EAGLE GOLD PROJECT

Response to Request for Supplementary Information (YESAB Assessment 2010-0267)

PURSUANT TO THE YUKON ENVIRONMENTAL AND SOCIO-ECONOMIC ASSESSMENT ACT

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1 INTRODUCTION

On September 16, 2011, the Executive Committee requested that Victoria Gold (VIT) provide supplementary information to the proposed Eagle Gold Project (YESAB Project No. 2010-0267) to enable completion of a Draft Screening Report. The request includes 31 individual information requests resulting from Executive Committee review of comments received during the first Public Comment Period.

Victoria Gold is providing this report as an addendum to the Project Proposal to assist the Executive Committee in preparation of the Draft Screening Report. The Supplementary Information Report is organized similarly to the YESAB request. The report is organized to provide:

1. **Background Information**—provided in the YESAB request for Supplementary Information
1. **Information Requests**—each individual information request as provided by YESAB
2. **Response**—supplementary information to the Eagle Gold Mine Project Proposal for each information request.

Some of the individual responses require detailed technical information, data, and figures. Where necessary, this additional supporting information is provided as appendices to the report.

The text immediately below provides context for supplementary information provided in this response, and also provides an update on the status of review of the Eagle Gold Project Proposal by the YESAB Executive Committee.

YESAA Overview

The Eagle Gold Mine Project Proposal is undergoing assessment under the *Yukon Environmental and Socio-economic Assessment Act* (YESAA) administered by the Yukon Environmental and Socio-economic Assessment Board (YESAB). YESAA provides an environmental assessment process whereby affected governments (territorial, federal or First Nations) use an assessment report and recommendation prepared by an arms-length assessment body to evaluate whether a project can proceed to the regulatory approvals process (permits, authorizations and licenses). Based on the size and complexity of the proposed project, the Eagle Gold Project requires a screening by the YESAB Executive Committee. During the screening, there are two opportunities for the public including governments (First Nations, Federal, and Territorial) and non-governmental organizations to comment on the Project. Notice of these opportunities is published, and all comments may be viewed on the YESAB Online Registry (YOR). During the screening, the Executive Committee evaluates public comments to determine whether YESAB requires additional information from the proponent to complete the assessment. The Executive Committee uses information provided by the Proponent to complete a Screening Report, which includes the Project Proposal and any supplementary information required by the Executive Committee.

There are four main stages of the Executive Committee review process as required by YESAA:

- **Adequacy**—YESAB determines adequacy of information provided by proponent
- **Screening**—YESAB completes assessment and drafts screening report

- **Recommendation**—YESAB provides recommendation to Decision Bodies that the project should proceed, proceed with terms and conditions, or not proceed
- **Decision**—Decision Bodies issue a Decision Document accepting, varying or rejecting the YESAB recommendation.

Timeline for Eagle Gold Project Proposal review

Currently, the Eagle Gold Mine Project Proposal is undergoing a screening. Once complete, YESAB forwards a Screening Report with a recommendation to relevant Government Decision Bodies.

On December 20, 2010, Victoria Gold submitted the Eagle Gold Project Proposal as required by YESAA to the YESAB Executive Committee. The following is a brief summary of YESAA review milestones (also available via the YOR).

- December 20, 2010—Submission of Eagle Gold Mine Project Proposal to YESAB
- January 21, 2011—YESAB Executive Committee determined that Victoria Gold (VIT) met the statutory requirement under s. 50(3) of YESAA relating to consultation
- January 21, 2011—YESAB begins Adequacy Review period to review Project Proposal
- March 23, 2011—YESAB extension of Adequacy Review period
- March 29, 2011—YESAB provides Adequacy Review Report to Victoria Gold that requests supplementary information
- May 24, 2011—Victoria Gold submits supplementary information to YESAB
- June 23, 2011—YESAB extension of Adequacy Review period to review supplementary information
- July 15, 2011—Victoria Gold submits revised Project Proposal including supplementary information
- July 18, 2011—Adequacy Review Complete/YESAB Publishes Notice of Screening
- July 22, 2011—YESAB issues Preliminary Statement of Scope of Project
- July 22, 2011—Screening Review/Public Comment Period begins
- August 12, 2011—YESAB Extension of Public Comment Period to August 31, 2011
- August 24, 2011—YESAB sponsored Public Meeting held in Mayo
- August 31, 2011—Public Comment Period ends
- September 1, 2011—Screening Review/Considering Comments stage begins
- September 14, 2011—YESAB issues revised Preliminary Statement of Scope of Project
- September 16, 2011—YESAB issues Victoria Gold a request for supplementary information as a result of Public Comments
- December 2, 2011—Victoria Gold submits response to YESAB request for supplementary information.

VIT will be pleased to answer questions regarding the responses to the Supplementary Information Request.

2 WATER BALANCE

2.1 Background

Yukon Conservation Society (YOR 2010-0267-201-1), First Nation of Na-cho Nyäk Dun (NND) (YOR 2010-0267-200-1), and Environment Canada (YOR 2010-0267-192-1) submitted comments regarding the water storage capacity in the Heap Leach Facility (HLF) and the events ponds.

Environment Canada identified a concern that there appears to be up to two months per year, both during operation and closure, where precipitation will exceed the Mine Water Treatment Plant capacity. While the proposal outlines mitigations for managing excess capacity, it is uncertain how the two months of excess precipitation are accounted for in the water balance model and water storage capacities.

In their comment submission, NND identified concerns with the water balance of the HLF. The proposal indicates that there is sufficient water storage capacity in the in-heap pond (435 000 m^3) and the event ponds (175 000 m^3) to contain the estimated 613 000 m^3 of draindown volume from the HLF. However, based on numbers in the proposal, independent calculations of the draindown volume are estimated by NND to be approximately 1 690 000 m^3.

NND identified the potential for positive water balance in the HLF during the rinsing and detoxification stage. While ore is being placed on the heap, water is required to raise the moisture content. However, when the heap is nearing completion this water would no longer be required to raise the moisture content as no fresh ore was being stacked. The water balance does not appear to address a potential positive water balance or the requirement for lower ore moisture.

Therefore, please provide the following information:

R1. Describe how the water balance model and water storage capacities account for up to two months per year of excess precipitation.

R1.1 Response

Summary

The surface water balance model has been revised and refined using GoldSim software with stochastic precipitation inputs, an updated Heap Leach Facility (HLF) closure draindown curve, and a revised total cumulative draindown volume of approximately 1.3 million m^3 provided by Tetra Tech in November 2011 (Appendix R1: Seepage and Draindown Evaluation of the 66 MT Eagle Gold Heap Leach Facility).These revised model results (for a non-optimized condition) indicate that the design capacity of the Mine Water Treatment Plant (MWTP) during operations (310 m^3/hr) and closure (620 m^3/hr) will not be exceeded when considering 90th percentile high flow values (essentially equivalent to the 90th percentile wet precipitation conditions), as shown on Figure R1-1.

The non-optimized MWTP discharge values shown on Figure R1-1 result in dilution ratios of less than 10:1 (i.e., 10 parts Haggart Creek flow to 1 part MWTP discharge) in some months during closure (Figure R1-2). High dilution ratios (i.e., ≥ 10:1) are more desirable with respect to maintaining in-stream water quality objectives. To achieve a dilution ratio of ≥ 10:1, a water conveyance and storage scheme was optimized to route excess flow (i.e., any flow that would result in a dilution ratio of < 10:1) to available storage in the events ponds (183,000 m^3) and/or recycled back to the HLF (in-heap storage up to 459,000 m^3). The GoldSim model then simulated a delayed release of the stored excess flow over the following subsequent months as an operational control. Figure R1-3 illustrates the optimized MWTP discharge over the life of the Project, and Figure R1-2 presents the dilution ratios in Haggart Creek before and after optimization of the MWTP discharge. The following paragraphs provide the basis for the updated water balance model and supporting information.

Introduction

The surface water balance model for the Eagle Gold Project Proposal (Appendix 21) (Stantec 2011) has been revised and refined to address a number of water management challenges, including how the model accounts for excess water storage requirements under high precipitation conditions.

The previous water balance model was created in Excel and simulated as a flow-through model, without the capacity to store water from one month to the next. The updated water balance model is simulated using the modeling software GoldSim, which is a dynamic modeling tool that provides enhanced capabilities for water storage routing and probabilistic modeling of precipitation conditions using stochastic analysis. The components of the updated water balance model are essentially the same as those outlined in Appendix 21 of the Project Proposal (Stantec 2011) with the following refinements:

- Reservoir elements in the GoldSim model are used to route flows through water storage design elements with the storage capacities as listed in Table 5.1-1 of Appendix 21 of the Project Proposal (Stantec 2011).
- The previous Excel water balance model constrained the maximum HLF in-heap storage capacity to 200,000 m^3 during operations and closure. The updated water balance model utilizes the total in-heap storage volume of 459,000 m^3, to accommodate heap leach recycling and months of high precipitation conditions. This refinement allows for an improved simulation of actual conditions.
- The updated GoldSim water balance model utilizes an updated HLF draindown curve and total cumulative draindown volume (1.3 million m^3) developed by Tetra Tech (Appendix R1). Appendix R1 outlines a revised HLF seepage and draindown evaluation during closure and post-closure.
- The updated GoldSim water balance model utilizes an optimized water management scenario to simulate the recycling of excess discharge from the HLF back to the HLF or events ponds in that event that:
    - The inflow to the MWTP in any month exceeds the design capacity of the mine water treatment plant (MWTP) of 310 m^3/hr during operations and 620 m^3/hr in closure (Project Proposal, Appendix 20: Mine Water Treatment Technical Memorandum) (Stantec 2011) **and/or**

- The dilution ratio in Haggart Creek is less than 10:1 for a given discharge from the MWTP (i.e., 10 parts Haggart Creek flow to 1 part MWTP discharge).

- The updated GoldSim water balance model utilizes a stochastic analysis that simulates a very wide range of possible climatic conditions using a Monte Carlo type simulation approach. The model was run with thousands of varying monthly precipitation sequences, with the resulting storage volumes summarized in terms of probabilities of occurrence, as opposed to the previous water balance model that only considered annual 'wet' and 'dry' conditions. Further details of the stochastic modelling are provided below.

Stochastic Inputs

The potential variability of climatic conditions was addressed by using a stochastic version of the updated GoldSim water balance model. A Monte Carlo type simulation was used to model monthly climate parameters as probability distributions rather than simply as mean values as represented by the Excel model submitted with the Project Proposal.

The year-to-year variability of monthly precipitation values was quantified using coefficient of variation (C_v) values that were derived from the regional precipitation dataset recorded at Mayo by Environment Canada. The monthly C_v values for precipitation, along with the monthly mean precipitation values for the project site (and corresponding standard deviation) were used to develop monthly probability distributions, as required for a Monte Carlo simulation. Monthly precipitation values were modeled using the Gamma distribution. The Monte Carlo simulations were run with 10,000 iterations, enabling a suitably large combination of wet, dry and average months and years of precipitation to be considered. The water volumes and flow rates were tracked for each month, in each year, and for each iteration of the simulation. The results were then compiled as distributions for each month in each year, from which probabilities of occurrence were assessed for each output parameter of interest.

Conclusions

The model results were used to determine the likelihood of exceeding the design capacity of the MWTP (Figure R1-1) and/or the dilution ratio in Haggart Creek through the mine life (Figure R1-2 – results are truncated to dilution ratios of 20:1 or less). Figure R1-1 presents the non-optimized range of possible monthly inflow volumes to the MWTP during operations and closure, in terms of the median, 10^{th} percentile (90^{th} percentile dry), and 90^{th} percentile values. The results indicate that the design capacity of the MWTP is never exceeded during operations and closure for a large range of anticipated climatic conditions. This result is notably different than the result that was achieved with the previous Excel water balance.

Figure R1-2 presents the range of possible monthly dilution ratios of Haggart Creek flows to MWTP inflows, in terms of the median and minimum values, for both unmanaged and optimized scenarios. The results on Figure R1-2 indicate that for the unmanaged scenario there is a high likelihood of high inflow to the MWTP (resulting in a less than 10:1 dilution ratio in Haggart Creek) occurring during the initial year of the HLF rinse period (Year 11) and the initial year of the HLF draindown period (Year 13). The increased flow predicted in Year 11 is due to net precipitation inputs to the heap that exceed the moisture losses from the ore, as ore production has ceased, which creates a positive water balance. The model also predicts increased flow in Year 13 which is due to the initiation of draindown at closure.

In the event that the cumulative inflows (HLF infiltration and other possible sources) to the MWTP would be close to the design capacity and/or result in a dilution ratio in Haggart Creek below the minimum required to meet water quality objectives, the model simulates an optimized water management plan by rerouting the excess flow to the events ponds, where it is temporarily held until there is sufficient capacity in the MWTP to treat it and/or sufficient flow in Haggart Creek to provide the required dilution ratio. Figure R1-2 presents the resulting median and minimum dilution ratios in Haggart Creek for the optimized water management scenario. The minimum values demonstrate that under this scenario the ratio never drops below the minimum required value of 10:1, for all possible precipitation conditions. Figure R1-3 illustrates the MWTP inflow/discharge with these constraints, in terms of 90^{th} percentile and median values. Even under very wet conditions, the inflow is well below the MWTP design capacity.

R2. Resolve and discuss the differences between the two predicted Heap Leach Facility draindown volumes (i.e., 613,000 m^3 in the proposal and 1 690,000 m^3 calculated by NND in their comment submission [YOR 2010-0267-200-1]).

R2.1 Response

The discrepancy between the Heap Leach Facility (HLF) draindown volume predicted in the Project Proposal and that calculated by NND is attributed to the methods and assumptions used to calculate the volumes. The volume calculated by the NND (1.69 million m^3) appears to estimate the total volume of water that could potentially drain from 36 million tonnes (or 20 million m^3) of porous heap material over the entire period of draindown which will likely occur over several to many years. The draindown estimate of 613,000 m^3 presented in the Project Proposal provides the water volume contained in the heap after a 120-day leach cycle and is used to derive the short-term draindown rate required to design water management systems for upset conditions. This estimated short-term draindown volume was derived from laboratory column test data scaled up to field size. The HLF draindown volume can be calculated in the following ways to support Project design and site-wide water management: 1) Calculation of the total draindown volume and duration that will occur over several to many years supports closure water management planning, and, 2) calculation of the maximum rate and volume of heap drainage over a short-term in the event of seasonal variation combined with an accident or malfunction that would result in an upset condition (i.e., over hours to days) supports water management planning during operations. The NND estimate applies to the first consideration while the estimate in the Project Proposal applies to the second consideration. Thus due to the differences in assumptions with specific focus on the assumed temporal condition in the NND estimate, the estimated draindown values are not comparable.

Additional modeling was performed using the VADOSE/W program from the GeoStudio 2007 software package (GEO-SLOPE 2007) to update the draindown volume for the heap as part of this supplementary information response. The model results provide revised draindown volumes and rates that can be anticipated from the heap over short and long-term periods (Appendix R1). The VADOSE/W model provides input to the water management plan during operations in the event of an upset condition (e.g., power failure that shuts down recirculation pumps) and closure (e.g., draindown rates) prior to decommissioning the cyanide detoxification and the mine water treatment plants. The modeling results estimate the volume of water that will drain from the heap over time once recirculation has ceased. The cumulative volume of water estimated to drain from the heap after a 120 day leach cycle (651,000 m^3) is close to the draindown volume estimated from the scaled-up column tests results reported in the Project Proposal (discussed above). This expected draindown volume represents approximately 50% of the total heap draindown of 1.296 million m^3 (Figure 6 of Appendix R1).

The site-wide water management plan requires an estimate of the volume of water that could drain from the heap in the first few days under an upset condition (e.g., power failure). Under an upset condition, in the unlikely event that pumps are not readily available to recirculate water back to the heap or remove it from the in-heap pond to the cyanide detoxification and mine water treatment plants, water would continue to drain from the upper portion of the heap to the in-heap pond and thus continue to increase to volume of stored solution. Should the in-heap pond ever reach design capacity, solution would spill to the event ponds for additional storage prior to treatment and discharge. Through continued advancement of the HLF design, the capacities of the in-heap and event ponds have increased slightly over the volumes published in the Project Proposal. The current design capacity of the in-heap pond is 459,000 m^3 and that of the event ponds is 183,000 m^3. Therefore, the total combined in-heap and event ponds capacity is 642,000 m^3. The cumulative volume of water that would drain from the heap during a prolonged and unlikely power outage and/or loss in pumping capabilities over a 10 day period is estimated at 255,000 m^3 which is 40 percent of the total storage capacity of the HLF and events ponds (Appendix R1).

R3. Clarify the water balance for the Heap Leach Facility once ore is finished being stacked and the heap is saturated. Please address the concern regarding a potential positive water balance during the rinsing and detoxification stages.

R3.1 Response

Rinsing and detoxification of the Heap Leach Facility (HLF) will occur during the closure phase (Years 11 to 13). The HLF is predicted to be in a positive water balance condition in some months during closure as the heap will be near saturation and water will not be required for irrigation at the cease of operations. Net moisture in the heap is defined by the following equation:

> *Net moisture [m^3/yr] = Precipitation + Moisture from crushing + HLF irrigation – Total moisture losses*

Total moisture losses from the heap include evaporation and ore adsorption. Moisture losses from the ore during closure are zero as the ore is assumed to be near saturation at the time irrigation to the heap ceases at the end of the gold recovery phase (Year 10). The positive water balance predicted during closure is due the net precipitation inputs being greater than the evaporative losses from the heap surface. Importantly, the MWTP is designed to have sufficient treatment capacity such that all water is treated and/or there is sufficient storage in the system to handle any excess flows due to high precipitation events regardless of a positive water balance condition during closure. Additional detail regarding MWTP capacity during rinsing and detoxification stages is provided above in response R1 and Figure R1-3.

3 WATER QUALITY

3.1 Winter Water Quality Baseline

3.1.1 Background

The baseline water quality for the proposed Project is outlined in Section 4.1.12 of the proposal and detailed in Section 6.5.1.2 and Appendix 16 (Environmental Baseline Report: Water Quality and Aquatic Biota). Baseline data was collected between 1993 and 1996 and between 2007 and 2010. In their comment submission, NND identified that there are no baseline data for December, January, or February during those years (YOR 2010-0267-200-1). Furthermore, data is limited for November and March. Water quality baseline is critical to understanding the site and potential effects from the proposed Project. The Executive Committee understands that VIT undertook winter water quality studies in 2010 – 2011.

Therefore, please provide the following information:

R4. Updated water baseline information for winter months collected during the 2010/2011 winter season.

R4.1 Response

Winter water chemistry data were collected in January – April 2011. Additional water quality sampling is planned for November and December 2011 and will continue through 2012. Table R4-1 summarizes the baseline data collection program for winter months (November – April) by year and sampling site. The table includes past and planned sampling dates through winter 2012.

Figure 6.5-3 of the Project Proposal (Stantec 2011) depicts all aquatic monitoring sites, and is reproduced below as Figure R4-1. Appendix R4 presents all data collected during January – April 2011. This period is subsequent to the submission of the Project Proposal and therefore provides supplementary information.

Sites sampled in 2011 (W1, W4, W9, W10, W21, W22, W26, W29) were selected for their relevance to the Project design and to provide ongoing baseline information about water quality relevant to monitoring during Project operation. They were sampled throughout 2011.

Table R4-1: Baseline Winter Sampling Program, 2007 though 2012 planned

Site	Nov	Dec	Jan	Feb	Mar	Apr
W1 Dublin upstream of Stewart	2007 2011 planned 2012 planned	2011 planned 2012 planned	2011 2012 planned	2011 2012 planned	2010 2011 2012 planned	2008 2011 2012 planned
W4 Haggart d/s Dublin	2007 2011 planned 2012 planned	2011 planned 2012 planned	2011 2012 planned	2011 2012 planned	2010 2011 2012 planned	2008 2011 2012 planned
W5 Haggart u/s Lynx	2007					2008
W6 Lynx at Haggart	2007					2008
W9 Eagle Pup	2011 planned 2012 planned	2011 planned 2012 planned	2011 2012 planned	2011 frozen 2012 planned	2011 frozen 2012 planned	2011 2012 planned
W10 – Suttle Gulch	2011 planned 2012 planned	2011 planned 2012 planned	2011 frozen 2012 planned	2011 frozen 2012 planned	2011 frozen 2012 planned	2011 frozen 2012 planned
W21 Dublin at Haggart	2007 2011 planned 2012 planned	2011 planned 2012 planned	2011 2012 planned	2011 2012 planned	2011 2012 planned	2008 2011 2012 planned
W22 Haggart u/s Dublin	2007 2011 planned 2012 planned	2011 planned 2012 planned	2011 2012 planned	2011 2012 planned	2010 2011 2012 planned	2008 2011 2012 planned
W23 Haggart d/s Lynx	2007		2011			2008
W26 Stewart Gulch	2007		2011 frozen	2011 frozen	2011 frozen	2008 2011 frozen
W27 Eagle Creek d/s of Access Road	2007 2011 planned 2012 planned	2011 planned 2012 planned	2011 2012 planned	2011 frozen 2012 planned	2010 2011 2012 planned	2008 2011 2012 planned
W29 – Haggart d/s Platinum	2011 planned 2012 planned	2011 planned 2012 planned	2011 2012 planned	2011 2012 planned	2011 2012 planned	2011 2012 planned

NOTE:
Planned = planned for sampling in 2011 and 2012
Frozen = frozen, no water at time of sampling (either frozen to bottom, or too little water to obtain a sample)

R5. A description how the winter water quality data will affect the water quality predictions provided in the proposal

R5.1 Response

Including recent winter water quality data in the baseline dataset for water quality predictions will not materially change the Project Proposal's conclusions regarding potential environmental effects on water and aquatic biota as presented in Section 6.5 of the Project Proposal (Stantec 2011). The inclusion of winter data will not decrease the confidence level of the effect predictions. In addition, there are low or no discharges of effluent from the Project planned for winter months. Consequently, baseline water chemistry during winter will have little influence on modeled water quality predictions.

In most cases, the winter 2011 data values are lower than those used for modeling in the Project Proposal - this provides a conservative approach to predicted effects to water quality. Table R5-1 provides the winter data for sites used for water quality predictions in the Project Proposal (i.e., W1, W9 and W22) and the 2011 winter data subsequently collected at the same sites. Parameters included in Table R5-1 are those relevant to water quality guideline (WQG) exceedances in the baseline dataset at various times of year or in predictions for Project-related discharges.

The differences between data provided in the Project Proposal and data collected in 2011 is considered relatively small when considering natural variability and the accuracy of values that are close to analytical detection limits. Some of the data used in deriving the monthly means for the Project Proposal were influenced by the presence of elevated sediment (TSS) levels in the samples, as noted for W9 (132 mg/L TSS in modeled values) and, to a lesser extent, for W1 (<3 to 17 mg/L TSS). This includes aluminum and iron (common constituents of silt), as well as antimony, arsenic and manganese. Elevated TSS in winter may be related to operational variability (i.e., difficulty in collecting sediment-free water from shallow slow moving water under the ice) or natural processes that occur under the ice that may disturb fine sediment. For example, flow in the channel adjusts to variable heat and vapor pressure flux from above and shifts in hydrostatic pressure from hyporheic flow below, which can lead to shifts in the main flow location, subsequent breakage or collapse of ice pieces and, if sediment is available, to the release of fine sediment into the small system. Given that treated effluent discharges from the Project are not predicted to contain elevated aluminum or iron, variability in baseline winter data for these parameters would not be linked to a Project effect.

Table R5-1: Selected Baseline Total Metal Data Used in the Water Quality Model Collected During Winter 2011

Site	Aluminum		Antimony		Arsenic		Cadmium		Iron		Manganese		Selenium		Silver		TSS	
	Model	2011	Model	2011	Model	2011	Model[1]	2011	Model	2011	Model	2011	Model[1]	2011	Model[1]	2011	Model	2011
W1																		
Jan	0.0930	0.0186	0.0019	0.0011	0.0415	0.0293	<0.000017	<0.000017	0.127	<0.030	0.00049	0.00075	0.0004	<0.0010	0.000008	<0.000010	9	<5
Feb	0.0930	0.0113	0.0019	0.0010	0.0415	0.0254	<0.000017	<0.000017	0.127	<0.030	0.00049	0.00059	0.0004	<0.0010	0.000008	<0.000010	9	<3
Mar	0.1791	<0.012	0.0027	0.0010	0.0442	0.0238	<0.000017	0.000019	0.240	<0.030	0.00083	0.00077	0.0004	<0.0010	0.000005	0.000019	17	<3
Apr	0.0283	0.0088	0.0014	0.0011	0.0365	0.0273	0.000024	<0.000017	0.030	<0.030	0.00236	0.00054	0.0005	<0.0010	0.000005	<0.000010	<3	<3
W9																		
Jan	0.781	0.056	0.00060	0.00056	0.0299	0.0179	0.000020	<0.000017	0.948	0.085	0.00494	0.00153	0.0004	<0.0010	0.000009	<0.000010	132	23
Feb	0.781	frozen	0.00060	frozen	0.0299	frozen	0.000020	frozen	0.948	frozen	0.00494	frozen	0.0004	frozen	0.000009	frozen	132	frozen
Mar	0.781	frozen	0.00060	frozen	0.0299	frozen	0.000020	frozen	0.948	frozen	0.00494	frozen	0.0004	frozen	0.000009	frozen	132	frozen
Apr	0.781	0.028	0.00060	0.00063	0.0299	0.0144	0.000020	<0.000017	0.948	0.062	0.00494	0.0018	0.0004	<0.0010	0.000009	<0.000010	132	<3
W22																		
Jan	0.0074	0.0058	0.00023	0.00021	0.00068	0.00065	0.000013	<0.000017	0.078	<0.030	0.08550	0.0306	0.0005	<0.0010	0.000008	<0.000010	<3	<3
Feb	0.0074	0.0043	0.00023	0.00023	0.00068	0.00070	0.000013	0.00002	0.078	<0.030	0.08550	0.0333	0.0005	<0.0010	0.000008	<0.000010	<3	<3
Mar	0.0077	<0.015	0.00020	0.00023	0.00069	0.00077	0.000017	0.00002	0.089	0.058	0.12800	0.0354	0.0005	<0.0010	0.000005	0.000008	<3	3.6
Apr	0.0128	0.0446	0.00026	0.00024	0.00105	0.00082	0.000021	0.00002	0.130	0.131	0.08360	0.0494	0.0005	<0.0010	0.000005	<0.000010	<3	4.4

NOTES:

Frozen indicates that samples could not be collected as the channel ice was frozen to the bed

[1] Cadmium, selenium and silver levels are typically below or near the detection limits. The modeled resultsare lower than the 2011 results because they are derived from a combination of reported values below the detection limit (using the convention of one-half the detection limit) and just above the detection limits

In the absence of monthly winter data prior to 2011, the approach used to characterize baseline conditions upstream of project discharges was to use average values from November, March and April for Haggart Creek (W22) with Dublin Gulch (W70). The most suitable upstream site for Dublin Gulch would be downstream of Stewart Gulch and upstream of Eagle Pup; however, the long term monitoring site (W1) with a drainage area of 10.5 km^2 is located upstream of Stewart Gulch (drainage area of 1.5 km^2) so is not fully representative of the entire watershed (11.8 km^2) above the Project. To address this, a synthetic or virtual site (W70) was created by modeling water quality using chemistry and flow data for W1 and W26 (Stewart Gulch). Using mean or interpolated data for winter months is common practice and reasonable for northern projects in remote areas, because winter water chemistry is fairly consistent under ice (dominated by groundwater inputs, no surface water runoff).

3.2 Site Specific Water Quality Objectives

3.2.1 Background

Baseline water quality is characterized using data from 1993 to 2010. Total suspended solids and some metals were up to an order of magnitude higher from 1995 and 1996 than other years. This discrepancy is likely due to active placer mining in various surrounding watersheds during these years. Environment Canada (YOR 2010-0267-192-1), Yukon Government (YOR 2010-0267-197-1), and NND (YOR 2010-0267-200-1) expressed concern with using background data that appears to be influenced by anthropogenic disturbances. Furthermore, CCME (2003) indicates that the background concentration procedure for deriving Site Specific Water Quality Objectives (SSWQO) is suited to pristine conditions and that it may be difficult to apply in areas with anthropogenic disturbances.

Therefore, please provide the following information:

R6. A discussion on the implications to the proposed Site Specific Water Quality Objectives, the Water Management Plan, and the Water Treatment Process if the 1995 and 1996 data are removed from the baseline characterization

R6.1 Response

Baseline data were collected from 1993 – 1996 and from 2007 – 2010. Removal of the data from the 1990s would have a minor effect on the proposed SSWQO. This minor effect indicates no need for a change in the proposed water management plan or water treatment processes.

The Environmental Baseline Report: Water Quality and Aquatic Biota (Project Proposal Appendix 6.5-A) (Stantec 2011) discusses differences between data collected during the 1990s and during 2007 – 2010. As noted in Section 3.2.1 above, data from the 1990s had higher TSS, aluminum, iron, arsenic, copper, and lead at Haggart Creek sites W4 and W5, compared to data from 2007 – 2010. The water quality model presented in the Project Proposal excludes Haggart Creek and Dublin Gulch water quality data from the 1990s period in calculations of monthly mean baseline concentrations for the following metals, which had some reported values at or near the detection limit: cadmium, chromium, copper, lead, manganese, molybdenum, nickel, silver, and thallium. Data from the 1990s were excluded because of more recent improvements to analytical detection limits; retaining the older data would have introduced an undefined uncertainty into the calculations of mean values for the combined sampling period.

At this time, there is no plan for remodeling of water quality omitting the pre-2007 arsenic baseline data. Including the pre-2007 data (with its higher maximum and mean values for several parameters), is a conservative approach and consistent with what was presented in the Project Proposal. The use of higher baseline concentrations in the model results in higher predicted concentrations due to Project activities. Because water quality from the 2007 – 2010 period is somewhat better than the 1993 – 1996 period, due to increased placer mining activity in the watershed at that time, there is an additional margin of conservatism for future concentrations and predicted effects with respect to arsenic and other parameters. These higher mean baseline numbers were used to model Project effects and to establish mine water treatment plant effluent criteria, with the goal of ensuring WQG or SSWQO can be met in the receiving environment. We believe this provides a conservative approach to predicting effects to water quality for the YESAB.

