VICTORIA GOLD CORP

EAGLE GOLD MINE

RECLAMATION AND CLOSURE PLAN

Version 2020-01

OCTOBER 2020

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DOCUMENT CONTROL

Submission History

Version Number	Version Date	Document Description and Revisions Made
2014-01	Aug 2014	Original submission in support of an application to the Yukon Water Board for a Type A Water Use License for the full Construction, Operation and Closure of the Project. Version 2014-01 was also submitted to the Department of Energy, Mines and Resources in support of an application for a Quartz Mining Licence allowing the full Construction, Operation and Closure of the Project.
2016-01	Oct 2016	Revised based on information provided by the Yukon Water Board (YWB), Yukon Government, the First Nation of Nacho Nyak Dun (FNNND), and other interveners during the regulatory approvals phase of the Project and to satisfy licence requiring updates to the RCP every 2 yeas on or before October 1.
2018-01	Jul 2017	Revisions made to reflect the current site general arrangement and submitted to the Yukon Water Board in response to an information request in relation to the Type A WUL Amendment Application.
2018-02	Aug 2017	Minor revision made in support of an application to the Yukon Water Board for a Type A Water Use License amendment for the Project.
2018-03	Oct 2018	Revised to satisfy licence requiring updates to the RCP every 2 yeas on or before October 1.
2020-10	Oct 2020	Revised to satisfy licence requiring updates to the RCP every 2 yeas on or before October 1.

Version 2020-01 of the Reclamation and Closure Plan (the Plan) for the Eagle Gold Mine (the Mine) has been revised in September 2020 to update Version 2018-03 submitted to the Yukon Water Board in September 2018. The table below is intended to identify modifications to the Plan compared to Version 2018-03, being the last iteration provided to all interested parties, and provide the rationale for such modifications.

Version 2020-01 Revisions

Section	Revision/Rationale
1 Introduction	▪ Text revision to provide an update on the development of the Mine and the Reclamation and Closure Plan. ▪ StrataGold Corporation (SGC) updated to Victoria Gold (Yukon) Corp. (VGC) throughout the Plan to reflect corporate name change. ▪ Eagle Gold Project (the Project) updated to Eagle Gold Mine (the Mine) throughout the Plan to reflect commencement of operations at the site.
2.1 Status of Reclamation and Closure Planning	▪ Text revision to acknowledge Mine operation has commenced. ▪ Update to the status of issues identified in the Table of Concordance related to discussions contained within the Reasons for Decision for the Type A Water Use Licence QZ14-041 as requested by reviewers during the previous review process for the RCP.
2.2 Summary of Reclamation Research Completed to Date	▪ Update to the section to acknowledge reclamation research completed to date as requested by reviewers during the previous review process for the RCP.

Section	Revision/Rationale
2.3 First Nation of Na-Cho Nyak Dun Engagement	▪ Update to the consultation activities to date and future engagement (e.g., FMEA).
2.4 Stakeholder Engagement	▪ Update to acknowledge feedback received during WUL amendment process.
2.5 Comprehensive Cooperation and Benefits Agreement	▪ Updates to acknowledge the continued execution of contracts with Yukon based companies and the FNNND Development Corporation.
3.1.7 Closure Monitoring	▪ Update to reflect that operational monitoring is now ongoing.
Table 3-2 Summary of Decommissioning and Reclamation Planning for Mine Components Table 3-3 Summary of Decommissioning and Reclamation Planning for Valued Components	▪ Table format update to move Fundamental Objectives and improve readability.
3.2.1 Open Pit	▪ Update to reflect current mine plan as approved under QZ14-041-1 and QML-0011.
3.2.2 Waste Rock Storage Areas	▪ Update to reflect Issued For Construction design and updated stability analyses as approved under QZ14-041-1 and QML-0011.
3.2.3 Heap Leach Facility	▪ Inclusion of additional design summary material to align with documents approved under QZ14-041-1 and QML-0011.
4 Existing Environmental Description	▪ Inclusion of additional environmental characterization references as a result of ongoing monitoring and reporting requirements.
5 Project Description	▪ Update to text to reflect current mine status and mine plan as approved under QZ14-041-1 and QML-0011.
6.1 Definitions and Temporary Closure Objectives	▪ Update to the definition of Temporary Closure to align with the updated definition in QZ-14-041-1.
6.2.2.1 Waste Rock Storage Areas and Temporary Ore Stockpiles	▪ Minor revisions to clarify that runoff and seepage quality will meet effluent quality standards prior to discharge.
6.2.2.2 Heap Leach Facility	▪ Revision to clarify that discharge from HLF will be avoided to extent possible during Temporary Closure, and if discharge is necessary it will meet effluent quality standards and may be treated at the MWTP if required.

Section	Revision/Rationale
6.2.2.4 Water Management Facilities (Ponds, Pipes and Ditches)	▪ Revision to reflect the currently constructed water management facilities.
6.2.2.5 Mine Water Treatment	▪ Minor revision to reflect current operations status.
6.2.4 Financial Considerations	▪ Edit to introductory sentence to make it a complete sentence.
Table 6-2 Effluent Water Quality Standards	▪ Update to match effluent quality standards in the amended WUL QZ14-041-1.
6.4 Monitoring	▪ Update cross reference to the clause in the amended WUL QZ14-041-1.
6.5 Notification and Reporting	▪ Update to reflect notification requirements in the amended WUL QZ14-041-1.
7.1 Platinum Gulch Waste Rock Storage Area	▪ Addition of cross reference to Section 10.2 for cover trials initiated in 2020.
7.3 Ice-Rich Overburden Storage Area	▪ Revision to acknowledge volumes of ice-rich materials encountered to date and management strategies utilized.
7.4 Revegetation Program	▪ New section providing a summary of the ongoing revegetation efforts and programs completed to date.
8.1 Closure Schedule	▪ Updates to reflect current Mine schedule.
8.5 Estimated Areas of Disturbance at End of Mine Lice	▪ Revisions to acknowledge changes in facilities sizes/site disturbances based on Issued for Construction and As-Built configurations.
8.6.1.1 Water Quality Objectives	▪ Addition of station W99.
8.6.1.3 Transition Strategy	▪ Revisions to improve readability.
8.6.1.4 Water Conveyance Network	▪ Inclusion of description of currently constructed water collection channels. ▪ Revisions to improve readability.
8.8.1 Closure Objectives and Criteria	▪ Revision to further clarify closure objectives. ▪ Removal of table that had simply reiterated EQSs applied to the Mine.

Section	Revision/Rationale
8.8.2.2 Cyanide Destruction and Rinsing	▪ Revision to better describe the timing and purpose of rinsing process. ▪ Revision to explain that biological treatment process is considered a project opportunity and is not necessary for closure of the HLF.
8.8.2.4 Drain-down	▪ Minor revision to clarify draindown period. ▪ Revision to explain that biological treatment process is considered a project opportunity for a potential reduction in closure costs and is not necessary for closure of the HLF.
8.8.2.5 HLF Passive Water Treatment	▪ Minor revision to improve readability.
8.8.2.7 Final Reclamation Measures for HLF	▪ Revision to improve readability.
8.9.2.1 Passive Water Treatment	▪ Revision to better described the currently constructed water management infrastructure that will be used during closure.
8.9.2.2 Earthworks	▪ Revision to improve readability. ▪ Clarification that compaction of flat areas of the cover will be completed if necessary, based on research and modelling results.
8.10.2.2 Earthworks	▪ Revision to improve readability. ▪ Clarification that compaction of flat areas of the cover will be completed if necessary, based on research and modelling results.
8.12.2.2 Mine Water Treatment Plant	▪ Inclusion of date for the completion and commissioning of the MWTP (H2 2021).
8.12.2.3 Crushing and Conveyance Facilities	▪ Revision to improve readability. ▪ Inclusion of text to acknowledge backfill of the pad to establish stable landform.
8.12.2.7 Fuel Storage Tank Area	▪ Update to reflect number of tanks and structural components constructed.
8.13.2.4 Main Water Conveyance Channels	▪ New section discussing the main water conveyance channels.
10 Reclamation and Closure Research Program	▪ Revision to reflect that research programs have been initiated.
10.1 Revegetation Trials	▪ Updates to the status and results of the trials.
10.2 Engineered Covers	▪ Revision to main section and subsections to reflect that research programs have been initiated.
10.4 Passive Water Treatment	▪ Revision to main section and subsections to reflect that research programs have been initiated.

Section	Revision/Rationale
10.4.2 Schedule	▪ Updates to schedule based on the current status.
13 Reclamation Cost Estimate	▪ Complete revision based on current status of the Mine

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List of Acronyms and Abbreviations

ADR.....adsorption, desorption and recovery
ARD.....acid rock drainage
CCBA ..... Comprehensive Cooperation Benefit Agreement
CSL .....Contango Strategies Limited
CWTS..... constructed wetland treatment system
DGDC..... Dublin Gulch diversion channel
DRP..... Decommissioning and Reclamation Plan
EMR .....Yukon Government Department of Energy, Mines, and Resources
FN .....First Nations
FNNND..... First Nation of Na-Cho Nyäk Dun
ha ..... hectares
HLF .....heap leach facility
HRT.....hydraulic retention time
KPL ..... Knight Piésold Ltd.
LSA .....local study area
m ..... metres
m^2 ..... square metres
m^3/ha..... cubic metres per hectare
Mine .....Eagle Gold Mine
ML .....metal leaching
MLU..... Mining Land Use
MWh/y ..... megawatt hours per year
NSR.....net smelter return
PLS .....pregnant leach solution
PTS ..... passive treatment system
QMA .....*Quartz Mining Act*
QML ..... quartz mining licence
RoW .....right of way
RRC .....removal rate coefficient

RSA.....regional study area

SCP..... seepage collection pond

UTM .....Universal Transverse Mercator

VGC .....Victoria Gold Corp.

WMP ..... water management plan

WRSA .....waste rock storage area

WUL .....Water Use Licence

MWTP ..... mine water treatment plant

YESAA ..... *Yukon Environmental and Socio-economic Assessment Act*

YESAB .....Yukon Environmental and Socio-economic Assessment Board

YG ..... Yukon Government

yrs ..... years

YT.....Yukon Territory

YQMA..... Yukon Quartz Mining Act

YWA ..... Yukon Waters Act

YWB .....Yukon Water Board

1 INTRODUCTION

Victoria Gold (Yukon) Corp. (VGC) currently operates and will complete progressive and final closure and reclamation of the Eagle Gold Mine. The Eagle Gold Mine ("the Mine") is located 85 km from Mayo, Yukon using existing highway and access roads (Figure 1-1). The Mine (Figure 1-2) involves open pit mining and gold extraction using a three-stage crushing process, heap leaching, and a carbon adsorption, desorption, and recovery system over the mine life.

This *Reclamation and Closure Plan* (RCP) addresses the long-term physical and chemical stability of the site, including reclamation of surface disturbances from existing development. A program is presented for site management and monitoring both during implementation of closure and after decommissioning and reclamation measures are completed.

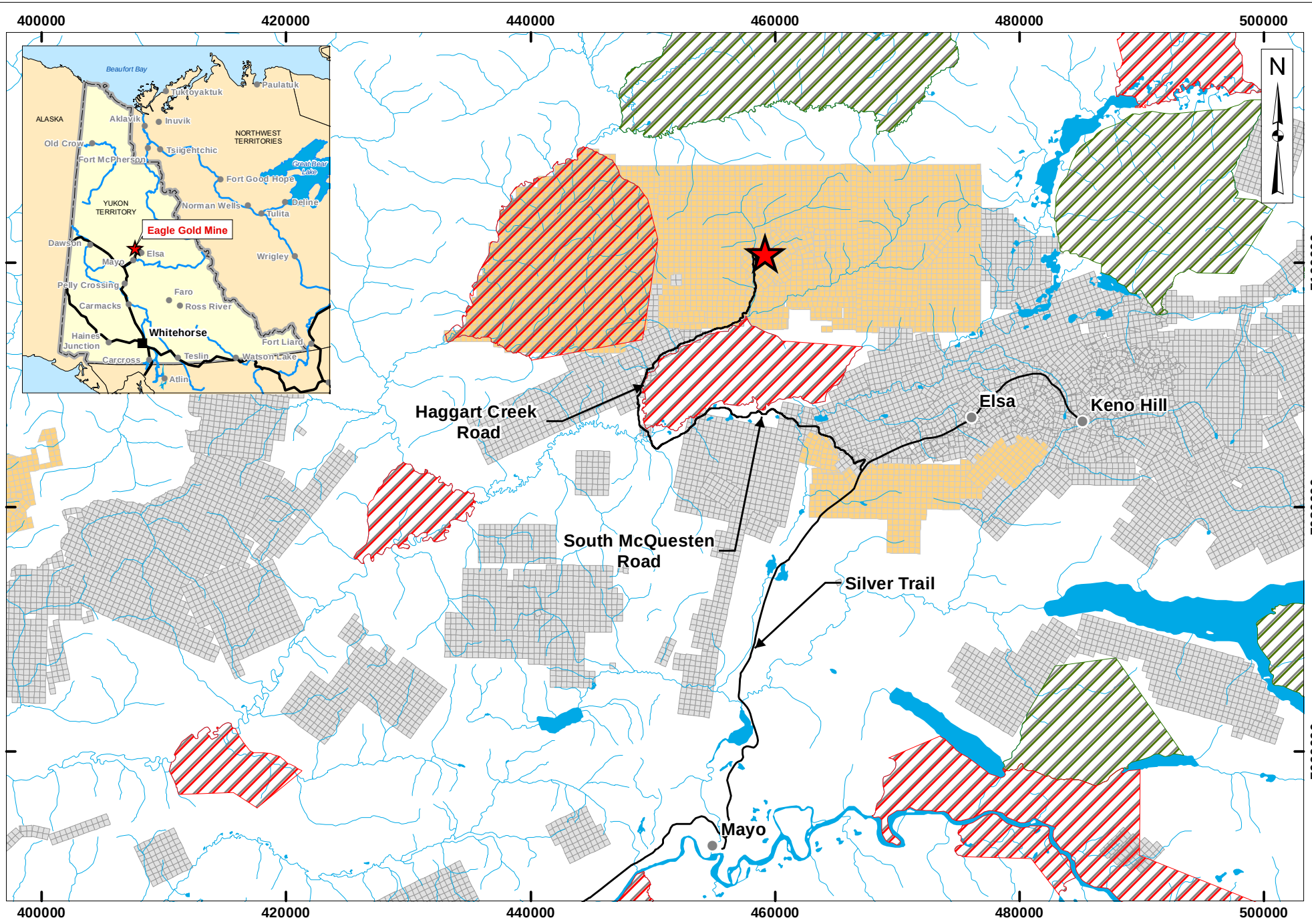
The Mine has received regulatory approvals that allow the construction, operation and closure pursuant to the *Yukon Waters Act,* which covers the administration of Type A and B Water Use Licences (WUL) and the *Yukon Quartz Mining Act*, which covers the administration of Quartz Mining Licenses (QML). The Mine is being operated in accordance with the terms of the Type A WUL QZ14-041-1 and the QML QML-0011. The Mine operations commenced in July 2019.

This current version of the RCP (Version 2020-01) is submitted to Yukon Water Board (YWB) and the Department of Energy, Mines and Resources (EMR) in accordance with Clause 148 (b) of QZ14-041-1 and Clause 7.2 of QML-0011 that require an update to the RCP every 2 years. The previous version of the RCP (Version 2018-03) was submitted to the Yukon Water Board (YWB) and Yukon Government (YG) and is approved under the Quartz Mining License QML-0011.

At present, VGC has posted a reclamation bond in the amount of $30,780,939 with the Government of Yukon, as represented by the Minister of Energy, Mines and Resources, as Obligee.

1.1 SCOPE OF THE RECLAMATION AND CLOSURE PLAN

This RCP has been specifically scoped to fulfill the requirements of the Type A WUL QZ14-041-1 and QML-0011 issued for the Mine through utilization of the EMR and YWB guidance document *Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and Closure Costing Guidance,* released August 2013. This guide provides overall guidance about expected processes for developing RCPs and performance outcome for reclamation and closure. This RCP should be considered as a living, dynamic document that will be refined throughout mine planning, development and operation.



Legend:

- Eagle Gold Mine
- Victoria Gold Claims
- Other Claims
- Town / Village
- Road
- Watercourse
- Category A Settlement Land
- Category B Settlement Land

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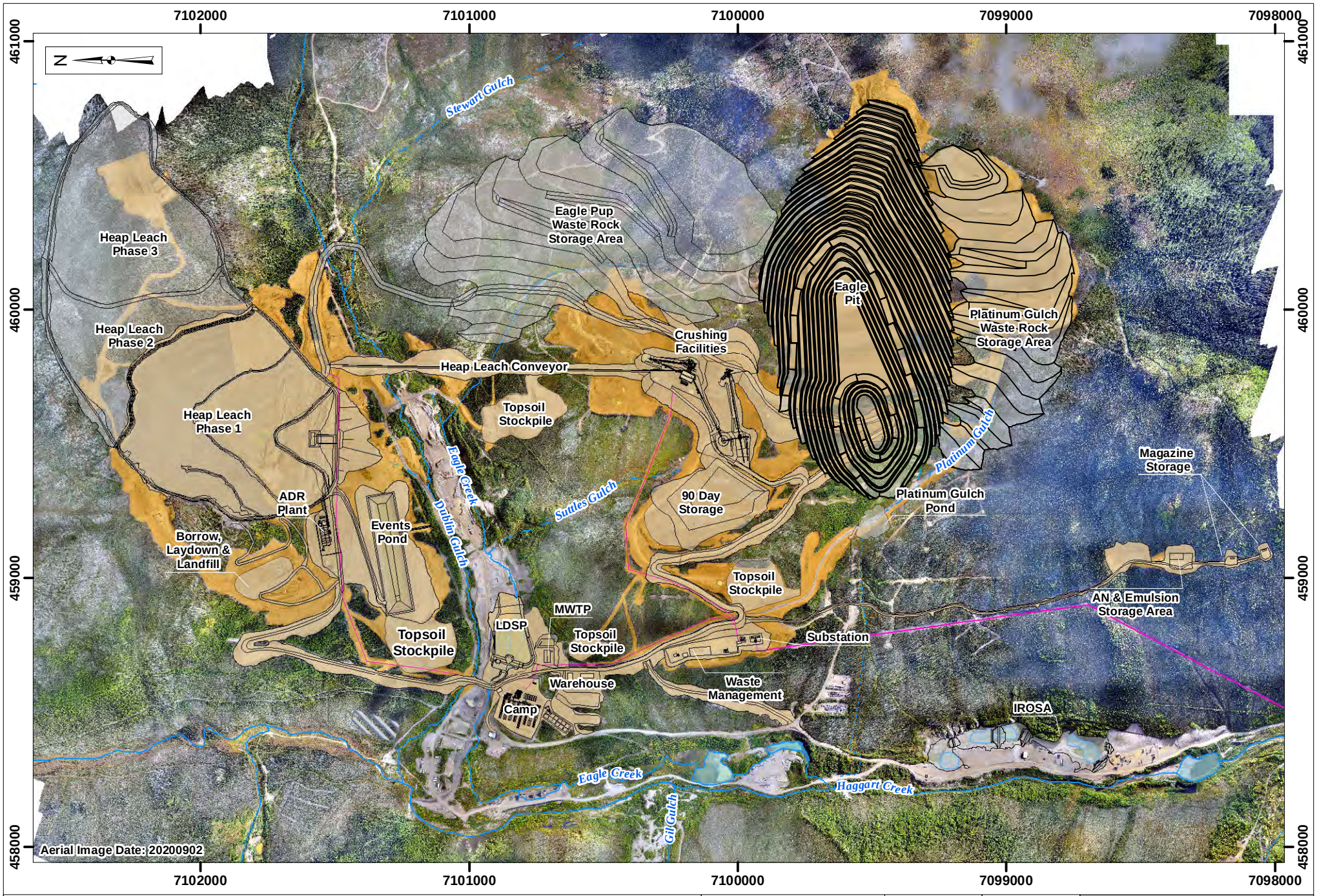
0 3 6 12
Kilometres

Projection:	Drawn By:	EAGLE GOLD MINE YUKON TERRITORY
NAD 83 Zone 8N	HC	
Date:	Figure:	Mine Location
2020/01/27	1-1	



Legend:

- Major Facility
- Site Power
- Reserved Area
- Current Construction and Mining Impacted Areas
- Watercourse - Perennial
- Watercourse - Ephemeral
- Watercourse - Intermittent

VICTORIA GOLD CORP

0 125 250 500
Metres

Projection:	Drawn By:	EAGLE GOLD MINE YUKON TERRITORY
NAD 83 UTM Zone 8N	HC	
Date:	Figure:	End of Mine Life General Arrangement
2020/09/30	1-2	

2 RECLAMATION AND CLOSURE PLANNING

The overall strategy for the RCP is to provide the proposed approach to decommission mine features, reclaim landforms, and provide a monitoring program to implement until mitigation measures have achieved the closure objectives. The focus of the RCP is to guide the return of the site to appropriate and functional ecosystems, similar to predevelopment conditions, while meeting key end land use objectives. The objectives of the RCP are to address water quality, physical stability (stable landforms), land use, aesthetics, and public health and safety.

Since 2009, VGC has worked with stakeholders (e.g., FNNND, YG) to refine the project and monitoring programs, and then develop closure objectives and proposed closure methods for the Mine site. This dialogue has been ongoing through construction and the first year of mining in the context of further refinements of objectives and reclamation research programs. Section 2.1 below presents a brief outline of the current status of reclamation and research planning for the Mine site and Section 10 outlines the ongoing and planned reclamation research for VGC's closure planning.

2.1 STATUS OF RECLAMATION AND CLOSURE PLANNING

Figure 2-1 below illustrates that the closure planning for mining projects is a continuum, and that the details contributing to closure implementation strategy, including level of design, should increase as a mine moves through the mine life cycle. As closure planning increases in detail, the information is integrated into development and operational decision making.

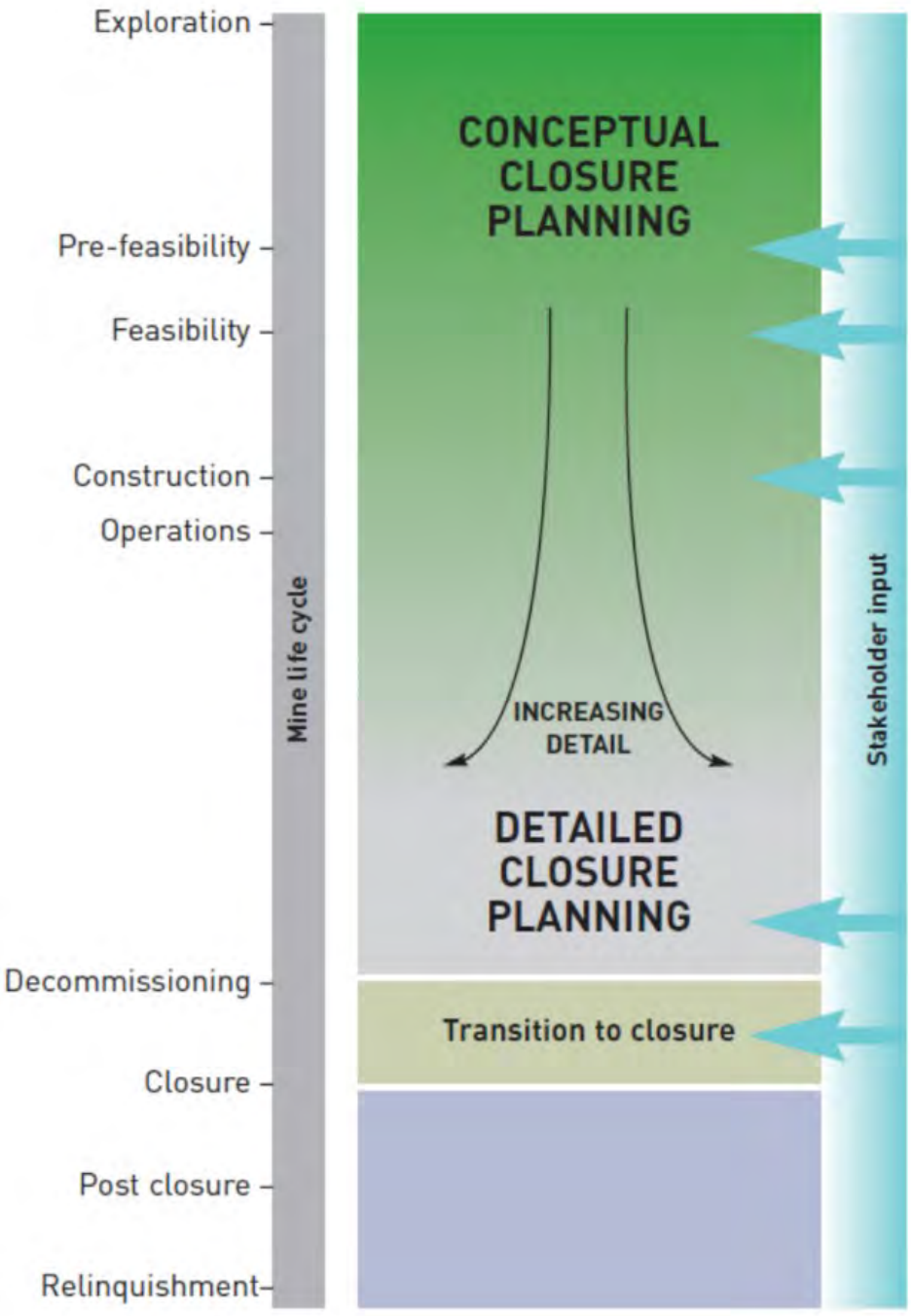


Figure 2-1: Continuum of Closure Planning Relative to Mine Life Cycle

2.1.1 Discussion of Issues Listed in Reasons

The YWB, by way of the Reasons for Decision (RFD) issued with QZ14-041, required VGC to include the 19 issues listed in the RFD whether or not efforts to resolve them have advanced. As of the effective date of this version of the RCP, an RFD document to support QZ14-041-1 (the amendment to the initial Type A WUL) has not been provided to VGC. In the absence of an updated RFD, accounting of the YWB's previously identified issues and requirements (from QZ14-041 and its RFD) has been integrated into the RCP. Commentary on advancement or planning related to these items and requirements is detailed in Table 2-1.

Table 2-1: Table of Concordance for QZ14-041 Reasons for Decision Relevant to this Plan

No.	Issue	Status/Where Addressed
1	The issue of use of assimilative capacity of the aquatic receiving environment is a matter that is expected to be addressed during the future development of the plan. VGC and all parties are encouraged to consider how this issue may best be addressed.	**Section 10.4** describes the PTS reclamation research program to refine, optimize and remove uncertainties with regard to achievable water quality chemistries, with the aim of minimizing the consumption of assimilative capacity, and alteration of water quality adjacent to settlement land (at W23). **Status - Started**: Step 1 of the research program to compare Mine water quality predictions with actual performance commenced with the start of construction and operation and is currently ongoing. A pilot bioreactor program was established on the Project site in 2019. The program is considered the next step in the reclamation research program for the passive treatment systems. The pilot program includes trial components exposed to ambient freeze-thaw stresses to evaluate the effect of the site climate regime on removal rates. These results will be used to further refine closure water quality predictions for the receiving environment.
2	The further definition of effluent discharge standards for closure is a clear expectation of all parties and VGC should be prepared to advance that issue in future revisions of the RCP.	As described for Item No. 1, above.
3	The issue of the long-term performance of the PTSs [passive treatment systems] with respect to selected water quality objectives and EQS requires further development.	As described for Item No. 1, above.
4	The logistics of rinsing the terraced heap requires further definition to clarify the timing, equipment, and effort that may be required. This should account for constraints on rinsing the sloping portions of the heap only during warmer months.	**Section 10.5** describes heap biological detoxification and in-heap bioreactor research program. **Status - To commence when the HLF is operational on site:** Field-based research is planned to be concurrent with heap leaching operations over a 3-year period at a similar time as the on-site PTS demonstration program.

No.	Issue	Status/Where Addressed
		Additionally, the MWTP will remain available for treating HLF solution for a period of 5 years after its last use to ensure the EQS are met during the post closure period.
5	Timing of placing cover materials on the heap in coordination with rinsing needs further resolution.	As described for Item No. 4, above.
6	The means of reliably conveying the relatively small volumes of seepage water collected from the EP WRSA down to the relatively distance proposed PTSs located at the LDSP [Lower Dublin South Pond] requires further consideration. The suitability of an unmaintained shallow buried pipeline to convey such seepage during closure is a concern without suitable provisions for long term maintenance of such a system.	Observations of the efficacy of site water management concepts utilized for other facilities (e.g., camp water supply), will be examined during the Operations Phase and will inform the design of closure drainage but the current proposed approach is considered appropriate.
7	The impact of icing development and subsequent thaw in PTSs that are collecting seepage is a concern that requires further consideration.	**Section 10.4** describes the PTS reclamation research program. Phase 3 involves outdoor pilot scale test at a cold-climate PTS testing facility to characterize spring thaw and winter freeze performance **Status - Started**. As described for Item No. 1, above.
8	The material balance for cover materials is only modestly positive which may result in the need to obtain additional materials from off-site if less materials are in fact produced or more materials are required. This should be carefully evaluated during early stages of the project.	**Section 8.5** describes the evaluation of materials available for cover. **Section 10.2** describes the research program for closure cover designs, which includes further assessment and refinement of material availability and volume. **Status – Started:** Updating of closure cover system design performance based on refined general arrangement. There is currently approximately 968,000 m^3 of stockpiled material available for covering facilities. The Year 2 estimate calls for a total of approximately 910,000 m^3 which suggests there will be adequate material for covers as the Project advances.
9	Refinement of the proposed cover systems will be expected, including further optimization for vegetation growth and confirmation that appropriate properties of the heap ore have been considered for the HLF.	**Section 10.1** describes revegetation trials and **Section 10.2** describes the research program for closure cover designs, during which cover system field trials provide opportunities to investigate vegetation prescriptions and techniques. **Status – Started:** Vegetation trials using local native species have commenced as have field scale trials of cover systems.

No.	Issue	Status/Where Addressed
10	The adequacy of the design criteria for closure water conveyance channels is a matter that is not resolved at this time but should be addressed in the near term.	**Section 3.2 Design Criteria** provides information on the design criteria for water management facilities. **Status – Started:** Seasonal climatic variability, longevity, and flow capacity are being examined on an ongoing basis as part of the considerations to update specific designs during operations and will be considered in more detail when evaluating specific design criteria to address long-term issues such as maintenance requirements, channel morphology changes, and minimizing the risk of failure.
11	Proposals for only limited re-sloping of the WRSA's and HLF appear suspect and not consistent with current expectations for development of suitable closure landforms. For the PG WRSA the re-sloping proposals appear inconsistent with the Requirements for general stability of that waste emplacement.	Closure objectives for the WRSAs are: to ensure long-term physical stability to minimize erosion, subsidence or slope failure; and, ensure long-term chemical stability such that runoff and seepage quality meets water quality criteria and that area is able to withstand severe climactic and seismic events. Targeted studies of closure landform design option(s) are proposed to balance risk mitigation, manage costs, and identify closure landform options with a high probability of achieving closure objectives. **Status - Not started.**
12	The need to develop and include water conveyance networks on the closed heap and WRSAs is an acknowledged deficiency in current planning.	As described for Item No. 11, above.
13	The need to more specifically identify passive treatment designs including the size and location of treatment train components is clear requirement for future revisions of the plan.	As described for Item No. 1, above. The current status of the Mine (i.e., volume of mined and stacked material) is not sufficiently advanced that contact water from the HLF and WRSAs would be representative of closure conditions such that at this time only preliminary designs for PTSs can be developed.
14	The need to refine the water conveyance network near the toe of EP WRSA where presently both contact and non-contact water conveyance channels intersect has been acknowledged by VGC and requires resolution.	As described for Item No. 11, above. In this case, alternate conveyance channels and downstream effects on the PTS will be examined to assess whether it will be beneficial to separate contact from non-contact water at this location.
15	The issue of collecting seepage from the northern edge of the EP WRSA that is not underlain by a rock drain and lies outside of the existing watershed for Eagle Pup will require further advancement.	**Not started:** At the time of the finalization of this iteration of the RCP, there has been no placement of waste rock in the EP WRSA and thus planning for this potential contact water source has not been started. The current concept being considered is to extend the current Ditch B to the toe of the EP WRSA and extend a smaller ditch to the north side of the WRSA.

No.	Issue	Status/Where Addressed
16	The expected function of the HLF closure drain to attenuate flows suggests either some level of understanding about saturated levels in the heap over the long term or some level of applied external control to establish and maintain a saturated zone in the heap during closure. In either case, more detail is required to understand the expected rate of flow from the heap during closure.	After the completion of draindown for the HLF, there will be no further external control necessary. The facility will be in a meta-stable equilibrium with meteoric input and thus the purpose of the drain is to provide a conveyance to the HLF PTS and is not to attenuate flows.
17	It is unclear whether the functioning of the HLF as a bioreactor is required only during heap drain down or whether it is necessary long term.	As described for Item No. 4, above. Presently, it is assumed that the in-heap bioreactor will only be utilized during heap drain down and as an alternative to full active treatment, and thus not a long-term feature.
18	The development of proposals for physical testing of the heap to confirm detoxification remain unresolved.	As described for Item No. 4, above.
19	Elsewhere in these reasons the issue of whether the storage capacity of the in-heap pond has been correctly estimated has been raised. This issue also has implications for closure of the HLF.	**Forte Dynamics (2018b)** describes In-heap pond solution storage capacity and informs HLF closure planning. The amendment issued for the Type A WUL includes a condition requiring a plan and program for confirming the in-heap pond storage capacity. **Status - Ongoing:** The Heap Leach Facility In-Heap Pond Pumping Test procedure was developed, independently audited and approved and submitted in accordance with QZ14-041-1. The test procedure will be executed in accordance with the conditions of QZ14-041-1 to confirm the In-Heap Pond storage capacity.

2.2 SUMMARY OF RECLAMATION RESEARCH COMPLETED TO DATE

VGC has developed reclamation research programs to be implemented during the Operations Phase to identify, characterize, evaluate and optimize closure practices, as described in Section 10. Several closure and reclamation research programs are on-going and/or planned, including engineered cover design test plots, growth media and revegetation trials, passive treatment research and natural groundwater attenuation programs.

An important component of the reclamation planning process is ongoing reclamation research with the objective of developing the methods required to implement a successful reclamation program. Reclamation research will focus primarily on the key closure methods proposed for the site.

A reclamation research program has been developed and initiated to provide proof of concept for these techniques in the Mine setting. Major elements of the reclamation and closure research programs are presented in Section 10 and the status of these programs to date is summarized in Table 2-2.

Table 2-2: Reclamation Research Completed to Date

Research Program	Status
Revegetation	Laberge Environmental Services has conducted vegetation trials at the Peso Mineral Exploration Site located nearby but independent of the Mine site. The objective of the revegetation program was to test the viability of incorporating biochar and other soil amendments into the Project with the goal of refining and improving the reclamation and revegetation plan. 2018 was the final year of these trials and the results from monitoring of the revegetation trials are presented in Appendix A. In 2019 and 2020, revegetation programs were completed on a number of exposed surfaces created during Mine construction. The programs utilized commercially available northern seed mixes. willow staking, pole drain installations, wattle fence installations and jute mat placement to manage areas identified as having some erosion and sediment release potential and to also inform candidate species selection for closure revegetation and erosion control selection for closure stabilization.
Soil Covers	O'Kane Consultants has updated the research program on engineered covers to align with the current Mine plan and included additional detail on execution of the research plan. A pilot scale cover trial has been initiated in 2020 on the PG WRSA. This information is provided below in Section 10.2 and Appendices F and G. Additionally, a Vegetation Rooting Study is planned to support the refinement of closure cover system designs (as summarized in Section 10.3 with additional detail provided in Appendix B).
Passive Water Treatment	Contango Strategies Limited updated conceptual wetland designs to align with the current Mine plan. This information is described in detail in Sections 8.8 through 8.10. An on-site pilot bioreactor program was initiated during 2019 and is ongoing; it is described in Section 10.4.
HLF Detoxification	The plan for testing biological detoxification and in-heap bioreactor for CN destruction and metals removal is provided in Appendix C. This work has not yet commenced.
Groundwater Attenuation	The groundwater arsenic attenuation study is described in Section 10.6. This work has not yet commenced.

2.3 FIRST NATION OF NA-CHO NYAK DUN ENGAGEMENT

VGC has engaged in a wide range of consultation activities and have made early and ongoing consultation with the First Nation of Na-Cho Nyäk Dun (FNNND) a priority to ensure an opportunity for input at all key stages of Mine development. Currently, ongoing revegetation program (see Section 7.4) continues to benefit from participation of FNNND citizens, as well as provision of seed for the program by Yukon Seed and Restoration, which is a local company jointly owned by Na-Cho Nyäk Dun Development Corporation (51%), Core Geosciences Services Inc. (34%), and Maureen Huggard (15%).

Future Failure Modes Effects Analyses (FMEA) will be conducted as part of closure planning as the Mine advances in accordance with the requirements for Reclamation and Closure Planning for Quartz Mining Projects – Plan Requirements and Closure Costing Guidance (YWB and EMR August 2013). It is expected that FMEA will be conducted once further information is available from the reclamation research programs (cover trials, passive water treatment trials, etc.), operations phase environmental monitoring programs, and when reclamation and closure options are advanced to incorporate the results and observations from those programs. When conducting

the FMEA, VGC will encourage FNNND participation in the identification and characterization of failure modes and their effects for Mine closure.

VGC and the FNNND entered into a Cooperation and Benefits Agreement (CBA) that applies to exploration and mine development conducted by VGC within the FNNND Traditional Territory. Details and objectives of the CBA are presented below in Section 2.5.

2.4 STAKEHOLDER ENGAGEMENT

VGC have engaged in a wide range of consultation activities and have made early and ongoing consultation with the FNNND, the Village of Mayo, Yukon Government and other stakeholders a priority to ensure an opportunity for input at all key stages of Mine development.

Consultation efforts carried out have been well received and well attended. Additional feedback on the RCP has been received from stakeholders throughout the regulatory review processes.

2.5 COMPREHENSIVE COOPERATION AND BENEFITS AGREEMENT

VGC and the FNNND signed a comprehensive Cooperation and Benefits Agreement (CBA) on October 17, 2011. The CBA applies to the Eagle Gold Mine development and exploration activities conducted by VGC anywhere in FNNND Traditional Territory located south of the Wernecke Mountains.

The objectives of the CBA are to:

- Promote effective and efficient communication between VGC and the FNNND in order to foster the development of a cooperative and respectful relationship and FNNND support of VGC's exploration activities and the Mine.
- Provide business and employment opportunities, related to the Mine, to the FNNND and its citizens and businesses in order to promote their economic self-reliance.
- Establish a role for the FNNND in the environmental monitoring of the Mine and the promotion of environmental stewardship.
- Set out financial provisions to enable the FNNND to participate in the opportunities and benefits related to the Mine.
- Establish a forum for VGC and the FNNND to discuss matters related to the Mine and resolve issues related to implementation of the CBA.

The construction and production activities undertaken to date have resulted in the execution of multiple significant contracts with Yukon based companies, of which over half have economic connection to the FNNND Development Corporation by either First Nation business or local business.

3 CLOSURE OBJECTIVES AND DESIGN CRITERIA

The following closure objectives and closure measures are based on previous experience and standard practices, as well as the Yukon Mine Site and Reclamation Closure Policy Financial and Technical Guidelines (Yukon Government 2013). The technical guidelines provide mining proponents with direction on reclamation and closure objectives, which must or should be considered. The guidelines present three elements: purpose, objectives and practice. The practices outlined include reference to principal legal requirements, policy detail pursuant to the Yukon Mine Site Reclamation and Closure Policy, and possible strategies for achieving the desired objectives.

Principles and approaches for reclamation planning from the Reclamation and Closure Planning for Quartz Mining Projects guidance document (Yukon Government 2013) are incorporated into Section 3.0. To achieve its purpose, the guide has the following objectives:

- Describing the context for mine closure planning in the Yukon, and the rationale for requirements to submit RCPs and liability estimates;
- Describe the principles, philosophy and broad objectives for closure planning for Yukon mining projects;
- Describe the information expectations for RCPs and liability estimates; and
- Identify key sources of additional guidance for preparing RCPs and liability estimates.

The guidance document includes: methods for developing fundamental reclamation and closure objectives, methods for conducting community and regulatory engagement, reclamation and closure principles and principles for estimating liability. The intent of this section is to present the closure goals, objectives, and criteria for reclamation and closure of the Mine, in the context of closure planning that is objectives-based.

Table 3-1 below includes reclamation and closure objectives to be achieved for reclamation and closure projects in Yukon for each recognized value. Information from this table has been incorporated into the development of closure objectives described in Table 3-1 and Table 3-2.

Table 3-1: Fundamental Mine Reclamation and Closure Objectives (YG 2013)

Value	Reclamation and Closure Objectives
Physical Stability	All mine-related structures and facilities are physically stable and performing in accordance with designs. All mine-related structures, facilities and processes can withstand severe climatic and seismic events.
Chemical Stability	Release of constituents and waste products from mine related waste materials occurs at rates that do not cause unacceptable exposure in the receiving environment.
Health and Safety	Reclamation eliminates or minimizes existing hazards to the health and safety of the public, workers and area wildlife by achieving conditions similar to local area features. Reclamation and closure implementation avoids or minimizes adverse health and safety effects on the public, workers and wildlife.
Ecological Conditions and Sustainability	Reclamation and closure activities protect the aquatic, terrestrial and atmospheric environments from mine-related degradation and restore environments that have been degraded by mine-related activities. The mine site supports a self-sustaining biological community that achieves land use objectives.
Land Use	Lands affected by mine-related activities (e.g., building sites, chemical and fuel storage sites, roads, sediment ponds, waste rock storage areas, etc.) are restored to conditions

Value	Reclamation and Closure Objectives
	that enable and optimize productive long-term use of land. Conditions are typical of surrounding areas or provide for other land uses that meet community expectations.
Aesthetics	Restoration outcomes are visually acceptable.
Socio-economic Expectations	Reclamation and closure implementation avoids or minimizes adverse socio-economic effects on local and Yukon communities, while maximizing socio-economic benefits. Reclamation and closure activities achieve outcomes that meet community and regulatory expectations.
Long-term Certainty	Minimize the need for long-term operations, maintenance and monitoring after reclamation activities are complete.
Financial Considerations	Minimize outstanding liability and risks after reclamation activities are complete.

3.1 RECLAMATION AND CLOSURE OBJECTIVES

An objectives-based approach has been adopted for the development of VGC's RCP. In an objectives-based approach, the closure goal is supported by closure principles that guide the selection of clear closure objectives for all Mine components. For each closure objective, proponents propose a set of closure options that could achieve the objective, and a selected closure activity is chosen from these options. Closure criteria measure whether the selected closure activity achieves the specific closure objective.

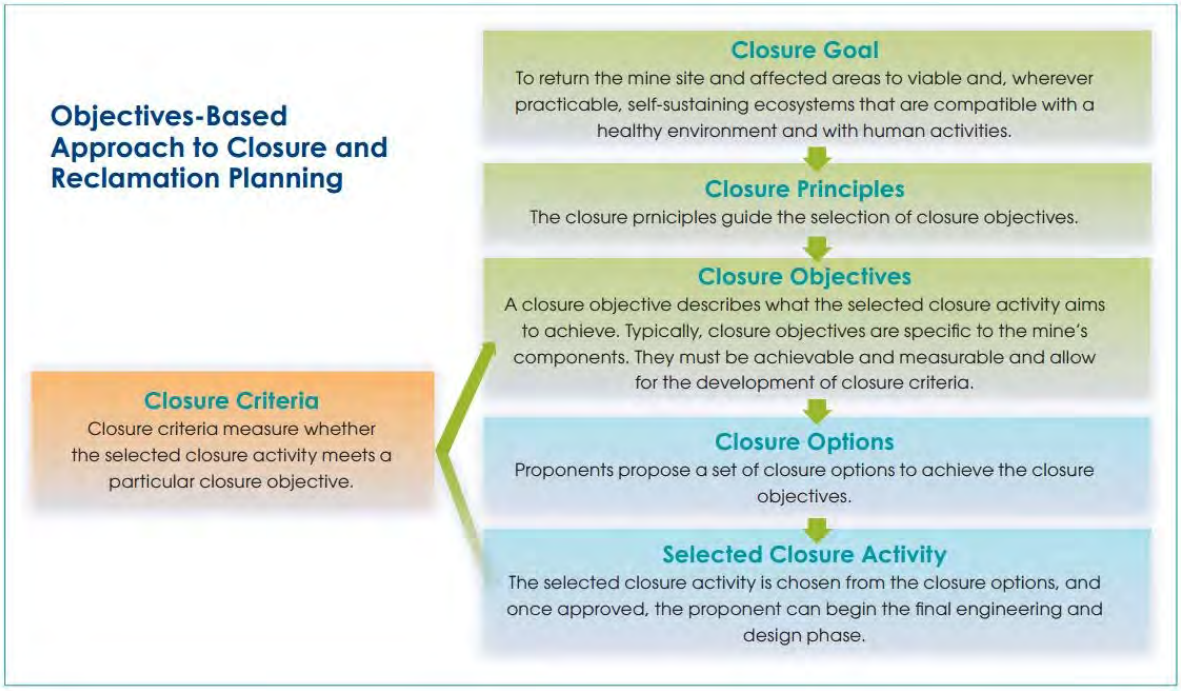


Figure 3-1: Objectives-based Approach to Closure and Reclamation Planning (from MVLWB/AANDC 2013)

Details defining an objectives-based approach, adapted from the MVLWB/AANDC (2013) are presented below and in some instances where information has been gathered from additional authors, sources are cited.

3.1.1 Closure Goal

The closure goal is the guiding statement and starting point for closure and reclamation planning. Establishment of goals are meant to ensure the long-term success of the program by developing a clear and executable plan. The closure goal is met when the proponent has satisfied all closure objectives.

For the Mine, the closure goal at all mining operations is to return the mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities.

3.1.2 Closure Principles

Closure principles guide the selection of closure objectives. Four core closure principles applicable to the Mine include:

- physical stability;
- chemical stability;
- no long-term active care requirements; and
- future use (including aesthetics and values).

3.1.3 Closure Objectives

Closure objectives are statements that clearly describe what the selected closure activities aim to achieve. They must be achievable and allow for the development of measurable closure criteria. Objectives are short-term concrete stepping stones toward achieving a goal and should be specific, appropriate and realistic (Huggard and Nadeau 2013). Selected closure objectives found in the Yukon Mine Site and Reclamation Closure Policy – Financial and Technical Guidelines (2013) directly relate to the closure goal and closure principles required for the RCP.

Component-specific closure objectives, categorized under the four closure principles presented above, are intended to be objectives-based and non-prescriptive. The purpose of implementing performance-based objectives is to encourage research and innovation resulting in cost-effective applications while ensuring public health and safety and environmental protection are met (Yukon Government 2013).

3.1.4 Closure Options and Selected Closure Activity

Closure options are potential activities that could be implemented to ensure that progressive and post-closure reclamation meets the stated closure objectives. These should utilize and adhere to the best available practices and technologies suitable to the site for each of the mine components.

Closure activities are chosen based on the closure options for each Mine component and outlines specific actions and measures to be undertaken. Established literature, bench scale, or pilot testing should support the activity so that stakeholders can be reasonably assured that the option will be successful. Reclamation research (detailed below) also provides certainty to planning appropriate activities. The selected closure activity may change prior to the final RCP based on factors such as environmental considerations, stakeholder input, the availability of new technologies/practices, the results of environmental monitoring programs, or the results of specific reclamation research.

3.1.5 Closure Criteria

Closure criteria are standards that measure the success of selected closure activities in meeting closure objectives. Also referred to as targets (Doran 1981), closure criteria should be clearly established to evaluate reclamation and restoration projects (Ruis-Jaen and Aide 2005) by meeting the closure objectives for each project component. Closure criteria should be measurable, realistic, and achievable within a specified time frame (Huggard and Nadeau 2013) to ensure successful reclamation of project components. Closure criteria can be site-specific or adopted from provincial/territorial/federal standards and can be narrative statements or numerical values.

3.1.6 Reclamation Research

Studies and investigations which are aimed at providing site-specific performance information, proof of concept and ultimately design refinement for closure measures are best referred to as reclamation research. Reclamation research includes engineering studies and/or focused research undertaken with the intention of reducing uncertainties to an acceptable level. It is the results of targeted reclamation research programs which provide the technical basis for mitigation and reclamation technologies that will be incorporated into both primary closure and contingency planning.

3.1.7 Closure Monitoring

Major mine monitoring programs typically consists of three phases:

- Assessment – Baseline conditions of ecosystems that will potentially be affected by the mine (complete);
- Operational – confirms or refutes accuracy of predictions of mine effects that were made during the environmental assessment (ongoing); and
- Transition/Post-Closure – monitoring that begins with the start of the approved decommissioned and reclamation activities, and carries on into the post-closure period (outlined in this RCP).

Defining monitoring needs during the assessment phase ensures that measurable targets are relevant to achieving the overarching goals of the closure plan. Monitoring of closure components at the Mine will continue until such a time that closure objectives have been met.

3.1.8 Eagle Gold Mine Reclamation and Closure Objectives

The goal of the RCP is to return the Mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities. This goal guides the selected closure scenario for the Mine through the above-mentioned objectives-based closure planning method. Fundamental closure planning objectives developed by Yukon Government (2013) in the Reclamation and Closure Planning for Quartz Mining Projects have been used to guide the development of detailed objectives that are site-specific, defined by factors that include environmental conditions, site conditions and community expectations.

These clearly defined closure objectives and tangible criteria against which to measure performance are presented in Tables 3-2 and 3-3. The detailed site-specific objectives were developed to address physical

stability, chemical stability, health and safety, ecological conditions and sustainability, land use, aesthetics, socio-economic expectations, long-term certainty and financial considerations.

Table 3-2: Summary of Decommissioning and Reclamation Planning for Mine Components

Component-Specific Activities	Water Retention and Water Conveyance Structures	Open Pit	Waste Rock Storage Areas and Temporary Stockpiles	Heap Leach Facility	Mine Infrastructure	Roads and Other Access	Temporary Closure Site Conditions
Fundamental Objective[1]	**Physical Stability**	**Health and Safety** **Physical Stability** **Chemical Stability**	**Physical Stability** **Chemical Stability**	**Physical Stability** **Chemical Stability**	**Health and Safety**	**Land Use** **Health and Safety**	**Health and Safety**
Closure Objectives	Ensure decommissioning of, or upgrades to, water retention and sediment control structures, and appurtenances, in such a way that drainage at, and adjacent to the site, is stable in the long term. Convey flows into and throughout the mine footprint, and off the site in a controlled, stable fashion under a reasonable range of anticipated conditions.	Ensure physical and chemical stability of decommissioned pit in accordance with designs. Able to withstand severe climatic and seismic events. Protect humans and wildlife from topographic hazards associated with pit and pit lake.	Ensure long-term physical stability to minimize erosion, subsidence or slope failure. Able to withstand severe climactic and seismic events. Ensure long-term chemical stability such that runoff and seepage quality meets water quality criteria.	Ensure drain-down and cyanide destruction are conducted in controlled manner. Ensure long-term physical stability to minimize erosion, subsidence or slope failure. Able to withstand severe climatic and seismic events. Ensure long-term chemical stability such that runoff and seepage quality meets water quality criteria; if required, contingency measures to be implemented.	Remove potential threats to public health and safety. Decommission facilities in a safe manner. Ensure physical stability of any remaining structures.	Remove access to Mine areas that were not accessible before Mine initiation. Re-establish access for FNNND to specific areas (TBD). Re-establish FNNND access through Mine site to traditional hunting grounds. Minimize, eliminate or manage invasive species colonization at linear features in closure. Provide for public safety.	Ensure public health and safety and protection of the environment in the event of a temporary closure and to manage risks associated with potential abandonment of site
Closure Measures	Convert ponds to passive treatment systems (Events Pond and Lower Dublin South Pond) as needed, or construct a passive treatment system (Platinum Gulch) Maintain suitable gradients to permit flow and reduce infiltration and erosion. Design facilities to minimize contact of surface flow with mine influenced soils. Modifications of flow patterns at site to achieve enhanced stability or accommodate water quality or other objectives.	Safety berm highwalls and control access to pit. Engineer controlled outflow from pit lake.	Stack waste rock during operations in accordance with the design so stable configurations and meet closure criteria. Engineer waste covers to reduce infiltration, encourage vegetation growth and minimize erosion. Provide engineered covers in combination with passive treatment systems to yield water quality acceptable for discharge.	Heap drain-down and transition period (additional gold recovery) planned and managed and fully integrated with water management plan. Cyanide destruction using in-situ biological treatment (or active treatment) during rinsing stage. Rinsing and recirculation to enhance degradation of cyanide and neutralization of heap solution. Progressively building closure cover (and re-grading as necessary) during draindown stage. Converting Events Pond to passive treatment system. Complete cover with enhanced engineered improvements to minimize infiltration	Mine site structures not required will be decommissioned and removed (partially or completely). Foundations demolished and buried. Pad areas re-graded as necessary, scarified and re-vegetated	Identify key or essential roads in coordination with FNNND. Develop a plan to minimize the advance of invasive species. Decommission, scarify and vegetate non-essential roads to provide a means of protection to public safety and encourage development of wildlife habitat	Care and maintenance of facilities. Site water and solution management/treatment as required.

[1] Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and Closure Costing Guide (2013), Government of Yukon.

Component-Specific Activities	Water Retention and Water Conveyance Structures	Open Pit	Waste Rock Storage Areas and Temporary Stockpiles	Heap Leach Facility	Mine Infrastructure	Roads and Other Access	Temporary Closure Site Conditions
Closure Criteria	The design flow at closure for all ditches, channels and other structures on site (storage ponds, spillways, culverts) is selected as the 100-year flood. Calculations are based on the 100-year storm event calculated over a time of concentration specific to each catchment (generally varying between 30 and 60 minutes for the Mine site). Ditches and channels for water conveyance will have a trapezoidal cross-section. They may be lined or unlined depending on the longitudinal slopes and associated flow velocities. Lining will consist of rip rap, grouted rip rap or synthetic liners. Maximum slopes are not to exceed 10% when possible. For steeper slopes, larger rip rap or energy dissipation structures will need to be put in place to avoid erosion. Culverts and pipes for seepage flows will be sized to accommodate the 1:100 year flood. Culvert minimum diameters are set at 750mm. Pipes will be buried to avoid freezing.	Open pit floor area will be flooded to the level of the west side of the open pit. The open pit disturbance area will be approximately 77 ha. Perimeter and upper benches within the overburden layer will be re-sloped and re-vegetated. Pre-development and ongoing geochemical characterization of rock indicates that they will not be acid generating. Although neutral pH metal leaching of arsenic and antimony has been identified as a potential, in open pit wall run-off, water quality modeling has indicated that direct discharge of pit lake water to Haggart Creek can occur.	At closure the PG WRSA will have an overall slope of 2.5H:1V. Valley bottom drainage under the dump at approximately 21° in WRSA footprint. At closure the EP WRSA will have an overall slope of 2.5H:1V. Valley bottom drainage under the dump ranges from 8° to 25°.	There are three stages in the HLF closure process: • residual leaching, • cyanide destruction rinsing, and • draindown. The HLF is the last feature to be reclaimed as the cyanide destruction and rinsing processes will take ~2 years, following mining cessation, ore placement and additional time for gold recovery. The construction of a store-and-release cover will start when cyanide destruction is complete (meets criteria), Seepage will be treated in a passive system constructed down gradient of the facility (converted from the Events Pond). The mine water treatment plant will remain on the Mine site for a period of at least 5 years after it was last required to treat effluent discharged from the site if necessary.	Decommissioning and demolition of mine infrastructure will ensure physical stability and remove potential hazards /threats to the public safety and health. Will include: • Decommissioning of facilities in a safe manner; • Ensuring physical stability of any remaining structures; • Removal/proper disposal of hazardous reagents, chemicals and materials: • Removal and decommissioning mechanical, electrical equipment and motors; • Demolition of steel structures: • Removal of concrete slabs; • Bulk earthworks will be completed, foundations broken up and buried in situ; • Foundations with rebar will be left in place.	The public South McQuesten / Haggart Creek Road will remain. Potato Hills access will be preserved (requested by FNNND), as well as other mine access roads associated with on-going and historical exploration activities that are covered under separate permit authorizations. All unnecessary culverts will be removed and stream channels stabilized.	Operation/Closure criteria apply.

Table 3-3: Summary of Decommissioning and Reclamation Planning for Valued Components

Valued Components	Terrain Stability	Soils	Watercourses	Aquatic Resources	Vegetation/Wildlife Habitat	Paleontological, Cultural and Heritage Values	Socio-economic benefits and effects
Fundamental Objective[2]	**Health and Safety** **Physical Stability**	**Health and Safety** **Physical Stability** **Chemical Stability**	**Physical Stability**	**Physical Stability** **Ecological Conditions and Sustainability**	**Ecological Conditions and Sustainability**	**Aesthetics**	**Socio-economic Expectations**
Closure Objectives	Remaining terrain should present no more significant hazard to people and wildlife by achieving conditions similar to local features. Ensure physical stability such that slopes, excavations and other disturbed lands are in a condition that will limit the incidence of soil erosion, slumping and other instabilities that are likely to impede re-vegetation of a reclaimed site, pose a threat to public safety, lead to wildlife mortality, or cause excessive sediment loads to enter nearby water bodies. Can withstand severe and climatic seismic events	Minimize exposure to and mobilization of substances that pose a risk to human health and environment through physical and chemical stability of remaining soils.	Ensure long-term stability for natural and created watercourses so that erosion and sediment processes are within a natural and acceptable condition	Minimize exposure to and mobilization of substances that pose a risk to aquatic resources through physical and chemical stability. Ensure long-term solutions rely on passive treatment technologies. Provide for functioning aquatic habitats similar to or improved from current conditions.	Ensure long-term physical stability that allows for successful re-vegetation. Encourage natural development of native species and communities. Return temporarily developed land to sustainable wildlife habitats.	Ensure protection of geological values and heritage features associated with mine site.	Reclamation and closure implementation avoids or minimizes adverse socio-economic effects on local and Yukon communities, while maximizing socio-economic benefits. Reclamation and closure activities achieve outcomes that meet community and regulatory expectations; maximizing benefits for NND businesses and citizens
Closure Measures	Re-grading of pads and facilities as necessary. Utilize safety berms where appropriate. Develop an inventory of site pre-disturbance, or a terrain disturbance registry to be populated during life of mine; develop a terrain hazard reduction plan to include registry from which hazard mitigation can be measured against. Develop engineered soil covers that reduce erosion potential, while accounting for precipitation patterns, infiltration capacity, cover depth, cover materials erosion sensitivity, optimal rooting depths of grasses and woody species prescribed for re-vegetation. Consider natural (bioengineered) and synthetic controls where erosion potential may still exist	Conduct site contamination assessment at initiation of closure activities. Develop site remediation plan that could include excavation, landfilling or land treatment, in-situ immobilization or amelioration.	Establish stable hydraulic geometries. Establish native species to enhance bank and floodplain stability. Where appropriate, rehabilitate disturbed watercourses to achieve characteristics similar to pre-disturbance conditions. Compensate for disturbed water courses as required under applicable legislation.	Utilize active water treatment technologies during transition to permanent closure. Progressively develop passive treatment technologies as facilities close, which will provide applicable results to improve designs. Integrate as appropriate various passive treatment technologies (bioreactor, engineered wetlands, in heap treatment) to address challenges with site-specific terrain conditions. Use results from progressive reclamation opportunities to refine and improve the methods for engineering a soil cover that minimizes metal leaching. Compensate for disturbed habitat as required under applicable legislation	Establish self-propagating early seral native plant communities. Encourage opportunities for progressive reclamation over the Mine life. Preparation and use of soil salvage location to store salvaged top soil and organics for reclamation. Develop growth media borrow locations. Develop re-vegetation plans according to prescriptions which include native species. Develop and implement invasive plant species SOPs. Ensure that synthetic liners or other materials that may entrap wildlife are not exposed.	Heritage Impact Assessment and Heritage Conservation Plan. Sites of significant heritage value identified and included in historic sites registry.	

[2] Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and Closure Costing Guide (2013), Government of Yukon.

Valued Components	Terrain Stability	Soils	Watercourses	Aquatic Resources	Vegetation/Wildlife Habitat	Paleontological, Cultural and Heritage Values	Socio-economic benefits and effects
Closure Criteria	Terrain of limited stability (e.g. permafrost, steep slopes, or wetlands) will be given special attention, and protected where possible.	Climate and resulting permafrost (discontinuous) are largest influences on soil development. Soil is limited for reclamation suitability primarily by high coarse-fragment content, due to development of soils from weathered bedrock. Average rooting depths are 50 cm, but can reach depths of over 120 cm. Baseline arsenic levels are naturally high in the soil, but do not limit soil reclamation suitability. The majority of the soil textures in the area are sandy-silt to silty-sand loam matrix with angular or tabular coarse fragments ranging from gravels to boulders. Soil types within the property that can be used as store and release covers for the HLF and WRSAs include: • Locally sourced compacted colluvium and placer tailings mixture over compacted waste rock or HLF. • A cap will be placed over the colluvium. • The cap will be seeded with species suitable for the aspect that the structure is facing.	Conveyance courses (channels and ditches) will be constructed with trapezoidal channel shape, sized to 1 in 10 year 24 hour storm for lined channels and 1 in 100 year 24 hour storm capacity for ditches. They will be lined with rip rap to minimize erosion and reduce flow velocity.	The mine site supports a self-sustaining biological community that achieves land use objectives. Reclamation and closure activities will protect the aquatic environment from mine-related degradation and restore environments that have been degraded by mine-related activities.	Closure activities will be conducted to promote ecological sustainability of re-vegetated areas to ensure (for example): • Vegetation growth in conveyance channels will minimize channel erosion and provide habitat for aquatic species • Vegetation growth on waste areas (HLF and WRSAs) will be sustainable and provide sufficient evapotranspiration to minimize infiltration into the capped waste deposit.	Closure activities will be conducted to restore the sites to an aesthetic condition consistent with surrounding areas.	Closure activities will be performed in a manner consistent with the CBA, and where possible utilize local and Yukon businesses in the performance of the work.

3.2 DESIGN CRITERIA

Reclamation and closure planning has been guided by many design criteria, ranging from regulatory and guidance based-criteria, constraints imposed by the Mine location and history, and criteria established through consultation with stakeholders.

Design criteria that are relevant to closure are presented in this section by closure component, including the applicable geotechnical, hydrologic, and/or water quality criteria for that component. Each section also includes references to the guidance documents, reports and analysis that support the design criteria.

3.2.1 Open Pit

A range of geologic, economic and geotechnical inputs were used to develop the open pit design for the Mine to maximize value while minimizing potential risk.

Over the life of the Mine, the Eagle pit will be advanced in four major stages. Based on the surface topography, the open pit is scalloped-shaped with a lower west highwall. To maintain access to the primary crusher, a single ramp will spiral down to the bottom of the final pit. This ramp will also connect to the external access road that leads to the truck shop. No ramps will be maintained inside the final pit above the crusher elevation to minimize stripping requirements.

Over the life of the Eagle pit, based on the current mine plan and regulatory approvals, approximately 86 Mt of ore will be placed on the HLF, 15 Mt of run of mine ore (i.e., blasted rock from the pit potentially reclassified as economic based on operational and financial considerations) at this time will be placed with 101 Mt of waste in waste rock storage areas. During the operations period, ore production will increase to the nominal production rate of 29,500 t/d on an annual average basis.

Using the designed phases and cut-off grade strategy, a detailed production schedule was developed. Operational constraints were added to ensure realistic mining sequences with scheduling conducted quarterly for the first two years of production, and then annually.

Further detail, including design criteria for the open pit is provided in the *Mine Development, Operations and Material Management Plan*.

3.2.2 Waste Rock Storage Areas

Design acceptability criteria for slope stability analyses for the WRSAs are based on the “Guidelines for Mine Waste Dump and Stockpile Design” (Hawley & Cunning, 2017). The suggested minimum factor of safety (FoS) presented in the guidelines are re-produced in Table 3-4 with each minimum FoS reflecting different levels of confidence in the understanding of site conditions, material parameters, and consequences of instability. The recently published Hawley & Cunning (2017) guidelines are considered an update and improvement to the previous (BCMWRPRC 1991) interim design acceptability criteria, which did not distinguish between important factors such as the size of facility, consequence of failure or confidence in foundation conditions.

Table 3-4: Suggested WRSF Stability Acceptance Criteria (Hawley & Cunning, 2017)

Consequence[1,3]	Confidence[2,3]	Static analysis		Pseudostatic	Maximum allowable strain
		Minimum FoS	Maximum PoF	Minimum FoS	
Low	Low	1.3 - 1.4	10 - 15%	1.05 - 1.1	≤ 1%
	Medium	1.2 - 1.3	15 - 25%	1.0 - 1.05	≤ 1.5%
	High	1.1 - 1.2	25 - 40%	1.0	≤ 2%
Moderate	Low	1.4 - 1.5	2.5 - 5%	1.1 - 1.15	≤ 0.75%
	Medium	1.3 - 1.4	5 - 10%	1.05 - 1.1	≤ 1%
	High	**1.2 - 1.3**	**10 - 15%**	**1.0 - 1.05**	**≤ 1.5%**
High	Low	≥ 1.5	≤ 1%	1.15	≤ 0.5%
	Medium	1.4 - 1.5	1 - 2.5%	1.1 - 1.15	≤ 0.75%
	High	1.3 - 1.4	2.5 - 5%	1.05 - 1.1	≤ 1%

Notes:

1. **Consequence**

   Low Consequence: waste dumps and stockpiles with overall fill slopes less than 25° and less than 100 m high and repose angle slopes less than 50 m high. No critical infrastructure or unrestricted access within potential runout shadow. Limited potential for environmental impact. Long-term (> 5 years) exposure for sites subject to very low to low (< 350 mm) annual precipitation; medium-term (1-5 years) exposure for sites subject to moderate (350-1000 mm) annual precipitation; short-term (< 1 year) exposure for sites subject to high (1000-2000 mm) annual precipitation; dry season construction/operation only for sites subject to very high (> 2000 mm) annual precipitation or intensive rainy season(s).

   Moderate Consequence: waste dumps with overall fill slopes less than 30° and less than 250 m high, or with repose angle slopes less than 100 m high. No critical infrastructure or unrestricted access, or robust containment/mitigative measures to protect critical infrastructure and access within potential runout shadow. Potential for moderate environmental impact, but manageable. Long-term (> 5 years) exposure for sites subject to moderate (350-1000 mm) annual precipitation; medium-term (1-5 years) exposure for sites subject to high (1000-2000 mm) annual precipitation; short-term (< 1 year) exposure for sites subject to very high (> 2000 mm) annual precipitation or intensive rainy season(s).

   High Consequence: waste dumps with overall fill slopes more than 30° and more than 250 m high, or with repose angle slopes more than 200 m high. Critical infrastructure or unrestricted access within potential runout shadow with limited runout mitigation/containment measures. Potential for high environmental impact that would be difficult to manage. Long-term exposure (> 5 years) for sites subject to high (1000 – 2000 mm) annual precipitation; medium (1-5 years) exposure for sites subject to very high (> 2000m) annual precipitation or intensive rainy season(s).

2. **Confidence**

   Low Confidence: limited confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or potential instability mechanism(s). Poorly defined or optimistic input parameters; high data variability. For proposed structures, investigations at the conceptual level with limited supporting data. For existing structures, poorly documented or unknown construction and operational history; lack of monitoring records; unknown or poor historical performance.

   Moderate Confidence: – moderate confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or potential instability mechanism(s). Input parameters adequately defined; moderate data variability. For proposed structures, investigations at the pre-feasibility level with adequate supporting data. For existing structures, reasonably complete construction documentation and monitoring records; fair historical performance.

   High Confidence: high confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or potential instability mechanism(s). Well-defined, conservative input parameters; low data variability. For proposed structures, investigations at the feasibility level with comprehensive supporting data. For existing structures, well documented construction and monitoring records and good historical performance.

3. In cases where the guidance for consequence or confidence conflicts or is unclear, selection of the appropriate level should be based on judgment, and the rational for the selection should be documented.

The EP and PG WRSA designs were determined by the Engineer of Record (EoR) to fall within the moderate consequence and high confidence categories. Corresponding minimum recommended factors of safety are 1.2 to 1.3 for static and 1.0 to 1.05 for pseudostatic loading conditions according to the guidelines.

Based on an evaluation of the potential seismic activity for the Mine site, the seismic design event utilized for the WRSAs design is an earthquake with a 1-in-475-year return period that generates a peak horizontal ground acceleration (PGA) of 0.14 g.

The EoR concluded the following from the results of the slope stability analyses:

- Stability of the bottom lifts, founded on colluvium soils control stability of both the PG (1027.5 m bench) and EP (947.5 m bench) WRSAs with static safety factors of 1.3 calculated for the lowest bench of each facility. Safety factors for the initial, temporary waste rock benches planned in the upper PG valley (1252.5 m and 1162.5 m benches) indicate static safety factors of 1.2 due to the steeper natural ground surface;
- Individual lifts placed over existing waste rock rather than native foundation soils indicate significantly higher safety factor of 1.5 for static loading which exceeds the minimum acceptable safety factor;
- Safety factors for large-scale failures involving multiple waste rock benches exceed minimum requirements with safety factors of 1.4 to 1.9 for the EP and PG WRSAs;
- The minimum acceptable safety factor for pseudostatic analyses of 1.05 was met or exceeded for all cases except the initial, temporary PG 1252.5 m bench which yielded a 1.03 safety factor;
- Sensitivity analyses indicate that WRSA stability is sensitive to pore water pressures within the bottom waste rock benches and foundation soils beneath the toes for both the PG (1027.5 m bench) and EP (947.5 m bench) facilities. The stability analyses have been conducted assuming that the rock drains beneath the bottom benches will work as designed and drain freely, and that static water levels will not exceed more than 1 or 2 meters above the pre-mine ground surface;
- Potentially thaw-unstable ice-rich materials have also been identified in the upper Eagle Pup drainage. The EP WRSA has been re-designed since the Tetra Tech/NELPCO (2018a) field investigation to be constructed in a bottom-up sequence, thereby buttressing the upper lifts potentially founded on ice-rich materials; and,
- Liquefaction potential of colluvium soils beneath the WRSAs is considered to be low.

3.2.3 Heap Leach Facility

Regulations and permitting requirements for Heap Leach Facilities in the Yukon Territory are not expressly stated, but rather, they have historically relied on regulations from other regions and on precedence established from other successful projects. Previous studies (Scott Wilson 2010) selected Brewery Creek, the gold mine (operational from 1996 until 2002) located approximately 55 km east of Dawson City, Canada as the example facility to follow for permitting guidelines. This was understood to be the only HLF permitted in the Yukon, the design of which was based on the Nevada State guidelines and associated permitting limitations. This approach was carried into the feasibility study and through final design along with best engineering practice.

The Heap Leach Facility design standards adopted for the project include:

- The regulatory requirements of Yukon and Canada;
- The Yukon Water Board Licensing Guidelines (2009);
- The existing project Water Use License permit requirements;
- Guidelines from the Canadian Dam Association (2013, 2014); and

- Permitting requirements of the State of Nevada. These are not regulatory requirements in the Yukon, but are considered as standards for best practice.

As stated above, there are currently no published international standards for the design and construction of a heap leach facility. Nevada State Guidelines provide minimum standards for heap leach facilities and have been adopted for the Mine. North American standards for the design of embankment dams were used where applicable, specifically the Canadian Dam Association (CDA 2014) guidelines. Table 3-5 summarizes the main technical and permitting requirements for the State of Nevada for the key elements of the HLF design.

Table 3-5: Summary of Design Requirements for the State of Nevada

Heap Leach Feature	Description
Leach Pad	System must have containment capability equal to or greater than that of a composite liner consisting of a synthetic liner over one foot of compacted soil at a permeability of 1 x 10^{-6} cm/s or 1 x 10^{-5} cm/s if a leak detection system is used beneath portions of the liner with the greatest potential for leakage.
	Synthetic liners must be rated as having resistance to fluid passage equal to a permeability of less than or equal to 1 x 10^{-11} cm/s.
Solution Ponds	System must have a primary synthetic liner and a secondary liner that meet the above-described liner specifications. The synthetic liners must be separated by a fluid transmission layer which is capable of transmitting leaked fluids at a rate that will ensure that excessive head will not develop on the secondary liner.
Solution Management and Containment	Process components must be demonstrated to have the capacity to "withstand" the runoff from a 100-year, 24-hour precipitation event. In addition, facility fluid management systems must demonstrate the capability of remaining "fully functional and fully contain all process fluids including all accumulation resulting from a 25-year, 24 hour precipitation event. The foregoing standards are minimal and additional containment capacity may be required if surface water bodies or human populations are in close proximity to the facility, or if groundwater is shallow.
Foundations	Consider static / dynamic loads and differential movement or shifting.
Construction QA/QC	Regulations require that each applicant develop and carry out a quality assurance and quality control program for liner construction. A summary of the QA/QC program must be submitted with as-built drawings after construction has been completed.
Neutralization/Detoxification of Spent Ore	Spent ore, whether it is to be left on pads or removed from a pad, must be rinsed until it can be demonstrated either the remaining solid material, when representatively sampled does not contain levels of contaminants that are likely to become mobile and degrade the waters of the state under the conditions that will exist at the site, or, the spent ore is stabilized in such a manner as to inhibit meteoric waters from migrating through the material and transporting contaminants that have the potential to degrade the waters of the state.

3.2.3.1 Design Basis

The Yukon Water Board Licensing Guidelines for Type A Quartz Mining Undertakings provide specific guidance for selected mine site earthworks facilities, as follows:

"General: Type A quartz mining undertakings may vary significantly in their magnitude and in the potential environmental effects associated with them. The guidelines contained in this document assume the development of a mine with significant potential environmental impacts such as those resulting from acid rock drainage or the failure of a large tailings impoundment. Projects such as this are considered to fall into the Very High Consequence of Failure category described in the Canadian Dam Safety Guidelines (January 1999). In situations where this category is not appropriate for some reason, the Board is prepared to consider well developed and documented

justification for the use of alternative consequences of failure criteria developed in accordance with the Canadian Dam Safety Guidelines."

Further, specific design guidance is included as follows:

- The design, construction, operation, maintenance and surveillance of dams and associated water management structures should be carried out in a manner which is consistent with the recommendations contained in the Canadian Dam Safety Guidelines (January 1999) for the Very High Consequence Category, unless compelling reasons consistent with the Canadian Dam Safety Guidelines for a lower consequence category are provided.
- Long-term dams and associated water management structures should be designed to withstand the Maximum Credible Earthquake (MCE) and pass the Probable Maximum Flood (PMF). Shorter term structures may be built to lesser standards but a compelling rationale for the selected criteria must be provided.
- Heaps should be designed to have a minimum factor of safety under static loading of 1.3 for short term cases (i.e. within the mine life) and 1.5 for long term cases (i.e. abandonment) as described in the Investigation and Design of Mine Dumps (British Columbia Mine Dump Committee, 1991). The factor of safety for dams should be as recommended in the Canadian Dam Safety Guidelines (January 1999).
- Designs for dams and associated water management structures, rock dumps, and heaps should recognize the probable presence of permafrost and should include appropriate measures to manage permafrost and maximize the stability of the structures consistent with recommendations contained in the Canadian Dam Safety Guidelines (January 1999).

Although the 1999 and 2007 CDA are referenced are referenced by the regulatory guidance documents summarized above, the latest version of the CDA guidelines (2013), including the Application of Dam Safety Guidelines to Mining Dams Technical Bulletin (2014), was used for the Mine.

BGC (2017b) performed a dam breach analysis to provide input into evaluating the HLF embankment hazard classification, per Canadian Dam Association (2013) guidelines. The results confirm that the confining embankment can be classified as a Significant dam (i.e., there is no permanent population or infrastructure at risk in the inundation path, and restoration of fish and wildlife habitat is highly possible). Nevertheless, the WUL for the Mine imposes an Extreme dam classification (the most stringent possible) for hydrologic and storage criteria. Thus, the Extreme hydrologic and storage criteria have been used for the HLF design. The WUL does not include a requirement to impose more conservative geotechnical criteria beyond those specified in the CDA guidelines; nevertheless, geotechnical criteria applied here assume a High hazard dam classification. The dam classifications used here also consider the input from the Application of Dam Safety Guidelines to Mining Dams (CDA 2014) and have been vetted during consideration and consultation between owner and regulators.

3.2.3.2 Design Criteria

The parameters and criteria are presented in the Heap Leach Facility Detailed Design Report (BGC 2017). The following supporting information to the Heap Leach Facility Detailed Design Report provide rationale for geotechnical design criteria: Seismic Peak Ground Accelerations for Design, Slope Stability Analyses and Settlement Analysis.

3.2.4 Water Management Facilities

For the purpose of the Construction and Operations Water Management Plan, the Mine area has been subdivided into a number of hydrologic watersheds and sub-watersheds. The watershed boundaries are based on the proposed end of mine topography.

A risk-based approach was used to select appropriate design storm events for water management facilities. This approach weighs the likelihood of failure, versus the consequence of failure, on a case-specific basis. Design storm events were developed by assessing the annual recurrence of precipitation events of a given magnitude, as described in the Eagle Gold Project Water Management Plan Version 2020-01.

Design storm events are used as input parameters in most rainfall-runoff type storm water models (e.g., HEC-HMS, PCSWMM, TR-55). Design criteria for various design elements are listed in Table 3-6.

Table 3-6: Water Management Design Criteria

Infrastructure Element	Design Element	Design Basis Criteria
Unlined Diversion or Collection Ditches	Design Storm Event	1 in 10-year, 24-hour for capacity and 1 in 100-year for armouring
	Maximum Depth (mm): Type 1 or 2	300
	Minimum Width (mm): Type 2	500
	Minimum Grade (%): Type 1 or 2	1.00
	Maximum Grade (%): Type 1 or 2	1.70
	Maximum Side Slopes: Type 1 or 2	3H:1V
	Maximum Velocity (m/s): Type 1 or 2	1.5
Lined Diversion or Collection Ditches	Design Storm Event	1 in 10-year, 24-hour for capacity and 1 in 100-year for armouring
	Design Storm Event (above major infrastructure)	1 in 100-year
	Maximum Depth (mm)	500
	Minimum Grade (%): Type 3 / Type 4	1.00 / 0.50
	Maximum Grade (%): Type 3 / Type 4	4.5 / 15
	Maximum Side Slopes: Type 3 / Type 4	2.5H:1V / 1H:1V
	Maximum Velocity (m/s): Type 3 / Type 4	2.33 / 4.0
Pipes	Design Storm Event	1 in 10-year, 24-hour
Culverts	Minimum Diameter (mm)	750
	Design Storm Event (Areas < 1 ha)	1 in 10-year, 24-hour

Infrastructure Element	Design Element	Design Basis Criteria
	Design Storm Event (Areas > 1 ha)	1 in 100-year, 24-hour
	Design Storm Event (at stream conveyances)	1 in 200-year, 24-hour
	Design Storm Event (downstream of the Lower Dublin South Pond)	1 in 1000-year, 24-hour
	Maximum HW/Diameter Ratio	2.0 for less than 1.0 m 1.5 for greater than 1.0 m
	Minimum Grade (%)	0.5
	Minimum Velocity (m/s)	1.0
	Maximum Velocity (m/s)	4.0
Temporary Sediment Control Ponds and Exfiltration Areas	Design Storm Event (storage)	1 in 10-year, 24-hour
	Design Storm Event (overflow spillway)	1 in 100-year, 24-hour
	Depth Requirements (m):	
	Minimum Dead Storage (sediment)	0.5
	Maximum Dead Storage (sediment)	50% of Total Depth
	Minimum Live Storage (liquid)	1.5
	Minimum Freeboard (100-year event)	0.5
Permanent Sediment Control Ponds	Design Storm Event (storage)	1 in 10-year, 24-hour
	Design Storm Event (overflow spillway)	1 in 200-year, 24-hour
	Design Storm Event (overflow spillway – dam)	1 in 1000-year, 24-hour
	Depth Requirements (m):	
	Minimum Dead Storage (sediment)	0.5
	Maximum Dead Storage (sediment)	50% of Total Depth
	Minimum Live Storage (liquid)	1.5
	Minimum Freeboard (200-year event)	0.5
	Dewatering (pumping capability)	Full Dewater in 24 hours

4 EXISTING ENVIRONMENT DESCRIPTION

Section 4 presents a summary of existing conditions for bio-physical components including climate, surface water, groundwater, vegetation and wildlife, soil and bedrock and seismicity. Environmental baseline data were collected between 2007 and 2017, construction phase data were collected between 2017 and 2019, and data collection as part of operations monitoring is ongoing. In addition to the reports noted below, the latest monitoring data is reported in the 2019 Annual Report (VGC 2020a), available on the YWB Waterline website registry for QZ14-041-1 under the Reports section, and in the Environmental Characterization Report (VGC 2020b), available through EMR.

4.1 CLIMATE

Climate information for the Mine is available on the YWB Waterline website registry for QZ14-041 in the following:

- Environmental Baseline Report: Climate (Stantec 2010a) - Exhibit 1.3.1
- Environmental Baseline Report: Climate 2011 Update (Stantec 2012a) - Exhibit 1.3.2
- Climate Baseline Summary (KP 2013a) - Exhibit 1.3.3
- Hydrometeorology Report (KP 2013c) - Exhibit 1.3.14

Additional climate information is available under the YWB Waterline website registry for QZ14-041-1 in the following:

- Eagle Gold Climate Baseline Report (Lorax 2016a) - Exhibit 1.19.1
- Eagle Gold Climate Baseline Report (Lorax 2018a) - Exhibit 1.19.2
- Eagle Gold Hydrometeorology Report (Lorax 2017a) - Exhibit 1.19.5
- Eagle Gold Climate Data Report (Lorax 2019a) - Appendix M to the Eagle Gold Project 2018 Annual Report
- Eagle Gold Climate Data Report (Lorax 2020a) - Appendix R to the Eagle Gold Project 2019 Annual Report

4.2 SURFACE WATER

4.2.1 Hydrology

Hydrology and streamflow conditions at the Mine site are described in a number of hydrology related baseline reports. These include the following reports available on the YWB website registry for QZ14-041:

- Environmental Baseline Report: Hydrology (Stantec 2010b) - Exhibit 1.4.1
- Environmental Baseline Data Report: Hydrology 2011 Update (Stantec 2012b) - Exhibit 1.4.2
- Hydrology Baseline Data Summary (KP 2013) - Exhibit 1.4.3

Additional hydrology and streamflow information is available under the YWB Waterline website registry for QZ14-041-1 in the following:

- Eagle Gold Hydrology Baseline Report (Lorax 2016b) - Exhibit 1.19.3
- Eagle Gold Hydrology Baseline Report - 2018 Update (Lorax 2018b) - Exhibit 1.19.4
- Eagle Gold Streamflow Monitoring Report - 2018 Updated (Lorax 2019b) - Appendix C to the Eagle Gold Project 2018 Annual Report
- Eagle Gold Streamflow Monitoring Report - 2019 Updated (Lorax 2020b) - Appendix E to the Eagle Gold Project 2018 Annual Report

4.2.2 Water Quality

Surface water quality conditions at the Mine site are described in a number of related baseline reports. These include the following reports available on the YWB website registry for QZ14-041:

- Environmental Baseline Report: Water Quality and Aquatic Biota (Stantec 2012d)- Exhibit 1.4.4
- Baseline Water Quality Report (Lorax 2013) - Exhibit 1.4.5

Additional water quality information is available under the YWB Waterline website registry for QZ14-041-1 in the following:

- Baseline Water Quality Report 2016 Update (Lorax 2017b) - Exhibit 1.19.6
- Water Quality Summary in Support of QZ14-041 Annual Report (Lorax 2020c) - Appendix F to the Eagle Gold Project 2019 Annual Report

These reports characterize water quality in receiving environment watercourses that may be affected by the Mine, including seasonal variability and identification of contaminants of concern and parameters with concentrations that are naturally elevated as well as parameters that may be appropriate indicators.

4.3 GROUNDWATER

Hydrogeologic baseline characterization studies were conducted from 2009 to 2012 and previous investigations were conducted in 1995 and 1996 (GeoViro 1996 and Knight Piésold 1996a, b, c). This information is available in available on the YWB Waterline website registry for QZ14-041 in the following:

- Environmental Baseline Report: Hydrogeology (Stantec 2011b) - Exhibit 1.4.6
- Environmental Baseline Data Report: Hydrogeology 2011-2012 Update (Stantec 2012c) - Exhibit 1.4.7
- Groundwater Data Report (BGC 2013b) - Exhibit 1.4.8
- Aquifer Test for Camp Water Supply (Stantec 2010c) - Exhibit 1.4.9
- Lower Dublin Gulch Valley Aquifer Tests (BGC 2012f) - Exhibit 1.4.10
- Open Pit Pumping Tests (BGC 2012g) - Exhibit 1.4.11
- Production Well Completion Report for PW-BGC12-04 (BGC 2013c) - Exhibits 1.4.12.1 to 1.4.12.5
- Eagle Gold Project Numerical Hydrogeologic Model (BGC 2014) - Exhibits 1.4.13.1 to 1.4.13.5

Additional information is available under the YWB Waterline website registry for QZ14-041-1 in the following:

- Eagle Gold Groundwater Quality Characterization Report (Core Geoscience Services 2017) - Exhibit 1.19.8
- Eagle Gold Project 2020 Numerical Hydrogeological Model Updated - Final (BGC 2020) - Appendix J to the Eagle Gold Project 2019 Annual Report

4.4 VEGETATION AND WILDLIFE

Vegetation and wildlife in the area of the Mine site are characterized in the Environmental Baseline Report: Vegetation (Stantec 2011c), presented as Exhibit 1.5.3 on the YWB Waterline website registry for QZ14-041, and the Environmental Baseline Report: Terrestrial Wildlife (Stantec 2011d) is presented as Exhibit 1.5.2 on the YWB Waterline website registry for QZ14-041.

4.5 GEOLOGY AND SOILS

An Environmental Baseline Report: Surficial Geology, Terrain and Soils (Stantec 2010e) is available on the YWB Waterline website registry for QZ14-041 as Exhibit 1.3.5.

Extensive characterization of surficial and bedrock material for geotechnical and geochemical purposes has also been undertaken on the Mine site and are available in the following documents on the YWB Waterline website registry for QZ14-041:

- Geochemical Characterization Report, Eagle Gold Project (SRK 2014) - Exhibit 1.3.12
- Geochemical Characterization of Proposed Excavation Areas and Borrow Sources from the Eagle Gold Project (SRK 2013) - Exhibit 1.3.13
- Site Facilities Geotechnical Investigation Factual Data Report (BGC 2009) - Exhibit 1.3.6
- 2010 Geotechnical Investigation for Mine Site Infrastructure, Factual Data Report (BGC 2011a) - Exhibits 1.3.7.1 to 1.3.7.6
- 2011 Geotechnical Investigation for Mine Site Infrastructure, Factual Data Report (BGC 2012a) - Exhibits 1.3.8.1 to 1.3.8.16
- 2011 Geotechnical Investigation for Mine Site Infrastructure, Foundation Report (BGC 2012b) - Exhibit 1.3.9
- 2012 Geotechnical Investigation for Mine Site Infrastructure, Factual Data Report (BGC 2012c) - Exhibits 1.3.10.1 to 1.3.40.4
- Estimate of Ice-rich Material (BGC 2012h) - Exhibit 1.3.11

Additional area specific ground condition information is also discussed in various Issued for Construction and As-Built information submitted for each facility to the YWB and EMR either as standalone submission or with the annual reports required by the agencies.

4.6 SEISMICITY

A site-specific seismic hazard analysis (TetraTech, 2012) was performed for the Mine. This information is available and is available on the YWB Waterline website registry for QZ14-041 as Exhibit 1.9.2.1.3.

5 PROJECT DESCRIPTION

The Mine involves the construction, operation, closure and reclamation of a gold mine in central Yukon. The Mine is located 85 km from Mayo, Yukon using existing highway and access roads. The Mine involves open pit mining at a production rate of approximately 10 million tonnes per year (Mt/y) ore, and gold extraction using a three-stage crushing process, heap leaching, and a carbon adsorption, desorption, and recovery system over the life of mine.

Construction of the major fixed Mine facilities (e.g., conveying systems, ADR Plant, warehouses, etc.) began in August 2017 and occurred over approximately two years. The Mine entered the operations phase (defined by VGC as the commencement of ore stacking on the HLF) in July 2019. Construction and development of the open pit, heap leach pad, and WRSAs will continue throughout the life of mine.

Economic gold-bearing ore and uneconomic barren waste rock are removed from the Eagle pit by conventional drill, blast, shovel and truck mining technology. The footprint of the final open pit is dictated by various operational and geotechnical considerations as mining progresses and is currently assumed to have a surface area of approximately 77 ha. Based on the surface topography, the open pit will be scalloped-shaped with a lower west highwall.

Uneconomic barren waste rock will be deposited in one of two waste rock storage areas (WRSAs) or utilized in the construction of various mine facilities. At the date of this RCP, waste rock has only been delivered to the Platinum Gulch (PG) WRSA. As mining advances, waste rock will be delivered to both the Platinum Gulch (PG) WRSA and the Eagle Pup (EP) WRSA. Based on current mine planning, it is assumed that from 2023, waste rock will only be trucked to the EP WRSA. The PG WRSA will contain approximately 23 Mt with a footprint of 41 ha, and will be constructed in 45 m lift heights. The EP WRSA will contain approximately 93 Mt of waste rock over the LOM contained within a foot print of approximately 77 ha. The EP WRSA will also be constructed in 45 m lift heights. The EP WRSA storage volume will also include approximately 15 Mt of low-grade material that will be kept segregated and accessible for future processing as feasible.

Economic gold-bearing ore is transported from the open pit by haul truck and delivered to the primary crusher at a rate of up to 29,500 tonnes per day (t/d), based on a 12-month average. Ore is crushed to a passing 80 percent (P80) particle size of 6.5 mm in a 3-stage crushing process. All three crushing stages are located north of the open pit. Ore is crushed and then conveyed by covered conveyor to the secondary crusher, secondary screens and tertiary crushers and screens. During an approximate 90-day period during each winter, ore is temporarily stored on a prepared pad following primary crushing. The stored ore is blended back into the crushing circuit over the rest of the year so that the total ore delivery rate to the HLF is approximately 39,200 tpd.

Crushed ore is delivered and stacked on a lined solution collection pad. Process solution containing cyanide is applied to the ore to extract gold and collected by the HLF pad leachate collection and recovery system. The HLF pad consists of a composite liner system in the upper and lower reaches of the facility. The HLF embankment impounds the lower section of the HLF pad, and forms an In-Heap Pond (essentially a saturated zone within the lower extent of the HLF) for primary storage of pregnant solution. Because the In-Heap Pond is saturated ore, there are no open or exposed surface areas of liquid sodium cyanide solution during normal operations. A lined events pond external to the HLF was constructed for the life of the Mine to temporarily store excess process solution during rare upset events, and/or freshet events as needed. It also collects direct precipitation that occurs on the pond and water transferred from other surface water management infrastructure. Any solution contained in the events pond is recycled back into the heap leach circuit as required.

Gold extraction utilizes cyanide heap leaching technology. Similar technology was employed in Yukon at the Brewery Creek mine in the late 1990s, and has been employed successfully in other cold climates such as the United States of America (Alaska), Chile, Argentina, Turkey and Russia. Process solution containing cyanide is applied to the ore to extract gold and then collected by the HLF leachate collection and recovery system.

Gold-bearing “pregnant” solution (pregnant leach solution [PLS]) is pumped from the HLF to the gold recovery plant. Gold is recovered from the PLS by activated carbon adsorption and desorption, followed by electro-winning onto steel cathodes, and on-site smelting to gold doré. This process is referred to as the adsorption, desorption, and recovery (ADR) process. The gold-barren leach solution that remains after passing through the carbon columns is re-circulated back to the HLF.

Other mine infrastructure includes a camp complex with administration and mine offices, a modular assay laboratory, a mine truck shop and water treatment plant (both to be constructed in 2021), a substation, and a guardhouse. Support components also include fuel and explosive storage facilities, a transmission line and an access road into the Mine site.

Figure 1-2 provides the general arrangement for the Mine at the end of active mining operations.

6 TEMPORARY CLOSURE

6.1 DEFINITIONS AND TEMPORARY CLOSURE OBJECTIVES

Mine closure refers to the cessation of mining operations. Temporary closure is defined in the Yukon Mine Site Reclamation and Closure Policy (Financial and Technical Guidelines) as closure that exceeds six months and is not expected to last longer than five years and can include both planned and unplanned closure (Yukon Government 2006). Yukon Government's guidance on the development of Reclamation and Closure Plans (2013) elaborates further:

> *Temporary closure is a closure in which mining related activities cease with the intent of resuming activities in the near future. Temporary closures may be planned or unplanned and could arise from a variety of circumstances including financial challenges, design failures, extreme climatic conditions, etc. Temporary closures may last for weeks, or could extend for years. Maximum durations of temporary closure periods are frequently defined in QMLs and WLs. At the conclusion of a defined temporary closure period, proponents will be required to implement permanent closure measures. In the event of a temporary closure, a full review of the RCP as well as liability estimate and security may be undertaken.*

According to the Type A WUL QZ14-041-1, Temporary Closure is considered to have commenced if notification is provided by the VGC of a planned Temporary Closure or on the first day after no new ore has been placed on the heap for 150 days and no Mining is occurring, and either:

a) once irrigation of the Heap Pad for the production of gold has ceased; or

b) once irrigation of the Heap Pad for the production of gold has occurred for a period of 12 months since the last stacking of ore into the HLF.

This section describes the measures and activities that will be undertaken for the Mine in the event of a temporary closure, and how protecting public health and safety, and the environment will be accomplished. It presents fundamental and site-specific reclamation and closure objectives for temporary closure, and demonstrates how they will be met. The main activities would focus on site stabilization and safety, followed by care and maintenance of all site facilities and routine monitoring until production recommences or full closure is implemented. Depending on the reasons for a temporary cessation of mining operations, the process facilities can be expected to continue to recirculate solutions and recover gold until all economically recoverable gold is processed.

There are certain general objectives that are paramount during temporary closure:

> *In general, temporary closure plans must focus on ensuring public health and safety, protecting the environment and managing risks associated with potential abandonment of a site. (Yukon Government 2013)*

The following sections identify the fundamental and site-specific closure and reclamation objectives that are relevant to mine components and values during a potential temporary closure of the Mine, with associated temporary closure measures planned to ensure these objectives are met.

6.2 TEMPORARY CLOSURE MEASURES

6.2.1 Physical Stability

Temporary closure objectives are to ensure that all mine-related structures and facilities are physically stable and performing in accordance with designs and that all mine-related structures, facilities and processes can withstand severe climatic and seismic events.

6.2.1.1 Open Pit

A geotechnical engineer will be retained to conduct water management and physical stability monitoring at the Open Pit. The pit will be allowed to fill with water to a pre-determined level during temporary closure if mining operations have advanced to a depth to allow for it. This level will depend on the pit geometry at the time of temporary closure. After the pit has filled to this level, water will be conveyed via ditches/pipes to treatment throughout the temporary closure as necessary.

6.2.1.2 Waste Rock Storage Areas and Temporary Ore Stockpiles

Temporary closure objectives for the WRSAs include:

- Ensure short-term physical stability to minimize erosion, subsidence or slope failure;
- Ensure short-term chemical stability such that runoff and seepage quality meets water quality criteria; and
- Ensure water management remains operational to convey runoff water to water treatment as required.

The following actions will be undertaken during operations to reduce the risk of WRSA physical instability at any point following their construction, including a temporary closure:

- Maintain sloped grading and bench surfaces to minimize surface water infiltration and erosion of downstream slopes;
- Continue with waste rock and heap leach facility management plan to store waste and ore in a chemically stable manner; and
- Maintain surface water collection ditches and the LDSP to control surface drainage.

During a temporary closure, WRSA inspections will be carried out by a geotechnical engineer on the predetermined schedule, as laid out in the Environmental Monitoring, Surveillance and Adaptive Management Plan (EMSAMP). Any repairs or maintenance of the facility, or improvements to runoff, erosion and sediment control will be undertaken on recommendation from the inspections.

6.2.1.3 Mine Infrastructure

The physical stability of the fuel and explosives facility will be maintained by a senior operator throughout the temporary closure. Controlling site access and ensuring the security of the fuel and explosives facilities will be of paramount importance.

6.2.1.4 Heap Leach Facility

The HLF includes primarily the leach pad, embankment and events pond. Temporary Closure Objectives for the HLF will ensure short-term physical stability to minimize erosion, subsidence or slope failure.

There are three factors influencing physical stability of the HLF that will be addressed during temporary closure. These factors are: 1) upslope runoff interception, 2) runoff, erosion and sediment control and 3) dust control. The upslope runoff interception ditches, which route water around the HLF will be maintained by the site caretaker as necessary during temporary closure. This will help to reduce the volume of water introduced into the HLF and limit the volume of water that requires storage and treatment. Precipitation may contribute to runoff, erosion and sediment concerns, which will be monitored and controlled by the site caretaker as required.

6.2.1.5 Water Management Facilities

Temporary closure objectives for water management facilities will ensure short-term physical stability to maintain site-wide water management.

To maintain physical stability throughout temporary closure, sediments will be excavated from ditches, sediment basins and ponds as required. Snow and aufeis will also be removed from the ditches and ponds if accumulation is hindering the performance of the facilities. Ditches will be inspected for physical integrity.

Visual inspections of the water management facilities will be undertaken as required.

6.2.2 Chemical Stability

Temporary closure objectives are to achieve chemical stability such that runoff and seepage quality meet effluent quality standards prior to discharge and manage release of constituents at rates that do not cause unacceptable exposure in the receiving environment.

6.2.2.1 Waste Rock Storage Areas and Temporary Ore Stockpiles

Temporary closure measures for the WRSAs will ensure short-term chemical stability such that runoff and seepage quality meet effluent quality standards prior to discharge.

Chemical stability of the runoff and seepage from the WRSAs will be maintained through the continued implementation of the water management plan. Periodic visual monitoring of the toes of WRSAs will enable one to search for and identify the emergence of new seeps. Following the identification of a new seep, additional activities (e.g., flow measurements and sample collection), as described in the EMSAMP will also be conducted. Water treatment by the Mine Water Treatment Plant (MWTP) that is deemed necessary, will be implemented as required.

6.2.2.2 Heap Leach Facility

With regard to chemical stability, the HLF includes the leach pad and in-heap pond. Temporary Closure Objectives for the HLF are to achieve chemical stability such that runoff and seepage quality meet effluent quality standards prior to discharge.

Chemical stability of the HLF will be maintained and monitored during temporary closure. The site caretaker will be responsible for monitoring and maintenance of the HLF and pond leak detection and recovery systems including emptying the leak collection sumps as required. Drainage from the leak collection sumps will be recycled back into the solution inventory. The groundwater monitoring wells will be maintained throughout temporary closure to enable ongoing monitoring as required by the regulatory approvals.

Water management and leaching from the HLF are concerns during temporary closure. For the period required during any temporary closure, a senior operator will continue to operate HLF pumping, irrigation, solution collection

and storage, reagent addition and gold recovery facilities, and maintain the HLF as a zero-discharge facility to the extent possible. Temporary closure of the HLF shall strive to avoid any discharges unless they are necessary to manage excess water volumes within the heap. Any discharge must meet EQS and may be treated at the MWTP as required (see Section 6.2.2.5). The site caretaker will assist with maintenance of the HLF pumping, irrigation, solution collection and storage facilities as required during temporary closure.

6.2.2.3 Mine Infrastructure

Site infrastructure, including buildings and process machinery, will be emptied/drained of hazardous reagents and process fluids where appropriate and stabilized for temporary closure based on recommendations from mechanical and chemical suppliers, contractors and engineers. This includes the proper storage on site or removal of all hazardous wastes, including waste hydrocarbons, coolants, lubricants, reagents, and process chemicals. A hazardous material inventory and description of hazardous material storage on site will be prepared.

6.2.2.4 Water Management Facilities (Ponds, Pipes and Ditches)

Water management facilities will be inspected and maintained during the period of temporary closure to ensure effective site-wide water management and the ability of the facilities to collect runoff and seepage, provide sufficient water storage, and convey any water requiring treatment to the MWTP.

6.2.2.5 Mine Water Treatment

To ensure the temporary closure objective of chemical stability is met, if required, cyanide detoxification or Mine Water Treatment Plant capability will be maintained during temporary closure.

Cyanide destruction capability is available on site so that it is readily available to treat excess cyanide contaminated water should the need arise and shall be maintained during temporary closure. The Mine Water Treatment Plant will be commissioned prior to loading ore on Phase 2 of the HLF and once installed, shall be maintained during temporary closure.

6.2.3 Health and Safety

Temporary closure objectives are to eliminate or minimize existing hazards to the health and safety of the public, workers and area wildlife by achieving conditions similar to local area features or preventing access to areas that are not reclaimed.

6.2.3.1 Open Pit

Pit development will cease in a temporary closure situation. The key temporary closure goal for the Open Pit relates to the protection of human health and safety, and therefore access control is the key temporary closure measure. Areas of particular concern for the public, if any, will be bermed or fenced and posted with warning signs.

6.2.3.2 Heap Leach Facility

If the HLF is not in use for a sufficient amount of time for dust to become a concern, dust control will be carried out by the site caretaker.

6.2.3.3 Mine Infrastructure

Structures and facilities that will require attention and monitoring during a temporary closure at the Mine will consist of:

- process offices;
- lab;
- shops and warehouse;
- process plant site;
- primary, secondary and tertiary crusher facilities;
- laydown area;
- gatehouse;
- main sub-station and onsite generators;
- camp/recreation area;
- water treatment plant and water tanks; and
- overland conveyors.

Temporary closure objectives for these facilities will be to remove potential threats to public health and safety and to maintain the physical stability and operational capacity of any remaining structures and assets. The process plant and related facilities will be secured. Gold and non-essential chemicals will be removed from the site. All essential chemicals will remain onsite and will be securely stored within double containment as necessary. The site caretaker will conduct weekly visual inspections of the buildings and solution containment areas. The caretaker will also secure the buildings and maintain the equipment required for solution recirculation and treatment. The solution treatment plant and required chemicals will be maintained.

Infrastructure that is not listed above as mine facilities and ancillary facilities; but exists within the mine footprint, and infrastructure outside the mine footprint (e.g., transmission line and access road upgrades) will also require maintenance throughout a temporary closure.

The bulk explosives inventory will be removed from site and explosives storage containers and facilities will be inspected regularly. Hazardous wastes that will be removed from site include coolants and lubricants. All hazardous fluids will be drained from non-essential machinery and mining equipment based on recommendations from mechanical and chemical suppliers, contractors and engineers.

6.2.3.4 Mine Water Treatment Plant

The appropriate management of site water and solutions is critical to meeting the objective of protecting human health and safety and the environment in the event of a temporary closure. All water management facilities, including the use of the mine water treatment plant, will be managed as if operations were continuing. A detailed description of the management of water during the operational period can be found in the *Water Management Plan* submitted in accordance with Clause 100 of QZ14-041-1 and available on the YWB Waterline website registry for QZ14-041-1. Linkan (2014), available on the YWB Waterline website registry for QZ14-041 as Exhibit 1.11.2, summarizes the preliminary design and operating approach of the MWTP.

The temporary closure objective at the Mine Water Treatment Plant will be to maintain equipment performance throughout the temporary closure period. This will be achieved by securing the buildings and maintaining the equipment required for solution recirculation and treatment. Water quality systems will be monitored as required.

6.2.3.5 Ecological Conditions and Sustainability

Temporary closure objectives are to protect the aquatic, terrestrial and atmospheric environments from mine-related degradation and ensure that the mine area supports a self-sustaining biological community that achieves water quality objectives in the receiving environment and land use objectives outside of the area of disturbance.

During temporary closure, measures to mitigate the risk of wildlife exposure to facilities (i.e., the Events Pond) which may contain dilute sodium cyanide solution, include:

- Fencing and controlling (minimizing) the growth of vegetative cover at any mine site location with compromised water quality (e.g., the Events Pond);
- Not reclaiming the Events Pond shoreline to prevent wildlife use of vegetation; and
- Using Bird Balls™, netting, sound cannons or reasonable alternatives to deter waterfowl or other birds from landing on the pond.

6.2.3.6 Land Use

Temporary closure objectives are to ensure that lands affected by mine-related activities (e.g., building sites, chemical and fuel storage sites, roads, sediment ponds, waste rock storage areas, etc.) do not cause adverse conditions that prevent productive long-term use of land, i.e., conditions which are typical of surrounding areas or provide for other land uses that meet community expectations.

The access road will require periodic visual inspections. Private contractors will be retained to complete maintenance of surface drainage infrastructure, culvert repair or road grading as required. Other miscellaneous infrastructure buildings will be secured and structural inspections and maintenance will be provided by the caretaker as necessary.

6.2.3.7 Aesthetics

Temporary closure objectives are integrated to encourage any restoration activities that are performed are visually acceptable.

However, aesthetics will not be a primary management driver for temporary closure because the mine is primarily being managed so that mining activities can recommence within 5 years or less.

6.2.3.8 Socio-economic Expectations

Temporary closure objectives also include minimizing or preventing adverse socio-economic effects on local and Yukon communities, while maximizing socio-economic benefits.

Temporary closure will be performed by local workers that already were working at the mine, or by local contractors performing the required site management and maintenance work.

6.2.3.9 Site Management

Access control, security and site care and maintenance are key to meeting the critical temporary closure objectives of protecting human health and safety and the environment. The Care and Maintenance Program is the program where a reduced workforce will inspect and maintain property assets, restrict access to mine site locations, manage site chemical and explosive storage, continue to implement the site Water Management Plan, and continue with the operational environmental monitoring for applicable elements. The Care and Maintenance Program will be implemented once the transition from operating mine to suspended activities is achieved. Transition activities before the Care and Maintenance Program is initiated will include:

- Complete all necessary outstanding repairs; and
- Winterize seepage collection systems, mobile equipment, buildings and other site infrastructure.

The temporary decommissioning and closure activities will only be conducted to a level such that all infrastructure, process and mining facilities are stable for a period of up to five years and such that full operations can be resumed in a timely manner should the decision be made to resume production. To meet these objectives of temporary closure, the essential equipment and assets will remain onsite or readily available through contract services to maintain infrastructure and facilities. All hazardous materials will either be removed from site and/or stored in a safe and secure manner with primary and secondary containments as required to ensure compliance with applicable regulations.

Full-time care and maintenance staff will be housed onsite in the main camp to provide security, control site access and monitor site activities. Access to the site will be restricted and enforced on a 24 hour per day basis. Restricted access consists of a vehicle gate at the entrance to the property.

Two caretakers will work different rotations to provide site security and monitoring. These two individuals are in addition to the reduced operations staff. Site equipment and vehicles will be kept onsite for the use of both the operations staff and caretakers. Contingency equipment (dozer/loader) will also remain onsite or readily available through contract services should earthworks be required during the temporary closure phase.

During temporary closure, the security gates on the access road will be locked with warning signs clearly posted at the gates and at key locations around the property indicating risk of entry. All site buildings will be kept locked and secured. The main access road will be maintained for access by the caretakers and operations staff with equipment retained onsite (grader/loader) or readily available through contract services.

The caretakers and operations staff will be responsible for a variety of activities including, but not limited to, the following:

- Supporting site inspections, security controls, first aid, emergency response and communications;
- Supporting water management, MWTP operations, sample collection and site monitoring;
- Supporting site monitoring and sample collection to ensure compliance with regulatory requirements;
- Ensuring critical process equipment such as pumps, generators and some mobile equipment are maintained in operating condition;
- Providing for snow removal and road access;
- In conjunction with VGC’s corporate office conducting any relevant administrative responsibilities.

It is currently planned that multiple staff will cover duties on a 24-hour basis as required.

6.2.4 Financial Considerations

Temporary closure objectives are to minimize outstanding liability and risks while the site is in temporary closure.

6.2.4.1 Entire Site

Financial considerations include:

- Transition to the Care and Maintenance Program which includes essential site repairs, if any, and winterization of seepage collection systems, mobile equipment, buildings and other site infrastructure. This will only be conducted to a level such that all infrastructure, process and mining facilities are stable for a period of up to five years and such that full operations can be resumed in a timely manner should the decision be made to resume production. To meet these objectives of temporary closure, the essential equipment and assets will remain onsite or readily available through contract services to maintain infrastructure and facilities.
- All hazardous materials will be secured at site including with primary and secondary containments as required to ensure compliance with applicable regulations.
- Full-time care and maintenance staff will be housed onsite in the main camp to provide security, control site access and monitor site activities. Access to the site will be restricted and enforced on a 24 hour per day basis. Restricted access consists of a vehicle gate at the entrance to the property.
- Two caretakers will work different rotations to provide site security and monitoring. These two individuals are in addition to the reduced operations staff. Site equipment and vehicles will be kept onsite for the use of both the operations staff and caretakers. Contingency equipment (dozer/loader) will also remain onsite or readily available through contract services should earthworks be required during the temporary closure phase.
- The main access road will be maintained for access by the caretakers and operations staff with equipment retained onsite (grader/loader) or readily available through contract services.
- The caretakers and operations staff will be responsible for a variety of activities including, but not limited to, the following:
    - Supporting site inspections, security controls, first aid, emergency response and communications;
    - Supporting water management and gold recovery, MWTP operations, sample collection and site monitoring;
    - Supporting site monitoring and sample collection to ensure compliance with regulatory requirements;
    - Ensuring critical process equipment such as pumps, generators and some mobile equipment are maintained in operating condition;
    - Providing for snow removal and road access; and
    - In conjunction with VGC's corporate office conducting any relevant administrative responsibilities.
- It is currently anticipated that multiple staff will cover duties on a 24-hour basis as required.

