

Appendix 1.0-E

SRK, Tenas Project Water and Load Balance Modeling Report

FINAL

Tenas Project – Water and Load Balance Modeling Report

Tenas Project, Telkwa, BC, Canada
Telkwa Coal Limited



SRK Consulting (Canada) Inc. ■ 1CT027.003 ■ February 18 2022



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Tenas Project, Telkwa, BC, Canada

Prepared for:

Telkwa Coal Limited
1410 – 409 Granville Street
Vancouver, BC, V6C 1T2
Canada

+1 778 643 2843
www.telkwacoal.com



Prepared by:

SRK Consulting (Canada) Inc.
1066 West Hastings Street, Suite 2200
Vancouver, BC V6E 3X2
Canada

+1 604 681 4196
www.srk.com



Lead Author: Samantha Barnes **Initials:** SB

Reviewer: Tom Sharp **Initials:** TS

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Useful Definitions

This list contains definitions of symbols, units, abbreviations, and terminology that may be unfamiliar to the reader.

7Q10	7-day low flow in a 1 in 10-year return period
AIR	Application Information Requirements
BC AWQG	British Columbia Approved Water Quality Guideline
BC WWQG	British Columbia Working Water Quality Guideline
CCME	Canadian Council of Ministers of Environment
POPC	Parameter of potential concern
CPP	Coal Processing Plant
EA	Environmental Assessment
EAO	Environmental Assessment Office
ECCC	Environment Canada and Climate Change
EDP	Effluent Discharge Permit
EMP	East Management Pond
ENV	BC Ministry of Environment and Climate Change Strategy
LSA	Local Study Area
NMP	North Management Pond
NSE	Nash Sutcliffe efficiency
PAG	Potentially acid-generating
PRISM	Parameter-elevation regressions on independent slopes model
RSA	Regional Study Area
SBEB	Science-based environmental benchmark
TCL	Telkwa Coal Limited
TSS	Total suspended solids
WMP	West Management Pond
WQG	Water quality guideline
WQS	Water quality station

Executive Summary

A water and load balance model has been developed in support of the Environmental Assessment application and joint application for a *Mines Act* permit and *Environmental Management Act* discharge permit for the Tenas Project (the Project) in northwest British Columbia. The Project consists of an open pit, a series of management ponds which will contain submerged potentially acid-generating materials, a coal processing plant, water management infrastructure, ancillary facilities, and rail infrastructure. The mine will take 1.5 years to construct and will operate for 21 years. Decommissioning and reclamation will take approximately 4 years with a further 25 years being assigned to post closure.

Inputs to the model include groundwater modeling results, climate and hydrology datasets, performance and operations of mining elements, water management infrastructure, catchment areas, geochemical source terms and baseline water quality. Model results provide expected and reasonable worst-case water quantity and quality, during and after mining is complete. Sensitivity analyses in the model are used to understand the variables the model results are most sensitive to. Where applicable, model results were calibrated using baseline information. Results are summarized in terms of water quantity and water quality changes to the surrounding watercourses which may be expected to occur in construction, operation, decommissioning and reclamation, and post-closure phases.

All modeling was completed in GoldSim software package, which uses a daily time step and reports monthly average results. Hydrologic components of the model were calibrated to regional and local streamflow datasets and encompass interactions between surface water and groundwater. Streamflow is generated on a daily timestep based on precipitation and temperature datasets, which include an orographic gradient adjustment. Both precipitation and temperature have additional adjustments to account for climate change, which projects an increase in temperature year-round and increase in precipitation for most months, through the year 2100.

The load balance component is based on conservation of mass, assuming complete mixing for each node and time step. Geochemical characterization results are included to estimate mass of constituents released per mass of rock stored in various mine waste facilities. The in-stream water quality is calculated based on mixing of Project discharge with background loading estimated from baseline monitoring of surface and groundwater quality.

Within the proposed Project area, the model simulates the flux of water and mass. Monthly withdrawals of water because of diverted catchment areas and monthly discharges into the downstream environment are estimated. Prediction nodes were selected to represent expected conditions in the downstream environment and are evaluated in relation to a baseline condition, which estimates streamflow and quality through 2100 without influence of the proposed Project.

Multiple assessment cases were selected to understand the range of potential effects from the Project throughout the life of mine. Cases incorporate variability in hydrologic conditions, groundwater conditions and geochemical source terms. The main results reported describe the Project Case, which incorporates all Project design mitigation measures and expected inputs for geochemical source terms and average hydrology. Results for each alternative assessment case are presented in Appendix G.

The Project Case model conditions are incorporated to simulate the expected, or best estimate based on available information. Where input assumptions are uncertain, more conservative assumptions were made. Preliminary model results were used to develop mitigation measures which were applied in subsequent model versions as appropriate.

Project Results

- Sufficient water is expected within the Project area to maintain the minimum 1.0 m water cover above all PAG materials within 1-year of placement on average, throughout operation and post-closure.
- Process and potable water demand as well as water to mix with sewage effluent will be met throughout operation based on available water in the Tenas Control Pond.
- Project discharge ranging from 9,000 m³/day to 15,900 m³/day from the Tenas Control Pond will include pumped flows and overflows via the spillway into a tributary of Goathorn Creek. Additional discharge to the Bulkley River is anticipated from the Rail Infrastructure Sedimentation Pond at a rate of up to 350 m³/day. In closure, Project discharge will occur from the North Management Pond to the tributary of Goathorn Creek at a rate of up to 27,000 m³/day.
- The Open Pit Lake will fill in approximately 12 years, after which excess water will flow through a rock drain in the backfilled rock towards the West Management Pond.
- Discharging facilities (Rail Infrastructure Sedimentation Pond, Tenas Control Pond and North Management Pond) are expected to meet the following calculated end of pipe limits for total selenium (0.050 mg/L) and nitrate-nitrogen (18.8 mg/L) during active discharge periods under Project Case conditions.

Receiving Environment Results

Water Quantity

Effects to surface water quantity were evaluated based on relative change over baseline conditions. A parallel pre-mining model was run in tandem with each assessment case using baseline conditions, and monthly percent change was calculated by comparing the proposed conditions relative to pre-mining results. Results are summarized in relation to changes to mean annual discharge, monthly discharge, and low and high flows.

- Four Creek nodes, including WQ03, WQS21, WQS20 and WQS03DS, show as high as 34% reduction and as high as 45% increase to monthly streamflow during operation. These results reflect the maximum change to catchment area and baseflow because of mining operations. Diversion channels and mine plan optimizations help to reduce the Project footprint as much as possible. However, the open pit and the Management Ponds continue to route water that would have otherwise drained to Four Creek towards Goathorn Creek via the Tenas Control Pond discharge, resulting in a reduction of catchment area, while the C02 channel diversion results in an increase in catchment area in portions of Four Creek.
- Tenas Creek is expected to experience up to a 10% reduction during low flow periods (April and August) during operation because of open pit groundwater drawdown and catchment area

reductions. The seepage from Management Ponds counters this effect by the end of operation and into post-closure, resulting in a long-term change to mean annual discharge of less than 6%.

- Goathorn Creek flows are expected to be reduced by up to 6% during low flow months in operation. Flows downstream of the Project discharge are expected to increase by up to 19% in operation during high flow months and 8% in post-closure due to routing of water through the Project infrastructure that would otherwise have reported to the Tenas Creek catchment. The change to mean annual discharge is less than a 3% reduction in operation and post-closure.
- The Project may reduce monthly average flows in the Telkwa River downstream of Goathorn Creek by less than 2% in operation and an increase of 1% in post-closure due to seepage from Management Ponds. Bulkley River monthly streamflow changes are negligible (less than 0.1% change during any phase of the Project).

Water Quality

Effects to surface water quality were evaluated based on screening against selected water quality guidelines (WQG) as well as variability within the historical monitoring record. Where model results exceeded the guidelines, site performance objectives (SPOs) were developed. Results are summarized below based on each parameter of potential concern (POPC) which produced a monthly average water quality result greater than both guideline and the historical variability:

- Baseline data show the streams are naturally elevated in dissolved and total aluminum, total iron and total copper and have experienced periods above the WQG values.
- The total selenium WQG in the receiving streams is exceeded for a period during post-closure because of seepage from management ponds. Nodes downstream of the facilities in Tenas and Four Creek are up to 2.9 times over the WQG during winter months, when groundwater discharge contributes the most to the total flow conditions. The SPO limits for selenium are not exceeded. All long-term water quality results are below the WQG. The driver of elevated selenium levels is runoff and seepage from Non-PAG rock in the backfilled open pit as well as the buttresses and dams to a much lesser extent. Mitigation measures include covering all backfilled areas with overburden and potential in-situ treatment of the open pit dewatering stream by pumping this water into the bottom of the Management Ponds which are expected to operate as a saturated rock fill.
- The nitrite WQG is exceeded in summer and winter months in Tenas and Four Creek downstream of Management Ponds by a multiplier of up to 2.3 times the WQG. The SPO is not exceeded in the receiving environment based on Project Case conditions, and all long-term results are below the WQG. Elevated nitrite concentrations result from incomplete detonation of ANFO and emulsion and are expected to be conservative based on the loss assumptions modelled given the mitigations proposed by TCL.
- The dissolved cadmium WQG is exceeded in winter months in Four Creek by up to a multiplier of 1.5 times the WQG. The exceedances are driven by seepage from the Management Ponds. Results do not exceed the SPO and are expected to be below the WQG in the long-term (2100).
- The sulphate WQG is exceeded in Tenas Creek and Four Creek by up to 1.2 times the WQG during winter months. Long-term water quality is below the WQG at all nodes.

- Groundwater seepage from management ponds into portions of Tenas and Four Creek is expected to increase the total dissolved solids concentration and conductivity of the stream above baseline levels. In Tenas Creek, baseline conductivity and total dissolved solids concentrations are exceeded in winter months through the end of the modelled period, while in Four Creek, the long-term concentrations are within the range of baseline conditions.

The effects to both stream water quantity and quality were further evaluated in terms of the affected area within the spatial boundaries of the Project, including the local stream watersheds, the local study area (LSA) and the regional study area (RSA).

- In terms of water quality, the modelled prediction nodes that experience long-term exceedances include the downstream portions of Tenas and Four creeks, which encompasses an area equal to 29 km². This affected area represents approximately 14% of the LSA and 2% of the RSA.
- In terms of water quantity:
 - The modelled prediction nodes that experience a change to mean annual discharge greater than 10% reduction or 30% increase include WQS21, WQS20 and WQ03DS, which encompasses an area equal to 7.6 km². This affected area represents approximately 3.6% of the LSA and 0.5% of the RSA.
 - A change in seasonal flow distribution greater than 10% reduction or 30% increase in any given month under average conditions is predicted to occur at WQS03, WQS21, WQS20 and WQS03DS. This change encompasses an area equal to 11 km², which represents approximately 5% of the LSA and 0.8% of the RSA.
 - High flows are expected to be reduced over baseline conditions for all nodes which will experience a reduction in catchment area. For the segment of Four Creek which will experience a net increase in catchment area, downstream of the diversion channel, an engineering control structure will limit the discharge during extreme events, sending excess water to the East Management Pond. Similarly, the Tenas Control Pond will have the ability to control high flood events through an additional attenuation capacity up to the 1 in 10-year flood event. As a result, the increase to high flows is expected to be minimal.
 - Low flows are expected to be reduced in operations along sections of Tenas and Four creeks because of drawdown of the groundwater table around the open pit. It is expected that extreme low flows will be similarly affected.

1 Introduction

1.1 Background

Telkwa Coal Limited (TCL) are proposing to develop the Tenas coal deposit (the Project) in northwest British Columbia. The Project is located approximately 25 km southwest of the town of Smithers within the Telkwa River watershed and will comprise of an open pit, backfill, external stockpiles, water Management Ponds, Control Ponds, a process plant pad, and rail infrastructure area. The Tenas Project's total mine life is 25 years including construction, operations, decommissioning and reclamation, and post-closure phases.

SRK Consulting (Canada) Inc. have developed a water quantity and quality model based on the proposed water management designs for the Tenas Project in support of the Environmental Assessment (EA) application. The EA has been prepared in accordance with the BC Environmental Assessment Office (BC EAO) Guidelines for Preparing Environmental Assessments (BC EAO 2016).

In May 2020, the EAO issued an Application Information Requirements (AIR) document that provided the requirements of the EA application (EAO, May 2020). This report supports the requirements of the EA application, including:

- Part A, Section 1.3, Project Design and/or Alternative Means of Carrying out the Project.
- Part B, Section 3.5, Assessment Methodology and Mitigation Measures.
- Part B, Section 4.0, Environmental Effects Assessment, Surface Water Intermediate Component.
- Part E, Management Plans and Management Strategies.

The objectives of the water quantity and quality model are defined in this report, along with the model inputs, assumptions, and results. Results of the model are used to inform the EA at the regional study area level.

1.2 Scope of Work

This report presents the inputs, methodologies and results of the water and load balance model (“the model”). As part of this work, the following were completed:

- Develop conceptual water balance flow diagrams.
- Compile climatic and hydrologic inputs.
- Develop water balance model and evaluate effects of the Project against baseline flow conditions.
- Modify water management infrastructure as required to achieve desired objectives.
- Develop background water quality source terms and geochemical source terms for load balance model.
- Develop load balance model and evaluate effects of the Project against baseline water quality conditions.

1.3 Model Objectives

Geochemical characterization studies have shown that a portion of waste rock from mining activities is expected to be potentially acid generating (PAG) material. To minimize oxidation of this material and the generation acid drainage and/or metal leaching, PAG rock will be stored in Management Ponds to maintain a perpetual water cover. One of the primary functions of the model is to test the ability of the Project water management infrastructure to maintain water cover.

The objectives of the model and water management plans include:

- Ensuring a minimum of 1 m water cover is maintained in all Management Ponds within 6-months of PAG rock placement throughout life of mine and post-closure.
- Ensuring sufficient water is available to meet coal preparation plant (CPP) demand throughout operations.
- Estimating the quality and quantity of water to be discharged to the receiving environment.
- Estimating the quality and quantity of water in the receiving environments at discharge locations and at prediction nodes in the receiving environment.
- Providing a basis for determining water management infrastructure requirements and water treatment requirements (if any).
- Providing a basis for the estimation of water management costs and water treatment costs (if any).

2 Model Overview

2.1 Regulatory Requirements and Commitments

Water takings for the Project are expected to be subject to the provincial *Water Sustainability Act* via a license for the use of surface and/or groundwater. The Project is expected to be subject to the federal *Fisheries Act* via the future *Coal Mining Effluent Regulations* which are currently in development (ECCC 2018), as well as the provincial *Environmental Management Act* via a Waste Discharge Authorization permit.

The *Coal Mining Effluent Regulations* are expected to specify end of pipe limits for total suspended solids (TSS), nitrate, and selenium for new and existing coal mines.

In the BC provincial jurisdiction, end of pipe limits for discharge of excess water to the environment may be specified in an Effluent Discharge Permit (EDP) issued by the BC Ministry of Environment (BC MOE) under the provincial *Environmental Management Act*, in addition to established surface water quality guidelines (WQG) for receiving environments. In advance of an EDP, the long-term average BC Approved Water Quality Guidelines or BC AWQG (ENV 2017) and the BC Working Water Quality Guidelines or BC WWQG (ENV 2015) for freshwater aquatic life were applied for the evaluation of results from the load balance. Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Aquatic Life (CCME WQG) are applied for parameters for which there is no BC AWQG or BC WWQG.

Site performance objectives (SPOs) were also developed for select parameters. The WQG incorporated for the Project as well as the SPOs and proposed end of pipe limits are summarized in Section 3.9.

2.2 Model Description

2.2.1 Simulation Approach

The model uses a daily time step and reports results as monthly averages throughout the life of mine through the year 2100. The year 2100 was selected based on the current extent of available global circulation models for climate change evaluation.

Water quantity results were generated using two sets of hydrologic conditions, both of which account for climate change:

- Historical hydrologic conditions based on select years from the historical record including a year like an average precipitation year (i.e., similar annual precipitation to the mean annual precipitation), a 1 in 100-year dry and a 1 in 100-year wet historical year. Details on this methodology are described in Section 3.1.1. Climate change adjustment factors were applied to temperature and precipitation inputs (Section 3.1.5).
- Monte Carlo simulation using a weather generating (WGEN) software with climatic data, including daily precipitation and daily temperature, for the Project area. A total of 100 model runs were completed using this approach. Climate change adjustment factors were applied to the daily

generated temperature and precipitation values. At the end of 100 model runs, all results were compiled, and probability distributions of the results were generated (i.e., 5th, 50th and 95th percentiles). Details of this methodology are described in Section 3.1.2.

Water quality predictions were completed using deterministic model runs (i.e., a single run with no probabilistic elements for climatic variables) with average hydrologic conditions to be consistent with the derivation of source terms.

2.2.2 Governing Equations

The water and load balance model operates based on conservation of mass. The water balance component tracks all inputs, outflows, and available storage at the Project. The water balance can be represented in a simplistic form as follows:

$$\text{Water Storage} = \text{Water Input} - \text{Water Output} \quad (\text{Eq. 3.1})$$

Where the total water inputs include groundwater and precipitation, and water outputs include groundwater, evaporation, process water demand, discharge offsite and water loss to rock void space. Storage is available in various Project facilities.

The load balance for the Project was developed to evaluate loadings from Project components to the receiving environment. The load balance and resultant receiving water quality predictions were used as a tool to iteratively refine water management infrastructure for the Project throughout the life of mine.

The load balance assumes fully mixed conditions at each node and time step. The mass balance does not account for some physical, chemical, and/or biological processes such as aerobic and anaerobic degradation, sorption and desorption, oxidation and reduction, dissolution and precipitation, and incomplete mixing within receiving environments.

Loadings and concentrations were calculated for each Project component, and loadings were generated for each corresponding receiving environment node in the water balance. Two types of loadings included in the load balance:

- Direct loadings based on defined input source terms.
- Linked loadings from reservoirs (from one reservoir to another).

Direct loadings are calculated based on the concentrations of source terms (eq. 3.2).

$$\text{Direct Loading [mg]} = \text{Inflow Volume}[m^3] \times \text{Source Term Concentration} \left[\frac{mg}{L} \right] \times 1000 \text{ L}/m^3 \quad (\text{eq. 3.2})$$

Linked loadings (eq. 3.3) from reservoirs are calculated based on the calculated concentration (eq. 3.4) for the reservoir and associated inflow from the water balance.

$$\text{Linked Loading [mg]} = \text{Inflow}[m^3] \times \text{Concentration} \left[\frac{mg}{L} \right] \times 1000 \text{ L}/m^3 \quad (\text{eq. 3.3})$$

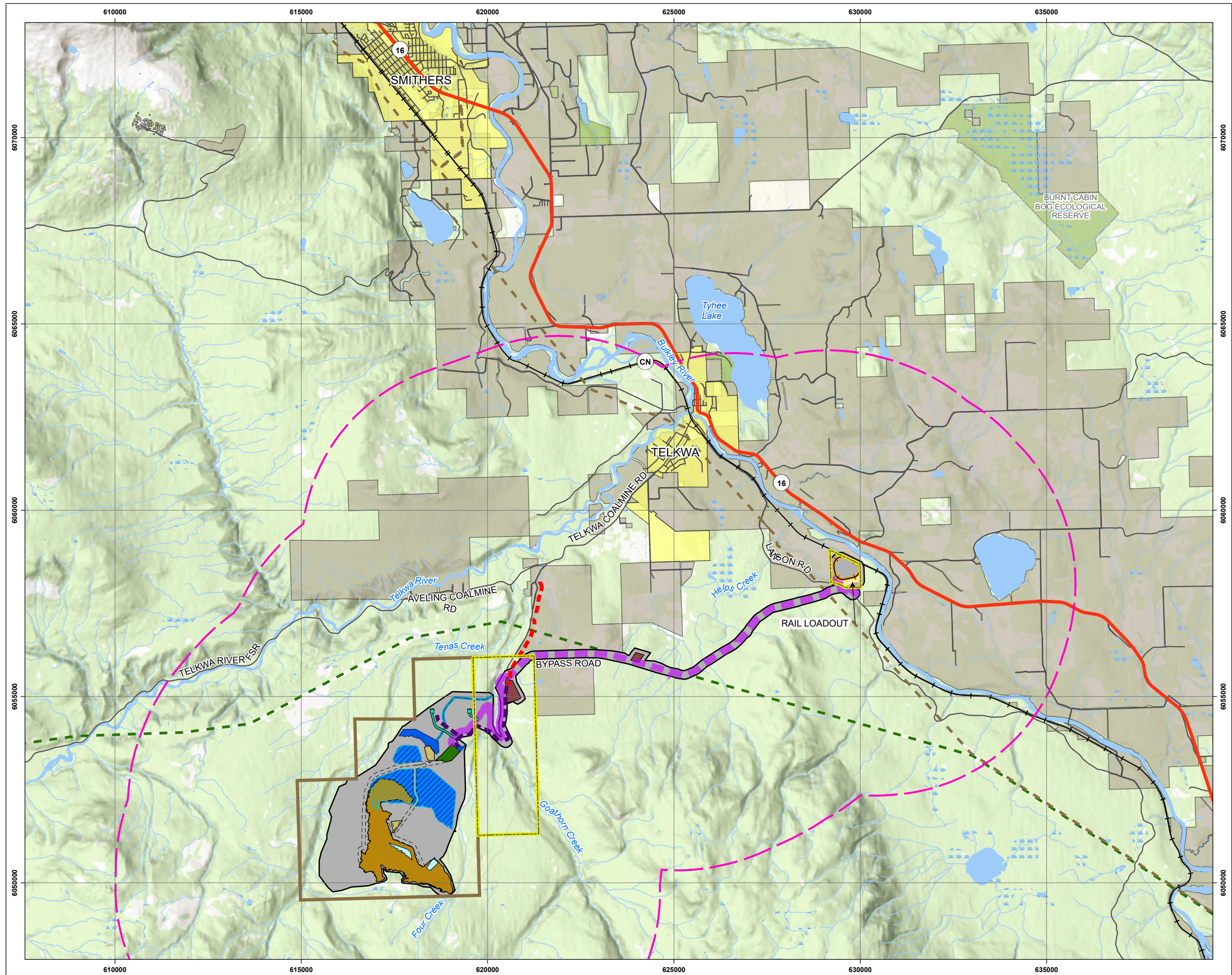
$$\text{Concentration} = \frac{\text{Mass (mg)}}{\text{Volume (L)}} \quad (\text{eq. 3.4})$$

2.3 Project Overview

The Project is located approximately 25 km southwest of the town of Smithers and is in the Telkwa River watershed, amongst the smaller watersheds of Tenas, Four and Goathorn creeks (Figure 2-1). Workings will consist of an open pit, generation of both PAG and non-PAG rock as well as overburden material, water Management Ponds, sedimentation ponds, a Coal Processing Plant (CPP), and rail infrastructure. The Project's total mine life is approximately 25 years including the construction, operation, decommissioning and reclamation phases. The post-closure phase will occur after the decommissioning and reclamation phase are completed and will have an unspecified timing but will likely be approximately 25 years.

Downstream water users include fish populations in Four, Tenas and Goathorn creeks as well as Telkwa and Bulkley rivers. The Village of Telkwa is located downstream at the confluence of the Telkwa and Bulkley rivers, and further downstream on Bulkley River is the Town of Smithers.

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Tenas Project

Site Location

Legend

—+— Rail Line	— Discharge Path
— Highway	— Tenas Access Corridor
— Road	▨ Backfill Area
— Watercourse	▨ Control and Plant Sedimentation Pond
▨ Wetland	▨ Explosive Infrastructure
▨ Waterbody	▨ Management Pond
▨ Park or Protected Area	▨ Mine Infrastructure Complex
▨ Municipal Area	▨ Open Pit
▨ General Private Property	▨ Pit Lake
— 138 kV Transmission Line	▨ Quarry
— 500 kV Transmission Line	▨ Rail Infrastructure
Project Features	▨ Topsoil Stockpile
▨ Existing 25 kV Power Line	▨ Tenas Coal Licenses
▨ 25 kV Power Line	▨ Telkwa Coal Limited Private Property
▨ Haul Road	▨ Project Area
— Rail Loop	▨ Wildlife LSA

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.
3. Project line features are for display only.

Sources

- Project Features: Allegiance Coal, April 21, 2021.
- Basedata: Government of British Columbia
- Basemap: World Topo Base

N

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Figure 2.1

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2.3.1 Project Infrastructure

Project infrastructure incorporated into the model is described below. Figure 2-1 presents the Project infrastructure footprint at the end of the life-of-mine.