Implications for a Proposed Site Specific Water Quality Objective

In the Project Proposal, SSWQOs are proposed for iron, aluminum, cadmium and arsenic, and discussed in a more general sense for antimony, selenium and silver (Section 6.5 and Table 6.5-29 of the Project Proposal) (Stantec 2011). The proposed SSWQO for iron, aluminum, cadmium and selenium were derived from WQG in other Canadian jurisdictions, not site data, so inclusion or exclusion of data from the 1990s would have no influence on derivation of these SSWQO. As noted on page 6-95 of the Project Proposal (Stantec 2011), and in the text for these parameters, SSWQO for antimony and silver were not proposed, given the that no WQG exceedances were predicted for operations and closure (treatment plant in operation), and that the post-closure mitigation measures being proposed (covers on the waste rock dumps to reduce infiltration, and passive wetland treatment processes) would be sufficient to avoid WQG exceedances. However, subsequent to submission of the Project Proposal, a need for a sulphate SSWQO was identified for short-term discharges during the peak of heap draindown at closure, as discussed in R9.

Arsenic is the only parameter where a SSWQO is derived using actual site data. Therefore, arsenic is the only parameter for which exclusion of data from the 1990s could have an influence on the SSWQO. Given the absence of alternative WQGs for arsenic that are useful in assessing toxicological implications of exceeding the WQG, the arsenic SSWQO was derived using a Background Concentration Procedure (mean plus two standard deviations). Implications of excluding arsenic data from the 1990s in derivation of a SSWQO are discussed on page 6-18 of the Project Proposal and summarized as follows:

- The proposed arsenic SSWQO for Eagle Creek is 0.070 mg/L, and was developed using data from 2007 – 2010 for site W27 in Eagle Creek. There are no data for site W27 from the 1990s. Hence the proposed SSWQO is not affected by data from the 1990s. The proposed SSWQO for Dublin Gulch would be the same (0.070 mg/L), given that Dublin Gulch will be diverted into Eagle Creek during construction.

- The proposed SSWQO for Haggart Creek (0.020 mg/L) was developed using data from the 1990s and 2007 – 2010 collected from site W4 on Haggart Creek, downstream of Dublin Gulch. Some of the arsenic data from the 1990s were notably higher than in the data from 2007 – 2010. Omitting the data from the 1990s, a SSWQO of 0.014 mg/L was calculated, rather than 0.020 mg/L, indicating the influence of historic placer mining and historic data on the calculation. This is described in the Project Proposal on page 6-18 (Stantec 2011).

Implications for the Water Management Plan

Omission of data from the 1990s in derivation of an arsenic SSWQO (i.e., a lower SSWQO for Haggart Creek) would not have implications for the water management plan, given that the plan involves routing of mine influenced water to the mine water treatment plant. The water management plan describes mechanisms to control conveyance, storage and discharge of mine influenced water to avoid exceedance of WQG or SSWQO in Haggart Creek (e.g., short-term storage of excess water).

Implications for the Proposed Water Treatment Process

Omission of data from the 1990s in derivation of an arsenic SSWQO (i.e., a lower SSWQO for Haggart Creek) would not have implications for the proposed water treatment process (ferric chloride precipitation) or effluent criterion for arsenic. To address the lowest dilution available during draindown, the effluent criterion for the mine water treatment plant was assumed to be 0.010 mg/L (twice the CCME WQG, and lower than the proposed SSWQO). This is more conservative than the conservative minimum 5:1 dilution modeled in the Project Proposal (Stantec 2011), or what is likely to occur (i.e., a minimum of at least 10:1 dilution ratio) during peak of draindown of the heap leach facility during closure (see responses R1 and R2). The effluent criterion remains feasible.

R7. Rationale for choosing the Background Concentration Procedure rather than other methods outlined in CCME (2003) (e.g., Recalculation Procedure or Water Effect Ratio Procedure) for deriving Site Specific Water Quality Objectives.

R7.1 Response

Various methods have been employed to derive SSWQOs depending upon the parameter and availability of alternative WQG. SSWQOs have been proposed for six parameters. Four of the SSWQO are based on more recently published WQG from British Columbia (aluminum, iron, selenium) or the CCME (draft WQG for cadmium). One SSWQO (sulphate) is based on recent literature re-evaluating the toxicology of sulphate. These five are discussed further in R9. The sixth SSWQO (arsenic) is based on site specific data, and was derived using the Background Concentration Procedure, given the elevated baseline levels of arsenic. Aside from the US EPA (2011) acute and chronic toxicity criteria for dissolved arsenic (0.340 mg/L and 0.150 mg/L, respectively), alternative WQG from other jurisdictions were not found. Existing permits and authorizations for other mines in the Yukon (Bellekeno, Brewery Creek, Wolverine and Minto mines) describe effluent criteria, but not receiving watercourse WQG for arsenic, so do not provide precedent.

VIT has proposed two separate arsenic SSWQOs, one for Haggart Creek (0.014 mg/L) and one for Dublin Gulch and Eagle Creek (0.070 mg/L), to reflect different baseline concentrations in each watercourse. Dublin Gulch and Eagle Creek have the same SSWQO, given that baseline arsenic levels are similar and that Dublin Gulch will be diverted into Eagle Creek. The SSWQO were derived using the Background Concentration Procedure (95^{th} percentile, using data from 2007 – 2010).

The rationale for choosing the Background Concentration Procedure for derivation of an arsenic SSWQO, rather than other methods outlined in CCME (2003), such as Recalculation Procedure or Water Effect Ratio Procedure, was discussed in the Project Proposal (Section 6.5.1.11, pages 6-17 to 6-20) (Stantec 2011). Further support for use of the Background Concentration Procedure is provided below, with additional detailed technical information provided in Appendix R7.

The background concentration procedure uses the natural background waterborne concentrations of a contaminant to define acceptable water quality conditions for the Project site. The rationale for using the Background Concentration Procedure is as follows:

- There are elevated baseline arsenic levels in surface water, groundwater and soils in the Dublin Gulch watershed and other watersheds in the Project area. Some of the arsenic can be attributed to natural origin and some to anthropogenic disturbance (current and historic placer mining). Baseline arsenic levels are not elevated in Haggart Creek upstream of Dublin Gulch, but increase downstream of the tributaries (disturbed Dublin Gulch and Eagle Creek, undisturbed Lynx Creek). Appendix R7 provides additional discussion.
- Dublin Gulch, Lynx Creek and other watercourses that contain elevated arsenic concentrations support healthy benthic communities (abundant and diverse periphyton and invertebrate assemblages), as does Haggart Creek. Although community composition in watercourses with elevated arsenic levels differs from that in Haggart Creek, general water chemistry, habitat and stream order also differ among these watercourses and are important factors in community development. Also, healthy benthic communities may develop, despite arsenic levels higher than the WQG, due to the presence of factors that reduce arsenic toxicity or due to an overly protective WQG. Appendix R7 provides additional discussion.
- A greater understanding of the factors that reduce toxicity and bioavailability of arsenic would be helpful in understanding the baseline condition for benthic communities already exposed to arsenic levels higher than the WQG. The Water Effect Ratio Procedure can be employed to compare toxicity of site water to standard laboratory test conditions, and derive a SSWQO. This procedure is most useful when there is an identifiable modifying characteristic (e.g., hardness, organic carbon, pH, nutrients) that affects bioavailability of the parameter in question, such is the case for arsenic. The additional analysis of relationships between dissolved arsenic and iron, aluminum and organic matter is provided in Appendix R7, and is helpful in describing methods that may occur naturally to reduce amounts of bioavailable arsenic, thereby protecting aquatic organisms. As described in the Project Proposal (page 6-19) and Appendix R7, discussions with a toxicology lab that performs this method did not identify arsenic as a good candidate for Water Effects Ratio testing.

- The derivation of a SSWQO by removing species that do not occur in the area (i.e., the Recalculation Procedure) would not be helpful for this Project area, as there will be too few species remaining in the database to provide a meaningful basis for a SSWQO. Only two species would be included, one invertebrate (*Chironomus tentans*, a pollution tolerant chironomid) and one fish (arctic grayling) species. Using this method, the lowest toxicity test endpoint would be 0.68 mg/L As [III] (effect concentration for mobility of *Chironomus tentans*, Khangarot and Ray 1989) and the SSWQG would be 0.068 mg/L (ten-fold safety factor). This would not account for the lower toxicity of As [V], which is more likely to be the prevalent form of arsenic in the Haggart Creek watershed, and would not address arsenic toxicity to algae, including the blue-green algae and diatom species that are predominant in the watershed. Appendix R7 provides additional discussion of toxicology data relevant to a discussion an arsenic SSWQO.

There are challenges in identifying a suitable arsenic SSWQO that recognizes the naturally elevated and highly variable levels in soil, surface water and groundwater. Further, due to the intrinsic high natural variability, it is difficult to quantify the effect of disturbance from historical placer mining in Haggart Creek and a number of its tributaries, including Dublin Gulch. The current (albeit not pristine) conditions should be considered when developing a SSWQO, along with other factors that may affect the ability of Dublin Gulch and Haggart Creek to support a healthy stream ecosystem. The Background Concentration Procedure, although ideally used in pristine situations, continues to be the most supportable approach for developing an arsenic SSWQO for watercourses in the Haggart Creek watershed. The information provided in Appendix R7 provides additional technical information used to arrive at this conclusion.

3.3 Mine Water Effluent Quality

3.3.1 Background

Table 6.5-4 in the proposal outlines the parameters analyzed and the limits for those parameters based on the CCME Water Quality Guidelines (WQG) or alternative WQG/SSWQO. The proposal indicates that where there are no CCME WQG, the alternative British Columbia (BC) WQG or SSWQO will be used. However, Table 6.5-4 is unclear which WQG are being used. For certain parameters, such as TSS, Cyanide, Boron, Chromium Total, there are both CCME WQG and BC WQG limits listed.

Table 2 of Appendix 20 (Mine Water Treatment Technical Memorandum) summarizes the mine water treatment end of pipe effluent criteria. These criteria are set at two times the downstream WQG or SSWQO. The table identifies which guidelines, the CCME WQG or the BC WQG, are being used for each parameter. Table 6.5-14 in the proposal also summarizes the effluent criteria from the mine water treatment end of pipe. However there are some discrepancies between the values in the tables. For example, in Table 2 fluoride is set at 0.4 mg/L and arsenic is set at 0.04 mg/L while in Table 6.5 14 fluoride is set at 0.6 mg/L and arsenic is set at 0.01 mg/L.

Section 6.5.5.5 proposes a SSWQO for silver three times CCME WQG (0.0003 mg/L). However, the above listed tables propose silver objective two times CCME WQG (0.0002 mg/L). Yukon

Government has expressed concern that the silver objective is being set at three times CCME WQG and that this is not consistent with the methods for developing SSWQO outlined in the proposal.

Comments from NND (YOR 2010-0267-200-1) have expressed further concern regarding which effluent standards are being applied. Based on the discrepancies, there is uncertainty in the proposed effluent discharge criteria and the rationale for choosing those criteria.

Therefore, please provide the following information:

R8. A table containing the proposed water quality objectives for relevant parameters

R8.1 Response

Table R8-1 provides a list of the WQG used to assess Project effects and is a clarification of Table 6.5-4 of the Project Proposal (entitled Parameters Analyzed, CCME Water Quality Guidelines for Protection of Aquatic Life and Alternative Recommendations for Site-specific Objectives) (Stantec 2011). The Yukon guidelines have been added to Table R8-1 at the request of the Yukon Government reviewers (Information Request 197-1, dated August 30, 2011: Environmental Programs, Section 7 Environmental Standards). The Yukon guidelines are derived from the Contaminated Sites Regulations, and are values for groundwater, divided by 10 to allow for a 10:1 dilution from groundwater to surface water. The Yukon guidelines are the same as either the CCME or BC WQG for most of the parameters, with the exception of nitrate, boron, copper, mercury, molybdenum, silver, and uranium, which are higher than for CCME and BC WQG.

The WQG listed in Table R8-1 are for the receiving watercourses, **and are not end-of-pipe criteria for the mine water treatment plant.**

Table R8-1: Water Quality Guidelines Used to Assess Receiving Water Quality for the Eagle Gold Project

Parameter	WQG Used to Assess Effects in the Project Proposal[1]	Water Quality Guidelines[2] (mg/L unless stated)	
		Yukon[3]	CCME WQG maximum (and alternatives)
pH, units	6.5 – 9	None provided	6.5 – 9
TSS	Not predicted, dealt with through permit requirements	None provided	Clear flow—maximum increase of 25 mg/L and 5 mg/L above background for short term and long term exposure, respectively High flow—maximum increase of 25 mg/L above background when background is 25 to 250 mg/L; ≤ 10% of background when background is >250 mg/L
Fluoride	0.30 at H>50	0.2 at H< 50 0.3 at H>50	No CCME (used BC WQG of 0.30 at H>50)
Sulphate	100	100	No CCME (used BC WQG of 100)

Parameter	WQG Used to Assess Effects in the Project Proposal[1]	Water Quality Guidelines[2] (mg/L unless stated)	
		Yukon[3]	CCME WQG maximum (and alternatives)
Ammonia-N	CCME WQG, varies with pH, temperature	varies with pH (1.13 for pH 7.5-8.0)	Varies with temperature and pH
Nitrate-N	2.9	40	2.9
Nitrite-N	0.06	0.02 at Cl <2 to 0.1 at Cl 8 to 10	0.06
Phosphorus-P (total)	none	none	none
Cyanide	0.010 WAD	0.005 WAD	0.005 (free CN) (used BC WQG of 0.010 WAD)
Aluminum	0.10 (dissolved)	None	0.10 total, pH≥6.5 (used BC WQG of 0.10 dissolved)
Antimony, total	0.02	0.02	No CCME (used BC WQG of 0.02)
Arsenic, total	0.005	0.005	0.005
Boron, total	1.2	5	1.5 (draft CCME 2009b) (used BC WQG of 1.2)
Cadmium, total	0.0003 at H=150	0.00001 at H<30 0.00003 at H 30-90 0.00005 at H 90 to 150 0.00006 at H 150-210	CCME (1986) is 0.00001 (H=20 mg/L) to 0.00006 (H = 210 mg/L Used draft CCME of 0.0001 (H=30 mg/L) to 0.00038 (H=210 mg/L)
Chromium, total	0.0089	0.009	0.0089 (Cr III)
Copper, total	0.003 at H=150	0.002 at H<50 0.003 at H 50-75 0.004 at H 75-100 0.005 at H 100-125 0.006 at H 125-150 0.007 at H 150-175 0.008 at H 175-200 0.009 at H >200	0.002 (H <120 mg/L) to 0.004 (H >180 mg/L)
Iron	1.0 (total)	None	CCME is 0.3 total (BC WQG is 1 total and 0.35 dissolved)
Lead, total	0.004 at H=150	0.004 at H<50 0.005 at H 50 to 100 0.006 at H 100-200 0.011 at H 200-300	0.001 to 0.007 (for H=60 to 180 mg/L)
Manganese, total	0.05	none	NA (used BC WQG for drinking water of 0.05)
Mercury, total	0.000026	0.0001	0.000026
Molybdenum, total	0.073	1	0.073

Parameter	WQG Used to Assess Effects in the Project Proposal[1]	Water Quality Guidelines[2] (mg/L unless stated)	
		Yukon[3]	CCME WQG maximum (and alternatives)
Nickel, total	0.110 at H=150	0.025 at H<60 0.065 at H 60-120 0.110 at H 120-180 0.15 at H >180	0.025 (H <60 mg/L) to 0.15 (H >180 mg/L)
Selenium, total	0.002	0.001	0.001 (used BC WQG of 0.002)
Silver, total	0.0001	0.00005 H <100 0.0015 H >100	0.0001
Thallium	0.0008	0.0003	No CCME (used BC WQG of 0.0008)
Uranium, total	0.015	0.3	No original CCME, used draft CCME of 0.015
Zinc, total	0.03 at H=150	0.0075 at H<90 0.015 at H 90-100 0.090 at H <200	0.03

NOTES:

1. WQG for hardness-dependant parameters were selected based on intermediate hardness (100 to 150 mg/L, representative of Haggart Creek baseline)
2. Yukon Environment (2011), CCME (2009), BC MOE (2006), BC MOE (2008), Nagpal et al.(2006), Roe et al. (2010)
3. Yukon standards are not for surface water. They are derived from Yukon Contaminated Sites Regulation water standards times 10, as the standards are designed to be applied to groundwater, and assume 10-fold dilution in surface water, as per directions provided in CSR documents.

Table R8-1 above and Table 6.5-4 in the Project Proposal (Stantec 2011) provide a list of available WQG from various sources (usually CCME, in some cases BC). These WQG are used to evaluate baseline water quality and to screen parameters that are predicted to exceed WQG during operations, closure or post-closure and require additional consideration of potential for adverse effects. The WQG used to assess project effects are described in the tables of predicted water chemistry. For example, Tables 6.5-9, 6.5-10, 6.5-11, 6.5-15, 6.5-16, 6.5-20, 6.5-21, 6.5-22, 6.5-23, 6.5-24, 6.5-26, 6.5-27, and 6.5-28 of the Project Proposal all include a column listing the WQG used for the assessment (the same in all tables, except when adjusted for hardness of a watercourse). The last column in these prediction tables is a comparison of the maximum predicted value to the WQG (max/WQG), with values greater than 1 flagged to indicate predicted exceedances.

As noted by YESAB in Section 3.3.1 above, two discrepancies were identified in the Project Proposal (Table 6.5-14 and Appendix 20, Table 2) (Stantec 2011) regarding effluent criteria for fluoride and arsenic. The criteria were set at two times the WQG, to allow a minimum 2:1 dilution in Haggart Creek at the peak of heap leach facility draindown, which was initially assumed for the assessment at that time. The discrepancies were not caught prior to submission of the Project Proposal. The clarification is as follows:

- For fluoride, the correct effluent criterion value for Table 6.5-14 and Appendix 20 Table 2 is 0.6 mg/L, which is based on hardness greater than 50 mg/L and the BC WQG of 0.3 mg/L.

Although BC has recently (2011) raised the fluoride WQG to 0.4 mg/L, this is not accounted for in the Project Proposal.

- For arsenic, the correct effluent criterion value for Table 6.5-14 and Appendix 20 Table 2 is 0.01 mg/L, which is based on two times the CCME WQG of 0.005 mg/L. The incorrect value reported in Appendix 20 Table 2 was based on two times the SSWQO of 0.020 mg/L for Haggart Creek initially proposed in the Project Proposal). The discrepancy does not affect the predictions or the conclusions of the assessment, as the effluent criterion of 0.01 mg/L is considered feasible.

Regarding a SSWQO for silver post-closure, described in Section 3.3.1 above (and discussed in a general sense in the Project Proposal in Section 6.5.5.5), the Project Proposal concluded that inclusion of a passive treatment system would be sufficient to reduce silver levels to meet the WQG post closure. Hence, there is no proposed SSWQO for silver. The value of 0.0002 mg/L listed in Table 6.5-14 of the Project Proposal refers to the treatment plant objective. It is noted that the Yukon water guideline based on the Yukon Contaminated Sites Regulation (0.0015 mg/L at hardness >100) is 15 times higher than CCME (0.0001 mg/L).

In the assessment of potential Project effects on water quality, the predictions are compared with the WQG (CCME or BC). In addition, a SSWQO for arsenic was developed to recognize the existing baseline conditions of arsenic levels higher than WQG in Dublin Gulch, Eagle Creek and Haggart Creek. After submission of the Project Proposal, VIT identified the need for a SSWQO for sulphate to cover a short period of time (high discharge rate and volume during the initial phase of draindown of the heap leach facility), based on refinement of the project understanding. The rationale for a sulphate SSWQO is discussed in Section R9.

Of the parameters and WQG listed in Table R8-1, some can be screened out based on low concentrations predicted in geochemical testing and water quality predictions (see Tables 6.5-13 and 6.5-18 in the Project Proposal, which describe contact water chemistry of the mine water treatment plant feed pond). These parameters are boron, chromium, iron, molybdenum, and thallium, all of which have predicted concentrations in contact water close enough to the WQG that subsequent dilution in Haggart Creek will not result in WQG exceedances.

R9. Rationale for which particular Water Quality Guidelines or Objectives are being applied to each parameter

R9.1 Response

The rationale (CCME, draft CCME, BC) for applying WQG to individual parameters is summarized in Table R8-1. In most cases, the CCME WQG for protection of aquatic life are used, although the BC WQG are used in some cases. All predictions are compared to these WQG. When concentrations of some parameters currently exceed WQG in baseline conditions (arsenic, aluminum, iron) or are predicted to exceed WQG as a result of Project discharges (cadmium, selenium, sulphate), SSWQO are proposed. The rationales for SSWQO for these parameters are listed in Table R9-1, and described further in the text following. The rationales for use of the BC WQG for selenium, aluminum and iron and the draft CCME WQG for cadmium have already been fully described in Section 6.5.5 of the Project Proposal (Stantec 2011). The rationale for arsenic is discussed in response R7.

Table R9-1: Updated List of Site-Specific Water Quality Objectives (SSWQO) for the Eagle Gold Receiving Environment

Parameter	WQG Used to Assess Effects (mg/L)	SSWQO to Further Assess Potential for Significant Adverse Effects	
		SSWQO (mg/L)	Overview of Rationale
Aluminum	0.10 dissolved	0.10 dissolved	To account for baseline exceedances of aluminum during freshet (particulate Al, not the toxic dissolved form). No project discharges are predicted. The SSWQO is based on BC WQG (BC MOE 2006).
Arsenic, total	0.005	0.014 for Haggart Creek 0.07 for Eagle Creek and Dublin Gulch	Reflects elevated baseline concentrations, and levels predicted to be present in mine contact water (can be treated to 0.010 mg/L in mine water treatment plant). The SSWQO was derived using Background Concentration Procedure (see R7 for rationale).
Cadmium, total	0.0003 at H=150	0.0003	Will be present in mine contact water. The SSWQO is the draft CCME WQG (Roe et al. 2010), derived using species sensitivity distribution approach. 0.0001 to 0.0003 for hardness of 20 to 150 mg/L Baseline hardness: Haggart Creek (W22) – mean 149 mg/L, Dublin Gulch (W70) – mean 61 mg/L.
Iron	1.0 total 0.35 dissolved	1.0 total 0.36 dissolved	To account for baseline exceedances of iron during freshet (particulate Fe, not the toxic dissolved form). The SSWQO is based on BC WQG (BC MOE 2008). No project discharges are predicted.
Selenium, total	0.002	0.002	Will be present in mine contact water. The SSWQO is the BC WQG, which is based on lotic, rather than lentic, habitat.
Sulphate	100	644 (during initial draindown at closure only)	Will be present in mine contact water, at levels controlled by gypsum solubility (1620 mg/L). During operations, post-closure, and much of closure, levels in Haggart Creek will meet the BC WQG of 100 mg/L. For four months during the high discharge period of draindown of the heap leach facility, sulphate levels may exceed the BC WQG (up to 225 mg/L), and a short-term SSWQO is requested. The SSWQO is based on Elphick et al. (2011), which describes a hardness-dependent WQG derived using recent toxicity tests on wide range of organisms. The value of 644 is for moderate hardness (species sensitivity distribution approach); although the predicted level will be considerably lower than this.

It is considered that meeting the SSWQO for parameters listed in Table R9-1 and the WQG listed in Table R8-1 for the remaining parameters will not result in significant adverse effects on water quality and aquatic life. The mine water treatment plant will be designed to meet these WQG and SSWQO through a combination of treatment technologies and management of water from draindown of the heap leach facility (the time of maximum loading from the project) during operation and closure. Post-closure, covers on the reclaimed heap leach facility and waste rock storage areas, combined with passive treatment systems, will allow the SSWQO and WQG to be met, as discussed in the Project Proposal.

For most of the parameters, the Project Proposal assesses water quality using the CCME WQG for protection of aquatic life. When there is no CCME WQG, a WQG from another jurisdiction (typically BC) has been used. More recent (or draft CCME) WQG are used for parameters if available. WQG from other jurisdictions have been used for the following parameters, given that there are no CCME WQG for protection of aquatic life for these parameters:

- Antimony—BC WQG for aquatic life (same as CCME WQG for drinking water)
- Cadmium—draft CCME (2010), which is a recent update based on species sensitivity distribution approach
- Fluoride—BC WQG for aquatic life (0.2 or 0.3 mg/L, depending on hardness).
- Iron—BC WQG for aquatic life (provides separate WQG for total and dissolved, and is more recent than CCME for total)
- Manganese—BC drinking water. There is now a hardness-related BC WQG (maximum of 1.6 mg/L and mean of 1.0 mg/L at 100 mg/L hardness; BC MOE (2011)), which has not been used in the Project Proposal
- Selenium—BC WQG for aquatic life (BC WQG is more recently revised than CCME; both were developed for lentic rather than lotic habitat, so are overly protective for Project-area lotic habitats)
- Sulphate—BC WQG for aquatic life (under review)
- Thallium—BC WQG for aquatic life (same as CCME WQG for drinking water)
- Uranium—draft CCME (2010), which is a recent update based on species sensitivity distribution approach.

After submission of the Project Proposal, a review of treatment technologies and toxicological literature indicated that additional consideration should be made for SSWQO for sulphate, as outlined in Table R9-1 and discussed below.

Aluminum

Project effluent is not predicted to contain elevated aluminum levels. The aluminum SSWQO is proposed to address elevated baseline concentrations that occur during freshets. It is proposed that the BC WQG for dissolved aluminum (0.100 mg/L), rather than the CCME WQG for total aluminum (0.100 mg/L), be used as has been described in the Project Proposal. Aluminum is a common constituent of silt, associated with high total suspended solids levels, and is often elevated during freshet. The dissolved, not particulate form is toxic, as recognized in the BC WQG (BC MOE 2006).

Arsenic

The rationale for the proposed arsenic SSWQO is provided in R7.

Cadmium

Treated Project effluent will contain cadmium at levels higher than the CCME WQG in various months of the year during operation, closure, and post-closure. Baseline levels are close to the CCME WQG, as is commonly noted in many northern temperate watercourses. The proposed SSWQO is based on the draft CCME WQG (Roe et al. 2010). The original WQG was interim and had not been reviewed for many years. Environment Canada revised the WQG using a Species Sensitivity Distribution Procedure, which is currently their preferred method. The rationale for use of the draft CCME WQG for cadmium was described in the Project Proposal. In brief:

- Cadmium toxicity is reduced with increasing levels of hardness and organic matter (US EPA 2001); the hardness factor is incorporated in the WQG.
- The draft CCME WQG is 0.0003 mg/L total cadmium at 150 mg/L hardness, based on a Species Sensitivity Distribution approach, revised in 2010. This value is protective of fish, including salmonids, and other aquatic life.
- The draft CCME WQG is similar to the US EPA criterion chronic concentration for dissolved cadmium of 0.00015 to 0.00039 mg/L for hardness of 50 to 180 mg/L (US EPA 2001). The US EPA criterion was based on a rigorous evaluation of chronic and acute toxicity data for freshwater biota, with peer and public reviews, and was developed for the more biologically relevant dissolved concentration.
- The existing CCME WQG is 0.00004 mg/L total cadmium at hardness of 150 mg/L, about eight times lower than the draft CCME WQG. This is an interim WQG based on the safety factor approach (test results for the most sensitive species, with a 10-fold safety margin; this was a Lowest Observed Effect Level [LOEL] of 0.00017 mg/L for the water flea Daphnia magna, and is adjusted for hardness).

Iron

Project effluent is not predicted to contain elevated iron levels; however, a SSWQO is proposed to recognize the baseline condition, where total iron levels are elevated during freshet. The proposed iron WQG is the BC WQG for total and dissolved iron (1.0 and 0.35 mg/L respectively), as described in BC MOE 2008, rather than CCME WQG for total iron (0.3 mg/L). The reasoning is similar to that described for aluminum: elevated total levels are related to freshet, and it is the dissolved, rather than particulate, fraction that is most toxic.

Selenium

Selenium is predicted to be present in discharged effluent during all Project phases, at levels that will meet the proposed SSWQO of 0.002 mg/L in the receiving watercourses. The proposed selenium

SSWQO is the BC WQG of 0.002 mg/L, as proposed in the Project Proposal, which is higher than the CCME and Yukon WQG (0.001 mg/L). The CCME and Yukon WQG is designed to protect organisms in lentic (slow flowing) habitat, which is the most sensitive habitat. Technical guidance in the BC WQG (Nagpal and Howell 2001) indicates that alternative WQG is justified for lotic (faster flowing) habitat. In addition, the US EPA criterion concentration is higher, at 0.005 mg/L (US EPA 2004).

Unlike other metals, which can have more direct effects on individuals in a species, the main toxicological concern related to high selenium concentration in watercourses are for long term population effects (Chapman et al. 2010). Selenium is an essential element to living organisms; however, elevated levels can lead to bioaccumulation through dietary sources. This can result in high levels of selenium in the yolk of vertebrate eggs, which can then lead to deformities in larvae.

Haggart Creek is primarily used by arctic grayling and sculpin. Species known to inhabit areas in Haggart Creek downstream of the Project include burbot, chinook, round whitefish and arctic lamprey. The literature indicates that a water concentration of 0.010 mg/L or less is not expected to result in sublethal effects on individual fish. Direct acute or chronic toxicity of selenium to fish (chinook alevin and juveniles, northern pike, rainbow trout, white sucker, Arctic grayling) is typically noted in the tens to hundreds of mg/L (Klaverkamp et al. 1983; Hamilton and Buhl 1990; Buhl and Hamilton 1991). Therefore direct acute or chronic toxicity from selenium to fish is orders of magnitude higher than the population level effects.