Table 6-1 presents a summary of the care, maintenance and monitoring activities of the various Mine components which would occur in the case of a temporary closure.

Table 6-1: Summary of Care and Maintenance Activities and Monitoring During Temporary Closure

Facility	Area	Care and Maintenance Activities	Monitoring Activities	Monitoring Frequency
Open Pit	Physical Stability	Site inspection for stability	Visual inspections	Weekly
	Water Management	Allow the pit to fill to pre-determined level depending on pit geometry at the time of closure, then continue to convey water to treatment, as necessary		
Waste Rock Storage Areas and Temporary Ore Storage Area	Physical Stability	Site inspection for stability	Visual inspections and water quality and systems monitoring	Weekly
	Chemical Stability	Continue to convey water to treatment Maintain groundwater and surface water quality monitoring stations		
	Water Management	Erosion and sediment control of WRSA surface; rock drain outlet maintenance	Visual inspections as outlined in operating licenses	Weekly – more frequent during freshet as needed
Heap Leach Facility	Physical Stability	Events Pond maintenance; Interceptor ditches maintenance; Runoff, erosion and sediment control Dust control	Visual inspections	Following major rain events and freshet
	Chemical Stability	Maintain groundwater monitoring wells and LDRS sump integrity	Water quality and systems monitoring	Weekly to monthly
	Leaching and Process Recovery System	Maintain process water management including HLF pumping, HLF irrigation, solution collection and storage, reagent addition and gold recovery facilities	Water quality and systems monitoring	Monthly for the term of temporary closure
Water Management Facilities (Ponds, Pipes and Ditches)	Physical Stability	Excavating sedimentation in ditches and ponds; Snow and aufeis removal as necessary	Visual inspections	Following major rain events and freshet
	Chemical Stability	Maintain groundwater and surface water quality monitoring stations	Water quality and systems monitoring	Weekly to monthly
Mine Water Treatment Plant	Equipment Performance	Secure buildings and maintain equipment for solution recirculation and treatment	Water quality and systems monitoring	Daily
Infrastructure Buildings, Equipment and Pads	Physical Stability	Secure buildings and provide maintenance; Conduct any sediment and erosion control measures as needed	Visual inspections	Quarterly and following freshet and major rain events
Main Access Road, haul roads secondary roads	Physical Stability	Maintain surface drainage, culvert repair, bridge maintenance, road grading and snow removal	Visual inspections	Quarterly and following freshet and major rain events
Entire Site	Security		Visual inspection	Ongoing

Facility	Area	Care and Maintenance Activities	Monitoring Activities	Monitoring Frequency
		Secure buildings and provide maintenance; Continue to restrict access to site; Remove non-essential chemicals and explosives from site. Remove all gold from site. Safely store in secure double containment area all essential chemicals		
	Reporting	Documentation of care and maintenance activities	Not applicable	As required by licenses

6.3 TEMPORARY CLOSURE CRITERIA

The site temporary closure criteria are to maintain water management, and as required, discharge water to meet the effluent quality standards of the Mine. The water quality treatment and discharge criteria during temporary closure are presented in Table 6-2.

Table 6-2: Effluent Water Quality Standards

Parameter[1]	*Effluent Quality Standards (Maximum concentration in a grab sample in mg/L)*
pH	6.5 to 8
TSS	15.00
Cl-	250
SO_4	1850
Nitrate-N	19.5
Nitrite-N	0.12
NH_3-N	7.5
Total Cyanide	1.0
CN_{WAD}	0.03
Al (diss)	0.4
Sb	0.13
As	0.053
Cd	0.00125
Cu	0.026
Co	0.026
Fe	6.4
Pb	0.05
Hg	0.00008
Mn	7.7
Mo	0.45
Ni	0.50

Parameter[1]	*Effluent Quality Standards (Maximum concentration in a grab sample in mg/L)*
Se	0.025
Ag	0.01
U	0.09
Zn	0.23
Acute Lethality 96-h LT50 using rainbow trout[2]	Non-toxic at 100% concentration
Acute Lethality 48-h LT50 using *Daphnia magna*[3]	Non-toxic at 100% concentration

NOTE:
1 All Concentrations are total values, unless otherwise noted
2. pH non-adjusted, Reference Method EPS 1/RM/13
3. pH non-adjusted, Reference Method EPS 1/RM/14

6.4 MONITORING

Monitoring activities for the site will follow the surveillance programs as described in the *Environmental Monitoring, Surveillance and Adaptive Management Plan* and will ensure that information gathered will enable reporting in accordance with clause 145 of QZ41-014-1. These may include, but are not limited to the following:

- Regular inspections of the site to observe and document the condition of any changes to site security, public safety measures, mine infrastructure (e.g., the MWTP), equipment (including equipment and back-up equipment to manage heap fluid), supplies, and staffing;
- Documentation of potential environmental or public health and safety issues;
- Routine physical stability monitoring;
- Routine chemical stability monitoring;
- Regular water quality and flow monitoring;
- Monitoring of existing climatic conditions will continue with operation of the onsite weather station(s);
- No regular air monitoring beyond PM_{10}, $PM_{2.5}$ and TSP is planned; however, visual monitoring of the crushing facility, waste rock storage areas, open pit and HLF conducted daily and weekly;
- Regular inspections of the HLF/ponds and the LDRS including emptying of leak collection sumps, as applicable and to enable VGC to report on the volume of water within the HLF monthly;
- Submittals of inspection and monitoring reports on a regular basis as required;
- Response to any security/safety breaches as required.

Site inspections and monitoring will likely be conducted by vehicle when seasonally possible. Some areas of the site may be inaccessible in winter as snow removal will not be reasonable in some locations. Inspection results will be documented and submitted on a monthly basis as required by QZ14-041-1. The inspection documentation will include details of the financial capacity for VGC to continue the appropriate management of the temporary

closure. Reports of changes to the physical status of any part of the site may warrant a follow-up investigation by the appropriate personnel. Some elements of the monitoring program such as geotechnical and structure inspections and non-routine water quality and biological monitoring, will be conducted by appropriate professionals. The results of these inspections will be included in annual reports and other required submittals.

6.5 NOTIFICATION AND REPORTING

If a temporary closure is planned by VGC, a notice will be provided to the YWB and EMR at least 60 days in advance of the temporary closure. The notice provided will include the reasons for entering a temporary closure and the anticipated duration. In accordance with QZ14-041-1, if Temporary Closure lasts longer than 12 consecutive months, an annual notice will be provided in writing to the YWB and the Inspector on or before the anniversary of the date of Temporary Closure and include the reason(s) for and the expected duration of the continuation of Temporary Closure.

If a temporary closure period is determined to have commenced based on the conditions provided in clause 138 of QZ14-041-1 (as shown in Section 6.1), VGC will provide notice to the YWB and EMR within 7 days of the trigger events. VGC will provide notice to the YWB and EMR immediately following any unplanned Temporary Closure.

In addition to the monthly reports specified in Section 6.4, the monthly status report submitted in March, if applicable, will include details with respect to the status of equipment and personnel required for the removal or management of ice and snow from diversions and collections channels and for the undertaking of HLF water management during freshet.

7 PROGRESSIVE RECLAMATION

Reclamation, closure planning, and implementation will provide for progressive reclamation to the greatest extent practical during mining operations. Progressive reclamation is often implemented during operations (or after construction) to reduce the amount of financial security required to be provided and maintained by VGC and to support ongoing reclamation research for final closure of the Mine.

7.1 PLATINUM GULCH WASTE ROCK STORAGE AREA

Stacking of the Platinum Gulch (PG) WRSA will enable progressive reclamation during the operational life of the WRSA. Progressive reclamation will help to reduce dust and infiltration of precipitation and runoff through the cover as well as minimize the visual footprint of the WRSA sooner. For safety reasons, such as falling rock onto worksite below, major cover placement will be started toward the end of the Platinum Gulch WRSA 3-year lifespan. A cover trial on one bench of the PG WRSA was established in 2020 that, if stable and meeting closure objectives, will remain in place. Beginning in Year 4, and after the PG WRSA cover is completed, a field scale proto passive treatment system (PTS) will be constructed downstream from the WRSA based on on-going research results during the previous year(s). This PTS will inform part of the reclamation research plan to test treatment methods through seasonal changes, while serving as an on-site demonstration of the potential effectiveness of the design. Over the next few years, and depending on results, design enhancements can be implemented as necessary. See Section 8.10 for more discussion on the PG PTS.

When initiated, reclamation of the footprint of Platinum Gulch WRSA will require the construction of an engineered cover. Cover material will consist of locally sourced mixtures of colluvium and placer tailings placed to a 0.3 m depth over the waste rock. A 0.2 m cover of previously stockpiled topsoil during WRSA site preparation will cover the engineered mixture. The cap will be re-vegetated with plant species suitable for the west facing aspect of the PG WRSA. Further details on the cover trials on the PG WRSA initiated in 2020 are provided in Section 10.

7.2 EAGLE PUP WASTE ROCK STORAGE AREA

The majority of the Eagle Pup WRSA will be closed during the first year of closure; however, progressive reclamation may be performed prior to closure on areas where final contour has been achieved to help reduce dust, minimize infiltration of precipitation and enhance runoff from the covered areas as well as minimize the visual footprint of the WRSA sooner.

7.3 ICE-RICH OVERBURDEN STORAGE AREA

To date, significant quantities of ice-rich overburden have not been encountered and as such local storage of small volumes has been utilized. If any stage of the IROSA is developed, it will be essentially non-active after dumping has ceased, the surface area will be re-vegetated early on during operations to minimize the potential effects of sediment movement during rainfall-runoff and/or freshet and maximize the effect of infiltration. Depending on soil volume requirements for reclamation, some of the IROSA soils may be utilized, and so these areas will need to be reclaimed again.

7.4 REVEGETATION PROGRAM

The objective of the initial revegetation program is to design and implement erosion control measures using revegetation and bioengineering techniques that would act as interim methods to control potential erosion and to

also inform final reclamation decisions with respect to appropriate seed mixes and revegetation methods. The revegetation program is targeted for the areas that had been identified as having the potential for erosion and sediment release.

In September and October 2019, the revegetation program was initiated by VGC with expertise provided by Laberge Environmental Services and support from Yukon College students enrolled in the Environmental Certification Program. Five areas were targeted for the 2019 program by utilizing the methods shown in Table 7-1 and Figure 7-1.

Table 7-1: 2019 Revegetation and Bioengineering Treated Areas

Location	Method / Installation	Notes
LDSP slopes	Hand seeding	Application of commercially available fowl bluegrass, ticklegrass, tufted hairgrass and wheatgrass Test plots with wheatgrass, fescue and bluejoint seeds harvested from Keno area and bluejoint and yarrow seeds harvested from the Mine site
	Willow staking	Eastern shore of the LDSP
	Pole drains	Two pole drains installed in erosion channels
	Wattle fence	Installed upslope of other bioengineering works to support erosion control
	Coco-matting	Geotextile installed upslope of wattle fence to help control any undercutting
	Jute mats	Test location to determine effectiveness of product for slope stabilization and vegetation growth
Ditch C	Hand seeding	Application of commercially available fowl bluegrass, ticklegrass, tufted hairgrass and wheatgrass
HLF Embankment	Hand seeding	Application of commercially available fowl bluegrass, ticklegrass, tufted hairgrass and wheatgrass
Events Pond western fill slope	Hand seeding	Application of commercially available fowl bluegrass, ticklegrass, tufted hairgrass and wheatgrass
Overland Conveyor drainage ditch	Willow staking	Willows were harvested from donor site but field conditions did not allow installation in 2019 and planned to be completed in 2020

The revegetation program continued in 2020. The 2020 program included evaluation of the success of the 2019 program, and the completion of seeding and willow staking in additional areas at the Mine site. Inspection of the areas that were part of the 2019 program showed that there was an outstanding success rate of close to 100% survival of willow staking, while seeded areas all had good growth and coverage of grass. Examples of areas revegetated during 2019 program during an August 2020 inspection are shown in Photo 7-1 and Photo 7-2.

The areas completed during the 2020 revegetation program are shown in Figure 7-1.

Additionally, the 2020 program included seed trials to evaluate the success of three native species. Two trial plot locations were selected for south and north facing aspects. In each location trial plots were constructed for three species, with duplicates for each, for a total of six 1 m^2 plots per trial location. The species selected for the trial are *Elymus sp.* (wheatgrass), *Festuca altai* (Altai fescue), and *Achillea millefolium* (yarrow). The seeds were purchased from a local supplier (Yukon Seed and Restoration) and are harvested within the local area. Prior to seeding, each plot was scarified to a depth of approximately 15 cm and any existing vegetation and large rocks were removed. Once the plots were prepared the seeds were scattered evenly throughout the square meter. The seeds were then gently tamped down to ensure good seed/soil contact. A buffer was left between each seeded plot. Commencing in the summer of 2021, annual monitoring of the trials will be conducted. The assessments will

measure the progress and allow for refinement of the prescriptions and techniques for application to similar areas requiring erosion control at the Eagle Gold Mine.

Seeding a steep slope near the LDSP, Sept 2019

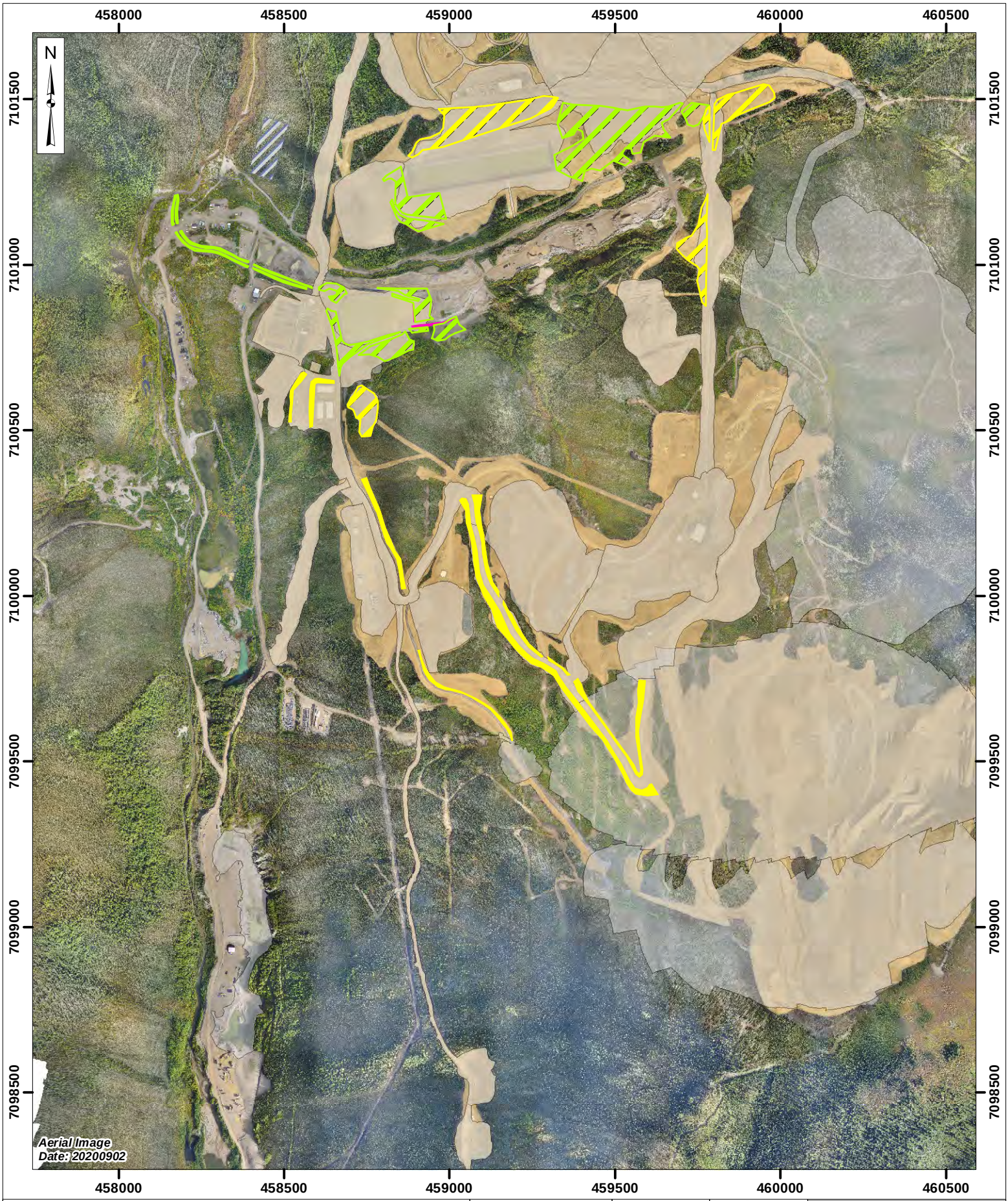
Good grass growth on same slope, August 2020

Photo 7-1: Slope Near the Weir Pond in 2019 and 2020

Installed willow staking, Sept 2019

Willows sprouting, August 2020

Photo 7-2: Willow Staking in 2019 and 2020



Legend:

2020 Revegetation
- Northern Reclamation Mix Seeding
- Fall Rye Seeding

2019 Revegetation
- Northern Reclamation Mix Seeding
- Willow Staking

- Major Facility
- Current Construction and Mining Areas
- Reserved Area

VICTORIA GOLD CORP

0 150 300
Meters

Projection: NAD 83 UTM Zone 8N

Drawn By: HC

Date: 2020/09/30

Figure: 7-1

EAGLE GOLD MINE
YUKON TERRITORY

Revegetation Program Areas

8 FINAL RECLAMATION AND CLOSURE MEASURES

8.1 CLOSURE SCHEDULE

Due to the extended process to draindown the HLF, the decommissioning and closure process of the Eagle Gold Mine will take several phases over a number of years to complete. The following outlines the activities that are planned to occur for each phase.

Phase 1 – 3 (2019 to 2027): Active mining, and mine closure research as described in Section 10. Complete cover construction on the PG WRSA and develop the passive treatment system (PTS) at PG WRSA.

Phase 4 (~2028-2029): Termination of mining and ore production, but continued irrigation of the ore stack for gold production; managed recirculation of the heap solution inventory; open pit begins to fill; begin building cover on EP WRSA; decommission crushers, some mine roads, temporary ore stockpile, explosives and magazine storage facilities; begin construction of PTS for Eagle Pup WRSA seepage at the LDSP.

Phase 5 (~20230 to 2031): Termination of gold production and beginning of rinsing and cyanide destruction (either passively or actively); managed pump-back of heap drain-down solution inventory; LDSP and PTS in place and being tested; LDSP PTS discharge to Haggart Creek when discharge criteria are met; PG PTS discharge to Haggart Creek when discharge criteria are met; open pit finished filling; decommission ADR; begin building cover on specific sections of the HLF, if feasible.

Phase 6 (~2032 to 2035): Controlled drain-down of heap (drain-down solution split into two flows: managed pump-back of heap drain-down solution inventory with proportion sent to MWTP). Enhanced evaporation and snowmaking in winter may be incorporated as part of solution management during this phase, and another may be infiltration to create in-heap bioreactor; begin conversion of Events Pond into PTS - when HLF seepage rate and concentration criteria are met - change from active treatment to passive treatment; open pit fills– afterwards flow allowed to drain to Haggart Creek (via PG PTS if necessary); complete building cover on HLF; decommission truck shop and reduce camp size, and decommission remaining site roads.

Phase 7 (~Years 2036 to TBD): All passive treatment systems in place; decommission MWTP once PTSs have been the only required treatment to reach discharge criteria for a period of five years; uncontrolled drain-down of heap – when seepage rate meets meteoric input; close substation and most of the camp infrastructure. Begin post closure monitoring and maintenance.

Phase 8 (~Years TBD): Post-closure monitoring and maintenance – all Mine facilities closed except that which is needed to support monitoring programs and PTS maintenance, as needed.

8.2 ORGANIZATION, SITE ACCESS & SECURITY

A number of personnel will be required on site to implement the various decommissioning and closure tasks. Generally, these tasks entail closure of mine workings, regrading of waste rock and overburden piles, decommissioning of the HLF and MWTP, salvage and removal of infrastructure, equipment and reagents, decommissioning of access roads and reclamation and revegetation of disturbed lands. These activities would be undertaken on a seasonal basis and directed by the onsite manager responsible for decommission and reclamation of the Mine. During site decommissioning, it is anticipated that at least a portion of the existing camp accommodations would remain on site to support site personnel. It is anticipated that during the initial post-closure phase, site security requirements will continue with a caretaker remaining on site following seasonal closure of

the site. A site inspection schedule will continue for the period of closure implementation (Phases 4 to 7) and then move into a post-closure monitoring period (Phase 8). Security personnel will no longer be required once decommissioning and reclamation activities are completed on the property. Once the majority of physical reclamation works are performed on the site, the number of employees or contractors required will be reduced. VGC is committed to having FNNND members employed during implementation of the RCP.

Controlled access will be maintained during implementation of the post-closure monitoring phase. Decommissioning and reclamation of haul and site roads will occur once closure measures have been completed at each facility and site access is no longer required.

Prior to decommissioning activities are completed onsite, and following a period of post-closure monitoring, VGC and FNNND will confirm which access roads are to remain open as determined by previous consultation processes.

8.3 SUPERVISION AND DOCUMENTATION OF WORK

All decommissioning and reclamation works will be supervised to ensure that works are constructed according to their design and that the work is properly carried out and documented. The mine manager or the construction supervisor will be responsible for supervising all closure works. Daily inspection procedures would be completed to document work progress, deficiencies and completion. Existing plans for spill response or other site internal procedures for fuel handling, waste disposal, fire control and suppression, health and safety and environmental management systems would be used, refined and followed as necessary.

Environmental inspections and tests conducted prior to the implementation of closure measures will be used to confirm areas requiring clean up.

Plans for all earth works and inspections will be prepared and submitted to the YWB and EMR for review prior to initiation as part of the final detailed RCP required by Clause 153 and 154 of QZ14-041-1. A competent engineer following standard quality control and assurance procedures will inspect and document this construction work. As-built plans and drawings will be completed and the results of the closure work that has been performed on the facilities documented in a final RCP report. This report would then be submitted to the YWB, EMR and appropriate regulatory agencies upon completion of closure activities.

A competent environmental practitioner following standard quality control and assurance procedures will design, direct and document all restoration work. A summary report of the works will then be prepared and submitted to the YWB, EMR, the FNNND and other appropriate regulatory agencies upon completion of closure activities.

Upon completion of the decommissioning and reclamation works, a final site plan report (summary text and drawings) will be prepared to outline the facilities or works remaining on the site following closure. This plan will identify the location of buried concrete structures or scrap and landfill disposal areas. It is expected that this plan would accompany an Application for a Certificate of Closure under the Yukon Quartz Mining Act.

Supervision and documentation of work will be consistent with VGC's commitment to proving the success of reclamation measures and with the overall objectives of the RCP including returning the mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities.

8.4 MINE RECORDS

As noted in the previous section, all relevant decommissioning and reclamation works will be documented. Active Mining period records showing the extent of mine workings would be retained by VGC. Other site records, files and plans will also be archived at the site. Where plans or drawings are required for mine safety reasons, these plans would also be submitted to government mine safety offices. As-built reports for structures completed for closure and the final site closure report will be retained for record by VGC and submitted to government agencies and boards as required.

8.5 ESTIMATED AREAS OF DISTURBANCE AT END OF MINE LIFE

The maximum estimated areas of disturbance and approximate dimensions (Table 8-1) include:

- Open Pit: 77 ha.
- Heap Leach Facility: 102 ha (including the heap embankment).
- Events Pond with approximately 300,000 m^3 of storage capacity.
- Waste Rock Storage Areas
    - Platinum Gulch WRSA approximately 23 Mt of waste rock with a final footprint of approximately 41 ha.
    - Eagle Pup WRSA approximately 93 Mt of waste rock with a final footprint approximately of 77 ha.
- For both WRSAs, overall slope angle of 2.5H:1V with construction in 45 m lifts

Table 8-1: Estimated Area of Disturbance at End of Mine Life

Component	Maximum Estimated Area of Disturbance (ha) Life of Mine	Maximum Estimated Area of Disturbance (ha) End of 2-Year Peak Liability
Open Pit	77	35
Heap Leach Facility		
Embankment	3.8	3.8
Phase 1	48.9	48.9
Phase 2	20.1	20.1
Phase 3	32.8	0
Events Pond	4.2	4.2
Industrial Infrastructure		
Crushing and Conveying Facilities	13.3	13.3
Truck Shop and Fuel Storage	6.4	6.4
Laydown and Camp Area	4.0	4.0
Process Facility and Water Treatment Plant	3.9	3.9
Explosives Facilities	3.9	3.9
Landfill and Land Treatment Facility, and Substation	3.2	3.2
Waste Rock and Overburden Storage Areas		
Eagle Pup Waste Rock Storage Area	77	49

Component	Maximum Estimated Area of Disturbance (ha) Life of Mine	Maximum Estimated Area of Disturbance (ha) End of 2-Year Peak Liability
Platinum Gulch Waste Rock Storage Area	41	41
Reclamation Stockpiles	22.4	22.4
Ice Rich Overburden Storage Area	5.6	3.2
Water Management Structures		
Lower Dublin South Pond	3.9	3.9
Off-Site Infrastructure		
Transmission Line Corridor	16.8	16.8
Miscellaneous Sites and Facilities		
On-Site Access and Haul Roads	63	67
Borrow Pits	17.2	17.2
Gate House	0.8	0.8
Temporary Ore Stockpile	13.2	13.2
Total Estimated Area of Disturbance	**482**	**381**

There is currently an excess of approximately 60,000 m3 of cut material during the first phase of construction above the Year 2 cover material requirement. This excess material is stored in the reclamation stockpiles or proximal to disturbed areas for ease of reclamation for use during the closure phase of the Mine.

Based on the requirements for closure covers on the WRSAs and the HLF and topsoil replacement on other disturbed areas, approximately 1.2 Mm3 of cover material will be required for the closure phase of the Mine. There is currently approximately 970,000 m3 of material available or cover development. It is anticipated that the deficit in cover material required for closure (~200,000 m3) will be sourced from topsoil stripped during the ongoing development of the WRSAs and HLF. Any remaining material required for the closure covers on the HLF and WRSA may be sourced from the approximately 2 Mm3 of exploitable placer tailings located in the Dublin Gulch and Haggart Creek valleys (BGC 2012b).

8.6 CLOSURE WATER MANAGEMENT PLAN

8.6.1 Closure Objectives

8.6.1.1 Water Quality Objectives

As with the operational strategy for managing water, mine site water quality will be managed to keep, where possible, unaffected water from contacting mine waste, by the use of covers and diversion ditches. The effluent quality objectives were developed assuming seepage from the HLF and WRSAs, and overflow from the Pit Lake will be the primary sources of mine affected water at closure (Lorax 2014b, 2018). Other contact water will be conveyed off the mine site into the Lower Dublin South Pond, which will be in place until reclamation objectives (e.g., during construction of covers) are achieved, runoff can be discharged directly to receiving waters and the LDSP is converted into a PTS. Thus, the performance of the covers, sediment control structures, the PTSs, and the water conveyance features all work together to achieve the water quality objectives.

Site specific water quality objectives (WQO) for receiving environment water quality in Haggart Creek (at stations W4, W29, W99 and W23) were developed for the operations phase to inform adaptive management and are presented in Table 8-2. These WQOs will be further examined as part of closure research and planning process.

Water quality objectives and adaptive management thresholds can be found in the Environmental Monitoring, Surveillance and Adaptive Management Plan.

Table 8-2: Water Quality Objectives for the Protection of the Receiving Environment in Haggart Creek (including W4, W29, W99 and W23)

Parameter		Site Specific Water Quality Objective
Dissolved Parameters	Sulphate	309
	Chloride	150
	Nitrate-N	3
	Nitrite-N	0.02
	Ammonia	1.13
	WAD Cyanide	0.005
	Aluminum	0.1
Total Metals	Antimony	0.02
	Arsenic	0.0085
	Cadmium	0.000197
	Copper	0.005
	Cobalt	0.004
	Iron	1.0
	Lead	0.0077
	Mercury	0.00002
	Manganese	1.17
	Molybdenum	0.073
	Nickel	0.116
	Selenium	0.002
	Silver	0.0015
	Uranium	0.015
	Zinc	0.038

8.6.1.2 Water Conveyance Objectives

The objectives for the design of the water conveyance features are to convey affected seepage to the PTS sites without coming into contact with other unaffected surface runoff, and to convey otherwise unaffected water away from mine contact areas. The primary affected water conveyance features are:

- From the In-Heap Pond to a PTS converted from the Events Pond; a HDPE buried pipe will convey water from the Closure Sump into the Heap PTS.
- From the Eagle Pup seepage emergence point, the effectiveness of a buried pipe and/or open channel ditch will be evaluated during operations to identify what will be used during the closure period to convey water to the LDSP area, where the LDSP will be converted to a PTS.
- Continue to convey Platinum Gulch seepage to the PG PTS, constructed subsequent to closure of PG WRSA; pit overflow water (when the pit is filled) will be conveyed to the PG PTS (unless monitoring data indicate it can be discharged directly to Haggart Creek); the PG PTS will then discharge to Haggart Creek.

There will be some conveyance features that route water from disturbed areas but are not expected to require treatment in closure as the reclaimed areas become vegetated and sediment load is decreased by the formation of the reclamation cover. These areas include:

- Water shedding off covers
    - On both sides of the heap, runoff from the cover will be conveyed into sediment basins, as needed until the cover is stable and then into Dublin Gulch and Haggart Creek.
    - On both sides of the Eagle Pup WRSA, runoff from the cover will be conveyed into a sediment basin until the cover is stable and then into Dublin Gulch and Eagle Creek/Ditch B.
    - On both sides of the Platinum Gulch WRSA, runoff from the cover will be conveyed into a sediment basin until the cover is stable and then into the Haggart Creek, joining with the treated water from the Platinum Gulch PTS.
- Water collected from disturbed areas including the reclamation and temporary ore stockpile areas.

Discharge from the PTS systems will be conveyed in open channels to discharge locations in Haggart Creek.

8.6.1.3 Transition Strategy

During operations, reclamation research will be performed at the full/demonstration scale at the PG WRSA to evaluate and determine operating performance of covers and PTS. Discharge from the PG PTS will be initially sent to the operational water/makeup water in the LDSP until meeting discharge criteria. At closure, when the PTS meets discharge water quality criteria, it will be routed back into the former Platinum Gulch channel.

When the in-heap cyanide concentrations are below maximum acceptable levels, the Events Pond (EP) will be converted into a PTS, specifically a CWTS. The heap draindown rate will be controlled (by recycling the residual fluids back to the heap) and the closure sump will be activated to drain to the EP CWTS. During the time that the EP CWTS is coming up to full performance (and prior to meeting water quality discharge criteria), the CWTS will be conveyed to the MWTP. When the EP CWTS is meeting discharge criteria, it will be directed into a channel that joins with the runoff from the heap cover and undisturbed areas, and then into Haggart Creek.

During operations, seepage will be piped to the LDSP then the MWTP or directly to the MWTP. During early closure Eagle Pup WRSA seepage will be conveyed as described above and flow via gravity to the LDSP, which will have been converted to a PTS (CWTS). Discharge will continue to be sent to the MWTP until the outflow meets discharge criteria, after which it will discharge into Haggart Creek.

The MWTP will be operational as long as the heap drain-down and the Open Pit and WRSA seepages require treatment, and while the CWTSs are becoming active. Following at least five consecutive years in permanent closure where the MWTP was not required to treat effluent discharged from the site, VGC will submit to the Board for Review and Approval a plan for the decommissioning of the MWTP, and implement the plan upon approval – see Section 8.9.

8.6.1.4 Water Conveyance Network

A water conveyance network has been constructed during operations to safely route water around the main mining components. Details for the water management infrastructure for operations is presented in the *Water Management Plan* (WMP). The proposed network at closure will incorporate the existing conveyance channels as

described in the WMP (with upgrades required in certain locations) complemented with new channels to accommodate the closure objectives.

Different types of cross-sections have been designed for operations and are presented in the WMP to accommodate various gradients and volumes of flow, depending on which ditch or channel is considered. These considerations will also be taken into account, in addition to field observations and input from regulatory agencies and other stakeholders, when developing the water conveyance network at closure. Typical ditch configurations include:

- Unlined ditch with triangular or trapezoidal cross-section for small watersheds;
- Riprap ditch with riprap with a D_{50} of 150 mm for larger watersheds;
- Lined ditch with riprap; alternatively, larger riprap with a D_{50} between 300 and 500 mm could also be used and allow for energy dissipation with flow through the riprap.
- Corrugated half pipe – CHP (or Culvert Lined Ditch): Lined ditch with a steel half pipe to protect against high velocities, in terrain that is steeper than 15%. This cross-section can be used in steep reaches or for spillways.

Typical cross-sections are shown in Figure 8-1 and Figure 8-2.

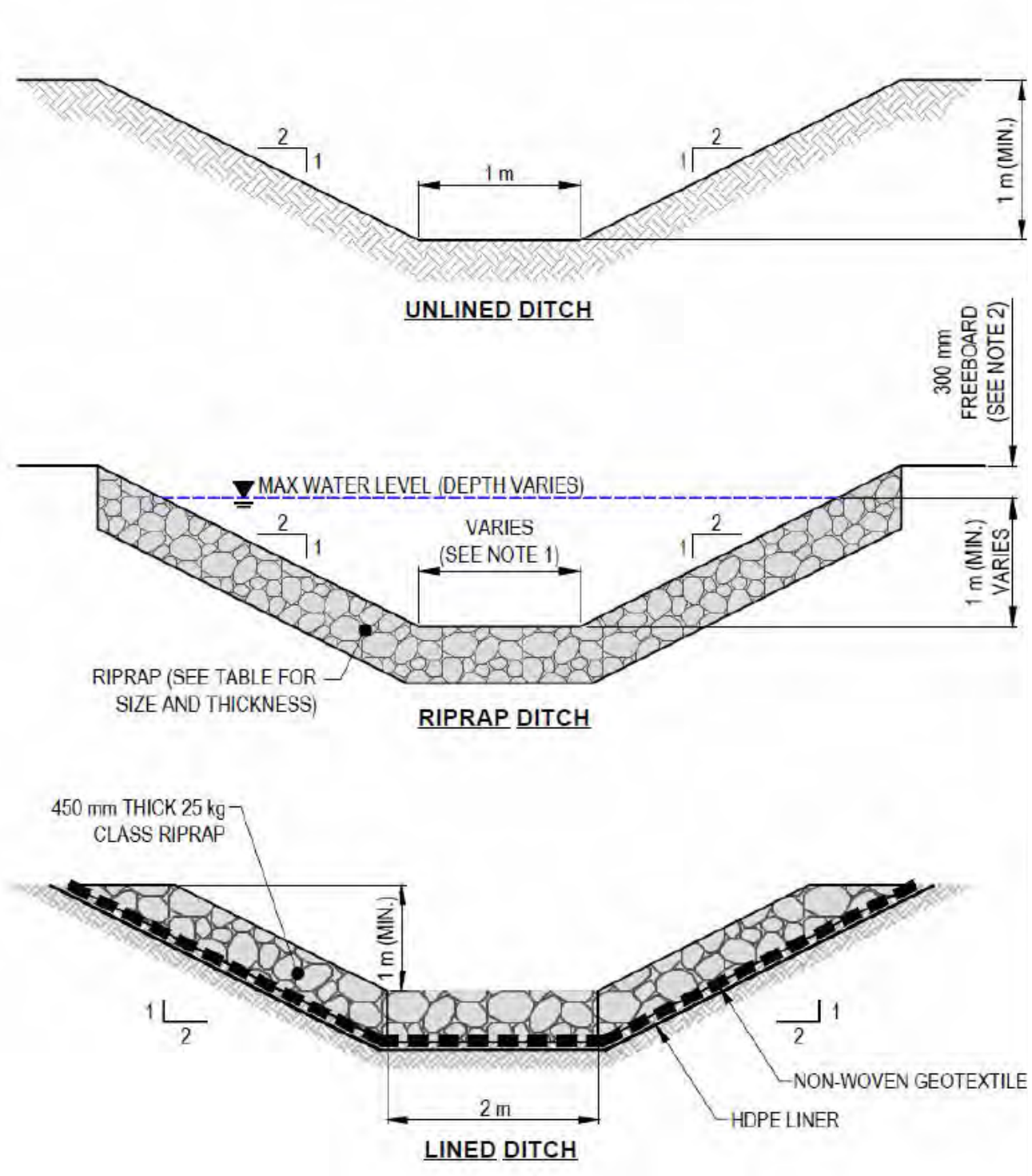


Figure 8-1: Typical Diversion and Collection Ditch Types

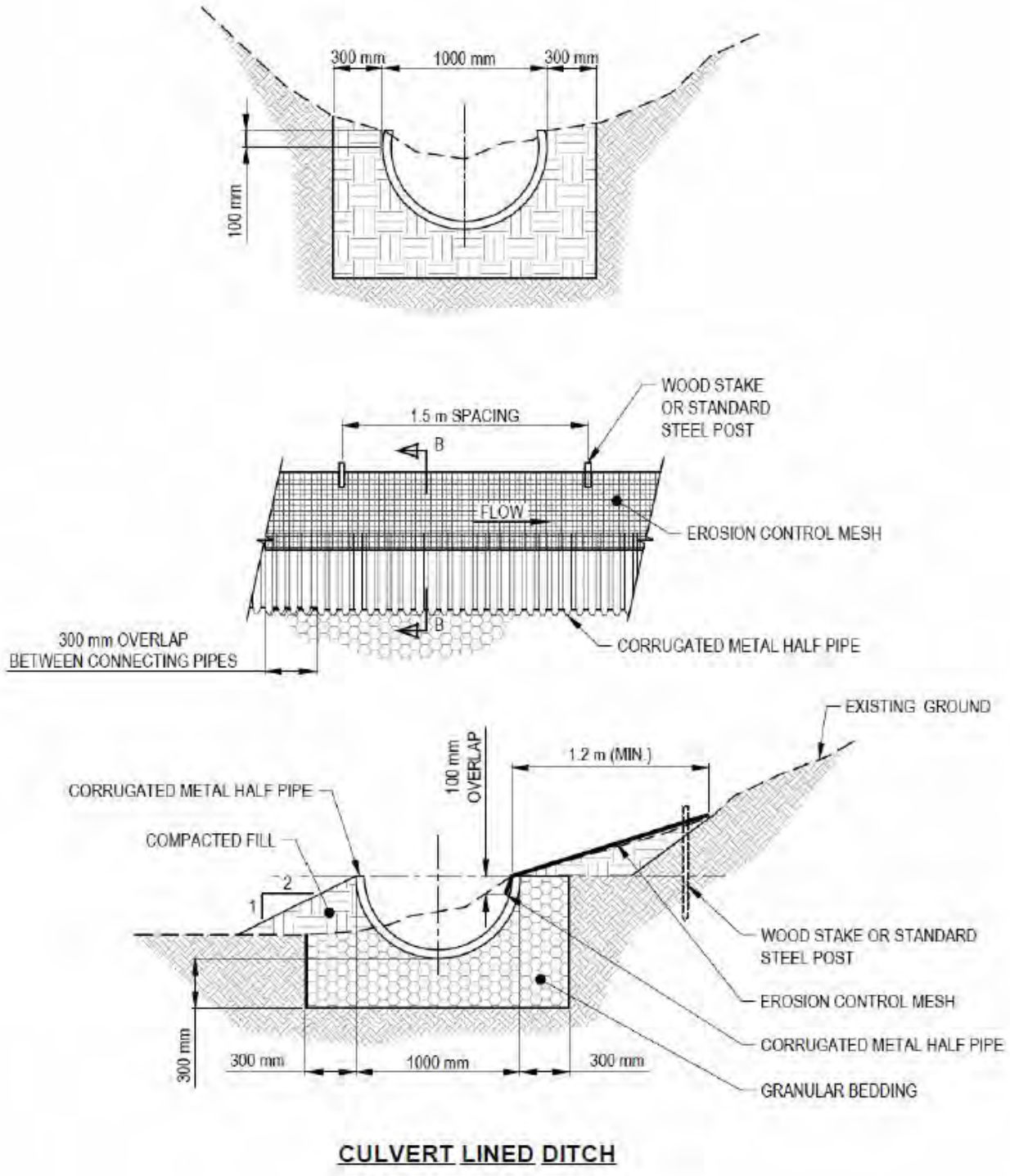


Figure 8-2: Typical Culvert Lined Ditch

The various ditches and channels that compose the water conveyance network for operations are described below.

1) Conveyance channels

A series of diversion ditches, collection channels, and culverts have been designed for operations to intercept non-contact and sediment-laden water.

a. Diversion ditches

Diversion ditches have been and will be constructed up-gradient of disturbed areas to intercept clean surface water runoff. A diversion ditch is a channel lined with vegetation, riprap, or other flexible, erosion resistant material. The main design considerations are the design flow and velocity of the water expected in the channel. During construction and operations, the ditches are sized to convey the 10-year 24-hour peak storm for the estimated watershed size, with diversion ditches located upslope of key mine infrastructure sized to convey the runoff from a 100-year 24-hour storm event. Diversion ditch design for operations is shown in Figure 8-1. The majority of diversion ditches that will be required at closure are riprap and lined ditches, with the following characteristics, shown in Table 8-4.

Table 8-4: Typical Diversion Ditch Design Criteria

Water Management Design Criteria		
Infrastructure Element	**Design Element**	**Design Basis Criteria**
Diversion Ditches	Design Storm Event	1 in 10-year, 24-hour
	Maximum Depth (mm)	500
	Minimum Grade (%) riprap / lined	1.00 / 0.50
	Maximum Grade (%): riprap / lined	4.5 / 15
	Maximum Side Slopes: riprap / lined	2.5H:1V / 1H:1V
	Maximum Velocity (m/s): riprap / lined	2.33 / 4.0

b. Collection channels

A collection channel intercepts sediment-laden water runoff from disturbed areas and diverts it to a stabilized area where it can be effectively managed. Collection channels will be used within construction areas to collect runoff and convey it to the appropriate sediment control measures.

Two large collection ditches (Ditch A and Ditch B) have been built at the downslope perimeter of development activities including the WRSAs, open pit and crushers, while smaller collection and diversion ditches have been used to direct flow to the main catchment ditches. Collection channels have been sized to convey the runoff from a 100-year 24-hour storm event assuming that the entire footprint area has been disturbed and contributes sediment-laden runoff to the seepage collection and recycle ponds. Collection channel design for operations is shown in Figure 8-1. The majority of collection channels that will be required in closure are riprap ditches, with the following characteristics, shown in Table 8-5.

Table 8-5: Collection Channels Design Criteria for Operations

Water Management Design Criteria		
Infrastructure Element	**Design Element**	**Design Basis Criteria**
Collection Channels	Design Storm Event	1 in 100-year, 24-hour
	Minimum Depth (mm)	500
	Minimum Width (mm)	1000
	Minimum Grade (%)	1.00 / 0.50
	Maximum Grade (%): riprap / lined	4.5 / 11
	Maximum Side Slopes: riprap / lined	2.5H:1V / 1H:1V
	Maximum Velocity (m/s): riprap / lined	2.75 / 5.0

c. Culverts

During construction and operations, culverts have been sized to convey the 100-year 24-hour storm event peak flow for small watersheds and the 200-year 24-hour peak storm event for stream crossings. The culvert will consist of corrugated metal pipe or corrugated polyethylene tubing installed according to the manufacturer's specifications to accommodate the anticipated vehicle loading and to prevent crushing. Standard culvert details can be seen in Figure 8-2, while Table 8-6 shows culvert design criteria.

Table 8-6: Typical Culvert Design Criteria

Water Management Design Criteria		
Infrastructure Element	**Design Element**	**Design Basis Criteria**
Culverts	Minimum Diameter (mm)	750
	Design Storm Event (Areas < 1 ha)	1 in 10-year, 24-hour
	Design Storm Event (Areas > 1 ha)	1 in 100-year, 24-hour
	Design Storm Event (at stream conveyances and downstream of sediment ponds)	1 in 200-year, 24-hour
	Maximum HW/Diameter Ratio	2.0 for less than 1.0 m 1.5 for greater than 1.0 m
	Minimum Grade (%)	0.5
	Minimum Velocity (m/s)	1.0
	Maximum Velocity (m/s)	4.0

For closure, an updated conveyance network is proposed. The proposed water conveyance network at closure is presented in Figure 8-3. This network will be based on the structures already in place during operations, with upgrades at closure, complemented with additional structures as needed at closure to meet the water management closure objectives.

It is expected that new ditches will be required, and operations ditches may need to be upgraded to safely convey the 1:100 year flood. All structures will be sized for the 100-year flood based on a 24 hours rainfall event. This is the same methodology that was used for design for operations. Lined diversion ditches and culverts that were sized for the 1:10 year flood will be upgraded for closure. For the existing sediment pond (i.e., the LDSP), calculations were made using a volume-based approach that considers the hydrograph related to the 1:100 year flood 24 hour rainfall event. Further, half pipe culverts installed during construction or operations will be replaced using natural rip-rap and likely involve some slope re-grading (depending on site-specific conditions) to meet physical stability objectives.

Most of the new ditches that will be built at closure will require cross-sections similar to the riprap and lined cross sections that were designed for operations. Some diversion ditches have higher design flows in closure than during operations, and these ditches would be lined ditches as necessary where there are longitudinal slopes of more than 2%. For any new ditches or ditches expanded due to changes in flow management during closure, riprap cross-sections are proposed for slopes between 2 and 5% and lined cross-sections are proposed for slopes between 5 and 15%. For ditches that require expansion or upgrading to accommodate the expanded flow requirements, they could be raised or widened to accommodate the design flow. For new ditches on steeper slopes, a trapezoidal cross-section with larger riprap with a D_{50} varying between 300 and 500 mm could be used instead of the CHP. The base width of the different ditches and channels could vary between 1 and 2 m depending on the calculated design flow for a given catchment.

For closure, existing diversion ditches and collection channels will be consolidated and rip rap will be added to ensure integrity of the channel, if required. Riprap with a D_{50} = 150 mm is generally selected but larger rip rap may be required in steeper reaches.

Additional energy dissipation basins may be developed, as needed, at the toe of steep reaches for the new ditches. Approximate dimensions are to be 5 m by 5 m, with a minimum water depth of 1m. Erosion protection would use riprap material with a D_{50} between 300 and 500 mm depending on the ditch considered.

A subsurface pipe will convey water the entire way from the HLF sump to the HLF PTS; this will be built during construction and the design and layout are provided in Appendix D. Seepage from the WRSA's will be allowed to drain in the natural creek beds to the PTS's; however, based on experience at Minto Mine, seepage collection from the base of the WRSAs may be enhanced by using rockfill sumps to protect from freezing and the development of aufeis. The lessons learned at the Mine, the Minto Mine and other northern sites will be integrated when developing final designs for seepage collection and conveyance.

The actual depth of burial for closure will be based on empirical information acquired through many years of operating at the site. A minimum slope of at least 5% will be set to ensure adequate flow velocities.

Profiles for each of the seepage ditch and pipe combination were developed to determine the slopes that will be encountered. There is no limitation in slope that the pipe can withstand, while for the ditch portion, a design will have to be finalized at closure to account for the updated predictions of additional seepage flows.

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Figure 8-3: Closure Water Conveyance Network

8.7 OPEN PIT

8.7.1 Closure Objectives and Criteria

Closure objectives for the Open Pit are to secure the pit to protect human health and safety, and to manage water flow from the pit into Haggart Creek in accordance with water quality guidelines and water management design criteria, and to ensure long-term chemical stability such that discharge meets water quality criteria as specified in QZ14-041-1.

8.7.2 Closure Measures

Upon cessation of mining, the pit pumps and pipe column will be removed and any other related infrastructure will be cleaned up. Access to the pit will be secured by placement of boulders across roadways, and signage will be used to warn about the presence of highwalls. A safety berm will have been installed around the highwall in operations that will prevent unintended access to the pit by snow machines or other cross terrain vehicles. After approximately eight years, outflow from the pit will flow though engineered structures to into the Platinum Gulch conveyance channel.

The approximate timing of the Pit and Pit Lake development is outlined below:

- Years 1 to 9 pit inflows pumped/conveyed to the LDSP
- Years 9 to 17 open pit is filling and no discharge occurs

After Year 17 open pit discharges directly and untreated to Haggart Creek (i.e., no PTS is required for pit discharge).

8.8 HEAP LEACH FACILITY

8.8.1 Closure Objectives and Criteria

Closure objectives for the HLF include:

- conducting drain-down and cyanide destruction (passive or active or both) activities in a controlled manner to achieve and maintain chemical stability of heap effluent;
- performing grading, as necessary, and cover placement in a manner that will achieve long-term physical stability including minimizing erosion, subsidence or slope failure;
- incorporating design criteria and attributes in the ongoing HLF construction and loading in accordance with the design so that the HLF is able to withstand severe climatic and seismic events;
- achieving long-term chemical stability such that runoff and seepage quality meet water quality criteria; and,
- implementing appropriate contingency measures as required.

The predicted source water quality of the heap at final draindown (i.e., influent into any passive treatment system) shows that the main water quality parameters of potential concern that would drive water treatment requirements are nitrate, $CN_{(WAD)}$, As, Sb, Pb, Hg, and Se, and these parameters require treatment prior to release to Haggart Creek. Thus, the long-term closure measures are designed to address these parameters either by treatment within the heap ore column, in the in-heap pond, or in the passive treatment system to be constructed in the Events Pond.

8.8.2 Closure Measures

The HLF will be the last feature to be reclaimed after all gold leaching is terminated and the cyanide destruction (either with biological or active treatment processes or both) and rinsing processes are completed, thus the cover will not be placed until approximately two to three years, following the cessation of active mining and placement of ore. The construction of a store-and-release cover system will commence once WAD cyanide concentrations meets discharge criteria, and seepage from the facility will be treated with a passive treatment system constructed down gradient of the facility. These measures are detailed below. There are essentially three stages in the closure process:

- residual leaching for gold recovery,
- rinsing and cyanide destruction, and
- draindown.

The phases of heap operation and their timing is outlined in Section 8.1.

8.8.2.1 Residual Leaching

After the last ore materials are placed, transition to a residual leaching period will commence. During this phase, diffusion of the cyanide solutions into the heap materials continues and recovery of gold from the heap drainage continues until it is decided that it is economically beneficial to transition to the rinsing and cyanide destruction phase. The exact duration of this residual leaching phase cannot be determined in advance (which will be a cost-benefit tradeoff of commodity prices, operational and overhead costs, and other site-specific factors), but for the purposes of cost estimation, a duration of one year is assumed. During this residual leaching phase, the crushing and stacking equipment is decommissioned, and the primary activities are movement of pipes and leaching equipment around the heap to maintain optimal leach phasing.

8.8.2.2 Rinsing and Cyanide Destruction

As the economic recovery of precious metals from the heap is reaching the transition point where the net economic benefits of gold recovery diminishes, the heap operations will transition to a closure phase. The use of a clear definition for this transition point is consistent with the current state of practice for the closure of heap leach facilities in that it articulates the time in which the heap is managed for the reduction of solution inventory rather than economic operation. The term “rinsing” thus refers to recirculation of the solution, including new meteoric inputs, during drain down without cyanide addition, until a manageable flow out of the heap is achieved, or in other words a steady state reduction of solution inventory in the heap through an actively managed draindown process through the in-heap pond. This is slightly different than in the previous version of the RCP, which implied the additional application of fresh water to flush out areas with higher cyanide concentrations. This extra addition of fresh water is likely not necessary, except for the fresh water what will be used as the medium for adding the

sugar solutions as part of the biological cyanide destruct process described below. This phase will appear similar to the residual leaching phase, in that the primary activities will be movement of pipes and leaching equipment around the heap as necessary to continue to deliver recycled solutions to the heap.

As described in Section 10, VGC will be conducting a reclamation research program to evaluate if biological treatment of fluids within the HLF will be more or additionally effective in destructing cyanide and reducing concentrations of certain metals of concern. A description of the biological treatment process is provided herein but this process is considered an opportunity and not the key closure method for the HLF. It is currently assumed, consistent with industry practice around the world, that the above described continued recycling of solution (with meteoric input) during the draindown process coupled with active mine water treatment will be sufficient.

During the biological treatment process, the solutions added to the top of the heap will only have residual cyanide concentrations as the biochemical treatment processes will remove most of the active cyanide from solution. This will be achieved by adding sugar solutions (sugar solution with reducing sugars, typically molasses or corn syrup are the most cost effective) to the barren solution exiting the gold recovery circuit, where any residual free or reactive cyanide forms biochemically react with the sugar molecule, forming cyanohydrin. The rate of sugar solution added to the barren solution is designed to both react with residual cyanide in the barren solution, as well as cyanide in the pores of the heap. Thus, the treatment is achieved both in the barren solution tank prior to circulation up to the heap, as well as within the heap, which is termed in situ treatment.

This process is similar to what was done at the Brewery Creek Heap Leach Facility to detoxify the solution inventory to close the heap, and also was successfully pilot tested for the Eagle heap materials (Tetra Tech 2014, Cyanide Destruction Column Studies Report, available on the YWB Waterline website registry for QZ14-041 as Exhibit 1.11.6). The heap treatment column test was able to achieve reduction of 16 mg/L WAD cyanide to less than the detection limit (0.025 mg/L) with a sustained application of a mixture of sugars and trace phosphate. This experience and experience elsewhere form the basis for the application approach and dosing rate for the biochemical treatment reagents.

In situ cyanide destruction treatment is a biologically mediated process in which a supplemental reduced carbon syrup (above what is required to directly react with residual cyanide in the barren solution) is added to the heap to degrade cyanide and to facilitate microbial growth within the heap. The reduced carbon promotes a direct consumption of free cyanide and some weak cyanide complexes within the pore water solutions in the heap, which leads to the creation of non-toxic cyanohydrins in the heap. Subsequent degradation of the cyanohydrins and other nitrogen forms is supported by excess carbon (over and above what is required to react with free and weak complexes of cyanide) because the additional carbon supports microbial growth and formation of a fine biofilm on the heap particles that incorporates the reduced nitrogen compounds (cyanohydrins, ammonia). In some cases, the sugar solutions are amended with other nutrients, including phosphate or phosphoric acid, and/or other trace biochemical nutrients to enhance microbial growth. The addition of sugar solutions in the barren solution is performed in phases through the same equipment used to leach the heap, i.e., barren solution tank, pumps, piping, and buried drip emitters. Thus, the only equipment required to detoxify the heap using a biological treatment process will be a heated storage tank located at the ADR and metering pump to deliver sugar solutions into the barren solutions as it is recirculated. The size of the reducing sugars mix tank will be sufficient to hold approximately 60 m^3 of sugar solution.

Depending on the thickness of the areas on the heap, the particular area where the barren solutions amended with reagents will be added will have solution added by drip emitter onto a specific area of the heap for a period

of approximately 60 days. This period of time will allow for the sugars/nutrient mixture to react with cyanide in pore waters in that area and biochemically degrade the cyanide species. Each zone in the heap will have solutions applied to that area such that the sugars/nutrients mixture to break through to the base of the heap. Over the subsequent 'rest period' where solutions are not being applied, the residual pore waters will continue to be biologically treated by the native microbes growing in the heap pores and on the surfaces of the heap materials supported by the sugars and nutrients delivered in the initial solution application period. The solution delivery will be accomplished in phases across the heap, similar to the leaching process, with approximately 12 areas successively treated, for a total period of treatment in the heap of approximately two years. During this time period the flow rates and the areas under solution application will be managed to deliver the solutions at the appropriate strength to the area under solution application until breakthrough of reactive sugars is achieved throughout the leach column, then the area under solution application will be moved to a new area, until the entire heap has received solutions that are amended with the appropriate amount of sugars/nutrients. During this two-year period, the costs of treatment includes recirculating solutions (e.g., pumping, moving drip emitters), and the cost of the sugars/nutrient solutions. This approach is consistent with the treatment of the Brewery Creek Mine, as well as several other heap leach facilities that have been treated using a biological treatment process that rely upon reducing sugars (Harrington and Levy 1999; Harrington 2002; Brewery Creek Mine Decommissioning and Reclamation Plan, 2002).

8.8.2.3 Formation of In-Heap Pond Bioreactor

When the cyanide concentrations have decreased in the In-Heap Pond such that the heap outflow to the ADR is consistently below the required free cyanide concentrations, the treatment strategy will shift to a strategy that will stabilize and further improve the water quality from within the heap for water quality constituents beyond cyanide. As described in Lorax (2018), after cyanide has been degraded the heap drain down water will still be elevated in nitrate, metals and metalloids (As, Pb, Hg, Se and Sb), and these parameters will require treatment prior to release to Haggart Creek. While the biochemical degradation of cyanide with sugars does not rely on the formation of a reducing condition within the heap pores, the treatment of these constituents will be based on reductive precipitation of metals within the saturated zone within the heap as well as the continued microbial degradation of cyanide destruction by-products (ammonia and thiocyanate) within the unsaturated heap column.

This subsequent phase of in situ treatment will provide a further treatment of constituents within the In-Heap Pond, as well as decreasing metals concentration to sufficient levels to either directly discharge, or at least provide water that is of sufficiently good quality to only require polishing in a passive treatment system (described below). As soon as the cyanide concentrations have decreased to less than the required free cyanide concentrations, heap drain-down will begin.

The saturated in-heap pond will be transformed to become strongly reducing by the addition of alcohol and trace nutrients designed to support biochemical processes that will remove these constituents requiring treatment within the in-heap pond. The processes that will be used to remove/treat these constituents are described below for each constituent potentially requiring treatment:

8.8.2.3.1 Nitrate

The predicted source concentration prior to treatment for nitrate is 250 mg/L Lorax (2018). Denitrification is the process where microbes oxidize organic carbon as an electron donor (alcohol is a preferred organic carbon

substrate to support denitrification) and reduce nitrate and nitrite to nitrogen gas N_2, which is the gas that comprises approximately 79% of the earth's atmosphere.

$2\ NO_3^- + 10\ e^- + 12\ H^+ \rightarrow N_2 + 6\ H_2O$

Microbes that perform denitrification are found nearly universally (ubiquitous) in soils and rocks. The Tetra Tech (2014) cyanide destruction column studies report on Mine materials showed that the addition of alcohol to the heap materials supported denitrification (initial concentration: 1.3 mg/L; final concentration 0.3 mg/L), and also importantly that ammonia was also removed (60.3 mg/L initial concentration; final concentration 0.79 mg/L).

8.8.2.3.2 Trace Metals and Metalloids (antimony, arsenic, lead, mercury, selenium)

The heap detoxification column study was operated to simulate unsaturated portions of the HLF, with the primary objective to degrade cyanide. The heap columns were not saturated and consequently the highly reducing conditions necessary to achieve sulfate reduction, which will be readily accomplished in the saturated heap column in the in-heap pond, were not achieved in the heap detox columns. However, metals that are of potential concern were reduced, including antimony (41% decrease), arsenic (83% reduced), selenium (68% reduced), and mercury (86% reduced). Lead concentrations did not decrease, but instead increased somewhat, consistent with the lack of sulfate reducing conditions.

With the utilization of the in-heap pond as a sulfate-reducing bioreactor, heavy metals concentrations are expected to be substantially reduced. For instance, the Yankee heap in Nevada was treated using a similar process, where organic carbon was recirculated onto the heap (Harrington, 2002). In leach extractions of heap materials using the meteoric water mobility procedure test, arsenic concentrations decreased from 1.85 mg/L to 0.32 mg/L, and mercury concentrations decreased from 0.5 mg/L to 0.00067 mg/L. Similarly, at the Couer Rochester Stage 1 heap (which similarly had an in-heap pond) selenium decreased from 0.107 mg/L to 0.01 mg/L, and mercury decreased from 0.0114 mg/L to 0.0007 mg/L (all results were composites of sonic drill cores removed from the heap before and after in-heap treatment, then leached using the MWMP procedure).

8.8.2.4 Drain-down

The heap drain-down and transition period (during which there will still be additional gold recovery) will be planned and managed to fully integrate with the site water management plan. The overall solution inventory will be decreased by processing water through the mine water treatment plant (MWTP) and/or the heap PTS for discharge. Depending on the flow rates achieved through the MWTP, the PTS, and the effectiveness of the cover system that is being built on the heap, the actively treated drain-down period will vary, but is expected to occur over a five to ten-year period, but could be shorter or longer depending on how the draindown process is managed. During this time the following activities will occur:

The transition to heap drain-down will occur with the perforation of the sump and activation of the closure sump. The transition from cyanide destruction to draindown will include the following steps:

- Discharge of water to the MWTP at a controlled rate consistent with the capacity of the MWTP to treat and discharge the water.
- Discharge of some water to a contingency passive treatment system/CWTS to be built in the Events Pond location.
- When either

- The heap is sufficiently drained and is discharging below QZ14-041-1 discharge criteria, or
- The passive treatment system is treating all of the remaining flow at the design capacity and achieving discharge criteria
- Then, after a five year wait period, the MWTP can be turned off and decommissioned in accordance with license terms.

During the draindown period, the solutions that are recirculated back up into the heap will have organic carbon sources amended into them if a cost benefit analysis deems that it provides a sufficient reduction in active treatment operating costs as to be worthwhile. This draindown in situ treatment period will switch from a sugar-based solution to an alcohol-based solution, with the purpose of creating sulfate reducing conditions within the saturated zone of the heap, i.e., the in-heap bioreactor described above. This will allow for the heap drainage to continue to improve and ultimately achieve water quality consistent with that observed in alcohol fed bioreactors. In these conditions, reduction in metal concentrations is also commonly observed as result of the reducing conditions established during microbial metabolic processes, because many metals are less soluble in a reduced state (chromium, copper, selenium, uranium, for instance). Other metals that preferentially sorb to iron or manganese oxides in a more neutral pH range created during the detoxification process will generally decrease, including trace metals such as arsenic and antimony. Metals that form insoluble sulfides will also become substantially treated. It is expected that at the end of the recirculation and draindown period that the heap solutions can either be directly discharged in accordance with the site discharge criteria, or that the PTS will be able to polish it using primarily aerobic processes, as described below.

8.8.2.5 HLF Passive Water Treatment

As described above, the main constituent that will not be completely treated prior to discharge from the heap is arsenic, which is conservatively estimated to be reduced in the heap but still remain at 0.5 mg/L. Thus, the passive treatment system is primarily being designed to remove arsenic, and because of its similar removal processes, antimony is also expected to be further reduced by passage through the CWTS.

Several passive treatment technologies have been evaluated for potential application for late closure and post-closure water treatment technologies for the Mine. Preliminary studies and planning suggested that Constructed Wetland Treatment Systems (CWTS) would best fulfill the site-specific objectives for passive treatment at the Eagle Gold site; however, a hybrid Passive Treatment System (PTS) comprised of a biochemical reactor (BCR), permeable reactive barrier (PRB), or zero valent iron (ZVI), followed by a CWTS may be optimal. Thus, the PTS design has been further refined, and is described here.

Based on predicted water qualities and quantities, there are slight variations in the proposed PTSs for the HLF and WRSA water sources. Using the predicted closure water quality, all CWTSs were sized according to plausible removal rate coefficients (RRC). The RRC is a way of expressing the rate of water treatment, based on treatability of the compound and hydraulic retention time. In Equation 1 (below), the first order RRC has been reconfigured to calculate from t (hydraulic retention time; HRT), allowing the use of Ci (initial concentration), Cf (final, desired concentration), and k (removal rate constant) to be used to size the wetlands accordingly. Although it is recognized that the treatment rate of a range of element concentrations varies in a CWTS, the predicted inflow and desired outflow concentrations for this system are in a range that allow a first order RRC to be loosely applied. During the reclamation research program for the PTS, this will be further refined and confirmed, so that the final CWTSs will be shown to be sufficiently sized.

Equation 1. Removal Rate Coefficient (RRC) calculation rearranged to solve for HRT

$$k = \frac{-ln(C_f/C_i)}{t}$$

$$t = \frac{-ln(C_f/C_i)}{k}$$

The first order RRCs used to size the wetlands for this Mine were developed using two different scenarios. The first scenario for RRC calculation is based on a pilot-scale CWTS with similar arsenic concentrations as those predicted for the Mine. This water has undetectable iron concentrations, and a water temperature of approximately +20°C to 25°C. This RRC was then adjusted based on the principals of Arrhenius' equation, dividing the rate by half to adjust for each 10 degrees of temperature decrease. This is a conservative estimate, since the CWTS is designed such that aeration and sorption will be the initial form of treatment, and this type of CWTS is therefore less influenced by temperature than other types of CWTS (such as those designed for municipal water and sewage, which are treating for high biological oxygen demand). After sorption, the slower process of biomineralization can occur, but this only needs to occur at a rate such that all sorption sites are not used within a given year, as the organic matter from the vegetation that dies off and becomes litter in the CWTS will provide sorption sites for the subsequent year(s). A review of these processes is found in Lizama et al, (2011).

A second scenario for RRC calculation was also applied, based on another pilot-scale study performed for a PTS in the Northwest Territories that has similar arsenic concentrations as is predicted for the HLF and WRSA seepage. In this pilot scale system, iron was present which enhances treatment by providing another removal process that is iron-coprecipitation based, in addition to the sorption by detritus and biomineralization. Iron-coprecipitation is also a well-known phenomenon in wetlands (Lizama, 2011). In this pilot system, when operating with water temperatures between +0.5°C and +4°C, the removal rate was triple that of the system that did not have iron in it that (operating at +20°C), despite other water parameters being the same. The size of CWTS required under both scenarios is presented in Table 8-8 and 8-9.

In an accreting CWTS, it is the removal rate that is key for determining size, while aspects such as total loading are secondary. The logic for this rationale is that loading can only be of concern after it is confirmed that it is thermodynamically possible to remove the compound from the water and load into the sediment. As both the RRC and loading generally follow a function that is exponentially decreasing (sometimes even logarithmically decreasing), it must be realized that building the system larger than appropriate can be detrimental to the system rather than beneficial due to thermodynamic minimums and concentration of compounds through evaporation. In other words, a larger CWTS of the same design as a smaller one will not necessarily produce better water quality.

Secondary to determining size based on RRC's, the sizing must be confirmed based on overall loading of compounds into the sediments of the CWTS, while accounting for accretion. All CWTSs have had loading rates to sediments calculated accounting for accretion, and in all cases the predicted average sediment concentrations of the CWTS are within the range of existing baseline concentrations previously measured on site (Appendix F–Soil metal data in Stantec 2011c, Environmental Baseline Report: Surficial Geology, Terrain and Soils (Stantec 2010e) is available on the YWB Waterline website registry for QZ14-041 as Exhibit 1.3.5).

Although both iron and manganese can carry out precipitation reactions with arsenic, the predicted concentrations of both manganese and iron in the HLF and WRSA drainage are insufficient by themselves to solely treat the predicted concentrations of arsenic. It is anticipated that with iron addition, concentrations as low as 0.015 mg/L can be achieved, but long-term operational maintenance by the addition of iron will be minimized by the use of iron rich materials in wetland construction. When wetland treatment is based on biological processes only, concentrations closer to the EQS are predicted. Further evaluation of this process will be performed in the piloting phase to determine whether adding iron within the conveyance channels both upstream and between the cells of the CWTS will improve the treatment capacity, or if it may be mixed directly into the CWTS substrates. Sources of iron and manganese that will be included in the CWTS include the soils used for plant growth media, rock used in riprap within the seepage collection ponds and seepage conveyance channels, and during the initial phase of CWTS, iron could also be added in liquid form to enhance the initial removal rates while plant growth is occurring. All CWTSs have been sized to meet the EQSs without added iron. As a comparison, predicted outflow concentrations have been provided for both scenarios assuming with and without added iron, as there may be some benefit (smaller system, more efficient removal rates) to using iron.

Based on water quality and site-specific considerations, the HLF PTS has been conceptualized as a four-step treatment train.

1. The HLF liner to the sump will be perforated through the access piping built into the heap and sump during construction, allowing seepage to flow under pressure from the sump to the PTS. A valving system within the head works of the piping can be used to control the drainage rate to the PTS, or alternatively recycle some portion of the heap drainage by pump back onto the heap surface and eventually via percolation to the In-Heap Pond, which will be dosed with an organic material (such as ethanol). This recirculation of heap drainage into the base of In-Heap Pond will support the operation of the anaerobic bioreactor within the saturated portion of the heap. In addition to denitrification processes, the bioreactor in the In-Heap Pond is expected to substantially reduce metals concentrations during the draindown period when the In-Heap Pond is still active, and before the cover system is fully operational. The in-heap bioreactor may result in effluent sufficiently treated to allow for direct discharge. Nevertheless, in the case that metal concentrations are still above criteria, the HLF PTS will be designed accordingly to meet effluent quality standards.
2. Seepage from the anaerobic bioreactor will flow through the closure drain system and ultimately discharge through a rip-rap lined cascade in the area of the Events Pond to aerate and precipitate elements as oxides. A preference will be given to rip-rap rock that contains iron or manganese oxides to help facilitate the formation of Fe and Mn surface coatings on the rip-rap that will enhance removal of As, Sb and Se.
3. The seepage will then flow through a series of CWTS cells, which will have been constructed using a portion of the Events Pond. The CWTS will bring water that has been largely treated by the bioreactor down to concentrations acceptable for discharge. The CWTS is designed to mineralize and sequester elements into the sediments in a benign manner through sorption, coupled biogeochemical reactions and accretion.
4. The treated water will enter a retention basin that will provide a mixing point for the water moving through parallel replicate systems in the CWTS and serve as a monitoring point for water prior to discharge into Haggart Creek.

The first two stages of the PTS have been designed into the operational phases of the facility (sump and Events Pond). The CWTS can be sized in two ways, the first way assumes complete treatment in the CWTS without a bioreactor, while the second way assumes that the sizing accounts for the expected performance of the bioreactor. The reduction of constituents in bioreactors is based on prior experience at other heap leach facilities (Harrington, 2002), but also synthetic water tests have been performed at Yukon College, where alcohol-fed sulfate-reducing columns decreased arsenic concentrations to less than 0.1 mg/L and selenium concentrations were decreased from 0.3 mg/L to less than 0.01 mg/L.

Conceptual design criteria for HLF CWTS component of PTS include:

- Cells will be between a 1:3 to 1:4 width to length ratio
- There will be a minimum of two replicated systems in parallel; each system will have one entry and one exit point
- Each system will have multiple cells in a series to achieve the needed HRT
- In between all cells, there will be an access berm of sufficient width for personnel to walk to conduct monitoring and sampling, and as needed, a berm of sufficient size for a light vehicle to travel to support maintenance activities as necessary
- Each aerobic cell will be able to accommodate 45cm of soil, a 30cm water depth, and an additional 30cm freeboard. Each anaerobic cell will be built in the same way, but capable of accommodating 100cm water depth.
- There will be a retention/equalization basin prior to flow into the PTS and a collection basin at the outflow.
- Flow channels from retention basin into CWTS cells, between cells within a series, and from the CWTS into the outflow basin will span the entire cell width and will be lined with riprap
- The embankments of the wetlands will be a 2:1 - 3:1 slope.
- Bottoms of wetland cells are level, but there must be a height difference between the first and second cells to provide aeration of the water.
- Cells will be constructed with approximately 45 cm of soil, composed of a sand/gravel mixture for aerobic cells and possibly amended with iron bearing material. If anaerobic cells are deemed appropriate, finer soils may be needed, and amended with organic materials from site (such as wood chips).
- Cells should be lined with locally derived fine-grained materials to minimize leakage to or from surrounding sediments
- The CWTS will be planted with local plants, to the greatest extent possible.

Table 8-8: Sizing of HLF CWTS Based on Area Available

Parameter	Size based on Events Pond area
CWTS Hectares	3.57 (85% of the Events Pond size)
Wetland Volume (m^3)	10,710

Depth (m)	0.3

Note: The available size of the Events Pond is 4.2 ha. The estimated size of the Events Pond once reconfigured to a CWTS is estimated to be 3.57 ha (85% of the size).

Table 8-9: Predicted HLF CWTS Performance for Arsenic Treatment Compared to Effluent Quality Criteria (mg/L)

Available Area	Average inflow concentration (mg/L)	Average CWTS outflow	Average modeled wetland Size to meet EQS
3.57 ha	0.5	<EQS	0.53 ha

8.8.2.6 Earthworks / Recontouring

Heap Leach material will be loaded as necessary for closure conditions during operations so no final regrading prior to cover placement will be required during closure.

8.8.2.7 Final Reclamation Measures for HLF

8.8.2.7.1 Engineered Cover

The HLF is a component of the Mine that requires a cover design based on using locally available materials that limits infiltration to the greatest extent possible. In addition to limiting infiltration, another objective of the cover is to provide a stable growth medium to allow for revegetation. The benefit of a reduced infiltration cover is a reduction in seepage flow rates which will minimize the total loadings from heap leaching processes, and thus minimize the required treatment of a PTS.

The proposed cover to be used during closure is a store and release cover, which reduces infiltration into the underlying material by storing precipitation (similar to a sponge) in the rooting zone of the cover material and then releasing some of the water back to the atmosphere through evapotranspiration from vegetation. The cover comprises a layer of material placed in a loose state and revegetated with selected local species that have high moisture uptake characteristics. A similar store and release cover system was constructed at a similar open pit-heap leach gold mine project (Brewery Creek, YT) that was closed and reclaimed.

Two stages of modelling were conducted to further evaluate cover system designs for the HLF. The first series of models used The Hydrologic Evaluation of Landfill Performance (HELP) 3.90 D Model (2011) to inform the model design and estimate infiltration through the cover (Knight Piesold, 2013). The preliminary model results were considered for the current cover system design.

The currently proposed design, referred to as the ‘Base Case’, is a 0.2 m thick layer of topsoil underlain by a 0.3 m thick layer of placer tailings / colluvium. The anticipated hydrological performance of the base-case cover system design was further assessed in OKC (2014), which provides recommendations to improve long-term performance from a net percolation reduction perspective. The following work was completed

- Reviewed pertinent background information and compiled key inputs for soil-plant-atmosphere (SPA) numerical modelling;
- Developed conceptual model of hydrological performance of the base case cover system design;

- Conducted Base Case and sensitivity analysis numerical simulations of cover system performance using the SPA model VADOSE/W; and
- Developed recommendations for future studies to reduce uncertainties in the current cover system design and identified potential opportunities for improvements in cover system performance using locally available materials.

The objectives of the SPA numerical modelling of the Base Case were to improve the confidence in estimating the mean and range of net percolation rates for the Base Case cover system for input to environmental loading and water treatment assessments, and to assess the:

- Influence of potential textural heterogeneity of locally available cover construction materials on cover system performance;
- Influence of the saturated permeability of underlying waste materials on cover system performance;
- Influence of various vegetation conditions on cover system performance;
- Influence of slope angle on cover system performance (i.e. difference in water balance fluxes for the bench plateaus compared to the bench faces);
- Influence of slope aspect on cover system performance; and to
- Examine the available water holding capacity (AWHC) for various cover configurations to avoid creating a 'false' drought condition for the anticipated climax vegetation cover.

In total, 43 long-term simulations were completed to determine the sensitivity of the Base Case due to variations in materials, climate, and/or vegetation. The simulations were also completed to evaluate whether, any improvements could be made to the Base Case design. All the scenarios were initially completed without vegetation present so that changes in performance could be directly correlated to changes in materials or climate. Vegetation was then included to further evaluate select scenarios. Finally, the Base Case results presented in the previous section showed little difference in performance between the WRSAs and HLF simulations. The results of these simulations can be summarized as follow:

1.) Slope aspect and gradient have the largest effect on NP rates estimated for both WRSAs and HLF. The added solar radiation on south facing slopes results in a higher AET rate, further drying out the cover in the summer months. In contrast, the north-facing aspect has substantially less solar radiation available to evaporate or transpire water stored in the cover profile. This increases the observed NP rate. A 2:1 slope gradient will result in a larger volume of runoff during the spring melt and high intensity rainfall events.

2.) Virtually no difference exists in predicted NP rates resulting from the use of different materials on-site. Cover system scenarios that used only colluvium or tailings (rather than the 2:1 mix) produced nearly identical NP rates as the 2:1 colluvium-tailings mixture. Layered cover systems of the two materials also produced similar NP rates. Based on these results, there is no advantage, from a NP perspective, to mixing the tailings and colluvium into a single cover system material based on the estimated hydraulic properties of the two material types.

3.) Thickening the cover system provides no reduction in the NP rate, and actually results in an increase in NP. NP rates do not decrease because the energy available for evaporation is low, which creates relatively low hydraulic gradients for removing water from the cover system. Hence, evaporation alone can only remove water stored nearer the surface. The model estimates a slight increase in NP with increased cover thickness because the underlying leached ore of waste rock is a textural discontinuity, which creates a capillary barrier inhibiting NP and keeping water closer to the surface. When the depth of the capillary barrier is increased by increasing the thickness of the cover system, the percolating water is able to get to depth more easily, which increases NP.

4.) The presence of vegetation is vital to hydrological performance of the cover system. The NP rate is reduced by 10% or more for both the WRSAs and HLF when a forest canopy is present. A large part of the improvement from the forested cover system scenario comes from the improvement of AET via canopy interception. The forest canopy intercepts precipitation on the foliage, which reduces the amount of water that infiltrates into the cover system. This intercepted water is then evaporated or sublimated from a location more exposed to solar radiation and wind compared to surface.

5.) The model estimates that the current cover system design adequately meets the water storage requirements for vegetation. Over an 80-year simulation period there were only seven periods when the cover system water volumes dropped near or below the acceptable limit. These are periods when vegetation would be at risk; but it must be noted that the model inputs were set to permit forest vegetation to be capable of removing water up to a suction of 2,500 kPa (based on research of tree species), and that VADOSE/W does not account for all plant survival mechanisms (e.g. dormancy).

6.) In general, material properties that lowered the k_{sat} of various materials resulted in slightly lower NP rates, while increasing the k_{sat} slightly increased NP rates. By increasing or decreasing the k_{sat} of the topsoil by one order of magnitude, the average NP rate varied from 35% to 29% of annual precipitation, respectively. It is essential that thorough testing be completed to verify the hydraulic properties of local topsoil material because the model suggests that k_{sat} also has a large influence on NP rates. Decreasing the heap or waste material k_{sat} also had an effect on the observed NP rate; however, increasing the k_{sat} above a certain threshold had little effect on the NP rate. The effect of varying the k_{sat} of the tailings-colluvium material was also analyzed; however, no measurable difference in the water balance was predicted when the material's k_{sat} was varied by one order of magnitude.

Based on the modelling of the Base Case a profile schematic of the waste rock and heap cover is shown below as Figure 8-4. This conceptual design schematic shows the cover profile for the flat areas on the plateaus and benches, as well as the inter-bench slopes.

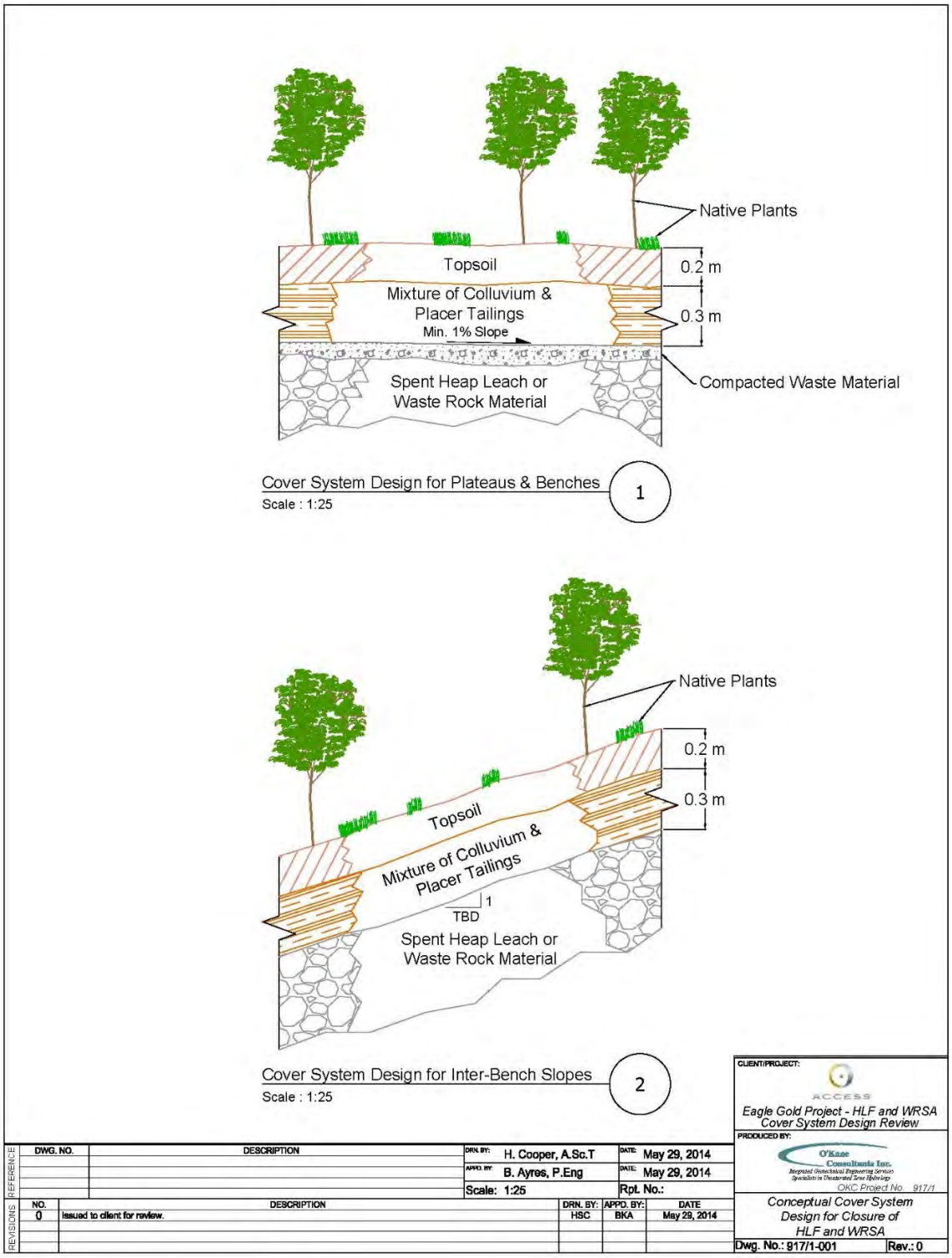

Figure 8-4: Conceptual HLF and WRSA Cover Design Drawings

8.8.2.7.1 HLF Revegetation

The revegetation program will include sowing of native grasses and forb seeds that are adapted to the specific elevation and aspect of the HLF. Results from reclamation research trials currently underway will guide and inform the plant selection process to ensure long-term physical stability and natural development of native plant species, assemblages and communities at the site.

8.9 EAGLE PUP WASTE ROCK STORAGE AREA

8.9.1 Closure Objectives and Criteria

Closure objectives for the Eagle Pup WRSA are to ensure long-term physical stability to minimize erosion, subsidence or slope failure; ensure long-term chemical stability such that runoff and seepage quality meets water quality criteria and that area is able to withstand severe climactic and seismic events.

8.9.2 Closure Measures

Initiatives taken during the operations phase will include constructed waste rock slopes and benches that have stable configurations to meet closure criteria.

Closure measures undertaken to achieve the above objectives will include installation of engineered waste covers to reduce infiltration, encourage vegetation growth and minimize erosion. Engineered covers will be combined with passive treatment systems to yield water quality that is acceptable for discharge.

8.9.2.1 Passive Water Treatment

The PTS for the EP WRSA will utilize water conveyance infrastructure already established, such that the seepage will flow to the LDSP via Ditch B, where a portion of the LDSP will be converted to a PTS for closure. The LDSP PTS design, sizing, and predicted outflow concentrations were developed as described for the HLF PTS, in Section 8.8. As with the HLF PTS, and based on water quality and site-specific considerations, the LDSP PTS has been conceptualized as a four-step treatment train. A more detailed description of the CWTS elements is provided in Section 8.8.2.5. The four-step train is as follows:

1. A rip-rap lined channel (Ditch B) will be used to convey water from the EP WRSA to the constructed wetland treatment system (CWTS). This channel will provide aeration to precipitate elements as oxides. As part of regular Ditch B maintenance during operations, added riprap rock that contains iron or manganese oxides will be used as available to help facilitate the formation of Fe and Mn surface coatings on the rip rap that will enhance removal of As, Sb and Se.
2. Water will first enter an equalization basin. This will serve for flow equalization, dampen flow velocity from the channel, and provide water retention if maintenance is needed on the CWTS.
3. The CWTS will consist of replicate cells designed in parallel to mineralize and sequester elements into the sediments in a benign manner through coupled biogeochemical reactions and accretion.
4. Water will exit the CWTS cells into a retention basin that will provide a mixing point for the water exiting all parallel replicate systems in the CWTS and serve as a monitoring point for water prior to entering receiving water bodies.

LDSP PTS sizing is provided in Tables 8-10 and 8-11, below.

Table 8-10: Sizing of LDSP CWTS Based on Available Area

Parameter	Size Based on LDSP Area
CWTS Hectares	2.3 (85% of the LDSP size)
Wetland Volume (m^3)	6,885
Depth (m)	0.3

Table 8-11: Predicted LDSP CWTS Performance for Arsenic Treatment Compared to Effluent Quality Criteria (mg/L)

Available Area	Average inflow concentration (mg/L)	Average CWTS outflow	Average modeled wetland Size to meet EQS
2.30 ha	0.1393	<EQS	1.01

Preliminary modelling shows that with the addition of an iron source the wetland size can be reduced by a factor of 6 while also increasing treatment efficacy. This option will be further investigated during additional modellings and during field scale trials.

8.9.2.2 Earthworks

The Eagle Pup WRSA will be constructed so that the final landform will be at the design criteria for slopes. An allowance in the closure cost estimate has been made for some fraction of the WRSA to be re-graded (for purposes of cost estimation, 10%) to tie the sides of the dump into the surface water management features/ditches. The flat areas will be compacted, if necessary, based on the results of reclamation research and cover modelling, to enhance the performance of the cover, primarily by the wheel pressure of the dump trucks. However, in any case some fraction of the WRSA will be compacted in the areas where grading is being performed or areas that were not compacted by wheel traffic. This preparation will allow for the cover to be placed efficiently across the entire dump, by placing cover material on higher benches and pushing the material down toward the lower bench.

8.9.2.3 Cover Construction

As with the HLF, the EP WRSA design concepts is a 0.5 m store-and-release cover constructed with locally available top soil and tailings/colluvium. The modelling and design work conducted for this facility is the same as the Base Case described in Section 8.8 Heap Leach Facility Closure Measures: Cover Construction. Modelling and sensitivity analyses conducted (O'Kane 2014) found very little difference in the performance of the Base Case cover design whether it was covering heap or waste rock materials.

8.9.2.4 Revegetation

The revegetation program will include sowing of native grasses and forb seeds that are adapted to the specific elevation and aspect of the store-and release cover. Results from reclamation research trials currently underway will guide and inform the plant selection process to ensure long-term physical stability and natural development of native plant species, assemblages and communities at the site.

8.10 PLATINUM GULCH WASTE ROCK STORAGE AREA

8.10.1 Closure Objectives and Criteria

Closure objectives for the Platinum Gulch WRSA are to ensure long-term physical stability to minimize erosion, subsidence or slope failure; ensure long-term chemical stability such that runoff and seepage quality meets water quality criteria and that area is able to withstand severe climactic and seismic events.

8.10.2 Closure Measures

8.10.2.1 Passive Water Treatment

The PTS for the PG WRSA was designed to meet discharge criteria during events of average flow and 75th percentile predicted for post-closure conditions. The CWTS design, sizing, and predicted outflow concentrations were developed as described for the HLF PTS, in Section 8.8.3.2. Based on water quality and site-specific considerations, and similar to the HLF PTS and LDSP PTS, the PG WRSA PTS has been conceptualized as follows.

1. PG WRSA seepage will flow through a rip-rap lined channel (upper Ditch A) to convey water to the purposed built CWTS. This channel will provide aeration to precipitate elements as oxides. As part of regular maintenance during operations, added riprap rock that contains iron or manganese oxides will be used as available to help facilitate the formation of Fe and Mn surface coatings on the rip rap that will enhance removal of As.
2. The CWTS will be designed to mineralize and sequester elements into the sediments in a benign manner through coupled biogeochemical reactions and accretion.
3. Water will exit the CWTS into a retention basin that will provide a mixing point for the water exiting all parallel replicate systems in the CWTS and serve as a monitoring point for water prior to entering receiving water bodies.

PG PTS sizing is provided in Tables 8-12 and 8-13, below.

During operations, the PG WRSA seepage will be routed to the LDSP for use as make up water. Commencing at the end of Year 3, after final loading of waste rock onto the PG WRSA, the PG WRSA cover will be completed and a field scale proto PTS will be constructed based on on-going research results during the previous year(s). The objective of this PTS is that it will be functional during operations for treatment of the PG seepage and inform part of the reclamation research plan to test treatment methods through seasonal changes, while serving as an on-site demonstration of the effectiveness of the design. Over the next few years, and depending on results, design enhancements can be implemented as necessary. PTS outflow will continue to be routed to the operational LDSP until it can be demonstrated that the system meets discharge criteria. During the initial closure phases, this

discharge may be routed to the pit, or may be discharged to Haggart Creek after treatment in the PG PTS. In long-term closure, the treatment required at the PG WRSA is dependent on water quality, and may involve routing to the pit, or treatment in the PTS. Currently both options are in consideration and serve as a contingency to one another.

The timetable described above is tentative, but it serves to describe the general approach. During years 2 and 3 of operations, progressive reclamation (initial cover placement) and research (vegetation trials) will be performed on the PG WRSA. Also, seepage water quality and flow rates collected as part of the EMSAMP will be used to inform lab and pilot studies of the PTS. The final profile and cover of the PG WRSA will be completed in year 4 of operations. It is expected that this additional year or so of seepage monitoring will be needed to finalize a PTS design, which will subsequently be completed downgradient from the PG WRSA by Year 5.

Table 8-12: Sizing of PG CWTS Based on Available Area

Parameter	Size Based on proposed purpose-built PG PTS Area
Hectares	0.66
Wetland Volume (m^3)	1,980
Depth (m)	0.3

Table 8-13: Predicted PG CWTS Performance for Arsenic Treatment Compared to Effluent Quality Criteria (mg /L)

Available Area	Average inflow concentration (mg/L)	Average CWTS outflow	Average modeled wetland Size to meet EQS
0.66 ha	<EQS	<EQS	Influent below EQS

8.10.2.2 Earthworks

The Platinum Gulch WRSA will be loaded so that the final landform will be at the design criteria for slopes. However, an allowance in the closure cost estimate has been made for some fraction of the WRSA to be regraded (for purposes of cost estimation, 10%) to tie the sides of the dump into the surface water management features/ditches. The flat areas will be compacted, as necessary, based on the results of reclamation research and cover modelling, to enhance the performance of the cover, primarily by the wheel pressure of the dump trucks. However, in any case, some fraction of the WRSA will be compacted in the areas where grading is being performed or areas that were not compacted by wheel traffic. This preparation will allow for the cover to be placed efficiently across the entire dump, by placing cover material on higher benches and pushing the material down toward the lower bench.

8.10.2.3 Cover Construction

As with the HLF and EP WRSA, the design concept is a 0.5 m thick store-and-release cover constructed with locally available top soil and placer tailings/colluvium. The modelling and design work conducted for this facility is

the same as the Base Case described in Section 8.8 Heap Leach Facility Closure Measures: Cover Construction. Modelling and sensitivity analyses conducted (O'Kane 2014; Appendix E) found very little difference in the performance of the Base Case cover design whether it was covering heap or waste rock materials.

8.10.2.4 Revegetation

The revegetation program will include sowing of native grasses and forb seeds that are adapted to the specific elevation and aspect of the store-and release cover. Results from reclamation research trials currently underway will guide and inform the plant selection process to ensure long-term physical stability and natural development of native plant species, assemblages and communities at the site.

8.11 TEMPORARY ORE STOCKPILES AND PADS

8.11.1 Closure Objectives and Criteria

Closure objectives for ore stockpiles will ensure long-term physical stability to minimize erosion or slope failure. After all the required material is used from the reclamation stockpiles and the ore stockpile, these areas will be regraded and re-vegetated for long term physical stability, and to ensure long-term chemical stability such that runoff and seepage quality meets water quality criteria.

8.11.2 Closure Measures

8.11.2.1 Earthworks

The ore stockpile will be scraped to collect, as much as practical, any residual ore materials, which can be added to the HLF (which will still be in gold recovery mode), and the area contoured to allow drainage to occur, according to the design criteria. Approximately 0.2 m of growth medium will be placed to allow revegetation to occur.

8.11.2.2 Revegetation

The revegetation program will include sowing of native grasses and forb seeds that are adapted to the specific elevation and aspect of the store-and release cover. Results from reclamation research trials currently underway will guide and inform the plant selection process to ensure long-term physical stability and natural development of native plant species, assemblages and communities at the site.

8.12 INDUSTRIAL INFRASTRUCTURE

8.12.1 Closure Objectives and Criteria

The objectives for decommissioning and demolition of the mine infrastructure are to ensure physical stability and to remove any potential hazards and threats to the public safety and health. This includes:

- Decommissioning of facilities in a safe manner
- Ensuring physical stability of any remaining structures

8.12.2 Closure Measures

8.12.2.1 ADR Process Facility

The process facilities are set on concrete pads and foundation bases to support the ADR plant, recovery plant, admin facility and assay lab. Internal equipment is supported on steel frames along with elevated concrete piers.

The decommissioning and demolition of the ADR facility will include:

- Removal and proper disposal of hazardous reagents, chemicals and materials
- Decommissioning of mechanical equipment
- Removal of mechanical equipment
- Removal of electrical equipment, motors and controls
- Demolition of steel structures
- Demolition of concrete slabs

The process facility will be cleared, bulk earthworks will be completed and the foundations will be broken up and buried in situ. Any foundations with rebar will be left in place.

Table 8-14: ADR Facility Infrastructure Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
ADR plant / Administration Facility	Pre-engineered steel building	42.3m x 17.9m	Carbon columns Screens Tanks Pumps Misc. equipment	Concrete foundation Concrete grade wall Structural steel columns Elevated concrete floors	Insulation Reagents Chemicals
Recovery plant	Pre-engineered steel building	102m x 35m	Refinery Carbon regen kiln Electrowinning cells Misc. equipment	Concrete foundation Concrete grade wall Structural steel frame, steel grits and purlins Insulated metal wall panels Metal standing seam room system	Insulation Reagents Chemicals
Assay lab	Pre-fabricated modular structure	38m x 18m	Lab equipment Chemical disposal equipment HVAC	Wood framing Insulated metal clad walls Ethylene propylene monomer roofing on plywood	Insulation Reagents Chemicals

8.12.2.2 Mine Water Treatment Plant

The mine water treatment plant, currently scheduled for complete construction and commissioning in H2 2021, will consist of standard process equipment (tanks, filters, pumps) housed inside a pre-engineered building on a

concrete foundation. Once heap drain down is complete and water quality criteria through the PTSs have been achieved for a continuous period of five years, the water treatment plant will be decommissioned and removed. It is anticipated that significant value will be retained in the WTP process equipment. For closure costing purposes, decommissioning and demolition of the water treatment plant includes:

- Removal and proper disposal of hazardous reagents, chemicals and materials
- Decommissioning of mechanical equipment
- Removal and salvage of mechanical equipment
- Removal of electrical equipment, motors and controls
- Demolition of steel structures
- Removal/demolition of concrete support and foundation

Table 8-15: Water Treatment Plant Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
Water Treatment Plant	Pre-engineered steel building	44.2m x 24.4m	Tanks Pumps Filters Misc. equipment	Concrete foundation Concrete grade wall Structural steel columns	Insulation Reagents Chemicals

8.12.2.3 Crushing and Conveyance Facilities

The crushing and conveyance facilities consists of two crushing buildings and a series of conveyance systems (i.e., covered conveyors and transfer stations) connecting the two buildings. The crushing facilities are set on concrete foundations along with the internal supporting steel structures.

The decommissioning and demolition of the crushing buildings will include:

- Disconnection of power supply
- De-dusting of the area via certified and safe methods
- Decommissioning and disassembling of all conveyor components
- Removal / demolishing any structural supports
- Removal / demolishing any concrete supports
- Backfill pad with colluvium to establish stable landform

The decommissioning and demolition of the conveyance systems will include:

- Disconnection of power supply
- Decommissioning and disassembling of all conveyor components
- Removal / demolishing any structural supports

- Removal / demolishing any concrete supports

Table 8-16: Crushing and Conveyance Infrastructure Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
Primary crushing building	Concrete construction	38 m x 19 m	Primary crusher Primary apron feeder Secondary feed conveyor	Concrete walls, foundations Steel platforms Rebar	Dust
Secondary / tertiary crushing building	Pre-engineered steel building	30 m x 21 m	Secondary and tertiary crushers Feed conveyors Transfer conveyors Dust collectors Plate work 25t overhead crane	Concrete foundation Concrete grade wall Elevated concrete piers Structural steel frame, steel grits and purlins Insulated metal wall panels Metal standing seam room system	Dust
Conveying / (No building)	n/a	n/a	Overland conveyors Grasshopper conveyors Radial stackers	n/a	Dust

8.12.2.4 Power Generation and Transmission Infrastructure

A 45 km long power supply line at 69 kV connect to the Yukon Energy Corporation power grid, via a tap point approximately 25 km southeast of the property. The power line is supported on wooden poles constructed parallel to the road access and running to the mine site substation and all the facilities. Power is distributed via two-step down substations and to all the process control, instrumentation and communication systems.

The decommissioning and demolition of the power distribution infrastructure will include:

- De-energizing the main power line and ensuring all power lines are grounded
- Securing any crossings of transmission lines and road
- Disconnection of conductors from insulators, and winding the conductors on reels to be transported off site
- Disassembling of supporting structures from their foundations
- Dismantling of all cross arms, fittings, insulators, pole hardware and guys to be transported offsite
- Removal of grounding rods, grounding wires, and guy anchors
- Backfilling of foundation anchor holes
- Removal and disposal of materials off site
- Demolition of substations foundations, concrete buried in situ. Any concrete with rebar will be left in place.

Table 8-17: Power Generation and Transmission Infrastructure Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
Power line	n/a	45 km	45 km of 69 kV power line Anchors Power line hardware	Wooden poles	None
69 kV substation	n/a	n/a	Vendor supplied unit Electrical rooms Conductors Insulators Transformers	Concrete foundation Concrete Containment area	Waste oils and lubricants
25 kV substation	n/a	n/a	Vendor supplied unit Electrical rooms Conductors Insulators Transformers	Concrete foundation Concrete Containment area	Waste oils and lubricants
Overhead power lines	n/a	n/a	25 kV power lines Anchors Power line hardware	Wooden poles	None

8.12.2.5 Explosives and Magazines

At closure, unused explosives that remain on site will be returned for credit and the explosives magazines and other equipment will be returned to the explosives' supplier. The magazine is a vendor supplied skid trailer that will be transported offsite during closure.

8.12.2.6 Truck Shop

Maintenance on heavy duty equipment including haul trucks, loaders and dozers will be completed within an insulated truck shop complete with an overhead crane and support equipment. Once active mining is complete and the majority of the large mining fleet is no longer required, the truck shop will be dismantled.

The decommissioning and demolition of the truck shop will include:

- Removal and proper disposal of hazardous reagents, lubes/oils, chemicals and materials
- Decommissioning of mechanical equipment
- Removal of mechanical equipment, overhead crane
- Removal of electrical equipment, motors and controls
- Demolition of steel structures
- Demolition of concrete slabs

Table 8-18: Truck Shop Infrastructure Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
Truck shop and mine dry	Pre-engineered steel building	126 m x 21 m	Wash bay with pressure washer Repair bays Electrical equipment Mechanical equipment Compressor 20t overhead crane	Concrete foundation Concrete grade wall Elevated concrete piers Structural steel frame, steel grits and purlins Insulated metal wall panels Metal standing seam room system	Insulation Solvents

8.12.2.7 Fuel Storage Tank Area

Diesel is delivered via trucks to storage tanks located near the camp and generator area. Propane is stored locally to the camp facilities and the ADR.

Table 8-19: Fuel Storage Tank Area Infrastructure Demolition Summary

Infrastructure			Material Handling		
Buildings / Areas	**Building Type**	**Size**	**Equipment**	**Structural Components**	**Hazardous Materials**
Diesel storage	n/a	5 x 75,000 L Tanks 1 x 35,000 L Tank 2 x 11,000 L Tank	Tanks Pumps	Earthen berms Containment areas	Diesel sludge
Propane	n/a	3 x 5000 gal Tanks	Tanks Pumps	Concrete foundations Containment areas	Propane

8.12.2.8 Equipment

There will be limited fixed or mobile equipment on site at the end of mine life when reclamation measures are complete. Any equipment present at closure not being used by on-going exploration activities will be removed from the site and either sold or salvaged. Equipment that cannot be sold or salvaged will be hauled off site to a licensed landfill.

8.12.2.9 Industrial Reagents and Hazardous Products

Any remaining industrial reagents or hazardous products will either be returned to the supplier or disposed of by a licensed third-party contractor.

8.12.2.10 Water Supply and Wastewater Structures

Water supply and wastewater conveyance include potable and sewage treatment structures are part of the camp and will be removed with the camp facilities.

The fresh water and firewater systems will be removed at closure if exploration activities are no longer anticipated. This would include the dismantling of the potable water treatment plant and distribution system.

8.13 WATER MANAGEMENT STRUCTURES

8.13.1 Closure Objectives and Criteria

As stated in the Yukon Mine Site and Reclamation Closure Policy Financial and Technical Guidelines, the main closure objective is “to ensure decommissioning of water retention and sediment control structures, and the appurtenances, in such a way that drainage at, and adjacent to the site, is stable in the long term.” Closure objectives will also ensure flows are conveyed into and throughout the mine footprint, and off of the site in a controlled, stable fashion under a reasonable range of anticipated conditions.

8.13.2 Closure Measures

8.13.2.1 Sediment and Erosion Control Structures

As described in Section 8.6, existing sediment and erosion control structures will be utilized in the transition to permanent closure, with new sediment control structures to accommodate any new surface water features added. As the covers and reclaimed areas reach maturity, the need for and reliance upon sediment control structures and certain built watercourses will no longer be necessary.

8.13.2.2 Lower Dublin South Pond

In preparation for closure, the conversion of the Lower Dublin South pond to a PTS will occur as needed. The majority of the LDSP will be used for construction of a CWTS, and the downgradient end will be used as a final sedimentation and settlement pond for the catchment around the LDSP prior to discharge into Haggart Creek.

8.13.2.3 Events Pond

In preparation for closure, after cyanide concentrations in the heap discharge meet criteria, the Events Pond will be repurposed for use as a PTS as described under the HLF PTS section.

8.13.2.4 Main Water Conveyance Channels

As part of the closure plan, Ditches A, B and C will remain in some capacity as they form the network for conveying waste rock and pit seepage, as needed, to PTSs or treated water to Haggart Creek. Thus, closure measures will include reviewing any channel stability issues observed during operations, with the intention of modifying the designs as necessary to maintain stability over the long term.

8.14 HAGGART CREEK ACCESS ROAD

At closure, the Haggart Creek Road will be left in place for future access to the property by the public and existing users.

8.14.1 Access Control

The main access road will remain gated and locked during the active reclamation activities. Access to the mine site will remain restricted and all visitors will be required to sign in and out at the gate house. Once the reclamation activities have been completed, the gate, gate house, and fencing will be removed.

8.14.2 Closure Objectives and Criteria

The responsibility for maintaining the existing Haggart Creek Access Road will be fully returned to Yukon Government to allow public access to meet the following closure objectives: physical stability, ecological viability and sustainability.

8.14.3 Closure Measures

The Haggart Creek Access Road will remain at closure; however, site access and haul roads will be reclaimed. Access to the Potato Hills will be provided (as requested by the FNNND), as well as other mine access roads associated with on-going and historical exploration activities that are covered under separate permit authorizations. However, long-term maintenance of this access is not a requirement nor a part of this RCP. The on-site access and haul roads will be re-contoured, scarified, and revegetated. All culverts associated with these roads that are not used for other purposes will be removed and the stream channels will be stabilized.

8.15 CAMP

8.15.1 Closure Objectives

The closure objective is to remove camp facilities to achieve physical stability, ecological viability and sustainability.

8.15.2 Closure Measures

Once the site is no longer required for mine operations or exploration activities, all equipment and structures will be removed; the septic system will be pumped of contents broken down and backfilled; the area will be re-contoured to stable grades and topography and pre-mining drainage patterns will be restored to the extent feasible and practical. Salvage soil material will be spread directly by dozer pushing from the windrow berms. Salvaged soil that has been stored in designated stockpiles will be hauled by dump trucks and placed at the disturbance sties to be spread by dozer.

Once the disturbance area becomes available for permanent reclamation, it will be revegetated with plant species that are typical of the projected post closure ecosystem (Stantec 2011b), generally native trees and shrubs. Interim reclamation, weed control and surface erosion control of the site will be achieved by seeding with native grass, legume and forb species as listed in Section 10, Table 10-1 and Table 10-2. A native seed collection program will be implemented during the life of the mine to ensure availability of stock.

8.16 EXPLORATION SITES AND TRAILS

The majority of the exploration sites and trails will be removed or encompassed within the planned works. However, any exploration sites and trails required for ongoing exploration activities will remain available for future

use. Yukon Government currently holds a bond from VGC for costs associated with reclamation of exploration programs.

8.17 SOLID WASTE STORAGE AREA

8.17.1 Closure Objectives and Criteria

The closure objective is to achieve physical and chemical stability, ecological viability and sustainability of decommissioned solid waste storage area.

8.17.2 Closure Measures

All solid waste will be removed to landfill or removed to appropriate offsite licensed landfill.

8.18 LANDFILL

8.18.1 Closure Objectives and Criteria

The onsite landfill provides a place to remove potential threats to public health, decommission facilities in a safe manner, and ensure physical stability.

The closure objectives are to achieve physical and chemical stability, ecological viability and sustainability.

8.18.2 Closure Measures

Landfill areas will be compacted and capped.

8.19 LAND TREATMENT FACILITY

8.19.1 Closure Objectives and Criteria

The onsite land treatment facility will provide a place to remove potential threats to public health, decommission facilities in a safe manner, and ensure physical stability.

The closure objectives are to achieve physical and chemical stability, ecological viability and sustainability.

8.19.2 Closure Measures

The land treatment facility (LTF) is a permitted facility to treat hydrocarbon contaminated soil. Contaminated solids from fuel/oil spills during operations will be treated in this facility to appropriate levels of remediation before being used as industrial fill as per regulatory requirements.

The closure of this facility is subject to the submission of a formal Closure Plan to YG, along with sampling results which demonstrate the final concentrations of contaminants in the soil being treated. It is expected that upon final closure of the entire site, dismantling and decommissioning activities may reveal or result in soil contamination requiring the relocation of contaminated soil to the LTF and an undetermined number of months of treatment to achieve desired remediation levels. As such, the LTF Closure Plan and final sampling results will be prepared and submitted sometime after final closure of the mine site has begun.

Generally, once the desired contaminant levels have been reached in the final volumes of treated soil, and the Closure Plan has been approved by YG, the soils will be spread at approved locations at the site, recontoured in place and revegetated. If required, additional overburden may be hauled and used as cover material and growth media for revegetation.

8.20 BORROW PITS

8.20.1 Closure Measures

The majority of the borrow pits are located within the footprint of other infrastructure components (i.e. HLF and the open pit) and therefore closure measures described for each respective facility will negate the need for additional measures. Borrow pits that are not located beneath infrastructure components will be stabilized and re-contoured, covered with growth media, and re-vegetated.

8.20.2 Borrow Materials Planning

- Rip-rap will be produced from clean mine rock that meets rip-rap design criteria which may include evaluation for freeze-thaw, soundness, wet abrasion, dry abrasion, and absorption.
- Stockpiles have been be created during the construction activities. In future construction areas, overburden materials will be stripped and segregated. Placer materials will also be collected, processed and used as needed.
- In general, three main reclamation materials (colluvium, placer tailings, topsoil) are anticipated to be used as cover soil or construction materials during closure.

9 PERFORMANCE UNCERTAINTY AND RISK MANAGEMENT

Closure and reclamation plans comprise a series of designs with drawings and specifications that define what will be constructed and coupled with an operating plan that describes how the constructed facilities will operate. Performance uncertainty and risk management are addressed with a failure modes and effects analysis (FMEA).

The purpose and intent of the FMEA is to:

1. address risk of designs and operating procedures not achieving the design intent; and
2. minimize fiscal and environmental risk failure associated with complex, long term performance of engineered systems assembled to achieve closure.