Sedimentation Ponds

Sedimentation ponds provide residence time for sediment removal and water storage. Five ponds will be included at the Project, including the Tenas Control Pond, the Coal Processing Plant (CPP) Sedimentation Pond, the Rail Infrastructure Sedimentation Pond, and the Explosives Facility and Explosives Magazine Sedimentation Ponds. Due to the small footprints (less than 0.01 km²), the Explosives Facility and Explosives Magazine Ponds were not included in the water and load balance model.

The Tenas Control Pond will be constructed downstream of all mining infrastructure and will also serve as the primary water supply source to the CPP as well as providing water supply to the Management Ponds. Excess water will be pumped from Tenas Control Pond to a tributary of Goathorn Creek, which will include a minimum discharge rate during open water months to mix with treated sewage effluent.

The CPP Sedimentation Pond and Rail Infrastructure Sedimentation Pond are local facilities at the CPP area and rail infrastructure area, respectively. Inflows to these ponds will include drainage from associated infrastructure, and outflows will consist of evaporation and discharges to downstream creeks and rivers via pumping systems and emergency spillways.

Management Ponds

The Project will include three Management Ponds for subaqueous storage of PAG rock and processed rock: North Management Pond (NMP), East Management Pond (EMP) and West Management Pond (WMP). All Management Ponds will be lined to reduce seepage losses to the environment. Upon completion of PAG rock placement within each facility, a non-PAG rock cover will be placed across the top of PAG, followed by a layer of overburden to reduce evaporation losses.

The NMP ring-dyke dam will be constructed during pre-mining at the downstream extent of the open pit and will store PAG rock during the first years of mining. Due to its geometry, all inflows other than direct precipitation will be pumped into the NMP, including water from Tenas Control Pond, subsequent Management Ponds, and inflows from the open pit. Outflows include groundwater seepage and evaporation, overflow via gravity spillway to the Tenas Control Pond, and pumped flow to the subsequent Management Ponds.

The EMP will consist of a dam along the northern extents of the facility, upstream of the NMP. PAG rock placement in the EMP will begin once the NMP is full. A division dam will also be constructed to separate between the subsequent WMP. Inflows will include natural upstream runoff, direct precipitation, and pumped flows from Tenas Control Pond, NMP and the open pit. Outflows include groundwater seepage and evaporation, and discharge via pump or spillway to the NMP and EMP.

The WMP will consist of a dam along the northern and western extents of the facility, adjacent to the EMP dam and directly upstream of the NMP. WMP will consist of a storage area on natural ground as well as a portion of the open pit, referred to herein as the In-Pit WMP and Ex-Pit WMP. Like the EMP, inflows to the WMP will include natural upstream runoff, direct precipitation and pumped flows from the other Management Ponds and the open pit. At closure, the backfilled open pit will discharge via gravity through a rock drain directly into the WMP. Outflows include groundwater seepage and evaporation, and discharge via pump or spillway to the NMP and EMP.

Open Pit

A single open pit will be mined throughout operations and will be backfilled with Non-PAG rock. The open pit is dewatered via pumping to the Management Ponds during active mining.

Non-PAG rock is backfilled into the open pit throughout operations. At closure, Non-PAG rock is covered with overburden and active dewatering will cease, allowing the remaining areas to flood and form the End Pit Lake. Discharge at closure will occur through the Non-PAG rock towards the WMP.

Coal Processing

Coal processing will occur on-site at the CPP. The CPP will produce coal that will be transported to the Rail Infrastructure Area for transport off-site, as well as processed rock which will be deposited in Management Ponds with PAG rock.

2.3.2 Project Stages

Four Project stages are described in Table 2-1.

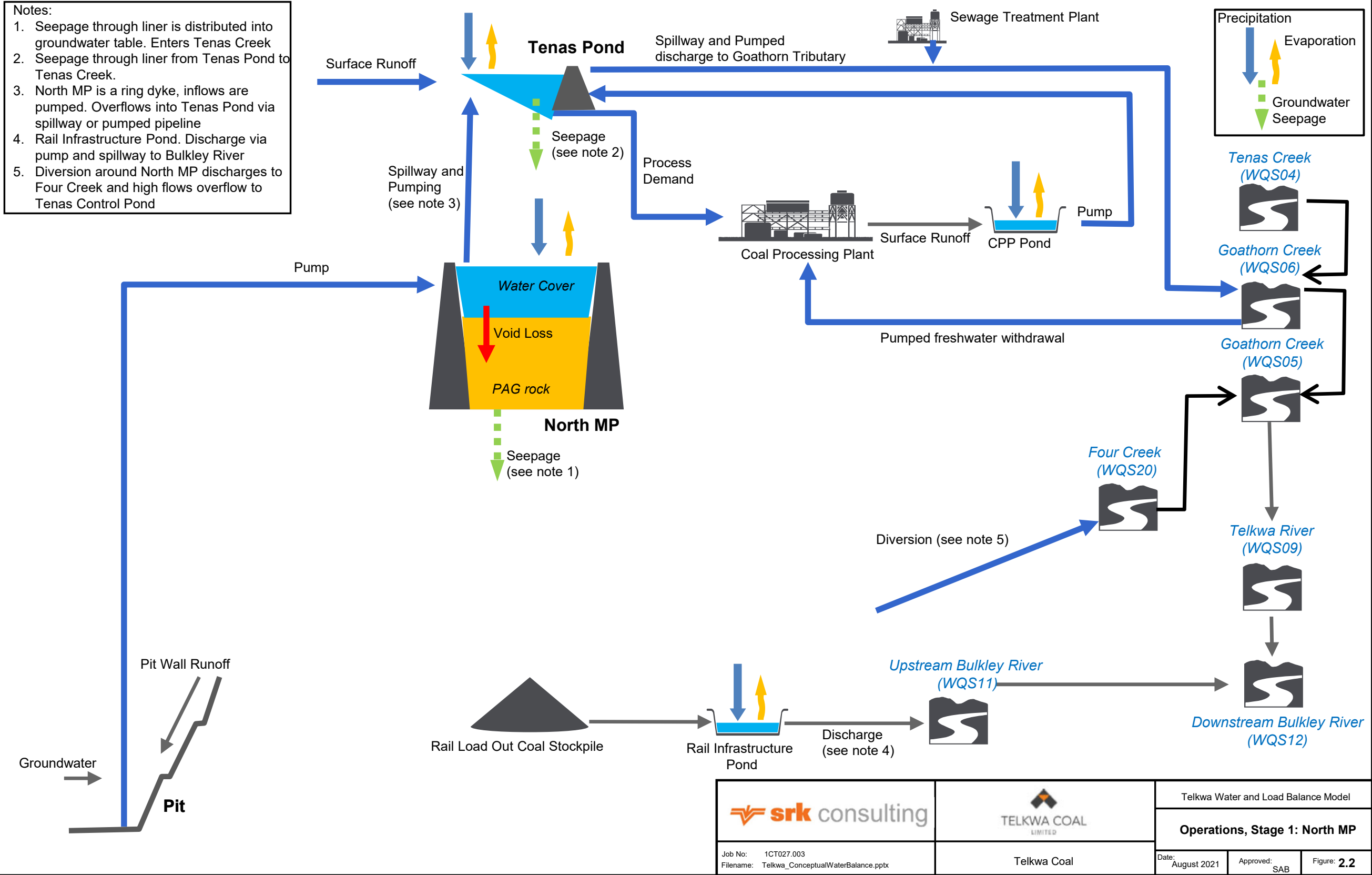
Table 2-1: Project Phases

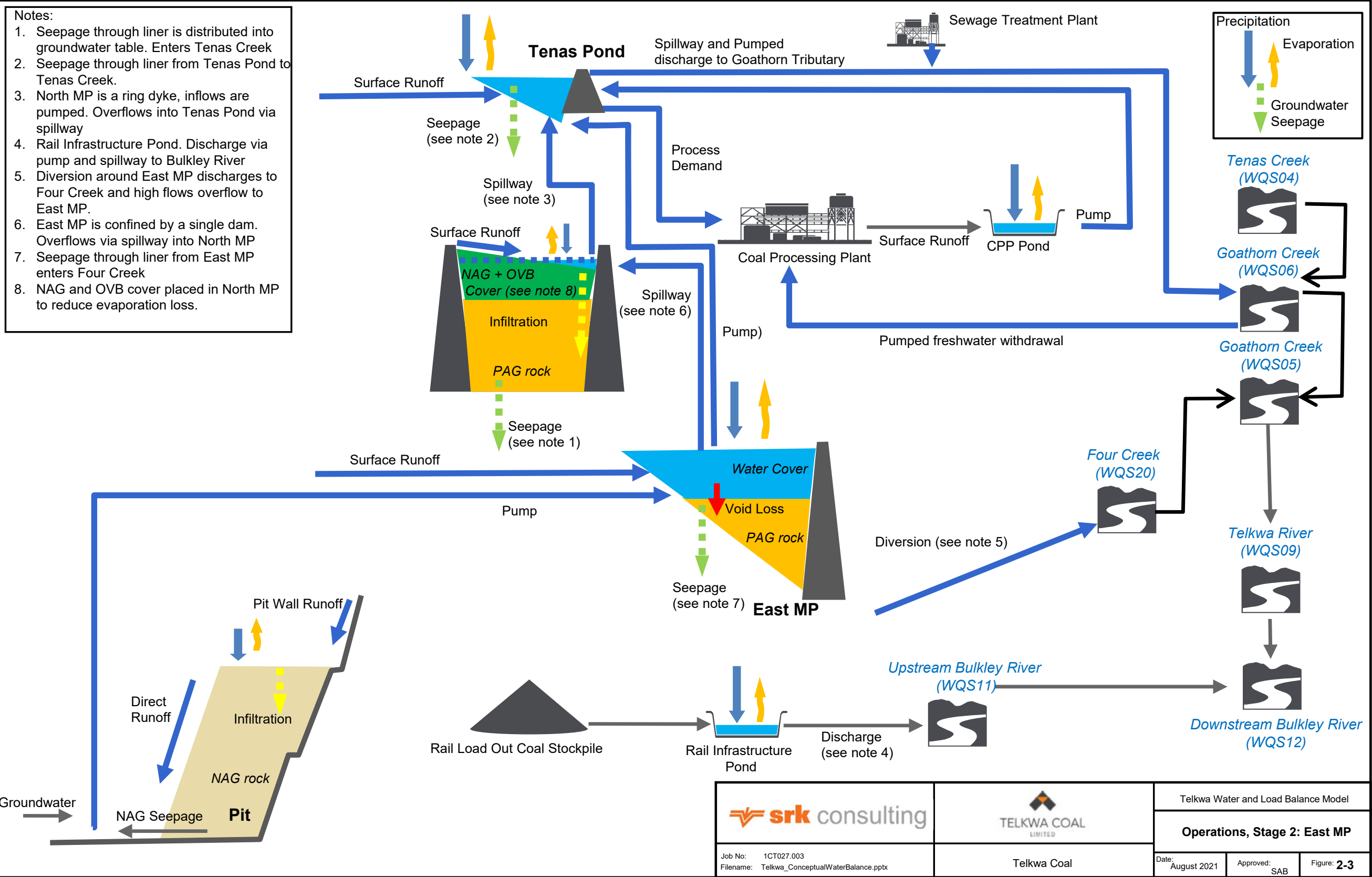
Project Stage	Project Years	Modelled Calendar Year	Length of Phase (years)	Description of Activities
Construction	-0.5 to 0	2020	1.5	Site clearing, soil salvage, open pit development, building construction, service and haul road development, Rail Infrastructure construction, bridge construction and development of onsite utilities and services. Development of mine rock, and overburden storage piles, stockpiling of reclamation material such as soil, overburden, and other materials suitable for reclamation. Development of water management systems and management ponds for storage of potentially acid generating (PAG) materials.
Operation	1 to 21	2022	21	Development of the open pit through drilling, blasting, loading, and hauling functions. Development of mine rock, and overburden storage piles, stockpiling of reclamation material such as soil, overburden, and other materials suitable for reclamation. Development of water management systems and management ponds for PAG storage. Conducting coal processing, stockpiling of raw coal prior to processing, and stockpiling of processed coal prior to shipping. Progressive reclamation will be accomplished during operation including, where available, reclamation activities such as sloping, topsoil placement and revegetation.
Decommissioning and Reclamation	22 to 25	2043	4	Decommissioning of infrastructure onsite plus reclamation activities, including sloping of storage piles, backfill materials, and placement of reclamation materials including growth media, overburden and non-PAG rock for management pond covers and revegetating surfaces that are planned to be reclaimed.
Post-closure	26 to 50	2047	53	Approximately 10 years of Active Post-Closure. This involves the filling of the open pit with water, monitoring of vegetation growth and water quality for both groundwater and surface water and wildlife. Control and sedimentation ponds may still be needed for settling of total suspended solid levels. The management ponds are left as dry land reclamation except for portions that will be left as open water. Passive closure when the control and sedimentation ponds are no longer required for settling of total suspended solid (TSS) levels and the management ponds are covered and reclaimed except for portions left as open water. Telkwa Coal Limited (TCL) will monitor site

2.3.3 Flow Diagrams

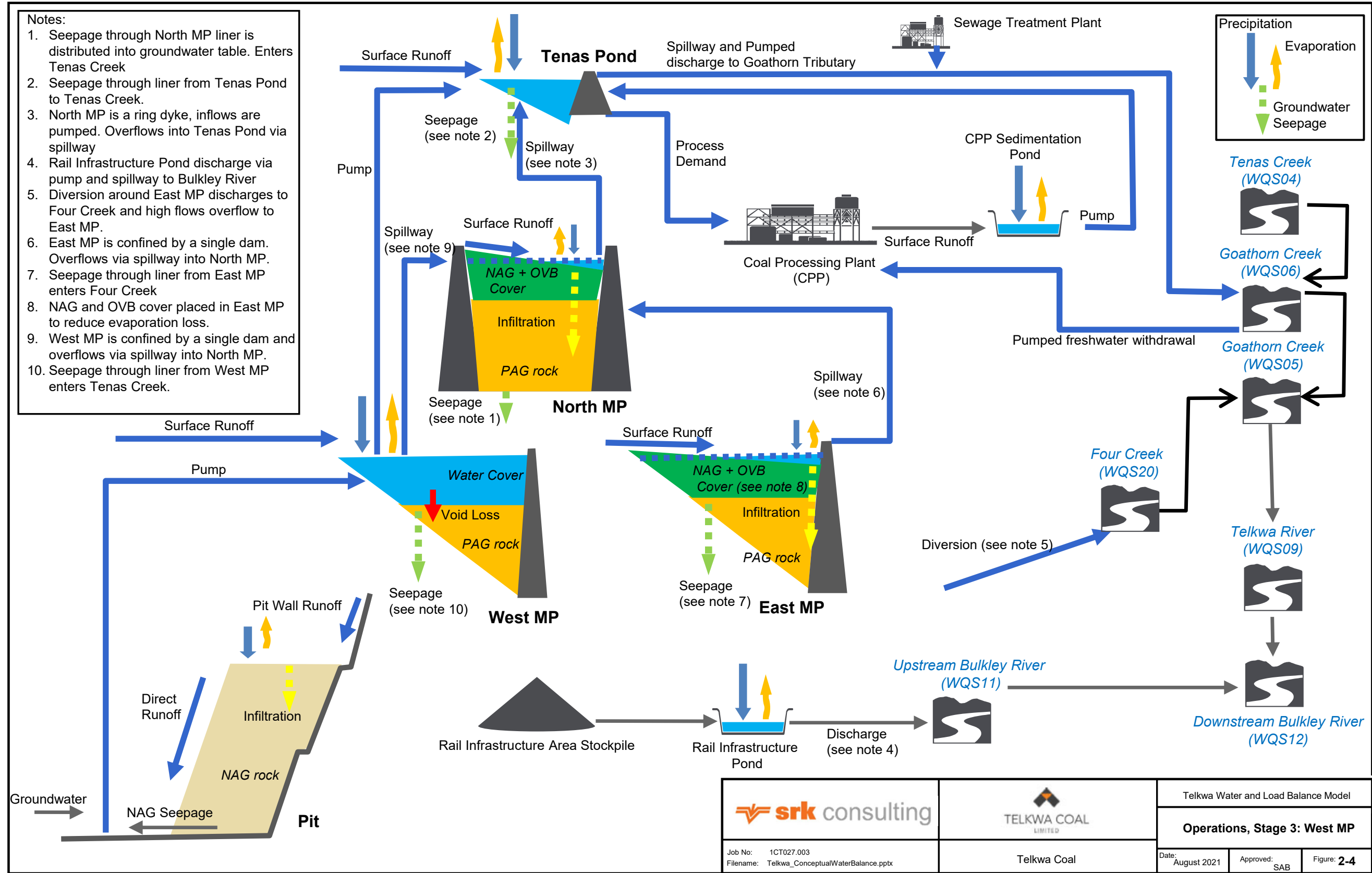
The water balance conceptual flow diagrams are provided in Figure 2-2, Figure 2-3 and Figure 2-4 for operations with the NMP, EMP and WMP, respectively, as well as in Figure 2-5 for post-closure.

- Notes:
1. Seepage through liner is distributed into groundwater table. Enters Tenas Creek
 2. Seepage through liner from Tenas Pond to Tenas Creek.
 3. North MP is a ring dyke, inflows are pumped. Overflows into Tenas Pond via spillway or pumped pipeline
 4. Rail Infrastructure Pond. Discharge via pump and spillway to Bulkley River
 5. Diversion around North MP discharges to Four Creek and high flows overflow to Tenas Control Pond

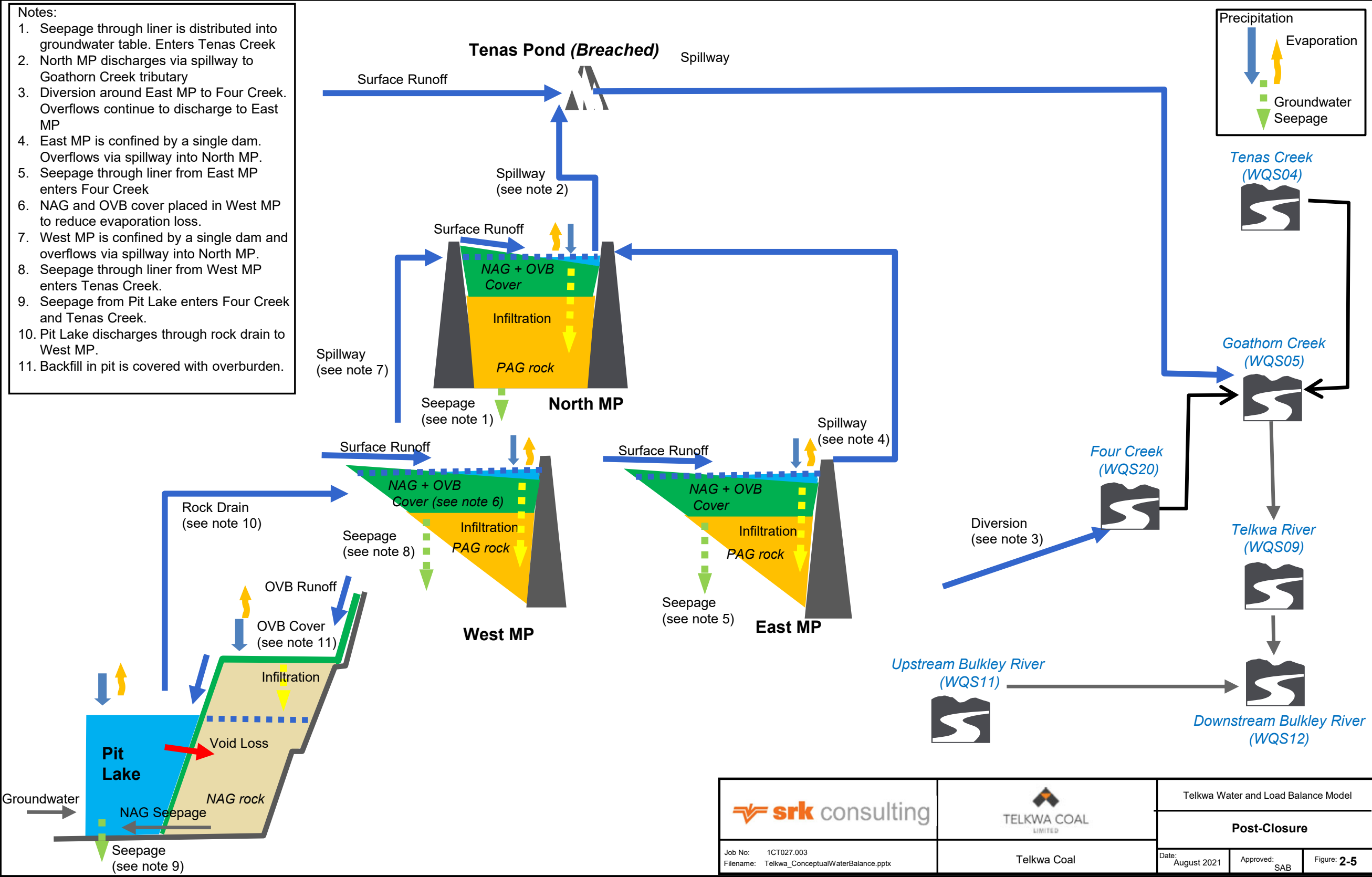




- Notes:
- 1. Seepage through North MP liner is distributed into groundwater table. Enters Tenas Creek
 - 2. Seepage through liner from Tenas Pond to Tenas Creek.
 - 3. North MP is a ring dyke, inflows are pumped. Overflows into Tenas Pond via spillway
 - 4. Rail Infrastructure Pond discharge via pump and spillway to Bulkley River
 - 5. Diversion around East MP discharges to Four Creek and high flows overflow to East MP.
 - 6. East MP is confined by a single dam. Overflows via spillway into North MP.
 - 7. Seepage through liner from East MP enters Four Creek
 - 8. NAG and OVB cover placed in East MP to reduce evaporation loss.
 - 9. West MP is confined by a single dam and overflows via spillway into North MP.
 - 10. Seepage through liner from West MP enters Tenas Creek.



- Notes:
1. Seepage through liner is distributed into groundwater table. Enters Tenas Creek
 2. North MP discharges via spillway to Goathorn Creek tributary
 3. Diversion around East MP to Four Creek. Overflows continue to discharge to East MP
 4. East MP is confined by a single dam. Overflows via spillway into North MP.
 5. Seepage through liner from East MP enters Four Creek
 6. NAG and OVB cover placed in West MP to reduce evaporation loss.
 7. West MP is confined by a single dam and overflows via spillway into North MP.
 8. Seepage through liner from West MP enters Tenas Creek.
 9. Seepage from Pit Lake enters Four Creek and Tenas Creek.
 10. Pit Lake discharges through rock drain to West MP.
 11. Backfill in pit is covered with overburden.



2.4 Overview of Predictions

2.4.1 Prediction Nodes

Model prediction nodes were selected to characterize upstream and downstream conditions in relation to the Project and its discharges. Creeks and rivers which were identified as providing habitat to fish and aquatic life have multiple prediction nodes. Node locations were typically located at historic water quality monitoring sites, with several additional nodes beyond the water quality campaigns on Four Creek and Tenas Creek.

Table 2-2 summarizes the prediction nodes in terms of their geographic location and the stream in which they are located. Justification for node selection is also presented, based on coordination with other EA value component disciplines and review of potential effects from the Project. Node locations are also presented on Figure 2-6 with the final footprints of the Project.