Sulphate

Sulphate is a common constituent of mine effluent and is predicted to be present in treated effluent from the Project. While licences for existing mines in the Yukon do not contain a WQG or SSWQO for sulphate in receiving watercourses, the Project Proposal apply the BC WQG of 100 mg/L. Although the Project Proposal assumed sulphate treatment sufficient to meet the WQG, additional information on sulphate toxicity and treatment methods was reviewed and indicates that sulphate can be managed based on the solubility of gypsum (1620 mg/L in effluent) rather than more active treatment. As a result, during a short period of closure (four months at the peak of draindown of the heap leach facility), sulphate levels in Haggart Creek are predicted to be higher than 100 mg/L. The approach taken in development of a proposed SSWQO for sulphate was to model the levels in Haggart Creek without specific treatment, and to examine various WQG that have been published.

To assess the implications for sulphate levels Haggart Creek if there is no specific sulphate treatment, the mixing model was run for site W4 (downstream of the effluent discharge) using the same assumptions as in the Project Proposal, with the exception that the draindown curve for the heap leach facility is that described in R1 and R2 (i.e., minimum dilution of 10:1 during the high discharge period of draindown), rather than the 5:1 dilution used for the Project Proposal. Also, the flow regime is for an average year (results are not expected to vary much for wet or dry years), whereas the mixing model used for the Project Proposal predicts sulphate levels in average, wet, and dry years. Predicted sulphate levels in Haggart Creek are shown in Table R9-2 for the ice-free season of April through October, as only minor discharges (<0.001 m^3/s) are predicted for winter.

The modeling indicates:

- During operations, a small increase over baseline and over those presented in the Project Proposal is predicted (W4 values of 26 to 77 mg/L, which is from 2 to 30% higher than baseline), which meets the WQG of 100 mg/L.
- During closure, only at the peak period of draindown, a larger increase over baseline and over values presented in the Project Proposal is predicted (W4 values of 45 to 225 mg/L). The maximum of 214 and 225 mg/L (assuming a minimum dilution ratio of 10:1) would occur during July through October of Year 13.
- The change in mine water treatment plant process would have no effect on post-closure discharges described in the Project Proposal.

Table R9-2: Predicted Monthly Sulphate Levels in Haggart Creek (W4) without Sulphate Treatment in the Minewater Treatment Plant

Condition	Haggart Creek (mg/L)						
	April	May	June	July	Aug	Sept	Oct
Baseline	55	26	45	55	64	51	63
Operations Year 9	55.9	26.1	57.6	69.4	77.5	61.7	64.0
Operations dilution ratio	115	1067	39	27	31	33	233
Closure Year 13	94	45	95	217	225	214	225
Closure dilution ratio	26	25	12	10	10	10	10
Post-Closure	69	36	53	62	70	56	66
Post-Closure dilution ratio	16	24	29	32	38	47	78

NOTE:
Modeled based on:
Baseline chemistry for Haggart Creek W4 (Project Proposal Table 6.5-13)
Baseline flows for Haggart Creek W4 (average flows prepared for R3, Section 2.1)
Treatment plant influent concentrations and flow for operations (Project Proposal Table 6.5-13)
Treatment plant influent concentrations for closure capped at 1062 mg/L (Project Proposal Table 6.5-18
Treatment plant effluent flows for closure (modified draindown curve, R3, Section 2.1)
Post-closure prediction based on Project Proposal Table 6.5-20, short term post-closure, before passive treatment

The predicted sulphate levels in Haggart Creek under the current modeling assumptions (maximum of 225 mg/L for a one month period) are higher than the BC WQG of 100 mg/L, but well within safety margins established in the BC guideline. Further context is provided in toxicology work published by Elphick et al. (2011), and contained in Appendix R9. Scientific concerns about the relevance and applicability of the existing 100 mg/L WQG are well documented by Elphick et al. (2011) and include difficulty reproducing toxicity test results, lack of hardness considerations in assessing sulphate toxicity, and inappropriate use of test conditions for estuarine species. To address these concerns, Elphick and coworkers conducted extensive toxicity testing of relevant aquatic organisms at a range of hardness values and reviewed the literature used to derive hardness-adjusted WQG for sulphate.

The WQG were derived using the Species Sensitivity Distribution approach favoured by CCME and the safety factor approach favoured by the BC Ministry of Environment. For moderate hardness (80 to 100 mg/L), similar to Haggart Creek, a WQG based on species sensitivity is 644 mg/L and a WQG based on safety factors is 625 mg/L.

Setting a short-term sulphate SSWQO at 644 mg/L (using the Species Sensitivity Distribution method) during Year 13 in closure would provide a scientifically derived SSWQO that would protect aquatic organisms in Haggart Creek from chronic and acute toxicity. The predicted sulphate concentrations (up to 225 mg/L over a four month period) are substantially lower than this proposed SSWQO, and predicted levels at other times during operation, closure and post-closure are predicted to be less than 100 mg/L, the BC WQG.

4 PASSIVE WATER TREATMENT

4.1 Background

The proposal and VIT's response to YESAB's Adequacy Review Report of March 2011 provide information on the use of constructed/engineered wetlands as a passive water treatment option for effluent during closure and post-closure. Conceptual details have been provided regarding location, possible design and performance, including the potential capabilities of reducing the occurring metals in the effluent. The water quality and treatment information presented is based on similar northern mines that use cyanide heap leach technology. The proponent intends to do laboratory testing, bench scale testing and pilot scale testing before implementing the passive water treatment systems at full scale. NND (YOR 2010-0267-200-1) has noted that not enough detail on flow rates, influent concentration or effluent concentrations has been provided. The Executive Committee requires additional information in order to assess the suitability of wetlands as an effluent treatment option.

Therefore, please provide the following information:

R10. A discussion on the predicted performance of the passive water treatment system likely for this Project. Include considerations on influent water quality and the effect of using covers over Waste Rock Storage Areas, inflow rates, the volume of the treatment cells, storage time, effluent water quality and quantity and how they meet the Site Specific Water Quality Objectives for the receiving environment.

R10.1 Response

Introduction

The predicted performance of the passive water treatment facilities proposed for the Eagle Gold Project requires consideration of the following conditions:

- Influent water chemistry

- The effect of using covers over the heap leach facility and waste rock storage areas
- The effectiveness of specific cover designs
- Inflow rates
- The volume capacity of the treatment cells
- Anticipated storage times
- Effluent water quality criteria
- Effluent discharge rates.

The following supplementary information provides a summary of these conditions as they relate to the predicted performance of closure methods proposed for the Project. Also included is a brief summary of the methods to achieve Site Specific Water Quality Objectives (SSWQOs) for the receiving environment post closure. Technical details regarding the above conditions necessary for the passive treatment system and proposed methods for meeting SSWQO's are provided in Appendix R10: Post-Closure Passive Treatment Systems (Knight Piésold 2011).

Influent Water Quality

Hydrogeochemical characterization completed for the Project Proposal indicates that low pH seepage and acid rock drainage are not expected to occur during any phase of the Project. However, conservative source term predictions indicate that neutral pH metal leaching may occur resulting in the exceedance of water quality guidelines in receiving watercourses for a limited number of metals without treatment once the mine water treatment plan is decommissioned post closure (Stantec 2011). Predicted effluent quality for parameters that may exceed water quality objectives is discussed in Section 6.5 of the Project Proposal and supplementary information provided in R9. Detailed leachate influent water quality per parameter is provided in Tables 2, 3 and 4 in Appendix R10.

Effect of Using Cover Systems on the Heap Leach Facility and Waste Rock Storage Areas

Cover systems, if properly engineered and constructed, can perform the following functions:

- Isolation of spent ore or waste rock
- Limit air entry into the spent ore or waste rock to limit in situ oxidation
- Limit surface water entry (infiltration) into spent ore or waste rock
- Resist erosion by wind and water
- Stabilize spent ore or waste rock
- Support vegetation (reclamation).

There is a variety of basic cover systems that may be used alone or in combination with one another. Cover systems are generally classified as either "wet" or "dry" covers—wet covers refer to systems where waste rock is stored subaqueously. Wet cover systems are not applicable to the Eagle Gold Project due to the steep terrain (lack of suitable impoundment locations) and the expectation that acid-generating material is not present in the waste rock and spent leach ore piles. Dry cover systems can be subdivided into a number of generic functional cover types including:

- Isolation covers
- Store and release covers
- Capillary break covers.

A dry cover system may be comprised of one or a combination of these generic cover types. The recommended cover systems for the WRSAs and HLF are proposed to consist of store and release layers overlying low permeability (likely capillary break) layers. The proposed cover designs are described in detail in Appendix 36 of the Project Proposal (Stantec 2011).

The primary objective of these cover systems is to reduce infiltration into the WRSAs and HLF. The post-closure waste characterizations suggest that both WRSAs and the HLF will leach metals under neutral pH conditions for a finite period of time, but likely over decades (Stantec 2011). By limiting precipitation infiltration through the WRSAs the quantity of metal-bearing leachate will be reduced. In addition to reducing leachate quantities, cover systems also reduce the peakedness of flow through these facilities. Peakedness refers to the rate of the rise and fall of a hydrograph. By reducing peakedness the leachate discharge from the facilities will be reduced. This will result in greater residence time of influent within constructed wetland cells and overall treatment efficacy of the passive treatment systems.

Cover systems will have the following effects on the passive treatment systems:

- Reduced infiltration → reduced leachate
- Reduced infiltration → moderated influent/effluent flow rates (by reducing the peakedness of flow).

In addition to cover systems over waste rock storage areas, covers may also be utilized to insulate and protect components of the passive treatment systems. Insulation will help maintain the optimal temperature range within closed passive treatment cells. The prevention of freezing during winter months and conservation of heat during warm months will result in increased efficacy and efficiency of the passive treatment system.

Inflow Rates

Influent rates to the passive treatment system have been assumed to be 1.3 times the median annual seepage rate from each facility. A 30% safety factor provides a conservative contingency for quantitative uncertainties associated with input parameters and anticipated conditions. Further, seepage rates exhibit intrinsically low variability due to the attenuating capacity of subsurface flow systems. Therefore a 1.3 safety factor is reasonable for design criteria of passive treatment systems.

Three passive treatment systems have been proposed for the Eagle Gold Project. Influent flow rates of 85 L/s, 36 L/s, and 120 L/s have been calculated for the HLF and the Eagle Pup and Platinum Gulch WRSAs respectfully. Influent flow rates were calculated with data from the baseline hydrologic studies – Appendix 14a and 14b of the Project Proposal (Stantec 2011)—and water balance modeling—Appendix 21 of the Project Proposal (Stantec 2011) – after application of the 1.3 safety factor. These influent flow rates are summarized in Table 1 of Appendix R10 (Knight Piésold 2011).

Volume of Treatment Cells and Storage Time

The volume of the treatment cells is dependent on the leachate characteristics and the applied treatment process. The key consideration for passive treatment system design is to provide enough residence time to allow for the complete sequence of chemical reactions or biological processes to convert mobilized metals and complexes contained in the leachate into immobile or inert compounds. Storage times required to meet water quality objectives within the treatment cells are generally short (<1 day for permeable reactive barriers, four days for biochemical reactors, and 24 hours for aerobic treatment wetlands). The reactions that result in the removal of metals are generally fast-acting first-order chemical reactions.

Further detail of treatment cell size requirements are discussed in Appendix R10-A (Knight Piésold 2011).

Effluent Water Quality and Meeting Site-Specific Water Quality Criteria

As described above, it is possible that a combination of source control measures (engineered cover systems, in situ passive treatment, groundwater controls) and mine water management techniques will be required to achieve Site Specific Water Quality Objectives.

The predicted performance of the proposed passive treatment systems is dependent on a number of factors including influent water (facility seepage) chemistry, cover effectiveness, inflow (facility seepage) rates, and treatment cell size and residence times. In the first stage, source control (e.g., covers) will effectively reduce leachate volume from the various facilities (HLF and WRSAs). Next, untreated effluent from these facilities will be routed through sequences of passive treatment modules where metals will be removed, neutral pH will be controlled, and general water quality will be made fit to discharge to the environment to achieve water quality objectives. Passive treatment systems apply aerobic and anaerobic processes to sequentially remove metals and nutrients from mine-influenced water. The systems operate using natural ecological and geochemical processes requiring no input of energy or chemical addition once constructed. Physio-chemical processes involved in passive treatment systems include:

- Oxidation
- Precipitation as hydroxides and carbonates under aerobic conditions
- Precipitation as sulphides and hydroxyl-sulphate under anaerobic conditions
- Complexation and adsorption onto organic matter
- Ion-exchange with organic matter
- Update by plants (phyto-remediation).

These processes have been shown to successfully remove most metals, metalloids and nutrients from mine water systems. In the case of Eagle Gold, the relatively low metal concentrations (in comparison to other hard rock metal mines) and anticipation of neutral drainage in the post-closure mine environment suggests that passive treatment systems will be an ideal fit to achieve the post-closure water quality objectives.

The actual treatment circuit may consist of in situ treatment such as a permeable reactive barrier or biochemical reactors in combination with aerobic wetland complexes. The ultimate configuration will depend upon the results of pilot testing through the life of mine.

It is anticipated that passive treatment systems will operate for a period of 20 – 40 years following the detoxification of the heap and subsequent cover construction, allowing for geochemical processes to equilibrate. This is considered a conservative estimate as a combination of source controls (covers, natural attenuation and possibly *in-situ* passive treatment) and downstream dilution will be utilized prior to discharge into the environment.

R11. Please indicate if alternate long-term closure measures have been identified and provide a rationale for selecting the proposed system.

R11.1 Response

Introduction

The multiple long-term closure measures considered for the Project are described below. For the purposes of post-closure at Eagle Gold, short-term refers to a period of time up to 5 to 20 years following closure and the cessation of operations; whereas, long-term refers to a 20 to 40 year period. The critical threshold for transitioning between short- and long-term is a confirmed state of stable equilibrium identified through periodic site monitoring during short-term closure.

The preferred long-term closure measures include a combination of source controls including engineered cover systems for the HLF and WRSAs and surface and groundwater controls in combination with passive treatment systems. The selection of these approaches was based upon a number of considerations including constructability, confidence in long-term performance (metal removal, effluent quality, cold regions performance) and ability to operate passively without the need for ongoing input of energy and frequent maintenance (frequent monitoring and maintenance will be required initially, but it is anticipated that the frequency can be reduced once successful operation has been observed and confirmed over an extended period of time).

This response focuses on the passive treatment aspect of the post-closure measures proposed for the Eagle Gold Project.

Table R11-1 provides the type, means of treatment, area of application (*ex-situ*, *in-situ* and per facility), cold regions applicability, the level of effort (active, semi-passive, passive), and the feasible duration for each measure.

The general definitions used for the various levels of effort include the following:

- Active measure: a measure or process that requires constant supervision, operation and maintenance to sustain operations; active measures typically also require the provision of external power supplies to operate mechanical equipment.
- Semi-passive measure: a measure or process that can operate for long periods of time (many months to years) without the need for human intervention (maintenance) or external power supply. Semi-passive measures may require periodic maintenance to ensure optimal operations. Most passive treatment techniques operate semi-passively for a certain period of time while early post-implementation monitoring provides guidance on the long term operating requirements (i.e. transition to fully passive operation).
- Passive measure: a measure or process that operates for an indefinite length of time without human intervention or power input.

These closure measures were identified to assess the most applicable method to meet closure and reclamation objectives for the Project using predicted long-term quality of effluent. Although covers and passive treatment systems have been selected to effectively treat mine effluent post closure based on predictions, additional closure measures may be implemented depending on the results of post closure monitoring. The closure measures listed below include mine-water control techniques that are proven in northern climates; however it does not include new technologies that are currently under development as their performance is unproven.

Table R11-1: Long-term Closure Measures

Type	Closure Measure	Area of Application	Proven in Cold Regions (Yes/No)	Active/ Passive/ Other	Feasible Duration
Source Control	Removal and disposal	HLF and WRSAs	Yes	Other[1]	Permanent
	Containment		Yes	Passive	Permanent
	Hydrodynamic isolation		Yes	Active	Limited to active control
	In-situ treatment		Yes	Semi-passive	10 – 25 years
Attenuation	Natural processes such as infiltration etc.	Entire mine site	Yes	Passive[2]	Permanent
Passive Treatment	Biochemical reactors	Downstream of MIW sources – surface water	Yes	Passive[3]	10 – 15 years, permanent
	Microbial mats		Yes	Passive[3]	10 – 15 years, permanent
	Constructed treatment wetlands		Yes	Semi-passive	15 – 20 years
	Anoxic limestone drains		Yes	Semi-passive	10 – 30 years
	Aeration		Yes	Passive	Permanent
	In-site treatment (physical/chemical)	Downstream of MIW sources – groundwater	Yes	Semi-passive	15 – 30 years
	In-site treatment (biological)		Yes	Passive[3]	10 – 25 years, permanent

NOTES:
[1] Removal and disposal is not considered feasible for this project.
[2] Natural attenuation is a fully-passive technique; however, active monitoring is required to confirm effectiveness.
[3] Microbiological processes can operate as fully-passive systems; however, this requires that self-sustaining, self-contained ecologies are established.

Source Control Measures

The source control measures identified above include the following (with brief definitions):

1. **Removal and disposal:** mine waste rock and spent ore is removed from the site and transported to an off-site location where it may be disposed of or re-used in a safe, contained environment.
2. **Containment:** mine waste rock and spent ore is stored in specific areas (such as topographic depressions or open areas) where the material can be isolated and contained. Isolation and containment can come in the form of surface controls such as engineered cover systems or sub-surface controls such as seepage cut-off walls.
3. **Hydrodynamic isolation:** hydrodynamic isolation is a groundwater control technique that utilizes active pumping wells to create isolated zones within a groundwater aquifer. The isolation is created by siting extraction wells downstream from the source material and injection recharge wells upstream of the source. This is not considered a viable long-term solution for the Eagle Gold Project; however, it is presented for completeness.
4. ***In-situ* treatment:** *in-situ* treatment represents a number of possible processes and techniques to sequester, immobilize, or transform metals, nutrients or other contaminants within the source mass. Techniques range from flow-through permeable reactive barriers to the injection of biological media and bacteria to facilitate anaerobic digestion.

Source control measures are proposed for the Project to provide physical and/or chemical separation between waste rock storage areas or the heap leach facility and the receiving environment. This can be achieved by reducing infiltration from the surface or preventing groundwater from flowing through the waste rock. Alternatively, the source control measure could provide a chemical or biological means of retaining metals and nutrients within source material prior to entering the receiving environment. The proposed source control measure for Project facilities is a semi-permeable cover system that limits the infiltration of precipitation and ultimately reduces the amount of leachate generated.

Four source control measures were considered for the Project—removal and disposal, containment, hydrodynamic isolation, and in-situ treatment. Containment is the preferred option given that the large volume of mine waste would be impractical to transport and dispose off-site, and hydrodynamic isolation would require the installation and operation of active pumping systems that would need to operate until water quality objectives are met. *In-situ* treatment is an option for an additional closure measure, particularly in the form of permeable reactive barriers (additional discussion is provided in response R10).

When considering containment as a source control measure, two interfaces must be considered:

- Waste rock surface and atmosphere interface (potential flux of surface water and oxygen into the system as well as potential for direct effluent discharge to the receiving environment prior to treatment)
- Waste rock to “native” ground interface (groundwater flow through the system, promoting the migration of effluent to groundwater aquifers).

Physical barriers may be constructed at these interfaces to eliminate or reduce the migration of water to and from the facilities (waste rock or spent ore). Low-permeability covers are often used to limit precipitation infiltration at the surface interface while cut-off walls can isolate the sources of mining influenced water from groundwater.

For the purposes of this Project, leachate is defined as solution formed as unaffected surface water/groundwater flows over or through waste rock or spent ore resulting in increased concentrations of metals. Well-designed and constructed cover system can significantly reduce infiltration and minimize leachate production. Despite source control, it is anticipated that leachate will be produced in the WRSAs and HLF until metal sources have been depleted below a critical threshold when chemical equilibrium is achieved. Chemical equilibrium depends on a number of factors including precipitation contact time within the stored material, pH, temperature, and the geochemical character of the waste rock and spent ore. Concentrations of metals and complexes as well as the quantity of leachate will dictate the need, degree and type of treatment required to achieve water quality objectives.

Engineered cover systems will provide separation between the surface and the waste rock/spent ore while allowing for the establishment of a surface suitable for reclamation. By limiting infiltration from entering the waste rock and spent ore will reduce the quantity of leachate that will require treatment to achieve water quality objectives.

As the project advances through engineering design and the regulatory review process, it is reasonable to assume that characterization of waste rock and spent ore (source terms) that have been developed to date may differ from the actual make-up of the three primary effluent streams at closure. Although the level of geochemical test work that has been completed to date is sufficient to assess potential effects to water quality, additional test work (e.g., column testing, field barrel testing, environmental monitoring of seepage from site facilities) will continue throughout the life of the Project to ensure that predictions are accurate and closure methods are sufficient.

Natural Attenuation

Baseline hydrogeochemical studies of the site suggest that existing groundwater conditions have the capability to naturally attenuate high ambient concentrations of arsenic and other metals. For example, arsenic concentrations have been observed to naturally attenuate in the Lower Dublin Gulch Valley aquifer. The tributary groundwater sub-basins of Ann Gulch, Eagle Pup and Suttle Gulch drain from primarily fractured and weathered meta-sediments into the Lower Dublin Gulch valley. Each of the tributary groundwater sub-basins contain relatively high naturally occurring arsenic concentrations that range from 0.02 to 3.9 mg/L, 0.012 to 0.24 mg/L, and 0.02 to 1.8 mg/L, respectively, depending on season. Arsenic concentrations in the Lower Dublin Gulch Valley aquifer (comprised primarily of re-worked gravels, sands and silts) have been observed to decrease in a down-gradient (westward) direction, from 0.07 to 0.46 mg/L at the junction of Ann Gulch to 0.0014 to 0.0050 mg/L at the mouth of the valley. Thus, the relatively high values contributed by the sub-basins are attenuated by natural groundwater processes by over two-orders of magnitude in the 1.4 km reach between Eagle Pup and Haggart Creek – Appendix 15 of the Project Proposal (Stantec 2011).

In terms of arsenic attenuation, possible reactions that may be occurring in the aquifer include sorption in aerobic environments, sorption/precipitation in anaerobic environments, and dilution from meteoric recharge. These processes depend on the abundance and stability of host elements such as iron and aluminum oxides. For anaerobic processes solid-phase sulfide accumulation, oxidation-reduction buffer capacity and sulfate-reducing activity dictate the groundwater system's ability to attenuate arsenic. Similar processes apply to other metals and metalloids.

It is suggested that a tiered decision-making approach be implemented for the Eagle Gold Project. A similar strategy has been implemented by the US EPA (Ford et al. 2006) as an effective means to screen sites that may be suitable for monitored natural attenuation (MNA). This procedure is considered feasible if it can be demonstrated that the predicted leachate concentrations are comparable to (or "better" than) existing concentrations of specific metals in groundwater from the sub-basins of interest. The strategy uses a succession of four tiers (or stages)—with each level reducing site uncertainty as MNA-specific data are collected.

These tiers are as follows:

- **Tier I:** where the leachate discharge does not threaten public health, terrestrial and aquatic life is stable, and some direct evidence of natural attenuation exists.
- **Tier II:** where the attenuation capacity of the site exceeds the estimated mass of containment at the site.
- **Tier III:** where there is strong evidence that attenuation mechanisms will prevail over long periods of time.
- **Tier IV:** where a record of decision (including long-term monitoring and site closure considerations) is developed.

At current time, the Eagle Gold Project would satisfy a Tier I designation as it meets the listed criteria; that is, there is no perceived risk to public health, fish and wildlife; and there is evidence to support the conclusion that natural attenuation processes are currently occurring at the site. As the Project progresses through construction and operations, further studies will confirm or reject the possibility of natural attenuation as an effective closure method.

Additional test work will be conducted to determine whether MNA is an appropriate closure method by using the tiered decision-making approach described above. Further test work will also determine if MNA may be used independently of other closure methods or in combination with methods currently proposed.

Passive Treatment Measures

Passive treatment systems are proven and effective measures for long-term treatment of mine effluent that contains elevated metal concentrations. Passive treatment system success requires three fundamental criteria:

1. Availability of proven and demonstrable techniques for effluent treatment
2. Robustness and longevity in cold region climates
3. Ability to operate with little to no human intervention long-term.

Passive treatment systems include a sequence of discrete modules that function together to treat effluent to achieve receiving environment water quality objectives. The selection and sequencing of these modules are summarized in Appendix 28 of the Project Proposal (Passive Techniques for the Treatment of Mine Effluent) (Stantec 2011). The options are subdivided into surface water or groundwater treatment modes with specific techniques listed below:

Surface Water Passive Treatment:

1. Biochemical reactors (BCRs)—treat mining-influenced water by using microorganisms to transform contaminants into immobile compounds through precipitation, sorption onto immobile surfaces- and to increase pH in the treated water. Passive BCRs incorporate bioprocesses, chemical reactions and the bulk of solids separation within an organic substrate (Gusek 2009).
2. Microbial mat aquatic bioremediation systems—use a naturally occurring, living organism to rapidly remove metals from mining-influenced water. Two very important aspects of microbial mats are their rapid growth rate and ability to survive harsh environmental conditions such as high salinity and low pH. Microbial mats also tolerate high concentrations of toxic compounds that often kill plants or algae (IRTC 2011b).
3. Constructed treatment wetlands—various designs include aerobic wetlands, anaerobic horizontal-flow wetlands, and vertical-flow ponds (vertical-flow wetlands). The main difference in these systems is the degree of biological and/or chemical reaction rates promoted and the rate and direction of water flow. Aerobic wetlands are typically designed to precipitate metals in water under aerobic conditions, usually in a horizontal-flow system. Anaerobic horizontal-flow wetlands treat water under anaerobic conditions through the use of a carbon substrate and typically move water horizontally. Vertical-flow wetlands move the affected water vertically through carbon substrate over a limestone bed (Demchak et al. 2001). Constructed treatment wetlands can be used in conjunction with other technologies to extend the operational lifespan of the systems or enhance the removal performance of specific constituents of concern. This flexibility makes the technology applicable to many types of water chemistries in many types of environments. (IRTC 2003)
4. Anoxic limestone drains (ALDs)—consist of buried beds of limestone engineered to intercept anoxic, acidic MIW and add alkalinity through the dissolution of the limestone (Watzlaf et al. 2000). ALDs are typically utilized where mining-influenced water is acidic.
5. Aeration—passive aeration utilizes simple gravity-driven cascades to introduce dissolved oxygen into mining-influenced water. This promotes the oxidation of iron, manganese, arsenic, and other problematic metal species thus increasing treatment effectiveness and efficiency, while reducing remediation costs (IRTC 2011a).

Groundwater Passive Treatment:

1. *In-situ* treatment (physical/chemical)—is often facilitated by the use of permeable reactive barriers (PRBs). These systems are continuous, in situ permeable treatment zones designed to intercept and remove metals from the affected waste stream. Treatment zones may be

created directly using reactive materials such as iron or indirectly using materials designed to stimulate secondary processes, such as adding carbon substrate and nutrients to enhance microbial activity. In this way, contaminant treatment may occur through physical, chemical, or biological processes (IRTC 2005).

2. *In-situ* biological treatment—consisting of the isolation of the source of mine-influenced water through the establishment of an in situ biological layer on exposed metal sulfides (Jin et al. 2008). This biological layer or "bio-film" is dependent on the introduction and distribution of inoculum and biological substrates into the MIW source material. PRB's can also be constructed with a biologically-reactive media layer that can provide improve and/or targeted contaminant removal.

The proposed passive treatment system and process sequences include biochemical reactors or permeable reactive barriers to remove heavy metals. In the case of biochemical reactors, they may be followed by aerobic wetlands to stabilize pH, biochemical oxygen demand (BOD) and to provide additional detention time to allow further precipitation of metals, sediment, and other potentially deleterious suspended solids.

The selection of individual and sequential passive treatment technologies depend on the considerations listed in Table R11-2 below.

Table R11-2: Passive Treatment Selection Considerations

General Characteristic	Parameter
Contaminant Properties	Biotic/abiotic decay potential
	Volatility
	Contaminant sorption potential
Contaminant Distribution	Volume of contaminated media
	Contaminant depth
Geologic Conditions	Stratigraphy
	Unconsolidated media texture
	Degree of heterogeneity
Groundwater Flow Parameters	Hydraulic conductivity
	Temporal variation
	Vertical flow
Effluent Characteristic	Chemical constituents and concentrations
	pH range
	Temperature range
	Hardness range
	Conductivity range

General Characteristic	Parameter
Environmental Conditions	Ambient temperatures
	Receiving water quality and quantity
	Turbulence of flow (i.e. mixing)
	Cold-regions processes
	Watershed processes (hydrologic and hydrogeologic)
	Geochemical processes (including available natural attenuation potential)
Physical Characteristics	Topography (available gradient)
	Available land
Material availability	General construction material
	Reagents
	Drainage media
	Donor substrate (biological systems)
	Inoculants (biological systems)
Technological Parameters	Scalability
	Treatment capacity
	Lifespan
	Maintenance requirements
	Technological status (established/emerging/infant)
	System limitations
Cost	Initial costs
	Operations and maintenance costs

Passive treatment systems have been used to treat varied effluent streams ranging from small-scale domestic waste water to large-scale industrial streams and mine-influenced water. Systems have been successfully designed, constructed, and operated in both variable and extreme climates (i.e. arctic). Key factors contributing to the success of passive treatment systems are the level of understanding of each parameter, including interaction among site specific parameters listed above.

Passive treatment systems, combined with appropriately designed and well-built source control measures provide a robust solution to achieve water quality objectives over the long-term. The proposed cover systems will reduce the quantity of effluent (loading rate) that reports to the passive treatment systems (either in situ permeable reactive barriers or external biochemical reactors with aerobic wetlands). The reduced loading rates will increase the longevity of the passive treatment systems and decrease the required size of treatment cells which improves economic feasibility and required financial security.

The robust functionality of passive treatment systems and their ability to operate remotely with little to no human intervention over the long-term make them viable for post-closure operation in the climatic conditions observed at the Eagle Gold Project.