The facilities that were considered to have a potential for high consequence failures were associated with the HLF. The FMEA process has been performed for the following components:

- HLF confining embankment
- In-Heap Pond
- Events Pond
- Liner System
- Leachate Detection/Recovery System
- Overliner Drain Fill
- Solution Collection and Delivery System
- Ore Heap

As these components will continue to be relied upon in some capacity into closure, the FMEA process has informed the closure plan development, especially in the area of heap-based events or water management events around the heap.

The FMEA consequence-severity definitions that were used covered the following categories:

- Biological Impacts and Land Use
- Regulatory Impacts and Closure
- Public Concern and Image
- Health and Safety

Specific failure modes and their effects on the mine site components evaluated led to recommendations for quality control and for potential contingency responses. Some of these have been considered and incorporated in the Environmental Monitoring, Surveillance and Adaptive Management Plan, and others are more focused on operational responses that will ensure that the facility is constructed and operated within the design criteria, which is reflected in the OMS manual specifically around the HLF.

10 RECLAMATION AND CLOSURE RESEARCH PROGRAMS

VGC has and will continue to undertake reclamation and closure research programs prior to decommissioning and closure of the Mine. Research programs (e.g., cover system performance, bioreactor testing, and revegetation trials) have been initiated to support the closure measures. These programs would continue to be implemented, as appropriate, during temporary closure, and/or after mining operations have commenced. Further, additional closure and reclamation research programs will be implemented in the next two years, including additional engineered cover designs and test plots, growth media and revegetation trials, passive treatment research and a natural groundwater attenuation study.

10.1 REVEGETATION TRIALS

Laberge Environmental Services (2012) conducted vegetation trials at the Peso Mineral Exploration Site, located on claims held by VGC and just west of the Mine but independent of the Mine site to test the viability of incorporating biochar and other soil amendments into soil to be used for the closure of the Mine. The objective of the revegetation program at Peso was thus to test the viability of incorporating biochar and other soil amendments into the site.

The Peso site, located approximately 6.5 km west of the Eagle Gold camp at Dublin Gulch was originally staked in 1910 with extensive exploration occurring from 1961 to 1965. Two disturbed areas on this site, which had not revegetated since 1962, were selected for vegetation trials: an old trench and the waste rock dump.

Laboratory analysis results from both sites indicate mineralized soil with little to no nutrient value. The waste rock soil pH is 2.6 and the trench site soil pH is 5.2. While the vegetation trials conducted at the Peso mine site have been conducted on waste rock with somewhat different chemistry than that found at the Eagle Gold Mine (i.e. Eagle Gold Mine soils are less mineralized with neutral to slightly alkaline attributes), there is still much to be gained from the findings, in that the Peso site is only several kilometers away, at a similar elevation and physiography, with the same candidate species and experiencing the same climate conditions. The study results will help guide the ongoing revegetation trials at the Mine site.

Several plant species were chosen for the reclamation seed mix due to their tolerances to acidic, low nutrient levels, drought and/or heavy metal conditions in the growth medium and are presented in Table 10-1 and Table 10-2 below. Seeds, hand collected from local alder and hedysarem, were also added to the seed mixture.

Table 10-1: Peso Waste Rock Site Selected Seed Mix for Reclamation

Festuca ovina	Sheep Fescue
Deschampsia caespitosa	Tufted Hairgrass
Poa glauca	Glaucous bluegrass
Agrostis scabra	Tickle Grass

Table 10-2: Peso Trench Site Selected Seed Mix for Reclamation

Festuca ovina	Sheep Fescue
Deschampsia caespitosa	Tufted Hairgrass
Poa alpine	Alpine bluegrass

Trisetum spicatum	Spike Trisetum

Three blocks consisting of five 1m x 1m plots were established at each site during the summer of 2012. A total of 30 plots were seeded with various amendments at the Peso site in the fall of 2012. Amendments included:

- none,
- compost and biochar,
- compost, biochar and leonardite,
- compost, biochar and dolomite, and
- compost, biochar, dolomite and leonardite.

Dolomite was added to the waste rock dump plots only.

The revegetation plots were assessed annually for species present, number of individuals and overall health of the vegetation within each plot. 2018 was the final year of this program and the work undertaken at that time included additional analysis of soil conditions, metals concentrations of plant tissues, height of above ground growth and rooting depth. The results of the revegetation trial are included in Appendix A.

At the completion of the program, it was found that the plots that were seeded but received no amendments support very little, if any growth over the six-year trial. This was consistent with observations of the general area. Although grasses are not the dominant growth form in the nearby local environment, native grasses were initially planted as they germinate quickly, assist in retaining moisture and help to build up the soil. By year two most of the treated plots supported relatively healthy growth of various grass species. Hedysarum germinated in some plots during year one but was absent in the following years. Alder seeds that were also added to the plots began noticeably growing in years two and three. In year four grasses were gradually dying back and shrubs, mainly alder, were taking over. Willow, dwarf birch, Labrador tea, blueberry and Alaska birch were also beginning to colonize some of the plots, all of which are present in the neighboring forest. Grasses were also dying back in the plots where alder was not prevalent.

In the absence of a suitable growth media or a soil amendment, all nontreated seeded plots produced no to very little growth. The acidic soil conditions at the Peso trench and the waste rock sites present a challenging scenario in relation to the site conditions at the majority of other disturbed sites in the Dublin Gulch area. However, the success of using compost and biochar to achieve robust plant growth on these highly mineralized and acidic soils, especially on the waste rock dump, indicates that revegetation can be successful with minimal effort and resources. Native plants were able to grow on the majority of the treated plots, including on the highly acidic (pH 2.6) Peso mine waste rock dump.

In summary, these trials have proven successful. By using appropriate species and soil amendments, healthy plants have grown, propagated and even thrived on acidic, highly mineralized soils. Revegetation trials are now continuing as part of progressive reclamation revegetation program, as described in Section 7.4. As described and shown in photos in Section 7.4, the results of 2019 revegetation program suggest that the revegetation on site with native species may be successful without amendment addition.

10.2 ENGINEERED COVERS

The currently planned end land-use for the reclaimed HLF and WRSA at the Mine site is natural habitat (wilderness). Key design objectives for the HLF / WRSA closure cover systems include long-term geotechnical and geomorphic stability, as well as providing a medium for sustainable growth of native plants. Another key function of the HLF / WRSA closure cover systems is to reduce long-term net percolation rates to the greatest extent possible using locally available materials for cover system construction. Passive treatment systems will be designed and implemented to handle resultant environmental loadings from the HLF and WRSA post-closure seepage. Stable and adequately designed cover systems will help to minimize the loadings to the passive treatment systems.

OKC (2014)[3] completed an assessment of the anticipated hydrological performance of a base-case cover system design and is detailed in Section 8.8. An 80-year climate database comprised of daily records using local and regional meteorological data was used to estimate hydrological performance of the base-case cover system design as well as variations to the base-case design. Some of the key factors influencing performance of the proposed HLF / WRSA cover system design are as follows:

- Hydraulic properties of candidate cover system materials;
- Hydraulic properties of HLF and WRSA waste materials;
- Slope aspect (i.e. solar radiation input and snowpack accumulation / melt); and
- Slope gradient.

The overall objective of the research program for closure cover designs is to build confidence in the initial long-term cover system design performance analyses in terms of net percolation and to inform eventual large-scale closure cover system construction. Six research tasks associated with engineered covers include:

Task 1: Update the conceptual model of cover performance;

Task 2: Develop a material characterization plan for candidate cover system materials;

Task 3: Conduct a material characterization of HLF and WRSA waste materials;

Task 4: Conduct enhanced meteorological monitoring on various slope aspects;

Task 5: Conduct closure cover system field trials for performance monitoring; and

Task 6: Assess the effect of high pH water treatment solids on the heap cover

For further discussion on research associated with the conceptual work on engineered covers, see Appendix F.

To initiate the research program, Tasks 2, 4 and 5 were initiated in summer 2020. A mixed overburden and topsoil stockpile was relocated in early September 2020 to the plateau of the 1370 bench of the Platinum Gulch WRSA. The work had included: Task 2) conducting material sampling before and during cover system construction to

[3] OKC (O'Kane Consultants Inc.). 2014. Eagle Gold Project – Further Assessment of Closure Cover System Designs for Heap Leach Facility and Waste Rock Storage Areas. Report no. 917/1-01 submitted to Access Consulting Group, April 28, 2014.

characterize the physical and hydraulic properties of the overburden material; Task 4) planning for, procuring and beginning the installation of enhanced meteorological instrumentation, and Task 5) beginning the cover system trial on the 1370 bench for performance monitoring. A summary of the work initiated for these tasks is provided below in each task section. A more detailed description of the 2020 work is provided in Appendix G.

10.2.1 Task 1: Update Conceptual Model of Closure Cover System Design Performance

The conceptual model of closure cover performance will be updated as monitoring and site investigation data are collected and analyzed. This will help refine the previous conceptual model of cover system performance. Monitoring and site investigation data include:

- material characterization programs (Tasks 2 and 3);
- meteorological monitoring on various slope aspects (Task 4);
- climate and hydrologic / hydrogeologic (Task 4; and data collected as part of the EMSAMP); and
- vegetation data (e.g., Vegetation Rooting Study).

The conceptual model has helped to direct the research program and identify key research targets. Continued studies help reduce uncertainty in model assumptions, are used to update the conceptual model and ultimately support the cover system field trial that has begun on the 1370 lift of the PG WRSA (Task 5). The conceptual model will be periodically reviewed and updated as appropriate during updates to the RCP. Ultimately, the model will improve confidence in cover system performance and provide +a basis for design as progressive cover development occurs on the WRSAs.

The current model of performance relies strongly on the ET mechanisms of the cover system due to the site-specific climate and material factors. During periods of low evaporative potential such as spring, when water surpluses (freshet) are expected, runoff becomes the dominant control mechanism. To manage NP, cover design components can incorporate components that enhance runoff. The 2014 modelling (Appendix E) conducted by O'Kane Consultants noted that runoff was strongly influenced by slope and cover system grade, and by the presence or absence of frozen ground. The update to the conceptual model will investigate ways to improve the runoff shedding performance of the cover system to manage NP during freshet. For example, increasing the grade of the benches or utilizing a cover structure that allows for better transmission of interflow of the upper unfrozen zone in the spring to improve runoff conveyance could improve performance. Given that most NP occurs in the short freshet, small improvements in runoff performance during this time of year could lead to significant overall gains in reducing annual NP even if they reduce NP performance to some degree in the following summer period.

Erosion of a cover system and associated landform are a direct result of hydraulic and physical material properties, surface / slope configuration, and the runoff imparted on the system. As such, research will also be conducted to examine, and ultimately balance, runoff and erosion performance of the cover system and will be used to refine the conceptual model. For example, clays and hydrophobic soils can increase surface runoff rates, but rill and interill erosion tends to be higher in materials without coarse material. This research is being informed by material characterization (Task 2) information.

The results of the research and updated conceptual model will be used to assess the cover system configurations that enhance runoff to manage NP while minimizing potential for erosion as much possible, which will then be

tested during field trials. This process of closure cover research and design requires flexibility, rather than prescriptive solutions, to produce effective site-specific closure solutions.

10.2.2 Task 2: Material Characterization Program for Candidate Cover System Materials

Material characterization of stockpiled material provides data to refine material property inputs to the conceptual model. The objectives of the material characterization program are to:

- assess material availability and volume,
- quantify certain hydraulic properties that will control the performance of the closure cover systems,
- determine soil fertility for candidate top soil material, and
- evaluate erosion characteristics.

An initial material sampling program was conducted before and during cover system construction on the 1370 bench of the PG WRSA to characterize the physical and hydraulic properties of the overburden material. Six different zones were sampled to account for potential variability in the stockpile material. The laboratory testing program includes particle size distributions, hydrometer analysis, determination of Atterburg limits, standard proctor analysis, hydraulic conductivity estimation, and soil-water curves. Data from the characterization program will aid in the interpretation of performance monitoring data collected as part of the instrumentation program (Task 4). Furthermore, material characterization data serve as a critical input for numerical modelling programs that use performance monitoring data for calibration. The laboratory results for the overburden material samples collected as part of the program are currently pending.

In general, to achieve the overall objective of the material characterization program, the sampling program evaluates three separate elements:

- material availability and volume,
- hydraulic properties, and
- erosion characteristics.

10.2.2.1 Material Availability and volume

While some initial material sampling has been conducted on the material that is now on the 1370 lift, additional sampling and borrow source availability will be conducted during 2021. Test pit samples and logs of the existing reclamation stockpiles that resulted from construction activities and other locally available sources of topsoil, colluvium and placer tailings will be used to evaluate borrow source feasibility and availability. Sample locations will be identified based on previous material investigations and site reconnaissance. The test pits or excavations would be logged for material layer depths, color, initial texture analysis, water table depth, and rooting depth (as compared to Vegetation Rooting Study results). A digital photographic record will be developed for each test pit and the specific location will be documented using a GPS device. Each potential borrow area will be surveyed for areal extent by walking the area using survey grade GPS equipment to determine the volume of material available in the area.

Between 7 and 10 samples of each material type will be collected and submitted for basic geotechnical testing including water content, particle size distribution (PSD) analyses and Atterberg limits. The exact number of samples collected will depend on the heterogeneity of the materials encountered.

10.2.2.2 Hydraulic Properties

Following a review of the PSD test results, a select number of duplicate samples would be submitted for compaction testing and hydraulic characterization including saturated permeability and moisture retention testing.

This component of the material characterization program is to verify the hydraulic properties of local topsoil material because saturated hydraulic conductivity (k_{sat}) of local topsoil material showed to have the largest influence on predicted net percolation rates in the 2014 numerical assessment. A large database of PSDs completed by BGC from a variety of borehole and test pit locations were provided to OKC for the 2014 assessment (BGC 2010, BGC 2011, BGC 2012a and BGC 2012b) and OKC used the PSD data to develop hydraulic properties of cover and waste materials for the 2014 assessment. PSD data was not available for the topsoil material and properties were developed by comparing topsoil materials from similar sites in an extensive material database developed by OKC.

The results of the characterization work done in 2020 and additional characterization work completed in 2021 should help to. refine of the currently estimated hydraulic properties for cover materials simulated in the 2014 VADOSE/W modelling program, and subsequent increase in the confidence of current estimates of long-term cover system performance.

Representative samples of potential cover materials will be submitted for chemical characterization testing. Soil fertility examination for agronomy assessment, including but not limited to, analyses for sodium adsorption ratio (SAR), cation exchange capacity (CEC), pH and EC, organic carbon, exchangeable K, Ca, Mg, macronutrients, and micronutrients will be performed.

Previously, Stantec (2011a) conducted a growth media survey for suitable salvage material based on reclamation suitability of soil and terrain conditions. A soil suitability rating system, originally developed by Alberta Agriculture, Food and Rural Development (AAFRD 1987) and the British Columbia's Mines Act (MEMPR 2006), was modified to reflect the presence of large stones and boulders as they are not accounted for in the Alberta rated system but needed to be accounted for the Mine. Additional modifications to account for steep or unstable slopes were considered for safety (2011a).

Reclamation suitability ratings of good or fair were designated as soils suitable for reclamation requiring minimal preparation while soils rated as poor (coarse fragments resulting in limited reclamation properties) were regarded as suitable if amended significantly or if higher rated media was available. Soil containing less than 15% by volume cobbles or boulders, with up to 50% total coarse fragments were rated good or fair for reclamation. Rating of poor or unsuitable soils was based on stoniness. Since chemical properties were not deemed to be the most limiting factor for suitability (Stantec 2011a), criteria were based on the most limiting soil physical properties of soil texture, coarse-fragment content, and stoniness.

The results of material characterization fertility test work will aid in assessing fertilizer requirements for revegetation of the cover systems and may show that a particular borrow source is chemically preferable to support growth of native plants.

10.2.2.3 Erosion Characteristics

Erodibility assessment of the topsoil or surface material would include aspects of the chemical and geotechnical assessment as well as the Emerson crumb test. The cover system material characterization program has been outlined to quantify the coarse fraction, in particular the void ratio, particle angularity and PSD. The coarse fractions are important for resisting rain splash erosion (i.e. interill erosion). Materials susceptible to erosion and not suitable for reclamation of side slopes would be identified.

Overall, the material characterization program will allow for incorporation of heterogeneity into the conceptual model, as preliminary modelling has demonstrated the sensitivity of the various materials properties to NP performance. Understanding the range of material properties to be included in final closure landscapes will allow for assessment of the range of NP performance across the closure landform. Sample results will increase the sample size for the various materials, allowing development of material property envelopes that can be used to more accurately assess the effect of material variability on predicted cover system performance over a larger range of material heterogeneity.

10.2.3 Task 3 Material Characterization Program for HLF and WRSA Waste Materials

Current estimates of long-term cover system performance for the Mine site are based on estimated particle size distributions for the spent heap leach and waste rock material.

Representative samples of spent heap leach and waste rock material will be collected when deemed the material available from the existing facilities is appropriately representative (likely in 2021 and 2022) and submitted for geotechnical characterization. Analyses include PSD, water content, standard Proctor compaction, saturated permeability, and moisture retention. The mine waste characterization program will also help to determine the technical feasibility and costs associated with reducing the permeability of flatter areas on the HLF and WRSA to help with future detailed cover system design development

Spent heap leach and waste rock materials may break down when exposed to the atmosphere and when mechanical energy is applied. A pilot-scale field compaction trial will be conducted to evaluate the extent to which the waste material can be compacted, thereby reducing its permeability. Large vibratory rollers may be able to reduce the saturated permeability of surface waste material on flatter areas of the HLF and WRSA, such as plateau areas and benches, by one to two orders of magnitude. The intent is to limit net percolation during relatively short-duration seasonal events when the storage capacity of the growth medium layer may be exceeded. Compaction field trials could be carried out once spent heap leach and waste rock stockpiles are established, and materials have been exposed to ambient conditions for several years. The test program would involve permeability and density testing of pre-compacted surfaces, followed by compaction with appropriate equipment and subsequent permeability and density testing of post-compacted surfaces. The technical feasibility and costs associated with reducing the permeability of flatter areas on the HLF and WRSA could then be weighed against the anticipated benefits of reduced net percolation or passive treatment.

The sensitivity results of the 2014 numerical modelling report demonstrated that increasing WRSA waste material k_{sat} by 2-orders of magnitude only resulted in a 4% increase in NP, from 34% to 38%. Likewise, increasing HLF waste material k_{sat} by 2-orders of magnitude only resulted in a 2% increase in NP, from 36% to 38%. For both waste types, the model showed limited sensitivity to the hydraulic conductivity properties of ore and waste material. Regardless, characterization of HLF and WRSA wastes will be used to further refine the material assumptions used in the closure cover performance model. Moreover, by increasing the sample size for the

various materials, material property envelopes can be developed to more accurately assess the effect of material variability on predicted results under a larger range of material heterogeneity.

The 2013 Eagle Gold Project Report of Metallurgical Test Work prepared by KCA reported the results from five compacted permeability tests on column tailings. Forte Dynamics also reviewed this work and summarized the results in *Hydraulic Conductivity Testing Review* (2018a). Compacted hydraulic conductivity testing (representing 70m of ore height loading) was performed on P80 7mm samples. Hydraulic conductivity results of this testing ranged from 0.0099 to 0.2607 cm/s, with an average of 0.1036 cm/s. While these results represent a deviation from the parameters used in the 2014 O'Kane assessment, given the limited sensitivity of the model to ore and waste hydraulic conductivity, refinements of this parameter will be made once results of compaction field trials are available.

10.2.4 Task 4: Enhanced Meteorological Monitoring on Various Slope Aspects

10.2.4.1 Objective

The objective of the enhanced hydrological and meteorological monitoring is to characterize different slope aspects to help validate site-specific climate input parameters used in numerical modelling analysis. This will help gain confidence in local (i.e., for each cover) water balance estimations and in the long-term predicted cover system performance. Meteorological monitoring will also examine snow pack sublimation and redistribution of snow, wind speed and incoming solar energy and wind speed. For the Mine, snow pack constitutes a significant portion of the water balance. Thus, characterizing the dominant wind direction during winter is important for informing where snow will tend to accumulate, allowing final closure landforms to be constructed in a way to minimize the effect of snow accumulation.

The first phase of this task is being initiated during October 2020. An automated performance monitoring system is being installed in the upper Platinum Gulch WRSA as part of the pilot cover program on the 1370 m lift. The monitoring system is summarized below and described in more detail in Appendix G.

10.2.4.2 Potential Evapotranspiration

Given the relatively high latitude of the Mine site, slope aspect and angle highly influence the amount of solar energy and resultant potential evapotranspiration (PET) applied to various areas of the site. For an exposed plateau or east- or west-facing slope, OKC (2014) estimated average annual PET to be about 370 mm/yr. However, PET was estimated to be 60% less on north-facing aspects and 50% more on south-facing aspects, resulting in average annual PET rates for these two aspects of about 150 mm/yr and 560 mm/yr, respectively. In short, slope aspect is a critical factor at northern latitudes that will influence long-term net percolation rates realized through the reclaimed HLF and WRSA landforms.

10.2.4.3 Solar Energy and Net Radiometers

Incoming solar energy is the main driver of potential evapotranspiration (PET) and varies with slope aspect and gradient. For the initial estimates of PET based on slope aspect, calculated values of extraterrestrial radiation (R_a), solar radiation, in addition to short and long wave radiation was employed according to the FAO's method (FAO, 1998). These calculations provide an estimate of major energy balance components when no direct measurements are available. As with most empirical formulas that are fitted across a range of parameters, there are instances where the calculation begins to lose accuracy. The initial calculation of extraterrestrial radiation is

dependent on latitude. Although the calculated R_a values have been shown to be accurate over across all latitudes during non-frozen periods, for the winter months in latitudes greater than 55° (N or S), the equations for R_a have limited validity. Reference can be made to the Smithsonian Tables to assess possible deviations if a correction for a region is available.

It is for this reason that the proposed meteorological monitoring program of the initial cover locations will incorporate net radiometers, on the varying slope aspects. This will provide data to calibrate the assumptions in the radiation portion of the PET calculations. By gathering a full solar cycle (365 days) of net radiation data, the estimates for PET can be refined to reduce uncertainty in the estimates. Furthermore, the direct measurement of net radiation can be used for future updates to the closure cover performance model as the surface conditions of the cover systems evolve on the WRSA's and HLF. As different types of vegetation establish, the albedo and consequently the partitioning of shortwave to long wave radiation will differ, both having implication for PET.

Enhanced monitoring of site-specific solar energy and snowpack on various slope aspects will increase the confidence in current estimates of long-term performance and water balance estimations for the proposed HLF / WRSA closure cover system. In addition, depending of the prevailing wind direction areas of the HLF / WRSA may be sheltered influencing the evaporative demand.

10.2.4.4 Site Climate Data

Currently climate data is being collected at two automated stations in the Mine area: the Potato Hill station installed in 2007 and the Camp station installed in 2009. Station details and the climate data that is being collected during this Task are found in the EMSAMP. Automated snow depth measurement and solar radiation are currently part of the climate station instrumentation. Net radiometers will be installed as part of the operations phase at the locations specified in the EMSAMP to provide measurement of incoming solar energy for north, west, and south facing slopes.

Climate information is analyzed and summarized annually, for parameters including: precipitation, potential evaporation, snow water equivalent (SWE, from snow surveys), and solar radiation that can be compared to the closure cover performance model inputs. Review of climate data analysis by Lorax (2016) shows that precipitation parameters used in the 2014 closure cover performance model remain conservative, as they are based on the 80-year historic climate database and are higher than site-specific precipitation data collected on site. Estimates of PET used in the 2014 O'Kane analyses were nearly identical to PET estimates generated based on Lorax (2016) data analyses.

10.2.4.5 Snow

Snow course surveys have been undertaken during late winter since 2009 in the vicinity of the climate stations and methods are described in the EMSAMP. The snow course surveys will continue to be conducted at these locations, as well as in the locations proposed for the installation of net radiometers. In addition, the snow course surveys are planned to expand to incorporate the HLF to refine the water balance model by providing improved estimates of snow water equivalent and sublimation. Snow survey methods will continue to be implemented according to those outlined in the EMSAMP. The surveys will be conducted on a monthly basis during the late winter season. The surveys will aim to capture the peak snow pack as best as possible, which will help determine the amount of snow water equivalent (SWE) available that will contribute to spring freshet events and has the potential to infiltrate and report as net percolation.

O'Kane's estimate of snow water equivalent (135 mm) does not differ significantly from the Lorax (2016) Camp station results, however, it does not include the variability the site experiences in SWE. SWE estimates will refined in the closure cover performance model subsequent to the expansion of snow course surveys to include the HLF.

10.2.4.6 2020 Field Program

An automated performance monitoring system is being installed in the cover system during October 2020. Monitoring performance of the cover system trial includes: 1) net radiometers, 2) snow surveys, and 3) a rainfall gauge. Additional meteorological parameters for use in performance monitoring will utilize data collected at the Camp and Potato Hills Stations. Analyses of the monitoring and other climate data will be an important element in assessing the efficacy of the base case cover system. Cover system performance monitoring will focus on partial elements of atmospheric water and energy balance inputs, along with soil water balance parameters. Measurements taken within the cover system provide insight into the partitioning of water at the cover system-atmosphere interface and the cover system-waste material interface. Additionally, measured in-situ soil parameters will include volumetric soil water content, soil temperature, and soil matric potential.

The monitoring system design for the cover system trial includes one monitoring station on the covered area of the WRSA plateau and one monitoring station on the adjacent covered southeast slope. Having sensors on both the plateau and slope ensures that the individual landform elements are captured as distinct units, thus aiding in data interpretation.

10.2.5 Task 5: Closure Cover System Field Trials for Performance Monitoring

10.2.5.1 Objective

The objective of the closure cover system field trials is to increase the level of confidence in estimates of long-term performance of the final HLF and WRSA closure cover systems under site-specific conditions. Cover system field trials track the evolution of the cover systems in response to site-specific processes (physical, chemical, and biological) to enhance understanding of key characteristics and processes that control cover system performance. Cover system field trials also provide the opportunity to assess and compare the performance of multiple cover system design alternatives. Cover system performance will be assessed based on net percolation of meteoric waters to the underlying waste material, the runoff of water and the vegetation rooting characteristics. The initial modelled assessment of cover system performance showed little difference in performance between the WRSAs and HLF simulations. Information gained in previous tasks will assist in the development of cover trials on different waste material types and on different slope angles.

Monitoring data will be used to update the cover system model. The results from the updated performance model will inform the optimum cover system design to be trialed at the site. The cover system field trial program would be designed to achieve the key objectives summarized in the Covers in Cold Regions Guidance Document prepared by MEND (MEND, 2012):

- Evaluate construction methodologies and equipment in support of finalizing the full-scale cover system design;
- Obtain performance monitoring data for calibration of the VADOSE/W model;
- Develop an understanding of key characteristics and processes that control cover system performance; and

- Track evolution of the trialed cover systems in response to various site-specific physical, chemical, and biological processes.

10.2.5.2 Cover System Field Trials

Cover system field trials can be used to further investigate variables, and calibrate the closure cover performance model in terms of:

- Cover system layer thickness;
- Cover system textural differences;
- Vegetation and soil amendments;
- Slope grade, length, aspect, and bench configurations; and
- Surface water management structures adhering to geomorphic principals.

The cover system field trials will be constructed with the same, geotechnically stable, landform cover system integration as intended to be used on the full operation scale facilities. Field trials represent an opportunity to examine landform geomorphic evolution (e.g., the potential for settlement, minor slumping and erosion) and use the information to highlight areas of the design to be refined or bolstered prior to implementation on full scale production facilities.

The cover system field trial would be revegetated using techniques and species outlined by KP (2012a and 2012b) and as informed by the Vegetation Rooting Study. Field trials provide an opportunity to investigate vegetation prescriptions and techniques by monitoring for vegetation establishment and continued growth. Vegetation growth is an essential component of the cover system water balance (in terms of AET rates) as well as a primary focus of achieving closure design objectives.

10.2.5.3 Monitoring Methods

Runoff processes and snowmelt-runoff interactions can be confirmed in the field by using soil matric potential, temperature and water content sensors staggered strategically throughout the cover system profile. In field permeability testing and UAV erosion surveys will also be conducted annually. Runoff collection and monitoring systems can be employed to directly measure the effects of different cover system configurations on runoff. Runoff and erosion monitoring will seek to identify how permeability of the cover trial growth medium will change with time, and how this might influence on runoff and erosion. By better characterizing the in-field conditions of the cover systems water and energy balance, the cover design can be refined to further improve management of snow melt and runoff.

As noted in MEND (2012), performance of cover system field trials should be monitored for a minimum of 2 to 3 years prior to proceeding with final design of the full-scale cover system. Information gathered during field trials will provide sufficient variability in thermal and hydraulic field responses to adequately calibrate the VADOSE/W models, thereby improving confidence in the predicted long-term performance of the final cover system design for full-scale implementation.

10.2.5.4 2020 Field Trial

A conceptual design for the field trial program consists of two field trials of the preferred cover system design established on a WRSA, one on the plateau and one on an inter-bench slope. Cover trials need to be large enough

to properly evaluate construction methodologies and equipment that would be used for full-scale construction and performance monitoring.

Initial efforts to construct and instrument a pilot scale cover system trial began in September 2020. A mixed overburden and topsoil stockpile was relocated to the plateau of the 1370 bench of the Platinum Gulch WRSA. The opportunity was taken to construct and monitor a pilot scale cover system using the relocated overburden. A 0.5 m thickness of cover system, chosen to align with the base case configuration, was constructed on the eastern portion of the plateau area and a portion of the south-southeast slope of the WRSA. Details regarding the construction and instrumentation of the trial, and the ways in which data collected at the trial will be used to advance subsequent areas of research is provided in Appendix G.

The cover trial will incorporate automated soil monitoring stations that consist of volumetric water content and matric suction sensors to quantify key surface water and energy balance fluxes. Data will be collected by a datalogger powered by battery and solar panel set up. Sensors will be installed in pairs through the cover system profile to capture data to calculate water and energy fluxes at the interfaces of different material types including between the cover system layers and between the cover system and waste. As the cover trial advances, stations will be installed to capture data on a plateau location and on different slope locations (upper, mid, and lower slope) to determine spatial variability. The number and location of the automated stations will be determined as part of the final design of the cover system monitoring trials informed by the updated conceptual model, the material characterization program, and the expanded site-specific meteorological dataset.

10.2.6 Task 6: Effect of High pH Water Treatment Solids on Heap Cover

The “Eagle Gold Mine Water Treatment Solids Management Plan” (Engineering Analytics, 2014) states that two types of solids will be created during water treatment operations. One type is a low pH solid produced from the iron coagulation water treatment step, and the other is a high pH solid, produced from the sodium hydroxide addition step for metals treatment. The high pH solids will only be produced during the heap draindown period. The low pH solids will be stored in lined facilities that will function as permanent disposal cells. The high pH solids will be pressed to a high solids content (estimated at 70%) which will then be suitable to be co-disposed on the heap in areas that will then be covered.

Specifically, the plan proposes that the high pH solids “will be generated concurrent with the closure of the HLF and, as such, the solids will be incorporated into the HLF. The solids will be periodically trucked to the HLF in areas that are being graded and prepared for capping. Like the spent ore, the caustic solids will be protected from exposure to meteoric water by the capping system. The caustic solids will exhibit similar metals loading as the spent ore and the solids will be geochemically stable in the HLF.” It was further stated during the WUL hearing that the “… design for disposal of water treatment sludges on the heap would be to dig a trench that would be deeper than the root zone” such that the sludges “…would be buried within the heap materials below the cover and below some portion of the heap materials to minimize that potential of uptake of metals into vegetation”.

One of the objectives of the research program is to demonstrate the suitability of the mine water treatment solids for use as heap cover material. The proposal is to mix the high pH solids into the heap materials and then cover the area with the water treatment solids the same as all other covered areas. Thus, the proposed research is focused on the effect of mixing the high pH solids on the heap as a cover basal layer, and not on the cover layer performance.

During the materials characterization program for cover described in Section 10.2.2, materials testing of heap materials with and without compaction will be performed. When high pH solids are first available, a second set of tests paralleling those described in Section 10.2.2 will be performed: Compaction field trials will be carried out once spent heap leach and waste rock stockpiles are established, and materials have been exposed to ambient conditions for several years.

The test program would involve permeability and density testing of pre-compacted surfaces, followed by compaction with appropriate equipment and subsequent permeability and density testing of post-compacted surfaces. This set of tests will be duplicated to include areas mixed with high pH solids. The geotechnical testing that is proposed includes specific gravity, Atterberg limits, gradation (sieve and hydrometer), and consolidation testing (oedometer). The consolidation testing would be used to determine void ratio before and after mixing in the water treatment solids, and would include tests on sludge, heap materials, and a mixture of the two. The sludge and the heap materials would also be characterized to compare their geochemical properties. Geochemical testing on both the spent ore, sludge, and mixed spent ore / sludge will include: paste pH (1:2); rinse pH (1:2); 1 M KCl and 4 M HCl extractions; Total S, Sulfide S, ANC, NAG pH, NAG Acidity to pH 4.5 and 7.0, SPLP testing at pH 3 and pH 7, and whole rock analysis.

Because the volume of high pH solids is estimated to be low (calculated to be 238 m^3/year during phase 6 only), only small portions of the heap will actually receive solids prior to the cover placement. While the solids management plan does state: “Uniformly spread over the entire heap, the caustic sludge generated over Phase 6 would represent a 3 mm thick layer under the HLF cap”, this illustrates only that it is a small volume compared to the volume of the heap materials. However, the high pH solids will not be spread uniformly over the surface of the entire heap. For instance, assuming a 10% mixing rate (high pH solids to heap solids), a 70m x 70m by 0.5 m deep zone would accommodate one year of high pH solids production. Thus, the sludge would not be spread over the entire HLF but still spread thin enough so that it could be ripped deep enough into the HLF pad surface so that the rock will maintain grain to grain contact (i.e., sludge just filling part of the void space within the rock), and so that it would have a negligible effect on the geotechnical performance of upper layer of the HLF pad. Based on experience at other sites and from conversations with contractors, conventional equipment (dozer/grader for spreading and ripper/disk) will be used to provide sufficient mixing action. The proposed geotechnical testing will confirm that the performance of this layer has not materially changed.

The plan will include a strategy for implementing the mixing test with sampling under the supervision of a geotechnical engineer such that the mixture achieves the objectives of maintaining grain to grain contact and the sludge fills only part of the void space within the heap leach materials. Close field supervision of the mixing program will help determine optimal field mixing ratios so excessive iterations of the blending operation can be avoided.

The research program will be used to demonstrate the suitability of the mine water treatment solids for use as heap cover material. Information gathered can be analyzed in the site-wide water quality and water balance models for closure to develop a refined picture of water quality management scenarios into closure.

10.3 VEGETATION ROOTING STUDY

10.3.1 Objective

The overall objective of the Rooting Study (Appendix B) is to gather information on plant rooting depths and develop optimal requirements for cover thicknesses to encourage maximum evapotranspiration from covers. The objectives of this scope of work are to:

1. Quantify the root depth and distribution of key functional types (grasses, shrubs, trees) of mature plants at or near the Mine site.
2. Characterize the growth materials associated with plant roots at the most active rooting depths for particle size distribution (PSD), textural, and nutrient analysis.
3. Summarize root depth / distributions of key functional types, the association between plant root and material characteristics, and develop specific recommendations for refining the cover closure plan.

10.3.2 Two-phased Approach

A two-phased approach is proposed for the vegetation rooting study. The first phase is to examine natural analogues to correlate rooting depth development over time to various rooting parameters. The second phase, is to apply first phase results and implement field trials to test the revegetation strategy. During field trials, vegetation will be destructively sampled at the climax period as informed by the natural system investigation. The two-phased approach to the Study consists of the following breakdown of tasks:

Phase 1: Examination of Natural Analogue Sites

- **Task 1**: Conduct a comprehensive literature search on vegetation in alignment with closure objectives for cover systems.
- **Task 2:** Establish test plots in analogous sites possessing similar plant communities (i.e. grasses, shrubs and trees) as the proposed successional end land use communities (KP, 2012a, 2012b). Climax successional vegetation communities would be confirmed through tree aging.
- **Task 3**: Conduct destructive sampling to assess vegetative characteristics of target species identified in the literature search, such as root density and length, and to identify rooting constraints/enhancements in each plot. The destructive sampling will focus on target species that are characterized by deeper penetrating rooting systems, and that may affect cover system performance. This will inform the development of recommendations regarding cover system materials (e.g., particle size, soil amendments, etc.).

Phase 2: Implement Cover System Field Trials

- **Task 1:** Develop cover system field trial design to assess vegetation treatments selected based on learnings from the Phase 1 Study results.
- **Task 2:** Construct a field trial landform and cover system. Landforms will be constructed from equivalent leached ore or waste rock material produced onsite

- **Task 3**: Vegetate constructed cover system trial area in alignment with successional end land uses. Seed mixes will be developed for any early successional grasses, and seedlings sourced for shrubs and trees.
- **Task 4:** Monitor moisture content of root zone to understand physical processes contributing to accumulation or removal of water (i.e. pore-water sampling collection over the duration of the cover system monitoring program).
- **Task 5:** Assess geochemical character of the cover system and underlying materials and identify any constituents that may be susceptible to bioaccumulation.
- **Task 6:** Conduct destructive sampling during and near the end of the program to assess the vegetative characteristics, such as root density and length.
- **Task 7:** Update cover system model based on results of the study to validate the effectiveness and applicability of the proposed vegetation strategy for the current cover system design.

Additional details on of the Rooting Depth Study tasks are provided in Appendix B.

10.4 PASSIVE WATER TREATMENT

Passive water treatment systems are proposed to treat mine waters upon closure. While the predicted water chemistries and site layout are conducive to passive water treatment, it is recognized that additional research will be required to optimize and confirm each PTS design and size. Despite being best available estimates for the sizing of the CWTS component of the PTS for closure, these are not site-specific and require further refinement and optimization through controlled pilot-scale testing and on-site demonstration. For this reason, a conservative size estimate has been included in the site plan and budgets at this early point of closure planning, with the understanding that these will be revisited once the PTS designs are refined.

The objective of this PTS reclamation research program is therefore to refine, optimize and remove uncertainties associated with the removal rate coefficients and thermodynamic minimums possible for the water predicted at closure for the Mine. More specifically, the proposed program contains four overriding objectives:

1. Refine the PTS or combination of PTSs for post-closure water treatment
2. Scientifically test and optimize PTS configurations
3. Validate function of PTS in cold climate
4. Demonstrate function of the system on site prior to closure

These four objectives will be met through a multi-phase research program. The phases of research for the PTS include bench/laboratory/pilot (controlled environment and/or outdoor cold-climate at CSL's dedicated PTS facilities), and demonstration (small-scale, on-site during operations). The purposes of each phase are outlined in Table 10-3.

Table 10-3: CWTS Phased Development

Aspects and Parameters Related to Different Constructed Wetland Scales	Pilot (CSL facilities)	Demo (on site)	Full
Test various water chemistries and formulations	+		

Aspects and Parameters Related to Different Constructed Wetland Scales	Pilot (CSL facilities)	Demo (on site)	Full
Test different sediment makeups	+		
Test different plant efficacies/properties	+		
Environmental parameter control	+		
Develop flow rates and water depths (HRT)	+		
Develop rate coefficients and kinetics	+		
Intensive monitoring	+	+	
Determine parameters for proper sizing	+	+	
Measure removal extent	+	+	+
Evaluate cold weather performance	+*	+	+
Compare demo/full scale data to pilot data (e.g., rate coefficients)		+	+
Confirm removal rates/extents		+	+

*if performed outdoors.

10.4.1 Methods

The final design will be comprehensive and based on sound scientific principles (biogeochemistry, pilot studies, etc.). PTSs can be developed from concept to sustained performance using a phased approach as described in the following sections. An overall schedule of the program is shown in Section 10.4.2.

10.4.1.1 Phase 1: Updating Information for Final Design

1. Continued characterization of water requiring treatment; comparing initial predictions with actual performance and reviewing if the initial plan needs adjustment
2. Confirmation of targeted constituents and performance goals
3. Characterization of existing wetlands systems in site vicinity to guide plant selection and water management approaches
4. Site assessment for implementation of CWTS

Phase 1 is currently ongoing. In Phase 1, the following list of information will be gathered from site operations monitoring programs and used for the design basis of the PTS. Additionally, potential borrow sites for hydrosoils and wetland plants will be identified. Plants may be collected from site for use in Phase 2, if appropriate.

- Intrinsic Factors
    - Concentration and identity of constituents that will require a decrease in concentration
    - Flow rates
    - Fluctuations in concentrations and flow rates
    - Cation/anion balance
    - Conductivity

  - Alkalinity
  - Hardness
  - pH
  - Concentration of Sulfate
  - Concentration of Iron and Manganese
  - Nutrient availability (N, P, K and micronutrients such as Cu, Se)
- Extrinsic Factors
  - Receiving system limits (water quality objectives, mixing zones)
  - Soils
  - Geology
  - Topography
  - Constructability
  - Sources of organic material
  - Depth to groundwater (hydrogeologic regime: recharge or discharge area)
  - Vertical and/or lateral proximity to permafrost
  - Duration of operation required
  - Wildlife deterrence
- Climatic
  - Geographic location (lat/long)
  - Aspect (i.e., north- or south-facing)
  - Seasonal distribution of Rainfall
  - Character of Storm events
  - Snowfall
  - Freshet (break-up) character
  - Freeze-up character
  - Growing season
  - Temperatures (max, min, mean)
  - Growing-degree days
  - Evaporation and evapotranspiration
- Putative evidence of system functionality at site

- Information gathered on existing wetland systems near the site
  - Types of native plant species
  - Redox in natural wetlands
  - Soil chemistry (total organic content, nutrient levels, etc.)
- Identify mechanisms in existing wetlands near the site to sequester constituents that will require a decrease in concentration
  - E.g., oxic or anoxic As removal pathways
- Accretion rates
- Availability and sources of local plants for CWTS planting

10.4.1.2 Phase 2: Indoor Pilot Scale

1. Design of pilot scale PTS (one or more designs may be tested for optimization)
2. Assembly of indoor pilot scale PTS
3. Performance monitoring and stress testing of the indoor pilot scale PTS

In Phase 2, pilot scale systems are to be designed and built in a year-round temperature-controlled greenhouse. At times, bench or laboratory scale testing is used to aid in the design of the pilot scale PTS. At pilot scale, there are typically two to four treatment cells in a series, two replicates of each system, and 2-4 different system designs tested (a total of 8-32 cells). For this phase, simulated water is to be created with chemical characteristics similar to that predicted to occur post closure. These systems are to be run for a minimum of 6 months and maximum of 2 years, depending on the extent of optimization and/or stress testing to be performed. A PTS such as a BCR may be used as a pre-treatment step and will be evaluated in line with any other components of the PTS (e.g., a CWTS). During Phase 2, explanatory parameters will be assessed regularly.

A pilot bioreactor program was established on the Project site in 2019. The program, being conducted with guidance from the Yukon Industrial Research Chair - Northern Mine Remediation at the Yukon College Research Centre, expands upon earlier lab scale trials on the removal rates for arsenic, selenium, antimony and other metals under site conditions. The lab scale program and results were described in the 2015 Yukon Research Centre report entitled Arsenic, Antimony and Selenium Removal from Mine Water by Anaerobic Bioreactors at Laboratory Scale. The pilot program includes trial components exposed to ambient freeze-thaw stresses to evaluate the effect of the site climate regime on removal rates. More specifically, the primary objective of the research program is to study freeze-thaw cycles on sulfate reducing bacteria and to assess their efficiency to remove heavy metals (particularly arsenic, selenium and antimony) from mine influenced water (MIW), and in this case MIW originating from Platinum Gulch catchment and the PG WRSA.

The program utilizes mine influenced waters (captured at site collection points along Ditch A or the LDSP pond water, which is then transferred to the trial area) pumped into a 1,000L tank filled once per week though the summer and twice per week during winter. The MIW is then transferred to 200L drums both inside and outside of the bioreactor program shack. The MIW solution is fed with a specified dosage of molasses, which helps to feed the bacteria and allow the bioreactor to work. The bioreactors are monitored weekly and sampled on a periodic

basis (weekly to monthly depending on field conditions). VGC continues to work with the YIRC to support the implementation and further development of the program with the results of the first year of program pending.

10.4.1.3 Phase 3: Outdoor Pilot Scale

As noted above, the current pilot bioreactor program on site has included elements of Phase 3 to evaluate freeze-thaw stresses on removal rates. Depending on data from Phase 2, it may be possible to skip this phase and proceed directly to on-site demonstration.

1. Assembly of outdoor pilot scale PTS in a cold climate environment (based on information gathered from indoor pilot scale findings)
2. Performance and seasonal monitoring of the outdoor pilot scale PTS

In Phase 3, the best performing systems from Phase 2 will be used for the design basis for outdoor pilot systems. Simulated discharge water will be used. Each treatment cell in the outdoor pilot-size system will contain approximately 500kg of hydrosoil, (total of approximately 2 tonnes per treatment system being tested) and will have 1,200-1,500 liters of simulated discharge water pass through per week. At a minimum, one treatment system will be tested in duplicate. Ideally, these systems will be built using hydrosoil from a borrow site near the Eagle Gold mine. These systems will be located outdoors, at a cold-climate PTS testing facility. These systems will be allowed to run for a minimum of 1.5 years, ideally 2-3 years to properly characterize spring thaw and winter freeze performance. During Phase 3, explanatory parameters will be assessed regularly (as in Phase 2).

10.4.1.4 Phase 4: On-site Demonstration Scale

1. Design of on-site demonstration scale PTS
2. Construction of demonstration scale PTS at the Mine
3. Performance monitoring of demonstration scale PTS at site

In Phase 4, the demonstration-scale system will be built on site at the Mine and will be sized to allow adequate monitoring and testing for the implementation of the full-scale PTS. It is currently conceptualized that this will be implemented by constructing the PG PTS downgradient of the PG WRSA once the WRSA is closed during early in operations. The outflow from the demonstration PTS will be sent to the LDSP to be used as make-up water or to the MWTP to ensure all water that enters the receiving system has been treated by an approved system. During Phase 4, explanatory parameters will be assessed regularly (as in Phase 2 and 3).

10.4.1.5 Phase 5: Full-Scale Implementation

1. Design of full-scale PTS
2. Construction bids, permitting and initiation
3. Construction
4. Planting and/or maturation
5. Acclimation and initial monitoring
6. Ongoing operation and periodic monitoring of PTS

In the final phase, the full-scale PTS will be built prior to or just after closure depending on the system to allow the system to stabilize and mature. Early commissioning of a full-scale PTS will provide additional confidence that the

systems are functional and reliable. For the HLF, the PTS will be built as soon as water is available for that system, and the MWTP will remain functional until the PTS has matured, stabilized, and demonstrated an acceptable treatment performance for a designated period of time.

10.4.2 Schedule

The current schedule for implementation of the research program is shown below.

Table 10-4: Passive Treatment Research Program Implementation Schedule

Phase	Start Date	End Date
Phase 1: Information Gathering	September 2012	2020
Phase 2: Indoor Pilot Scale	2019	2021
Phase 3: Outdoor Pilot Scale	2021	2022
Phase 4: On-site Demonstration Scale[a]	2022	2023
Phase 5: Full Scale Implementation	TBD	Into post-closure

Note:
a This will be implemented by constructing the PTS for the PG WRSA

10.5 HEAP BIOLOGICAL DETOXIFICATION AND IN-HEAP BIOREACTOR RESEARCH PROGRAM

This plan is part of the reclamation research is closely paired with the PTS research described in Section 10.4 because it affects the source water quality that will ultimately come to the heap PTS. It addresses uncertainties in the heap detoxification process which will be applied as the heap transitions from leaching into closure. The field-based research is planned to be concurrent with heap leaching operations over a 3-year period at a similar time as the on-site PTS demonstration program. The primary test phase is expected to take approximately 100 days followed by quarterly testing of effluents for up to 12 quarters thereafter to evaluate rebound, stability, and seasonal effects.

A phased Reclamation and Research program to verify the proposed biological detoxification of the heap, including incorporation of data gathered through the operation of the HLF and information from the use of similar technology at heap facilities operated in similar climatic conditions is proposed.

The elements of this research program include:

1. Review of operational parameters of the heap leach facility that could affect the specific approach to in-heap treatment, including water chemistry of heap drainage over time, construction and stacking, use of makeup water, operational observations about duration of leaching in each area, etc.
2. Setup of a sequential test facility adjacent to the heap, including placement of heap materials into two test facilities, including either a lined column or area and/or containers to hold heap materials and allow vadose percolation and saturated treatment in sequence. The test facility will include tanks to hold barren solution and reagents, pumps to apply reagent-amended solutions to the heap containers, and sampling ports.
3. Operation of the columns or containers over a period of several months, simulating full scale application of reagent amended barren solution during the proposed full-scale treatment. The monitoring of the

treatment efficiency will include heap materials before treatment, solution chemistry over time as carbon amended water is added and percolated through the unsaturated and saturated heap materials, and sampling of the treated heap solid phase materials after the treatment operation is complete.

4. The treatment test will also include a post-treatment simulation, where heap materials will be covered, and solutions that drain from the columns or containers will be sampled quarterly over 2-3 years to evaluate any rebound or changes in chemistry after the test is completed.

Details of this research plan are provided in Appendix C.

10.6 GROUNDWATER ARSENIC ATTENUATION STUDY

BGC (2014) prepared and calibrated a multi-purpose groundwater model, which has been used to determine the effects of mine operations on groundwater in the mine area. One purpose of the model was to evaluate the direction that seepage from the WRSAs might go, and the potential effect areas. The report states:

> At the end of mine operations, seepage from the WRSAs and 100-day storage area is not simulated to migrate outside of the facility footprints. However, within the WRSA footprints, seepage may report to the underdrains. Seepage originating from the 100 Day Storage Area could migrate to Suttles Gulch. While results for the end of passive closure are similar, seepage is predicted to also migrate west of the 100 Day Storage Area and the Platinum Gulch WRSA where it could discharge to Haggart Creek.

This conclusion was based strictly on a particle-type analysis ("ModPath") where a particle is modeled to move through groundwater based on hydrodynamic processes, but physical, chemical, or biological reactions that could cause a particular solute, such as arsenic or antimony, to migrate differentially as compared to a model particle, was not considered.

A review of groundwater quality data to current Yukon CSR AW standards identified by Stantec (June, 2012) showed dissolved arsenic exceedances in all sub-basins:

> Arsenic concentrations in Ann Gulch (MW10-AG5), Suttles Gulch (MW09-STU2) and Eagle Pup (MW96-13b) were 3 to 70 times higher than the CSR AW standard; whereas, arsenic concentrations in Platinum Gulch (MW10-PG1 and MW96-23) were 160 to 200 times higher than the CSR AW standard. The highest dissolved arsenic concentrations in the LSA occurred consistently in Platinum Gulch monitoring well MW10-PG1 and ranged from 7.98 mg/L to 9.62 mg/L in November 2011 and December 2012, respectively. These concentrations were approximately two times higher than dissolved arsenic values reported in Dublin Gulch well MW09-DG6, which ranged from 0.938 mg/L to 3.64 mg/L during 2011–2012, and approximately ten to one hundred times higher than concentrations reported in all other LSA sub-basins. Dissolved arsenic concentrations exceeding CSR AW standards were reported in monitoring wells completed in sand and gravel deposits, till deposits, phyllite metasediments and granodiorite bedrock units.

Across the site, dissolved arsenic in groundwater is consistently greater than the Yukon Contaminated Site Regulation for Freshwater Aquatic Life (Y-CSR AW) standards in six of the ten wells sampled and results for total arsenic were greater than the Canadian Council of Ministers of Environment for the protection of Freshwater Aquatic Life (CCME FW) guidelines in all ten wells sampled (BGC, 2012). Other metals also show elevations compared to guidelines, but not as consistently as does arsenic.

Current conditions show that arsenic concentrations significantly change as groundwater transitions from the Dublin Gulch into Haggart Creek. A preliminary evaluation of site chemistry may indicate that predictable chemical changes in major anions and cations as well as changes in iron and manganese concentrations correspond to changes in arsenic concentrations. Less apparent from the current data are trends that could imply causation with respect to solid phase aquifer changes, either from a source or a sink of arsenic or other constituents of interest.

The proposed research program would include the following activities:

- Utilize the existing groundwater information to establish the processes that could likely be controlling constituent migration. Geochemical modeling would be used to derive saturation indices that could indicate the sinks that are currently responsible for metals removal.
- Potential sources of constituents such as the WRSAs would be monitored to determine if the WRSAs are inducing chemistry changes in groundwater that could shift the chemical equilibrium to either favor or reduce the processes that are currently affecting arsenic or other metals' migration
- Known or modeled migration pathways would be further evaluated to determine if specific lithologies provide mechanisms that can be quantified to yield predictions of migration potential or reduction in migration potential under planned operating conditions.

The extent to which seepage from WRSAs does not come to surface will be evaluated, and this work will determine rates of potential migration of constituents in the seepage so that the groundwater monitoring program will be refined.

11 MAINTENANCE

The closure measures are designed to minimize maintenance; however, some facilities will require some minimal maintenance, which is expected to decrease over time as the combined systems work synergistically to achieve a stable, closed site. However, based on current understanding there will be some minimal requirement for maintenance.

Covers:

- All engineered covers will be monitored for erosion and if observed will be repaired and replanted.
- Additional riprap or localized repairs to remove sediment may be required in closure runoff ditches if a large storm occurs shortly after cover placement and prior to vegetation establishment.

Passive Treatment Systems:

- The In-Heap Pond bioreactor reactivity will be largely “charged up” by the in-situ heap cyanide degradation initial treatment. Some alcohol will be added to the In-Heap Pond bioreactor as the pond is drained down. When the cover is fully functional, the need for continued maintenance in Phase 7 onward should decrease or be eliminated entirely.

Water Conveyance Features:

- All ditches will be inspected and may require repairs or maintenance during the first few years post-reclamation while covers and vegetation are being established.
- Sediment settling ponds may require cleanout especially after a large storm just after covers have been placed.

Roads:

- Site roads will be maintained to provide access to areas requiring inspection or other maintenance.

12 MONITORING

Summarization of monitoring programs and methods can be found in *the Environmental Monitoring, Surveillance and Adaptive Management Plan*.

13 RECLAMATION COST ESTIMATE

This version of the RCP has been updated to address QZ14-041-1 Clause 148 (b) and Clause 7.2 of QML-0011 which require the submission of an updated Reclamation and Closure Plan on a two-yearly schedule.

Updated Current, 2-Year Peak Liability and End of Mine (EOM) security calculations are provided as Appendix H. Appendix H is a full closure cost estimate, informed by comments through the regulatory processes, the deliberations of the YWB during the amendment application process, and information gathered through construction, which contains the detailed closure cost estimate tables for each of the specific tasks.

The cost model tasks associated with the reclamation and closure of the Mine include the following:

T1 Cost Summary

The summary table provides an overview of all costs required for the closure and reclamation of the Mine and links to the costs calculated in the other costing tables. Each individual costing table (Tables T2 to T17) is described separately.

T2 Unit Costs

This table lists the unit rates for equipment, personnel, materials, and other rates, which are used repeatedly throughout the cost estimate. Unit rates are based on input received during previous review processes, updated labour rates based on the Yukon Government Fair Wage Schedule (effective February 20, 2020), the Yukon Third Party Equipment Rental Rates (effective February 8, 2019), developed custom rates based on the configuration of the Mine, estimates based on current site costs, and on the cost to fuel and operate certain installed equipment currently owned by VGC (with associated replacement costs as necessary).

T3 General and Administrative

This task accounts for typical G&A costs that are not directly associated with individual reclamation and closure tasks. Line items include light vehicles, power and heat not directly associated with heap fluid pumping, site security, equipment mobilization and demobilization, access road maintenance (the public South McQuesten/Haggart Creek Roads), travel and camp accommodations. Contractor costs such as profit and insurance are included in the specific unit rate for equipment.

T4 Exploration Disturbances:

No costs are included for this task as exploration disturbance is bonded for under the Class IV Mining Land Use Approval LQ00303. The security held by Yukon Government pursuant to LQ00303 includes an allowance for the removal of the 100-person camp that was installed to support exploration. The 100-person camp has been amalgamated into the expanded camp required for the construction and operations phase of the Mine; however, for the purposes of the current, year 2 and peak liability estimates, the cost for the removal of all camp facilities has been provided.

T5 Closure Planning

Costs for closure planning include an update to the closure plan, and costs to implement the reclamation research program which includes engineered cover evaluations, the rooting study, detailed design of the passive treatment systems and the in-heap bioreactor, and site contamination surveys.

T6 Open Pit

Reclamation tasks for the open pit will include removing pumps, placing boulders in the pit entrance to prevent egress by vehicles and establishing rip-rap water conveyance channels. Equipment hours for these tasks are based on experience and costs realized during Mine construction.

T7 Heap Leach Facility

The primary tasks associated with closure and reclamation of the HLF includes placement of the soil cover over the HLF surface (0.3 m colluvium-tailings mixture, 0.2 m overburden/topsoil) and the construction of a passive treatment system in the Events Pond. A custom rate has been calculated for haulage and placement of cover material. For the closure cost estimates, no credit is applied for the significant value of gold that would remain within in the HLF in the event that mine closure was required to be undertaken by a third party.

T8 Waste Rock Storage Areas

The majority of the cost associated with the WRSAs is associated with the haulage and placement of a soil cover over the Eagle Pup and Platinum Gulch WRSA surfaces. A custom rate based on equipment type, haulage distance, and standard productivity considerations is used for the calculation of cover construction rates/costs.

T9 Surface Facilities

Demolition costs for the surface facilities are calculated based on the assumption that no salvage value is credited against the cost of demolition. The majority of the costs for demolition is based on the amount of general and skilled labour along with the type of support equipment (crane, excavators, etc.). It is likely that significant salvage value will be realized in the facilities however no value, or credit, for salvage has been included within the security estimates.

T10 Infrastructure

Infrastructure remaining in addition to the surface facilities primarily consists of modular camp buildings and mobile containers (e.g. the explosives and magazine storage). Costs for removal of these assets are based on labour and equipment hours to disconnect services and haul away. A 0.2 m soil cover is placed over the area and costs for this task are based on unit costs. The costs associated with the removal of the conveyor systems is also considered in this tab.

T11 Waste Disposal and Remediation

The majority of costs associated with this task include offsite hazardous material disposal and the management of hydrocarbon contaminated soils from sources such as around the fuel storage facility and truck maintenance shop. It is assumed that contaminated soils will be managed on site at the land treatment facility and no off-site transportation costs are necessary.

T12 Landfills

Costs to expand the landfill are included in the closure cost estimate to account for the larger capacity necessary for non-salvaged materials buried during demolition. Once the landfill is full, it will be covered with a soil cover, recontoured and revegetated.

T13 Roads and Trails

Closure costs for the roads and trails account for both present and future roads on site, and consider the equipment and labour costs to recontour road crests, scarify the surface and revegetate. Costs for removal of culverts are included along with standard erosion control measures.

T14 Water Management Infrastructure

The major cost driver for water management is associated with upgrading existing ditches for closure and decommissioning groundwater wells. Work on the ponds is considered under the development for the PTSs. Power needed for HLF pumps to recirculate the heap solution inventory during Phase 5 (i.e., the ~ actively managed recirculation rinsing period) are considered in T16 Interim Care and Maintenance.

T15 Post Closure Care, Maintenance, and Monitoring – Phase 6, 7, and 8

This table includes costs for onsite management, employee transport, ongoing water treatment operating and capital replacement costs, long term funding of reclamation and closure research, monitoring and reporting, and site maintenance. A breakdown of water treatment operating and capital replacement costs are provided. The MWTP is scheduled for construction and commissioning during H2 2021.

This table also includes costs for power associated with pumping water during Phase 6 (i.e., the actively managed draindown period). Electrical power costs are based on heap draindown volumes from the Forte Dynamics (2020) HLF water balance model. The annual costs and full costs for each of these tasks are presented in this table, along with the Net Present Value (NPV) of the costs as they occur in the future. The NPV costs are calculated in separate tables. NPV is described further below.

T16 Interim Care and Maintenance

This table provides an allowance for the site to be managed during an interim 2-year period between the time of unanticipated closure (where it is further assumed that the mining proponent is unable to care for the site) and the point in time at which the government is able to initiate formal closure of the facility by third party contractors.

This table includes costs for power needed for HLF pumps to recirculate the heap solution inventory during the 2-year Interim Care and Maintenance period. During Interim Care and Maintenance period, the Phase 5 actively managed recirculation rinsing period will be completed. The time required to rinse the heap is 402 days at the EOM, and 160 days at the 2-Year Peak Liability. These durations were calculated by Forte Dynamics and are based on standard best management practice requirement that pads be rinsed with three pore volumes (Appendix I). For the purpose of current liability, the rinsing duration developed for the 2-Year Peak Liability has been assumed.

T17 Quantities

T17a contains quantities of materials and areas of disturbance for the Mine, which are used throughout the other tables in the estimate.

T17b shows the calculations of monthly power draw during Phase 5 recirculation and Phase 6 draindown. Pumping rates are based on HLF Water Balance Modelling by Forte Dynamics (2020) for recirculation and draindown and are used to calculate pumping and associated power requirements during Phase 5 and Phase 6. The maximum solution pumping power draw is from four 149 kw motors operating during Phase 5 and 6. Pumping rates are used to determine the number of pumps that would operate in a given month and the maximum power draw. A factor is applied to the connected motor load to account for a reduced power draw since solution will not

be pumped to the top of the heap as is the case during operations. The electrical power cost of $0.14/kw is used to calculate the monthly and annual power costs. During Phase 6 draindown, pumping rates and associated power costs are reduced as water is directed to the MWTP, until a pumping rate of approximately 20 L/s or less (the capacity of active/passive treatment) is reached and recirculation of solution will no longer be required. For conservatism in the cost estimate, the inputs from natural precipitation are modelled as if there are no covers placed on the heap.

NPV Calculations

The NPV calculations discount the costs on the assumption that the security for long-term tasks is in a form that will provide a net return of 1.5%. The equation used to determine the discounted value is:

$$NPV = \frac{C}{(1+R)^n}$$

Where C is the full cost;

R is the rate of return; and

n is the number of years from the current year.

13.1 BASIS OF COST ESTIMATE

The basis of the cost estimate for the Mine assumes the use of third-party contractors and equipment for implementation of major earthworks and terrestrial tasks. Many of the reclamation tasks may be implemented in-house but the assumption of third-party contractors is consistent with the guidance document. For the basis of the current cost estimate, standard equipment types are included that are locally available (i.e. D-9 dozer, CAT 235 excavator). VGC has refined some of the established rates to account for fuel, maintenance and operator costs, for equipment that is currently owned by VGC's and has been mobilized to site during operations.

Equipment and Personnel Rates Contractor rates and camp costs are based on current contract rates for the Mine assuming a loading rate of less than 50 people (i.e., the highest contract rate), and are based on Yukon Government Fair Wage Schedule, effective February 2020. Custom haul rates are based on site-specific information.

Lump Sum Values: Some costs are presented as a lump sum which could be either a one-time expenditure, repeating periodic cost or specific equipment costs. Many lump sum costs have been derived based on experience with similar tasks at other Yukon mine site or have been developed in consultation with knowledgeable vendors. A review and further breakdown of lump sum costs in excess of $50,000 is provided where necessary.

Indirect Costs: Indirect cost factor rate of 15% includes insurance, taxes, and other administrative costs Site security, project management and engineering are included separately in the estimate.

Contingency Costs: Contingency cost factors are included at rates that range from 15-30% as informed by the rates considered during previous review. Contingency cost factor rates will continue to be reviewed and refined based on detailed engineering, design requirements and implementation strategies in future submissions.

A discussion of the major cost drivers for each of the task elements, along with notable updates to costing assumptions and/or methodology relative to the previous costing iteration, is provided below.

13.2 YEAR 2 PEAK LIABILITY COST ESTIMATE

The activities included within the two-year reclamation cost estimate are based on the current Mine Plan. The specific Mine components that will exist at this point in time are presented in Table 8-1.

To support the development of the 2-Year peak liability cost estimate, feedback from the Reasons for Decision issued in connection with the QZ14-041-1 closure costing review commissioned by the YWB and the third-party review commissioned by EMR have been incorporated. The fully updated, detailed costing model is located in Appendix H.

The updated 2-Year Peak Liability Closure Cost Estimate is $29,329,429.

The following section highlights the rationale behind the most recent costing update and describes specific modifications that have been proposed for individual costing tables.

13.2.1 Discussion of Year 2 Closure Costing Tables and Notable Adjustments

T1 Summary

Modifications to T1 from the previous reclamation cost estimate include reconsideration of certain individual contingency rates for each activity based on further consideration of input received and the current Mine status.

T2 Unit Costs

This table lists the unit rates for equipment, personnel, materials, and other rates, which are used repeatedly throughout the cost estimate. Rates have been adjusted based on current market rates in Yukon. Additionally, personnel rates were updated based on the Yukon Government Fair Wage Schedule effective February 2020. A 10% project management and engineering fee is estimated for work tasks on each individual sheet.

T3 General and Administrative

Costs reflect power and heat, site security and camp costs.

T5 Closure Planning

The costs associated with Closure Planning have been increased to reflect the currently considered mine disturbance over the next 2 years from the effective date of this RCP. Costs are informed by the costs incurred to date in the preparation of the Eagle Gold Mine Reclamation and Closure Plan and are consistent with costs experienced by other mining projects in Yukon and other jurisdictions. The program contemplated for the 2-Year peak liability is virtually identical to the EOM estimate with all major programs consistent between both estimates.

T6 Open Pit

The costs associated with closure of the open pit were adjusted to reflect the pit dimensions 2-Years from the effective date of this RCP. The previous reclamation cost estimate considered scarification and revegetation of the area; however, the 2-year advanced configuration of the pit will allow for the formation of a pit lake as is also contemplated in the EOM.

T7 Heap Leach Facilities

Areas were updated to reflect the 2-Year peak liability site configuration. The cost estimate scenario at the end of Year 2 includes provisions for the operation of active treatment of heap solution to the capacity required by QZ14-

041-1 (in T9 Surface Facilities). Anticipated costs for a biological treatment process for cyanide destruction is provided to remain consistent with previous estimates; however, these costs are not carried forward in the estimate as rinsing and active treatment through a MWTP, as discussed in Section 8.8, are all that is necessary for closure of the HLF as is standard practice. Biological treatment is considered a potential cost reduction practice for final closure that may be utilized by VGC and it thus part of ongoing internal analysis.

T8 Waste Dumps

Areas updated to reflect optimized Project Year 2 site configuration.

T9 Surface Facilities

Costs have been adjusted to reflect the Mine layout required for compliance with license terms (i.e., operation of the full MWTP which will be constructed and commissioned in H2 2021).

T10 Infrastructure

Minor update to costs based on feedback received from the previous review processes, current unit rates and as built configurations/areas for facilities.

T11 Waste Disposal & Remediation

Minor update to costs based on feedback received from the previous review processes and current unit rates.

T12 Landfills

Minor update to costs based on feedback received from the previous review processes and current unit rates.

T15 Road and Trails

Costs have been adjusted based on the current and Year-2 planned Mine layout and current unit rates.

T14 Water Management Infrastructure

Costs have been adjusted based on the current and Year-2 planned Mine layout and current unit rates.

T15 Post Closure Care, Maintenance and Monitoring

Post Closure Maintenance and Monitoring was updated based on the current HLF water balance model and subsequent changes to activity durations. Post closure monitoring and reporting was also increased from 5 to 10 years based on feedback received during previous review processes.

T16 Interim Care and Maintenance

Costs have been adjusted based on the Year-2 planned Mine layout and current unit rates. As described above, Phase 5 rinsing of the heap would occur during the first 160 days of the 2-year Interim Care and Maintenance period.

T17 Quantities

T17a was updated to accurately reflect the current and projected Mine configurations.

As described above, T17b shows the calculations of monthly power draw during Phase 5 recirculation and Phase 6 draindown. Pumping rates are based on optimized Mine HLF Water Balance Modelling by Forte Dynamics

(2020) of recirculation and draindown and are used to calculate pumping and associated power requirements during Phase 5 and Phase 6.

13.3 END OF MINE LIFE COST ESTIMATE

The total cost of implementing the Reclamation and Closure Plan at the end of mine (EOM) life as outlined in this document is $42,838,434. A summary of the RCP costs for both the 2-year peak and EOM liability are presented in Table 13.1. The EOM cost estimate reflects the cost to reclaim the full extent of build-out for the open pit, HLF, WRSAs and surface facilities for the Mine (as described in Table 8-1) and assumes that no progressive reclamation has been undertaken during the life of the Mine.

Direct implementation costs for all of the reclamation tasks total approximately $19.7M for the EOM life cost estimate. Indirect costs are 15% of the direct costs and total $3.0M. Direct and indirect costs are then inflated, using a compounding factor, by 2% over the period of interim care and maintenance and implementation. The EOM cost estimate includes $6.1M for inflation. The plan requires 4 years (Phase 6) to implement and complete followed by 15 years of late closure/post-closure monitoring and maintenance (Phase 7), as well as monitoring and maintenance at 28, and 43 years after the end of mine (Phase 8). The 4-year duration for implementation is driven by the time required to drain down the heap and establish drainage that can be managed passively. As stated above, the duration for draindown considered for the cost estimate conservatively assumes that no covers are placed during the draindown period. The current closure of the HLF would include placing covers sometime during the draindown process.

Future long-term costs for solution draindown, long-term monitoring and maintenance, and post closure decommissioning are calculated on a NPV basis using a discount rate of 1.5%. The NPV of CN destruction, water treatment operating costs and long-term monitoring for the EOM case totals $8.4 M. A further 15% indirect costs ($1.3 M) and contingency costs are added ($1.3 M) to the direct NPV costs to derive an overall total of $42.8 M.

13.3.1 Discussion of End of Mine Life Costing Tables and Notable Adjustments

T1 Summary

Previously discussed in Section 13.2.1

T2 Unit Rates

Previously discussed in Section 13.2.1.

T3 General and Administrative

Previously discussed in Section 13.2.1.

T5 Closure Planning

The program contemplated for the EOM liability estimate includes the costs for the fully executed research program.

T6 Pit

No changes for EOM scenario.

T7 Heap Leach Facility

No changes for EOM scenario.

T8 Waste Rock Storage Areas

No changes for EOM scenario.

T9 Surface Facilities

Previously discussed in Section 13.2.1.

T10 Infrastructure

Previously discussed in Section 13.2.1.

T11 Waste Disposal and Remediation

Previously discussed in Section 13.2.1.

T12 Landfills

Previously discussed in Section 13.2.1.

T13 Roads and Trails

Previously discussed in Section 13.2.1.

T14 Water Management

Previously discussed in Section 13.2.1.

T15 Post Closure Care, Maintenance and Monitoring

Previously discussed in Section 13.2.1.

T16 Interim Care and Maintenance

As described in Section 13.2.1, T16 was updated to include costs for power to recirculate solution and rinse the heap. At the EOM, Phase 5 rinsing of the heap would occur during the first 402 days of the Interim Care and Maintenance period.

T17 Quantities

T17b shows the calculations of monthly power draw during Phase 5 recirculation and Phase 6 draindown. Pumping rates are based on the HLF Water Balance Modelling by Forte Dynamics (2020) of recirculation and draindown and are used to calculate pumping and associated power requirements during Phase 5 and Phase 6.

Table 13-1: Summary Table of Estimated Closure Costs

Description of Cost	2-Year Peak Liability	Estimated Cost EOM
Closure Implementation		
T3 General & Administration	$1,499,440	$2,836,721
T4 Exploration Disturbances	n/a	n/a
T5 Closure Planning	$917,668	$917,668
T6 Pit	$54,359	$54,359

Description of Cost	2-Year Peak Liability	Estimated Cost EOM
T7 Heap Leach Pad	$3,073,015	$4,185,742
T8 Waste Dumps	$3,684,424	$4,990,148
T9 Surface Facilities	$2,210,558	$2,210,558
T10 Infrastructure	$404,125	$404,125
T11 Waste Disposal and Remediation	$171,221	$171,221
T12 Landfills	$138,449	$138,449
T13 Roads & Trails	$473,354	$449,027
T14 Water Management	$293,934	$249,810
T16 Interim Care & Maintenance	$2,675,256	$3,126,599
Sub-total	$15,595,803	$19,734,427
Indirect Costs	$2,339,370	$2,960,164
Contingency Costs	$2,567,561	$3,181,736
Cost Inflation	$1,478,435	$6,087,638
Total Closure Implementation Costs	**$19,413,608**	**$28,782,229**
T15 Care, Maintenance, and Monitoring Costs (Phase 6, 7/8)		
	NPV (1.5% DROR)	
Onsite Management	$958,786	$932,999
Transport Costs	$58,806	$53,326
Water Treatment Costs (Phase 6)	-	-
Active Treatment (Phase 6)	-	-
Capital Costs (included in T9, above)	$0	$0
Capital Replacement Costs	$417,661	$861,819
Operating Costs	$520,963	$2,812,217
Draindown Pumping (Phase 6)	$262,435	$462,110
Passive Treatment (Phase 7-8)	-	-
Capital Costs	$244,094	$210,014
Operating Costs	$85,606	$106,567
Reclamation & Closure Research Phase 6	$28,057	$49,009
Monitoring & Reporting	$2,091,465	$2,039,332
Post Closure Maintenance (Phase 7/8)	$984,635	$837,584
Sub-Total	$5,652,507	$8,364,976
Indirect Costs	$847,876	$1,254,746
Contingency Costs	$847,876	$1,254,746
Total Care, Maintenance and Monitoring Costs	$6,500,383	$9,619,723
Total Closure Costs	**$25,913,992**	**$38,401,951**
Contingency Amount	**$3,415,437**	**$4,436,483**
Total Closure Costs (Plus Contingency)	**$29,329,429**	**$42,838,434**

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APPENDIX A

Revegetation Trials on the Peso Site on the Dublin Gulch Property, 2012 to 2018

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REVEGETATION TRIALS

ON THE PESO SITE ON THE DUBLIN GULCH PROPERTY

2012 to 2018

Volunteer spruce and shrubs growing with the alder on a plot at the Waste Rock Dump

For
Victoria Gold Corp.

Submitted by

Laberge
ENVIRONMENTAL SERVICES

April 2019

EXECUTIVE SUMMARY

A six year revegetation trial was conducted at the old Peso mine site on Victoria Gold's Dublin Gulch property located in central Yukon. The latest mining activity and disturbance at Peso occurred in the 1960s and very little natural revegetation had taken place over the ensuing decades. Blocks of plots were established on two sites; an old trenched area and the waste rock dump below the adit. Plots in each block received no treatment or a variety of amendments including biochar, compost, leonardite and dolomite lime prior to seeding with native grasses and locally collected alder seed.

The soil at Peso is acidic, nutrient poor and highly mineralized. Biochar was chosen as one of the amendments due to its ability to transform degraded land. It increases the pH of acidic soils, adds moisture retention to arid soils, provides surface area for microbes and nutrients to use, immobilizes metals and can sequester carbon into the ground for very long periods. Biochar itself is not a fertilizer, and is combined with compost in this trial, to provide nutrients for initial plant growth.

Annual assessments were conducted midsummer from 2013 to 2018. Unsurprisingly, there was minimal, if any, growth on the plots that were seeded but received no amendments, analogous to the surrounding areas. Although grasses are not the dominant growth form in the nearby local environment, native grasses were initially planted as they germinate quickly, assist in retaining moisture and help to build up the soil through litter decomposition. By year two most of the treated plots supported relatively healthy growth of various grass species. Alder seeds that were also added to the plots began noticeably growing in years two and three. In year four grasses were gradually dying back and shrubs, mainly alder, were taking over. Willow, dwarf birch, Labrador tea, blueberry and Alaska birch were also beginning to colonize some of the plots, all of which are present in the neighbouring forest. The shrubs increased in growth over the final years and in 2018 some of the alders had produced seed cones.

Alder is a nitrogen fixing woody plant. Nitrogen is an essential element in plant development and the primary limiting factor for plant growth in boreal forests. The successful growth of this species on the plots provides nitrogen to the soil increasing soil fertility. During the 2018 assessment nitrogen nodules were observed on alder roots. In addition, the decomposition of alder leaves and other alder parts contributes nitrogen to the soil.

In the final year of the trial, soil and foliar tissue samples were collected and analysed for metals. Soil analysis indicated that the growth medium is acidic, nutrient poor and mineralized with very high concentrations of several metals. It appeared biochar was sequestering some metals in the treated plots. Although metal concentrations were extremely high in the soil (i.e arsenic, antimony and lead), these metals were not taken up in large amounts by the plants. Concentrations in the tissues appear relatively similar to those collected at other locations at Dublin Gulch and at other Yukon mine sites.

In summary, these trials have proven successful. With minimal effort, the use of appropriate species and soil amendments have produced healthy plants that have grown, propagated and even thrived on these acidic, highly mineralized soils.

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1.0 INTRODUCTION

1.1 Background

The claims at the Peso site were first staked in June 1910 by J. Alverson and G. Huffman, who sank a 4.9 m shaft in 1912 and trenched until 1916 (Yukon Minfile). In 1948, with antimony in demand, Cecil D. Poli re-staked Alverson's old silver-lead-antimony property as the Peso 1 – 12 claims and trenched the vein by hand. On route back to Haggart Creek he discovered the Rex vein two miles to the southeast. The Peso vein gave 40 ounces of silver per ton and a sample from the Rex vein gave 25 ounces per ton. These properties were optioned in the early 1950s at the height of the boom, but no significant work was done on them (Aho, 2006).

In 1961 Tanar Gold Mines Ltd transferred the claims to a new company, Peso Silver Mines Ltd who carried out extensive exploration from 1961 to 1965, including underground development on the Peso vein. The two main vein zones at Peso Rex contained a reasonably well proven-probable reserve of about 154,000 tons at 20.9 ounces of silver per ton and 3.7% lead (Campbell, 1965). The veins contain abundant pyrite and arsenopyrite, with jamesonite, tetrahedrite and minor shalerite and bismuthinite, including the metallic minerals galena and chalcopyrite (Aurum Geological Consultants, 1992).

M.J. Moreau explored with hand trenching in 1986 and bought the Peso and Rex claims at a Sheriff's sale in August 1988 (Yukon Minfile).

In 1991, M. J. Moreau Enterprises Ltd made a request of Aurum Geological Consultants to prepare a report summarizing the economic potential of the Pierre Property, which included the Peso claims. Results from samples collected in 1991 from the No. 1 Vein (Peso) returned a high silver value of 318.5 ppm which when fire assayed returned 37.8 oz/ton silver (Aurum Geological Consultants, 1992).

In 1994 First Dynasty Mines Ltd acquired claims throughout the area and in 1996 its wholly owned subsidiary, New Millennium Mining Ltd carried out a major drilling program in the Dublin Gulch area.

Stratagold acquired the Dublin Gulch property in 2004 and commenced a drilling program in 2005 to delineate the Eagle Zone. Victoria Gold Corp. assumed control in 2009.

Recent exploration work has been undertaken by Victoria Gold in the Rex/Peso area, however the locations of the trial plots are outside of the active zone and provide a representative site for the revegetation experiment.

1.2 Scope of Work

Victoria Gold Corp has sponsored revegetation research in support of reclamation planning for the Eagle Gold Project at their Dublin Gulch Property. The objective of the revegetation program at Peso is to test the viability of incorporating biochar and other soil amendments into the site with a goal of creating an ultimate reclamation and revegetation plan that will be transferable to the Eagle Gold Project Reclamation and Closure Plan (StrataGold 2014). The Peso site was chosen because 1) there were existing and un-reclaimed facilities (waste dump

and trenches) at the site that were located in similar terrain and with similar climatic conditions and geologic properties as the Eagle Gold Project, and 2) unlike other areas within the Eagle Gold Project area subject to exploration, construction and other activities, the established plots at Peso would remain undisturbed.

Biochar is a light charcoal material produced by heating or combusting biomass under low or no oxygen conditions, a process known as pyrolysis. Residues of incomplete organic pyrolysis (e.g., from cooking fires), are thought to be the key component of terra preta soils, a very dark fertile anthropogenic soil known most commonly from the Amazon basin. It was most likely intentionally developed by humans between 450BC and 950AD to improve the poor soil conditions in the Amazonian basin. Terra preta is characterized by high concentrations of low temperature charcoal; quantities of pottery shards; and organic matter such as plants, animals, bones and feces (Bates, 2010). While the biochar process has been known for over a century, recent efforts are underway to recreate the fertile Terra preta like soils through the biochar process (Economist 2009).

One of the greatest benefits of biochar is its capacity to transform degraded land. It adds moisture retention to arid soils, it provides surface area for microbes and nutrients to use, it immobilizes metals and it can lock carbon into the ground for very long periods (Bruges, 2009, Chen et al, 2018). The agronomic and environmental benefits of adding biochar to soils have been investigated for many years, but in the past several years research has begun into the use of biochar for bioremediation of mine-affected soil (Laberge Environmental Services, 2012). For example, Fellet *et al* (2011) found that an increase in biochar content in mine tailings reduced the bioavailability of cadmium, lead, thallium and zinc. In column leaching tests, the sorption of cadmium and zinc to biochar's surfaces reduced their leachate concentrations by 300 and 45 fold respectively (Beesley and Marmiroli, 2011). Therefore, as well as enhancing growing conditions in the soil for successful plant growth, biochar can also help to sequester metals and mitigate leachate water quality.

The organic material (i.e., trees, shrubs and organic surface cover) that will be cleared from the various development areas to make way for mining operations at Eagle Gold, can be processed into biochar on site thus creating a local source and thereby eliminating the introduction of unknown or unwanted components of outsourced biochar. The pyrolysis of plant biomass to generate biochar converts much of the carbon into a form of carbon which is very stable in soils for thousands of years. Thus, by creating biochar from the plant overburden, instead of allowing it to naturally decompose and consequently release carbon dioxide (a greenhouse gas) into the atmosphere, the carbon becomes unavailable and is sequestered. If applicable, Victoria Gold could earn carbon credits by 1) producing its own biochar as a soil amendment for the site's closure activities and 2) planting vegetation. With the introduction of a tax on carbon in the Yukon, the sequestration of carbon through these activities offsets at least some of the carbon dioxide that the mine will emit and thus lowers its carbon footprint.

The Peso plots were established in 2012 and assessed annually until 2018. Additional monitoring was completed in the final year (2018) of the trial, including soil testing, metal analysis of plant tissues, height of above ground growth and rooting depth.

2.0 STUDY AREA

The Eagle Gold Project at Dublin Gulch is located approximately 85 km northeast of the village of Mayo in central Yukon and lies wholly within the traditional territory of the First Nation of the Na Cho Nyak Dun. The project is 100% owned by Victoria Gold Corp and covers an area of approximately 650 square kilometers. Its centre is situated at the confluence of Haggart Creek and Dublin Gulch at the UTM Coordinates 7100950N / 453750E, Zone 8, NAD 83 Datum.

The historic Peso Minesite is located approximately 6.5 km west of the camp at the Eagle Gold Project, near Secret Creek, a tributary to Haggart Creek (Figure 1). The study area lies within the northern region of the Yukon Plateau North ecoregion in the Stewart River sub-basin of the Yukon River watershed. This area is generally characterized by rolling uplands with steep slopes leading into U-shaped valleys (Smith *et al,* 2006). There are two zones within the Eagle Gold Site; subalpine, and open black spruce forests at lower elevations. The subalpine zones (above 1225 masl) are generally dominated by dwarf birch and willows. Other species occurring within the forested areas are Alaska birch, aspen, balsam poplar and white spruce, depending on aspect. Subalpine fir is also found in small pockets at higher elevations (Stantec, 2011).

Climate stations are operational within the Eagle Gold Project area at the Potato Hills Station (1420 masl) and at the Camp Station (782 masl). Knight Piesold Consulting (KPC) examined and summarized the meteorological data collected over a four year period, 2009 to 2012 (KPC, 2013). Since the two climate stations are located at significantly different elevations and thus will have varied temperature and precipitation results due to orographic tendencies, KPC used a reference elevation of 1125m for their analysis and summary. Table 1 summarizes selected climatic parameters for this elevation.

TABLE 1 MEANS FOR SELECTED CLIMATIC PARAMENTERS AT ELEVATION 1125m

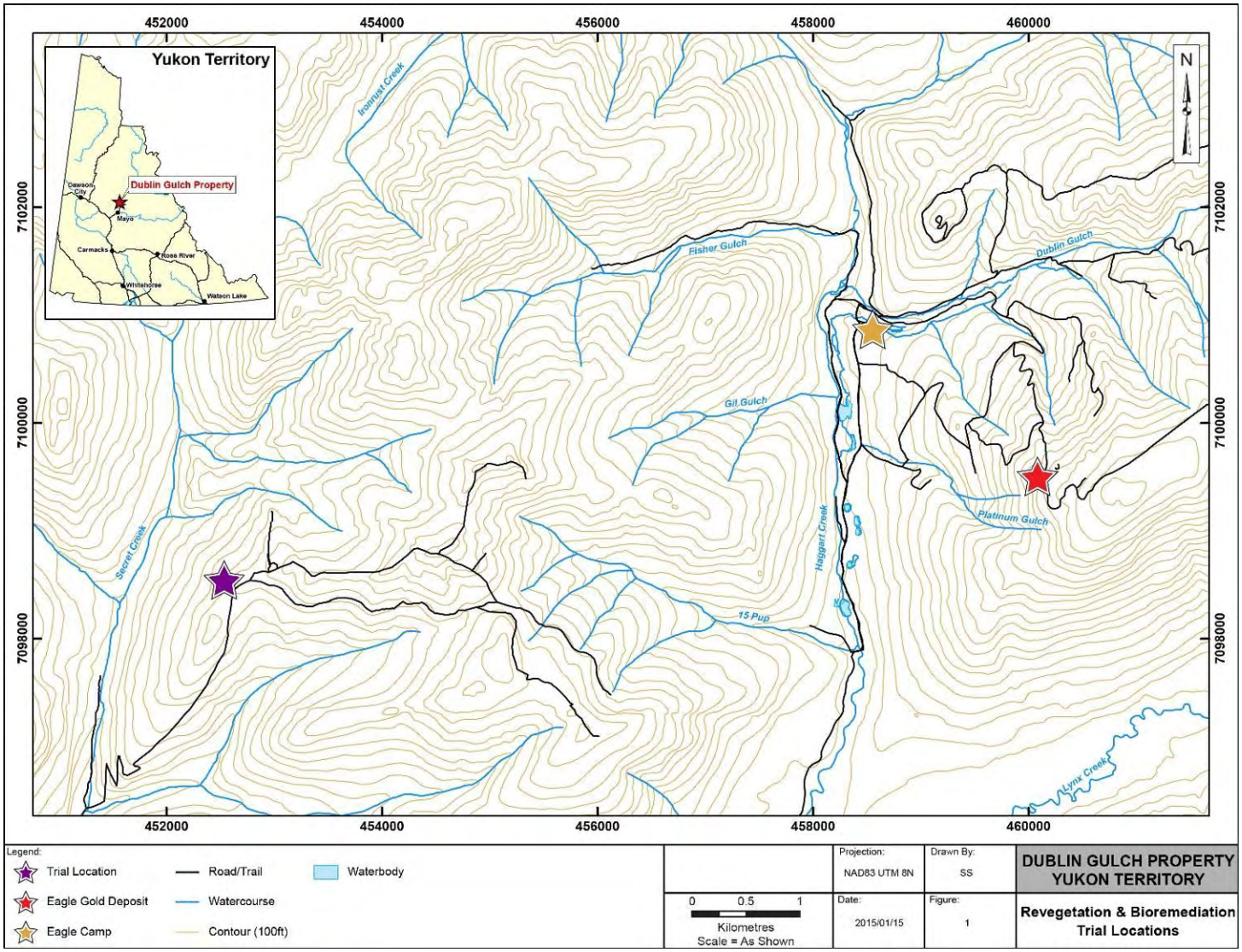
Parameter	Value
Mean annual temperature	-4.2
Mean January temperature	-19.7
Mean July temperature	11.4
Mean annual precipitation	500 mm
Mean annual rainfall	190 mm
Mean annual snowfall (water-equivalent)	310 mm
Mean annual rainfall/snowfall distribution	38% / 62%

Taken from KPC 2013

Since the elevation of the vegetation trials is slightly lower than 1125 m (see Table 2), the above values should be relatively representative of temperature and rainfall at the Peso plots.

The majority of the exploration work at the Peso site was completed during the early 1960s. With the exception of dense growth of alders at the less disturbed sites, very little natural revegetation has taken place in the areas disturbed by historical activities in the Peso area over this time period. Vegetation in the adjacent undisturbed and lesser disturbed sites consists of subalpine fir, white spruce, black spruce and Alaska birch, with occasional balsam poplar and trembling aspen. Mountain alder, dwarf birch, Scouler's willow and blue-green willow are the most common medium to tall shrub species (Laberge and Nacho Nyak Dun Development Corporation, 2004).

FIGURE 1 PESO REVEGETATION TRIAL LOCATIONS ON THE DUBLIN GULCH PROPERTY



The ground cover includes low shrubs such as Labrador tea, Beauverd's spiraea, kinnikinick, lingonberry, blueberry and crowberry. Dwarf dogwood, toadflax, lupine and fireweed are the most common forb species (Laberge Environmental Services and NND-DC, 2004).

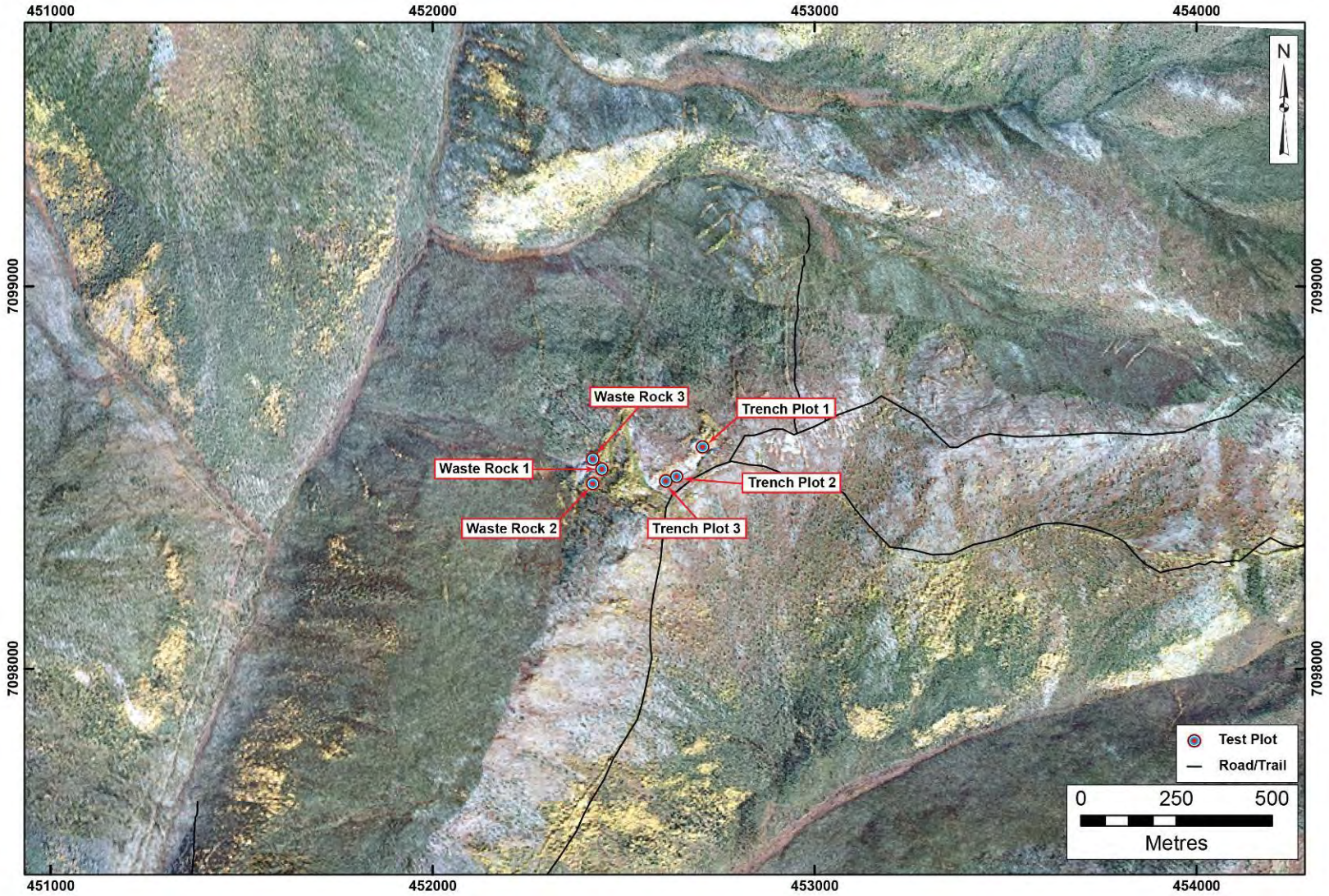
During a reconnaissance trip in June 2012, two sites at Peso were selected for the revegetation trials, an exploration trench and the waste rock dump. Although trenching has been undertaken at the site since the early 1900s, mostly hand trenching, it is assumed that the trench chosen for the trials was a result of bulldozer exploration in the early 1960s by Peso Silver Mines. Three blocks, each containing 5 test plots, were established at the trench site. Block #1 is located north of an exploration trail and the other 2 Blocks are located south.

The Peso adit is located approximately 250 m west of the trench. Peso Silver Mines conducted underground development on the Peso vein resulting in the formation of the waste rock dump on the west facing slope. The waste rock dump covers an area approximately 50 m by 70 m. It is comprised of three lifts varying in thickness from two to six meters. A total of three blocks, each containing 5 test plots, were established on each tier. The locations of the blocks are detailed below in Table 2 and shown on Figure 2.

TABLE 2 BLOCK LOCATIONS AT PESO

Site	Latitude	Longitude	Elevation (m)
Trench:			
Block #1	64° 00.649'	135° 58.038'	1040
Block #2	64° 00.607'	135° 58.119'	1030
Block #3	64° 00.601'	135° 58.154'	1042
Waste Rock:			
Block #1	64° 00.616'	135° 58.360'	992
Block #2	64° 00.595'	135° 58.388'	986
Block #3	64° 00.630'	135° 58.390'	973

FIGURE 2 TEST PLOT LOCATIONS AT THE OLD PESO MINESITE



3.0 STUDY DESIGN

3.1 Soil Analysis

The success of a revegetation project depends firstly on characterizing site-specific conditions such as soil fertility, climate, aspect, elevation, slope, drainage, etc, prior to making any decisions regarding seed mixes and amendments.

For the purposes of this study, a reconnaissance visit to the old Peso mine site was initially conducted on June 24th, 2012. After assessing the area, two areas were chosen for the revegetation trials and are described in Section 2.0. Soil samples were collected from these sites and sent to Maxxam Analytical Laboratory in Burnaby, BC. The complete analytical report can be found in Appendix A and a summary of data in Section 4.1.

The soil was extremely acidic at the waste rock site and strongly acidic at the trench site. Acid tolerant plant species consequently were selected for the revegetation project. Soil samples collected from the waste rock in 2003 showed it to be extremely acidic with a pH value of 2.8 (Laberge, 2004). Soil samples collected near the portal and from the easternmost lobe of the waste rock in 1997 were potentially acid generating following bottle roll tests (Environmental Services, 1998). The soil samples collected in 2012 confirm the strong acidity of the waste rock dump (pH 2.6). Soil testing of the trench area had not been done previously.

All available nutrients were extremely low where detected. Organic matter and total organic carbon were very low at the waste rock site and below the detection limits at the trench site.

Concentrations of antimony, arsenic and lead were extremely high at both sites. Antimony is a trace element and background levels are generally very low. Antimony concentrations are usually much greater at mining and contaminated sites.

Background levels of arsenic in soils are low and rarely exceed 15 mg/kg (Singh, 2005). Arsenic concentrations were very high at the Peso site with much higher levels that appear atypical when compared to other sites sampled for soil geochemistry at the Dublin Gulch site (Burns, 2013, Laberge Environmental Services, 2018a).

Lead concentrations were also extremely high in the two soil samples at Peso and were much greater than documented at other locations at Dublin Gulch.

Generally the metal concentrations were similar at both of the selected trial sites.

3.2 Field Design

3.2.1 Site Preparation

The plots at the two sites were installed on July 19th, 2012. Three blocks of plots were situated on relatively level ground with the same aspect at each site. Each block measured 5m by 2m and contained 10 one-meter square plots. The blocks and plots were measured and demarked with orange fluorescent painted rebar. Labeled flagging tape was added to each corner pin of the plots.

The plots were prepared and seeded from September 18th to 20th, 2012. Each plot to be seeded was scarified first with a hand-cultivator (tine length 15 cm), and then raked with a fine-toothed rake (see Photo #1, Appendix B). Soil amendments were well mixed into the prepared plot and then the seeds were hand broadcast throughout the plot. Each plot was tamped gently but firmly with the back of a rake to create micro-sites and achieve good seed placement.

Every other plot within each block was seeded, allowing the unseeded/untreated plots to represent buffer zones. The implementation of buffer plots ensures that each test plot is isolated and uninfluenced from neighboring plots. As well, each plot can be assessed and closely examined without the risk of trampling on plants on the other test plots. Further details, including photographs are included in a report prepared for Victoria Gold (Laberge, 2013). As described below, due to the differences in acidity at the two sites, slightly different seed mixes and treatments were prepared.

3.2.2 Treatments

The intention of these trials was to determine in a relatively simple manner which amendments might be utilized for successful native plant growth to initiate the restoration process. The amendments used in these trials were biochar, compost, leonardite and dolomite.

Raw biochar chips were obtained locally from Zakuas Farms, Whitehorse, Yukon. Prior to application they were ground in a steel-blade seed grinder to produce a fine, almost powdery mix. It has been well established that biochar on its own (due to the lack of nutrients) is insufficient as an amendment on poor soils (Peltz *et al*, Beesley and Marmiroli, 2011, Beesley *et al*, 2010), hence it was combined with nutrient rich compost for each plot.

Bags of compost were obtained from the co-operative project at the Whitehorse Solid Waste Facility which produces commercial quantities of high quality compost.

Leonardite is defined as a naturally occurring oxidized form of lignite coal that is rich in humic acids. Its main use is as a soil amendment in agriculture and reclamation. For the purposes of this study, leonardite was obtained from Tisdale, Saskatchewan. This leonardite consisted mostly of humic acid with small amounts of fluvic acid and required minimal processing. It was also included with the amendments for some of the plots as an additional source of nutrients.

Due to the relatively higher acidity at the waste rock dump site, commercially available dolomite, purchased from Canadian Tire, was added to the amendment mix at some of the plots to create some buffering capacity.

No other fertilization was used and the plots were not watered at any time. The plots were exposed to the natural conditions that existed at each of the local areas throughout the seasons. Thus, aside from the initial site development and treatment, no other treatment or site modification was implemented.

3.2.2.1 Waste Rock Site

In attempts to control acid generation and enhance soil rehabilitation, the following amendments were used on the waste rock sites; biochar, compost, leonardite and dolomite lime.

The application rates per plot are as follows:

- 6 liters of biochar (just under 1 kg)
- 15 liters (1/2 bag) of compost
- 0.15 kg/m^2 of leonardite
- 3.3 kg/m^2 of dolomite

There were five treatments per block of plots:

Treatment Method #	Treatment Composition
1	Seed only
2	Seed, biochar, compost
3	Seed, biochar, compost, leonardite
4	Seed, biochar, compost, dolomite lime
5	Seed, biochar, compost, leonardite, dolomite lime

The layout of the plots and treatments per block is presented in Figure 3. Each treatment is represented once per block and three times in total for the site. The shaded plots received no treatments and represent buffers between plots.

FIGURE 3 LAYOUT OF TREATMENTS AND PLOTS AT WASTE ROCK

Waste Rock Block #1 (on top tier near the adit) – seeded and amendments added Sept 18, 2012 @13:00

1 Plot # 1-1		**3** Plot # 1-3		**5** Plot # 1-5
	2 Plot # 1-2		**4** Plot # 1-4	

Waste Rock Block #2 – (on second tier) seeded and amendments added on September 18, 2012 @ 14:30

	2 Plot # 2-2		**4** Plot # 2-4	
1 Plot # 2-1		**3** Plot # 2-3		**5** Plot # 2-5

Waste Rock Block #3 – (on third tier from top) seeded and amendments added on September 18, 2012 @ 16:00

1 Plot # 3-1		**3** Plot # 3-3		**5** Plot # 3-5
	2 Plot # 3-2		**4** Plot # 3-4	

3.2.2.2 Trench Site

The soil at the trench site was not as acidic as on the waste rock dump, with a pH of 5.15, consequently dolomite lime was not included as an amendment. Biochar, compost and leonardite were again applied to the trench plots at the following application rates:

- 3 liters of biochar
- 15 liters (1/2 bag) of compost
- 0.15 kg/m2 of leonardite

There were three treatments per block of plots:

Treatment Method #	Treatment Composition
1	Seed only
2	Seed, biochar, compost
3	Seed, biochar, compost, leonardite

The layout of the plots and treatments per block is presented in Figure 4. Each treatment is represented five times for the site. The shaded plots received no treatments and represent buffers between plots.

FIGURE 4 LAYOUT OF TREATMENTS AND PLOTS AT TRENCH SITE

Trench Block #1 – seeded and amendments added on September 19, 2012 @ 11:00

1 Plot #1-1A		**3** Plot #1-3		**2** Plot #1-2B
	2 Plot #1-2A		**1** Plot #1-1B	

Trench Block #2 – seeded and amendments added on September 18, 2012 @ 18:00

	1 Plot # 2-1A		**3** Plot # 2-3A	
3 Plot # 2-3B		**2** Plot # 2-2		**1** Plot # 2-1B

Trench Block #3 – seeded and amendments added on September 19th, 2012 @ 10:00.

2 Plot #3-2A		**1** Plot #3-1		**3** Plot #3-3B
	3 Plot #3-3A		**2** Plot #3-2B	

3.2.3 Seed Mix

The species chosen for the trials were determined through consultation of the Yukon Revegetation Manual (Matheus and Omtzigt, 2012) as well as through the observation of species currently growing in the near vicinity of the sites. The appropriate seed mixes were distributed for each plot as per the quantities noted in Table 3. In addition, because alder grows prolifically around the site and is well adapted to localized conditions, a small handful of local alder seeds was collected on site and distributed with the seed mix. Furthermore, alder fixes nitrogen and all parts of the plants contribute nitrogen to the soil during decomposition. Seeds from Hedysarum plants (a nitrogen fixing legume) were also added to the seed mix to increase the nitrogen potential.

The seed mix is slightly different for the two sites due to soil conditions. The soil at the waste rock site was extremely acidic, had little to no nutrient values and was highly mineralized. Several plant species were chosen due to their tolerances to acidic, low nutrient levels, drought and/or heavy metal conditions in the growth medium. The seed rate, adjusted to $1m^2$ plot size, is also provided in Table 3. The soil at the trench site was not as acidic as on the waste rock dump and slight alterations were made to the seed mix (Table 3).

TABLE 3 SEED MIX AND RATE OF APPLICATION FOR WASTE ROCK AND TRENCH SITES

Common Name	Scientific Name	Application rate/plot at Waste Rock	Application rate/plot at Trench
Sheep fescue	*Festuca ovina*	0.4 g	0.4 g
Tufted hairgrass	*Deschampsia caespitosa*	0.14 g	0.14 g
Glaucous bluegrass	*Poa glauca*	0.19 g	---
Alpine bluegrass	*Poa alpina*	---	0.21 g
Tickle grass	*Agrostis scabra*	0.04 g	---
Spike Trisetum	*Trisetum spicatum*	---	0.9 g
Bear root	*Hedysarum alpinum*	20 seeds	20 seeds
Alder	*Alnus viridus*	small handful	small handful

The first six plant species are native occurring plants with commercially available accredited seed obtained from BrettYoung$_{TM}$ of Calmar, Alberta. Alder seeds were hand collected from local plants near the plots on the day of planting and spread onto each plot. Hedysarum seeds, previously collected from various sites in the Yukon, were also added to the plots.

4.0 ASSESSMENTS

4.1 Soil

Soil samples were collected from each plot in 2018, including the plots that received no treatment. Surface samples were collected to a depth of 5 to 10 cm, using a stainless steel trowel and placed into resealable plastic bags. All samples were kept cool until delivered to the ALS lab in Whitehorse, Yukon.

The soil was analyzed for pH, organic content, available nutrients and metals. The complete analytical report is presented in Appendix A.

Selected parameters were compared from the untreated plots to the soil samples collected in 2012 (Table 4). As actual plot locations were not yet determined in June 2012, the soil samples were not collected from the exact locations on both years. The results for the 2018 soil sample analysis collected from the untreated plots in each block were averaged to represent the concentrations existing at the Trench and Waste Rock Dump sites.

It appears that the organic matter content has slightly increased over the time period. It was noted that scant vegetation was gradually colonizing the untreated plots as well as the buffer plots. The pH at each location is consistent. Available phosphate was similar however available potassium concentrations were higher in 2018 than in 2012. Some of the metal concentrations were quite different in the two time periods, notably at the waste rock dump, and likely is reflective of the distribution of the disturbed terrain as the waste material was removed from the adit.

TABLE 4 EXISTING SOIL CONCENTRATIONS, 2012 AND 2018

Parameter	MDL	Units	NO TREATMENT			
			Waste Rock		Trench	
			2018	2012	2018	2012
			N=3	N=1	N=3	N=1
Loss on Ignition @ 375 C	1.0	%	1.7	6.1	1.6	4.0
Organic Matter	1.0	%	1.6	0.6	1.5	<0.35
pH (1:2 soil:water)	0.10	pH	2.70	2.62	5.8	5.15
Total Carbon by Combustion	0.05	%	0.50	0.37	0.4	<0.20
Available Phosphate-P	2.0	mg/kg	2.2	2.9	2.9	1.8
Available Potassium	20	mg/kg	27.0	<2.0	28.3	8.5
Aluminum (Al)	50	mg/kg	5,030	2,690	3,230	2,350
Antimony (Sb)	0	mg/kg	1,777	3,680	3,567	3,580
Arsenic (As)	0	mg/kg	2,743	6,150	7,863	9,810
Cadmium (Cd)	0.020	mg/kg	1.3	4.88	4.7	4.28
Chromium (Cr)	0.50	mg/kg	11.7	6.7	11.7	12.2
Cobalt (Co)	0.10	mg/kg	6.04	3.54	5.31	5.33
Copper (Cu)	0.50	mg/kg	161.0	210	125.4	75.9
Iron (Fe)	50	mg/kg	40,700	57,500	50,300	46,300
Lead (Pb)	1	mg/kg	2,427	9,070	7,057	7,330
Mercury (Hg)	0.005	mg/kg	0.131	0.796	0.428	0.410
Nickel (Ni)	0.50	mg/kg	17.6	9.1	11.7	12.0
Selenium (Se)	0.20	mg/kg	5.4	19.30	7.9	12.70
Silver (Ag)	0.10	mg/kg	23.2	89.4	44.4	103.0
Zinc (Zn)	2.0	mg/kg	133.3	252.0	194.3	129.0

Soil samples were also collected from each of the treated plots in 2018 and the analytical data is presented in Tables A-1 (Trench) and A-2 (Waste Rock) in Appendix A. Means for each treatment

was calculated and selected parameters tabulated for the Trench (Table 5) and the Waste Rock Dump (Table 6).

Soil pH was raised slightly with the amendments except for plots where leonardite was also included. Leonardite is rich in humic acid and this additional acid limited buffering by the biochar.

Organic matter (%), Total Kjeldahl Nitrogen and total carbon by combustion increased with the addition of amendments.

TABLE 5 MEAN CONCENTRATIONS (N=3) OF EACH TREATMENT, TRENCH

Parameter	MDL	Units	No treatment	Biochar and compost	Biochar, Compost and Lenardite
pH (1:2 soil:water)	0.10	pH	5.8	6.7	6.6
Organic matter	1.00	%	1.5	2.3	2.5
Total Kjeldahl Nitrogen	0.020	%	0.066	0.086	0.094
Total Carbon by Combustion	0.05	%	0.4	1.3	1.3
Available Ammonium-N	1.0	mg/kg	1.8	2.5	2.3
Available Phosphate-P	2.0	mg/kg	2.9	23.0	21.1
Available Potassium	20	mg/kg	28.3	43.3	42.0
Aluminum (Al)	50	mg/kg	3230	3037	2973
Antimony (Sb)	0.10	mg/kg	3567	920	3036
Arsenic (As)	0.10	mg/kg	7863	2697	5007
Cadmium (Cd)	0.020	mg/kg	4.7	0.8	2.6
Calcium (Ca)	50	mg/kg	620	1215	2137
Chromium (Cr)	0.50	mg/kg	11.7	8.6	10.1
Cobalt (Co)	0.10	mg/kg	5.3	3.7	4.0
Copper (Cu)	0.50	mg/kg	125.4	66.4	74.7
Iron (Fe)	50	mg/kg	50300	32100	33367
Lead (Pb)	0.50	mg/kg	7057	1933	3273
Magnesium (Mg)	20	mg/kg	102.0	250.0	253.3
Manganese (Mn)	1.0	mg/kg	246.3	200.7	181.3
Mercury (Hg)	0.0050	mg/kg	0.4	0.3	0.5
Nickel (Ni)	0.50	mg/kg	11.7	8.6	9.4
Phosphorus (P)	50	mg/kg	762	678	805
Selenium (Se)	0.20	mg/kg	7.9	2.4	5.0
Silver (Ag)	0.10	mg/kg	44.4	14.2	21.6
Sulfur (S) *	1000	mg/kg	1733	1100	1600
Zinc (Zn)	2.0	mg/kg	194.3	107.5	96.8

* less than values (<) were excluded from the averaging MDL = method detection limit

The requisite macro nutrients required for all plant growth are nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sulfur (S) and magnesium (Mg) (DalCorso *et al*, 2014). Total Kjeldahl Nitrogen (TKN) is the amount of nitrogen that is in organic form. TKN was present in all of the plots and generally increased with the applied amendments. Phosphorus was present in all plots however available phosphate was absent in a few plots, more so at the waste rock site (probably a function of pH). Total potassium and available potassium were documented at each site and concentrations increased with amendments at the Trench site. There was little

change in potassium with the amendments at the waste rock site. Calcium concentrations increased considerably with the amendments at both locations. Magnesium levels fluctuated throughout the study area. Sulphur levels were low at the Trench plots and frequently not detected (Table A-1), whereas high Sulphur concentrations were documented at the waste rock site, reflective of the acid rock drainage potential here.