Table 2-2: In-Stream Prediction Nodes

Prediction Node	Receiving Environment	Justification for Node Selection	Coordinates NAD 1983 UTM Zone 9N	
			Easting	Northing
WQS01	Tenas Creek, upstream of Project	Minor effects from Project anticipated from open pit groundwater table drawdown	615,171	6,050,438
WQS02	Tenas Creek, adjacent (West) to Project	Potential effects anticipated from open pit drawdown and management pond seepage, minor reduction of catchment area	617,171	6,053,841
WQS03	Four Creek, upstream of Project	Minor effects from Project anticipated from open pit groundwater table drawdown	619,235	6,049,989
WQS03DS	Four Creek, downstream of WQS20 and Project	Potential effects anticipated from open pit drawdown and management pond seepage, reduction of catchment area	620,034	6,054,076
WQS04	Tenas Creek, downstream of WQS02 and Project	Potential effects anticipated from open pit drawdown and management pond seepage, reduction of catchment area	620,499	6,057,020
WQS05	Goathorn Creek, downstream of Tenas Creek and WQS06	Potential effects anticipated, based on summation of effects to Four and Tenas creeks and Project discharge into Goathorn Creek	620,615	6,058,133
WQS06_US	Goathorn Creek, upstream of Four Creek	Minor effects from Project anticipated from open pit groundwater table drawdown	620,587	6,053,711
WQS06	Goathorn Creek, upstream of Tenas Creek, downstream of Four Creek	Potential effects anticipated from Project discharge and effects to Four Creek	621,095	6,057,390
WQS09	Telkwa River, downstream of Goathorn Creek	Potential effect from Project anticipated from catchment area reduction and summation of effects from Goathorn, Tenas and Four creeks	621,394	6,058,998
WQS11	Bulkley River, upstream of Telkwa River, downstream of Rail Infrastructure	Minor effects from Project anticipated from Rail Infrastructure runoff	629,601	6,059,221
WQS12	Bulkley River, downstream of Telkwa River	Minor effects anticipated, based on summation of effects in Telkwa River and all upstream creeks, as well as upstream Bulkley River	625,021	6,063,831
WQS13	Goathorn Creek, upstream of Project	Minor effects from Project anticipated from open pit groundwater table drawdown		
WQS20	Four Creek, adjacent (East) of Project	Potential effects anticipated from open pit drawdown and management pond seepage, reduction of catchment area	619,344	6,052,005
WQS21	Four Creek, upstream of WQS20 and Project	Potential effects anticipated from open pit drawdown and management pond seepage, reduction of catchment area	619,269	6,051,446
WQS22	Tenas Creek, downstream of WQS02 and Project	Potential effects anticipated from open pit drawdown and management pond seepage, minor reduction of catchment area	619,313	6,056,222

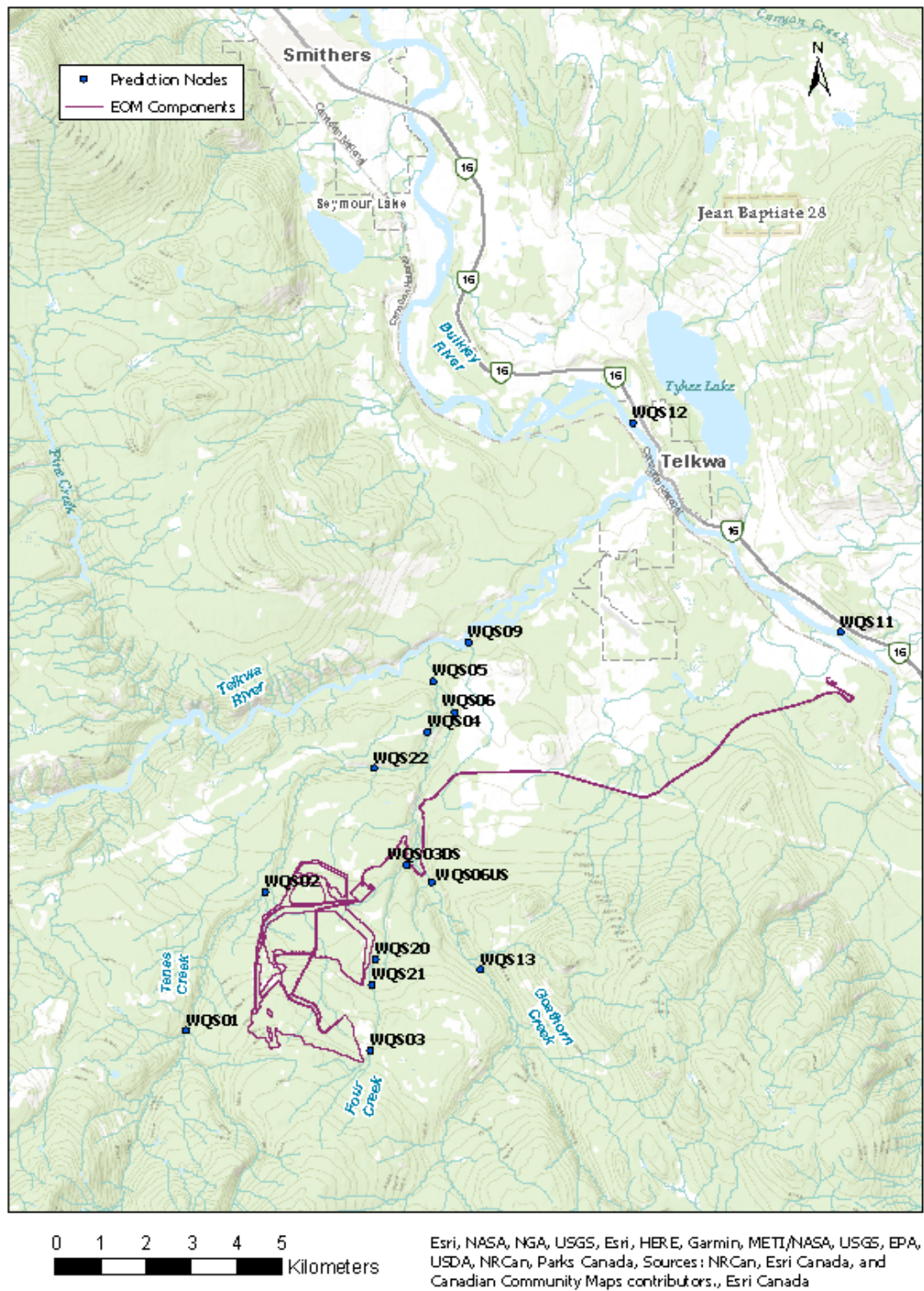


Figure 2-6: Receiving Environment Prediction Nodes Map

2.4.2 Modelled Assessment Cases

Multiple assessment cases were developed to understand the range of potential effects from the Project throughout the life of mine. Cases incorporate variability in hydrologic conditions, groundwater conditions and geochemical source terms:

- **Background concentrations:** Concentration (in mg/L of water) of each water quality parameter applied to streamflow or groundwater generated from natural catchments. All assessment cases consider the median (50th percentile) water quality data. The upper percentile (95th) is used for screening purposes of model results.
- **Geochemical source terms:** Concentration (in mg/L of water from a given source) or loading rate (in mg per kg of mine rock placed over time) source terms were developed from review of geochemical datasets. Results are presented for the base case source term, which is most likely to occur, and a high source term for a reasonable worst case.
- **Hydrology:** Streamflow and Project discharge are driven by precipitation and temperature inputs and calibrated runoff parameters. Hydrologic scenarios are further described in Section 3.1. and include:
 - Repeated average year precipitation and temperature
 - Consecutive wet or dry year precipitation
 - Stochastically generated daily precipitation, and
 - A low flow condition using the 7-day low flow in a 1 in 10-year return period (7Q10).
- **Groundwater seepage:** Groundwater modeling results were incorporated into the model (Section 3.8). Two cases are presented, including the expected groundwater conditions and high case seepage rates.

A Pre-Mining Case was simulated in parallel to each assessment case to evaluate the effects of the Project for surface water quantity with respect to a similar baseline. The hydrologic scenario applied to each assessment case was mirrored in the Pre-Mining Case for the same years, enabling comparisons with identical assumptions without mining influences. The assessment considers effects in relation to surface water quantity based on the percent change over Pre-Mining Case (i.e., without effects of mining) conditions.

Table 2-3 presents a summary of assessment cases applied in the model. Relevant results include water quantity and water quality in the receiving environment (Stream) as well as within Project infrastructure (Project).

Table 2-3: Summary of Modelled Assessment Cases

Assessment Case	Background Concentrations	Geochemical Source Terms	Hydrology	Groundwater Seepage	Relevant Results	Purpose
Project Case	Median from Baseline	Typical	Average Annual Precipitation	Expected Groundwater Conditions	Stream and Project Water Quantity, Water Quality	Applied and evaluated for all nodes, forming the basis of the effects assessment of the Project
Alternative Case 1	Median from Baseline	Typical	Average Annual Precipitation	High Groundwater Conditions	Stream and Project Water Quantity, Water Quality	Considers higher seepage rates from Project infrastructure and higher drawdown from open pit and the effects on Four Creek and Tenas Creek baseflow rates and winter (low flow) water quality
Alternative Case 2	Median from Baseline	High	Average Annual Precipitation	Expected Groundwater Conditions	Stream and Project Water Quality	Considers higher loading rates from Project to downstream environment and the associated in-stream water quality. Used for Initial Dilution Zone model scenarios in Goathorn Creek (SRK 2021e)
Alternative Case 3	n.a.	n.a.	Consecutive 100-year Dry Events	Expected Groundwater Conditions	Project Water Quantity	Minimize water available for water covers
Alternative Case 4	Median from Baseline	Typical	Consecutive 100-year Wet Events	Expected Groundwater Conditions	Stream and Project Water Quantity, Water Quality	Maximize Project discharge rates and the effects to receiving environment (Goathorn Creek) in terms of flow rates and water quality
Alternative Case 5	Median from Baseline	Typical	7Q10 Low Flow with Average Annual Precipitation ¹	Expected Groundwater Conditions	Stream Water Quantity, Water Quality	Project influence on low flow conditions. Water quality predictions used in Initial Dilution Zone model (SRK 2021e)
Alternative Case 6	n.a.	n.a.	Stochastic Precipitation	Expected Groundwater Conditions	Project Water Quantity	Effect on water covers and Project discharge rates
Pre-Mining Case	n.a.	n.a.	Variable to coincide with selected assessment case	Pre-Mining	Stream Water Quantity	Baseline conditions without Project interaction (i.e., no-mining condition)

n.a. = not applicable

2.4.3 Spatial Boundaries of Assessment

Two spatial boundaries were considered in the EA for surface water:

- the Local Study Area (LSA).
- the Regional Study Area (RSA).

The LSA is defined where direct discharges occur to watercourses within the vicinity of the mine (e.g., Tenas Creek, Four Creek, and Goathorn Creek), to the edge of the mixing zone in the Telkwa River, and downstream of the Rail Infrastructure Area in the Bulkley River. The total area of the LSA is 208.3 km².

The RSA, which encompasses the LSA, extends to monitoring location WQS12 in the Bulkley River, approximately 2km downstream of the confluence with the Telkwa River, and includes the Telkwa River catchment area to be consistent with other valued component boundaries. The RSA continues upstream of the confluence of the Telkwa River to the Bulkley River at Quick Water Survey of Canada station (08EE004), which captures conditions upstream of the Rail infrastructure Area. The total area of the RSA is 1430 km²

Spatial boundaries are presented in Figure 2-7, where the LSA is a purple dashed line, and the RSA is a green dashed line.

2.4.4 Predicted Parameters

The following types of model results are presented for water quality and water quantity to support the EA Application.

Water Quantity Results

Internal Project Results:

- Ability of the Project to maintain the minimum water cover requirements for all Management Ponds throughout life of mine.
- Ability of the Project to meet process water demands at the CPP.
- Project discharge rates to Goathorn Creek tributary.
- Flooding time of the closure pit lake.

Receiving Environment Results:

- Relative change to streamflow under a no-mining condition (Pre-Mining Case). Monthly percent change over Pre-Mining conditions were calculated at each node and summarized per Project stage.

Water Quality Results

Parameters included in the model are summarized in Table 2-4. Other parameters estimated outside of the model include temperature, pH, conductivity, total suspended solids, total dissolved solids, PAHs, and turbidity. Estimates for these parameters were developed based on relationships to modelled parameters, or qualitatively.

Internal Project Results:

- Monthly average and maximum concentrations within Management Ponds and the end pit lake as well as all discharging facilities, including the Tenas Control Pond and the Rail Infrastructure Sedimentation Pond. Note that the Explosives Facility and Explosives Magazine Sedimentation Ponds have not been modelled in the GoldSim model but will discharge runoff to the downstream environment. Changes to water quality downstream of these ponds is expected to be minimal based on use of best management practices. Total suspended solids will be controlled with sedimentation pond designs.
- Results are screened against effluent discharge criteria, which include nitrate and total selenium.

Receiving Environment Results:

- Monthly average water quality results at each prediction node, screened against the WQG.
- For each period and each Project stage, both the average and maximum monthly results are presented for winter and summer conditions:
 - Winter extends from November through April (frozen conditions)
 - Summer extends from May through October (open-water season).

Table 2-4: Water Quality Parameters Modelled in the Load Balance

Parameters Included in Predictions				
Aluminum, dissolved	Cadmium, dissolved	Iron, total	Nickel, dissolved	Sodium, total
Aluminum, total	Cadmium, total	Lead, dissolved	Nickel, total	Strontium, dissolved
Ammonia-Nitrogen, total	Calcium, dissolved	Lead, total	Nitrate-Nitrogen	Sulfate
Antimony, dissolved	Calcium, total	Lithium, dissolved	Nitrite-Nitrogen	Thallium, dissolved
Antimony, total	Chloride	Lithium, total	Phosphorus, total	Thallium, total
Arsenic, dissolved	Chromium, dissolved	Magnesium, dissolved	Potassium, dissolved	Tin, dissolved
Arsenic, total	Chromium, total	Magnesium, total	Potassium, total	Tin, total
Barium, dissolved	Cobalt, dissolved	Manganese, dissolved	Selenium, dissolved	Uranium, dissolved
Barium, total	Cobalt, total	Manganese, total	Selenium, total	Uranium, total
Beryllium, dissolved	Copper, dissolved	Mercury, dissolved	Silica, dissolved	Vanadium, dissolved
Beryllium, total	Copper, total	Mercury, total	Silver, dissolved	Vanadium, total
Boron, dissolved	Fluoride	Molybdenum, dissolved	Silver, total	Zinc, dissolved
Boron, total	Iron, dissolved	Molybdenum, total	Sodium, dissolved	Zinc, total

2.4.5 In-Stream Characteristics

Changes from the Project on streamflow are characterized in accordance with guidance documents for the EA Application. Surface water has been identified as a valued component, of which water quantity and water quality are each sub-components. The characterization of effects (magnitude, frequency, duration, context, reversibility, and extent) is discussed in the EA Application.

Surface water quantity results are evaluated in terms of:

- Change to mean annual discharge, based on percent change between mean annual discharge in Project Case conditions and Pre-Mining conditions.
- Change to seasonal flow distribution, based on percent change between monthly average discharge in Project Case conditions and Pre-Mining conditions.
- Change to low flows, based on percent change between the 7Q10 in Alternative Assessment Case 5 and Pre-Mining conditions.

Surface water quality results are evaluated in relation to WQG and SPOs, in context with the natural variability from baseline monitoring data.

3 Model Inputs and Assumptions

3.1 Climate and Hydrology

SRK prepared a hydrometeorological characterization report for the Project to support water management designs and water balance modeling (SRK 2021a). Outputs from the analyses relevant to the water balance include:

- Average lake evaporation rates.
- Long-term temperature and precipitation records developed from Smithers Airport and other regional datasets and corrected for the Project location and prediction node catchments.
- Rainfall-runoff models calibrated for each stream.

Inputs to the water balance are summarized in the following sections.

3.1.1 Historical Climate Conditions

The Project-specific precipitation record includes 77 years of data, from 1943 to 2020. Annual precipitation values were compared with the annual frequency analysis results presented in the hydrometeorological characterization report (SRK 2021a), and select years were identified to simulate dry and average conditions. Table 3-1 presents the historical precipitation datasets incorporated into the model for select hydrologic conditions, including the 100-year dry and 100-year wet.

Table 3-1: Historical precipitation data incorporated for specific hydrologic conditions in the model

Hydrologic Condition	Return Period (years) ⁽¹⁾	Frequency Analysis Results for Annual Precipitation (mm/a) ⁽²⁾	Corresponding Historical Year with Similar Annual Precipitation	Historical Annual Precipitation (mm/a)
Wet	100	882	1977	596
Mean	n.a.	608	1977	596
Dry	100	396	1970	399

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\MasterInputs_TelkwaEA_Rev08_sab_ccm.xlsm

Notes:

1. Frequency analysis described in SRK 2021a
2. Return periods were selected based on available historical information

The annual precipitation recorded in 1977 was like the MAP for the Project and is run as the base condition climate to simulate the historical average climate condition.

Sensitivity analyses (Section 2.4.2) were prepared to assess three consecutive wet or dry years applied at critical periods throughout the life of mine:

- Three consecutive dry years were applied at the most critical period for water demand, during operations of all three Management Ponds. The Project discharge during this period is minimized, which influences downgradient streamflow.

- Three consecutive wet years were applied at the most critical period of the mine life, at the end of operations when the Project footprint is maximized and the Management Ponds approach maximum capacity. This period produced the highest annual discharge rates and therefore increases stream water quantity.

Under all historical precipitation conditions, the monthly average temperatures were applied (Table 3-2).

Table 3-2: Project Monthly Average Temperature Summary

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature (°C)	-9.2	-6.1	-2.7	2.1	6.8	10.7	13.0	12.5	8.4	2.6	-3.8	-7.9	2.2

Source: SRK 2021a

3.1.2 WGEN and Stochastic Hydrology

The weather-generating (WGEN) model stochastically generates daily precipitation and minimum and maximum air temperature based on monthly statistics. WGEN generates precipitation independently of other variables and air temperature is dependent on the occurrence of rain. The long-term timeseries for air temperature and total precipitation developed for the Project were used as inputs to generate statistical parameters for the WGEN model.

Precipitation is first determined by the probability of consecutive precipitation days, then the precipitation amount is generated according to a gamma distribution. The monthly probabilities of a wet day occurring after a wet day, $P(W/W)$, or dry day, $P(W/D)$, are given in Table 3-3. A wet day is defined as having more than 0.25 mm of precipitation. Table 3-4 shows the fitted gamma distribution parameters (α and β). The WGEN methodology is described in (Richardson and Wright, 1984).

Table 3-3: Probabilities of wet or dry day occurrence

Month	P(W/W)	P(W/D)
January	0.650	0.367
February	0.603	0.263
March	0.484	0.260
April	0.554	0.239
May	0.535	0.288
June	0.611	0.331
July	0.598	0.276
August	0.615	0.258
September	0.615	0.331
October	0.687	0.397
November	0.641	0.425
December	0.627	0.371

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Model\WGEN\wgen_inputs.xlsx

Table 3-4: Precipitation gamma distribution parameters

Month	A	b
January	0.860	0.176
February	0.817	0.177
March	0.859	0.131
April	0.816	0.137
May	0.768	0.172
June	0.777	0.185
July	0.860	0.164
August	0.865	0.156
September	0.857	0.174
October	0.769	0.217
November	0.793	0.210
December	0.804	0.185

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Model\WGEN\wgen_inputs.xlsx

Air temperature is generated based on the occurrence of precipitation, and the seasonal change in the means and coefficients of variation for minimum and maximum air temperature fitted with a sinusoidal curve:

$$u_i = \bar{u} + C \cos\left(\frac{2\pi}{365}(i - 200)\right), i = 1, \dots, 365$$

Where u_i is the air temperature or coefficient of variation value on day i , $\bar{u}$ is the mean of u_i , C is the seasonal amplitude, and i is the amplitude position in days. Richardson and Wright (1984) recommends a i of 200 days. The maximum daily air temperature is highly dependent on the occurrence of precipitation; however, the minimum daily air temperature is not, and statistics were generated using both wet and dry days. These parameters are presented in Table 3-5.

Table 3-5: WGEN air temperature parameters

Parameter	Value
Mean of maximum air temperature (dry) (°C)	7.83
Mean of maximum air temperature (wet) (°C)	6.61
Amplitude of maximum air temperature (wet or dry) (°C)	-4.25
Mean coefficient of variation of maximum air temperature (wet or dry)	0.26
Amplitude of coefficient of variation of maximum air temperature (wet or dry)	-0.21
Mean of minimum air temperature (wet or dry) (°C)	-2.13
Amplitude of minimum air temperature (wet or dry) (°C)	-8.67
Mean coefficient of variation of minimum air temperature (wet or dry)	0.44
Amplitude of coefficient of variation of minimum air temperature (wet or dry)	-0.47

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Model\WGEN\wgen_inputs.xlsx

3.1.3 Prediction Node Climate Adjustments

Based on the range of terrain and elevation bands within the watersheds of each prediction node, an adjustment to climate parameters was required to develop streamflow estimates in each stream. Detailed methodology for the climate adjustments is presented in Appendix A.

The long-term Project temperature and precipitation records were adjusted using the Parameter-elevation Relationships on Independent Slopes Model (PRISM) to estimate climate parameters for each of the local hydrometric stations within each stream. An average monthly precipitation for each hydrometric station watershed was derived from the gridded PRISM monthly precipitation model. These monthly precipitation values were compared against the monthly precipitation estimates for the Project, and a ratio was calculated for each month and each station (Table 3-6).

Table 3-6: Monthly Precipitation Correction Factors applied to Project Precipitation based on PRISM

Month	Tenas Hydro	Four-Hydro	Goathorn Hydro	Telkwa Hydro	Bulkley Hydro
Jan	1.84	1.30	1.88	2.06	1.74
Feb	1.68	1.19	1.71	1.89	1.81
Mar	2.00	1.42	2.03	2.29	2.07
Apr	1.81	1.39	1.87	2.05	1.83
May	1.28	1.04	1.26	1.31	1.14
Jun	1.18	1.15	1.23	1.19	1.09
Jul	1.11	1.13	1.16	1.10	1.03
Aug	1.28	1.03	1.28	1.31	1.17
Sep	1.52	1.09	1.53	1.60	1.33
Oct	1.53	1.09	1.56	1.79	1.70
Nov	1.92	1.37	1.94	2.20	1.95
Dec	1.92	1.36	1.96	2.22	1.93

Appendix A

A similar process was employed for temperature. A monthly average temperature for each hydrometric station watershed was derived from the gridded PRISM monthly temperature model. These monthly temperature values were compared against the monthly temperature estimates for the Project, and a correction addend was calculated for each month and each station (Table 3-7).

Table 3-7: Monthly Average Temperature Correction Addends (in degrees Celsius) applied to Project Average Temperature based on PRISM

Month	Tenas Hydro	Four-Hydro	Goathorn Hydro	Telkwa Hydro	Bulkley Hydro
Jan	-0.45	-0.24	-0.52	-0.45	-0.27
Feb	-0.88	-0.37	-0.98	-1.03	-0.73
Mar	-1.27	-0.43	-1.54	-1.66	-0.93
Apr	-1.64	-0.68	-1.96	-2.13	-1.19
May	-1.74	-0.78	-2.03	-2.29	-1.26
Jun	-1.81	-0.74	-2.06	-2.46	-1.38
Jul	-1.77	-0.80	-2.00	-2.33	-1.24
Aug	-1.48	-0.51	-1.71	-2.00	-0.92
Sep	-1.28	-0.43	-1.51	-1.73	-0.70
Oct	-1.17	-0.55	-1.46	-1.50	-0.58
Nov	-0.93	-0.30	-1.08	-1.16	-0.43
Dec	-0.32	-0.04	-0.36	-0.37	-0.15

Appendix A

The daily temperature and precipitation time series adjusted for each streamflow station were used to calibrate rainfall-runoff model inputs (Section 3.1.7) as well as in the water balance model.

3.1.4 Evaporation

Lake surface evaporation for the Project was developed using the Morton CRWE shallow lake evaporation (SRK 2021a). Based on the Project temperature record, as well as modelled solar radiation, relative humidity and wind speeds from the Smithers Airport station, the estimated mean annual evaporation for the Project is 529 mm. Table 3-8 presents the monthly average lake evaporation rates applied in the model.

Table 3-8: Historical Project Monthly Open Water Evaporation Rates (mm)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Monthly Evaporation (mm/mo)	0	0	0	60	97	108	116	99	50	0	0	0	529
Daily Evaporation (mm/d)	0	0	0	2	3.1	3.6	3.7	3.2	1.7	0	0	0	n.a

Source: SRK 2021a

Evaporation rates for covered Management Ponds are described in Section 3.4.4.

3.1.5 Climate Change

Climate change was evaluated for the Project in terms of rates of change using monthly adjustment factors for three published projection periods. Dates to effect climate change in the model were

selected as the center of each published projection period. Climate beyond 2085 was assumed to remain constant. All scenarios, hydrologic conditions and water management cases include climate change. Climate change scenario 4.5 was selected for the purpose of the Project evaluation and model. Methodologies for developing rates of change are presented in SRK 2021a.

Daily precipitation rates were multiplied by monthly adjustment factors presented in Table 3-9, where a value of 100% represents the use of historical data, a value less than 100% represents a decrease in monthly precipitation, and a value greater than 100% represents an increase in monthly precipitation. Results indicate a net increase in precipitation for all months except July and August, which are expected to decrease to 2070, after which August will begin to increase and July will continue to decrease through 2100.