Further test work in the form of bench and pilot-scale test facilities will be undertaken to provide proof of concept and design refinement. This work is seen as an integral and required component to justify the proposed design.

5 HEAP LEACH FACILITY: ORE PROPERTIES AND ORE BEHAVIOUR

5.1 Background

Understanding the physical properties (e.g., grain sizes, density, porosity, permeability) and the initial and long term behaviour (e.g., absorption, compaction, reaction to applied stress and strain, chemical reactions) of the ore placed on the heap is critical for estimating the in-heap pond storage capacity as well as the time and water needed for detoxification/rinsing the heap.

The in-heap pond is the primary water storage facility on the Project site. The volume of the in-heap pond is determined by predicting and calculating all the spaces between the grains of ore (i.e., pore volume) in that part of the heap behind and below the embankment. The proposal indicates that the in-heap pond will be operated with approximately 60,000 m^3 of solution and have a maximum storage capacity of 435,000 m^3.

Effective detoxification/rinsing of the heap requires the rinse water to percolate through the entire heap. Examples from other mine sites and field scale tests have shown that if the rinse water follows channels down through the heap or if impermeable lenses/pockets are created in the ore, then rinsing processes are less effective. As a result, heap detoxification may take longer or be difficult to achieve. Both channeling and lense formation are related to ore properties, ore behaviour over time and the movement of fines through the heap. The proponent has suggested that the agglomeration of fines could decrease the likelihood of these problems. NND has identified that Appendix 26-27 of the proposal recommends additional agglomeration testing (YOR 2010-0267-200-1), but no such information has been provided.

The Executive Committee requires additional information regarding ore properties and behaviour as it relates to in-heap pond storage capacity and detoxification/rinsing in order to have confidence that the heap can be operated and effectively detoxified as proposed.

Therefore, please provide the following information:

R12. Outline the physical properties and predicted behaviour of the ore placed on the heap. Indicate if any agglomeration testing or similar testing has been undertaken or is planned. If completed, please provide the results.

R12.1 Response

Background and Ore Physical Properties

The Project Proposal (Stantec 2011) built upon earlier assessments and project design conducted in the mid- to late-1990s for the Dublin Gulch Project advanced by New Millennium Mining Ltd. The mid- to late-1990s planning included pre-feasibility studies and a suite of engineering test work, as well as initial assessment and regulatory review under the *Canadian Environmental Assessment Act* (CEAA) as required at the time in 1995. In the mid-1990s and again in 2009, agglomeration testing was conducted on the various ores that comprise the Eagle Gold deposit to assess the ores' behaviour in a heap setting. The physical properties of the ore and the results of the tests are summarized below.

The tests were performed by Kappes, Cassiday & Associates (KCA 1996; 1997); on samples either composed of individual ore types or sample composites of two or more ore types. The samples tested were developed from both surficial and core material from the project site. VIT evaluated these historical testing results and directed KCA to perform additional testing on new samples in 2009 to model the ore's behaviour to support the Project Proposal and advance Project engineering design (KCA 2010).

The Eagle Gold deposit ore types upon which tests were performed are identified in Table R12-1.

Table R12-1: Eagle Gold Project—Ore Type Description

Ore Type Designation	Rock Type Description
A	Weathered granodiorite
B	Fresh to weakly altered granodiorite (<20% moderately or strongly altered)
C	Sericite, chlorite, carbonate altered granodiorite
D	Fine grained granodiorite
E	Weathered and fresh metasediments

SOURCE: Modified from KCA (2010)

As the heap is constructed over time, it will be comprised of various proportions of the five ore types. Although final ore type proportions are more of a function of optimizing the operation during mining, in general, based on likely pit shells, pit geology and other factors, the heap will be comprised of primarily (~80%) Types A and B, with minor amounts of Type C and E. Thus the heap properties and its response to various stresses will be reflected primarily by the agglomeration testing results of Types A and B.

Agglomeration Tests and Results

The agglomeration test work examined the permeability of various ore composites under varying conditions. Test variables included crush type, crush size, cement levels, and percolation rates at different simulated heap heights to simulate percolation under load. The agglomeration cement levels utilized for the series of tests were 0 (no cement addition) to 12 kg of cement per metric tonne of material. Tests were conducted on composites crushed to sizes ranging from 2 to 12.5 mm by High Pressure Grinding Rolls (HPGR) and by conventional cone crushing methods. The tests were intended to simulate the heap percolation rate at the bottom of a heap under the compressive load at the respective total heap height. Tests were conducted at simulated heap heights varying from 30 to 100 m, which are representative of the range of proposed heap levels. The overall results of the tests were then examined to determine Pass or Failure. The flow rate and % slump were monitored to provide meaningful indications and to help judge what represents a “Pass,” “Marginal,” or “Fail” result. The criteria for evaluating the tests are described below. The agglomeration test results are summarized in Table R12-2.

The agglomeration tests were conducted on surface and core samples taken in 1996, 1997 and 2009. Appendix R12 contains information on the test procedures used.

Most of the testing was conducted on samples crushed by HPGR’s as this was the crushing method selected in a pre-feasibility study completed in 2009 and in a feasibility study completed in 1997. Crushing material with an HPGR crusher tends to create more fines than conventionally crushing of the same material to the same 80% passing (P80) size. Therefore, test results under similar conditions on the samples of the same ore composites that were conventionally crushed would show higher percolation rates.

Maintaining consistent flow through the heap is key to the success of both the leaching and rinsing processes. Therefore, laboratory testing is performed to demonstrate that the ore is capable of transmitting adequate flows in a heap environment, including under loading anticipated under full heap buildout. The test results on most of the HPGR crushed composites and on all of the conventionally crushed composites show excellent percolation rates (>100 L/hr/m^2) and minimal settling (% slump) at low or no cement addition levels and at simulated heap heights up 100 m (Table R12-2). A heap design solution application rate of 10 to 12 L/hr/m^2 of column surface was utilized to examine compaction data. As stated above, when examining results from compacted permeability tests, KCA considered two parameters: flow (the most important factor) and percent slump. A measured flow of ten times the heap design rate (or >100 L/hr/m^2) was scored a “Pass”. The percent slump examined was the Wet-Dry Slump. This represents the slump from the dry compacted ore height to that in the wet compacted ore height. KCA generally considered a slump of over 10% as high and an indication of a potential “Fail”. In cases where percent slump was greater than 10% but with a high flow rate (>100 L/hr/m^2), this was considered “Marginal”.

In cases where measured flow of less than ten times the heap design flow was modeled, then the number of tests, the consistency among the tests, and the percent slump were considered in determining a score of Pass, Marginal, or Fail. If there were a sufficient number of tests with enough consistency among tests and all percent slumps indicated a “Pass,” then a test would “Pass” with less than ten times the flow.

Of the 35 tests, four of the tests were graded marginal. These were on HPGR crushed composites that showed relatively high settling (% slump), but with high (acceptable) flow rates. Two of 35 tests failed due to low percolation rates (89 L/hr/m^2). None of the tests failed or were marginal due to both flow and slump. The two failures (on HPGR crushed composite samples) are the only tests that showed less than 100 L/hr/m^2, while four of the 13 Type A core composites (HPGR crushed) showed higher than 10% slump.

The two 2009 HPGR crushed composites without agglomeration did not pass the tests at simulated heap heights of 60 and 90 m. Individual samples that made up the composite were then conventionally crushed to approximately 7 mm and tested at a 70-meter simulated heap height. All of these samples passed the tests without any cement addition. Flow rates through the core samples were generally significantly higher than the flows through the surface samples. This indicates that the surface material may require a minor amount of agglomeration with cement.

The tests on the samples conventionally crushed all indicate passing results. However, to be conservative, cement at an addition rate of 2.5 to 3 kg/t was selected to minimize any potential percolation issues. This cement addition rate also gives the required alkalinity, without any excess, to maintain pH during leaching. Nevertheless, based on current optimized engineering and designs, HPGR crushing is no longer being considered for the project, so no further testing on HPGR is being conducted.

Table R12-2: Eagle Gold Heap Leach Project Summary of Agglomeration Tests

Sample Description	Crush Type	Estimated P80 Crush Size, mm	Cement, kg/t	Simulated Heap Height, m	Flow at the Simulated Height, L/h/m^2	Initial Bulk Density, t/m^3	Final Compacted Bulk Density, t/m^3	% Slump	Pass/Fail
Type A Pit 1, Surface, 2009	Conv.	7	0	70	355	1.84	1.88	2%	Pass
Type A Pit 2, Surface, 2009	Conv.	7	0	70	5153	1.74	1.78	2%	Pass
Type A Pit 3, Surface, 2009	Conv.	7	0	70	998	1.76	1.82	3%	Pass
Type A Core Comp, 2009	Conv.	7	0	70	9385	1.69	1.74	3%	Pass
Type C1 Core, 2009	Conv.	7	0	70	4144	1.78	1.86	4%	Pass
Type C2 Core, 2009	Conv.	7	0	70	2335	1.82	1.84	1%	Pass
Type A, Core Comp, 1996	Conv.	12.5	0	30	15400	1.56	1.59	2%	Pass
Type A, Core Comp, 1996	Conv.	12.5	0	50	16300	1.56	1.57	1%	Pass
Type A, Core Comp, 1996	Conv.	12.5	0	100	10700	1.65	1.68	2%	Pass
2009 Comp, A, B, C	HPGR	7	0	60	89	1.94	1.96	1%	Fail
2009 Comp, A, B, C	HPGR	7	0	90	89	2.19	2.21	1%	Fail
2009 Comp, A, B, C	HPGR	7	12	60	3004	1.86	1.86	0%	Pass
2009 Comp, A, B, C	HPGR	7	2.5	60	597	2.06	2.08	1%	Pass
2009 Comp, A, B, C	HPGR	7	2.5	90	231	2.14	2.16	1%	Pass
Type A, Core Comp, 1997	HPGR	2	0	60	1645	1.50	1.57	4%	Pass
Type A, Core Comp, 1997	HPGR	2	0	100	987	1.57	1.64	4%	Pass
Type A, Core Comp, 1997	HPGR	2	3.75	60	2632	1.38	1.44	4%	Pass
Type A, Core Comp, 1997	HPGR	2	3.75	100	1645	1.38	1.57	12%	Marginal
Type A, Core Comp, 1997	HPGR	12.5	0	60	263	1.85	2.07	11%	Marginal
Type A, Core Comp, 1997	HPGR	12.5	0	100	263	1.85	2.07	11%	Marginal
Type A, Core Comp, 1997	HPGR	12.5	3.75	0	3355	1.85	1.99	7%	Pass
Type A, Core Comp, 1997	HPGR	12.5	3.75	60	1875	1.85	2.03	9%	Pass
Type A, Core Comp, 1997	HPGR	12.5	3.75	100	987	1.85	2.07	11%	Marginal
Type A, B, C Core, 1997	HPGR	12.5	0	60	165	1.92	1.92	0%	Pass
Type A, B, C Core, 1997	HPGR	12.5	0	60	1050	1.80	1.80	0%	Pass
Type A, B, C Core, 1997	HPGR	12.5	0*	60	1710	1.73	1.73	0%	Pass
Type A, B, C Core, 1997	HPGR	12.5	2*	60	2895	1.66	1.69	2%	Pass
Type A, B, C Core, 1997	HPGR	12.5	3*	60	2500	1.66	1.66	0%	Pass
Type A, Core Comp, 1997	HPGR	12.5	0	80	658	1.92	1.92	0%	Pass
Type A, Core Comp, 1997	HPGR	12.5	0*	80	1150	1.80	1.80	0%	Pass
Type A, Core Comp, 1997	HPGR	12.5	2*	80	1315	1.73	1.73	0%	Pass
Type A, Core Comp, 1997	HPGR	12.5	3*	80	1120	1.76	1.76	0%	Pass
Type A, Core Comp, 1997	HPGR	12.5	3.75	80	2430	1.66	1.66	0%	Pass
Type A High Grade, 1997	HPGR	12.5	1**	80	1700	1.66	1.80	8%	Pass
Type A, B, C Core, 1997	HPGR	12.5	1**	80	2800	1.63	1.73	6%	Pass

*Includes 2 kg/t hydrated lime in agglomeration step

**Includes 1 kg/t hydrated lime in agglomeration step

Considering the results from the agglomeration testing, although there is not a stability concern, it is recommended that heap design and development allow for adding 2.5 to 3 kg/t of Portland Type II or equivalent cement in the first few lifts to insure that there will not be any permeability issues at the base of the heap, especially when leaching upper lifts. The exact number of lifts requiring cement will depend up the total heap height. Lime at approximately 1.05 kg/t will be required for alkalinity purposes in material not agglomerated with cement. The recommended cement addition rate will add sufficient, but not an excessive amount of alkalinity to the system. Alkalinity is required to prevent volatilization of HCN gas from NaCN. Although not the case for this project, cement addition in some heaps is high enough that pregnant solution pH is high (>11.5), which can cause scaling issues and hinder heap neutralization.

Future Agglomeration Testing and Conclusions

Based on available data, Eagle Gold ore crushed to 5 mm or larger has no permeability issues at heap heights up to 90 m, if irrigated at a 10 L/hr/m^2 rate and properly agglomerated with 2.5 to 3 kg/t cement. Cement addition will also add to heap stability. Additional agglomeration testing is planned for surface and core composites to confirm past test results and to simulate optimized heap design parameters, such as final crush size and composite type, cement addition rate, and ultimate heap height. The cumulative ore testing results will provide information to optimize the flow of fluids through the heap, which will both enhance the recovery of gold and increase the efficiency of the detoxification and rinsing phases of the heap life cycle. In addition, ore will not be placed on the heap during the winter months as cold temperatures could potentially affect the ore stacking process and result in non-uniform fluid flow during the subsequent leaching, detoxification, and rinsing phases. The combined ore preparation and stacking plan will promote homogeneity and isotropy in the heap, thereby minimizing the potential for development of layers with lower permeability.

R13. Pore volume calculations for the Heap Leach Facility and discuss the relationship between ore behaviour, heap pore volumes, and in-heap pond storage capacity

R13.1 Response

The cumulative body of historical and planned column test data for the Eagle Gold Project (see response R12) provides an understanding of the behaviour of ore in the heap, especially as it relates to maintaining the in-heap pond storage capacity.

The capacity of the current in-heap pond design has increased slightly over the volume published in the Project Proposal (435,000 m^3) through optimization of the heap design. The current in-heap pond capacity (storage volume within the ore pore space) of 459,000 m^3 was estimated by multiplying the volume of ore in the portion of the heap that will contain the pond (3.35 million m^3) by an ore storage solution factor of 0.1371 (0.1371 m^3 of solution/m^3 of ore). The relationship between heap pore volume and in-heap pond storage capacity is represented by several equations which are used to calculate the ore storage solution factor. The assumptions and equations built into the calculation are provided in Appendix R13.

Ore absorption is primarily a function of initial ore moisture content and porosity as represented by particle size gradation. Particle size range will be closely controlled by the three stage crushing process, so should vary minimally within the heap. Initial moisture content will vary seasonally and affect the heap water balance, but this factor has little effect on the ultimate in-heap pond capacity. Compaction and the potential response of the heap facility to loading is a function of the strength of the crushed and stacked rock. As discussed in R12, the historic testing on agglomerated ore of varying sizes has demonstrated minimal (acceptable or <10% slump) slumping at simulated heap heights of up to 100 m (Table 12-2). Therefore, it is expected that the flow potential and storage capacity of the in-heap pond will not substantially decrease as the height (and load) of the heap increases, provided that the appropriate and optimal agglomeration rates are refined and utilized for the multi-ore composites that will be used to build the heap.

As part of the preparation of the water license application and additional regulatory review, additional column testing with agglomerated ore has begun to refine these past test results and to also simulate the current heap parameters, such as final ore crush size (conventional crush to a P80 size of 6.3 mm) and ore type (multi-ore composites containing types A, B, C and E), cement addition rate, and ultimate heap height. The cumulative body of ore test results will provide information to refine the current estimate of in-heap storage capacity of 459,000 m^3 under operational conditions. Further, based on the 2009 testing results for conventionally crushed ore to a P80 of 7 mm (Table 12-2), which is close to the current design ore size, the narrow range of initial to final bulk density values (1% to 4%) demonstrates that the operational capacity of in-heap pond should not differ significantly from the final modeled capacity.

R14. A discussion confirming that the detoxification/rinsing process is achievable as proposed given predicted ore behaviour and heap pore volumes

R14.1 Response

Consistent flow will be maintained through the heap during both the leaching and rinsing processes, including when operating the heap under the loading anticipated at full height. As discussed in R12, historical testing on agglomerated Project ore has demonstrated excellent percolation rates and minimal settling at simulated heap heights (Table R12-2). Additional column testing has begun to refine these past test results with the current heap design parameters. Further, ore will not be stacked on the heap during the winter months when cold temperatures could potentially affect the ore stacking process, thereby minimizing the potential for non-uniform fluid flow through the heap. Consequently, the combined ore preparation (conventional crush, agglomeration) and stacking plan (including lift height) will promote homogeneity and isotropy in the heap, thereby maximizing the efficiency of the detoxification and rinsing processes.

Additional environmental testing has begun to evaluate two cyanide detoxification and rinsing processes, and to evaluate the long-term drainage chemistry from the capped heap. Combined with the updated drainage modeling performed for the heap (Appendix R1), data from the environmental testing program will help refine the estimates for the duration of the rinsing phase and the water volume required to rinse the heap. Finally, humidity test cells will be conducted to refine the estimate of the long-term quality of drainage from the detoxified, rinsed and capped heap.

The additional environmental testing involves column studies and humidity test cell studies in a laboratory setting. Two detoxification processes are being tested: 1) the *ex-situ* hydrogen peroxide cyanide destruction method forwarded in the Project Proposal, and, 2) an *in-situ* biological cyanide treatment method similar to that employed at the Brewery Creek Mine. The goals of the environmental testing on the columns are to:

1. Assess the relative performance of *ex-situ* chemical treatment and in-situ biological treatment in detoxifying cyanide in the heap.
2. Assess the short-term production rate of cyanide degradation products (e.g., cyanate, ammonia, and nitrate) that form at various times or steps in the detoxification processes.
3. Assess the volume of water and time required for the rinsing process.
4. Estimate the mass and availability of cyanide and cyanide degradation products.
5. Remaining in the heap at the end of the detoxification/rinsing processes.
6. Identify and estimate the mass of metals remaining and the various metal precipitates that have developed in the heap at the end of the detoxification/rinsing processes.
7. Estimate the long-term quality of waters that could drain from the heap following capping.

The procedures for the environmental testing programs which will lead to the refinement of the detoxification and rinsing processes are discussed below. Preparation of ore and columns for the testing has begun; testing will be performed on conventionally crushed (P80 of 6.3 mm) and agglomerated ore loaded into columns. The columns will be leached with cyanide in a laboratory setting to simulate the gold recovery phase. Separate sets of columns will used to test the following two detoxification treatment methods.

***Ex-situ* Chemical Treatment**

The *ex-situ* chemical treatment will begin at the end of the cyanide leaching step and will include an initial detoxification/rinsing phase employing hydrogen peroxide (with copper catalyst) to oxidize cyanide to cyanate in the water draining from the columns. This is the first step in the process originally described in the Project Proposal and simulated in previous column studies. The “detoxified” water will be recirculated through the column, flushing additional cyanide from the ore with subsequent chemical treatment and recirculation through the column until the cyanide concentrations in the drainage decrease to a predetermined level.

During the second rinsing phase, fresh water and/or simulated MWTP effluent will be added to the columns to rinse cyanide degradation products and metals from the ore. In the actual heap setting, the heap drainage from the first phase would be treated to remove cyanide degradation products, and then blended with other site water for further treatment at the MWTP to remove metals before being recirculated back to the heap. Because the water treatment technologies to remove cyanide degradation products and metals are well understood and would overly complicate this testing program, the laboratory will use fresh water and/or simulated MWTP effluent to perform the second phase of rinsing. The second rinsing phase will continue until key parameter concentrations in the water draining from the columns decrease to target levels.

***In-situ* Biological Treatment**

The *in-situ* biological treatment process will also begin at the end of the cyanide leaching step. The in-situ biologically mediated treatment of the heap will be simulated by the addition of a reduced sugar (e.g., molasses) to the columns to stimulate microbial growth. The reduced sugar promotes direct microbial consumption of free cyanide and some weak cyanide complexes by the formation of non-toxic sugar cyanohydrins. Subsequent degradation of the cyanohydrins and other nitrogen forms is supported by excess sugar (over what is required to react with free and weak complexes of cyanide) because the additional organic carbon generates a fine biofilm on the leached ore that enhances the formation of reduced nitrogen compounds (cyanohydrins, ammonia).

Additional carbon sources may be added to support nitrate removal (denitrification) and to support additional metals precipitation in the column by formation of metal sulphides through microbial sulphate reduction. As reducing conditions develop, metals that are less soluble in a reduced state will precipitate out of solution. The concentrations of metals that preferentially sorb to iron or manganese oxides in the more neutral pH range that is created during the detoxification process will also decrease.

Closure (Long-term Seepage) Phase

Upon completion of the detoxification/rinsing phases, representative material from the columns will be repurposed to serve as a humidity test cell (HTC) for long-term kinetic testing. Separate HTCs will be constructed from ore subjected to the two treatment methods described above. The leached and detoxified material will be homogenized, sub-sampled, and re-packed to generate separate humidity cell columns. The remaining material will be sampled and submitted for whole rock metals analyses, Acid-Base Accounting (ABA), NAG pH, and neutral metals leaching analyses. The baseline static testing results of the leached and detoxified material will be used to generate depletion calculations and aid in the interpretation of the HTC analytical results. These data will be interpreted to provide an estimate of the quality of the water draining from the heap in the long-term.

6 MINE INFRASTRUCTURE

6.1 Stability

6.1.1 Background

The description and location of mine infrastructure described in the proposal is based on the completion of the mine pre-feasibility study and baseline studies of soils, surficial geology, permafrost, hydrology and terrain hazards assessment. We note many sections of the proposal describe mine infrastructure and characterize effects to the environment and feasibility and robustness of the infrastructure. Details on terrain and soil stability as well as geotechnical design basis are included in Appendix 6 (Environmental Baseline Report: Surficial Geology, Terrain, and Soils) and Appendix 35 (Geotechnical Design Basis for Mine Site Infrastructure in the proposal).

NND has a contrasting view to the impact predictions and mitigations identified in the proposal (YOR 2010-0267-200-1). The Executive Committee recognizes the importance of geotechnical information used for determining the design of mine infrastructure. Additional information is required to support our understanding of the predictions of environmental effects of the Project and feasibility of mine infrastructure.

Therefore, please provide the following information:

R15. Appendix 35 of the proposal provides a geotechnical design bases for mine infrastructure. Appendix A and C of the report refer to sections of the pre-feasibility study completed by Scott Wilson Mining, however those excerpts are not included in the appendix. Please provide the following excerpts from the pre-feasibility study:

a. Pages 9-1 to 9-43; and

b. Pages 6-43 to 6-60 of Scott Wilson Mining. 2010. Prefeasibility Study on the Eagle Gold Project, Yukon Territory, Canada. August 13, 2010 (July 16, 2010). Prepared for Victoria Gold Corp by Scott Wilson Roscoe Postle Associates Inc, Toronto, ON. Authors: J. Cox, D. Rennie and D. Kappes. 334 pp

R15.1 Response

Geotechnical Studies

The executive committee has requested additional geotechnical information to support its understanding of the predictions of environmental effects of the Project and the feasibility of the proposed mine infrastructure. Specifically requested were pages 6-43 to 6-60; and pages 9-1 to 9-43 of Scott Wilson Mining's Prefeasibility Study on the Eagle Gold Project. As requested, the above listed sections of the pre-feasibility study are provided as Appendices R15A and R15B to this response. Pages 6-43 to 6-60 and pages 9-1 to 9-43 of the pre-feasibility study are also contained in item #1 below (Appendix 15C).

Given the importance of geotechnical information in evaluating the design of mine infrastructure, VIT, in addition to the requested sections of the pre-feasibility study, is also appending additional geotechnical information to assist YESAB and others with review of the Project Proposal. The appended studies include:

1. **Eagle Gold—Geotechnical Design Basis for Mine Site Infrastructure in the Project** Proposal (Appendix R15C). This memorandum was prepared by BGC to summarize the geotechnical design basis prepared by others (Scott Wilson RPA) for the major earthworks structures, namely the heap leach facility and waste rock storage areas.
2. **Eagle Gold Project—2009 Site Facilities Geotechnical Investigation Factual Data Report,** March 5, 2010 (Appendix R15D). This report presents data from an intrusive geotechnical site investigation program which was primarily used for site selection of the heap leach facility and waste rock storage areas. The work included seven drill holes and 69

test pits. Scott Wilson RPA used this work, in addition to prior work by Knight Piésold and Sitka Corporation from the mid-90s, to develop the geotechnical design basis in their Prefeasibility Study for the Eagle Gold Project.

3. **Eagle Gold Project—2010 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report**, March 9, 2011 (Appendix R15E). This report summarizes the findings of geotechnical site investigation work conducted in the summer of 2010. The report addresses investigations conducted in 2010 for proposed mine site infrastructure including: the heap leach pad; waste rock storage areas; crushers and conveyors; water diversion structures; plant site buildings; solution and water management ponds; and other miscellaneous buildings and facilities. In 2010, a total of forty-nine (49) test pits and twenty-five (25) drill holes were completed to characterize the overburden material and bedrock conditions. Additionally, three (3) cut slopes were logged for exposed soil and rock conditions, and core from one client-drilled condemnation hole was logged for geotechnical purposes. Laboratory testing was completed on selected samples for moisture content, and representative samples were also tested for Atterberg Limits and grain size analysis. Various other lab tests were also completed on bulk samples of placer tailings being considered for potential use as select fill or aggregate. The data in this report were used, in combination with previous data from Item 2 above and the prior (Knight Piésold and Sitka) reports as input to engineering design.

FNNND Concerns

YESAB has stated that FNNND has a contrasting view to the impact predictions and mitigations identified in the proposal (YOR 2010-0267-200-1). Specifically, the consultant contracted by FNNND to review the Project Proposal states, "*The project proposal does not contain sufficient information about project design to support a comprehensive assessment of the significance and likelihood of environmental effects as required under YESAA. The proposal describes design concepts for mine facilities but fails to provide details and test work results that demonstrate the practicality, feasibility and performance of the proposed concepts within the context of the Dublin Gulch site*." The consultant provided the following rationale for this conclusion – *"…The focus of the Scott Wilson pre-feasibility evaluation was on economic feasibility of the project. The report describes concepts for mine facilities and components but primarily addresses the economic implications, for example haul costs and construction costs. Environmental implications and effects are addressed, but the report recognizes the need for additional technical testing and evaluation of these areas to support mine permitting*."

The Pre-Feasibility Study (Scott Wilson Mining 2010) included a Mineral Resource and Reserve estimate that conforms to the NI 43-101 Standards of Disclosure for Mineral Projects as well as engineering design and the recommendation for additional studies to support mine licensing. National Instrument 43-101 (NI 43-101) is a mineral resource classification scheme used for the public disclosure of information relating to mineral properties in Canada. The Instrument is a codified set of rules and guidelines for reporting and displaying information related to mineral properties owned by, or explored by, companies which report these results on stock exchanges within Canada.

However, the Pre-Feasibility Study includes extensive detail beyond those related to economic implications. The study was led by Scott Wilson Mining, which was responsible for geology, resource estimation, mine design, heap leach design, and cost estimation in the report. Kappes Cassiday & Associates (KCA) carried out metallurgical test work, process design, and process cost estimation. BGC Engineering Inc. (BGC) carried out geotechnical field investigation and analysis for open pit slopes and for infrastructure requirements. Stantec Inc. completed an assessment of potential environmental effects, in the course of preparing the Project Proposal concurrently with the Pre-Feasibility Study. Additional environmental and engineering studies were carried out in support of and described within the Project Proposal and in response to subsequent request from YESAB for additional information during the Adequacy Review.

VIT recognizes that the confidence level of a Pre-Feasibility Study is less than that provided by a Feasibility Study, and as consequence is not, in and of itself, the definitive basis for financing, or for license application requirements to support the regulatory review of the Project. The conceptual detail provided by the Pre-Feasibility Study was used in part to assess environmental and socio-economic effects of the Project. The scope of the Project Proposal included additional investigation and analysis beyond that provided in the Pre-Feasibility Study. This additional information enables the assessment of potential environmental effects including accidents and malfunctions and environmental events (seismic, hydraulic) on the Project.

Progression from Pre-Feasibility Study to Feasibility Study includes optimization of the mine design to take into account new information about continued engineering investigations, geology, market conditions, and input from the environmental assessment process. A mining project development process is a sequence of activities from discovery of a mining property, development, production and closure. Project development often includes the following phases (in approximate order):

- Exploration
- Project discovery
- Project resource definition and scoping studies
- Pre-Feasibility Study
- Environmental Assessment
- Feasibility Study
- Regulatory - Licensing and Permitting
- Project financing
- EPCM – detailed design engineering
- Construction
- Operations
- Closure and reclamation.

To enable further development of the Eagle Gold Project, VIT is currently completing a Feasibility Study that will conform to the NI-43-101 Standards of Disclosure for Mineral Projects. NI 43-101 defines Feasibility Study as a comprehensive study of a deposit in which all geological, engineering, operating, economic and other relevant factors are considered in sufficient detail that it could reasonably serve as the basis for a final decision by a financial institution to finance the development of the deposit for mineral production. The Eagle Gold Feasibility Study currently underway includes comprehensive engineering analysis, design and investigations that are a refinement of analysis completed for the Pre-Feasibility Study. In advancing the Eagle Gold Project from the Pre-feasibility Study through to construction VIT recognizes the need to undertake additional investigations to ensure the Project is designed to a detailed engineering design basis to ensure proper construction and environmental protection. These investigations are underway concurrently with the Feasibility Study to support design engineering and the license application requirements.