Essential micro nutrients include iron (Fe), boron (B), nickel (Ni), copper (Cu), manganese (Mn), zinc (Zn) and molybdenum (Mo). Iron concentrations were high throughout the study area and ranged from 17,900 mg/kg to 70,100 mg/kg. Boron and molybdenum levels were very low and were barely detected at some plots. Nickel, copper, manganese and zinc were present at all plots.

Elements that are not essential but however benefit plant growth are sodium (Na), selenium (Se), aluminum (Al) and cobalt (Co). Aluminum is one of the most abundant elements in the earth's crust. Although low levels of aluminum are beneficial for plants due to its role in increasing the bioavailability of nutrient metal ions, high concentrations are toxic to most plants, especially in acidic soils. High concentrations were recorded at all plots. Cobalt was present in low concentrations at all plots. Selenium was also present at all plots, but concentrations increased with amendments at the Waste Rock site. Sodium was not detected at the plots at the Trench site but was present with fluctuating concentrations at the Waste Rock plots.

TABLE 6 MEAN CONCENTRATIONS (N=3) OF EACH TREATMENT, WASTE ROCK DUMP

Parameter	MDL	Units	No treatment	Biochar and compost	Biochar, compost and leonardite	Biochar, compost, dolomite lime	Biochar, compost, dolomite lime, leonardite
pH (1:2 soil:water)	0.10	pH	2.7	3.4	2.7	3.9	3.6
Total Kjeldahl Nitrogen	0.020	%	0.049	0.080	0.103	0.129	0.113
Total Carbon by Combustion	0.05	%	0.50	1.42	2.69	3.10	3.48
Available Ammonium-N	1.0	mg/kg	4.4	6.3	8.4	5.1	6.9
Available Phosphate-P	2.0	mg/kg	2.2	5.1	6.4	ND	15.6
Available Potassium	20	mg/kg	27.0	23.0	20.0	28.5	45.0
Aluminum (Al)	50	mg/kg	5030.0	4863.3	4336.7	4130.0	3360.0
Antimony (Sb)	0.10	mg/kg	1776.7	2855.0	2527.0	2952.7	4283.3
Arsenic (As)	0.10	mg/kg	2743.3	3653.3	4206.7	5466.7	5430.0
Cadmium (Cd)	0.020	mg/kg	1.3	2.4	2.9	3.0	3.2
Calcium (Ca)	50	mg/kg	476.7	918.7	588.7	4916.7	10726.7
Chromium (Cr)	0.50	mg/kg	11.7	12.0	10.0	10.1	6.7
Cobalt (Co)	0.10	mg/kg	6.0	6.0	8.9	6.5	2.0
Copper (Cu)	0.50	mg/kg	161.0	176.8	209.3	280.3	269.7
Iron (Fe)	50	mg/kg	40700.0	38233.3	45566.7	50600.0	47466.7
Lead (Pb)	0.50	mg/kg	2426.7	6400.3	5137.0	5223.3	9410.0
Magnesium (Mg)	20	mg/kg	1427.3	1477.3	677.3	3033.7	5464.0
Manganese (Mn)	1.0	mg/kg	171.0	170.6	161.7	147.9	127.3
Mercury (Hg)	0.0050	mg/kg	0.1	0.3	0.4	0.4	0.6
Nickel (Ni)	0.50	mg/kg	17.6	15.3	20.8	17.1	6.7
Phosphorus (P)	50	mg/kg	437.0	849.7	1011.0	1093.3	1144.0
Selenium (Se)	0.20	mg/kg	5.4	10.6	10.9	12.2	18.0
Silver (Ag)	0.10	mg/kg	23.2	11.8	30.8	45.8	62.9
Zinc (Zn)	2.0	mg/kg	133.3	137.8	174.9	126.2	93.5

* less than values (<) were excluded from the averaging

Plants must deal with the non-essential elements such as arsenic (As), mercury (Hg), silver (Ag), antimony (Sb), cadmium (Cd), lead (Pb) and uranium (U), which may potentially be harmful. Arsenic

concentrations were very high throughout the soils in the study area and ranged from 1,240 mg/kg to 11,400 mg/kg. Mercury was detected at all plots. Silver is widely distributed in the earth's crust with an average abundance estimated at 0.07 mg/kg (Taylor, 1964). High concentrations of silver were documented in the soil samples collected from all the plots with some results greater than what the analytical method could determine. Antimony concentrations were very high at the plots with levels ranging from 369 mg/kg to 6,410 mg/kg. The earth's crustal average has been estimated at 0.2 mg/kg (Taylor, 1964). Lead concentrations were also high throughout ranging from 331 mg/kg to 16,600 mg/kg. Cadmium and uranium were present at all plots in fairly low concentrations.

4.2 Vegetation

4.2.1 Annual Assessments on Growth

The trial plots have been assessed on seven different occasions; twice in 2013 (July and September), early August 2014, early August 2015, mid July 2016, early August 2017 and late July 2018. All plots have had six full years of growth opportunity. Photographs chronicling each block and selected plots over the time period are provided in Appendix B.

The results for all seven assessments are presented in Table C-1 for the Trench Site and Table C-2 for the Waste Rock Site, both in Appendix C. The percentage of vegetative cover, species composition and overall health were observed for each plot. Vegetation cover is determined through point-based methods or ocular estimates. Due to the small size of the examined plots ocular estimates were made for the cover of each plot. Ocular estimates have a subjective element. In order to minimize observer variance, one member of the initial field team was present for each of the annual assessments.

The plots that were seeded but received no amendments supported very little, if any, growth over the six years. This is consistent with the general area as the acidic and mineral soils here have limited natural revegetation in the disturbed areas. The other plots with the different amendments sustained various levels of growth over time.

Although grasses are not the dominant growth form in the nearby local environment, native grasses were initially planted as they germinate quickly, assist in retaining moisture and helping to build up the soil. By year two most of the treated plots supported relatively healthy growth of various grass species. Hedysarum germinated in some plots during year one but was absent in the following years. Alder seeds that were also added to the plots began noticeably growing in years two and three. In year four grasses were gradually dying back and shrubs, mainly alder, were taking over. Willow, dwarf birch, Labrador tea, blueberry and Alaska birch were also beginning to colonize some of the plots, all of which are present in the neighbouring forest. Grasses were also dying back in the plots where alder was not prevalent. Table C-3 in Appendix C lists the species, planted and volunteer, that were identified in the plots over the course of the study period.

As the grasses and shrubs lose their leaves, organic matter builds up, which leads to an increase in soil fertility. During the 2018 assessment, nitrogen fixing nodules were observed on the roots of several alder plants on both the trench and waste rock plots (see Photos 40 and 55). Nitrogen is an essential element in plant development and generally the most limiting nutrient in boreal ecosystems. Plants however, cannot directly access nitrogen gas, which makes up about 80% of the atmosphere. Plants absorb the dissolved nitrogen in the soil

through their roots in the form of ammonium and nitrates. Legumes (Fabaceae) host a bacteria that fixes nitrogen in root nodules which then becomes available to plants. Alder, of the family Betulaceae, is a non-legume which also fixes nitrogen. The presence of these nodules on the alder roots indicates that nitrogen is being produced on the treated plots both on the Trench and the Waste Rock Dump. The decomposition of alder leaves and plant parts likewise provides available nitrogen. This in turn increases the nutrient levels in the soil allowing other species to grow and become established.

Initially the vegetative cover of the plots increased but generally decreased in years three and four, coinciding with grass die off. Cover typically increased in following years as the shrubs grew larger. The exception to this was the plots that received no amendments (seed only). On some of these plots there initially was some minor growth however it had died back in later assessments. Cover at all of the treated plots in Block 3 of the Waste Rock site also decreased over time.

Plant growth was stressed in the plots that were seeded with no treatment (Treatment #1). The healthiest plots generally occurred at those treated with biochar and compost (Treatment #2), and the addition of dolomite tended to assist in the health at some of the plots at the Waste Rock site. The inclusion of Leonardite did not show any marked improvements in the plots and actually tended to decrease the health in the plants on some of the plots on the Waste Rock site. Although most of the alder on the waste rock amended plots exhibited healthy growth, some plants appeared to be suffering from necrosis – browning of leaves and yellow venation (Photo #81). This is likely the result of high concentrations of metals in the soil coupled with nutrient deficiency.

Some of the grass species were mature and producing seed at several plots commencing in the second year. For the first time, several alder had produced seed cones (Photos 28 and 54) in 2018.

During the annual assessments there had been occasional signs of herbivory.

Rooting depth and length were measured on several of the plants in 2018. Rooting depth ranged from 2 to 5 cm depending on the depth of the humus layer that had been built up over time. The roots then grew laterally above the mineral substrate and tended to average around 7 to 9 cm (Table C-4). The root lengths are likely underestimated due to their fragility and the difficulty involved in removing them from the substrate.

4.2.2 Metals in Foliar Tissues

Foliar samples were collected in 2018 from each plot where possible. Several plots, primarily those that received no treatment, supported very little, if any, growth, preventing the collection of sufficient biomass for analysis. Alder was growing at most of the other plots and was the principal tissue collected. There was insufficient growth of grasses in any of the plots by the sixth year of the trial preventing the analysis of this tissue type. Willow was growing in adequate volume to warrant the individual collection of this shrub at Plot 1-4 on the Waste Rock Dump only. Table 7 describes which species were collected at the various plots.

TABLE 7 FOLIAR SAMPLES COLLECTED PER PLOT

SITE	BLOCK #	PLOT #	ALDER LEAVES	ALDER STEMS	ALDER LEAVES & STEMS	WILLOW LEAVES & STEMS
TRENCH	1	1-1B			√	
		1-2AB	√	√		
		1-3	√	√		
	2	2-3A	√	√		
		2-2	√	√		
	3	3-2AB	√	√		
		3-3AB	√	√		
WASTE ROCK DUMP	1	1-2	√	√		
		1-3	√	√		
		1-4	√	√		√
		1-5	√	√		
	2	2-2	√	√		
		2-3	√	√		
		2-4	√	√		
		2-5	√	√		
	3	3-4			√	√
# of individual samples:			14	14	3*	
* samples collected at Plot #3-4 were combined into one sample due to low biomass						

New disposable nitrile gloves were worn for each collection. Where possible, separate samples were collected for the shrub leaves and the current season's growth of twigs. Samples were placed in resealable plastic bags and kept cool until delivered to the ALS laboratory in Whitehorse, Yukon. After the samples were logged in, they were frozen and shipped to the lab in Burnaby, BC, for analysis. The foliar samples were rinsed thoroughly with de-ionized water, homogenized and sub-sampled prior to hot-block digestion with nitric and hydrochloric acids, in combination with the addition of hydrogen peroxide. Metals were analyzed using collision cell inductively coupled plasma-mass spectrometry. Analysis for mercury was done by atomic fluorescence or atomic absorption spectrophotometry.

The complete analytical report is provided in Appendix C. The data has been summarized according to the type of treatment and according to tissue type and is presented below per site.

4.2.2.1 Trench Site

There were three treatments applied to the Trench Site; no treatment, biochar and compost, and biochar, compost and leonardite. There were five plots per block so some treatments were repeated in each block. The tissue samples collected from the same treatment in the same block were combined and analyzed as a single sample. The analytical data for each of the plots is presented in Table C-5 in Appendix C. There were five metals that were below detection at all plots: beryllium, lithium, tellurium, vanadium and zirconium.

The data per treatment has been averaged and tabulated (Table 8). There are no guidelines regarding metal concentrations in vegetation with respect to wildlife consumption (e.g., moose and/or caribou). For reference, Stantec (2011) compared the 2009 baseline Eagle Gold foliar data to the dietary tolerances for beef cattle. These toxic values have also been included in Table 8.

TABLE 8 METALS (mg/kg) IN TISSUES PER AMENDMENT, TRENCH SITE

Parameter	Lowest Detection Limit	No treatment N=1	Biochar and compost N=6	Biochar, compost and leonardite N=6	Toxicity Thresholds
Aluminum (Al)-Total	2.0	33.5	16.40	9.66	>1200
Antimony (Sb)-Total	0.010	5.59	0.915	0.447	
Arsenic (As)-Total	0.020	17.0	2.42	1.72	>10*
Barium (Ba)-Total	0.050	39.5	38.74	32.75	>20**
Bismuth (Bi)-Total	0.010	0.219	0.07	0.035	
Boron (B)-Total	1.0	7.7	7.15	8.33	>200
Cadmium (Cd)-Total	0.0050	ND	0.011	0.01	50 - 500
Calcium (Ca)-Total	20	11000	6156.67	7056.67	
Cesium (Cs)-Total	0.0050	0.136	0.246	0.149	
Chromium (Cr)-Total	0.050	0.22	0.06	ND	>40
Cobalt (Co)-Total	0.020	0.121	0.120	0.088	>30
Copper (Cu)-Total	0.10	6.54	8.06	6.39	>100
Iron (Fe)-Total	3.0	222	54.67	48.37	>4000
Lead (Pb)-Total	0.020	48.0	11.00	6.06	>100
Magnesium (Mg)-Total	2.0	2430	1513.83	1451.67	
Manganese (Mn)-Total	0.050	214	62.68	61.28	2000 - 4000
Mercury (Hg)-Total	0.0050	0.0067	ND	ND	
Molybdenum (Mo)-Total	0.020	3.71	3.39	4.74	10 - 20
Nickel (Ni)-Total	0.20	5.54	2.07	1.34	>1500
Phosphorus (P)-Total	10	938	2122	2013	
Potassium (K)-Total	20	7510	5907	6108	
Rubidium (Rb)-Total	0.050	7.81	11.44	7.82	
Selenium (Se)-Total	0.050	ND	0.14	0.12	5 - 20
Sodium (Na)-Total	20	29	ND	ND	
Strontium (Sr)-Total	0.050	44.0	34.13	31.37	>2000
Thallium (Tl)-Total	0.0020	0.0060	0.0041	0.004	
Tin (Sn)-Total	0.10	0.21	ND	ND	
Uranium (U)-Total	0.0020	0.0180	0.0042	0.00	
Zinc (Zn)-Total	0.50	48.5	31.27	31.42	>5000

* There is no actual toxic value, only what is considered normal or adequate in the referenced table.

** There is no actual toxic value, only what is considered high in the referenced table. ND = not detected

In one of the six plots that received no treatment at the Trench site (Plot #1-1B), there was enough alder growing to warrant tissue analysis. This has allowed for the comparison of no treatment versus treatment on the effects of metal uptake.

The addition of treatments significantly decreased the uptake of the following metals: antimony, arsenic, iron, lead and to a lesser extent chromium, nickel and uranium.

The addition of treatments significantly increased the uptake of the nutrient phosphorus.

There is no actual toxic threshold assigned for arsenic, but the value given is the concentration that is considered “normal” (Stantec, 2011). This value was exceeded in foliar tissues collected from the untreated plot only. Likewise there is no defined toxic concentration for barium although the value presented in the table is considered high. This value was exceeded in all of the treated plots and concentrations were similar.

Alder were the only plants sampled at the Trench site owing to the lack of other species. Due to the small size of alders in Plots 1-1B, alder leaves and twigs were combined and analyzed as one sample. The other plots had sufficient biomass that leaves and stems could be analyzed separately (Table 9). Concentrations of metals were generally higher in leaves than in stems. The exceptions to this include barium, boron, manganese, molybdenum, strontium and zinc where concentrations were greater in the stems.

TABLE 9 FOLIAR METALS (mg/kg) PER TISSUE TYPE, TRENCH SITE

PARAMETER	MDL	ALDER LEAVES AND TWIGS N=1	ALDER LEAVES N=6	ALDER STEMS N=6
Aluminum (Al)-Total	2.0	33.5	18.08	7.64
Antimony (Sb)-Total	0.010	5.59	0.791	0.571
Arsenic (As)-Total	0.020	17.0	2.50	1.64
Barium (Ba)-Total	0.050	39.5	22.35	49.13
Bismuth (Bi)-Total	0.010	0.219	0.059	0.051
Boron (B)-Total	1.0	7.7	6.92	8.57
Cadmium (Cd)-Total	0.0050	ND	0.0057	0.0118
Calcium (Ca)-Total	20	11000	7401.67	5811.67
Cesium (Cs)-Total	0.0050	0.136	0.212	0.183
Chromium (Cr)-Total	0.050	0.22	ND	0.06
Cobalt (Co)-Total	0.020	0.121	0.132	0.073
Copper (Cu)-Total	0.10	6.54	7.21	7.24
Iron (Fe)-Total	3.0	222	65.52	37.52
Lead (Pb)-Total	0.020	48.0	9.06	8.00
Magnesium (Mg)-Total	2.0	2430	1888.33	1077.17
Manganese (Mn)-Total	0.050	214	53.52	70.45
Mercury (Hg)-Total	0.0050	0.0067	ND	ND
Molybdenum (Mo)-Total	0.020	3.71	3.69	4.44
Nickel (Ni)-Total	0.20	5.54	1.90	1.51
Phosphorus (P)-Total	10	938	2456.67	1678.33
Potassium (K)-Total	20	7510	6471.67	5543.33
Rubidium (Rb)-Total	0.050	7.81	10.85	8.41
Selenium (Se)-Total	0.050	ND	0.156	0.10
Strontium (Sr)-Total	0.050	44.0	29.20	36.30
Thallium (Tl)-Total	0.0020	0.0060	0.00	0.0047
Tin (Sn)-Total	0.10	0.21	ND	ND
Uranium (U)-Total	0.0020	0.0180	0.00	0.0025
Zinc (Zn)-Total	0.50	48.5	26.28	36.40

MDL = method detection limit ND = not detected

4.2.2.2 Waste Rock Site

There were five amendments applied to the blocks at the waste rock dump site: no treatment; biochar and compost; biochar, compost and leonardite; biochar, compost and dolomite lime; and biochar, compost, leonardite and dolomite lime. The data per treatment has been averaged and

tabulated (Table 10). Sodium, tellurium and zirconium were not detected in any samples and are not included in Table 10.

TABLE 10	**METALS IN TISSUES (mg/kg) PER AMENDMENT, WASTE ROCK DUMP**					
Parameter	**MDL**	**Biochar and compost** N=4	**Biochar, compost & leondardite** N=3	**Biochar, compost & dolomite lime** N=5	**Biochar, compost, leondarite & dolomite lime** N=4	**Toxicity**
Aluminum (Al)-Total	2.0	22.7	43.1	11.4	7.4	>1200
Antimony (Sb)-Total	0.010	1.47	0.81	2.73	2.30	
Arsenic (As)-Total	0.020	4.25	3.34	4.38	2.93	>10*
Barium (Ba)-Total	0.050	4.66	3.09	0.78	0.48	>20**
Beryllium (Be)-Total	0.010	ND	0.019	ND	ND	
Bismuth (Bi)-Total	0.010	0.14	0.09	0.29	0.33	
Boron (B)-Total	1.0	11.9	8.9	5.0	9.5	>200
Cadmium (Cd)-Total	0.0050	0.059	0.036	0.544	0.060	50 - 500
Calcium (Ca)-Total	20	4603	2240	5010	6715	
Cesium (Cs)-Total	0.0050	0.394	0.616	0.566	0.364	
Chromium (Cr)-Total	0.050	0.082	ND	0.078	ND	>40
Cobalt (Co)-Total	0.020	0.308	0.197	0.206	0.140	>30
Copper (Cu)-Total	0.10	10.9	19.0	11.7	10.6	>100
Iron (Fe)-Total	3.0	105.9	104.4	92.7	65.1	>4000
Lead (Pb)-Total	0.020	5.19	2.05	5.04	5.14	>100
Lithium (Li)-Total	0.50	ND	0.6	ND	ND	
Magnesium (Mg)-Total	2.0	937	809	2678	2278	
Manganese (Mn)-Total	0.050	294.5	247.3	70.3	101.6	2000 - 4000
Mercury (Hg)-Total	0.0050	0.0051	ND	ND	0.0051	
Molybdenum (Mo)-Total	0.020	1.01	1.42	2.66	5.00	10 - 20
Nickel (Ni)-Total	0.20	3.3	7.0	2.1	2.2	>1500
Phosphorus (P)-Total	10	1658	1523	1778	1935	
Potassium (K)-Total	20	3645	3737	3634	3755	
Rubidium (Rb)-Total	0.050	11.1	14.7	11.4	11.3	
Selenium (Se)-Total	0.050	0.110	ND	0.062	0.138	5 - 20
Strontium (Sr)-Total	0.050	13.26	7.07	3.08	4.09	>2000
Thallium (Tl)-Total	0.0020	0.0028	0.0061	0.0033	0.0091	
Tin (Sn)-Total	0.10	ND	ND	ND	ND	
Uranium (U)-Total	0.0020	0.0061	0.0128	0.0079	0.0040	
Vanadium (V)-Total	0.10	0.1	ND	ND	ND	
Zinc (Zn)-Total	0.50	43.7	23.0	45.5	58.5	>5000
Note: did not include the multiple species, W3-4. MDL = method detection limit. ND = not detected						

There were no plants growing on any of the three untreated plots so comparisons can only be made regarding actual amendment type. The tissues collected from one plot only at Block 3 (Plot #3-4), were excluded from the table as there were a variety of species collected from this plot to increase tissue biomass for analysis. Also, the high metal concentrations had the potential to skew

the results and as there were no other tissues from Block 3 it is not possible to tell if the other amendments would have had different uptake concentrations. It has been left out as an outlier in these calculations, however the data is presented in Table C-1 in Appendix C. Generally the highest metal concentrations were documented in the tissues from Plot 3-4, notably antimony, arsenic, bismuth, cadmium, iron, lead, magnesium, manganese and zinc. Of these, only arsenic exceeded the referenced toxicity level.

There generally was not a great range in tissue concentrations for the different treatments and it cannot be suggested that any one of these treatments is obviously better than another in reducing metal uptake. It appears however that for the waste rock dump site an additional amendment to biochar and compost is beneficial.

Similar to the Trench site, the Waste Rock data has been compared to the dietary tolerances for beef cattle in Table 10. There were no exceedances for any parameter. Unlike the Trench site, barium concentrations were low throughout the plots.

The mean concentrations of metals in the types of tissues have been tabulated (Table 11). Alder was also the principal vegetation type at the Waste Rock Dump and leaves and stems were sampled and analyzed separately. There was sufficient willow biomass to allow the analysis of tissues from a different species.

The single sample of willow leaves and stems collected from Plot #1-3 generally had the lowest concentrations of most metals. The combination sample of willow leaves, willow stems, alder leaves and alder stems collected from Plot #3-4 had the greatest concentration of the majority of the metals. When comparing just the alder tissues, levels were frequently lower in the stems than the leaves, or were relatively similar. During an ecological health assessment at the decommissioned Sä Dena Hes mine north of Watson Lake, Azimuth (2014) found that metal concentrations in alder leaves tended to be approximately double of that of twigs. The combination sample containing alder leaves and stems collected from Plot #1-3 typically reported higher concentrations than either those in the leaves or in the stems.

TABLE 11 MEAN METAL CONCENTRATIONS IN FOLIAR TISSUES PER SPECIES AND TYPE, WASTE ROCK

Species	Alder	Alder	Alder	Willow	Alder & Willow
Tissue type	Leaves	Stems	Leaves & Stems	Leaves & Stems	Leaves & Stems
N	7	7	1	1	1
Aluminum (Al)-Total	25.2	5.2	82.6	11.0	40.8
Antimony (Sb)-Total	3.5	0.7	0.910	1.15	32.4
Arsenic (As)-Total	5.3	1.7	7.36	3.88	68.7
Barium (Ba)-Total	1.2	2.9	4.41	0.595	1.88
Beryllium (Be)-Total	ND	ND	0.019	ND	ND
Bismuth (Bi)-Total	0.4	0.1	0.139	0.164	4.29
Boron (B)-Total	8.7	8.7	9.7	5.9	30.7
Cadmium (Cd)-Total	0.016	0.064	0.0737	2.14	6.44
Calcium (Ca)-Total	6202.9	3470.0	3300	6030	9190
Cesium (Cs)-Total	0.573	0.404	0.777	0.0901	0.188
Chromium (Cr)-Total	0.080	ND	ND	ND	0.099
Cobalt (Co)-Total	0.284	0.100	0.256	0.466	0.769
Copper (Cu)-Total	11.1	12.0	34.8	4.68	9.20
Iron (Fe)-Total	131.1	45.5	166	58.5	530
Lead (Pb)-Total	7.6	2.0	2.66	2.60	68.6
Lithium (Li)-Total	ND	ND	0.63	ND	ND
Magnesium (Mg)-Total	2419.1	883.3	791	4770	4840
Manganese (Mn)-Total	134.5	183.3	360	93.0	414
Mercury (Hg)-Total	0.005	ND	ND	ND	0.0121
Molybdenum (Mo)-Total	2.1	3.5	2.22	0.049	1.15
Nickel (Ni)-Total	3.9	1.9	11.3	1.30	1.67
Phosphorus (P)-Total	1985.7	1411.4	1710	2340	3700
Potassium (K)-Total	4268.6	3042.9	3400	4400	7890
Rubidium (Rb)-Total	14.8	8.9	18.1	6.97	18.9
Selenium (Se)-Total	0.101	ND	ND	0.067	0.655
Strontium (Sr)-Total	6.1	7.5	8.47	2.70	8.04
Thallium (Tl)-Total	0.006	0.005	0.0061	ND	0.0165
Tin (Sn)-Total	ND	ND	ND	ND	0.59
Uranium (U)-Total	0.006	ND	0.0203	ND	0.0313
Vanadium (V)-Total	0.1	ND	ND	ND	ND
Zinc (Zn)-Total	34.0	47.2	29.7	107	304
Zirconium (Zr)-Total	0.22	ND	ND	ND	0.23

ND = not detected

5.0 DISCUSSION

No mining activity has taken place at the Peso site since the 1960s. After 50 years the disturbed areas of Peso have had very little natural colonization. There has been sporadic growth in the trench area, mainly shrubs, but the waste rock dump was devoid of any growth.

Phytoremediation, the use of plants to decontaminate soils and waters, has been developed over recent decades. The purpose of phytoremediation is to remove the contaminant from the media into plants. Heavy metals can be removed through plant processes such as uptake, adsorption, transport and translocation, sequestration into vacuoles, hyperaccumulation and, in some cases, volatilization (Bieby Voijant Tangahu et al, 2011). The strategy is to extract metals from contaminated soil and transfer it to the smaller volume of harvestable plants for disposal (Capuana, 2011). However, the purpose of this trial was to determine how to cover the contaminated soils with a sustaining plant community but leave the metals in situ. Uptake of metals into the tissues is not desirable as the resulting vegetation may be consumed by

herbivores (from mice to moose). Biochar has the ability to immobilize metals thereby reducing their bioavailability for plant uptake and hence was chosen as an amendment for the Peso trials.

The objective of on-site treatment of contaminated lands using soil amendments is to establish a self-sustaining system that does not rely on additional care, and, ideally, is similar to and provides nearly equal ecological value as the undisturbed adjacent landscape. Without the necessity of an application of a layer of till, the Peso site could be revegetated using biochar and some form of nutrient rich amendment. Dolomite should also be added for the waste rock site. This has implications for the revegetation of other areas eventually requiring reclamation at the Eagle Gold Project site. As areas are cleared, the woody material in the overburden could be turned into biochar on site in easily constructed pits. The remaining stockpiled overburden material can be spread over the area to be revegetated, providing soil material, nutrients, seed banks, and the associated mycorrhiza to allow healthy growth of native plants through direct seeding, planting and natural colonization.

As described in Section 4.1, all of the plots had very high concentrations of metals in the soils, notably antimony, arsenic and lead. This has not been reflected in the tissue samples. With the exception of a couple of plots, very low concentrations of these metals were taken up by the plants. The soil samples from Block 3 at the Waste Rock Dump had the highest concentrations of antimony, arsenic and lead in the study area and correspondingly the single foliar sample collected here contained the highest levels of these metals. (There was only sufficient plant biomass from one plot in this block for analysis.)

There currently is not an available database on metals in plant tissues for the Yukon. A compendium has been prepared by the Yukon College (Soprovich and Janin, 2017) discussing metal concentrations in plants from several mine sites in the Yukon, however the presented information and data is limited. A literature search was conducted in attempts to compare the Peso foliar data with other sites. Only studies that also included soil chemistry data were reviewed. Note that the soil samples were not necessarily collected at the same locations as the vegetation samples, however the data does give an idea of the metal concentrations throughout each study area.

Vegetation and soil samples were collected from four permanent sites at the Eagle Gold Project Site in the summer of 2018 to monitor any effects from the construction activities and basically represent baseline conditions (Laberge, 2018b). Willow and dwarf birch comprised the majority of the foliar samples. Stantec (2011) undertook baseline soil and foliar sampling in 2009 throughout the footprint of the Eagle Gold Project. Vegetation types analyzed included willow, sedge and grasses. Access Consulting Group (2015) devised a vegetation monitoring plan for the Minto Mine and collected soil and vegetation samples in areas that may be influenced by mining activities. Grasses, willows and aspen were the tissues analyzed. As part of a human health and ecological risk assessment, Azimuth (2014) conducted extensive soil sampling throughout the project area at Sä Dena Hes, and submitted several willow and alder twig samples for vegetation analysis.

Neither arsenic nor lead have any beneficial value to plants. These metals were extremely high in the soils at Peso and Table 12 summarizes the range of concentrations in the soil and in the vegetation at each project site. The two sites at Peso have been presented separately. The

numbers in brackets after the maximum value indicated the next highest concentration after the outlier is eliminated from the range. As significant numbers of willow and alder samples were collected at Sa Dena Hes, these have been included as separate entries. Only twigs were analyzed.

TABLE 12 METAL CONCENTRATIONS IN SOIL AND FOLIAR TISSUES FROM VARIOUS PROJECTS

Metal	Site	Year	Author	Range of Concentration (mg/kg)			
				Soil	N	Foliar	N
Arsenic	Peso - Trench	2018	LES	1490 to 11,400	15	0.4 to 17.0 (4.09)	13
	Peso - Waste Rock	2018	LES	1240 to 10,900	15	0.7 to 68.7 (7.4)	17
	Eagle Gold	2018	LES	15.1 to 302	4	0.090 to 7.73	60
	Eagle Gold	2009	Stantec	9.4 to 1350	20	<0.1 to 0.4	16
	Minto	2015	Access	1.1 to 9.0	12	0.06 to 0.49	10
	Sa Dena Hes	2013	Azimuth	1.0 to 357	69	willow: 0.006 to 0.012	16
						alder: 0.004 to 7.36	16
	Keno Valley	2003	LES	12.9 to 373	11	<2 to 2.0	18
Lead	Peso - Trench	2018	LES	1160 to 8680	15	2.5 to 48.0 (18.5)	13
	Peso - Waste Rock	2018	LES	331 to 16,600	15	1.0 to 68.6 (15.3)	17
	Eagle Gold	2018	LES	19.8 to 40.6	4	0.036 to 1.55	60
	Eagle Gold	2009	Stantec	5.7 to 85.8	20	<0.1 to 0.2	16
	Minto	2015	Access	2.4 to 7.5	12	0.13 to 0.53	10
	Sa Dena Hes	2013	Azimuth	76 to 10,400	115	willow: 0.042 to 61.4	16
						alder: 0.045 to 5.35	16
	Keno Valley	2003	LES	22.3 to 1350	11	<5 to 3.3	18

The arsenic concentrations in the soil at Peso were far greater than at the other sites, especially when comparing the minimums. The maximum concentration of arsenic documented at Eagle Gold by Stantec was similar to the minimum concentrations reported at Peso. Arsenic concentrations were slightly higher in the tissues collected from Peso than the other sites, although the maximum concentration from alder tissues at Sä Dena Hes were similar to the maximums at Peso (which were mostly alder) when the outliers are excluded.

Generally lead concentrations were much greater in the soils at Peso than the other sites, however there was a comparable maximum lead concentration collected from a site at Sä Dena Hes. Again, the minimum concentrations of lead in the soils were much higher at Peso. Lead in tissues from Peso were somewhat higher than the other sites, even when the outliers where excluded. The exception to this was a willow sample analyzed from Sä Dena Hes which had concentrations almost as great as the sample analyzed from Block 3 at the Waste Rock Dump.

Although Peso is a highly contaminated site regarding metals, the potentially harmful metals do not appear bioavailable as evidenced by the low concentrations in the foliar tissues. Only two samples had a concentration greater than the referenced dietary tolerances for cattle. Arsenic concentrations in the foliar sample collected from an untreated plot at the Trench site slightly exceeded what is considered “normal”. Arsenic in the vegetation sample from Block 3 on the Waste Rock Dump exceeded the tolerance level to a greater extent. All other metals were well below the referenced tolerances. It appears that biochar has been effective in

reducing the uptake of metals in plant tissues. The biochar application rate must be sufficient to match and treat the amount of heavy metals that are contained in the soil (Chen et al, 2018). The application rate for the plots on the waste rock was twice that applied to the Trench plots, however, an increase in the application rate may have reduced uptake more efficiently, notably at Block 3.

There is little doubt that amendments are required for plants to grow in the study area. All non-treated seeded plots produced no to very little growth. The acidic soil conditions at the Peso trench and the waste rock sites present a challenging scenario in relation to the site conditions at the majority of other disturbed sites in the Dublin Gulch area. However, the success of using compost and biochar to achieve robust plant growth on these highly mineralized and acidic soils, especially on the waste rock dump, indicates that nothing is impossible.

With minimal effort and resources, native plants were able to grow on the majority of the treated plots, including on the highly acidic (pH 2.6) waste rock dump.

In summary, these trials have proven successful. By using appropriate species and soil amendments, healthy plants have grown, propagated and even thrived on acidic, highly mineralized soils.

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APPENDIX A

SOILS DATA

- **TABLE A-1**
- **TABLE A-2**
- **MAXXAM JOB #: B256252, 2012**
- **ALS Lab Work Order #: L2139940,2018**

TABLE A-1 **SOIL DATA, TRENCH SITE 2018**

Parameter	Lowest Detection Limit	Units	Block #1			Block #2			Block #3		
			T1-1AB	T1-2AB	T1-3	T2-1AB	T2-2	T2-3A	T3-1	T3-2AB	T3-3AB
Physical Tests (Soil)											
Loss on Ignition @ 375 C	1.0	%	1.2	3.1	3.6	1.3	1.3	1.4	2.3	3.3	3.5
Organic Matter	1.0	%	1.2	2.7	3.1	1.3	1.3	1.4	2.0	2.9	3.0
pH (1:2 soil:water)	0.10	pH	6.30	7.17	6.74	5.88	7.12	6.12	5.17	5.75	6.79
Particle Size (Soil)											
% Sand (2.0mm - 0.05mm)	1.0	%	83.3	83.8	82.5	65.0	65.7	65.2	60.9	64.2	58.0
% Silt (0.05mm - 2um)	1.0	%	15.3	14.1	15.7	28.9	28.6	28.3	34.7	31.0	37.9
% Clay (<2um)	1.0	%	1.4	2.1	1.7	6.1	5.7	6.5	4.4	4.7	4.1
Texture		-	Loamy sand	Loamy sand	Loamy sand	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Leachable Anions & Nutrients (Soil)											
Total Kjeldahl Nitrogen	0.020	%	0.069	0.118	0.132	0.059	0.064	0.063	0.070	0.077	0.088
Organic / Inorganic Carbon (Soil)											
C:N Ratio		-	5.8:1	15.7:1	14.5:1	7:01	8.9:1	6.8:1	7.2:1	20.1:1	17.5:1
Total Carbon by Combustion	0.05	%	0.40	1.86	1.91	0.42	0.57	0.43	0.50	1.55	1.53
Plant Available Nutrients (Soil)											
Available Ammonium-N	1.0	mg/kg	1.8	2.5	3.1	2.0	2.3	1.4	1.7	2.6	2.5
Calcium (Ca)	0.50	meq/100g	0.92	5.33	3.74	0.74	2.26	1.20	<0.50	3.97	4.48
Magnesium (Mg)	0.50	meq/100g	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Available Phosphate-P	2.0	mg/kg	3.4	46.9	17.9	<2.0	6.8	<2.0	2.3	15.2	24.2
Available Potassium	20	mg/kg	24	51	51	30	39	29	31	40	46
Potassium (K)	0.50	meq/100g	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Sodium (Na)	0.50	meq/100g	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Metals (Soil)											
Aluminum (Al)	50	mg/kg	3220	2050	1630	3440	3390	4620	3030	3670	2670
Antimony (Sb)	0.10	mg/kg	3750	818	6410	2360	492	369	4590	1450	2330
Arsenic (As)	0.10	mg/kg	6380	2190	2690	5810	1490	1730	11400	4410	10600
Barium (Ba)	0.50	mg/kg	47.2	32.6	35.6	70.3	65.7	91.3	42.3	40.6	38.6
Beryllium (Be)	0.10	mg/kg	0.13	<0.10	<0.10	0.13	0.11	0.15	0.12	0.13	<0.10
Bismuth (Bi)	0.20	mg/kg	145	26.1	236	504	53.5	30.5	320	91.5	222
Boron (B)	5.0	mg/kg	10.0	<5.0	7.1	7.4	<5.0	8.2	7.4	<5.0	<5.0
Cadmium (Cd)	0.020	mg/kg	4.08	0.427	3.26	3.89	0.564	0.482	6.21	1.53	3.91
Calcium (Ca)	50	mg/kg	578	1830	3890	947	1180	1330	334	634	1190
Chromium (Cr)	0.50	mg/kg	16.6	7.83	5.92	7.33	7.84	10.6	11.2	10.1	13.8
Cobalt (Co)	0.10	mg/kg	7.91	4.18	2.26	2.93	2.84	3.44	5.08	4.21	6.24
Copper (Cu)	0.50	mg/kg	132	55.6	29.8	74.3	50.9	73.3	170	92.7	121
Iron (Fe)	50	mg/kg	56700	31900	17900	51100	28400	39300	43100	36000	42900
Lead (Pb)	0.50	mg/kg	7790	1440	3670	4700	1160	1260	8680	3200	4890
Lithium (Li)	2.0	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Magnesium (Mg)	20	mg/kg	94	312	475	81	84	92	131	354	193
Manganese (Mn)	1.0	mg/kg	278	290	131	277	142	199	184	170	214
Mercury (Hg)	0.0050	mg/kg	0.227	0.169	0.468	0.358	0.146	0.193	0.700	0.571	0.924
Molybdenum (Mo)	0.10	mg/kg	1.45	1.36	1.05	0.85	1.31	1.05	0.79	1.15	1.27
Nickel (Ni)	0.50	mg/kg	20.3	11.5	5.92	5.34	5.52	7.03	9.32	8.65	15.1
Phosphorus (P)	50	mg/kg	581	500	452	1170	1200	1480	534	333	484
Potassium (K)	100	mg/kg	580	460	320	670	630	790	520	470	590
Selenium (Se)	0.20	mg/kg	5.62	1.70	6.76	9.01	1.98	1.68	9.01	3.54	6.42
Silver (Ag)	0.10	mg/kg	>165	15.8	>126	50.7	8.51	7.37	38.0	18.3	35.8
Sodium (Na)	50	mg/kg	<50	<50	<50	<50	<50	<50	<50	<50	<50
Strontium (Sr)	0.50	mg/kg	93.0	35.7	32.6	337	349	483	108	57.1	79.5
Sulfur (S)	1000	mg/kg	1500	<1000	<1000	1700	<1000	<1000	2000	1100	1600
Thallium (Tl)	0.050	mg/kg	0.262	0.149	0.147	0.282	0.118	0.116	0.263	0.180	0.189
Tin (Sn)	2.0	mg/kg	51.0	16.5	24.7	41.3	17.2	18.0	201	38.3	105
Titanium (Ti)	1.0	mg/kg	22.3	28.9	38.7	19.5	<16	18.4	17.3	37.1	<19
Tungsten (W)	0.50	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Uranium (U)	0.050	mg/kg	14.3	1.72	4.75	6.05	2.17	2.17	3.49	2.06	3.12
Vanadium (V)	0.20	mg/kg	18.6	10.4	6.31	10.7	8.41	11.7	10.5	12.7	13.3
Zinc (Zn)	2.0	mg/kg	354	142	70.4	117	85.5	113	112	95.0	107
Zirconium (Zr)	1.0	mg/kg	12.0	3.8	2.1	7.4	7.5	6.2	10.4	8.7	10.2

TABLE A-2 **SOIL DATA, WASTE ROCK SITE 2018**

Parameter	Lowest Detection Limit	Units	Block #1					Block #2					Block #3				
			W1-1	W1-2	W1-3	W1-4	W1-5	W2-1	W2-2	W2-3	W2-4	W2-5	W3-1	W3-2	W3-3	W3-4	W3-5
Physical Tests (Soil)																	
Loss on Ignition @ 375 C	1.0	%	2.0	2.3	4.4	3.0	9.2	1.4	1.5	3.0	4.8	1.9	1.6	6.1	8.0	9.5	7.9
Organic Matter	1.0	%	1.8	2.1	3.7	2.6	7.5	1.4	1.5	2.6	4.1	1.7	1.5	5.0	6.5	7.7	6.5
pH (1:2 soil:water)	0.10	pH	3.04	4.81	3.25	4.10	5.71	2.75	3.11	3.04	3.28	2.84	2.32	2.41	1.77	4.32	2.20
Particle Size (Soil)																	
% Sand (2.0mm - 0.05mm)	1.0	%	59.4	69.2	80.3	82.3	75.5	37.4	42.6	87.1	73.2	71.2	53.3	69.2	63.7	68.6	68.8
% Silt (0.05mm - 2um)	1.0	%	36.4	27.2	17.2	16.0	20.8	59.4	55.6	11.2	23.6	22.4	40.5	25.4	28.6	26.9	25.0
% Clay (<2um)	1.0	%	4.2	3.6	2.4	1.7	3.7	3.1	1.8	1.7	3.2	6.3	6.2	5.4	7.6	4.5	6.2
Texture		-	Sandy loam	Sandy loam	Loamy sand	Loamy sand	Loamy sand	Silt loam	Silt loam	Sand	Sandy loam / Loamy sand	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Leachable Anions & Nutrients (Soil)																	
Total Kjeldahl Nitrogen	0.020	%	0.062	0.073	0.095	0.115	0.152	0.023	0.033	0.063	0.096	0.046	0.061	0.135	0.150	0.175	0.140
Organic / Inorganic Carbon (Soil)																	
C:N Ratio		-	10.5:1	12.2:1	30.7:1	11.5:1	37.6:1	15.1:1	12.9:1	15.6:1	24:01:00	5.7:1	8.7:1	21.9:1	27.6:1	32.4:1	32:01:00
Total Carbon by Combustion	0.05	%	0.64	0.89	2.91	1.33	5.72	0.34	0.42	0.99	2.31	0.26	0.53	2.95	4.16	5.66	4.47
Plant Available Nutrients (Soil)																	
Available Ammonium-N	1.0	mg/kg	4.1	3.4	3.6	3.3	6.3	2.2	1.8	2.9	4.5	2.8	6.9	13.6	18.6	7.5	11.5
Calcium (Ca)	0.50	meq/100g	<0.50	1.27	<0.50	0.75	11.2	<0.50	<0.50	<0.50	2.84	<0.50	<0.50	<0.50	<0.50	3.60	19.4
Magnesium (Mg)	0.50	meq/100g	<0.50	<0.50	<0.50	<0.50	2.26	<0.50	<0.50	<0.50	0.90	<0.50	<0.50	<0.50	<0.50	1.96	2.12
Available Phosphate-P	2.0	mg/kg	2.2	5.7	6.4	<2.0	15.6	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	4.4	<2.0	<2.0	<2.0
Available Potassium	20	mg/kg	27	23	<20	25	45	<20	<20	<20	32	<20	<20	<20	20	<20	<20
Potassium (K)	0.50	meq/100g	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Sodium (Na)	0.50	meq/100g	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Metals (Soil)																	
Aluminum (Al)	50	mg/kg	7160	5840	4990	3550	2780	4540	5820	4920	5080	4590	3390	2930	3100	3760	2710
Antimony (Sb)	0.10	mg/kg	1280	542	241	838	3350	1110	333	1320	2100	2360	2940	7690	6020	5920	7140
Arsenic (As)	0.10	mg/kg	3750	3220	2140	3610	3130	1470	1240	2530	2980	2260	3010	6500	7950	9810	10900
Barium (Ba)	0.50	mg/kg	116	72.0	44.3	24.3	46.3	158	196	102	134	86.8	116	47.3	53.7	60.5	48.1
Beryllium (Be)	0.10	mg/kg	0.20	0.18	0.20	0.18	0.13	0.13	0.13	0.27	0.22	0.27	0.14	0.16	0.17	0.17	0.11
Bismuth (Bi)	0.20	mg/kg	110	66.5	21.2	73.4	313	43.5	12.1	132	252	422	246	1020	975	822	1250
Boron (B)	5.0	mg/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.2	<5.0	6.7	5.8	<5.0	5.8
Cadmium (Cd)	0.020	mg/kg	1.85	1.29	1.61	1.95	2.40	0.291	0.253	0.442	0.633	0.996	1.81	5.74	6.59	6.44	6.31
Calcium (Ca)	50	mg/kg	452	1150	296	4040	28500	756	1160	899	1540	1390	222	446	571	9170	2290
Chromium (Cr)	0.50	mg/kg	14.2	12.2	11.9	9.60	5.22	10.4	13.9	8.69	8.62	6.91	10.6	9.91	9.40	12.0	7.89
Cobalt (Co)	0.10	mg/kg	9.72	11.6	22.5	14.0	2.54	3.00	4.69	2.24	2.38	1.39	5.39	1.80	1.82	3.01	2.13
Copper (Cu)	0.50	mg/kg	145	172	120	214	229	88.0	59.4	194	194	180	250	299	314	433	400
Iron (Fe)	50	mg/kg	46500	45400	50500	48600	27200	38500	33500	53900	48900	45100	37100	35800	32300	54300	70100
Lead (Pb)	0.50	mg/kg	1870	4570	391	1380	6770	1600	331	2220	3590	4860	3810	14300	12800	10700	16600
Lithium (Li)	2.0	mg/kg	7.5	5.8	5.3	3.2	<2.0	4.7	6.9	2.2	2.2	<2.0	2.4	<2.0	<2.0	<2.0	<2.0
Magnesium (Mg)	20	mg/kg	2250	1820	1620	3190	14800	1410	2350	307	731	212	622	262	105	5180	1380
Manganese (Mn)	1.0	mg/kg	272	238	320	225	207	112	179	83.4	86.7	66.9	129	94.8	81.8	132	108
Mercury (Hg)	0.0050	mg/kg	0.0935	0.0853	0.0327	0.105	0.654	0.0933	0.0465	0.182	0.361	0.302	0.207	0.701	1.05	0.797	0.706
Molybdenum (Mo)	0.10	mg/kg	0.78	1.60	1.69	1.04	2.20	0.77	0.80	1.04	1.89	1.09	1.30	2.57	1.79	2.57	1.94
Nickel (Ni)	0.50	mg/kg	27.6	27.6	48.7	34.2	7.42	8.91	13.2	8.26	8.19	6.94	16.2	5.14	5.46	8.84	5.78
Phosphorus (P)	50	mg/kg	461	827	594	410	914	561	602	1670	1640	1730	289	1120	769	1230	788
Potassium (K)	100	mg/kg	640	580	420	400	700	970	980	1130	1240	1460	670	900	850	870	750
Selenium (Se)	0.20	mg/kg	3.93	5.46	1.04	4.02	12.2	2.46	1.14	4.04	6.75	6.31	9.79	25.1	27.5	25.8	35.5
Silver (Ag)	0.10	mg/kg	17.6	18.9	3.50	16.3	62.9	19.5	4.72	58.0	75.3	>108	32.5	>122	>112	>111	>135
Sodium (Na)	50	mg/kg	149	184	73	<50	55	392	353	92	162	75	106	58	53	94	106
Strontium (Sr)	0.50	mg/kg	26.0	32.8	13.3	17.8	193	90.6	39.4	407	458	565	41.2	188	215	168	141
Sulfur (S)	1000	mg/kg	2900	3400	1600	2400	6700	6300	4000	5900	9000	9800	3900	6300	8500	8400	16600
Thallium (Tl)	0.050	mg/kg	<0.10	<0.15	0.062	<0.10	<0.35	0.151	0.078	0.242	0.301	0.418	<0.20	<0.30	<0.35	0.265	<35
Tin (Sn)	2.0	mg/kg	6.9	7.6	2.6	7.6	33.2	11.3	5.1	21.0	32.2	26.5	33.9	64.0	131	81.7	68.5
Titanium (Ti)	1.0	mg/kg	99.7	75.9	49.8	26.8	<31	274	314	31.1	78.7	10.6	74.2	39.6	39.9	46.0	<47
Tungsten (W)	0.50	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Uranium (U)	0.050	mg/kg	2.41	2.27	2.73	2.99	2.21	0.967	0.785	2.32	2.46	3.87	2.52	6.00	7.07	5.62	6.01
Vanadium (V)	0.20	mg/kg	19.5	15.7	12.9	10.0	8.13	28.0	29.3	14.5	18.0	12.2	17.1	8.07	7.03	9.26	7.35
Zinc (Zn)	2.0	mg/kg	258	249	333	210	121	47.8	54.5	88.7	68.5	69.2	94.1	110	103	100	90.2
Zirconium (Zr)	1.0	mg/kg	3.3	1.4	2.5	7.1	<1.0	4.6	2.5	4.6	4.4	6.8	9.8	1.2	9.7	<1.0	2.9

Your Project #: BIOCHAR RESEARCH
Your C.O.C. #: EB492312

Attention: Ken Nordin
LABERGE ENVIRONMENTAL SERVICES
WHITEHORSE
405 Ogilvie Street
PO Box 21072
Whitehorse, YT
CANADA Y1A 6P7

Report Date: 2012/07/13

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B256252
Received: 2012/06/29, 14:00

Sample Matrix: Soil
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Cation Exchange Capacity (1)	4	2012/07/10	2012/07/10	AB SOP-00009	SSMA 18.2, EPA 200.7
Carbon Nitrogen Ratio (1)	4	2012/07/05	2012/07/13	Calc	
Elements by ICPMS (total)	4	2012/07/05	2012/07/05	BBY7SOP-00001	EPA 6020A
Potassium (Available) (1)	4	2012/07/09	2012/07/09	AB SOP-00042	EPA 200.7
Loss on Ignition, Org. & Inorg. Residue (2)	4	N/A	2012/07/06	BBY6SOP-00040	Carter SSMA 44.3
Nitrate-N (Available) (1)	4	2012/07/09	2012/07/09	AB SOP-00023	SM 4110-B
Organic Matter - Calculated from LOI	4	N/A	2012/07/06	BBY6SOP-00040	Carter SSMA 44.3
Phosphorus (Available by ICP) (1)	4	2012/07/09	2012/07/09	AB SOP-00042	EPA 200.7
pH (2:1 DI Water Extract)	4	2012/07/05	2012/07/05	BBY6SOP-00028	Carter, SSMA 16.2
Texture by Hydrometer (1)	3	N/A	2012/07/13	AB SOP-00030	MMFSPA Ch9
Texture Class (1)	3	N/A	2012/07/13	AB SOP-00030	MMFSPA Ch9
Total Kjeldahl Nitrogen - Soil (1)	4	2012/07/13	2012/07/13	AB SOP-00008	EPA 351.1, 351.2
Organic Carbon and Organic Matter (1)	4	2012/07/11	2012/07/11	AB SOP-00012	MMFSPA Ch6

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) This test was performed by Maxxam Calgary Environmental
(2) Loss on Ignition was reported on a dry weight basis.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Tabitha Rudkin, Burnaby Project Manager
Email: TRudkin@maxxam.ca
Phone# (604) 638-2639

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

LABERGE ENVIRONMENTAL SERVICES
Client Project #: BIOCHAR RESEARCH

Maxxam Job #: B256252
Report Date: 2012/07/13

CARBON NITROGEN RATIO (TKN,TOC)

Maxxam ID		DV0612	DV0613	DV0614	DV0615		
Sampling Date		2012/06/24 12:00	2012/06/24 12:00	2012/06/26 12:00	2012/06/26 12:00		
COC Number		EB492312	EB492312	EB492312	EB492312		
	UNITS	**PESO WASTE ROCK**	**PESO TRENCHES**	**WHC A,B,C**	**MSGM A,B,C**	**RDL**	**QC Batch**
Misc. Inorganics							
Total Kjeldahl Nitrogen	mg/kg	180	98	18	18	10	6000949
Misc. Inorganics							
Carbon Nitrogen Ratio	N/A	20.1	0.000	0.000	142	N/A	5976738
Organic Matter	%	0.64	<0.35	<0.35	0.44	0.35	5991753
Total Organic Carbon (C)	%	0.37	<0.20	<0.20	0.25	0.20	5991753

RDL = Reportable Detection Limit

Maxxam Job #: B256252
Report Date: 2012/07/13

LABERGE ENVIRONMENTAL SERVICES
Client Project #: BIOCHAR RESEARCH

NPK (AVAILABLE)

Maxxam ID		DV0612	DV0613	DV0614	DV0615		
Sampling Date		2012/06/24 12:00	2012/06/24 12:00	2012/06/26 12:00	2012/06/26 12:00		
COC Number		EB492312	EB492312	EB492312	EB492312		
	UNITS	**PESO WASTE ROCK**	**PESO TRENCHES**	**WHC A,B,C**	**MSGM A,B,C**	**RDL**	**QC Batch**
Nutrients							
Available (NH4F) Nitrogen (N)	mg/kg	<2.0	<2.0	<2.0	22	2.0	5985283
Available (NH4F) Phosphorus (P)	mg/kg	2.9	1.8	<1.0	<1.0	1.0	5978596
Available (NH4OAc) Potassium (K)	mg/kg	<2.0	8.5	72	150	2.0	5978595

RDL = Reportable Detection Limit

LABERGE ENVIRONMENTAL SERVICES
Client Project #: BIOCHAR RESEARCH

Maxxam Job #: B256252
Report Date: 2012/07/13

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		DV0612	DV0613	DV0614	DV0615		
Sampling Date		2012/06/24 12:00	2012/06/24 12:00	2012/06/26 12:00	2012/06/26 12:00		
COC Number		EB492312	EB492312	EB492312	EB492312		
	UNITS	**PESO WASTE ROCK**	**PESO TRENCHES**	**WHC A,B,C**	**MSGM A,B,C**	**RDL**	**QC Batch**
Elements							
Cation exchange capacity	cmol+/Kg	<10	<10	48	38	10	5984044
Misc. Inorganics							
Organic Matter	%	6.1	4.0	2.2	1.8	1.0	5976739
Physical Properties							
% sand by hydrometer	%		70	39	23	2.0	5999590
% silt by hydrometer	%		25	48	54	2.0	5999590
Clay Content	%		5.6	12	23	2.0	5999590
Loss on Ignition	%	6.1	4.0	2.2	1.8	1.0	5978220
Texture	N/A		SANDY LOAM	LOAM	SILT LOAM	N/A	5970847

RDL = Reportable Detection Limit

Maxxam Job #: B256252
Report Date: 2012/07/13

LABERGE ENVIRONMENTAL SERVICES
Client Project #: BIOCHAR RESEARCH

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		DV0612	DV0613	DV0614	DV0615		
Sampling Date		2012/06/24 12:00	2012/06/24 12:00	2012/06/26 12:00	2012/06/26 12:00		
COC Number		EB492312	EB492312	EB492312	EB492312		
	UNITS	**PESO WASTE ROCK**	**PESO TRENCHES**	**WHC A,B,C**	**MSGM A,B,C**	**RDL**	**QC Batch**
Physical Properties							
Soluble (2:1) pH	pH Units	2.62	5.15	8.56	8.30	0.010	5974214
Total Metals by ICPMS							
Total Aluminum (Al)	mg/kg	2690	2350	10100	12200	100	5974132
Total Antimony (Sb)	mg/kg	3680	3580	1.32	1.45	0.10	5974132
Total Arsenic (As)	mg/kg	6150	9810	16.3	74.2	0.50	5974132
Total Barium (Ba)	mg/kg	46.0	46.8	90.9	31.5	0.10	5974132
Total Beryllium (Be)	mg/kg	<0.40	<0.40	<0.40	1.29	0.40	5974132
Total Bismuth (Bi)	mg/kg	527	372	9.59	0.14	0.10	5974132
Total Cadmium (Cd)	mg/kg	4.88	4.28	0.223	0.571	0.050	5974132
Total Calcium (Ca)	mg/kg	306	332	31300	35300	100	5974132
Total Chromium (Cr)	mg/kg	6.7	12.2	20.0	19.3	1.0	5974132
Total Cobalt (Co)	mg/kg	3.54	5.33	32.5	7.92	0.30	5974132
Total Copper (Cu)	mg/kg	210	75.9	2420	105	0.50	5974132
Total Iron (Fe)	mg/kg	57500	46300	143000	27900	100	5974132
Total Lead (Pb)	mg/kg	9070	7330	6.27	27.0	0.10	5974132
Total Lithium (Li)	mg/kg	<5.0	<5.0	7.3	20.7	5.0	5974132
Total Magnesium (Mg)	mg/kg	512	<100	46400	7890	100	5974132
Total Manganese (Mn)	mg/kg	927	189	803	640	0.20	5974132
Total Mercury (Hg)	mg/kg	0.796	0.410	<0.050	<0.050	0.050	5974132
Total Molybdenum (Mo)	mg/kg	0.87	0.74	36.1	3.16	0.10	5974132
Total Nickel (Ni)	mg/kg	9.06	12.0	13.9	3.14	0.80	5974132
Total Phosphorus (P)	mg/kg	500	623	527	738	10	5974132
Total Potassium (K)	mg/kg	475	340	2020	839	100	5974132
Total Selenium (Se)	mg/kg	19.3	12.7	1.01	1.13	0.50	5974132
Total Silver (Ag)	mg/kg	89.4	103	2.57	1.21	0.050	5974132
Total Sodium (Na)	mg/kg	<100	<100	104	468	100	5974132
Total Strontium (Sr)	mg/kg	114	134	88.9	77.4	0.10	5974132
Total Thallium (Tl)	mg/kg	0.259	0.169	0.064	0.077	0.050	5974132
Total Tin (Sn)	mg/kg	35.0	38.8	0.75	0.52	0.10	5974132
Total Titanium (Ti)	mg/kg	31.1	5.8	380	549	1.0	5974132
Total Uranium (U)	mg/kg	3.73	4.81	3.31	0.419	0.050	5974132
Total Vanadium (V)	mg/kg	9.8	12.2	43.3	32.0	2.0	5974132

RDL = Reportable Detection Limit

Maxxam Job #: B256252
Report Date: 2012/07/13

LABERGE ENVIRONMENTAL SERVICES
Client Project #: BIOCHAR RESEARCH

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		DV0612	DV0613	DV0614	DV0615		
Sampling Date		2012/06/24 12:00	2012/06/24 12:00	2012/06/26 12:00	2012/06/26 12:00		
COC Number		EB492312	EB492312	EB492312	EB492312		
	UNITS	**PESO WASTE ROCK**	**PESO TRENCHES**	**WHC A,B,C**	**MSGM A,B,C**	**RDL**	**QC Batch**
Total Zinc (Zn)	mg/kg	252	129	59.7	135	1.0	5974132
Total Zirconium (Zr)	mg/kg	9.15	9.77	3.24	6.91	0.50	5974132

RDL = Reportable Detection Limit

LABERGE ENVIRONMENTAL SERVICES
Client Project #: BIOCHAR RESEARCH

Maxxam Job #: B256252
Report Date: 2012/07/13

General Comments

Results relate only to the items tested.

LABERGE ENVIRONMENTAL SERVICES
Attention: Ken Nordin
Client Project #: BIOCHAR RESEARCH
P.O. #:
Site Location:

Quality Assurance Report

Maxxam Job Number: VB256252

QA/QC Batch Num	Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	UNITS	QC Limits
5974132	DJ	Matrix Spike	Total Antimony (Sb)	2012/07/05		94	%	75 - 125
			Total Arsenic (As)	2012/07/05		99	%	75 - 125
			Total Barium (Ba)	2012/07/05		NC	%	75 - 125
			Total Beryllium (Be)	2012/07/05		105	%	75 - 125
			Total Cadmium (Cd)	2012/07/05		100	%	75 - 125
			Total Chromium (Cr)	2012/07/05		97	%	75 - 125
			Total Cobalt (Co)	2012/07/05		99	%	75 - 125
			Total Copper (Cu)	2012/07/05		90	%	75 - 125
			Total Lead (Pb)	2012/07/05		97	%	75 - 125
			Total Lithium (Li)	2012/07/05		102	%	75 - 125
			Total Manganese (Mn)	2012/07/05		NC	%	75 - 125
			Total Mercury (Hg)	2012/07/05		106	%	75 - 125
			Total Molybdenum (Mo)	2012/07/05		100	%	75 - 125
			Total Nickel (Ni)	2012/07/05		89	%	75 - 125
			Total Selenium (Se)	2012/07/05		102	%	75 - 125
			Total Silver (Ag)	2012/07/05		98	%	75 - 125
			Total Strontium (Sr)	2012/07/05		97	%	75 - 125
			Total Thallium (Tl)	2012/07/05		101	%	75 - 125
			Total Tin (Sn)	2012/07/05		95	%	75 - 125
			Total Titanium (Ti)	2012/07/05		NC	%	75 - 125
			Total Uranium (U)	2012/07/05		99	%	75 - 125
			Total Vanadium (V)	2012/07/05		NC	%	75 - 125
			Total Zinc (Zn)	2012/07/05		NC	%	75 - 125
		QC Standard	Total Aluminum (Al)	2012/07/05		100	%	70 - 130
			Total Antimony (Sb)	2012/07/05		86	%	70 - 130
			Total Arsenic (As)	2012/07/05		89	%	70 - 130
			Total Barium (Ba)	2012/07/05		96	%	70 - 130
			Total Cadmium (Cd)	2012/07/05		91	%	70 - 130
			Total Calcium (Ca)	2012/07/05		89	%	70 - 130
			Total Chromium (Cr)	2012/07/05		98	%	70 - 130
			Total Cobalt (Co)	2012/07/05		87	%	70 - 130
			Total Copper (Cu)	2012/07/05		72	%	70 - 130
			Total Iron (Fe)	2012/07/05		92	%	70 - 130
			Total Lead (Pb)	2012/07/05		94	%	70 - 130
			Total Magnesium (Mg)	2012/07/05		88	%	70 - 130
			Total Manganese (Mn)	2012/07/05		93	%	70 - 130
			Total Mercury (Hg)	2012/07/05		114	%	70 - 130
			Total Molybdenum (Mo)	2012/07/05		91	%	70 - 130
			Total Nickel (Ni)	2012/07/05		72	%	70 - 130
			Total Phosphorus (P)	2012/07/05		87	%	70 - 130
			Total Strontium (Sr)	2012/07/05		82	%	70 - 130
			Total Thallium (Tl)	2012/07/05		90	%	70 - 130
			Total Titanium (Ti)	2012/07/05		105	%	70 - 130
			Total Uranium (U)	2012/07/05		82	%	70 - 130
			Total Vanadium (V)	2012/07/05		99	%	70 - 130
			Total Zinc (Zn)	2012/07/05		72	%	70 - 130
		Spiked Blank	Total Antimony (Sb)	2012/07/05		97	%	75 - 125
			Total Arsenic (As)	2012/07/05		98	%	75 - 125
			Total Barium (Ba)	2012/07/05		97	%	75 - 125
			Total Beryllium (Be)	2012/07/05		104	%	75 - 125
			Total Cadmium (Cd)	2012/07/05		101	%	75 - 125
			Total Chromium (Cr)	2012/07/05		97	%	75 - 125
			Total Cobalt (Co)	2012/07/05		99	%	75 - 125
			Total Copper (Cu)	2012/07/05		100	%	75 - 125
			Total Lead (Pb)	2012/07/05		96	%	75 - 125

LABERGE ENVIRONMENTAL SERVICES
Attention: Ken Nordin
Client Project #: BIOCHAR RESEARCH
P.O. #:
Site Location:

Quality Assurance Report (Continued)

Maxxam Job Number: VB256252

QA/QC Batch Num	Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	UNITS	QC Limits
5974132	DJ	Spiked Blank	Total Lithium (Li)	2012/07/05		98	%	75 - 125
			Total Manganese (Mn)	2012/07/05		95	%	75 - 125
			Total Mercury (Hg)	2012/07/05		106	%	75 - 125
			Total Molybdenum (Mo)	2012/07/05		97	%	75 - 125
			Total Nickel (Ni)	2012/07/05		97	%	75 - 125
			Total Selenium (Se)	2012/07/05		102	%	75 - 125
			Total Silver (Ag)	2012/07/05		97	%	75 - 125
			Total Strontium (Sr)	2012/07/05		95	%	75 - 125
			Total Thallium (Tl)	2012/07/05		93	%	75 - 125
			Total Tin (Sn)	2012/07/05		93	%	75 - 125
			Total Titanium (Ti)	2012/07/05		95	%	75 - 125
			Total Uranium (U)	2012/07/05		95	%	75 - 125
			Total Vanadium (V)	2012/07/05		96	%	75 - 125
			Total Zinc (Zn)	2012/07/05		104	%	75 - 125
		Method Blank	Total Aluminum (Al)	2012/07/05	<100		mg/kg	
			Total Antimony (Sb)	2012/07/05	<0.10		mg/kg	
			Total Arsenic (As)	2012/07/05	<0.50		mg/kg	
			Total Barium (Ba)	2012/07/05	<0.10		mg/kg	
			Total Beryllium (Be)	2012/07/05	<0.40		mg/kg	
			Total Bismuth (Bi)	2012/07/05	<0.10		mg/kg	
			Total Cadmium (Cd)	2012/07/05	<0.050		mg/kg	
			Total Calcium (Ca)	2012/07/05	<100		mg/kg	
			Total Chromium (Cr)	2012/07/05	<1.0		mg/kg	
			Total Cobalt (Co)	2012/07/05	<0.30		mg/kg	
			Total Copper (Cu)	2012/07/05	<0.50		mg/kg	
			Total Iron (Fe)	2012/07/05	<100		mg/kg	
			Total Lead (Pb)	2012/07/05	<0.10		mg/kg	
			Total Lithium (Li)	2012/07/05	<5.0		mg/kg	
			Total Magnesium (Mg)	2012/07/05	<100		mg/kg	
			Total Manganese (Mn)	2012/07/05	<0.20		mg/kg	
			Total Mercury (Hg)	2012/07/05	<0.050		mg/kg	
			Total Molybdenum (Mo)	2012/07/05	<0.10		mg/kg	
			Total Nickel (Ni)	2012/07/05	<0.80		mg/kg	
			Total Phosphorus (P)	2012/07/05	<10		mg/kg	
			Total Potassium (K)	2012/07/05	<100		mg/kg	
			Total Selenium (Se)	2012/07/05	<0.50		mg/kg	
			Total Silver (Ag)	2012/07/05	<0.050		mg/kg	
			Total Sodium (Na)	2012/07/05	<100		mg/kg	
			Total Strontium (Sr)	2012/07/05	<0.10		mg/kg	
			Total Thallium (Tl)	2012/07/05	<0.050		mg/kg	
			Total Tin (Sn)	2012/07/05	<0.10		mg/kg	
			Total Titanium (Ti)	2012/07/05	<1.0		mg/kg	
			Total Uranium (U)	2012/07/05	<0.050		mg/kg	
			Total Vanadium (V)	2012/07/05	<2.0		mg/kg	
			Total Zinc (Zn)	2012/07/05	<1.0		mg/kg	
			Total Zirconium (Zr)	2012/07/05	<0.50		mg/kg	
		RPD	Total Aluminum (Al)	2012/07/05	3.5		%	35
			Total Antimony (Sb)	2012/07/05	NC		%	30
			Total Arsenic (As)	2012/07/05	2.1		%	30
			Total Barium (Ba)	2012/07/05	23.3		%	35
			Total Beryllium (Be)	2012/07/05	NC		%	30
			Total Bismuth (Bi)	2012/07/05	NC		%	30
			Total Cadmium (Cd)	2012/07/05	NC		%	30
			Total Calcium (Ca)	2012/07/05	2.1		%	30
			Total Chromium (Cr)	2012/07/05	3.1		%	30

LABERGE ENVIRONMENTAL SERVICES
Attention: Ken Nordin
Client Project #: BIOCHAR RESEARCH
P.O. #:
Site Location:

Quality Assurance Report (Continued)

Maxxam Job Number: VB256252

QA/QC Batch Num	Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	UNITS	QC Limits
5974132	DJ	RPD	Total Cobalt (Co)	2012/07/05	0.5		%	30
			Total Copper (Cu)	2012/07/05	4.5		%	30
			Total Iron (Fe)	2012/07/05	0.2		%	30
			Total Lead (Pb)	2012/07/05	4.7		%	35
			Total Lithium (Li)	2012/07/05	NC		%	30
			Total Magnesium (Mg)	2012/07/05	4.3		%	30
			Total Manganese (Mn)	2012/07/05	1.7		%	30
			Total Mercury (Hg)	2012/07/05	NC		%	35
			Total Molybdenum (Mo)	2012/07/05	NC		%	35
			Total Nickel (Ni)	2012/07/05	2.2		%	30
			Total Phosphorus (P)	2012/07/05	3.0		%	30
			Total Potassium (K)	2012/07/05	5.4		%	35
			Total Selenium (Se)	2012/07/05	NC		%	30
			Total Silver (Ag)	2012/07/05	NC		%	35
			Total Sodium (Na)	2012/07/05	NC		%	35
			Total Strontium (Sr)	2012/07/05	12.8		%	35
			Total Thallium (Tl)	2012/07/05	NC		%	30
			Total Tin (Sn)	2012/07/05	NC		%	35
			Total Titanium (Ti)	2012/07/05	2.2		%	35
			Total Uranium (U)	2012/07/05	NC		%	30
			Total Vanadium (V)	2012/07/05	4.4		%	30
			Total Zinc (Zn)	2012/07/05	0.6		%	30
			Total Zirconium (Zr)	2012/07/05	NC		%	30
5974214	NS6	Spiked Blank	Soluble (2:1) pH	2012/07/05		101	%	96 - 104
		RPD	Soluble (2:1) pH	2012/07/05	0.5		%	20
5978220	JGD	Method Blank	Loss on Ignition	2012/07/06	<1.0		%	
		RPD [DV0615-01]	Loss on Ignition	2012/07/06	NC		%	35
5978595	PL	Spiked Blank	Available (NH4OAc) Potassium (K)	2012/07/09		95	%	80 - 120
		Method Blank	Available (NH4OAc) Potassium (K)	2012/07/09	<2.0		mg/kg	
		RPD	Available (NH4OAc) Potassium (K)	2012/07/09	0.4		%	35
5978596	PL	Spiked Blank	Available (NH4F) Phosphorus (P)	2012/07/09		101	%	80 - 120
		Method Blank	Available (NH4F) Phosphorus (P)	2012/07/09	<1.0		mg/kg	
		RPD	Available (NH4F) Phosphorus (P)	2012/07/09	NC		%	35
5984044	DL6	RPD [DV0612-02]	Cation exchange capacity	2012/07/10	NC		%	35
5985283	RP0	Matrix Spike	Available (NH4F) Nitrogen (N)	2012/07/09		100	%	80 - 120
		Spiked Blank	Available (NH4F) Nitrogen (N)	2012/07/09		98	%	90 - 110
		Method Blank	Available (NH4F) Nitrogen (N)	2012/07/09	<2.0		mg/kg	
		RPD	Available (NH4F) Nitrogen (N)	2012/07/09	NC		%	35
5991753	DL6	QC Standard	Organic Matter	2012/07/11		94	%	83 - 118
			Total Organic Carbon (C)	2012/07/11		94	%	83 - 118
		RPD [DV0613-02]	Organic Matter	2012/07/11	NC		%	35
			Total Organic Carbon (C)	2012/07/11	NC		%	35
5999590	KVD	QC Standard	% sand by hydrometer	2012/07/13		99	%	88 - 112
			% silt by hydrometer	2012/07/13		101	%	85 - 115
			Clay Content	2012/07/13		100	%	79 - 121
		RPD	% sand by hydrometer	2012/07/13	4.2		%	35
			% silt by hydrometer	2012/07/13	7.6		%	35
			Clay Content	2012/07/13	15.7		%	35
6000949	IA0	Matrix Spike [DV0615-02]	Total Kjeldahl Nitrogen	2012/07/13		90	%	75 - 125
		QC Standard	Total Kjeldahl Nitrogen	2012/07/13		90	%	75 - 125
		Spiked Blank	Total Kjeldahl Nitrogen	2012/07/13		105	%	75 - 125
		Method Blank	Total Kjeldahl Nitrogen	2012/07/13	<10		mg/kg	
		RPD [DV0615-02]	Total Kjeldahl Nitrogen	2012/07/13	NC		%	35

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

LABERGE ENVIRONMENTAL SERVICES
Attention: Ken Nordin
Client Project #: BIOCHAR RESEARCH
P.O. #:
Site Location:

Quality Assurance Report (Continued)

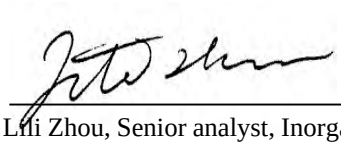
Maxxam Job Number: VB256252

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Spiked Blank: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Validation Signature Page

Maxxam Job #: B256252

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Lili Zhou, Senior analyst, Inorganic department.

Rob Reinert, Data Validation Coordinator

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Maxxam Job #: B256252 COC #: EB492312 Click here to get the COC number Page: 1 of 1

Invoice To: Require Report? Yes ☐ No ☐

Company Name: Laberge Environmental Services
Contact Name: Ken Nordin
Address: Box 21072 Whitehorse Yukon PC: Y1A 6P7
Phone / Fax#: Ph: 867 668 6838 Fax: 867 667 6956
E-mail

Report To:

Company Name: same
Contact Name:
Address: PC:
Phone / Fax#: Ph: Fax:
E-mail

PO #:
Quotation #:
Project # : Biochar Research
Proj. Name:
Location:
Sampled by: Ken Nordin

REGULATORY REQUIREMENTS:

☐ CSR
☐ CCME
☐ BC Water Quality
☐ Other
☐ DRINKING WATER

SERVICE REQUESTED:

◉ Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

Lab Use Only

	* Sample Identification	Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) Y☐N☐	Field Filtered? Y☐N☐	Total Metals Y☐N☐	Field Acidified? Y☐N☐	Cation Exchange Capacity (CEC)	Water Holding Capacity	% Organic Matter	metals	NPK (Nutrients)	pH	Particle size	C:N Ratio	Number of Containers
1	Peso Waste Rock	DV0612		12/06/24 12:00					x	x	x	x	x	x	x	x	
2	Peso Trenches	DV0613		12/06/24 12:00					x	x	x	x	x	x	x	x	
3	WHC A,B,C	DV0614		12/06/26 12:00					x	x	x	x	x	x	x	x	
4	MSGM A,B,C	DV0615		12/06/26 12:00					x	x	x	x	x	x	x	x	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	

Ken Nordin:
Please Homogenize WHC and MSGM jars A, B and C to form single sample for each.

B256252

Print name and sign

Print name and sign

Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by :	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Ken Nordin	12/06/28	17:00	Noelle Laurel Bertrier	2012/06/29	14:00	☐	A) 18 B) 17 C) 18	Present?	☐	☑
							Just sampled & rec'd on ice: ☐	Intact?	☐	☐ N/A

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

STRATAGOLD CORPORATION
ATTN: Hugh Coyle
Suite 1000 - 1050 W. Pender St
Vancouver BC V6E 3S7

Date Received: 01-AUG-18
Report Date: 29-AUG-18 12:31 (MT)
Version: FINAL

Client Phone: 604-682-5122

Certificate of Analysis

Lab Work Order #: L2139940

Project P.O. #: NOT SUBMITTED
Job Reference: EAGLE GOLD
C of C Numbers:
Legal Site Desc: Victoria Gold Corp.

Heather McKenzie
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2139940-1	L2139940-2	L2139940-3	L2139940-4	L2139940-5
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
Sampled Time					
Client ID	T1-1AB	T1-2AB	T1-3	T2-1AB	T2-2
Grouping / **Analyte**					
SOIL					
Physical Tests Loss on Ignition @ 375 C (%)	1.2	3.1	3.6	1.3	1.3
Organic Matter (%)	1.2	2.7	3.1	1.3	1.3
pH (1:2 soil:water) (pH)	6.30	7.17	6.74	5.88	7.12
Particle Size % Sand (2.0mm - 0.05mm) (%)	83.3	83.8	82.5	65.0	65.7
% Silt (0.05mm - 2um) (%)	15.3	14.1	15.7	28.9	28.6
% Clay (<2um) (%)	1.4	2.1	1.7	6.1	5.7
Texture	Loamy sand	Loamy sand	Loamy sand	Sandy loam	Sandy loam
Leachable Anions & Nutrients Total Kjeldahl Nitrogen (%)	0.069	0.118	0.132	0.059	0.064
Organic / Inorganic Carbon C:N Ratio	5.8:1	15.7:1	14.5:1	7:1	8.9:1
Total Carbon by Combustion (%)	0.40	1.86	1.91	0.42	0.57
Plant Available Nutrients Available Ammonium-N (mg/kg)	1.8	2.5	3.1	2.0	2.3
Calcium (Ca) (meq/100g)	0.92	5.33	3.74	0.74	2.26
Magnesium (Mg) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
Available Phosphate-P (mg/kg)	3.4	46.9 DLHC	17.9	<2.0	6.8
Available Potassium (mg/kg)	24	51	51	30	39
Potassium (K) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
Sodium (Na) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
Metals Aluminum (Al) (mg/kg)	3220	2050	1630	3440	3390
Antimony (Sb) (mg/kg)	3750	818	6410	2360	492
Arsenic (As) (mg/kg)	6380	2190	2690	5810	1490
Barium (Ba) (mg/kg)	47.2	32.6	35.6	70.3	65.7
Beryllium (Be) (mg/kg)	0.13	<0.10	<0.10	0.13	0.11
Bismuth (Bi) (mg/kg)	145	26.1	236	504	53.5
Boron (B) (mg/kg)	10.0	<5.0	7.1	7.4	<5.0
Cadmium (Cd) (mg/kg)	4.08	0.427	3.26	3.89	0.564
Calcium (Ca) (mg/kg)	578	1830	3890	947	1180
Chromium (Cr) (mg/kg)	16.6	7.83	5.92	7.33	7.84
Cobalt (Co) (mg/kg)	7.91	4.18	2.26	2.93	2.84
Copper (Cu) (mg/kg)	132	55.6	29.8	74.3	50.9
Iron (Fe) (mg/kg)	56700	31900	17900	51100	28400
Lead (Pb) (mg/kg)	7790	1440	3670	4700	1160
Lithium (Li) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Magnesium (Mg) (mg/kg)	94	312	475	81	84
Manganese (Mn) (mg/kg)	278	290	131	277	142
Mercury (Hg) (mg/kg)	0.227	0.169	0.468	0.358	0.146

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2139940-6	L2139940-7	L2139940-8	L2139940-9	L2139940-10
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
Sampled Time					
Client ID	T2-3A	T3-1	T3-2AB	T3-3AB	W1-1
Grouping / **Analyte**					
SOIL					
Physical Tests Loss on Ignition @ 375 C (%)	1.4	2.3	3.3	3.5	2.0
Organic Matter (%)	1.4	2.0	2.9	3.0	1.8
pH (1:2 soil:water) (pH)	6.12	5.17	5.75	6.79	3.04
Particle Size % Sand (2.0mm - 0.05mm) (%)	65.2	60.9	64.2	58.0	59.4
% Silt (0.05mm - 2um) (%)	28.3	34.7	31.0	37.9	36.4
% Clay (<2um) (%)	6.5	4.4	4.7	4.1	4.2
Texture	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Leachable Anions & Nutrients Total Kjeldahl Nitrogen (%)	0.063	0.070	0.077	0.088	0.062
Organic / Inorganic Carbon C:N Ratio	6.8:1	7.2:1	20.1:1	17.5:1	10.5:1
Total Carbon by Combustion (%)	0.43	0.50	1.55	1.53	0.64
Plant Available Nutrients Available Ammonium-N (mg/kg)	1.4	1.7	2.6	2.5	4.1
Calcium (Ca) (meq/100g)	1.20	<0.50	3.97	4.48	<0.50
Magnesium (Mg) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
Available Phosphate-P (mg/kg)	<2.0	2.3	15.2	24.2	2.2
Available Potassium (mg/kg)	29	31	40	46	27
Potassium (K) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
Sodium (Na) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
Metals Aluminum (Al) (mg/kg)	4620	3030	3670	2670	7160
Antimony (Sb) (mg/kg)	369	4590	1450	2330	1280
Arsenic (As) (mg/kg)	1730	11400	4410	10600	3750
Barium (Ba) (mg/kg)	91.3	42.3	40.6	38.6	116
Beryllium (Be) (mg/kg)	0.15	0.12	0.13	<0.10	0.20
Bismuth (Bi) (mg/kg)	30.5	320	91.5	222	110
Boron (B) (mg/kg)	8.2	7.4	<5.0	<5.0	<5.0
Cadmium (Cd) (mg/kg)	0.482	6.21	1.53	3.91	1.85
Calcium (Ca) (mg/kg)	1330	334	634	1190	452
Chromium (Cr) (mg/kg)	10.6	11.2	10.1	13.8	14.2
Cobalt (Co) (mg/kg)	3.44	5.08	4.21	6.24	9.72
Copper (Cu) (mg/kg)	73.3	170	92.7	121	145
Iron (Fe) (mg/kg)	39300	43100	36000	42900	46500
Lead (Pb) (mg/kg)	1260	8680	3200	4890	1870
Lithium (Li) (mg/kg)	<2.0	<2.0	<2.0	<2.0	7.5
Magnesium (Mg) (mg/kg)	92	131	354	193	2250
Manganese (Mn) (mg/kg)	199	184	170	214	272
Mercury (Hg) (mg/kg)	0.193	0.700	0.571	0.924	0.0935

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2139940-11	L2139940-12	L2139940-13	L2139940-14	L2139940-15
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
Sampled Time					
Client ID	W1-2	W1-3	W1-4	W1-5	W2-1
Grouping / **Analyte**					
SOIL					
Physical Tests Loss on Ignition @ 375 C (%)	2.3	4.4	3.0	9.2	1.4
Organic Matter (%)	2.1	3.7	2.6	7.5	1.4
pH (1:2 soil:water) (pH)	4.81	3.25	4.10	5.71	2.75
Particle Size % Sand (2.0mm - 0.05mm) (%)	69.2	80.3	82.3	75.5	37.4
% Silt (0.05mm - 2um) (%)	27.2	17.2	16.0	20.8	59.4
% Clay (<2um) (%)	3.6	2.4	1.7	3.7	3.1
Texture	Sandy loam	Loamy sand	Loamy sand	Loamy sand	Silt loam
Leachable Anions & Nutrients Total Kjeldahl Nitrogen (%)	0.073	0.095	0.115	0.152	0.023
Organic / Inorganic Carbon C:N Ratio	12.2:1	30.7:1	11.5:1	37.6:1	15.1:1
Total Carbon by Combustion (%)	0.89	2.91	1.33	5.72	0.34
Plant Available Nutrients Available Ammonium-N (mg/kg)	3.4	3.6	3.3	6.3	2.2
Calcium (Ca) (meq/100g)	1.27	<0.50	0.75	11.2	<0.50
Magnesium (Mg) (meq/100g)	<0.50	<0.50	<0.50	2.26	<0.50
Available Phosphate-P (mg/kg)	5.7	6.4	<2.0	15.6	<2.0
Available Potassium (mg/kg)	23	<20	25	45	<20
Potassium (K) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
Sodium (Na) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
Metals Aluminum (Al) (mg/kg)	5840	4990	3550	2780	4540
Antimony (Sb) (mg/kg)	542	241	838	3350	1110
Arsenic (As) (mg/kg)	3220	2140	3610	3130	1470
Barium (Ba) (mg/kg)	72.0	44.3	24.3	46.3	158
Beryllium (Be) (mg/kg)	0.18	0.20	0.18	0.13	0.13
Bismuth (Bi) (mg/kg)	66.5	21.2	73.4	313	43.5
Boron (B) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
Cadmium (Cd) (mg/kg)	1.29	1.61	1.95	2.40	0.291
Calcium (Ca) (mg/kg)	1150	296	4040	28500	756
Chromium (Cr) (mg/kg)	12.2	11.9	9.60	5.22	10.4
Cobalt (Co) (mg/kg)	11.6	22.5	14.0	2.54	3.00
Copper (Cu) (mg/kg)	172	120	214	229	88.0
Iron (Fe) (mg/kg)	45400	50500	48600	27200	38500
Lead (Pb) (mg/kg)	4570	391	1380	6770	1600
Lithium (Li) (mg/kg)	5.8	5.3	3.2	<2.0	4.7
Magnesium (Mg) (mg/kg)	1820	1620	3190	14800	1410
Manganese (Mn) (mg/kg)	238	320	225	207	112
Mercury (Hg) (mg/kg)	0.0853	0.0327	0.105	0.654	0.0933

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2139940-16 Soil 31-JUL-18 W2-2	L2139940-17 Soil 31-JUL-18 W2-3	L2139940-18 Soil 31-JUL-18 W2-4	L2139940-19 Soil 31-JUL-18 W2-5	L2139940-20 Soil 31-JUL-18 W3-1
SOIL						
Physical Tests	Loss on Ignition @ 375 C (%)	1.5	3.0	4.8	1.9	1.6
	Organic Matter (%)	1.5	2.6	4.1	1.7	1.5
	pH (1:2 soil:water) (pH)	3.11	3.04	3.28	2.84	2.32
Particle Size	% Sand (2.0mm - 0.05mm) (%)	42.6	87.1	73.2	71.2	53.3
	% Silt (0.05mm - 2um) (%)	55.6	11.2	23.6	22.4	40.5
	% Clay (<2um) (%)	1.8	1.7	3.2	6.3	6.2
	Texture	Silt loam	Sand	Sandy loam / Loamy sand	Sandy loam	Sandy loam
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.033	0.063	0.096	0.046	0.061
Organic / Inorganic Carbon	C:N Ratio	12.9:1	15.6:1	24:1	5.7:1	8.7:1
	Total Carbon by Combustion (%)	0.42	0.99	2.31	0.26	0.53
Plant Available Nutrients	Available Ammonium-N (mg/kg)	1.8	2.9	4.5	2.8	6.9
	Calcium (Ca) (meq/100g)	<0.50	<0.50	2.84	<0.50	<0.50
	Magnesium (Mg) (meq/100g)	<0.50	<0.50	0.90	<0.50	<0.50
	Available Phosphate-P (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Available Potassium (mg/kg)	<20	<20	32	<20	<20
	Potassium (K) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
	Sodium (Na) (meq/100g)	<0.50	<0.50	<0.50	<0.50	<0.50
Metals	Aluminum (Al) (mg/kg)	5820	4920	5080	4590	3390
	Antimony (Sb) (mg/kg)	333	1320	2100	2360	2940
	Arsenic (As) (mg/kg)	1240	2530	2980	2260	3010
	Barium (Ba) (mg/kg)	196	102	134	86.8	116
	Beryllium (Be) (mg/kg)	0.13	0.27	0.22	0.27	0.14
	Bismuth (Bi) (mg/kg)	12.1	132	252	422	246
	Boron (B) (mg/kg)	<5.0	<5.0	<5.0	5.2	<5.0
	Cadmium (Cd) (mg/kg)	0.253	0.442	0.633	0.996	1.81
	Calcium (Ca) (mg/kg)	1160	899	1540	1390	222
	Chromium (Cr) (mg/kg)	13.9	8.69	8.62	6.91	10.6
	Cobalt (Co) (mg/kg)	4.69	2.24	2.38	1.39	5.39
	Copper (Cu) (mg/kg)	59.4	194	194	180	250
	Iron (Fe) (mg/kg)	33500	53900	48900	45100	37100
	Lead (Pb) (mg/kg)	331	2220	3590	4860	3810
	Lithium (Li) (mg/kg)	6.9	2.2	2.2	<2.0	2.4
	Magnesium (Mg) (mg/kg)	2350	307	731	212	622
	Manganese (Mn) (mg/kg)	179	83.4	86.7	66.9	129
	Mercury (Hg) (mg/kg)	0.0465	0.182	0.361	0.302	0.207

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2139940-21	L2139940-22	L2139940-23	L2139940-24	
Description	Soil	Soil	Soil	Soil	
Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	
Sampled Time					
Client ID	W3-2	W3-3	W3-4	W3-5	
Grouping	**Analyte**				
SOIL					
Physical Tests	Loss on Ignition @ 375 C (%)	6.1	8.0	9.5	7.9	
	Organic Matter (%)	5.0	6.5	7.7	6.5	
	pH (1:2 soil:water) (pH)	2.41	1.77	4.32	2.20	
Particle Size	% Sand (2.0mm - 0.05mm) (%)	69.2	63.7	68.6	68.8	
	% Silt (0.05mm - 2um) (%)	25.4	28.6	26.9	25.0	
	% Clay (<2um) (%)	5.4	7.6	4.5	6.2	
	Texture	Sandy loam	Sandy loam	Sandy loam	Sandy loam	
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.135	0.150	0.175	0.140	
Organic / Inorganic Carbon	C:N Ratio	21.9:1	27.6:1	32.4:1	32:1	
	Total Carbon by Combustion (%)	2.95	4.16 DLHC	5.66	4.47	
Plant Available Nutrients	Available Ammonium-N (mg/kg)	13.6	18.6	7.5	11.5	
	Calcium (Ca) (meq/100g)	<0.50	<0.50	3.60	19.4	
	Magnesium (Mg) (meq/100g)	<0.50	<0.50	1.96	2.12	
	Available Phosphate-P (mg/kg)	4.4	<2.0	<2.0	<2.0	
	Available Potassium (mg/kg)	<20	20	<20	<20	
	Potassium (K) (meq/100g)	<0.50	<0.50	<0.50	<0.50	
	Sodium (Na) (meq/100g)	<0.50	<0.50	<0.50	<0.50	
Metals	Aluminum (Al) (mg/kg)	2930	3100	3760	2710	
	Antimony (Sb) (mg/kg)	7690	6020	5920	7140	
	Arsenic (As) (mg/kg)	6500	7950	9810	10900	
	Barium (Ba) (mg/kg)	47.3	53.7	60.5	48.1	
	Beryllium (Be) (mg/kg)	0.16	0.17	0.17	0.11	
	Bismuth (Bi) (mg/kg)	1020	975	822	1250	
	Boron (B) (mg/kg)	6.7	5.8	<5.0	5.8	
	Cadmium (Cd) (mg/kg)	5.74	6.59	6.44	6.31	
	Calcium (Ca) (mg/kg)	446	571	9170	2290	
	Chromium (Cr) (mg/kg)	9.91	9.40	12.0	7.89	
	Cobalt (Co) (mg/kg)	1.80	1.82	3.01	2.13	
	Copper (Cu) (mg/kg)	299	314	433	400	
	Iron (Fe) (mg/kg)	35800	32300	54300	70100	
	Lead (Pb) (mg/kg)	14300	12800	10700	16600	
	Lithium (Li) (mg/kg)	<2.0	<2.0	<2.0	<2.0	
	Magnesium (Mg) (mg/kg)	262	105	5180	1380	
	Manganese (Mn) (mg/kg)	94.8	81.8	132	108	
	Mercury (Hg) (mg/kg)	0.701	1.05	0.797	0.706	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2139940-1	L2139940-2	L2139940-3	L2139940-4	L2139940-5
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
Sampled Time					
Client ID	T1-1AB	T1-2AB	T1-3	T2-1AB	T2-2
Grouping / **Analyte**					
SOIL					
Metals Molybdenum (Mo) (mg/kg)	1.45	1.36	1.05	0.85	1.31
Nickel (Ni) (mg/kg)	20.3	11.5	5.92	5.34	5.52
Phosphorus (P) (mg/kg)	581	500	452	1170	1200
Potassium (K) (mg/kg)	580	460	320	670	630
Selenium (Se) (mg/kg)	5.62	1.70	6.76	9.01	1.98
Silver (Ag) (mg/kg)	>165	15.8	>126	50.7	8.51
Sodium (Na) (mg/kg)	<50	<50	<50	<50	<50
Strontium (Sr) (mg/kg)	93.0	35.7	32.6	337	349
Sulfur (S) (mg/kg)	1500	<1000	<1000	1700	<1000
Thallium (Tl) (mg/kg)	0.262	0.149	0.147	0.282	0.118
Tin (Sn) (mg/kg)	51.0	16.5	24.7	41.3	17.2
Titanium (Ti) (mg/kg)	22.3	28.9	38.7	19.5	<16 DLM
Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Uranium (U) (mg/kg)	14.3	1.72	4.75	6.05	2.17
Vanadium (V) (mg/kg)	18.6	10.4	6.31	10.7	8.41
Zinc (Zn) (mg/kg)	354	142	70.4	117	85.5
Zirconium (Zr) (mg/kg)	12.0	3.8	2.1	7.4	7.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2139940-6	L2139940-7	L2139940-8	L2139940-9	L2139940-10
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
Sampled Time					
Client ID	T2-3A	T3-1	T3-2AB	T3-3AB	W1-1
Grouping / **Analyte**					
SOIL					
Metals Molybdenum (Mo) (mg/kg)	1.05	0.79	1.15	1.27	0.78
Nickel (Ni) (mg/kg)	7.03	9.32	8.65	15.1	27.6
Phosphorus (P) (mg/kg)	1480	534	333	484	461
Potassium (K) (mg/kg)	790	520	470	590	640
Selenium (Se) (mg/kg)	1.68	9.01	3.54	6.42	3.93
Silver (Ag) (mg/kg)	7.37	38.0	18.3	35.8	17.6
Sodium (Na) (mg/kg)	<50	<50	<50	<50	149
Strontium (Sr) (mg/kg)	483	108	57.1	79.5	26.0
Sulfur (S) (mg/kg)	<1000	2000	1100	1600	2900
Thallium (Tl) (mg/kg)	0.116	0.263	0.180	0.189	<0.10 DLM
Tin (Sn) (mg/kg)	18.0	201	38.3	105	6.9
Titanium (Ti) (mg/kg)	18.4	17.3	37.1	<19 DLM	99.7
Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Uranium (U) (mg/kg)	2.17	3.49	2.06	3.12	2.41
Vanadium (V) (mg/kg)	11.7	10.5	12.7	13.3	19.5
Zinc (Zn) (mg/kg)	113	112	95.0	107	258
Zirconium (Zr) (mg/kg)	6.2	10.4	8.7	10.2	3.3

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2139940-11 Soil 31-JUL-18 W1-2	L2139940-12 Soil 31-JUL-18 W1-3	L2139940-13 Soil 31-JUL-18 W1-4	L2139940-14 Soil 31-JUL-18 W1-5	L2139940-15 Soil 31-JUL-18 W2-1
SOIL						
Metals	Molybdenum (Mo) (mg/kg)	1.60	1.69	1.04	2.20	0.77
	Nickel (Ni) (mg/kg)	27.6	48.7	34.2	7.42	8.91
	Phosphorus (P) (mg/kg)	827	594	410	914	561
	Potassium (K) (mg/kg)	580	420	400	700	970
	Selenium (Se) (mg/kg)	5.46	1.04	4.02	12.2	2.46
	Silver (Ag) (mg/kg)	18.9	3.50	16.3	62.9	19.5
	Sodium (Na) (mg/kg)	184	73	<50	55	392
	Strontium (Sr) (mg/kg)	32.8	13.3	17.8	193	90.6
	Sulfur (S) (mg/kg)	3400	1600	2400	6700	6300
	Thallium (Tl) (mg/kg)	<0.15 DLM	0.062	<0.10 DLM	<0.35 DLM	0.151
	Tin (Sn) (mg/kg)	7.6	2.6	7.6	33.2	11.3
	Titanium (Ti) (mg/kg)	75.9	49.8	26.8	<31 DLM	274
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Uranium (U) (mg/kg)	2.27	2.73	2.99	2.21	0.967
	Vanadium (V) (mg/kg)	15.7	12.9	10.0	8.13	28.0
	Zinc (Zn) (mg/kg)	249	333	210	121	47.8
	Zirconium (Zr) (mg/kg)	1.4	2.5	7.1	<1.0	4.6

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2139940-16	L2139940-17	L2139940-18	L2139940-19	L2139940-20
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
Sampled Time					
Client ID	W2-2	W2-3	W2-4	W2-5	W3-1
Grouping / **Analyte**					
SOIL					
Metals Molybdenum (Mo) (mg/kg)	0.80	1.04	1.89	1.09	1.30
Nickel (Ni) (mg/kg)	13.2	8.26	8.19	6.94	16.2
Phosphorus (P) (mg/kg)	602	1670	1640	1730	289
Potassium (K) (mg/kg)	980	1130	1240	1460	670
Selenium (Se) (mg/kg)	1.14	4.04	6.75	6.31	9.79
Silver (Ag) (mg/kg)	4.72	58.0	75.3	>108	32.5
Sodium (Na) (mg/kg)	353	92	162	75	106
Strontium (Sr) (mg/kg)	39.4	407	458	565	41.2
Sulfur (S) (mg/kg)	4000	5900	9000	9800	3900
Thallium (Tl) (mg/kg)	0.078	0.242	0.301	0.418	<0.20 DLM
Tin (Sn) (mg/kg)	5.1	21.0	32.2	26.5	33.9
Titanium (Ti) (mg/kg)	314	31.1	78.7	10.6	74.2
Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Uranium (U) (mg/kg)	0.785	2.32	2.46	3.87	2.52
Vanadium (V) (mg/kg)	29.3	14.5	18.0	12.2	17.1
Zinc (Zn) (mg/kg)	54.5	88.7	68.5	69.2	94.1
Zirconium (Zr) (mg/kg)	2.5	4.6	4.4	6.8	9.8

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2139940-21	L2139940-22	L2139940-23	L2139940-24	
Description	Soil	Soil	Soil	Soil	
Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	
Sampled Time					
Client ID	W3-2	W3-3	W3-4	W3-5	
Grouping / **Analyte**					
SOIL					
Metals Molybdenum (Mo) (mg/kg)	2.57	1.79	2.57	1.94	
Nickel (Ni) (mg/kg)	5.14	5.46	8.84	5.78	
Phosphorus (P) (mg/kg)	1120	769	1230	788	
Potassium (K) (mg/kg)	900	850	870	750	
Selenium (Se) (mg/kg)	25.1	27.5	25.8	35.5	
Silver (Ag) (mg/kg)	>122	>112	>111	>135	
Sodium (Na) (mg/kg)	58	53	94	106	
Strontium (Sr) (mg/kg)	188	215	168	141	
Sulfur (S) (mg/kg)	6300	8500	8400	16600	
Thallium (Tl) (mg/kg)	<0.30 DLM	<0.35 DLM	0.265	<35 DLM	
Tin (Sn) (mg/kg)	64.0	131	81.7	68.5	
Titanium (Ti) (mg/kg)	39.6	39.9	46.0	<47 DLM	
Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	
Uranium (U) (mg/kg)	6.00	7.07	5.62	6.01	
Vanadium (V) (mg/kg)	8.07	7.03	9.26	7.35	
Zinc (Zn) (mg/kg)	110	103	100	90.2	
Zirconium (Zr) (mg/kg)	1.2	9.7	<1.0	2.9	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Additional Comments for Sample Listed:

Samplenum	Matrix	Report Remarks	Sample Comments
L2139940-1	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-10	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-11	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-12	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-13	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-14	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-15	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-16	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-17	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-18	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-19	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-2	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-20	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-21	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-22	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-23	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-24	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-3	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-4	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-5	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-6	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-7	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-8	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	
L2139940-9	Soil	Note: Method variance: analysis performed by ICPMS, this method variance is not accredited.	

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Cadmium (Cd)	DUP-H	L2139940-10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -20, -21, -22, -24
Duplicate	Strontium (Sr)	DUP-H	L2139940-10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -20, -21, -22, -24
Duplicate	Zinc (Zn)	DUP-H	L2139940-10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -20, -21, -22, -24
Certified Reference Material	Chromium (Cr)-Total	RRQC	L2139940-40, -41, -42, -43, -44, -45, -46, -47, -48, -49, -50, -51, -52, -53, -54

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
RRQC	Refer to report remarks for information regarding this QC result.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
AG-200.2-A-CCMS-VA	Soil	Elevated Ag in Soil by CRC ICPMS	EPA 200.2/6020A
This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Analysis is by Collision/Reaction Cell ICPMS.			
C-TOT-LECO-SK	Soil	Total Carbon by combustion method	CSSS (2008) 21.2
The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.			
CAT-XTR-SK	Soil	Ammonium Acetate Extractable Cations	CSSS 19.4 - 1M NH4OAc Extraction @ pH 7
Exchangeable Ca, Mg, Na, and K are extracted from the soil using neutral 1N ammonium acetate, then determined by ICP-OES. This method does not correct for calcium or magnesium extracted from carbonates or free gypsum.			
ETL-C:N-RATIO-SK	Soil	Carbon:Nitrogen Ratio - Calculation	Calculation
HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)
Soil samples are digested with hot nitric and hydrochloric acids, followed by CVAAS analysis. This method is fully compliant with the BC SALM strong acid leachable metals digestion method.			
HG-DRY-CVAFS-N-VA	Tissue	Mercury in Tissue by CVAFS (DRY)	EPA 200.3, EPA 245.7
This method is conducted following British Columbia Lab Manual method "Metals in Animal Tissue and Vegetation (Biota) - Prescriptive". Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with addition of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry, adapted from US EPA Method 245.7.			
HG-DRY-MICR-CVAF-VA	Tissue	Mercury in Tissue by CVAFS Micro (DRY)	EPA 200.3, EPA 245.7
This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry, adapted from US EPA Method 245.7.			
MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)
This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. Analysis is by Collision/Reaction Cell ICPMS.			
MET-DRY-CCMS-N-VA	Tissue	Metals in Tissue by CRC ICPMS (DRY)	EPA 200.3/6020A
This method is conducted following British Columbia Lab Manual method "Metals in Animal Tissue and Vegetation (Biota) - Prescriptive". Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with addition of hydrogen peroxide. Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).			
Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.			
MET-DRY-MICR-HRMS-VA	Tissue	Metals in Tissue by HR-ICPMS Micro (DRY)	EPA 200.3/200.8
Trace metals in tissue are analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICPMS) modified from US EPA Method 200.8, (Revision 5.5). The sample preparation procedure is modified from US EPA 200.3. Analytical results are reported on dry weight basis.			
Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.			
N-TOTKJ-COL-SK	Soil	Total Kjeldahl Nitrogen	CSSS (2008) 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.			
NH4-AVAIL-SK	Soil	Available Ammonium-N	Comm Soil Sci 19(6)
Ammonium (NH4-N) is extracted from the soil using 2 N KCl. Ammonium in the extract is mixed with hypochlorite and salicylate to form indophenol blue, which is determined colorimetrically by auto analysis at 660 nm.			
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

Reference Information

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-1-SK Soil Particle Size Analysis:Mini-Pipet Method SSIR-51 Method 3.2.1

Dry, < 2 mm soil is treated with sodium hexametaphosphate to ensure complete dispersion of primary soil particles. The homogenized suspension is allowed to settle in accordance with Stoke's Law so that only clay particles remain in suspension.To determine the clay fraction, an aliquot of the clay suspension is removed, then dried and weighed. The sand fraction is determined by wet sieving the remaining suspension, then drying and weighing the sand retained on the sieve. The silt fraction is determined by calculation where % Silt = 100 - (%Sand+%Clay)

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.

Kalra, Y.P., Maynard, D.G. 1991. Methods manual for forest soil and plant analysis. Forestry Canada. p. 42-45.

** 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.

L2139940-COFC

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COC #

Page 1 of 5

Report To				Report Format / Distribution				Service Requested (Rush for routine analysis subject to availability)
Company:	StrataGold Corporation			☑ Standard	☐ Other			◉ Regular (Standard Turnaround Times - Business Days)
Contact:	Hugh Coyle			☑ PDF	☑ Excel	☑ Digital	☐ Fax	○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
Address:	1000 - 1050 West Pender Street			Email 1:	hcoyle@vitgoldcorp.com			○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
	Vancouver, BC V6E 3S7			Email 2:	bonnieburns@northwestel.net			○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	604-696-6600	Fax:		Email 3:	jknox@vitgoldcorp.com, cbeaudry@vitgoldcorp.c			**Analysis Request**
Invoice To	Same as Report ?	☑ Yes	☐ No	**Client / Project Information**				Please indicate below Filtered, Preserved or both (F, P, F/P)
Hardcopy of Invoice with Report?		☐ Yes	☑ No	Job #:	Eagle Gold			
Company:				PO / AFE:				
Contact:				LSD:	Victoria Gold Corp.			
Address:								
Phone:		Fax:		Quote #:	Q69293, Peso Samples			
Lab Work Order # (lab use only)				ALS Contact:	Heather Mackenzie	Sampler:	Bonnie Burns &Crystal Beaudry	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Carbon to Nitrogen Ratio	Cation Exchange Capacity	Metals, CCME	Particle Size Analysis	Available Ammonium	Organic matter by LOI	Plant Available P and K						Number of Containers
	T1-1AB	31-7-17		Soil	X	X	X	X	X	X	X						2
	T1-2AB	31-7-17		Soil	X	X	X	X	X	X	X						2
	T1-3	31-7-17		Soil	X	X	X	X	X	X	X						2
	T2-1AB	31-7-17		Soil	X	X	X	X	X	X	X						2
	T2-2	31-7-17		Soil	X	X	X	X	X	X	X						2
	T2-3A	31-7-17		Soil	X	X	X	X	X	X	X						2
	T3-1	31-7-17		Soil	X	X	X	X	X	X	X						2
	T3-2AB	31-7-17		Soil	X	X	X	X	X	X	X						2
	T3-3AB	31-7-17		Soil	X	X	X	X	X	X	X						2
	W1-1	31-7-17		Soil	X	X	X	X	X	X	X						2
	W1-2	31-7-17		Soil	X	X	X	X	X	X	X						2
	W1-3	31-7-17		Soil	X	X	X	X	X	X	X						2
	W1-4	31-7-17		Soil	X	X	X	X	X	X	X						2

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

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 provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Bonnie Burns			EHF	1 Aug 2018	16:30	12 D °C	HA	8/L	1 pm	

GENF 20.00 Front

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L2139940-COFC

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Report To				**Report Format / Distribution**				**Service Requested** (Rush for routine analysis subject to availability)
Company:	StrataGold Corporation			☑ Standard	☐ Other			◉ Regular (Standard Turnaround Times - Business Days)
Contact:	Hugh Coyle			☑ PDF	☑ Excel	☑ Digital	☐ Fax	○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
Address:	1000 - 1050 West Pender Street			Email 1:	hcoyle@vitgoldcorp.com			○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
	Vancouver, BC V6E 3S7			Email 2:	bonnieburns@northwestel.net			○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	604-696-6600	Fax:		Email 3:	Jknox@vitgoldcorp.com, cbeaudry@vitgoldcorp.c			**Analysis Request**
Invoice To	Same as Report ?	☑ Yes	☐ No	**Client / Project Information**				Please indicate below Filtered, Preserved or both (F, P, F/P)
Hardcopy of Invoice with Report?		☐ Yes	☑ No	Job #:	Eagle Gold			
Company:				PO / AFE:				
Contact:				LSD:	Victoria Gold Corp.			
Address:								
Phone:		Fax:		Quote #:	Q69293, Peso Samples			

Lab Work Order # (lab use only)		**ALS Contact:**	Heather Mackenzie	**Sampler:**	Bonnie Burns & Crystal Beaudry

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Carbon to Nitrogen Ratio	Cation Exchange Capacity	Metals, CCME	Particle Size Analysis	Available Ammonium	Organic matter by LOI	Plant Available P and K						Number of Containers
	W1-5	31-7-17		Soil	X	X	X	X	X	X	X						2
	W2-1	31-7-17		Soil	X	X	X	X	X	X	X						2
	W2-2	31-7-17		Soil	X	X	X	X	X	X	X						2
	W2-3	31-7-17		Soil	X	X	X	X	X	X	X						2
	W2-4	31-7-17		Soil	X	X	X	X	X	X	X						2
	W2-5	31-7-17		Soil	X	X	X	X	X	X	X						2
	W3-1	31-7-17		Soil	X	X	X	X	X	X	X						2
	W3-2	31-7-17		Soil	X	X	X	X	X	X	X						2
	W3-3	31-7-17		Soil	X	X	X	X	X	X	X						2
	W3-4	31-7-17		Soil	X	X	X	X	X	X	X						2
	W3-5	31-7-17		Soil	X	X	X	X	X	X	X						2

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

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 provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Bonnie Burns			EHF	1 Aug 2017	1630	12 °C	HA	8/2	1pm	

GENF 20.00 Front

7

APPENDIX B

PHOTOGRAPHS,
SEPTEMBER 2012 TO AUGUST 2018

TRENCH – BLOCK #1

Photo #1: Trench - Block #1 staked out, July 2012

Photo #2: Each plot was decompacted using a 5-pronged cultivator

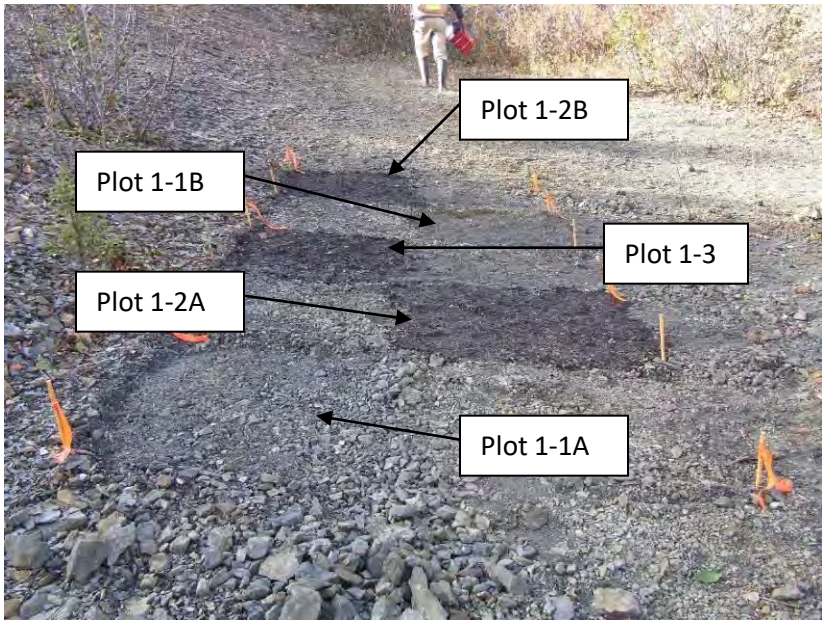


Photo #3: Trench - Block #1 plots prepared, seeded and treated.