Table 3-9: Daily Precipitation Adjustment Factors for Climate Change

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1/1/2020	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1/1/2035	105%	107%	106%	100%	114%	102%	101%	99%	105%	107%	104%	103%	105%
1/1/2055	112%	108%	114%	114%	134%	133%	95%	100%	110%	112%	111%	112%	112%
1/1/2085	112%	111%	116%	109%	148%	123%	77%	102%	114%	118%	116%	118%	115%

Source: SRK 2021a

Note: Red text reflects a decrease over baseline conditions

Daily temperature changes were included as a net increase or decrease to historical values, as presented in Table 3-10. A value of 0 represents no change from historical temperature data, where a value greater than 0 represents a net increase in daily temperature in degrees Celsius (°C). The annual trend is a net increase in temperature for all months of the year.

Table 3-10: Daily Mean Temperature Increase for Climate Change (°C)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
1/1/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
1/1/2035	1.25	1.23	1.16	1.13	1.35	1.44	1.35	1.21	1.00	0.97	1.02	0.86	+1.2
1/1/2055	2.89	2.16	2.42	2.30	2.60	2.51	2.45	2.39	2.11	2.07	2.26	2.48	+2.4
1/1/2085	3.45	2.79	3.01	3.04	3.14	3.13	3.24	2.99	2.72	2.56	2.85	2.97	+3.0

Source: SRK 2021a

Daily evaporation rates were multiplied by monthly adjustment factors presented in Table 3-11, where a value of 100% represents the use of historical data, a value less than 100% represents a decrease in monthly evaporation, and a value greater than 100% represents an increase in monthly evaporation. The annual trend is a net increase in evaporation for all months of the year.

Table 3-11: Daily Evaporation Adjustment Factors for Climate Change

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1/1/2020	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1/1/2035	101%	101%	103%	103%	103%	104%	103%	103%	103%	101%	101%	101%	102%
1/1/2055	102%	102%	106%	106%	106%	106%	106%	106%	106%	102%	102%	102%	104%
1/1/2085	102%	103%	107%	108%	108%	108%	108%	108%	108%	102%	102%	102%	105%

Source: SRK 2021a

Climate inputs are drivers of the streamflow modeling in the water balance model, as described in Section 3.1.7. Effects of climate change on streamflow is therefore carried forward through the adjustments to temperature and precipitation.

3.1.6 Snowmelt

The SNOW-17 snow accumulation and ablation model developed by the National Weather Service River Forecast System (NWSRFS) was implemented in GoldSim to model snowmelt for the Project. The main processes included in this model are dividing precipitation into rain or snow, accumulation of snowpack, energy exchange, heat deficit in the snowpack, ground melt and snowmelt as a snow water equivalent (Anderson 2006). Model inputs include temperature and precipitation, based on the selected climate scenario, and input parameters to model a column of snow. Details on model inputs and calibration using a regional snow gauging station are described in SRK 2021a.

The routine in Goldsim produces an excess water term daily, which is the sum of rainfall and snowmelt.

3.1.7 Project Runoff Model

Runoff is frequently presented as the depth of water distributed evenly throughout the watershed area. Since the Project is located within the Goathorn Creek, Tenas Creek, Four Creek, Telkwa River and Bulkley River watersheds, rainfall-runoff models were calibrated for each stream based on the excess water produced from the snowmelt model described in Section 3.1.6.

Constant variables including the lag time, minimum baseflow and recession coefficient, along with monthly runoff coefficients, were adjusted to fit the modelled daily flow to the observed daily flow at each stream. A Nash Sutcliffe Efficiency (NSE) function was included in GoldSim, comparing the modelled vs. observed flow results. Model calibration results are described in SRK 2021a and summarized in Table 3-12.

Impacted catchments, including open pit wall areas and Management Ponds or other ponded areas, incorporated a different set of monthly runoff coefficients. Basin lag and recession were not incorporated for these types of catchments, allowing all runoff to report to the downstream node in a single timestep. Open pit walls were assumed to consist primarily of exposed rock, resulting in fewer losses to infiltration than natural runoff. In this case, a monthly runoff coefficient of 0.8 or 1.0 was used, based on the corresponding values for natural catchments. Pond surfaces were assumed to have

runoff coefficients equal to 1.0 year-round. Model inputs for open pit wall and pond areas are also presented in Table 3-12.

Table 3-12: Rainfall-Runoff Model Inputs

Location	Goathorn	Telkwa	Tenas	Bulkley	Four	Project	Open pit Wall	Waterbody
Minimum Unit Baseflow [L/s/km²]	1.8	4.1	0.43	3.0	0.3	1.1	n.a	n.a
Lag Time [days]	1	1	1	1	1	1	n.a	n.a
Recession	0.9	0.92	0.91	0.96	0.90	0.905	n.a	n.a
Runoff Coefficient	January	1	1	1	1	1	1	1
	February	1	1	1	1	1	1	1
	March	1	1	1	1	1	1	1
	April	0.42	1	0.45	0.76	0.5	0.43	1
	May	0.27	0.83	0.32	0.50	0.01	0.30	1
	June	0.20	0.38	0.17	0.36	0.1	0.18	1
	July	0.46	0.59	0.09	0.88	0.05	0.28	1
	August	0.33	0.74	0.03	0.22	0.05	0.18	1
	September	0.29	0.54	0.19	0.48	0.08	0.24	1
	October	0.29	0.69	0.28	0.47	0.03	0.28	1
	November	0.56	0.5	0.88	0.81	0.9	0.72	1
	December	1	1	1	1	0.4	1	1

Source: SRK 2021a

Runoff from overburden stockpiles was assumed to mimic natural runoff conditions, based on the expectation that dumps will be vegetated once completed, and were assigned the same parameters as natural catchments. Runoff for Non-PAG rock are discussed in Section 3.6.

3.1.8 Low Flow Model

Low flow conditions are an important indicator of stream stability in terms of its capacity to provide habitat for fish and aquatic life, as well as other users. The water and load balance model incorporates a baseflow rate calibrated on historical records (Section 3.1.7), which represents typical monthly average low flow conditions. The baseflows were selected based on review of the extended historical records at each hydrometric station, converted to unit baseflows (m³/s/km²) and applied to each modelled prediction node (SRK 2021a, summarized in Table 3-12). However, the model is unable to simulate more extreme low flow conditions, such as the 7-day low flow for specific return periods.

Low flow conditions were evaluated in two ways:

- Change to low flow conditions were developed external to the water and load balance model based on a ratio of modelled baseflow and the statistical 7-day low flow for a 1 in 10-year return period event (7Q10). Baseline 7Q10 conditions were calculated for each stream based on the extended

long-term flow records. A ratio of modelled baseflow over statistical 7Q10 was calculated for each stream or river, based on the unit 7Q10 and the unit baseflow inputs. This ratio was applied to the modelled low flow conditions, which are the same under average precipitation and the 100-year dry conditions based on the constant baseflow input, to calculate the corresponding 7Q10 under post-mining conditions. Percent change relative to Pre-Mining 7Q10 was calculated for each stream node.

- Change to water quality under low flow conditions were evaluated in the Initial Dilution Zone model (SRK 2021e) and are not presented in this report.

3.2 Mine Plan

A mine plan summarizing tonnages and/or volumes of overburden, PAG and non-PAG rock and PAG processed rock was provided by Telkwa Coal Limited as input to the water and load balance. Cumulative annual volumes of open pit capacity, Non-PAG backfill, PAG material and processed rock are presented in Table 3-13.

Table 3-13: Mine Plan Annual Volumes

Year	Mine Year	Cumulative Non-PAG Backfill Volume (m ³)	Cumulative PAG Volume (m ³)	Cumulative Processed Rock Volume (m ³)
2021	-1	0	00	0
2022	1	1.16	0.33	0.04
2023	2	2.61	1.54	0.23
2024	3	3.35	3.09	0.41
2025	4	7.19	4.80	0.58
2026	5	11.41	6.57	0.76
2027	6	13.87	8.55	0.94
2028	7	17.39	10.32	1.12
2029	8	19.18	12.08	1.30
2030	9	19.18	13.21	1.51
2031	10	20.40	14.93	1.70
2032	11	23.50	16.37	1.88
2033	12	26.65	18.23	2.06
2034	13	29.34	20.06	2.24
2035	14	31.67	21.21	2.41
2036	15	33.83	22.53	2.56
2037	16	35.73	24.12	2.73
2038	17	38.05	25.28	2.90
2039	18	40.30	26.52	3.07
2040	19	42.08	28.23	3.26
2041	20	42.20	29.43	3.47
2042	21	42.20	30.91	3.65
2043	22	42.20	31.83	3.77

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\MasterInputs_TelkwaEA_Rev08_sab_ccm.xlsm

3.3 Catchment Areas

The expansion of mining footprints and resulting reduction in natural catchments contributing to each facility is captured in the varying catchment area timeline. A total of 13 catchment regions were delineated and sub-delineated based on varying land types.

Appendix B includes catchment area figures for each phase of the Project, as well as summary tables with model input areas for each catchment and sub-catchment. Tables are also provided for the changing catchment areas of downstream prediction nodes, while figures for the pre-mining and post-mining prediction node areas are presented in Appendix A.

3.4 Management Ponds

Each Management Pond cell was modelled with two reservoir elements in GoldSim: one representing the free water volume and one representing the water in the void space of deposited PAG rock and processed rock. Inflows including precipitation and runoff or pumped water from other facilities are linked to the free water reservoir. Outflows from the free water reservoir include evaporation, pumped water to other facilities, and water lost (infiltration) to the void space of placed rock. The only outflow from the rock voids reservoir is seepage into the ground, which is replaced by infiltration from the free water reservoir. This approach enables the separation of water quality in the rock voids from water quality in the free water body, which accounts for the difference in retention time of each facility. Retention time in the rock voids reservoir is the quotient of the void volume and the groundwater seepage rate. The retention time in the void space of the placed waste rock is much longer than the flushing time of the free water reservoir.

Free water reservoirs are used to track the water cover depth above PAG and processed rock to ensure the minimum water cover of 1.0 m is achieved. Water more than target water cover depths is pumped or discharged via spillway from the pond to manage the water level (SRK 2021d). Controls to manage water cover depths are to:

- Activate pump at a rate of 9,000 m³/day from Tenas Control Pond to any given Management Pond when that ponds' water cover depth is less than 1.00 m.
- Activate pump at a rate of 9,000 m³/day from any given Management Pond to the Tenas Control Pond when water cover depth exceeds 1.20 m.

Pumping rates were determined based on a monthly water balance for the Tenas Control Pond, presented in the Water Management Design Technical Report (SRK 2021d).

3.4.1 Management Pond Volumetrics

Management Pond capacity and water cover thicknesses are calculated in the model based on stage-storage relationships developed from the final dam and open pit configuration of each facility (Appendix C).

presents the design levels and volumes for each Management Pond, including the dam crest, spillway invert and cumulative volume, as well as the cumulative PAG rock, processed rock, Non-PAG rock and overburden volumes deposited in each pond. Volumes include total volume occupied by material, including void space. The void volumes were assumed to be 30% of the total volume for placed Non-PAG and PAG rock, and 15% for processed rock.

Table 3-14: Summary of Management Pond Levels and Capacities

Parameter	NMP	EMP	WMP	Notes
Total Saturated PAG Rock Volume [m³]	2,386,000	11,561,000	27,432,000	Total volume with water in voids,
Total Saturated Processed Rock Volume [m³]	344,000	986,000	3,006,000	Total volume with water in voids,
Top of PAG Rock Elevation [masl]	825.3	847.4	847.4	Based on stage-storage curves (Appendix C)
Non-PAG Rock Cover average approximate Thickness [m]	1.5	1.5	1.5	Selected by TCL and SRK
Non-PAG Rock Cover Volume [m³]	427,000	1,580,000	1,441,000	Based on stage-storage curves (Appendix C)
Top of Non-PAG Rock Elevation [masl]	826.8	848.9	848.9	
Closure Spillway Invert [masl]	828.0	850.0	850.0	Selected by TCL and SRK
Overburden Cover average approximate Thickness [m]	1.2	1.1	1.1	Calculated based on spillway invert and top of Non-PAG rock
Overburden Cover Volume [m³]	338,000	1,222,000	1,138,000	Based on stage-storage curves (Appendix C)
Dam Crest Elevation [masl]	830.0	852.0	852.0	Selected by TCL and SRK

Source: Z:\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\ MasterInputs_TelkwaEA_Rev08_sab_ccm.xlsm

3.4.2 PAG Rock Deposition

The PAG rock deposition schedule by volume for each Management Pond is presented in Figure 3-1.

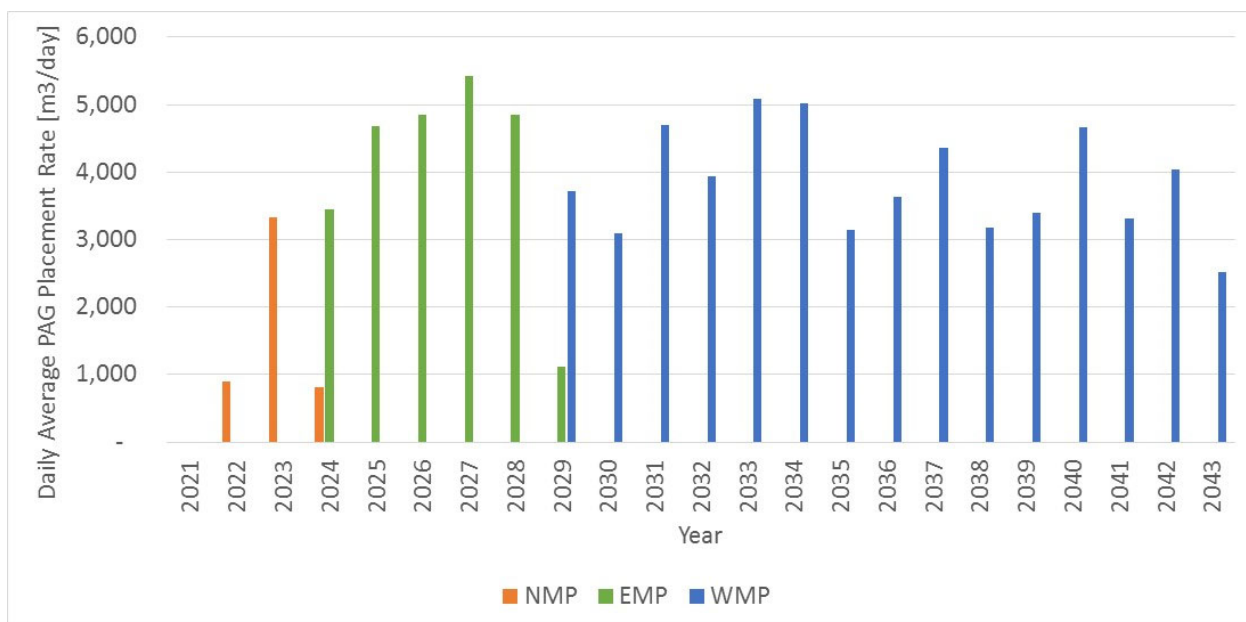


Figure 3-1: Annual Average PAG Placement Rates, m³/day

Source: Z:\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\ MasterInputs_TelkwaEA_Rev08_sab_ccm.xlsm

3.4.3 Processed Rock Deposition

Processed rock from the CPP is deposited in the active Management Ponds, comingled with PAG rock deposition. The deposition rate of processed road is 500 m³/day on average.

3.4.4 Management Pond Covers

Upon completion of PAG rock and processed rock deposition in each Management Pond, a cover system will be constructed to provide the following:

1. Reduce evaporative losses by decreasing the water vapor gradient between the water and atmosphere.
2. Isolate PAG rock from potential human and environmental influence and exposure.
3. Help return the landscape to pre-mining conditions.

The cover design is discussed in Appendix C of the Water Management Technical Design Report (SRK 2021d).

Evaporation rates from the Management Ponds once covered were reviewed as part of the scoping-level cover design. Covers will be vegetated with plant species that meet closure objectives. Based on existing vegetation in the area, a forest of black spruce and aspen will be planted across the Management Pond covers as part of progressive closure of each facility. Actual evapotranspiration rates from similar forests range from 252 mm/year to 450 mm/year (SRK 2021d, Appendix C). Based on this range, it was assumed that the cover would reduce annual evaporation rates from the

Management Ponds to 400 mm/year, or effectively reducing evaporation by 25% over an open-water body. A sensitivity analysis was performed on this assumption, which considered the ability of Management Ponds to maintain minimum water covers without the benefit of the cover (i.e., evaporation rates are equal to open-water conditions). Results are discussed in Section 4.1.1.

3.4.5 Management Pond Dams and Buttresses

Seepage and runoff from Management Pond dams and buttresses will be captured in peripheral ditches and conveyed to the Tenas Control Pond.

The dams and long-term buttresses constructed for each Management Pond will be constructed with Non-PAG rock and overburden. The volume of Non-PAG rock and overburden will be approximately equal throughout the life of mine. Modeling assumes that the water chemistry of buttress and dam runoff and seepage will be the average of the Non-PAG rock and overburden source terms.

Once construction of each dam and buttress are complete, a compacted overburden layer will be placed over each facility to reduce the infiltration rate into the structures from 40% to 10% of precipitation (Section 3.7). This will be followed by layer of growth media and/or soil for final vegetation planting for the decommissioning and reclamation and post-closure phases. Runoff from the cover will have overburden source term and seepage will have the average of the Non-PAG rock and overburden source terms. Runoff and seepage rates are described with the waste rock hydrology conceptual model (Section 3.7).

3.5 Water Supply

Tenas Control Pond supplies water for the Project. Water is distributed to three locations:

- the CPP.
- the Management Ponds to maintain water covers over PAG rock.
- mixing with the treated effluent from the sewage treatment plant discharge during May through October.

3.5.1 CPP Process Requirements

The CPP water demand is approximately 15,000 m³/month based on the processing rate of 1.05 million tonnes per annum. A maximum water demand of 130 litres per tonne, and an allowance of 3,625 m³/month for wash bays and dust suppression (all rates provided by TCL) were also implemented. Water is supplied by the Tenas Control Pond throughout operations. A contingency water supply source from Goathorn Creek was also simulated at a rate equal to 2.5% percent of the pre-mining flow rate. This source is configured to be utilized as needed based on low water volumes in the Project area, however the removal from Goathorn Creek at node WQS06 occurs throughout the entire Project operations period for the purpose of the EA. This condition is discussed in model results (Section 4.1.2). The water balance completed showed this contingency is not required.

3.5.2 Management Pond

Management Ponds are required to maintain a minimum water cover above stored PAG rock and processed rock to reduce the risk of oxidation (Section 3.4) and subsequent acid rock drainage. Water supply requirements for the Management Ponds vary throughout the life of mine and are expected to increase with increasing PAG rock and processed rock volumes. The Management Ponds collect flows from active open pit mining and natural runoff from undisturbed catchment areas. Any deficits are made up by pumping from the Tenas Control Pond, supplied by a pumping system with a capacity of 9,000 m³/day.

3.5.3 Sewage Effluent

The sewage treatment plant will discharge 5,000 m³ of treated effluent per year into the tributary of Goathorn Creek (Radloff 2021) during the open-water season (May through September). A dilution rate of 10:1 is required, which will be supplied by a minimum discharge rate from the Tenas Control Pond of 8,300 m³/month during the discharge period (50,000 m³/year).

3.5.4 Tenas Control Pond Operations

The Tenas Control Pond design is presented in SRK (2021d), which includes a maximum operating level, an emergency spillway, a minimum operating level, and a contingency storage volume to attenuate storm events. Target volumes are used in the model to trigger actions including discharge to environment or pumps to Management Ponds. The following triggers have been included:

- The design volume of the Tenas Control Pond to its spillway is 1,060,300 m³. The design stipulates that a minimum of 210,300 m³ of storage be maintained as contingency for storm events (SRK 2021d). The model does not simulate storm events and uses an upper bound equal to the target maximum operating volume of 850,000 m³, thereby ensuring that the contingency storage is maintained. Pond overflows in the model represent depletion of contingency storage and the model was optimized to ensure overflows do not occur under average hydrologic conditions.
- Discharge to Goathorn Creek tributary is enabled when pond volume exceeds 500,000 m³ and only occurs during open water season months (May to October). This volume was selected as part of pond optimization to avoid depletion of contingency storage during average conditions. Discharge during winter months is minimized where possible due to the reduced dilution capacity in Goathorn Creek at that time.
- Pumping to Management Ponds for water cover supply is disabled when the pond volume is reduced below 50,000 m³/month. This target volume ensures that a minimum volume is available for sediment control and to provide process water supply.

The Tenas Control Pond stage-storage curve is presented in Appendix C.

3.6 Ditch Efficiency

Diversion and collection channels were assumed to operate at 80% efficiency, where the remaining 20% of runoff collected at each location bypasses the channel and reports to downstream receptors or Project facilities.

A diversion channel south of the EMP (channel C02) will divert runoff to Four Creek. Ditch bypass contributes to water availability to maintain the Management Pond water cover. A sensitivity analyses was completed on the ditch efficiency for this system to ensure water cover could be maintained without relying on ditch bypass (20% of flows).

3.7 Waste Rock Hydrology

The hydrologic model for waste rock storage facilities differs from natural catchment hydrology, due to the lack of overburden and vegetation and the ability of dumps to temporarily store water in void space. During active material placement, all rock piles, including Non-PAG rock backfill and buttresses, are modelled as water reservoirs, accumulating inflow until the internal moisture content reaches a specified level. At the specified saturation level, water is assumed to discharge as seepage from the toe of the facilities, where it is captured by collection channels and diverted to downstream ponds.

Due to the nature of the mine plan, which includes flooded backfill in the open pit at closure, two conceptual rock pile models were included: unsaturated rock pile and saturated rock pile. Figure 3-2 presents the two conceptual models and Table 3-15 summarizes the model inputs and assumptions.

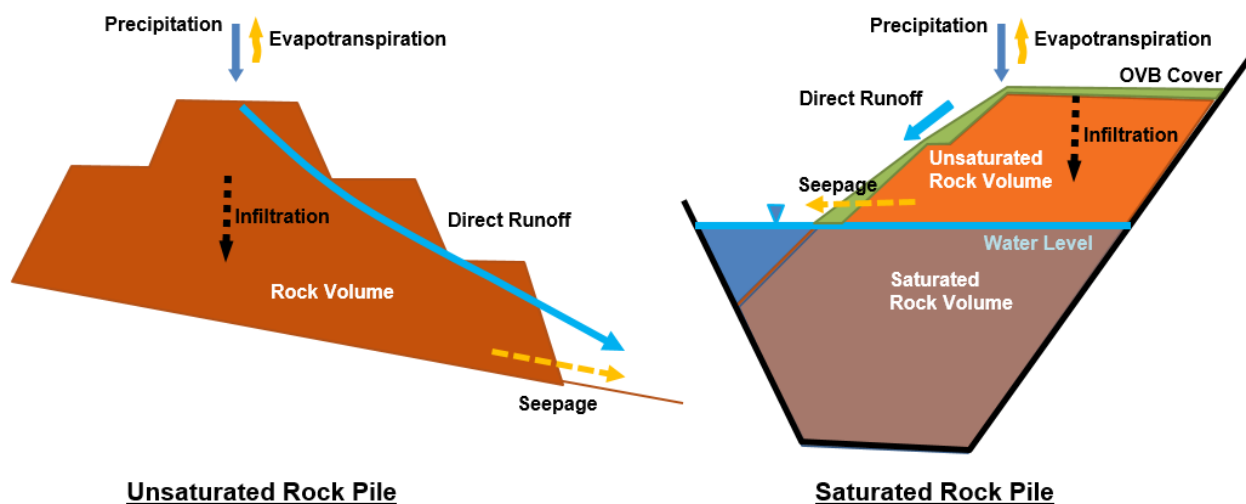


Figure 3-2: Conceptual Waste Pile Models for Unsaturated Rock (left) and Saturated Rock (right) piles

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\ConceptualModel\Planning\TelkwaWB_Planning_01292021.pptx

Unsaturated Rock Pile

Unsaturated rock piles include backfilled areas during operations as well as rock dams and buttresses of Management Ponds. The model assumes fixed percentages of precipitation falling on unsaturated rock pile areas will runoff, evaporate, or infiltrate. Water that infiltrates will be stored in the rock pile until the pile reaches the target moisture content of 7.0%, after which any additional water will discharge as seepage at the toe of the pile.

The mine plan currently states that dams and buttresses will be half Non-PAG rock and half overburden material by volume. Seepage water chemistry is modeled as being the average of the overburden (i.e., natural source terms) and Non-PAG rock source terms. This assumes that overburden will be distributed throughout backfill, ensuring that water is in contact with both materials equally limiting the chance of preferential flow pathways in the Non-PAG rock which could result in Non-PAG rock dominated seepage water chemistry. Seepage will be lagged with a recession value, like natural runoff rates. A recession value of 0.995 was selected for seepage to simulate a relatively smooth outflow.