In addition to the reports listed above and provided as part of this response, multiple geotechnical studies are underway to support the Feasibility Study, detailed engineering for final design and the regulatory review process. A selection of the reports described below will be included as part of the Type A Water Use License and/or Quartz Mine License applications as necessary. This list is not exhaustive as the scope of required studies is not yet complete. While many of these reports will not be available before submission of the license applications they will be available and incorporated into the detailed design considerations to meet all licensing objectives:

1. **Eagle Gold Project, Dublin Gulch, Yukon, Feasibility Study Open Pit Slope Design**. The objective of this report is to describe safe, achievable pit slope angles for the proposed open pit. Additional rock quality, structural geology and hydraulic conductivity information was collected. The pit slope design angles dictate the strip ratio, recoverable gold, and the waste quantities generated from mining.
2. **Eagle Gold Project, Dublin Gulch, Yukon, Feasibility Study Waste Rock Storage Area Design**. The objective of this report is to provide details on foundation preparation requirements, rock drain size and specifications, waste material placement and sequencing to maintain a stable dump under static and seismic conditions. This work relies on geotechnical data developed in several of the reports in the following list, plus older reports by Knight Piésold and Sitka Corporation produced in the mid-90s for New Millennium Mining Ltd.
3. **Eagle Gold Technical Memorandum: Dublin Gulch—Seismic Peak Ground Accelerations for Design**. This document will provide seismic hazard analysis that includes results from both deterministic and probabilistic methods. Deterministic analyses were performed using five equally weighted attenuation relationships to evaluate seismic hazards for the property resulting from a maximum credible earthquake (MCE). A deterministic analysis therefore allows for a more conservative approach to the determination of risks associated with identified seismic hazards. Data published by Natural Resources Canada (NRCAN) were used in the probabilistic analysis to estimate the probability of exceedance of peak ground accelerations (PGA) at the site for various return periods.
4. **Eagle Gold—Feasibility Study: Heap Leach Facility Geotechnical Assessment**. Geotechnical stability of the HLF will be evaluated for both static and pseudo-static (earthquake) conditions using a Maximum Design Earthquake (MDE) determined through a site-specific seismic hazard analysis. The structures to be analyzed include the HLF

confining embankment, the ore pile, the diversion dam, and the event pond embankments. Liquefaction potential of the foundation materials will be assessed and mitigation measures determined for design of the facilities, as needed. The slope stability analyses will be performed using the computer program GeoStudio SLOPE/W, which enables the user to conduct Limit Equilibrium slope stability calculations by a variety of methods. A one-dimensional settlement assessment will also be performed for the HLF. The construction of the HLF will apply loads to the foundation soils which would result in total and differential settlements. These settlements may impact the performance of the proposed liner system and collection pipe network at the base of the HLF pad. Results of the settlement assessment will be used to evaluate the need for mitigation measures or specific design features, if any. These geotechnical analyses will be based on currently available material properties derived from the site investigations and laboratory testing completed to date.

5. **Eagle Gold—Borrow Evaluation Report.** This technical engineering memo will provide further guidance regarding potential sources of engineering construction materials for earthworks construction, including heap/pond liner materials, structural fill, rock fill, concrete aggregate and other materials.
6. **Eagle Gold—Mine Site Infrastructure, General Earthworks Guidance**. This report will present a high level compilation of selected subsurface data (e.g. thickness of overburden, presence of placer tailings, presence of frozen ground and excess ice, and depth to rock types requiring common excavation, ripping or blasting), along with general commentary on expected earthworks construction issues at a variety of functional areas within the proposed mine site.
7. **Eagle Gold Project: 2011 Geotechnical Investigation for Mine Site Infrastructure Factual Data Report**. This report, when finalized after receipt of geophysics and laboratory data, will present all field and lab findings from 2011 geotechnical site investigations for mine site infrastructure. This report will provide select data from the summer 2011 geotechnical site investigations for mine site infrastructure, including all photographic and descriptive logs from 59 outcrops (natural and man-made cuts), 96 test pits, 29 diamond drill holes, and 17 auger drill holes plus point load tests, plate load tests, slug tests, surface geophysics (seismic refraction), downhole geophysics (shear and compression wave velocity profiles), and a variety of laboratory testing for rock strength, index testing of soil, permeability testing of potential silt liner, and material quality for concrete aggregate.

In conclusion, VIT is confident that the conceptual design combined with appropriate mitigation measures detailed design required in support of future license applications will prevent significant negative environmental or socio-economic effects.

6.2 Ore Stockpile

6.2.1 Background

Section 5.5.1.6 of the proposal refers to two permanent stock pile areas that have been identified in the mine plan for mined lower-grade mineralized material. In their comment submission, NND is concerned that low grade ore stock piles often represent a significant contaminant source at mine sites (YOR 2010-0267-200-1). Insufficient details have been provided on how these stock piles will be managed at closure and their potential as sources for contamination. Further, loadings from these sources do not appear to have been considered in the water quality modeling presented in the proposal. The Executive Committee requires additional information in order to assess the potential environmental effects associated with the establishment of these two low-grade ore stock piles.

Therefore, please provide the following information:

R16. Description and/or characterization of the proposed low grade ore stock piles, including exact location, material characteristics, drainage characteristics and potential contaminant loading for surface water and groundwater.

R16.1 Response

There is one proposed low grade ore stockpile (2.5 MT) with an adjacent small satellite stockpile (0.3 MT), both located in the Suttle Gulch sub-basin and adjacent to the open pit. Contrary to what is stated in the in the Project Proposal, neither stockpile is permanent. Both will be removed prior to Closure. Below is discussed the characteristics of the stockpiles, including their purpose, location, material composition, and drainage. The characteristics of the stockpiles and their temporary existence support the conclusion that potential for contaminant loading to surface water or groundwater from the stockpiles is negligible.

The low grade ore stockpiles described in Section 5.5.1.6 of the Project Proposal were included as part of the Pre-Feasibility Study (Scott Wilson Mining 2010) and include a maximum capacity of 2.8 MT. The Pre-Feasibility Study mine plan utilizes the low grade ore stockpiles over the first three years of operations to move lower grade ore out of the production line to allow access and processing of higher grade (essentially higher monetary value) ore earlier in the operation phase. This will provide a higher financial rate of return in the initial stages of operations. In the Pre-Feasibility Study mine plan, both stockpiles were located directly to the north of the open pit and adjacent (and east) of the primary crusher (Figure 5.5-2 in Project Proposal).

The use of the word “permanent” in Section 5.5.1.6 of the Project Proposal is a misnomer. For the purposes of the Eagle Gold Project, the low grade ore stockpiles are defined as temporary storage areas that will be used during operations. The low grade ore stockpiles will be utilized in one of two ways depending on market conditions: 1) the low grade ore from the stockpile will be crushed and conveyed to the heap leach facility during the later stages of the mine life if the value of the stockpiled ore makes it economical; or 2) the low grade ore will be returned to the open pit as backfill and/or added to the Eagle Pup waste rock storage area. Because the HLF has a design capacity of 66 MT, Option 1 would allow for 2.8 MT of ore from the stockpile to be used for processing in lieu of excavating 2.8 MT from the open pit. If market conditions and ore grades in later stages of mining dictate further excavation of ore from the pit, the 2.8 MT low grade ore that has been stockpiled will be transferred to the open pit and/or the Eagle Pup WRSA, depending on closure criteria, as the WRSA will not be at design capacity. Both options include total removal of the stockpile during operations and prior to mine closure.

The stockpile material is characterized as low grade ore that consists of a combination of oxidized, unaltered and altered granodiorite as described in the Project Proposal's Appendix 8: Geochemical Characterization and Water Quality Predictions (Stantec 2011). Based on SRK's findings, there is no significant difference among these three granodiorite ore types from a potential water chemistry loading perspective. The approximately 9 ha temporary stockpile material will be located within the Suttle Gulch sub-basin, and at its potential maximum area would be a relatively small proportion of the sub-basin (approximately 9%). For water management, all drainage and seepage from the stockpiles will be treated as mine influenced contact runoff. Thus, during operations, the water balance model (Appendix 21 of the Project Proposal) assumed all drainage and seepage from the stockpiles and adjacent developed areas would be captured with other contact runoff, combined with water from the open pit and the Platinum Gulch WRSA and then from these locations to the MWTP feed pond for use as heap make-up water or treated as necessary prior to discharge to the receiving environment. Thus, due to the short-term occurrence of the stockpile and the water management of runoff from the stockpile, the potential for contaminant loading to surface water or groundwater from the low grade stockpile is negligible.

R17. A plan how these ore stock piles and their drainage will be addressed at closure

R17.1 Response

As described above in response R16, if low grade stockpiles are used during operation, there will be no low grade stockpiles on site at closure. The stockpiles would be either fed into the heap leach process during operation, added to the Eagle Pup WRSA and/or used as backfill into the open pit.

6.3 Ferric Sludge Storage

6.3.1 Background

The mine water treatment process will produce low pH ferric sludge from the ferric chloride coagulation process. This sludge will be consolidated and stored on a lined pad during operations and encapsulated within a lined cell at closure. During operations the sludge pad will be exposed to precipitation. Appendix 20 of the Project Proposal (Mine Water Treatment Technical Memorandum) indicates that in order to prevent the release of contaminants the low pH condition must be maintained. It is uncertain if any additional measures are necessary in order to maintain the pH of the ferric sludge during operations and closure.

Section 5.6.5.1 indicates that the final closure cell for ferric sludge will be comprised of encapsulation in HDPE liner, rock fill, growth media, and underlain with drainage material. It is unclear if the purpose of the drainage material is to collect water that may be in contact with the ferric sludge or not.

Therefore, please provide the following information:

R18. Identify and provide a description of any additional measures that may be necessary in order to maintain the low pH condition of the ferric sludge during operations and/or closure.

R18.1 Response

The following measures are in addition to those described in the Project Proposal (Stantec 2011) and will be employed to maintain the low pH condition of the ferric sludge:

- Dewatered sludge will be covered with an impermeable cover while on the storage pad.
- Dewatered sludge will be transferred from the storage pad to be encapsulated in the permanent lined disposal cells at a frequency needed to manage the inventory of sludge on the storage pad so that covering the sludge is practical.

As described in Appendix 20 of the Project Proposal, the production of ferric chloride sludge will be freeze consolidated and then transferred to a high density polyethylene (HDPE) lined pad for interim storage before being periodically transferred and then encapsulated for closure. It is during this interim storage period that the potential exists for re-wetting of the dewatered sludge, which could result in an undesirable pH shift. The additional measure of maintaining an impermeable cover at the interim storage pad will minimize exposure of the sludge to precipitation and mitigate the possibility of a pH shift. Rainfall and snowmelt runoff from the cover will be collected (as described in Appendix 20) and conveyed to a small control pond, where if necessary per water quality monitoring, it will be routed to the mine water treatment plant (MWTP), prior to discharge to the environment.

The final encapsulation process described in Appendix 20 of the Project Proposal is presented as a single operation that would be performed at the conclusion of active mine water treatment. However, the efficiency and practicality of maintaining a cover on the stored sludge may be improved by transferring the accumulated sludge to the permanent lined disposal cells more frequently depending on generation rate. Management of the ferric sludge in this manner would result in several smaller encapsulation cells within the general footprint of the larger cell shown in Appendix 20. Construction and monitoring details of each disposal cell would be as described in Appendix 20, shown on Figure 6 of Appendix 20, and as detailed in response R19.

R19. Clarify the purpose of the drainage material beneath the encapsulated ferric sludge. If the purpose is to collect water that may be in contact with the ferric sludge, please provide a management plan for the contact water.

R19.1 Response

The drainage material underlying the Ferric Sludge Cake Permanent Disposal Cell is not intended to collect water in contact with the ferric sludge. Rather, the purpose of this drainage layer is to capture interflow or shallow groundwater, if present, and to route it in a controlled manner around and/or under the fully encapsulated ferric sludge cake. This hydraulic isolation of the cell will inhibit the development of excess pore pressure below the bottom liner and help maintain cell stability. The operations, closure and post-closure environmental monitoring programs will include a sludge cell monitoring plan to provide verification of cell integrity. The plan will include the monitoring of both runoff collected from the small control pond and groundwater collected from a monitoring well installed immediately downslope of the cell as shown on Figure 6 in Appendix 20 of the Project Proposal.

6.4 Project Alternatives

6.4.1 Background

Section 5.8.2.4 of the proposal describes six alternatives that have been considered for the choice of the heap leach facility location. However, no details about the evaluation and selection of the proposed location have been presented. In their comment submission, NND questions if the selection of the locations for the heap leach facility adequately considered environmental implications and benefits of the various options (YOR 2010-0267-200-1). Four potential alternatives have been considered for the location of the waste rock storage areas (Section 5.8.2.8 of the proposal) but no information is given why Eagle Pup and Platinum Gulch have been selected.

Therefore, please provide the following information:

R20. Additional information on the various alternatives and rationale for the selection of the proposed locations for major mine site facilities

R20.1 Response

Alternative locations for major mine site facilities were assessed using economic, engineering and environmental evaluations. The Project Proposal (Stantec 2011) puts forth the best technically and economically feasible means of constructing, operating, and closing the Project in a way that maximizes environmental protection.

The Project Proposal included additional investigation and analysis beyond that provided in the Pre-Feasibility Study. However, an environmental constraints analysis of potential Project facility locations was undertaken concurrently with the Pre-Feasibility which enabled the selection of mine site infrastructure locations while considering environmental implications.

Overall Mine Site Infrastructure Arrangement—Environmental Considerations

The Project Proposal (Stantec 2011) built upon earlier assessments and project design conducted in the mid to late 1990's for the Dublin Gulch Project proposed by New Millennium Mining Ltd. The mid- to late-1990s planning included pre-feasibility studies, as well as initial assessment and regulatory review under the *Canadian Environmental Assessment Act* (CEAA) as required at the time in 1995. This earlier effort, and in particular the infrastructure location selection process used for the proposed Dublin Gulch Project, provided valuable engineering and environmental information that was used as part of the site selection process for the Eagle Gold Project. Also informing the pre-feasibility and Project Proposal assessments were multiple meetings with Stantec and other environmental consultants, as well Yukon Government, and NNDFN representatives familiar with the Valued Environmental Components and baseline conditions of the Project site.

A primary objective identified through the consultation and assessment process was reduction of the disturbance area created by the mine site footprint. Wildlife and fisheries habitat values throughout stream channels located in the upper Haggart Creek watershed have been heavily impacted by past placer mining activity. In contrast the Lynx Creek watershed, adjacent to the Haggart Creek watershed (where the Eagle Gold ore deposit is located), is a relatively pristine area undisturbed by placer mining. Therefore a key criterion for selection of mine infrastructure was to locate all mine site infrastructure and related activity outside of the Lynx Creek watershed. To achieve this, focus was placed on reducing the overall footprint, and keeping the footprint contained within the Dublin Gulch/upper Haggart Creek watershed. Another critical criterion is long term geotechnical stability, which is both an engineering and environmental consideration. Failure of mine site infrastructure could lead to significant environmental effects. The presence of and ability to manage permafrost is the key issue in evaluating potential Heap Leach Facility and potential Waste Rock Storage Area locations.

Because wildlife habitat, archaeological, and air quality values amongst the potential Heap Leach Facility and Waste Rock Storage Area locations are relatively homogenous throughout the Dublin Gulch valley, the primary environmental considerations were the presence of permafrost (long-term stability and construction management) and watercourse impacts (the need to realign watercourses and impacts to fish habitat). As mentioned above, the overall extent of the Project footprint was considered in selection of potential infrastructure locations. The preference was to reduce the overall disturbance area which will result in decreased environmental effects and favorable economics via a reduction in haulage distance.

Heap Leach Facility Locations

The 1995 New Millennium project proposal and 1996 feasibility study included a different location for the HLF and a similar location of the waste rock storage area in the Eagle Pup sub-basin. The Dublin Gulch Project evaluated four sites for the HLF. Two potential locations from the Dublin Gulch Project were brought forward for evaluation by the Eagle Gold Project planning process. Two potential locations from the Dublin Gulch Project were not included for evaluation primarily due to environmental constraints—they were located in the Lynx Creek watershed.

In total six locations for the HLF location were evaluated for the Eagle Gold Project. Section 5.8.2.4 of the Project Proposal entitled "Heap Leach Facility Alternatives" describes the six alternative potential locations. Criteria used in the alternatives assessment included engineering, geotechnical stability, earth work requirements, closure and reclamation efforts required, mining, surface water, groundwater, wildlife habitat, fish habitat, archaeological value, and air quality. Details of the alternatives analysis are provided in pages 9-1 to 9-6 in Section 9 of the Pre-Feasibility Study (Scott Wilson Mining 2010). Section 9 is provided as part of this response to the Supplementary Information Request (See R15). Short summaries for each assessment of the six location options are provided below.

- **Option 1**—Cross valley type HLF within Dublin Gulch (lower valley). There is sufficient land space available for the design and throughput and there is potential for further expansion. The valley floor is relatively flat, though it has a small footprint that would make early phase operation slightly more difficult. Initial construction and later stage operation of the heap are relatively straightforward. The major disadvantage of this site is that it would require a significant diversion of Dublin Gulch both during operation and post closure.
- **Option 2**—Cross valley type HLF within Dublin Gulch (mid valley). The site for Option 2 is similar to Option 1, in that it also sits across the valley floor but in the mid part of the Dublin Gulch. It has a similar layout; similar foundation conditions and also requires diversion of Dublin Gulch. It has no advantages over Option 1 but has a considerable disadvantage of steep northern flanks (significantly steeper than 1:2.5), that will result in increased earthworks to effect suitable conditions for liner construction.
- **Option 3**—Valley type HLF on Potato Hills within Bawn Boy headwaters. Option 3 was the location selected for the heap leach facility that formed the basis of a previous 1996 feasibility study conducted by New Millennium Mining Ltd. The site is a gently sloping upper valley site with the main part of the pad located on a ridge. The foundation conditions are favourable and unlikely to require special treatment. The main disadvantages are that the site is furthest from the Eagle Zone and has a 500 m difference in elevation which is seen as a significant operational disadvantage. In addition, this site would expand the overall footprint of the Project and increase overall environmental impacts to flora and fauna.
- **Option 4**—Side valley type HLF on slopes below the Eagle Zone ore deposit. Option 4 is a development of the Option 1 site. It is located away from Dublin Gulch to avoid requirements for a river diversion and is located on the side of the valley with a portion of the facility in Eagle Pup. It is immediately down slope of the Eagle Zone and therefore even closer than Option 1. The major disadvantage of the site is the significant depth of permafrost within colluvial deposits and tills. Significant earthworks in the toe area are also required to accommodate the 20 m bluff in the till and colluvium deposits, and perched groundwater on the permafrost has a potentially significant impact to be addressed to provide stability to the lined base of the heap leach pad.

- **Option 5**—Valley type HLF on the granodiorite ridge within Olive Gulch headwaters. Option 5 is similar to Option 3 in that it is also largely located on the granodiorite ridge near the catchment boundary with the in-heap pond located in the upper reaches of Olive Gulch. Its main advantage, compared to Option 3, is that it is closer the Eagle Zone, however, the slope of the creek and valley walls are steeper (with substantial geotechnical challenges and making initial operations slightly more difficult) and there is limited space for future expansion.
- **Option 6**—Side valley type HLF in Ann Gulch headwaters. Option 6 is a modification of the Option 1 site. It requires the diversion of Dublin Gulch during operation and post closure but not of the same magnitude as Option 1 as it is located on the side of the valley with the main portion of the HLF in Ann Gulch. Therefore a shorter section of Dublin Gulch would require diversion and the overall realignment would be to a lesser extent. Use can be made of natural terrain to minimize earthworks for subsequent lifts of the heap leach pads. The major advantage over Option 4 is a significant reduction in the amount of permafrost to be dealt with, minimal potential impact from or to groundwater and a relatively simpler geological profile of the colluvium over bedrock.

The engineering assessment of alternatives scored Options 3, 5, and 6 significantly more suitable than 1, 2, and 4. From an engineering and construction perspective of the HLF, Option 3—Potato Hills is the most favorable of the group.

Further evaluation of the leading options was undertaken considering the following factors:

- Mining operations—particularly haulage and access
- Other infrastructure layouts – available area given other infrastructure requirements
- Mineral resources—condemnation requirements and potential for future mineral extraction
- Environmental—potential effects to surface and ground water, fish habitat, wildlife habitat, air quality as well as archaeological, historical and traditional resources.

The results of the Project-wide review of the leading three sites established a clear site location preference for Option 6—Ann Gulch. The primary environmental constraints that favor Ann Gulch include less permafrost and impact to watercourses. Warm (i.e., typically 0 to -1 degrees Celsius) discontinuous permafrost is present throughout the Project area, and is preferentially located on north-facing slopes. It occasionally contains excess ground ice, especially on the lower north-facing slopes, where it is prevalent adjacent to Eagle Creek. Ann Gulch is a south-facing slope and is located on the north side of Dublin Gulch. It contains a low density of discontinuous permafrost pockets that are considerably shallower than the other options not requiring diversion of Dublin Gulch. From a long term stability perspective, Ann Gulch is favorable compared to the other leading options.

While Option 6-Ann Gulch, includes the need to re-align a portion of Dublin Gulch, the realigned portion is located in lower Dublin Gulch valley which has been severely impacted by historical placer mining. The portion of Dublin Gulch that is proposed to be realigned with this option is not currently located in its natural alignment. Realignment of the watercourse will allow for restoration of the watercourse to a more natural flow path with improved habitat values (see the Fish Habitat Compensation Plan, Appendix 23 of the Project Proposal).

Based on this evaluation Option 6-Ann Gulch was taken forward for pre-feasibility engineering and environmental assessment.

Waste Rock Storage Areas

Few economically feasible potential locations for Waste Rock Storage Areas exist for the Project. The Pre-Feasibility Study considered four locations in the Dublin Gulch/Haggart Creek sub-drainage basins. These sites were located in: Eagle Pup, Platinum Gulch, Suttle Gulch, and Stewart Gulch. Each potential site was compared based on storage capacity, location and geology. Placing waste rock in Suttle Gulch would interfere with crushing and conveying operations and was therefore ruled out. Platinum Gulch, while close to the open pit, its location and elevation differences are not as ideal for an optimized pit design and truck haul routing perspective so is less economically feasible as a primary independent storage area. Therefore another location was required either as a replacement or in addition. Stewart Gulch is the farthest from the proposed open pit and therefore the least economically attractive. Eagle Pup is advantageous for economic and environmental reasons. It is closer than Stewart Gulch, thereby reducing hauling costs which improves Project economics. In addition, because Eagle Pup is closer to the Open Pit, the overall extent of disturbance by the mine site footprint is reduced when compared to more distant locations. Stewart Gulch does not have any environmental advantages over the Eagle Pup site. Selection of Eagle Pup and Platinum Gulch Waste Rock Storage Areas therefore reduces the overall environmental effects to the lower Dublin Gulch valley when compared to an alternative area in the Stewart Gulch sub-basin.

Based on these considerations, the Eagle Pup site was chosen as the primary Waste Rock Storage Area and Platinum Gulch was chosen as a supplementary site. These locations were taken forward for the Pre-Feasibility Study and Project Proposal assessment.

7 FISH AND FISH HABITAT

7.1 Background

The proposal identifies direct impacts to fish habitat in Haggart Creek, Dublin Gulch and Eagle Pup as a result of the diversion of Dublin Gulch and due to the infilling of tributaries to Dublin Gulch and Eagle Pup to accommodate the heap leach facility and waste rock storage areas. The Water Management Plan included in the proposal provides a construction schedule for the Dublin Gulch Diversion Channel and other mine components. Much of the construction works and stream flow diversions are planned to occur between April and June during the first and second year of construction. Mitigations by the proponent to avoid fish mortalities stipulates instream works will be carried out during the least risk periods for fish or not occur in spawning areas, and that fish salvages will be conducted before isolating channels. VIT especially mentions to avoid key migration periods. NND is concerned that the proposal does not provide enough information to understand fish migration periods in the area (YOR 2010-0267-200-1). DFO identified similar concerns, stating: “the least risk period for Arctic grayling is from July 1 to April 15” (YOR 2010-0267-191-1). The planned work described above appears to conflict with this window and it may be difficult to implement the mitigation measures effectively. DFO is concerned that fish egg mortalities may result if either Eagle Creek or Dublin Gulch is dewatered between April 15 and July 1, or if extensive instream works are completed between these dates.

Therefore, please provide the following information:

R21. Date ranges for fish migration periods along with best available supporting data.

R21.1 Response

This response describes the habitat use and migrations of Arctic grayling (*Thymallus arcticus*) in the Haggart Creek watershed. Previous studies and fish sampling have demonstrated that Chinook salmon are only present in the South McQuesten River and lower Haggart Creek, and do not utilize the upper areas of the Haggart Creek watershed in which the Project is located. Therefore, Chinook salmon are not discussed in this response. Figure R21-1 provides an overview of the Haggart Creek watershed and shows its location relative to the South McQuesten River.

Arctic grayling overwinter in the South McQuesten River and in the lower Haggart Creek watershed from freeze-up (early to mid-November) to spring (late April to early May). Adult fish spawn in the latter half of May in the South McQuesten and likely lower Haggart Creek. After spawning, adults and juvenile fish move into the upper Haggart Creek watershed including Dublin Gulch, and Eagle Creek to feed and rear during summer and fall. Arctic grayling are present in upper Haggart Creek, Eagle Creek, and Dublin Gulch from approximately June to November. There are no records of Arctic grayling spawning in Eagle Creek or Dublin Gulch, therefore it is not anticipated that eggs will be present in these watercourses at any time.

Portions of the Haggart Creek valley and the lower Dublin Gulch valley have been extensively reworked due to a long history of placer mining and exploration in the area. Currently, several of the drainages in the lower valley have been rerouted, including the Eagle Pup and Suttle Gulch watercourses. Prior to placer mining activities, Eagle Pup and Suttle Gulch flowed to Dublin Gulch. These watercourses are now tributaries to the existing Eagle Creek channel, which now discharges into Haggart Creek downstream of Gil Gulch (Figure R21-2). In the Project Proposal, the naming convention for the watercourse known as Eagle Pup is divided into two sections: Eagle Creek and Eagle Pup. Eagle Pup refers to the natural upper section of the watercourse which flows north from the proposed open pit location to the Dublin Gulch valley. Eagle Creek refers to the section which has been artificially created by placer mining activity. Eagle Creek flows westward within the Dublin Gulch valley and parallel to Dublin Gulch and after making an abrupt turn to the south, flows into the Haggart Creek flood plain for approximately 1.6 km, prior to connecting with Haggart Creek (Figure R21-2). Fish are not present in upper Eagle Creek due to a perched culvert barrier; yet they are present in the lower Eagle Creek section. Arctic grayling and slimy sculpin inhabit the lower reaches of Eagle Creek. Grayling have been observed in the two large ponds on the Haggart Creek floodplain approximately 650 m upstream of the Eagle Creek/Haggart Creek confluence. Both ponds were created by placer mining activity by previous claim holders. Slimy sculpin have been observed throughout the lower sections of Eagle Creek from its mouth upstream to the culvert at the Haggart Creek Road (approximately 1.8 km upstream).

As stated above, there are no records of Arctic grayling spawning in the upper Haggart Creek watershed, including Dublin Gulch and Eagle Creek. Data from past and current studies (Hallam Knight Piésold 1996; Madrone 2006; Pendray 1983; Stantec 2010) indicate that after spring freshet and spring spawning, Arctic grayling move into the upper Haggart Creek watershed in late May and in June for summer rearing and feeding. Details of spawning habitat quality in Eagle Creek and Dublin Gulch, as well as Arctic grayling spawning timing in Haggart Creek is provided in response R22. A detailed description of Arctic grayling migratory patterns and habitat use in the area is provided below.

Arctic grayling found in the Haggart Creek watershed, (including Dublin Gulch and Eagle Creek), follow a riverine life-history with a complex seasonal migratory pattern between larger and smaller habitats according to age and aquatic conditions. The fish are characterized by annual movement from over-wintering and spring spawning habitats to summer feeding sites, and have a strong inter-annual fidelity to summer feeding sites (West et al. 1992). Field sampling indicates that grayling spawning occurs in May in the low gradient sections of the South McQuesten River near the mouth of Haggart Creek (Pendray 1983). Throughout June and early July, fish of all age classes move into Haggart Creek and its tributaries (Pendray 1983).

Arctic grayling fry move into deep side channels and areas associated with groundwater to overwinter and then shift back to tributary streams in the late-spring and summer. They are generally weak swimmers and stay on the edges of the current, in quiet pools and small tributaries (McLeod et al. 1978). Shallow depths and low flows in both Dublin Gulch and Eagle Creek suggest that fish move downstream in September – October to Haggart Creek and the South McQuesten River to avoid freezing in winter. Fish tagged by Pendray showed movement into the smaller tributaries of Haggart Creek in the summer months and movement back to overwinter in Haggart Creek itself (Pendray 1983). These conclusions were supported in April 2008 when Stantec biologists found Arctic grayling overwintering in a placer pool in Haggart Creek (Stantec 2010).

Fish sampled by Stantec in Dublin Gulch and Eagle Creek during July and August in 2007 and 2009 indicated that the creek was dominated by 101-200 mm sized grayling with an absence of larger fish. These fish were, on average, larger than fish sampled in Haggart Creek (61 – 80 mm). The size of fish sampled by Stantec, and the habitat quality in Dublin Creek and Eagle Creek suggests that Arctic grayling are migrating upstream into Dublin Gulch and Eagle Creek in June to summer rearing (feeding) habitats. Habitat surveys conducted by Stantec in Dublin Gulch and Eagle Creek noted that the creek was good for rearing, staging, and holding, but rated as poor for overwintering and spawning (Stantec 2010). VIT will conduct spring spawning surveys in both Dublin Gulch and Eagle Creek to confirm the absence of Arctic grayling spawning in these watercourses.

In summary, data indicate that Arctic grayling do not spawn in Eagle Creek or Dublin Gulch, the two watercourses that would be directly affected by mine construction. After spring spawning, Arctic grayling move upstream from the South McQuesten River and lower Haggart Creek into the upper areas of the Haggart Creek watershed, including Dublin Gulch and Eagle Creek, for summer rearing.