Photo #4: Trench – Block #1, July 2013, grass has started growing.

Photo #5: Trench – Block #1, Aug 2014.

Photo #6: Trench – Block #1, alders becoming established, July 2016.

Photo #7: Trench – Block #1, increased growth of alders, Aug 2017.

Photo #8: Trench – Block #1, July 2018.

Photo #9: Trench – Plot #1-3, July 2013.

Photo #10: Trench – Plot #1-3, August 2014.

Photo #11: Trench – Plot #1-3, August 2015.

Photo #12: Trench – Plot #1-3, July 2016.

Photo #13: Trench – Plot #1-3, August 2017.

Photo #15: Trench, Block #1, young alder with long lateral root. 2018.

Photo #14: Trench – Plot #1-3, July 2018.

Photo #16: Root ball of alder plant from Plot #1-2B, July 2018.

TRENCH – BLOCK #2

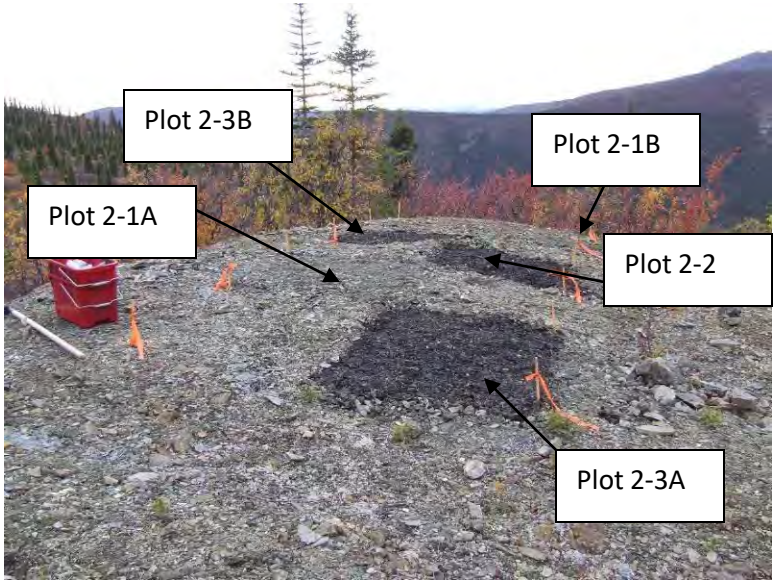


Photo #17: Trench – Block #2 prepared, seeded and treated. September 2012.

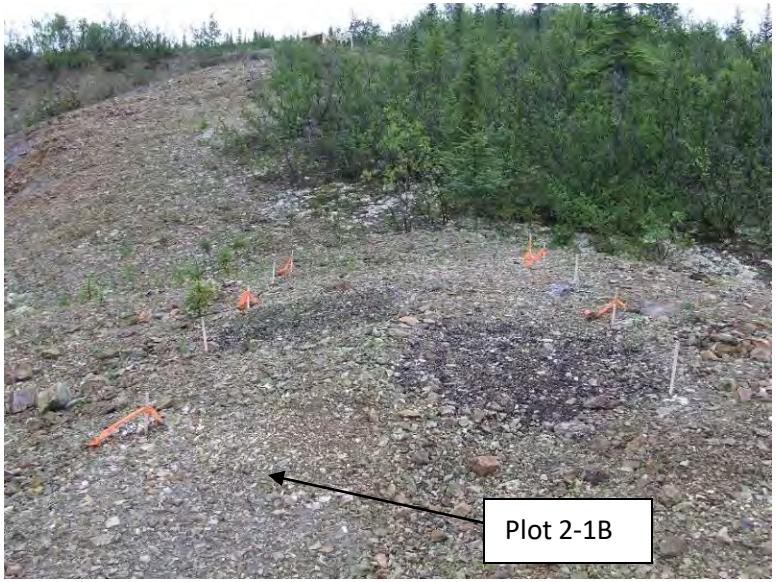


Photo #18: Trench – Block #2, July 2013.

Photo #19: Trench – Block #2, July 2016.

Photo #20: Trench – Block #2, Aug 2017.

Photo #21: Trench – Block #2, July 2018.

Photo #22: Trench, Plot #2-2, July 2013.

Photo #23: Trench, Plot #2-2, August 2014.

Photo #24: Trench, Plot #2-2, July 2015.

Photo #25: Trench, Plot #2-2, July 2016.

Photo #26: Trench, Plot #2-2, August 2017.

Photo #27: Trench, Plot #2-2, July 2018.

Photo #28: The alder in Plot #2-2 has produced seed cones in 2018.

TRENCH – BLOCK #3

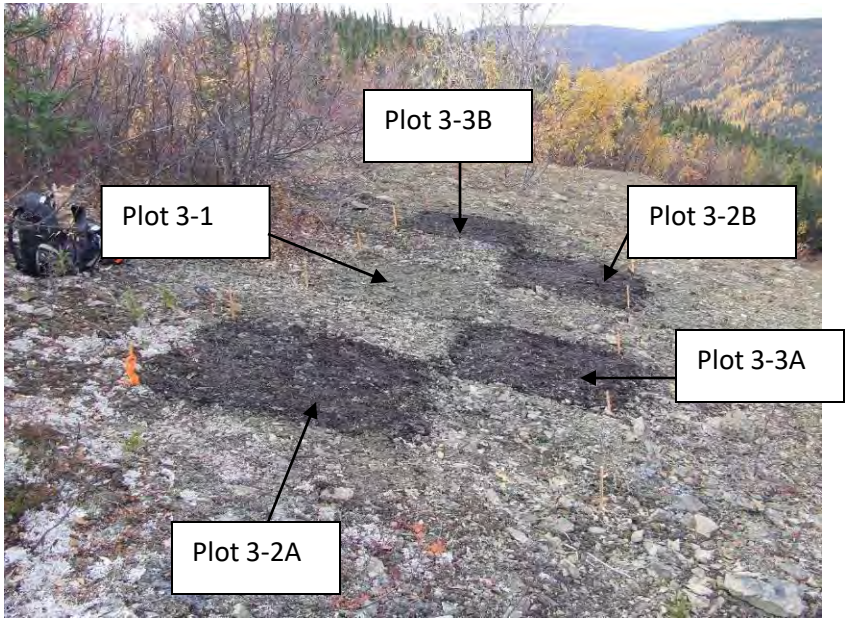


Photo #29: Trench Block #3, prepared, seeded and treated, Sept/12

Photo #30: Trench – Block #3, July 2013.

Photo #31: Trench – Block #3, August 2014, increased growth.

Photo #32: Trench – Block #3, July 2016.

Photo #33: Trench – Block #3, August 2017.

Photo #34: Trench – Block #3, July 2018. Increase alder growth.

Photo #35: Trench, Plot 3-2B, July 2013.

Photo #36: Trench, Plot 3-2B, Aug 2014, healthy grasses.

Photo #37: Trench, Plot #3-2B, August 2015.

Photo #38: Trench, Plot #3-2B, August 2017.

Photo #39: Trench, Plot #3-2B, July 2018

Photo #40: Nitrogen nodule on alder from Plot 3-2B, July 2018.

WASTE ROCK DUMP – BLOCK #1

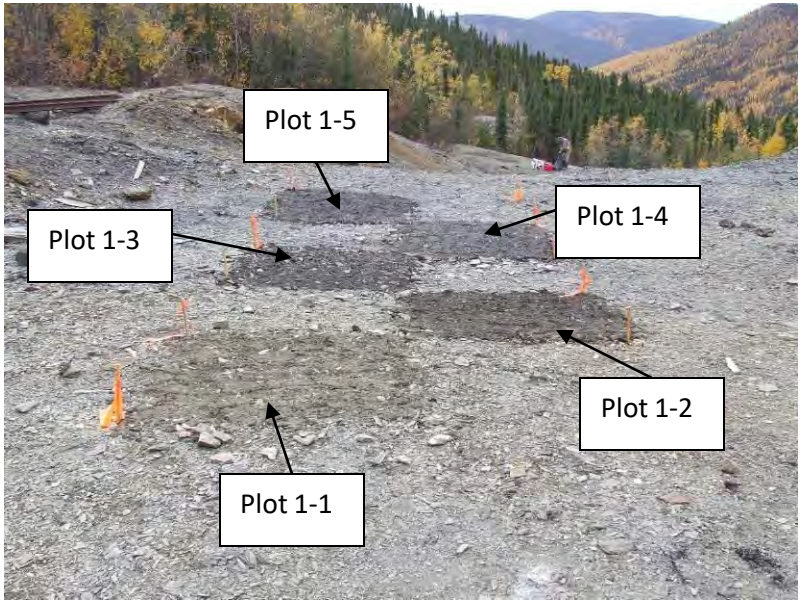


Photo #41: Waste Rock, Block #1, prepared, seeded and treated, Sept 2012.

Photo #42: Waste Rock, Block #1, July 2013.

Photo #43: Waste Rock, Block #1, August 2014, increased grass growth.

Photo #44: Waste Rock, Block #1, July 2016.

Photo #45: Waste Rock, Block #1, August 2017.

Photo #46: Waste Rock, Block #1, July 2018.

Photo #47: Waste Rock, Plot #1-5, very little growth, July 2013.

Photo #48: Waste Rock, Plot #1-5, healthy grass growth, Aug 2014.

Photo #49: Waste Rock, Plot #1-5, alders appearing, Aug 2015.

Photo #50: Waste Rock, Plot #1-5, grasses dying back, July 2016.

Photo #51: Waste Rock, Plot 1-5, August 2017.

Photo #52: Waste Rock, Plot 1-5, July 2018.

Photo #53: Waste Rock, healthy spruce growing among volunteer willow, paper birch and the alders at Plot #1-4.

Photo #54: Waste rock. Seed cones on an alder growing on Plot #1-4. July 2018.

Photo #55: Waste Rock, nitrogen nodules on alder root, Plot #1-2.

WASTE ROCK – BLOCK #2

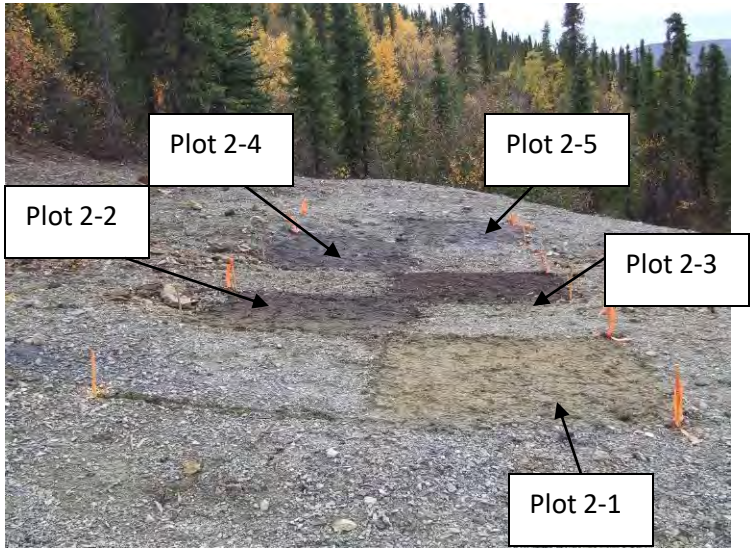


Photo #56 : Waste Rock, Block #2, prepared, seeded and treated, September 2012.

Photo #57: Waste Rock, Block #2, July 2013, good germination.

Photo #58: Waste Rock Block #2, August 2014. Healthy grasses.

Photo #59: Waste Rock, Block #2, July 2016. Alders growing.

Photo #60: Waste Rock, Block #2, August 2017. Alders have increased in growth.

Photo #61: Waste Rock, Block #2, July 2018.

Photo #62: Waste Rock, Plot 2-4, July 2013. Dolomite granules can still be seen.

Photo #63: Waste Rock, Plot 2-4, August 2014. Mature grasses.

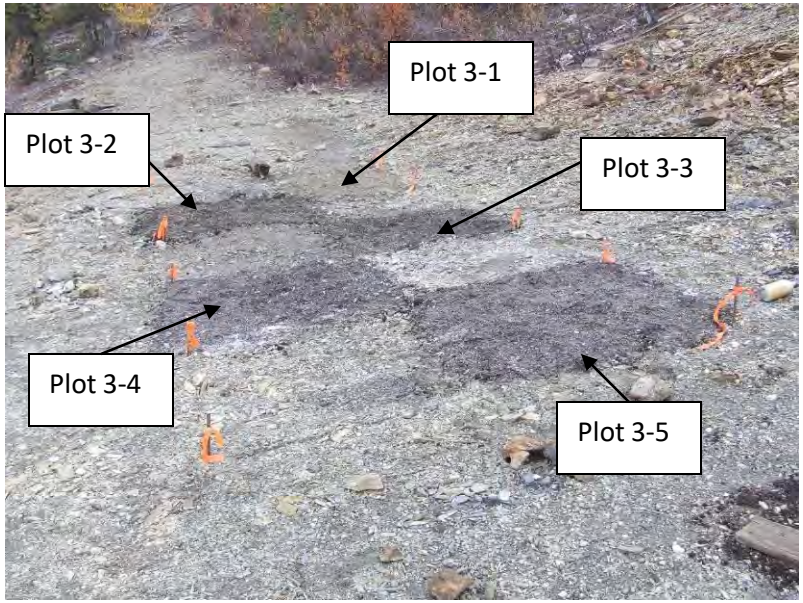
Photo #64: Waste Rock, Plot 2-4, July 2015. Alders growing.

Photo #65: Waste Rock, Plot 204, August 2016.

Photo #66: Waste Rock, Plot #2-4, August 2017.

Photo #67: Waste Rock, Plot #2-4, July 2018. Defoliation evident on stems both in 2017 and 2018.

WASTE ROCK – BLOCK #3



Photo# 68: Waste Rock, Block #3, prepared, seeded and treated. September 2012.

Photo #69: Waste Rock, Block #3, July 2013.

Photo #70: Waste Rock, Block #3, August 2014.

Photo #71: Waste Rock, Block #3, July 2016.

Photo #72: Waste Rock, Block #3, August 2017.

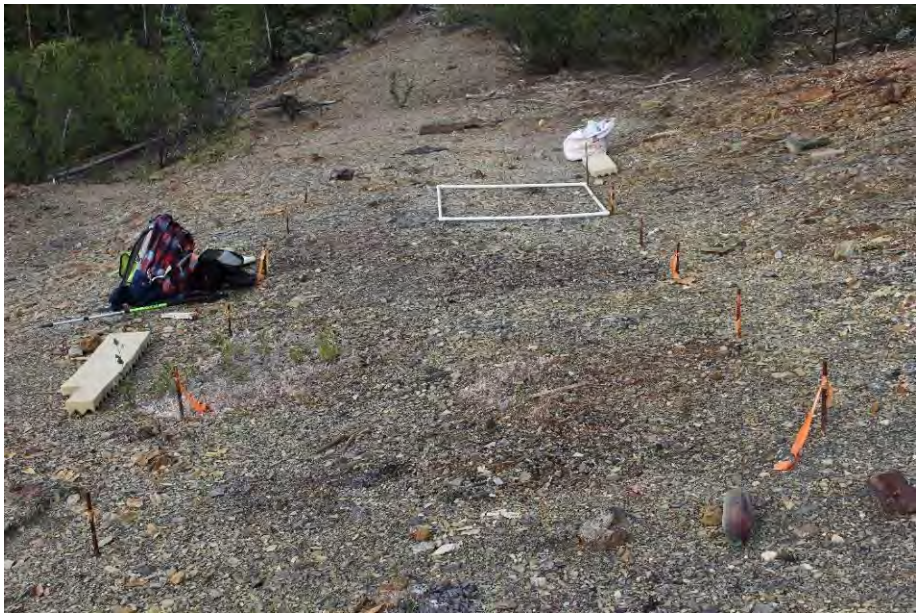


Photo #73: Waste Rock, Block #3, July 2018.

Photo #74: Waste Rock, Plot 3-4, July 2013.

Photo #75: Waste Rock, Plot #3-4, August 2014. Note mature grass.

Photo #76: Waste Rock, Plot #3-4, August 2015.

Photo #78: Waste Rock, Plot #3-4, August 2017.

Photo #77: Waste Rock, Plot #3-4, July 2016. Young willow in plot.

Photo #79: Waste Rock, Plot #3-4, July 2018.

Photo #80: Waste Rock, willows and dwarf birch in Plot 3-4, July 2018.

Photo #81: Necrosis on leaf edges on several alder at Waste Rock, Plot 2-3, July 2018.

APPENDIX C

VEGETATION DATA

- **TABLE C-1**
- **TABLE C-2**
- **TABLE C-3**
- **TABLE C-4**
- **TABLE C-5**
- **TABLE C-6**
- **ALS Lab Work Order #: L2139940, 2018**

TABLE C-1 ASSESSMENTS OF THE PLOTS AT THE TRENCH SITE, 2013, 2014, 2015, 2016, 2017 & 2018

BLOCK #1

Plot #	Date	% Cover	Species, avg height cm and/or # of individuals	Overall Health	Comments
1-1A	Jul-13	<1	sparse scraggly grass growth 1 hedysarum	stressed	a few shoots deep in gravel
	Sep-13	<1	unidentifiable grass, mostly brown, 2-3 cm	stressed	some green growth
	Aug-14	0			no growth
	Aug-15	<1	4 alder	good	small, seem healthy
	Jul-16	<1	2 alder 3 dwarf birch, up to 4.5 cm	good	plants are small but appear healthy, no grass
	Aug-17	<1	5 dwarf birch, very small	good	no grass
	Jul-18	<1	1 dwarf birch, 5 cm 3 small alder, <1 cm	struggling stressed	no grass browning of leaves
1-2A	Jul-13	45 - 50	alpine bluegrass unidentifiable grass hedysarum, 7 plants	good	even grass cover
	Sep-13	50	alpine bluegrass < 2cm 2 other grass species up to 4cm alder < 1cm hedysarum, < 2cm	good	Signs of grazing.
	Aug-14	60	alpine bluegrass ticklegrass, max 30 cm sheep fescue, max 30 cm alder, 13 plants	good	lots of tufts of unidentifiable grass 5 - 7 cm tall
	Aug-15	40	alpine bluegrass tickle grass unidentified grasses 12 alder	good	grass shows signs of grazing
	Jul-16	60	unidentified grasses, some possible immature hairgrass alpine bluegrass tickle grass spike trisetum, some in seed sheep fescue 12 alder, robust growth up to 21 cm	good	some accumulated leaf litter, a few small mushrooms present.
	Aug-17	40	Fescue, several mature and producing seed, dominant tufted harigrass, 1 is mature alpine bluegrass ticklegrass spike trisetum, 1 is mature 10 alder , robust growth unidentified small forbs	good	lots of leaf litter and last year's grasses.
	Jul-18	65	alpine bluegrass, 9 cm mature sheep fescue, 33 cm mature tufted hairgrass, 35 cm unidentified grasses, 23, 27 cm 12 alder, 43.5, 65.5, 76 and 58 cm moss	good	all plants look healthy lots of leaf litter - both alder and grasses
1-3	Jul-13	40	alpine bluegrass unidentified grasses hedysarum, 8 plants alder, 3 plants	good	most robust growth in Block #1
	Sep-13	50 - 60	alpine bluegrass, dominant species, < 3cm 3 other grass species up to 5 cm alder, <2 cm hedysarum, < 2cm	good	Signs of grazing.
	Aug-14	70	ticklegrass, max 30 cm, more mature plants than 1-2A alpine bluegrass, avg 4 cm alder, 8 plants sheep fescue, max 22 cm, 1 mature plant	good	Lots of tufts of unidentifiable grass 5 - 6 cm tall. Signs of grazing.
	Aug-15	50	alpine bluegrass tickle grass unidentified grasses 20 alder	good	alders growing significantly Signs of grazing. alder leaf litter
	Jul-16	70	unidentified grasses alpine bluegrass tickle grass spike trisetum sheep fescue tufted hairgrass, 1 in seed, 50.5 cm 1 willow 24 alder, some heights: 30 cm, 21.5 cm, 18.5 cm	good	lots of leaf litter plants look healthy
	Aug-17	60	Fescue, several mature, dominant alpine bluegrass tickle grass 25 alder - robust unidentifed small forbs	good	all plants appear healthy lots of leaf litter % cover includes leaf litter,
	Jul-18	80	alpine bluegrass, 42.5, 38 cm sheep fescue, 52, 48, 56 cm spike trisetum, 27, 40 cm tufted hairgrass, 33.5 cm 25 alder, 50.5, 87, 78, 67, 71 volunteer willow	good	all species of grasses had mature specimens, healthy growth

Plot #	Date	% Cover	Species, avg height cm and/or # of individuals	Overall Health	Comments
1-1B	Jul-13	<5	unidentified grass hedysarum, 4 plants alder, 1 plant	stressed	but some green growth
	Sep-13	<5	brown grasses, 2 - 4 cm hedysarum	stressed	
	Aug-14	<1	hedysarum, 1 plant	stressed	dead grass from last year
	Aug-15	<1	alder unidentified grasses	stressed	alder stunted
	Jul-16	<1	8 alder, all ≤ 1 cm		1 dwarf birch just ouside plot
	Aug-17	1	14 alder 1 spruce seedling	good	no grasses
	Jul-18	2	ticklegrass, 20.5 cm 20 alder, 4.5 cm 1 spruce seedling lichen moss,	fairly healthy	all alder were very small
1-2B	Jul-13	35	alpine bluegrass unidentified grasses hedysarum alder	good	even coverage of plot
	Sep-13	45	alpine bluegrass, 2 - 3 cm 3 other grass species, 2 - 4 cm alder, < 1cm	good	Signs of grazing. scat in plot
	Aug-14	60	tickle grass, many mature, max 38 cm alpine bluegrass, 3-4 cm, not as many as 1-3 alder, 4 plants some small hedysarum	good	Several tufts of unidentifiable grass. Alder leaf litter from near by.
	Aug-15	45	alpine bluegrass tickle grass unidentified grasses 20 alder	good	Signs of grazing. rabbit scat leaf litter 1 juvenile willow
	Jul-16	55	unidentified grasses tickle grass alpine bluegrass sheep fescue 51 alder, up to 8 cm 7 Salix spp		small black bugs on some plants
	Aug-17	60	alpine bluegrass, some mature, dominant grass ticklegrass tufted harigrass, 1 is mature 48 alder 1 spruce seedling a few willow seedlings	good	even coverage of plot lots of leaf litter
	Jul-18	80	sheep fescue, 73, 49, 45 cm tufted hairgrass, 31, 36, 33 cm alpine bluegrass, immature, 11.5, 13, 16 cm >40 alder, 52, 49, 35, 55, 54 cm several volunteer willow, 13, 11 cm spruce seedling moss		lots of alder leaf litter

TABLE C-1 ASSESSMENTS OF THE PLOTS AT THE TRENCH SITE, 2013, 2014, 2015, 2016, 2017 & 2018

BLOCK #2

Plot #	Date	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
2-3A	Jul-13	25 - 30	unidentified grasses alder, 2 plants hedysarum, 1 plant	good	Buffer plot above 2-3A and beside 2-1A has 14 alder and 1 labrador tea.
	Sep-13	35	alpine bluegrass, <2cm 3 other species of grass alder	good	Signs of grazing. Rabbit pellet spruce seedling
	Aug-14	45	spiked trisetum, 2 mature, up to 27 cms sheep fescue, 5 mature, up to 27 cm alpine bluegrass, <2cm lots of tufts of unidentified grasses alder, 6 plants	good	1 possible volunteer blueberry plant in plot
	Aug-15	40	alpine bluegrass spiked trisetum sheep fescue 6 alder	good	blueberry plant on edge of plot, 2 willow spp, 1 labrador tea in plot
	Jul-16	30	alpine bluegrass sheep fescue 2 alder, one large 53 cm, robust growth 11 dwarf birch 20 Salix spp	somewhat stressed	1 small spruce in plot 3 probable paper birch blueberry on plot edge
	Aug-17	35	unidentified stressed grasses are dominant grass alpine bluegrass, none mature 4 alder, up to 80 cm labrador tea willow seedlings blueberry several dwarf birch moss spruce seedling	grasses - poor others - good	The grasses are stressed but the alders and the volunteer plants are healthy.
	Jul-18	80	1 large alder, 122 cm, ~ a dozen small alder several willow, 18, 12 cm dwarf birch 32 cm labrador tea blueberry, 5.5 cm spike trisetum - sparse growth alpine bluegrass fescue, very small spruce, 12 cm moss	good	large alder has cones
2-1A	Jul-13	<5	sparse straggly grass shoots alder, 3 plants	stressed	
	Sep-13	<5	2 grasses, 2 - 3 cm hedysarum, 1 plant alder	stressed	Most grasses were brown
	Aug-14	<1	small grasses alder, 3 plants	stressed	1 labrador tea in plot
	Aug-15	<1	alder unidentified grass species	stressed	1 labrador tea in plot 1 spruce and willow
	Jul-16	<1	a few unidentified blades of grass 9 dwarf birch subalpine fir Salix spruce	stressed	all plants very small
	Aug-17	<5	labrador tea dwarf birch blueberry spruce seedlings small tufts of dead grass from previous years	good	no grasses, all volunteer plants in plot
	Jul-18	1 to 2	1 alder, 17 cm 19 dwarf birch 4 spruce seedlings	good	

Plot #	Date	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
2-2	Jul-13	40	alpine bluegrass unidentified grasses	good	even distribution
	Sep-13	45	alpine bluegrass, 2 cm unidentified grass species up to 5 cm	good	
	Aug-14	50	sheep fescue, several mature, up to 25 cm lots of immature alpine bluegrass, <3 cm spiked trisetum, 3 mature, up to 15 cms tickle grass, 1 mature, up to 23 cm alder, 2 plants	good	good healthy coverage see Photo #23
	Aug-15	45	alpine bluegrass spiked trisetum sheep fescue alder	good	4 willow spp 1 labrador tea in plot
	Jul-16	45	sheep fescue, up to 46 cm alpine bluegrass spike trisetum 2 alder, one large 73 cm 12 Salix spp dwarf birch spruce	good	1 blueberry plant in plot 1 labrador tea below plot
	Aug-17	50	fescue, several mature alpine bluegrass 1 large alder - 130 cm, also small ones labrador tea blueberry spruce seedling	good	some leaf litter
	Jul-18	95	1 giant alder, 189 cm labrador tea dwarf birch several small willow, 4.5 cm fescue, 48 cm moss		the large alder takes up almost the whole plot, has cones (see Photos #27 & 28)
2-3B	Jul-13	20	unidentified tufts of grasses hedysarum, 1 plant	good	
	Sep-13	30	alpine bluegrass, 2 cm 2 species of grass, <4 cm hedysarum	good	Tiny capped mushrooms in plot.
	Aug-14	40	tickle grass, 2 plants up to 20 cm alpine bluegrass, 1 mature, up to 10 cm several tufts of unknown grasses alder, 1 plant	good	2 alders growing just outside of plot
	Aug-15	35	alpine bluegrass spiked trisetum sheep fescue alder	good	1 spruce seedling in plot labrador tea and willow spp
	Jul-16	25	sheep fescue, up to 23.5 cm alpine bluegrass spike trisetum, up to 19 cm unidentified grasses dwarf birch, 19.5 cm 9 Salix spp 4 labrador tea	good	many small shrubs growing in the neighbouring buffer plot (dwarf birch, salix, labrador tea) and 3 paper birch and 3 spruce
	Aug-17	25	unidentified tufts of grasses alpine bluegrass several willow seedlings labrador tea dwarf birch spruce seedling	fair	leaf litter from grasses
	Jul-18	5	dwarf birch, 27.5, 13 cm willows 11, 11, 8.5, 6 cm labrador tea mostly dead grasses moss	volunteer plants appear healthy	very different from 2-3A even tho they both have the same amendments
2-1B	Jul-13	<5	a few blades of unidentified grass hedysarum, 1 plant	stressed	1 spruce seedling in plot
	Sep-13	5	unidentified grass, 3 - 4 cm alder, <1 cm, 4 plants	stressed	most grasses are brown
	Aug-14	<1	quite a bit of dead grass - didn't survive alder, 3 plants	stressed	possible 3 willows in plot
	Aug-15	<1	alder	stressed	willow spp in plot
	Jul-16	1 to 5	unidentified grasses 4 Salix spp 8 dwarf birch 1 paper birch	stressed shrubs fairly healthy	
	Aug-17	1	a few blades of unidentified grass dwarf birch willow seedlings labrador tea spruce seedling	grasses - poor others - good	only 1 tuft of spindly grass volunteer shrubs doing well
	Jul-18	2 to 3	18 dwarf birch, 3.5, 19 cm 5 labrador tea, 8, 12 cm 2 willow, 12, 8 cm spruce	good	volunteer plants are small but healthy

TABLE C-1 ASSESSMENTS OF THE PLOTS AT THE TRENCH SITE, 2013, 2014, 2015, 2016, 2017 & 2018

BLOCK #3

Plot #	Date	% Cover	Species, avg height cm and/or # of individuals	Overall Health	Comments
3-2A	Jul-13	40	unidentified tufts of grass - lots alpine bluegrass, alder, 1 plant hedysarum, 2 plants	good	robust healthy plot
	Sep-13	40	alpine bluegrass, 2 cm 2 other grass species, <4 cm hedysarum, <1 cm alder, <1 cm	good	Sign of grazing. Some moss in plot
	Aug-14	60	tufted hairgrass, 4 mature plants, up to 70 cm ticklegrass, mature up to 35 cm sheep fescue, mature up to 35 cm spiked trisetum, mature up to 33 cm alpine bluegrass, lots of immature, < 3cm alder, 1 plant	good	4 volunteer willow in plot, very diverse plot, has the most mature plants
	Aug-15	50	tufted hairgrass sheep fescue alpine bluegrass spiked trisetum tickle grass alder	good	lots of moss, clover willow
	Jul-16	70*	unidentified grasses tickle grass tufted hairgrass alpine bluegrass (only a few plants) 5 alder, tallest 71 cm 11 Salix spp 5 dwarf birch	grasses are stressed other plants appear healthy	lots of moss, large tuft of alsike clover
	Aug-17	65	unhealthy grasses likely fescue - dominant grass alpine bluegrass, immature ticklegrass, mature 1 large alder, 118 cm 3 smaller alder willow labrador tea dwarf birch 1 large tuft of alsike clover moss	poor to good	most plants appear robust and healthy
	Jul-18	65 to 70	alder, 80, 82, 173, 13 cm alsike clover willows, 3 cm fescue spruce seedling dwarf birch, 5 cm	grass - poor others - good	alsike colver is dying back due to shading from the growing alder caterpillar in plot rabbit pellet in plot
3-3A	Jul-13	35	unidentified tufts of grass - lots tufted hairgrass, 1 mature plant	good	
	Sep-13	40	tufted hairgrass, mature, up to 30 cm alpine bluegrass, 2 cm other grasses, 3 cm alder	good	Sign of grazing.
	Aug-14	50	tufted hairgrass, mature, up to 42 cm ticklegrass, mature up to 36 cm sheep fescue, mature up to 30 cm spiked trisetum, mature up to 20 cm alpine bluegrass, lots of immature, 2 - 4 cm alder, 4	good	1 willow in plot
	Aug-15	40	tufted hairgrass alpine bluegrass spiked trisetum sheep fescue tickle grass alder	good	willow lots of moss, 1 mushroom
	Jul-16	65	unidentified grasses tickle grass sheep fescue alpine bluegrass 7 alder up to 37 cm 8 Salix spp 1 possible Hedysarum plant	good	Some moss in plot
	Aug-19	50	tufted hairgrass, mature ticklegrass, mature alpine bluegrass Calamagrotis canadensis, mature fescues, mature 7 alder up to 88 cm dwarf birch willows, labrador tea spruce	good	good biodiversity healthy growth of all plants
	Jul-18	80	alder, 134, 95, 63 cm spike trisetum, 19, 24 cm trufted hairgrass, 19, 26 cm willow, 15, 9, 5.5 cm spruce seedlings moss	good	

Plot #	Date	% Cover	Species, avg height cm and/or # of individuals	Overall Health	Comments
3-1	Jul-13	5	sparse unhealthy unidentified grass	stressed	in upper right corner only
	Sep-13	5 - 10	unidentified grass, <3 cm alder, <1 cm	stressed	grass is brown
	Aug-14	<5	sheep fescue, immature - small but healthy ticklegrass, 1 mature, 10 cm alder, 10 plants, very small	good	1 labrador tea and 1 tiny spruce seedling in plot, one fairly large aspen growing downhill of plot
	Aug-15	5	tickle grass unidentified grass species alder	good	1 labrador tea 1 willow
	Jul-16	5	unidentified grasses tickle grass alder 8 dwarf birch 2 small spruce		small amount of moss 1 very small blueberry labrador tea
	Aug-17	5 to 10	sparse unhealthy fescue 1 ticklegrass dwarf birch labrador tea willow spruce moss	grasses - poor others - good	grasses appear somewhat stressed, volunteer plants appear to be doing well
	Jul-18	3 to 5	3 alder, 7, 10, 17 cm dwarf birch 5, 4 cm tufted harigrass, 27, 25, 17 cm spruce seedlings, 3 cm labrador tea, 5 cm willow, 6.5, 4.5 cm	grasses - fair others - good	
3-2B	Jul-13	20	unidentified small tufts of grasses alpine bluegrass alder, 3 plants hedysarum, 5 plants	good	
	Sep-13	30	alder, <2cm, 12 plants alpine bluegrass, < 2cm unidentified grass, < 4cm hedysarum, < 2cm	partially stressed	But lots of green healthy plants.
	Aug-14	40	tickle grass up to 15 cm alpine bluegrass unidentified immature grasses alder, approx 20	good	1 willow growing in plot
	Aug-15	35	sheep fescue spiked trisetum alpine bluegrass tickle grass unidentified grasses alder	good	willow, clover in flower
	Jul-16	45	unidentified grasses (may be some sheep fescue) alpine bluegrass tickle grass tufted hairgrass, 40.5 cm 11 alder 13 dwarf birch 7 Salix spp	overall good but some grasses appear slightly stressed	some moss signs of grazing on upper leaves of alder alsike clover in plot 2 paper birch
	Aug-17	40	struggling fescue alpine bluegrass 9 robust alder up to 80 cm willows, spruce seedlings moss dwarf birch	fair to good	the fescues appear somewhat stressed. alders appear very healthy
	Jul-18	75	alder, 26, 120, 139, 94 cm dwarf birch, 21, 8.5 cm willow, 6.5 cm spruce seedling mostly dead grasses - unidentified moss	grasses - poor others - good	alders have grown quite a bit since the previous year - see Photo #39. Alder has nitrogen nodule on root, see Photo #40
3-3B	Jul-13	10 - 15	small tufts of unidentified grasses alpine bluegrass alder, 5 plants hedysarum, 1 plant	fairly good	possible willow in plot
	Sep-13	15 - 20	alpine bluegrass, < 1cm unidentified grass, < 3cm alder, < 1cm hedysarum, < 2cm	good	plants appear healthy although small
	Aug-14	30	unidentified tufts of grass - several alpine bluegrass, immature alder, 9 plants	good	no mature grasses 1 spruce in plot 1 willow in plot
	Aug-15	25	spiked trisetum alpine bluegrass unidentified grasses alder	good	1 spruce seedling willow lots of moss,
	Jul-16	5 to 10	unidentified grasses alpine bluegrass, a few plants 5 alder 8 dwarf birch 5 Salix spp 1 spruce	grasses are stressed other plants appear healthy	lots of moss, not included in cover estimate.
	Aug-17	20	alpine bluegrass fescues 6 alder up to 44 cm dwarf birch willows spruce moss	stressed to healthy	all grasses appear to be struggling, however the grasses growing near the alder appear more healthy. Alder and volunteer plants appear healthy
	Jul-18	45	7 alder, 67, 76, 49 cm dwarf birch, 14, 28, 13, 6.5 cm willow, 9, 4.5, 6 cm grass - mostly dead moss - lots (approx 85 % cover if moss included)	grass - poor others - good	many small dwarf birch sprouting

* = includes moss cover, without moss, approximately 35 % cover

TABLE C-2 ASSESSMENTS OF THE PLOTS AT THE WASTE ROCK SITE, 2013, 2014, 2015, 2016, 2017 AND 2018

BLOCK #1

Plot #	Date	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
1-1	Jul-13	0			bare plot
	Sep-13	<1	1 blade of unidentifiable grass	stressed	bare plot
	Aug-14	0			bare plot, moist soil
	Aug-15	0			bare plot
	Jul-16	0			bare plot
	Aug-17	0			bare plot
	Jul-18	0			bare plot, ants in plot
1-2	Jul-13	40 - 50	2 species of grass - unidentified alder, 8 plants hedysarum, 2 plants	good	tallest and most robust growth of all plots in block
	Sep-13	60 - 65	tickle grass, some in seed, max 30 cm glaucous bluegrass up to 12 cm sheep fescue (?), 8 cm alder < 1cm hedysarum, < 2cm	good	green healthy growth, signs of grazing
	Aug-14	70	tufted hairgrass, 2 plants up to 40 cm ticklegrass, many plants, avg 35 cm sheep fescue, 3 mature plants, max 35 to 40 cm alder, 7 plants	good	even coverage of plot, 1 willow in plot
	Aug-15	55	tufted hairgrass glaucous bluegrass tickle grass sheep fescue alder	good	willow in plot
	Jul-16	50	unidentified grasses tickle grass sheep fescue tufted hairgrass glaucous bluegrass 5 alders up to 34.5 cm 10 Salix spp	good	some moss lady bug in plot
	Aug-17	50	fescue, some mature 15 alder up to 61 cm spruce willows	stressed to good	mostly dead or stressed grasses, trees are healthy
	Jul-18	50 - 60	6 large alder; heights: 71, 97, 90, 20, 13 cm willows; heights: 15, 9, 4 cm spruce sapling, 12 cm fescue, some mature; 38, 42, 25 cm unidentified grass moss	good some grasses are stressed	several small alder herbivory on one willow nitrogen nodule on alder root - see Photo #55. lots of dead grass ant in plot
1-3	Jul-13	15 - 20	small tufts of unidentified grass alder, 2 plants - very small	good	
	Sep-13	30 - 35	glaucous bluegrass up to 8 cm unidentified grass up to 10 cm alder, <1 cm	good	sporadic cover
	Aug-14	40	ticklegrass, max 35 cm alder, 1 plant	fairly good	uneven distribution, bare sections
	Aug-15	15	tickle grass tufted hairgrass unidentified grasses alder	some grasses are stressed	
	Jul-16	5	ticklegrass unidentified tufts of stressed grasses 2 alders up to 11.5 cm	stressed	
	Aug-17	5	live grasses growing next to alders only 2 alder plants - healthy small dwarf birch	stressed to good	lots of dead or stressed grasses
	Jul-18	~10	3 alder plants	nodule on alder root	dead grasses in plot

Plot #	Date	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
1-4	Jul-13	10 - 15	small tufts of unidentified grass, at least 2 species	fairly good	
	Sep-13	30 - 35	glaucous bluegrass up to 8 cm unidentified grass up to 4 cm alder, <1 cm	partially stressed	
	Aug-14	50	ticklegrass, many mature plants, up to 30 cm sheep fescue, a few plants, up to 15 cm alder, 5 plants	good	uneven distribution
	Aug-15	20	tickle grass glaucous bluegrass alder	good	willow in plot
	Jul-16	15 to 20	unidentified grasses glaucous bluegrass ticklegrass 13 alder 22 Salix spp 3 spruce	grasses appear somewhat stressed, others appear healthy	herbivory on the alders and on some grasses
	Aug-17	40	fescue, several in seed alders up to 68 cm willows - healthy and growing spruce - growing	good	
	Jul-18	75	alder; heights: 84, 72, 88, 27 cm felt leaf willow; 32, 34 cm another willow species; 34, 30, 15, 12 cm spruce; 28 cm paper birch; 38 cm grass	good	all plants are healthy except for the grasses - only a few green blades and none were mature Some willows had insect damage Seed cones on alder, Photo #54
1-5	Jul-13	5	sparse short growth of grasses	stressed	
	Sep-13	50	glaucous bluegrass, 4 cm tickle grass up to 3 cm unidentified grass up to 4 cm alder, < 2cm hedysarum	good	Signs of grazing. even coverage of growth
	Aug-14	60	tickle grass, mature, max 25 cm immature glaucous bluegrass immature grass - may be sheep fescue alder, 2 plants	good	Several tufts of unidentifiable grass. Photo #48.
	Aug-15	45	sheep fescue tickle grass glaucous bluegrass alpine bluegrass alders	good	willows
	Jul-16	30	unidentified grasses ticklegrass sheep fescue glaucous bluegrass 5 alders up to 61.5 cm 16 Salix spp	grasses appear somewhat stressed, shrubs appear healthy	
	Aug-17	30	ticklegrass - immature fescue 4 large alder up to 111 cm small willow seedlings	fair to good	lots of grass litter grasses appear stressed
	Jul-18	65 - 70	alder; 122, 98, 68, 97 cm fescue; 31, 29 cm spruce seedling willow 8, 6, 8 cm paper birch moss	good	1 of the alders had produced cones previous year's grass litter

TABLE C-2 ASSESSMENTS OF THE PLOTS AT THE WASTE ROCK SITE, 2013, 2014, 2015, 2016, 2017 AND 2018

BLOCK #2

Plot #	Date	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
2-1	Jul-13	0	no sign of any growth		bare plot
	Sep-13	0	no sign of any growth		bare plot
	Aug-14	0	no sign of any growth		bare plot
	Aug-15	0	no sign of any growth		bare plot
	Jul-16	0	no sign of any growth		bare plot
	Aug-17	0	no sign of any growth		bare plot, moose tracks in plot
	Jul-18	0	no sign of any growth		bare plot
2-2	Jul-13	35	unidentified tufts of grass - healthy alder, 1 plant, very small hedysarum, 2 plants	good	coverage mostly on east half
	Sep-13	50	ticklegrass up to 16 cm sheep fescue up to 12 cm glaucous bluegrass up to 8 cm alder hedysarum,	good	growth covers most of the eastern half of plot
	Aug-14	60	ticklegrass, mature, max 30 cm alder, 7 plants volunteer willow, 6 plants volunteer spruce, 2 plants	good	growth covers most of the eastern half of plot
	Aug-15	60	tickle grass glaucous bluegrass unidentified grasses alders	good	healthy alder growth, many juvenile willow plants, 2 spruce seedlings, leaf litter
	Jul-16	40	ticklegrass unidentified grasses 51 alder up to 34 cm, many small 16 Salix spp 2 spruce 1 subalpine fir	good	moose had walked thru Block leaf litter blue bug on alder leaf
	Aug-17	60	ticklegrass, mature plants immature fescue many alder of various sizes 2 spruce seedlings willows	good	grass leaf litter coverage mostly on east half
	Jul-18	85	alder; heights: 45, 76, 63, 26, 95 cm 7 spruce	good	some alder leaves have brown edges and some alders have no leaves on the top of the stem - possible defoliation
2-3	Jul-13	45	unidentified tufts of grass - healthy alder, 9 plants	good	more even coverage
	Sep-13	60	ticklegrass up to 11 cm glaucous bluegrass up to 11 cm alder, several small seedlings	good	even cover of plot
	Aug-14	60	ticklegrass, max 38 cm immature sheep fescue alder, >20 plants	good	even distribution
	Aug-15	60	tickle grass unidentified grasses many alder	good	healthy alder growth willow in plot
	Jul-16	40	ticklegrass unidentified grasses many alder, more than in 2-2, up to 36 cm 6 Salix spp 3 paper birch		
	Aug-17	60	numerous alder 5 paper birch 3 spruce willows	good	some of the alder appear to have suffered from browsers and/or defoliators
	Jul-18	60 - 65	alder; 94, 31, 92, 48, 31 cm paper birch; 45, 21 cm	good	some alders have necrosis on some of their leaves, see Photo #81

Plot #	Date	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
2-4	Jul-13	50	unidentified tufts of 2 to 3 species of grass - healthy glaucous bluegrass alder, 1 plant	good	even growth on plot
	Sep-13	60	glaucous bluegrass up to 8 cm sheep fescue up to 4 cm ticklegrass up to 3 cm alder, <1 cm	good	even cover of plot
	Aug-14	60	sheep fescue, several mature immature glaucous bluegrass, up to 15 cm alder, 15 plants	good	even distribution 1 volunteer willow plant see Photo #63
	Aug-15	70	tufted hairgrass tickle grass sheep fescue glaucous bluegrass many alder	good	healthy alder growth willow in plot
	Jul-16	80	glaucous bluegrass ticklegrass lots of alder 2 Salix spp 2 spruce 1 paper birch	good	lush growth
	Aug-17	90	tufted hairgrass, several in flower fescue, some mature ticlegrass numerous alder - thick growth willows	good	some of the alder seem to have suffered as in Plot 2-3 (2017)
	Jul-18	95	numerous alder; 45, 103, 82, 94 cm fescue - mature tufted hairgrass mature	good	no leaf disease on alder but tops of stems appear to be stripped by a grazer - Photos #66 & 67
2-5	Jul-13	30	unidentified tufts of grass - healthy hedysarum, 2 plants	good	
	Sep-13	40 - 50	tickle grass up to 30 cm glaucous bluegrass up to 13 cm alder, < 1cm	good	even cover of plot, less robust growth than plot 2-4
	Aug-14	50	tickle grass, many mature, up to 30 cm sheep fescue, several, up to 25 cm alder, 8 plants	good	
	Aug-15	50	ticklegrass glaucous bluegrass unidentified grasses	good	willows in plot
	Jul-16	30	unidentified grasses glaucous bluegrass - couple of plants 16 alder 3 Salix spp 1 paper birch	grasses appear stressed, others look healthy	
	Aug-17	75	numerous alder unhealthy fescue willows spruce seedlings	fair to good	some of the alder seem to have suffered as in Plot 2-3 (2017)
	Jul-18	99	numerous alder some willow dead grass	good	some alders have stripped stems as in Plot 2-4 (2018)

TABLE C-2 ASSESSMENTS OF THE PLOTS AT THE WASTE ROCK SITE, 2013, 2014, 2015, 2016, 2017 AND 2018

BLOCK #3

Plot #	Date	% Cover	Species, height cm and/or # of individuals	Overall Health	Comments
3-1	Jul-13	0	no growth		bare plot
	Sep-13	0	no growth		bare, moist plot
	Aug-14	0	no growth		moose track in plot
	Aug-15	0	no growth		
	Jul-16	0	no growth		bare plot
	Aug-17	0	no growth		bare plot
	Jul-18	0	no growth		old moose prints in bare plot
3-2	Jul-13	30	unidentified tufts of grass alder, 5 plants	partially stressed	growth localized, plants appear stressed on right side
	Sep-13	30	ticklegrass, lots in seed, up to 35 cm glaucous bluegrass up to 8 cm	partially stressed	
	Aug-14	20	ticklegrass, mature, max 33 cm sheep fescue, several mature, max 15 cm	partially stressed	half of plot is bare
	Aug-15	10	tickle grass glaucous bluegrass	stressed	
	Jul-16	<5	ticklegrass glaucous bluegrass	stressed	
	Aug-17	0	no live growth		only dead plant material from previous years
	Jul-18	0	no live growth		only dead plant material from previous years
3-3	Jul-13	5	sparse stressed grass growth	stressed	
	Sep-13	5 - 10	unidentified grass up to 5 cm	stressed	
	Aug-14	0	dead grasses from last year's growth	stressed	
	Aug-15	0	no growth		
	Jul-16	0	no growth		
	Aug-17	0	no growth		bare plot
	Jul-18	0	no growth		bare plot
3-4	Jul-13	40 - 50	many tufts of healthy unidentified grasses	good	good growth in lower half
	Sep-13	50	tickle grass, some in seed, up to 4 cm sheep fescue (?), 7 cm glaucous bluegrass, up to 2 cm	good	
	Aug-14	35	ticklegrass, up to 35 cm tufted hairgrass, 1 mature plant, up to 40 cm sheep fescue, 1 mature plant, up to 34 cm	good	healthiest plot in Block #3 see Photo #74
	Aug-15	25	tufted hairgrass tickle grass sheep fescue glaucous bluegrass	good	willow in plot
	Jul-16	15	unidentified grasses glaucous bluegrass ticklegrass tufted hairgass 4 Salix spp 2 dwarf birch	grasses stressed	
	Aug-17	5	1 ticklegrass in seed 1 tuft of glaucous bluegrass 2 alder a few willows small dwarf birch small tufts of fescue	fair to stressed	
	Jul-18	2	several willow; 7, 12, 13, 8, 11, 15.5 cm alder; 4 cm paper birch; 15 cm ticklegrass; 31, 19 cm, mature dwarf birch; 5.5 cm	healthy	See Photo #80
3-5	Jul-13	<10	unidentified grasses	partially stressed	some tufts quite healthy
	Sep-13	10 - 15	glaucous bluegrass, < 2 cm unidentified grass up to 3 cm	stressed	most plants are brown
	Aug-14	<10	tickle grass, a few mature and immature, up to 25 cm glaucous bluegrass, 1 mature, 25 cm stressed stunted grasses dead grass from last year	stressed	good soil moisture
	Aug-15	10	tickle grass	good	
	Jul-16	<5	glaucous bluegrass unidentified grasses	stressed	
	Aug-17	<5	glaucous bluegrass, mature ticklegrass, mature	fair	
	Jul-18	1	a few tufts of ticklegrass; 29, 19 cm	fair	some mature

NOTE: stressed = brown or withered plants
good = green plants showing vigor

TABLE C-3 SPECIES DOCUMENTED AT THE PLOTS		
	Common Name	**Scientific Name**
Planted	Sheep fescue	*Festuca ovina*
	Tufted hairgrass	*Deschampsia caespitosa*
	Glaucous bluegrass	*Poa glauca*
	Alpine bluegrass	*Poa alpina*
	Tickle grass	*Agrostis scabra*
	Spike Trisetum	*Trisetum spicatum*
	Bear root	*Hedysarum alpinum*
	Alder	*Alnus viridus*
Volunteer	Willow	*Salix* spp
	Dwarf birch	*Betula glandulosa*
	Labrador Tea	*Rhododendron groenlandicum*
	Blueberry	*Vaccinium uliginosum*
	White spruce	*Picea glauca*
	Alaska birch	*Betula neoalaskana*
	Alsike clover	*Trifolium hybridum*
	Bluejoint grass	*Calamagrotis canadensis*

TABLE C-4 ROOT LENGTH OF RANDOMLY SELECTED PLANTS			
Site	**Plot #**	**Species**	**Root Length (cm)**
Trench	1-3A	Alpine Bluegrass	7
	1-3A	Alder	9
	1-1B	Alder	7
	1-2B	Sheep Fescue	8
	1-2B	Alpine Bluegrass	6
	1-2B	Alder	7
	2-1A	Alder	9
	2-1A	Dwarf birch	6
	2-2	Alder	8
	2-2	Willow	7
	2-1B	Dwarf birch	7
	2-1B	Dwarf birch	8
	3-2A	Alder	6
Waste Rock Dump	1-2	Willow	9
	1-3	Alder	8
	1-3	Alder	9
	1-5	Willow	4
	2-2	Alder	18
	2-3	Alder	7
	2-4	Alder	7
	2-5	Alder	3
	2-5	Alder	7

TABLE C-5 METAL CONCENTRATIONS (mg/kg) IN FOLIAR TISSUES AT THE TRENCH SITE, 2018

Plot #	T1-1B	T1-2AB	T1-2AB	T1-3	T1-3	T2-2	T2-2	T2-3A	T2-3A	T3-2AB	T3-2AB	T3-3AB	T3-3AB	Range
Species	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	
Tissue Type	Leaves and stems	Leaves	Stems	Leaves	Stems	Leaves	Stems	Leaves	Stems	Leaves	Stems	Leaves	Stems	
Aluminum (Al)-Total	33.5	14.3	12.1	10.0	4.8	20.0	5.2	8.2	<2.0	37.2	9.6	18.8	6.5	4.8 to 37.2
Antimony (Sb)-Total	5.59	1.16	0.963	0.471	1.32	0.127	0.050	0.117	0.044	2.48	0.709	0.391	0.337	0.044 to 5.590
Arsenic (As)-Total	17.0	4.02	2.88	3.40	3.07	1.37	0.626	0.571	0.411	4.09	1.53	1.54	1.31	0.41 to 17.00
Barium (Ba)-Total	39.5	4.61	12.8	5.60	10.5	37.2	62.5	28.2	58.9	36.2	79.1	22.3	71.0	4.6 to 79.1
Beryllium (Be)-Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	ND to ND
Bismuth (Bi)-Total	0.219	0.058	0.044	0.014	0.072	0.020	<0.010	<0.010	<0.010	0.173	0.060	0.028	0.026	0.014 to 0.219
Boron (B)-Total	7.7	5.5	8.3	7.3	7.7	7.8	10.4	9.4	12.0	4.9	6.0	6.6	7.0	4.9 to 12.0
Cadmium (Cd)-Total	<0.010	0.0052	0.0163	<0.0050	0.0055	<0.0050	0.0163	<0.0050	0.0097	0.0062	0.0111	<0.0050	0.0120	ND to 0.016
Calcium (Ca)-Total	11000	7370	5170	10600	6710	7470	6020	6860	5690	5790	5120	6320	6160	5120 to 11000
Cesium (Cs)-Total	0.136	0.0957	0.258	0.149	0.176	0.330	0.225	0.161	0.104	0.379	0.191	0.159	0.145	0.10 to 0.38
Chromium (Cr)-Total	0.22	<0.050	0.060	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	ND to 0.22
Cobalt (Co)-Total	0.121	0.058	0.030	0.065	<0.020	0.100	0.065	0.054	0.034	0.334	0.132	0.180	0.105	0.03 to 0.33
Copper (Cu)-Total	6.54	6.03	6.12	4.34	5.20	9.61	9.16	7.03	7.85	9.51	7.94	6.75	7.16	4.34 to 9.61
Iron (Fe)-Total	222	64.5	42.6	47.2	26.3	71.6	35.9	68.2	42.6	75.9	37.5	65.7	40.2	26.30 to 222.00
Lead (Pb)-Total	48.0	7.39	5.28	2.46	4.43	11.5	8.24	5.15	5.85	18.5	15.1	9.35	9.09	2.46 to 48.00
Lithium (Li)-Total	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	ND to ND
Magnesium (Mg)-Total	2430	1670	983	1660	780	2170	1230	1960	1290	1930	1100	1940	1080	780 to 2430
Manganese (Mn)-Total	214	42.3	71.2	64.2	74.2	44.9	44.0	30.7	35.3	72.7	101	66.3	97.0	30.7 to 214.0
Mercury (Hg)-Total	0.0067	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	ND to 0.0067
Molybdenum (Mo)-Total	3.71	4.34	6.40	8.51	6.59	1.15	1.73	2.16	3.82	1.98	4.74	3.97	3.38	1.15 to 8.51
Nickel (Ni)-Total	5.54	1.08	0.77	0.55	0.39	3.03	2.66	1.65	1.77	3.05	1.83	2.04	1.64	0.39 to 5.54
Phosphorus (P)-Total	938	2820	1980	2470	1450	2270	1780	2330	1770	2350	1530	2500	1560	938 to 2820
Potassium (K)-Total	7510	5850	5110	5330	4110	7080	6590	7970	7750	6000	4810	6600	4890	4110 to 7970
Rubidium (Rb)-Total	7.81	11.4	11.0	7.09	5.92	10.3	8.64	7.58	6.58	17.5	9.79	11.2	8.55	5.92 to 17.50
Selenium (Se)-Total	<0.10	<0.050	<0.050	<0.050	<0.050	0.241	0.124	0.242	0.116	0.054	<0.050	0.087	0.052	0.052 to 0.242
Sodium (Na)-Total	29	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	ND to 29.0
Strontium (Sr)-Total	44.0	18.0	20.5	22.7	22.8	52.1	60.7	37.2	49.3	23.5	30.0	21.7	34.5	18.0 to 60.7
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.0 to 0.0
Thallium (Tl)-Total	0.0060	0.0021	0.0052	0.0020	0.0058	<0.0020	0.0038	<0.0020	<0.0020	<0.0020	0.0053	<0.0020	0.0032	ND to 0.0060
Tin (Sn)-Total	0.21	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	ND to 0.21
Uranium (U)-Total	0.0180	0.0023	0.0025	<0.0020	<0.0020	0.0092	<0.0020	0.0027	<0.0020	0.0026	<0.0020	<0.0020	<0.0020	ND to 0.0180
Vanadium (V)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	ND to ND
Zinc (Zn)-Total	48.5	24.6	34.5	34.8	43.6	22.1	40.1	25.7	31.7	29.7	36.6	20.8	31.9	20.8 to 48.5
Zirconium (Zr)-Total	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	ND to ND

ND = not detected

TABLE C-6 METAL CONCENTRATIONS (mg/kg) IN FOLIAR TISSUES AT THE WASTE ROCK DUMP, 2018

Plot #	W1-2	W1-2	W1-3	W1-4	W1-4	W1-4	W1-5	W1-5	W2-2	W2-2	W2-3	W2-3	W2-4	W2-4	W2-5	W2-5	W3-4	Range
Species	Alder	Alder	Alder	Alder	Alder	Willow	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Alder	Several Species	
Tissue type	Leaves	Stems	Leaves and Stems	Leaves	Stems	Leaves and Stems	Leaves	Stems	Leaves	Stems	Leaves	Stem	Leaves	Stems	Leaves	Stems		
Aluminum (Al)-Total	27.8	6.9	82.6	14.9	5.1	11.0	13.7	3.8	48.3	7.7	40.7	5.9	22.6	3.5	8.7	3.4	40.8	3.4 to 82.6
Antimony (Sb)-Total	1.85	0.640	0.910	2.35	0.903	1.15	6.08	1.08	2.77	0.629	1.11	0.402	8.51	0.726	1.48	0.575	32.4	0.4 to 32.4
Arsenic (As)-Total	7.37	2.97	7.36	7.31	2.96	3.88	6.72	2.19	5.16	1.51	1.97	0.701	6.84	0.900	2.04	0.778	68.7	0.7 to 68.7
Barium (Ba)-Total	3.64	8.78	4.41	0.513	1.02	0.595	0.573	0.591	1.76	4.47	0.609	4.26	0.960	0.820	0.355	0.417	1.88	0.36 to 8.78
Beryllium (Be)-Total	<0.010	<0.010	0.019	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	ND to 0.01900
Bismuth (Bi)-Total	0.181	0.070	0.139	0.327	0.124	0.164	0.937	0.160	0.252	0.050	0.100	0.037	0.782	0.062	0.156	0.065	4.29	0.037 to 4.290
Boron (B)-Total	17.3	13.3	9.7	3.1	6.7	5.9	15.1	10.8	8.1	9.0	8.3	8.6	4.1	5.2	4.6	7.4	30.7	3.1 to 30.7
Cadmium (Cd)-Total	0.0200	0.166	0.0737	<0.0050	0.0136	2.14	0.0439	0.178	0.0080	0.0420	0.0091	0.0262	0.0088	0.0125	0.0079	0.0093	6.44	0.008 to 6.440
Calcium (Ca)-Total	6860	4550	3300	4790	3450	6030	10900	3670	3570	3430	1490	1930	7640	3140	8170	4120	9190	1490.0 to 10900.0
Cesium (Cs)-Total	0.254	0.148	0.777	1.05	0.578	0.0901	0.239	0.129	0.690	0.483	0.594	0.477	0.668	0.445	0.519	0.569	0.188	0.090 to 1.050
Chromium (Cr)-Total	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.082	<0.050	<0.050	<0.050	0.078	<0.050	<0.050	<0.050	0.099	0.078 to 0.099
Cobalt (Co)-Total	0.515	0.146	0.256	0.274	0.140	0.466	0.228	0.110	0.448	0.124	0.285	0.049	0.094	0.055	0.143	0.079	0.769	0.049 to 0.769
Copper (Cu)-Total	11.3	11.6	34.8	12.0	16.9	4.68	9.73	11.7	10.2	10.3	12.1	10.1	13.2	11.9	9.20	11.7	9.20	4.7 to 34.8
Iron (Fe)-Total	123	47.9	166	130	56.8	58.5	97.1	37.6	195	57.8	111	36.3	177	41.3	84.6	41.0	530	36.3 to 530.0
Lead (Pb)-Total	8.84	3.67	2.66	4.28	1.61	2.60	12.3	3.74	6.86	1.37	2.48	1.01	15.3	1.42	3.21	1.32	68.6	1.0 to 68.6
Lithium (Li)-Total	<0.50	<0.50	0.63	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	ND to 0.6
Magnesium (Mg)-Total	1900	689	791	2950	1180	4770	3920	942	734	426	930	706	3330	1160	3170	1080	4840	426.0 to 4840.0
Manganese (Mn)-Total	206	311	360	45.6	70.5	93.0	117	101	262	399	107	275	94.2	48.1	110	78.4	414	45.6 to 414.0
Mercury (Hg)-Total	0.0051	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0051	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0121	ND to 0.012
Molybdenum (Mo)-Total	1.05	1.88	2.22	1.81	5.78	0.049	4.52	5.81	0.158	0.946	0.297	1.73	2.52	3.16	4.48	5.19	1.15	0.05 to 5.810
Nickel (Ni)-Total	4.68	2.01	11.3	2.71	2.00	1.30	2.93	1.50	4.65	2.01	7.23	2.39	2.86	1.81	2.52	1.79	1.67	1.30 to 11.300
Phosphorus (P)-Total	2170	1390	1710	1570	1410	2340	2390	1570	1840	1230	1730	1130	2020	1550	2180	1600	3700	1130 to 3700
Potassium (K)-Total	4800	2650	3400	3130	2750	4400	3870	2830	4460	2670	4960	2850	4360	3530	4300	4020	7890	2650 to 7890
Rubidium (Rb)-Total	11.8	5.14	18.1	15.1	9.79	6.97	11.7	6.54	18.7	8.82	16.9	9.20	14.6	10.5	14.8	12.3	18.9	5.1 to 18.9
Selenium (Se)-Total	0.110	<0.050	<0.050	0.059	<0.050	0.067	0.159	<0.050	<0.050	<0.050	<0.050	<0.050	0.060	<0.050	0.117	<0.050	0.655	0.059 to 0.655
Sodium (Na)-Total	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	ND to ND
Strontium (Sr)-Total	14.6	17.5	8.47	1.86	2.29	2.70	7.92	4.52	7.53	13.4	2.78	9.95	5.46	3.10	2.29	1.62	8.04	1.62 to 17.50
Tellurium (Te)-Total	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	ND to ND
Thallium (Tl)-Total	<0.0020	0.0022	0.0061	<0.0020	0.0053	<0.0020	0.0085	0.0162	<0.0020	0.0034	<0.0020	<0.0020	0.0026	0.0021	<0.0020	0.0025	0.0165	0.002 to 0.0165
Tin (Sn)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.59	ND to 0.590
Uranium (U)-Total	0.0049	<0.0020	0.0203	0.0074	<0.0020	<0.0020	0.0048	<0.0020	0.0072	<0.0020	0.0053	<0.0020	0.0084	<0.0020	0.0031	<0.0020	0.0313	ND to 0.0313
Vanadium (V)-Total	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	ND to 0.110
Zinc (Zn)-Total	43.5	76.1	29.7	23.6	41.8	107	82.5	79.7	20.0	35.2	12.6	26.6	24.6	30.7	31.5	40.1	304	12.6 to 304.0
Zirconium (Zr)-Total	0.22	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.23	ND to 0.23

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Date Received: 01-AUG-18
Report Date: 29-AUG-18 12:31 (MT)
Version: FINAL

Client Phone: 604-682-5122

Certificate of Analysis

Lab Work Order #: L2139940

Project P.O. #: NOT SUBMITTED
Job Reference: EAGLE GOLD
C of C Numbers:
Legal Site Desc: Victoria Gold Corp.

Heather McKenzie
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2139940-25 Veg 31-JUL-18 T1-1B - ALDER	L2139940-26 Veg 31-JUL-18 T1-2AB - ALDER LEAVES	L2139940-27 Veg 31-JUL-18 T1-2AB - ALDER TWIGS	L2139940-28 Veg 31-JUL-18 T1-3 - ALDER LEAVES	L2139940-29 Veg 31-JUL-18 T1-3 - ALDER TWIGS
TISSUE						
Metals	Aluminum (Al)-Total (mg/kg)	33.5	14.3	12.1	10.0	4.8
	Antimony (Sb)-Total (mg/kg)	5.59	1.16	0.963	0.471	1.32
	Arsenic (As)-Total (mg/kg)	17.0	4.02	2.88	3.40	3.07
	Barium (Ba)-Total (mg/kg)	39.5	4.61	12.8	5.60	10.5
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	0.219	0.058	0.044	0.014	0.072
	Boron (B)-Total (mg/kg)	7.7	5.5	8.3	7.3	7.7
	Cadmium (Cd)-Total (mg/kg)	<0.010	0.0052	0.0163	<0.0050	0.0055
	Calcium (Ca)-Total (mg/kg)	11000	7370	5170	10600	6710
	Cesium (Cs)-Total (mg/kg)	0.136	0.0957	0.258	0.149	0.176
	Chromium (Cr)-Total (mg/kg)	0.22	<0.050	0.060	<0.050	<0.050
	Cobalt (Co)-Total (mg/kg)	0.121	0.058	0.030	0.065	<0.020
	Copper (Cu)-Total (mg/kg)	6.54	6.03	6.12	4.34	5.20
	Iron (Fe)-Total (mg/kg)	222	64.5	42.6	47.2	26.3
	Lead (Pb)-Total (mg/kg)	48.0	7.39	5.28	2.46	4.43
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	2430	1670	983	1660	780
	Manganese (Mn)-Total (mg/kg)	214	42.3	71.2	64.2	74.2
	Mercury (Hg)-Total (mg/kg)	0.0067	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/kg)	3.71	4.34	6.40	8.51	6.59
	Nickel (Ni)-Total (mg/kg)	5.54	1.08	0.77	0.55	0.39
	Phosphorus (P)-Total (mg/kg)	938	2820	1980	2470	1450
	Potassium (K)-Total (mg/kg)	7510	5850	5110	5330	4110
	Rubidium (Rb)-Total (mg/kg)	7.81	11.4	11.0	7.09	5.92
	Selenium (Se)-Total (mg/kg)	<0.10	<0.050	<0.050	<0.050	<0.050
	Sodium (Na)-Total (mg/kg)	29	<20	<20	<20	<20
	Strontium (Sr)-Total (mg/kg)	44.0	18.0	20.5	22.7	22.8
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	0.0060	0.0021	0.0052	0.0020	0.0058
	Tin (Sn)-Total (mg/kg)	0.21	<0.10	<0.10	<0.10	<0.10
	Uranium (U)-Total (mg/kg)	0.0180	0.0023	0.0025	<0.0020	<0.0020
	Vanadium (V)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	48.5	24.6	34.5	34.8	43.6
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2139940-30	L2139940-31	L2139940-32	L2139940-33	L2139940-34
Description	Veg	Veg	Veg	Veg	Veg
Sampled Date	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18	31-JUL-18
Sampled Time					
Client ID	T2-2 - ALDER LEAVES	T2-2 - ALDER TWIGS	T2-3A - ALDER LEAVES	T2-3A - ALDER TWIGS	T3-2AB - ALDER LEAVES
Grouping **Analyte**					
TISSUE					
Metals Aluminum (Al)-Total (mg/kg)	20.0	5.2	8.2	<2.0	37.2
Antimony (Sb)-Total (mg/kg)	0.127	0.050	0.117	0.044	2.48
Arsenic (As)-Total (mg/kg)	1.37	0.626	0.571	0.411	4.09
Barium (Ba)-Total (mg/kg)	37.2	62.5	28.2	58.9	36.2
Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
Bismuth (Bi)-Total (mg/kg)	0.020	<0.010	<0.010	<0.010	0.173
Boron (B)-Total (mg/kg)	7.8	10.4	9.4	12.0	4.9
Cadmium (Cd)-Total (mg/kg)	<0.0050	0.0163	<0.0050	0.0097	0.0062
Calcium (Ca)-Total (mg/kg)	7470	6020	6860	5690	5790
Cesium (Cs)-Total (mg/kg)	0.330	0.225	0.161	0.104	0.379
Chromium (Cr)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt (Co)-Total (mg/kg)	0.100	0.065	0.054	0.034	0.334
Copper (Cu)-Total (mg/kg)	9.61	9.16	7.03	7.85	9.51
Iron (Fe)-Total (mg/kg)	71.6	35.9	68.2	42.6	75.9
Lead (Pb)-Total (mg/kg)	11.5	8.24	5.15	5.85	18.5
Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium (Mg)-Total (mg/kg)	2170	1230	1960	1290	1930
Manganese (Mn)-Total (mg/kg)	44.9	44.0	30.7	35.3	72.7
Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Molybdenum (Mo)-Total (mg/kg)	1.15	1.73	2.16	3.82	1.98
Nickel (Ni)-Total (mg/kg)	3.03	2.66	1.65	1.77	3.05
Phosphorus (P)-Total (mg/kg)	2270	1780	2330	1770	2350
Potassium (K)-Total (mg/kg)	7080	6590	7970	7750	6000
Rubidium (Rb)-Total (mg/kg)	10.3	8.64	7.58	6.58	17.5
Selenium (Se)-Total (mg/kg)	0.241	0.124	0.242	0.116	0.054
Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	<20
Strontium (Sr)-Total (mg/kg)	52.1	60.7	37.2	49.3	23.5
Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
Thallium (Tl)-Total (mg/kg)	<0.0020	0.0038	<0.0020	<0.0020	<0.0020
Tin (Sn)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Uranium (U)-Total (mg/kg)	0.0092	<0.0020	0.0027	<0.0020	0.0026
Vanadium (V)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Zinc (Zn)-Total (mg/kg)	22.1	40.1	25.7	31.7	29.7
Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2139940-35 Veg 31-JUL-18 T3-2AB - ALDER TWIGS	L2139940-36 Veg 31-JUL-18 T3-3AB - ALDER LEAVES	L2139940-37 Veg 31-JUL-18 T3-3AB - ALDER TWIGS	L2139940-38 Veg 31-JUL-18 W1-2 - ALDER LEAVES	L2139940-39 Veg 31-JUL-18 W1-2 - ALDER TWIGS
TISSUE						
Metals	Aluminum (Al)-Total (mg/kg)	9.6	18.8	6.5	27.8	6.9
	Antimony (Sb)-Total (mg/kg)	0.709	0.391	0.337	1.85	0.640
	Arsenic (As)-Total (mg/kg)	1.53	1.54	1.31	7.37	2.97
	Barium (Ba)-Total (mg/kg)	79.1	22.3	71.0	3.64	8.78
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	0.060	0.028	0.026	0.181	0.070
	Boron (B)-Total (mg/kg)	6.0	6.6	7.0	17.3	13.3
	Cadmium (Cd)-Total (mg/kg)	0.0111	<0.0050	0.0120	0.0200	0.166
	Calcium (Ca)-Total (mg/kg)	5120	6320	6160	6860	4550
	Cesium (Cs)-Total (mg/kg)	0.191	0.159	0.145	0.254	0.148
	Chromium (Cr)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	<0.050
	Cobalt (Co)-Total (mg/kg)	0.132	0.180	0.105	0.515	0.146
	Copper (Cu)-Total (mg/kg)	7.94	6.75	7.16	11.3	11.6
	Iron (Fe)-Total (mg/kg)	37.5	65.7	40.2	123	47.9
	Lead (Pb)-Total (mg/kg)	15.1	9.35	9.09	8.84	3.67
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	1100	1940	1080	1900	689
	Manganese (Mn)-Total (mg/kg)	101	66.3	97.0	206	311
	Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	0.0051	<0.0050
	Molybdenum (Mo)-Total (mg/kg)	4.74	3.97	3.38	1.05	1.88
	Nickel (Ni)-Total (mg/kg)	1.83	2.04	1.64	4.68	2.01
	Phosphorus (P)-Total (mg/kg)	1530	2500	1560	2170	1390
	Potassium (K)-Total (mg/kg)	4810	6600	4890	4800	2650
	Rubidium (Rb)-Total (mg/kg)	9.79	11.2	8.55	11.8	5.14
	Selenium (Se)-Total (mg/kg)	<0.050	0.087	0.052	0.110	<0.050
	Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	<20
	Strontium (Sr)-Total (mg/kg)	30.0	21.7	34.5	14.6	17.5
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	0.0053	<0.0020	0.0032	<0.0020	0.0022
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Uranium (U)-Total (mg/kg)	<0.0020	<0.0020	<0.0020	0.0049	<0.0020
	Vanadium (V)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	36.6	20.8	31.9	43.5	76.1
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	0.22	<0.20

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2139940-40 Veg 31-JUL-18 W1-3 - ALDER LEAVES AND TWIGS	L2139940-41 Veg 31-JUL-18 W1-4 - ALDER LEAVES	L2139940-42 Veg 31-JUL-18 W1-4 - ALDER STEMS	L2139940-43 Veg 31-JUL-18 W1-4 - WILLOW LEAVES AND TWIGS	L2139940-44 Veg 31-JUL-18 W2-2 - ALDER LEAVES
TISSUE						
Metals	Aluminum (Al)-Total (mg/kg)	82.6	14.9	5.1	11.0	48.3
	Antimony (Sb)-Total (mg/kg)	0.910	2.35	0.903	1.15	2.77
	Arsenic (As)-Total (mg/kg)	7.36	7.31	2.96	3.88	5.16
	Barium (Ba)-Total (mg/kg)	4.41	0.513	1.02	0.595	1.76
	Beryllium (Be)-Total (mg/kg)	0.019	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	0.139	0.327	0.124	0.164	0.252
	Boron (B)-Total (mg/kg)	9.7	3.1	6.7	5.9	8.1
	Cadmium (Cd)-Total (mg/kg)	0.0737	<0.0050	0.0136	2.14	0.0080
	Calcium (Ca)-Total (mg/kg)	3300	4790	3450	6030	3570
	Cesium (Cs)-Total (mg/kg)	0.777	1.05	0.578	0.0901	0.690
	Chromium (Cr)-Total (mg/kg)	<0.050	<0.050	<0.050	<0.050	0.082
	Cobalt (Co)-Total (mg/kg)	0.256	0.274	0.140	0.466	0.448
	Copper (Cu)-Total (mg/kg)	34.8	12.0	16.9	4.68	10.2
	Iron (Fe)-Total (mg/kg)	166	130	56.8	58.5	195
	Lead (Pb)-Total (mg/kg)	2.66	4.28	1.61	2.60	6.86
	Lithium (Li)-Total (mg/kg)	0.63	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	791	2950	1180	4770	734
	Manganese (Mn)-Total (mg/kg)	360	45.6	70.5	93.0	262
	Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/kg)	2.22	1.81	5.78	0.049	0.158
	Nickel (Ni)-Total (mg/kg)	11.3	2.71	2.00	1.30	4.65
	Phosphorus (P)-Total (mg/kg)	1710	1570	1410	2340	1840
	Potassium (K)-Total (mg/kg)	3400	3130	2750	4400	4460
	Rubidium (Rb)-Total (mg/kg)	18.1	15.1	9.79	6.97	18.7
	Selenium (Se)-Total (mg/kg)	<0.050	0.059	<0.050	0.067	<0.050
	Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	<20
	Strontium (Sr)-Total (mg/kg)	8.47	1.86	2.29	2.70	7.53
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	0.0061	<0.0020	0.0053	<0.0020	<0.0020
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Uranium (U)-Total (mg/kg)	0.0203	0.0074	<0.0020	<0.0020	0.0072
	Vanadium (V)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	0.11
	Zinc (Zn)-Total (mg/kg)	29.7	23.6	41.8	107	20.0
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2139940-45 Veg 31-JUL-18 W2-2 - ALDER STEMS	L2139940-46 Veg 31-JUL-18 W2-3 - ALDER LEAVES	L2139940-47 Veg 31-JUL-18 W2-3 - ALDER STEMS	L2139940-48 Veg 31-JUL-18 W2-4 - ALDER LEAVES	L2139940-49 Veg 31-JUL-18 W2-4 - ALDER STEMS
TISSUE						
Metals	Aluminum (Al)-Total (mg/kg)	7.7	40.7	5.9	22.6	3.5
	Antimony (Sb)-Total (mg/kg)	0.629	1.11	0.402	8.51	0.726
	Arsenic (As)-Total (mg/kg)	1.51	1.97	0.701	6.84	0.900
	Barium (Ba)-Total (mg/kg)	4.47	0.609	4.26	0.960	0.820
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	0.050	0.100	0.037	0.782	0.062
	Boron (B)-Total (mg/kg)	9.0	8.3	8.6	4.1	5.2
	Cadmium (Cd)-Total (mg/kg)	0.0420	0.0091	0.0262	0.0088	0.0125
	Calcium (Ca)-Total (mg/kg)	3430	1490	1930	7640	3140
	Cesium (Cs)-Total (mg/kg)	0.483	0.594	0.477	0.668	0.445
	Chromium (Cr)-Total (mg/kg)	<0.050	<0.050	<0.050	0.078	<0.050
	Cobalt (Co)-Total (mg/kg)	0.124	0.285	0.049	0.094	0.055
	Copper (Cu)-Total (mg/kg)	10.3	12.1	10.1	13.2	11.9
	Iron (Fe)-Total (mg/kg)	57.8	111	36.3	177	41.3
	Lead (Pb)-Total (mg/kg)	1.37	2.48	1.01	15.3	1.42
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	426	930	706	3330	1160
	Manganese (Mn)-Total (mg/kg)	399	107	275	94.2	48.1
	Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Molybdenum (Mo)-Total (mg/kg)	0.946	0.297	1.73	2.52	3.16
	Nickel (Ni)-Total (mg/kg)	2.01	7.23	2.39	2.86	1.81
	Phosphorus (P)-Total (mg/kg)	1230	1730	1130	2020	1550
	Potassium (K)-Total (mg/kg)	2670	4960	2850	4360	3530
	Rubidium (Rb)-Total (mg/kg)	8.82	16.9	9.20	14.6	10.5
	Selenium (Se)-Total (mg/kg)	<0.050	<0.050	<0.050	0.060	<0.050
	Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	<20
	Strontium (Sr)-Total (mg/kg)	13.4	2.78	9.95	5.46	3.10
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	0.0034	<0.0020	<0.0020	0.0026	0.0021
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Uranium (U)-Total (mg/kg)	<0.0020	0.0053	<0.0020	0.0084	<0.0020
	Vanadium (V)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	35.2	12.6	26.6	24.6	30.7
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2139940-50 Veg 31-JUL-18 W2-5 - ALDER LEAVES	L2139940-51 Veg 31-JUL-18 W2-5 - ALDER STEMS	L2139940-52 Veg 31-JUL-18 W3-4 - SEVERAL SPECIES	L2139940-53 Veg 31-JUL-18 W1-5 ALDER STEMS	L2139940-54 Veg 31-JUL-18 W1-5 ALDER LEAVES
TISSUE						
Metals	Aluminum (Al)-Total (mg/kg)	8.7	3.4	40.8	3.8	13.7
	Antimony (Sb)-Total (mg/kg)	1.48	0.575	32.4	1.08	6.08
	Arsenic (As)-Total (mg/kg)	2.04	0.778	68.7	2.19	6.72
	Barium (Ba)-Total (mg/kg)	0.355	0.417	1.88	0.591	0.573
	Beryllium (Be)-Total (mg/kg)	<0.010	<0.010	<0.010	<0.010	<0.010
	Bismuth (Bi)-Total (mg/kg)	0.156	0.065	4.29	0.160	0.937
	Boron (B)-Total (mg/kg)	4.6	7.4	30.7	10.8	15.1
	Cadmium (Cd)-Total (mg/kg)	0.0079	0.0093	6.44	0.178	0.0439
	Calcium (Ca)-Total (mg/kg)	8170	4120	9190	3670	10900
	Cesium (Cs)-Total (mg/kg)	0.519	0.569	0.188	0.129	0.239
	Chromium (Cr)-Total (mg/kg)	<0.050	<0.050	0.099	<0.050	<0.050
	Cobalt (Co)-Total (mg/kg)	0.143	0.079	0.769	0.110	0.228
	Copper (Cu)-Total (mg/kg)	9.20	11.7	9.20	11.7	9.73
	Iron (Fe)-Total (mg/kg)	84.6	41.0	530	37.6	97.1
	Lead (Pb)-Total (mg/kg)	3.21	1.32	68.6	3.74	12.3
	Lithium (Li)-Total (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
	Magnesium (Mg)-Total (mg/kg)	3170	1080	4840	942	3920
	Manganese (Mn)-Total (mg/kg)	110	78.4	414	101	117
	Mercury (Hg)-Total (mg/kg)	<0.0050	<0.0050	0.0121	<0.0050	0.0051
	Molybdenum (Mo)-Total (mg/kg)	4.48	5.19	1.15	5.81	4.52
	Nickel (Ni)-Total (mg/kg)	2.52	1.79	1.67	1.50	2.93
	Phosphorus (P)-Total (mg/kg)	2180	1600	3700	1570	2390
	Potassium (K)-Total (mg/kg)	4300	4020	7890	2830	3870
	Rubidium (Rb)-Total (mg/kg)	14.8	12.3	18.9	6.54	11.7
	Selenium (Se)-Total (mg/kg)	0.117	<0.050	0.655	<0.050	0.159
	Sodium (Na)-Total (mg/kg)	<20	<20	<20	<20	<20
	Strontium (Sr)-Total (mg/kg)	2.29	1.62	8.04	4.52	7.92
	Tellurium (Te)-Total (mg/kg)	<0.020	<0.020	<0.020	<0.020	<0.020
	Thallium (Tl)-Total (mg/kg)	<0.0020	0.0025	0.0165	0.0162	0.0085
	Tin (Sn)-Total (mg/kg)	<0.10	<0.10	0.59	<0.10	<0.10
	Uranium (U)-Total (mg/kg)	0.0031	<0.0020	0.0313	<0.0020	0.0048
	Vanadium (V)-Total (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Zinc (Zn)-Total (mg/kg)	31.5	40.1	304	79.7	82.5
	Zirconium (Zr)-Total (mg/kg)	<0.20	<0.20	0.23	<0.20	<0.20

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
AG-200.2-A-CCMS-VA	Soil	Elevated Ag in Soil by CRC ICPMS	EPA 200.2/6020A
This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Analysis is by Collision/Reaction Cell ICPMS.			
C-TOT-LECO-SK	Soil	Total Carbon by combustion method	CSSS (2008) 21.2
The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.			
CAT-XTR-SK	Soil	Ammonium Acetate Extractable Cations	CSSS 19.4 - 1M NH4OAc Extraction @ pH 7
Exchangeable Ca, Mg, Na, and K are extracted from the soil using neutral 1N ammonium acetate, then determined by ICP-OES. This method does not correct for calcium or magnesium extracted from carbonates or free gypsum.			
ETL-C:N-RATIO-SK	Soil	Carbon:Nitrogen Ratio - Calculation	Calculation
HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)
Soil samples are digested with hot nitric and hydrochloric acids, followed by CVAAS analysis. This method is fully compliant with the BC SALM strong acid leachable metals digestion method.			
HG-DRY-CVAFS-N-VA	Tissue	Mercury in Tissue by CVAFS (DRY)	EPA 200.3, EPA 245.7
This method is conducted following British Columbia Lab Manual method "Metals in Animal Tissue and Vegetation (Biota) - Prescriptive". Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with addition of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry, adapted from US EPA Method 245.7.			
HG-DRY-MICR-CVAF-VA	Tissue	Mercury in Tissue by CVAFS Micro (DRY)	EPA 200.3, EPA 245.7
This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry, adapted from US EPA Method 245.7.			
MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)
This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. Analysis is by Collision/Reaction Cell ICPMS.			
MET-DRY-CCMS-N-VA	Tissue	Metals in Tissue by CRC ICPMS (DRY)	EPA 200.3/6020A
This method is conducted following British Columbia Lab Manual method "Metals in Animal Tissue and Vegetation (Biota) - Prescriptive". Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with addition of hydrogen peroxide. Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).			
Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.			
MET-DRY-MICR-HRMS-VA	Tissue	Metals in Tissue by HR-ICPMS Micro (DRY)	EPA 200.3/200.8
Trace metals in tissue are analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICPMS) modified from US EPA Method 200.8, (Revision 5.5). The sample preparation procedure is modified from US EPA 200.3. Analytical results are reported on dry weight basis.			
Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.			
N-TOTKJ-COL-SK	Soil	Total Kjeldahl Nitrogen	CSSS (2008) 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.			
NH4-AVAIL-SK	Soil	Available Ammonium-N	Comm Soil Sci 19(6)
Ammonium (NH4-N) is extracted from the soil using 2 N KCl. Ammonium in the extract is mixed with hypochlorite and salicylate to form indophenol blue, which is determined colorimetrically by auto analysis at 660 nm.			
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

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	Vancouver, BC V6E 3S7		Email 2:	bonnieburns@northwestel.net			○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	604-696-6600	Fax:	Email 3:	Jknox@vitgoldcorp.com, cbeaudry@vitgoldcorp.c			**Analysis Request**
Invoice To	Same as Report ? ☑ Yes	☐ No	**Client / Project Information**				Please indicate below Filtered, Preserved or both (F, P, F/P)
Hardcopy of Invoice with Report?	☐ Yes	☑ No	Job #:	Eagle Gold			
Company:			PO / AFE:				
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Phone:		Fax:	Quote #:	Q69293, Peso Samples			
Lab Work Order # (lab use only)			**ALS Contact:**	Heather Mackenzie	**Sampler:**	Bonnie Burns & Crystal Beaudry	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Metals	Number of Containers
	T1-1B - alder	31-7-17			X	1
	T1-2AB - alder leaves	31-7-17			X	1
	T1-2AB - alder twigs	31-7-17			X	1
	T1-3 - alder leaves	31-7-17			X	1
	T1-3 - alder twigs	31-7-17			X	1
	T2-2 - alder leaves	31-7-17			X	1
	T2-2 - alder twigs	31-7-17			X	1
	T2-3A - alder leaves	31-7-17			X	1
	T2-3A - alder twigs	31-7-17			X	1
	T3-2AB - alder leaves	31-7-17			X	1
	T3-2AB - alder twigs	31-7-17			X	1
	T3-3AB - alder leaves	31-7-17			X	1
	T3-3AB - alder twigs	31-7-17			X	1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

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Bonnie Burns			EHF	1 Aug 2017	16:30	12.0 °C	ItA	8/2	1pm	

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	Vancouver, BC V6E 3S7			Email 2:	bonnieburns@northwestel.net			○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	604-696-6600	Fax:		Email 3:	Jknox@vitgoldcorp.com, cbeaudry@vitgoldcorp.c			**Analysis Request**
Invoice To	Same as Report ?	☑ Yes	☐ No	**Client / Project Information**				Please indicate below Filtered, Preserved or both (F, P, F/P)
Hardcopy of Invoice with Report?		☐ Yes	☑ No	Job #:	Eagle Gold			
Company:				PO / AFE:				
Contact:				LSD:	Victoria Gold Corp.			
Address:								
Phone:		Fax:		Quote #:	Q69293, Peso Samples			
Lab Work Order # (lab use only)				**ALS Contact:**	Heather Mackenzie	**Sampler:**	Bonnie Burns & Crystal Beaudry	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Metals	Number of Containers
	W1-2 - alder leaves	31-7-17			X	1
	W1-2 - alder twigs	31-7-17			X	1
	W1-3 - alder leaves and twigs	31-7-17			X	1
	W1-4 - alder leaves	31-7-17			X	1
	W1-4 - alder stems	31-7-17			X	1
	W1-4 - willow leaves and twigs	31-7-17			X	1
	W2-2 - alder leaves	31-7-17			X	1
	W2-2 - alder stems	31-7-17			X	1
	W2-3 - alder leaves	31-7-17			X	1
	W2-3 - alder stems	31-7-17			X	1
	W2-4 - alder leaves	31-7-17			X	1
	W2-4 - alder stems	31-7-17			X	1
	W2-5 - alder leaves	31-7-17			X	1

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Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
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	Vancouver, BC V6E 3S7		Email 2:	bonnieburns@northwestel.net			○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	604-696-6600	Fax:	Email 3:	Jknox@vitgoldcorp.com, cbeaudry@vitgoldcorp.c			**Analysis Request**
Invoice To	Same as Report ? ☑ Yes	☐ No	**Client / Project Information**				Please indicate below Filtered, Preserved or both (F, P, F/P)
Hardcopy of Invoice with Report?	☐ Yes	☑ No	Job #:	Eagle Gold			
Company:			PO / AFE:				
Contact:			LSD:	Victoria Gold Corp.			
Address:							
Phone:		Fax:	Quote #:	Q69293, Peso Samples			

Lab Work Order # (lab use only)		**ALS Contact:**	Heather Mackenzie	**Sampler:**	Bonnie Burns & Crystal Beaudry

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Metals												Number of Containers
	W2-5 - alder stems	31-7-17			X												1
	W3-4 - several species	31-7-17			X												1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

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Released by:	Date (dd-mmm-yy)	Time (hh:mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Bonnie Burns			EHF	20/8 1 Aug	16:30	12.0°C	HA	8/2	1 pm	

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APPENDIX B

Vegetation Rooting Study

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EAGLE GOLD PROJECT

PRELIMINARY VEGETATION ROOTING STUDY

Version 2018-01

JUNE 2018

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1. INTRODUCTION

The purpose of the Vegetation Rooting Study ("the Study") is to establish an approximate range of rooting depths for climax vegetation within the proposed cover system for the Eagle Gold Project ("the Project"). Previous cover analysis for the Project assumed an approximate root penetration depth of 0.5 m based on the rooting systems of common tree species in the Yukon (e.g. white spruce, black spruce, and balsam polar). A more detailed assessment of rooting depth is needed to confirm the current cover model assumptions.

1.1 PROJECT OBJECTIVES AND SCOPE

The benefits of vegetation on cover systems are well documented and rely on plant root water uptake to increase evapotranspiration (ET) through plant transpiration, thus limiting deep seepage to underlying mine waste (Benson et al. 2001, Ayres et al. 2004). Plant transpiration relies primarily on plant water availability, which is largely a function of root distribution within the cover profile, in combination with soil texture. Vegetation acts to remove water from the cover system through transpiration and interception. Therefore, through the addition of vegetation, the amount of water that reaches the surface of the cover system (effective precipitation) is immediately reduced as compared to a bare surface condition. As vegetation density increases, so does the root density. Increasing interception, transpiration and runoff will be the primary mechanisms to reduce net percolation into the cover system. Initial vegetation establishment (typically grasses) following cover system construction provides erosion protection. As the cover system ages and conditions allow, shrubs and eventually trees establish. Quantification of root depth / distributions and associated near surface material characteristics will yield valuable closure planning information. Key outcomes from the Study are to:

- Collect site specific or analogous site information pertaining to root depth / distributions that will be used to inform the final cover system designs;
- Identify key plant functional groups and material types for each plant functional group; and
- Calibrate a soil-plant-atmosphere (SPA) model using site-specific root depth / distribution and material characteristics information to improve output accuracy.

The objectives of this scope of work are to:

1. Quantify the root depth and distribution of key functional types (grasses, shrubs, trees) of mature plants at or near the Project site.
2. Characterize the growth materials associated with plant roots at the most active rooting depths for particle size distribution (PSD), textural, and nutrient analysis.
3. Summarize root depth / distributions of key functional types, the association between plant root and material characteristics, and develop specific recommendations for refining the cover closure plan.

1.2 STUDY ORGANIZATION

Reviewer comments suggested that a rooting study should examine existing climax vegetation in locations with similar soils to the proposed cover (and exist in thicknesses at depths more than 0.5 m) to determine the likelihood that rooting depths may exceed 0.5 m. While this is an aspect to be evaluated, more importantly there are key constraints to rooting depth to be considered that can be broadly grouped into physical, chemical, and biological factors (Robinson et al., 2003). Thus, it is not necessarily how deep roots are able to penetrate under ideal conditions, but how deeply can roots be expected to penetrate under conditions proposed for the engineered cover system and how the rooting depth effects net percolation rates. Therefore, a two-phased approach is proposed for the vegetation rooting study.

The first phase is to examine natural analogues to correlate rooting depth development over time to various rooting parameters. The second phase, is to apply first phase results and implement field trials to test the revegetation strategy. During field trials, vegetation will be destructively sampled at the climax period as informed by the natural system investigation. The two-phased approach to the Study consists of the following breakdown of tasks:

Phase 1: Examination of Natural Analogue Sites

- **Task 1**: Conduct a comprehensive literature search on vegetation in alignment with closure objectives for cover systems.
- **Task 2:** Establish test plots in analogous sites possessing similar plant communities (i.e. grasses, shrubs and trees) as the proposed successional end land use communities (KP, 2012a, 2012b). Climax successional vegetation communities would be confirmed through tree aging.
- **Task 3**: Conduct destructive sampling to assess vegetative characteristics of target species identified in the literature search, such as root density and length, and to identify rooting constraints/enhancements in each plot. The destructive sampling will focus on target species that are characterized by deeper penetrating rooting systems, and that may affect cover system performance. This will inform the development of recommendations regarding cover system materials (e.g., particle size, soil amendments, etc.).

Phase 2: Implement Cover System Field Trials

- **Task 1:** Develop cover system field trial design to assess vegetation treatments selected based on learnings from the Phase 1 Study results.
- **Task 2:** Construct a field trial landform and cover system. Landforms will be constructed from equivalent leached ore or waste rock material produced onsite
- **Task 3**: Vegetate constructed cover system trail area in alignment with successional end land uses. Seed mixes will be developed for any early successional grasses, and seedlings sourced for shrubs and trees.

- **Task 4:** Monitor moisture content of root zone to understand physical processes contributing to accumulation or removal of water (i.e. pore-water sampling collection over the duration of the cover system monitoring program).
- **Task 5:** Assess geochemical character of the cover system and underlying materials and identify any constituents that may be susceptible to bioaccumulation.
- **Task 6:** Conduct destructive sampling during and near the end of the program to assess the vegetative characteristics, such as root density and length.
- **Task 7:** Update cover system model based on results of the study to validate the effectiveness and applicability of the proposed vegetation strategy for the current cover system design.

Tasks 1 to 6 are aimed to better understand the physical, chemical, and biological constraints to rooting depth and cover system design that can be developed at the Project site. In this way, the uncertainties regarding possible rooting depths are constrained to the cover system design parameters that can be controlled as opposed to having to evaluate the broad range of natural variables that exist in nature.

1.3 STUDY OUTCOMES

The main outcomes of the proposed study include:

- Clarification of the optimal (and minimum) cover thickness capable of supporting plant water requirements for a mature rehabilitated plant community.
- Characterization of an improved plant establishment that will result in higher plant water-use (transpiration).
- Integration of root depth/proportion information in soil-plant-atmosphere (SPA) model improving their predictive accuracy.

2. PROPOSED FIELD METHODS

Proposed field methods to the two-phased approach are described below.

2.1 PHASE 1: NATURAL ANALOGUE SITE INVESTIGATION

2.1.1 Task 1: Literature Review

The comprehensive literature search on vegetation characteristics and forests in the region will be conducted to develop a list of target species to investigate further. In this case, target species (i.e., various trees and shrubs) to study are assumed to be those that fit into end land use vegetation communities but have penetrating root systems that may affect cover system performance.

2.1.2 Task 2: Establish Test Plots

To confirm the appropriate age class of vegetation to be sampled, tree coring and ring counts will be conducted at analogous study sites. The Study sites may include natural areas remaining on or adjacent to the Project site. Due to the possibility that the climax vegetation species may have roots systems that do not have optimal depths, the study will also examine rooting characteristics of various successional forest types that yield more appropriate rooting depths for the proposed cover designs. The rooting depth characteristics have been shown to relate to many factors, so rooting depth may also be constrained by physical properties such as textural contrasts and interfaces. By aging target species at natural analogue sites identified in the literature search, the age of the species in question and root depth can be correlated.

Additional characterization of near surface materials and plant root characteristics at the Project will yield valuable information to further inform closure planning. Assessment of cover trials will be used to optimize cover system design and performance as the current vegetation community is representative of one likely to establish on the cover system post closure.

2.1.3 Task 3: Destructive Sampling

A ‘skid steer’ or loader is proposed to be used to sample pits for each deep rooting plant target species at the base of each plant stem (Figure 2.1-1a). Sample pits at the base of each target species will be dug consecutively to minimize required machine and operator time for these works.

Pits will be dug as close to the stem as practicable (approximately 0.1 m), to a depth based on literature information on the maximal rooting depth of the target species and 0.25 m on either side of the stem (Figure 2.1-1a). Pit walls will then be smoothed using shovels and small water sprayers to remove excess soil and expose roots. Sampling frames divided into 0.05 x 0.05 m grid cells (0.0025 m^2) can be used to count the number of roots in each cell (Figure 2.1-1b). This method will allow for quantification of root depth and distribution, in addition to estimates of cumulative root distributions with soil depth exemplified in Figure 2.1-2.

Information on root distribution is valuable for determining where plants place most of their roots for water extraction, allowing cover designers to implement cover system with adequate growth media

thickness to satisfy plant root and moisture requirements. Root depth and distribution information can also be integrated into SPA models to achieve more accurate estimates of cover system performance over time. This information will improve the likelihood of successful rehabilitation and improve the design and performance of cover systems at the Project.

Figure 2.1-1: Creation of pit into a cover system with established vegetation to quantify root depths, distribution, and material textures

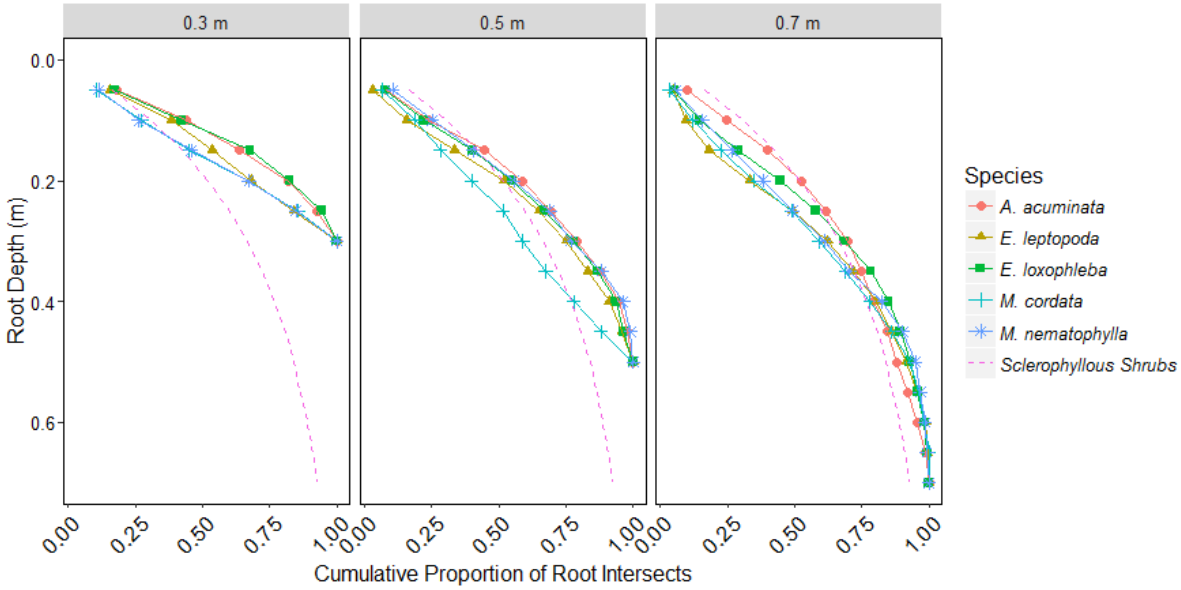

Figure 2.1-2: Example of cumulative proportion of root intersects (root counts) for saplings of five local native species with depth for three cover thicknesses

After root quantification, sampling the soil material from the Study pit wall in active rooting interval will be conducted. The active rooting soil interval likely represents the depth at which most roots extract water; characterizing the active rooting interval will help develop recommendations regarding the cover system growth medium. Soil samples for texture and plant available nutrients will be analyzed. These works can optimize cover system material characterisation in association with plant root characteristics.

2.2 PHASE 2: COVER SYSTEM FIELD TRIAL

2.2.1 Task 1: Field Trial Design

Task 1 is to develop a design for the cover system field trial based on proposed conceptual cover system design and learnings from the natural analogue site investigation to assess selected vegetation treatments.

A store-and-release cover system made up of nominally 0.5 m of cover system material with locally available topsoil and tailings or colluvium will be constructed to cover the landform produced in Task 2 below. The design base case will be of the design specified in the latest closure and reclamation plan for the site as shown in Figure 2.2-1. It may be possible that slight modifications to the cover system and its vegetation performance can be examined as part of field trials.

2.2.2 Task 2: Construct Field Trial Landform and Cover System

Landforms will be constructed from equivalent leached ore or waste rock material produced on site. Modelling and sensitivity analyses conducted (O'Kane, 2014) found very little difference in the performance of the Base Case cover design whether it was covering leached ore or waste rock materials. Landforms will be sized and built with commercial scale equipment that will represent the soil conditions with the expected compaction on closure landforms. Generally, these trials may only need to be on the order of 0.5 ha in area and they will be constructed according to specifications anticipated for closure.

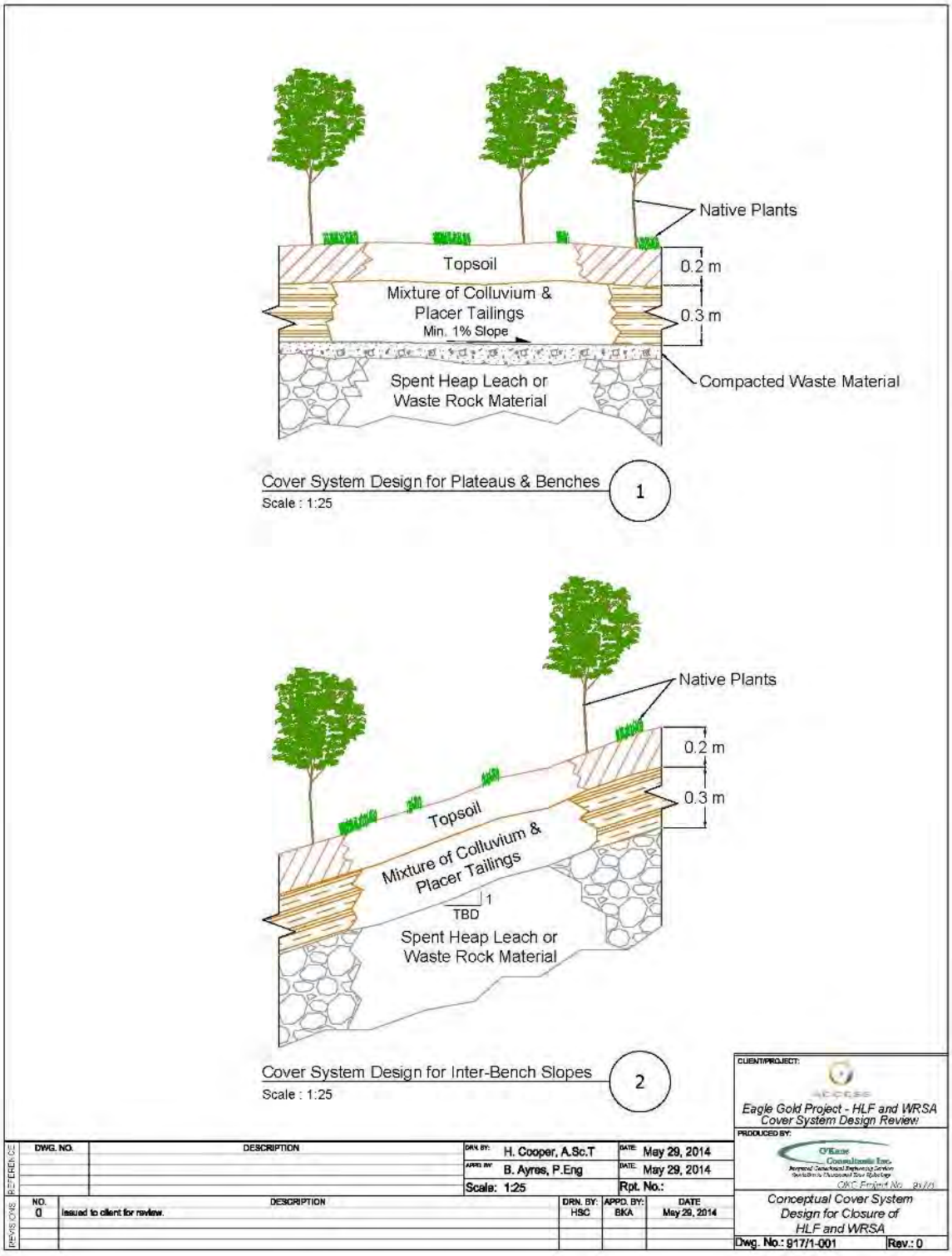

Figure 2.2-1: Conceptual HLF and WRSA Cover Design Drawings

2.2.3 Task 3: Vegetate Cover System Field Trial

Task 3 involves vegetating the constructed cover system trial area in alignment with successional end land uses. Given the end land use, seed mixes will be developed for early successional grasses, and seedlings will be sourced for climax shrubs and trees. The cover system field trial area will be revegetated using standard techniques (Table 2.2-1) with native species and based on updated vegetation information gathered during the natural analogue site investigation. The cover system field trials provide an opportunity to investigate vegetation prescriptions and techniques and evaluate the degree of success of the closure cover system design.

The field trials will require planting or seeding with desired species chosen as based on results from Phase 1. A short summary of the pros and cons of each re-vegetation technique is provided in Table 2.2-1 and is not intended as an exhaustive list.

Table 2.2-1: The pros (+) and cons (-) of common re-vegetation techniques (Florabank.org.au)

Direct Seeding	Planting	Natural Regeneration
(+) Lower establishment costs	(+) More reliable	(+) Plants are well-adapted to the site
(+) Natural look and more diversely structured	(+) Uniform	(+) Establishes healthiest plants
(+) Establishes healthier plants	(+) Re-vegetation is visible to passers by	(+) Lowest establishment costs
(-) Long establishment times may lead to more maintenance such as weed control.	(+) Uses small quantities of seed	(-) Needs an adjacent or nearby seed source
(-) Ants have been known to take seed	(-) Higher establishment costs	(-) May have to wait a long period for results
(-) Uses lots of seed	(-) Often results in unnatural looking rows	(-) Long establishment times may lead to more maintenance such as weed control.

NOTES:
Symbols of (+) and (-) denote a pros and cons, respectively, associated with each re-vegetation techniques.

If the cover trial is to be vegetated via direct planting, then the density of stems per unit area for a given species should resemble its natural stem density in natural areas. Appropriate planting densities between seedlings are important as water demands increase with plant size as vegetation communities mature. Moreover, planted species often represent those found in the final community stage that often require greater rooting volume, plant available water, and nutrients, thus stressing the importance of planting densities, growth material characteristics, plant available water, and growth medium thickness.

