.58	0.46	0.52	<0.05	<0.05	<0.05	0.08	<0.05	<0.05
Copper	22.6	23.1	22.7	10.8	8.23	8.96	8.85	8.1	7.7	5.3	4.85	4.65
Lead	0.2	0.31	0.26	0.6	0.68	0.74	0.15	0.16	0.17	0.1	0.17	0.15
Molybdenum	7	10.6	10.8	1.25	1.42	1.63	3.6	5.48	5.22	0.5	0.84	0.85
Selenium	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	54	72.5	71	27.7	29.2	31.2	18.7	23	23	84	107	111

Measured as mg per dry kg

1996: SD - Soutl

Element	SD5			SD6			SD7			SD8		
	Prickly Rose			Western Mountain Ash			Birched-Leaved Spiraea			Black Cottonwood		
	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Arsenic	<0.05	<0.05	<0.05	0.08	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05
Copper	4.2	4.35	4.65	3.9	4.1	4	4.7	4.2	4.38	7.35	7.15	7
Lead	<0.05	0.08	0.08	0.11	0.11	0.17	0.28	0.35	0.36	0.07	0.2	0.19
Molybdenum	1.06	0.92	1.02	1.87	1.9	2.35	4.32	5.4	4.7	0.27	0.47	0.4
Selenium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	14.7	17	17	52.5	50	48.8	136	148	152	278	255	256

Measured as mg

1996: OP - Open Pit

Element	OP1			OP2			OP3			OP4			OP5			OP6		
	Willow Species A			Fireweed			Trembling Aspen			Thimbleberry			Douglas Maple			Subalpine Fir		
	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3
Arsenic	0.24	0.27	0.28	0.17	0.32	0.14	0.34	0.31	0.31	0.17	0.16	0.18	<0.05	<0.05	<0.05	0.05	<0.05	<0.05
Copper	23.9	24.1	22.6	16.6	14.6	14.8	21.6	18.6	19	10.6	10.5	10.7	6.25	5.7	5.6	2.45	2.15	2
Lead	0.2	0.33	0.3	0.15	0.18	0.17	0.31	0.4	0.37	0.35	0.25	0.27	0.06	0.24	0.25	0.09	0.12	0.15
Molybdenum	0.25	0.42	0.37	3.72	3.92	4.02	<0.25	0.25	0.25	4.25	4.35	5.43	1.1	1.47	1.35	<0.25	<0.25	<0.25
Selenium	<0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	141	141	136	27.7	27.1	27.4	213	216	226	18.2	17.6	21.5	67	79.5	77	19.1	22.6	21.7

Measured as mg per dry kg

2007: Tree Plots

Sample ID	**A1**	**A2**	**A3**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	**D1**
Date Sampled	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**
Species	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**
Total Metals										
Aluminum T-Al	124	203	425	247	219	150	230	186	503	153
Antimony T-Sb	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic T-As	0.187	0.264	0.389	0.273	0.155	0.214	0.250	0.266	0.440	0.135
Barium T-Ba	12.6	31.9	48.7	39.7	50.3	38.3	23.6	57.0	80.7	44.0
Beryllium T-Be	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth T-Bi	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Cadmium T-Cd	0.038	0.121	0.03	0.106	0.03	0.03	0.03	0.03	0.03	0.03
Calcium T-Ca	3550	5350	14800	17100	15100	17200	13800	15300	16900	18200
Chromium T-Cr	9.30	4.08	11.7	1.36	1.71	5.34	6.21	1.46	4.32	6.98
Cobalt T-Co	0.21	0.25	0.60	0.46	0.37	0.45	0.54	0.34	0.61	0.37
Copper T-Cu	19.7	28.3	48.5	36.6	30.4	26.1	31.8	35.7	47.2	27.6
Iron T-Fe	226	325	811	500	358	302	469	340	825	444
Lead T-Pb	0.18	0.15	0.20	0.21	0.14	0.10	0.14	0.14	0.23	0.11
Lithium T-Li	2.01	8.16	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium T-Mg	1310	1330	3190	3240	2450	3240	2450	3030	3930	2550
Manganese T-Mn	105	95.9	67.8	94.6	86.0	98.8	75.9	64.8	79.3	99.5
Mercury T-Hg	0.0103	0.0144	0.0128	0.0086	0.0093	0.0091	0.0098	0.0110	0.0160	0.0108
Molybdenum T-Mo	3.03	9.66	20.7	16.5	6.39	14.1	8.70	30.8	13.9	6.68
Nickel T-Ni	4.81	2.32	6.20	1.36	1.56	3.25	3.15	1.13	3.78	3.89
Selenium T-Se	1	3.6	1.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Strontium T-Sr	19.3	39.0	140	148	79.2	95.7	56.9	81.7	154	89.9
Thallium T-Tl	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Tin T-Sn	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Uranium T-U	0.01	0.01	0.017	0.011	0.01	0.01	<0.010	0.01	0.019	<0.010
Vanadium T-V	0.73	1.20	3.04	1.71	1.21	0.91	1.78	1.20	2.86	0.94
Zinc T-Zn	7.10	5.89	16.4	21.3	23.7	25.5	17.0	19.4	16.2	38.1

units as mg/kg

2007: Tree Plots

Sample ID	D2	D3	E1	E2	E3	F1	F2	F3	G1	G2
Date Sampled	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**
Species	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**
Total Metals										
Aluminum T-Al	145	141	108	135	117	169	142	489	192	156
Antimony T-Sb	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic T-As	0.159	0.183	0.208	0.171	0.128	0.191	0.191	0.386	0.230	0.152
Barium T-Ba	48.9	60.1	30.7	22.5	48.5	43.7	67.4	86.6	36.4	28.9
Beryllium T-Be	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth T-Bi	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Cadmium T-Cd	0.071	0.03	0.066	0.03	0.03	0.03	0.03	0.03	0.03	0.057
Calcium T-Ca	17600	15900	16200	15900	12600	17800	14900	14900	16400	14000
Chromium T-Cr	0.99	2.65	0.63	1.57	5.62	1.81	1.45	4.64	2.00	1.57
Cobalt T-Co	0.27	0.35	0.28	0.32	0.32	0.41	0.33	0.76	0.34	0.39
Copper T-Cu	36.9	34.0	27.7	25.5	28.7	28.6	31.1	58.4	30.9	28.0
Iron T-Fe	291	323	226	265	292	312	311	873	382	324
Lead T-Pb	0.15	0.14	0.60	0.14	0.1	0.15	0.10	0.20	0.14	0.11
Lithium T-Li	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium T-Mg	3360	3550	2990	2720	2760	2900	3760	3140	3020	2190
Manganese T-Mn	67.1	79.5	69.2	86.3	60.7	119	92.6	94.5	94.1	81.7
Mercury T-Hg	0.0105	0.0105	0.0082	0.0097	0.0142	0.0091	0.0081	0.0095	0.0091	0.0098
Molybdenum T-Mo	11.2	11.1	9.76	27.0	8.70	6.93	16.7	14.3	8.33	12.4
Nickel T-Ni	1.15	1.90	0.72	1.21	3.16	1.71	1.88	2.95	1.73	1.15
Selenium T-Se	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Strontium T-Sr	88.1	178	89.9	83.9	92.6	82.6	145	80.8	101	74.3
Thallium T-Tl	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Tin T-Sn	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Uranium T-U	0.01	<0.010	<0.010	<0.010	<0.010	0.01	0.01	0.020	0.01	0.01
Vanadium T-V	0.99	0.99	0.70	0.85	0.79	0.98	0.87	3.11	1.22	1.03
Zinc T-Zn	50.3	20.9	27.3	23.9	22.2	28.0	21.0	20.7	25.2	18.6

units as mg/kg

2007: Tree Plots

Sample ID	**G3**	**H1**	**H2**	**H3**	**I1**	**I2**	**I3**
Date Sampled	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**
Species	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**
Total Metals							
Aluminum T-Al	633	165	155	303	181	130	109
Antimony T-Sb	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic T-As	0.375	0.143	0.201	0.279	0.154	0.144	0.127
Barium T-Ba	66.7	45.9	36.2	96.4	40.8	21.0	22.9
Beryllium T-Be	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth T-Bi	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Cadmium T-Cd	0.045	0.096	0.03	0.041	0.03	0.03	0.032
Calcium T-Ca	17400	15700	15300	15700	14700	13800	14900
Chromium T-Cr	14.1	1.42	1.25	4.98	1.45	1.34	0.88
Cobalt T-Co	0.71	0.46	0.44	0.55	0.36	0.25	0.30
Copper T-Cu	64.2	28.7	30.5	51.9	44.5	24.3	25.0
Iron T-Fe	1110	304	334	997	362	272	250
Lead T-Pb	0.22	0.12	0.11	0.21	0.14	0.1	0.1
Lithium T-Li	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium T-Mg	3160	2870	3020	2830	2650	2680	2820
Manganese T-Mn	138	102	96.0	101	72.4	55.5	58.7
Mercury T-Hg	0.0123	0.0060	0.0059	0.0100	0.0071	0.0068	0.0090
Molybdenum T-Mo	13.2	6.88	7.86	9.36	6.08	14.4	81.1
Nickel T-Ni	6.99	1.87	1.36	2.99	1.05	0.86	0.87
Selenium T-Se	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Strontium T-Sr	109	101	112	79.4	64.4	52.7	59.8
Thallium T-Tl	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Tin T-Sn	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Uranium T-U	0.020	0.01	0.01	0.014	<0.01	<0.010	<0.010
Vanadium T-V	4.13	0.96	1.08	3.72	1.14	0.83	0.77
Zinc T-Zn	21.8	29.8	23.9	19.8	28.4	24.6	32.8

units as mg/kg

2007: Tree Plots

Sample ID	**J1**	**J2**	**K1**	**K2**	**L1**	**L2**	**M1**	**M2**	**M3**	**Z**
Date Sampled	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**	**25-Jul-06**
Species	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**	**Red Clover**
Total Metals										
Aluminum T-Al	76	106	111	341	91	89	92	73	120	288
Antimony T-Sb	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Arsenic T-As	0.134	0.129	0.115	0.250	0.111	0.106	0.150	0.099	0.156	0.238
Barium T-Ba	22.4	24.6	25.5	37.0	28.2	24.1	25.3	22.7	30.1	58.1
Beryllium T-Be	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Bismuth T-Bi	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Cadmium T-Cd	0.03	0.038	0.034	0.039	0.03	0.033	0.044	0.042	0.03	<0.030
Calcium T-Ca	11800	14800	15200	18600	14900	15500	13500	14800	14300	15600
Chromium T-Cr	0.5	0.77	0.71	2.65	0.57	0.78	0.62	<0.50	0.63	1.80
Cobalt T-Co	0.18	0.27	0.26	0.56	0.25	0.30	0.22	0.26	0.23	0.38
Copper T-Cu	20.5	25.5	28.1	41.9	23.9	23.9	27.4	24.2	34.2	36.7
Iron T-Fe	164	230	240	640	199	206	261	188	260	508
Lead T-Pb	0.1	0.1	0.1	0.17	0.1	0.1	0.1	0.1	0.1	0.16
Lithium T-Li	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium T-Mg	2790	3000	2630	3520	2910	2920	2990	2870	2980	2960
Manganese T-Mn	24.1	51.5	60.6	79.8	49.0	48.8	37.6	46.7	59.7	51.1
Mercury T-Hg	0.005	0.0079	0.0072	0.0104	0.0060	0.0109	0.0073	0.0056	0.0058	0.0097
Molybdenum T-Mo	19.6	53.0	15.2	44.4	38.4	51.9	48.8	88.0	20.9	19.1
Nickel T-Ni	0.61	0.97	0.78	2.19	1.29	0.85	0.89	0.68	0.84	1.75
Selenium T-Se	<1.0	<1.0	1	1.2	<1.0	<1.0	1.2	1.2	1	1.2
Strontium T-Sr	134	59.6	69.9	76.1	78.5	59.8	70.6	66.8	76.6	130
Thallium T-Tl	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Tin T-Sn	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Uranium T-U	<0.010	<0.010	0.01	0.026	<0.010	<0.010	<0.010	<0.010	<0.010	0.011
Vanadium T-V	0.5	0.70	0.75	2.08	0.60	0.59	0.88	0.5	0.87	1.96
Zinc T-Zn	20.0	26.1	31.7	35.2	27.8	26.5	27.0	35.4	36.5	16.6

units as mg/kg

2012: North Bell Dump

Sample ID	NBD P1-1	NBD P1-2	NBD P1-3	NBD P1-4	NBD P1-5
Date Sampled	17-JUL-12	17-JUL-12	17-JUL-12	17-JUL-12	17-JUL-12
Species	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite
Metals					
Aluminum (Al)-Total	32.9	19.3	42.0	35.8	26.9
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	<0.12	<0.10	<0.15	<0.10	<0.10
Barium (Ba)-Total	8.29	4.66	7.98	5.15	7.36
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Boron (B)-Total	14.1	6.3	8.6	7.4	8.2
Cadmium (Cd)-Total	0.045	0.032	0.054	0.053	0.027
Calcium (Ca)-Total	5510	3720	4960	4380	4270
Cesium (Cs)-Total	0.199	0.213	0.131	0.106	0.237
Chromium (Cr)-Total	0.091	0.066	0.086	0.076	<0.050
Cobalt (Co)-Total	0.063	0.056	0.058	0.050	0.041
Copper (Cu)-Total	11.8	10.5	11.5	10.7	10.9
Gallium (Ga)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Iron (Fe)-Total	87.7	61.3	103	90.2	73.9
Lead (Pb)-Total	0.020	<0.020	0.023	<0.020	<0.020
Lithium (Li)-Total	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-Tot	1740	1410	1310	1450	1470
Manganese (Mn)-Tot	137	110	113	102	139
Molybdenum (Mo)-T	1.46	1.44	2.05	1.00	1.16
Nickel (Ni)-Total	0.158	0.090	0.084	0.084	0.107
Phosphorus (P)-Total	2700	2620	2610	2980	3000
Potassium (K)-Total	21300	17000	16400	20800	18500
Rhenium (Re)-Total	0.044	0.025	0.037	0.028	0.048
Rubidium (Rb)-Total	24.1	28.5	16.0	18.1	24.8
Selenium (Se)-Total	0.12	0.12	0.12	0.11	0.15
Sodium (Na)-Total	<100	<100	<100	<100	<100
Strontium (Sr)-Total	22.1	14.8	21.2	18.9	16.7
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	0.0074	<0.0020	<0.0020	0.0105	0.0044
Thorium (Th)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Titanium (Ti)-Total	3.23	1.65	4.02	3.42	2.53
Uranium (U)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Vanadium (V)-Total	0.202	0.111	0.252	0.212	0.146
Yttrium (Y)-Total	0.021	0.011	0.026	0.021	0.016
Zinc (Zn)-Total	43.2	39.8	42.8	34.1	42.4
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20

units as mg/kg

2012: North Bell Dur

Sample ID	NBD P2-1	NBD P2-2	NBD P2-3	NBD P2-4	NBD P2-5
Date Sampled	17-JUL-12	17-JUL-12	17-JUL-12	17-JUL-12	17-JUL-12
Species	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite
Metals					
Aluminum (Al)-Total	33.9	49.3	34.3	43.1	43.7
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	<0.10	<0.13	<0.11	<0.14	<0.14
Barium (Ba)-Total	8.03	15.2	11.2	13.6	9.89
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Boron (B)-Total	9.1	9.3	5.8	7.2	8.0
Cadmium (Cd)-Total	0.042	0.100	0.062	0.077	0.072
Calcium (Ca)-Total	5240	6890	4260	5460	5050
Cesium (Cs)-Total	0.373	0.388	0.380	0.561	0.373
Chromium (Cr)-Total	0.057	0.065	0.055	0.095	0.084
Cobalt (Co)-Total	0.071	0.094	0.062	0.073	0.064
Copper (Cu)-Total	11.3	15.9	13.4	13.9	14.7
Gallium (Ga)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Iron (Fe)-Total	94.3	120	87.2	112	98.3
Lead (Pb)-Total	0.022	0.033	0.027	0.025	0.029
Lithium (Li)-Total	<0.20	<0.20	<0.20	<0.20	<0.20
Magnesium (Mg)-Tot	1800	2110	1280	1610	1630
Manganese (Mn)-Tot	97.3	143	75.7	93.7	99.8
Molybdenum (Mo)-T	2.81	6.10	4.85	3.80	5.06
Nickel (Ni)-Total	0.198	0.278	0.203	0.233	0.247
Phosphorus (P)-Total	3260	3070	2610	2580	2860
Potassium (K)-Total	16200	17900	15800	15500	16300
Rhenium (Re)-Total	<0.010	0.020	0.037	<0.010	0.017
Rubidium (Rb)-Total	25.4	25.8	23.1	25.2	25.0
Selenium (Se)-Total	0.18	0.25	0.50	0.29	0.33
Sodium (Na)-Total	<100	<100	<100	<100	<100
Strontium (Sr)-Total	16.7	25.1	15.6	18.7	18.0
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	0.0071	0.0031	0.0060	0.0048	0.0050
Thorium (Th)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Titanium (Ti)-Total	2.75	4.03	2.83	3.58	3.70
Uranium (U)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Vanadium (V)-Total	0.172	0.249	0.176	0.224	0.222
Yttrium (Y)-Total	0.019	0.023	0.019	0.021	0.024
Zinc (Zn)-Total	44.7	55.5	32.8	40.2	34.5
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20

units as mg/kg

2012: Tailings Area Control Plot

Sample ID	**T12-01**
Date Sampled	**12-JUL-12**
Species	**Groundcover Composite**
Metals	
Aluminum (Al)-Total	83.9
Antimony (Sb)-Total	<0.010
Arsenic (As)-Total	<0.060
Barium (Ba)-Total	15.0
Beryllium (Be)-Total	<0.010
Bismuth (Bi)-Total	<0.010
Boron (B)-Total	17.7
Cadmium (Cd)-Total	0.025
Calcium (Ca)-Total	9200
Cesium (Cs)-Total	0.0949
Chromium (Cr)-Total	0.205
Cobalt (Co)-Total	0.084
Copper (Cu)-Total	8.83
Gallium (Ga)-Total	0.032
Iron (Fe)-Total	210
Lead (Pb)-Total	0.057
Lithium (Li)-Total	<0.20
Magnesium (Mg)-Total	2470
Manganese (Mn)-Total	63.4
Molybdenum (Mo)-Total	1.50
Nickel (Ni)-Total	0.331
Phosphorus (P)-Total	2780
Potassium (K)-Total	16500
Rhenium (Re)-Total	0.038
Rubidium (Rb)-Total	46.6
Selenium (Se)-Total	<0.10
Sodium (Na)-Total	<100
Strontium (Sr)-Total	49.6
Tellurium (Te)-Total	<0.020
Thallium (Tl)-Total	<0.0020
Thorium (Th)-Total	0.013
Tin (Sn)-Total	<0.020
Titanium (Ti)-Total	7.23
Uranium (U)-Total	0.0035
Vanadium (V)-Total	0.574
Yttrium (Y)-Total	0.052
Zinc (Zn)-Total	28.0
Zirconium (Zr)-Total	<0.20

units as mg/kg

2012: Tree Plots

Sample ID	TREE PLOT 1	TREE PLOT 2	TREE PLOT 3	TREE PLOT 4	TREE PLOT 5
Treatment ID	**I**	**H**	**B**	**D**	**A**
Date Sampled	**11-JUL-12**	**11-JUL-12**	**11-JUL-12**	**11-JUL-12**	**11-JUL-12**
Species	**Groundcover Composite**	**Groundcover Composite**	**Groundcover Composite**	**Groundcover Composite**	**Groundcover Composite**
Metals					
Aluminum (Al)-Total	18.7	45.3	38.8	32.0	55.1
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	<0.060	<0.080	<0.080	<0.070	<0.090
Barium (Ba)-Total	8.97	13.7	25.8	18.9	37.6
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	0.034	<0.010	<0.010	0.024	<0.010
Boron (B)-Total	7.0	7.6	11.3	10.2	11.9
Cadmium (Cd)-Total	<0.010	<0.010	0.011	0.063	<0.010
Calcium (Ca)-Total	3970	9310	10300	7860	13100
Cesium (Cs)-Total	0.0403	0.349	0.878	0.147	0.396
Chromium (Cr)-Tota	0.075	0.113	0.086	0.099	0.280
Cobalt (Co)-Total	0.049	0.292	0.294	0.093	0.112
Copper (Cu)-Total	8.69	16.7	17.3	17.9	19.0
Gallium (Ga)-Total	<0.020	0.022	<0.020	<0.020	0.025
Iron (Fe)-Total	71.6	156	147	95.1	190
Lead (Pb)-Total	0.039	0.062	0.045	0.043	0.049
Lithium (Li)-Total	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-To	1310	2410	3050	2070	2480
Manganese (Mn)-To	57.7	74.4	37.4	43.9	27.6
Molybdenum (Mo)-T	3.65	6.92	11.3	10.9	3.50
Nickel (Ni)-Total	0.149	0.878	0.947	0.861	0.571
Phosphorus (P)-Tota	3030	2940	1360	2970	2310
Potassium (K)-Total	25400	27700	18000	22500	17700
Rhenium (Re)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Rubidium (Rb)-Total	16.2	34.8	38.2	32.2	41.2
Selenium (Se)-Total	<0.10	0.31	0.28	0.30	0.54
Sodium (Na)-Total	<100	<100	<100	<100	<100
Strontium (Sr)-Total	16.8	79.2	129	45.9	122
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020	0.0021	<0.0020
Thorium (Th)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Titanium (Ti)-Total	2.10	5.77	5.67	3.40	7.66
Uranium (U)-Total	<0.0020	0.0028	0.0021	<0.0020	0.0035
Vanadium (V)-Total	0.160	0.381	0.373	0.259	0.489
Yttrium (Y)-Total	0.014	0.038	0.035	0.023	0.049
Zinc (Zn)-Total	30.7	29.1	10.8	61.3	19.9
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20

units as mg/kg

2012: Tree Plots

Sample ID	TREE PLOT 6	TREE PLOT 7	TREE PLOT 8	TREE PLOT 9	TREE PLOT 10
Treatment ID	I	G	C	E	F
Date Sampled	11-JUL-12	11-JUL-12	11-JUL-12	11-JUL-12	11-JUL-12
Species	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite
Metals					
Aluminum (Al)-Total	8.8	31.2	46.4	21.5	34.2
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	<0.050	<0.070	<0.090	<0.080	<0.080
Barium (Ba)-Total	8.07	13.4	20.1	17.8	82.3
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010	<0.010	0.027
Boron (B)-Total	2.2	7.2	9.7	13.4	13.1
Cadmium (Cd)-Total	0.012	0.033	0.013	0.050	0.010
Calcium (Ca)-Total	1380	5600	14500	12900	10600
Cesium (Cs)-Total	0.0088	0.0651	0.332	0.363	0.197
Chromium (Cr)-Tota	<0.10	0.132	0.116	0.117	0.200
Cobalt (Co)-Total	<0.020	0.134	0.403	0.140	0.209
Copper (Cu)-Total	4.05	10.4	19.0	13.4	14.1
Gallium (Ga)-Total	<0.020	<0.020	0.021	<0.020	<0.020
Iron (Fe)-Total	25.8	116	184	82.2	85.5
Lead (Pb)-Total	<0.020	0.036	0.049	0.031	0.038
Lithium (Li)-Total	0.50	<0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-To	519	2510	2590	2220	2030
Manganese (Mn)-To	19.8	223	81.4	46.9	40.1
Molybdenum (Mo)-T	7.43	4.73	12.9	8.96	5.19
Nickel (Ni)-Total	<0.50	1.46	0.407	1.29	0.798
Phosphorus (P)-Tota	1410	3210	2400	2010	723
Potassium (K)-Total	12200	24800	22100	13400	15600
Rhenium (Re)-Total	<0.010	<0.010	<0.010	0.016	<0.010
Rubidium (Rb)-Total	4.66	25.6	33.6	23.1	21.6
Selenium (Se)-Total	0.50	0.19	0.48	0.14	0.44
Sodium (Na)-Total	<100	<100	<100	<100	<100
Strontium (Sr)-Total	4.91	24.2	43.3	51.9	62.5
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Thorium (Th)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Titanium (Ti)-Total	0.757	3.76	5.51	2.80	3.10
Uranium (U)-Total	<0.0020	<0.0020	0.0026	<0.0020	<0.0020
Vanadium (V)-Total	0.093	0.257	0.414	0.188	0.225
Yttrium (Y)-Total	<0.010	0.026	0.037	0.020	0.033
Zinc (Zn)-Total	18.2	27.1	23.9	62.8	14.6
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20