Saturated Rock Pile

Saturated rock piles include the Non-PAG rock and overburden backfill in areas of the open pit that will be flooded at closure. All Non-PAG rock will be covered with overburden at the end of operations, reducing infiltration and increasing direct runoff rates, and approximately 70% of total rock volume placed in the open pit will be Non-PAG. The remainder is overburden. End pit lake water levels were used to calculate the total backfill volumes that would be submerged and saturated, while all rock above this level was assumed to remain unsaturated. All the void volume is filled with water when saturated. Once the rock is saturated, seepage is conveyed to the West Management Pond.

Table 3-15: Assumptions for Saturated and Unsaturated Rock Piles

Parameter	Unsaturated Rock	Saturated Rock	Justification
% of Precipitation that Infiltrates	40%	10%	Saturated rock model is applied at closure when overburden cover is placed, reducing infiltration, and increasing direct runoff
% of Precipitation as Direct Runoff	10%	Varies per month based on natural runoff rates	
% of Precipitation that Evaporates on surface	50%	50%	Based on monthly water balance
Target Moisture Content which enables Seepage	7%	30%	Based on SRK experience with operational waste rock dumps (unsaturated) and void volume for saturated rock
Runoff Recession Value	0.995	0.995	Selected to create an even outflow with minimal response to peak rainfall events

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\ConceptualModel\Planning\TelkwaWB_Planning_01292021.pptx

3.8 Groundwater

A regional groundwater model was developed for the EA Application. The model estimated groundwater fluxes, discharge, and recharge from the Project (SRK 2021c). Model results assume that all facilities are lined, including the in-pit portions of the WMP which are in contact with overburden. All non-overburden contact areas in the WMP in-pit area are not lined. Two modelled scenarios were considered:

- Expected groundwater scenario corresponds to the best fit model inputs, calibrated against head observations and average annual baseflows in each stream. This condition produced a normalized root mean square error (NRMSE) of 3.2% for hydraulic heads and 3.6% for baseflows (SRK 2021c).
- High groundwater scenario corresponds to an outlier condition where the hydraulic conductivities are maximized, while the calibration target is held near the minimum generally accepted in British Columbia (10% NRMSE). This condition emphasizes the potential groundwater flows into the open pit, underneath the waste and water management facilities, and into the creeks (SRK 2021c).

Four snapshot periods were evaluated in the groundwater model:

- End of Year 1: The North Management Pond and Tenas Control Pond are filled with water and PAG rock. No other Management Ponds are active. Connections to the open pit are dictated by the facility footprint and depth at this time. Active dewatering is occurring.
- End of Year 7: The East Management Pond is filled with water and PAG rock, joining the North Management Pond and the Tenas Control Pond. The open pit extents have increased, and active dewatering continues.
- End of Mining: The West Management Pond is filled with water and PAG rock, joining the North and East Management Ponds and the Tenas Control Pond. The open pit is filled to the maximum level but the open pit is still being actively dewatered.
- Post-Closure: All Management Ponds remain in-place, however the Tenas Control Pond has been breached and no longer stores water. Dewatering from the open pit has ended and the end pit lake and saturated waste rock have formed.

Groundwater connections are incorporated into the water and load balance model based on three components: direct connections to Project infrastructure, changes to stream baseflow, and load transport to streams.

3.8.1 Groundwater Flow Rates through Project Infrastructure

Instantaneous connections occur between the groundwater system and each mining facility, including the open pit, Management Ponds, and the Tenas Control Pond. Groundwater inflows and groundwater seepage loss connected to each facility occur on a daily timestep throughout the model period and are presented in Table 3-16 for the expected case groundwater model scenario and in Table 3-17 for the high case groundwater model scenario.

Table 3-16: Expected Case Groundwater Connections to Mining Facilities throughout Life of Mine [m³/day]

Phase	WMP	NMP	EMP	Tenas Control Pond	Open Pit	End Pit Lake	Open pit with Saturated Backfill
Inflows							
EoY1	0.0	0.0	0.0	0.0	316.8	n.a	n.a
EoY7	0.0	0.0	0.0	0.0	874.1	n.a	n.a
End of Mining	74.4	0.0	0.0	0.0	521.5	n.a	n.a
Post-Closure	154.7	0.0	0.0	0.0	n.a.	233.4	55.9
Outflows							
EoY1	0.0	0.0	0.0	140.0	0.0	n.a	n.a
EoY7	0.0	0.0	395.0	140.0	0.0	n.a	n.a
End of Mining	610.3	0.0	395.0	140.0	0.0	n.a	n.a
Post-Closure	584.7	0.0	395.0	0.0	n.a.	0.0	3.9

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Groundwater\Telkwa_Summary_2020_GW_model_results_Draft_20201203_gf_sab_rev03.xlsx

Notes:

Connections are not applicable (n.a.) for end pit lake at closure since it is replaced by the end pit lake and saturated backfill components. The reverse is true for the End Pit Lake and saturated backfill during operations

Table 3-17: High Case Groundwater Connections to Mining Facilities throughout Life of Mine [m³/day]

Phase	WMP	NMP	EMP	Tenas Control Pond	Open Pit	End Pit Lake	Open Pit with Saturated Backfill
Inflows							
EoY1	0.0	0.0	0.0	0.0	409.3	n.a	n.a
EoY7	0.0	0.0	0.0	0.0	1130.8	n.a	n.a
End of Mining	9.2	0.0	0.0	0.0	639.4	n.a	n.a
Post-Closure	114.7	0.0	0.0	0.0	n.a.	255.5	5.2
Outflows							
EoY1	0.0	0.0	0.0	290.0	0.0	n.a	n.a
EoY7	0.0	0.0	454.0	290.0	0.0	n.a	n.a
End of Mining	1650.8	0.0	454.0	290.0	0.0	n.a	n.a
Post-Closure	1483.7	0.0	454.0	0.0	n.a.	71.0	192.5

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Groundwater\Telkwa_Summary_2020_GW_model_results_Draft_20201203_gf_sab_rev03.xlsx

Note:

Connections are not applicable (n.a.) for end pit lake at closure since it is replaced by the end pit lake and saturated backfill components. The reverse is true for the End Pit Lake and saturated backfill during operations

3.8.2 Changes to Stream Baseflow

The change in water levels within the Management Ponds, Control Ponds, and the open pit affect the groundwater discharge rates to each downstream creek and river. The calibrated rainfall-runoff model included a constant unit baseflow for each major creek, which is applied to each associated prediction node. The baseflows were simplified in the groundwater model calibration. To understand the change to baseflows because of the mine, the groundwater model predicted baseline baseflow and baseflow during mining at each prediction node for each scenario. The rate baseflow changed between baseline conditions and mining conditions were directly applied to the baseflow component for each prediction node in the water balance model.

The baseflow dominates the total streamflow during winter months but represents a minor portion of the total streamflow during the open-water season. Baseflow rates in the receiving environment increase or decrease, depending on location in relation to the open pit and the Management Ponds. These changes are linearly interpolated between each snapshot for each prediction node. Table 3-18 presents the rate of change to prediction node baseflows under base case groundwater modeling conditions, and Table 3-19 presents the results for high case conditions.

Table 3-18: Rate of Change to Baseflow for Prediction Nodes throughout Life of Mine under Base Case Groundwater Conditions

Node	Stream	End of Year1	End of Year7	End of Mining	Post-Closure
WQS01	Tenas Creek	-0.1%	-0.2%	-0.4%	-0.3%
WQS02	Tenas Creek	-1.1%	-3.9%	1.7%	1.9%
WQS03	Four Creek	-0.7%	-20.5%	-29.8%	-22.7%
WQS03DS	Four Creek	-4.2%	-5.0%	-0.3%	4.0%
WQS04	Tenas Creek	-0.9%	-5.6%	3.3%	3.0%
WQS05	Goathorn Creek	-0.5%	-1.9%	0.8%	1.1%
WQS06	Goathorn Creek	-0.3%	-0.5%	-0.1%	0.3%
WQS06US	Goathorn Creek	0.0%	-0.2%	-0.2%	0.0%
WQS09	Telkwa River	-0.4%	-1.6%	0.7%	1.0%
WQS11	Bulkley River	0.0%	0.0%	0.0%	0.0%
WQS12	Bulkley River	-0.01%	-0.02%	0.01%	0.01%
WQS13	Goathorn Creek	0.0%	-0.2%	-0.3%	0.0%
WQS20	Four Creek	-2.6%	-21.3%	-32.8%	-22.3%
WQS21	Four Creek	-1.5%	-22.0%	-34.4%	-25.0%
WQS22	Tenas Creek	-1.0%	-5.9%	3.4%	3.1%

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Groundwater\Telkwa_Summary_2020_GW_model_results_Draft_20201203_gf_sab_rev03.xlsx

Table 3-19: Rate of Change to Baseflow for Prediction Nodes throughout Life of Mine under High Case Groundwater Conditions

Node	Stream	End of Year1	End of Year7	End of Mining	Post-Closure
WQS01	Tenas Creek	-0.1%	-0.5%	-0.5%	-0.3%
WQS02	Tenas Creek	-1.6%	-6.6%	10.9%	11.5%
WQS03	Four Creek	0.0%	0.0%	0.0%	0.0%
WQS03DS	Four Creek	-16.8%	-13.4%	92.2%	121.3%
WQS04	Tenas Creek	0.0%	-10.6%	32.0%	30.7%
WQS05	Goathorn Creek	-0.2%	-2.1%	7.1%	7.1%
WQS06	Goathorn Creek	-0.3%	-0.3%	1.9%	2.2%
WQS06US	Goathorn Creek	0.0%	-0.2%	-0.2%	-0.3%
WQS09	Telkwa River	-0.2%	-1.5%	5.2%	5.3%
WQS11	Bulkley River	0.0%	0.0%	0.0%	-0.2%
WQS12	Bulkley River	0.00%	-0.02%	0.08%	0.08%
WQS13	Goathorn Creek	0.0%	-0.1%	-0.3%	-0.6%
WQS20	Four Creek	-22.9%	-100.0%	-100.0%	-100.0%
WQS21	Four Creek	-22.9%	-100.0%	-100.0%	-100.0%
WQS22	Tenas Creek	-0.2%	-12.4%	36.4%	35.1%

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Groundwater\Telkwa_Summary_2020_GW_model_results_Draft_20201203_gf_sab_rev03.xlsx

Under the high case groundwater model predictions, there is no baseflow to Four Creek at WQS20 and WQS21 (i.e., 100% reduction in Table 3-19). Rate of change to combined streamflow, including runoff contributions, is discussed with the model results.

3.8.3 Contaminant Plume from Project Infrastructure

Water outflows from the Management Ponds, Tenas Control Pond and the open pit into the groundwater system take place instantaneously. However, there is a natural lag between the timing of seepage at the source and seepage being observed within the various stream prediction nodes. Particle tracing within the groundwater model revealed that a portion of seepage reaches the adjacent reach of Tenas Creek before end of mining, but that most of the seepage will not be observed until well past closure.

The model assumes the following:

- Seepage contributions into Tenas Creek nodes WQS02 and WQS22 begin at end of Year 7 and increase linearly to their end of mining.
- Seepage from each Management Pond is delayed 25 years from infiltrating into the facility to reaching prediction nodes. This timing is conservatively early based on the particle tracing results.
- Tenas Control Pond is decommissioned in closure; however, the seepage plume is assumed to continue contributing to the streams for 25 years beyond its decommissioning. Modeling assumes the pond is decommissioned 5 years after the start of closure, and seepage is assumed to continue to discharge to the creeks for an additional 25 years.

The contaminant load reaching each prediction node is calculated based on the percentage of particles leaving each Management Pond, open pit or Control Pond that reach each node under steady-state conditions. Results for expected case conditions are presented in Table 3-20 and high case groundwater seepage conditions in Table 3-21.

Table 3-20: Percentage of Groundwater Seepage from each Mining Facility Reporting to Downstream Prediction Nodes under Expected Case Groundwater Conditions

Facility	Node	Phase			
		End of Year1	End of Year7	End of Mining	Post Closure
North Management Pond	WQS04	0%	0%	7%	67%
	WQS05	0%	0%	5%	67%
	WQS09	0%	0%	8%	0%
	WQS22	0%	0%	7%	67%
East Management Pond	WQS03DS	0%	0%	0%	56%
	WQS04	0%	0%	0%	7%
	WQS05	0%	0%	0%	98%
	WQS06	0%	0%	0%	91%
West Management Pond	WQS02	0%	0%	5%	38%
	WQS04	0%	0%	7%	83%
	WQS05	0%	0%	7%	89%
	WQS06	0%	0%	0%	6%
	WQS09	0%	0%	7%	0%
	WQS22	0%	0%	7%	76%
Tenas Control Pond (1)	WQS04	0%	0%	0%	37%
	WQS05	0%	0%	0%	38%
	WQS03DS	0%	0%	0%	0%
Saturated Open pit Backfill	WQS02	0%	0%	0%	17%
	WQS04	0%	0%	0%	67%
	WQS05	0%	0%	0%	83%
	WQS06	0%	0%	0%	17%
	WQS22	0%	0%	0%	50%

Notes:

1. Seepage from the Tenas Control Pond is reduced to zero from 1/1/2074 onwards to reflect the decommissioning of the facility

Table 3-21: Percentage of Groundwater Seepage from each Mining Facility Reporting to Downstream Prediction Nodes under High Case Groundwater Conditions

Facility	Node	Phase			
		End of Year1	End of Year7	End of Mining	Post Closure
North Management Pond	WQS04	0%	0%	15%	32%
	WQS05	0%	0%	15%	32%
	WQS09	0%	0%	15%	0%
	WQS22	0%	0%	15%	32%
East Management Pond	WQS03DS	0%	0%	0%	34%
	WQS04	0%	0%	0%	10%
	WQS05	0%	0%	0%	98%
	WQS06	0%	0%	0%	87%
West Management Pond	WQS02	0%	0%	25%	48%
	WQS04	0%	0%	51%	81%
	WQS05	0%	0%	51%	87%
	WQS06	0%	0%	0%	5%
	WQS09	0%	0%	51%	0%
	WQS22	0%	0%	51%	77%
Tenas Control Pond (1)	WQS04	0%	0%	0%	28%
	WQS05	0%	0%	0%	38%
	WQS03DS	0%	0%	0%	0%
End Pit Lake (2)	WQS03DS	0%	0%	0%	56%
	WQS05	0%	0%	0%	100%
	WQS06	0%	0%	0%	100%
Saturated Open pit Backfill	WQS02	0%	0%	0%	8%
	WQS03DS	0%	0%	0%	8%
	WQS04	0%	0%	0%	58%
	WQS05	0%	0%	0%	100%
	WQS06	0%	0%	0%	42%
	WQS22	0%	0%	0%	25%

Notes:

1. Seepage from the Tenas Control Pond is reduced to zero from 1/1/2074 onwards to reflect the decommissioning of the facility
2. End Pit Lake discharge to groundwater only occurs under High Case groundwater modeling predictions and is therefore excluded from Table 3-20 (base case).

3.9 Water Quality Objectives

The following sections present the proposed in-stream guidelines and end of pipe limits.

3.9.1 In-Stream Guidelines

The long-term average BC Approved Water Quality Guidelines or BC AWQG (ENV 2017) and the BC Working Water Quality Guidelines or BC WWQG (ENV 2015) for freshwater aquatic life and the BC Source Drinking Water Quality Guidelines (BC SDWQG 2020) are applied in the evaluation of results from the load balance. The most stringent value for each parameter from each source was selected as the in-stream target threshold concentration. Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Aquatic Life (CCME WQG) are applied for parameters for which there is no BC AWQG or BC WWQG. WQG values for various parameters depend on the water quality in the receiving environment itself. WQG values are established for different potential receiving environments, based on average background concentrations (i.e., pre-mining conditions). When guidelines depend on hardness, the median hardness from baseline datasets within each creek was selected. Post-mining stream hardness will be higher than baseline and are presented with water quality results in Section 4.4.

In the case of selenium, the CCME WQG is 0.001 mg/L, which was developed as an alert concentration for early detection of selenium concerns. The BC Ministry of Environment proposed a guideline value of 0.002 mg/L by comparing ambient selenium surface water concentrations in British Columbia (ENV 2014), Alberta and across Canada. With the review of existing toxicological data, the CCME advise that the BC WQG for selenium can be applied across Canada based on jurisdiction's needs and policy goals (ECCC 2021). For this reason, the BC WQG for total selenium was selected as the in-stream target threshold concentration for the Project.

The BC WQG for total mercury is dependent on the in-stream concentration of methyl mercury (MeHg), and can range from 0.02 µg/L for streams where MeHg represents 0.5% or less of total mercury, 0.01 µg/L for streams where MeHg represents 1.0% of total mercury, and 0.00125 µg/L for streams where MeHg represents more than 8.0% of total mercury. Concentrations of MeHg were not measured as part of the baseline monitoring program. The detection limit for total mercury in baseline datasets is 0.0025 µg/L, which is greater than the lowest BC WQG of 0.00125 µg/L ~~range~~ for higher proportions of MeHg. The geochemical characterization found mercury concentrations in the humidity cell data were always below the detection limit of 0.01 µg/L. For these reasons, mercury is not expected to be a parameter of concern for the Tenas Project, and the mid-range BC WQG (0.01 µg/L) was used to assess model results. Site performance objectives (SPOs) were also developed for some of the constituents of potential concern. SPOs were developed for total aluminum (Borealis, Windward 2021a), total selenium (Borealis, Windward 2021b), dissolved cadmium (Borealis, Windward 2021c), total cobalt (Borealis, Windward 2020), total thallium (Borealis, Windward 2021d) and nitrite (Nautilus Environmental 2020). The SPOs are presented with the proposed in-stream WQG, however all screening was prepared with respect to the approved BC ENV and/or CCME WQG. For total selenium, a SPO of 0.008 mg/L was developed based on a regression relationship between selenium concentrations in water and the rainbow trout egg selenium, which is referred to as the Tier 1 SPO. In addition, a sulphate-dependent guideline was identified as the Tier 2 SPO to account for the mitigating

effect of sulphate on selenium bioaccumulation (Borealis, Windward 2021b). The Tier 2 SPO for selenium is calculated on a daily time timestep using the modelled results at each prediction node. Screening of results is presented based on the Tier 1 SPO and any exceedances identified are further assessed against the Tier 2 SPO.

Proposed long-term average WQG for the protection of freshwater aquatic life and human health at the Project are summarized in Table 3-22 along with SPOs where applicable.

Table 3-22: Proposed Long-term average water quality guidelines and Site Performance Objectives (SPOs) for freshwater aquatic life in receiving environments

Parameter	Units	SPO	BC SDWQG	Tenas Creek			Four Creek			Goathorn Creek			Telkwa River			Bulkley River		
				BC AWQG	BC WWQG	CCME WQG	BC AWQG	BC WWQG	CCME WQG	BC AWQG	BC WWQG	CCME WQG	BC AWQG	BC WWQG	CCME WQG	BC AWQG	BC WWQG	CCME WQG
Ammonia, total*	mg-N/L			1.2			0.95			1.5			1.7			1.7		
Chloride	mg/L			150			150			150			150			150		
Fluoride**	mg/L					0.12			0.12			0.12			0.12			0.12
Nitrate-Nitrogen	mg-N/L			3			3			3			3			3		
Nitrite-Nitrogen*	mg-N/L	0.0524		0.02			0.02			0.02			0.02			0.02		
Sulfate*	mg/L			218			309			218			218			128		
Aluminum, total*	mg/L	0.236				0.1			0.1			0.1			0.1			0.1
Aluminum, dissolved*	mg/L		9.5	0.05			0.05			0.05			0.05			0.05		
Antimony, total	mg/L				0.009			0.009			0.009			0.009			0.009	
Arsenic, total	mg/L			0.005			0.005			0.005			0.005			0.005		
Barium, total	mg/L		5.0		1			1			1			1			1	
Beryllium, total	mg/L				0.00013			0.00013			0.00013			0.00013			0.00013	
Boron, total	mg/L			1.2		1.5	1.2		1.5	1.2		1.5	1.2		1.5	1.2		1.5
Cadmium, diss*	mg/L	Varies*		0.00017			0.00024			0.00016			0.00011			0.00008		
Chromium (Cr(III)), total	mg/L		0.050			0.0089			0.0089			0.0089			0.0089			0.0089
Chromium (Cr(VI)), total***	mg/L					0.001			0.001			0.001			0.001			0.001
Cobalt, total	mg/L	0.0174	0.010	0.004			0.004			0.004			0.004			0.004		
Copper, total*	mg/L		2.0	0.003			0.005			0.003			0.002			0.002		
Iron, total**	mg/L			1		0.3	1		0.3	1		0.3	1		0.3	1		0.3
Iron, dissolved**	mg/L		0.30	0.35			0.35			0.35			0.35			0.35		
Lead, total*	mg/L		0.0050	0.006			0.007			0.005			0.004			0.004		
Manganese, total*	mg/L		0.12	0.94			1.1			0.92			0.79			0.73		
Mercury, total	mg/L		0.0010	0.00001			0.00001			0.00001			0.00001			0.00001		
Molybdenum, total	mg/L		0.088	1		0.073	1		0.073	1		0.073	1		0.073	1		0.073
Nickel, total*	mg/L		0.080		0.11			0.11			0.11			0.025			0.025	
Selenium, total	mg/L	0.008	0.010	0.002		0.001	0.002		0.001	0.002		0.001	0.002		0.001	0.002		0.001
Silver, total*	mg/L			0.00005		0.00025	0.0015		0.00025	0.00005		0.00025	0.00005		0.00025	0.00005		0.00025
Thallium, total	mg/L				0.0008	0.0008		0.0008	0.0008		0.0008	0.0008		0.0008	0.0008		0.0008	0.0008
Uranium, total	mg/L		0.020		0.0085	0.015		0.0085	0.015		0.0085	0.015		0.0085	0.015		0.0085	0.015
Zinc, total*	mg/L		3.0	0.0075			0.023			0.0075			0.0075			0.0075		

Source: \\Srk.ad\dfs\l\al\van\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\100_Data_Analysis\SurfaceWQ_BaselineData_rev09_kmp_smh_njs.xlsx

Notes:

- SPO = Site performance objective
- * Guidelines determined by baseline receiving water quality.
- ** Short-term maximum BC AWQG are provided for fluoride and total and dissolved iron.
- *** All chromium in baseline monitoring data is assumed to be Cr(VI)
- **** The guideline for total mercury is dependent on the methyl mercury concentrations of the receiving environment, which is not measured in the baseline data. The mid-range guideline was selected, which assumes a concentration of MeHg that is 1.% of total mercury. since the lowest limit is below the detection limit of the baseline monitoring data.

3.9.2 Proposed End of Pipe Limits

In the Canadian federal jurisdiction, end of pipe limits for discharge of excess water to the environment are not currently specified for the coal mining sector. *Coal Mining Effluent Regulations* under the federal *Fisheries Act* are currently in development and expected to come into force in 2021 (ECCC 2018). The *Coal Mining Effluent Regulations* are expected to specify end of pipe limits for TSS, nitrate, and selenium for new coal mines.

TCL have developed site-specific end of pipe limits to meet the proposed in-stream WQG for nitrate and total selenium presented in Table 3-22. End of pipe limits were back-calculated based on in-stream and Project discharge conditions consistent with the reasonable worst-case approach included in the Initial Dilution Zone study (SRK 2021e). Assumptions for the reasonable worst-case include:

- Average Project discharge during the highest flow month, corresponding with spring freshet. The long-term closure freshet discharge was selected over operations due to a higher expected flow rate at this time.
- In-stream flow conditions representative of 7Q10 during typical spring freshet.
- 95th percentile water quality in the receiving environment (Goathorn Creek).
- Final mixed in-stream concentration equal to the proposed in-stream WQG.

In the case of total selenium, the Tier 1 SPO of 0.008 mg/L was applied as the final in-stream concentration, while the BC AWQG of 3 mg/L was applied for nitrate. The resultant end of pipe limits under these conditions were calculated to be 0.050 mg/l and 18.8 mg/L for total selenium and nitrate-nitrogen, respectively.

3.10 Source Term Summary

The load balance considers multiple scenarios of source term combinations, based on alternative rock management strategies and ranges in geochemical source terms.

Two PAG rock exposure scenarios were considered, including a 6-month exposure period (typical exposure), and a 12-month exposure period (high case exposure). The longer exposure period simulates a scenario where the PAG rock may oxidize for a longer period, and therefore generate more soluble load that will be flushed from surfaces when placed in the management ponds.