If the cover system is to be seeded, then it will be important to select the seed mix based on the literature review, the targeted end land use and the ability to source the seeds from local provenance. Using seed from the local area will take advantage of subtle adaptations present in plants occurring in the area, thus increasing the likelihood of successful re-vegetation. Seeding rates and seed mixtures for each species should resemble stem densities of their natural analogues on undisturbed sites, and

account for typical germination rates for each species present in the mixture. Seeders may be used to spread the seeds on the trial areas. Longer establishment times associated with seeding will likely required increased weed management until seeded plants are well established.

A combination of planting and seedling may be used; however, it is recommended that planting occur first to ensure establishment over a sufficient time followed by seeding. Natural re-vegetation may also occur and be beneficial if not mainly comprised of weeds.

2.2.4 Task 4: Moisture Content Monitoring

Monitoring of the soil water content in the plant root zone will be important in understanding the physical processes contributing to storage or removal of water.

During construction of the cover system it is proposed that an array of automated sensors be deployed in each location where seedling plots are located. Soil matric potential and water content are two parameters that are used to determine the water allocation in the rooting zone; they provide information on how roots are affecting the water balance of the cover system. The sensors will be configured in predetermined depths in the soil profile and connected to a data acquisition system (DAS), whereby measurements will be recorded at high frequency intervals. Generally, the instrumentation proposed here forms the basis of a cover system performance monitoring system that may be used in future stages.

2.2.5 Task 5: Geochemical Characterization

Task 5 will look to assess the geochemical character of the cover system and underlying materials and will identify any constituents that may be susceptible to bioaccumulation as identified through cover system material and waste material sampling programs.

Geochemical sampling during construction of the field trial is proposed in the same locations to where seedlings are to be planted. Samples will be collected of the underlying materials and the cover system materials. Sample collection will be followed by sampling during the destructive sampling to investigate if constituent concentrations in the various cover layers have increased with time. Key areas of geochemical sampling will coincide with target species to be destructively sampled to investigate if water demand by vegetation has assisted in the upward migration of any constituents of concern and if they are bioavailable to the species.

2.2.6 Task 6: Destructive Sampling

Task 6 will involve destructive sampling during and near the end of the program to assess the vegetative characteristics, such as root density and length. As with destructive sampling in the natural analogue site, a ‘skid steer’ or loader is proposed to be used to sample pits for each deep rooting plant target species at the base of each plant stem. Sample pits at the base of each target species will be dug consecutively to minimize required machine and operator time for these works. The methodology will follow the same protocol as in Task 3 of the natural analogue site investigation (Section 2.1.3).

2.2.7 Task 7: Cover System Model Update

The objective of the updated conceptual model will be to incorporate the accumulated monitoring and site investigation data. A review of results of monitoring data including climate, material characterization, hydrologic / hydrogeologic, and vegetation data will be used to refine the previous conceptual model of cover system performance. The updated conceptual model will help to direct the research program and identify key target areas where any data gaps exist.

The research program has been structured in such a way that areas posing the highest risk and uncertainty to the cover system's performance can be further evaluated. By conducting studies aimed at reducing uncertainty in estimates, numerical modelling can be refined to support field observations. This leads to an update of the conceptual model. Once the level of risk for the cover system performance has been reduced to an acceptable level agreed upon, the conceptual model can be moved forward as a basis for design.

Based on the results of both phases of the study, the cover system model will be updated to include the proposed vegetation strategy for the cover system design. The rooting profile characteristics of the cover system trial site will be compared to an analogue natural site of similar age. At some point during the study, the cover trail can be destructively sampled based on operation feasibility; this may not be until five or more years post-planting. Assuming similarity, the climax community species rooting depths in the analogue sites can then be used to infer the potential for rooting depth on the cover trail into the future.

3. CONCLUSIONS

The proposed two-phased study described herein provides the opportunity to optimize closure planning for the Project. The initial field investigation will increase immediate and short-term knowledge that can be used to improve the design of cover system field trials. Characterization of near-surface materials and plant root characteristics at the Project site will yield valuable information to further Project closure planning and increase the likelihood of successful rehabilitation. The vegetation study outlined here will help refine the anticipated rooting depths on the proposed cover system for specific species from construction through closure. Rooting characteristic information can also be used to identify specific vegetation as likely candidates for the cover system, and what their contribution to increasing AET is likely to be.

APPENDIX C

Alexco Environmental Group – Plan for Testing Biological Detoxification and In-Heap Bioreactor for CN and Metals

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Technical Memorandum

To: Steve Wilbur, Hugh Coyle, Victoria Gold

From: Jim Harrington, Alexco Environmental Group

Re: Plan for Testing Biological Detoxification and In-Heap Bioreactor for CN and Metals

1 INTRODUCTION AND BACKGROUND

This plan has been developed as part of the closure planning process for the Eagle Gold Project (Project). It is part of the reclamation research identified in the Reclamation and Closure Plan (RCP) to address uncertainties in the heap detoxification process as the heap transitions from leaching into closure. The field-based research is planned to be concurrent with heap leaching operations over a 3-year period, with the primary test taking approximately 100 days followed by quarterly testing of effluents for up to 12 quarters thereafter to evaluate rebound, stability, and seasonal effects.

Water Use Licence QZ14-041, which was granted to the Project in December 2015, requires a phased Reclamation and Research program "to verify the proposed biological detoxification of the heap, including incorporation of data gathered through the operation of the HLF and information from the use of similar technology at heap facilities operated in similar climatic conditions." Further, it also requires "a phased program, similar to that provided for the PTSs, for the proposed in-heap bioreactor treatment system including the assessment of the ability to maintain reducing condition in the long term and the potential for rebound and/or release of metals."

Gold-containing materials leached by cyanide are characterized by cyanide residuals, elevated pH, and some soluble metals and metalloids. These conditions result from the elevated pH due to lime addition during heap placement, cyanide-metals complexation, and oxidation of materials that were previously less exposed to atmospheric conditions. Prior column tests (performed at Kappes Cassidy in 2013-2014 and summarized by TetraTech, 2014) verified that treatment of cyanide residuals in Eagle Gold spent ore, nitrogen-containing CN breakdown products (cyanate, thiocyanate, nitrate/nitrite, and ammonia) can be degraded using microbial degradation. Furthermore, some metals showed significant reduction in concentrations during this treatment process, whether by 1) enhanced sorption as the pH was reduced toward neutral conditions, 2) the removal of the complexing action of cyanide as it was degraded, or 3) via other biological precipitation processes such as formation of mixed valence iron and manganese oxides or biogenic sulphide minerals.

As is indicated in the Reclamation and Closure Plan (RCP; AEG 2014), during late stages of heap operation and heap draindown a biological treatment process will be employed for the Project. The purpose will be to improve heap drainage water quality such that it can be readily treated in a water treatment plant (WTP) or in constructed wetland treatment systems (CWTS).

There are two proposed processes that are complementary and thus are discussed in this Study Plan together. These processes are:

- Biological CN degradation in the vadose and saturated portions of the heap, where sugar-containing-solutions are applied to the heap using the same equipment used in heap leaching (pumps, pipes, drip emitters/sprinklers). Application of the sugar solution within the heap promotes the reaction of sugars and cyanide, which yields less toxic cyanohydrins, and supports the degradation of nitrogenous CN breakdown products that ultimately transforms CN and other N compounds to gaseous N_2.

- Formation of biochemically-created reducing conditions within the saturated portion of the heap, where alcohol-containing solutions are applied to heap materials using the same equipment used in heap leaching (pumps, pipes, drip emitters/sprinklers).

Typically, biological CN degradation is performed with slower solution application rates than that used during active leaching, while targeting a solution quantity to any active application area that is equivalent to a pore volume of the liquid in the vadose zone in that area. Solutions from the gold recovery (in the Adsorption Desorption and Recovery plant) are amended with molasses or other similar sugar source, and pumped back up to the heap. The sugar solution is applied at a rate calculated to degrade both the solution-phase CN and the sorbed CN forms, and is applied slow enough onto the surface of the heap to target the smaller pores within the heap materials, thus enhancing coverage of the solution into zones that could otherwise create rebounds in CN once biological treatment solutions are no longer being applied to the heap. For the Project heap areas, this is estimated to be 12 areas each for approximately 60 days, and the timing of the initial treatment application is targeted to be just after CN addition has stopped, beginning with the oldest areas of the heap and working over the next 2 years progressively toward areas that were last leached.

As the effect of the sugars reaches the in-heap pond, microbes in the pond begin to transform the pond to anaerobic conditions. This effect is tempered by the continued mobilization of nitrate from the vadose zone into the in-heap pond, but because the systems are not well mixed, zones of both denitrification and sulphate reduction will likely form. As CN treatment within the vadose zone progresses to completion, the saturated zone is further driven to more reducing conditions (i.e., more strongly into sulphate-reducing conditions) by the continued application of alcohol. Thus the in-heap treatment process is sequential in timing (sugars targeting CN degradation followed by alcohols enhancing nitrate and sulphate reduction) while migrating in location along the flow path (from vadose zone through to the saturated in-heap pond) prior to discharge from the heap.

2 OPERATIONAL DATA RELEVANT TO BIOLOGICAL DETOXIFICATION AND BIOREACTOR DESIGN

There are several areas where heap operational information will be reviewed in the final design of the biological detoxification and bioreactor tests.

2.1 WATER CHEMISTRY

While metallurgical column testing provides some understanding of the formation and evolution of constituents that may be present in the full-scale larger heap setting, the smaller-scale testing typically does not fully represent the more complex heterogeneity of the ore body (and hence the resultant stacking of ore in the heap), the length of atmospheric exposure and wetting and drying cycles in the heap leach process, and the localized gradients and variability of pH, cyanide concentration, lime addition rates, etc. Changes in mining plans and other operational decisions can also affect water chemistry, including the extent of evaporative concentration of heap solutions, extent of freshwater makeup and constituents present in the fresh water, the use of sprinklers vs. drip emitters, and the solution application rate which can affect relative oxidation levels in the heap.

When performing the final design of the biological detoxification and bioreactor field tests, water chemistry from the pregnant and barren solutions will be reviewed to ensure that all relevant constituents that may affect reagent requirements have been considered.

2.2 HEAP LEACHING PERFORMANCE

As part of the HLF Operations, Maintenance and Surveillance program, for example, gold recovery, leach times (i.e., duration of solution application) for each area of the heap, grades of pregnant solution over time, cyanide use, and pH of the pregnant solution will be monitored. This operational data can be used to assess the potential lateral variability in flow paths which might be relevant for biological detoxification. A review of this operational data would be done during the planning stage for biological detoxification so that solution delivery and potential variability by heap area for duration or concentration of reagents can be evaluated.

3 FIELD TEST STUDY PLAN

3.1 BIOLOGICAL DETOXIFICATION COLUMN AND BIOREACTOR SETUP

During the leaching process over the entire operational period, there will be lifts that will have been leached and then stacked over and re-leached, with the areas deepest in the heap and nearest to the in-heap pond leached the longest. Thus a few years into the heap leach operation, materials will be available that have been well leached and will be representative of the heap at closure. While unsaturated heap materials will be readily available during operations to study the biological detoxification process, the saturated portion of the heap will not be accessible until closure, and consequently heap materials will need to be newly flooded to simulate the in-heap pond area which will become the bioreactor. Thus the field program will create two settings that are similar to the sequential unsaturated and saturated zones in the heap that will be used to treat the water contained in the heap materials. Field columns, small lined areas on the heap, and tanks will be used to set up a flow path that simulates the conditions on site.

The following summarizes essential aspects of the column setup (see attached illustration):

- Select heap materials from the longer leached portion of the heap that have completed their leaching process and have been exposed to atmospheric oxygen for several years. These will be placed into a contained area for biological detoxification testing. While this rehandling will affect the localized material characteristics which affect unsaturated flow of solutions in the heap, this test is studying the chemistry of the process not the unsaturated flow variables of the heap treatment process.

- Two approaches for the vadose-portion of the heap column setup are considered to be appropriate and are acceptable, with some specific advantages and disadvantages for each considered below:

    - A large scale wide diameter column can be constructed, with heights of 10 m or more similar to a lift of stacked heap materials (this setup will be referred to as the “column” approach).

    - A trench can be excavated in the side of the heap, a liner placed, and the heap materials re-placed on the lined area, similar to a field scale lysimeter construction (this setup will be referred to as the “lysimeter” approach.

- Either approach is considered acceptable to study the water chemistry outcomes of the process and yield design parameters and confirmation of the full scale approach.

- Some advantages and disadvantages of the column approach include:

    - All columns suffer from skin effects, i.e., solution flow tends to move vertically until lower permeability materials are encountered, then flow goes laterally until the edge of the column is reached, then flow continues along the surface of the column, and may result in column areas that do not receive representative solution application.

  - Column materials provide restrictions on gas exchange similar to a given soil column that is contained in the heap, allowing for formation of anaerobic conditions within the column more similar to what would be experienced in the bulk heap materials.

- Some advantages and disadvantages of the lysimeter approach include:

  - It may be difficult to apply solutions to the side-heap area that are representative of the vertical column flow path which is the primary flow path in a full scale heap.

  - Side-heap areas are the area where atmospheric exchange is greatest, resulting in a more inefficient use of the reagent.

- The bioreactor setup should be done in such a way as to provide about 14 days of residence time within saturated heap materials. The portion of the test simulating the saturated heap can be done by creating a tank or a lined area that is filled with leached spent heap materials, and providing an invert elevation for the tank or lined area such that the area remains saturated. Options to create this bioreactor can include a small lined area on the side of the heap, a tank placed on the heap area next to the column or lysimeter area, or a second column that each would receive solutions in an upflow configuration. While ideal, it is not necessary that all solutions from the column or heap be applied to the bioreactor. From here on bioreactor setup will be referred to as a "bioreactor tank" even though it may be constructed using liner.

- The bioreactor tank will have an upflow configuration, such that solutions will be added to the bottom of the reactor through a perforated pipe network, and pumped or forced by gravity upward to the overflow area. The heap materials will be entirely saturated such that the all the flow passes through the saturated heap materials, which will become coated by a biofilm of microbes that will ultimately drive the metals treatment process. By providing a shallow layer of standing water over the top, short circuiting to the discharge location will be avoided.

- The solution application process will utilize a similar or slower solution application rate as the heap leaching process itself. For instance, a common range of solution application is 5-20 liters/m^2/hour (Bliewas, USGS 2012 Open-File Report 2012–1085). A solution application rate for biological treatment will typically be half or less than the solution application rate utilized in the actual heap operations. While a design solution application rate has been suggested for the Project based on column test work, the actual solution application rate should be reviewed as it will vary during the life of the project as the heap leach characteristics are determined in the full scale configuration. For this study plan a solution application rate of 5 liters/m^2/hour is assumed.

- Based on the assumed solution application rate, a drip emitters spacing will be utilized so that the material in the heap materials are wetted and maintained wet during the course of the test operation.

- Heap materials will be tested prior to the treatment test for soluble cyanide and nitrogen species using a meteoric water mobility test or hot water rinse. Heap materials will be re-tested after the test operation to compare reduction in solid phase concentrations.

- Heap materials loaded into the bioreactor tank should be tested for metals and sulphate using a meteoric water mobility test or hot water rinse, as well as for hydroxylamine-extractable iron (described in Lovely and Phillips, 1987). Soluble metals, cyanide and nitrogenous species will be measured in the overflow of the bioreactor tank after it is filled, and continue at a frequency equivalent to each calculated pore volume exchange through the rest of the test.

3.2 COLUMN OPERATION

The following summarizes essential aspects of the column operations:

- Barren solution from the ADR will be filled into a holding tank (approximately 5,000 liters) and replenished periodically. Molasses amendment will be added to and mixed into the barren solution every time it is replenished. The molasses concentration will account for both solid and soluble cyanide and reduced nitrogen species. Low levels of phosphoric acid will be added to the molasses to stimulate microbial growth at a C:P molar ratio of approximately 100:1. (This ratio is based on experience; all heap materials will contribute some phosphate, though its solubility will be initially limited.) The purpose of the P amendment is to stimulate microbial growth, where P limitation can be a factor in the transition from an autotrophic setting (which the heap is during leaching) to a heterotrophic setting (which the heap will be during biological detoxification).

- Drainage from the column or lysimeter will be amended with alcohol (methyl or ethyl alcohols or a mixture of both are acceptable) and directed to the bioreactor. Alcohol amendment concentration will account for soluble oxidized nitrogen species (nitrate, nitrite), soluble metals, sulphate, and a portion of hydroxylamine-extractable iron measured in the heap materials. The objective of the alcohol amendment is to support microbial conversion of the metals into primary metal sulphides via sulphate reduction and metal sulphide precipitation (e.g., FeS, FeAsS, CuS, etc.).

- The overall duration of the solution application will continue for approximately 90 days, then allowed to drain for 10 days at the end for an overall duration of ~100 days. The expectation is that it will take approximately 60 days for the treatment to biologically detoxify the heap materials, and that sulphate reduction will become fully effective in the bioreactor within this same time period, allowing for three samples at the end of the test (i.e., day 70, day 84, and day 98) to show treated effluent concentrations from both the biological detoxification test and from the bioreactor test.

- The solution concentration of molasses in the feed solution will be what is stoichiometrically required to account for equimolar sugars and cyanide and reduced nitrogenous forms in the barren solution and the heap solids, with these compounds including:

    - Total cyanide,
    - WAD cyanide
    - Cyanate,
    - Thiocyanate,

- Ammonia.

Note: biological detoxification is accomplished in two phases: the first is a rapid reaction of sugars with free or weakly complexed cyanide (minutes to hours), and the second is a slower reaction that is microbially-catalyzed, where microbes that are naturally present in the ore materials grow and utilize cyanide as a nitrogen source, or detoxify cyanide to render the pore water environment more benign from a microbial perspective. Microbial growth is stimulated by the addition of a carbon source at a typical molar ratio of 0.5:1 sugars to cyanide (i.e., 4:1 C:N ratio). In prior heap detoxification experience, this ratio has been highly variable (i.e., as low as 3:1 and as high as 10:1), and other nitrogen species (nitrate/nitrite or ammonia) can be a bigger control on carbon demand; however, in a test column the WAD and free cyanide are typically the driver of a carbon demand. Total cyanide is assayed to understand if heap drainage could have a secondary CN formation upon exposure to sunlight where FeCN complexes could break down and release free CN.

- The solution concentration of alcohol in the bioreactor feed solution will be what is stoichiometrically required to account for biological reduction of soluble and sorbed species:
  - Nitrate plus nitrite,
  - Divalent cationic metals soluble and sorbed that form primary sulphides: Cd, Cu, Ni, Zn etc.
  - Metalloids that can be incorporated in sulphides: As, Sb
  - Soluble or hydroxylamine-extractible Fe
  - Sulphate that is sufficient to form sulphide and precipitate the above metals
  - Elements that form reduced insoluble (non-sulphide) precipitates: Cr, Se.
- Test operation (i.e., solution and reagent amendment) will continue until stable data for relevant constituents has been achieved for three consecutive data points (four weeks if sampled every 14 days) to determine end points relevant to active WTP design and CWTS design. As currently conceptualized, drainage from the biological detoxification column is expected to be relevant to active water treatment during heap draindown, and drainage from the bioreactor tank is expected to be relevant to the CWTS that would be constructed in the events pond or other areas.

3.3 POST-TEST CLOSURE SIMULATION

At the end of the test, the biological detoxification test will have cover soil placed on the surface using the design that is contemplated for the heap. All flow from the biological detoxification test will be routed through the bioreactor such that the combined biological detoxification and bioreactor processes simulate the heap unsaturated and saturated areas.

Drainage from the bioreactor will then be collected in a buried holding tank and pumped dry quarterly. The volume of the drainage should be measured, and water chemistry assayed for all licence parameters and field

parameters (DO, pH, conductivity). No special treatment will be done to ensure flow through the seasons, and it is expected that the columns or tanks may freeze and thaw and the effect of this will be assessed over the subsequent quarterly testing.

While of limited use in predicting cover performance (as this test will simulate only a small area in a setting that reflects only a single aspect that is present in the heap area) this information will show the effect of continued input of meteoric water and any rebound from areas less treated on the chemistry of the combined areas.

4 REFERENCES

Bleiwas, D.I., 2012, Estimated water requirements for gold heap-leach operations (ver. 1.1, December 11, 2012): U.S. Geological Survey Open-File Report 2012–1085, 17 p., available only at *http://pubs.usgs.gov/of/2012/1085*.

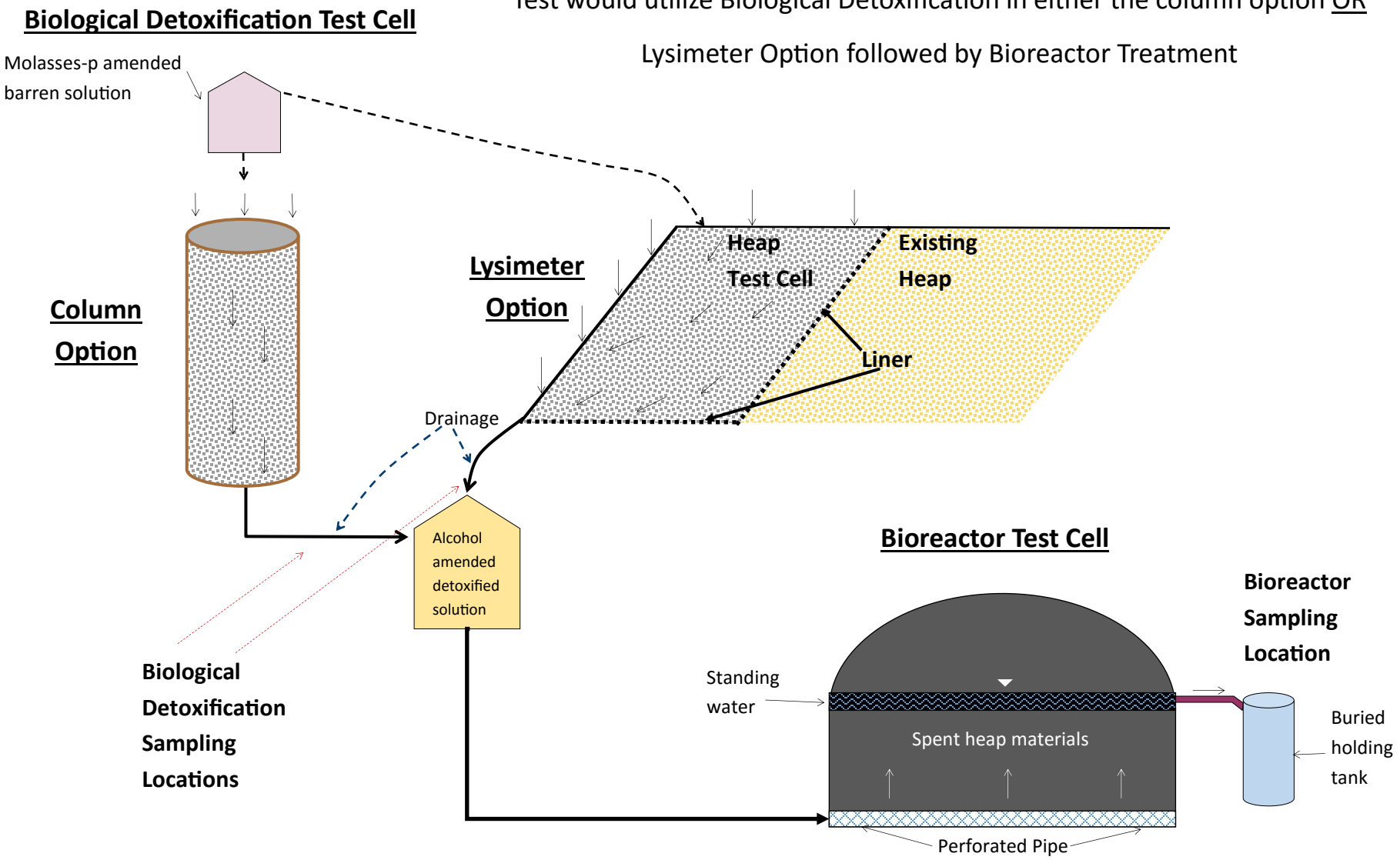
Lovely, Derek R.; Phillips, Elizabeth J. 1987. Rapid Assay for Microbially Reducible Ferric Iron in Aquatic Sediments. Applied and Environmental Microbiology. v53(7). 1536-1540.

Tetratech, 2014. Cyanide Destruction Column Studies Report, Eagle Gold Project. March 13, 2014. TetraTech Project No 133-77355-12001.

Biological Detoxification and Bioreactor Test Schematic

Test would utilize Biological Detoxification in either the column option OR

Lysimeter Option followed by Bioreactor Treatment



APPENDIX D

Closure Pipe Design Analysis

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Project Memorandum

To:	**File**	**Doc. No.:**	
From:	**Troy Meyer and Derek Hrubes**	**Date:**	**June 29, 2018**
Subject:	**Closure Pipe Design Analysis**		
Project No.:	**0792021**		

1.0 INTRODUCTION

The purpose of this memorandum is to present the methods and results of the closure drain pipe analysis completed for the design of the proposed Heap Leach Facility (HLF) at StrataGold Corporation's (SGC) Eagle Gold Project located in Yukon Territory, Canada. SGC is a directly held, wholly owned subsidiary of Victoria Gold Corp. The HLF design is presented in a report titled "Eagle Gold Project Heap Leach Facility Detailed Design", issued by BGC Engineering and dated January 2018. Select Design Drawings have been provided in Attachment 1 for reference.

2.0 CLOSURE SYSTEM DESIGN

During closure of the HLF, the cyanide in the spent ore will be destructed, the heap will be rinsed and draindown flows will be managed through the existing pumping system. Once draindown flow and water quality are acceptable for the passive treatment system, the liner system below the In-Heap Pond will be punctured by drilling to allow complete drainage of water through a pre-installed outlet system into the closure sump. The closure sump drain system will consist of a linear low-density polyethylene (LLDPE) lined gravel sump with perforated N-12 pipe drain loop directing flow to high-density polyethylene (HDPE) outlet pipes (Drawing 05-04, Detail 31). The closure sump will be placed directly below the leak detection sump to direct residual flows from the leak detection system to the closure outfall (Drawing 05-02, Detail 22).

At closure, the liner system will be punctured by drilling through two 250 mm open casing pipes extending to the In-Heap Pond installed during initial construction (Drawing 05-04, Detail 33). The PLS and LDRS Sump liners will be punctured by a drill string which will be lowered through each casing. A series of steel plates installed during initial construction will guide the drill and stop the drilling head at the appropriate depth within the closure sump. Once the drill string is retrieved, fluid will drain through the punctured liner into the closure sump where it will enter the closure drain loop and drain by gravity to the outlet monitoring vault (Drawing 05-05, Detail 37). Three 150 mm SDR 11 HDPE pipes lead from the closure drain loop at a minimum 2% slope; approximately 40 m downstream from the closure sump at approximately Station 2+72, the three drain pipes merge into one 150 mm SDR 11 HDPE pipe where the grade steepens significantly (Drawing 03-05). This pipe transitions into one 150 mm SDR 17 HDPE pipe at approximately Station 1+80, once there is a sufficient reduction in the buried depth (Drawing 03-05).

The closure drain pipes will be installed such that they connect to the monitoring vault and to allow for water quality and quantity monitoring (Drawing 05-06). An additional closure pipe will be installed to connect from the event pond to approximately Station 0+40 of the design closure pipe alignment, complete with valves to direct flow, as shown in Figure 2-1.

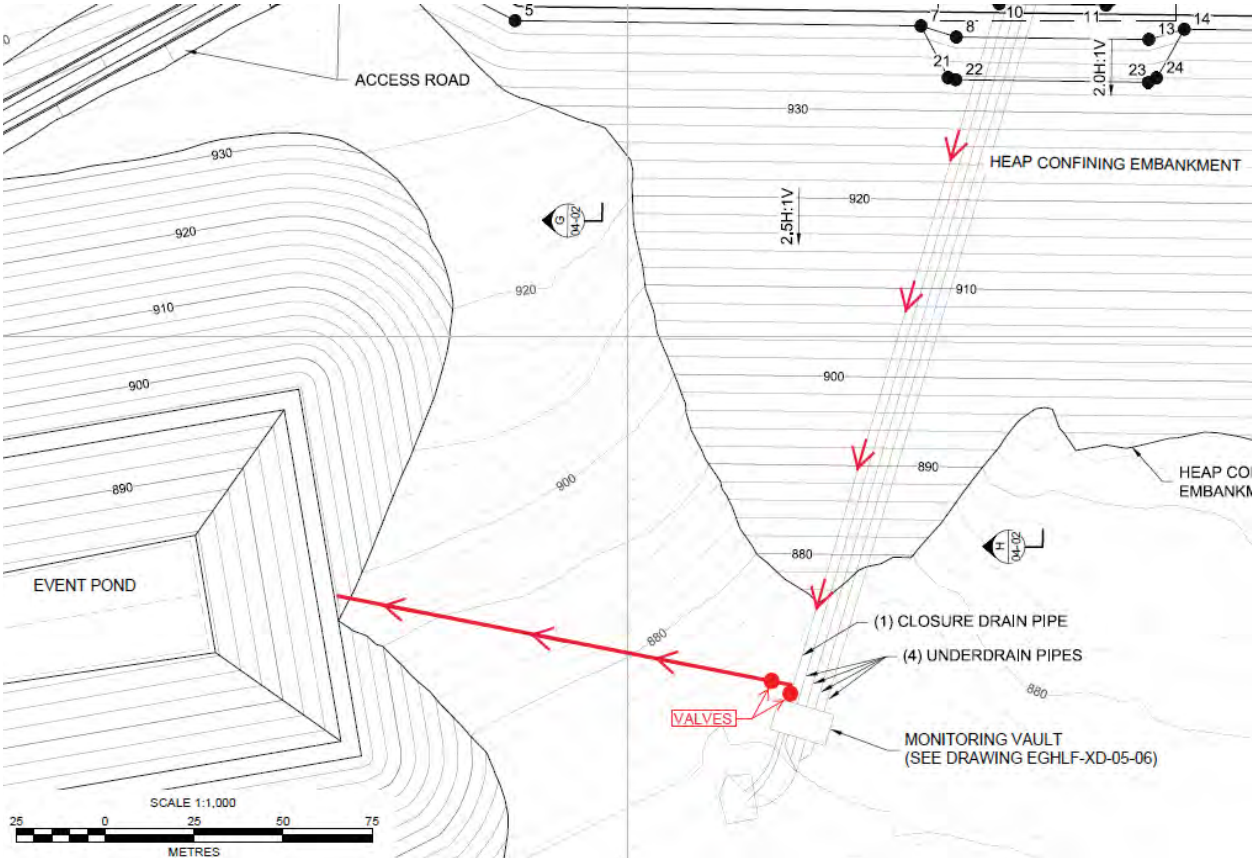

Figure 2-1. Proposed connection pipe alignment

The additional section of closure pipe will be required to flow under confined pressure uphill and this analysis is being performed to verify that there is sufficient elevation (head) difference between the closure sump and the event pond for the pipe system to convey the anticipated design flow at closure and through the post closure period.

3.0 CLOSURE PIPES

Solid wall HDPE pipe is specified for the closure pipes downstream of the closure drain loop. SDR 11 and SDR 17 HDPE pipe are used for the closure system based on the amount of overburden pressure at each section. Pipe sectional properties were obtained from available vendor product data and are presented in Table 3-1.

Table 3-1. Non-perforated solid wall HDPE pipe properties.

Dimension Ratio	Nominal Diameter (mm)	Outside Diameter (mm)	Inside Diameter (mm)	Wall Thickness (mm)	Pressure Rating (psi)	Manning's Roughness Coefficient
11	150	168	136	15.3	160	0.011
17	150	168	147	9.9	100	0.011

The additional section of closure pipe has been modeled as SDR 17, due to the minor amount of overburden pressure anticipated post-installation.

4.0 ANALYSIS METHOD

Hydraulic modeling was performed using Autodesk's Storm and Sanitary Analysis 2018 program, Version 12.0.42.0. The Storm and Sanitary Analysis 2018 program is capable of modeling complex hydrology and hydraulics, through detailed catchment and conveyance system definition. This is accomplished by inputting basins (catchments) and linking these with hydraulic elements (channels, pipes, manholes, ponds, orifices, weirs, etc.). The hydraulic model elements used for this analysis were used to provide results including peak flows, water surface elevations (hydraulic grade lines), and energy grade lines.

Numerous analysis methods are available for use within the Storm and Sanitary Analysis 2018 program. Since one of the pipes does have an uphill slope, where the outlet elevation is higher than the inlet elevation, the system required analysis with hydrodynamic routing.

A flow rate of 10 litres per second (l/s) was modeled to confirm conveyance within the system, based on anticipated maximum closure flow rates provided by SGC.

5.0 ANALYSIS RESULTS

A summary of the results of the hydraulic model for a flow rate of 10 l/s are summarized in Table 5-1 and Table 5-2. A model plan view, detailed output report, and hydraulic profile are provided in Attachment 2.

Table 5-1. Summary of hydraulic link results (10 l/s).

Pipe ID	Peak Flow During Analysis (l/s)
1_SDR11	10
2_SDR17	10
3_SDR17	10
4_SDR17 (DIVERSION)	10

Table 5-2. Summary of hydraulic node results (10 l/s).

Node ID	Invert Elevation (m)	Maximum Hydraulic Grade Line Depth (m)	Maximum Pressure Head (psi)
STA. 2+72.3 (IN-HEAP POND)	906.70	0.04	~ 0
STA. 1+81.4	890.80	6.42	9.13
STA. 0+58.2	871.40	24.91	34.43
STA. 0+40	869.80	26.42	**37.58**
EVENT POND	896.00	0.04	~ 0

Routing 10 l/s through the closure pipe system identified that the system could adequately convey this assumed flow, without backing water into the in-heap pond behind the embankment. The maximum head pressure anticipated for a flow rate of 10 l/s occurs at Station 0+40, which has the lowest invert elevation in the modeled system. Results show that the maximum head pressure at that location should be approximately 37.58 psi, which is well below the 100 psi pressure rating for the SDR 17 closure pipe.

The potential flow capacity within the closure pipe system increases as the elevation (head) difference between the water levels in the closure sump and the event pond increases. A sensitivity analysis was performed, and it was estimated that water would begin backing up into the in-heap pond once the flow rate exceeds approximately 19 l/s. The piping system is capable of conveying flows in excess of this through an increase in pressure head if the In-Heap Pond impounds water. However, the maximum flow rate is likely dictated by the hydraulic conductivity of the gravel surrounding the closure drain loop, within the closure sump.

A summary of the results of the hydraulic model for a flow rate of 19 l/s are summarized in Table 5-3 and Table 5-4. A detailed output report and hydraulic profile are provided in Attachment 3.

Table 5-3. Summary of hydraulic link results (19 l/s).

Pipe ID	Peak Flow During Analysis (l/s)
1_SDR11	19
2_SDR17	19
3_SDR17	19
4_SDR17 (DIVERSION)	19

Table 5-4. Summary of hydraulic node results (19 l/s).

Node ID	Invert Elevation (m)	Maximum Hydraulic Grade Line Depth (m)	Maximum Pressure Head (psi)
STA. 2+72.3 (IN-HEAP POND)	906.70	0.06	~ 0
STA. 1+81.4	890.80	9.67	13.75
STA. 0+58.2	871.40	27.72	39.43
STA. 0+40	869.80	29.04	**41.30**
EVENT POND	896.00	0.05	~ 0

The maximum head pressure anticipated for a flow rate of 19 l/s occurs at Station 0+40, which has the lowest invert elevation in the modeled system. Results show that the maximum head pressure at that location should be approximately 41.30 psi, which is well below the 100 psi pressure rating for the SDR 17 closure pipe.

6.0 CLOSURE

BGC Engineering Inc. (BGC) prepared this document for the account of StrataGold Corporation. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

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Yours sincerely,

BGC ENGINEERING INC.
per:

Troy Meyer, P.Eng.
Principal Engineer

Derek Hrubes, P.E.
Civil Engineer

Reviewed by:

Brad Bijold, P.E.
Principal Engineer

Engineers Yukon Permit to Practice
PP092 BGC Engineering Inc.

TM/HW/rm/pg

ATTACHMENT 1
SELECT PHASE 1 FINAL DESIGN DRAWINGS

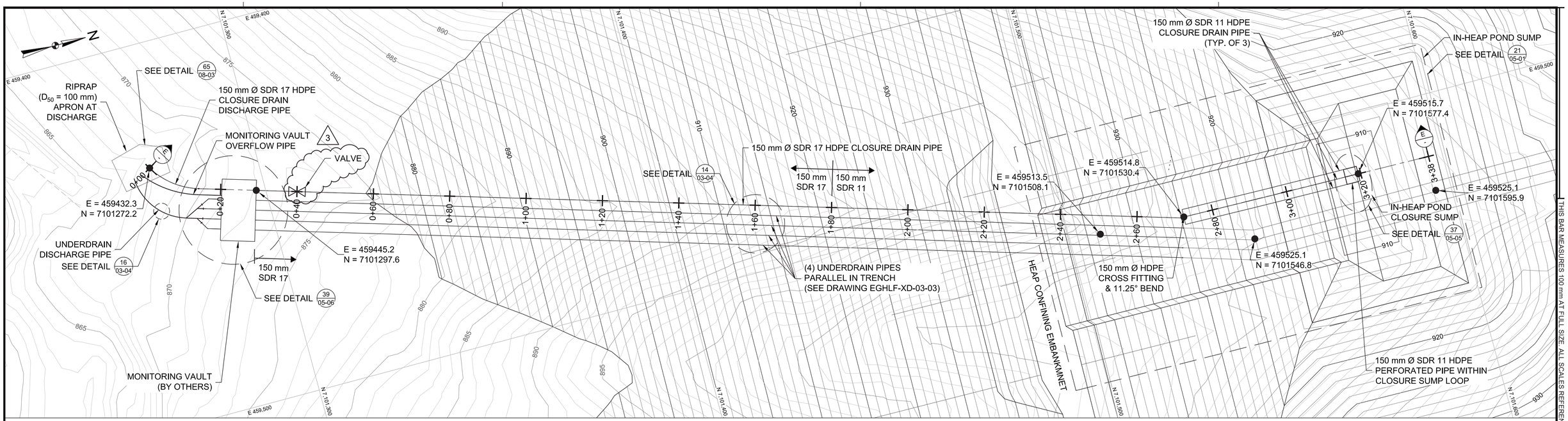
EGHLF-XD-03-05

EGHLF-XD-05-02

EGHLF-XD-05-04

EGHLF-XD-05-05

EGHLF-XD-05-06



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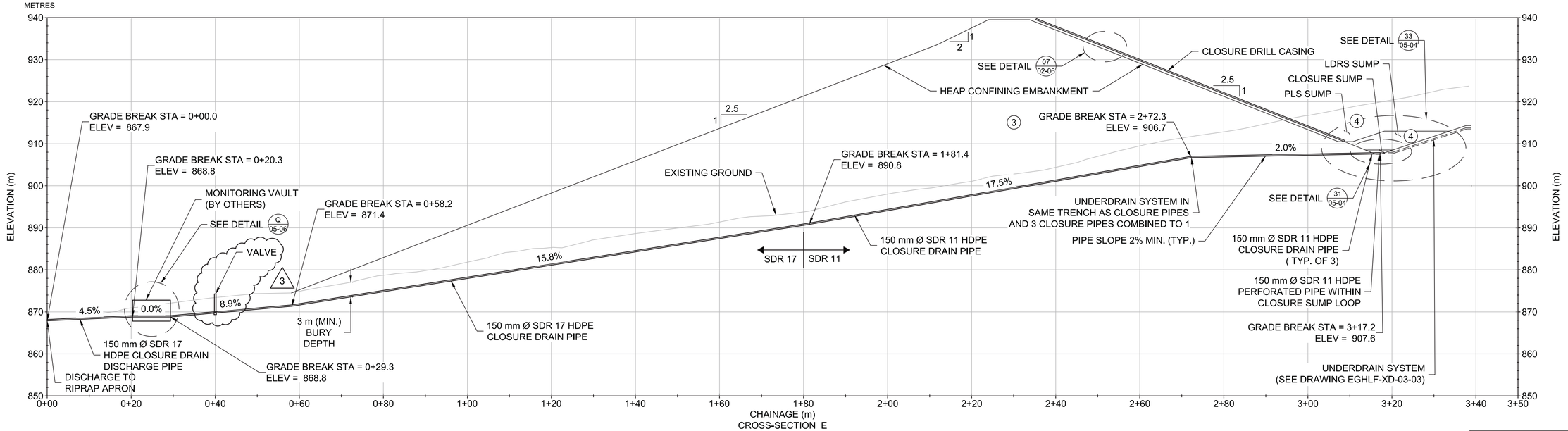
METRES



THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL FRACTIONAL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

ISSUED FOR CONSTRUCTION

LEGEND
- (2) SELECT FILL
- (3) STRUCTURAL FILL
- (4) OVERLINER DRAIN FILL
- (5) SELECT DRAIN FILL

NOTES:
1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.

REVISION INFORMATION

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS
A	17	08	11	DAG	TLM	MEH	TLM	ISSUED FOR REVIEW
0	17	09	08	DAG	TLM	MEH	TLM	ISSUED FOR CONSTRUCTION
1	17	09	22	DAG	TLM	MEH	TLM	CLOSURE AND UNDERDRAIN ALIGNMENT AND PROFILE REVISED
2	17	10	12	DAG	TLM	MEH	TLM	REVISED PIPE SDR
3	18	06	27	DAG	TLM	MEH	TLM	ADD VALVE AT STATION 0+40

DRAWN BY:	CHECK DRAWING:
DAG	CJT
DESIGN BY:	CHECK DESIGN:
TLM	MEH
LEAD ENGINEER:	APPROVAL DATE:
DEH	09/08/17
PROJECT MANAGER:	APPROVAL DATE:
TLM	09/08/17

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

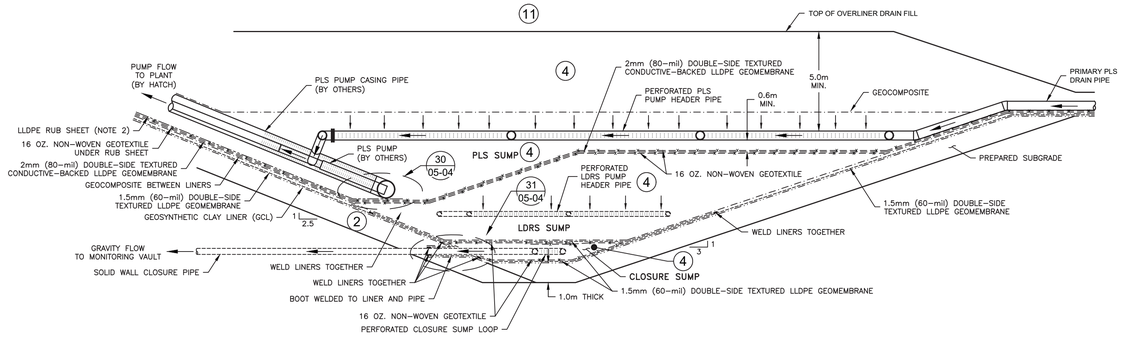
CLIENT: StrataGold Corporation

PROJECT: EAGLE GOLD - HEAP LEACH FACILITY

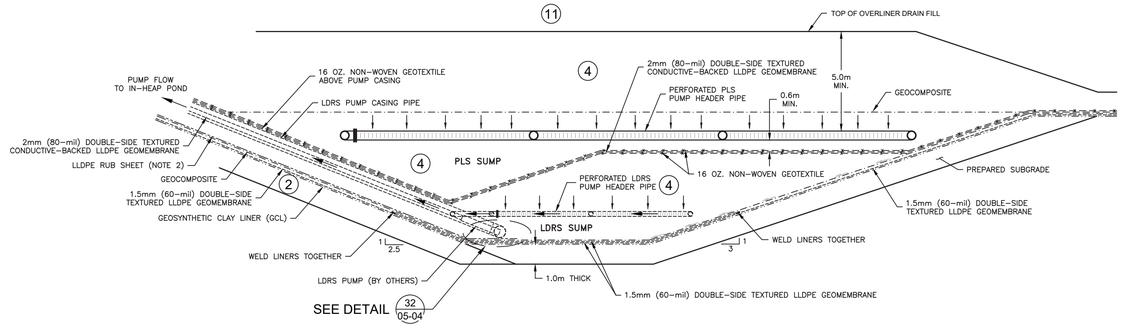
TITLE: CLOSURE PIPING PLAN AND PROFILE

SCALE:	DWG No.:	REV.:
1:500	EGHLF-XD-03-05	3

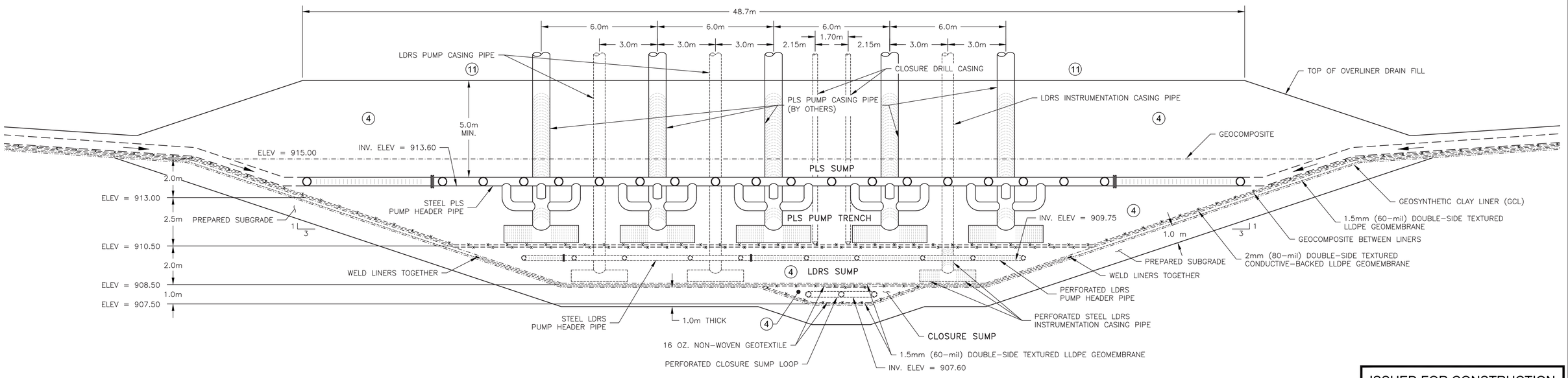
X:\Projects\0792 Victoria Gold\CAD\Production\IFC\EAGLE GOLD - HEAP LEACH FACILITY\EGHLF-XD-03-05.dwg Layout: EGHLF-XD-03-05 Plot Date: Jun 28, 18 Time: 12:00 PM



PLS, LDRS & CLOSURE SUMP DETAIL 22 05-01



PLS, LDRS & CLOSURE SUMP DETAIL 23 05-01



PLS, LDRS & CLOSURE SUMP DETAIL 24 05-01

THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL FRACTIONAL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

NOTES:
1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.
2. RUB SHEET SHALL BE INSTALLED UNDER EACH STEEL CASING WITH DIRECT CONTACT TO THE LINER. RUB SHEET SHALL CONSIST OF A 16 OZ. NON-WOVEN GEOTEXTILE AND AN ADDITIONAL LAYER OF 2 mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE PLACED BENEATH EACH PUMP CASING FOR LINER PROTECTION. TEMPORARILY SECURE RUB SHEET WITH SAND BAGS AS NEEDED.
3. 2 m LONG CONCRETE FILLED STEEL PIPE ANCHOR POSTS (EACH SIDE OF PUMP CASING) EMBEDDED 0.9 m INTO CONCRETE ANCHOR TO INHIBIT LATERAL MOVEMENT AND VERTICAL SETTLEMENT OF RISER.
4. ALL SOLID PIPE FITTINGS AND CONNECTIONS TO CONFORM TO AWWA C-906 STANDARDS.
5. FREE-FLOATING (LOW FRICTION) PIPE SUPPORT TO BE INSTALLED AT TOP OF RISER TO ALLOW FOR THERMAL EXPANSION/CONTRACTION WHILE INHIBITING LATERAL MOVEMENT AND VERTICAL SETTLEMENT.
6. ALL CONNECTIONS BETWEEN PE AND STEEL PIPE (AND OTHER CONNECTIONS AS IDENTIFIED BY THE FIELD ENGINEER) SHALL BE COMPLETELY AND SECURELY WRAPPED WITH TWO LAYERS OF 12 OZ. GEOTEXTILE TO AT LEAST 500 mm ON BOTH SIDES OF THE CONNECTIONS.

ISSUED FOR CONSTRUCTION

LEGEND
- (2) SELECT FILL
- (4) OVERLINER DRAIN FILL
- (11) ORE STOCKPILE
- 16 oz NON-WOVEN GEOTEXTILE
- 2mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE
- 1.5mm (60-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE
- GEOCOMPOSITE
- GEOSYNTHETIC CLAY LINER (GCL)
- LLDPE RUB SHEET

PROFESSIONAL ENGINEER — YUKON TERRITORY — TROY LEE MEYER — 03 JAN 18

REVISION INFORMATION

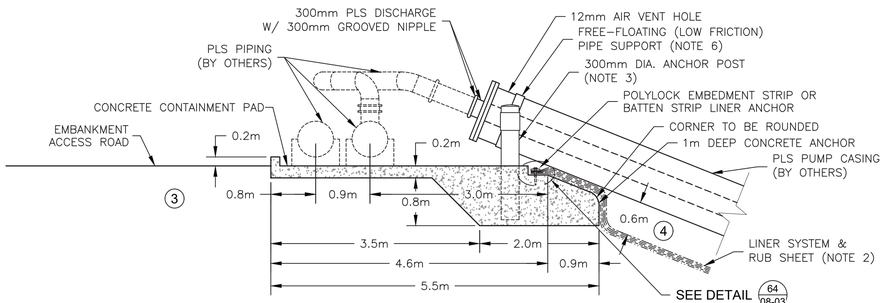
REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS
A	17	08	11	DAG	TLM	MEH	TLM	ISSUED FOR REVIEW
0	17	12	08	DAG	TLM	MEH	TLM	ISSUED FOR CONSTRUCTION

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS

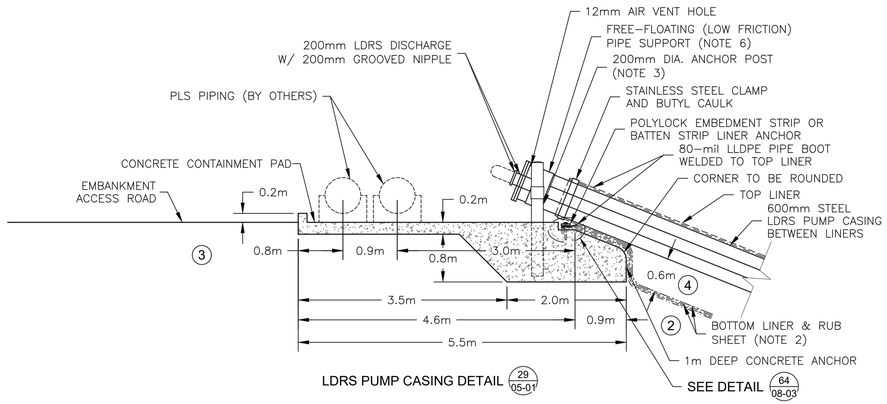
DRAWN BY: DAG	CHECK DRAWING: CJT	BGC ENGINEERING INC. AN APPLIED EARTH SCIENCES COMPANY	PROJECT: EAGLE GOLD - HEAP LEACH FACILITY
DESIGN BY: TLM	CHECK DESIGN: MEH		TITLE: IN-HEAP SUMP DETAILS SHEET 2 OF 2
LEAD ENGINEER: DEH	APPROVAL DATE: 12/08/17	CLIENT: StrataGold Corporation	SCALE: N.T.S. / DWG No.: EGHLF-XD-05-02 / REV.: 0
PROJECT MANAGER: TLM	APPROVAL DATE: 12/08/17		

THIS BAR MEASURES 100 mm AT FULL SIZE. ALL SCALES REFERENCED TO FULL SIZE.

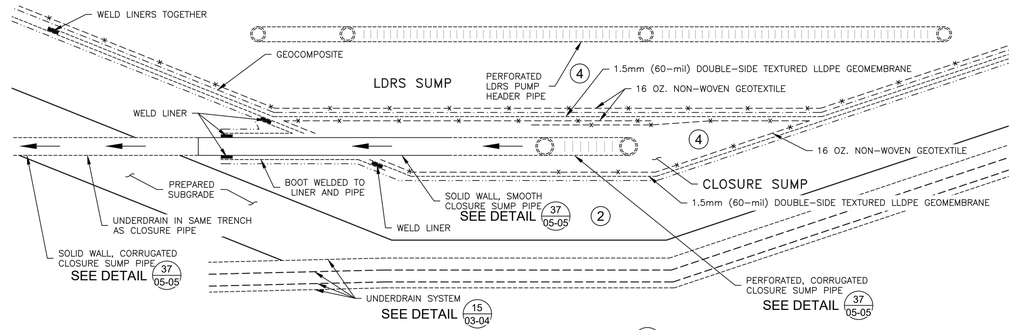
X:\Projects\0792 Victoria Gold\CAD\Production\FC\EAGLE GOLD - HEAP LEACH FACILITY\EGHLF-XD-05-02.dwg Layout: EGHLF-XD-05-02 Plot Date: Jan 2 18 Time: 4:19 PM



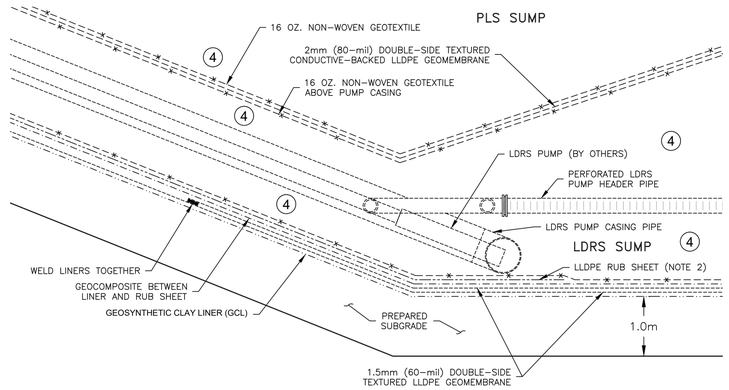
PLS PUMP CASING DETAIL 28 05-01



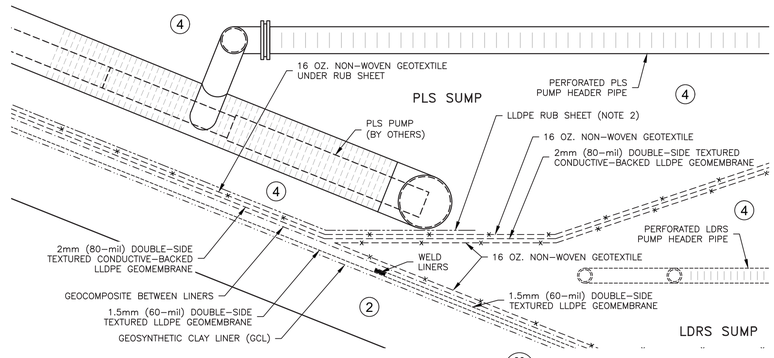
LDRS PUMP CASING DETAIL 29 05-01



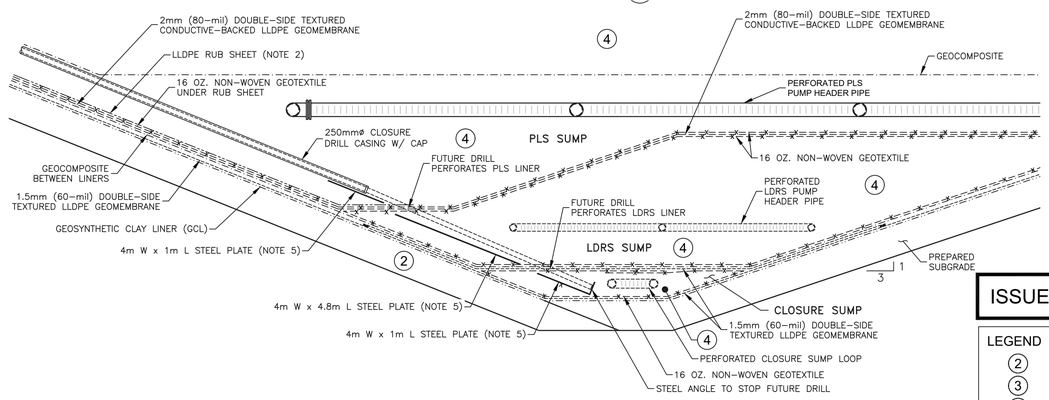
CLOSURE SUMP LINER DETAIL 31 05-02, 03-05



LDRS SUMP LINER DETAIL 32 05-02



PLS SUMP LINER DETAIL 30 05-02



CLOSURE DRILL CASING DETAIL 33 05-03

NOTES:

1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.
2. RUB SHEET SHALL BE INSTALLED UNDER EACH STEEL CASING WITH DIRECT CONTACT TO THE LINER. RUB SHEET SHALL CONSIST OF A 16 OZ. NON-WOVEN GEOTEXTILE AND AN ADDITIONAL LAYER OF 2 mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE PLACED BENEATH EACH PUMP CASING FOR LINER PROTECTION. TEMPORARILY SECURE RUB SHEET WITH SAND BAGS AS NEEDED.
3. 2 m LONG CONCRETE FILLED STEEL PIPE ANCHOR POSTS (EACH SIDE OF PUMP CASING) EMBEDDED 0.9 m INTO CONCRETE ANCHOR TO INHIBIT LATERAL MOVEMENT AND VERTICAL SETTLEMENT OF RISER.
4. ALL SOLID PIPE FITTINGS AND CONNECTIONS TO CONFORM TO AWWA C-906 STANDARDS.
5. INSTALL 12.5 mm (0.5") THICK STEEL PLATES ON TOP OF LINER TO PROTECT DURING CLOSURE DRILLING. STEEL PLATES ARE TO BE UNDERLAIN WITH CONVEYOR BELT MATERIAL OR 16 OZ. NON-WOVEN GEOTEXTILE AND THE EDGES BEVELLED TO PREVENT PUNCTURING OF LINER. STEEL PLATE INSTALLED IN CLOSURE SUMP IS TO INCLUDE AN ANGLE AT THE BOTTOM TO IDENTIFY TERMINATION POINT FOR DRILLING. STEEL PLATES ARE TO BE SPACED 0.2 m APART TO ALLOW ROOM FOR LINER SYSTEM BETWEEN THEM.
6. FREE-FLOATING (LOW FRICTION) PIPE SUPPORT TO BE INSTALLED AT TOP OF RISER TO ALLOW FOR THERMAL EXPANSION/CONTRACTION WHILE INHIBITING LATERAL MOVEMENT AND VERTICAL SETTLEMENT.
7. ALL CONNECTIONS BETWEEN PE AND STEEL PIPE (AND OTHER CONNECTIONS AS IDENTIFIED BY THE FIELD ENGINEER) SHALL BE COMPLETELY AND SECURELY WRAPPED WITH GEOCOMPOSITE TO AT LEAST 500 mm ON BOTH SIDES OF THE CONNECTIONS.

THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL FRACTIONAL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

ISSUED FOR CONSTRUCTION

LEGEND

- (2) SELECT FILL
- (3) STRUCTURAL FILL
- (4) OVERLINER DRAIN FILL
- (5) SELECT DRAIN FILL
- (11) ORE STOCKPILE
- 16 oz NON-WOVEN GEOTEXTILE
- 2mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE
- 1.5mm (60-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE
- GEOCOMPOSITE
- GEOSYNTHETIC CLAY LINER (GCL)
- LLDPE RUB SHEET

PROFESSIONAL ENGINEER — YUKON — TROY LEE MEYER — TERRITORY — 08 JAN 18

REVISION INFORMATION	REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS
	A	17	08	11	DAG	TLM	MEH	TLM	ISSUED FOR REVIEW
	0	17	12	08	DAG	TLM	MEH	TLM	ISSUED FOR CONSTRUCTION

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS

DRAWN BY: DAG	CHECK DRAWING: CJT
DESIGN BY: TLM	CHECK DESIGN: MEH
LEAD ENGINEER: DEH	APPROVAL DATE: 12/08/17
PROJECT MANAGER: TLM	APPROVAL DATE: 12/08/17

BGC ENGINEERING INC. AN APPLIED EARTH SCIENCES COMPANY

CLIENT: StrataGold Corporation

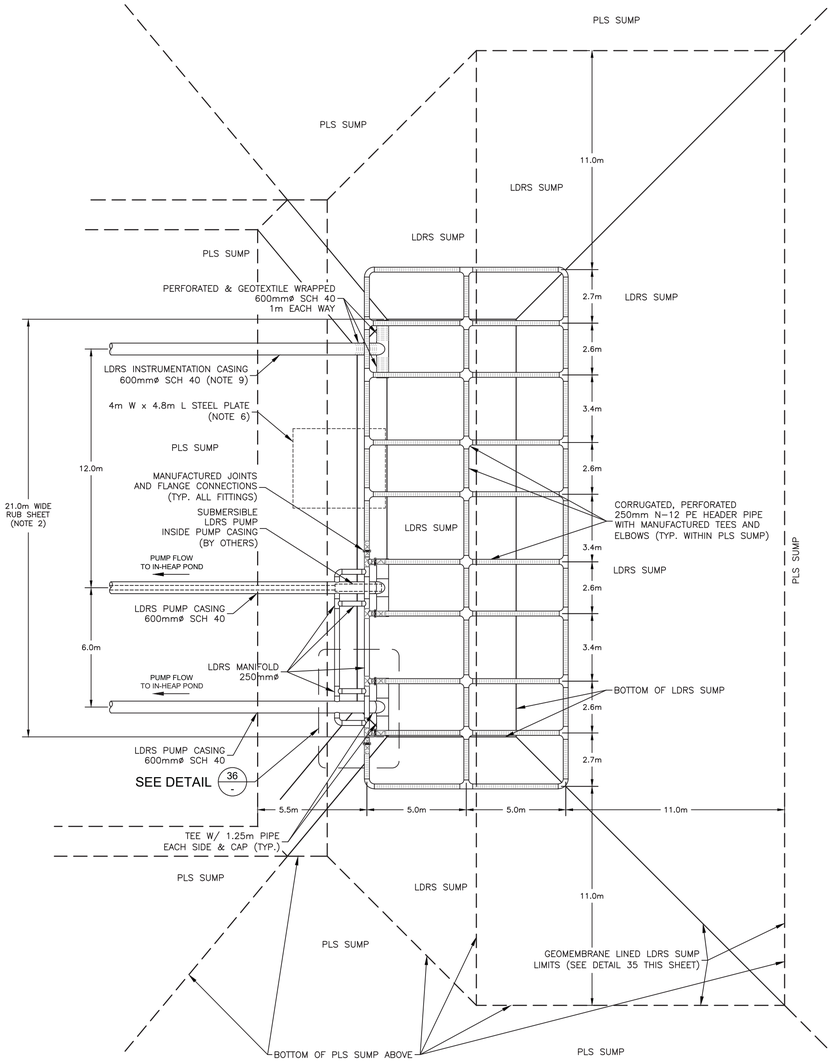
PROJECT: EAGLE GOLD - HEAP LEACH FACILITY

TITLE: PLS SUMP DETAILS SHEET 2 OF 2

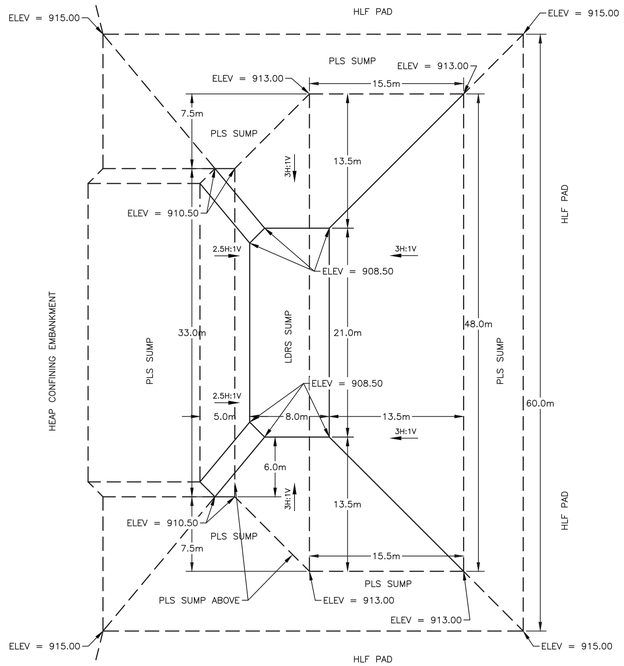
SCALE:	DWG No.:	REV.:
N.T.S.	EGHLF-XD-05-04	0

THIS BAR MEASURES 100 mm AT FULL SIZE ALL SCALES REFERENCED TO FULL SIZE

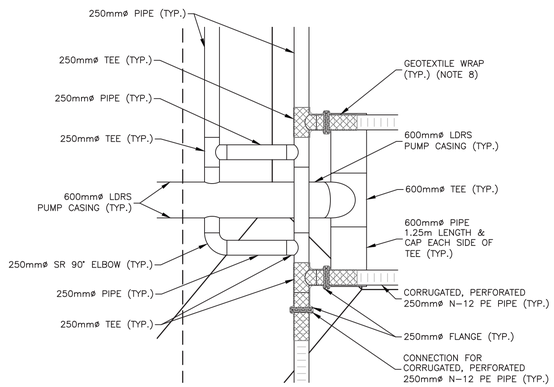
X:\Projects\0792 Victoria Gold\CAD\Production\FC\EAGLE GOLD - HEAP LEACH FACILITY\EGHLF-XD-05-04.dwg Layout: PLS SUMP DETAILS SHEET 2 OF 2 Plot Date: Jan 2 18 Time: 4:55 PM



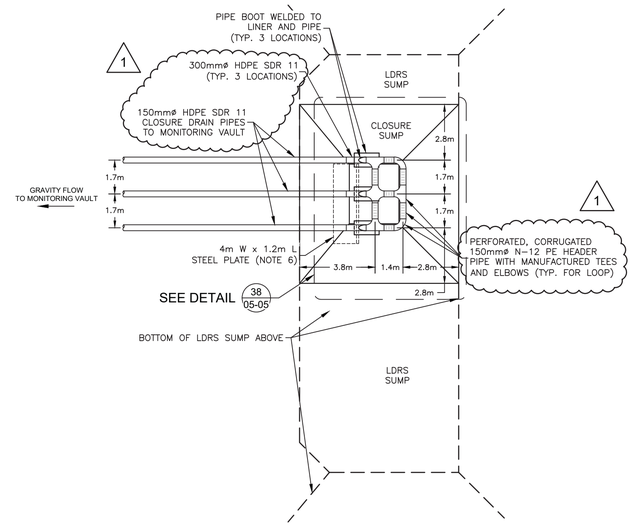
LDRS SUMP AND PIPING PLAN (34 / 05-01)



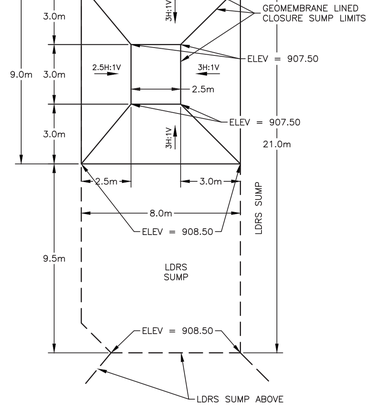
LDRS SUMP GEOMETRY DETAIL (35 / -)



LDRS PIPING DETAIL (36 / -)



CLOSURE SUMP AND PIPING PLAN (37 / 05-01, 03-05, 05-04)



CLOSURE SUMP GEOMETRY DETAIL (38 / -)

NOTES:

1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.
2. RUB SHEET SHALL BE INSTALLED UNDER EACH STEEL CASING WITH DIRECT CONTACT TO THE LINER. RUB SHEET SHALL CONSIST OF A 16 OZ. NON-WOVEN GEOTEXTILE AND AN ADDITIONAL LAYER OF 2 mm (80-mil) DOUBLE-SIDE TEXTURED LLDPE GEOMEMBRANE PLACED BENEATH EACH PUMP CASING FOR LINER PROTECTION. TEMPORARILY SECURE RUB SHEET WITH SAND BAGS AS NEEDED.
3. LDRS RISER PIPE ASSEMBLIES SHALL BE 600mm O.D. FABRICATED USING ASTM 139 HIGH STRENGTH LOW ALLOY STEEL (A606 TYPE 4.) MINIMUM PIPE WALL THICKNESS SHALL BE 17.5mm (SCH 40).
4. 2 m LONG CONCRETE FILLED STEEL PIPE ANCHOR POSTS (EACH SIDE OF PUMP CASING) EMBEDDED 0.9 m INTO CONCRETE ANCHOR TO INHIBIT LATERAL MOVEMENT AND VERTICAL SETTLEMENT OF RISER.
5. ALL SOLID PIPE FITTINGS AND CONNECTIONS TO CONFORM TO AWWA C-906 STANDARDS.
6. INSTALL 12.5 mm (0.5") THICK STEEL PLATES ON TOP OF LINER TO PROTECT DURING CLOSURE DRILLING. STEEL PLATES ARE TO BE UNDERLAIN WITH CONVEYOR BELT MATERIAL OR TWO LAYERS OF 12 OZ. NON-WOVEN GEOTEXTILE AND THE EDGES BEVELLED TO PREVENT PUNCTURING OF LINER. STEEL PLATE INSTALLED IN CLOSURE SUMP IS TO INCLUDE AN ANGLE AT THE BOTTOM TO IDENTIFY TERMINATION POINT FOR DRILLING. STEEL PLATES ARE TO BE SPACED 0.2 m APART TO ALLOW ROOM FOR LINER SYSTEM BETWEEN THEM.
7. FREE-FLOATING (LOW FRICTION) PIPE SUPPORT TO BE INSTALLED AT TOP OF RISER TO ALLOW FOR THERMAL EXPANSION/CONTRACTION WHILE INHIBITING LATERAL MOVEMENT AND VERTICAL SETTLEMENT.
8. ALL CONNECTIONS BETWEEN PE AND STEEL PIPE (AND OTHER CONNECTIONS AS IDENTIFIED BY THE FIELD ENGINEER) SHALL BE COMPLETELY AND SECURELY WRAPPED WITH TWO LAYERS OF 12 OZ. GEOTEXTILE TO AT LEAST 500 mm ON BOTH SIDES OF THE CONNECTIONS.
9. THE BOTTOM 2m OF LDRS INSTRUMENTATION CASING SHALL BE SLOTTED. SLOTTING IN THE STEEL PIPE SHALL BE 2mm WIDE BY 75mm LONG (MEASURED PERPENDICULAR TO PIPE FLOW) SPACED 150mm ON CENTER AROUND THE PIPE IN ROWS SPACED 150mm ON CENTER.

ISSUED FOR CONSTRUCTION

THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL FRACTIONAL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

REVISION INFORMATION

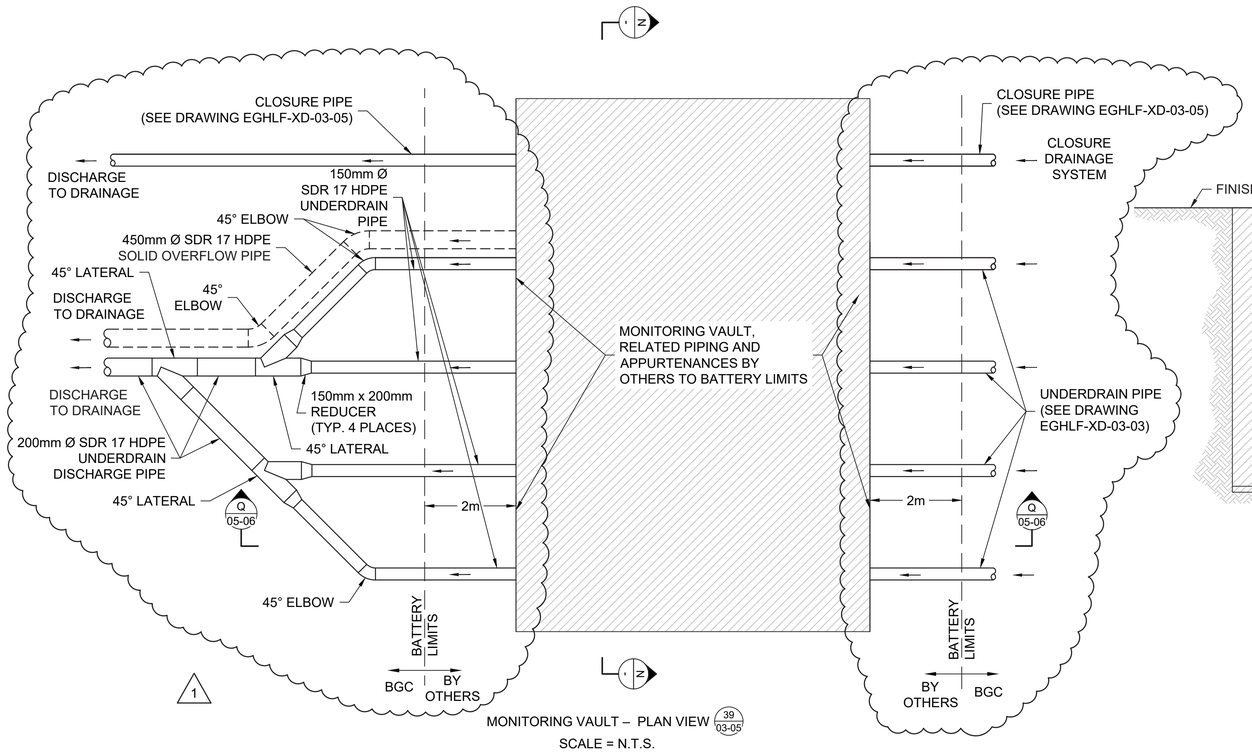
REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS
A	17	08	11	DAG	TLM	MEH	TLM	ISSUED FOR REVIEW
0	17	12	08	DAG	TLM	MEH	TLM	ISSUED FOR CONSTRUCTION
1	18	06	27	DAG	TLM	MEH	TLM	REVISE DETAIL 37 PIPES

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS

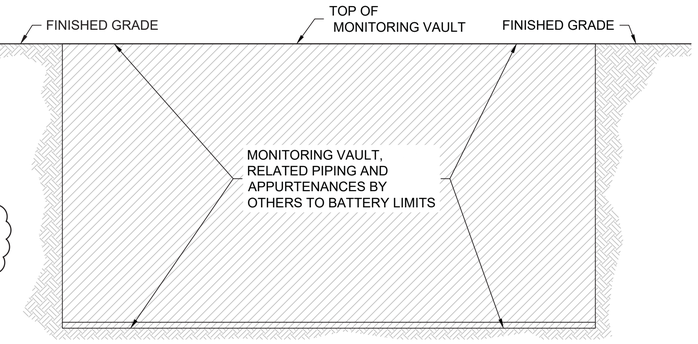
DRAWN BY: DAG	CHECK DRAWING: CJT	BGC ENGINEERING INC. AN APPLIED EARTH SCIENCES COMPANY	PROJECT: EAGLE GOLD - HEAP LEACH FACILITY
DESIGN BY: TLM	CHECK DESIGN: MEH		TITLE: LDRS AND CLOSURE SUMP DETAILS
LEAD ENGINEER: DEH	APPROVAL DATE: 12/08/17	CLIENT: StrataGold Corporation	SCALE: N.T.S. / DWG No.: EGHLF-XD-05-05 / REV.: 1
PROJECT MANAGER: TLM	APPROVAL DATE: 12/08/17		

THIS BAR MEASURES 100 mm AT FULL SIZE ALL SCALES REFERENCED TO FULL SIZE.

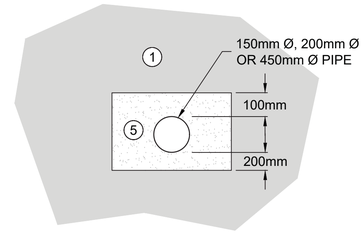
X:\Projects\0792 Victoria Gold\CAD\Production\IFC\EAGLE GOLD - HEAP LEACH FACILITY\EGHLF-XD-05-05.dwg Layout: EGHLF-XD-05-05 Plot Date: Jun 28 18 Time: 12:09 PM



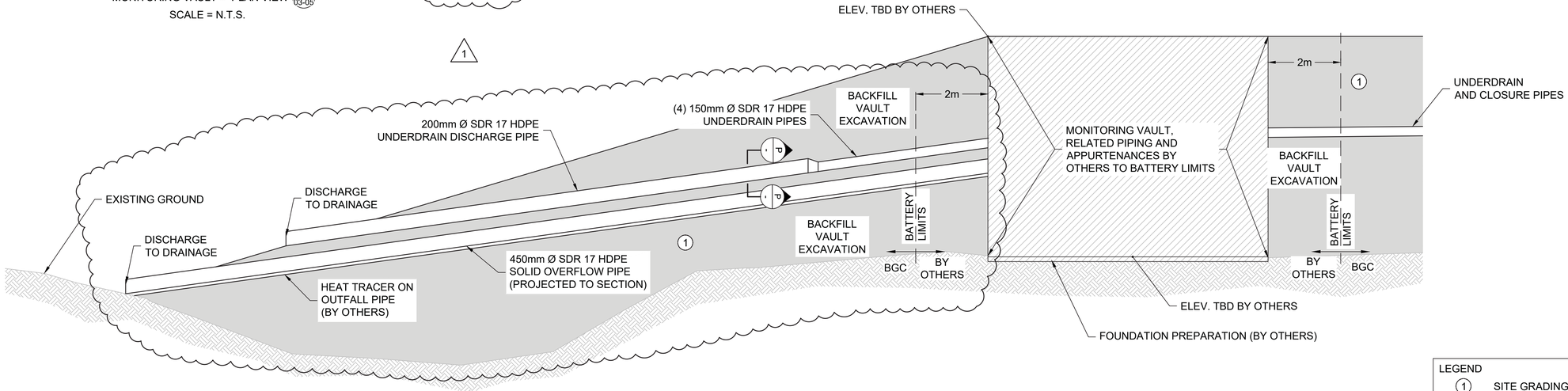
MONITORING VAULT – PLAN VIEW (39 / 03-05)
SCALE = N.T.S.



CLOSURE OUTLET VAULT SECTION (N / -)
SCALE = N.T.S.



TYPICAL PIPE TRENCH DETAIL (P / -)
SCALE = N.T.S.



MONITORING VAULT – PROFILE VIEW (Q / 03-05)
SCALE = N.T.S.

LEGEND
1 SITE GRADING FILL
5 SELECT DRAIN FILL

NOTES:
1. SEE DRAWING EGHLF-XD-00-02 FOR GENERAL NOTES, ABBREVIATIONS, LEGEND AND FILL TYPES.
2. MONITORING VAULT TO BE DESIGNED BY OTHERS AND SHOWN HERE FOR REFERENCE ONLY. BATTERY LIMITS FOR BGC DESIGN ARE 2 m FROM OUTSIDE OF MONITORING VAULT. DESIGN OUTSIDE TETRA TECH BATTERY LIMITS ARE FOR REFERENCE ONLY..

REVISION INFORMATION

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS
A	17	08	11	DAG	TLM	MEH	TLM	ISSUED FOR REVIEW
0	17	09	08	DAG	TLM	MEH	TLM	ISSUED FOR CONSTRUCTION
1	17	09	22	DAG	TLM	MEH	TLM	MONITORING VAULT DETAILS REVISED

REV. NO.	YY	MM	DD	DRAWN	DESIGN	CHECK	APPROVED	REVISION / ISSUED DESCRIPTIONS

DRAWN BY: DAG	CHECK DRAWING: CJT
DESIGN BY: TLM	CHECK DESIGN: MEH
LEAD ENGINEER: DEH	APPROVAL DATE: 09/08/17
PROJECT MANAGER: TLM	APPROVAL DATE: 09/08/17

PROFESSIONAL ENGINEER — YUKON TERRITORY — TROY LEE MEYER — 03 JAN 18

ISSUED FOR CONSTRUCTION

THIS DRAWING MAY HAVE BEEN REDUCED OR ENLARGED. ALL FRACTIONAL SCALE NOTATIONS INDICATED ARE BASED ON ORIGINAL FORMAT DRAWINGS.

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

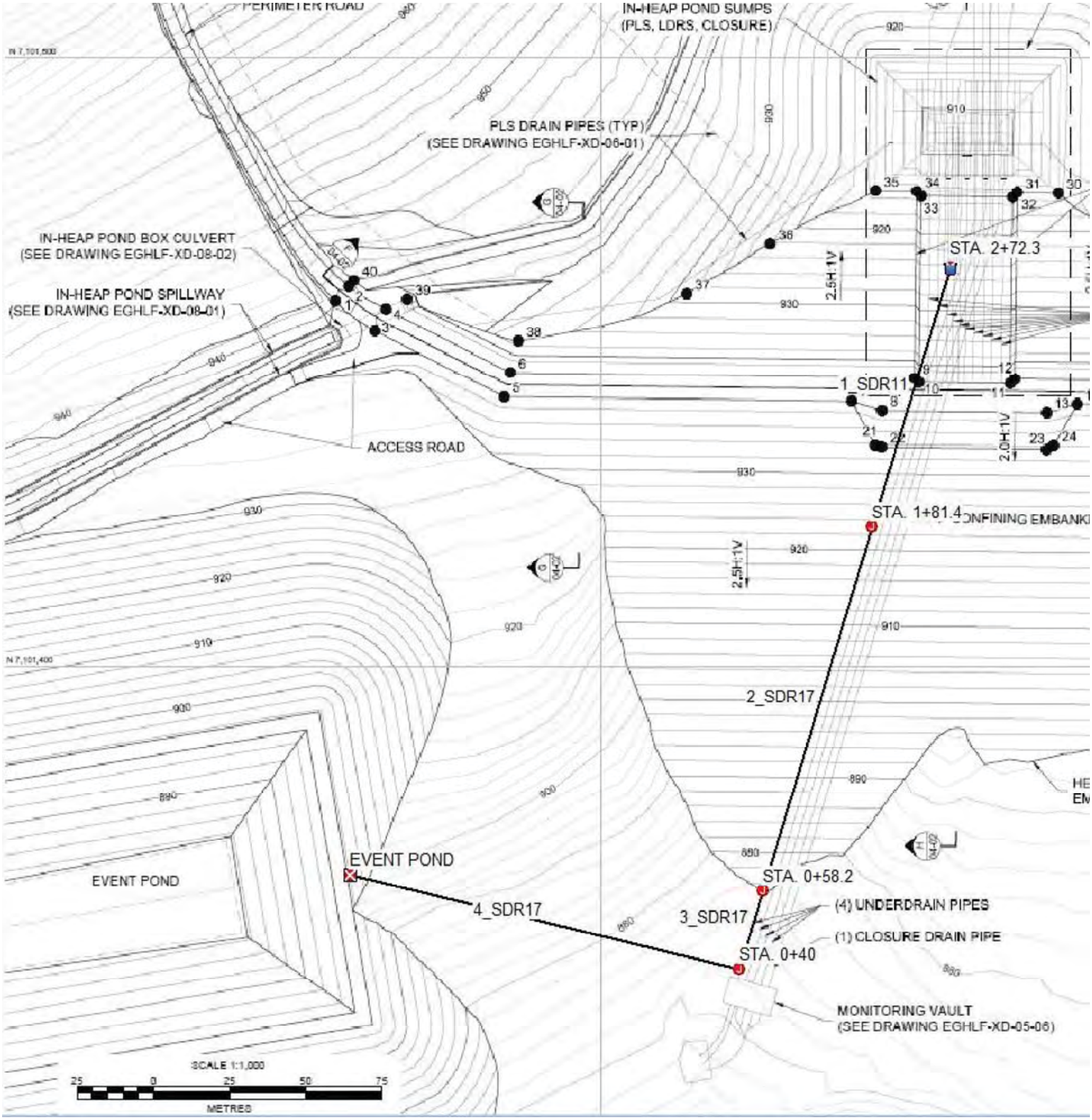
CLIENT: StrataGold Corporation

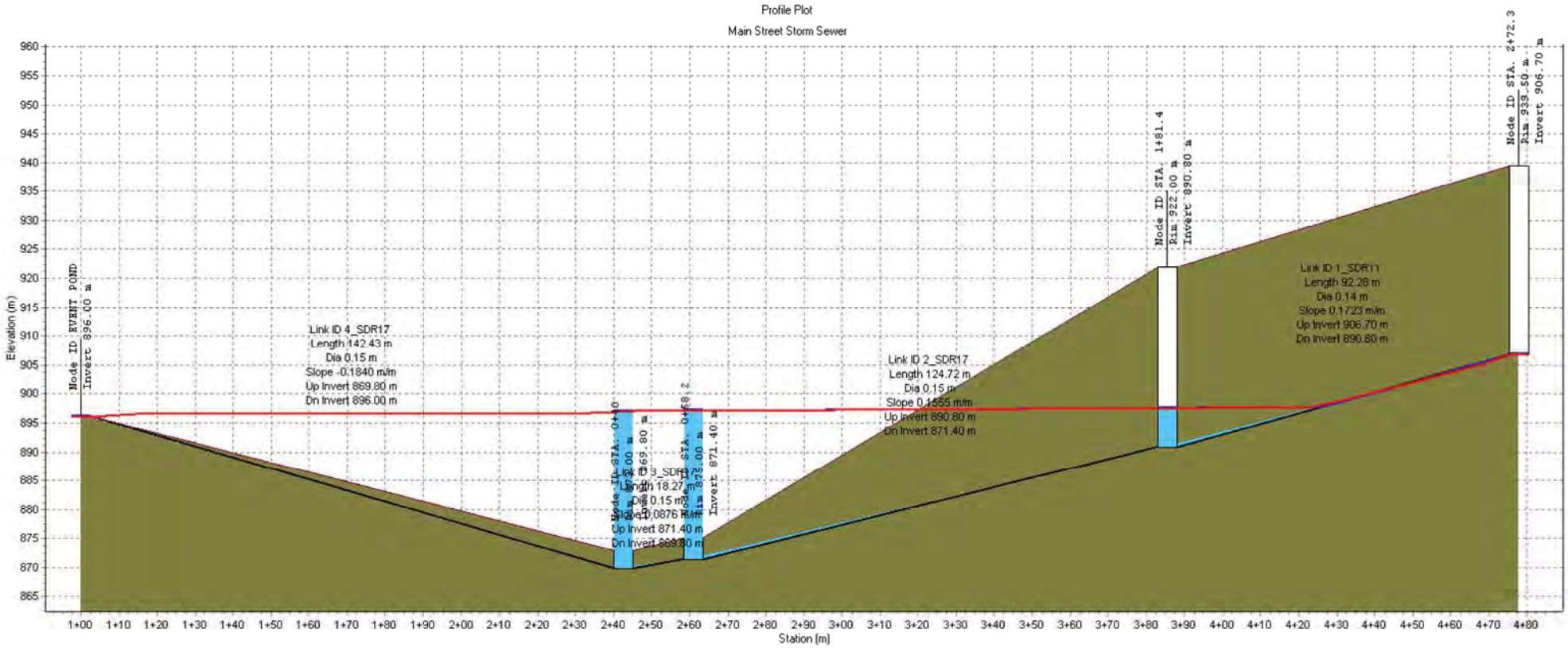
PROJECT:	EAGLE GOLD - HEAP LEACH FACILITY
TITLE:	MONITORING VAULT DETAILS
SCALE: N.T.S.	DWG No.: EGHLF-XD-05-06
REV.: 1	

THIS BAR MEASURES 100 mm AT FULL SIZE. ALL SCALES REFERENCED TO FULL SIZE.

X:\Projects\0792 Victoria Gold\CAD\Production\FC\EAGLE GOLD - HEAP LEACH FACILITY\EGHLF-XD-05-06.dwg Layout: EGHLF-XD-05-06 Plot Date: Jan 2 18 Time: 5:12 PM

ATTACHMENT 2
HYDRAULIC MODELING RESULTS – 10 LPS FLOW


IN-HEAP POND SUMPS
(PLS, LDRS, CLOSURE)
PLS DRAIN PIPES (TYP)
(SEE DRAWING EGHLF-XD-06-01)
IN-HEAP POND BOX CULVERT
(SEE DRAWING EGHLF-XD-08-02)
IN-HEAP POND SPILLWAY
(SEE DRAWING EGHLF-XD-08-01)
ACCESS ROAD
STA. 2+72.3
STA. 1+81.4
STA. 0+58.2
STA. 0+40
1_SDR11
2_SDR17
3_SDR17
4_SDR17
(4) UNDERDRAIN PIPES
(1) CLOSURE DRAIN PIPE
EVENT POND
EVENT POND
MONITORING VAULT
(SEE DRAWING EGHLF-XD-05-06)
2.5H:1V
2.0H:1V
SCALE 1:1,000
25 0 25 50 75
METRES



Node ID:	EVENT POND	STA. 0+40	STA. 0+58.2	STA. 1+81.4	STA. 2+72.3
Rim (m):		873.00	875.00	922.00	939.50
Invert (m):	896.00	869.80	871.40	890.80	906.70
Min Pipe Cover (m):		3.05	3.45	31.05	
Max HGL (m):	896.04	897.00	897.07	897.50	906.74

Link ID:	4_SDR17	3_SDR17	2_SDR17	1_SDR11
Length (m):	142.43	18.27	124.72	92.28
Dia (m):	0.15	0.15	0.15	0.14
Slope (m/m):	-0.1840	0.0876	0.1555	0.1723
Up Invert (m):	869.80	871.40	890.80	906.70
Dn Invert (m):	896.00	869.80	871.40	890.80
Max Q (lps):	10.00	10.00	10.00	10.00
Max Vel (m/s):	0.90	1.82	2.46	3.22
Max Depth (m):	0.09	0.15	0.15	0.09

Autodesk® Storm and Sanitary Analysis 2016 - Version 12.0.42 (Build 0)

****
Project Description
****
File Name ..... Closure Pipe Analysis.SPF

****
Analysis Options
****
Flow Units ..... LPS
Link Routing Method ..... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date JUN-01-2018 00:00:00
Ending Date JUN-02-2018 00:00:00
Report Time Step 00:05:00

****
Element Count
****
Number of rain gages 0
Number of subbasins 0
Number of nodes 5
Number of links 4

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
STA. 0+40	JUNCTION	869.80	873.00	0.00	
STA. 0+58.2	JUNCTION	871.40	875.00	0.00	
STA. 1+81.4	JUNCTION	890.80	922.00	0.00	
EVENT POND	OUTFALL	896.00	896.15	0.00	
STA. 2+72.3	STORAGE	906.70	939.50	0.00	Yes

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
1_SDR11	STA. 2+72.3	STA. 1+81.4	CONDUIT	92.3	17.2302	0.0110
2_SDR17	STA. 1+81.4	STA. 0+58.2	CONDUIT	124.7	15.5548	0.0110
3_SDR17	STA. 0+58.2	STA. 0+40	CONDUIT	18.3	8.7575	0.0110
4_SDR17	EVENT POND	STA. 0+40	CONDUIT	142.4	18.3950	0.0110

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity LPS
1_SDR11	CIRCULAR	0.14	0.14	1	0.01	0.03	

57.53
2_SDR17 CIRCULAR 0.15 0.15 1 0.02 0.04
67.27
3_SDR17 CIRCULAR 0.15 0.15 1 0.02 0.04
50.47
4_SDR17 CIRCULAR 0.15 0.15 1 0.02 0.04
73.15

Flow Routing Continuity	Volume hectare-m	Volume Mliters
External Inflow	0.086	0.864
External Outflow	0.084	0.837
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.001	0.008
Continuity Error (%)	0.020	

Node Depth Summary

Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume ha-mm	Total Time Flooded minutes	Retention Time hh:mm:ss
STA. 0+40	26.42	27.20	897.00	0	07:17	0	0	0:00:00
STA. 0+58.2	24.91	25.67	897.07	0	06:47	0	0	0:00:00
STA. 1+81.4	6.42	6.70	897.50	0	21:11	0	0	0:00:00
EVENT POND	0.04	0.04	896.04	0	06:18	0	0	0:00:00
STA. 2+72.3	0.04	0.04	906.74	0	00:23	0	0	0:00:00

Node Flow Summary

Node ID	Element Type	Maximum Lateral Inflow LPS	Peak Inflow LPS	Time of Peak Inflow Occurrence days	Time of Peak Inflow Occurrence hh:mm	Maximum Flooding Overflow LPS	Time of Peak Flooding Occurrence days	Time of Peak Flooding Occurrence hh:mm
STA. 0+40	JUNCTION	0.00	10.00	0	07:03	0.00		
STA. 0+58.2	JUNCTION	0.00	10.00	0	18:43	0.00		
STA. 1+81.4	JUNCTION	0.00	10.00	0	00:24	0.00		
EVENT POND	OUTFALL	0.00	10.00	0	06:18	0.00		
STA. 2+72.3	STORAGE	10.00	10.00	0	00:00	0.00		