units as mg/kg

2012: Tree Plots

Sample ID	TREE PLOT 11	TREE PLOT 12	TREE PLOT 13	TREE PLOT 14	TREE PLOT 15
Treatment ID	C	M	D	F	B
Date Sampled	11-JUL-12	11-JUL-12	11-JUL-12	11-JUL-12	11-JUL-12
Species	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite
Metals					
Aluminum (Al)-Total	81.3	16.4	18.5	60.8	37.5
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	<0.12	<0.070	<0.050	<0.090	<0.080
Barium (Ba)-Total	101	8.32	15.7	23.3	21.9
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Boron (B)-Total	17.0	11.6	5.8	9.1	10.0
Cadmium (Cd)-Total	0.014	0.069	0.010	<0.010	0.015
Calcium (Ca)-Total	20200	3940	7080	11100	10100
Cesium (Cs)-Total	0.552	0.0467	0.0909	0.171	0.261
Chromium (Cr)-Tota	0.126	<0.050	0.072	0.184	0.110
Cobalt (Co)-Total	0.519	0.045	0.118	0.512	0.337
Copper (Cu)-Total	32.4	8.36	11.0	20.7	15.9
Gallium (Ga)-Total	0.031	<0.020	<0.020	0.026	<0.020
Iron (Fe)-Total	258	58.0	86.8	213	144
Lead (Pb)-Total	0.084	0.026	0.029	0.066	0.042
Lithium (Li)-Total	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-To	2190	1240	1800	3010	2370
Manganese (Mn)-To	94.1	48.3	75.2	108	57.5
Molybdenum (Mo)-T	8.40	6.00	3.61	3.65	7.26
Nickel (Ni)-Total	1.87	1.15	0.605	1.53	0.519
Phosphorus (P)-Tota	1630	1880	3560	2750	2110
Potassium (K)-Total	21000	14300	30500	28000	22300
Rhenium (Re)-Total	<0.010	<0.010	<0.010	<0.010	0.012
Rubidium (Rb)-Total	50.5	13.3	27.6	39.5	39.4
Selenium (Se)-Total	0.91	0.27	0.21	0.19	0.56
Sodium (Na)-Total	<100	<100	<100	<100	<100
Strontium (Sr)-Total	118	11.7	35.7	53.3	48.9
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Thorium (Th)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total	0.021	<0.020	<0.020	<0.020	0.023
Titanium (Ti)-Total	9.20	2.07	2.07	7.86	4.83
Uranium (U)-Total	0.0035	<0.0020	<0.0020	0.0034	0.0021
Vanadium (V)-Total	0.680	0.142	0.146	0.574	0.344
Yttrium (Y)-Total	0.127	0.013	0.016	0.051	0.031
Zinc (Zn)-Total	27.8	42.4	54.9	28.9	24.9
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20

units as mg/kg

2012: Tree Plots

Sample ID	TREE PLOT 16	TREE PLOT 17	TREE PLOT 18	TREE PLOT 19	TREE PLOT 20
Treatment ID	H	E	L	H	A
Date Sampled	11-JUL-12	11-JUL-12	11-JUL-12	11-JUL-12	11-JUL-12
Species	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite
Metals					
Aluminum (Al)-Total	36.7	50.8	21.6	21.8	19.1
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	<0.10	<0.090	<0.060	<0.070	<0.050
Barium (Ba)-Total	66.8	46.3	18.3	11.7	3.32
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	0.019	0.050	0.011	<0.010	0.020
Boron (B)-Total	11.8	12.8	19.8	4.6	2.6
Cadmium (Cd)-Total	0.022	0.018	0.059	<0.010	<0.010
Calcium (Ca)-Total	12500	12400	9200	3280	1340
Cesium (Cs)-Total	0.305	0.409	0.0619	0.0646	0.0383
Chromium (Cr)-Tota	0.079	0.102	0.087	0.126	0.098
Cobalt (Co)-Total	0.272	0.250	0.124	0.030	0.024
Copper (Cu)-Total	17.7	21.4	10.8	7.20	6.35
Gallium (Ga)-Total	<0.020	0.025	<0.020	<0.020	<0.020
Iron (Fe)-Total	128	169	85.4	79.1	60.5
Lead (Pb)-Total	0.060	0.065	0.032	0.045	0.031
Lithium (Li)-Total	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-To	2460	3850	2110	986	565
Manganese (Mn)-To	73.7	45.5	42.8	82.1	22.7
Molybdenum (Mo)-T	11.1	11.5	35.9	1.22	1.77
Nickel (Ni)-Total	1.03	1.36	0.726	0.144	0.143
Phosphorus (P)-Tota	962	2770	2170	3150	1550
Potassium (K)-Total	15600	34300	19100	25300	10400
Rhenium (Re)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Rubidium (Rb)-Total	28.7	65.9	15.3	18.3	13.1
Selenium (Se)-Total	0.46	0.72	0.71	0.22	0.84
Sodium (Na)-Total	<100	<100	<100	<100	<100
Strontium (Sr)-Total	61.3	99.6	32.6	19.4	5.12
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Thorium (Th)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Titanium (Ti)-Total	4.19	6.36	2.68	2.62	2.60
Uranium (U)-Total	0.0022	0.0024	<0.0020	<0.0020	<0.0020
Vanadium (V)-Total	0.304	0.464	0.191	0.178	0.177
Yttrium (Y)-Total	0.046	0.043	0.017	0.016	0.015
Zinc (Zn)-Total	15.1	30.3	28.0	31.4	5.81
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20

units as mg/kg

2012: Tree Plots

Sample ID	TREE PLOT 21	TREE PLOT 22	TREE PLOT 23	TREE PLOT 24	TREE PLOT 25
Treatment ID	G	C	G	K	B
Date Sampled	11-JUL-12	11-JUL-12	11-JUL-12	11-JUL-12	11-JUL-12
Species	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite
Metals					
Aluminum (Al)-Total	29.2	53.2	43.5	23.2	61.1
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	<0.070	<0.13	<0.070	<0.080	<0.090
Barium (Ba)-Total	13.9	57.6	30.9	23.2	25.5
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Boron (B)-Total	9.2	15.5	13.5	27.3	14.5
Cadmium (Cd)-Total	0.012	0.015	0.012	0.078	0.012
Calcium (Ca)-Total	7510	11900	13300	10100	13900
Cesium (Cs)-Total	0.271	0.300	0.561	0.380	0.287
Chromium (Cr)-Tota	0.063	0.091	0.090	0.077	0.149
Cobalt (Co)-Total	0.189	0.195	0.287	0.118	0.557
Copper (Cu)-Total	13.1	18.7	19.7	10.0	19.3
Gallium (Ga)-Total	<0.020	<0.020	<0.020	<0.020	0.024
Iron (Fe)-Total	111	150	133	88.2	201
Lead (Pb)-Total	0.061	0.058	0.044	0.040	0.107
Lithium (Li)-Total	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-To	2510	2230	2330	2820	3030
Manganese (Mn)-To	71.9	38.3	48.5	55.1	126
Molybdenum (Mo)-T	7.05	12.3	8.39	38.9	6.95
Nickel (Ni)-Total	0.887	0.804	0.869	0.883	1.07
Phosphorus (P)-Tota	2600	1180	1730	1570	1790
Potassium (K)-Total	21600	14500	22300	19300	18600
Rhenium (Re)-Total	<0.010	0.015	<0.010	<0.010	<0.010
Rubidium (Rb)-Total	41.7	26.3	49.5	14.9	33.8
Selenium (Se)-Total	0.76	0.78	0.66	1.01	0.29
Sodium (Na)-Total	<100	<100	<100	<100	<100
Strontium (Sr)-Total	37.1	64.7	78.8	38.3	59.6
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	0.0025	<0.0020	<0.0020	<0.0020	<0.0020
Thorium (Th)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Titanium (Ti)-Total	3.72	6.11	4.79	2.86	6.95
Uranium (U)-Total	<0.0020	0.0024	0.0021	<0.0020	0.0034
Vanadium (V)-Total	0.275	0.419	0.356	0.190	0.518
Yttrium (Y)-Total	0.023	0.052	0.039	0.018	0.053
Zinc (Zn)-Total	23.9	14.1	19.5	25.5	20.8
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20

units as mg/kg

2012: Tree Plots

Sample ID	TREE PLOT 26	TREE PLOT 27	TREE PLOT 28	TREE PLOT 29	TREE PLOT 30
Treatment ID	E	F	A	D	M
Date Sampled	11-JUL-12	11-JUL-12	11-JUL-12	11-JUL-12	11-JUL-12
Species	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite
Metals					
Aluminum (Al)-Total	16.2	51.6	63.0	21.6	26.4
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	<0.080	<0.12	<0.12	<0.080	<0.060
Barium (Ba)-Total	9.73	46.0	17.3	6.84	8.71
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	0.024	0.176	<0.010
Boron (B)-Total	5.6	11.9	8.4	3.5	22.5
Cadmium (Cd)-Total	0.015	0.011	<0.010	0.023	0.058
Calcium (Ca)-Total	4120	8220	2010	2640	7150
Cesium (Cs)-Total	0.102	0.490	0.0240	0.128	0.0924
Chromium (Cr)-Tota	0.122	0.114	0.103	0.111	0.073
Cobalt (Co)-Total	0.122	0.235	0.099	0.075	0.165
Copper (Cu)-Total	9.09	20.1	16.4	9.37	11.5
Gallium (Ga)-Total	<0.020	0.028	0.024	<0.020	<0.020
Iron (Fe)-Total	57.5	168	144	61.6	98.1
Lead (Pb)-Total	0.036	0.091	0.128	0.052	0.060
Lithium (Li)-Total	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-To	1080	2740	874	1050	1830
Manganese (Mn)-To	51.4	51.9	56.3	83.9	64.5
Molybdenum (Mo)-T	2.45	5.71	2.33	1.51	57.0
Nickel (Ni)-Total	2.84	1.33	0.561	2.81	1.27
Phosphorus (P)-Tota	2360	1660	1250	2160	2770
Potassium (K)-Total	14500	18900	5860	17700	18100
Rhenium (Re)-Total	<0.010	<0.010	<0.010	<0.010	0.011
Rubidium (Rb)-Total	17.5	41.3	8.85	26.8	23.2
Selenium (Se)-Total	0.11	0.32	0.48	0.12	1.30
Sodium (Na)-Total	<100	<100	<200	<100	<100
Strontium (Sr)-Total	12.5	82.3	8.61	9.22	22.2
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Thorium (Th)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total	<0.020	<0.020	0.022	<0.020	<0.020
Titanium (Ti)-Total	1.82	6.74	6.61	2.15	3.07
Uranium (U)-Total	<0.0020	0.0033	0.0031	<0.0020	<0.0020
Vanadium (V)-Total	0.124	0.500	0.489	0.152	0.222
Yttrium (Y)-Total	0.011	0.053	0.043	0.014	0.020
Zinc (Zn)-Total	45.4	19.0	15.8	56.5	39.1
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20

units as mg/kg

2012: Tree Plots

Sample ID	TREE PLOT 31	TREE PLOT 32	TREE PLOT 33	TREE PLOT 34	TREE PLOT 35
Treatment ID	K	I	J	L	M
Date Sampled	11-JUL-12	11-JUL-12	11-JUL-12	11-JUL-12	11-JUL-12
Species	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite
Metals					
Aluminum (Al)-Total	35.0	15.7	17.3	23.7	27.8
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	<0.070	<0.060	<0.050	0.045	<0.070
Barium (Ba)-Total	19.0	28.9	14.3	25.4	19.2
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Boron (B)-Total	17.0	12.9	11.7	18.0	12.7
Cadmium (Cd)-Total	0.034	0.042	0.037	<0.010	0.072
Calcium (Ca)-Total	9480	11500	6500	11000	3530
Cesium (Cs)-Total	0.150	0.111	0.0533	0.161	0.0208
Chromium (Cr)-Tota	0.112	0.076	0.077	0.072	0.114
Cobalt (Co)-Total	0.306	0.129	0.107	0.149	0.046
Copper (Cu)-Total	12.5	13.2	9.93	12.2	9.06
Gallium (Ga)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Iron (Fe)-Total	120	60.9	71.4	80.0	82.3
Lead (Pb)-Total	0.061	0.034	0.046	0.049	0.084
Lithium (Li)-Total	<0.10	0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-To	2750	3300	1750	2130	1340
Manganese (Mn)-To	106	64.3	36.8	32.9	47.0
Molybdenum (Mo)-T	9.99	11.7	14.8	17.0	5.85
Nickel (Ni)-Total	0.916	0.504	0.804	1.57	2.62
Phosphorus (P)-Tota	1640	1520	1670	1720	2100
Potassium (K)-Total	18300	21300	21900	17900	13800
Rhenium (Re)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Rubidium (Rb)-Total	22.5	16.7	16.9	17.5	11.4
Selenium (Se)-Total	0.19	0.24	0.12	0.62	0.51
Sodium (Na)-Total	<100	<100	<100	<100	<100
Strontium (Sr)-Total	40.2	48.5	28.3	46.2	10.2
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Thorium (Th)-Total	<0.010	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total	<0.020	<0.020	<0.020	<0.020	<0.020
Titanium (Ti)-Total	4.18	1.82	2.01	2.62	3.16
Uranium (U)-Total	0.0022	<0.0020	<0.0020	0.0023	<0.0020
Vanadium (V)-Total	0.306	0.131	0.139	0.181	0.231
Yttrium (Y)-Total	0.034	0.019	0.017	0.019	0.018
Zinc (Zn)-Total	34.9	21.1	22.8	24.7	55.9
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20

units as mg/kg

2012: Tree Plots

Sample ID	**TREE PLOT 36**
Treatment ID	**J**
Date Sampled	**11-JUL-12**
Species	**Groundcover Composite**
Metals	
Aluminum (Al)-Total	16.3
Antimony (Sb)-Total	<0.010
Arsenic (As)-Total	<0.060
Barium (Ba)-Total	14.6
Beryllium (Be)-Total	<0.010
Bismuth (Bi)-Total	<0.010
Boron (B)-Total	20.5
Cadmium (Cd)-Total	0.025
Calcium (Ca)-Total	10900
Cesium (Cs)-Total	0.305
Chromium (Cr)-Tota	0.070
Cobalt (Co)-Total	0.143
Copper (Cu)-Total	16.8
Gallium (Ga)-Total	<0.020
Iron (Fe)-Total	80.8
Lead (Pb)-Total	0.038
Lithium (Li)-Total	<0.10
Magnesium (Mg)-To	2960
Manganese (Mn)-To	37.4
Molybdenum (Mo)-T	23.7
Nickel (Ni)-Total	1.08
Phosphorus (P)-Tota	2200
Potassium (K)-Total	19600
Rhenium (Re)-Total	0.011
Rubidium (Rb)-Total	22.5
Selenium (Se)-Total	0.83
Sodium (Na)-Total	<100
Strontium (Sr)-Total	33.6
Tellurium (Te)-Total	<0.020
Thallium (Tl)-Total	<0.0020
Thorium (Th)-Total	<0.010
Tin (Sn)-Total	<0.020
Titanium (Ti)-Total	1.92
Uranium (U)-Total	<0.0020
Vanadium (V)-Total	0.139
Yttrium (Y)-Total	0.016
Zinc (Zn)-Total	26.0
Zirconium (Zr)-Total	<0.20

units as mg/kg

2012: NEZ Dump

Sample ID	2A-1	2A-2	2A-3	2A-4	2A-5	2A-6	2A-7	2A-8	2A-9
Date Sampled	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**
Species	**Mountain Brome**	**Native Red Fescue**	**Rocky Mountain Fescue**	**Bluebunch Wheatgrass**	**Blue Wildrye**	**June Grass**	**Tickle Grass**	**Fireweed**	**Lupine**
Metals									
Aluminum (Al)-Total	9.5	14.9	39.1	10.5	97.9	183	14.7	39.4	23.0
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	<0.060	<0.070	<0.090	<0.050	<0.090	0.183	<0.070	0.162	<0.070
Barium (Ba)-Total	4.65	2.00	6.94	6.12	3.25	18.5	5.82	5.74	8.01
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Boron (B)-Total	3.3	3.5	4.4	3.9	3.6	4.9	3.9	28.3	23.7
Cadmium (Cd)-Total	0.016	0.029	0.033	0.013	0.030	0.017	0.034	0.010	0.052
Calcium (Ca)-Total	1440	1110	1470	1910	1660	1130	1520	7310	8050
Cesium (Cs)-Total	0.0403	0.0199	0.0215	0.0456	0.0398	0.0310	0.0345	0.175	0.769
Chromium (Cr)-Total	<0.060	<0.050	<0.12	<0.060	<0.20	<0.35	<0.070	<0.10	<0.12
Cobalt (Co)-Total	<0.020	0.021	0.035	<0.020	0.069	0.136	<0.020	0.048	0.098
Copper (Cu)-Total	4.09	3.76	6.14	3.51	9.25	10.6	4.97	9.84	15.6
Gallium (Ga)-Total	<0.020	<0.020	<0.020	<0.020	0.032	0.063	<0.020	<0.020	<0.020
Iron (Fe)-Total	33.3	37.1	66.6	36.1	157	297	37.7	111	115
Lead (Pb)-Total	<0.020	0.031	0.077	<0.020	0.085	0.088	<0.020	0.031	0.022
Lithium (Li)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-Total	551	545	661	596	579	573	761	2730	2640
Manganese (Mn)-Total	106	59.7	70.8	92.5	43.8	110	110	80.4	39.2
Molybdenum (Mo)-Total	0.978	1.57	2.08	0.881	2.17	1.61	4.24	1.15	24.9
Nickel (Ni)-Total	<0.35	<0.70	1.34	<0.40	<0.40	1.03	<0.70	<0.40	1.37
Phosphorus (P)-Total	1520	1170	1460	1460	1580	1400	1920	2370	2190
Potassium (K)-Total	9970	8370	6910	9340	10800	6590	10500	15400	18700
Rhenium (Re)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.121	<0.010
Rubidium (Rb)-Total	12.7	8.45	7.65	11.6	9.76	5.77	7.90	17.0	57.1
Selenium (Se)-Total	0.23	0.14	0.16	0.19	0.26	0.22	0.27	0.40	0.26
Sodium (Na)-Total	<100	<100	<100	<100	<100	<100	<100	<100	<100
Strontium (Sr)-Total	8.51	4.23	6.54	12.0	8.00	6.88	6.02	34.4	40.1
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0034	<0.0020
Thorium (Th)-Total	<0.010	<0.010	<0.010	<0.010	0.012	0.028	<0.010	<0.010	<0.010
Tin (Sn)-Total	<0.020	<0.020	0.024	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Titanium (Ti)-Total	0.949	1.27	2.09	1.05	7.30	15.6	0.941	3.23	2.44
Uranium (U)-Total	<0.0020	<0.0020	<0.0020	<0.0020	0.0050	0.0096	<0.0020	<0.0020	<0.0020
Vanadium (V)-Total	0.079	0.099	0.163	0.085	0.478	0.987	0.073	0.336	0.170
Yttrium (Y)-Total	<0.010	<0.010	0.013	<0.010	0.061	0.105	<0.010	0.034	0.025
Zinc (Zn)-Total	17.4	14.4	21.6	19.0	16.9	20.8	16.8	28.2	25.5
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

units as mg/kg

2012: NEZ Dump

Sample ID	2B1-1	2B1-2	2B1-3	2B1-4	2B1-5	2B1-6	2B1-7	2B1-8	2B1-9	2B2-1
Date Sampled	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**
Species	**Mountain Brome**	**Native Red Fescue**	**Rocky Mountain Fescue**	**Bluebunch Wheatgrass**	**Blue Wildrye**	**June Grass**	**Tickle Grass**	**Fireweed**	**Lupine**	**Mountain Brome**
Metals										
Aluminum (Al)-Total	5.4	36.2	8.8	7.6	5.0	18.5	4.2	22.8	24.6	6.6
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	<0.070	<0.090	<0.060	<0.060	<0.070	<0.070	<0.050	<0.10	<0.090	<0.070
Barium (Ba)-Total	4.65	13.6	6.50	17.7	2.90	7.49	2.46	1.71	2.40	3.21
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Boron (B)-Total	5.2	16.0	5.8	7.9	4.6	3.9	4.2	32.0	33.6	6.0
Cadmium (Cd)-Total	<0.010	0.066	0.031	0.010	0.018	0.013	0.052	0.010	0.060	<0.010
Calcium (Ca)-Total	2810	6500	2630	3150	3170	1680	1850	8740	11600	2480
Cesium (Cs)-Total	0.276	0.484	0.231	0.560	0.505	0.210	0.126	1.16	1.74	0.300
Chromium (Cr)-Total	<0.050	<0.25	<0.050	<0.050	<0.050	<0.050	<0.050	<0.080	<0.12	<0.050
Cobalt (Co)-Total	<0.020	0.065	0.027	<0.020	<0.020	0.029	<0.020	0.050	0.081	<0.020
Copper (Cu)-Total	4.59	14.6	5.80	9.35	8.21	11.1	7.25	9.31	10.6	4.71
Gallium (Ga)-Total	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Iron (Fe)-Total	33.3	134	45.3	49.8	40.4	77.4	34.1	131	120	39.9
Lead (Pb)-Total	<0.020	0.045	<0.020	<0.020	<0.020	0.028	0.020	0.030	0.025	0.023
Lithium (Li)-Total	<0.10	0.12	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-Total	776	2000	942	930	875	730	954	2200	2440	897
Manganese (Mn)-Total	77.5	188	56.1	66.5	42.8	57.7	122	60.4	84.3	82.0
Molybdenum (Mo)-Total	1.25	3.46	1.18	1.96	4.63	2.05	3.30	2.03	50.6	1.31
Nickel (Ni)-Total	<0.20	1.17	<0.60	<0.40	<0.30	<0.55	<0.65	<0.50	1.87	<0.20
Phosphorus (P)-Total	2390	3450	2260	2630	3000	2990	2340	3870	3150	2080
Potassium (K)-Total	10600	14500	9630	9160	15800	12000	10300	15800	22800	9390
Rhenium (Re)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Rubidium (Rb)-Total	14.9	32.0	21.2	12.5	17.4	16.4	12.5	23.2	47.5	15.1
Selenium (Se)-Total	0.15	0.30	<0.10	0.20	0.20	0.11	0.12	0.18	0.55	0.17
Sodium (Na)-Total	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Strontium (Sr)-Total	19.5	40.2	17.6	27.4	19.0	13.6	10.5	56.9	71.2	15.6
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Thorium (Th)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Tin (Sn)-Total	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.054	<0.020	<0.020	<0.020
Titanium (Ti)-Total	0.538	3.85	0.931	0.798	0.541	1.96	0.440	2.41	2.28	0.634
Uranium (U)-Total	<0.0020	0.0030	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Vanadium (V)-Total	0.040	0.272	0.075	0.055	0.043	0.144	0.032	0.222	0.180	0.053
Yttrium (Y)-Total	<0.010	0.023	<0.010	<0.010	<0.010	0.012	<0.010	0.017	0.020	<0.010
Zinc (Zn)-Total	30.6	66.8	26.9	39.0	32.3	34.1	32.6	30.3	47.0	31.8
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