For baseline surface water and groundwater concentrations 50th (P50) and 95th percentile (P95) source terms were developed. Base case and high case source terms were developed for non-PAG rock runoff, pit wall rock runoff and coal stockpile runoff. The base case uses geochemical inputs that are representative of the average bulk properties of the mine rock. The high case source term is calculated assuming the drainage from each source is in equilibrium with gypsum (i.e., sulfate concentrations are increased to gypsum saturation) and scaling up elemental concentrations assuming the base case element sulfate ratios are preserved. Additional detail on the source term derivation methods is provided in Appendix E.

Table 3-23 shows a summary of geochemical source terms developed for the Project where each source term represents an estimate of water quality (mg/L), or parameter loadings (kg/t of rock) contributed by a Project component. The following sections provide more detailed explanations of the source terms included in the load balance.

Table 3-23: Summary of Load Balance Source Terms

Source Term	Units	Applies to
Background Groundwater Concentration	mg/L	Groundwater inflows to open pit and Management Ponds
Background Surface Water Concentrations	mg/L	Applied to undisturbed catchments. Includes separate terms for Telkwa River, Bulkley River, Four Creek, Tenas Creek and Goathorn Creek
Non-PAG Runoff/Seepage Concentration	mg/L	Non-PAG waste rock storage piles, also applied to infrastructure pad surface areas, rail infrastructure area and CPP area
Coal stockpile runoff	mg/L	Applied to temporary coal stockpiles in the Rail Infrastructure area
Open pit wall runoff	mg/L	Applied to exposed open pit wall area
Processed Rock Runoff Concentration	mg/L	Applied to surface runoff volume from coal stockpiles in the Rail Infrastructure area
PAG Rock Flush Rate	kg/t	PAG waste rock backfill to Management Ponds
Blasting Residue	mg/a	Non-PAG, PAG and coal waste rock volumes
Sewage Treatment Plant Effluent	mg/L	Applied to effluent water from sewage treatment plant into Tenas Pond

Source: Generated in report.

3.10.1 Background Water Quality

Background water quality has been monitored since at least the early 1980s. Baseline water quality monitoring specific to the Project was initiated in 2017 by ERM. There is a considerable amount of existing surface water and groundwater quality baseline information available.

Available water quality data were reviewed in support the EA Application, and statistics were developed for both surface water and groundwater. Detailed baseline water quality characterization is presented in ERM 2021, including reference to the certified laboratories that conducted sample analysis and quality assurance completed with result compilation.

Groundwater Quality

50th and 95th percentile background groundwater chemistry for wells in the Project area was used for groundwater inflows to the open pit. Total or dissolved concentrations for each parameter were applied depending on whether the WQG for the parameter applies to total or dissolved fractions. For some parameters of particular interest for the Project (namely, aluminum, chromium, copper, and iron), both total and dissolved concentrations were applied regardless of whether the WQG for the parameter applies to total or dissolved fractions.

Background groundwater chemistry is summarized in Appendix D. In processing the background and receiving water quality data, values presented as less than the method detection limit were assumed equal to the method detection limit to be conservative.

Groundwater in the overburden and bedrock wells exceed CCME WQG for fluoride on average. Groundwater exceedances of WQG for total metals are likely an artefact of high TSS concentrations. Both overburden wells and bedrock wells exceed the BC WQG for dissolved cadmium on average.

Surface Water Quality

50th and 95th percentile background surface water quality in Tenas Creek, Four Creek, and Goathorn Creek was applied for the Tenas area, as well as excess water from overburden and topsoil stockpiles. Background surface water quality is summarized in Appendix D.

50th and 95th percentile background surface water quality in each of Four Creek, Goathorn Creek, Tenas Creek, Telkwa River, and Bulkley River was applied as receiving water quality for associated prediction nodes. Receiving environment water quality is summarized in Appendix D.

In processing the background and receiving water quality data, values presented as less than the method detection limit were assumed to be equal to the method detection limit to be conservative.

Based on grab samples, all surface water streams have occasionally exceeded the CCME WQG and BC AWQG for total and dissolved aluminum, respectively, and exceedances typically occur during the spring freshet. Average values also exceed the CCME WQG for total aluminum. The BC AWQG for dissolved aluminum is exceeded on average for the Bulkley River.

Based on grab samples, all surface water streams have exceeded the BC AWQG for total copper, again with exceedances typically occurring during spring freshet. However, average values comply with the BC AWQG for total copper.

Based on grab samples, all surface water Tenas Creek, Goathorn Creek, Telkwa River, and Bulkley River have exceeded the short-term BC AWQG for total iron, while only Telkwa River and Bulkley River have exceeded the short-term BC AWQG for dissolved iron. Based on grab samples, all streams have exceeded the CCME WQG for total iron. Again, exceedances typically occur during the spring freshet. The CCME WQG for total iron is exceeded on average for the Telkwa River and Bulkley River.

3.10.2 Non-PAG, Open Pit Wall, Coal Stockpile, Processed Rock, and PAG Source Terms

Estimated source term ranges for non-PAG runoff, coal stockpile runoff, and open pit wall runoff are summarized in Appendix E. Base case and high case source terms were developed. As described in Section 3.10, the base case uses geochemical inputs that are representative of the average bulk properties of the mine rock and the high case source term is calculated assuming the drainage from each source is in equilibrium with gypsum. Element concentrations are scaled-up in the high case assuming the base case element sulfate ratios.

Open pit wall source terms were generated for three periods throughout the life of mine based on the exposed pit wall area at the end of deposition of PAG rock in each management pond. The model conservatively incorporates a constant source term for pit wall runoff based on the maximum source term concentration for each element across the three periods. Runoff from pit wall areas is expected to be neutral throughout operations. Modeling assumes that 95% of open pit walls will be covered by end of closure, including all areas that have the potential to become acid-generating.

Source terms for non-PAG rock, coal stockpiles and open pit walls are dissolved element concentrations. Particulate element concentrations were calculated for ponds discharging to the environment based on an assumed TSS concentration of 35 mg/L and proportions of TSS comprised by various elements based on whole rock analysis for non-PAG and PAG rock. Total element concentrations were calculated by adding dissolved and particulate concentrations (Appendix E).

Particulates were assumed to be filtered in groundwater pathways. All groundwater loadings to downstream prediction nodes were assumed to be dissolved concentrations only.

3.10.3 PAG Rock, Coal Rejects and Non-PAG Flushing Terms

Supporting information on the derivation of flushing source terms are presented in Appendix E.

Loading from PAG rock, coal rejects and non-PAG rock used in the management pond covers is assumed to be flushed from the rock when it is placed in the management ponds into the ponded water within one year of placement. Annual PAG rock and unit coal reject and non-PAG rock flushing rates were prepared for the following two scenarios:

- Typical Exposure Scenario: assuming rock is stored on surface for six months.
- High Exposure Scenario: assumes rock is stored on surface for 12 months.

3.10.4 Nitrogen Species derived from Blasting

Nitrogen loading from blasting with ammonium nitrate and fuel oil (ANFO) explosives was accounted for using estimates of explosive usage and the annual tonnages of waste rock. Explosive characteristics were developed based on Fergusson and Leask 1988 and SRK experience (Table 3-24). Typical ammonium nitrate and nitrogen contents, nitrogen losses, and nitrogen distribution were applied to estimate concentrations of ammonia, nitrate, and nitrite, based on volumes of waste rock reported in mine plans. Delayed release and natural attenuation of nitrogen species have not been accounted for within the water and load balance at this time to be conservative, and it is assumed that all nitrogen species are flushed from waste rock on an annual basis.

Table 3-24: Explosive demand and characteristics

Parameter	Units	Value
Powder Factor	g/m ³ waste rock	500
Explosive Loss		
% ANFO	%	0.90
% Emulsion	%	5.1
Explosives Mix		
% Bulk ANFO	%	75
% Bulk Emulsion	%	25
Quantities in Ammonium Nitrate		
% Nitrogen	% of ANFO	35
Nitrogen Composition		
% Nitrate	%	87
% Nitrite	%	2
% Ammonia	%	11

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Model\EA_Modeling\TelkwaEAModel_v24.gsm

Nitrate, nitrite, and ammonia loading were added to each Management Pond or Tenas Control Pond based on the mass of PAG or Non-PAG rock upstream of each facility.

The ANFO model assumptions do not account for operational controls and mitigation measures during blasting to reduce the potential release of blast residuals. The approach is conservative and therefore a high case scenario for these source terms have not been included.

3.10.5 Sewage Treatment Plant

A sewage treatment plant will operate onsite and will discharge treated effluent to Goathorn Creek tributary at a rate of 5,000 m³/year from May through September. The effluent water quality for parameters in the model are presented in Table 3-25 (Radloff 2021).

Table 3-25: Sewage Treatment Plant Effluent Water Quality

Parameter	Units	Value
Nitrate (as N)	mg-N/L	36.9
Nitrite (as N)	mg-N/L	0.1
Total Ammonia (as N)	mg-N/L	1.9

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Model\EA_Modeling\TelkwaEAModel_v24.gsm

3.11 Model Quality Assurance and Quality Control

SRK's quality assurance and quality control (QA/QC) procedures include:

- Verification that all model elements were correctly linked.
- Cross-checking of flows and source terms to ensure model elements not duplicated or missed.
- Cross-checking of model elements and mine phases to ensure the timing of events is accurate as per the EA mine plan.
- Confirmation that the inputs and assumptions were correct and consistent with other EA models.
- Verification of model functions and expressions to ensure are working as intended.
- Professional judgement and experience to evaluate if results reflect the understanding of the conceptual model.

3.12 Uncertainty, Complexity and Conservatism

Project Case Results and Mitigation Measures

The Project Case model conditions, including the source terms and average hydrologic conditions are incorporated to simulate the expected, or best estimate, based on available information. An appropriate level of conservatism was used for model assumptions as described in the sections above. Mitigation measures were incorporated into the water management plan to address impacts to water quantity or quality.

The alternative assessment cases are intended to represent the reasonable worst case, or the upper bound of expected water quality and quantity. Mitigation measures have not necessarily been incorporated to address potential water quality or quantity considerations identified in the Alternative Assessment cases. Contingency planning and/or adaptive management may be more appropriate if concentrations exceed the Project Case estimates.

4 Model Results

Model results are presented in the following sections for all assessment cases described in Section 2.4.2.

Results are grouped into sub-sections on water quantity and water quality.

4.1 Project Water Quantity Results

4.1.1 Water Cover

Water balance results are used to determine whether the minimum water cover thickness of 1 m can be maintained in all Managements Ponds within 6-months of PAG rock placement throughout life of mine and closure. The depth of the water cover 30 days after rock placement is also predicted.

Water cover results for each relevant assessment case area summarized in the following sections.

Project Case

Monthly average water cover results for the Project Case are presented in Figure 4-1, including the PAG rock elevation (red), the water surface elevation (green), the monthly average water cover depth (blue) and the 30-day lagged water cover depth (pink). A temporary (4-month) reduction in EMP water cover occurred in the winter of 2025. Water was pumped from the Tenas Control Pond to EMP to increase the water cover. Additional water could be sourced from the NMP cover during this period. The actual location water can be sourced from to account for a deficit in any pond is an operator decision. Since the duration is less than 6 months (duration of exposure in source terms), and the water cover is not depleted, results show that the minimum water cover can be maintained in operation and closure. The 30-day lagged water cover is always above 1.0 m under average conditions. The system is sufficiently robust for average conditions.

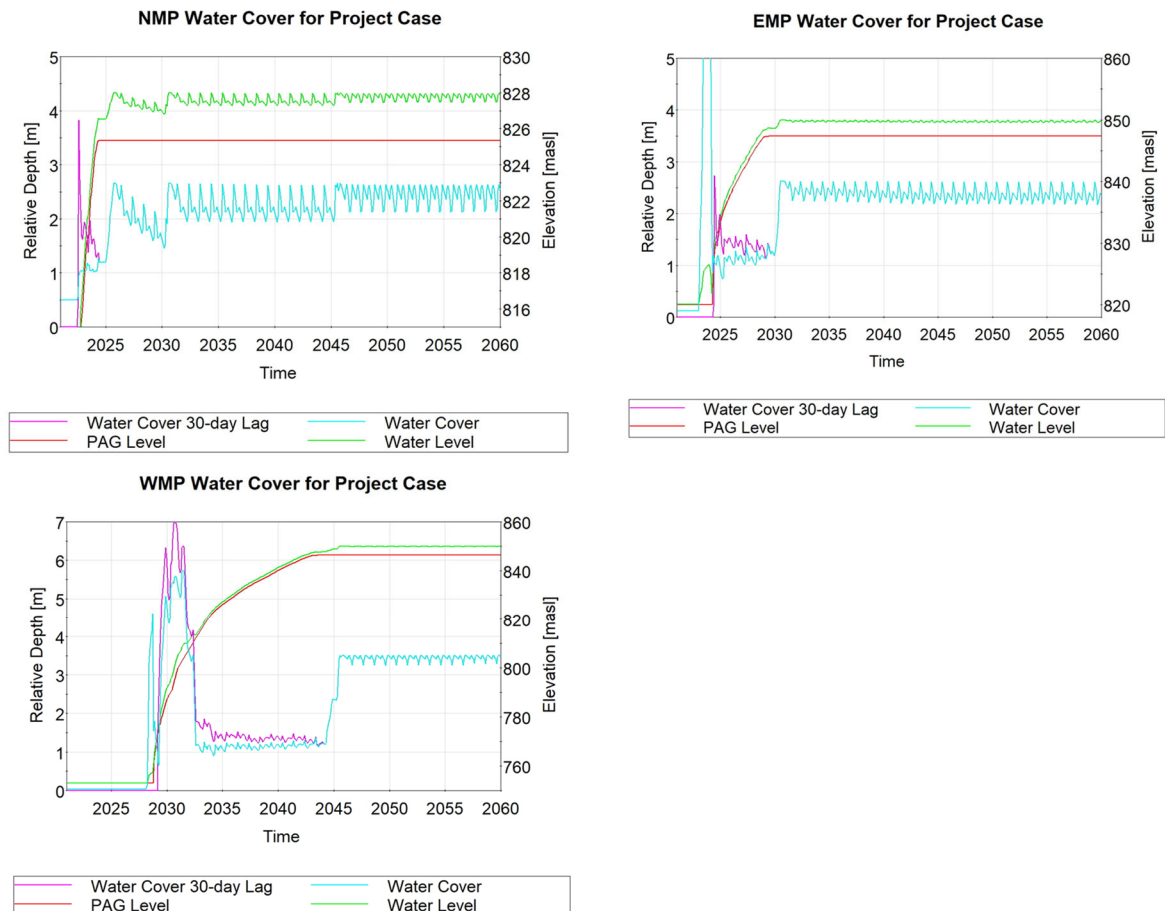


Figure 4-1: Monthly Average Water Cover in Management Ponds for Project Case

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Model\EA_Modeling\TelkwaEAModel_v25.gsm

Alternative Case 1

Water cover thickness results for Alternative Case 1 with high groundwater seepage rates are presented in Figure 4-2 for each Management Pond. Like Project Case results, a short-term low water cover period is observed in the EMP during 2025, while the minimum 1 m thickness is maintained in all other years throughout operation and closure. The 30-day lagged water cover is always above 1.0 m.

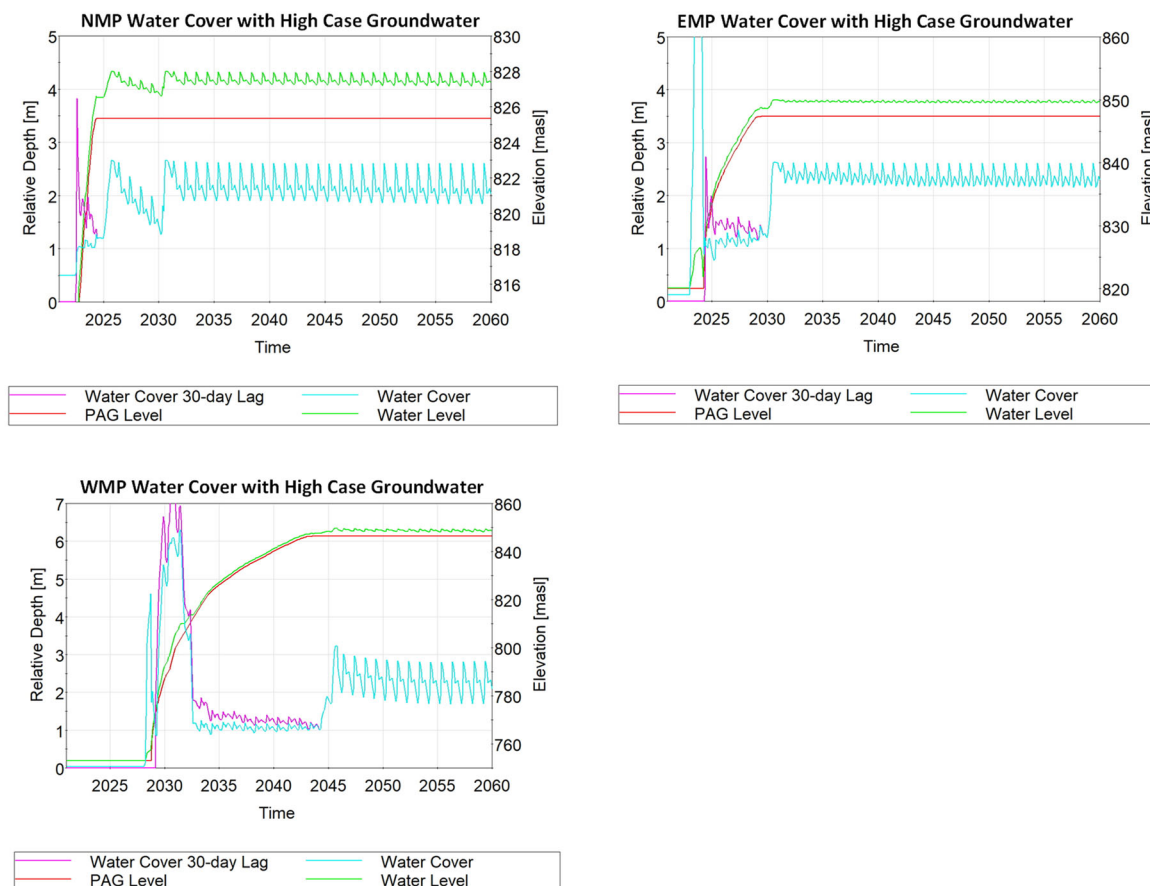


Figure 4-2: Monthly Average Water Cover in Management Ponds for Alternative Case 1 with High Groundwater Seepage Loss

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Model\EA_Modeling\TelkwaEAModel_v25.gsm

Alternative Case 3

Alternative Case 3 applies three consecutive 100-year dry precipitation conditions to the Project area. An early operations period was evaluated (Figure 4-3) as well as a late operations period (Figure 4-4), for years 2022 through 2024 and 2041 through 2044, respectively. Results show the 10-year operating period around each scenario.

The early operations period is more critical than the late operations period. The water cover in the EMP is less than 1.0 m for multiple months from March 2024 through August 2025. In this scenario, the Tenas Control Pond is discharging to Goathorn Creek in May 2024 during freshet. As an operational decision water could be stored to provide additional water cover. In the event of an extreme period of dry years, contingency pumping from Goathorn Creek may also be enabled to provide water supply. During these prolonged dry periods, the 30-day lagged cover remains greater than 1.0m. At no time would PAG rock be directly exposed. For this reason, and accounting for alternative pumping sources or storage of water during freshet, the water management system is sufficiently robust to meet management objectives under the extreme dry scenario considered.

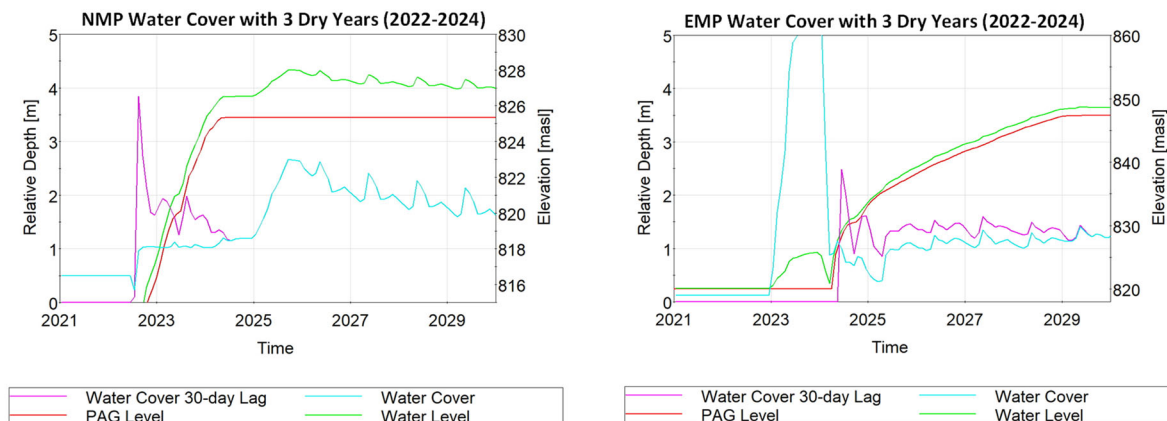


Figure 4-3: Monthly Average Water Cover in Management Ponds for Alternative Case 3 with Three Consecutive 100-year Dry Years in Early Operations (2022-2024)

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Model\EA_Modeling\TelkwaEAModel_v25.gsm

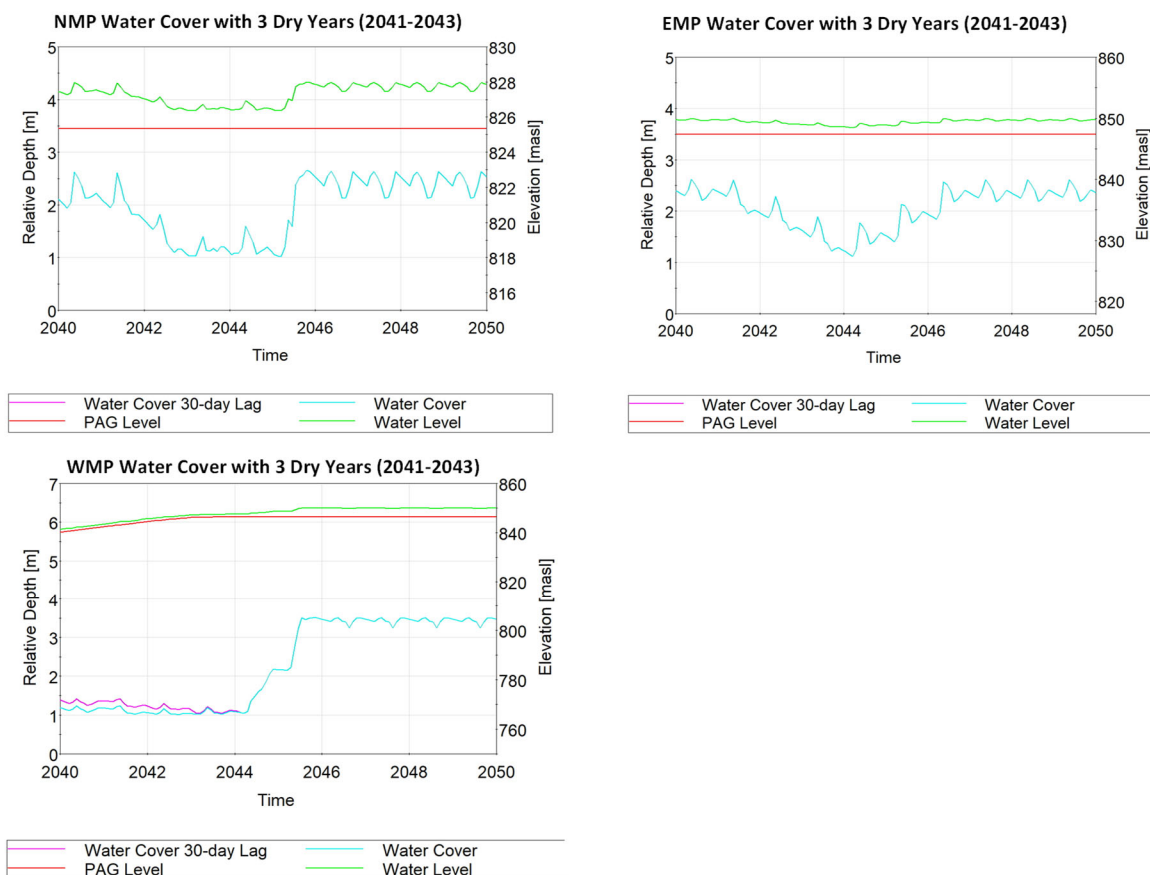


Figure 4-4: Monthly Average Water Cover in Management Ponds for Alternative Case 3 with Three Consecutive 100-year Dry Years in Late Operations (2041-2043)

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Model\EA_Modeling\TelkwaEAModel_v25.gsm

Alternative Case 6

Stochastic modeling of climatic variables (temperature and precipitation) over the life of mine was also used to test the robustness of the water management system. On each timestep (daily), the WGEN climate model selects a precipitation, daily maximum and daily minimum temperature value based on historical statistics. A total of 100 realizations of the full mine life were simulated. The statistical distribution of all modelled simulations from the Monte Carlo simulation are presented in Figure 4-5, including the 1%, 50% and 99% percentile of results. Note that the plots were cropped to 2050 for ease of presentation, however the full closure period was simulated to 2100. Water cover fluctuations beyond 2050 are like those observed from 2045 to 2050, without being depleted below the 1.0 m minimum thickness.