Storage Node Summary

Storage Node ID	Maximum Ponded Volume 1000 m³	Maximum Ponded Volume (%)	Time of Max Ponded Volume days hh:mm	Average Ponded Volume 1000 m³	Average Ponded Volume (%)	Maximum Storage Node Outflow LPS	Maximum Exfiltration Rate cmm	Time of Max. Exfiltration Rate hh:mm:ss	Total Exfiltrated Volume 1000 m³

```
  STA. 2+72.3              0.003          0       0  00:23      0.003         0         10.00
0.00       0:00:00        0.000


  ***********************
  Outfall Loading Summary
  ***********************

  ------------------------------------------------
  Outfall Node ID        Flow   Average      Peak
                    Frequency      Flow    Inflow
                          (%)       LPS       LPS
  ------------------------------------------------
  EVENT POND            95.52      9.99     10.00
  ------------------------------------------------
  System                95.52      9.99     10.00


  *****************
  Link Flow Summary
  *****************


------------------------------------------------------------------------------------------------------------------------
  Link ID              Element       Time of   Maximum  Length   Peak Flow      Design  Ratio of  Ratio of       Total  Reported
                       Type        Peak Flow  Velocity  Factor      during        Flow   Maximum  Maximum        Time  Condition
                                  Occurrence  Attained            Analysis    Capacity   /Design     Flow  Surcharged
                                  days hh:mm     m/sec                 LPS         LPS      Flow     Depth     minutes
------------------------------------------------------------------------------------------------------------------------
  1_SDR11              CONDUIT      0  00:24      3.22    1.00       10.00       57.53      0.17      0.64           0  Calculated
  2_SDR17              CONDUIT      0  18:43      2.46    1.00       10.00       67.27      0.15      1.00        1408  SURCHARGED
  3_SDR17              CONDUIT      0  07:03      1.82    1.00       10.00       50.47      0.20      1.00        1430  SURCHARGED
  4_SDR17              CONDUIT      0  06:18      0.90    1.00       10.00       73.15      0.14      0.62           0  Calculated


  *******************************
  Highest Flow Instability Indexes
  *******************************
  All links are stable.

  WARNING 107 : Initial water surface elevation defined for Junction STA. 0+40 is below junction invert
elevation.
                Assumed initial water surface elevation equal to invert elevation.
  WARNING 107 : Initial water surface elevation defined for Junction STA. 0+58.2 is below junction invert
elevation.
                Assumed initial water surface elevation equal to invert elevation.
  WARNING 107 : Initial water surface elevation defined for Junction STA. 1+81.4 is below junction invert
elevation.
                Assumed initial water surface elevation equal to invert elevation.
  WARNING 110 : Initial water surface elevation defined for Storage Node STA. 2+72.3 is below storage
node invert elevation.
                Assumed initial water surface elevation equal to invert elevation.

  Analysis began on:  Mon Jun 25 08:56:24 2018
  Analysis ended on:  Mon Jun 25 08:56:25 2018
  Total elapsed time: 00:00:01
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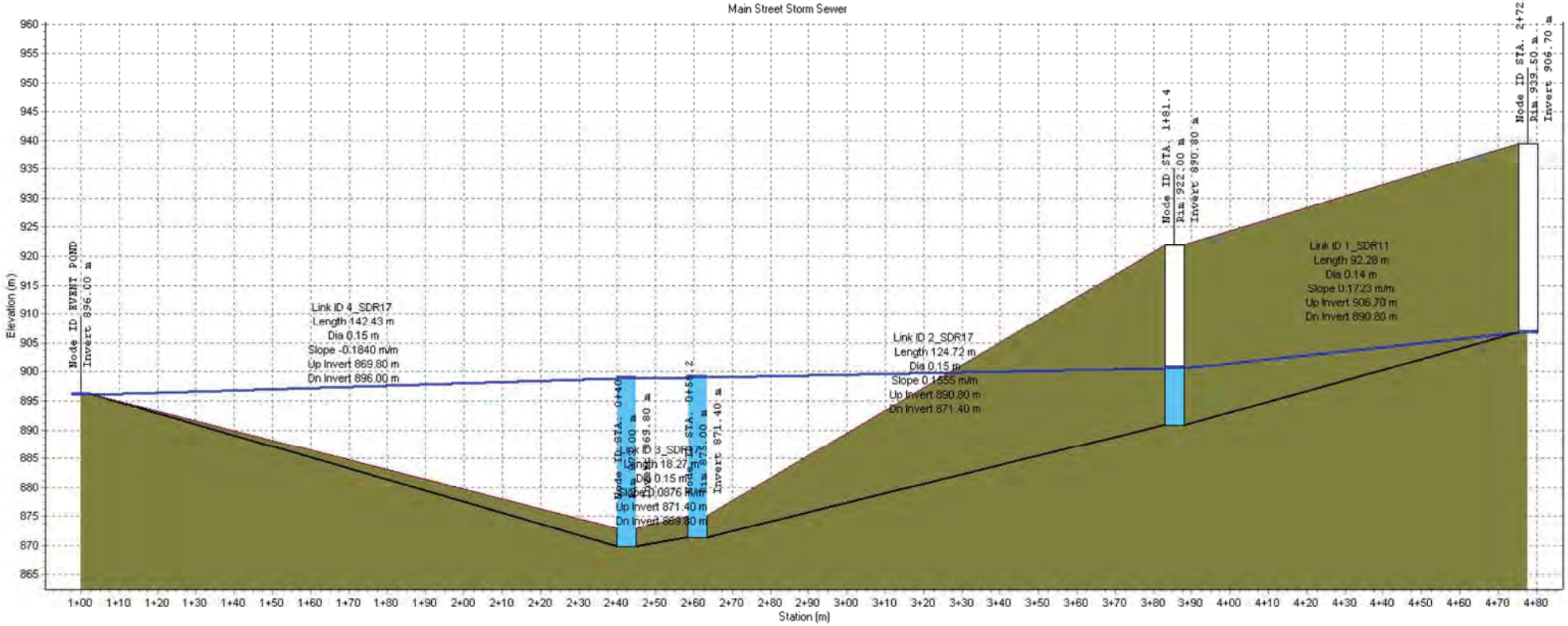
ATTACHMENT 3
HYDRAULIC MODELING RESULTS – 19 LPS FLOW

Profile Plot

Main Street Storm Sewer



Node ID:	EVENT POND	STA. 0+40	STA. 0+58.2	STA. 1+81.4	STA. 2+72.3
Rim (m):		873.00	875.00	922.00	939.50
Invert (m):	896.00	869.80	871.40	890.80	906.70
Min Pipe Cover (m):		3.05	3.45	31.05	
Max HGL (m):	896.05	898.84	899.12	900.66	906.76

Link ID:	4_SDR17	3_SDR17	2_SDR17	1_SDR11
Length (m):	142.43	18.27	124.72	92.28
Dia (m):	0.15	0.15	0.15	0.14
Slope (m/m):	-0.1840	0.0876	0.1555	0.1723
Up Invert (m):	869.80	871.40	890.80	906.70
Dn Invert (m):	896.00	869.80	871.40	890.80
Max Q (lps):	19.00	19.00	19.00	19.00
Max Vel (m/s):	1.56	2.21	2.89	4.15
Max Depth (m):	0.10	0.15	0.15	0.10

Autodesk® Storm and Sanitary Analysis 2016 - Version 12.0.42 (Build 0)

****
Project Description
****
File Name ..... Closure Pipe Analysis_Sensitivity Analysis.SPF

****
Analysis Options
****
Flow Units ..... LPS
Link Routing Method ..... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date JUN-01-2018 00:00:00
Ending Date JUN-02-2018 00:00:00
Report Time Step 00:05:00

****
Element Count
****
Number of rain gages 0
Number of subbasins 0
Number of nodes 5
Number of links 4

****
Node Summary
****

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
STA. 0+40	JUNCTION	869.80	873.00	0.00	
STA. 0+58.2	JUNCTION	871.40	875.00	0.00	
STA. 1+81.4	JUNCTION	890.80	922.00	0.00	
EVENT POND	OUTFALL	896.00	896.15	0.00	
STA. 2+72.3	STORAGE	906.70	939.50	0.00	Yes

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness
1_SDR11	STA. 2+72.3	STA. 1+81.4	CONDUIT	92.3	17.2302	0.0110
2_SDR17	STA. 1+81.4	STA. 0+58.2	CONDUIT	124.7	15.5548	0.0110
3_SDR17	STA. 0+58.2	STA. 0+40	CONDUIT	18.3	8.7575	0.0110
4_SDR17	EVENT POND	STA. 0+40	CONDUIT	142.4	18.3950	0.0110

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity LPS
1_SDR11	CIRCULAR	0.14	0.14	1	0.01	0.03	

57.53						
2_SDR17	CIRCULAR	0.15	0.15	1	0.02	0.04
67.27						
3_SDR17	CIRCULAR	0.15	0.15	1	0.02	0.04
50.47						
4_SDR17	CIRCULAR	0.15	0.15	1	0.02	0.04
73.15						

Flow Routing Continuity	Volume hectare-m	Volume Mliters
External Inflow	0.164	1.642
External Outflow	0.162	1.620
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.001	0.010
Continuity Error (%)	0.007	

Node Depth Summary

Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume ha-mm	Total Time Flooded minutes	Retention Time hh:mm:ss
STA. 0+40	28.61	29.04	898.84	0	13:40	0	0	0:00:00
STA. 0+58.2	27.29	27.72	899.12	0	10:04	0	0	0:00:00
STA. 1+81.4	9.67	9.86	900.66	0	16:19	0	0	0:00:00
EVENT POND	0.05	0.05	896.05	0	05:39	0	0	0:00:00
STA. 2+72.3	0.06	0.06	906.76	0	15:58	0	0	0:00:00

Node Flow Summary

Node ID	Element Type	Maximum Lateral Inflow LPS	Peak Inflow LPS	Time of Peak Inflow Occurrence days	Time of Peak Inflow Occurrence hh:mm	Maximum Flooding Overflow LPS	Time of Peak Flooding Occurrence days	Time of Peak Flooding Occurrence hh:mm
STA. 0+40	JUNCTION	0.00	19.00	0	08:53	0.00		
STA. 0+58.2	JUNCTION	0.00	30.96	0	00:06	0.00		
STA. 1+81.4	JUNCTION	0.00	19.00	0	04:32	0.00		
EVENT POND	OUTFALL	0.00	19.00	0	05:39	0.00		
STA. 2+72.3	STORAGE	19.00	19.00	0	00:00	0.00		

Storage Node Summary

Storage Node ID	Maximum Ponded Volume 1000 m³	Maximum Ponded Volume (%)	Time of Max Ponded Volume days hh:mm	Average Ponded Volume 1000 m³	Average Ponded Volume (%)	Maximum Storage Node Outflow LPS	Maximum Exfiltration Rate cmm	Time of Max. Exfiltration Rate hh:mm:ss	Total Exfiltrated Volume 1000 m³

STA. 2+72.3 0.005 0 0 15:58 0.005 0 19.00
0.00 0:00:00 0.000

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow LPS	Peak Inflow LPS
EVENT POND	98.06	18.97	19.00
System	98.06	18.97	19.00

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days	hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis LPS	Design Flow Capacity LPS	Ratio of Maximum /Design Flow	Ratio of Maximum Depth	Total Time minutes	Reported Condition
1_SDR11	CONDUIT	0	04:32	4.15	1.00	19.00	57.53	0.33	0.72	0	Calculated
2_SDR17	CONDUIT	0	04:38	2.89	1.00	19.00	67.27	0.28	1.00	1426	SURCHARGED
3_SDR17	CONDUIT	0	08:53	2.21	1.00	19.00	50.47	0.38	1.00	1434	SURCHARGED
4_SDR17	CONDUIT	0	05:39	1.56	1.00	19.00	73.15	0.26	0.67	0	Calculated

****
Highest Flow Instability Indexes
****
All links are stable.

WARNING 107 : Initial water surface elevation defined for Junction STA. 0+40 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.
WARNING 107 : Initial water surface elevation defined for Junction STA. 0+58.2 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.
WARNING 107 : Initial water surface elevation defined for Junction STA. 1+81.4 is below junction invert elevation.
Assumed initial water surface elevation equal to invert elevation.
WARNING 110 : Initial water surface elevation defined for Storage Node STA. 2+72.3 is below storage node invert elevation.
Assumed initial water surface elevation equal to invert elevation.

Analysis began on: Fri Jun 29 07:05:30 2018
Analysis ended on: Fri Jun 29 07:05:31 2018
Total elapsed time: 00:00:01

APPENDIX E

O'Kane Consultants Inc. - Eagle Gold Project - Further Assessment of Closure Cover System Designs for Heap Leach Facility and Waste Rock Storage Areas

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O'Kane Consultants Inc.
Integrated Geotechnical Engineering Services
Specialists in Unsaturated Zone Hydrology

April 28, 2014

Jim Harrington
Access Consulting Group
#3 Calcite Business Centre, 151 Industrial Road
Whitehorse, YK Y1A 2V3

Mr. Harrington:

Re: Eagle Gold Project – Further Assessment of Closure Cover System Designs for Heap Leach Facility and Waste Rock Storage Areas

O'Kane Consultants Inc. (OKC) was retained by Alexco Environmental Group (AEG) in February 2014 to aid in furthering the development of cover system designs for closure of the proposed heap leach facility (HLF) and waste rock storage areas (WRSAs) at Victoria Gold's Eagle Gold Project (EGP) in the Yukon. The currently planned end land-use for the reclaimed HLF and WRSAs is natural habitat (wilderness). Aside from being geotechnically and geomorphically stable and providing a medium for sustainable growth of native plants, a key design objective for the HLF / WRSA closure cover system is to reduce long-term net percolation rates to the greatest extent possible using locally available materials for cover system construction. Passive treatment systems will be designed and implemented to handle resultant environmental loadings from the HLF and WRSAs post-closure. This letter report documents the work completed by OKC for this project.

Project Objectives and Work Scope:

The overall objective of this project was to aid in further development of cover system designs using locally available materials for closure of the proposed HLF and WRSAs at the EGP site. The currently proposed closure cover system design, referred to as the 'base case' cover system design, is a 0.2 m thick layer of topsoil underlain by a 0.3 m thick layer of placer tailings / colluvium. The specific objectives of this project were to further assess the anticipated hydrological performance of the base case cover system design and provide recommendations to improve its predicated long-term performance from a net percolation reduction perspective.

The following tasks were completed to address the above project objectives:

- Project orientation including review of pertinent background information and compilation of key inputs for soil-plant-atmosphere (SPA) numerical modelling;
- Development of a conceptual model of hydrological performance of the base case cover system design;
- Base case and sensitivity analysis numerical simulations of cover system performance using the SPA model VADOSE/W[1]; and

[1] Geo-Slope International Ltd. 2013. Vadose Zone Modelling with VADOSE/W: An Engineering Methodology. September 2013 Ed.

- Development of recommendations for future studies to reduce uncertainties in the current cover system design and identify potential opportunities for improvements in cover system performance using locally available materials.

SPA numerical modelling was completed with the following outcomes in mind:

- Improved confidence in the mean and range of net percolation rates for the base case cover system for input to environmental loading and water treatment assessments;
- Influence of potential textural heterogeneity of locally available cover construction materials on cover system performance;
- Influence of the saturated permeability of underlying waste materials on cover system performance;
- Influence of various vegetation conditions on cover system performance;
- Influence of slope angle on cover system performance (i.e. difference in water balance fluxes for the bench plateaus compared to the bench faces);
- Influence of slope aspect on cover system performance; and
- Examination of the available water holding capacity (AWHC) for various cover configurations to avoid creating a 'false' drought condition for the anticipated climax vegetation cover.

Conceptual Model of Hydrological Performance:

A conceptual model of hydrological performance of closure cover systems for the EGP site was developed prior to the start of SPA numerical modelling. This required consideration of the following water balance fluxes:

- precipitation (Ppt),
- potential evapotranspiration (PET),
- actual evapotranspiration (AET),
- runoff (RO),
- sublimation (Sub), and
- net percolation (NP).

The average precipitation for the EGP site is estimated to be 492 mm/yr with a range from 262 mm/yr to 694 mm/yr, based on the 80-year historic climate database developed for this project (see Attachment A for further details). The average annual estimate is similar to that developed by KP[2].

Given the relatively high latitude of the EGP site, slope aspect and angle highly influences the amount of solar energy and resultant PET applied to various areas of the site (MEND, 2012)[3]. Hence, for an exposed plateau (i.e. a flat area with no slope influences) or east- or west-facing slope, average annual PET is estimated to be 372 mm/yr with an annual range from 196 mm/yr to 1,413 mm/yr. However, PET is estimated to be 60% less on north-facing aspects and 50% more on south-facing aspects; resulting in average annual PET rates for these two aspects of 149 mm/yr and 558 mm/yr, respectively.

[2] KP (Knight Piesold Ltd.). 2013. *Victoria Gold Corp. Eagle Gold Project – Hydrometeorology Report. VA101-290/6-8*. Prepared for Victoria Gold Corp., August 30.
[3] MEND (Mine Environment Neutral Drainage). 2012. Cold regions cover system design technical guidance document. Canadian Mine Environment Neutral Drainage Program, Project 1.61.5c, March.

In general, the ratio of annual AET to precipitation ranges from 40 to 60% for study areas similar to the EGP site (Kane and Yang, 2004)[4]. This results in a typical AET:PET ratio of 50 to 70%. However, it must be noted that results for north or south aspects may be outside of the general ranges. Also note that forest canopy interception, which is not calculated by the VADOSE/W model, is included as part of the AET results in this report by using the estimation method described in Attachment A.

Runoff to precipitation ratio for northern sites typically has an increasing trend with increasing latitude (Kane and Yang, 2004). A runoff rate of 5 to 20% of precipitation is expected for the EGP site given the latitude at which the site is located combined with the locally available materials for the base cover system design and the range of vegetation conditions.

Sublimation and redistribution of snow constitutes a significant portion of the water balance in several seasonally snow-covered areas of the Canadian North such as the EGP site (Pomeroy *et al.*, 1995)[5]. Snow interception and sublimation are important hydrological processes that occur as a result of complex mass and energy exchanges. Sublimation of snow intercepted in the vegetation canopy can be as high as 25 to 45% of annual snowfall (Pomeroy and Gray, 1995)[6]. Comparing the EGP site to other northern sites at a similar latitude, a sublimation rate of 25 to 35% of annual snowfall is expected (Kane and Yang, 2004). This corresponds to a sublimation rate of approximately 10 to 15% of total annual precipitation.

NP is a vital component of the water balance for northern climates. Previous modelling completed by KP (2013) determined that the long-term NP rate for the current or base case cover system design would be between 18 and 32% of annual precipitation. NP is functionally halted during the winter months due to frozen ground conditions. In general, the majority of NP at the EGP site occurs during spring melt. Through the summer months, NP rates are lower due to the store and release function of a vegetated soil profile. NP rates generally increase in the fall due to lower PET rates.

A typical annual water balance for the site estimated using VADOSE/W is shown in Figure 1, and demonstrates that the VADOSE/W model estimates conform to the conceptual model.

[4] Kane, D. and Yang, D. 2004. Northern Research Basins Water Balance. International Association of Hydrological Sciences. Oxfordshire, United Kingdom.
[5] Pomeroy, J., Hedstrom, N., and Parvianinen., J. 1995. *The Snow Mass Balance of Wolf Creek, Yukon: Effects of Snow Sublimation and Redistribution*. National Hydrology Research Center. Environment Canada: Saskatoon.
[6] Pomeroy, J.W. and Gray, D.M. 1995. *Snow Accumulation, Relocation and Management*. NHRI Science Report No. 7. Environment Canada: Saskatoon. 144 pp. (Available from NWRI, Saskatoon)

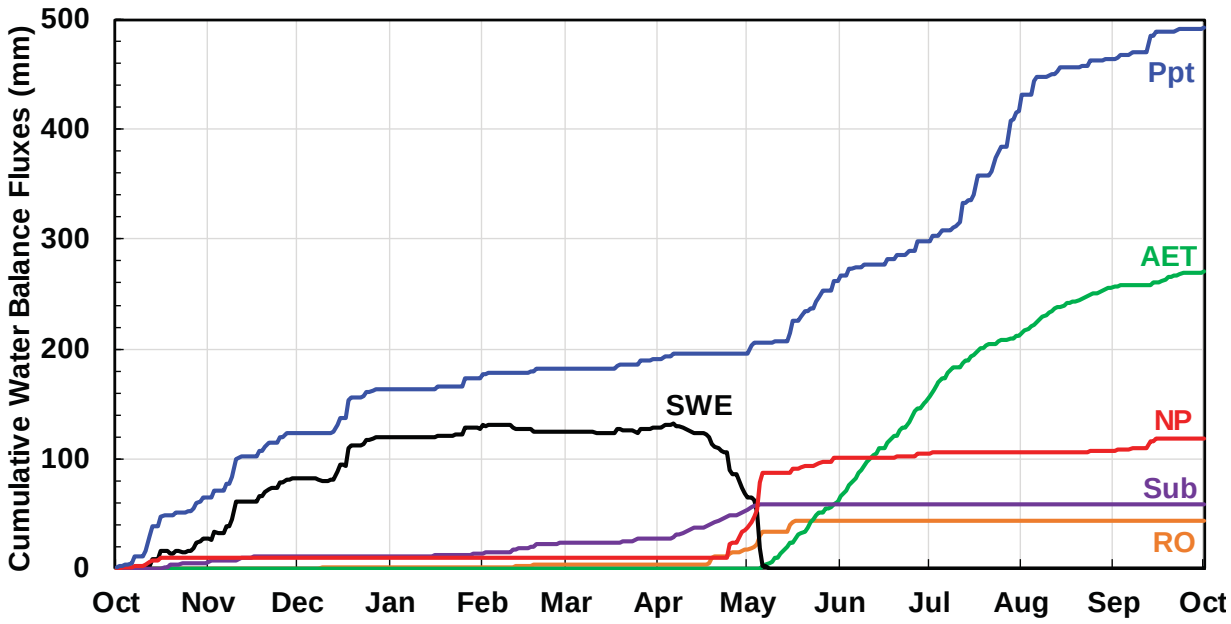

Figure 1 Typical annual water balance fluxes for the EGP site for an east/west bench during an average precipitation year.

Preliminary Estimates of Long-Term Cover System Performance:

The currently proposed closure cover system design, referred to as the 'base' cover system design, consists of a 0.2 m thick layer of topsoil underlain by a 0.3 m thick layer of placer tailings / colluvium. Tables 1 and 2 provide preliminary estimates of average annual long-term water balances (i.e. post-closure and once climax forest vegetation has established). A description of the model inputs used for the simulations is provided in Attachment A. All modelling completed for this project used the computer modelling program VADOSE/W Version 8.12.3.7901[7].

As shown in the sensitivity analysis section of this report, little can be done to improve performance of the current cover system design based on current knowledge of waste materials and candidate cover materials. Also, the current estimates for east-, west-, and north-facing slopes have AET:PET ratios at or above the typical maximum of 70% stated for the conceptual model. Hence, minimal potential exists for reducing NP rates via increasing AET, which means the store-and-release component of the cover system design cannot be improved upon with any design changes. The only other method to reduce NP is to increase lateral flow (i.e. runoff or interflow) by including a low permeability layer (saturated hydraulic conductivity (k_{sat}) less than $1x10^{-7}$ cm/s), but such a layer cannot be constructed from site materials; this would require the import of sodium bentonite for admixing to local sandy materials or the use of a geomembrane product.

[7] Geo-Slope International Ltd. 2013. GeoStudio 2012. Version 8.12.3.7901. Online. www.geo-slope.com.

Table 1
Average annual water balance fluxes predicted for base case cover system design on WRSAs
(values in percent of annual precipitation with mm/yr in brackets).

Aspect	**East / West**		**North**		**South**		**Conceptual Model**
Angle	**Benches /Plateaus**	**2H:1V**	**Benches**	**2H:1V**	**Benches**	**2H:1V**	
RO	9% (44)	14% (69)	9% (44)	15% (74)	9% (44)	12% (59)	5% – 20%
AET	55% (271)	53% (261)	27% (133)	26% (128)	59% (290)	58% (285)	40% – 60%
Sub	12% (59)	12% (59)	12% (59)	12% (59)	12% (59)	12% (59)	10% – 15%
NP	24% (118)	21% (103)	52% (256)	47% (231)	20% (98)	18% (89)	15% – 45%

*RO: Runoff; AET: Actual Evapotranspiration; Sub: Sublimation; NP: Net percolation.

Table 2
Average annual water balance fluxes predicted for base case cover system design on HLF
(values in percent of annual precipitation with mm/yr in brackets).

Aspect	**East / West**		**North**		**South**		**Conceptual Model**
Angle	**Benches /Plateaus**	**2H:1V**	**Benches**	**2H:1V**	**Benches**	**2H:1V**	
RO	9% (44)	14% (69)	9% (44)	15% (74)	9% (44)	12% (59)	5% – 20%
AET	56% (276)	54% (266)	26% (128)	25% (123)	60% (295)	58% (285)	40% – 60%
Sub	12% (59)	12% (59)	12% (59)	12% (59)	12% (59)	12% (59)	10% – 15%
NP	23% (113)	20% (98)	53% (261)	48% (236)	19% (93)	18% (89)	15% – 45%

*RO: Runoff; AET: Actual Evapotranspiration; Sub: Sublimation; NP: Net percolation.

It must be emphasized that the values provided in Tables 1 and 2 are averages, but that the components of the water balance will vary greatly from year-to-year, and (as shown in Figure 1) during any given year. As shown in Figures 2 and 3, annual NP at the EGP site can range anywhere from 0 to 500 mm for a given year depending on climate, slope angle and aspect, underlying material, and antecedent moisture conditions. Figures 2 and 3 also provide an estimate of the probability of a given NP rate being exceeded during any given year. For example, there is a 20% probability (i.e. 1-in-5 years) that annual NP rate through a cover system overlying waste rock on a south-facing slope aspect will be greater than 140 mm/yr. Equations for the trendlines in Figures 2 and 3 are provided in the footnotes.

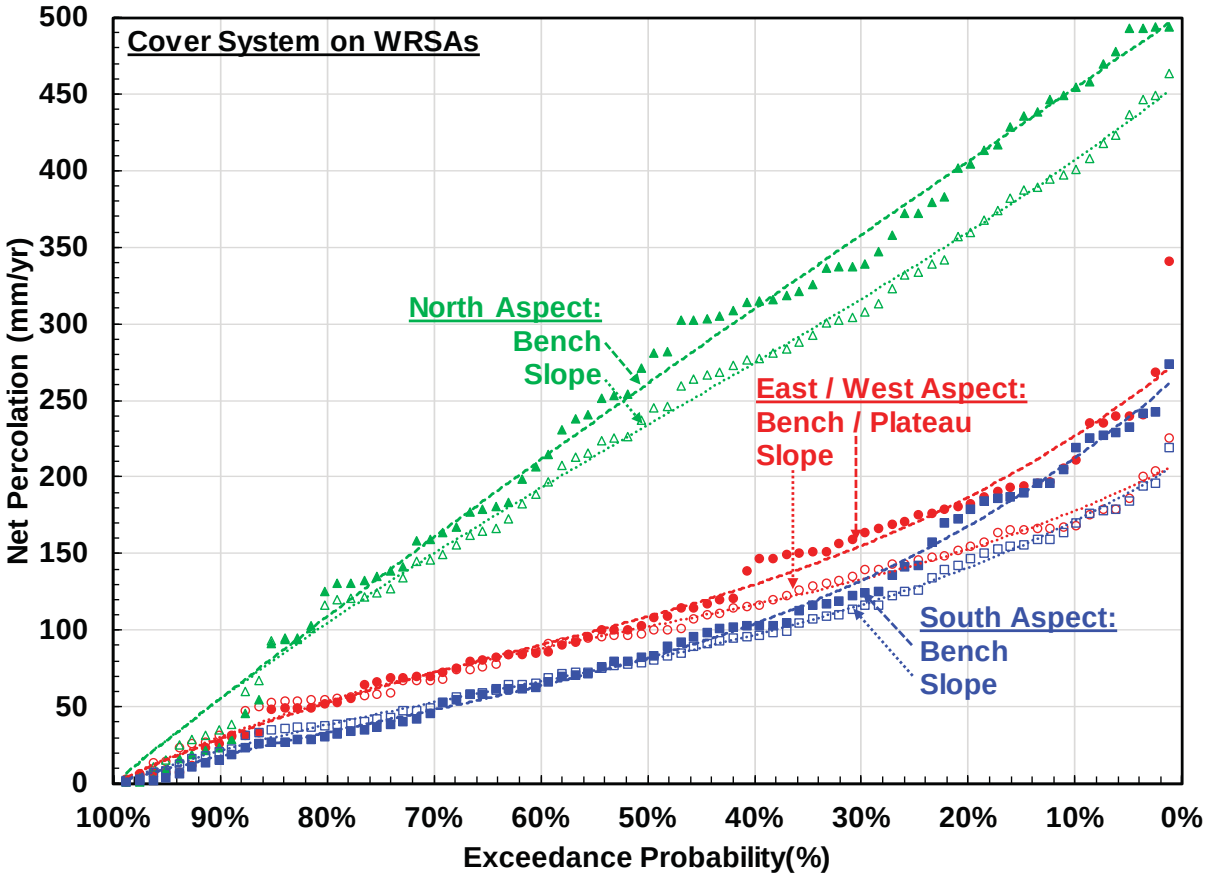

Figure 2 Exceedance probability for annual net percolation though the base case cover system design on WRSAs[8].

[8] Equations for trendlines fitted to data in Figure 2 (equations provide estimate of annual net percolation rate (NP in mm/yr) for a given exceedance probability (x)):
NP (WRSA North Aspect – Bench) = $40.0041311586974(1-x)^3 - 99.5768877417431(1-x)^2 + 561.738884175022(1-x)$
NP (WRSA North Aspect – Slope) = $206.353645699448(1-x)^3 - 327.934585562733(1-x)^2 + 580.167973306423(1-x)$
NP (WRSA East / West Aspect – Bench/Plateau) = $334.907229739852(1-x)^3 - 383.091823084556(1-x)^2 + 325.661910099225(1-x)$
NP (WRSA East / West Aspect – Slope) = $280.502595140468(1-x)^3 - 409.768319621682(1-x)^2 + 339.373074364743(1-x)$
NP (WRSA North Aspect – Bench) = $272.348822876258(1-x)^3 - 199.583918676042(1-x)^2 + 195.342583203572(1-x)$
NP (WRSA North Aspect – Slope) = $242.715256690288(1-x)^3 - 267.520494862459(1-x)^2 + 234.753215517809(1-x)$

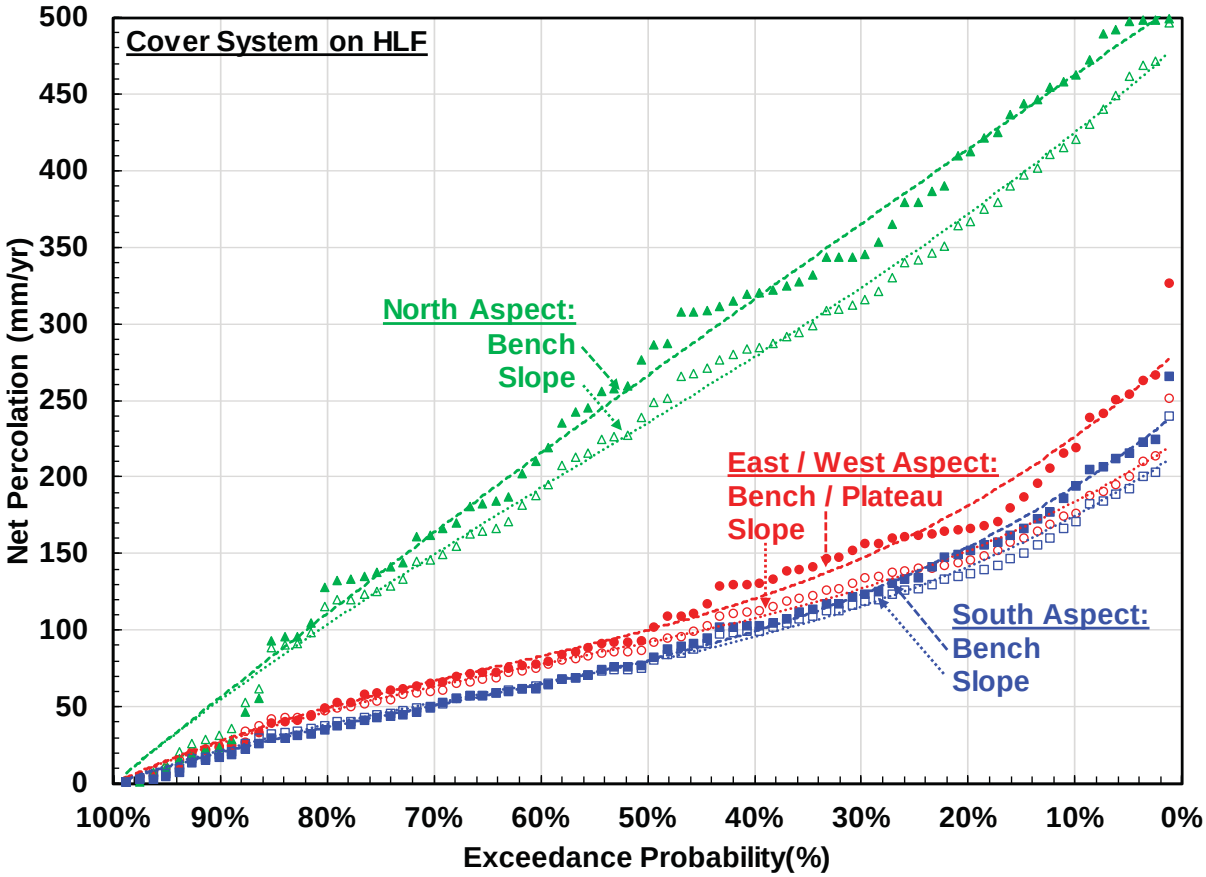

Figure 3 Exceedance probability for annual net percolation though the base case cover system design on HLF[9].

The model results presented prior to this point are estimates of long-term cover system performance, i.e. post-closure once a climax forest vegetation has established on the cover system. Water balance fluxes will vary greatly at different pre- and post-closure stages of the EGP operation. Tables 3 and 4 provide predicted water balance fluxes for different pre- and post-closure stages of the WRSAs and HLF, respectively. The first stage is a pre-closure scenario when the closure cover system is not in place; the NP rate on WRSAs for this case is estimated to be 49% of annual precipitation. The NP rate is estimated to drop to 36% on WRSAs when the cover system is initially constructed, but before vegetation establishment. Once vegetation is established, the NP rate further drops to 28% and 24% of annual precipitation for a grasses & shrubs and climax forest vegetation scenario, respectively. Table 4 shows a similar trend for predicted NP rates for the base case cover system design on the HLF.

[9] Equations for trendlines fitted to data in Figure 3 (equations provide estimate of annual net percolation rate (NP in mm/yr) for a given exceedance probability (x)):
NP (HLF North Aspect – Bench) = $31.272632650886(1-x)^3 - 89.742473682767(1-x)^2 + 569.412107857963(1-x)$
NP (HLF North Aspect – Slope) = $230.751591012202(1-x)^3 - 318.847922658053(1-x)^2 + 572.512360031695(1-x)$
NP (HLF East / West Aspect – Bench/Plateau) = $401.880632485379(1-x)^3 - 433.796816800299(1-x)^2 + 316.593775515019(1-x)$
NP (HLF East / West Aspect – Slope) = $310.161269957891(1-x)^3 - 383.422721152048(1-x)^2 + 298.154325857064(1-x)$
NP (HLF North Aspect – Bench) = $297.902638452382(1-x)^3 - 279.853973662612(1-x)^2 + 226.194792839713(1-x)$
NP (HLF North Aspect – Slope) = $282.980662582457(1-x)^3 - 307.881636956547(1-x)^2 + 242.043952583721(1-x)$

Table 3
Average annual water balance fluxes predicted for WRSA base case cover design at different pre- and post-closure stages
(values are in percent of annual precipitation for a plateau or bench section of an east- or west-facing slope aspect).

Stage	**1: pre-closure**	**2: closure**	**3: vegetation established**	**4: climax vegetation**	**Conceptual Model**
Cover	**None**	**Base**	**Base**	**Base**	
Vegetation	**None**	**None**	**Grasses & Shrubs**	**Forest**	
RO	5%	10%	9%	9%	5% – 20%
AET	34%	44%	50%	55%	40% – 60%
Sub	12%	12%	12%	12%	10% – 15%
NP	49%	34%	28%	24%	15% – 45%

*RO: Runoff; AET: Actual Evapotranspiration; Sub: Sublimation; NP: Net percolation.

Table 4
Average annual water balance fluxes predicted for HLF base case cover design at different pre- and post-closure stages
(values are in percent of annual precipitation for a plateau or bench section of an east- or west-facing slope aspect).

Stage	**1: pre-closure**	**2: closure**	**3: vegetation established**	**4: climax vegetation**	**Conceptual Model**
Cover	**None**	**Base**	**Base**	**Base**	
Vegetation	**None**	**None**	**Grasses & Shrubs**	**Forest**	
RO	5%	10%	9%	9%	5% – 20%
AET	37%	42%	51%	56%	40% – 60%
Sub	12%	12%	12%	12%	10% – 15%
NP	46%	36%	28%	23%	15% – 45%

*RO: Runoff; AET: Actual Evapotranspiration; Sub: Sublimation; NP: Net percolation.

Analysis of Alternate Cover System Designs and Sensitivity to System Variations:

In total, 43 long-term simulations were completed to determine the sensitivity of the base cover system design due to variations in materials, climate, and/or vegetation. The simulations were also completed to determine what (if any) improvements can be made to the base case cover system design. All the scenarios were initially completed without vegetation present so that changes in performance could be directly correlated to changes in materials or climate. Vegetation was then included to further evaluate select scenarios. Finally, the base case results presented in the previous section showed little difference in performance between the WRSAs and HLF simulations. Hence, all sensitivity scenarios were simulated with a cover system overlying waste rock unless otherwise noted. Tornado plots of net percolation predictions for the WRSAs and HLF scenarios simulated are provided in Figures 4 and 5, respectively, followed by detailed analyses.

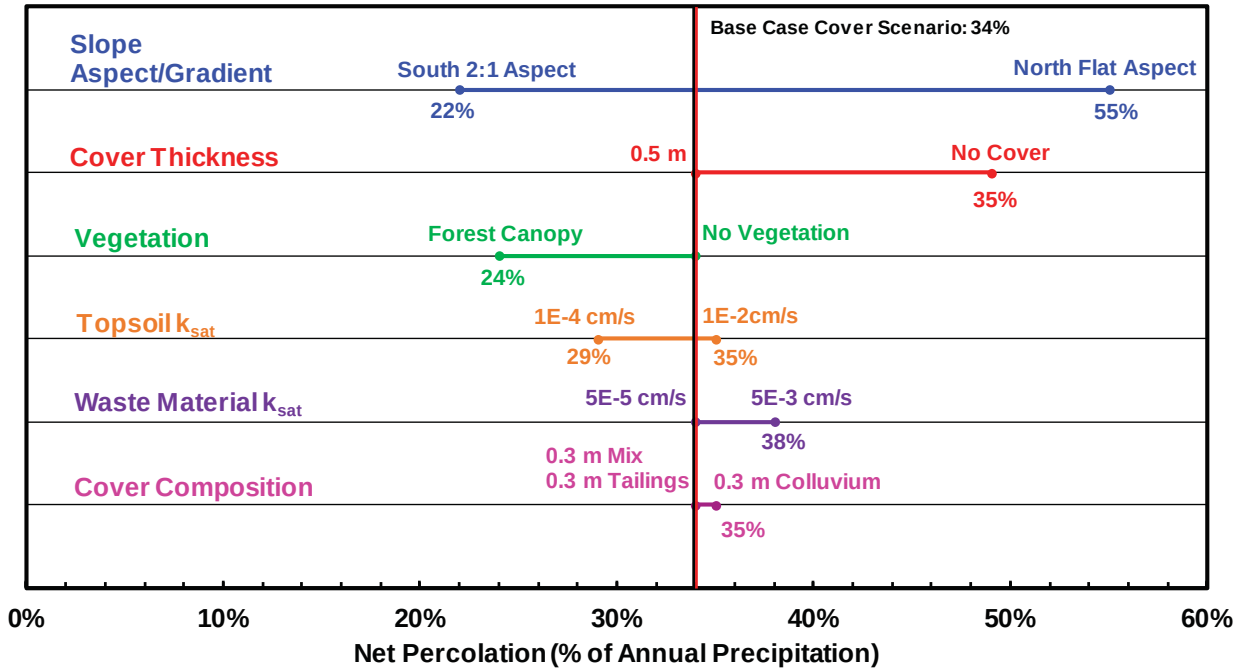

Figure 4 Tornado plot for WRSA cover system net percolation predictions.

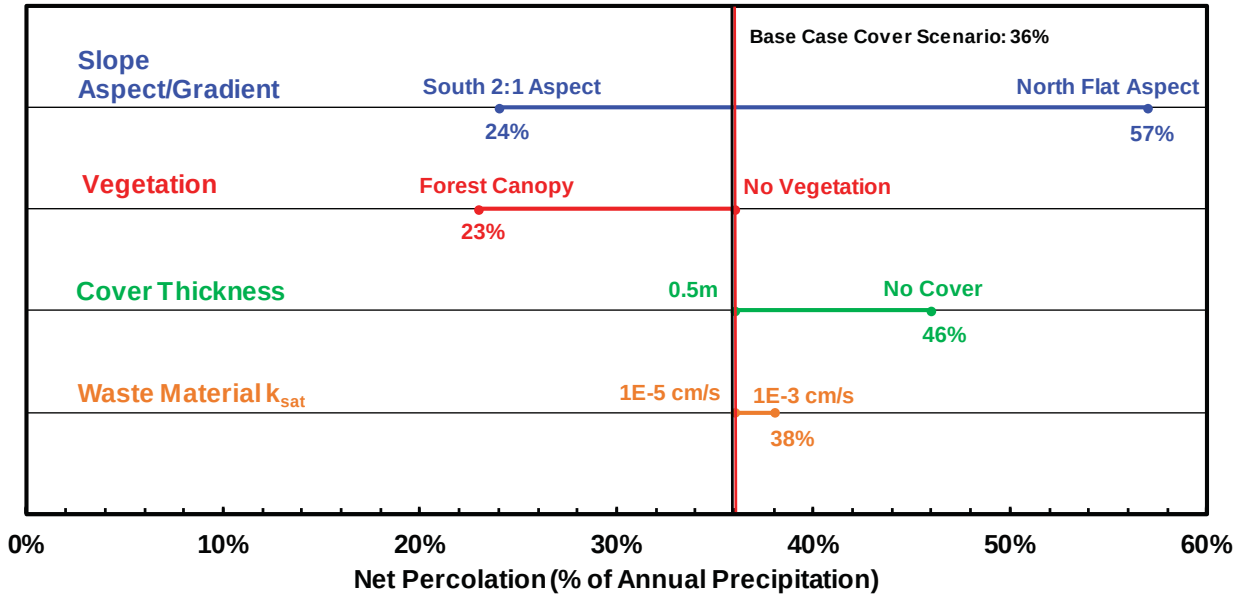

Figure 5 Tornado plot for HLF cover system net percolation predictions.

Slope aspect and gradient have the largest effect on NP rates estimated for both WRSAs and HLF. The added solar radiation on south facing slopes results in a higher AET rate, further drying out the cover in the summer months. In contrast, the north-facing aspect has substantially less solar radiation available to evaporate or transpire water stored in the cover profile. This increases the observed NP rate. A 2:1 slope gradient will result in a larger volume of runoff during the spring melt and high intensity rainfall events.

Table 5 shows predicted average annual NP rates for eight cover system scenarios with varied layer thickness and composition. The majority of the cover thickness and composition scenarios were completed for the WRSAs only. The HLF only compared the uncovered waste material to the base cover system. For the WRSAs, three thicknesses of the tailings-colluvium mix were evaluated to determine if additional storage capacity would improve cover system performance. The materials that comprise the cover system were also varied to determine the effect of different compositions.

Table 5
Average annual NP rates predicted for varying cover thickness and composition scenarios (values in percent of annual precipitation).

Layer 1		*Layer 2*		*Layer 3*		*Net Percolation*
Material	***Thickness (m)***	***Material***	***Thickness (m)***	***Material***	***Thickness (m)***	
TPSL	0.2	MIX	0.3	-	-	34%
TPSL	0.2	MIX	0.5	-	-	35%
TPSL	0.2	MIX	0.7	-	-	35%
TPSL	0.2	TLS	0.3	-	-	34%
TPSL	0.2	CLVM	0.3	-	-	35%
TPSL	0.2	TILL	0.3	-	-	35%
TPSL	0.2	TLS	0.1	CLVM	0.2	35%
TPSL	0.2	CLVM	0.2	TLS	0.1	35%

*TPSL: topsoil; MIX: tailings-colluvium mix; TLS: tailings; CLVM: colluvium; TILL: till; WR: waste rock.

Virtually no difference exists in predicted NP rates resulting from the use of different materials on-site. Cover system scenarios that used only colluvium or tailings (rather than the 2:1 mix) produced nearly identical NP rates as the 2:1 colluvium-tailings mixture. Layered cover systems of the two materials also produced similar NP rates. Based on these results, there is no advantage, from a NP perspective, to mixing the tailings and colluvium into a single cover system material based on the estimated hydraulic properties of the two material types.

Without vegetation to remove water from depth, thickening the cover system provides no reduction in the NP rate, and actually results in an increase in NP. NP rates do not decrease because the energy available for evaporation is low, which creates relatively low hydraulic gradients for removing water from the cover system. Hence, evaporation alone can only remove water stored nearer the surface. The model estimates a slight increase in NP with increased cover thickness because the underlying waste rock is a textural discontinuity, which creates a capillary barrier inhibiting NP and keeping water closer to the surface. When the depth of the capillary barrier is increased by increasing the thickness of the cover system, the percolating water is able to get to depth more easily, which increases NP.

As shown in the previous section, the presence of vegetation is vital to hydrological performance of the cover system. The NP rate is reduced by 10% or more for both the WRSAs and HLF when a forest canopy is present. A large part of the improvement from the forested cover system scenario comes from the improvement of AET via canopy interception. The forest canopy intercepts precipitation on the foliage, which reduces the amount of water that infiltrates into the cover system. This intercepted water is then evaporated or sublimated from a location more exposed to solar radiation and wind compared to surface.

Vegetation requires water to be readily available for root uptake for establishment and survival. When a material dries below a point at which plants are unable to remove water, the material is said to be at its permanent wilting point (PWP). The PWP is generally defined to occur at a suction of 1,500 kPa. At the other end of the range is the field capacity (FC) of the soil. FC is defined as the water content held in the soil after excess water has drained away and the rate of downward movement has decreased. FC is generally stated to occur at a suction of 33 kPa for finer soils and 10 kPa for coarser materials. FC and PWP define the upper and lower limits, respectively, that a growth material is able to supply water for root uptake. Hence, the difference between FC and PWP defines a soil's AWHC (i.e. AWHC = FC – PWP).

Figure 6 shows the estimated amount of water stored within the base case cover system design during the 80-year simulation period for three scenarios: base cover system on WRSA; base cover system on HLF; and, a cover system consisting of 0.2 m of topsoil overlying 0.3 m of till (referred to in Figure 6 as till cover system) overlying WRSA. Till was chosen for the third simulation as it has the highest AWHC of all the potential cover materials considered in this study. The cover system water volume for all three scenarios is estimated to almost always stay within or above the AWHC range. There are only seven periods when the cover system water volumes drop near or below the PWP line. These are periods when vegetation would be at risk; but it must be noted that the model inputs were set to permit forest vegetation to be capable of removing water up to a suction of 2,500 kPa (based on research of tree species), and that VADOSE/W does not account for all plant survival mechanisms (e.g. dormancy). Hence, the model estimates that the current cover system design adequately meets the water requirements for vegetation.

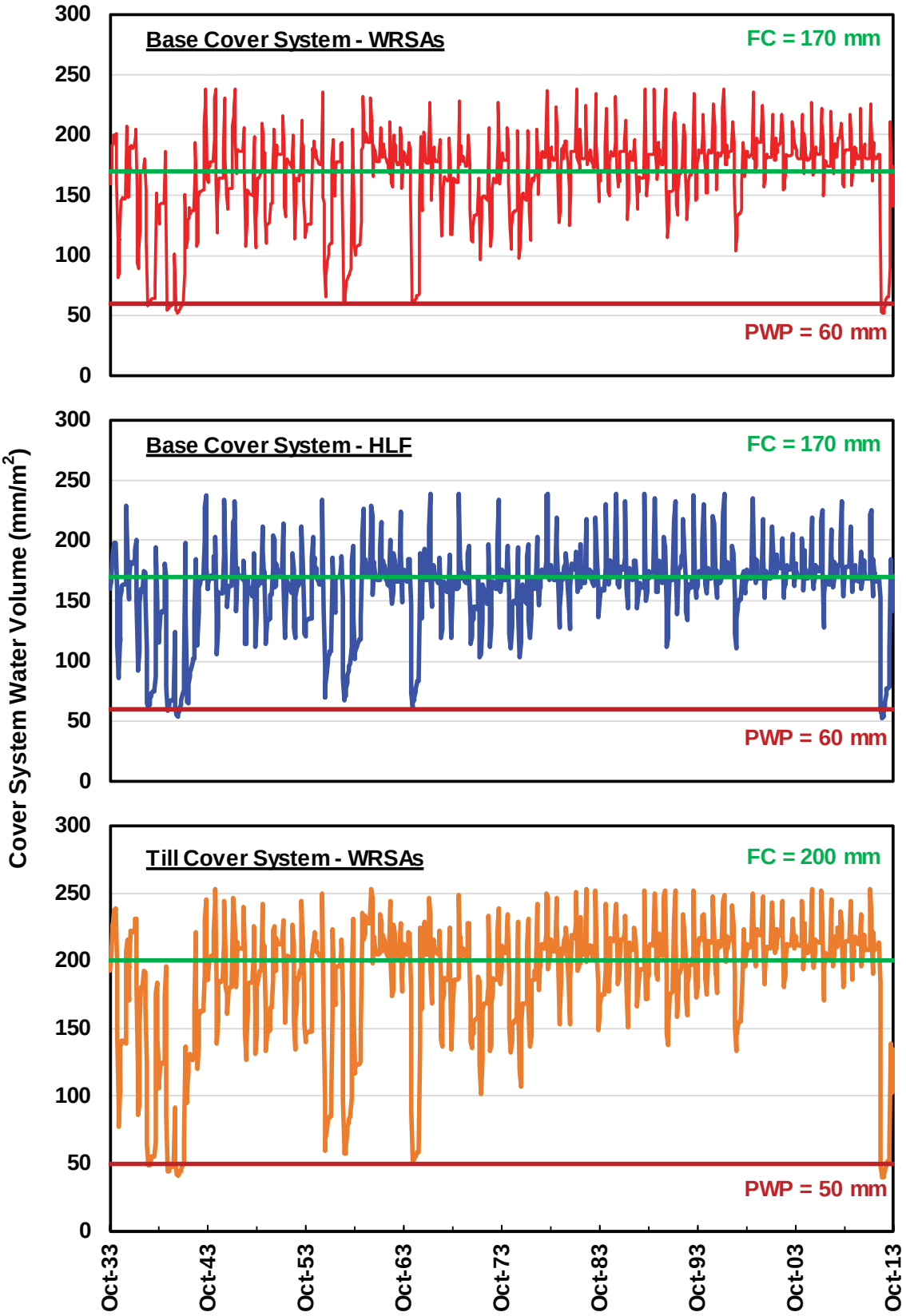

Figure 6 Cover system water volumes estimated during 80-year simulations for three scenarios (from top to bottom): base cover system on WRSAs and HLF and till cover system on WRSAs.

The material properties of the cover system materials were also varied. In general, scenarios that lowered the k_{sat} of various materials resulted in slightly lower NP rates, while increasing the k_{sat} slightly increased NP rates. Table 6 shows predicted average annual water balance fluxes for six cover system scenarios that varied the material properties of the cover system materials.

Table 6
Average annual water balance fluxes predicted for the varied material properties scenarios (values in percent of annual precipitation).

Waste Material	***Waste Rock***	***Waste Rock***	***Waste Rock***	***Waste Rock***	***Heap Leach***	***Heap Leach***
Modification	**Waste Rock k_{sat} increased by 10x**	**Waste Rock k_{sat} decreased by 10x**	**Topsoil k_{sat} increased by 10x**	**Topsoil k_{sat} decreased by 10x**	**Heap Leach k_{sat} increased by 10x**	**Heap Leach k_{sat} decreased by 10x**
Runoff	10%	10%	8%	15%	10%	10%
AE	43%	44%	45%	44%	40%	42%
Sublimation	12%	12%	12%	12%	12%	12%
Net Percolation	35%	34%	35%	29%	38%	36%

The k_{sat} of the topsoil proved to be an influential property during the sensitivity analysis. By increasing or decreasing the k_{sat} of the topsoil by one order of magnitude, the average NP rate varied from 35% to 29% of annual precipitation, respectively. It is essential that thorough testing be completed to verify the hydraulic properties of local topsoil material because its k_{sat} is showing to have the largest influence on predicted NP rates. Decreasing the waste material k_{sat} also had an effect on the observed NP rate; however, increasing the k_{sat} of the waste material had little effect on the NP rate. The effect of varying the k_{sat} of the tailings-colluvium material was also analyzed; however, no difference in the water balance was observed when the material's k_{sat} was varied by one order of magnitude.

One sensitivity that was not included in the above tornado plot is climate change. Climate change predictions for Mayo, YT predict an increase in monthly air temperature and precipitation[10]. The 100-yr average temperature increase is predicted to be between 3 and 6°C, whereas annual precipitation is estimated to increase by 15 to 35%. This increase would have a substantial effect on hydrological cover system performance at the EGP site. Hence, simulations were completed with no ground freezing effects simulated and with the historic climate database adjusted to mid-range climate change estimates (i.e. temperature increase of 4°C and precipitation increase of 25%). Table 7 provides the average water balances for these scenarios (note that the results are stated as a percent of average annual historic precipitation (492 mm/yr) but the climate change scenario has an average annual precipitation rate of 615 mm/yr).

[10] Scenarios Network for Alaska & Arctic Planning. 2013. *Community Charts: Mayo, YT*. Version 1.219. Online. www.snap.uaf.edy.com

Table 7
Average annual water balance fluxes predicted for the base case and climate change scenarios (values in percent of annual historic precipitation with mm/yr in brackets).

Scenario	Runoff	AE	Sublimation	Net Percolation
Base Case	10% (49)	44% (215)	12% (59)	34% (169)
No Ground Freezing	0% (4)	42% (205)	12% (55)	46% (228)
Climate Change	4% (21)	51% (251)	7% (34)	63% (311)

The majority of runoff from the base case scenario is generated during the spring melt. The frozen ground encourages runoff because the water cannot easily infiltrate due to ice blocking soil pores. When the cover is not able to freeze to a suitable depth due to increased air temperature, spring melt waters are able to infiltrate rather than runoff. The increased infiltration rate contributes to a rise in NP. These scenarios illustrate the advantage of a frozen cover at the EGP site and the risk of its loss due to climate change. The deep frost penetration allows the cover system to limit NP despite the coarser textured locally available material. If the climate change prevents the cover system from freezing to a suitable depth, geosynthetic products would have to be used to limit NP.

Future Studies Recommended to Further WRSA / HLF Closure Cover System Design:

The 2014 EGP modelling program completed by OKC relied on estimated material properties. In order to increase the confidence in the predicted water balance components (especially NP), further study of the EGP site and locally available materials should be completed. Studies recommended by OKC are as follows:

- Material characterization program potential cover materials and waste materials (when they become available), including:
  - hydraulic conductivity,
  - moisture retention, and
  - geochemical properties;
- Construction and monitoring of cover system field trials to provide field performance data under local climatic conditions;
- Monitoring of climate conditions on various slope aspects to improve estimates of such climate variables as net radiation, snow distribution and sublimation, which vary greatly with aspect; and
- Potentially expanded borrow source search for till or lower permeability materials for use in the cover system design.

Closure:

Thank you for the opportunity to assist AEG with closure planning at Victoria Gold's Eagle Gold Project. Please do not hesitate to contact the undersigned should you have any questions.

Sincerely,

Brian Ayres, M.Sc., P.Eng.
Senior Geotechnical Engineer

cc: Scott Keesey and Leia Fougere – Access Consulting Group
Robert Shurniak and Kent Schapansky – O'Kane Consultants Inc.

Attachment A: Key Inputs for 2014 VADOSE/W Modelling Program

ATTACHMENT A

Key Inputs for 2014 VADOSE/W Modelling Program for EGP HLF / WRSA Closure Cover Design Assessment

Preliminary Cover System Modelling Inputs

Before SPA numerical modelling was undertaken the model inputs needed to be clearly defined. These inputs can be placed into five categories: geometry; material properties; initial conditions; upper boundary conditions; and lower and side boundary conditions. A brief description of these model inputs is presented in the following sections. SPA modelling was completed using the software VADOSE/W.

Geometry (Cover System Profile Designs):

The 'base' cover system design consists of a 0.2 m thick layer of topsoil underlain by a 0.3 m thick layer of placer tailings / colluvium. Variations to this design were simulated as part of the sensitivity analysis as described in the main body of the report.

Material Properties:

Seven materials were defined for the OKC modelling program: waste rock, colluvium, heap leach, placer tailings, topsoil, till, and a tailings-colluvium mix. A large database of particle size distributions (PSDs) completed by BGC from a variety of borehole and test pit locations were provided to OKC[11][12][13][14]. These PSDs were the basis for the estimates of all material properties for all but one of the materials; no PSD data was available for the topsoil material. Topsoil material properties were developed by comparing a variety of topsoil materials from the OKC material database from similar sites to images of topsoil from EGP. The estimated porosity, saturated hydraulic conductivity (k_{sat}), as well as the percent sand and fines for each of the materials is given in Table A-1.

Table A-1
Summary of basic material properties for SPA modelling.

Material Type	Porosity (m^3/m^3)	k_{sat} (cm/s)	Particle Size Distributions (Minimum – Maximum (Average)		
			% Coarse (>4.75 mm)	% Sand (4.75–0.075 mm)	% Fines (<0.075 mm)
Waste rock	0.30	$5.0X10^{-4}$	34 – 60 (44)	22 – 43 (30)	16 – 44 (26)
Colluvium	0.33	$5.0X10^{-5}$	12 – 60 (40)	18 – 53 (36)	4 – 45 (24)
Heap Leach	0.31	$1.0X10^{-4}$	15 – 50 (33)	20 – 63 (35)	16 – 58 (42)
Tailings	0.26	$5.0X10^{-4}$	25 – 75 (49)	19 – 61 (39)	5 – 19 (12)
Topsoil	0.59	$1.1X10^{-3}$			
Till	0.45	$1.0X10^{-4}$	0 – 33 (11)	5 – 40 (22)	40 – 95 (67)
Tailings-Colluvium Mix (1:2)	0.40	$5.0X10^{-4}$	6 – 68 (34)	27 – 71 (48)	4 – 45 (18)

[11] BGC. 2010, Appendix B – Laboratory Reports, from *Eagle Gold Project Site Facilities Geotechnical Investigation Factual Data Report.* Prepared for Victoria Gold Corp., March
[12] BGC. 2011, Appendix G – Laboratory Reports, from *2010 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., November
[13] BGC. 2012a, Appendix L – Laboratory Reports, from *2011 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., January
[14] BGC. 2012b, Appendix K – Laboratory Reports, from *2012 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., November

In order to complete the proposed SPA modelling, additional properties or functions needed to be estimated. The required properties or functions for each material in the modelling program are as follows:

- moisture retention curve (MRC - suction versus volumetric water content);
- hydraulic conductivity function (k-function - suction versus hydraulic conductivity);
- thermal conductivity function (volumetric water content versus thermal conductivity); and
- volumetric specific heat function (volumetric water content versus volumetric specific heat).

The MRC, or soil-water characteristic curve, is a continuous function relating energy and the state of water, and hence describes the water content of a material as a function of soil suction, or negative pore-water pressure. The MRC for each of the materials used during the OKC modelling program are shown in Figure A-1.

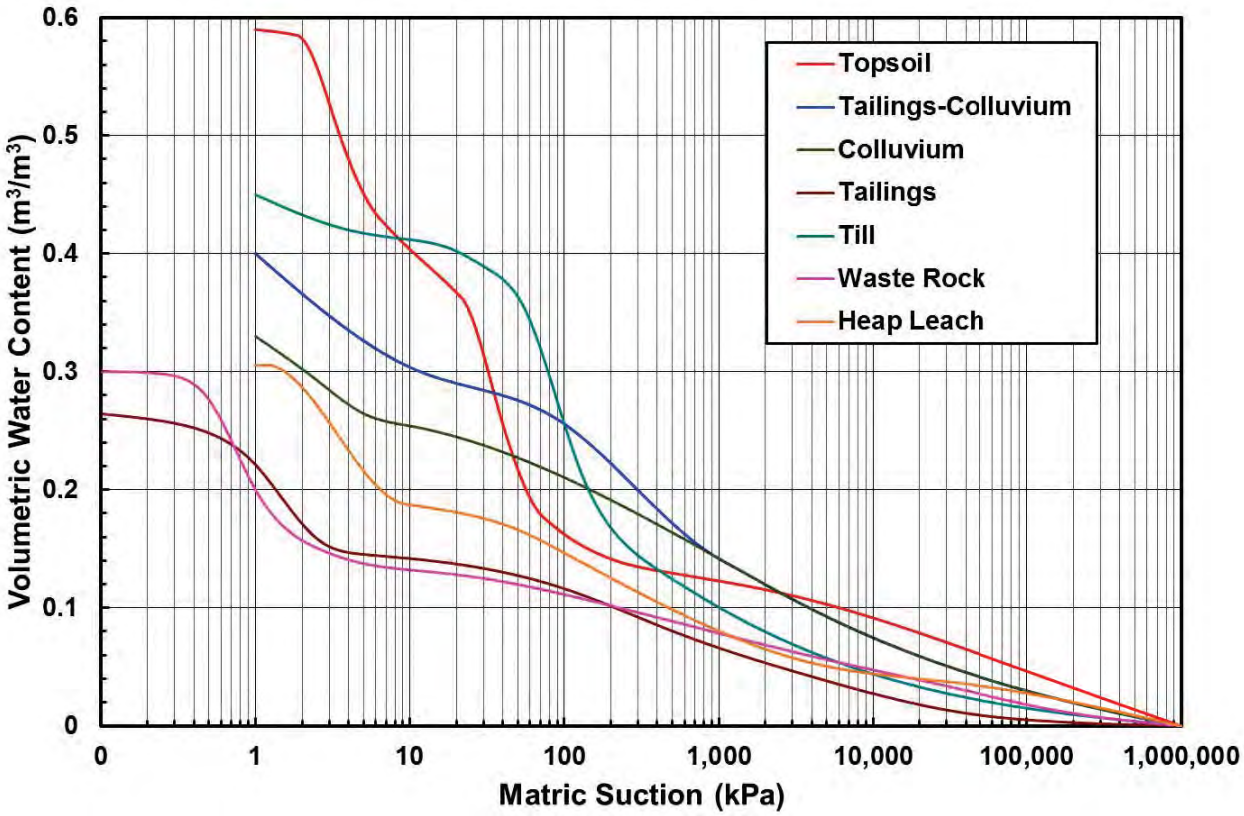

Figure A-1 Moisture retentions curves for all materials used during the OKC modelling program.

Hydraulic conductivity is a measure of the ability of a material to transmit water, and is a maximum for saturated materials. The k-function for each material was estimated from its MRC and k_{sat} using the Fredlund *et al.* method[15]. The k-function for each of the materials used during the OKC modelling program are shown in Figure A-2.

[15] Fredlund, D.G., Xing, A., and Huang, S. 1994. Predicting the permeability function for unsaturated soils using the soil-water characteristic curve. Canadian Geotechnical Journal, Vol. 31, pp. 533-546.

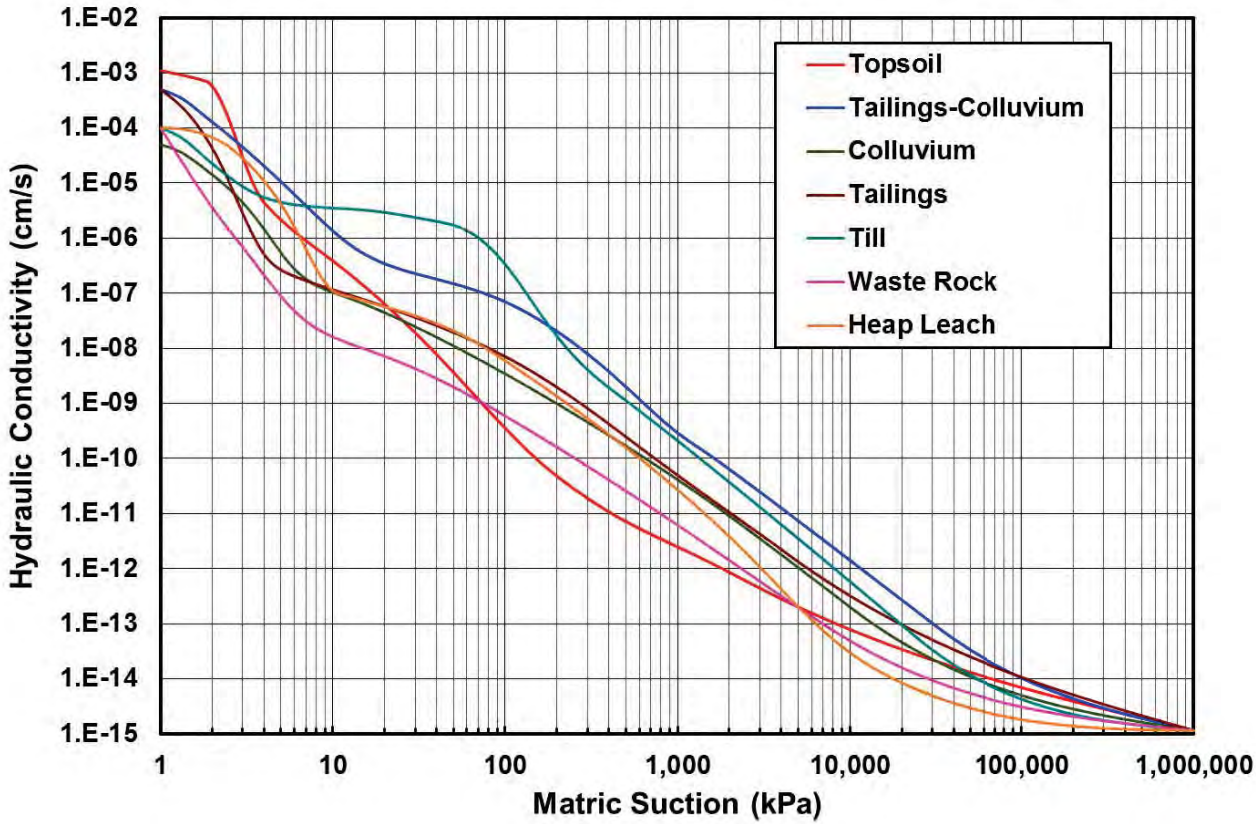

Figure A-2 Hydraulic conductivity function for all materials used during the OKC modelling program.

Thermal conductivity characterizes the ability of a soil medium to transmit heat by conduction. It is defined as the quantity of heat that will flow through a unit area of a soil medium of unit thickness in unit time under a unit temperature gradient. The thermal conductivity functions for all the materials were estimated by VADOSE/W using the Johansen method[16].

The heat capacity of a material is defined as the quantity of heat required to raise the temperature of the material by a unit degree. A volumetric specific heat function describes the relationship between volumetric water content and volumetric specific heat. The volumetric specific heat functions for all the materials were estimated by VADOSE/W using the deVries method[17].

[16] Johansen, O. 1975. *Thermal Conductivity of Soils*. Ph.D. Thesis, (CRREL Draft Translation 637, 1977), Trondheim, Norway.
[17] de Vries, D.A. 1963. *Thermal properties of soils*. Physics of Plant Environment, W.R. Van Wihk (ed.), North Holland Pub. Co., pp. 382.

Upper Boundary Conditions:

The upper boundary conditions required for the VADOSE/W model can be divided into two parts: climate and vegetation. Details regarding the model inputs developed for each are described below.

Climate:

Due to the lack of a long-term data record available for the EGP site, a synthetic climate database was required to proceed with the proposed modelling program. This database consisted of adapting data from several locations. The climate of the EGP site is characterized by long, dry winters and short, warm, wet summers. Local conditions vary due to the variation of elevations found throughout the site.

The elevation of the HLF ranges from approximately 875 to 1,175 masl, and the WRSA's range from approximately 950 to 1,400 masl. This means there is the potential for significantly different climatic conditions at varying elevations on the landforms. For the purposes of OKC's initial cover design modelling, a reference elevation of 1,175 masl was used to develop the base synthetic climate database. All parameters of the synthetic climate database were corrected to this elevation.

The climate data for the OKC modelling program consist of the synthesis of data from three weather stations. Data from two of the stations were provided by AEG. These are the Potato Hills and Camp stations located at the EGP site. These two stations have excellent data quality, but have only operated for a short period. The third station, located at Mayo, Yukon Territory (approximately 85 km south of EGP), is operated by Environment Canada and has long-term data ranging from 1925-2012. Table A-2 summarizes data available for each station. The "Missing Records" column in Table A-2 only lists dates of large sections of missing data. Information from the Hydrometeorology Report prepared by Knight Piésold was also considered while constructing the synthetic climate database[18].

[18] Knight Piésold. 2013, *Hydrometeorology Report*. Prepared for Victoria Gold Corp., August.

Table A-2
Summary of data used for climate database development.

Potato Hills Station: N 64°02' W 135°44' elevation 1420 masl		
Parameter	**Period of Record**	**Missing Records**
Daily Rainfall (mm)	August 14, 2007 – December 31, 2011	-
Daily Maximum Temperature (°C)	August 14, 2007 – December 31, 2012	42 missing entries
Daily Minimum Temperature (°C)	August 14, 2007 – December 31, 2012	42 missing entries
Daily Maximum Relative Humidity (%)	August 14, 2007 – December 31, 2011	37 missing entries
Daily Minimum Relative Humidity (%)	August 14, 2007 – December 31, 2011	37 missing entries
Daily Average Wind Speed (m/s)	August 14, 2007 – December 31, 2011	-
Daily Average Net Radiation (W/m^2)	August 14, 2007 – December 31, 2011	-
Camp Station: N 64°01' W 135°51' elevation 782 masl		
Parameter	**Period of Record***	**Missing Records**
Daily Rainfall (mm)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Maximum Temperature (°C)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Minimum Temperature (°C)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Maximum Relative Humidity (%)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Minimum Relative Humidity (%)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Daily Average Wind Speed (m/s)	August 25, 2007 – September 15, 2013	January 1, 2013 – May 20, 2013
Mayo Airport Station: N 63°37' W 135°52' elevation 504 masl		
Daily Precipitation (mm)	June 1, 1925 – December 31, 2012	March 1, 1946 – March 31, 1946 April 1, 1989 – April 30, 1989 January 1, 1995 – February 28, 1995 April 1, 1995 – December 31, 1995
Daily Maximum Temperature (°C)	January 1, 1925 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977
Daily Minimum Temperature (°C)	January 1, 1925 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977
Daily Maximum Relative Humidity (%)	April 2, 1940 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977
Daily Minimum Relative Humidity (%)	April 2, 1940 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977
Daily Average Wind Speed (m/s)	January 2, 1934 – December 31, 2012	January 2, 1948 – January 1, 1956 August 1, 1960 – September 4, 1962 August 1, 1963 – September 1, 1977

One important parameter that was not available for the Camp or Mayo Airport station is net radiation (NR). This is a vital input for VADOSE modelling to predict potential evapotranspiration (PET) and resultant actual evapotranspiration (AET). For these two stations, NR was calculated using an analytical spreadsheet. This calculation uses the daily maximum and minimum temperature and relative humidity (RH) together with the latitude and elevation of the site to determine the estimated NR. The spreadsheet was first calibrated comparing the measured NR at the Potato Hills station and the calculated NR. The calibration data were then used to predict NR for both the Camp and Mayo Airport Stations.

Climate data obtained from the three stations was thoroughly reviewed with any questionable or incomplete data removed from the record. An equation was developed from the data set for each parameter at each station to provide average conditions for any given day of the year. The equations were obtained by fitting trendlines through daily average graphs for each climate input. Missing data from each station was filled using these average values. The datasets were then compared and adjusted to be representative of the assumed elevation.

The adjusted Mayo Airport data was used as the template for the synthetic climate database. Due to the sparse data available before 1933, the database was reduced to the period between 1933 and 2013, resulting in an 80-year synthetic climate database. Several large gaps in the adjusted Mayo Airport data were filled using either the adjusted data from other stations, or the developed average year. A summary of the average monthly values from the synthetic climate database is provided in Table A-3. The mean annual precipitation for the 80-year climate database is 492 mm, which is similar to the mean annual precipitation noted by Knight Piésold [19].

Table A-3
Monthly average climate for the long-term synthetic climate database.

Month	Average Temperature		Average RH	Monthly Precipitation	Average Daily Wind Speed	Average Net Radiation
	Daily High	Daily Low				
	°C	°C	%	mm	m/s	MJ/m^2
January	-15.7	-23.7	65	34	1.6	-1.2
February	-10.6	-20.4	63	29	1.8	0.3
March	-7.5	-18.3	58	26	2.3	4.6
April	1.8	-7.9	55	24	2.3	10.4
May	9.5	-1.0	37	37	2.2	14.3
June	15.2	3.8	49	52	1.8	17.2
July	16.0	4.8	55	65	1.8	16.1
August	14.1	2.8	62	60	1.8	12.1
September	9.2	-2.4	66	49	1.6	5.3
October	-3.6	-10.0	73	42	1.6	1.2
November	-12.7	-19.5	73	38	1.6	-0.6
December	-15.7	-23.3	71	36	1.0	-1.3

[19] *Op. Cit.*

Vegetation:

VADOSE/W incorporates vegetation affects using a nodal vegetative uptake source term that is combined with a surface energy term based on canopy cover[20]. The amount of actual nodal root uptake depends also on root depth and density, and water stress (negative pore water pressure).

Lack of available plant water and/or high evaporative demands will cause most plants to biologically react by closing stoma, reducing transpiration, and reducing metabolic reactions[21]. Under continued and increasing stress the plant will reach its wilting point. The wilting point results in leaf drop and tissue death. In VADOSE/W the user must implement a plant moisture limiting function, which determines the percentage decrease in the plants' ability to draw water as the negative pore-water pressure increases in unsaturated ground.

The leaf area index (LAI) is used by VADOSE/W to reduce the amount of net radiation intercepting the soil surface, which in turn reduces the computed actual evaporation. In other words, LAI controls how the energy at the surface is partitioned between that available for direct evaporation from the soil and that which is available to the plants in their attempt to transpire water. VADOSE/W uses Equation 1 to determine how much energy is intercepted by the plant canopy:

$$I = -0.21 + 0.7 \times LAI^{½} \quad [1]$$

where:

I = percent of net radiation intercepted by the plant canopy, and

LAI = leaf area index.

Hence, the model estimates that the canopy intercepts all energy if LAI is greater than 3.0 (i.e. all energy is applied to transpiration) and does not intercept any energy if LAI is less than 0.1 (i.e. all energy is used for evaporation).

If the soil is saturated, the full amount of energy will be applied to the roots according to the root depth and root distribution functions. In VADOSE/W, two root distribution functions are available: triangular and rectangular. A triangular distribution will potentially draw more water near the surface, whereas a rectangular distribution will potentially draw the same amount of water over the full root depth. If the soil is partially saturated, then the actual transpiration value is further reduced according to the plant moisture limiting function entered by the user.

Three vegetation sequences were chosen that represent different timeframes of the reclamation process: bare ground, grasses and shrubs, and mature forest. Each sequence has a significantly different influence on cover system performance. The bare ground sequence also serves as a baseline for comparing cover systems' performance once vegetation has established.

[20] Tratch, D. 1996. *Moisture uptake within the root zone*. M.Sc. Thesis, Department of Civil Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.
[21] Saxton, K.E. 1982. *Mathematical modelling of evapotranspiration on agricultural watersheds*. *In* Modeling Components of the Hydrologic Cycle. Singh, H. (ed.), May 18 - 21, 1981. pp. 183-203.

The grasses and shrubs sequence consists of the application of a rectangular rooting depth of 0.3 m as specified by Access Consulting Group[22]. The plant limiting moisture function for this sequence is shown in Figure A-3.

The final vegetation sequence consists of the application of a mature forest to the modelled sites. The mature forest models were simulated with a triangular rooting depth of 0.5 m. The plant limiting moisture function of this sequence is shown in Figure A-3. A canopy interception (CI) rate of up to 1 mm per rainfall event is assumed when simulating the mature forest. This accounts for rainfall that it collected on the forest canopy, and evaporates before ever reaching the cover system. When applying the canopy interception, a proportional amount of net radiation is also removed during rainfall days to account for the energy required to evaporate the intercepted rainfall.

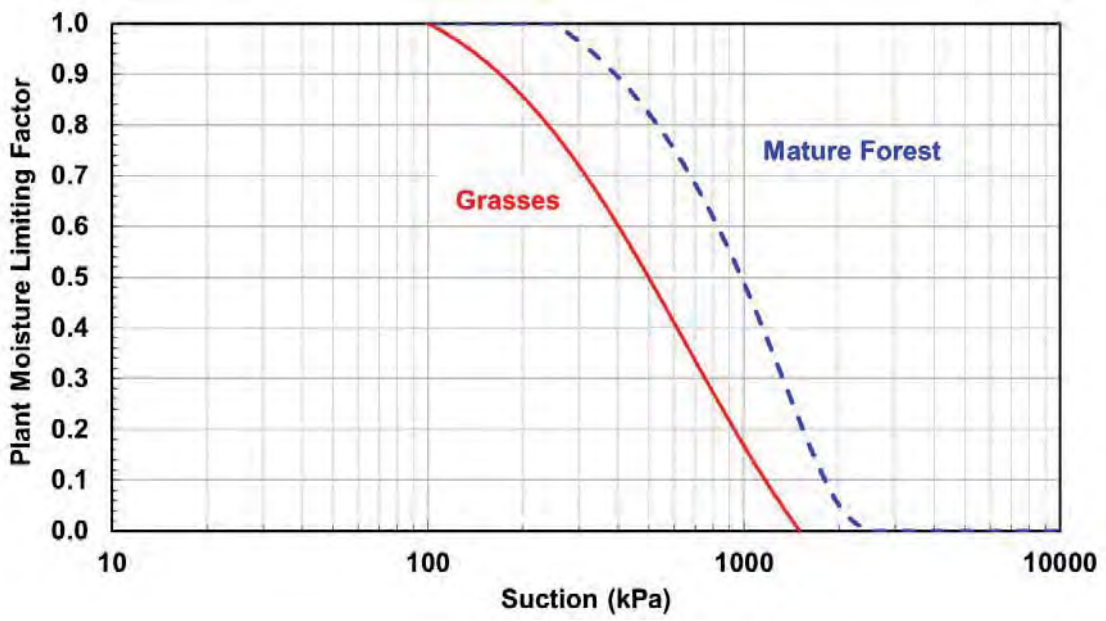

Figure A-3 Plant limiting moisture function for the grasses and mature forest vegetation sequences.

Lower and Side Boundary Conditions:

The lower boundary of each SPA model was simulated as a unit hydraulic gradient at the base of the waste material. This boundary condition simulates the water table to be well below the base of the cover system. A unit hydraulic gradient boundary condition assumes that at the lower boundary the soil suction (and, as a result, water content and hydraulic conductivity) are constant with depth. When this is the case, the total head equals the gravitational head causing a unit hydraulic gradient. In other words, a unit hydraulic gradient represents a location in the modelled profile where water movement is controlled mainly by gravity.

The sides of the 1D models was simulated as no flow boundaries for all simulations.

[22] Access Consulting Group. 2013. *Memorandum: 2012 Dry Stack Tailings Facility Cover Trial*. Prepared for Victoria Gold Corp., March.

APPENDIX F

O'Kane Consultants Inc. – Reclamation and Closure Plan Updates for License QZ14-041 – Clauses 178(d) and 178(e) Closure Cover System Research and Monitoring Plan

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Our ref: 917/03
September 30, 2016

Steve Wilbur
Senior Scientist
Victoria Gold Corp

By email: swilbur@vitgoldcorp.com

Mr. Wilbur:

Re: Reclamation and Closure Plan Updates for License QZ14-041 – Clauses 178(d) and 178(e) Closure Cover System Research and Monitoring Plan

O'Kane Consultants (OKC) was retained by Alexco Environmental Group (AEG) to provide updates to the Eagle Gold Project Reclamation and Closure Plan (RCP). The scope of OKC's work was to provide updates to the RCP based on the Type A Water Use Licence QZ14-041 Clause 178(d): *Research Program for Closure Cover System Designs* and Clause 178(e): *Vegetation Rooting Study*. The required updates were also reiterated in the Quartz Mining License QML-0011 in Schedule C, Part 2, Clause 4.1 (a). The following report provides a brief summary of background information that the conceptual plans were based on, followed by the proposed research program descriptions.

Summary of Previous Work:

OKC worked with AEG in 2014 to further assess the development of cover system designs for closure for the proposed heap leach facility (HLF) and waste rock storage areas (WRSAs) at VG's Eagle Gold Project (EGP) in the Yukon[1]. The closure cover system design was assessed to align with closure design objectives which included being geotechnically and geomorphically stable, providing a medium for sustainable growth of native plants, and reduce long-term net percolation rates to meet closure objectives using locally available materials. Specific project objectives were to further assess the anticipated hydrological performance of the base case cover system design and to provide recommendations to improve its predicated long-term performance from a net percolation reduction perspective. The 'base case' cover system design assessed was a 0.2 m thick layer of topsoil underlain by a 0.3 m thick layer of placer tailings / colluvium.

The assessment was completed through development of a conceptual model for the performance of the base case cover system followed by conducting sensitivity analysis (numerical simulations) of cover system performance using the soil-plant-atmosphere (SPA) model VADOSE/W[2] with available site-specific inputs. The SPA numerical modelling was completed to determine:

[1] O'Kane Consultants Inc. 2014. Eagle Gold Project – Further Assessment of Closure Cover System Designs for Heap Leach Facility and Waste Rock Storage Areas. OKC Rpt 917-1-01. April.

[2] Geo-Slope International Ltd. 2013. Vadose Zone Modelling with VADOSE/W: An Engineering Methodology. September 2013 Ed.

- Improved confidence in the mean and range of net percolation rates for the base case cover system for input to environmental loading and water treatment assessments;
- Influence of potential textural heterogeneity of locally available cover construction materials on cover system performance;
- Influence of the saturated permeability of underlying waste materials on cover system performance;
- Influence of various vegetation conditions on cover system performance;
- Influence of slope angle on cover system performance (i.e. difference in water balance fluxes for the bench plateaus compared to the bench faces);
- Influence of slope aspect on cover system performance; and
- Examination of the available water holding capacity (AWHC) for various cover configurations to avoid creating a 'false' drought condition for the anticipated climax vegetation cover.

Some of the key factors influencing performance of the proposed HLF / WRSA cover system design are as follows:

- Hydraulic properties of candidate cover system materials;
- Hydraulic properties of HLF and WRSA waste materials;
- Slope aspect (i.e. solar radiation input and snowpack accumulation / melt); and
- Slope gradient.

To increase the confidence in the predicted water balance components, specifically net percolation, OKC (2014) provided the following recommendations for further studies:

- Material characterization program of potential cover materials and waste materials (when they become available);
- Construction and monitoring of cover system field trials to provide field performance data under local climatic conditions;
- Monitoring of climate conditions on various slope aspects to improve estimates of such climate variables as net radiation, snow distribution and sublimation, which vary greatly with aspect; and
- Potentially expanded borrow source search for till or lower permeability materials for use in the cover system design.

Clause Specific Updates for RCP:

Clause 178(d): Research Program for Closure Cover System Designs

The overall objective of this research program is to build confidence in the initial long-term cover system design performance analyses in terms of net percolation and to inform eventual large-scale closure cover system construction. Four tasks for the research plan include:

1. Complete background and results review of any recent monitoring data including climate, material characterization, hydrologic / hydrogeologic, and vegetation data to inform and update the conceptual model of cover system performance;

2. Develop a material characterization plan for candidate cover system and HLF and WRSA materials;

3. Enhanced meteorological monitoring; and

4. Design cover system field trials to facilitate the collection and development of a database of moisture and thermal responses (field performance monitoring data).

Tasks 1, 2, and 3 will be completed to update the current long-term cover system performance using numerical models to inform the field trial designs of Task 4.

Task 1: Update Conceptual Model of Closure Cover System Design Performance

The objective of the updated conceptual model will be to incorporate recent available monitoring and site investigation data to refine the previous conceptual model of cover system performance. The updated conceptual model will help to direct the research program and identify key target areas where any data gaps exist. In addition, the conceptual model will provide a basis to compare field trial monitoring results as they are obtained. This will be an iterative process where the conceptual model will continue to be updated and refined as new information is received.

Task 2a: Material Characterization Program for Candidate Cover System Materials

The objective of the material characterization program is to:

- quantify certain hydraulic properties that will control the performance of the closure cover systems,
- assess material availability and volume,
- determine soil fertility for candidate top soil material, and
- evaluate erosion characteristics.

A key component of the material characterization program is to verify the hydraulic properties of local topsoil material because saturated hydraulic conductivity (k_{sat}) showed to have the largest influence on predicted net percolation rates in the 2014 numerical assessment. A large database of particle size distributions (PSDs) completed by BGC from a variety of borehole and test pit locations were provided to OKC for the

2014 assessment[3456] and OKC used the PSD data to develop hydraulic properties of cover and waste materials for the 2014 assessment. PSD data was not available for the topsoil material and properties were developed by comparing topsoil materials from similar sites in an extensive material database developed by OKC. To achieve the overall objective of the material characterization program a sampling and borrow source availability program is proposed. The sampling program will be conducted during excavation during facility construction phase or during a test pit program to collect samples and log profiles of viable sources of the following candidate cover system materials:

- Topsoil,
- Colluvium, and
- Placer tailings.

The sample location plan will be developed following review of previous material investigations. Previous borrow material investigations and a site reconnaissance would be used to identify areas for further investigation and test pit specifications and execution details. The test pits or excavations would be logged for material layer depths, color, initial texture analysis, water table depth, rooting depth. A digital photographic record will be developed for each test pit and the specific location will be documented using a GPS device. Each potential borrow area will be surveyed for aerial extent by walking the area using survey grade GPS equipment to determine the volume of material available in the area.

Between 7 and 10 samples of each material type be collected and submitted for basic geotechnical testing including water content, particle size distribution (PSD) analyses and Atterberg limits. The exact number of samples collected would depend on the heterogeneity of the materials encountered during the program. Following a review of the PSD test results, a select number of duplicate samples would be submitted for compaction testing and hydraulic characterization including saturated permeability and moisture retention testing. The results of this testwork would allow refinement of the currently estimated hydraulic properties for cover materials simulated in the 2014 VADOSE/W modelling program, and subsequent increase in the confidence of current estimates of long-term cover system performance.

Representative samples of potential cover materials will be submitted for chemical characterization testing. Soil fertility examination for agronomy assessment, including but not limited to, analyses for sodium adsorption ratio (SAR), cation exchange capacity (CEC), pH and EC, organic carbon, exchangeable K, Ca, Mg, macronutrients, and micronutrients will be performed. Erodibility assessment of the topsoil or surface material would include aspects of the chemical and geotechnical assessment as well as the Emerson crumb test. The results of this testwork will aid in determining fertilizer requirements for revegetation of the cover systems, and may show that a particular borrow source, such as placer tailings, is chemically unsuitable to support growth of native plants. In addition, materials susceptible to erosion and not suitable for reclamation of side slopes would be identified.

[3] BGC. 2010, Appendix B – Laboratory Reports, from *Eagle Gold Project Site Facilities Geotechnical Investigation Factual Data Report.* Prepared for Victoria Gold Corp., March

[4] BGC. 2011, Appendix G – Laboratory Reports, from *2010 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., November

[5] BGC. 2012a, Appendix L – Laboratory Reports, from *2011 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., January

[6] BGC. 2012b, Appendix K – Laboratory Reports, from *2012 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report.* Prepared for Victoria Gold Corp., November

Task 2b: Material Characterization Program for HLF and WRSA Waste Materials:

Representative samples of spent heap leach and waste rock material will be collected once available, and submitted for geotechnical characterization. Analyses include PSD, water content, standard Proctor compaction, saturated permeability, and moisture retention. The mine waste characterization program will also help to determine the technical feasibility and costs associated with reducing the permeability of flatter areas on the HLF and WRSA to help with future detailed cover system design development.

Spent heap leach and waste rock materials may have a propensity to break down when exposed to the atmosphere and when mechanical energy is applied. A pilot-scale field compaction trial should be conducted to determine the extent to which the waste material can be compacted, thereby reducing its permeability. Large vibratory rollers may be able to reduce the saturated permeability of surface waste material on flatter areas of the HLF and WRSA, such as plateau areas and benches. The intent is to limit net percolation during relatively short-duration seasonal events when the storage capacity of the growth medium layer may be exceeded. Compaction field trials could be carried out once spent heap leach and waste rock stockpiles are established, and materials have been exposed to ambient conditions for several years. The test program would involve permeability and density testing of pre-compacted surfaces, followed by compaction with appropriate equipment and subsequent permeability and density testing of post-compacted surfaces.

Task 3: Enhanced Meteorological Monitoring

The objective of the enhanced meteorological monitoring for different slope aspects is to verify climate input parameters used in numerical modelling analysis to gain confidence in site water balance estimations and in the long-term predicted cover system performance. Meteorological monitoring will focus on snow pack sublimation and redistribution of snow, incoming solar energy and wind speed. For northern sites, such as for the EGP site, snow pack constitutes a significant portion of the water balance. Incoming solar energy is the main driver of potential evapotranspiration (PET) and varies with slope aspect and gradient. Enhanced monitoring of site-specific solar energy and snowpack on various slope aspects will increase the confidence in current estimates of long-term performance and water balance estimations for the proposed HLF / WRSA closure cover system. In addition, depending of the prevailing wind direction areas of the HLF / WRSA may be sheltered influencing the evaporative demand.

Currently climate data is being collected at two automated stations in the Project area: the Potato Hill station installed in 2007 and the Camp station installed in 2009. Station details and the climate data that will be collected during this Task are found in the Environmental Monitoring, Surveillance and Adaptive Management Plan[7]. Automated snow depth measurement and solar radiation are currently part of the climate station instrumentation. Net radiometers will be installed as part of the operations phase at the locations specified in the Environmental Monitoring, Surveillance and Adaptive Management Plan to provide measurement of incoming solar energy for north, west, and south facing slopes (SGC, 2016).

Snow course surveys have been undertaken during late winter since 2009 in the vicinity of the climate stations and methods are described in SGC (2016). The snow course surveys will continue to be conducted

[7] Strata Gold Corporation (SGC). 2016. Eagle Gold Project Environmental Monitoring, Surveillance and Adaptive Management Plan, Version 2016-01.

at these locations, as well as in the locations proposed for the installation of net radiometers. In addition, the snow course surveys are planned to expand to incorporate the HLF to refine the water balance model by providing improved estimates of snow water equivalent and sublimation. Snow survey methods will continue to be implemented according to those outlined in SGC (2016). The surveys will be conducted on a monthly basis during the winter season. The frequency of surveys will increase in late spring and based on climate and temperature patterns to capture the peak snow pack as best as possible, which will help determine the amount of snow water equivalent (SWE) available that will contribute to spring freshet events and has the potential to infiltrate and report as net percolation.

Task 4: Closure Cover System Field Trials for Performance Monitoring

The objective of the closure cover system field trials is increase the level of confidence in estimates of long-term performance of the final HLF and WRSA closure cover systems under site-specific conditions. The results from the material characterization program and most recent site investigation and monitoring data would be used to update current numerical models of predicted cover system performance to inform the optimum cover system design to be trialed at the EGP site. The cover system field trial program would be designed to achieve the key objectives summarized in the Covers in Cold Regions Guidance Document prepared by MEND (MEND, 2012)[8]:

1) Evaluate construction methodologies and equipment in support of finalizing the full-scale cover system design;
2) Obtain performance monitoring data for calibration of numerical models, such as VADOSE/W;
3) Develop an understanding of key characteristics and processes that control cover system performance; and
4) Track evolution of the trialed cover systems in response to various site-specific physical, chemical, and biological processes.

A conceptual design for the field trial program consists of two field trials of the preferred cover system design established on a WRSA, one on the plateau and one on an inter-bench slope. The initial modelled assessment of cover system performance showed little difference in performance between the WRSAs and HLF simulations. Information gained in previous tasks will assist in the development of cover trials on different waste material types and on different slope angles. Automated soil monitoring stations consisting of volumetric water content and matric suction sensors will be installed in each cover trial to quantify key surface water and energy balance fluxes. Data will be collected by a datalogger powered by battery and solar panel set up. The two sensor types will be installed in pairs through the cover system profile to capture data to calculate water and energy fluxes at the interfaces of different material types including between the cover system layers and between the cover system and waste. Stations will be installed to capture data on a plateau location and on different slope locations (upper, mid, and lower slope) to determine spatial variability. The number and location of the automated stations will be determined as part of the final design of the cover system monitoring trials informed by the updated conceptual model, the material characterization program, and the expanded site-specific meteorological dataset. The cover system field

[8] MEND (Mine Environment Neutral Drainage). 2012. Cold regions cover system design technical guidance document. Canadian Mine Environment Neutral Drainage Program, Project 1.61.5c, March.

trial would be revegetated using techniques and species outlined by KP (2012a and 2012b)[9][10] and any updated vegetation monitoring information. The cover system field trials provide an opportunity to investigate vegetation prescriptions and techniques to evaluate the degree of success of the closure cover system design. The monitoring plan developed for the research program would include monitoring for vegetation establishment and continued growth. Vegetation growth is an essential component of the cover system water balance (in terms of AET rates) as well as a primary focus of achieving closure design objectives. Revegetation studies have been previously conducted to examine site-specific vegetation species and ecosystem characteristics (KP 2012a and 2012b) and will help in developing the re-vegetation component of the detailed research and monitoring plan.

As noted in MEND (2012), performance of cover system field trials should be monitored for a minimum of 2 to 3 years prior to proceeding with final design of the full-scale cover system. This will provide sufficient variability in thermal and hydraulic field responses to adequately calibrate the initial VADOSE/W models, thereby improving confidence in the predicted long-term performance of the final cover system design for full-scale implementation.

Clause 178(e): Vegetation Rooting Study

The overall objective of Clause 178E: *Rooting Study* is to evaluate the potential risk for plant root uptake of contaminants of concern (CoCs) from physical, geochemical, and vegetative perspectives. The rooting study will be conducted concurrently with the Closure Cover System Field Trials. The following Tasks will be conducted to achieve this goal:

Task 1: Root Zone Monitoring to understand physical processes contributing to the accumulation or removal of constituents in the rooting zone (i.e. pore-water sampling collection over the duration of the program);

Task 2: Geochemical assessment of cover system and underlying materials to identify any constituents that may be susceptible to bioaccumulation; and

Task 3: Destructive sampling during and near the end of the program to assess the vegetative characteristics, such as root density and length, which would lead to an update of constituents in the cover system and underlying materials.

The following work plan is proposed to address the three Tasks outlined above.

Task 1: Rooting Zone Monitoring in Cover System Field Trial

A manual soil monitoring system would be installed adjacent to an automated soil monitoring system installed during field trials described above to monitor process that allow CoCs to accumulate in the root zone. The location and the number of the manual stations will be determined based on the final design of the cover system monitoring field trials. Deep pressure/vacuum soil water samplers (soil water samplers) would be installed in the cover system to manually monitor and sample pore-water over the duration of the

[9] Knight Piesold Consulting (KP). 2012a. Memorandum to Todd Goodsell. Site visit re-vegetation plan. File No. VA101-290/6-A.01. September 5.
[10] Knight Piesold Consulting (KP). 2012b. Memorandum to Todd Goodsell. Re-vegetation test plots. File No. VA101-290/6-A.01. September 7.

program, providing a basic understanding of soil moisture content and gradient within the cover system that would be verified with the automated system. Additionally, pore-water samples would be analyzed for aqueous chemistry to understand the movement of CoCs within the cover system. The instrumentation installation details will be determined based on the final cover system field trial design; however, the samplers will be installed to capture pore-water through the cover system and particularly near the cover system / waste material contact. Sampling frequency and monitoring plan will be developed to capture high flow periods in the seasonal cycle such as during or immediately following spring melt / cover system profile thaw or intense rainfall events. Pore-water samples collected with the soil water samplers would be submitted for general aqueous chemistry analysis. Samples would be submitted to be tested for measurement of metals (routine and trace) and routine water consisting of pH, EC, total dissolved solids (TDS) and major cations and anions.

Task 2: Geochemical Assessment

In addition to pore-water sample collection, samples of cover system and underlying materials would be collected for geochemical analysis as the field trial is being constructed. General overall geochemical characterization can be included as part of the material characterization program, but discreet samples of the materials used in the field trial should be obtained during construction to provide baseline conditions. Because vegetation will need to be supported by the cover system, basic characterization of the cover system materials and underlying materials will provide an indication of chemical composition related to growth characteristics, inform of potential fertilizer requirements for initial vegetative establishment, and aid in identifying any constituents susceptible to bioaccumulation. Basic chemical characterization would be conducted on samples of cover system layers and waste materials. Initially, samples would be collected and submitted for laboratory chemical characterization of: paste pH and EC, SAR, CEC, calcium carbonate equivalent (CCE) depending on CEC results, and leachate chemistry. The number of samples for each material will be determined as part of the detailed cover system trial work and monitoring plan. Samples will also be collected in conjunction with destructive sampling toward the end of the program to access any changes in soil geochemistry.

Task 3: Destructive Sampling

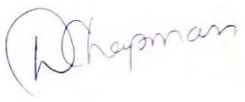
Destructive sampling would be completed during and near the end of the program to determine spatial vegetation characteristics that include vegetation type, ground cover percentage, vertical root length and density. A vegetation survey, consisting of sample plots randomly located throughout the cover system, would be completed to quantify spatial vegetation characteristics. Percentage of ground cover as well as the proportion of species in each sample plot would be determined using a 0.25 m^2 quadrat.

Following the assessment of ground cover, excavation of a number of plots would be conducted to determine the vertical root length density distribution per mass of soil for the cover system; the excavation may be a portion of the 0.25 m^2 quadrat. Small excavations would be completed using methods such as a backhoe at specified increments. Root presence and density would initially be noted and pictures taken for each increment. Each depth increment would be subsampled for water content and root density; water content subsamples would be tested for moisture content and root density samples would be weighed, stored in plastic bags, and water added to each sample. Upon returning from the field, samples should be soaked overnight in a cooler on ice to minimize root degradation. All roots would be separated from the soil matrix, dried and weighed to determine a root density for each plot. Methodology following Lazorko

(2008)[11] would be used for the root mass survey. The depth of each excavation would be dependent on the presence of roots or until the maximum investigation depth is reached. The number of vegetation and root mass surveys would be determined as part of the overall detailed monitoring plan for the cover system field trials.

Closure:

We thank you for the opportunity to assist Victoria Gold Corp with providing updates for the DCP. Please do not hesitate to contact me at (306) 955-0702 or dchapman@okc-sk.com should you have any questions or comments.



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cc: Hugh Coyle, Victoria Gold Corp.
Jim Harrington, Alexco Environmental Group
Greg Meiers, O'Kane Consultants Inc.

[11] Lazorko, H. M, (2008). Root distribution, activity, and development for boreal species on reclaimed oil sand minesoils in Alberta, Canada (Doctoral dissertation, University of Saskatchewan Saskatoon, Canada).

APPENDIX G

O'Kane Consultants Inc. – Victoria Gold Eagle Gold Mine - 2020 Update to RCP re Pilot Scale Cover Trials

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Memorandum

To:	Lindsay Rear – Environmental Manager, Victoria Gold Corp
From:	Larisa Doucette, Geoscientist
Cc:	Lindsay Tallon – Okane Consultants Inc.
Our ref:	B-1048-005
Date:	September 29, 2020
Re:	B-1048-005 Victoria Gold Eagle Gold Mine - 2020 Update to RCP

Introduction

Victoria Gold Corp. (VG) own and operate the Eagle Gold mine in central Yukon Territory. The mine licences issued for Eagle Gold by the Yukon Water Board and the Yukon Department of Energy, Mines, and Resources require the submission of a Reclamation and Closure Plan (RCP) to fulfill the requirements of the license. The previous version of the RCP submitted by VG was Version 2018-03 and requires a revision for 2020.

Previous updates to the RCP detailed a phased approach to reclamation and closure through operations and into decommissioning. A research program had been proposed in the previous RCP in support of ongoing planning efforts at the mine. Previous research tasks in the RCP included research into reclamation cover system configurations and the processes governing performance.

A key objective of the reclamation and closure research plan was to measure and understand cover system water dynamics, such that an appropriate estimate can be made

of the long-term infiltration rates through cover systems. Infiltration rates could then be used to update the proposed cover system configuration, if necessary.

The current efforts to instrument a cover system trial are in service of advancing commitments made in the RCP. As per clause 178(d): Research Program for Closure Cover System Designs, the research program is meant to inform on the eventual large-scale closure cover system configuration. A memorandum previously submitted by Okane to VG discussed broader aspects of Closure Planning that overlapped with the RCP. Four specific tasks for the research program were detailed in the clause 178(d) of the RCP:

1) Complete background and results review of any recent monitoring data including climate, material characterization, hydrologic / hydrogeologic, and vegetation data to inform and update the conceptual model of cover system performance;

2) Develop a material characterization plan for candidate cover system and HLP and WRSA materials;

3) Enhanced meteorological monitoring; and,

4) Design cover system field trials to facilitate the collection and development of a database of moisture and thermal responses (field performance monitoring data).

While not strictly adhering to the sequence detailed in the RCP, the cover system trial currently being constructed very much align with the goals of the program. The current cover system trial was opportunistic, in that VG was able to take advantage of operational schedules to construct a cover system that closely mirrors the RCP base case cover system. In this way, VG will be able to collect real-world monitoring data on the base case design. Monitoring data can then be used to modify any revised designs, should that be required. Furthermore, the collection of stockpile material samples for characterization and the collection of monitoring data during the current program will provide useful inputs into any subsequent work programs.

Activities

An overburden stockpile was relocated to the plateau of the 1370 bench of the Platinum Gulch waste rock storage facility (WRSF). The opportunity was taken to construct and monitor a pilot scale cover system using the relocated overburden. A 0.5 m thickness of cover system was chosen to align with the base case configuration in Version 2018-03 of the RCP. Details of the cover system trial and subsequent instrumentation program are provided below.

As-built Cover System

A 0.5 m cover system was recommended for construction on the eastern portion of the plateau area and a portion of the south-southeast slope of the WRSF (Figure 1). A slope trial area survey and as-built documentation are pending. Standard operating procedures for the mine are being implemented to complete construction of the cover system (Figure 2). Standard procedures include dozing of the overburden material from the existing stockpile across the plateau of the WRSF to produce the 0.5 m cover system layer, and nominal tracking by dozer after placement. Some of the remaining overburden has been pushed over the crest and spilled down the south-southeast slope (Figure 3). The area for slope coverage was selected in order to reduce slope lengths while avoiding the air quality station on the east side of the WRSF. This application method for the cover system aligns with the proposed final closure method for the mine, as waste rock slopes are not intended to be regraded and slope faces will be covered by dozing material over the crest of each bench. This application method does not provide a uniform cover system thickness on the waste rock slopes but will allow for a greater understanding of the infiltration rates on both benches and slopes for the refinement of cover system model inputs.

It was recommended that extra attention be paid to ensure that no additional runoff from the plateau may be inadvertently directed onto the slope, thus accelerating erosive processes. Erosion control in final closure is expected to be achieved through the establishment of vegetation, which is not planned for the trial. Therefore, engineering controls were completed to control erosion. A plateau area berm was constructed to isolate the water balance to a single landscape element and prevent erosion to the extent possible (Figure 4).

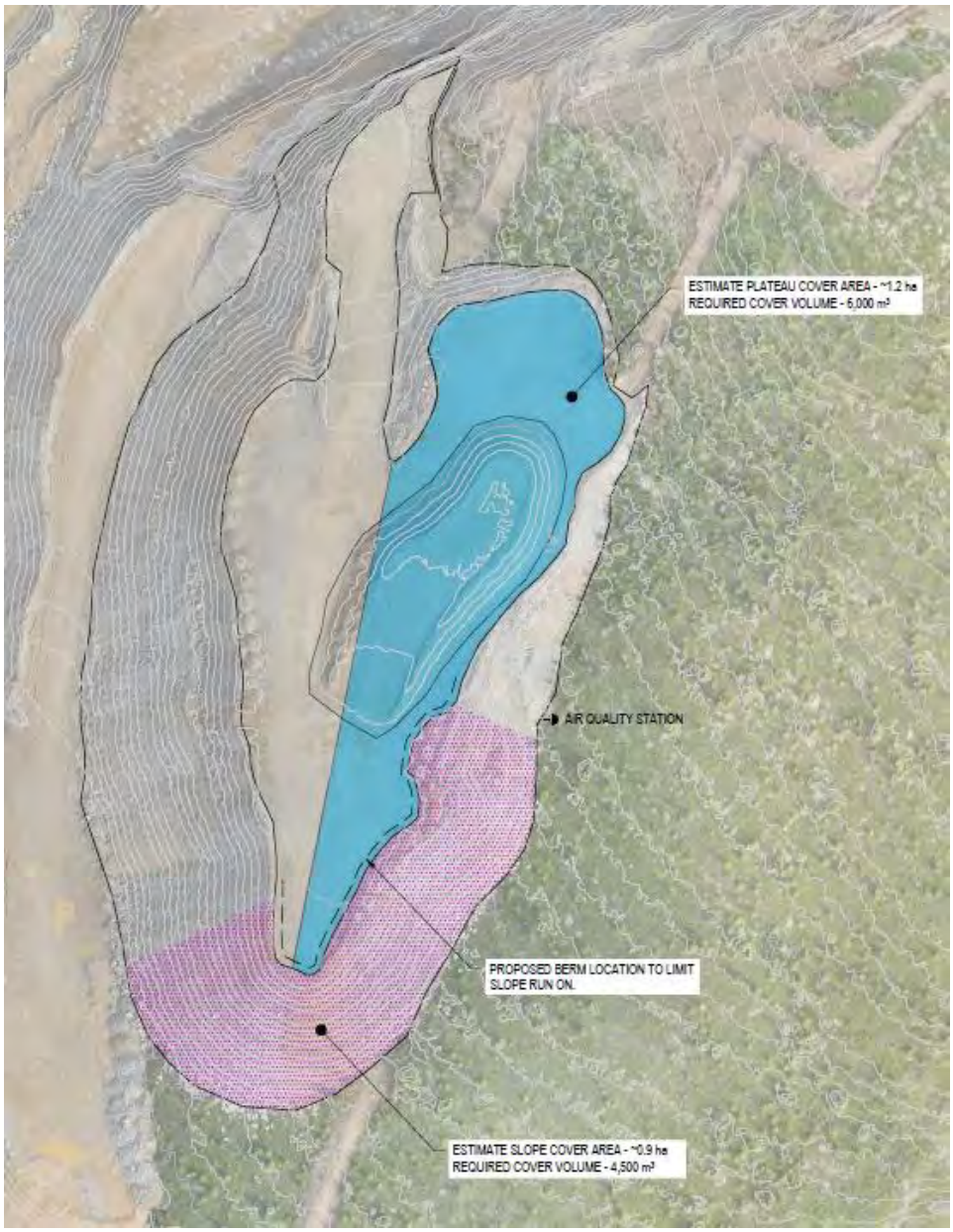

Figure 1: Platinum Gulch WRSF 1370 bench proposed cover system area.

Figure 2: Photograph of WRSF 1370 bench constructed cover system area.

Figure 3: Photograph of WRSF 1370 bench covered slope.

Figure 4: Photograph of WRSF 1370 bench plateau and berm.

Material Characterization

A material sampling program was conducted before and during cover system construction to characterize the physical and hydraulic properties of the overburden material. Data from the characterization program will aid in the interpretation of performance monitoring data collected as part of the instrumentation program. Furthermore, material characterization data serve as a critical input for numerical modelling programs that use performance monitoring data for calibration.

The material characterization program collected samples from six overburden zones (Figure 5), to account for potential variability in properties of the material. Three zones were within the overburden stockpile and three zones were within the overburden material that was already spread on the plateau when sampling began.

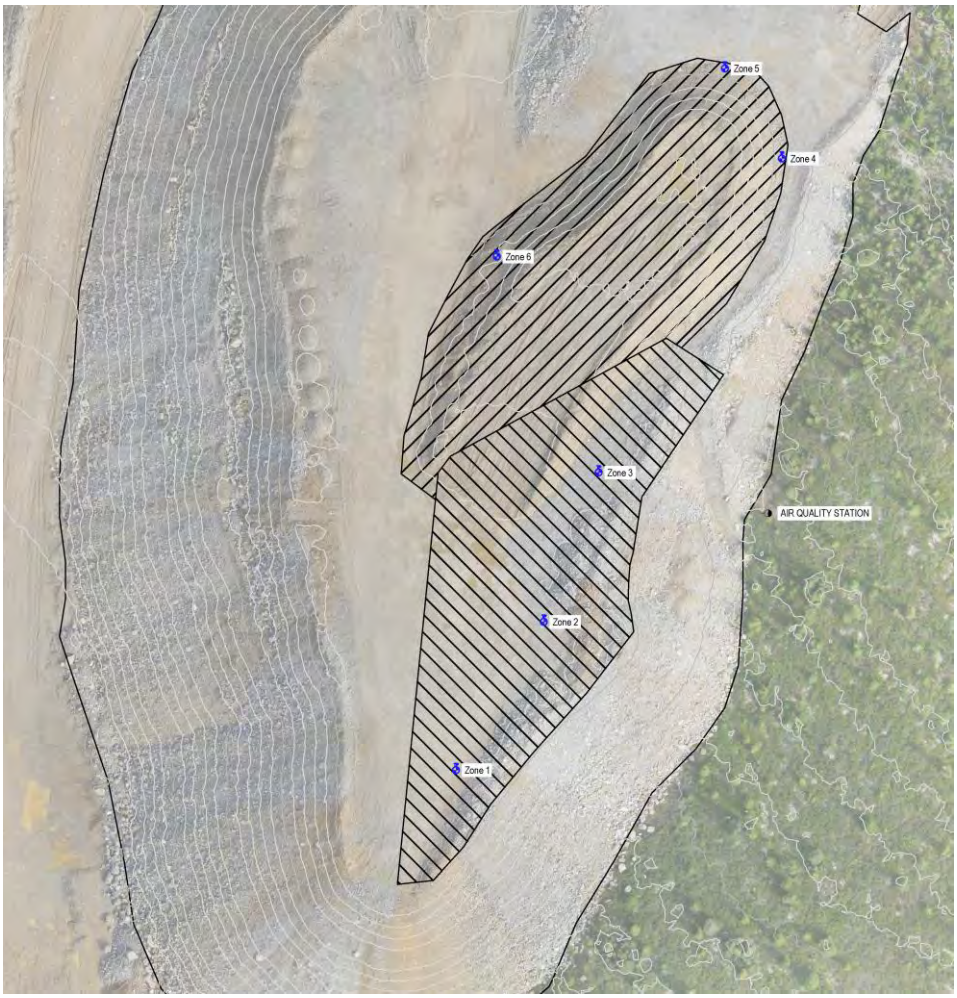

Figure 5: Overburden material sampling zones and locations.

Overburden material samples were collected from five random locations in each discrete zone to produce one composite sample collected in one 20 L pail. The same procedure was carried out two additional times for a total of three composite samples per zone. Three composite samples were collected in this manner in each of the six zones, for a total of 18 composite samples. Sampling locations were spread out to capture the variability of material properties within the overburden stockpile and spread material. In addition, a digital PSD sample was collected in each zone.

One composite sample of overburden material in each zone will be sent to an offsite laboratory for an initial characterization. While some laboratory tests will be conducted on every composite sample sent, a subset will be submitted for more detailed analysis (Table 1).

Table 1: Laboratory testing program.

Laboratory Test	Zone					
	1	2	3	4	5	6
Particle Size Distribution (PSD) (ASTM D422)	✓	✓	✓	✓	✓	✓
Hydrometer (ASTM D7928-17)	✓	✓	✓	✓	✓	✓
Atterberg Limit (ASTM D4318-17)	✓	✓	✓	✓	✓	✓
Standard Proctor (D698-12)			✓			✓
Hydraulic Conductivity (D5084-16)			✓			
Soil Water Characteristic Curve (ASTM D6839-02)			✓			
Digital Particle Size Distribution	✓	✓	✓	✓	✓	✓

Automated Monitoring System

An essential component of a cover system field trial is collection of monitoring data to measure cover system performance. Monitoring performance of the cover system trial will be a critical element in determining the efficacy of the base case cover system. Evaluating efficacy of the base case cover system is best achieved by comparing measured data collected from the trial with a conceptual model of performance. Developing an understanding of how the system interacts with site-specific conditions will lead to a more robust design for the entire closure system. An automated performance monitoring system will be installed in the cover system in the coming weeks to reduce the risk of missing collection of field data during key times of the year such as spring snowmelt and major storm events. Instrumentation will be installed in areas of the cover system field trial that have an as-built thickness of 0.5 m.

Purpose

Performance monitoring data are used to interpret the interactions of the cover system with the atmosphere and underlying waste material. In this way, the response of the physical system can be measured, and appropriate estimates can be made of the long-term infiltration rates through the cover system. Furthermore, performance monitoring data can be used to calibrate numerical modelling programs.

Instrumentation Installation

Data Types

Cover system performance monitoring instrumentation has been procured and will be installed on the cover system trial. Cover system performance monitoring will focus on partial elements of atmospheric water and energy balance inputs, along with soil water balance parameters. Parameters to be measured above ground will include net radiation, snow depth, and rainfall.