units as mg/kg

2012: NEZ Dump

Sample ID	2B2-2	2B2-3	2B2-4	2B2-5	2B2-6	2B2-7	2B2-8	2B2-9
Date Sampled	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**	**10-JUL-12**
Species	**Native Red Fescue**	**Rocky Mountain Fescue**	**Bluebunch Wheatgrass**	**Blue Wildrye**	**June Grass**	**Tickle Grass**	**Fireweed**	**Lupine**
Metals								
Aluminum (Al)-Total	12.8	5.9	13.6	6.2	95.2	3.4	20.5	34.9
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	<0.080	<0.050	<0.060	<0.070	<0.10	<0.050	0.141	0.106
Barium (Ba)-Total	5.14	5.63	17.4	5.11	13.4	2.16	2.60	3.46
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.243
Boron (B)-Total	6.3	5.5	4.9	3.5	4.5	4.2	28.5	38.9
Cadmium (Cd)-Total	0.014	0.016	0.010	0.018	0.015	0.057	0.011	0.055
Calcium (Ca)-Total	1900	2210	2630	3330	1850	1830	8090	15700
Cesium (Cs)-Total	0.140	0.212	0.524	0.301	0.225	0.154	1.25	1.22
Chromium (Cr)-Total	<0.17	<0.050	<0.080	<0.050	<0.24	<0.060	<0.11	<0.15
Cobalt (Co)-Total	0.027	0.021	<0.020	<0.020	0.070	0.023	0.050	0.136
Copper (Cu)-Total	6.95	6.39	9.22	6.42	11.7	8.31	8.59	10.4
Gallium (Ga)-Total	<0.020	<0.020	<0.020	<0.020	0.034	<0.020	<0.020	<0.020
Iron (Fe)-Total	46.1	38.6	52.8	37.5	188	29.0	81.6	135
Lead (Pb)-Total	<0.020	<0.020	0.023	<0.020	0.060	<0.020	0.027	0.032
Lithium (Li)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium (Mg)-Total	903	957	827	722	870	879	2350	2910
Manganese (Mn)-Total	66.0	55.2	49.7	53.1	67.5	107	62.4	123
Molybdenum (Mo)-Total	1.42	1.81	1.79	2.86	1.88	4.11	3.50	41.7
Nickel (Ni)-Total	<0.80	<0.60	<0.30	<0.20	<0.75	0.824	<0.40	1.24
Phosphorus (P)-Total	2050	2230	2400	2730	2970	2050	4940	3000
Potassium (K)-Total	8950	10100	9990	12800	12800	11200	18900	14400
Rhenium (Re)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.013	<0.010
Rubidium (Rb)-Total	16.7	19.8	14.4	15.7	23.4	15.4	32.7	37.7
Selenium (Se)-Total	<0.10	<0.10	0.18	0.14	0.10	0.11	0.23	0.25
Sodium (Na)-Total	<100	<100	<100	<100	<100	<100	<100	<100
Strontium (Sr)-Total	11.2	13.2	24.7	23.2	17.6	12.7	67.7	113
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	0.0023	<0.0020	<0.0020	<0.0020	<0.0020	0.0035	<0.0020
Thorium (Th)-Total	<0.010	<0.010	<0.010	<0.010	0.012	<0.010	<0.010	<0.010
Tin (Sn)-Total	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Titanium (Ti)-Total	0.998	0.630	1.18	0.717	6.83	0.300	1.74	3.51
Uranium (U)-Total	<0.0020	<0.0020	<0.0020	<0.0020	0.0046	<0.0020	<0.0020	0.0024
Vanadium (V)-Total	0.070	0.047	0.078	0.051	0.525	0.025	0.185	0.274
Yttrium (Y)-Total	<0.010	<0.010	<0.010	<0.010	0.055	<0.010	0.014	0.024
Zinc (Zn)-Total	24.6	27.7	37.3	26.0	41.6	36.5	29.6	35.0
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

units as mg/kg

2014: Baseline Plots

Sample ID	OP1-1	OP1-2	OP1-3	OP1-1	OP1-2	OP1-3
Date Sampled	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**
Species	**Deciduous Composite**	**Deciduous Composite**	**Deciduous Composite**	**Groundcover Composite**	**Groundcover Composite**	**Groundcover Composite**
Metals						
Aluminum (Al)-Total	60.1	45.6	59.4	83.1	71.0	87.0
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	0.023	<0.020	0.025	0.039	0.034	<0.020
Barium (Ba)-Total	27.1	26.0	21.3	14.7	17.9	29.8
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Boron (B)-Total	23.1	25.1	22.3	17.9	16.5	25.4
Cadmium (Cd)-Total	0.847	0.715	0.660	0.0106	0.0948	0.200
Calcium (Ca)-Total	14300	11300	13100	9190	9800	11100
Cesium (Cs)-Total	0.0287	0.0269	0.0184	0.0378	0.0218	0.0322
Chromium (Cr)-Total	0.055	<0.050	0.065	0.109	0.083	0.125
Cobalt (Co)-Total	2.15	2.23	1.71	0.137	0.115	0.308
Copper (Cu)-Total	9.12	7.27	8.70	9.21	8.50	9.56
Iron (Fe)-Total	120	93.5	119	157	141	156
Lead (Pb)-Total	0.038	0.036	0.041	0.027	0.030	0.031
Lithium (Li)-Total	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Tot	2580	2430	2640	2390	2730	2760
Manganese (Mn)-Tot	129	86.0	98.5	48.0	50.5	52.1
Molybdenum (Mo)-T	0.466	0.379	0.649	1.34	0.813	0.913
Nickel (Ni)-Total	1.28	0.93	1.12	1.25	0.93	1.49
Phosphorus (P)-Total	3190	2670	3070	3840	3390	3970
Potassium (K)-Total	13300	12800	12600	18900	19300	24200
Rubidium (Rb)-Total	9.25	7.96	7.92	12.5	11.8	15.6
Selenium (Se)-Total	<0.050	<0.050	<0.050	<0.050	<0.050	0.051
Sodium (Na)-Total	<20	<20	<20	<20	<20	<20
Strontium (Sr)-Total	90.2	90.2	86.3	48.6	56.7	68.9
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Tin (Sn)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Uranium (U)-Total	<0.0020	<0.0020	<0.0020	0.0022	0.0021	0.0021
Vanadium (V)-Total	0.34	0.27	0.34	0.42	0.41	0.45
Zinc (Zn)-Total	181	107	137	24.1	19.9	28.2
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

units as mg/kg

2014: Baseline Plots

Sample ID	V2-1	V2-2	V2-3	V2-1	V2-2	V2-3	SD2-1	SD2-2
Date Sampled	09-JUL-14	09-JUL-14	09-JUL-14	09-JUL-14	09-JUL-14	09-JUL-14	09-JUL-14	09-JUL-14
Species	Groundcover Composite	Groundcover Composite	Groundcover Composite	Deciduous Composite	Deciduous Composite	Deciduous Composite	Groundcover Composite	Groundcover Composite
Metals								
Aluminum (Al)-Total	179	133	74.8	137	155	162	15.0	20.5
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	0.085	0.077	0.037	0.083	0.104	0.075	<0.020	0.031
Barium (Ba)-Total	63.5	47.9	16.7	20.4	20.9	24.6	10.3	13.2
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Boron (B)-Total	21.2	19.3	12.5	11.5	13.3	15.7	25.1	20.0
Cadmium (Cd)-Total	0.0720	0.142	0.0472	2.26	2.33	2.82	0.0350	0.136
Calcium (Ca)-Total	9830	10300	6080	13100	12600	14300	12500	14000
Cesium (Cs)-Total	0.0955	0.0339	0.0572	0.312	0.369	0.373	1.69	1.50
Chromium (Cr)-Total	0.175	0.115	0.140	0.095	0.122	0.163	<0.050	<0.050
Cobalt (Co)-Total	0.173	0.130	0.094	1.60	1.65	1.75	0.071	0.079
Copper (Cu)-Total	16.6	16.3	11.6	19.3	20.3	20.9	7.54	7.73
Iron (Fe)-Total	331	262	175	291	328	328	67.0	70.0
Lead (Pb)-Total	0.100	0.096	0.051	0.107	0.108	0.116	<0.020	<0.020
Lithium (Li)-Total	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Tot	2410	3040	1690	1670	1810	1950	3550	3780
Manganese (Mn)-Tot	126	64.7	40.0	70.4	75.1	87.5	64.0	74.1
Molybdenum (Mo)-T	0.728	0.743	1.19	0.496	0.407	0.465	6.74	3.57
Nickel (Ni)-Total	0.60	0.71	1.08	0.84	1.13	1.32	0.46	0.35
Phosphorus (P)-Total	4190	3380	3250	2480	2550	2610	4530	3780
Potassium (K)-Total	23000	18800	23900	13800	14100	13700	29600	26800
Rubidium (Rb)-Total	13.2	13.6	18.6	16.7	17.3	17.9	22.8	20.4
Selenium (Se)-Total	<0.050	<0.050	<0.050	0.084	0.077	0.080	<0.050	<0.050
Sodium (Na)-Total	<20	<20	<20	<20	<20	<20	<20	<20
Strontium (Sr)-Total	68.0	69.5	36.2	72.3	70.8	79.6	51.0	66.3
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Tin (Sn)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Uranium (U)-Total	0.0070	0.0057	0.0032	0.0060	0.0073	0.0068	<0.0020	<0.0020
Vanadium (V)-Total	0.95	0.89	0.49	0.91	1.06	1.05	<0.10	0.10
Zinc (Zn)-Total	41.3	27.6	32.8	180	162	168	27.5	30.8
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

units as mg/kg

2014: Baseline Plots

Sample ID	SD2-3	SD2-1	SD2-2	SD2-3	TA5-1	TA5-2	TA5-3	TA5-1	TA5-2
Date Sampled	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**
Species	**Groundcover Composite**	**Deciduous Composite**	**Deciduous Composite**	**Deciduous Composite**	**Groundcover Composite**	**Groundcover Composite**	**Groundcover Composite**	**Deciduous Composite**	**Deciduous Composite**
Metals									
Aluminum (Al)-Total	20.5	23.7	30.3	17.5	216	138	375	110	80.6
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.020	<0.010	<0.010	<0.010
Arsenic (As)-Total	0.032	0.038	0.029	0.029	0.077	<0.040	0.090	0.034	0.032
Barium (Ba)-Total	13.1	8.85	8.76	8.43	75.7	53.1	68.0	14.1	9.52
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.020	0.011	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.020	<0.010	<0.010	<0.010
Boron (B)-Total	20.9	44.6	42.7	46.2	22.3	28.3	20.8	19.1	19.4
Cadmium (Cd)-Total	0.621	1.09	1.18	1.05	0.165	0.046	0.143	1.55	1.13
Calcium (Ca)-Total	14800	26300	26500	28400	11600	11100	8900	11600	10900
Cesium (Cs)-Total	0.765	0.876	0.850	1.05	0.0269	0.014	0.0314	0.0384	0.0334
Chromium (Cr)-Total	0.088	<0.050	<0.050	<0.050	0.222	0.21	0.378	0.168	0.123
Cobalt (Co)-Total	0.147	0.783	0.826	0.854	0.114	0.047	0.189	0.578	0.587
Copper (Cu)-Total	6.99	7.45	9.11	7.06	9.74	6.94	13.8	8.71	7.62
Iron (Fe)-Total	72.4	66.3	84.9	56.9	268	125	468	189	146
Lead (Pb)-Total	<0.020	0.021	0.023	<0.020	0.065	<0.040	0.109	0.057	0.039
Lithium (Li)-Total	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0	<0.50	<0.50	<0.50
Magnesium (Mg)-Tot	3440	2990	3620	3340	3420	4350	3010	3020	2880
Manganese (Mn)-Tot	109	90.5	103	88.0	261	332	263	197	114
Molybdenum (Mo)-T	4.54	0.684	0.877	0.601	0.665	0.537	0.655	0.108	0.101
Nickel (Ni)-Total	0.61	0.81	1.17	0.90	1.01	1.32	1.20	2.39	1.71
Phosphorus (P)-Total	4220	1710	2050	1690	3700	3400	2760	2830	2380
Potassium (K)-Total	28900	13200	14400	12800	27400	17800	20700	15600	14000
Rubidium (Rb)-Total	27.0	12.9	14.9	12.6	16.0	10.8	10.3	16.3	15.1
Selenium (Se)-Total	0.055	0.206	0.195	0.241	<0.050	<0.10	0.055	0.104	0.116
Sodium (Na)-Total	28	<20	<20	<20	<20	<40	<20	<20	<20
Strontium (Sr)-Total	66.9	166	163	178	60.6	57.0	41.2	65.6	54.5
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020	<0.040	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0040	<0.0020	<0.0020	<0.0020
Tin (Sn)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.20	<0.10	<0.10	<0.10
Uranium (U)-Total	<0.0020	<0.0020	0.0026	0.0024	0.0070	<0.0040	0.0093	0.0033	0.0026
Vanadium (V)-Total	0.15	0.14	0.20	0.10	0.82	0.29	1.46	0.48	0.36
Zinc (Zn)-Total	37.0	70.7	75.7	71.3	29.6	32.0	21.9	150	193
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20	<0.40	<0.20	<0.20	<0.20

units as mg/kg

2014: Baseline Plots

Sample ID	**TA5-3**
Date Sampled	**09-JUL-14**
Species	**Deciduous Composite**
Metals	
Aluminum (Al)-Total	86.9
Antimony (Sb)-Total	<0.010
Arsenic (As)-Total	0.042
Barium (Ba)-Total	10.5
Beryllium (Be)-Total	<0.010
Bismuth (Bi)-Total	<0.010
Boron (B)-Total	19.4
Cadmium (Cd)-Total	1.27
Calcium (Ca)-Total	10500
Cesium (Cs)-Total	0.0346
Chromium (Cr)-Total	0.126
Cobalt (Co)-Total	0.572
Copper (Cu)-Total	7.78
Iron (Fe)-Total	151
Lead (Pb)-Total	0.042
Lithium (Li)-Total	<0.50
Magnesium (Mg)-Tot	2790
Manganese (Mn)-Tot	141
Molybdenum (Mo)-T	0.099
Nickel (Ni)-Total	1.79
Phosphorus (P)-Total	2380
Potassium (K)-Total	14500
Rubidium (Rb)-Total	15.1
Selenium (Se)-Total	0.121
Sodium (Na)-Total	24
Strontium (Sr)-Total	56.1
Tellurium (Te)-Total	<0.020
Thallium (Tl)-Total	<0.0020
Tin (Sn)-Total	<0.10
Uranium (U)-Total	0.0030
Vanadium (V)-Total	0.37
Zinc (Zn)-Total	192
Zirconium (Zr)-Total	<0.20

units as mg/kg

2014: Tree Plots

Sample ID	TREE PLOT A	TREE PLOT B	TREE PLOT C
Date Sampled	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**
Species	**Deciduous Composite**	**Deciduous Composite**	**Deciduous Composite**
Metals			
Aluminum (Al)-Total	36.2	52.8	48.4
Antimony (Sb)-Total	<0.010	<0.010	0.025
Arsenic (As)-Total	0.111	0.032	0.164
Barium (Ba)-Total	14.9	9.08	31.9
Beryllium (Be)-Total	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	0.021	<0.010	<0.010
Boron (B)-Total	27.1	17.4	25.6
Cadmium (Cd)-Total	0.413	0.262	0.536
Calcium (Ca)-Total	15300	15900	22000
Cesium (Cs)-Total	0.111	0.138	0.103
Chromium (Cr)-Total	0.058	0.055	0.055
Cobalt (Co)-Total	0.497	0.357	0.818
Copper (Cu)-Total	10.1	10.9	11.8
Iron (Fe)-Total	88.1	117	116
Lead (Pb)-Total	0.039	0.048	0.041
Lithium (Li)-Total	<0.50	<0.50	<0.50
Magnesium (Mg)-Total	1540	1720	2580
Manganese (Mn)-Total	66.0	51.7	85.6
Molybdenum (Mo)-Total	1.02	0.719	1.64
Nickel (Ni)-Total	0.23	0.28	0.58
Phosphorus (P)-Total	2480	2050	3040
Potassium (K)-Total	13800	16400	15600
Rubidium (Rb)-Total	13.2	18.3	18.5
Selenium (Se)-Total	2.50	2.01	3.90
Sodium (Na)-Total	26	<20	<20
Strontium (Sr)-Total	68.8	53.0	135
Tellurium (Te)-Total	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020
Tin (Sn)-Total	<0.10	<0.10	<0.10
Uranium (U)-Total	<0.0020	0.0023	0.0021
Vanadium (V)-Total	0.27	0.33	0.34
Zinc (Zn)-Total	96.6	43.9	80.5
Zirconium (Zr)-Total	<0.20	<0.20	<0.20

units as mg/kg

2014: Tree Plots

Sample ID	TREE PLOT D	TREE PLOT E	TREE PLOT F
Date Sampled	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**
Species	**Deciduous Composite**	**Deciduous Composite**	**Deciduous Composite**
Metals			
Aluminum (Al)-Total	79.4	32.7	31.7
Antimony (Sb)-Total	<0.010	<0.010	<0.010
Arsenic (As)-Total	0.078	0.074	0.073
Barium (Ba)-Total	13.7	9.16	9.66
Beryllium (Be)-Total	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010
Boron (B)-Total	20.8	15.0	20.2
Cadmium (Cd)-Total	0.508	0.430	0.514
Calcium (Ca)-Total	12100	13000	14900
Cesium (Cs)-Total	0.156	0.177	0.134
Chromium (Cr)-Total	0.091	0.114	<0.050
Cobalt (Co)-Total	0.496	0.429	0.400
Copper (Cu)-Total	14.7	9.38	9.44
Iron (Fe)-Total	184	81.2	78.0
Lead (Pb)-Total	0.066	0.039	0.037
Lithium (Li)-Total	<0.50	<0.50	<0.50
Magnesium (Mg)-Total	2460	1610	1690
Manganese (Mn)-Total	68.8	60.2	61.7
Molybdenum (Mo)-Total	0.810	1.14	0.963
Nickel (Ni)-Total	0.47	0.36	0.30
Phosphorus (P)-Total	3200	2140	2450
Potassium (K)-Total	14400	12300	15500
Rubidium (Rb)-Total	16.5	13.3	13.1
Selenium (Se)-Total	1.34	2.39	1.99
Sodium (Na)-Total	20	<20	<20
Strontium (Sr)-Total	96.8	50.4	56.8
Tellurium (Te)-Total	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020
Tin (Sn)-Total	<0.10	<0.10	<0.10
Uranium (U)-Total	0.0037	<0.0020	<0.0020
Vanadium (V)-Total	0.58	0.21	0.21
Zinc (Zn)-Total	116	73.7	121
Zirconium (Zr)-Total	<0.20	<0.20	<0.20

units as mg/kg

2014: Tree Plots

Sample ID	TREE PLOT G	TREE PLOT H	TREE PLOT I
Date Sampled	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**
Species	**Deciduous Composite**	**Deciduous Composite**	**Deciduous Composite**
Metals			
Aluminum (Al)-Total	46.3	57.7	35.1
Antimony (Sb)-Total	<0.010	<0.010	<0.010
Arsenic (As)-Total	0.040	0.078	0.086
Barium (Ba)-Total	10.9	11.6	19.5
Beryllium (Be)-Total	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010
Boron (B)-Total	27.3	16.6	18.6
Cadmium (Cd)-Total	0.288	0.308	0.521
Calcium (Ca)-Total	15100	12100	13900
Cesium (Cs)-Total	0.210	0.224	0.132
Chromium (Cr)-Total	0.057	0.062	<0.050
Cobalt (Co)-Total	0.622	0.669	0.403
Copper (Cu)-Total	10.4	12.0	12.4
Iron (Fe)-Total	109	134	89.7
Lead (Pb)-Total	0.042	0.051	0.035
Lithium (Li)-Total	<0.50	<0.50	<0.50
Magnesium (Mg)-Total	2790	1990	1710
Manganese (Mn)-Total	61.0	63.1	63.4
Molybdenum (Mo)-Total	1.11	0.699	1.21
Nickel (Ni)-Total	0.53	0.44	0.43
Phosphorus (P)-Total	2070	2870	2490
Potassium (K)-Total	15200	15800	13200
Rubidium (Rb)-Total	19.2	15.2	12.7
Selenium (Se)-Total	3.07	1.73	1.21
Sodium (Na)-Total	<20	<20	<20
Strontium (Sr)-Total	67.2	58.4	75.1
Tellurium (Te)-Total	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020
Tin (Sn)-Total	<0.10	<0.10	<0.10
Uranium (U)-Total	0.0023	0.0032	<0.0020
Vanadium (V)-Total	0.29	0.41	0.23
Zinc (Zn)-Total	59.3	74.4	206
Zirconium (Zr)-Total	<0.20	<0.20	<0.20

units as mg/kg

2014: Tree Plots

Sample ID	TREE PLOT J	TREE PLOT K	TREE PLOT L
Date Sampled	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**
Species	**Deciduous Composite**	**Deciduous Composite**	**Deciduous Composite**
Metals			
Aluminum (Al)-Total	33.1	23.4	40.6
Antimony (Sb)-Total	<0.010	<0.010	<0.010
Arsenic (As)-Total	0.048	0.046	0.094
Barium (Ba)-Total	11.2	12.4	16.2
Beryllium (Be)-Total	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	<0.010
Boron (B)-Total	31.2	41.0	29.3
Cadmium (Cd)-Total	0.598	0.762	0.696
Calcium (Ca)-Total	10600	16700	15000
Cesium (Cs)-Total	0.0655	0.161	0.200
Chromium (Cr)-Total	<0.050	<0.050	<0.050
Cobalt (Co)-Total	0.384	0.399	0.450
Copper (Cu)-Total	11.4	8.19	10.6
Iron (Fe)-Total	79.9	62.2	103
Lead (Pb)-Total	0.033	0.030	0.046
Lithium (Li)-Total	<0.50	<0.50	<0.50
Magnesium (Mg)-Total	1910	1660	1830
Manganese (Mn)-Total	32.5	62.9	50.5
Molybdenum (Mo)-Total	3.39	1.82	2.61
Nickel (Ni)-Total	1.03	0.70	1.49
Phosphorus (P)-Total	2370	2180	1840
Potassium (K)-Total	12500	15400	10900
Rubidium (Rb)-Total	8.89	12.4	11.9
Selenium (Se)-Total	1.59	1.39	2.51
Sodium (Na)-Total	<20	<20	<20
Strontium (Sr)-Total	52.1	51.2	80.6
Tellurium (Te)-Total	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020
Tin (Sn)-Total	<0.10	<0.10	<0.10
Uranium (U)-Total	<0.0020	<0.0020	0.0027
Vanadium (V)-Total	0.21	0.14	0.27
Zinc (Zn)-Total	80.4	133	72.6
Zirconium (Zr)-Total	<0.20	<0.20	<0.20

units as mg/kg

2014: Tree Plots

Sample ID	**TREE PLOT M**
Date Sampled	**09-JUL-14**
Species	**Deciduous Composite**
Metals	
Aluminum (Al)-Total	31.4
Antimony (Sb)-Total	<0.010
Arsenic (As)-Total	0.088
Barium (Ba)-Total	12.4
Beryllium (Be)-Total	<0.010
Bismuth (Bi)-Total	<0.010
Boron (B)-Total	25.3
Cadmium (Cd)-Total	0.370
Calcium (Ca)-Total	10700
Cesium (Cs)-Total	0.224
Chromium (Cr)-Total	<0.050
Cobalt (Co)-Total	0.335
Copper (Cu)-Total	9.29
Iron (Fe)-Total	77.3
Lead (Pb)-Total	0.035
Lithium (Li)-Total	<0.50
Magnesium (Mg)-Total	1690
Manganese (Mn)-Total	40.6
Molybdenum (Mo)-Total	1.31
Nickel (Ni)-Total	0.49
Phosphorus (P)-Total	1930
Potassium (K)-Total	12300
Rubidium (Rb)-Total	14.3
Selenium (Se)-Total	1.26
Sodium (Na)-Total	<20
Strontium (Sr)-Total	67.6
Tellurium (Te)-Total	<0.020
Thallium (Tl)-Total	<0.0020
Tin (Sn)-Total	<0.10
Uranium (U)-Total	<0.0020
Vanadium (V)-Total	0.20
Zinc (Zn)-Total	85.8
Zirconium (Zr)-Total	<0.20