Results indicate that temporary reductions in water cover below the 1.0m target are plausible in all Management Ponds, however these periods are less than 6 months in duration and the water cover is never fully depleted (to 0 m thickness). Like Alternative Assessment 3, alternative water supply sources may be incorporated as mitigation measures throughout the operational period if extreme dry conditions persist. All water covers are maintained at the 99% result level in closure.

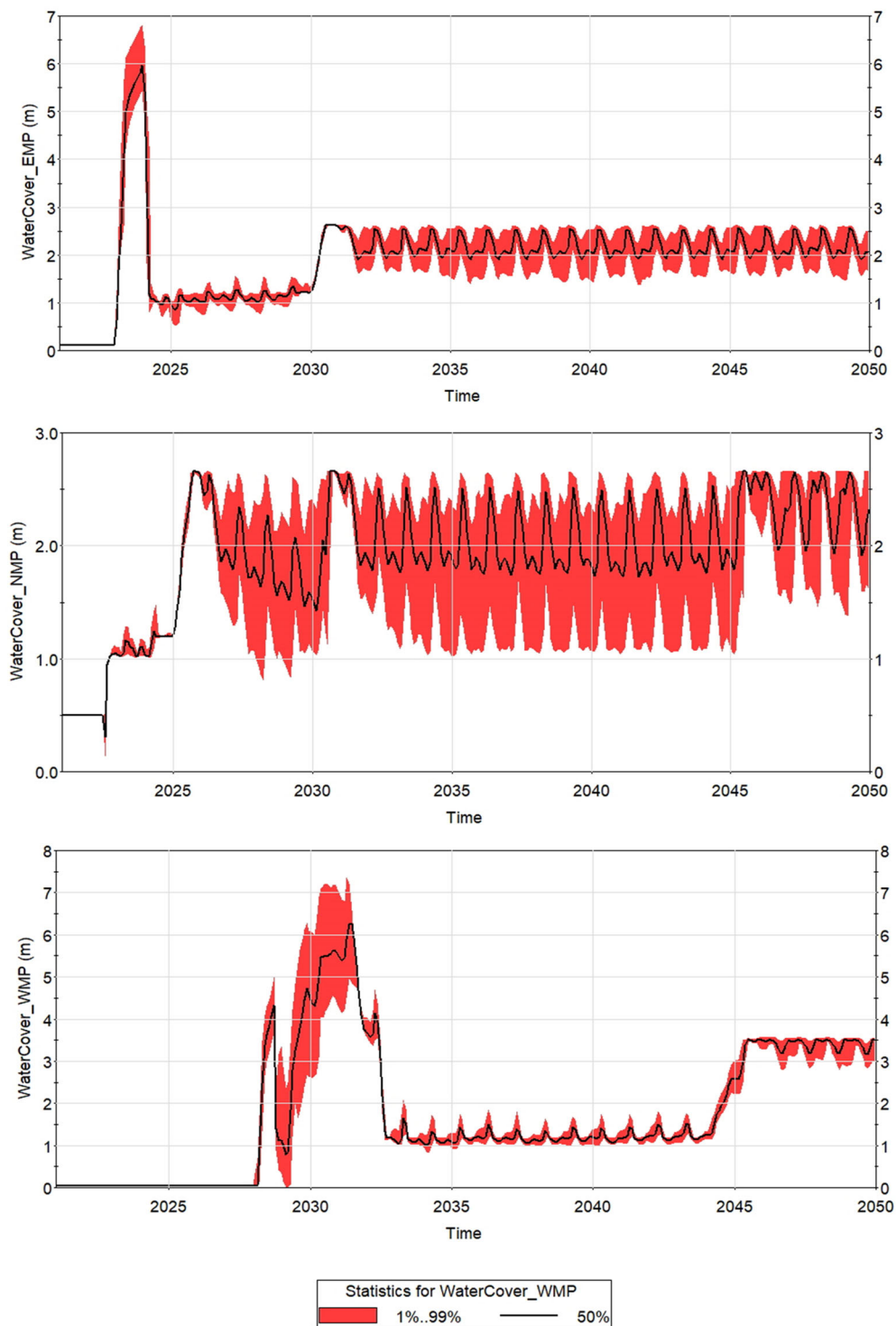


Figure 4-5: Monthly Average Water Cover in Management Ponds for Alternative Case 6 with Stochastic Climate, including the 1%, 50% and 99% Results

Additional Sensitivity Analyses

Other sensitivity analyses included:

- An upper-case evaporation analysis where Management Pond water covers were left without soil and rock covers was modelled. This increased evaporation rates to the full open-water values, instead of 25% reduction (as described in Section 3.4.4). Results show that the water cover requirements are still achieved in all ponds under average hydrologic conditions.
- The capture efficiency of the diversion channel upstream of the East Management Pond was assumed to be 80%, which results in 20% of upstream runoff contributing to the pond's water cover in perpetuity. A case was modelled assuming 100% diversion efficiency, which reduces the inflows to the water cover. In this case and under average hydrologic conditions, the minimum water covers are maintained.

4.1.2 Process Water Supply

The Tenas Control Pond is the primary source of process water for the CPP at a rate of approximately 500 m³/day. Under Project Case conditions, process water supply is met year-round throughout the operation period.

Alternative Assessment Case 6 was used to test process water supply under variable annual climatic conditions. Results presented in Figure 4-6 show that temporary periods of reduced water supply may occur under extreme dry conditions. This occurred in March of various years due to drawdown of Tenas Control Pond. The operations manual for the Tenas Control Pond will stipulate a minimum water volume that will be made available to manage a 6-month period. This minimum volume has not been included in the model but would be expected to maintain water supply during dry periods.

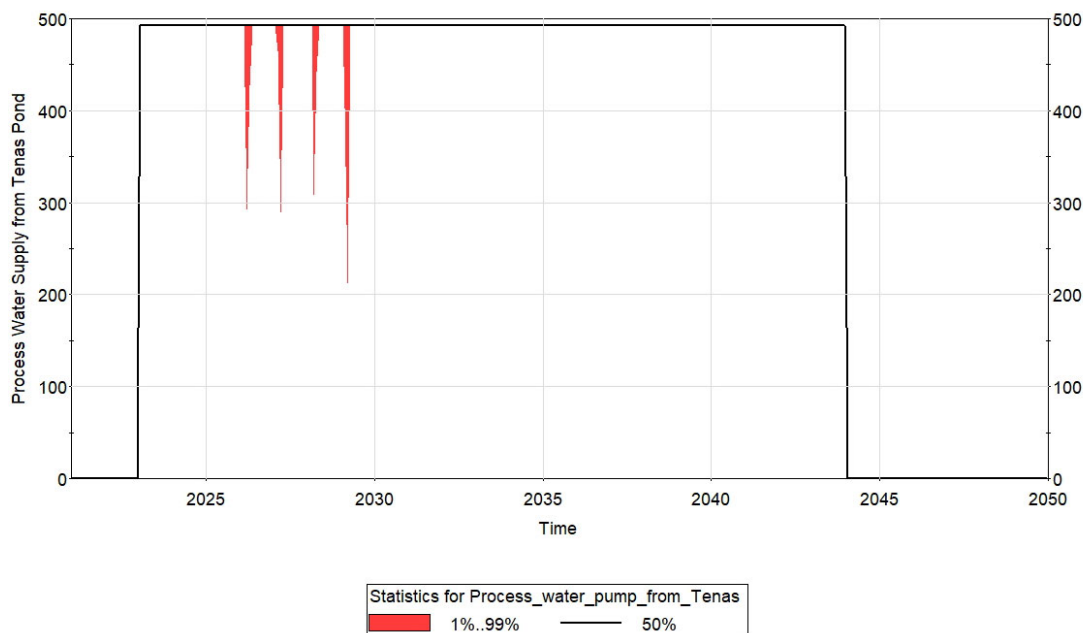


Figure 4-6: Monthly Average Process Water Supply in Alternative Assessment Case 6 with Stochastic Climate, including the 1%, 50% and 99% Results

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Model\EA_Modeling\TelkwaEAModel_v24.gsm

4.1.3 Project Discharge

Tenas Control Pond, the Rail Infrastructure Sedimentation Pond, and the North Management Pond. discharge surface water to the receiving environment (Table 4-1).

Table 4-1: Summary of Discharging Facilities Throughout Life of Mine

Project Facility	Means of Discharge	Receiving Environment	Active Project Stage
Tenas Control Pond	Pump or spillway	Tributary of Goathorn Creek	Construction, Operation, Closure and Reclamation
Rail Infrastructure Sedimentation Pond	Pump or spillway	Tributary of Bulkley River	Construction, Operation
North Management Pond	Spillway	Tributary of Goathorn Creek	Post-Closure

Source: Prepared in text.

The monthly average discharge rates and annual total discharge volumes for the Project Case and Alternative Assessment Case 4 are presented in Table 4-2. For Alternative Assessment Case 4, the consecutive wet periods were applied to years where the discharge would be maximized for each facility. In the case of the Tenas Control Pond, maximum discharge occurs in early operations when the Project water storage capacity is minimized. For the North Management Pond, maximum discharge occurs near the end of the post-closure model period, when climate change effects to precipitation are maximized and available storage is minimized.

Table 4-2: Project Facility Discharge Rates

Assessment Case	Project Facility		
	Tenas Control Pond	Rail Infrastructure Sedimentation Pond	North Management Pond
Project Stage	Operation and Closure Reclamation	Operation and Construction	Post-Closure
Maximum Monthly Discharge Rates [m ³ /day]			
Project Case	12,000	210	17,600
Alt Case 4: 3 Wet Years ⁽¹⁾	15,900	350	27,000
Maximum Annual Discharge Volume [m ³]			
Project Case	1,652,000	18,400	903,000
Alt Case 4: 3 Wet Years ⁽¹⁾	1,735,000	22,400	1,475,000
Average Annual Discharge Volume [m ³]			
Project Case	725,000	17,700	803,000

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Results\ ProjectDischargeRates_05132021.xlsx

Notes:

- Three consecutive wet years (approximately the 1 in 100-year wet return period) applied to most critical period, depending on the structure. For Tenas Control Pond and Rail Infrastructure Pond, critical period is 2022-2024 when operational storage is minimized, while the critical period is 2092-2094 for North Management Pond which only discharges to environment in post-closure.

The Tenas Control Pond pumping rate to the tributary in Goathorn Creek was 9,000 m³/day between May and October. The maximum discharge in the Project Case exceeds the pumping rate, which means the spillway is used during operations. The overflow occurs during spring freshet when the EMP is also overflowing.

The NMP only discharges to the tributary of Goathorn Creek in post-closure after the Tenas Control Pond has been decommissioned. It discharges over the closure spillway.

Changes to Goathorn Creek and Bulkley River from the Project discharges are discussed in Section 4.3.

4.1.4 Open Pit Flooding

At closure, open pit dewatering to the Management Ponds will stop, allowing runoff to flood the open pit. The maximum capacity of the open pit is 1.1 Mm³ (elevation of 909 masl) after it is backfilled with Non-PAG rock.

Open Pit filling lasts approximately 12 years with average hydrologic and groundwater inputs (Figure 4-7).

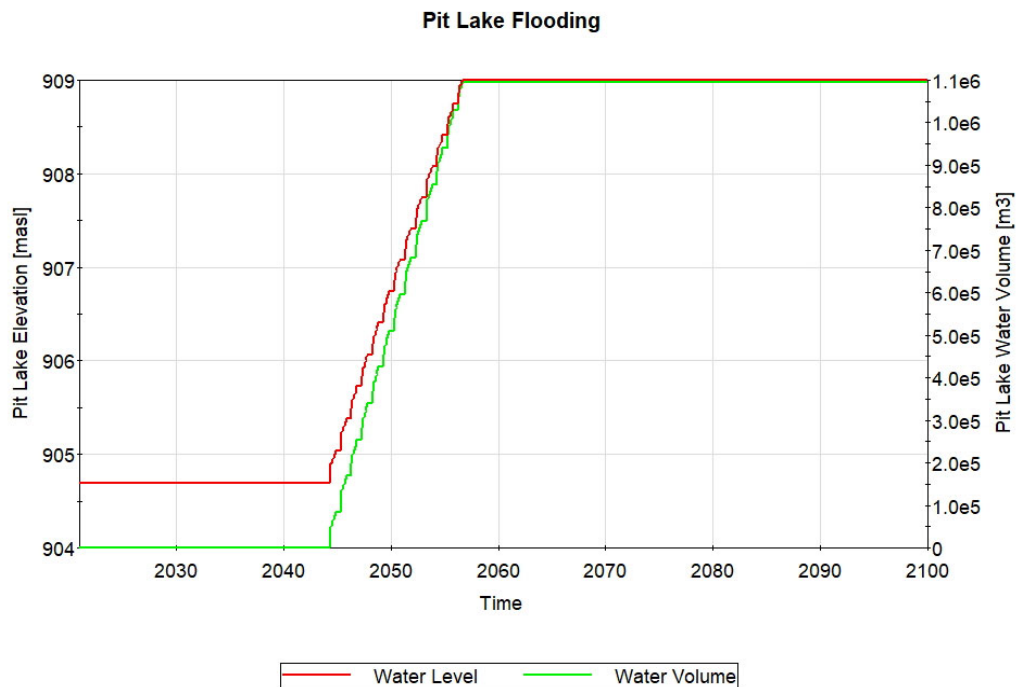


Figure 4-7: Open Pit Flooding Time Series for Project Case

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Model\EA_Modeling\TelkwaEAModel_v24.gsm

4.2 Project Water Quality Results

Modelled water quality in the sedimentation ponds and Management Ponds are a function of the following loading sources:

- PAG and processed rock loading rates based on volume of rock placed per year.
- Water pumped from the open pit , which includes open pit wall runoff and non-PAG rock backfill seepage.
- Natural runoff.
- Seepage from Non-PAG rock and overburden in Management Pond dams and buttresses.

Results were screened against water quality guidelines in the receiving environment and the end of pipe limits for nitrate-nitrogen and total selenium. Results were also compared to receiving water baseline water quality statistics. The Management Ponds and end pit lake are compared to Goathorn Creek WQG and baseline statistics. The Rail Infrastructure Sedimentation Pond is compared to the Bulkley River water quality statistics and guidelines.

Monthly average and maximum concentrations are presented for winter and summer periods. Winter is the 6-month period from November to April (frozen conditions). Summer is from May to October (open-water season). Ponds decommissioned during closure and reclamation are only evaluated during operations. Ponds that operate through post-closure are evaluated during operations and

closure. All results are presented in Appendix F for Project Case conditions and Appendix G for alternative assessment cases.

4.2.1 Management Ponds

The Management Ponds do not discharge directly to the environment during operations. The Management Ponds discharge excess water via pumps and spillways to the Tenas Control Pond (discussed in Section 4.2.2). For this reason, only the parameters with end of pipe limits are discussed, which include total selenium and nitrate.

Figure 4-8 and Figure 4-9 present the modelled concentrations of total selenium and nitrate, respectively, in each Management Pond over time for the Project Case, including the water quality in the water cover (solid lines) and the water quality in the rock voids (dashed lines). Results for all other parameters are presented in Appendix F.

As discussed in Section 3.4, the water cover and water in rock voids within each Management Pond were modelled as two separate reservoirs. The water cover quality fluctuates seasonally (Figure 4-8). Concentrations increase as PAG rock is added but decrease because of dilution during freshet (May). The water quality in the voids is more constant throughout the year. Peak concentrations in each Management Pond occur near the end of each ponds' operation, prior to the placement of Non-PAG and overburden rock covers. A secondary spike occurs in the NMP from the WMP near the end of operations. After PAG rock and processed rock placement is complete, the water cover quality is diluted until reaching steady-state approximately 5 to 10 years after the rock covers are in-place. Dilution of the void water concentrations (Figure 4-8) occurs more slowly, based on the lower flushing rate controlled by seepage to groundwater. The water quality in the voids is used for seepage water quality to downstream prediction nodes. The travel times from the pond to downgradient receivers is approximately 25-years (see Section 3.8.3).

The proposed end of pipe limit for total selenium is 0.050 mg/L (Section 3.9.2). Modelled results for Project Case conditions are below the end of pipe limit in all Management Ponds (Figure 4-8). The proposed end of pipe limit for nitrate-nitrogen is 18.8 mg/L (Section 3.9.2). Modelled results for Project Case conditions are below the end of pipe limit in all Management Ponds (Figure 4-9).

At the end of operations when Tenas Control Pond has been decommissioned, the NMP will discharge to a tributary to Goathorn Creek. Water quality in the NMP is below end of pipe limits in post-closure, including selenium and nitrate (Appendix F).

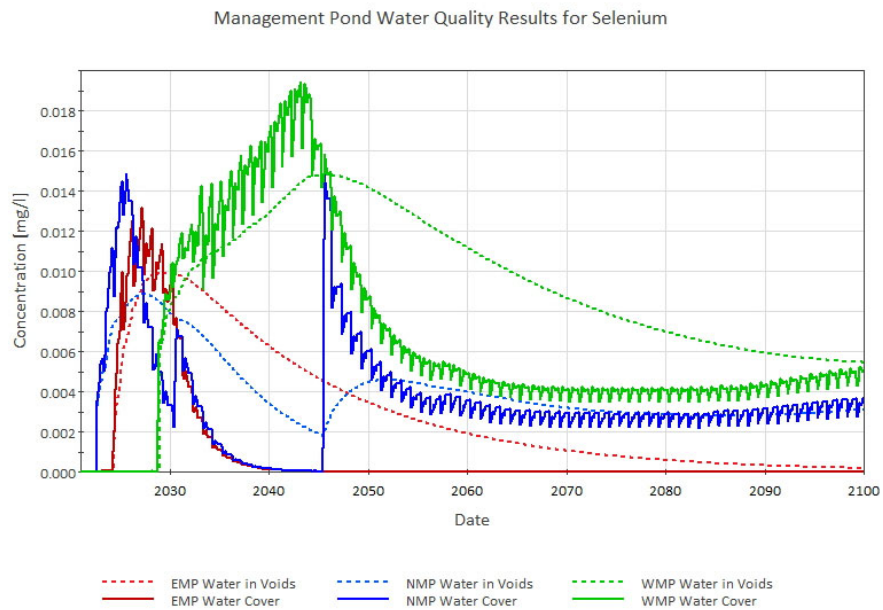


Figure 4-8: Management Pond Total Selenium Results for Project Case

Source: https://srk.sharepoint.com/sites/NA1CT027.003/Internal/500_Water_Balance/Results/Feb2022_NewSourceTerms/Plot_MP%20Se%20Water%20Quality_EA21.jpg

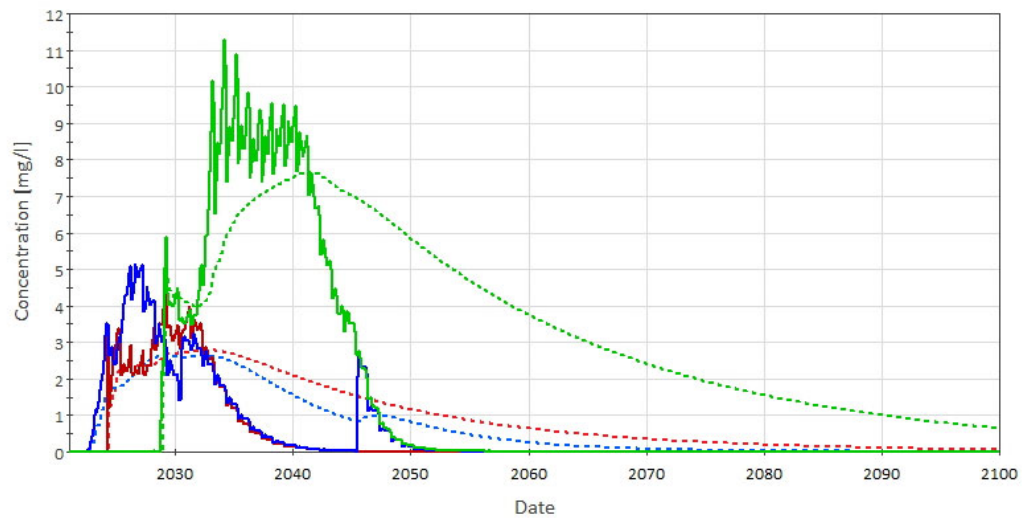


Figure 4-9: Management Pond Nitrate-Nitrogen Results for Project Case

https://srk.sharepoint.com/sites/NA1CT027.003/Internal/500_Water_Balance/Results/Feb2022_NewSourceTerms/Plot_MP%20NO3%20Water%20Quality_EA21

4.2.2 Tenas Control Pond

The Tenas Control Pond will discharge to a tributary of Goathorn Creek during operations until it is decommissioned. Since the Tenas Control Pond is assumed to be fully mixed, the water quality of any seepage is expected to be equal to the pond water quality, and therefore separate seepage water quality is not presented. Water quality results for the Tenas Control Pond are presented in Appendix F. Figure 4-10 and Figure 4-11 present Tenas Control Pond total selenium and nitrate-nitrogen concentrations, respectively. The water volume is also shown in both figures. Results extend through 2050, which includes the pond dewatering period. Tenas Control Pond will be dewatered from 2044 through 2045 and is decommissioned by 2050.

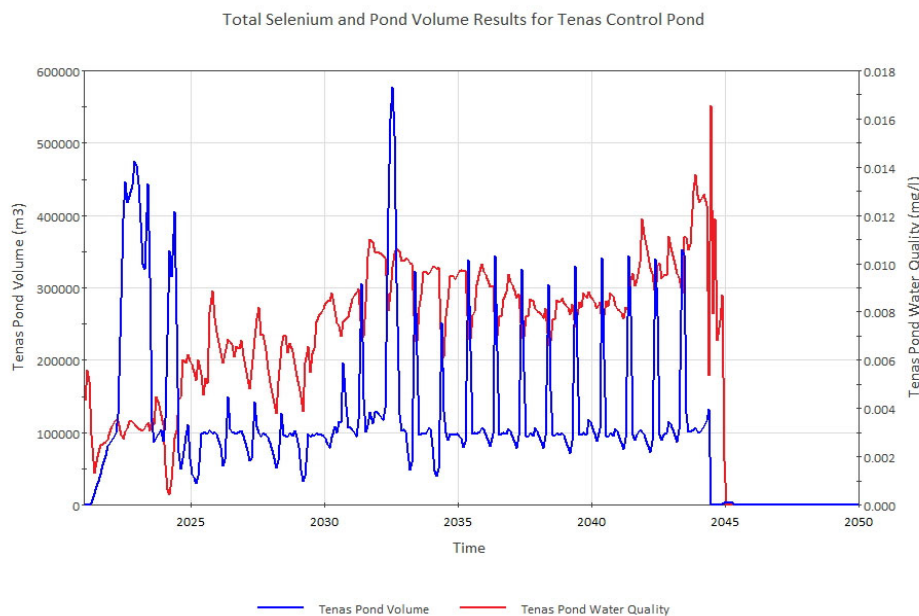


Figure 4-10: Pond Volume and Total Selenium Concentration in Tenas Control Pond

Source:
https://srk.sharepoint.com/sites/NA1CT027.003/Internal/500_Water_Balance/Results/Feb2022_NewSourceTerms/Plot_TCP%20Se%20Water%20Quality_EA21.jpg

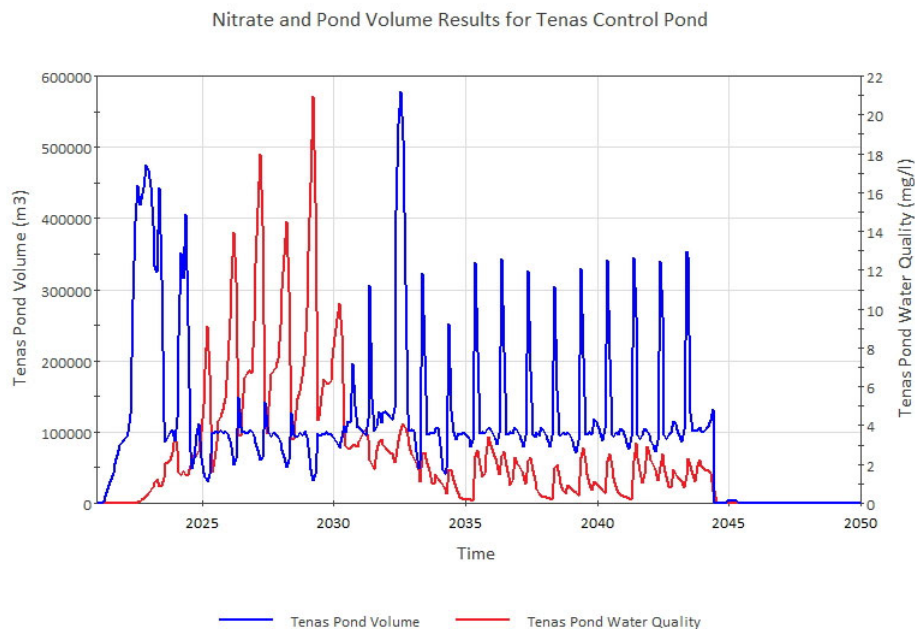


Figure 4-11: Pond Volume and Nitrate-Nitrogen Concentration in Tenas Control Pond

Source:

https://srk.sharepoint.com/sites/NA1CT027.003/Internal/500_Water_Balance/Results/Feb2022_NewSourceTerms/Plot_TCP%20NO3%20Water%20Quality_EA21.jpg

Selenium concentrations increase over time in the Tenas Control Pond as the volume of PAG and Non-PAG rock in the Project footprint expand to maximum extent. Seasonal fluctuations occur. Concentrations are lowest in freshet (May) each year. The pond volume is highest during freshet (Figure 4-10). The pond water quality is consistently below the proposed end of pipe limit of 0.050 mg/L with a peak concentration of 0.017 mg/L at the end of operations.