There may be local fish movements throughout these watercourses in the summer, and then a downstream migration to overwintering habitats in Haggart Creek and the South McQuesten River in late fall. VIT is committed to future spawning surveys to confirm the absence of grayling spawning in Eagle Creek and Dublin Gulch.

R22. Evidence to confirm Arctic grayling do not spawn in Eagle Creek and Dublin Gulch

R22.1 Response

Arctic grayling use habitat in the upper portions of the Haggart Creek watershed, including Eagle Creek and Dublin Gulch, for summer rearing and feeding only. Surveys to date have found no evidence of spawning in these water courses. These findings are consistent with baseline habitat surveys conducted for the Project that have found that the upper portions of the Haggart Creek watershed offer poor habitat for spawning. Results of past and current studies that demonstrate Arctic grayling habitat use in Haggart Creek and the South McQuesten River are presented below.

In a thorough study of the area, Pendray confirmed that Arctic grayling spawn during the last two weeks of May in the South McQuesten River (Pendray 1983). He identified a small area of the South McQuesten River near the mouth of Haggart Creek as a probable spawning area but reports that no spawning grayling were detected in Haggart Creek or its tributaries. Pendray concluded that Arctic grayling do not spawn in the smaller tributaries of the South McQuesten River and were utilizing the warmer waters and more suitable substrates of the mainstem.

Habitat surveys conducted by Stantec in 2007 and 2009 (Stantec 2010) in the Haggart Creek and Lynx Creek watersheds supported Pendray's conclusions. These surveys concluded that Dublin Gulch was good for rearing, staging, and holding, but rated poor for overwintering and spawning because of numerous cascades, absence of deep pools, large boulders, and steep channel gradients. The scarcity of older age classes of grayling (>2+) found in Dublin Gulch was likely explained by the limiting habitat characteristics of the fish bearing section (shallow depth, steep gradient, few pools, lack of cover etc.). Spawning habitat in all sampling locations on Dublin Gulch was rated as poor due to a lack of spawning substrates and high water velocities during the spring Arctic grayling spawning period (Stantec 2010).

Eagle Creek is characterized by low flows, shallow water depths, and small braided channels (in the Haggart Creek valley reaches) with heavily silted substrates due to on-going erosion of deposits exposed (but not recovered) from historical placer mining activity (Stantec 2010). Spawning habitat quality throughout the watercourse is poor to non-existent. The only observations of Arctic grayling in Eagle Creek have been juveniles in two large placer ponds located in the lower reaches (below the small braided reaches) of the watercourse.

Supporting these observations, Stantec (Stantec 2011) used surrogate HSI (habitat suitability index) and IFIM (Instream Flow Incremental Methodology) variables to evaluate the quality of habitat for Artic grayling at key life-stages in Eagle Creek. Only five of twelve habitat units had any rating as spawning habitat and these were rated very low. Stantec concluded that the primary factors limiting habitat value within the existing Eagle Creek channel were: poor spawning substrates; high water velocities for fry and juvenile fish; shallow water depths; high percentages of fines unsuitable for fry rearing; and absence of overwintering habitat for juveniles and adults.

In summary, there are no historic records of Arctic grayling spawning in Dublin Gulch or Eagle Creek; and consistent with this, habitat suitability studies indicate that the watercourses of the upper watershed of Haggart Creek provide poor habitat for spawning.

R23. A description identifying how VIT intends to avoid fish egg mortalities in Eagle Creek and Dublin Gulch, including an overview of the sequence of the construction activities and the impact they will have on the watercourses, as well as a description of when and how the fish salvages will be completed.

R23.1 Response

As described in the previous Reponses (R21 and R22), Arctic grayling occupy Dublin Gulch and Eagle Creek during the summer and fall months only, and do not utilize these watercourses for spawning. Therefore, there is extremely low potential for egg mortality from instream works or dewatering in either Dublin Gulch or Eagle Creek.

Although not utilized for spawning, Arctic grayling do use Dublin Gulch and Eagle Creek for summer rearing. Fish mortalities from instream works will be avoided during project construction using the following mitigations:

- Fish access into Eagle Creek will be restricted prior to late spring-summer fish migrations of the first year of Project construction to prevent fish from entering the watercourse prior to dewatering. As a redundant protective measure, a fish salvage will be conducted to ensure no fish are in the watercourse prior to dewatering.
- Construction of the Eagle Creek Compensation Channel will include re-routing all Eagle Creek water flow in the first year of construction. All upper Eagle Creek flows will be diverted to lower Dublin Gulch which then discharges directly to Haggart Creek. Thus, there will be no flow in the lower Eagle Creek channel during the first year of construction. This will accommodate construction of the Eagle Creek Compensation Channel in the dry.
- Although constructed in the dry and thus no fish will inhabit the creek during construction, it is anticipated that construction of the Eagle Creek Compensation Channel will take approximately three months, beginning in April and completed before July 1; the least risk period for Arctic grayling.
- Fish passage into lower Dublin Gulch will be restricted prior to upstream seasonal migration The Dublin Gulch Diversion Channel (DGDC) will be constructed in the dry and will be connected after spring freshet (May – June). Once the DGDC is connected to upper Dublin Gulch, the existing lower Dublin Gulch stream channel will be dewatered.

- As a redundant mitigation measure, fish salvages will be conducted along the entire length of the fish-bearing section of Dublin Gulch as water levels are gradually reduced and flows are diverted through the DGDC. This will ensure that any fish that may have migrated prior to installation of the temporary seasonal barrier will be removed prior to dewatering. Salvaged fish will be transported to Haggart Creek downstream of the Dublin Gulch confluence.

Adequate sediment and erosion control measures will be implemented during all phases of construction to prevent releases of sediments which may cause harm to fish and eggs in downstream fish-bearing waters. Details of these measures are provided in the Erosion and Sediment Control Plan in Appendix 30 of the Project Proposal (Stantec 2011).

8 WILDLIFE AND WILDLIFE HABITAT

8.1 Background

The Project is located within important moose habitat. In their comment submission Yukon Government, Environment) is concerned about the impact of the access road on moose, as the road is planned to be open year-long but was previously unmaintained during winter (YOR 2010-0267-197-1). Yukon Government, Environment and NND (YOR 2010-0267-200-1) make suggestions on the spatial scope of the moose surveys and elements to be included. The Executive Committee is aware that VIT has performed moose surveys in winter 2011.

Therefore, please provide the following information:

R24. Report on the moose surveys performed in winter 2011, including spatial scope, methodology, results and interpretation of results as well as linking the moose survey to snow depth data of the area.

R24.1 Response

Commitment to conduct Moose-Surveys

VIT has committed to conduct aerial mapping of winter moose distribution. Commitment 35 in the Project Proposal (Stantec 2011) states:

> *VIT will implement annual aerial mapping of winter moose distribution within 5 km of the access road and mine site and in adjacent control areas. This will be conducted before construction (in 2011 and 2012), during construction, and during mine operations, to allow for assessment of displacement and population reduction resulting from mine activities, and adaptive management measures if negative effects occur.*

Subsequent comments received August 24, 2011 from Environment Yukon's Environmental Programs Branch, recommended changes to the commitment (YOR 2010-0267-197-1). The changes specified that the survey transects should extend 10 km from the access road and mine site, and that the area from 5 km to 10 km out was to be treated as the “control” area. These recommendations were received after the completion of the 2011 baseline moose distribution survey, which was conducted in March 2011. Consequently changes to the survey methods were not incorporated in the first year survey. During the 2011 survey, the access road survey transects were 10 km long on each side of the access road, whereas transects buffering the proposed mine site were between 5 km and 10 km long. No formal “control area” was established between the 5 km and 10 km marks along transects buffering the access road or the proposed mine site. VIT will incorporate the recommended changes to the survey study design in subsequent monitoring years.

After the initial survey years, VIT will evaluate the survey results with Environment Yukon to determine any required adjustments to survey methods and survey frequency. This evaluation has been the subject of communications with the Yukon Government Regional Biologist when it was discussed that if no effects are observed after five years of monitoring, the frequency of monitoring could possibly be reduced (O’Donoghue 2010, pers. comm.).

Summary of First Year Survey Results

Below is a summary of results from the 2011 survey. Please refer to Appendix R24 for the complete report: *Eagle Gold Project, Technical Data Report: 2011 Moose Distribution Aerial Survey*.

The 2011 survey provided pre-construction data on the distribution of moose in the vicinity of the Project. Analysis methods for this first survey entailed compiling and mapping the locations of moose observations including information on number, sex, and whether single animals or calf-cow pairs were seen.

The moose survey area was 1,130 km^2 and included the proposed mine site, the South McQuesten and Haggart Creek access road to the site, and a 10 km buffer extending in all directions from the access road and mine site center (Appendix R24, Figure 2.1-1). However, this study design is not consistent with the post-survey Environment Yukon recommendation of transects extending 10km from the access road and mine site perimeter as well as delineating the area from 5 km out to 10 km as a “control area”.

A fixed-wing Cessna 206 was used to conduct the survey over the three day period of March 7– 9, 2011. Two Stantec personnel, a Registered Professional Biologist and a Registered Professional Forester (both registered in British Columbia), and the aircraft’s pilot participated in the survey all three days. A member of the First Nation of Na-Cho Nyäk Dun (NNDFN) joined the survey team the second and third day.

Forty transects, spaced 1 km apart, were flown (Appendix R24, Figure 2.1-1). Transects were flown at a speed of 120 – 150 km/hr at a range of 100 – 400 m above ground. Aircraft speed, height-above-ground, and ability to fly “true” to transect lines were variable due to the rolling and mountainous terrain of the area. When spotted, moose were typically circled 1 – 2 times to identify sex and age, and to locate other moose potentially in the vicinity. All observed moose were recorded. Incidental moose observations (observations occurring outside the formal aerial survey area) were also recorded.

A total of 30 moose—seven cow/calf pairs, three cows, one bull, and 12 adults of undetermined sex—were observed in the survey area over the three-day survey period. Moose were observed throughout the survey area (Appendix R24, Figure 2.1-1) with the majority of animals occurring at mid to lower elevations east and south-east of the mine site between Lynx Creek and the South McQuesten River. Only one moose was observed within the proposed mine site area. This is consistent with habitat suitability findings (Stantec 2011) which indicated that the majority of preferred habitat for moose is found outside of the direct mine site footprint development area. No moose were observed directly on the access roads; though three moose were noted adjacent to the northern end of the Haggart Creek access road, near the south-western boundary of the proposed mine site. Four moose were also observed adjacent to the eastern section of the South McQuesten access road just off of Highway 11.

Effects of Snow Depth

Snow depth unrelated to mine activities is an important potential factor influencing moose abundance and distribution in the survey area. The Ungulate Winter Range Technical Advisory Team (2005) reviewed data from a number of published studies and identified the following snow depth categories for moose: “nominal” (snow depth does not inhibit movement) <60 cm; “inhibiting” (snow inhibits movement) 60 – 90 cm; and “critical” (snow severely restricts movement) >90 cm.

Snow surveys, within the aerial moose survey area, were conducted near the Potato Hills (high elevation) and Camp station (low elevation) locations in April 2009, March 2010, and March 2011 (Stantec 2011). Snow depths at the Camp Station have ranged between 50 and 69 centimeters and between 103 and 126 centimeters at the Potato Hills station during 2009 – 2011 survey efforts (Appendix R24, Table 3.2-1).

VIT has collected baseline climate data since 2007. A climate station was installed at Potato Hills (1,420 m asl) in August 2007, while a second station was installed near the camp (823 m asl) in August 2009. The second station was installed based on the findings of a snow survey undertaken in April 2009 at the Potato Hills station and at the Camp station location. The snow survey demonstrated large differences in snow accumulation between the two sites. Therefore two stations were necessary to characterize climatic conditions in the upper and lower elevations of the study area which exhibit significant variability due to elevation and physiography. The Potato Hills station is located in the southeast part of the Dublin Gulch drainage basin along the drainage divide, while the Camp climate station is located in the lower Dublin Gulch valley near the existing camp. In addition to automated meteorological stations VIT has conducted annual snow surveys that have been compared to Yukon Government snow survey data collected from two other nearby stations in Calumet and Mayo. Please see the climate baseline report for further detail (Appendix 7 of the Project Proposal) (Stantec 2011).

In March 2011 when the survey was conducted, snow depth was measured at 55 cm at the Camp Meteorological Station. At this nominal depth (<60 cm) it is not expected that moose movements in the lower Dublin Gulch valley were impeded during the March, 2011 survey. In comparison, snow depth measurements at the higher elevation Potato Hills Meteorological station were over one meter during March 2011 (Appendix 24, Table 3.2-1) which is the critical depth where snow severely restricts moose movement. Consistent with pre–survey assumptions and supported by literature (Keystone Wildlife Research 1995; MacCracken et al. 1997), moose were located outside of high alpine habitats and were consistently distributed at lower elevations during March, 2011. Snow depth restrictions on moose movement have implications for a number of critical factors such as foraging efficiency or ability to escape form predation by wolves.

Monthly snow accumulation data is available both Meteorological Stations and will be an important parameter to consider as further understandings of moose winter habitat use are established in subsequent survey years.

Closure

Monitoring of moose distribution via aerial surveys permits a snapshot-in-time comparison of the pre-construction data to the construction and initial operational phases of the mine development. The 2011 survey represents the first survey (baseline) upon which subsequent surveys will be compared to identify potential changes in both moose abundance and distribution. Survey findings will be used to both refine survey methods and inform adjustments to mitigations designed to minimize potential Project effects on moose.

9 AIR QUALITY

9.1 Background

R25. A description of the air quality model including a discussion of:

a. Why 2D modeling was used rather than 3D modeling and what effect this may have had on the conclusions reached.

b. Why reclamation activities were not included in the air quality model. Discuss how the inclusion of the activities would affect the results

c. Why wet deposition has not been included in the model.

R25.1 Response

a. Use of 2D Meteorological Data Model and Potential Effects on Conclusions

Dispersion modeling for the Project was completed using the US EPA CALPUFF v6.262 model in ISC mode (3D terrain and atmosphere fields with a 2D meteorological field) rather than CALMET mode (3D terrain and atmosphere fields with a 3D meteorological field) for the following reasons:

- The ISC mode simulates dispersion by incorporating the 3D complexity of the terrain.
- The meteorological database is not adequate as there are only two near-field stations for accurate representation of meteorological parameters (i.e., wind and temperature fields) in three dimensions over the modeled area (a CALMET requirement).

- The variable complexity of wind and temperature conditions observed at the site (e.g., timing and location of temperature inversions) could not be estimated beyond the site with any confidence.
- The ISC mode utilizes dispersion algorithms without having to fully develop fully three dimensional wind fields.

CALPUFF is a multi-layer, multi-species, non-steady-state dispersion model that can simulate the variable spatial and temporal effects of meteorological conditions on pollutant transport, transformation, and deposition. For this assessment, CALPUFF was applied in Industrial Source Complex (ISC) mode (rather than CALMET mode) to use single station winds in a format consistent with the available meteorological database. There are two meteorological stations (Camp and Potato Hills) in the modeled area and both of these are near field within the project boundary. There are no stations beyond the project boundary in the model domain. As a result there is nothing to support the development of three dimensional wind fields other than the terrain itself.

Using the CALPUFF model in the ISC mode considers complex terrain features. The model disperses the air contaminant concentrations in three dimensions and incorporates complex terrain algorithms that provide 3-dimensional modelling of terrain effects. However, during any of the 3-dimensional dispersion simulation time steps, while the meteorological parameters do not vary in the horizontal planes of the assessment area, the vertical variation of the meteorological parameters is computed. The model is suitable for estimating air quality concentrations on both local and regional scales, from tens of metres to hundreds of kilometres. The use of the model in ISC mode is consistent with the British Columbia Guidelines for Air Quality Dispersion Modelling (BC MOE, 2008). These guidelines are commonly accepted by Yukon Environment given the lack of Yukon-specific dispersion modelling guidance (Kostelnik, J. 2011, Pers. Com.).

Of the Criteria Air Contaminants (CACs) considered in the assessment, only the 24-hour predicted maximum TSP and $PM_{2.5}$ concentrations exceed applicable regulatory objectives. These exceedances occur at or directly adjacent to the proposed mine site. The predicted area in exceedance is a very small portion (approximately 3.5 km^2) of the modeled area (Stantec 2011). Application of 3D meteorological dataset would not be expected to materially change the maximum predicted concentrations nor the conclusions reached. This is because the only exceedances predicted were at or very close to the Project perimeter, where wind directions and wind speeds have low variability over short distances. At this short distance 2D meteorological data are adequate for modelling potential effects to air quality.

The model and its results use conservative assumptions. Low probability extreme scenarios were modeled to evaluate the potential significant adverse effects to air quality. Therefore the modeled predictions include a large safety margin while predicting that potential effects to air quality will not be significant. As examples of the conservative assumptions used, the effects of wet scavenging (natural dust suppression by rain and snow), even though they will occur, were not included in the assessment. If wet scavenging were considered, predicted exceedances of ambient air quality regulatory objectives would be less likely as one moved farther away from the Project perimeter. In addition, based on experience there is a high degree of confidence that emissions levels used in the model were over-estimates due to conservative assumptions regarding the proposed equipment inventory.

In sum, we believe that the use of 3D meteorological data would not substantively change the conclusion in the Project Proposal. As stated in the Project Proposal, the predicted concentrations of CAC's above the regulatory objectives are expected to be very rare, local, short in duration, reversible and therefore not significant. Any advantages of using the 3D CALMET mode would have been undermined by the large uncertainties associated with attempting to develop representative three-dimensional wind and temperature fields in the modeled area where no data exist.

As an additional safeguard, an air quality monitoring plan has been developed for use during the life of the Project (Section R27). Any exceedances will be addressed with adjustments to the fugitive dust control plan, and the combustion source control plan (Stantec 2011).

b. Why Reclamation Activities were not Modelled

The Project includes construction, operations, closure, and reclamation phases. Of these phases, the operations phase includes the greatest number of air emission sources and therefore offers the greatest potential for adverse effects to air quality. The contribution of reclamation activities is negligible relative to blasting, transport of waste rock and ore, ore crushing, and ore stacking that will occur throughout the approximate 7.3 years of operations.

Reclamation activities such as the excavation, transport and placement of stockpiled topsoil, subsoil, and overburden fines will produce dust, and there will be emissions from internal combustion engines. However, these effects on air quality will occur during active reclamation activities which are proposed for a short period of time relative to operations.

Because significant adverse effects will not result during the longer, more intensive operations phase, it is reasonable to conclude that significant effects will not result during other phases, including reclamation. Based on this reasoning, and to ensure that this approach would be sufficient for YESAB to assess potential effects of the Project on air quality, it is reasonable and more conservative to base the assessment of project effects during the reclamation phase by considering that the modeled results for construction and operations would be representative for the reclamation phase.

c. Why Wet Deposition was not Modelled

Wet deposition is the process whereby precipitation scavenges particulate from the atmosphere, and deposits it to the ground in liquid or solid form. It is an important naturally-occurring means to remove airborne particulate. The key reason for not including wet deposition is that inclusion of wet scavenging would have resulted in lower predicted concentrations of CACs away from the project site. The more reasonable and conservative approach to address far-field effects (e.g., potential effects on humans or wildlife in the vicinity of, for example, the confluence of the lower Haggart Creek-South McQuesten River) would be to assume that particulates were not scavenged by precipitation. Thus, as stated above in R25.1-a, consideration of wet scavenging was excluded in the dispersion modelling to create a more conservative assessment—one that provides greater confidence in the determination that potential effects on particulate air quality would not be significant.

Excluding wet deposition from the model slightly underestimates the amount of deposition that will occur close to the sources of emissions at the mine site. Within the mine site, mitigation measures such as soil salvage and appropriate placement of stockpiles from dust sources will be in place to mitigate dust deposition on soils.

Given the proven effectiveness of these mitigation measures, VIT concludes that the potential increases in dust concentration near the mine site will not have an adverse effect to the terrestrial environment.

R26. The distance at which the deposition of Total Suspended Particulate (TSP) is predicted to be indistinguishable from background rates, given that a very small area outside of the Project site will have concentrations of airborne TSP that exceed regulatory objectives.

R26.1 Response

TSP deposition was not modeled as part of this assessment. However, TSP airborne concentrations were modeled, and the amount of TSP deposition is expected to be directly correlated with airborne TSP low atmospheric level concentrations.

The model's uncertainty in predicted airborne concentrations at any given location is expected to be approximately ±10%. Given the direct correlation between TSP airborne concentrations and TSP deposition rates, the distance at which Project-related airborne concentration reach background airborne concentrations by ±10% should provide a good proxy of where Project-related deposition rates would be indistinguishable from background rates. The distances, depending on topography and meteorological conditions, at which the modelled TSP airborne concentration is ±10% of background airborne concentrations is approximately 10 to 15 km from the Project boundary (Stantec 2011). Consequently, the distance at which deposition of TSP is predicted to be indistinguishable from background rates is also approximately 10 – 15 km from the Project boundary.

R27. A detailed ambient air quality monitoring plan. Please make sure to include among others information regarding "maintenance of Criteria Air Contaminants (CAC) emissions inventories" and "Particulate Matter Monitoring".

R27.1 Response

Below is the Project's ambient air quality monitoring plan. It is at a detail appropriate for the Project Proposal's level of design. As Project design advances the plan will be modified.

Objectives

The Project will produce atmospheric emissions as detailed in the Project Proposal Air Quality TDR (Stantec 2011). To help manage and mitigate potential effects on air quality from Project emissions, VIT has prepared the following Air Quality Monitoring Plan, which applies to all phases of the Project. The Plan has the following objectives:

- To monitor compliance with the regulatory objectives
- To assess the effectiveness of mitigation measures related to air quality
- To help refine or enhance mitigations, if deemed necessary by results of the monitoring.

Air Quality Monitoring

Dispersion modeling results (Stantec 2011) predict that Project emissions of the Criteria Air Contaminants (CACs), except for particulate matter, will not exceed applicable regulatory objectives and standards. Assuming conservative meteorological conditions (e.g., no wet scavenging, high winds, etc.), predicted concentrations of total suspended particulates (TSP) and respirable particulate matter ($PM_{2.5}$) may exceed the Canada regulatory objectives (Health Canada 2006) and the Yukon Ambient Air Quality Standards (Yukon Environment 2010) near the Project site. High rates of dustfall can also be expected to occur during periods of high ambient TSP concentrations[1]. Therefore, dustfall measurements will be the primary means of monitoring ambient particulate conditions near the mine. These measurements will be complemented by continued meteorological observations. A map of the Project area showing existing meteorological stations and proposed dustfall stations is included as Figure R27.2-1.

Meteorology

VIT currently operates two continuous meteorological monitoring stations near the proposed mine site: i) Potato Hills at 1420 m asl from July 2007 to present, and, ii) at the existing advanced exploration camp (Camp) at 823 m asl from August 2009 to present. These stations are marked as M1 and M2, respectively, on Figure R27.2-1. An analysis of wind data from these stations is included in the Project Proposal Air Quality TDR (Stantec 2011). The dominant wind direction at the Potato Hills station is from the west-northwest, and at Camp station the prevailing direction is from the north. At Camp station, winds less than 2 m/s are frequent, suggesting a high incidence of stagnant days. The Camp station is relatively protected, while the Potato Hills station is open to the prevailing winds. Continued operation of these two meteorological stations is required to support meteorological monitoring at the Project. The existing wind database for these stations is summarized in Appendix 7 (Eagle Gold Project Environmental Baseline Report: Climate) of the Project Proposal (Stantec 2011).

Particulate Matter (PM)

Dustfall monitoring is a simple and cost-effective means of evaluating effects of particulate emissions downwind of the sources. Dustfall is airborne PM that accumulates on a horizontal surface due to gravitational settling and wet deposition. Dustfall monitoring will comprise Phase 1 of the PM monitoring program. If results of the dustfall monitoring from any of the stations indicate exceedance of the 1.75 $mg/dm^2/d$ standard, then Phase 2 of the program will be activated.

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[1] Environment Yukon does not have a dustfall objective; therefore, the BC dustfall objective (1.75 $mg/dm^2/d$) will be applied as the standard.

Phase 1: Dustfall Monitoring

Dustfall monitoring stations will be installed during or prior to the construction phase of the Project. Equipment standards and siting recommendations from ASTM (2010) will be followed to the extent practicable. Four stations will be installed; this will allow for rejected samples and sampling in areas of various distance and direction from the Project disturbance area. Station locations are shown on Figure R27.2-1. These are preliminary locations, which will be adjusted as needed to satisfy siting recommendations and accessibility considerations.

Dustfall station D1 will be co-located with the Potato Hills meteorological station. Although downwind of the mine site, this station will be far enough away from mine activities (approximately 2 km) to serve as a background reference for the area, as it is beyond the area found to be significantly influenced by TSP from the mine (Stantec 2011).

Dustfall station D2 will be located at or near the Camp meteorological station. This station will be representative of the Project area boundary.

Station D3 will be located below the hilltop just southeast of the Project area. This corresponds to the area of highest TSP concentrations and dustfall that were predicted by dispersion modeling (Stantec 2011a), i.e., the area of maximum impingement.

Station D4 will be approximately 1.5 km south of the mine camp, to the east of the access road. This location is downwind of prevailing winds at the Camp meteorological station.

Dustfall collectors will be installed far enough from roads (>100 m) so as to not be dominated by locally generated road dust.

Both Environment Canada and Yukon Environment will be consulted prior to installation of the dustfall monitoring stations for input regarding site selection.

The sampling accumulation period for the dustfall stations will be one calendar month. The dustfall collectors will be changed out monthly and sent to a certified lab for analysis. Sampling procedures will follow those detailed in ASTM (2010). Total dustfall will be calculated in $mg/dm^2/d$, averaged over a 30-day period, to correspond to the BC objective. Analysis of metals content in the dustfall will also be included in the lab work.

Phase 2: Ambient PM Monitoring

If triggered by exceedances of the dustfall standard, Phase 2 will consist of ambient monitoring of TSP and $PM_{2.5}$, which will be deployed along with enhanced dust mitigation measures. The PM monitoring will provide an additional means of evaluating the effectiveness of mitigation procedures and will allow for comparison to the national objectives and Yukon Environment standards that exist for TSP and $PM_{2.5}$.

Instrumentation will be placed at or near the site of the Camp meteorological and dustfall station. Sampling equipment will consist of either a constant flow air monitoring system or a discrete sampler designed for regulatory compliance monitoring. Environment Canada and Yukon Environment will be consulted prior to site selection and installation of the PM station.

The sampling interval will be 24 hours or shorter to enable reporting of 24-hour and annual averages for comparison to national objectives and territorial standards.

Greenhouse Gases

Environment Canada administers the Greenhouse Gas Emissions Reporting Program, which requires annual reporting by operators of facilities in Canada that emit 50 kilotonnes (kt) or more of greenhouse gases (GHGs), in carbon dioxide equivalent (CO_{2e}) terms annually. This requirement does not apply to the Project, as the predicted Operations phase emissions are less than 8 kt CO_{2e} per year.

Data Recording and Reporting

VIT is committed to applying industry standard best management practices to reduce Project emissions. VIT will construct and operate the Project in a way that minimizes the release of PM to the atmosphere and thus minimizes the potential for the ambient standards to be exceeded. VIT will adopt a range of design and operational safeguards and procedures for the Project to ensure that emission controls are working effectively through the different stages of the Project. Specific mitigation measures and commitments to protect air quality are included in the Project Proposal (Stantec 2011).

The efficacy of these efforts will be evaluated through the monitoring phases detailed above. Data management and record keeping will be an integral part of the monitoring program. Dustfall sampling and reporting will be performed in accordance with the industry standards (ASTM 2010). If implemented, PM monitoring will follow the Environment Yukon guidelines.

Data from the monitoring program will be reviewed monthly as dustfall results become available. If exceedance of any of the applicable objectives or standards is detected, then VIT will take the following actions:

1. Review all applicable air quality and meteorological data as well as metadata (e.g., records of Project activities during the exceedance period, field notes from monthly dustfall station visits, and any other information that may be relevant) to diagnose the conditions that led to the exceedance episode.
2. Based on findings from Step 1, modify or add mitigation measures to reduce airborne PM.
3. Notify Government of Yukon of the exceedance and any changes to mitigation measures.

Additionally, VIT will report air quality monitoring results as required by Yukon Government on an annual basis.

R28. A description of how open burning of cleared vegetation was accounted for in the emission estimates.

R28.1 Response

Estimates of potential emission from open burning of cleared vegetation indicated that emissions from this source would not present a potential significant effect. Any potential effects will be mitigated using measures discussed in the Air Quality Monitoring Program and Air Quality effects assessment in Section 6.6 of the Project Proposal. Consequently, emissions from open burning of cleared vegetation were not included in the reported emission estimates.

Following salvage logging, the amount of land-clearing waste remaining from the construction and operations phases is estimated to be 9,635 tonnes and 298 tonnes respectively (Appendix 30, Section 15, table 16.1, in Stantec 2011). It was assumed that all land-clearing waste will be disposed of through open burning. Using a TSP emission factor of 4.0 kg/tonne burned (Taylor and Sherman 1996) the total TSP emission due to open burning during the Construction and Operations phases are 38.5 tonnes and 1.2 tonnes respectively.

TSP is the principal contaminant of concern. The estimated 31.8 tonnes of TSP produced per year by open burning during the eighteen months of construction is 14% of the 228 tonnes per year produced by dust and engine exhaust. After the start of operations in 2013, open burning will take place over several years. During operations, the total TSP open burning emissions estimate of 1.2 tonnes is 0.4% of the TSP dust and engine exhaust emission estimates of 332 tonnes per year (Appendix 9 of the Project Proposal, Stantec 2011).

It is estimated that open burning will result in emissions of 39.7 tonnes of TSP. This estimate is small compared to that produced from other sources during construction and particularly operations, and is very small in comparison to that emitted from naturally occurring activities such as wildfire.