The purpose of the above ground components of the monitoring system is to begin to quantify elements of an energy and water balance for the cover system. Specifically:

- Net radiation: Measure the net input of radiation into or out of the soil-atmosphere boundary.
    - Net radiation is important in understanding temperature fluctuations in the cover system and is the primary energy input for evaporating water from the cover system surface.
- Snow depth: Measure the depth of snow above the cover system surface.
    - Snow represents a major input of water into the cover system. Knowing how snow is partitioned between runoff, storage in the cover system, or percolation through the cover system will have a large effect on the design of the closure system.
- Rainfall: Measure the amount of liquid precipitation that is incident to the cover system surface.
    - Rainfall is the primary input of liquid water to the cover system during periods when the cover system is not frozen. Knowing the volume of precipitation incident to the cover system will allow for development of a defensible cover system water balance.

Measurements taken within the cover system provide insight into the partitioning of water at the cover system-atmosphere interface and the cover system-waste material interface.

Measured parameters will include volumetric soil water content, soil temperature, and soil matric potential.

- Volumetric soil water content: Measure the volume of water in the soil at given depths throughout the profile and add to measurements from adjacent sensors to determine cover system water storage.
    - Soil water content is the primary parameter used when developing water balance inputs to a cover system model for a reclamation cover system. The changes of water storage in the cover system provide insight into how the system behaves, and whether water is stored and subsequently released through evaporation, runs off overland, or is transported through the cover system into the underlying waste material.
- Soil temperature: Measure the temperature of the soil at given depths throughout the profile.
    - Soil temperature is an important parameter of interest in cold regions, as temperature is indicative of the energy balance of the system and provides insight into how water is partitioned at the soil-atmosphere interface.
- Soil matric potential: Measure the stress state of the soil and express the wetness of the system in terms of a potential at given depths throughout the profile.
    - Measurement of soil matric potential provides an indication of how tightly the soil is holding the pore water at a given depth. When used with water content sensors it allows for the calculation of gravitational gradients that are then used to calculate a flux through the system. The calculated flux is then used to calculate a rate of percolation of water through the cover system into the underlying waste, where it is then available to report to surface or groundwater receptors.

Sensors To be Installed

The monitoring system design for the cover system trial includes one monitoring station on the covered area of the WRSF plateau and one monitoring station on the adjacent covered southeast slope. Having sensors on both the plateau and slope ensures that the individual landform elements are captured as distinct units, thus aiding in data interpretation. Proposed general locations for monitoring stations are shown in Figure 6; however, safety and construction considerations will likely result in different final locations. Five Campbell Scientific (CS) 616 volumetric water content probes and five CS229 matric suction / temperature probes will be installed at each monitoring station: four pairs in the cover system, and 1 pair in the upper waste material (Figure 7).

Net radiation and snow depth will be measured at both the plateau and slope monitoring stations, as these parameters are aspect-specific, while rainfall will be measured at the plateau station. Net radiation will be measured using a Kipp and Zonen NRLite2 sensor, snow depth using an SR50A sensor, and rainfall using an EML Metric ARG314 rain gauge (Figure 7). Additional meteorological parameters for use in performance monitoring are collected on site at existing meteorological stations.

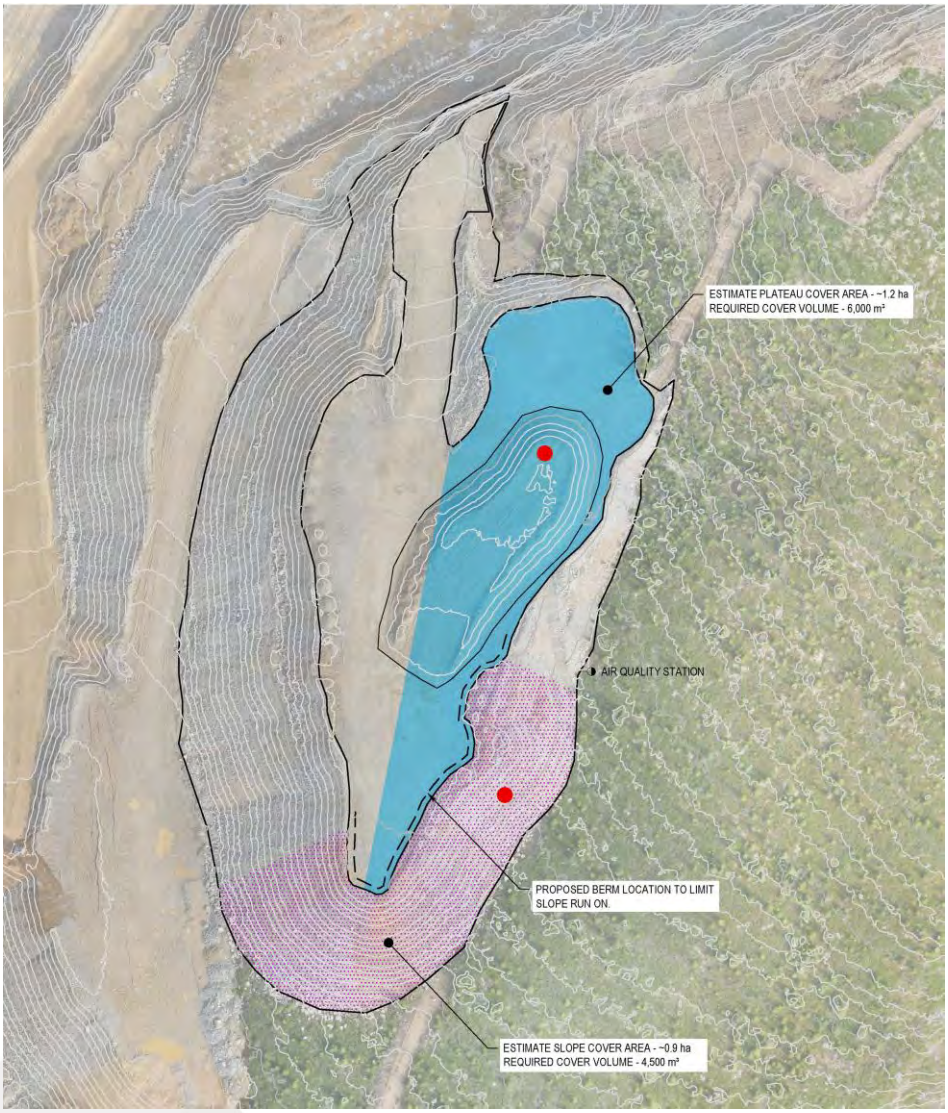

Figure 6: Platinum Gulch WRSF 1370 bench original proposed monitoring station locations.

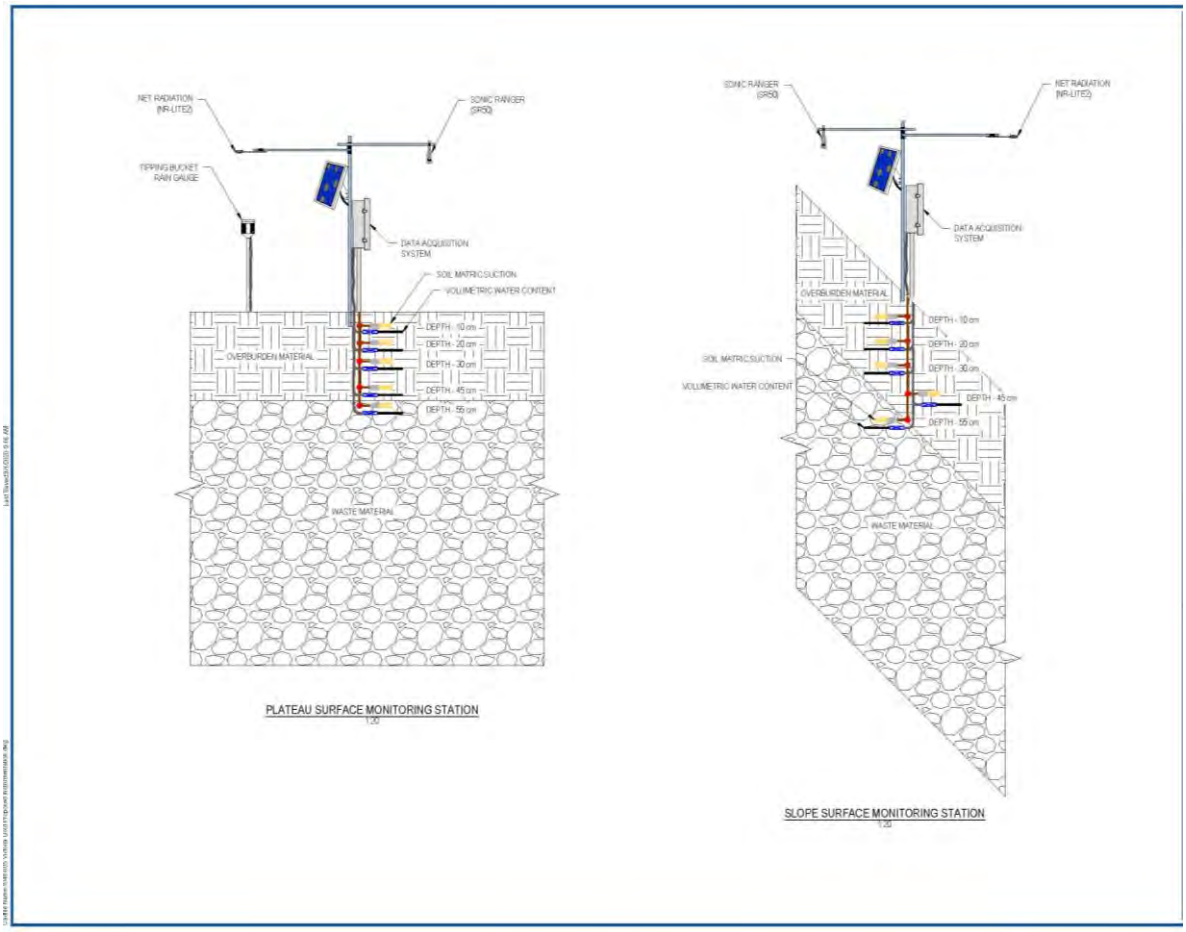

Figure 7: Plateau and slope monitoring station instrumentation proposed design.

Data Capture Frequency

Once the monitoring stations are installed, soil parameters will be measured every four hours to capture any changes that may occur following precipitation events. Net radiation will be measured every minute, snow depth will be measured once per hour, and rainfall will be measured on an event basis. Meteorological parameters will be output into daily and hourly data tables. High frequency data collection ensures that cover system water balances can be estimated on a daily basis.

Trial Duration

It is recommended that the cover system field trial be monitored for as long as possible prior to developing detailed cover system designs for closure. Ideally, monitoring should continue for five years or more in order to capture multiple climatic cycles; however, at a minimum it is recommended that the cover system trial be monitored for three years.

Closure

We trust information provided in this memorandum is satisfactory for your requirements. Please do not hesitate to contact me at (306) 955-0719 or ldoucette@okc-sk.com should you have any questions or comments.

APPENDIX H

Detailed Closure Cost Estimate

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Summary Table of Estimated Closure Costs

Description of Cost	Current Liability	2-Year Peak Liability	Estimated Cost EOM
Closure Implementation			
T3 General & Administration	$966,133	$1,499,440	$2,836,721
T4 Exploration Disturbances	n/a	n/a	n/a
T5 Closure Planning	$422,500	$917,668	$917,668
T6 Pit	$420,295	$54,359	$54,359
T7 Heap Leach Pad	$2,305,221	$3,073,015	$4,185,742
T8 Waste Dumps	$1,327,149	$3,684,424	$4,990,148
T9 Surface Facilities	$6,084,731	$2,210,558	$2,210,558
T10 Infrastructure	$304,311	$404,125	$404,125
T11 Waste Disposal and Remediation	$158,721	$171,221	$171,221
T12 Landfills	$138,449	$138,449	$138,449
T13 Roads & Trails	$554,879	$473,354	$449,027
T14 Water Management	$186,450	$293,934	$249,810
T16 Interim Care & Maintenance	$2,665,256	$2,675,256	$3,126,599
Sub-total	$15,534,094	$15,595,803	$19,734,427
Indirect Costs	$2,330,114	$2,339,370	$2,960,164
Contingency Costs	$2,466,032	$2,567,561	$3,181,736
Cost Inflation	$721,714	$1,478,435	$6,087,638
Total Closure Implementation Costs	**$18,585,922**	**$19,413,608**	**$28,782,229**
T15 Care, Maintenance, and Monitoring Costs (Phase 6, 7/8)			
			NPV (1.5% DROR)
Onsite Management	$512,257	$958,786	$932,999
Transport Costs	$42,000	$58,806	$53,326
Water Treatment Costs (Phase 6)	-	-	-
Active Treatment (Phase 6)	-	-	-
Capital Costs (included in T9, above)	$0	$0	$0
Capital Replacement Costs	$128,326	$417,661	$861,819
Operating Costs	$556,456	$520,963	$2,812,217
Draindown Pumping (Phase 6)	$138,075	$262,435	$462,110
Passive Treatment (Phase 7-8)	-	-	-
Capital Costs	$251,471	$244,094	$210,014
Operating Costs	$45,737	$85,606	$106,567
Reclamation & Closure Research Phase 6	$28,905	$28,057	$49,009
Monitoring & Reporting	$1,453,280	$2,091,465	$2,039,332
Post Closure Maintenance (Phase 7/8)	$760,206	$984,635	$837,584
Sub-Total	$3,916,714	$5,652,507	$8,364,976
Indirect Costs	$587,507	$847,876	$1,254,746
Contingency Costs	$587,507	$847,876	$1,254,746
Total Care, Maintenance and Monitoring Costs	$4,504,221	$6,500,383	$9,619,723
Total Closure Costs	**$23,090,144**	**$25,913,992**	**$38,401,951**
Contingency Amount	**$3,053,539**	**$3,415,437**	**$4,436,483**
Total Closure Costs (Plus Contingency)	**$26,143,683**	**$29,329,429**	**$42,838,434**

Cost Factors	
Indirect Cost Factor	Contingency Factor
15%	15.0%
n/a	n/a
15%	30.0%
15%	15.0%
15%	15.0%
15%	15.0%
15%	15.0%
15%	15.0%
15%	30.0%
15%	30.0%
15%	15.0%
15%	30.0%
15%	15.0%

Cost Factors	
Indirect Cost Factor	Contingency Factor
15%	15%

Closure Unit Rates

Equipment Rates			
Equipment	**Unit Rates**	**Unit**	**Comment/Source**
D9H Dozer	$400.00	hr	Yukon Third Party Rental Rate (wet rate)
Wheel Loader (939 or equivalent)	$160.00	hr	Yukon Third Party Rental Rate (wet rate)
Loader (PC3000 or equivalent)			
General Purpose Loader (Cat 416 E or equivalent)			
Haul Truck (Komatsu HD 1500-7 or equivalent)	$302.97	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 11 CAT 785 B Haul Trucks
Track Dozer (570 HP or equivalent)	$215.00	hr	wet rate
Drill Rig (DR 500 or equivalent)			
Grader (Cat 140K or equivalent)			
Water Truck (52,994 L 550 HP)	$142.50		Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
D6D Dozer	$170.00	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
Haul Truck D250E	$265.00	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
Tandem Haul Truck	$150.00	hr	Wet rate
Cat 235 Excavator	$240.00	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
Cat 235 Excavator w hammer	$390.00	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
Cat 16H grader	$162.50	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
988B Loader	$225.00	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
Tractor Trailer (lowbed)	$195.00	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
30 ton Crane	$123.83	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 3 Cranes
Hiab Flatdeck truck	$195.00	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
Cat 950 loader	$150.00	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
Vibratory Roller	$182.50	hr	Yukon Third Party Rental Rate (wet rate) recommended by YG Third party RECLAIM Model
Pickup Truck	$6.52	hr	Price for fuel/maintenance and equipment operator; SGC currently owns 8 Pickup Trucks
Mobilize Heavy Equipment - Road Access	$0.15	kmtonne	Updated based on YG third party RECLAIM Model

Personnel Rates			
Personnel	**Unit Rates**	**Unit**	
Blaster	$46.95	hr	Updated based on Yukon Fair Wage Schedule
General Labourer	$37.79	hr	Updated based on Yukon Fair Wage Schedule
Trades Labourer	$52.37	hr	Updated based on Yukon Fair Wage Schedule
Site Manager	$187.50	hr	
Design Engineer	$156.00	hr	
Environmental Scientist	$116.00	hr	Updated based on YG third party RECLAIM Model; Labour Buildup not utilized
Supervisor	$14,742.00	month	Updated based on YG third party RECLAIM Model; Labour Buildup not utilized
Camp Labourer	$7,141	month	Updated based on Yukon Fair Wage Schedule
Site Caretaker	$15,156.96	month	Updated based on Yukon Fair Wage Schedule
Environmental Technician	$10,845	month	Updated based on Yukon Fair Wage Schedule

Revegetation Rates	**Unit Rates**	**Unit**	
Revegetation Seed Mix	$18.38	kg	
Revegetation Seed Mix - 50kg/ha	$919.00	ha	
Fertilizer	$1.16	kg	
Fertilizer - 250kg/ha	$290.00	ha	
Tree Seedlings (1,000 seedlings per ha)	$2,100	ha	
Seed/Fertilizer Application	$1,785	ha	
Erosion Barrier	$3.15	m^2	
Revegetation cost per ha. Including application cost	**$2,994.00**	**ha**	

Passive/Heap In Situ Treatment	**Unit Rates**	**Unit**	
Custom Rate: Heap Leach Recirculation Cost--Reagent Delivery		day	
In Situ Treatment Reagent--Reducing Sugars and Nutrients	$1,200	ton	
In Situ Treatment Reagent--Alcohols and Nutrients	$1,200	ton	
Fertilizer - 250kg/ha		ha	
Wetland plants (4,000 seedlings per ha)	$8,000	ha	
Seed/Fertilizer Application		ha	

Contractor Unit Rates & Camp Costs	**Unit Rates**	**Unit**	
Excavation of Soil	$4.50	m^3	
Custom Rate A (Load, haul, place soil cover Heap)	$5.11	m^3	
Custom Rate B (Load, haul, place soil cover Eagle Pup)	$5.11	m^3	
Custom Rate C (Load, haul, place soil cover Platinum Gulch)	$5.11	m^3	
Custom Rate D (Load, haul, place wetland soil in CWTS)	$5.11	m^3	
Custom Rate E (Load, haul, place soil cover IROSA)	$5.80	m^3	
Custom Rate F (Load, haul, place soil cover Open Pit)	$5.11	m^3	
Produce rip-rap	$15.75	m^3	Modified based on Board's comments in Reason for Decision on unit rates.
Load, haul and place rip-rap	$15.75	m^3	Modified based on Board's comments in Reason for Decision on unit rates.
Deliver and install geosynthetic membrane on prepared foundation	$21.00	m^2	Modified based on Board's comments in Reason for Decision on unit rates.
Unit Basis (footing burial)	$5.25	each	Modified based on Board's comments in Reason for Decision on unit rates.
GeoWeb - GW30V3	$5.60	m^2	
GeoWeb - GW30V4	$7.10	m^2	
GeoWeb - GW30V6	$10.60	m^2	
Freight run to Whitehorse	$1,500.00	load	
Camp Cost	$82.04	day/person	Rate based on costs for operating a camp of less than 50 people
Site Security Cost	$6,100.00	month	
Power for recirculation pumps	$20,412.00	month	
Power and Heat (Year 2)	$7,500.00	month	
Employee Transport Costs	$7,875.00	month	

Notes:
1) Custom Rates A through F developed specifically for Eagle Project, taking into account such factors as haul distance, grade, machinery req`d, time req'd, etc.
2) Unit rates for GeoWeb materials are provided by a licensed vendor and are considered conservative costs which include delivery and installation.

Labour Buildup

Personnel	Base Rate	Loading Rate	Estimate Hourly Rate	Rotation	Weeks per Year	Days per week	Hours per day	Total Annual Hours	Total Annual Salary	Monthly Rate
Blaster[1]	$31.30	150%	$46.95	3 in -2 out	33	7	12	2772	$130,145	$10,845
General Labourer[1]	$25.19	150%	$37.79	3 in -2 out	33	7	12	2772	$104,740	$8,728
Trades Labourer[1]	$34.91	150%	$52.37	3 in -2 out	33	7	12	2772	$145,156	$12,096
Site Manager	$125.00	150%	$187.50	2 in -2 out	27	7	12	2268	$425,250	$35,438
Design Engineer	$156.00	100%	$156.00	2 in -2 out	27	7	12	2268	$353,808	$29,484
Environmental Scientist	$74.16	150%	$111.24	3 in -2 out	33	7	12	2772	$308,357	$25,696
Project Manager/Supervisor	$52.00	150%	$78.00	2 in -2 out	27	7	12	2268	$176,904	$14,742
Camp Labourer[1]	$25.19	150%	$37.79	2 in -2 out	27	7	12	2268	$85,696	$7,141
Site Caretaker[1]	$27.76	150%	$41.64	1 in -1 out	52	7	12	4368	$181,884	$15,157
Environmental Technician[1]	$31.30	150%	$46.95	3 in -2 out	33	7	12	2772	$130,145	$10,845

Notes:
1 - Base rates: Yukon Government Fair Wage Schedule - Effective Apr 1, 2020
2 - Loading rate includes overtime, CPP, EI, and Worker's Compensation

General and Administration Costs

Item No.	Work Item Description	Equipment / Labour			Quantity			Cost		
		Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
3.1	**Onsite Management**									
	Pickup truck (Phase 6) (2 trucks)	Pickup Truck	hourly	$6.52	6,300	6,300	14,400	$41,076	$41,076	$93,888
	Sundry equipment maintenance (Phase 6)	Unit Cost Basis	annually	$10,000	1.8	1.8	4	$17,500	$17,500	$40,000
	Power and heat (Phase 6)	Power and Heat (Year 2)	monthly	$7,500	21	21	48	$157,500	$157,500	$360,000
	General Administrative expenses (Phase 6)	Unit Cost Basis	monthly	$7,500	21	21	48	$157,500	$157,500	$360,000
	Camp Costs (Phase 6)	Camp Cost	person-day	$82.04	3,630	10,131	17,207	$297,834	$831,141	$1,411,684
							Sub-Total	**$671,410**	**$1,204,717**	**$2,265,572**
3.2	**Transport Costs**									
	Employee transport costs (Phase 6)	Unit Cost Basis	monthly	$7,875	21	21	48	$165,375	$165,375	$378,000
							Sub-Total	**$165,375**	**$165,375**	**$378,000**
3.3	**Contractor Costs**									
	Contractor Profit & Home Office Overhead	Percentage	%	-	All in contractor equipment rates include profit, insurance					
	Insurance	Percentage	%	-						
	Bonding	Percentage	%	-	Bonding, Taxes, Government Bond Costs, and Property Holding Costs included in "Indirect costs" calculated on Summary table					
	Taxes	Percentage	%	-						
	Government Bond Costs	Unit Cost Basis	monthly	-						
	Property Holding Costs	Unit Cost Basis	monthly	-						
							Sub-Total	**$0**	**$0**	**$0**
3.4	**Mobilization and De-Mobe from Whitehorse**									
		1000	km							
	Excavators x 3	39	kmtonne	$0.15	117,000	117,000	117,000	$17,550	$17,550	$17,550
	Dump trucks x 7	23.5	kmtonne	$0.15	164,500	164,500	164,500	$24,675	$24,675	$24,675
	D9 Dozer x 2	50	kmtonne	$0.15	100,000	100,000	100,000	$15,000	$15,000	$15,000
	Demolition shears x 1	3	kmtonne	$0.15	3,000	3,000	3,000	$450	$450	$450
	Crane x 1	40	kmtonne	$0.15	40,000	40,000	40,000	$6,000	$6,000	$6,000
	Loader x 2	13	kmtonne	$0.15	26,000	26,000	26,000	$3,900	$3,900	$3,900
	Compactor x 1	12	kmtonne	$0.15	12,000	12,000	12,000	$1,800	$1,800	$1,800
	Light duty vehicles x 2	2	kmtonne	$0.15	4,000	4,000	4,000	$600	$600	$600
	Shipping Container - Tools x1	40	kmtonne	$0.15	40,000	40,000	40,000	$6,000	$6,000	$6,000
	Grader x 1	25	kmtonne	$0.15	25,000	25,000	25,000	$3,750	$3,750	$3,750
							Sub-Total	**$79,725**	**$79,725**	**$79,725**
3.5	**Access to Site**									
	Road Maintenance (Phase 6; see breakdown belo	Unit Cost Basis	monthly	$2,363	21	21	48	$49,623	$49,623	$113,424
							Sub-Total	**$49,623**	**$49,623**	**$113,424**
Total Estimated Cost for General and Administration Costs								**$966,133**	**$1,499,440**	**$2,836,721**
Notes:										

Breakdown of Item 3.1 Onsite Maintenance

ACTIVITY	Description	Quantity
Labour (Phase 6 manpower staying in camp)	Project Manager	1
	Water Management	2
	Caretaker/Security	1
	Catering/Housekeeping	3
	Total Personnel	**7**

Labour Estimates for Camp Costs

Description	Total Hours			Total Days		
	Current	Hours Y2	Hours EOM	Current	Days Y2	Days EOM
Total Site Maintenance	53,655	53,655	122,640	4,471	4,471	10,220
Total Active Labour	42,203	49,960	54,217	3,630	4,365	5,208
Total Earthworks for covers					1,295	1,780

Breakdown of Item 3.5 Road Maintenance

ACTIVITY	DESCRIPTION / SPECS	UNITS	UNIT PRICE	NO. OF UNITS	COST ESTIMATE
Labour	General Labourer	Rate per hour	$37.79	40	$1,511.40
	Trades Labourer	Rate per hour	$52.37	40	$2,094.60
Equipment	Cat 235 Excavator	Rate per shift	$2,880.00	3	$8,640.00
	Haul Truck D250E	Rate per shift	$3,180.00	2	$6,360.00
	Cat 16H grader	Rate per shift	$1,950.00	5	$9,750.00
TOTAL ESTIMATED COST			**Annual**		**$28,356.00**
			Monthly		**$2,363.00**

Exploration Disturbances

Assumption is that all exploration disturbance is already bonded for or else will be within the footprint of other areas that will be reclaimed elsewhere

Closure Plan Development - Phase 4

Item No.	Work Item Description	Equipment / Labour	Units	Unit Rates	Quantity Current	Quantity 2-Year	Quantity EOM	Cost Current	Cost 2-Year	Cost EOM
3.1	**Closure Specific Studies and Field Trials**									
3.1.1	Update closure plan every two years	Engineering/Design	l.s.	$30,000	1	1	1	$30,000	$30,000	$30,000
3.1.2	Ongoing Revegetation Trials	Engineering/Design	n/a	n/a	Included in costs for implementing the EMSAMP			$0	$0	$0
3.1.3	Engineered Cover Evaluations	Engineering/Design	n/a	n/a	See Breakdown			$157,500	$415,000	$415,000
3.1.4	Rooting Study	Engineering/Design	n/a	n/a	See Breakdown			$110,000	$110,000	$110,000
3.1.5	Passive Treatment Detailed Plan	Engineering/Design	n/a	n/a	See Breakdown			$45,000	$209,668	$209,668
3.1.6	Heap Biological Detoxification and In-heap Bioreactor	Engineering/Design	n/a	n/a	See Breakdown			$0	$43,000	$43,000
3.1.7	Site contamination surveys (pre $35K, post $20K)	Engineering/Design	l.s.	$55,000	1	1	1	$55,000	$55,000	$55,000
							Sub-Total	**$397,500**	**$862,668**	**$862,668**
3.2	**Closure Plan Development**	Engineering/Design	l.s.		See Breakdown			$25,000	$55,000	$55,000
							Total Estimated Cost for Closure Plan Development	**$422,500**	**$917,668**	**$917,668**

Notes:

Breakdown of Item 3.1 Research Program Tasks

Item No.	Work Item Description	Equipment / Labour	Units	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
3.1.2	**Ongoing Revegetation Trials**	Included in costs for implementing the EMSAMP						$0	$0	$0
							Sub-Total	**$0**	**$0**	**$0**
							Revegetation Trials Total	**$0**	**$0**	**$0**
3.1.3	**Engineered Cover Evaluations**									
3.1.3.1	**Task 1: Conceptual Model**									
	Review and Update of 2014 Numerical Model Assessment	Engineering/Design	l.s.	$50,000	0.5	1.0	1	$25,000	$50,000	$50,000
	Runoff and Surface Water Drainage Modelling	Engineering/Design	l.s.	$50,000	0.5	1.0	1	$25,000	$50,000	$50,000
	Landform Erosion Assessment Modelling	Engineering/Design	l.s.	$35,000	0.5	1.0	1	$17,500	$35,000	$35,000
	Field Permeability Testing Program	Engineering/Design	l.s.	$15,000	0.5	1.0	1	$7,500	$15,000	$15,000
	Reporting	Engineering/Design	l.s.	$15,000	0.5	1.0	1	$7,500	$15,000	$15,000
							Sub-Total	**$82,500**	**$165,000**	**$165,000**
3.1.3.2	**Cover System and Heap Materials**									
	Material Characterization Plan Design (Cover and Heap Leach Materials)	Engineering/Design	l.s.	$15,000	0.5	1.0	1	$7,500	$15,000	$15,000
	Field Test Pit Program and Sample Collection	Engineering/Design	l.s.	$50,000	-	1.0	1	$0	$50,000	$50,000
	Laboratory Testing	Engineering/Design	l.s.	$35,000	0.5	1.0	1	$17,500	$35,000	$35,000
							Sub-Total	**$25,000**	**$100,000**	**$100,000**
3.1.3.3	**Task 4: Enhanced Meteorological Monitoring**									
								-	$0	$0
							Sub-Total	**$0**	**$0**	**$0**
3.1.3.4	**Task 5: Cover System Field Trials**									
	Instrumentation	Engineering/Design	l.s.	$50,000	-	-	-	$0	$0	$0
	Cover System Field Trial Performance Monitoring	Engineering/Design	l.s.	$25,000	2	4	4	$50,000	$100,000	$100,000
							Sub-Total	**$50,000**	**$100,000**	**$100,000**
3.1.3.5	**Task 6: Assess Effect of High pH Water Treatment Solids on the Heap Cover**									
		Engineering/Design	l.s.	$50,000	-	1	1	$0	$50,000	$50,000
							Sub-Total	**$0**	**$50,000**	**$50,000**
							Engineered Cover Evaluations Total	**$157,500**	**$415,000**	**$415,000**
3.1.4	**Rooting Study**									
3.1.4.1	**Phase 1 - Analogous Forest Communities**									
	Review and update Field Program Design	Engineering/Design	l.s.	$15,000	1	1	1	$15,000	$15,000	$15,000
	Set up of Test Plots for analogous forest communities	Engineering/Design	l.s.	$35,000	-	-	-	$0	$0	$0
	Destructive sampling of vegetation root system and cover mate	Engineering/Design	l.s.	$35,000	1	1	1	$35,000	$35,000	$35,000
							Sub-Total	**$50,000**	**$50,000**	**$50,000**
3.1.4.2	**Phase 2 - Examination for Mine Engineered Cover Systems**									
	Review and update Field Program Design	Engineering/Design	l.s.	$10,000	1	1	1	$10,000	$10,000	$10,000
	Geochemical Assessment of Cover and Underlying Materials	Engineering/Design	l.s.	Included in material characterization program for Engineered Cover Evaluations				$0	$0	$0
	Destructive sampling of vegetation root system and cover mate	Engineering/Design	l.s.	$35,000	1	1	1	$35,000	$35,000	$35,000
	Project Management and Reporting	Engineering/Design	l.s.	$15,000	1	1	1	$15,000	$15,000	$15,000
							Sub-Total	**$60,000**	**$60,000**	**$60,000**
							Rooting Study Total	**$110,000**	**$110,000**	**$110,000**

Breakdown of Item 3.1 Research Program Tasks Continued

Item No.	Work Item Description	Equipment / Labour	Units	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
3.1.5	**Passive Treatment Detailed Plan**									
3.1.5.1	**Phase 1: Information Gathering**									
	Continued characterization of water requiring treatment	Engineering/Design	l.s.	$5,000	1	1	1	$5,000	$5,000	$5,000
	Target constituents and performance goals	Engineering/Design	l.s.	$5,000	1	1	1	$5,000	$5,000	$5,000
	Existing wetland characterization (to guide plant selection) and	Engineering/Design	l.s.	$35,000	1	1	1	$35,000	$35,000	$35,000
							Sub-Total	**$45,000**	**$45,000**	**$45,000**
3.1.5.2	**Phase 2: Indoor Pilot Scale**									
	Design	Engineering/Design	l.s.	$10,000	-	1	1	$0	$10,000	$10,000
	Assembly	Engineering/Design	l.s.	$5,000	-	1	1	$0	$5,000	$5,000
	Performance Monitoring	Engineering/Design	l.s.	$5,000	-	5	5	$0	$25,000	$25,000
							Sub-Total	**$0**	**$40,000**	**$40,000**
3.1.5.3	**Phase 3: Outdoor Pilot Scale**									
	Assembly	Engineering/Design	l.s.	$10,000	-	1	1	$0	$10,000	$10,000
	Performance Monitoring	Engineering/Design	l.s.	$5,000	-	5	5	$0	$25,000	$25,000
							Sub-Total	**$0**	**$35,000**	**$35,000**
3.1.5.4	**Phase 4: On-Site Demonstration Scale**									
	Design	Engineering/Design	l.s.	$10,000	-	1	1	$0	$10,000	$10,000
	Construction									
	Excavate Pond	Construction	cu.m	$4.50	-	1,980	1,980	$0	$8,910	$8,910
	Load, haul dump fill, mulch, organics material	Construction	cu.m	$5.11	-	7,920	7,920	$0	$40,478	$40,478
	Planting Wetland Vegetation	Construction	ha	$8,000	-	0.66	1	$0	$5,280	$5,280
	Performance Monitoring		l.s.	$5,000	-	5	5	$0	$25,000	$25,000
							Sub-Total	**$0**	**$89,668**	**$89,668**
3.1.5.5	**Phase 5 Full Scale Implementation**	See costs for Passive Water Treatment for the LSDP and Events Pond								
							Sub-Total	**$0**	**$0**	**$0**
							Passive Treatment Detailed Plan Total	**$45,000**	**$209,668**	**$209,668**
3.1.6	**Heap Biological Detoxification**									
	Review of operational parameters of the heap leach facility	Engineering/Design	l.s.	$5,000	-	1	1	$0	$5,000	$5,000
	Setup of a sequential test facility adjacent to the heap	Engineering/Design	l.s.	$5,000	-	1	1	$0	$5,000	$5,000
	Operation of the columns	Engineering/Design	l.s.	$1,500	-	12	12	$0	$18,000	$18,000
	Post-treatment simulation	Engineering/Design	l.s.	$15,000	-	1	1	$0	$15,000	$15,000
							Sub-Total	**$0**	**$43,000**	**$43,000**
							Heap Biological Detoxification Total	**$0**	**$43,000**	**$43,000**
3.1.7	**Groundwater Arsenic Attenuation**									
	Geochemical Modelling	Engineering/Design	l.s.	$30,000	-	1	1	$0	$15,000	$30,000
	Monitoring of potential As Sources onsite	Engineering/Design	l.s.	$5,000	-	1	1	$0	$2,500	$5,000
	As Evaluation	Engineering/Design	l.s.	$5,000	-	1	1	$0	$2,500	$5,000
							Sub-Total	**$0**	**$20,000**	**$40,000**
							Groundwater Arsenic Attenuation Total	**$0**	**$20,000**	**$40,000**
Total Estimated Cost for Research Program Execution								**$267,500**	**$525,000**	**$525,000**
NOTES	The estimates are based on previous OKC programs and are estimated to be +/-30%. The final detailed cost will be based on areas, number of monitoring locations, number of samples, and resulting tests that need									
	Costs to conduct monitoring including net radiation, wind speed and direction, snow surveys, maintenance of systems, and data analysis for 5 years of monitoring are included as part of EMSAMP									

Breakdown of Item 3.2 Closure Plan Development Tasks

Item No.	Work Item Description	Equipment / Labour	Units	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
3.2.1	**Reclamation and Closure Planning**									
	Optimization Workshop	Engineering/Design	l.s.	$7,500	0	1	1	$0	$7,500	$7,500
	Community and First Nation Engagement	Engineering/Design	l.s.	$2,500	1	1	1	$2,500	$2,500	$2,500
	Reclamation Research Plan	Engineering/Design	l.s.	$5,000	0.5	1	1	$2,500	$5,000	$5,000
3.2.2	**Closure Cost Estimation**	Engineering/Design	l.s.	$18,000	0.5	1	1	$9,000	$18,000	$18,000
3.2.3	**Report Writing**	Engineering/Design	l.s.	$22,000	0.5	1	1	$11,000	$22,000	$22,000
Total Estimated Cost for Closure Development								**$25,000**	**$55,000**	**$55,000**

Open Pit, Estimated Closure Costs - Phase 6

Item No.	Work Item Description	Equipment / Labour			Quantity			Cost		
		Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
6.1	**Open Pit**									
	Remove pit pumps and pipe column/general cleanup	General Labourer	hrs	$37.79	-	96	96	$0	$3,627	$3,627
		Trades Labourer	hrs	$52.37	-	24	24	$0	$1,257	$1,257
		Support equipment	l.s.	$1,000	-	1	1	$0	$1,000	$1,000
	Secure pit access - boulder placement	Cat 235 Excavator	hrs	$240.00	20	20	20	$4,800	$4,800	$4,800
		Haul Truck D250E	hrs	$265.00	20	20	20	$5,300	$5,300	$5,300
	Signage	General Labourer	hrs	$37.79	20	20	20	$756	$756	$756
	Highwall perimeter safety berm/trench (~7km)	Cat 235 Excavator	hrs	$240.00	-	-	-	$0	$0	$0
	Construct inflow spillway from upgradient of pit	Cat 235 Excavator	hrs	$240.00	-	40	40	$0	$9,600	$9,600
		Haul Truck D250E	hrs	$265.00	-	20	20	$0	$5,300	$5,300
		Produce rip-rap	cu.m	$15.75	-	200	200	$0	$3,150	$3,150
		Load, haul and place rip-rap	cu.m	$15.75	-	200	200	$0	$3,150	$3,150
	Construct exit channel into Platinum Gulch water conveyance channel	Cat 235 Excavator	hrs	$240.00	-	20	20	$0	$4,800	$4,800
		Produce rip-rap	cu.m	$15.75	-	200	200	$0	$3,150	$3,150
	Rip-rap shoulder exiting pit-spillway	Load, haul and place rip-rap	cu.m	$15.75	-	200	200	$0	$3,150	$3,150
		General Labourer	hrs	$37.79	-	10	10	$0	$378	$378
	Scarify Surface	Cat 16H grader	hrs	$162.50	170	-	-	$27,625	$0	$0
	Haul and place overburden for revegetation (0.2 m thickness)	Custom Rate F (Load, haul, place soil cover Open Pit)	cu.m	$5.11	52,000	-	-	$265,762	$0	$0
	Revegetate	Revegetation cost per ha. Including application cost	ha	$2,994.00	26	-	-	$77,844	$0	$0
	Project Management & Engineering		%		10.00%	10.00%	10.00%	$38,209	$4,942	$4,942
							Sub-Total	**$420,295**	**$54,359**	**$54,359**
Total Estimated Cost in Reclaiming Open Pit								**$420,295**	**$54,359**	**$54,359**

Note:

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours			Total Days		
		Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Ops	210	120	120	19	11	11
$37.79	General Labour	0	106	106	0	9	9
$52.37	Trades Labour	46	24	24	4	2	2
$52.37	Unit Quantity Labour	0	15	15	0	1	1
$156.00	Design Engineer/Project Ma	245	32	32	20	3	3
	TOTAL	501	297	297	43	26	26

Heap Leach Facility, Estimated Closure Costs

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour Description	Units	Unit Rates	Quantity Current	Quantity 2-Year	Quantity EOM	Cost Current	Cost 2-Year	Cost EOM
7.1	**Heap Reclamation Cover**										
	Roll crest and recontour		D9H Dozer	hrs	$400	744	1,048	1,488	$297,576	$419,146	$595,333
	Additional compaction, as req'd		Vibratory Roller	hrs	$183	35	49	70	$6,386	$8,994	$12,775
	Haul & place colluvium for revegetation - (0.3 m thickness)		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.11	147,600	207,900	295,290	$754,354	$1,062,535	$1,509,168
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.11	105,980	146,180	204,440	$541,642	$747,097	$1,044,852
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994	49	69	98	$147,305	$207,484	$294,699
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$174,726	$244,526	$345,683
								Sub-Total	**$1,921,989**	**$2,689,782**	**$3,802,510**
7.2	**Heap Passive Treatment CWTS**										
	Develop closure sump piping drainage control		Drilling	lump sum	$20,000	1	1	1	$20,000	$20,000	$20,000
	Rework Events Pond		Misc.	lump sum	$10,000	1	1	1	$10,000	$10,000	$10,000
	Develop subsurface flow component	~200 m buried pipe	Misc.	lump sum	$30,000	1	1	1	$30,000	$30,000	$30,000
	Form Berm (400 m x 4 m high x 5 m wide)		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.11	8,000	8,000	8,000	$40,886	$40,886	$40,886
	Haul and place bedding and topsoil layers 0.8 m plus 0.4 m bedding provision		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.11	42,840	42,840	42,840	$218,947	$218,947	$218,947
	Wetland Planting		Wetland plants (4,000 seedlings per ha)	ha	$8,000	3.57	3.57	3.57	$28,560	$28,560	$28,560
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$34,839	$34,839	$34,839
								Sub-Total	**$383,232**	**$383,232**	**$383,232**
7.3	**Heap Passive In Situ Treatment**										
	Nutrients added to heap for cyanide degradation		In Situ Treatment Reagent--Reducing Sugars and Nutrients	ton	$1,200	648	972	972	$777,592	$1,166,400	$1,166,400
	Nutrients added to heap for heap bioreactors		In Situ Treatment Reagent--Alcohols and Nutrients	ton	$1,200	402	402	402	$481,882	$481,882	$481,882
	Management of heap in situ treatment		Environmental Scientist	hrs	$116	1,080	1,080	1,080	$125,280	$125,280	$125,280
	Sonic Drilling for physical testing to confirm detoxification	500 m	Drilling	m	$75	500	500	500	$37,500	$37,500	$37,500
	Moving pumps, piping, drip emitter connections, solution application		Site Caretaker	monthly	$15,157	18	18	18	$272,825	$272,825	$272,825
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$169,508	$208,389	$208,389
								Sub-Total	**$1,864,587**	**$2,292,276**	**$2,292,276**
Total Estimated Cost in Reclaiming Heap Leach Facility									**$2,305,221**	**$3,073,015**	**$4,185,742**
NOTE:											

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours Current	Total Hours 2-Year	Total Hours EOM	Total Days Current	Total Days 2-Year	Total Days EOM
n/a	Equipment Ops	779	1097	1558	71	100	142
$37.79	General Labour	1583	2186	3060	158	219	306
$52.37	Trades Labour	0	0	0	0	0	0
$52.37	Unit Quantity Labour	0	0	0	0	0	0
$116.00	Environmental Scientis	1080	1080	1080	90	90	540
	Caretaker	6480	6480	6480	540	540	540
$156.00	Design Engineer/Proje	1343	1791	2439	112	149	203
	TOTAL	11265	12634	14618	971	1098	1731

Waste Rock and Overburden Dumps, Estimated Closure Costs

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
4.1	**Eagle Pup**										
	Roll crest and recontour		D9H Dozer	hrs	$400.00	-	744	1,254	$0	$297,697	$501,403
	Additional compaction, as req'd		Vibratory Roller	hrs	$182.50	-	83	140	$0	$15,170	$25,550
	Haul & place colluvium for revegetation - (0.3 m thickness)		Custom Rate B (Load, haul, place soil cover Eagle Pup)	cu.m.	$5.11	-	147,660	248,700	$0	$754,661	$1,271,056
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate B (Load, haul, place soil cover Eagle Pup)	cu.m.	$5.11	-	98,440	165,800	$0	$503,107	$847,370
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	-	49	83	$0	$147,365	$248,203
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$0	$171,800	$289,358
								Sub-Total	**$0**	**$1,889,799**	**$3,182,940**
4.2	**Platinum Gulch WRSA**										
	Roll crest and recontour		D9H Dozer	hrs	$400.00	437	614	614	$174,796	$245,742	$245,742
	Additional compaction, as req'd		Vibratory Roller	hrs	$182.50	50	70	70	$9,087	$12,775	$12,775
	Haul & place colluvium for revegetation - (0.3 m thickness)		Custom Rate C (Load, haul, place soil cover Platinum Gulch	cu.m.	$5.11	86,700	121,890	121,890	$443,106	$622,955	$622,955
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate C (Load, haul, place soil cover Platinum Gulch	cu.m.	$5.11	57,800	81,260	81,260	$295,404	$415,304	$415,304
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	29	41	41	$86,527	$121,646	$121,646
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$100,892	$141,842	$141,842
								Sub-Total	**$1,109,811**	**$1,560,264**	**$1,560,264**
4.3	**Temporary Ore Stockpiles and Pads**										
	Removal of bottom layer of material to Eagle Pup WRSA		Custom Rate B (Load, haul, place soil cover Eagle Pup)	cu.m.	$5.11	7,870	7,870	7,870	$40,222	$40,222	$40,222
	Recontour		D9H Dozer	hrs	$400.00	20	20	20	$8,000	$8,000	$8,000
	Place 20 cm topsoil cover		Cat 235 Excavator	hrs	$240.00	30	30	30	$7,200	$7,200	$7,200
			Trades Labourer	hrs	$52.37	30	30	30	$1,571	$1,571	$1,571
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	13	13	13	$39,581	$39,581	$39,581
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$9,657	$9,657	$9,657
								Sub-Total	**$106,231**	**$106,231**	**$106,231**
4.4	**Reclamation Stockpiles**										
	Recontour		D9H Dozer	hrs	$400.00	85	85	85	$34,000	$34,000	$34,000
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	22	22	22	$67,006	$67,006	$67,006
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$10,101	$10,101	$10,101
								Sub-Total	**$111,106**	**$111,106**	**$111,106**
4.5	**Ice Rich Overburden Storage Area**										
	Recontour and scarify surface		D9H Dozer	hrs	$400.00	-	12	20	$0	$4,600	$8,000
			Cat 16H grader	hrs	$162.50	-	5.75	10	$0	$934	$1,625
			Trades Labourer	hrs	$52.37	-	5.75	10	$0	$301	$524
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	-	3.22	6	$0	$9,641	$16,766
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$0	$1,548	$2,692
								Sub-Total	**$0**	**$17,024**	**$29,607**
4.6	**Eagle Pup Passive Treatment Ditch**										
	Combined pipeline/ditch for Eagle Pup - transport to constructed wetlands		Cat 235 Excavator	hrs	$240.00	-	-	-	$0	$0	$0
			Cat 16H grader	hrs	$162.50	-	-	-	$0	$0	$0
	Provision for ditching rip-rap		Produce rip-rap	cu.m.	$15.75	-	-	-	$0	$0	$0
	Provision for ditching filter material under rip-rap		Load, haul and place rip-rap	cu.m.	$15.75	-	-	-	$0	$0	$0
	Sedimentation Pond (# of ponds)		Misc.	l.s.	$50,000.00	-	-	-	$0	$0	$0
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
Total Estimated Cost in Reclaiming Overburden and Waste Rock Dumps									**$1,327,149**	**$3,684,424**	**$4,990,148**

Note:

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours			Total Days		
		Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Ops	622	1664	2243	57	151	204
$37.79	General Labour	1935	3860	4942	194	386	494
$52.37	Trades Labour	30	36	40	3	3	3
$156.00	Design Engineer/Pr	773	2147	2908	64	179	242
	TOTAL	3360	7707	10133	317	$719	944

ADR & Ancillary Facilities, Estimated Closure Costs - Phase 6 and 7

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
	ADR AND ANCILLARY FACILITIES										
9.1	**Buildings and Structures Demolition**										
	Remove salvageable equipment		General Labourer	hrs	$37.79	1,344	1,344	1,344	$50,783	$50,783	$50,783
			Trades Labourer	hrs	$52.37	504	504	504	$26,392	$26,392	$26,392
			30 ton Crane	hrs	$123.83	84	84	84	$10,401	$10,401	$10,401
	Decontaminate Building-hosing and clean-up		Trades Labourer	hrs	$52.37	168	168	168	$8,797	$8,797	$8,797
	Dismantle Buildings		General Labourer	hrs	$37.79	5,376	5,376	5,376	$203,132	$203,132	$203,132
			Trades Labourer	hrs	$52.37	4,032	4,032	4,032	$211,136	$211,136	$211,136
			Cat 235 Excavator	hrs	$240.00	210	210	210	$50,400	$50,400	$50,400
			30 ton Crane	hrs	$123.83	672	672	672	$83,210	$83,210	$83,210
	Concrete Demolition		Blaster	hrs	$46.95	-	-	-	$0	$0	$0
			Cat 235 Excavator w hammer	hrs	$390.00	252	252	252	$98,280	$98,280	$98,280
			D9H Dozer	hrs	$400.00	168	168	168	$67,200	$67,200	$67,200
	Misc. Supplies & Tools		Misc.	l.s.	$15,000.00	1	1	1	$15,000	$15,000	$15,000
	Scrap haul to solid waste facility		Cat 235 Excavator	hrs	$240.00	168	168	168	$40,320	$40,320	$40,320
			Haul Truck D250E	hrs	$265.00	168	168	168	$44,520	$44,520	$44,520
	Haul and place overburden for revegetation (0.2 m thickness	1.89	Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.11	3,780	3,780	3,780	$19,319	$19,319	$19,319
	Revegetate	1.89	Revegetation cost per ha. Including application cost	ha	$2,994.00	1.89	1.89	1.89	$5,659	$5,659	$5,659
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$93,455	$93,455	$93,455
								Sub-Total	**$1,028,004**	**$1,028,004**	**$1,028,004**
9.2	**Fuel Storage Area**										
	Cleanout tanks-remove sludge, pressure wash		General Labourer	hrs	$37.79	504	504	504	$19,044	$19,044	$19,044
			Removal to Licensed facility	l.s.	$12,500.00	1	1	1	$12,500	$12,500	$12,500
	Remove bulk fuel storage and piping facilities		General Labourer	hrs	$37.79	756	756	756	$28,565	$28,565	$28,565
			Trades Labourer	hrs	$52.37	336	336	336	$17,595	$17,595	$17,595
			30 ton Crane	hrs	$123.83	84	84	84	$10,401	$10,401	$10,401
			Support Equipment	l.s.	$7,500.00	1	1	1	$7,500	$7,500	$7,500
			Cat 235 Excavator	hrs	$240.00	-	-	-	$0	$0	$0
			General Labourer	hrs	$37.79	-	-	-	$0	$0	$0
			Tractor Trailer (lowbed)	hrs	$195.00	-	-	-	$0	$0	$0
	Fold and Bury Liner		Cat 235 Excavator	hrs	$240.00	48	48	48	$11,520	$11,520	$11,520
			D9H Dozer	hrs	$400.00	24	24	24	$9,600	$9,600	$9,600
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$11,673	$11,673	$11,673
								Sub-Total	**$128,398**	**$128,398**	**$128,398**
9.3	**Reagents Removal and Cleanup**										
	Load and return extra reagents/chemicals		General Labourer	hrs	$37.79	96	96	96	$3,627	$3,627	$3,627
			Support Equipment	l.s.	$2,500.00	1	1	1	$2,500	$2,500	$2,500
			Disposal Cost-bulk materials	l.s.	$5,000.00	1	1	1	$5,000	$5,000	$5,000
			Disposal Cost-lab pacs	pallets	$2,000.00	5	5	5	$10,000	$10,000	$10,000
	Removal of drums, steel, oils, glycol & batteries etc.		Contractor quote	l.s.	$50,900.00	1	1	1	$50,900	$50,900	$50,900
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$7,203	$7,203	$7,203
								Sub-Total	**$79,230**	**$79,230**	**$79,230**
9.4	**Crusher Area and Screening Area**										
	Test soils for contamination		Environmental Scientist	hrs	$116.00	20	20	20	$2,320	$2,320	$2,320
			Analytical Costs	l.s.	$6,000.00	1	1	1	$6,000	$6,000	$6,000
	Haul any contaminated soils to Land Treatment Facility		Cat 235 Excavator	hrs	$240.00	40	40	40	$9,600	$9,600	$9,600
			Haul Truck D250E	hrs	$265.00	40	40	40	$10,600	$10,600	$10,600
	Haul any ore contaminated soils to heap		Load, haul & place mat'l on heap	cu.m.	$10.00	100	100	100	$1,000	$1,000	$1,000
	Haul and place backfill for stable slopes		Custom Rate B (Load, haul, place soil cover Eagle Pup)	cu.m.	$5.11	72,000	72,000	72,000	$367,978	$367,978	$367,978
	Haul & place overburden topsoil for revegetation - (0.2 m thic	1.5	Custom Rate B (Load, haul, place soil cover Eagle Pup)	cu.m.	$5.11	3,000	3,000	3,000	$15,332	$15,332	$15,332
	Revegetate	1.5	Revegetation cost per ha. Including application cost	ha	$2,994.00	1.5	1.5	1.5	$4,491	$4,491	$4,491
	Re-contour area and slopes to bury footings and establish drainage		D9H Dozer	hrs	$400.00	60	60	60	$24,000	$24,000	$24,000
	Scarify Surface	13.30	Cat 16H grader	hrs	$162.50	60	60	60	$9,750	$9,750	$9,750
	Haul and place overburden cap (0.5 m thickness)	13.30	Custom Rate F (Load, haul, place soil cover Open Pit)	cu.m.	$5.11	26,600	26,600	26,600	$135,947	$135,947	$135,947
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$58,702	$58,702	$58,702
								Sub-Total	**$645,720**	**$645,720**	**$645,720**
9.5	**Truck Shop Area (s 6.9.7)**										
	Remove salvageable equipment		General Labourer	hrs	$37.79	504	504	504	$19,044	$19,044	$19,044
			Haul Truck D250E	hrs	$265.00	-	-	-	$0	$0	$0
			Trades Labourer	hrs	$52.37	84	84	84	$4,399	$4,399	$4,399
	Dismantle buildings		General Labourer	hrs	$37.79	-	2,100	2,100	$0	$79,349	$79,349
			30 ton Crane	hrs	$123.83	-	168	168	$0	$20,803	$20,803
			Cat 235 Excavator	hrs	$240.00	-	120	120	$0	$28,800	$28,800
	Haul building pieces off site - equipment		Tractor Trailer (lowbed)	hrs	$195.00	-	168	168	$0	$32,760	$32,760
	Scrap haul to site landfill		Haul Truck D250E	hrs	$265.00	24	24	24	$6,360	$6,360	$6,360
			Cat 235 Excavator	hrs	$240.00	24	24	24	$5,760	$5,760	$5,760
	Excavate & haul contaminated materials to site LTF		Misc.	l.s.	$6,250.00	1	1	1	$6,250	$6,250	$6,250
	Bury footings - haul and place fill, locally sourced		Unit Basis (footing burial)	each	$5.25	-	300	300	$0	$1,575	$1,575
	Recontour		D9H Dozer	hrs	$400.00	24	24	24	$9,600	$9,600	$9,600
	Haul and place overburden for revegetation (0.2 m thickness	6.4	Custom Rate C (Load, haul, place soil cover Platinum Gulch	cu.m.	$5.11	12,800.00	12,800.00	12,800.00	$65,418	$65,418	$65,418
	Revegetate	6.4	Revegetation cost per ha. Including application cost	ha	$2,994.00	6.40	6.40	6.40	$19,162	$19,162	$19,162
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$13,599	$29,928	$29,928
								Sub-Total	**$149,591**	**$329,206**	**$329,206**
9.6	**Water Treatment Plant**										
	Phase 2-5 Capital Costs		See Breakdown for 9.6	l.s.		See Breakdown for 9.6			$3,207,050	$0	$0
	Phase 2-5 Pipeline and Containment		See Breakdown for 9.6	l.s.		See Breakdown for 9.6			$251,799	$0	$0
	Phase 6 Capital Costs		See Breakdown for 9.6	l.s.		See Breakdown for 9.6			$0	$0	$0
	Phase 6 Pipeline and Containment		See Breakdown for 9.6	l.s.		See Breakdown for 9.6			$226,413	$0	$0
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$368,526	$0	$0
								Sub-Total	**$4,053,787.65**	**$0**	**$0.00**
Total Estimated Cost in Reclaiming ADR and Ancillary Facilities									**$6,084,731**	**$2,210,558**	**$2,210,558**

Labour Estimates for Camp Costs

Hourly Unit Rate	Description		Total Hours			Total Days		
			Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Operators (Addit'l Load Haul Place)		2090	2546	2546	190	231	231
$37.79	General Labour		8580	10680	10680	715	890	890
$52.37	Trades Labour		5124	5124	5124	427	427	427
	General Labour (reveg)		249	249	249	25	25	25
	WTP Construction		343	0	0	29	0	0
$156.00	Design Engineer/Project Management		1198	1303	1303	100	109	109
		TOTAL	17584	19902	19902	1485	1682	1682

Breakdown of Item 9.6 Water Treatment Plant

Item No.	Work Item Description	Units	Equipment / Labour	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
	Mine Water Treatment Plant Phase 2-5									
	SITE CIVIL									
	EOM Pre-Engineered Building (44.2m x 24.38m)(145'x80') Current will utilize existing building (i.e., warehouse or truck shop)	ls			-	0	0	$ -	$ -	$ -
	Building Erection	ls		$ -	-	0	0	$ -	$ -	$ -
	Building Concrete (all)	m³		$ 850.00	-	0	0	$ -	$ -	$ -
	Steel Mezzanine	ls		$ -	-	0	0	$ -	$ -	$ -
	Lab Sink	ls		$ 1,000.00	1	0	0	$ 1,000.00	$ -	$ -
	MCC	ls		$ 150,000.00	1	0	0	$ 150,000.00	$ -	$ -
	Control Room	ls		$ 12,000.00	1	0	0	$ 12,000.00	$ -	$ -
	HVAC	ls		$ -	-	0	0	$ -	$ -	$ -
	Electrical	ls		$ -	1	0	0	$ 65,000.00	$ -	$ -
	SITE CIVIL SUBTOTAL		Subtotal					$ 228,000.00	$ -	$ -
	PROCESS EQUIPMENT									
	Microfilter (Transverse 200mm)	ea		$ 1,050,000.00	1	0	0	$ 1,050,000.00	$ -	$ -
	CIP Skid w/CHN	ea		$ 160,000.00	1	0	0	$ 160,000.00	$ -	$ -
	IPS 2000	ea		$ 368,000.00	2	0	0	$ 736,000.00	$ -	$ -
	Thickener Tank	ea		$ 35,000.00	1	0	0	$ 35,000.00	$ -	$ -
	Polymer system	ea		$ 6,800.00	1	0	0	$ 6,800.00	$ -	$ -
	Duplex Sump Pump System	ea		$ 28,000.00	1	0	0	$ 28,000.00	$ -	$ -
	Strainer	ea		$ 28,200.00	1	0	0	$ 28,200.00	$ -	$ -
	Plant Feed Pumps	ea		$ 18,200.00	2	0	0	$ 36,400.00	$ -	$ -
	Process Water Transfer Pumps	ea		$ 10,700.00	6	0	0	$ 64,200.00	$ -	$ -
	Chemical Pumps	ea		$ 8,000.00	8	0	0	$ 64,000.00	$ -	$ -
	Waste Pumps	ea		$ 4,700.00	3	0	0	$ 14,100.00	$ -	$ -
	EOM Reaction Tank - 225 m3 Current Reaction Tank - 120m3	ea		$ 202,200.00	1	0	0	$ 110,000.00	$ -	$ -
	Chemical Storage Tanks - 20 m3	ea		$ 10,100.00	5	0	0	$ 50,500.00	$ -	$ -
	EOM Finished Water Tank - 225 m3 -insulated Current Finished Water Tank - 120m3 -insulated	ea		$ -	1	0	0	$ 136,000.00	$ -	$ -
	EOM MF Feed Tank - 60 m3 Current MF Fee Tank - 40m3	ea		$ -	1	0	0	$ 50,000.00	$ -	$ -
	Neutralization Tank - 14 m3	ea		$ 8,600.00	1	0	0	$ 8,600.00	$ -	$ -
	Filter Press System	ea		$ 202,000.00	1	0	0	$ 202,000.00	$ -	$ -
	Safety Shower System	ea		$ 68,000.00	1	0	0	$ 68,000.00	$ -	$ -
	Air compressors and receiver tank	ea		$ 8,000.00	1	0	0	$ 8,000.00	$ -	$ -
	Citric Acid Mix Tank, 0.2 m3	ea		$ 3,250.00	1	0	0	$ 3,250.00	$ -	$ -
	PROCESS EQUIPMENT SUBTOTAL		Subtotal					$ 2,859,050.00	$ -	$ -
	PIPING									
	Primary Piping	m		$ 125.00	870	0	0	$ 108,750.00	$ -	$ -
	Secondary Piping	m		$ 90.00	500	0	0	$ 45,000.00	$ -	$ -
	Chem Piping	m		$ 50.00	800	0	0	$ 40,000.00	$ -	$ -
	PIPING SUBTOTAL		Subtotal					$ 193,750.00	$ -	$ -
	CONTROL									
	PLC Integration	ls		$ 45,000.00	1	0	0	$ 45,000.00	$ -	$ -
	Instrumentation	ls		$ 75,000.00	1	0	0	$ 75,000.00	$ -	$ -
	CONTROL SUBTOTAL		Subtotal					$ 120,000.00	$ -	$ -
							Mine Water Treatment Plant Phase 2-5 Subtotal	$3,400,800	$0	$0
	Phase 2-5 Pipeline and Containment									
	SITE CIVIL									
	Concrete manhole	m³		$ 850.00	48	0	0	$ 40,800.00	$ -	$ -
	Valves	ls		$ 1,800.00	1	0	0	$ 1,800.00	$ -	$ -
	Containment Earthwork	m³		$ 15.00	10000	0	0	$ 150,000.00	$ -	$ -
	Containment Liner	m²		$ 19.25	1850	0	0	$ 35,612.50	$ -	$ -
	Electrical	ls		$ 20,000.00	1	0	0	$ 20,000.00	$ -	$ -
	SITE CIVIL SUBTOTAL		Subtotal					$ 248,212.50	$ -	$ -
	PIPING									
	ADR Feed Pipeline - 150mm HDPE SDR11 Artic Pipe	m		$ 56.25	1500	0	0	$ 84,375.00	$ -	$ -
	Discharge Pipeline - 300mm HDPE SDR11 Artic Pipe	m		$ 181.06	400	0	0	$ 72,424.00	$ -	$ -
	Discharge Diffuser	ls		$ 75,000.00	1	0	0	$ 75,000.00	$ -	$ -
	PIPING SUBTOTAL		Subtotal					$ 231,799.00	$ -	$ -
							Phase 2-5 Pipeline and Containment Subtotal	$251,799	$0	$0

Breakdown of Item 9.6 Water Treatment Plant Continued

Item No.	Work Item Description	Units	Equipment / Labour	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
	Mine Water Treatment Plant Phase 6									
	SITE CIVIL									
	Pre-Engineered Building (30.48m x 24.38m)	ls		$ 194,000.00	-	-	-	$ -	$ -	$ -
	Building Erection	ls		$ 157,000.00	-	-	-	$ -	$ -	$ -
	Building Concrete (all)	m³		$ 850.00	-	-	-	$ -	$ -	$ -
	Mezzanine (Bio Filters)	ls		$ 65,000.00	-	-	-	$ -	$ -	$ -
	Mezzanine (Filter Press)	ls		$ 105,000.00	-	-	-	$ -	$ -	$ -
	HVAC	ls		$ 35,000.00	-	-	-	$ -	$ -	$ -
	Electrical	ls		$ 65,000.00	-	-	-	$ -	$ -	$ -
	SITE CIVIL SUBTOTAL		Subtotal					$ -	$ -	$ -
	PROCESS EQUIPMENT									
	Thickener Tank	ea		$ 35,000.00	-	-	-	$ -	$ -	$ -
	Polymer system	ea		$ 7,000.00	-	-	-	$ -	$ -	$ -
	Filter Press	ea		$ 307,000.00	-	-	-	$ -	$ -	$ -
	Plant Feed Pumps	ea		$ 9,300.00	-	-	-	$ -	$ -	$ -
	Plate Clarifier IGS-1130	ea		$ 370,000.00	-	-	-	$ -	$ -	$ -
	Bio Tank Thickener	ea		$ 35,000.00	-	-	-	$ -	$ -	$ -
	Bio Filters	ea		$ 270,000.00	-	-	-	$ -	$ -	$ -
	Duplex Sump Pump System	ea		$ 28,000.00	-	-	-	$ -	$ -	$ -
	Process Water Transfer Pumps	ea		$ 7,500.00	-	-	-	$ -	$ -	$ -
	Chemical Pumps	ea		$ 8,000.00	-	-	-	$ -	$ -	$ -
	Waste Pumps	ea		$ 4,700.00	-	-	-	$ -	$ -	$ -
	Reaction Tank - 30 m3	ea		$ 11,000.00	-	-	-	$ -	$ -	$ -
	Chemical Storage Tanks - 20 m3	ea		$ 19,100.00	-	-	-	$ -	$ -	$ -
	Hot Water Tank	ea		$ 12,300.00	-	-	-	$ -	$ -	$ -
	Heat Exchangers	ea		$ 5,400.00	-	-	-	$ -	$ -	$ -
	Air compressors and receiver tank	ea		$ 8,000.00	-	-	-	$ -	$ -	$ -
	Safety Shower System	ea		$ 5,000.00	-	-	-	$ -	$ -	$ -
	PROCESS EQUIPMENT SUBTOTAL		Subtotal					$ -	$ -	$ -
	PIPING									
	Primary Piping	m		$ 38.00	-	-	-	$ -	$ -	$ -
	Secondary Piping	m		$ 27.50	-	-	-	$ -	$ -	$ -
	Chem Piping	m		$ 15.00	-	-	-	$ -	$ -	$ -
	PIPING SUBTOTAL		Subtotal					$ -	$ -	$ -
	CONTROL									
	PLC Integration	ls		$ 45,000.00	-	-	-	$ -	$ -	$ -
	Instrumentation	ls		$ 75,000.00	-	-	-	$ -	$ -	$ -
	CONTROL SUBTOTAL		Subtotal					$ -	$ -	$ -
							Mine Water Treatment Plant Phase 6 Subtotal	$0	$0	$0
	Phase 6 Pipeline and Containment									
	SITE CIVIL									
	Earthwork	m³		$ 850.00	48	-	-	$ 40,800.00	$ -	$ -
	Containment Earthwork	m³		$ 15.00	10,000	-	-	$ 150,000.00	$ -	$ -
	Containment Liner	m²		$ 19.25	1,850	-	-	$ 35,612.50	$ -	$ -
	SITE CIVIL SUBTOTAL		Subtotal					$ 226,412.50	$ -	$ -
	PIPING									
	ADR Feed Pipeline - 150mm HDPE SDR11 Artic Pipe	m		$ 56.25	-	-	-	$ -	$ -	$ -
	PIPING SUBTOTAL		Subtotal					$ -	$ -	$ -
							Phase 6 Pipeline and Containment Subtotal	$226,413	$0	$0

Infrastructure, Estimated Closure Costs, Phase 6/7

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
10.1	**Mine Camp and Related Infrastructure (including guard house area)**										
	Disconnect Services		Trades Labourer	hrs	$52.37	106	106	106	$5,560	$5,560	$5,560
	Remove salvageable equipment		General Labourer	hrs	$37.79	319	319	319	$12,036	$12,036	$12,036
	Dismantle buildings		General Labourer	hrs	$37.79	637	637	637	$24,071	$24,071	$24,071
			Cat 235 Excavator	hrs	$240.00	80	80	80	$19,112	$19,112	$19,112
	Haul scrap to Solid Waste Facility		Haul Truck D250E	hrs	$265.00	27	27	27	$7,034	$7,034	$7,034
			Cat 235 Excavator	hrs	$240.00	27	27	27	$6,371	$6,371	$6,371
	Site Clean-Up		General Labourer	hrs	$37.79	212	212	212	$8,024	$8,024	$8,024
	Decommission water supply wells		Fill with concrete	each	$2,000.00	2.00	2	2	$4,000	$4,000	$4,000
	Haul and place overburden for revegetation (0.2 m thickness)	3.95	Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.11	7,900	7,900	7,900	$40,375	$40,375	$40,375
	Revegetate		Revegetation cost per ha. Including application cost	ha	$2,994.00	3.95	3.95	3.95	$11,826	$11,826	$11,826
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$13,841	$13,841	$13,841
								Sub-Total	**$152,249**	**$152,249**	**$152,249**
10.2	**Explosive / Magazine Storage Facility**										
	Remove salvageable equipment		General Labourer	hrs	$37.79	-	72	72	$0	$2,721	$2,721
			Trades Labourer	hrs	$52.37	-	72	72	$0	$3,770	$3,770
	Dismantle buildings		General Labourer	hrs	$37.79	-	48	48	$0	$1,814	$1,814
			Cat 235 Excavator	hrs	$240.00	-	24	24	$0	$5,760	$5,760
	Disconnect Services		Trades Labourer	hrs	$52.37	-	24	24	$0	$1,257	$1,257
	Crane services		30 ton Crane	hrs	$123.83	-	48	48	$0	$5,944	$5,944
	Haul scrap to Solid Waste Facility		Haul Truck D250E	hrs	$265.00	-	24	24	$0	$6,360	$6,360
			Cat 235 Excavator	hrs	$240.00	-	24	24	$0	$5,760	$5,760
	Haul and place overburden for revegetation (0.2 m thickness)	3.93	Custom Rate E (Load, haul, place soil cover IROSA)	cu.m.	$5.80	-	7,860	7,860	$0	$45,588	$45,588
	Revegetate	3.93	Revegetation cost per ha. Including application cost	ha	$2,994.00	-	3.9	3.9	$0	$11,766	$11,766
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$0	$9,074	$9,074
								Sub-Total	**$0**	**$99,814**	**$99,814**
10.5	**Electrical Dismantle and Remove**										
		44 km		see T15							
								Sub-Total	**$0**	**$0**	**$0**
10.6	**Conveyor Dismantle and Remove**										
	Remove salvageable equipment		General Labourer	hrs	$37.79	1,344	1,344	1,344	$50,783	$50,783	$50,783
			Trades Labourer	hrs	$52.37	1,008	1,008	1,008	$52,784	$52,784	$52,784
	Crane services		30 ton Crane	hrs	$123.83	280	280	280	$34,671	$34,671	$34,671
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$13,824	$13,824	$13,824
								Sub-Total	**$152,062**	**$152,062**	**$152,062**
Total Estimated Cost in Reclaiming Miscellaneous Sites and Facilities									**$304,311**	**$404,125**	**$404,125**
Note:											

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours			Total Days		
		Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Operators	413	509	509		46	46
$37.79	General Labour	2512	2632	2632	209	219	219
$52.37	Trades Labour	1114	1210	1210	93	101	101
n/a	General Labour (reveg)	119	236	236	12	24	24
$156.00	Design Engineer/Project Managemen	177	236	236	15	20	20
	TOTAL	4335	4823	4823	329	410	410

Waste Disposal / Remediation, Estimated Closure Costs

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
11.1	**Solid Waste Disposal**										
	Disposal at the onsite landfill (see individual cost sheets for hauling and T12)					-	-	-	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
11.2	**Hazardous Materials Disposal**										
	Hazmat consolidation, packaging and documentation for disposal			l.s.	$49,807.00	1	1	1	$49,807	$49,807	$49,807
	Off-Site Disposal			l.s.	$2,500.00	5	10	10	$12,500	$25,000	$25,000
								Sub-Total	**$62,307**	**$74,807**	**$74,807**
11.3	**Hydrocarbon Contaminated Soils**										
	Off-Site Disposal			l.s.	$2,500.00	-	-	-	$0	$0	$0
	On-Site Land Treatment Farm (LTF)										
	Prepare and submit closure plan		Misc	l.s.	$2,000.00	1	1	1	$2,000	$2,000	$2,000
	Characterize final soil hydrocarbon concentrations		Misc	l.s.	$4,000.00	1	1	1	$4,000	$4,000	$4,000
	Recontour		D9H Dozer	hrs	$400.00	36	36	36	$14,400	$14,400	$14,400
	Haul and place overburden cover from nearby		Cat 235 Excavator	hrs	$240.00	48	48	48	$11,520	$11,520	$11,520
			Haul Truck D250E	hrs	$265.00	48	48	48	$12,720	$12,720	$12,720
			D9H Dozer	hrs	$400.00	24	24	24	$9,600	$9,600	$9,600
	Final Decommissioning of LTF			l.s.	$17,500	1	1	1	$17,500	$17,500	$17,500
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$7,174	$7,174	$7,174
								Sub-Total	**$78,914**	**$78,914**	**$78,914**
11.4	**Process Residue Contaminated Soils**										
	Off-Site Disposal			l.s.	$3,500	5	5	5	$17,500	$17,500	$17,500
								Sub-Total	**$17,500**	**$17,500**	**$17,500**
Total Estimated Cost for Waste Disposal / Remediation									**$158,721**	**$171,221**	**$171,221**

Notes:

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours			Total Days		
		Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Operators	156	156	156	14	14	14
$156.00	Design Engineer/Project M	46	46	46	4	4	4
	TOTAL	202	202	202	18	18	18

Landfills, Estimated Closure Costs

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
12.1	**Expansion of Facility to Accommodate Closure Phase Debris**										
	Expand landfill		Cat 235 Excavator	hr	$240.00	252	252	252	$60,480	$60,480	$60,480
			General Labourer	hr	$37.79	252	252	252	$9,522	$9,522	$9,522
			Vibratory Roller	hr	$182.50	36	36	36	$6,570	$6,570	$6,570
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$7,657	$7,657	$7,657
								Sub-Total	**$84,229**	**$84,229**	**$84,229**
12.2	**Operation During Closure Phase**										
	Disposal of solid waste at the onsite landfill (see individual cost sheets for hauling solid waste)								$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
12.3	**Final Closure**										
	Prepare detailed closure plan		Misc	l.s.	$2,000.00	1	1	1	$2,000	$2,000	$2,000
	Characterize final waste area		Misc	l.s.	$2,000	1	1	1	$2,000	$2,000	$2,000
	Remove recyclables and special waste materials		Tractor Trailer (lowbed	hrs	$195.00	24	24	24	$4,680	$4,680	$4,680
	Final Compaction & Grading		D9H Dozer	hrs	$400.00	36	36	36	$14,400	$14,400	$14,400
	Haul and cover with adjacent fill and place overburden cap		Cat 235 Excavator	hrs	$240.00	24	24	24	$5,760	$5,760	$5,760
			Haul Truck D250E	hrs	$265.00	24	24	24	$6,360	$6,360	$6,360
	Compaction of cover		D9H Dozer	hrs	$400.00	24	24	24	$9,600	$9,600	$9,600
	Revegetation		Revegetation cost per	ha	$2,994.00	1.5	1.5	1.5	$4,491	$4,491	$4,491
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$4,929	$4,929	$4,929
								Sub-Total	**$54,220**	**$54,220**	**$54,220**
Total Estimated Landfill Costs									**$138,449**	**$138,449**	**$138,449**
Notes:											

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours			Total Days		
		Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Operators	420	420	420	38	38	38
$37.79	General Labour	252	252	252	21	21	21
n/a	General Labour (reveg	45	45	45	5	5	5
$156.00	Design Engineer/Proje	81	81	81	7	7	7
	TOTAL	798	798	798	70	70	70

Roads & Trails, Estimated Closure Costs

Item No.	Work Item Description	Area (ha) / Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
13.1	**On Site Access and Haul Roads**										
	Recontour crests		Cat 235 Excavator	hrs	$240.00	808	671	630	$194,016	$161,040	$151,200
	Scarify surfaces		Cat 16H grader	hrs	$162.50	210	210	210	$34,125	$34,125	$34,125
	Revegeate		Revegetation cost per ha. Including application c	ha	$2,994.00	81	67	63	$242,035	$200,897	$188,622
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$47,018	$39,606	$37,395
								Sub-Total	**$517,194**	**$435,669**	**$411,342**
13.2	**Culverts**										
	Culvert excavation		Cat 235 Excavator	hrs	$240.00	50	50	50	$12,000	$12,000	$12,000
	Culvert removal		General Labourer	hrs	$37.79	168	168	168	$6,348	$6,348	$6,348
	Recontour slopes and drainage		D9H Dozer	hrs	$400.00	36	36	36	$14,400	$14,400	$14,400
	Stabilize slopes		General Labourer	hrs	$37.79	20	20	20	$756	$756	$756
	Silt Curtains (20m^2 per crossing)		Erosion Barrier	sq. m.	$3.15	140	140	140	$441	$441	$441
	Enviro matting (15m^2 per crossing)		Enviro matting	sq. m.	$3.00	105	105	105	$315	$315	$315
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$3,426	$3,426	$3,426
								Sub-Total	**$37,686**	**$37,686**	**$37,686**
Total Estimated Cost for Closure of Roads & Trails									**$554,879**	**$473,354**	**$449,027**
Note:											

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours			Total Days		
		Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Operator	1104	967	926	100	88	84
$37.79	General Labour	20	20	20	2	2	2
n/a	General Labour (rev	2425	2013	1890	243	201	189
$156.00	Design Engineer/Pro	323	276	262	27	23	22
	TOTAL	3873	3276	3098	372	314	297

Water Management, Estimated Closure Costs

Item No.	Work Item Description	Length (m)	Equipment / Labour			Quantity			Cost		
			Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
14.1	**Diversion & Collection Ditches**										
	Raise and/or widen operational 1:10 year ditches			km	$12,500.00	6	6	6	$75,000	$75,000	$75,000
	Removal of Corrugated Steel Half Pipe	2000	Cat 235 Excavator	hr	$240.00	20	20	20	$4,800	$4,800	$4,800
			Tractor trailer for off-site salvage	hr	$180.00	30	30	30	$5,400	$5,400	$5,400
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$8,520	$8,520	$8,520
								Sub-Total	**$93,720**	**$93,720**	**$93,720**
14.2	**Groundwater Wells - Decommissioning**										
	Production Wells			l.s.	$3,600.00	4	12	12	$14,400	$43,200	$43,200
	De-Watering Wells			l.s.	$3,600.00	4	12	12	$14,400	$43,200	$43,200
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$2,880	$8,640	$8,640
								Sub-Total	**$31,680**	**$95,040**	**$95,040**
14.3	**Pumping**										
	Phase 5										
	Heap Rinsing (See Tab T17b)			$/kw	$ 0.14	325,240	1,239,009	3,113,011	$0	$0	$40,113
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$0	$0	$4,011
								Sub-Total	**$0**	**$0**	**$44,124**
14.4	**Construction of New Drainage Channels and Diversions for Closure**										
	Contour ditching (m)		Cat 235 Excavator	hrs	$240.00	100	100	100	$24,000	$24,000	$24,000
	Provision for ditching rip-rap		Produce rip-rap	cu.m.	$15.75	1,000	1,000	1,000	$15,750	$15,750	$15,750
			Load, haul and place rip-rap	cu.m.	$15.75	1,000	1,000	1,000	$15,750	$15,750	$15,750
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$5,550	$5,550	$5,550
								Sub-Total	**$61,050**	**$61,050**	**$61,050**
14.6	**Lower Dublin South Pond**										
	Removal of infrastructure and Liner		General Labourer	hr	$37.79	-	-	-	$0	$0	$0
			Cat 235 Excavator	hr	$240.00	-	-	-	$0	$0	$0
	Haul waste to landfill		Tandem Haul Truck	hr	$150.00	-	-	-	$0	$0	$0
	Breaching and re-contouring			ha	$10,700.00	-	-	-	$0	$0	$0
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.11	-	-	-	$0	$0	$0
	Revegetate Disturbed Area		Revegetation cost per ha. Including application cost	ha	$2,994.00	-	-	-	$0	$0	$0
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
14.7	**Platinum Gulch Pond**										
	Removal of infrastructure and Liner		General Labourer	hr	$37.79	-	-	-	$0	$0	$0
			Cat 235 Excavator	hr	$240.00	-	-	-	$0	$0	$0
	Haul waste to landfill		Tandem Haul Truck	hr	$150.00	-	-	-	$0	$0	$0
	Breaching and re-contouring			ha	$10,700.00	-	-	-	$0	$0	$0
	Haul & place overburden topsoil for revegetation - (0.2 m thickness)		Custom Rate A (Load, haul, place soil cover Heap)	cu.m.	$5.11	-	-	-	$0	$0	$0
	Revegetate Disturbed Area		Revegetation cost per ha. Including application cost	ha	$2,994.00	-	-	-	$0	$0	$0
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$0	$0	$0
								Sub-Total	**$0**	**$0**	**$0**
Total Estimated Cost for Water Management									**$186,450**	**$293,934**	**$249,810**
Note:											

Labour Estimates for Camp Costs

Hourly Unit Rate	Description	Total Hours			Total Days		
		Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Operators	150	150	150	14	14	14
$37.79	General Labour	0	0	0	0	0	0
n/a	General Labour (riprap)	27	27	27	2	2	2
$156.00	Design Engineer/Project	109	146	171	9	12	14
	TOTAL	285	322	348	25	28	30

Post Closure Care, Maintenance, and Monitoring, Estimated Closure Costs

		Current	2-Year	EOM
Phase 6 =	Heap Drain Down	1.75	1.75	4
Phase 7 =	WTP Decommissioning	5	10	15
Phase 8 =	Post Closure Monitoring	2	2	2
	TOTAL YEARS	**8.75**	**13.75**	**21**

Item No.	Work Item Description	Equipment / Labour	Units	Unit Rates	Annual Cost (for NPV Calc)	Quantity			Cost			NPV		
						Current	2-Year	EOM	Current	2-Year	EOM	Current	2-Year	EOM
15.1	**Onsite Management**													
	Project Management and Engineering - Included in PME Costs in each Closure Component													
	Pickup truck													
	Phase 7/8	Light truck	monthly	$2,000	$24,000	84	144	204	$168,000	$288,000	$408,000			
	Fuel		monthly	$200		84	144	204	$16,800	$28,800	$40,800			
	Heavy equipment maintenance													
	Phase 7/8	Unit Cost Basis	annually	$10,000	$10,000	7	12	17	$70,000	$120,000	$170,000			
	Power and heat													
	Phase 7/8	Unit Cost Basis	monthly	$5,000	$60,000	84	144	204	$420,000	$720,000	$1,020,000			
	General Administrative expenses													
	Phase 7/8	Unit Cost Basis	monthly	$1,500	$18,000	84	144	204	$126,000	$216,000	$306,000			
	Camp Cost													
	Phase 7/8	Unit Cost Basis	person-day	$82.04	$0	-	-	-	$0	$0	$0			
	Subtotal - Phase 7/8 Onsite Management:				**$112,000**				**n/a**	**n/a**	**n/a**	**$512,257**	**$958,786**	**$932,999**
15.2	**Transport Costs**													
	Employee transport costs													
	Phase 7/8	Unit Cost Basis	monthly	$500	$6,000	84	144	204	$42,000	$72,000	$102,000			
	Subtotal - Onsite Management:				**$6,000**				**n/a**	**n/a**	**n/a**	**$42,000**	**$58,806**	**$53,326**
15.3	**Water Treatment Costs**													
	Active Treatment (Phase 6)													
	Capital Costs (See T9)	Misc.	annually	$0.00	$0	1	-	-	$0	$0	$0			
	Capital Replacement Costs					-	-		$0	$0	$0			
	Phase 2-5 WTP, 10-YEAR FREQUENCY	Misc.	10-yrs	*$537,600*	*$537,600*	-	1	1	$0	$198,400	$537,600			
	Phase 2-5 WTP, 4-YEAR FREQUENCY	Misc.	4-years	*$118,987*	*$118,987*	1	2	3	$55,744	$111,487	$356,961			
	Phase 6 A WTP, 4-YEAR FREQUENCY	Misc.	4-years	*$82,500*	*$82,500*	1	2	3	$82,500	$165,000	$247,500			
	Subtotal - Capital Replacement Costs :								**n/a**	**n/a**	**n/a**	**$128,326**	**$417,661**	**$861,819**
	Annual Operating Costs													
	Phase 2-5 WTP	Misc.	annually	*$334,609*	*$334,609*	1.75	1.75	4	$215,384	$215,384	$1,338,437			
	Phase 6 WTP	Misc.	annually	*$526,120*	*$526,120*	1.75	1.75	4	$341,072	$341,072	$2,104,482			
	Subtotal -Annual Operating Costs :								**$0**	**n/a**	**n/a**	**$556,456**	**$520,963**	**$2,812,217**
	Draindown Pumping (Phase 6)													
	Year 1 Heap Recycle/Draindown	Unit Cost Basis	$/kw	$ 0.14	-	Electrical power costs to recirculate heap solution inventory and managed draindown see Tab T17b Draindown			$109,476	$109,476	$297,633	$106,264	$103,146	$248,566
	Year 2 Heap Recycle/Draindown	Unit Cost Basis	$/kw	$ 0.14	-				$33,264	$33,264	$97,012	$31,811	$30,878	$79,822
	Year 3 Heap Recycle/Draindown	Unit Cost Basis	$/kw	$ 0.14	-				$0	$0	$11,212	$0	$0	$9,089
	Year 4 Heap Recycle/Draindown	Unit Cost Basis	$/kw	$ 0.14					$0	$0	$13,536	$0	$0	$10,811
	In-Heap Pond Pump Capital Replacement	Misc.	4-years	$ 45,430.00			3	3	$0	$136,290	$136,290	$0	$128,410	$113,822
	Subtotal - Draindown Costs :								**n/a**	**n/a**	**n/a**	**$138,075**	**$262,435**	**$462,110**
	Passive Treatment (Phase 7/8)													
	Capital Costs (Occurs in Phase 6)	Misc.	annually	$262,958	$262,958	1	1	1	$262,958.05	$262,958.05	$262,958	$251,471	$244,094	$210,014
	Operating Costs	Misc.	annually	$10,000	$10,000	5	10	15	$50,000	$100,000	$150,000	$45,737	$85,606	$106,567
	Subtotal Passive Treatment Costs:								**n/a**	**n/a**	**n/a**	**$297,209**	**$329,699**	**$316,582**
	Subtotal Water Treatment Costs:								**n/a**	**n/a**	**n/a**	**$1,120,066**	**$1,530,758**	**$4,452,727**
15.4	**Reclamation & Closure Research Plan (Long Term Funding)**													
	Reclamation & Closure Research Plan	Misc.	annually	$15,000	$15,000	2	2	4	$30,000	$26,250	$60,000	$28,905	$28,057	$49,009
	Subtotal Reclamation Research:								**n/a**	n/a	n/a	**$28,905**	**$28,057**	**$49,009**
15.5	**Monitoring & Reporting**													
	Disbursements (non-labour/non-analytical)	Misc.	annually	$0	$0	2	2	2	$0	$0	$0	n/a	$0	$0
	Water Quality Monitoring													
	Phase 6	Misc.	annually	$157,935	$157,935	2	2	4	$276,386	$276,386	$631,740	$266,578	$258,757	$516,013
	Phase 7/8	Misc.	annually	$110,555	$110,555	7	12	17	$773,882	$1,326,654	$1,879,427	$657,849	$1,083,551	$736,632
	Sediment Monitoring:													
	Phase 6	Misc.	annually	$1,272	$1,272	1	1	2	$1,113	$1,113	$2,544	$1,216	$1,181	$2,063
	Phase 7/8	Misc.	annually	$890	$890	4	6	9	$3,116	$5,342	$7,568	$2,855	$4,887	$5,309
	Biological Monitoring (Benthos):													
	Phase 6	Misc.	annually	$1,272	$1,272	1	1	2	$1,113	$1,113	$2,544	$1,216	$1,181	$2,063
	Phase 7/8	Misc.	annually	$890	$890	4	6	9	$3,116	$5,342	$7,568	$2,855	$4,887	$5,309
	Site groundwater monitoring	Misc.												
	Phase 6	Misc.	annually	$41,785	$41,785	2	2	4	$73,124	$73,124	$167,140	$70,529	$68,460	$136,522
	Phase 7/8	Misc.	annually	$29,250	$29,250	7	12	17	$204,747	$350,994	$497,242	$174,048	$286,676	$194,891
	Geotechnical Inspections:													
	Phase 6	Misc.	annually	$15,000	$15,000	2	2	4	$26,250	$26,250	$60,000	$28,905	$28,057	$49,009
	Phase 7/8	Misc.	annually	$15,000	$15,000	7	12	17	$105,000	$180,000	$255,000	$89,257	$109,924	$123,052
	Reclamation Inspections:													
	Phase 6	Misc.	annually	$0	$0	2	2	4	$0	$0	$0	$0	$0	$0
	Phase 7/8	Misc.	annually	$10,000	$10,000	7	12	17	$70,000	$120,000	$170,000	$59,505	$98,011	$82,036
	Monitoring of piezometers, thermistors													
	Phase 6	Misc.	each	$0	$0	2	2	4	$0	$0	$0	$0	$0	$0
	Phase 7/8	Misc.	each	$0	$0	7	12	17	$0	$0	$0	$0	$0	$0
	Annual Inspection + report	Misc.	annually	$12,500	$12,500	9	14	21	$109,375	$171,875	$262,500	$98,468	$145,894	$186,434
	Subtotal:								$1,647,222	n/a	n/a	**$1,453,280**	**$2,091,465**	**$2,039,332**
15.6	**Post Closure Maintenance, Decommissioning and Demobilization**													
	CWTS--Carry out inspection recommendations/maintenance	Misc.	annually	$7,500	$7,500	7	12	17	$52,500	$90,000	$127,500	$44,628	$73,508	$87,356
	Misc. maintenance work related to the site after closure	Misc.	annually	$60,000	$60,000	7	12	17	$420,000	$600,000	$600,000	$274,423	$513,635	$432,766
	Electrical Dismantle and Remove	44 km												
	De-energize, Disassemble structures and dismantle (521 structures)		Trades Labourer	hrs	$52.37	1,042	1,042	1,042	$54,564	$54,564	$54,564			
			General Labourer	hrs	$37.79	1,042	1,042	1,042	$39,372	$39,372	$39,372			
			30 ton Crane	hrs	$123.83	521	521	521	$64,513	$64,513	$64,513			
	Backfill foundation anchor holes		Haul Truck D250E	hrs	$265.00	130	130	130	$34,516	$34,516	$34,516			
			D9H Dozer	hrs	$400.00	48	48	48	$19,200	$19,200	$19,200			
	Haul scrap to Solid Waste Facility		Haul Truck D250E	hrs	$265.00	130	130	130	$34,516	$34,516	$34,516			
			Cat 235 Excavator	hrs	$240.00	48	48	48	$11,520	$11,520	$11,520			
	Project Management & Engineering		10% of Total Cost	%		10.00%	10.00%	10.00%	$25,820	$25,820	$25,820			
	Sub-Total Electrical Dismantle and Remove:								**$284,022**	**$284,022**	**$284,022**	$252,129	$227,175	$181,436
	Water Treatment Plant Decommissioning (Phase 7/8)													
	Remove salvageable equipment	General Labourer	hrs	$37.79		672	672	672	$25,392	$25,392	$25,392			
		Haul Truck D250E	hrs	$265.00		-	-	-	$0	$0	$0			
		Trades Labourer	hrs	$52.37		252	252	252	$13,196	$13,196	$13,196			
	Dismantle buildings	General Labourer	hrs	$37.79		960	960	960	$36,274	$36,274	$36,274			
		30 ton Crane	hrs	$123.83		168	168	168	$20,803	$20,803	$20,803			
		Cat 235 Excavator	hrs	$240.00		120	120	120	$28,800	$28,800	$28,800			
	Haul building pieces off site - equipment	Tractor Trailer (lowbed)	hrs	$195.00		168	168	168	$32,760	$32,760	$32,760			
	Scrap haul to site landfill	Haul Truck D250E	hrs	$265.00		24	24	24	$6,360	$6,360	$6,360			
		Cat 235 Excavator	hrs	$240.00		24	24	24	$5,760	$5,760	$5,760			
	Excavate & haul contaminated materials to site LTF	Misc.	l.s.	$6,250.00		1	1	1	$6,250	$6,250	$6,250			
	Bury footings - haul and place fill, locally sourced	Unit Basis (footing burial)	each	$5.25		300	300	300	$1,575	$1,575	$1,575			
	Recontour	D9H Dozer	hrs	$400.00		24	24	24	$9,600	$9,600	$9,600			
	Haul and place overburden for revegetation (0.2 m thickness)	Custom Rate A (Load, haul, place soil c	cu.m.	$5.11		3,960	3,960	3,960	$20,239	$20,239	$20,239			
	Revegetate	Revegetation cost per ha. Including app	ha	$2,994.00		1.98	1.98	1.98	$5,928	$5,928	$5,928			
	Subtotal Water Treatment Decommissioning Costs:								**$212,936**	**$212,936**	**$212,936**	$189,025	$170,317	$136,026
	Subtotal:								n/a	n/a	n/a	**$760,206**	**$984,635**	**$837,584**
Total Estimated Cost for Post Closure Site Management									**n/a**	**n/a**	**n/a**	**$3,916,714**	**$5,652,507**	**$8,364,976**

Note:

Labour Estimates for Camp Costs

Hourly Unit Rate	Description		Total Hours			Total Days		
			Current	2-Year	EOM	Current	2-Year	EOM
n/a	Equipment Operators		1358	1358	1358	123	123	123
$37.79	General Labour		2674	2674	2674	223	223	223
	Trades Labourer		1294	1294	1294	108	108	108
n/a	General Labour (reveg)		59	128	128	6	13	13
	Water Treatment Operator		1341	1341	3640	112	112	303
$156.00	Design Engineer/Project Management		166	166	166	14	14	14

Breakdown of Item 15.3 Water Treatment Costs

Item No.	Work Item Description	Units	Equipment / Labour	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
	Phase 2-5 Equipment Replacement Costs									
	10-YEAR FREQUENCY									
	MF Membranes	ea		$ 3,200.00	62	62	168	$ 198,400	$ 198,400	$ 537,600
	10-YEAR SUBTOTAL		**Subtotal**					**$ 198,400**	**$ 198,400**	**$ 537,600**
	4-YEAR FREQUENCY									
	Feed Pumps	ea		$ 18,243.50	1	1	2	$ 18,244	$ 18,244	$ 36,487
	Transfer Pumps	ea		$ 7,500.00	2	2	5	$ 15,000	$ 15,000	$ 37,500
	Chemical Pumps	ea		$ 7,500.00	3	3	6	$ 22,500	$ 22,500	$ 45,000
	4-YEAR FREQUENCY SUBTOTAL		**Subtotal**					**$ 55,744**	**$ 55,744**	**$ 118,987**
	Phase 6 Equipment Replacement Costs									
	4-YEAR FREQUENCY									
	Transfer Pumps	ea		$ 7,500.00	5	5	5	$ 37,500	$ 37,500	$ 37,500
	Chemical Pumps	ea		$ 7,500.00	6	6	6	$ 45,000	$ 45,000	$ 45,000
	4-YEAR FREQUENCY SUBTOTAL		**Subtotal**					**$ 82,500**	**$ 82,500**	**$ 82,500**
	Phase 2-5 Annual Operating Costs									
	EQUIPMENT POWER COSTS									
	Transverse 200 Microfilter	Kw/h	3 kW @ 100%	$ 0.14	0.74	0.74	2	$ 2,301	$ 2,301	$ 6,255
	Feed Pumps	Kw/h	50 Hp (37.285kW) @ 50%	$ 0.14	0.74	0.74	2	$ 14,296	$ 14,296	$ 38,867
	Process Transfer Pumps	Kw/h	20 Hp (14.914 kW) @ 50%	$ 0.14	3.68	3.68	10	$ 28,593	$ 28,593	$ 77,735
	Filter Press	Kw/h	15 Hp (11.185) @ 20%	$ 0.14	0.37	0.37	1	$ 858	$ 858	$ 2,332
	SUBTOTAL EQUIPMENT POWER		**Subtotal**					**$ 46,047**	**$ 46,047**	**$ 125,189**
	LABOUR COSTS									
	Transverse 200 Microfilter	hrs/yr	Trades Labourer	$52.37	191	191	520	$ 10,016	$ 10,016	$ 27,230
	Filter Press	hrs/yr	Trades Labourer	$52.37	383	383	1040	$ 20,031	$ 20,031	$ 54,460
	Plate Clarifiers	hrs/yr	Trades Labourer	$52.37	38	38	104	$ 2,003	$ 2,003	$ 5,446
	Chemical Batching	hrs/yr	Trades Labourer	$52.37	38	38	104	$ 2,003	$ 2,003	$ 5,446
	SUBTOTAL LABOUR		**Subtotal**					**$ 34,053**	**$ 34,053**	**$ 92,581**
	CHEMICAL COSTS									
	Process Chemical									
	Ferric Chloride, 39%	L/y		$0.40	34,952	34952	95023	$ 13,981	$ 13,981	$ 38,009
	Sulfuric Acid, 93% Micro C	L/y		$0.38	12,081	12081	32846	$ 4,591	$ 4,591	$ 12,481
	Sodium Hydroxide, 50%	L/y		$1.00	21,204	21204	57647	$ 21,204	$ 21,204	$ 57,647
	Cleaning Chemical									
	Sodium Bisulfite 40%	L/y		$0.70	537	537	1460	$ 376	$ 376	$ 1,022
	Sodium Hypochlorite, 12.5%	L/y		$0.47	1,611	1611	4380	$ 757	$ 757	$ 2,059
	Citric Acid, Solid	kg/y		$2.20	940	940	2555	$ 2,068	$ 2,068	$ 5,621
	SUBTOTAL LABOUR		**Subtotal**					**$ 42,976**	**$ 42,976**	**$ 116,839**
							Total Phase 2-5 Annual Operating Costs	**$ 123,077**	**$ 123,077**	**$ 334,609**
	Phase 6 Operating Costs									
	EQUIPMENT POWER COSTS									
	Process Transfer Pumps	Kw/h	10 Hp (7.457 kW) @ 50%	$ 0.14	4	4	10	$ 15,547	$ 15,547	$ 38,867
	SUBTOTAL EQUIPMENT POWER		**Subtotal**					**$ 15,547**	**$ 15,547**	**$ 38,867**
	LABOUR COSTS									
	Bio Filters	hrs/yr	Trades Labourer	$52.37	192	192	520	$ 10,054	$ 10,054	$ 27,230
	Plate Clarifiers	hrs/yr	Trades Labourer	$52.37	345	345	936	$ 18,066	$ 18,066	$ 49,014
	Chemical Batching	hrs/yr	Trades Labourer	$52.37	154	154	416	$ 8,064	$ 8,064	$ 21,784
	SUBTOTAL LABOUR		**Subtotal**					**$ 36,184**	**$ 36,184**	**$ 98,027**
	CHEMICAL COSTS									
	Process Chemical									
	Micro C		L/y	$0.40	67,128	67128	182,500	$ 26,851	$ 26,851	$ 73,000
	Sodium Bisulfite 40%		L/y	$0.70	7,035	7035	19,126	$ 4,925	$ 4,925	$ 13,388
	Sodium Hypochlorite, 12.5%		L/y	$0.47	96,522	96522	262,414	$ 45,365	$ 45,365	$ 123,335
	Sodium Hydroxide, 50%		L/y	$1.00	66,026	66026	179,503	$ 66,026	$ 66,026	$ 179,503
	SUBTOTAL LABOUR		**Subtotal**					**$ 143,167**	**$ 143,167**	**$ 389,226**
							Total Phase 6 Annual Operating Costs	**$ 194,898**	**$ 194,898**	**$ 526,120**

Breakdown of Item 15.3 Passive Treatment Systems

Item No.	Work Item Description	Units	Equipment / Labour	Unit Rates	Quantity Current	Quantity Year 2	Quantity EOM	Cost Current	Cost Year 2	Cost EOM
	PG Passive Treatment (Research Pond = 0.66 ha)									
	Included in T5 Reclamation Research			$ -	-	0	0	$ -	$ -	$ -
	HLF Passive Treatment (85% of Events Pond = 3.57 ha)									
	Included in T7 Passive treatment system			$ -	-	-	-	$ -	$ -	$ -
	LDSP Passive Treatment (85% of LDSP Pond = 2.3 ha)									
	Construction									
	Excavate Pond	cu.m	Excavation of Soil	$ 4.50	23000	23000	23000	$ 103,500	$ 103,500	$ 103,500
	Load, haul dump fill, mulch, organics material	cu.m	Custom Rate D (Load, haul, place wetland soil in CWTS)	$ 5.11	27600	27600	27600	$ 141,058	$ 141,058	$ 141,058
	Planting Wetland Vegetation	ha	Wetland plants (4,000 seedlings per ha)	$ 8,000.00	2.3	2.3	2.3	$ 18,400	$ 18,400	$ 18,400
	SUBTOTAL LABOUR		**Subtotal**					$ 262,958	$ 262,958	$ 262,958

Interim Care and Maintenance

Item No.	Work Item Description	Equipment / Labour			Quantity			Cost		
		Description	Units	Unit Rates	Current	2-Year	EOM	Current	2-Year	EOM
16.1	**Personnel**									
	On-site Caretaker + 2nd worker = 2 Full-Time									
	Full time (2 people on alternate 7in-7out schedule)	Site caretaker	$15,156.96	$/person-month	24	24	24	$363,767	$363,767	$363,767
	Extra Personnel									
	Electrician (estimate 1 mo/yr total for EOM)	Trades Labourer	$52.37	$/hr	88	88	176	$4,608	$4,608	$9,216
	Mechanic (estimate 1 mo/yr total for EOM)	Trades Labourer	$52.37	$/hr	88	88	176	$4,608	$4,608	$9,216
	Senior Operator/Supervisor (estimate 2 mo/yr total for EOM)	Supervisor	$14,742.00	$/mo	2	2	2	$29,484	$29,484	$29,484
	Camp Costs									
	for above personnel (365+365+15+15+30)	Unit Cost Basis	$82.04	person-days	790	790	850	$64,812	$64,812	$69,734
							Sub-Total - Personnel	**$467,279**	**$467,279**	**$481,418**
16.2	**Equipment**									
	Small Excavator (1)	Misc.	$10,000	annually	1	1	1	$10,000	$10,000	$10,000
	Small Dozer (1)	Misc.	$10,000	annually	1	1	1	$10,000	$10,000	$10,000
	Small Loader (1)	Misc.	$10,000	annually	1	1	1	$10,000	$10,000	$10,000
	Pick-Up Truck (1)	Misc.	$2,500	monthly	12	12	12	$30,000	$30,000	$30,000
	Snow Machine & ATV	Misc.	$10,000	annually	1	1	1	$10,000	$10,000	$10,000
							Sub-Total - Equipment	**$70,000**	**$70,000**	**$70,000**
16.3	**Tasks**									
	Interim water treatment (active)	Misc.	See T15	annually	See Breakdown in T15			$123,077	$123,077	$334,609
	Water Quality monitoring	Misc.	$157,935	annually	1	1	1	$157,935	$157,935	$157,935
	Geotechnical Assessments	Misc.	$15,000	annually	0.67	1	1	$10,000	$15,000	$15,000
	Sediment monitoring	Misc.	$1,272	annually	1	1	1	$1,272	$1,272	$1,272
	Biological monitoring	Misc.	$1,272	annually	1	1	1	$1,272	$1,272	$1,272
	Groundwater monitoring	Misc.	$41,785	annually	1	1	1	$41,785	$41,785	$41,785
	Monitoring of piezometers and thermistors	Misc.	$3,000	annually	-	-	-	$0	$0	$0
	Communications & reporting	Misc.	$12,500	annually	1	1	1	$12,500	$12,500	$12,500
							Sub-Total - Tasks	**$347,841**	**$352,841**	**$564,373**
16.4	**Miscellaneous**									
	Misc Supplies	Misc.	$50,000	annually	1	1	1	$50,000	$50,000	$50,000
	Annual Fuel	Misc.	$1.80	$/litre	1,000	1,000	1,000	$1,800	$1,800	$1,800
	Power to maintain water recirculation	$/kw	$ 0.14	annually	2,826,490	2,826,490	2,826,490	$395,709	$395,709	$395,709
							Sub-Total - Miscellaneous	**$447,509**	**$447,509**	**$447,509**
Annual Cost for ICM								**$1,332,628**	**$1,337,628**	**$1,563,299**
Number of Years								**2**	**2**	**2**
Total ICM Cost								**$2,665,256**	**$2,675,256**	**$3,126,599**
Note:										

Labour Estimates for Camp Costs

Hourly Unit Rate	Description		Total Hours			Total Days		
			Current	2-Year	EOM	Current	2-Year	EOM
n/a	Caretaker		8640	8640	8640	720	720	720
$37.79	Electrician		88	88	176	7	7	15
n/a	Mechanic		88	88	176	7	7	15
	Supervisor		720	720	720	60	60	60
	Environmental Scientist		28	30	30	2	3	3

Table of Quantities

Item Description	Value Current	Value 2- Year Peak	Value EOM	Units	Source/Comment EOM
Open Pit					
Inflow Spillway Rip-Rap	0.00	200.00	200.00	m^3	
Exit Channel Rip-Rap	0	200.00	200	m^3	
Open Pit Area	35	0.0	0	ha	
Overburden for revegetation	52,000	0	0	m^3	0.2 m thickness - For current, area based on surfaces that can be covered
Heap Leach Facility					
Heap Leach Facility	49.20	69.30	98.43	ha	
Colluvium for revegetation	147,600	207,900	295,290	m^3	0.3 m thickness over total area
Overburden topsoil for revegetation	98,400	138,600	196,860	m^3	0.2 m thickness over total area
Heap Leach Facility - Embankment Area	3.79	3.79	3.79	ha	
Colluvium for revegetation	0	0	0	m^3	Colluvium required for leached material and waste rock not embankment face
Overburden topsoil for revegetation	7,580	7,580	7,580	m^3	
Passive Treatment CWTS Area	3.57	3.57	3.57	ha	85% of Events Pond area available for CWTS
Passive Treatment berm	8,000	8,000	8,000	m^3	400 m x 4 m high x 5 m wide
Bedding and topsoil layers	42,840	42,840	42,840		0.8 m topsoil layer plus 0.4 m bedding provision
Nutrients added to heap for cyanide degradatio	648	972	972	ton	
Nutrients added to heap for heap bioreactors	402	402	402	ton	
Waste Rock and Overburden Dumps					
Eagle Pup Area	0.00	49.22	82.90	ha	
Eagle Pup Waste Rock	0	24,758,000	92,942,000	t	
Colluvium for revegetation - Eagle Pup	0	147,660	248,700	m^3	0.3 m thickness over total area
Overburden topsoil for revegetation - Eagle Pup	0	98,440	165,800	m^3	0.2 m thickness over total area
Platinum Gulch Area	28.90	40.63	40.63	ha	Based on aerial survey
Platinum Gulch Waste Rock	11.4	23.14	23.14	t	
Colluvium for revegetation - Platinum Gulch	86,700	121,890	121,890	m^3	0.3 m thickness over total area
Overburden topsoil for revegetation - Platinum (	57,800	81,260	81,260	m^3	0.2 m thickness over total area
Temporary Ore Stockpiles and Pads Area	13.2	13.2	13.2	ha	Full pad (outside of ore stack zone reseed only)
Pad material removal to Eagle Pup	7,870	7,870	7,870	m^3	0.1 m depth of removal (ore stack zone)
Reclamation Stockpiles Area	22.4	22.4	22.4	ha	
Ice Rich Overburden Storage Area	0.0	3.2	5.6	ha	
Eagle Pup Passive Treatment Ditch Rip-Rap	0	0	0	m^3	No longer required.
Process Plant & Ancillary Facilities					
Process Plant Area	1.89	1.89	1.89	ha	Pad area based on aerial survey
Overburden for revegetation	3,780	3,780	3,780	m^3	0.2 m thickness
Crusher and Screening Area	13.3	13.3	13.3	ha	Based on aerial survey
Ore contaminated soils to be hauled to heap	100	100	100	m^3	
Overburden for revegetation	26,600	26,600	26,600	m^3	0.2 m thickness
Truck Shop Area	6.40	6.40	6.40	ha	Based on aerial survey
Overburden for revegetation	12,800	12,800	12,800	m^3	0.2 m thickness
Water Treatment Plant area	1.98	1.98	1.98	ha	
Overburden for revegetation	3,960	3,960	3,960	m^3	0.2 m thickness
Miscellaneous Sites and Facilities					
Mine Camp area	3.95	3.95	3.95	ha	Based on aerial survey
Overburden for revegetation	7,900	7,900	7,900	m^3	0.2 m thickness
Explosive / Magazine Storage Facility area	3.93	3.93	3.93	ha	Based on aerial survey
Overburden for revegetation	7,860	7,860	7,860	m^3	0.2 m thickness
Roads and Trails					
On site access and haul roads	52	63	63	ha	
Construction Trails	29	4	0	ha	
Slope Stabilization					
Silt Curtains (m^2 per crossing)	20	20	20	m^2	
Enviro matting (m^2 per crossing)	15	15	15	m^2	
Number of crossings	7	7	7		
Silt Curtains Total	140	140	140	m^2	
Enviro matting Total	105	105	105	m^2	
Water Management					
New Drainage channels and diversions					
Provision for Rip-Rap	1,000	1,000	1,000	m^3	

Breakdown of Item 14.3 Pumping during Phase 6 Draindown

Assumption	Value	Unit
Maximum power draw per pump	149	kW
Maximum capacity per pump	520	m^3/hr
Maximum capacity per pump	144	L/s
Draindown Pumping Factor	75%	%
Application Rate (2-Year Peak and EoM)	1,500,000	L/hr
Application Rate (2-Year Peak and EoM)	417	L/s
Cost per Kw	0.14	$/kw-hr

See Forte assumptions Sep 4, 2020

Note - For conservatism, the pumping rate assumption for EOM uses the peak pumping volume from the previous year during rinsing and the associated draindown/pumping model outputs from that point. Yr 2 estimate based on ratio of loaded volumes utilized for the rinse duration

Item No.	Work Item Description	Month	Hrs per month	EOM					2-Year Peak (also used for current estimate)				
				Days of Rinse	Pumping Rate (m^3/hr)	Number of Pumps	Duration Energy Consumption (kW-hr)	Total Phase 5 Rinsing Power Cost	Days of Rinse	Pumping Rate (m^3/hr)	Number of Pumps	Duration Energy Consumption (kW-hr)	Total Phase 5 Rinsing Power Cost
14.4	**Phase 5 - Recirculation Pumping**												
	Total Duration Required for Rinsing			402	1500	3	3,113,011	$ 435,821.50	160	1500	3	1,239,009	$ 173,461.29

Item No.	Work Item Description	Month	Hrs per month	EOM					2-Year Peak				
				Pumping Rate (L/s) during draindown month*	No. of pumps req'd for recirculation	Maximum Power draw (kW)	Energy Consumption per month (kW-hr)	Monthly Power Cost	Pumping Rate (L/s) during draindown month	No. of pumps req'd for recirculation	Maximum Power draw (kW)	Energy Consumption per month (kW-hr)	Monthly Power Cost
14.4	**Phase 6 - Draindown Pumping**												
	Year 1	1	744	455	4	596.56	262,211	$ 36,709.50	167	2	298.28	96,447	$ 13,502.55
		2	672	353	3	447.42	183,536	$ 25,695.02	130	1	149.14	67,508	$ 9,451.18
		3	744	354	3	447.42	204,234	$ 28,592.82	130	1	149.14	75,122	$ 10,517.06
		4	720	411	3	447.42	229,253	$ 32,095.42	151	2	298.28	84,324	$ 11,805.39
		5	744	337	3	447.42	194,165	$ 27,183.09	124	1	149.14	71,418	$ 9,998.53
		6	720	330	3	447.42	183,914	$ 25,747.95	121	1	149.14	67,648	$ 9,470.65
		7	744	332	3	447.42	191,401	$ 26,796.13	122	1	149.14	70,401	$ 9,856.19
		8	744	275	2	298.28	158,247	$ 22,154.60	101	1	149.14	58,207	$ 8,148.94
		9	720	240	2	298.28	133,959	$ 18,754.26	88	1	149.14	49,273	$ 6,898.22
		10	744	235	2	298.28	135,510	$ 18,971.37	87	1	149.14	49,843	$ 6,978.08
		11	720	211	2	298.28	117,813	$ 16,493.81	78	1	149.14	43,334	$ 6,066.78
		12	744	229	2	298.28	131,709	$ 18,439.28	84	1	149.14	48,445	$ 6,782.37
							2,125,952	$ 297,633.25				781,971	$ 109,475.93
	Year 2	13	744	222	2	298.28	127,663	$ 17,872.88	82	1	149.14	46,957	$ 6,574.03
		14	672	190	2	298.28	98,783	$ 13,829.65	70	1	149.14	36,335	$ 5,086.84
		15	744	151	2	298.28	87,157	$ 12,201.96	56	1	149.14	32,058	$ 4,488.14
		16	720	144	1	149.14	80,102	$ 11,214.27	53	1	149.14	29,463	$ 4,124.85
		17	744	122	1	149.14	70,432	$ 9,860.52	45	1	149.14	25,907	$ 3,626.91
		18	720	105	1	149.14	58,519	$ 8,192.69	39	1	149.14	21,525	$ 3,013.45
		19	744	95	1	149.14	54,558	$ 7,638.16	35	1	149.14	20,068	$ 2,809.48
		20	744	66	1	149.14	37,877	$ 5,302.76	24	1	149.14	13,932	$ 1,950.47
		21	720	55	1	149.14	30,880	$ 4,323.16	20	1	149.14	11,358	$ 1,590.15
		22	744	33	1	149.14	18,824	$ 2,635.32	12	1	149.14	6,924	$ 969.33
		23	720	30	1	149.14	16,658	$ 2,332.10	11	1	149.14	6,127	$ 857.80
		24	744	20	1	149.14	11,491	$ 1,608.68	7	1	149.14	4,226	$ 591.71
							692,944	$ 97,012.14				254,880	$ 35,683.16
	Year 3	25	744	18	1	149.14	10,429	$ 1,460.10	7	1	149.14	3,836	$ 537.06
		26	672	16	1	149.14	8,098	$ 1,133.75	6	1	149.14	2,979	$ 417.02
		27	744	14	1	149.14	7,820	$ 1,094.86	5	1	149.14	2,877	$ 402.71
		28	720	12	1	149.14	6,651	$ 931.20	4	1	149.14	2,447	$ 342.52
		29	744	11	1	149.14	6,069	$ 849.62	4	1	149.14	2,232	$ 312.51
		30	720	9	1	149.14	5,270	$ 737.83	3	1	149.14	1,938	$ 271.39
		31	744	9	1	149.14	4,950	$ 693.02	3	1	149.14	1,821	$ 254.91
		32	744	8	1	149.14	4,530	$ 634.22	3	1	149.14	1,666	$ 233.28
		33	720	7	1	149.14	4,066	$ 569.29	3	1	149.14	1,496	$ 209.40
		34	744	8	1	149.14	4,326	$ 605.59	3	1	149.14	1,591	$ 222.75
		35	720	17	1	149.14	9,627	$ 1,347.75	6	1	149.14	3,541	$ 495.73
		36	744	14	1	149.14	8,249	$ 1,154.92	5	1	149.14	3,034	$ 424.80
				Year 3 Total			80,087	$ 11,212.16				29,458	$ 4,124.07
	Year 4	37	744	15	1	149.14	8,361	$ 1,170.51	5	1	149.14	3,075	$ 430.54
		38	672	17	1	149.14	8,745	$ 1,224.28	6	1	149.14	3,217	$ 450.32
		39	744	16	1	149.14	9,222	$ 1,291.05	6	1	149.14	3,392	$ 474.88
		40	720	14	1	149.14	7,950	$ 1,112.97	5	1	149.14	2,924	$ 409.37
		41	744	13	1	149.14	7,401	$ 1,036.13	5	1	149.14	2,722	$ 381.11
		42	720	12	1	149.14	6,505	$ 910.71	4	1	149.14	2,393	$ 334.98
		43	744	11	1	149.14	6,178	$ 864.87	4	1	149.14	2,272	$ 318.12
		44	744	10	1	149.14	5,692	$ 796.88	4	1	149.14	2,094	$ 293.11
		45	720	9	1	149.14	5,046	$ 706.46	3	1	149.14	1,856	$ 259.85
		46	744	9	1	149.14	4,908	$ 687.05	3	1	149.14	1,805	$ 252.71
		47	720	25	1	149.14	14,026	$ 1,963.68	9	1	149.14	5,159	$ 722.28
		48	744	22	1	149.14	12,654	$ 1,771.51	8	1	149.14	4,654	$ 651.60
				Year 4 Total			96,687	$ 13,536.11				35,563	$ 4,978.87
	Year 5	49	744	17	1	149.14	9,964	$ 1,394.97	6	1	149.14	3,665	$ 513.10
		50	672	16	1	149.14	8,330	$ 1,166.17	6	1	149.14	3,064	$ 428.94
		51	744	14	1	149.14	8,346	$ 1,168.44	5	1	149.14	3,070	$ 429.78
		52	720	13	1	149.14	7,214	$ 1,009.91	5	1	149.14	2,653	$ 371.47
		53	744	12	1	149.14	6,740	$ 943.54	4	1	149.14	2,479	$ 347.06
		54	720	11	1	149.14	5,938	$ 831.33	4	1	149.14	2,184	$ 305.78
		55	744	10	1	149.14	5,631	$ 788.31	4	1	149.14	2,071	$ 289.96
		56	744	9	1	149.14	5,164	$ 722.97	3	1	149.14	1,899	$ 265.92
		57	720	8	1	149.14	4,558	$ 638.09	3	1	149.14	1,676	$ 234.70
		58	744	8	1	149.14	4,866	$ 681.28	3	1	149.14	1,790	$ 250.59
		59	720	10	1	149.14	5,345	$ 748.33	4	1	149.14	1,966	$ 275.25
		60	744	10	1	149.14	5,680	$ 795.14	4	1	149.14	2,089	$ 292.47
				Year 5 Total			77,775	$ 10,888.50				28,607	$ 4,005.02

NOTES:

* Based on GOLDSIM HLF Water Balance Model Report dated April 14, 2020, and the assumption that up to 20L/s is directed to active treatment during draindown.

At 20L/s recirculation pumping will no longer be required; Phase 7/8 begins.

APPENDIX I

Eagle Gold Heap Leach Rinse Duration

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Project Memo

Project No.: 109001
September 4, 2020

To: StrataGold Corporation **From:** Forte Dynamics, Inc.

Eagle Gold SGC
Heap Leach Rinse Duration

Technical Memorandum

1. Introduction

As part of the Security Estimate Update being conducted by StrataGold Corporation (SGC), SGC commissioned Forte Dynamics, Inc. (Forte) to develop an initial estimate for the rinse time required at various phases of the Eagle Gold Heap Leach Facility (HLF). This memorandum details the assumptions and calculations used to develop the rinsing duration at the End-of-Mine (EOM) and at the 2-Year Peak. This an update from the previously generated memo in September of 2018.

2. Requirements, Methodology, & Results

The methodology, used by Forte for this work, is consistent with that applied at various heap leach facilities around the globe and matches best practices for rinsing of pads. It is a typical requirement that pads be rinsed with three pore volumes for adequate CN removal. A pore volume is defined as the volume associated with raising the entire pad from its residual moisture content to its operation content as seen below in Equation 1.

$$V_{Pore} = V_{Stacked} * (\theta_{operational} - \theta_{Residual})$$

For the various scenarios to be considered, (EOM and 2-Year Peak), the total flow rate supplied to the pad based on volume loaded and area available for leaching were used to calculate the time required to rinse the pad with the three pore volumes. Additional time was added to the rinse duration based on the breakthrough time associated with average depth of loading for each scenario. This was used to develop the total rinse duration presented below. The 2-year peak volume utilized corelates to the project volume of ore stacked at the end of September 2022.

Based on the above methodology, Table 2-1 below details the results for each scenario.

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Table 2-1 Rinse Duration

Scenario	Flowrate (m3/hr)	Volume Loaded (m3)	Operational Moisture Content (%)*	Residual Moisture Content (%)*	Total Rinse Volume (m3)	Break-through Delay (Days)	Rinse Duration (Days)
EOM	1,500	45,850,000	24.44%	14.79%	4,425,000	33	402
2-Year Peak	1,500	16,864,620	24.44%	14.79%	1,628,000	25	160

*All moisture contents shown are volumetric

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