units as mg/kg

2014: NEZ Dump

Sample ID	NEZ 2B2-1	NEZ 2B2-2	NEZ 2B2-3	NEZ 2B1-1
Date Sampled	09-JUL-14	09-JUL-14	09-JUL-14	09-JUL-14
Species	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite
Metals				
Aluminum (Al)-Total	19.5	18.9	18.9	36.0
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	0.076	0.073	0.037	0.064
Barium (Ba)-Total	9.74	6.52	3.91	20.5
Beryllium (Be)-Total	<0.010	<0.010	<0.010	0.014
Bismuth (Bi)-Total	<0.010	<0.010	<0.010	<0.010
Boron (B)-Total	34.2	41.2	37.6	34.3
Cadmium (Cd)-Total	0.0680	0.0146	0.0182	0.0318
Calcium (Ca)-Total	18900	17000	9330	23300
Cesium (Cs)-Total	0.277	0.615	0.194	0.697
Chromium (Cr)-Total	<0.050	0.085	<0.050	0.060
Cobalt (Co)-Total	0.075	0.093	0.060	0.159
Copper (Cu)-Total	6.25	7.75	6.53	16.0
Iron (Fe)-Total	79.6	146	70.6	118
Lead (Pb)-Total	<0.020	0.022	<0.020	0.020
Lithium (Li)-Total	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total	3330	3620	2880	3840
Manganese (Mn)-Total	72.6	65.5	48.3	143
Molybdenum (Mo)-Total	29.0	43.5	5.00	13.4
Nickel (Ni)-Total	0.24	0.22	0.33	0.30
Phosphorus (P)-Total	2980	3380	4710	2460
Potassium (K)-Total	13300	15200	21800	22400
Rubidium (Rb)-Total	10.8	17.6	13.2	27.4
Selenium (Se)-Total	0.327	0.292	0.974	0.186
Sodium (Na)-Total	123	84	148	52
Strontium (Sr)-Total	375	348	222	226
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020	0.0026
Tin (Sn)-Total	<0.10	<0.10	<0.10	<0.10
Uranium (U)-Total	0.0141	0.0091	0.0278	0.0067
Vanadium (V)-Total	0.16	0.16	0.17	0.19
Zinc (Zn)-Total	19.2	27.1	25.0	22.7
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20

units as mg/kg

NEZ 2B1-2	NEZ 2B1-3	NEZ 2A-1	NEZ 2A-2	NEZ 2A-3
09-JUL-14	09-JUL-14	09-JUL-14	09-JUL-14	09-JUL-14
Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite	Groundcover Composite
20.8	21.2	29.3	22.5	24.9
<0.010	<0.010	<0.010	<0.010	<0.010
0.057	0.045	0.052	0.051	0.047
7.80	16.6	6.58	10.3	9.62
<0.010	<0.010	<0.010	<0.010	<0.010
<0.010	<0.010	<0.010	<0.010	<0.010
34.8	25.1	32.3	34.8	32.6
0.0081	0.0381	0.0200	0.0388	0.236
12500	18500	13400	15900	18300
0.244	0.407	0.601	0.375	1.34
<0.050	<0.050	<0.050	<0.050	<0.050
0.102	0.060	0.054	0.075	0.089
12.5	10.1	9.86	12.1	9.38
131	92.8	104	102	94.9
<0.020	<0.020	<0.020	<0.020	<0.020
<0.50	<0.50	<0.50	<0.50	<0.50
2630	3180	2770	3000	3050
96.0	79.8	56.9	59.5	45.4
13.7	12.0	58.3	16.7	15.3
0.23	<0.20	<0.20	0.28	0.29
2450	2970	2290	2500	2190
16800	19700	17000	18800	22900
17.8	23.9	30.0	24.6	58.7
0.183	0.184	0.453	0.240	0.309
31	46	32	27	49
192	233	146	153	145
<0.020	<0.020	<0.020	<0.020	<0.020
<0.0020	<0.0020	0.0078	<0.0020	0.0096
<0.10	<0.10	<0.10	<0.10	<0.10
0.0071	0.0061	0.0074	0.0056	0.0064
0.15	0.13	0.19	0.17	0.19
20.8	24.8	22.5	22.9	32.5
<0.20	<0.20	<0.20	<0.20	<0.20

2014: Control Plots

Sample ID	C14-01	C14-01	C14-2	C14-2
Date Sampled	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**	**09-JUL-14**
Species	**Deciduous Foliage Composite**	**Groundcover Composite**	**Groundcover Composite**	**Deciduous Foliage Composite**
Metals				
Aluminum (Al)-Total	31.3	35.3	14.7	15.7
Antimony (Sb)-Total	<0.010	<0.010	<0.010	<0.010
Arsenic (As)-Total	<0.020	<0.020	<0.020	<0.020
Barium (Ba)-Total	24.9	37.8	18.6	8.82
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total	<0.010	<0.010	0.014	<0.010
Boron (B)-Total	19.2	21.4	17.3	23.5
Cadmium (Cd)-Total	2.45	0.0282	0.163	1.60
Calcium (Ca)-Total	12600	9250	8120	14200
Cesium (Cs)-Total	0.0296	0.0663	0.0057	0.0057
Chromium (Cr)-Total	<0.050	<0.050	0.056	<0.050
Cobalt (Co)-Total	0.460	0.157	0.056	0.505
Copper (Cu)-Total	6.85	7.09	6.21	8.85
Iron (Fe)-Total	79.1	70.1	66.1	68.5
Lead (Pb)-Total	0.022	<0.020	<0.020	<0.020
Lithium (Li)-Total	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total	2580	3450	2760	2850
Manganese (Mn)-Total	101	204	36.2	69.4
Molybdenum (Mo)-Total	0.811	5.40	2.29	0.320
Nickel (Ni)-Total	0.73	0.67	1.24	1.80
Phosphorus (P)-Total	3810	4120	4270	2940
Potassium (K)-Total	21000	23000	21900	13400
Rubidium (Rb)-Total	9.62	19.1	10.4	6.71
Selenium (Se)-Total	0.123	<0.050	<0.050	0.070
Sodium (Na)-Total	<20	21	<20	<20
Strontium (Sr)-Total	66.2	43.2	42.1	75.6
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total	<0.0020	<0.0020	<0.0020	<0.0020
Tin (Sn)-Total	<0.10	<0.10	<0.10	<0.10
Uranium (U)-Total	<0.0020	<0.0020	<0.0020	<0.0020
Vanadium (V)-Total	0.19	<0.10	0.11	0.11
Zinc (Zn)-Total	105	33.0	35.4	215
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20

units as mg/kg

Appendix B:

Vegetation Metal Uptake Sampling Procedure (MPMC Work Method 18)

MOUNT POLLEY MINING CORPORATION
IMPERIAL METALS CORPORATION

MPMC – WORK – 018: Vegetation Sampling

Objective

To collect vegetation samples according to consultant, lab recommendations, and established best practices methods.

Work Methods

Equipment:

Collect the equipment listed in Table 1.

Table 1. Vegetation sampling equipment checklist

Stainless steel scissors or collection tools		Field notebook	
Clean paper bags or Ziploc bags		Pencils and indelible markers	
Cooler with ice packs		Sampling gloves	
GPS		Camera with extra batteries	
PPE and handheld radio		Rebar (or other site marker)	
Flagging tape		Hammer	

Sample Planning:

Review the existing sample program. This document stratifies the site into sample types (reclaimed sites, baseline sites and control sites), and provides rationale for sample locations, sample species selection, sample frequency, and duplicate sample requirements.

1. Confirm the sites to be sampled, the composite samples and individual species samples to be taken at each site, and the number of duplicate samples required. Obtain input from consultants if making significant changes to the plan or sample methodology.
2. If new locations are going to be sampled, pre-select sample locations with a systematic sample plan on a map, for example using a grid or transects. Note that a brief reconnaissance may be

required at new sites to assess anthropogenic impacts and to determine the prevalence and distribution of the different candidate species. Avoid selecting sites adjacent to roads or active disturbance to prevent sample contamination.

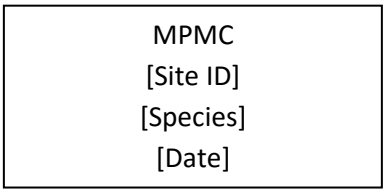
3. Develop a schedule:
    - Sample grasses prior to seed head emergence and prior to the bloom stage for legumes (approximately late June/early July).
    - Sample deciduous foliage in the summer.

Collection:

Collection of vegetation samples should be done in a fashion that mimics browsing.

1. Locate sample site, using a GPS as needed. For new samples sites:
    - Mark the site with rebar (or a different type of site marker) and flagging tape.
    - Take a photo referencing obvious landmarks.
    - Record the GPS waypoint (if different from the pre-selected location, due to unforeseen constraints).
2. Label clean paper sample bags or Ziploc bags as shown in Figure 1.
3. Collect samples of the current year's growth only with stainless steel scissors or tools. Samplers must wear gloves.
    - For grass species, all above ground foliar material can be sampled.
    - For legume species sample from the top 1/3 of the plant.
4. Collect foliage from the plant(s) of the selected species nearest to the sample point.
5. Collect a minimum of 5 grams per sample or amount required by the lab. A handful is typically sufficient.
6. Collect duplicate or replicate samples, as per the program design.
7. Fold and tape paper bags or close Ziploc bags and store in coolers with ice packs.
8. At the base of each plant where vegetation is sampled, collect two 125mL glass sediment jars of sediments from the A horizon where the roots are growing and label as per Figure 1 (excluding the species line).
9. Store samples in paper bags in refrigerator for up to 48 hours or freeze samples in Ziploc bags before shipping them to the lab in coolers with ice packs for metal analysis.

Figure 1. Sample bag label template



Safety in the Field

- Complete a FLRA prior to leaving the office.
- Follow *MPMC-SOP-011: Check In and Check Out Procedure*.
- Always wear appropriate PPE and carry a handheld radio.
- Work with a partner in remote locations, or when known hazards exist.
- Drive responsibly with headlights and blinker on at all times.
- Inform the Pit Shifter/TSF Supervisor if you are entering active mining and dumping sites/ the TSF area, and contact them again when you have safely left the area.
- Be aware of bears and other wildlife.
- Use caution when walking on reclaimed dump surfaces or unstable terrain, in particular when carrying scissors or other sharp objects.

APPENDIX X:

LIABILITY BOND COSTING

SUBMITTED TO THE MEM UNDER SEPARATE COVER

APPENDIX Y:

CONSULTATION DOCUMENTS

Implementation Committee Minutes

MINUTES DECEMBER 20TH, 2012 11:00AM WLIB - CJL

MEETING CALLED BY	SCIB/WLIB/MPMC Implementation Committee
TYPE OF MEETING	Monthly
FACILITATOR	WLIB
NOTE TAKER	Luke Moger (MPMC – Project Engineer)
ATTENDEES	Jacinda Mack (SCIB – Natural Resource Manager), Byron Louie (WLIB - Community Economic Developer Worker), Willie Sellars (WLIB - Councilor), Shawna Philbrick (WLIB – Employment Coordinator/Natural Resource Assistant), Tim Fisch (MPMC – General Manager), Paul Allan (MPMC - Human Resources Manager), Luke Moger (MPMC – Project Engineer), Ryan Brown (Senior Mine Engineer)

Excerpt from Meeting Minutes:

RECLAMATION AND CLOSURE PLANNING LUKE MOGER

DISCUSSION	**LM** updated that MPMC is currently working on a detailed five-year reclamation plan for Mount Polley Mine and would like to include some plant species selection input from SCIB and WLIB. **LM** furthered that the current plan is based on the approved 2016 mine plan, but that another reclamation and closure plan will be required for the 2023 mine plan (when the application is approved) and so suggestions could be incorporated for this document. **BL** responded that WLIB would appreciate an opportunity to participate in this, and asked for information on potential 2013 hydoseeding opportunities. **LM** responded that he would provide this when plans are finalized.
CONCLUSIONS	**LM** explained that MPMC is creating a reclamation and closure plan for submission in January based on the already-permitted 2016 mine plan. With the proposed 2023 mine plan, there is opportunity for WLIB/SCIB input.

ACTION ITEMS	PERSON RESPONSIBLE	DEADLINE
Forward copy of 2016 Reclamation and Closure Plan to SCIB/WLIB	**LM**	ASAP
Forward copy of potential 2013 hydoseeding areas to **WS**	**LM**	As Finalized

First Nations and Public Information Sharing Summary

From:	Mount Polley Mining Corporation
Contact:	Luke Moger
	Phone: (250) 790-2215 ext.2113
	E-mail: LMoger@MountPolley.com
Application Document:	Return to Restricted Operations, Revision 1 (March 20, 2015)
Permit Relevance:	Permit Amendment Application (*Mines Act*, M-200; *Environmental Management Act*, PE11678)
Last Update to Sharing Summary:	June 12, 2015
Updated By:	Luke Moger
All Parties Referred To:	Soda Creek Indian Band (Xatśūll)
	Williams Lake Indian Band (T'exelc)
	Likely Representative
	Public
	Cariboo Regional Mine Development Committee
	Public Liaison Committee

Note

This *Information Sharing Summary* is provided in support of the permit amendment applications under the *Mines Act* (M-200) and *Environmental Management Act* (PE11678) as part of the proposed return to restricted operations at Mount Polley Mine (*Mount Polley Mine Return to Restricted Operations, Revision 1*, dated March 20, 2015). Consultation with First Nations and public on the proposed works pre-dates the original application, and has been formally summarized and submitted to regulators in documents prior to this *Information Sharing Summary*: the *RMDRC Comment Tracking* documents (April 30, 2015; May 21, 2015 update) and *Public Consultation Report* (May 29, 2015).

Since the TSF Breach occurring in August, 2014, Mount Polley Mining Corporation (MPMC) has shared information and updates on permit amendment applications within general updates on site activities, in addition to permit application-specific settings. As of the time of the application (March 20, 2015), a commonly held view was that the restart application was an all-encompassing application that also included effluent treatment and discharge. Mount Polley, since this time, has sought to clarify (and the Ministry of Environment (MoE)/the Ministry of Energy and Mines (MEM) have done the same) that:

1) The temporary restart is for a *Mines Act* permit (M-200) amendment to allow mining and milling and an *Environmental Management Act* permit (PE11678) amendment to allow tailings to be deposited in the Springer Pit; and,

2) A separate amendment application will be filed for an (*Environmental Management Act*) effluent permit to enable short-term water management (treatment and discharge) to allow control of Springer Pit water levels. This permit amendment application will be subject to an additional thirty (30) day consultation period; however, MPMC has been engaging with the Williams Lake Indian Band and the Xat'sull First Nation, as well as with local community representatives, regulators and stakeholders in advance of this application being filed.

Additionally, The MEM and the MoE have indicated that the short-term water management Technical Assessment Report (submitted May 29, 2015) will be required to provide a permittable plan for short-term water management in support of a decision on the return to restricted operations application; thus, information sharing on the permit amendment applications includes some references to information regarding short-term water management.

Date of Contact	Contacted Parties (Medium)	Action (Reference Document)	Comments
November 5, 2014	Cariboo Mine Development Review Committee (CMDRC) (Meeting)	**MPMC presented on the Mine Operations and Mill Restart Operations with use of the Springer Pit for deposition. Updates provided on the breach repair and site remediation work.** Ref: 2014 11 05 – CMDRC Minutes	Presentation of Mining Operations and Mill Restart Options: use of Springer Pit for tailings deposition for set amount (4,000,000t) of tailings; no use of TSF for tailings storage; update on hydrogeological study for Springer Pit; volume preserved for subaqueous disposal of PAG material in closure scenario; benefits would include generation of capital, maintain employment of crews, retain skilled labour, regional economic benefits, source of waste rock for remediation and any required future TSF work. Proposed application ~December, 2014.
November 13, 2014	SCIB/WLIB (Implementation Committee Meeting)	**Discussion was held around the CMDRC presentation and MPMC fielded questions as to the proposed operations. Updates provided on the breach repair and site remediation work.** Ref: Meeting Minutes (Joint Implementation Committee) - 2014 11 13	Proposed timing for the submission of the permit amendment application was confirmed late November. Question about requirement to lift Abatement Order for permitting of restricted operations; follow-up confirmed that this would not be necessary as were independent. Confirmation that this was standalone from the TSF Breach Repair work. Confirmation that the proposed tonnage would be half a year production, allowing for subaqueous disposal of existing and generated PAG stockpiles, making this a 'stand-alone' proposal not dependent on future use of the TSF. Confirmation that the application would not involve deposition of tailings into the TSF. Discussion that start-up timing would be dependent on permitting timelines; there would not be a requirement for large infrastructure changes. Discussion of benefits including continued employment, rock sourcing for TSF buttressing and cash flow. Discussion of presenting material to Chief and Council.
December 8, 2014	SCIB/WLIB (Chief and Council Meeting)	**MPMC presented on the Mine Operations and Mill Restart Operations with use of the Springer Pit for deposition. Updates provided on the breach repair and site remediation work.** Ref: 2014 12 06 – Mount Polley Update	Discussion about the longer the mine remains closed, the more difficult it becomes to reopen. Proposed timing for the submission of the permit amendment application was mid-December. Confirmation that the proposed tonnage would be half a year production. Discussion that start-up timing would be dependent on permitting timelines, but proposed for February 2015. Discussion of benefits including continued employment, rock sourcing for TSF buttressing and cash flow. Confirmation of intent to return to full operations in future, and mine out tailings deposited in Springer Pit, but current plan does not require mining out, sufficient space is available for permanent deposition in a closure scenario.
December 9, 2014	Public Liaison Committee (Meeting)	**MPMC presented on the Mine Operations and Mill Restart Operations with use of the Springer**	Proposed timing for the submission of the permit amendment application was pre-Christmas (December 2014). Confirmation that the proposed tonnage would be half a year production. Discussion

		Pit for deposition. Updates also provided on site monitoring, reclamation planning, breach repair and site remediation work. Ref: PLC Meeting Minutes December 9 2014	that start-up timing would be dependent on permitting timelines, but proposed for February 2015. Discussion of benefits including continued employment, rock sourcing for TSF buttressing and cash flow. Confirmation that the 2015 Freshet Embankment Construction was for freshet management and not for use in restricted operations proposed. Confirmation that if future operations involved use of the TSF, tailings from Springer Pit could be re-handled into TSF.
December 11, 2014	SCIB/WLIB (Implementation Committee Meeting)	**Updates on permit application timelines and review process. Updates provided on site monitoring, reclamation planning, breach repair and site remediation work.** Ref: Meeting Minutes (Joint Implementation Committee) - 2014 12 11	Confirmed that a draft of the permit amendment application would be provided to First Nations the following week, with formal submission to the MEM and the MoE prior to Christmas (December, 2014).
December 19, 2015	SCIB/WLIB (E-mail)	**Provided copy of the draft permit amendment to FN for review prior to submission to the MEM and the MoE.** Ref: Draft Restricted Operating Permit (Springer Pit Tailings Deposition)	Provided to SCIB/WLIB for comment in advance of formal submission to MEM/MoE projected for January 1, 2015.
January 13, 2015	MEM – Diane Howe (E-mail)	**Formal submission of Permit Amendment Application** Ref: M-200 Permit Amendment Application Return to Restricted Operations	None.
January 13, 2015	MoE – Hubert Bunce (E-mail)	**Formal submission of Permit Amendment Application** Ref: PE11678 Permit Amendment Application Return to Restricted Operations	None.
January 13, 2015	SCIB/WLIB (E-mail)	**Formal submission of Permit Amendment Application** Ref: Draft Restricted Operating Permit (Springer Pit Tailings Deposition)	None.
January 13, 2015	Public (Community Update Bulletin)	**Update on formal submission of permit amendment application for temporary restart of mining operations. Updates on ongoing site remediation, breach repair and**	Update on formal submission of application for return to restricted operations and start of associated review, projected start-up date of 2015Q2.

		monitoring results. Ref: 2015 01 13 - Community Update Bulletin	
January 22, 2015	SCIB/WLIB (Implementation Committee Meeting)	**Review of the permit application document and discussion of permitting timelines. Updates provided on site monitoring, reclamation planning, breach repair and site remediation work.** Ref: Meeting Minutes (Implementation Committee) - 2015 01 22	Confirmation that presentation to Chief and Council of SCIB/WLIB had been completed. SCIB/WLIB confirmed that the draft copies permit amendment applications had been received previously. Confirmation of formal submission of permit amendment application and start of review of the document by regulators, with screening comments having been received. Discussion around comments from the MEM/MoE regarding water management, and indication that water management application was parallel to the return to restricted operations, but impact of return to restricted operations was not material for requirements for water management solutions on site (i.e., need for water management with or without return to restricted operations and confirmation that MPMC continues work on this front). SCIB/WLIB discussion of anticipated ~three (3) month review period from discussion with regulators. Confirmation from MPMC that they were awaiting direction from the MEM/MoE on referral to the RMDRC. Discussion of target operational date of April 1, 2015; with current staff levels not being sustainable without a return to restricted operations.
January 27, 2015	CMDRC (E-mail)	**Update to CMDRC Membership from Chair that formal application for a return to restricted operations had been submitted and screening level review is ongoing.** Ref: 2015 01 27 - RMDRC Referral Update	Confirmation that screening level review had been completed by the MEM, the MoE and SCIB/WLIB. Confirmation of ongoing discussions between the MEM/MoE of information requirements to refer to CMDRC.
February 22, 2015	Public (Community Update Bulletin)	**Update on review of formal submission of permit amendment application for temporary restart of mining operations. Updates on ongoing site remediation, breach repair and monitoring results.** Ref: 2015 02 22 - Community Update Bulletin	Update that formal application for return to restricted operations is under review by regulators and that consultation with First Nations is ongoing.
February 22, 2015	Public (Likely Community Informal Drop-In Meeting)	**Update on site activities and studies, including temporary restricted**	Opportunity provided for the community to hear Q&A on topics of their choosing; to follow up on specific questions arising from the

		operations status.	public meeting; opportunity to express concerns on a one-on-one basis for those uncomfortable with speaking in public meetings, and same as above (i.e. update that formal application for return to restricted operations is under review by regulators and that consultation with First Nations is ongoing).
February 23, 2015	Public (Horsefly Community Meeting)	**Update on site activities and studies, including temporary restricted operations status.**	First public meeting in Horsefly. Overview of MPMC response to spill, site activities and studies. Updates as above (i.e. update that formal application for return to restricted operations is under review by regulators and that consultation with First Nations is ongoing).
February 26, 2015	SCIB/WLIB (Implementation Committee Meeting)	**Update on permit application document permitting. Updates provided on site monitoring, reclamation planning, breach repair and site remediation work.** Ref: Meeting Minutes (Implementation Committee) – 2015 02 26	Confirmation that formal re-submission of the application was scheduled for early March, 2015. Confirmation that the restricted operations application would be decoupled from water management permitting, but a support document outlining water management planning would be submitted in parallel to the restricted operations outline water management plan approach. Confirmation from MPMC that they are moving forward with water management planning in anticipation of permitting as soon as appropriate level of study is complete. Confirmation that the return to restricted operations does not have a material effect on water management requirements and timelines, and so MPMC was moving ahead on both fronts in parallel.
February 26, 2015	CMDRC (E-mail)	**Update to CMDRC Membership from Chair that formal application for a return to restricted operations had been submitted and is being reviewed. Updates also provided on the Mount Polley Independent Engineering Review Panel.** Ref: 2015 02 26 – MEM Letter to RMDRC	Confirmation of initial submission of permit amendment application on January 13, 2015. Confirmation that application had undergone screening by the MEM/MoE, and that further information had been requested, this information being required for initiation of the formal application review period.
March 9, 2015	SCIB/WLIB Technical Working Group (meeting)	**Discussion of Mount Polley Mine Restricted Restart and Water Management Planning.** Ref: 2015 03 09 – CMDRC Meeting Summary Notes	Review of restricted operations application: does not include long-term mining operations; takes into account Springer Pit hydrogeology, including future storage volume requirements for subaqueous disposal of PAG material; formal re-submission of application planned for March 13, 2015; review and discussion of supporting Water Management Plan document to be submitted at time of application. Request from SCIB/WLIB to be provided liability costing information (provided during re-submission of the permit amendment application, and in Implementation Committee