VIT's air quality monitoring program (see R27) will monitor emissions from open burning to indicate whether additional mitigation measures are required. The activity will be timed in conjunction with other mine activities to assure that open-burning does not result in exceedances of regulatory objectives. Piles of debris will be allowed to dry before burning, and efforts will be made to exclude soil and rock from burn piles. In this way combustion will be enhanced, minimizing the by-product smoke.

10 OUTFITTING

10.1 Background

The spatial scope of the Project overlaps with trapping and an outfitting concession and may have potential to reduce the remote wilderness setting for clients and reduce the quantity of game and hunter success. During the public comment period, Midnight Sun Outfitters pointed out that the Project will downsize the concession land base and accordingly reduce potential hunting area and revenue (YOR 2010-0267-199-1). Further Midnight Sun Outfitters indicated that the proponent has not initiated any discussions about compensation. Yukon Government, Economic Development is concerned about the lack of data pertaining to impacts of the Project to outfitting and tourism in the area (YOR 2010-0267-197-1). The Executive Committee requires information regarding communication between the proponent and the outfitter and trappers in order to better understand project effects.

Therefore, please provide the following information:

R29. Describe any follow-up communication with the outfitter and trappers, especially regarding compensation.

R29.1 Response

Registered Trapline Concessions

VIT is committed to engaging with Registered Trapline Concession (RTC) holders that may be adversely affected by the Project. The following paragraphs describe the RTCs that overlap with Project, engagement to date with the holders and VIT representatives, and the status of ongoing discussions.

RTCs provide both economic benefits as well as preservation of traditional activities for their operators. Two RTCs overlap with the Project footprint including the proposed mine site, transmission line corridor and access road upgrade. The proposed mine site and the majority of the access road/transmission line corridor overlaps with RTC #81 (Figure R29-1). A relatively small portion of the access road/transmission line corridor overlaps with RTC #84 (Figure R29-1).

RTC #81

Contact was initiated with the holders of RTC #81 in May 2010. Subsequent meetings and telephone conversations regarding compensation have taken place between VIT representatives and legal representation for the holders of RTC #81. Conversations involved potential impacts of both the proposed Eagle Gold mine and the advanced exploration camp at Dublin Gulch. VIT began communicating with the trapper working RTC #81 in early 2010 to minimize or mitigate any impacts the exploration program might have on trapping success. VIT has undertaken discussions to determine the location of traps so they can be avoided and minimize disturbance in the immediate area. In addition, VIT has cleared and maintained the South McQuesten Road (SMR) and Haggart Creek Road (HCR) in winter to allow better access to the exploration camp, and provided pull-outs which create easier and safer winter access for the trapper to the trap line. Additionally the trapper maintains informal communication with VIT's Camp Manager at the exploration camp to help ensure current operations and future Project activities minimize any impact to RTC #81. The objective of future dialog with the concession holder and the trapper currently working the concession will be to better understand how the proposed Eagle Gold Mine Project and existing exploration program may affect the value of RTC #81. Discussions are ongoing and confidential.

RTC #84

Contact was initiated by VIT with the holders of RTC #84 in the fall of 2010. At the time there was no immediate concern by the holders. VIT has been available during frequent community open houses and meetings, and generally in the community as a result of the current advanced exploration program. VIT is not aware of any concern of RTC #84 holders about the Project. VIT will continue to update the RTC#84 holder with Project information and be available for discussion about any potential impacts the Project may have on RTC #84. Discussions are ongoing and confidential.

Outfitting Concessions

VIT is committed to engaging with the two outfitting concession holders that may be adversely affected by the Project.

Yukon Outfitting Concessions provide exclusive rights to outfit hunting to non-residents in their respective areas. However, these exclusive rights do not extend to limit other land users within a given concession area. The Department of the Environment, Yukon Government is responsible for the management of wildlife and inland fisheries on territorial lands. That department issues concessions for big game guide outfitting which provide the right to guide non-resident hunters within concession areas.

There is one outfitting concession that overlaps with the proposed Project. The proposed mine site and the access road/transmission line corridor overlaps with outfitting concession #4 (Figure R29-1). Outfitting concession #7 is located south of Highway 11 and is therefore adjacent but does not overlap with the proposed Project footprint (mine site and access road/transmission line corridor).

Below are descriptions of the two concessions that may be affected by the Project, VIT's engagement to date with the holders, and the status of ongoing discussions.

Outfitting Concession #4

Midnight Sun Outfitting Ltd. holds Concession #4. The concession covers approximately 31,000 km^2 (including the Project footprint). This includes the watersheds of the Wind, Hart, Klondike, Little Wind, and McQuesten Rivers. Trips are conducted from late-July to early-October. In addition Midnight Sun Outfitting Ltd. offers fishing and other wilderness adventures (e.g., canoeing, rafting, heli-hiking).

VIT contacted the owner of Midnight Sun Outfitting Ltd., Alan Young, on October 15, 2010 via telephone. During the conversation, VIT's Environmental Manager introduced the Project and discussed possible face to face meeting in Whitehorse during November 2010 to provide an update on Project plans and potential interactions with Concession #4. Subsequently, Alan Young and VIT's Vice President Yukon held two telephone discussions regarding Midnight Sun Outfitting's operations and the Project. Mr. Young made clear his opinion the two activities (exploration/mining and outfitting) are incompatible and that Midnight Sun Outfitting should be compensated for lost outfitting land base. VIT has offered to discuss the coordination where possible of management plans for both operations during overlapping seasons to minimize disturbance to respective operations. At that time Midnight Sun Outfitting was not interested in working with VIT.

During the public comment period, however, Midnight Sun Outfitting Ltd. did provide YESAB comments on the Project Proposal (YOR 2010-0267-199-1). In the comments, Alan Young states that the Project will downsize the concession land base and accordingly reduce potential hunting area and revenue. Mr. Young also indicated that the proponent has not initiated discussions regarding compensation.

Representatives of Midnight Sun Outfitting and VIT met on October 25, 2011 to discuss the comments provided to YESAB. Alan Young presented concerns about the Project consistent with those provided to YESAB. VIT stated its understanding that Midnight Sun Outfitters does not hold land tenure that overlaps with the proposed Project footprint. Further, VIT was not aware of any outfitting operations within the proposed Project footprint over the last five years. VIT personnel have been operating the exploration camp and conducting environmental and engineering studies for the past five years at Dublin Gulch. Given this information and that Midnight Sun Outfitters does not hold land tenure that overlaps with the proposed Project footprint it appears that outfitting activities likely focus on more remote areas of the relatively large geographic area of Concession #4. VIT is of the opinion that there is very little potential for the Project to adversely affect the outfitting operation of Midnight Sun Outfitting Ltd. (Concession #4). As for positive effects of the Project, outfitting concession holders may experience indirect benefits, if Project employees or contractors decide to utilize their services for vacation or recreational activities in the future.

In the October 25, 2011 meeting, VIT representatives requested that Midnight Sun Outfitting information about its use of the proposed Project footprint. VIT will continue to engage in dialog with Midnight Sun Outfitting to better understand how the Project may affect the value of Concession #4. Discussions are ongoing and confidential.

Outfitting Concession #7

Outfitting concession #7 is held by Rogue River Outfitting Ltd. As described above, the proposed Project footprint, including the mine site and the access road/transmission line corridor, do not overlap with the concession boundaries. However, the concession is located adjacent to the proposed Project footprint. Therefore VIT initiated contact with the concession holder to determine if there were any concerns regarding the proposed Project or existing exploration activities. A telephone message from October 2010 was not returned, no comments were provided by the holder during the public comment period, and VIT is not aware of any concern about the Project from the holders of outfitting concession #7.

11 CLARIFICATIONS

R30. Figure 1 and Figure 2 in Appendix 28 (Passive Treatment System) are missing. Please supply the correct figures.

R30.1 Response

Please see Appendix R30.

R31. Confirm the estimates of groundwater flows to the pit and from pit dewatering presented in Appendix 21 (Water Management Plan), the time needed to fill the pit and the inflow rates. Please include a discussion on implications on water treatment and closure Acknowledgement and Certification.

R31.1 Response

Based on follow-up discussions with YESAB, the request to confirm the estimates of groundwater flows to the pit and from pit dewatering stems from a NND submittal, which stated:

> *"The estimates appear somewhat erratic during operations but additional details about the predictions are not provided – though referenced to BGC. Also, the closure plan predicts that the pit will fill within a single year once pumping is discontinued, but the inflow rates appear inadequate to fill this capacity that quickly. Additional information about predicted flow rates should be provided and the rates should be reconciled with timing for closure activities and outcomes.*
>
> *… request clarification about pit inflows and the implications on treatment and closure requirements."*

The key to the request is based on explaining the cause for the "apparent" predicted erratic inflows to the pit, and how BGC (2010) derived these values. The second part of NND's comment requests an explanation on the derivation of the rate of pit infilling associated with these predictions, and the last part of this request concerns the implication of these predictions on treatment and closure requirements. Thus, this response is discussed in three parts.

1. With respect to the "erratic" estimates, the annual fluctuations in groundwater inflows shown in Table 5.2-3 of Appendix 21 of the Project Proposal (Surface Water Balance Model Report – **NOTE:** the Water Management Plan is Appendix 18 of the project Proposal) reflect how the model represented the stages of open pit development.

   In the numerical model, each stage of the open pit was represented by drain cells, which were turned on with each expansion of the pit (i.e. the pit shells) corresponding to Mine Years 1, 3, 5, and 8. The conductance of the drains was set to a high value to allow water to freely drain into the simulated open pit. Thus, whenever a pit shell was turned on, a large inflow rate occurred in response to the instantaneous removal of a portion of the pit slope. As the model simulation continued in time, the inflow rate dropped as water levels approached a new equilibrium position. In reality, mining will be essentially continuous, and inflow rates would increase in a more gradual (or smoother) fashion. Including annual pit shells would result in smoothing of the predicted inflow rate, however spikes in the predicted inflow rate would still be present.

   Further, groundwater inflows were predicted for two scenarios: 1) Active Depressurization (AD); and, 2) No Dewatering Wells (NDW). The AD scenario assumed the use of both horizontal drains (referred to as Open Pit Flows in Table 5.2-3) and dewatering wells (referred to as Well Flows in Table 5.2-3), whereas the NDW scenario assumed only horizontal drains. Inflow data from the groundwater modeling study are summarized for the Active Depressurization scenario **only** on an annual basis (in m^3/day) in Table 5.2-3 and a monthly basis (in m^3/mo) in Table C1-1 of Appendix 21. **Both** scenarios (AD and NDW) are presented on a monthly basis in Tables B-5 and B-6 of Appendix 21.

For the purposes of the assessment and from a conservative standpoint, the AD scenario was assumed so that some combination of horizontal drains and dewatering wells would be used (based on BGC's modeling results) as it was the more likely scenario that would be followed and it resulted in more total water that would need to be managed.

2. The calculated time needed to fill the pit at closure was based on the assumed pit volume (270,000 m^3), amount of backfilling (~150,000 m^3) and the inflow rates from pit wall runoff/snowmelt (which represent from 87% to 99% per month of the total inflow) plus any residual input from the horizontal drains (no active dewatering after closure). At closure, it was conservatively assumed that the groundwater inflow to the pit would be equivalent to the last year of modeled horizontal drain flows (or 42 m^3/day).This value represents only a small fraction of the total inflow to the pit, and was assumed to be constant for the duration of closure and reclamation and post-closure monitoring.

   The estimated time needed to fill the pit is described in Section 6.3.1, which states that after freshet 2027 (i.e., after a six-year period of reclamation and stabilization), the open pit would be allowed to slowly fill and then form a small pit lake. The lake is expected to take approximately three months to fill approximately 120,000 m^3 assuming average hydroclimatic conditions (groundwater inflow during this time represents about 3.2% of the total).

3. As noted above for closure, the water balance model assumes that groundwater inflows from the horizontal drains do not decrease over time (i.e., as would occur until a new equilibrium between recharge and discharge is attained), and so likely overestimating that proportion. Further, groundwater inflows to the pit represent only a minor to negligible proportion of the total annual flow to the pit; most of the inflow is pit wall runoff and precipitation. Thus, the effects of the assumed (and predicted) groundwater inflow rates are not significant to treatment volume during post operations or during post-closure.

12 REFERENCES

ASTM. 2010 Standard Test Method for Collection and Measurement of Dustfall (Settleable Particulate Matter). D 1739-98(2010)

BC Ministry of Environment (BC MOE). 2006. British Columbia Approved Water Quality Guidelines, 2006 Edition. Science and Information Branch. Available at: http://www.env.gov.bc.ca/wat/wq/BCguidelines/approv_wq_guide/approved.html

BC Ministry of Environment (BC MOE). 2008. *Ambient Aquatic Life Guidelines for Iron, Overview Report*. Available at: http://www.env.gov.bc.ca/wat/wq/BCguidelines/iron/iron_overview.pdf

BC Ministry of Environment (BC MOE). 2011. *Ambient Water Quality Guidelines for Manganese. Overview Report.* Available at: http://www.env.gov.bc.ca/wat/wq/BCguidelines/manganese/manganese.html

BGC Engineering Inc. (BGC). 2010. *Eagle Gold Project, Pre-Feasibility Open Pit Depressurization.* Final Report, May 31

Buhl, K.J. and S.J. Hamilton. 1991. "Relative sensitivity of early life stages of arctic grayling, coho salmon and rainbow trout to nine inorganics". *Ecotoxicol. Environ. Safety* 22: 184-197

Canadian Council of Ministers of the Environment (CCME). 2001. "Canadian water quality guidelines for the protection of aquatic life: Arsenic". Updated. In: *Canadian environmental quality guidelines*, 1999, Canadian Council of Ministers of the Environment. Winnipeg, MB

Canadian Council of Ministers of the Environment (CCME). 2003. "Guidance on the Site-Specific Application of Water Quality Guidelines." In *Canada: Procedures for Deriving Numerical Water Quality Objectives*. Available at: http://ceqg-rcqe.ccme.ca/

Canadian Council of Ministers of the Environment (CCME). 2007. "A protocol for the derivation of water quality guidelines for the protection of aquatic life 2007." In: *Canadian Environmental Quality Guidelines*, Canadian Council of Ministers of the Environment. Winnipeg, MB. Available at: ceqg-rcqe.ccme.ca/download/en/220/

Canadian Council of Ministers of the Environment (CCME). 2009. "Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary Table." Updated 2009. In: *Canadian environmental quality guidelines*, 1999, Canadian Council of Ministers of the Environment. Winnipeg, MB

Chapman P.M., W.J. Adams, M.L. Brooks, C.G. Delos, S.N. Luoma, W.A. Maher, H.M. Ohlendorf, T.S. Presser, and D.P. Shaw. 2010. *Ecological Assessment of Selenium in the Aquatic Environment*. Society of Environmental Toxicology and Chemistry (SETAC). Pensacola, FL

Demchak, J., T. Morrow, and J. Skousen. 2001. "Treatment of Acid Mine Drainage by Four Vertical Flow Wetlands in Pennsylvania," *Geochemistry: Exploration, Environment, Analysis* 1(1): 71–80

Elphick, J. M. Davies, G. Gilron, E. Canaria, B. Lo and H. Bailey. 2011. An aquatic toxicological evaluation of sulphate: the case for considering harness as a modifying factor in setting water quality guidelines. Env. Toxicology and Chemistry 30: 247-253

Ford, R.G., R.T. Wilkins and S. Acree. 2006. *Site Characterization to Support Use of Monitored Natural Attenuation for Remediation of Inorganic Contaminants in Ground Water*. US EPA

GEO-SLOPE International, Ltd. (GEO-SLOPE). 2007. *Vadose Zone Modeling with VADOSE/W 2007: An Engineering Methodology*. Calgary, AB

Gusek, J.E. 2009. "A Periodic Table of Passive Treatment for Mining Influenced Water." *2009 National Meeting of the American Society of Mining and Reclamation, Billings, MT. Revitalizing the Environment: Proven Solutions and Innovative Approaches, May 30-June 5*, 2009. R.R. Barnhisel (Ed.) Published by ASMR. Lexington, KY

Hallam Knight Piésold Ltd. 1996. *New Millennium Mining Ltd., Dublin Gulch Project, 1996 Fisheries Survey*. Prepared for Department of Fisheries and Oceans Canada. 12pp

Hamilton, S.J. and K.J. Buhl. 1990. "Safety assessment of selected inorganic elements to fry of chinook salmon (*Oncorhynchus tshawytscha*)." *Ecotoxicol. Environ. Safety* 20: 307-324

Health Canada. 2006. *National Ambient Air Quality Objectives*. Available online at: http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/reg-eng.php#a3

Interstate Technology Regulatory Council (IRTC). 2003. *Technical and Regulatory Guidance Document for Constructed Treatment Wetlands*, Washington, DC

Interstate Technology Regulatory Council (IRTC). 2005. *Permeable Reactive Barriers: Lessons Learned/New Directions*. PRB-4. Permeable Reactive Barriers Team. Washington, DC

Interstate Technology Regulatory Council (IRTC). 2011a. *Aeration*. Mining Waste Team. Accessed: November 8. Available at: http://www.itrcweb.org/miningwaste-guidance/to_aeration.htm

Interstate Technology Regulatory Council (IRTC). 2011b. *Technology Overview as part of a Web-based Technical and Regulatory Guidance: Microbial Mats*. Available at: http://www.itrcweb.org/miningwaste-guidance/to_microbial_mats.htm

Jin, S., P.H. Fahlgren, J.M. Morris, and R.B. Gossard. 2008. "Biological Source Treatment of Acid Mine Drainage Using Microbial and Substrate Amendments: Microcosm Studies," *Mine Water and the Environment* 27(1): 20-30.

Kappes, Cassiday & Associates. 1996. *Dublin Gulch Project Laboratory Report of Metallurgical & Environmental Studies*.

Kappes, Cassiday & Associates. 1997. *Dublin Gulch Project Phase II Metallurgical Test Report*.

Kappes, Cassiday & Associates. 2010. *Eagle Gold Heap Leach Project Metallurgy and Detoxification Summary*

Keystone Wildlife Research. 1995. *Wildlife studies on the Okanagan Connector Freeway, 1987-1992*. Report prepared for BC Ministry of Transportation and Highways, Victoria, BC

Khangarot BS, Ray PK. 1989. "Sensitivity of midge larvae of *Chironomus tentans* Fabricus (Diptera Chironomidae) to heavy metals." *Bulletin of Environmental Contamination and Toxicology* 42: 325-330

Klaverkamp, J.F., D.A. Hodgins, and A.Lutz. 1983. "Selenite toxicity and mercury-selenium interactions in juvenile fish." *Arch. Environ. Contam. Toxicol*. 12: 405-413

Knight Piésold. 2011. *Post-Closure Passive Treatment Systems*. Prepared for Victoria Gold Corporation

MacCracken, J.G., V. Van Ballenberghe, and J. M. Peek. 1997. "Habitat relationships of moose on the Copper River Delta in coastal south-central Alaska." *Wildlife Monographs* (136): 5-52

Madrone Environmental Services Ltd.(Madrone). 2006. *Dublin Gulch Project Gap Analysis: Environmental Baseline Information*. Prepared for Strata Gold Corporation. 32pp

Nagpal, N.K. and K. Howell. 2001. *Water Quality Guidelines For Selenium. Technical Appendix*. Water Protection Branch, Water, Lands and Air Protection, Victoria, BC. Available at: http://www.env.gov.bc.ca/wat/wq/BCguidelines/selenium/ index.html

Nagpal, N.K., L.W. Pommen and L.G. Swain. 2006. *A compendium of working water quality guidelines for British Columbia*. Environmental Protection Division, Ministry of Environment. Available at: http://www.for.gov.bc.ca/hfd/library/ffip/Nagpal_NK2001.pdf

O'Donoghue, M. 2010. Email, August 5. Northern Tutchone Regional Biologist, Environment Yukon, Fish & Wildlife Branch. Mayo, YT

Pendray, T., 1983. *Life History and Habitat Utilization of Arctic Grayling (Thymallus arcticus) in Two Central Yukon Drainages*. Land Planning Branch, Department of Renewable Resources, Government of Yukon, Yukon River Basin Study, Project Report: Fisheries No. 8. 63pp

Roe, S., L. Van der Vliet, A. Bouffard, J. Leney, T. El-Fityani, and L. Clark. 2010. *Canadian water quality guidelines for the protection of aquatic life for cadmium, uranium and zinc developed under the Canadian Council of Ministers of the Environment (CCME)*. Environment Canada. Aquatic Toxicity Workshop 2010, presentation

Scott Wilson Mining. 2010. *Pre-Feasibility Study on the Eagle Gold Project, Yukon Territory, Canada*. August 13, 2010 (July 16, 2010). Prepared for Victoria Gold Corp by Scott Wilson Roscoe Postle Associates Inc, Toronto, ON. Authors: J. Cox, D. Rennie and D. Kappes. 334 pp

Stantec Consulting Ltd. (Stantec). 2011. *Eagle Gold Project: Project Proposal for Executive Committee Review*. Prepared for Victoria Gold Corp. by Stantec. Consulting, Ltd. Burnaby, BC. Available at Yukon Environmental and Socio-economic Assessment Board (YESAB) online registry: http://www.yesab.ca

Taylor and Sherman. 1996. *Biomass Consumption and Smoke Emissions from Contemporary and Prehistoric Wildland Fires in British Columbia*

Tetra Tech. 2011. *Technical Memorandum – Seepage and Draindown Evaluation of the 66 Million Tonne Eagle Gold Project Heap Leach Facility*. November 23

Tremblay, G.A. and C.H. Hogan (eds.). 2001. *MEND Manual 5.4.2d., Volume 4 – Prevention and Control*

United States Environmental Protection Agency (US EPA). 2004. *Draft Aquatic Life Water Quality Criteria for Selenium*. EPA-822-D-04-001. Office of Water, Office of Science and Technology, US Environmental Protection Agency, Washington, DC

United States Environmental Protection Agency (US EPA). 2011. *National recommended water quality criteria*. Available at: http://water.epa.gov/scitech/swguidance/standards/current/index.cfm

Watzlaf, G. R., K. T. Schroeder, and C. L. Kairies. 2000. *Long-Term Performance of Anoxic Limestone Drains*. US Department of Energy, National Energy Technology Laboratory. Available at: www.imwa.info/bibliographie/19_2_098-110.pdf

West, R.L., M.W. Smith, W.E. Barber, J.B.Reynolds, and H.Hop. 1992. "Autumnal migration and over-wintering of Arctic grayling in coastal streams of the Arctic National Wildlife Refuge, Alaska." *Transactions of the American Fisheries Society* 121: 709-715

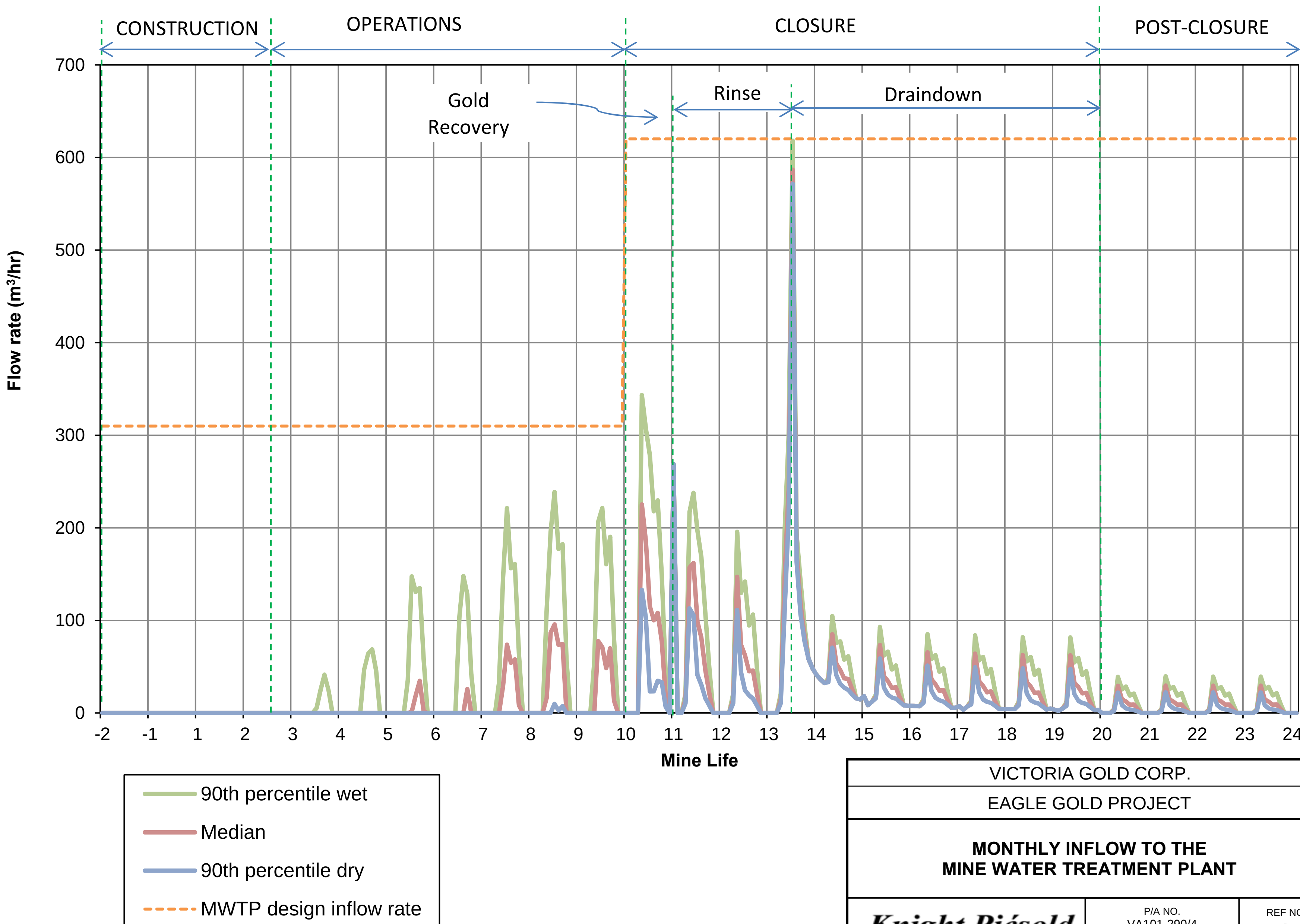
Wilkins, R.T. 2006. *Metal Attenuation Processes at Mining Sites*. US Environmental Protection Agency

Yukon Environment. 2010. *Yukon Ambient Air Quality Standards*. Available online at: http://www.env.gov.yk.ca/monitoringenvironment/documents/ambient_air_quality_standards_2010.pdf. Accessed November 2011

Yukon Environment. 2011. *Protocol for the Contaminated Sites Regulation. Protocol No. 6. Application of Water Quality.* Available at: http://www.env.gov.yk.ca/monitoringenvironment/documents/protocol_6_water_quality_standards_mar-11.pdf

13 FIGURES

Please see the following pages.



0	21NOV'11	ISSUED FOR INFORMATION	ER	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

VICTORIA GOLD CORP.

EAGLE GOLD PROJECT

MONTHLY INFLOW TO THE MINE WATER TREATMENT PLANT

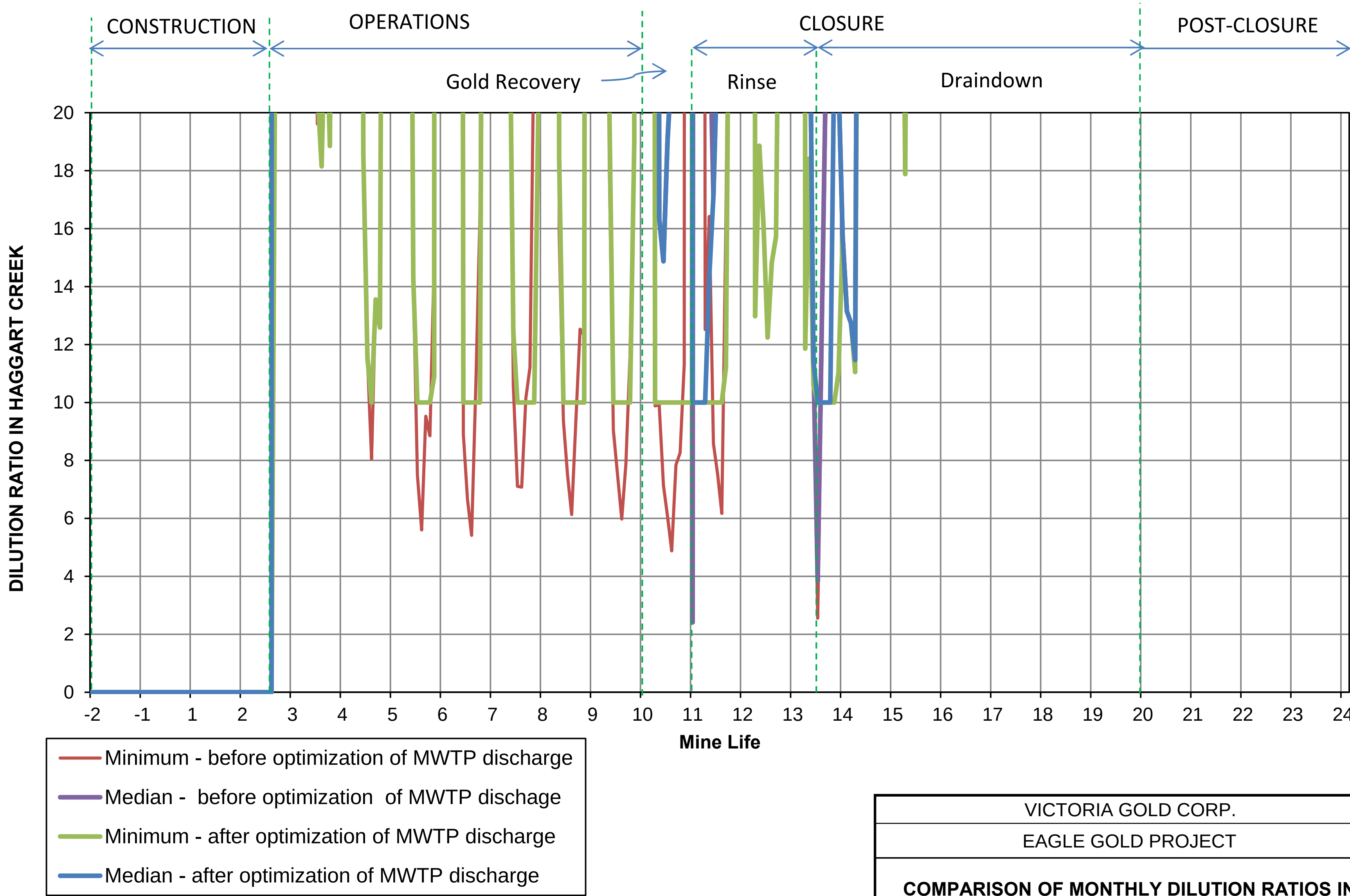
Knight Piésold CONSULTING

P/A NO. VA101-290/4

REF NO -

FIGURE R1-1

REV 0



NOTES:

1. MINE WATER TREATMENT PLANT BECOMES OPERATIONAL AS OF JULY 2024, AT MINE START UP.

0	24NOV'11	ISSUED FOR INFORMATION	ER	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

VICTORIA GOLD CORP.