			meetings). Confirmation that copies of the revised application are to be provided to First Nations for pre-screening at the time of submission to the MEM/MoE (completed March 18, 2015).
March 13, 2015	CMDRC Technical Working Group (meeting)	**Water balance review; discussion of return to restricted operations included in context of water management scenarios.**	Review of water management and Springer Pit filling scenarios, including sensitivity analysis, with and without return to restricted operations. Confirmation that water management (i.e., discharge) is required in short-term regardless of return to restricted operations, and operations is not material to timelines in context of sensitivity analyses.
March 18, 2015	SCIB/WLIB (E-mail)	**Referral of draft permit application submission for pre-screening.** Ref: 2015 03 18 – MEM Circulation for Pre-Screening	MPMC submitted draft of revision 1 to the application to MEM for comment prior to formal submission; this was also provided to SCIB/WLIB for review of the draft.
March 19, 2015	SCIB/WLIB (E-mail)	**Pre-screening comments from First Nations on draft permit application.** Ref: 2015 03 19 - FN Pre-Screening Comments	Confirmation that revised application was improved and addressed issues previously raised. Discussion of importance of closure planning and liability cost estimates moving forward, confirming that these discussions between SCIB/WLIB and MPMC would be independent of the permitting review. Request for future discussion of liability cost estimates (later provided in Implementation Committee meetings).
March 20, 2015	MEM/MoE – Diane Howe/Hubert Bunce (E-mail)	**Formal submission of Permit Amendment Application** Ref: 2015 03 20 - Permit Submission E-mail (MoE and MEM)	None.
March 20, 2015	SCIB/WLIB (E-mail)	**Formal re-submission of Permit Amendment Application** Ref: 2015 03 20 - Permit Submission E-mail (First Nations)	None.
March 24, 2015	Likely Representative (E-mail)	**Formal re-submission of Permit Amendment Application** Ref: 2015 03 24 – Permit Submission E-mail (Doug Watt – Likely)	None.
March 26, 2015	SCIB/WLIB (Implementation Committee Meeting)	**Update on permit application document permitting. Updates also provided on site work and environmental updates.** Ref: Meeting Minutes (Implementation Committee) - 2015 03 26	Confirmation that formal re-submission of the permit amendment application and water management document was complete, adding that SCIB/WLIB had pre-screened the document prior to formal submission to the MEM and the MoE. Update on anticipated referral to RMDRC on March 31, 2015. SCIB/WLIB comment that the reporting frequency had been good, and was helping in providing timely and valuable information. Confirmation of ongoing public

			meetings in regards to site work, and would include updates on permitting moving forwards.
March 31, 2015	CMDRC (Meeting)	**MPMC presented on the Mine Operations and Mill Restart Operations with use of the Springer Pit for deposition. Updates provided on site water balance, water quality and discharge options, MPMC Independent Engineering Review Panel and Environmental Assessment Office.** Ref: 2015 03 31 - MDRC Meeting Minutes	Review of the revised permit amendment application: 4Mt of tailings over one (1) year of operation; mining is within existing footprint; considerations of impact on future operations and mine management; Springer Pit hydrogeology and groundwater flow; updated reclamation costs included in the application. Confirmation by the MEM/MoE that the application will require a 30-day public comment period. Clarification that a Technical Assessment Report for short-term water discharge will need to be submitted for decision making on return to restricted operations permit amendment. Update provided on review process: RMDRC comments due April 13, 2015; check-in call scheduled for April 9, 2015.
April 1, 2015	Public (Community Update Bulletin)	**Update on review of formal submission of permit amendment application for temporary restart of mining operations. Updates on water management, site monitoring, remediation work, breach repair and MPMC Independent Engineering Review Panel provided.** Ref: 2015 04 01 – Community Update Bulletin	Confirmation of March 20, 2015 formal submission of permit amendment application for return to restricted operations. Confirmation of CMDRC meeting on March 31, 2015. Confirmation of proposed restart operations: 4Mt of throughput; Springer Pit for tailings deposition; benefits including local and regional economy, Company cash flow, retention of skilled employees, increasing employment numbers, continuing opportunities for local businesses and service providers, and sourcing of material for TSF repair work. Review of 30-day public consultation period, comment e-mail addresses and proposed public meeting dates.
April 1, 2015	Public (Likely Community Meeting)	**Update on site activities, including temporary restricted operations status. Informed community of water management activities and need for effluent.** Ref: 2015 04 01 – Community Update Bulletin; Likely Community Meeting - April 1 2015	Update on site activities. Update on turbidity. Overview of Hazeltine Creek rehabilitation work. Presented community with the water balance situation and the need to discharge. Presented BAT and discharge options being selected.
April 3, 2015	Public (Williams Lake Tribune Newspaper)	**Environmental Protection Notice and Public Notice.** Ref: 2015 04 03 – Tribune Publication of EPN & Public Notice	Public posting of Environmental Protection Notice (EPN) and Public Notice.
April 7, 2015	Public (Likely Library)	**Drop-off of permit amendment application for public review.** Ref: 2015 04 07 – Confirmation of Drop-off in Likely Library	Hard copy of application and water management plan made available.

April 8, 2015	Public (Williams Lake Library)	**Drop-off of permit amendment application for public review.** Ref: 2015 04 08 – Confirmation of Drop-off in Williams Lake Library	Hard copy of application and water management plan made available.
April 9, 2015	CMDRC (Meeting)	**Update call during which RMDRC review groups reviewed preliminary screening comments to be formalized for April 13, 2015, and received clarifications from MPMC on information in application.**	Responses to RMDRC comments included in the RMDRC Comment Tracking Document.
April 9, 2015	Public (BC Gazette Newspaper)	**EPN and Public Notice.** Ref: 2015 04 09 - BC Gazette Publication of EPN & Public Notice	Public posting of EPN and Public Notice.
April 9, 2015	Public (Website)	**Permit Amendment Application Documents and EPN and Public Notice made available on Imperial Metals Website.** Ref: http://www.imperialmetals.com/s/Mt_Polley_Update.asp?ReportID=671045	Electronic copies of application and water management plan made available (had already been made available by the MEM/MoE).
April 10, 2015	SCIB/WLIB (E-mail)	**Notification from SCIB/WLIB that their RMDRC comment period had been extended to April 24, 2015 by the MEM/MoE.** 2015 04 10 - Comment Extension Update (SCIB&WLIB)	Comments from SCIB/WLIB provided April 24, 2015, and responses included in the RMDRC Comment Tracking Document.
April 13, 2015	Likely Representative (Letter)	**Comments provided on the Application through RMDRC process.** Ref: 2015 04 13 - Likely Comments	Comments addressed in RMDRC Comment Tracking Document.
April 22, 2015	Public (Williams Lake Community Meeting)	**Update on site activities, including temporary restricted operations status. Overview of water balance/management and effluent discharge needs.**	Update on site activities. Update on turbidity. Overview of Hazeltine Creek rehabilitation work. Presented community with the water balance situation and the need to discharge. Presented best-available-technology (BAT) and discharge options being selected
April 23, 2015	SCIB/WLIB (FN Community Meeting).	**Update on site activities, including temporary restricted operations status. Overview of water balance/management and effluent discharge needs.**	Update on site activities. Update on turbidity. Overview of Hazeltine Creek rehabilitation work. Presented community with the water balance situation and the need to discharge. Presented BAT and discharge options being selected

April 23, 2015	SCIB/WLIB (Implementation Committee Meeting)	**Update on permit application document permitting. Updates also provided on site work, breach repair, remediation work and environmental updates.** Ref: Meeting Minutes (Implementation Committee) – 2015 04 23	Updated that RMDRC comments had been received and that a formal response document was being drafted for circulation by the end of the month. SCIB/WLIB indicated that their comment period had been extended to April 24, 2015. Discussion around comments received; most being about water management and few comments on the activities as included in the restricted operation activities.
April 24, 2015	SCIB/WLIB (Letter)	**Comments provided on the Application through RMDRC process.** Ref: 2015 04 24 - First Nations Comments (from MEM)	Comments addressed in RMDRC Comment Tracking Document.
April 24, 2015	Public (Likely Informal Drop-In)	**Update on site activities, including temporary restricted operations status.**	Opportunity provided for the community to hear Q&A on topics of their choosing; to follow up on specific questions arising from the public meeting; opportunity to express concerns on a one-on-one basis for those uncomfortable with speaking in public meetings
April 25, 2015	Public (Quesnel Gold Show)	**Update on site activities, including temporary restricted operations status.**	Opportunity for informal discussion about ongoing work at Mount Polley as well as the proposed return to restricted operations.
April 28, 2015	CMDRC (Meeting)	**Update on RMDRC Response Comments provided. Updates on the MPMC IERP and water management planning and discharge options also provided.** Ref: RMDRC Meeting - 2015 04 28 [FINAL]	Review of responses included in the RMDRC Comment Tracking Document.
April 30, 2015	RMDRC Comment Tracking	**RMDRC Comment Tracking Document provided to the MEM and the MoE.** Ref: 2015 04 30 - Permit Rev1 - RMDRC Comment	Includes responses to First Nations and Likely comments received through the RMDRC process in addition to those received from other regulators.
May 8, 2015	CMDRC Technical Working Group (meeting)	**Discussion of return to restricted operations included in context of water management scenarios.** Ref: 2015 05 08 - Options Analysis Summary	Review of water discharge and treatment options in context of site water management.
May 11, 2015	Likely Representative (Letter)	**Follow-up comments provided on the Application through RMDRC process.** Ref: 2015 05 11 - Likely Comments #2	Comments addressed in RMDRC Comment Tracking Document Update.
May 13, 2015	Public (Likely Community Meeting)	**Update on site activities, including temporary restricted operations status.**	In addition to an update on site activities, this meeting was, as previously promised, another opportunity for the Likely community

		Overview of effluent management discussions and selection of short term discharge options. Ref: Likely Community Meeting Invitation	to hear about and ask questions about the effluent discharge. Clarification was provided (also by H. Bunce of MoE) that the effluent amendment would not be part of the restricted operations amendment and that the public would still have an opportunity to comment.
May 21, 2015	RMDRC Comment Tracking Update	**RMDRC Comment Tracking Document update provided to the MEM and the MoE.** Ref: 2015 05 21 - Permit Rev1 - RMDRC Comment	Includes responses to First Nations and Likely comments received through the RMDRC process in addition to those received from other regulators.
May 28, 2015	SCIB/WLIB (Implementation Committee Meeting)	**Update on permit application document permitting. Updates also provided on site work and environmental work.** Ref: Meeting Minutes (Implementation Committee) - 2015 05 28	Updated that the RMDRC Comment Tracking Document Update had been submitted, including SCIB/WLIB comments submitted April 24, 2015. Updates were provided on reclamation and liability costing, including the process for calculation, the submission process for these calculations, and the bonding process. Updates were given on the current review of the liability costing based on current site water management, existing site conditions and proposed works in the restricted operations. Updates were also provided on the ore stockpile geochemical characterization program. Discussion was held about a possible future SCIB/WLIB community meeting including information on the liability costing process.
May 29, 2015	Public Consultation Report	**Public Consultation Report provided to the MEM and the MoE.** Ref: Public Consultation Report (Mount Polley)	Response to comments received during the 30-day public comment period.

First Nations and Public Information Sharing Summary

From:	Mount Polley Mining Corporation
Contact:	Luke Moger
	Phone: (250) 790-2215 ext.2113
	E-mail: LMoger@MountPolley.com
Permit:	Application for an Authorization to Discharge Waste
Permit Relevance:	Permit Amendment Application (*Mines Act*, M-200; *Environmental Management Act*, 11678); Authorization and Notification (*Fisheries Act*; *Water Act*); Approval (*Lands Act*)
Last Update to Sharing Summary:	October 5, 2015
Updated By:	Luke Moger
All Parties Referred To:	Soda Creek Indian Band (Xatśūll)
	Williams Lake Indian Band (T'exelc)
	Public

Note

This *Information Sharing Summary* is provided in support of the permit amendment applications under the *Mines Act* (M-200) and *Environmental Management Act* (PE11678) as part of the proposed Short Term Effluent Discharge. Consultation with First Nations and public on the proposed works pre-dates the applications, and has been formally summarized and submitted to regulators in documents prior to this *Information Sharing Summary*, notably in the: *RMDRC Comment Tracking* documents for the return to restricted operations (April 30, 2015; May 21, 2015 update); the *Information Sharing Summary* document for the return to restricted operations (June 12, 2015); and, the *Screening Comment Tracking* document for the Short Term Effluent Discharge Technical Assessment Report (August 7, 2015).

Since the TSF Breach occurring in August 2014, Mount Polley Mining Corporation (MPMC) has shared information and updates on permit amendment applications within general updates on site activities, in addition to permit application-specific settings.

Date of Contact	Contacted Parties (Medium)	Action (Reference Document)	Comments
August 14, 2014	SCIB/WLIB (Implementation Committee Meeting)	**Discussion was held around site water management and existing discharge of water from Polley Lake into Hazeltine Creek and Quesnel Lake.** Ref: 2014 08 14 - Meeting Minutes (Joint Implementation Committee)	None.
September 17, 2014	SCIB/WLIB (Implementation Committee Meeting)	**Updates were provided on site water management and existing discharge of water from Polley Lake into Hazeltine Creek and Quesnel Lake.** Ref: 2014 09 17 - Meeting Minutes (Joint Implementation Committee)	None.
October 7, 2014	SCIB/WLIB (Implementation Committee Meeting)	**Updates were provided on site water management and rehabilitation work in Hazeltine Creek.** Ref: 2014 10 07 - Meeting Minutes (Joint Implementation Committee)	Discussion around requirement of constructing new channel for Hazeltine Creek.
November 5, 2014	Cariboo Mine Development Review Committee (CMDRC) (Meeting)	**MPMC presented on site water management and the use of the Polley Lake Weir for discharge down Hazeltine Creek and to Quesnel Lake.** Ref: 2014 11 05 – CMDRC Minutes	None.
November 13, 2014	SCIB/WLIB (Implementation Committee Meeting)	**Discussion was held around the site water management, construction of the Polley Lake Weir, rehabilitation work in Hazeltine Creek.** Ref: 2014 11 13 - Meeting Minutes (Joint Implementation Committee)	Agreed on benefits of constructing the Polley Lake Weir to regulate flows in Hazeltine Creek during reconstruction and freshet seasons. Discussion of presenting material to Chief and Council.
December 5, 2014	Cariboo Mine Development Review Committee (CMDRC) (Meeting)	**MPMC presented on site water management and the design of the 2015 Freshet Embankment.** Ref: 2014 12 05 – CMDRC Minutes	None.
December 8, 2014	SCIB/WLIB (Chief and Council Meeting)	**MPMC presented on the Mine Operations and Mill Restart Operations with use of the Springer Pit for deposition; also introduced options being considered for handling of site water surplus.**	None.

		Ref: 2014 12 06 – Mount Polley Update	
December 9, 2014	Public Liaison Committee (Meeting)	**MPMC presented on site water management and investigation into options for managing site water surplus.** Ref: 2014 12 09 - PLC Meeting Minutes	None.
December 11, 2014	SCIB/WLIB (Implementation Committee Meeting)	**Updates on water management (Springer Pit filling), and water management timelines was provided.** Ref: 2014 12 11 - Meeting Minutes (Joint Implementation Committee)	Confirmed Springer Pit critical fill elevations (1030m/1050m) and discussion of water management timelines and permitting starting with the TSF Freshet Embankment construction and Return to Restricted Operations and continuing into permitting in 2015Q1.
January 22, 2015	SCIB/WLIB (Breach Technical Working Group Meeting)	**Review of the remediation work around Polley Lake (including weir), down Hazeltine Creek and in Quesnel Lake. Update on water monitoring.** Ref: 2015 01 22 - Meeting Minutes (Breach Technical Working Group)	None.
January 22, 2015	SCIB/WLIB (Implementation Committee Meeting)	**Review of the return to restricted operations permit application document and discussion of site water management, and regulatory requirement for development of water management submissions.** Ref: 2015 01 22 - Meeting Minutes (Implementation Committee)	MPMC confirmed that regulators had requested submission of water management planning documents in support of return to restricted operations despite the established lack of material effect on water management timelines for the site. Discussion of treatment and/or management of surplus mine water with potential discharge to Quesnel Lake. MPMC confirmed that further direction was required from regulators on their request prior to formal submission of documents/applications by MPMC.
February 26, 2015	SCIB/WLIB (Breach Technical Working Group Meeting)	**Review of the remediation work around Polley Lake (including weir), down Hazeltine Creek and in Quesnel Lake. Update on water monitoring.** Ref: 2015 02 26 - Meeting Minutes (Breach Technical Working Group)	Updates on site water management systems provided.
February 26, 2015	SCIB/WLIB (Implementation Committee Meeting)	**Update on permit application document permitting (return to restricted operations) and water management planning.** Ref: 2015 02 26 - Meeting Minutes (Implementation Committee)	Confirmation that the restricted operations application would be decoupled from water management permitting, but a support document outlining water management planning would be submitted in parallel to the restricted operations outline water management plan approach.
March 9, 2015	SCIB/WLIB Technical Working Group (meeting)	**Discussion of Mount Polley Mine Water Management Planning**	Review of water management planning for short- and long-term scenarios and update on current site conditions.

		Ref: 2015 03 09 - CMDRC Meeting Summary Notes	
March 13, 2015	CMDRC Technical Working Group (meeting)	**Water balance review; discussion of return to restricted operations included in context of water management scenarios.**	None.
March 18, 2015	Public (Informational Handout)	**Informational handout (also posted online) provided giving details on site water management and requirements to discharge from site.** Ref: 2015 03 18 - MP Mine Water Planning Update	None.
March 26, 2015	SCIB/WLIB (Breach Technical Working Group Meeting)	**Review of the remediation work around Polley Lake (including weir), down Hazeltine Creek and in Quesnel Lake. Update on water monitoring.** Ref: 2015 03 26 - Meeting Minutes (Breach Technical Working Group)	Updates on site water management systems provided.
March 26, 2015	SCIB/WLIB (Implementation Committee Meeting)	**Update on water management planning.** Ref: 2015 03 26 - Meeting Minutes (Implementation Committee)	Confirmation that formal submission of the water management document was complete, adding that SCIB/WLIB had pre-screened the document prior to submission to the MEM and the MoE. Update on referral to RMDRC on March 31, 2015.
March 31, 2015	CMDRC (Meeting)	**Update on the site water balance, water quality and discharge options (Quesnel Lake and Quesnel River); use of Hazeltine Creek as non-fish bearing, long term water management option investigation is ongoing.** Ref: 2015 03 31 - CMDRC Minutes	Update on review process: RMDRC comments due April 13, 2015; check-in call scheduled for April 9, 2015; clarification that TAR for short-term water discharge will need to be submitted for decision making on permit. Review of the permit document and water management plan document.
April 1, 2015	Public (Community Update Bulletin)	**Update to site water management, including the requirement to discharge surplus mine contact water from site.** Ref: 2015 04 01 - Community Update Bulletin	None.
April 1, 2015	Likely (Meeting)	**Informal drop-in session discussing water management and requirement to discharge.**	None.
April 1, 2015	Public (Horsefly Community Meeting)	**Update on site operations, including water management and requirement**	None.

		to discharge.	
April 9, 2015	CMDRC (Meeting)	**Update call during which RMDRC reviewed discharge permit application, long-term water management and associated permitting.** Ref: 2015 04 09 - CMDRC Minutes	None.
April 9, 2015	Public (Website)	**Approach for Long-Term Water Management Plan made publicly available.** Ref: http://www.imperialmetals.com/i/mt-polley/2015-03-20_MPM_LTWMPD.pdf	None.
April 22, 2015	Public (Williams Lake Community Meeting)	**Update on site activities, including site water management requirements.**	None.
April 23, 2015	SCIB/WLIB (FN Community Meeting).	**Update on site activities, including water management.**	None.
April 23, 2015	SCIB/WLIB (Implementation Committee Meeting)	**Update on remediation work, water monitoring and site water management.** Ref: 2015 04 23 - Meeting Minutes (Implementation Committee)	Update on work in Hazeltine Creek, on-site water management and water quality. Updates were provided on the potential diffuser into Quesnel Lake.
April 24, 2015	Public (Likely Informal Drop-In)	**Update on site activities, including site water management.**	None.
April 25, 2015	Public (Quesnel Gold Show)	**Update on site activities, including site water management.**	None.
April 28, 2015	CMDRC (Meeting)	**Update on water management planning, including options analysis, water quality, treatment options, TAR and discharge applications update.** Ref: 2015 04 28 - RMDRC Meeting [FINAL]	None.
April 30, 2015	RMDRC Comment Tracking	**RMDRC Comment Tracking Document for return to restricted operations provided to the MEM and the MoE.** Ref: 2015 05 01 - CMDRC Update E-mail	Includes responses to First Nations and Likely comments received through the RMDRC process; document was transmitted by the MEM to the RMDRC on May 1, 2015.
May 8, 2015	CMDRC Technical Working Group	**Discussion of return to restricted**	Decision to move forward with discharge of treated mine contact

	(meeting)	**operations included in context of water management scenarios.** Ref: 2015 05 08 – Options Analysis Summary	water to Hazeltine Creek with open-ditch flow and diffuser in Quesnel Lake.
May 13, 2015	Public (Community Update Bulletin)	**Information on site water management and requirements to discharge water from site.** Ref: 2015 04 01 - Community Update Bulletin	None.
May 13, 2015	Public (Likely Community Meeting)	**Update on site activities, including site water management.** Ref: 2015 05 13 - Likely Meeting Invitation	None.
May 21, 2015	RMDRC Comment Tracking Update	**RMDRC Comment Tracking Document update for return to restricted operations provided to the MEM and the MoE.** Ref: 2015 05 22 - CMDRC Update E-mail	Includes responses to First Nations and Likely comments received through the RMDRC process; document was transmitted by the MEM to the RMDRC on May 22, 2015.
May 28, 2015	SCIB/WLIB (Breach Technical Working Group Meeting)	**Review of the remediation work around Polley Lake (including weir), down Hazeltine Creek and in Quesnel Lake. Update on water monitoring.** Ref: 2015 05 28 - Meeting Minutes (Breach Technical Working Group)	Updates on permitting for Quesnel Lake/Quesnel River option application for site discharge; confirmation that formal applications would follow the submission of the Technical Assessment Report.
May 28, 2015	SCIB/WLIB (Implementation Committee Meeting)	**Update on site water management and proposed discharge work.** Ref: 2015 05 28 - Meeting Minutes (Implementation Committee)	Update to costing of water management components.
May 29, 2015	Public Consultation Report	**Public Consultation Report for the return to restricted operations provided to the MEM and the MoE.** Ref: 2015 05 29 - Public Consultation Report (Return to Restricted Operations)	None.
May 29, 2015	Technical Assessment Report	**Technical Assessment Report (TAR) for Short Term Effluent Discharge submitted to the MoE.** Ref: 2015 05 29 - Golder Submission of TAR	None.