EAGLE GOLD PROJECT

COMPARISON OF MONTHLY DILUTION RATIOS IN HAGGART CREEK

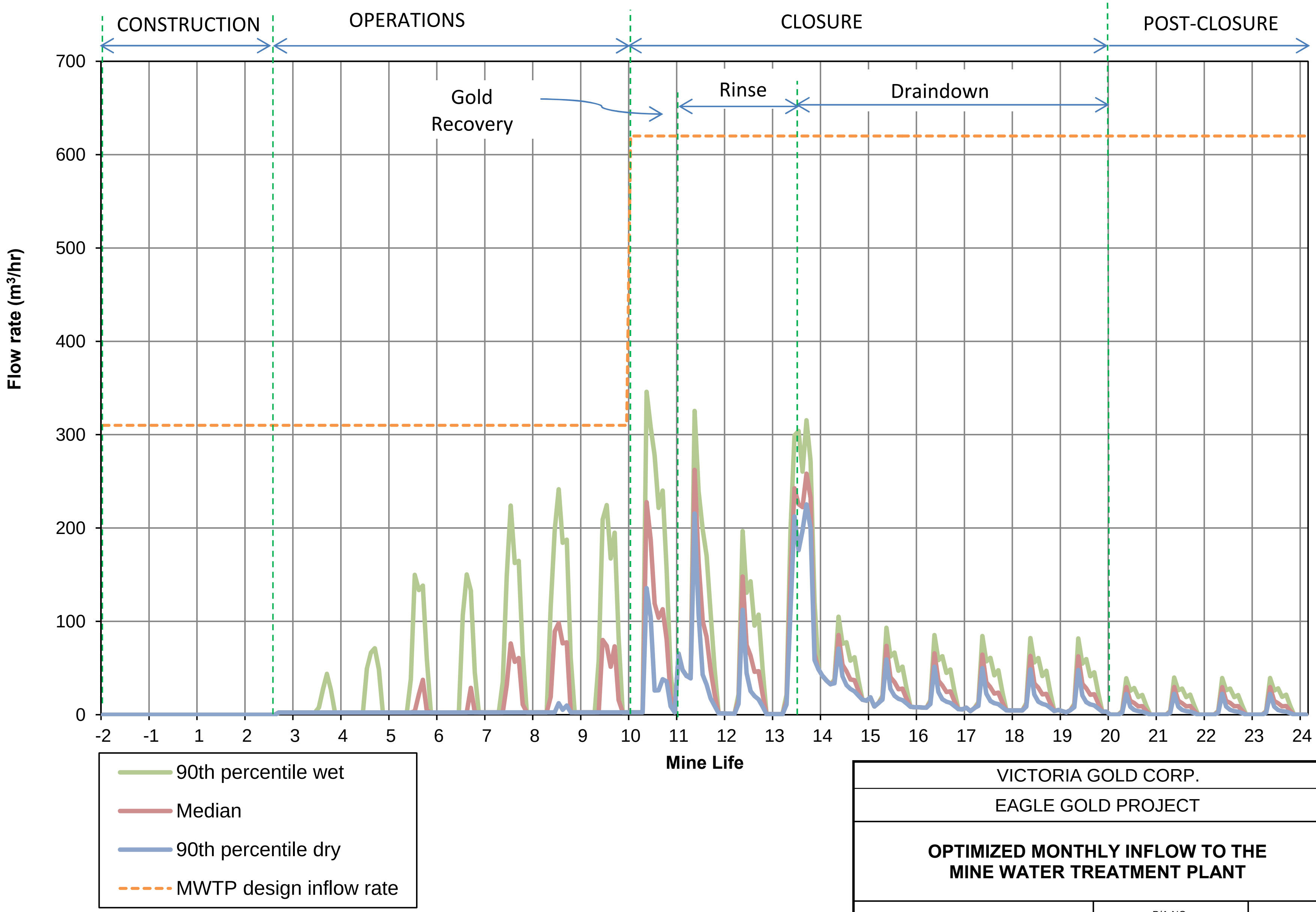
Knight Piésold CONSULTING

P/A NO. VA101-290/4

REF NO -

FIGURE R1-2

REV 0



VICTORIA GOLD CORP.

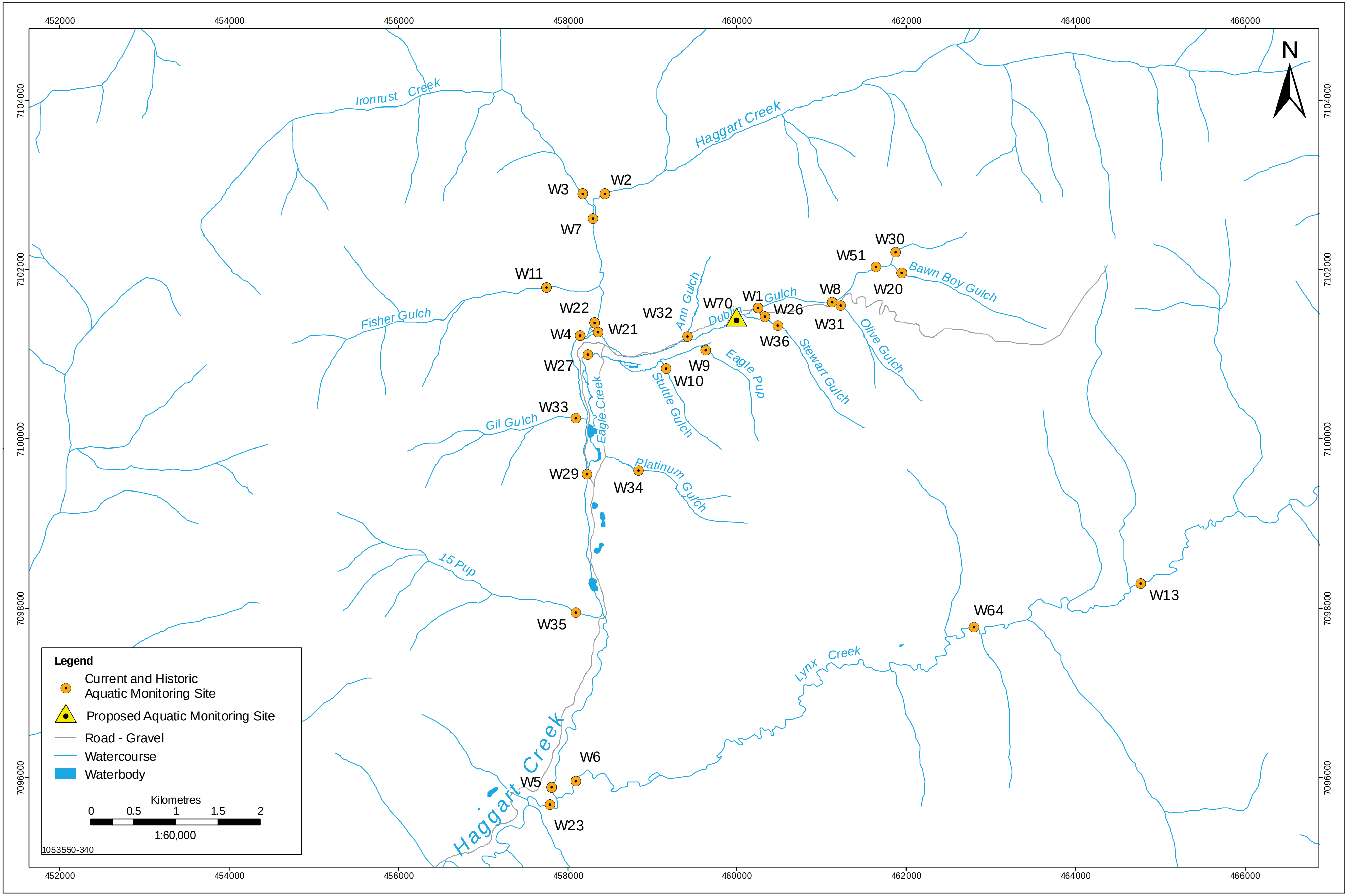
EAGLE GOLD PROJECT

OPTIMIZED MONTHLY INFLOW TO THE MINE WATER TREATMENT PLANT

Knight Piésold CONSULTING

P/A NO.	REF NO	
VA101-290/4	-	
FIGURE R1-3		REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	23NOV'11	ISSUED FOR INFORMATION	ER	JGC	KJB



Data Sources: Government of Canada, Victoria Gold Corp.

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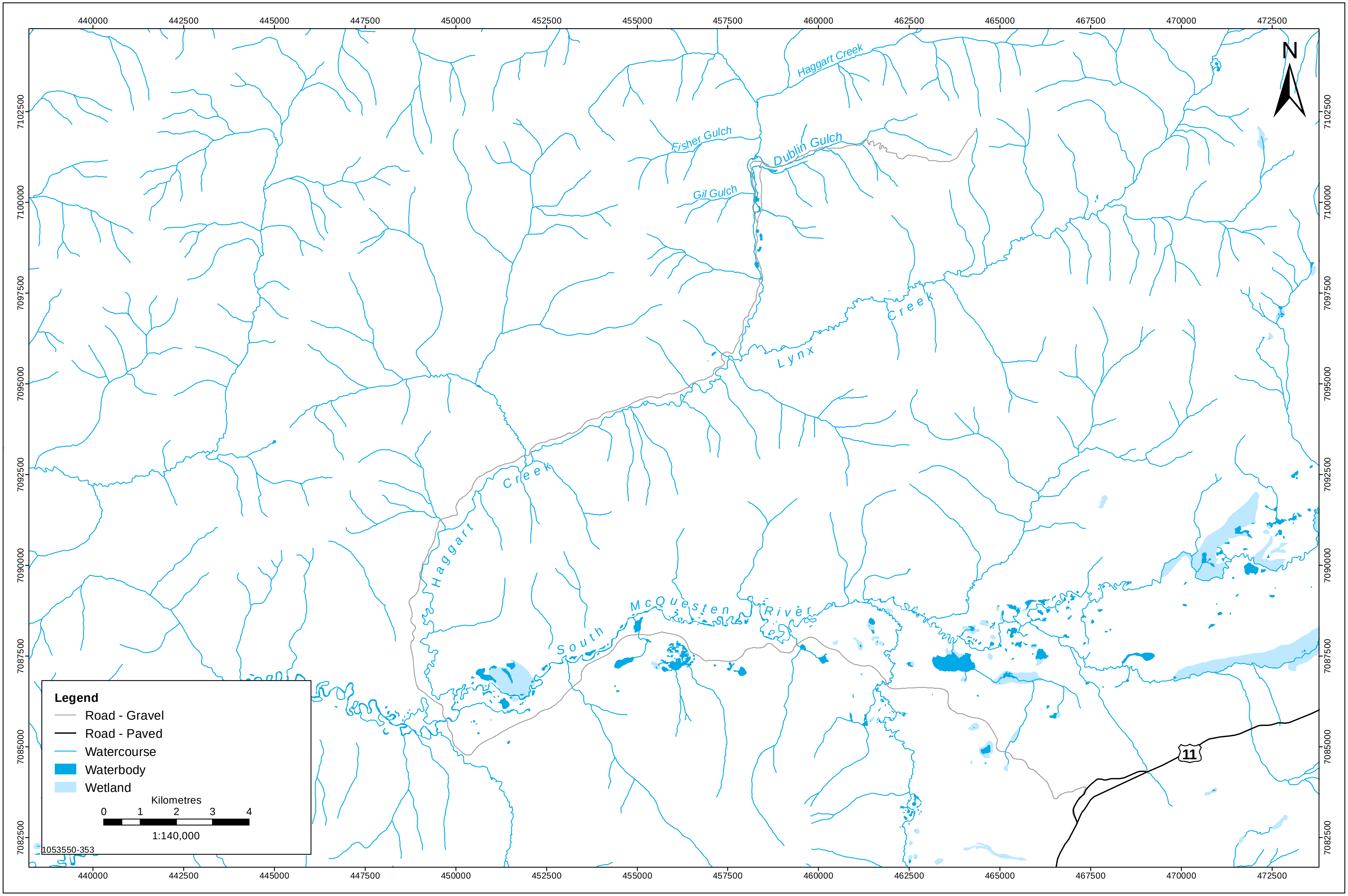
Victoria GOLD CORP

CURRENT, HISTORIC, AND PROPOSED AQUATIC MONITORING SITES
EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION UTM - ZONE 8	DRAWN BY LS
DATUM NAD 83	CHECKED BY RS
DATE 7-November-2010	FIGURE NO. R4-1



Data Sources: Government of Canada, Victoria Gold Corp.

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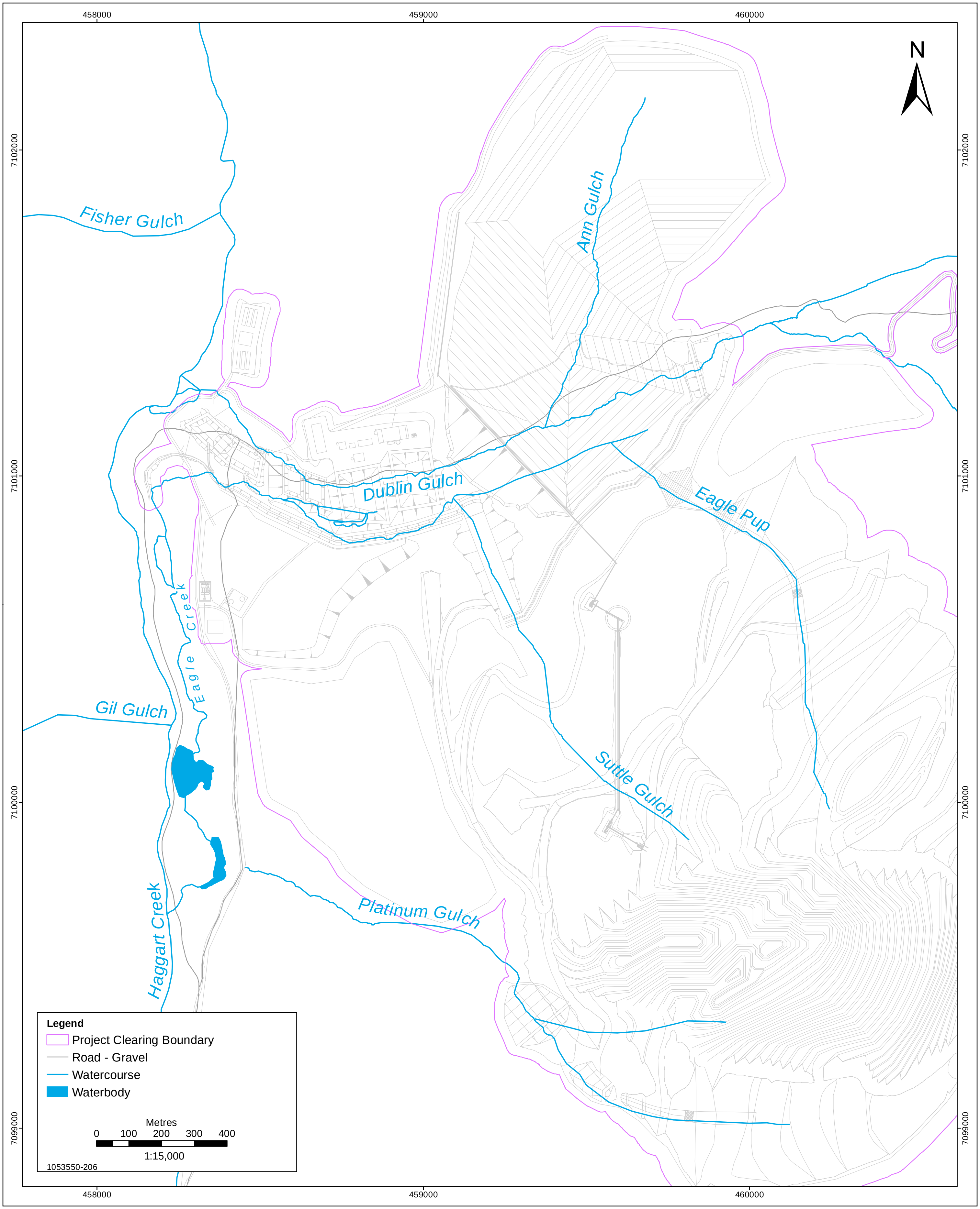
HAGGART CREEK WATERSHED OVERVIEW

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION: UTM - ZONE 8	DRAWN BY: LS
DATUM: NAD 83	CHECKED BY: RS
DATE: 24-November-2011	FIGURE NO.: R21-1



Data Sources; Government of Canada, Victoria Gold Corp.

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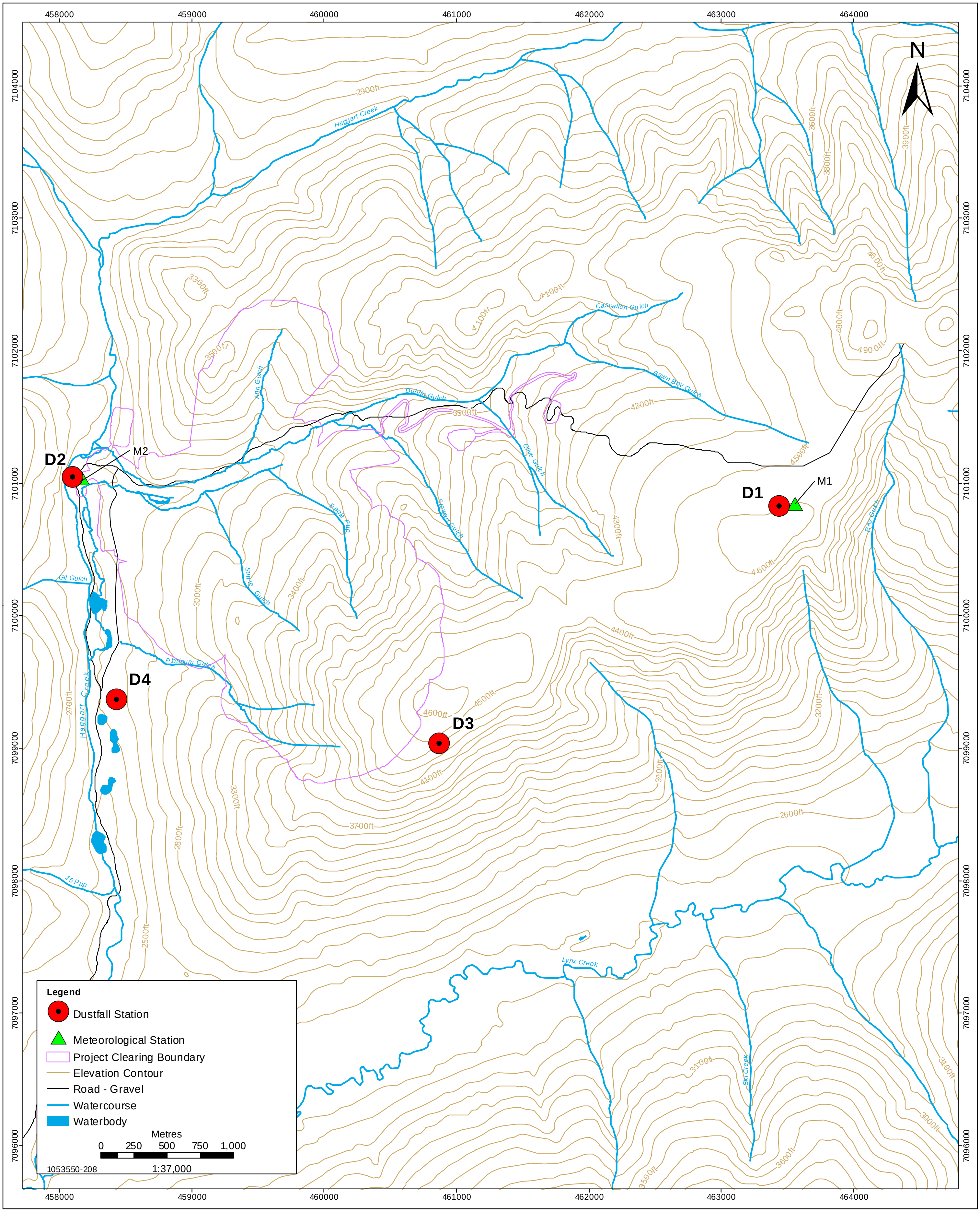
EAGLE GOLD PROJECT - MINE SITE WATERCOURSES

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	RS
DATUM	CHECKED BY
NAD 83	KO
DATE	FIGURE NO.
22-November-2010	R21-2



Data Sources; Government of Canada, Victoria Gold Corp.

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EAGLE GOLD PROJECT - METEOROLOGICAL AND DUSTFALL MONITORING STATIONS

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	RS
DATUM	CHECKED BY
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DATE	FIGURE NO.
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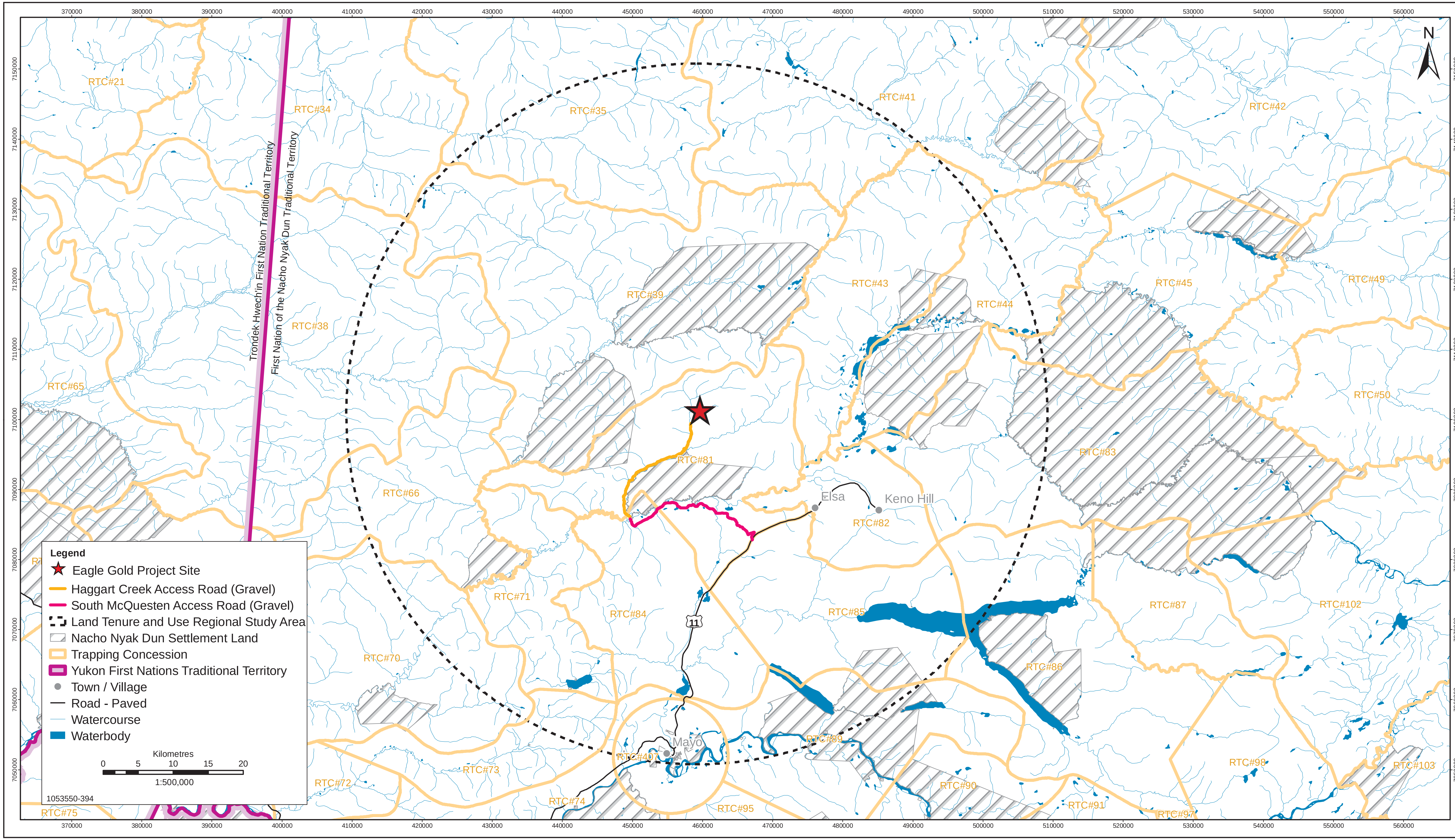

Data Sources; Government of Canada, Victoria Gold Corp.

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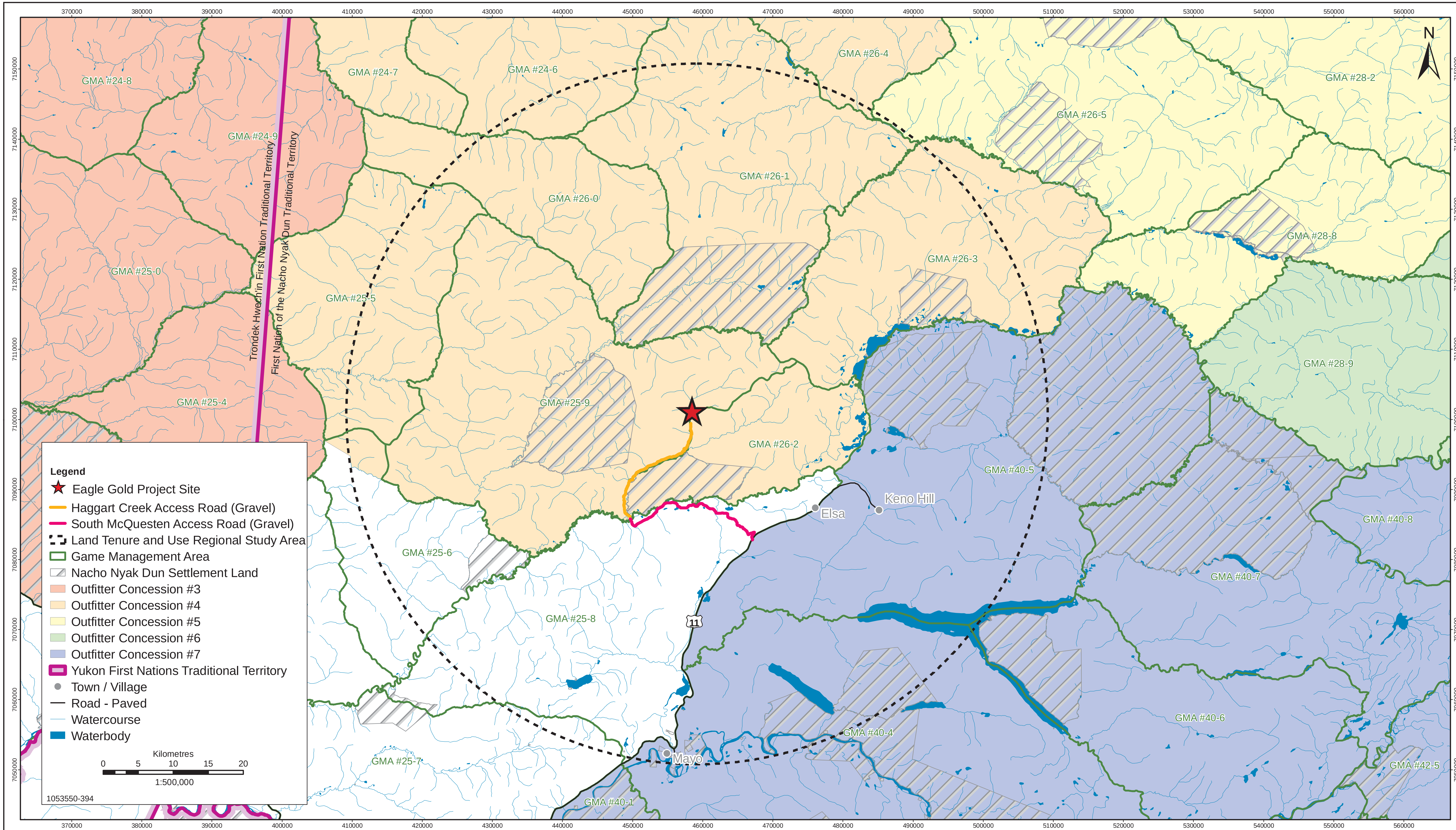
Victoria GOLD CORP

PROJECT REGIONAL STUDY AREA - TRAPPING CONCESSIONS

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION UTM - ZONE 8	DRAWN BY LS
DATUM NAD 83	CHECKED BY RS
DATE 11-November-2010	FIGURE NO. R29-1



Data Sources; Government of Canada, Victoria Gold Corp.

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PROJECT REGIONAL STUDY AREA OVERVIEW WITH OUTFITTING CONCESSIONS

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION UTM - ZONE 8	DRAWN BY LS
DATUM NAD 83	CHECKED BY RS
DATE 11-November-2010	FIGURE NO. R29-2