May 29, 2015	MEM (E-mail)	**MEM referral to DFO, SCIB/WLIB, Likely of TAR.** Ref: 2015 05 29 - MEM Referral of TAR.	Comments required by June 15, 2015.
June 12, 2015	Public (Site Tour)	**Site your for public members, including site water management components and discussion of requirements to discharge water.**	None.
June 22, 2015	Environment Canada	**EC comments received on TAR received.** Ref: 2015 06 22 – EC Comments on TAR	Addressed in Screening Comment Response Document provided August 7, 2015.
July 6, 2015	MEM (E-mail)	**MEM provision of Lorax (MEM), Lorax (MoE), DFO, EC and SCIB/WLIB TAR Screening comments.** Ref: 2015 07 06 - TAR Screening Comments	Addressed in Screening Comment Response Document provided August 7, 2015.
July 16, 2015	MPMC (E-mail)	**Short Term Effluent Discharge Permit Application made to the MoE.** Ref: 2015 07 16 - MoE Application	None.
July 16, 2015	CMDRC (E-mail)	**Short Term Effluent Discharge Permit Application referred to the CMDRC** Ref: 2015 07 16 - CMDRC Update E-mail	Comments required by August 7, 2015
July 22, 2015	Public (Williams Lake Tribune Newspaper)	**Environmental Protection Notice.** Ref: 2015 07 22 - WL Tribune EPN Publication	None.
July 23, 2015	Public (BC Gazette)	**Environmental Protection Notice.** Ref: 2015 07 23 - BC Gazette EPN Publication	None.
July 23, 2015	MPMC (Online)	**Crown Land Tenure Application Submitted.**	None.
July 23, 2015	MPMC (Online)	**Section 9 Application Submitted.**	None.
July 24, 2015	MoE (E-mail)	**MoE provided screening comments on TAR.** Ref: 2015 07 24 - MoE TAR Comments	Addressed in Screening Comment Response Document provided August 7, 2015.
July 29, 2015	SCIB/WLIB (Breach Technical	**Review of the remediation work**	None.

	Working Group Meeting)	**around Polley Lake (including weir), down Hazeltine Creek and in Quesnel Lake. Update on water monitoring.** Ref: 2015 07 29 - Meeting Minutes (Breach Technical Working Group)	
July 29, 2015	SCIB/WLIB (Implementation Committee Meeting)	**Update on site water management and proposed discharge work.** Ref: 2015 07 29 - Meeting Minutes (Implementation Committee)	Presentation on short term effluent discharge planning and completed works. Overview of permitting requirements and submissions for short term effluent discharge.
August 3, 2015	City of Williams Lake (Letter)	**Letter of support received from City of Williams Lake (Mayor).** Ref: 2015 08 03 - Imperial Metals Water Discharge (City of Williams Lake)	Supports short-term water discharge applied for by MPMC.
August 6, 2015	CMDRC (Meeting)	**Update on the site water management, short-term water discharge, permitting and TAR pre-screening comments.** Ref: 2015 08 06 – CMDRC Minutes	Reminder that MDRC review comments due by August 7, 2015. Confirmation that anticipated duration is ~2 years. Discussion of monitoring plans; intensive to start and then adjusted based on results.
August 7, 2015	MPMC (E-mail)	**TAR Screening Comment Response Document provided to MOE.** Ref: 2015 08 07 – TAR Screening Comment Response to MoE	Addresses comments from MoE (and Lorax), MEM (and Lorax), DFO, EC and WLIB/SCIB (and consultants).
August 7, 2015	MEM (E-mail)	**Comments from Likely, First Nations Consultant and Interior Health Association Received from MEM.** Ref: 2015 08 07 – TAR Comments Received	MEM indicated to be included in update to Comment Tracking Document.
August 8, 2015	MPMC (E-mail)	**MMER Notification completed.**	
August 10, 2015	CMDRC (E-mail)	**Provision of MPMC TAR Comment Tracking Document to CMDRC.** Ref: 2016 08 10 – CMDRC Update E-mail	Request for follow up comments by August 28, 2015.
August 21, 2015	MEM (E-mail)	**MEM Request for information on bench-test results of Water Treatment Plant.** Ref: 2015 08 21 - MEM Request for Information	Information provided September 14, 2015.
August 24, 2015	Public Meeting	**Public held for Likely to review short term effluent discharge.**	None.

		Ref: 2015 08 24 - Likely Public Meeting Minutes	
August 25, 2015	SCIB/WLIB Meeting	**Meeting held for SCIB/WLIB at Xatśūll Heritage Site to review short term effluent discharge.**	None.
August 26, 2015	DFO (E-mail)	**Request for Project Review made to DFO** Ref: 2015 08 06 – MPMC Request for Project Review Submission	None.
August 26, 2015	Public Meeting	**Public held for Williams Lake to review short term effluent discharge.** Ref: 2016 08 26 - Williams Lake Public Meeting Minutes	None.
August 27, 2015	Public Meeting	**Public held for Quesnel to review short term effluent discharge.**	None.
September 2, 2015	MEM (E-mail)	**Comments from Likely that had previously not been forwarded provided to MPMC.** Ref: 2015 09 02 – TAR Comments Received	MEM indicated to be included in update to Comment Tracking Document.
September 4, 2015	MEM (E-mail)	**MEM Confirmation that Likely, BOA, IHA and anticipated Lorax Comments to be included in next Comment Response Document.** Ref: 2015 09 04 - MEM Confirmation of Screening Comment Response	Lorax comments not received at this time.
September 10, 2015	CMDRC (E-mail)	**Draft copies of Short Term Discharge Monitoring Plan provided to CMDRC.** Ref: 2015 09 10 – CMDRC Update E-mail	None.
September 14, 2015	MPMC (E-mail)	**Update on water treatment bench-testing provided to the MEM and MoE.** Ref: 2015 09 14 - TAR Comment Follow-up Veolia Bench Testing Update	None.
September 17, 2015	Cariboo Regional District (Letter)	**Letter of support received from Chair of CRD.** Ref: 2015 09 17 - Polley temp permit support (CRD Letter)	Support Application; states understanding that most members of the public are in favour.

September 17, 2015	PLC (Meeting)	**Update on remediation work (Polley Lake Weir to Quesnel Lake), site water management and short-term water management.** Ref: 2015 09 17 - PLC Meeting [Final]	None.
September 23, 2015	SCIB/WLIB (Breach Technical Working Group Meeting)	**Review of the remediation work around Polley Lake (including weir), down Hazeltine Creek and in Quesnel Lake. Update on water monitoring.** Ref: 2015 09 23 - Meeting Minutes (Breach Technical Working Group)	Updated that Hazeltine Creek flow would be diverted into Edney Creek during installation of diffuser for water discharge.
September 23, 2015	SCIB/WLIB (Implementation Committee Meeting)	**Update on site water management, water quality monitoring and proposed discharge work.** Ref: 2015 09 23 - Meeting Minutes (Implementation Committee)	Presentation on short term effluent discharge planning and completed works. Overview of permitting submissions for short term effluent discharge.
September 25, 2015	MPMC (E-mail)	**MEM M-200 Permit Application Submitted.** Ref: 2015 09 25 - MPMC Submission of M-200 Permit Application	None.
September 29, 2015	CMDRC (E-mail)	**Additional comments provided to the MoE/MEM by MPMC, including bench-scale testing on water treatment plant provided to CMDRC.** Ref: 2015 09 29 - CMDRC Update E-mail	None.

Implementation Committee Minutes

MINUTES JANUARY 22ND, 2013 9:30AM MPMC – 2ND FLOOR BOARDROOM

MEETING CALLED BY	SCIB/WLIB/MPMC Implementation Committee
TYPE OF MEETING	Monthly
FACILITATOR	MPMC
NOTE TAKER	Luke Moger (MPMC – Project Engineer)
ATTENDEES	Jacinda Mack (SCIB – Natural Resource Manager), Chus Sam (SCIB – Natural Resources Referral Coordinator), Donna Dickson (SCIB – Executive Assistant), Byron Louie (WLIB - Community Economic Developer Worker), Aaron Higginbottom (WLIB – Natural Resource Manager), Willie Sellars (WLIB – Special Projects Coordinator), Tim Fisch (MPMC – General Manager), Paul Allan (MPMC - Human Resources Manager), Luke Moger (MPMC – Project Engineer), Stan Wycotte (MPMC - Environmental Technician)

Agenda topics

ENVIRONMENTAL UPDATE TIM FISCH

DISCUSSION	Colleen Hughes (MPMC – Environmental Technologist), Katie McMahen (MPMC - Environmental Technologist), and Gabriel Holmes (MPMC – Environmental Technologist) came to the meeting to present an environmental update for Mount Polley Mine. **CH** updated the group that MPMC had received a mine effluent permit amendment in November stating that MPMC have satisfied all the requirements to obtain a discharge permit at the Mine. **CH** added that as part of this amendment, there was a Communication Plan drafted which outlines dissemination of information relating to environmental issues (a copy was circulated for review). **CH** asked about reporting threshold for the Communication Plan in regards to the definition of environmental emergencies. **CH** also asked if there were any comments on the format of the Quarterly Report submitted to SCIB/WLIB. **AH** responded that WLIB hasn't reviewed the document as of yet. **CH** clarified that the Quarterly Report format is up for review, but the Annual Report format is legislated by government, and so is not able to be changed. **BL** asked if there was an executive summary for the Annual Report. **TF** confirmed that there was an executive summary provided for Imperial Metals, and so this could be provided. **CH** added that digital copies of the Annual Report were also included in the hard copies circulated to WLIB/SCIB. **CH** (referring to the Communication Plan) suggested that incidents reportable to PEP (Provincial Emergency Program) could be a good threshold for communication of "Significant Events". **CH** requested that the Communication Plan be reviewed next week in order to provide feedback for the January 31st submission to MOE. **TF** suggested that this would be a good goal, but added that amendments may be made after this point. **CH** then reviewed the 2013 Surface and Groundwater Monitoring Plan, circulating a copy of a map and summary table. **JM** asked about dustfall monitoring stations on the map (lack thereof). **CH** identified these locations on the map where they were not labeled, adding that these were not a permit requirement, but initiated by MPMC and the data submitted to MOE. **JM** asked if there were any close to Quesnel Lake. **CH** identified Site W7 (Hazeltine Creek) as being the closest. **AH** asked how the statistics on the collection were. **CH**

responded that they were good, there was one outlier data point above regulation since inception two years ago, and the rest of the data met recommended levels. **AH** asked if the dust collected were separated into categories. **CH** responded that data is only separated into "combustible" and "non-combustible" categories. **JM** asked if there was any metal analysis completed on the samples. **CH** responded that the sample size was so small that none was able to be completed (so little dust). **CH** updated that MOE plans to come to site in February to do some dust sampling work on the snow (to measure influence on the lakes.) **AH** asked if any additional sample sites had been recommended by MOE. **CH** responded that none had been formerly requested, but there was initial talk of the possibility of monitoring on Polley Lake. **KM** then told the group that the detailed Five-year Reclamation and Closure Plan had been submitted in 2013, providing electronic copies to SCIB/WLIB. **AH** asked when the last plan was completed. **KM** said that the last report had been submitted in 2004, and that this update had been postponed to this point to match up with the permitted 2016 Mount Polley Mine closure. **BL** asked if the report discussed research completed to date. **KM** confirmed that the report summarizes all work completed to date. **AH** asked about the approval process for the Plan. **KM** responded that the document had just been sent to MEM for review, and that this submission to WLIB/SCIB would also be complimented by review at the next Public Liaison meeting. **LM** added that this was an ideal time to review the plan, as with the proposed new 2023 mine plan (and permit amendment application to follow in 2013) there would be a new Reclamation and Closure Plan required accordingly; adding that feedback on this document at this point would be greatly appreciated as to include recommendations in the next plan. **GH** presented a draft work outline for review (one as a template, and one for a Willow Planting job). **GH** added that there were lots of small projects for "crews" to be completed over the next few years, involving planting and seeding, and so feedback on this submission template would be appreciated. **AH** asked if any of the previously reclaimed areas had become part of the new mine design area, or that any areas had been disturbed to date. **LM** responded that no areas to date had been re-disturbed, adding that the only potential area for disturbance would be a small re-sloped area on the old Northeast Zone Dump (not planned, but potential on account of the future size of the Southeast Rock Dump Site). **BL** inquired as to quality assurance on the seeding. **GH** responded that MPMC has "checkers" come out to verify planting rates and methodology. **BL** asked if bank stability was of concern. **GH** responded that in the MPMC mine permit, this is a requirement under the construction of dumps, but some of the road systems are steeper, adding that smaller projects will need review (i.e. sumps), but that all major sites are re-sloped. **BL** asked if there was a concern between the timing of reclamation and re-sloping. **LM** responded that this wasn't really a concern as the 2:1 sloping requirement is generous for long-term stability, and that all areas are verified by consultants for stability prior to construction and permitting. **TF** requested that **GH** review 2013 reclamation projects. **GH** responded that these weren't fully flushed out yet. **KM** added that the Reclamation and Closure Plan outlined the proposed work to be completed. **GH** clarified that there was some willow and shrub planting, but not too much tree planting – there is also some hydroseeding. **AH** asked if cedar planting was planned. **GH** answered that in 2014 there are approximately 20,000 mixed trees. **CS** asked about native species in the mix. **GH** answered that there were lots of native species included - NEZ dump test plots had been successful, and were used to refine the reclamation prescriptions moving forwards; adding that future results will continue to shape final mixes.

GH suggested that the Reclamation and Closure Plan summarized this well. **GH** suggested that having an employee pool
to draw from for small projects as they arise would be helpful. **WS** asked if these workers would require orientation. **TF**
responded that they would require driver's license and on-site drug tests, but that orientation could be completed in town.
JM commented that the tree mix was good, but suggested that a mix of different plants to encourage biodiversity would
be good. **SW** suggested that in reviewing the plan, if comments could also be made on reclamation areas and timing as
well as seed mixes that would be helpful, suggesting that the sooner feedback was provided, the earlier it can be
incorporated into research and planning. **SW** suggested that having large wall maps of the Mount Polley flyover may be
helpful for the Bands for discussion and reference purposes. **SW** added that his draft Quarterly report was done and would
be submitted shortly. **BL** asked if prescriptions were broken down for specific reclamation areas, or if they were based on
area "type" (i.e. rock dump/pit). **SW** said that he would follow up. **JM** asked if **SW** could come out to the quarterly natural
resource meetings held in SCIB, adding that visibility of his position is very important. **SW** agreed that this was a good
idea, and added that he should be able to do this for the April meeting. **CS** asked if there were reports on the background
GW quality provided to the Bands. **TF** responded that this is included in the Annual Reports, and that MPMC can provide
additional electronic copies if required. **SW** was requested to provide an employment summary to the bands.
CONCLUSIONS The MPMC Environmental Department provided an update on environmental topics at MPMC and draft
copies of several documents were provided for comment and review.

ACTION ITEMS	PERSON RESPONSIBLE	DEADLINE
Review the draft Communication Plan and comment	**SCIB/WLIB**	**ASAP**
Review and comment on format of MPMC and **SW** Quarterly Reports	**SCIB/WLIB**	**Mar. 12, 2013**
Review and comment on Closure Plan	**SCIB/WLIB**	**April, 2013**
Review and comment on draft work template	**SCIB/WLIB**	**Mar. 12, 2013**
Provide additional hard-copies of large maps to **SCIB/WLIB**	**SW**	**ASAP**
Disseminate Quarterly update report	**SW**	**Complete**
Follow-up on site-specific area prescriptions	**SW**	**Mar. 12, 2013**
Provide information on dates and topics for Quarterly Natural Resource Meeting for **SW** to address	**JM**	**Mar. 12, 2013**
Re-circulate digital copies of Annual Reports to SCIB/WLIB	**LM**	**ASAP**
Provide request for work experience summary from **SW**	**WLIB**	**ASAP**
Provide work experience summary to SCIB/WLIB	**SW**	**Pending Request**

OUSTANDING PA ITEMS TIM FISCH

DISCUSSION **TF** reviewed the reference in the PA to annual report on employment at MPMC to the Bands. **JM**
requested that the report include members that were employed prior to the PA as well. **BL** requested that statistics be
provided on the number of First Nations members as a total of employees as well as broken down specifically by SCIB
and WLIB. **SW** reminded the group that it is important that potential future employees respect the union progression for

job placement: that individuals, even if they have experience, start as truck drivers and work their way up in Mine Operations. **TF** agreed that this was a good point; need to understand that we cannot circumvent MPMC's agreement with the Union in job placements. **TF** suggested that education initiatives should be brought back into discussion under the framework of the PA. **JM** asked about training allowances. **BL** furthered that with the relationships with BCAMTA and KTec there were distinct differences: KTec trains with guaranteed job placement at the end of training, while BCAMTA provides training for identified skill gaps in the workforce to increase the potential of employment. **BL** suggested that if a better communication path was opened with such groups, they could take on the training load (their expertise) rather than it being primarily organized through the respective Bands. **WS** added that there was talk of the new HR Coordinator also taking on some of this work. **TF** agreed that he thought this could become part of the job. **SW** asked about potential positions at other Imperial Metals sites. **TF** responded that it is hard to comment on, as Red Chris Mine has its own agreements to abide by, but thought there may be opportunities with the exploration group. **TF** furthered that staff positions are the more probable due to availability to move between sites as compared to the Union employees. **WS** asked about summer student positions referenced in the PA – was this for on-site work at Mount Polley or sponsorship. **TF** clarified that the existing mechanism on site gives hiring preference to employee family members, but FN could definitely be given consideration after this. **WS** asked about potential for job shadowing and placement competitions. **TF** suggested that MPMC could give a presentation on the WorkShare program already in place to SCIB/WLIB to discuss these existing opportunities. **SW** commented that he would like to see SCIB/WLIB members in more technical positions, and that getting the required education and training would be important for this. **ALL** agreed. **WS** asked for background information on the WorkShare program as **TF** had described. **TF** suggested that in terms of business contracts, **GH** had previously covered planting, but summarized that sandblasting will be moving ahead in the Spring (conversation is ongoing with maintenance department and WLIB), and that as soon as information was complete on the hydroseeding, this would be circulated.

CONCLUSIONS	A review of all items in the PA that had not been addressed in regularity at previous IC meetings were reviewed.

ACTION ITEMS	**PERSON RESPONSIBLE**	**DEADLINE**
Provide Annual Employment Report to SCIB/WLIB	**PA**	ASAP
Provide background information on WorkShare Program to **WS**	**PA**	ASAP
Provide information on hydroseeding to Bands as it becomes available	**GH**	As Available

UPDATES TIM FISCH

DISCUSSION	**TF** confirmed that the TKLUOS had been received and submitted to government, and **JM** furthered that hard copies of the document were still to be printed. **TF** requested that **AH** follow-up with the consultant retained for the Slum Gulch Archaeological Report, as no progress had been made in MPMC calling and e-mailing them. **TF** provided hard copies of the revised Exploration Notice of Work to the Bands, and confirmed that it had also been provided to MEM for review. **TF** confirmed that Imperial Metals is willing to sponsor a member from each of SCIB and WLIB to attend "Round-

Up" in Vancouver, if each band could provide an invoice of costs then Imperial Metals can reimburse. **TF** requested
information on the golf tournament proposal from **BL**. **WS** mentioned that Robin Hood had discussed a ball hockey
tournament with him, and would follow up and provide details to **TF**. **BL** suggested that he will talk to Heather MacKenzie
and get an update on the Education Funds received by WLIB in 2012 and how they were allocated. **TF** suggested that
SCIB and MPMC create a media release on the PA rather than a signing ceremony; **JM** agreed this would be good.

CONCLUSIONS	Updates were provided on outstanding items from previous meetings and correspondence.
Responsibilities were assigned for providing these updates.	

ACTION ITEMS	PERSON RESPONSIBLE	DEADLINE
Follow up on Slum Gulch Arch Study	**AH**	ASAP
Review and comment on Exploration NOW	**SCIB/WLIB**	ASAP
Provide cost information for Round-Up to be reimbursed	**SCIB/WLIB**	As Incurred
Provide information on Golf Tournament Proposal to **TF**	**BL**	ASAP
Provide information on Ball Hockey Tournament to **TF**	**WS**	As Received
Provide update on Education Funds to **TF**	**BL**	Mar. 12, 2013

Implementation Committee Minutes

MINUTES MARCH 12TH, 2013 10:00AM SCIB - BOARDROOM

MEETING CALLED BY	SCIB/WLIB/MPMC Implementation Committee
TYPE OF MEETING	Monthly
FACILITATOR	SCIB
NOTE TAKER	Luke Moger (MPMC – Project Engineer)
ATTENDEES	Jacinda Mack (SCIB – Natural Resource Manager), Thomas Phillips (SCIB – Economic Development Coordinator), Chus Sam (SCIB – Natural Resources Referral Coordinator), Donna Dickson (SCIB – Executive Assistant), Byron Louie (WLIB - Community Economic Developer Worker), Tim Fisch (MPMC – General Manager), Paul Allan (MPMC - Human Resources Manager), Art Frye (MPMC – Mine Operations Manager), Luke Moger (MPMC – Project Engineer), Stan Wycotte (MPMC - Environmental Technician), Katie McMahen (MPMC – Environmental Technologist)

Excerpt from Meeting Minutes:

ENVIRONMENTAL UPDATE KATIE MCMAHEN

DISCUSSION	**KM** asked for feedback on documentation that had been previously circulated. **CS** stated that he had issues opening the 2012 Annual Reclamation and Closure plan, and asked **KM** to re-send a copy. **BL** stated that he had opened the package, and that the WLIB was reviewing the document. **KM** updated the group that the Communication Plan provided had been submitted to the government for review, but was still in draft form, and so comments could still be incorporated. **KM** clarified that this document was separate from the respective Participation Agreement communication verbiage, and was part of government-required environmental reporting. **KM** asked for feedback on the work request template that Gabriel Holmes (MPMC – Environmental Technician) had provided previously. **JM** commented that she liked the format, and **BL** concurred. **AF** added that this template will be further refined with the hiring of the HR Position. **SW** asked for feedback on his quarterly reports provided to SCIB/WLIB. **BL** responded that he would like to see some continuity between reports from all environmental technicians across different projects that submit reports to WLIB/SCIB, adding that Aaron Higginbottom (WLIB – Natural Resource Manager) was following up on this. **AF** added that **SW** had been trying to follow up with Aaron on this already, and was working towards this – furthering that MPMC reporting was different from some of the other reports given that it is for an operating mine (vs. exploration projects). **JM** requested that a comment column be added to the reports to track follow-up on items. **CS** commented that some of the report items were vague (i.e. cleanup of buckets and pails). **AF** suggested that some of the day-to-day items should be removed from the reports as they are simply housekeeping items for MPMC. **CS** noticed that selenium levels were above Provincial Levels in the last report. **KM** responded that MPMC had been aware of an upward trend and had been tracking the levels, and that now the levels fluctuate above and below the guidelines; MPMC is in the process of an intensive sampling project to source the issue. **AF** furthered that MPMC thinks that the levels are not a result of surficial disturbance, but most probably a function of loading the ground with new construction and groundwater being "forced up". MPMC has installed two new

groundwater monitoring wells to provide further information on this water. **AF** added that MPMC is planning on using a new potable water well in this area for domestic water, which may draw down the water table and have a remediating effect, and if not, MPMC will create a ditching and sump system to collect the water to be captured on site; summarizing that MPMC is definitely working on this issue. **CS** requested further information on the numbers related to the issue. **AF** suggested that MPMC could provide graphs detailing all the information collected to date. **KM** asked for feedback on the 2013 MPMC Annual Sampling Plans for surface water and Groundwater that Colleen Hughes (Environmental Technologist) presented at the last meeting and clarified that the government is now asking industry (MPMC) to provide more input into the development of the sampling requirements rather than imposing them. **BL** asked how involved government is with the document, suggesting that this seemed fairly short-sighted on their behalf for gaps and regulating. **AF** stated that MPMC is acting under an old government-imposed guideline, but that with the development completed on site since its issue, some sample sites are now buried and new ones required. **AF** furthered that MPMC is pro-active in this sense; often suggesting going above-and-beyond regulation and requirements. **KM** commented that the major changes in the 2013 Plan submitted are removing outdated sites and adding new sites accordingly. **BL** asked as to how often the government were on site. **AF** responded that they come out and audit sampling and do site visits; adding that MPMC has also voluntarily had AMEC (3rd party consultant) out to site to complete a full hydrogeological study identify any gaps in current groundwater monitoring program. **BL** clarified that he was more curious as a measure of holding government accountable. **BL** added that realizing that the governing bodies were stretched, he feels it is important that they are still being held accountable for how they are regulating; noting that often government isn't forthcoming with information as to regulations so there is a need to find out what is happening. **KM** updated the group on the 2013 Biological Monitoring and Lake Sampling Plan. **KM** was meeting with MOE on that day, adding that it is not finalized yet, but will be circulated for review when MOE is satisfied with the document. **KM** stated that the key items from the Plan were that the depths at which sampling the lakes was being increased; there is now a formal wildlife monitoring program; and receiving-environment biological monitoring in required annually on account of the discharge permit. **KM** introduced to the group the 2013 Annual Discharge Plan as part of the newly approved discharge permit at MPMC. **KM** informed the group that MPMC now have to submit an annual discharge plan each year outlining water source, volume and quality – using historic site-specific data in combination with year-specific data to model and predict the parameters. **KM** was meeting with MOE that day, and would provide SCIB/WLIB with the Plan for review once MOE is satisfied with the document. **CS** stated that he understood that there were restrictions on the times in which MPMC could discharge (starting in April) and asked for the volume of water planned to be discharged. **KM** responded that the total volume of water suggested was 84,000m^3. **AF** clarified that discharge flow-rates were regulated as a percentage of the receiving creek flow. **CS** asked as to how often the system was monitored. **AF** responded that all monitoring is real-time. **JM** stated that she was very interested in the system itself. **AF** suggested that a tour on-site would be a great idea, and **KM** adding that there is lots of detail in the document as well – **TF** summarized that May (the next IC Meeting) would be a good month to do this. **JM** asked if there were Coho in Edney Creek, adding that timing of water release with spawning was important. **AF** responded that the time

of concern with the system would correspond the high-flow in the creek, as discharge flow is regulated to 35% of Hazeltine Creek flow. **CS** asked if there was planned discharge during spawning time (October-November). **KM** is to follow up. **AF** noted that it was important to remember the amount of water that MPMC has to collect versus that which it is planning to release, suggesting that putting "water back into the system" is a good thing. **CS** asked if there were brown trout in any of the water systems around Mount Polley. **TF** suggested that he didn't believe there were. **CS** added that it would be nice to know that there is no discharge during fish-spawning times. **BL** asked for the timing of effects of the discharge system on fish and creek water quality. **AF** responded that the discharge permit is designed on science in order to prevent any negative effects on the creek quality of life. **CS** suggested that a baseline on fish tissues would be of interest to track this. **AF** responded that it would be, but this presents a challenge now given that the mine has been in place since 1995 and background information is not always available.**KM** added that background information on selenium in fish was collected in 2011 and again in 2012. **AF** observed that Selenium is now a "hot-topic" in environmental discussion on account of issues in the coal mining in the Kootneys, but the past ten years has been where it has really come to the forefront; this has spurred a lot of research and activity in industry with water management and treatment (i.e. the ABR). **TP** asked as to how the ABR was operating. **AF** updated that we have signed onto Phase II of the project with UBC, and have drained, made some modifications and re-filled it in the past year; adding that the plan is to change water sources in 2013 as the existing set-up is treating water that is already suitable for discharge, and so MPMC would like to test the system on water of lesser quality. **TP** asked if there were still plans for another pond. **AF** responded that with the new mine life, the new Tailings Storage Facility footprint has grown and has condemned some planned locations; confirming that the intent was still to continue the research. **KM** suggested that she could go through the selenium section of the 2012 (and 2011) Annual Reports at the next IC meeting if so desired. **CS** asked if there was potential to treat selenium if the source is identified. **KM** responded that nano-filtration is the only known technology currently, **AF** adding that the ABR (Anaerobic Biological Reactor) is also an effective means as it mimics natural swamps and captures sulphate and selenium within. **SW** presented two examples of site-specific reclamation plans that had been discussed at the last IC meeting. **JM** asked if these were adaptive plans. **KM** responded that these are detailed in the five-year plan for reclamation, but are always adapted with ongoing research and site observation. **SW** added that there are examples that have been provided by Gabriel Holmes, and outlay an itemized list of site-specific work that has been completed and is planned for future work. **CS** asked if reclaimed areas were sampled. **KM** confirmed that they were sampled for vegetation metal uptake and details are in the Annual Reclamation Reports, adding that there is also good baseline data available. **CS** asked if there was any difference between soil depth and success rates. **KM** responded that she was not sure on this specifically. **SW** stated that these plans were general ideas for now, and added that he would like to see some feedback on them. **JM** asked if there was a staged process for reclamation. **KM** responded that there is; adding as an example that cedar may be incorporated later to a site, when wetter conditions have developed.
CONCLUSIONS The MPMC Environmental Department provided an update on environmental topics at MPMC and draft copies of several documents were provided for comment and review.

ACTION ITEMS	PERSON RESPONSIBLE	DEADLINE
Provide **CS** with new copy of the Reclamation and Closure Plan	**KM**	Complete
Provide comments on the Communication Plan to **CH**	**JM/BL**	ASAP
Provide feedback on Quarterly Report Format to **SW**	**AH**	ASAP
Remove "housekeeping items" from Quarterly Reports	**SW/KM**	As Applicable
Provide graphical information on Selenium spikes to **CS**	**KM**	Next Quarterly Report
Provide WLIB/SCIB with copy of the Biological Monitoring and Lake Sampling Plan	**KM**	Attached to Minutes
Provide feedback on discharge during Coho spawn to **CS**	**KM**	ASAP
Follow up on presence of brown trout in the discharge watershed	**KM**	ASAP
Review 2011/2012 Annual Reports Selenium Section at next meeting	**KM**	Next Meeting
Provide Feedback on the Annual Discharge Plan to **KM**	**JM/BL**	April 1, 2013

TOWARDS SUSTAINABLE MINING LUKE MOGER

DISCUSSION	**LM** updated the group on the Towards Sustainable Mining (TSM) initiative that MPMC is following as part of membership of the Mining Association of Canada (MAC). **LM** stated that MPMC is currently in its first year of internal submission against the guidelines of the program, and that the mine is rated very highly in safety, tailings management and Aboriginal and Community of Interest categories, and is working towards a three-year plan to improve success against all of the TSM Protocols (Greenhouse Gas and Energy Management, Biodiversity and Crisis Management). **LM** provided two documents for review under the TSM requirements (Tailings Management Policy and Tailings Management Framework) and suggested that the IC Meetings would provide a good forum for presentation of other materials and documentation as they arise. **LM** suggested that he would present on the TSM submission at the next IC meeting at Mount Polley as the submission will be completed at that time (March 29th deadline).
CONCLUSIONS	**LM** provided an update on the MPMC submission of their TSM work, adding that this is the first year that MPMC has been involved, and that there is a three-year-plan in place to continuously improve against the guidelines.

ACTION ITEMS	PERSON RESPONSIBLE	DEADLINE
Electronic copies of Tailings Policy and Framework to WLIB/SCIB	**LM**	ASAP
Review and comment on Tailings Policy	**WLIB/SCIB**	Next Meeting
Review and comment on Tailings Management Framework	**WLIB/SCIB**	Next Meeting
Present on 2013 MPMC TSM Submission	**LM**	Next Meeting

DISCUSSION	**SW** provided an update on the willow planting on site that was being completed as a job opportunity under the PA; stating that Carmen was currently on site completing some work. **BL** suggested that these kind of jobs could be co-ordinate better under the new HR Coordinator. **BL** updated that Willie Sellars (WLIB – Special Projects Coordinator) had been in contact with MPMC on regards to sandblasting and hydroseeding and would continue to do so. **AF** added that there may be an opportunity to do some work with slash burning and asked as to capacity; suggesting MPMC would complete a work request and outline. **JM** updated that there are some printing errors with the TKLUOS, but they were to be corrected in the coming week. **TF** updated that the Slum Gulch report had been received and forwarded to government, adding that he would forward a copy to SCIB. **TF** updated that there was no news on the Exploration NOW, **BL** confirming that he had also not heard anything. **BL** updated that Willie Sellars completed a report on the Mining Round-up that he would forward to **TF**. **BL** updated that golf tournament information had been forward to **TF** for review. **AF** provided a package on Dome Mountain Ore and asked for SCIB and WLIB to review it, adding that an electronic copy would be provided. **CS** suggested that it may be a good idea to develop Terms of Reference, adding that he would complete a draft for review; **ALL** agreed that this was a good idea.
CONCLUSIONS	Updates on the various projects and housekeeping items under the PA were addressed and provided by all.

ACTION ITEMS	PERSON RESPONSIBLE	DEADLINE
Continue to update Willie Sellars on Hydroseeding and Sandblasting	**SW**	As Arising
Complete work outline request for slash burning	**SW**	ASAP
Forward a copy of the Slum Gulch Report to SCIB	**TF**	ASAP
Forward a copy of Willie Sellars Round-Up report to TF	**BL**	ASAP
Review Golf Tournament information	**TF**	April 1, 2013
Provide electronic copy of Dome Mountain Ore Application	**AF**	ASAP
Develop draft Terms of Reference for Review	**CS**	April 1, 2013

Mount Polley Mining Corporation Public Liaison Meeting Minutes
12:00 pm, May 11, 2013
Mount Polley Mine

Attendees

Name	Affiliation
Tim Fisch	General Manager, MPMC
Luke Moger	Project Engineer, MPMC
Colleen Hughes	Environmental Coordinator, MPMC
Katie McMahen	Environmental Technologist, MPMC
Art Frye	Mine Operations Manager, MPMC
Gabriel Holmes	Environmental Technician, MPMC
Harry Jennings	BC FLNRO
Stephanie Huska	BC MOE
Martin Kruus	Cariboo-Chilcotin Conservation Society
Moss Giasson	Montane Environmental (MPMC)
Bee Hooker	Echofar Enterprises
Joan Sorley	Cariboo Regional District
Richard Holmes	Cariboo Envirotech
Wayne Henke	Likely Resident
Sam Albers	UNBC Quesnel River Research Centre
Pierre Stecko	Minnow Environmental (MPMC)
Jacinda Mack	Xatsull First Nations
Claudia Blair	Williams Lake Chamber of Commerce
Karen Roberts	Williams Lake Chamber of Commerce
Norm Zirnhelt	Environmental Quality Consulting Ltd

Minutes

12:15 pm: Colleen Hughes – Welcome and Introduction of MPMC staff

12:16 pm: Tim Fisch – Introduction & Review of Past Year

- 2012 developments
- 2013 planned developments
- Extended life of mine/updated ore reserves
- Underground update
- Community Involvement

12:40 pm: Ryan Brown (Senior Mine Engineer, MPMC) – Mine Life Update

- Review of MPMC site (active pits, dumps, and Tailings Storage Facility).
- Year by year overview of extended mine plan (to 2023).
    - Springer Pit will extend downward from 1000 masl to 750 masl.
    - Mine will operate at 90,000 tonnes per day for the next 4 – 5 years, then will increase the following 3 years, and then decrease to 55 tonnes per day through the rest of the mine life.
- Planned 2013 infrastructure projects to extend mine life (permit amendment pending)
    - TSF Haul Road
    - High Grade Ore Stockpile

    - Expanded Temporary PAG (potentially acid generating) Stockpile.
- Outstanding permits: raising of Tailings Storage Facility, increase scope and length of mining activity.
- Underground operations update.

Q. Martin Kruus: When will the first ore from the underground operation be processed?
A. Ryan Brown: Probably the end of 2013. MPMC has processed approximately 15,000 tonnes already that was encountered when building the tunnel infrastructure.

Q. Sam Albers: When will the PAG rock become acid generating? How does this fit into the long-term mine plan?
A. Ryan Brown: Onset time is used to refer to the period of time it will take PAG rock to begin generating acid. The PAG at MPMC has a predicted onset time of 100 years. Additional testing of site geochemistry is being completed by SRK Consulting to ensure waste rock that will be encountered in the future has the same onset time.
A. Art Frye: Planning to start monitoring the inside of the Temporary PAG Stockpile for oxygen and moisture.

Q. Same Albers: Is rain on the PAG rock a concern?
A. Art Frye: Acid from waste rock is generated from exposure to water and oxygen. SRK Consulting has constructed humidity cells using MPMC waste rock to make models for predicting acid generation on site. Because these cells are stored at an average temperature of 20°C, while the average temperature here is 5°C, when the results of the humidity cells show a 20 year onset period, it is likely that this extrapolates to a lag time of 100 years for the dump.
A. Ryan Brown: All rock has an NP (neutralizing potential) and AP (acid potential). The ratio of AP and NP are a key characteristic in predicting acid rock drainage. MPMC is fortunate because the site does not have large quantities of PAG, and it has a high NP, which means a longer lag time before acid generation begins.

1:05 pm: Moss Giasson – Mount Polley Re-vegetation

- Soil Handling and amendments
- Plant selection - seeding and planting
- Reclamation research – incorporating results into reclamation planning
- Tree growth trials
- Native seed test plots
- Planning for succession

Q. Jacinda Mack: Has MPMC considered using compost or more local sources of nutrifor or other amendments?
A. Colleen Hughes: It is not a closed subject – MPMC is open to discussions on this topic, however it is often difficult to obtain the necessary volumes of amendments such as compost, and to organize transport of materials.

Q. Joan Sorley: Does MPMC plan for climate change when selecting species for reclamation?
A. Moss Giasson: It is challenging to plan in advance, as is it unknown exactly what the site specific effects of climate change will be. MPMC is not currently doing any specific climate change planning; however, species that show success on xeric sites are often selected due to the hot, dry conditions of waste dumps undergoing reclamation.

Q. Claudia Blair: Aren't the Canadian and US governments currently researching changes in vegetation communities due to climate change?
A. Moss GIasson: Yes. One example is in Smithers where vegetation changes are being monitored over time. The Forest and Agriculture Ministries are also carrying out research related to the effects of climate change on pests and diseases.

1:30 pm: Stephanie Huska – MPMC Compliance Report

- The Compliance Report is based on 7 reports/site visits and 3 audit samples.
- MPMC was out of compliance in 3 of the 7 cases:
    - Temperature data was not uploaded into the government EMS system in a quarterly report.
    - Monitoring of groundwater well GW05-01 was suspended without notifying MOE.
    - The Perimeter Seepage Pond breached in April 2012.

Q. Karen Roberts: How long does MPMC have to fix non-compliance issues?
A. Stephanie Huska: It depends on the specifics of the non-compliance issue. MPMC is required to notify MOE of any incidents within 24 hours and stop the source of the problem as soon as possible. Moving forward, a long term plan is to be developed to prevent a re-occurrence.

Q. Wayne Henke: Requested an update on the Hazeltine Creek discharge system.
A. Stephanie Huska: MPMC received their permit in November 2012 and is developing the required monitoring plans for the discharge. Installation of the system is underway.
A. Colleen Hughes: MPMC will have a more accurate idea of the discharge start day when all of the equipment is programmed. MOE and Environment Canada have to complete inspections before MPMC can start discharging.

Q. Sam Albers: Are MOE and Environment Canada in charge of monitoring the system?
A. Luke Moger: MPMC has incorporated real time monitoring, and automatic shut-offs into the system as required by MOE and Environment Canada.
A. Pierre Stecko: Monitoring of the discharge receiving environment is prescribed by the provincial and federal regulators, but is completed by MPMC and reported to the regulators.

1:40 pm: Pierre Stecko – Aquatic Biological Monitoring at MPMC

- Overview of aquatic biological monitoring carried out at MPMC as required by the provincial and federal governments.
- Selenium Monitoring Program:
    - Rationale for implementing the program – understanding selenium uptake through trophic levels (a site specific relationship).
    - Overview of selenium monitoring at MPMC.
    - Review of 2012 selenium study results.

Q. Jacinda Mack: How long has MPMC been doing biological monitoring?
A. Pierre Stecko: Fish data was collected in 1998/1999, and a full biological monitoring program was completed in 2009, with varying levels of selenium monitoring conducted over the last three years.

Q. Wayne Hanke: Doesn't the discharge system flow into Hazeltine Creek?
A. Pierre Stecko: Previously effluent was discharged into Edney Creek (when the mine was temporarily shut down), but the new system discharges into Hazeltine Creek. Routine water quality sampling and the 2009 biological monitoring results show robust benthic communities and healthy rainbow trout.

Q. Jacinda Mack: How will MPMC ensure that the downstream environments in Quesnel Lake are protected?
A. Pierre Stecko: The majority of the monitoring focuses on Hazeltine Creek because this is where effluent concentrations will be the highest. If results show no effects in Hazeltine Creek, this ensures no effects will be observed in the highly diluted environment of Quesnel Lake. Pre-discharge selenium data was also collected in Quesnel Lake in 2012.

Q. Richard Holmes: Is any monitoring completed at the mouth of Hazeltine Creek into Quesnel Lake?
A. Pierre Stecko: Yes – monitoring is completed at the creek mouth depositional site.

Q. Jacinda Mack: Will this monitoring continue?
A. Pierre Stecko: Yes, however the level of monitoring will depend on results of current studies. MPMC is currently working to understand the transfer of selenium in this environment, which is highly site specific. Based on findings, the program will be ratcheted up or down as needed.

Q. Jacinda Mack: Are fish the highest trophic level that will be monitored?
A. Pierre Stecko: Yes, they are the most sensitive species. A very good threshold effect curve has been developed, and monitoring of selenium levels in fish ovaries. This is currently the best available science to evaluate effects on receiving environments.

Q. Richard Holmes: Does this slide indicate that selenium concentrations in Rainbow Trout ovaries are decreasing in Polley Lake now that the Long Ditch has been constructed?
A. Pierre Stecko: It is too early to be confident in the trend, but it will be interesting to review future results in light of the Long Ditch construction.

Q. Richard Holmes: Are the fish monitored always the same age?
A. Pierre Stecko: Yes.

2:10 pm: Luke Moger – Towards Sustainable Mining Overview

- The Mining Association of Canada (MAC) started this initiative in the late 1990's after a number of tailings pond incidents and disasters. What started as a Tailings Management Protocol has now developed into the Towards Sustainable Mining (TSM) Program, which was launched in 2004 and has six protocols: Tailings Management; Energy Use and Greenhouse Gas Emissions Management; Aboriginal and Community Outreach; Crisis Management Planning, Biodiversity Conservation Management; and Safety and Health.
- A social licence to operate is becoming increasingly important in the mining industry. All MAC members are rated on their performance in these areas and results are public on MAC's website.
- MPMC has become a member of MAC and has completed a self-assessment this year.
- Analysis of results will allow for improvements in next year's assessment, in which results will not be public but will be used in MAC aggregate data.
- The following year, MPMC results will be public.
- Mines self-report, but are audited by a certified third party every three years.
- More information: http://www.mining.ca/site/index.php/en/towards-sustainable-mining.html

Q. Sam Albers: Decreasing greenhouse gas emissions is difficult – what kind of strategies do mines use to do this?
A. Luke Moger: A few simple options exist, such as turning of idling vehicles and equipment. More complex solutions include: operator awareness of driving and equipment use that minimizes fuel consumption; analysis of hydro costs, and including greenhouse gas effects into larger economic calculations to determine the viability of various projects.

Q. Richard Holmes: Does MPMC use offsets?
A. Luke Moger: No, MPMC does not.

2:20 pm: Tim Fisch – Closing Remarks

- Thank you to the consultants (Pierre and Moss) for presenting at the meeting.
- Thank you also to the MPMC staff that participated and organized the meeting.
- Thank you to everyone who took time out of their weekends and busy schedules to attend the meeting.

2:25 pm: End of Meeting

2:30 pm – 3:30 pm: Site Tour

- Cariboo Pit/Springer Pit/Future WX Zone Pit/Temporary PAG Stockpile
- SERDS (non-acid generating waste rock dump)
- NEZ Dump reclamation site
- View Point of Tailings Storage Facility, SERDS, and Polley Lake

Implementation Committee Minutes

MINUTES MAY 14TH, 2013 10:00AM MPMC – 3RD FLOOR BOARDROOM

MEETING CALLED BY	SCIB/WLIB/MPMC Implementation Committee
TYPE OF MEETING	Monthly
FACILITATOR	MPMC
NOTE TAKER	Luke Moger (MPMC – Project Engineer)
ATTENDEES	Jacinda Mack (SCIB – Natural Resource Manager), Chus Sam (SCIB – Natural Resources Referral Coordinator), Byron Louie (WLIB - Community Economic Developer Worker), Willie Sellars (WLIB – Special Projects Coordinator); Art Frye (MPMC – Mine Operations Manager), Luke Moger (MPMC – Project Engineer), Stan Wycotte (MPMC - Environmental Technician), Colleen Hughes (MPMC – Environmental Technologist)

Excerpt from Meeting Minutes:

ENVIRONMENTAL UPDATE STAN WYCOTTE

DISCUSSION	**SW** asked if there were any comments on the Quarterly Report. **JM** responded that there were a couple of questions around selenium; "there were a couple of samples above provincial guidelines, what is the protocol". **AF** answered that MPMC is putting a sump under the culvert which feeds the areas in question to collect mine-affected water and feed it to the TSF, adding that it appears that this is groundwater that is presenting as a function of the ground loading associated with the new mine infrastructure. **AF** summarized that as a protocol, MPMC always tries to collect mine-affected water and keep other water reporting to natural waterways. **CH** furthered that the process includes a warning from the database to which the data is uploaded, and so there is always follow-up analysis and re-sampling to ensure that there is not a sample error present – based on the results of the re-sampling further analysis (and if warranted, mitigation) follows. **BL** asked if MPMC had guidelines or triggers outside of the provincial regulations. **CH** responded that this is not the case for freshwater sites, but for the discharge permit to Hazeltine Creek, there will be. **AF** added that MPMC has a good program with lots of sampling and data collection above and beyond the regulated amount of sampling. **CH** furthered that naturally occurring (baseline) levels are important as sometimes these can be above guidelines. **AF** clarified that this was the reason that site-specific data is so important; sometimes existing conditions exceed legislated levels prior to any potential influence from a mine. **CH** related that sometimes certain levels of elements in one system can be devastating in one receiving system and have no effect in another. **CS** asked why this was the case. **AF** commented that this was a function of the availability of the parameter. **CS** asked if fish studies follow as a function of MPMC being over guidelines. **CH** responded that downstream, through the Hazeltine Discharge, fish studies would remain, but clarified that the current exceedances are very minor. **AF** added that in all data, regardless of exceedance, analysis is still completed for trending data to have early awareness of potential issues. **BL** asked if numbers in guidelines at the bottom of the effect threshold. **CH** answered that these levels are very conservative, and offer a lot of protection room below where any effects would be notable; they are set to protect. **JM** asked when the dustfall data collected will be

interpreted. **CH** responded that this would probably not take place until the end of the year as the sample size collected is so small, but added that the government (MOE) is also doing some sampling, but was unsure when this will be completed. **AF** added that the low levels measured to date have been reassuring. **WS** asked if MPMC added calcium to the roads, and asked as to the cost. **AF** responded that this is done annually on the Bootjack access Road, at a cost of about $50,000. **JM** asked as to vegetation uptake on mine areas. **CH** responded that MPMC sampled as if "animal grazing" had occurred; adding that this work is conducted by a third party and the levels need interpreting. **JM** clarified that she was curious as to levels and bioaccumulation. **BL** asked if there was information on barren areas that have naturally started to revegetate. **SW** asked if this was in reference to growth prior to soil application and planting. **BL** responded that he was just curious as to whether the natural revegetation potential of a site was factored into reclamation prioritization. **CH** commented that MPMC generally reclaims areas as soon as they are available to do so, and so there were no barren areas as such encountered to date. **AF** (responding to **JM** question) added that there should be a good body of work on uptake of vegetation prior to full-scale reclamation of Mount Polley through all the progressive reclamation and research. **BL** asked if the invasive plant council visited the site. **CH** responded that she is a Director, and so although there are no visits there is presence on site. **JM** asked if there was a balance between uptake potential and invasive species. **CH** responded that this wasn't an issue to date, but is monitored through existing systems. **JM** asked if there were any issues with livestock on site. **CH** responded that there have been no issues to date, and that there is active grazing on site. **SW** asked for clarification as to whether **BL** previous comments were on "baseline reclamation". **BL** responded that he was more curious as to the metrics for site prioritization for reclamation. **AF** commented that MPMC has a commitment to return land to original viability, and so this is the drive to reclaim; adding that end-land use does pose an interesting topic for discussion. **CH** (referencing Moss Giasson's comments at the Public Liaison Committee Meeting) re-iterated that there is no "right" way to reclaim; each passing year or additional area feeds into refinement and improvement. **SW** suggested that it would be a good idea to get Moss together with the bands to discuss reclamation planning. **AF** confirmed that this had already been discussed with Moss, and would be a good idea to have this coincide with planning for the next permit amendment (and subsequent reclamation and closure plan update). **BL** added that one conversation with MEM had involved cross-mine filling of pits with waste rock to eliminate final pit lakes. **AF** commented that economics of hauling between mines would kill this idea. **BL** stated that QR Mine had done some processing of ore for a mine in Smithers, and so that why the question came up. **WS** asked for a ballpark figure on what the economics would be like. **AF** suggested that the range would be in the billions. **JM** asked about the waste haul road till spill. **AF** responded that this was all part of the Mine Drainage Creek remediation plan. **BL** asked who put the quarterly report together. **SW** responded that he and Katie McMahen (MPMC – Environmental Technologist) had completed this. **BL** commented that this document looked very good. **JM** asked about the till slide. **SW** identified the area on a site map, and provided background to the incident: **SW** had noticed the slide on a tour, and the cause had been from haul road cleaning when the material had broken through a berm and into the creek area. **AF** added that the berm gave way when they were cleaning slop collecting on the haul road, and that there has since been a design for elevating this area such that material is directed away from the creek and

collected in a sump system; clarifying that this system will be constructed at a later date. **CH** furthered that as soon as the release had been identified it was reported to PEP, Provincial regulators and Federal regulators; and that none of the bodies knew what the reporting protocol was for such an incident. **SW** added that there was some misinterpretation with the reporting, which had stated that it was tailings that had been released into the creek – this wasn't the case – it was an error on the part of the PEP representative fielding the call. **CH** asked if the Biological and Water Monitoring Plan was okay. **ALL** responded that this was okay. **CH** asked if the Surface Water/Ground Water report was okay. **ALL** responded that this was okay. **CH** asked if the Reclamation and Closure Plan was okay. **JM** commented that she had talked with Jason Kerley (MOFLNRO) and will have comments back by the end of the month. **BL** commented that WLIB are in the stage of final review, but had no comments so far. **CH** asked about the Communications Plan, clarifying that SCIB comments already made included: any report to MOE would be copied to SCIB/WLIB; Terms of Reference will be outside the scope; MOE may be included in IC Meetings if discussion would warrant their presence. **WS** responded that WLIB was okay with these items. **CH** asked about the Annual Discharge Plan. **JM** responded that SCIB will provide comments after completing the tour of the structure planned for that afternoon. **WS** asked for the volume of water to be release and the effects on the creek. **CH** responded that this was all contained within the report, and that all water quality guidelines were set to have no effect on creek healthiness, adding that the system monitoring was all fail-safed in real time. **SW** added that MPMC samples quality weekly, and there is also real sampling built into the system. **SW** asked if questions at previous IC Meetings regarding Coho had been answered. **JM** asked if the samples were still ongoing, and asked if Edney Creek and the mouth of Quesnel were monitoring sites. **CH** responded that there is annual testing and three-year EEM. **WS** commented that the last Quarterly report was not in the Boo Maga. **SW** added that he hoped that the quarterly report could provide community information to prevent double-up of presentation materials. **WS** asked if **SWs** title and name of the mine could be added to his report. **JM** asked if a brief intro to **SW** could be included. **BL** requested that band ties also be included. **JM** requested a copy of **SW** job description as to have clarity and not step over his bounds in their requests. **SW** suggested that each party of the IC should have a key contact member to focus transfer of information between the three parties. **AF** suggested that a job progression would be more appropriate than a job description. **BL** agreed that perhaps an overview would be more effective. **JM** commented that SCIB would like to have more visibility and presence in the community as to the Participation Agreement, and agreed with **SW** that Terms of Reference would be a useful tool to expedite the exchange of information between the three parties, and would demonstrate accountability to communities and Council. **SW** responded that he would be more than willing to come out and discuss his position and experiences, but was not comfortable answering technical questions at this point. **JM** confirmed that any such presentation would be controlled to ensure that this was the case. **BL** furthered that the request for the presentation was more for transparency with the position and relationship building with the Bands; adding that **SW** represents First Nations interest at Mount Polley, and his comments would be greatly appreciated. **SW** asked what the Bands would like to see in terms of hours of exposure. **JM** responded that a quarterly update would be ideal.
CONCLUSIONS	The Quarterly Report was discussed, along with housekeeping on documents previously circulated by

MPMC. An incident on a release of till was discussed, as well as **SWs** visibility among the bands.		
ACTION ITEMS	**PERSON RESPONSIBLE**	**DEADLINE**
Provide final comments on Reclamation and Closure Plan to MPMC	**JM/BL**	June 15, 2013
Provide final comments on Annual Discharge Plan	**JM/BL**	June 15, 2013
Include Title and Mine, Introduction and Band Ties into Report	**SW**	Next Report
Provide **SW** job description to SCIB/WLIB	**SW/AF**	ASAP

TOWARDS SUSTAINABLE MINING LUKE MOGER

DISCUSSION	**LM** updated the group on the Towards Sustainable Mining (TSM) initiative that MPMC is following as part of membership of the Mining Association of Canada (MAC). **LM** stated that MPMC is currently in its first year of internal submission against the guidelines of the program, and that the mine is rated very highly in safety, tailings management and Aboriginal and Community of Interest categories, and is working towards a three-year plan to improve success against all of the TSM Protocols (Greenhouse Gas and Energy Management, Biodiversity and Crisis Management). **LM** reviewed the submission and three-year plan in detail as well as giving an overview of how the TSM program is formally structured, providing a hard copy handout. **LM** reviewed the online training associated with the TSM Initiative and **JM** asked if it would be possible for SCIB/WLIB to get access to the training. **LM** responded that he would talk to the Mining Association of Canada about this, and also suggested that anyone interested should refer to the website for details.
CONCLUSIONS	**LM** provided an update on the MPMC submission of their TSM work, detailing the TSM Initiative as well as reviewing MPMC first year submission and three-year plan.

ACTION ITEMS	**PERSON RESPONSIBLE**	**DEADLINE**
Get Logins for the MAC TSM website for SCIB/WLIB	**LM**	ASAP

Mount Polley Mining Corporation

IMPERIAL METALS CORPORATION

WLIB Elders Tour of Mount Polley Mine – August 7, 2013

Tour Summary

On August 7, 2013, Mount Polley Mine Corporation (MPMC) hosted a group of Elders and interested individuals from the Williams Lake Indian Band (WLIB) on a tour of reclamation sites at Mount Polley mine. The objectives of this site visit were to: introduce the site; review reclamation implemented to date; and discuss future reclamation plans - specifically how MPMC might integrate planting of species of interest to WLIB into closure planning. The tour and discussions will help MPMC refine the plant list for reclamation research purposes.

The tour and group discussion was a great success. The tour included the North Bell Dump and North East Dump reclamation areas and review of the basic processes of reclamation. Additionally, "next steps" for planning of reclamation and end land use were discussed.

The round table introductions and conversation were positive and allowed for the WLIB Elders to share information, experiences and anecdotes about gathering in the area, specifically the importance of traditional plant medicine and food sources.

Participating Williams Lake Indian Band Members:

Roberta Gilbert
Anna Gilbert
Amy Sandy
Jack Wycotte
Violet Alphonse
JoAnne Moiese
Virginia Gilbert
Joan Meshue
Millie Emile
Nancy Sandy

Participating Mount Polley Employees:

Colleen Hughes, Environmental Coordinator
Katie McMahen, Environmental Technologist
Art Frye, Mine Operations Manager
Luke Moger, Project Engineer
Gabriel Holmes, Environmental Technician

Discussions and Actions

1. Dust

   There was discussion regarding dust (visually observed on site) and the effects on vegetation and on workers - of interest were dust monitoring and dust suppression.
   - The mine monitors dust as required by permits, and dust suppression is conducted on site through the applicable months
   - Question about dust effects on workers should be directed to Paul Allen (Human Resources Manager)

2. Culture Camp

   There was discussion around holding a joint (MPMC/WLIB) cultural camp near the mine site
   - JoAnne Moiese and Colleen Hughes will work together to develop a culture camp in 2014
   - MPMC employees who are First Nations could be invited to speak at the camp
   - WLIB Elders could present different medicine and food gathering and preparation techniques

3. Youth Tours

   There was a discussion around planning MPMC tours for First Nations youth nearing graduation.
   - JoAnne to contact Paul Allen at MPMC regarding this tour.

4. Reclamation

   There was discussion around plant species used by WLIB members and appropriateness to incorporation in reclamation planning at the mine site.
   - Amy Sandy reviewed some of her research and agreed to send Colleen a list of plants that she would like to see planted on site
   - A book about traditional plants and medicines was thought to be nearing publication, and MPMC requested a copy when available
   - In open discussion, the following plant list was put forwarded by WLIB as being of interest for use in reclamation on site:

Balsam Fir	Chamomile
Paper birch	Blueberry (low, mid, and high bush)
Cedar	Common Juniper
Kinnikinnick	mosses
Soapberry (dry berry)	Devil's Club
Yarrow	Mullen

Next Steps

MPMC will be developing an updated reclamation and closure plan to be submitted in 2014. This plan will be developed with consideration of all the topics discussed on this tour and any future tours with the WLIB. MPMC greatly appreciates the participation of the band members in reclamation planning.

Mount Polley Mining Corporation Public Liaison Meeting Minutes
17:30 pm, November 6, 2013
Big Lake Community Centre

Attendees

Name	Affiliation
Dale Reimer	General Manager, MPMC
Art Frye	Mine Operations Manager, MPMC
Ryan Brown	Senior Mine Engineer, MPMC
Luke Moger	Project Engineer, MPMC
Colleen Hughes	Environmental Coordinator, MPMC
Gabriel Holmes	Environmental Technician, MPMC
Gavin Stephen	Environmental Co-op Student, MPMC
Douglas Hill	BC FLNRO
Harry Jennings	BC FLNRO
Dan Bings	BC MOE
Jennifer McConnachie	BC MEM
Richard Holmes	Cariboo Envirotech
Marianne Woods	Big Lake Community Association
Venta Rutkauskas	Likely Resident
Norm Zirnhelt	BC Lake Stewardship Society
Jenny Howell	Cariboo Conservation Society
Sam Albers	UNBC Quesnel River Research Centre

Minutes

17:30: Art Frye – Welcome, Introduction to Dale Reimer, MPMC General Manager
- Round table introduction to all in attendance

17:40: Dale Reimer – Introduction & Review of Year to Date
- 2013 Mine production update
- 369 Full-time employees, 20 temporary employees
- Review of safety statistics year to date

17:50: Norm Zirnhelt – Lake Stewardship Society and LakeKeepers Workshop Overview

- Overview of the mandate of the Lake Stewardship Society
- Outline of the LakeKeepers Workshop agenda
- MPMC will be sponsoring a workshop in the Spring of 2014
-

Q: Harry Jennings - are there local lake stewardship groups
A: Norm – yes, there are a large number of groups in the Cariboo
Q: Sam Albers - what are the objectives for the data collection done by the stewardship groups?
A: Norm – a minimum 3 years of data is collected, the data is submitted and included in a report. These reports are available on the Lake Stewardship website http://www.bclss.org/

18:05: Ryan Brown (Senior Mine Engineer, MPMC) – Mine Update
- Review of MPMC site (active pits, dumps, and Tailings Storage Facility)
- Update on 2013 infrastructure projects to
    - TSF Haul Road
    - Bootjack Creek crossing

- PAG dump extension
- West ditch
- Reclamation sites and irrigation
- Evolution of the West Ditch project

18:20: Gabriel Holmes – 2013 Reclamation Update

- Target areas and activities for 2013 included North Bell Dump, East Rock Dump and Roadsides
- Productive soils through direct placement or amendments (Biosolids)
- Long term reclamation objectives

Q: Jennifer McConnachie – where do the biosolids come from?
A: Gabriel Holmes – Annacis Island, Metro Vancouver
Q: Richard Holmes: it appears that there is not any course woody debris (CWD) on the reclamation. Would that not benefit your reclamation?
A: Gabriel Holmes: yes and we are working to use more CWD as it becomes available. One of the challenges is having the equipment to move and replace it. Also, though it is difficult to see in this photo, there is CWD on the North Bell.

18:35: Luke Moger – Hazeltine Creek Discharge System Update

- System was commissioned on September 23rd at a rate of 2 m3/hour
- After testing the operation of the system the discharge rate was increased to approximately 48 m3/day – remaining under the MMER trigger
- Review of the design and construction of the system
- Plan to increase discharge rate in 2014 under existing permit and trigger MMER

18:45: Colleen Hughes – Environmental Department Update

- Update on monitoring completed as per PE-11678 and M200
- Update on 2013 projects
  - Cardboard, paper, and florescent lamp recycling
  - Water management project monitoring
  - Reclamation Planning – meeting and tour with WLIB Elders
  - Cover for ABR
  - Wildlife Observations

Q: Sam Albers – can you explain the kind of fail-safe mechanisms in place?
A: Luke Moger – the system is designed to shut down if any real-time reading is in excess of required levels, or if an operator turns it off; the system first shutting off flow to the creek from the final discharge tank and then working its way backwards and shutting down the feeding flows – once the flow to the creek is shut off, the water flows into the containment pond in the old till borrow

19:00: Luke Moger – Water Management

- MPMC has progressed from operating at a water deficit, through neutral, and is now holding a surplus of water within the Tailings Storage Facility (TSF)
- Previous ability to store water in exhausted pits and TSF, but now mining pits out, and water in TSF will reach point of geotechnical instability in 2-3 years if not addressed
- There are short-term (existing accumulation) and long-term management (yearly net surplus) strategies being researched at the same time, but the focus is on the short-term strategy, for which water treatment has been identified
- To deal with the surplus we are
  - Developing a model (volume, timing)
  - Researching water treatment technologies

    - Planning for location and infrastructure of treatment (currently looking at treating ditch water and discharging treated water into Polley Lake using the existing intake infrastructure)
- Next steps
    - Permitting (Spring 2014)
    - System design
    - Implementation

Q: Douglas Hill – how does the test work being completed relate to existing on site test work for selenium and other site loading
A: Luke Moger – this water treatment project described, and associated test work, is a short-term solution to the surplus of water accumulated on site currently; the long-term water management solution will continue to be refined during this process, incorporating any findings of the short-term treatment. The existing research referenced will continue, and will be mostly used in long-term water management planning, with applicable information applied to the short-term water treatment research

19:20: Colleen Hughes, Art Frye, and Dale Reimer – Closing Remarks

- Thank you to everyone for their participation in the meeting we appreciate the involvement and interest from the community.
- Thank you also the MPMC staff that participated and organized the meeting.
- Thank you to everyone for attending our meeting.

19:30: End of Meeting

Implementation Committee Minutes

MINUTES JANUARY 23RD, 2014 1:00PM SCIB

MEETING CALLED BY	SCIB/WLIB/MPMC Implementation Committee
TYPE OF MEETING	Monthly
FACILITATOR	SCIB
NOTE TAKER	Luke Moger (MPMC – Project Engineer)
ATTENDEES	Thomas Phillips (SCIB – Economic Development Coordinator), Richard Holmes (SCIB – Mining and Mineral Exploration Coordinator), Aaron Higginbottom (WLIB – Natural Resources Manager), Byron Louie (WLIB - Community Economic Developer Worker), Willie Sellars (WLIB – Special Project Coordinator), Dale Reimer (MPMC – General Manager), Art Frye (MPMC – Mine Operations Manager), Paul Allan (MPMC – Human Resources Manager), Luke Moger (MPMC – Project Engineer), , Noella William (MPMC – First Nation Employment Coordinator), Colleen Hughes (MPMC – Environmental Coordinator), Joseph Sandy (MPMC – Environmental Technician), Steve Robertson (Imperial Metals – Vice President, Corporate Affairs), Gordon Keevil (Imperial Metals – Vice President, Corporate Development)

Excerpt from Meeting Minutes:

ENVIRONMENTAL UPDATE COLLEEN HUGHES

DISCUSSION	**CH** reviewed the requirement of MPMC to provide an Annual Monitoring Plan for Mount Polley mine every year, furthering that the document was substantially similar to the previous year's, but highlighted changes. **CH** stated that W20 was added for quarterly monitoring, as fish were observed in the it. **AH** asked if water to this creek had been cut off with mine development, even if not effected. **CH** responded that this didn't seem to be the case as the water surfaced approximately 200m from where the water was monitored. **AH** asked if there had historically been fish at this site. **CH** responded that there was no baseline data, and added that only recently fish had been observed, necessitating monitoring. **CH** continued that the Perimeter Pond, in anticipation for future construction of a water treatment facility, had been added as a monitoring point. **CH** added that Edney Creek monitoring frequency was being decreased from monthly to quarterly due to the lack of change in water quality observed. **AH** asked if there was any benefit to monitoring more in high-flow periods rather than at even intervals. **CH** responded that the Environmental Department had been completing this sampling monthly historically, and so with moving to quarterly sampling, if a variation was noted to historical levels, then the frequency would be increased again. **CH** added that "E5" or the toe drain flow had been removed as its sampling had been altered on account of the existing Hazeltine Discharge infrastructure (now East and West toe drain). **CH** added that well 96-5A had been buried during a construction project, and that 00-2B had been removed due to lack of sufficient sample water at the location since 2010, adding that a report from AMEC Consultants indicated that it was natural for flow to fluctuate over time. **AH** asked as to what 'nested' wells referred to. **CH** clarified that wells were most often installed with a shallow (8m-20m) and deep (40m-50m) component to better profile water at the location. **RH** asked if well 96-5A would be replaced. **CH** responded that a third-party was being brought in to analyze well locations and suitability at Mount

Polley this year. **LM** furthered that, especially in the TSF area (where this well is located), there will be footprint expansion on account of the to-be-permitted mine life extension, and so this area would shortly not be suitable for monitoring. **CH** clarified that this was an upstream control well. **LM** provided a hard copy flyover map of the property, and provided an update on the water treatment application: the second round of piloting was being completed, with the test results thus far indicating that reverse osmosis technology would be a suitable application for the desired outcomes; consultation had been completed with the public through the Public Liaison Committee (held in Big Lake) and with a public meeting (held in Likely) to compliment the discussions as part of the IC; the schedule to implementation was slightly delayed on account of the second round of piloting currently being completed, but was still anticipated to be completed as close to spring 2014 as possible. **AH** asked who had replaced Karen Moores in MOE. **CH** responded that the key contact to date had been Dan Bings (MOE – Environmental Protection Officer), adding that the first phase of the pilot plant met all water quality objectives as set out with the exception of Nitrate and Nitrite, and so a second round of piloting based on these results was scheduled to address this. **AF** furthered that the first pilot plant had been designed around low-pressure operation, which provides significant economic savings through plastic piping and lesser pumping requirements, but that the second phase of the testing was catered to more traditional industrial R/O, requiring higher pressure and steel piping. **AH** asked what the pressure rating would be with plastic piping. **AF** responded that this would be in the ~150psi range. **AF** added that a sample of the water was also sent off for bench-testing with another company researching R/O applications for Mount Polley mine; specifically looking into the effect of water temperature variation on membrane efficiency. **CH** stated that, for perspective, the guideline for Nitrate used to be a lot higher (**RH** clarified that this was in the 40-50mg/L range) while the regulatory level was 3mg/L, and the first phase of testing had a peak level of 3.25mg/L, so MPMC and the R/O providers were confident that this could be met. **LM** enquired as to whether the government had contacted SCIB or WLIB in regards to their consultation. **TP/AH** confirmed that neither party had been contacted. **CH** suggested that it was her understanding that the government was waiting for all applications associated with this project (and some supplementary) to be received prior to consulting. **CH** provided a handout map on the proposed discharge right-of-way for the water treatment facility, adding that the alignment was designed to minimize new disturbance by being contained within existing footprint where possible, and tying into existing infrastructure in Polley Lake. **AG** asked who owned Polley Lake Road. **DR** responded that MPMC had built the road as part of the previous intake permit, and that it was on crown land, but only accessible by road through the (controlled) Mount Polley mine site. **CH** confirmed that there was no public access, but that signage would also be added to the Polley Lake access point to the site in regards to the private property.

CONCLUSIONS	Changes to the Annual Monitoring Plan were reviewed, and updates as to the water treatment research and permitting were provided.

ACTION ITEMS	**PERSON RESPONSIBLE**	**DEADLINE**
Provide updates on water treatment permitting	**LM**	As Arising

BRITISH COLUMBIA | Ministry of Energy and Mines

Cariboo Mine Development Review Committee Meeting
Meeting Notes

Date and Time: 13:00 – 16:00, June 18, 2014
Location: Cariboo Room, 640 Borland Street, Williams Lake

Preliminaries

- Introductions
- Review agenda
- Review Mount Polley Mine related action items from March meeting

Mount Polley Mine – Update on Permitting, Mine Planning and Reclamation

- MPMC presentation (previously distributed to MDRC)
- Update on site history, current operations and site conditions
- Discussion of water management, mine planning and expected schedule for permit amendment applications
- Polley Lake discharge application expected in early July
- Further amendments to existing Hazeltine Cr discharge to allow for other sources expected but not imminently
- Updated pit design pending completion of geotech work
- New haul road and dump extension planned for, but amendment applications will be made for each phase as needed. Additional cutting permits for timber and approvals for Bootjack Cr diversion will be made in later phases of SERDS dump when final design completed.
- MPMC will proceed with discussions with DFO and others regarding compensation for fish habitat before applying for Water Act diversion approvals. Proposal for offsets for impacts to Mine Drainage Creek has been submitted. **ACTION: Colleen Hughes to co-ordinate an ad hoc working group to discuss options for fish habitat offsets related to Bootjack Creek proposed diversion.**
- Amount of annual dam raise required depends on water balance. Applications for further TSF development expected in July.
- Crown Land tenure for pipeline may be issued in advance of MEM and MOE decisions regarding works and discharge authorization. **ACTION: Tania Demchuk to confirm any MEM concerns or issues regarding pipeline with Crown Lands.**

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- MEM confirmed that format for Mines Act application for treatment plant can be in form of Notice of Departure with application material that has been prepared for MOE and details regarding plant design appended to the letter.
- Technical assessment report for EMA permit application near completion. MPMC has discussed with MOE all outstanding details of application requirements.
- Government First Nations consultation report has been provided to SDMs for Polley Lake discharge project. MPMC must still provide a consultation report to MOE with the Polley Lake discharge application that responds to previously provided direction. This includes MPMCs efforts to engage First Nations as well as the efforts made to consult with the public, other agencies and stakeholder groups. **ACTION: Colleen Hughes to follow-up with Brian Yamelst on details of consultation report.**
- MPMC presented on reclamation efforts and planning. End land uses discussed and shift in focus from productivity targets to capability targets has been noted. **ACTION: Tania Demchuk to review reclamation presentation with Jennifer McConnachie.**
- MPMC waiting for decision on biosolids permit amendment application. **ACTION: Shelley Metcalfe to advise Katie McMahon on status of application.**

Attachments:

- June 18/14 Cariboo MDRC attendance list
- Table of Outstanding Applications for Amendments to MPMC Authorizations

Next Meeting and Meeting Closure **– next planned meeting of MDRC will be in October 15, 2014**

Ministry of Energy and Mines

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