Nitrate-nitrogen concentrations are highest in the first 10 years of operations after the construction of the Management Pond dams and buttresses. The peak concentration is approximately 21 mg/L, which occurs over winter months when the pond doesn't discharge. The concentration in Tenas Control Pond is below the proposed end of pipe limit of 18.8 mg/L when the pond discharges in the open-water season.

4.2.3 Rail Infrastructure Sedimentation Pond

Modelled water quality in the Rail Infrastructure Sedimentation Pond is a function of processed coal rock source terms, with dilution from runoff and direct precipitation. The pond is decommissioned in closure. Pond concentrations increase in the summer months from evaporation. Average water quality in the pond in summer and winter during operations are summarized and compared against WQG calculated for Bulkley River in Appendix F.

The pond meets proposed end of pipe limits throughout the life of mine. Changes to the Bulkley River are discussed in Section 4.4. No exceedances of WQG are expected because of Rail Infrastructure

Sedimentation Pond discharge. Figure 4-12 presents the modelled total selenium concentrations at the Rail Infrastructure Sedimentation Pond.

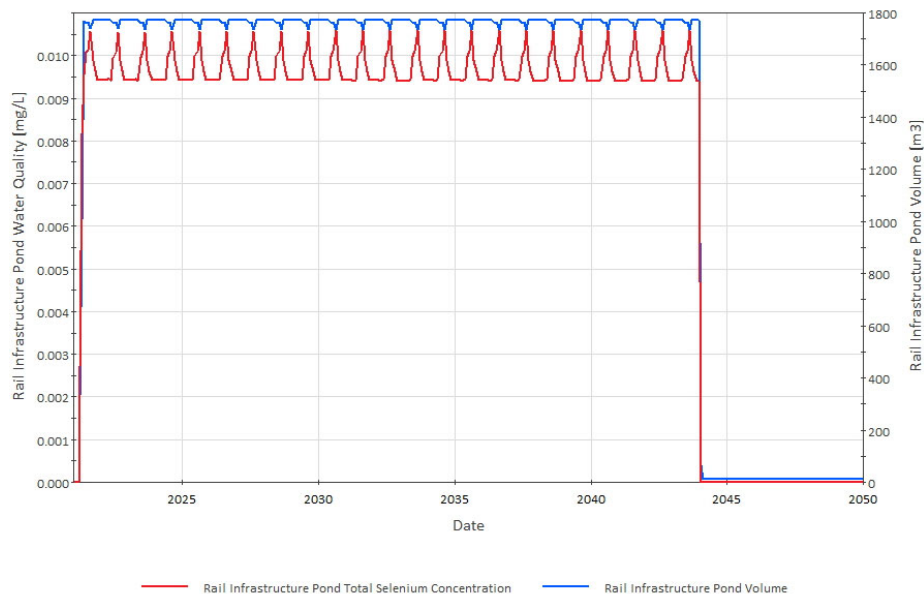


Figure 4-12: Total Selenium Concentration in Rail Infrastructure Sedimentation Pond for Project Case

Source:
https://srk.sharepoint.com/sites/NA1CT027.003/Internal/500_Water_Balance/Results/Feb2022_NewSourceTerms/Plot_RLO%20Se%20Water%20Quality_EA21.jpg

Applying the processed coal rock source terms to the full pad area is conservative because coal isn't stockpiled for long before being loaded on a train. It is not likely to oxidize.

4.2.4 Alternative Assessment Cases

The only alternative assessment case which affects the pond water quality is Case 2, using high geochemical source terms. Table 4-3 compares the maximum monthly water quality in each operating facility for the Project Case and Alternative Assessment Case 2 model conditions. Results for all parameters in Case 2 are presented in Appendix A, including time series plots of results, similar to those presented in Section 4.2.1, 4.2.2 and 4.2.3.

Table 4-3: Project Water Selenium Results for Project Case and Alternative Assessment Case 2 with High Source Terms

Facility	Maximum Monthly Total Selenium Concentration [mg/L]	
	Project Case	Alt Case 2: High Source Terms
WMP	0.019	0.043
EMP	0.013	0.032
NMP	0.015	0.040
Tenas Control Pond	0.017	0.033
Rail Infrastructure Sedimentation Pond	0.011	0.011

Selenium concentrations in all management ponds and the Tenas Control Pond are less than the proposed end of pipe limit for selenium (0.050 mg/L) with the high source terms (Alternative Case 2

Assumptions around ANFO release are conservative and do not account for mitigation measures and controls during blasting. For this reason, a high case source term was not applied for nitrate.

4.3 Change to Streamflow

The relative change between streamflow for each assessment case and the Pre-Mining Case were calculated using the monthly average water balance model result time series.

Results are discussed in relation to change to mean annual discharge (MAD), seasonal flow distribution, and high and low flows.

4.3.1 Project Case Results for Mean Annual Discharge

The change to mean annual discharge was evaluated using the following thresholds:

- 10% decrease from mean annual discharge.
- 30% increase from mean annual discharge.

The water quantity thresholds were selected based on the BC Environmental Flow Needs environmental risk management framework, which uses a 10% reduction or withdrawal from streamflow as an indicator of stream sensitivity for fish habitat (BC ENV, 2016).

Table 4-4 presents the maximum increase, average change and maximum decrease in MAD based on the Project Case relative to Pre-Mining Case for each Project Stage. Yellow highlighted cells identify nodes and Project stages where an increase in streamflow exceeds 30% and orange highlighted cells identify nodes where streamflow is reduced by more than 10%. Results indicate whether a net increase or net decrease is not expected for a node or Project stage as not applicable (n.a.).

Table 4-4: Percent Change in Mean Annual Discharge for Project Case Relative to Pre-Mining Case, including Maximum Increase, Maximum Decrease and Average Change, over each Project Stage

Stream	Node	% Change in Mean Annual Discharge relative to Base Case Conditions								
		Construction			Operation			Post-Closure		
		Maximum Increase	Average Change	Maximum Decrease	Maximum Increase	Average Change	Maximum Decrease	Maximum Increase	Average Change	Maximum Decrease
Tenas Creek	WQS01	n.a	0.0%	0.0%	n.a	0.0%	0.0%	n.a	0.0%	0.0%
	WQS02	n.a	0.0%	0.0%	n.a	-1.4%	-1.6%	n.a	-0.7%	-0.7%
	WQS22	n.a	0.0%	0.0%	n.a	-5.9%	-6.5%	n.a	-5.0%	-5.2%
	WQS04	n.a	0.0%	0.0%	n.a	-6.9%	-7.6%	n.a	-5.2%	-5.4%
Four Creek	WQS03	n.a	-0.1%	-0.1%	n.a	-1.8%	-2.6%	n.a	-1.6%	-1.9%
	WQS21	n.a	-0.1%	-0.1%	47.2%	35.6%	-0.2%	32.7%	32.5%	n.a
	WQS20	n.a	-0.2%	-0.2%	45.5%	33.8%	-0.3%	31.9%	31.7%	n.a
	WQS03DS	n.a	-0.3%	-0.3%	0.9%	-15.0%	-23.9%	n.a	-14.8%	-14.9%
Goathorn Creek	WQS13	n.a	0.0%	0.0%	n.a	0.0%	0.0%	n.a	0.0%	0.0%
	WQS06_US	n.a	0.0%	0.0%	n.a	0.0%	0.0%	0.0%	0.0%	0.0%
	WQS06	n.a	0.0%	0.0%	3.9%	1.4%	n.a	1.8%	1.4%	n.a
	WQS05	n.a	0.0%	0.0%	0.7%	-1.4%	-2.7%	n.a	-0.7%	-0.8%
Telkwa River	WQS09	n.a	0.0%	0.0%	0.1%	-0.2%	-0.4%	0.1%	0.1%	n.a
Bulkley River	WQS11	0.0%	0.0%	n.a	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	WQS12	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Source: \\van-svr0.van.na.srk.ad\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Results\Results_Streams_ChangeToMAD_07132021_sab.xlsx

Note: n.a. (not applicable) values represent nodes which do not experience a net increase or net decrease over Pre-Mining conditions

The maximum percent decrease to MAD is greater than 10% at downstream Four Creek node, WQS03DS, and increases by more than 30% in the Four Creek nodes WQS20 and WQS21 during the operation and post-closure Project stages. Figure F-1 in Appendix F presents a time series of the annual change to mean annual discharge throughout the modelled period at Four Creek nodes.

All other streams are not expected to have greater than 10% reduction to MAD.

4.3.2 Project Case Results for Seasonal Flow Distribution

Changes to seasonal flow distribution are evaluated for each node and Project stage. Results discussed below focus on Four Creek nodes, where MAD could decrease by at least 10% or increase by more than 30%.

Table 4-5 presents the monthly variability of the change in streamflow at Four Creek for the Project Case relative to the Pre-Mining Case, while the results through the life of mine are plotted in Figure F- 1 in Appendix F. Results highlight the monthly maximum, average and minimum percent change in monthly streamflow throughout each Project stage.

Table 4-5: Four Creek Project Case Streamflow Monthly Change over Pre-Mining Case

Scenario		Four Creek Monthly % Change Relative to Pre-Mining Case											
Period	Month	WQS03			WQS21			WQS20			WQS03DS		
		Maximum Increase	Average	Maximum Decrease	Maximum Increase	Average	Maximum Decrease	Maximum Increase	Average	Maximum Decrease	Maximum Increase	Average	Maximum Decrease
Construction	January		-0.18			-0.40			-0.67			-1.10	
	February		-0.19			-0.43			-0.72			-1.19	
	March		-0.20			-0.46			-0.77			-1.27	
	April		-0.07			-0.15			-0.25			-0.41	
	May		-0.02			-0.05			-0.09			-0.15	
	June		-0.07			-0.15			-0.25			-0.41	
	July		-0.04			-0.10			-0.16			-0.27	
	August		-0.15			-0.33			-0.56			-0.92	
	September		-0.03			-0.08			-0.13			-0.22	
	October		-0.10			-0.22			-0.38			-0.62	
	November		-0.28			-0.63			-1.06			-1.76	
	December		-0.33			-0.74			-1.25			-2.07	
Operations	January	-	-17.5	-29.1	-	-19.7	-33.6	-0.7	-19.2	-32.1	-0.6	-3.2	-5.0
	February	-	-17.6	-29.2	-	-19.8	-33.6	-0.7	-19.3	-32.1	-0.6	-3.2	-5.0
	March	-	-17.7	-29.2	-	-19.9	-33.7	-0.8	-19.4	-32.2	-0.6	-3.2	-4.9
	April	-	-3.9	-5.8	37.7	25.8	-0.3	35.7	24.3	-0.5	2.3	-12.4	-20.7
	May	-	-0.9	-1.3	49.9	36.8	-0.1	48.3	34.9	-0.1	3.4	-14.6	-24.8
	June	-	-3.3	-5.9	49.7	34.0	-0.2	48.0	32.1	-0.4	0.9	-15.2	-24.9
	July	-	-2.8	-4.9	49.8	34.5	-0.2	47.9	32.6	-0.3	-0.3	-15.2	-25.0
	August	-	-8.8	-17.8	49.5	25.9	-2.1	47.3	24.3	-2.6	-0.9	-14.5	-21.8
	September	-	-2.1	-3.6	49.8	35.0	-0.1	47.7	33.2	-0.2	-0.2	-15.4	-25.2
	October	-	-5.1	-8.7	49.5	31.5	-0.3	47.2	29.8	-0.6	-0.6	-16.0	-25.3
	November	-	-15.6	-25.0	20.8	-1.0	-19.4	18.9	-1.4	-18.9	-1.8	-8.1	-9.2
	December	-	-18.7	-29.7	-	-21.0	-34.4	-	-20.4	-32.8	-	-3.1	-5.0
Post-Closure	January	-	-22.7	-22.7	-	-25.0	-25.0	-	-22.3	-22.3	-	4.0	-
	February	-	-22.7	-22.7	-	-25.0	-25.0	-	-22.3	-22.3	-	4.0	-
	March	-	-22.7	-22.7	-	-25.0	-25.0	-	-22.3	-22.3	-	4.0	-
	April	-	-3.3	-3.4	37.7	27.5	-	35.7	27.0	-	2.3	-13.0	-13.4
	May	-	-0.8	-0.8	49.9	34.3	-	48.3	33.4	-	3.4	-15.4	-15.4
	June	-	-3.4	-4.1	49.7	31.5	-	48.0	30.9	-	0.9	-14.9	-15.0
	July	-	-3.6	-4.3	49.8	31.2	-	47.9	30.6	-	-	-14.9	-15.0
	August	-	-10.3	-14.6	49.5	22.9	-	47.3	23.2	-	-	-12.9	-14.1
	September	-	-2.4	-2.7	49.8	32.6	-	47.7	31.8	-	-	-15.1	-15.1
	October	-	-5.4	-6.3	49.5	29.3	-	47.2	28.9	-	-	-14.6	-14.7
	November	-	-18.2	-18.9	20.8	-2.9	-5.3	18.9	-1.3	-3.5	-	-3.2	-3.7
	December	-	-22.7	-22.7	-	-25.0	-25.0	-	-22.3	-22.3	-	4.0	-

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Results\Results_Streams_MonthlyChange_07132021_sab.xlsm

Notes:

Construction stage is only 1.5 years in duration. Results reflect maximum monthly percent change for months which occur twice in the construction period
Blank rows represent periods where an increase or decrease in flows is not expected based on model results

Monthly streamflow during operations in Four Creek (WQ03, WQS21, WQS20 and WQS03DS) decrease by up to 34% and increase up to 45% (Table 4-5). Diversion channels and mine plan optimizations reduce the Project footprint as much as practical. However, the open pit and the Management Ponds route water that would flow to Four Creek towards Goathorn Creek via the Tenas Control Pond discharge. This reduces the catchment area. The C02 channel diversion increases the catchment area.

Monthly flow in Four Creek varies from upstream to downstream (Table 4-5). WQS21 and WQS20, located adjacent to the East Management Pond, gain flow, or lose insignificant flow during open water season months. During the winter, flow at these locations decreases. Flow at WQS03DS decreases year-round during operations. This decrease is most apparent during the open water season months.

The causes of these changes in flow are:

- Winter flow at WQS03, WQS20 and WQS21 decreases from the drawdown of the groundwater table by the adjacent open pit. Flow decreases proportionally to the expansion of the open pit (Table 4-5). At closure, the open pit is backfilled and floods. The groundwater table rises but not to pre mining levels. Post closure flow is lower than baseline conditions.
- WQS03DS is located downstream of the open pit and the East and North Management Ponds. The drawdown of the groundwater table by the open pit is countered by the mounding of groundwater under the East and North Management Ponds. Water seeps from the Management Ponds to the creek in the long-term during post-closure. Accounting for both conditions, there is a net reduction of winter streamflow in operations and a net increase in winter streamflow after mine closure.
- A diversion channel south of the East Management Pond will direct undisturbed surface runoff towards Four Creek throughout operation and post-closure. In the Pre-Mining case, this area would report to Four Creek downstream of the outlet of the proposed channel, increasing surface runoff upstream of the stream (e.g., WQS20 and WQS21). The increased flow in the upstream nodes (WQS20 and WQS21) is highest in early operations when the catchment area reporting to the diversion channel is largest. As the footprint of the open pit expands, the diversion's catchment area decreases and flow decreases. At closure, a portion of the backfilled open pit will drain towards the diversion channel, increasing open-water season flow by approximately 30% long-term. These percent changes assume 100% of the diverted area reports to Four Creek, however the hydraulic designs include a flow control structure which will limit erosion from individual flow events up to the 1 in 10-year event (SRK 2021d).
- Downstream (e.g., WQS03DS), the effect of the diversion partially mitigates the reduction of streamflow. The catchment area reduction is reduced from pre-mining conditions in operations and post-closure.

Appendix F includes the results for nodes in other streams (Table F-12, Table F-13 and Table F-14 for Tenas Creek, Goathorn Creek, Telkwa River and Bulkley River, respectively).

Tenas Creek flow may decrease by up to 10% during low flow periods (April and August) in operations because of groundwater drawdown and catchment area reductions. The seepage from Management

Ponds counters some of this flow reduction by the end of operations and into post-closure. The maximum monthly flow is just 6% less than average monthly flow.

Goathorn Creek flows are expected to be reduced by up to 6% during low flow periods in operations. Flows downstream of the Project discharge may also increase by up to 19% in operations and 8% after closure due to routing of water that would otherwise have reported to the Tenas Creek catchment.

The Project may reduce monthly average flows in the Telkwa River downstream of Goathorn Creek by less than 2% in operations and an increase of 1% in post-closure due to seepage from Management Ponds. Bulkley River monthly streamflow changes are negligible (less than 0.1%).

4.3.3 Project Case Results for High and Low Flows

The changes to high and low flow were evaluated using Alternative Assessment cases 4 and 5 at each modelled node. Summary tables with results for all Alternative Assessment cases are presented in Appendix G.

High Flows and Alternative Assessment Case 4: Three Consecutive Wet Years

In general, the relative change to high flows is driven by the relative change to stream catchment area. As such, high flows are reduced at nodes and stream sections where the catchment area (and MAD as presented in Section 4.3.1) decreases.

The catchment area will increase for two nodes on Four Creek, downstream of the C02 channel discharge. A control structure has been designed to mitigate high flows in Four Creek at nodes WQS20 through WQS21 in Four Creek from C02 high runoff conditions (SRK 2021d).

Discharge from Tenas Control Pond in operations and North Management Pond in post-closure may also increase streamflow in Goathorn Creek. This was assessed in Alternative Assessment Case 4 with three consecutive wet years (1 in 100-year wet return periods) to examine the expected discharge rates under more extreme conditions. The results show a potential increase over baseline streamflow of 19% at WQS06 and 12% further downstream at WQS05 during spring freshet (Table G-16). Further downstream in the Telkwa River, the change relative to baseline is negligible under consecutive wet years.

The Tenas Control Pond will provide additional attenuation up to the 1 in 10-year flood event, reducing the peak flows in tributaries to Goathorn Creek and downstream in Goathorn Creek. This attenuation has not been incorporated into the water and load balance model but is expected to reduce the expected change in streamflow in Goathorn Creek during high flow events.

Low Flows and Alternative Assessment Case 5: 7Q10 Low Flow

Seasonally flow is lowest in the winter when streamflow is primarily baseflow (i.e., groundwater discharge). The annual low flow is most sensitive to changes in groundwater table and the stream's catchment area. Alternative Assessment Case 5 was also included to evaluate changes to 7Q10 flow rates in all stream nodes. Change to low flows are presented in Table G-17 for each Project stage,

based on the minimum monthly average flow projected for modelled conditions and the most downstream node on each stream.

Extreme low flows are expected to be lower than Pre-Mining conditions by the same percentage as monthly average baseflow. Low flows in Four Creek and Tenas Creek downgradient of the open pit could be reduced by 34% and 6% respectively.

4.3.4 Other Alternative Assessment Cases

Results for the alternative assessment cases are presented in Appendix G and summarized in Table 4-6. Alternative Assessment Case 1 (see Section 4.3.3) is the high groundwater seepage case. Streamflow changes are likely in Four, Tenas and Goathorn creeks but these changes are negligible in the Telkwa River and Bulkley River.

Table 4-6: Summary of Change to Streamflow for Alternative Assessment Cases

Alternative Assessment Case	Stream	Nodes Affected	Project-related Effects
Case 1: High Groundwater Seepage	Four Creek	WQS21 WQS20	Reduction in winter streamflow equal to 100% from drawdown of groundwater table from open pit (Table G-12)
	Tenas Creek	WQS22 WQS04 WQS06	Reduction to MAD remains less than 10%, however monthly flow during operations decreases more than 10% for most months except freshet (May, June, July) and early fall (September, October, November) (Table G-13). The effect reverses in post-closure, when the higher management pond seepage result in increases of up to 35% in Tenas Creek winter flows.
Case 4: Consecutive Wet Years (High Flow)	Goathorn Creek	WQS06 WQS05	Increased Project discharge rates to Goathorn Creek, increase the maximum monthly over baseline streamflow by of 19% at WQS06 and 12% further downstream at WQS05 (Table G-16)
Case 5: Low Flow	Four Creek	WQS03DS	Extreme low flows are expected to be reduced over Base Case conditions by the same percentage as monthly average baseflow (Table G-17)
	Tenas Creek	WQS04	

4.4 Change to Stream Water Quality

Water quality model results in the receiving environment are presented in summary tables by node and are screened against the natural variability within each stream and the selected WQG and SPOs.

Results are presented as monthly average and maximum concentrations in winter (November through April) and summer (May to October) to demonstrate seasonal variability. Results are colored green

where the average or maximum monthly water quality is expected to exceed both baseline data (95th percentile from monitoring results) and the applicable guideline value, and in red where results exceed the SPO.

Appendix F provides each prediction node summary table under the Project Case conditions, while other assessment cases are presented in Appendix G. Appendix F also provides time series plots for any water quality parameter exceeding water quality guidelines.

The following constituents of potential concern (POPCs) have been identified based on exceedances in relation to each streams' natural variability (95th percentile) and WQGs: sulphate, total selenium, nitrite, and dissolved cadmium. In the case of selenium, model results are screened against the Tier 1 SPO and any exceedances of Tier 1 are further evaluated against the Tier 2 SPO. Exceedances are discussed in the following sections.

Note that water quality results are only presented for prediction nodes that are located downstream of the Project (i.e., receiving discharge or seepage). Nodes upstream of interactions are expected to continue to have baseline or pre-mining water quality. Similarly, nodes on Four Creek and Tenas Creek only experience a change in stream water quality after closure, resulting from Management Ponds seeping to groundwater. For these nodes, only the post-closure water quality results are presented, and all operation water quality is expected to equal baseline conditions. Goathorn Creek, Telkwa River and Bulkley River nodes include operation water quality to express the change from expected Project discharges.

4.4.1 Project Case Results

POPCs are identified as constituents exceeding the water quality guideline in any month. Summary tables present the nodes which exceed, along with the average long-term winter and summer concentrations and the baseline 50th and 95th percentile concentrations. Where applicable, the SPO values are also presented and discussed. Results are presented for all water quality parameters in Appendix F.

Results are highlighted in green where they exceed the water quality guideline and in red where they exceed the SPOs.

Each POPC is discussed below. The following general observations can be made for the source and trend in exceedances:

- WQG exceedances occur more frequently during the winter months from seepage discharge to the receiving environment(s) during periods of low flow, and therefore low dilution / assimilation capacity.
- Exceedances are driven by seepage from the Management Ponds and occur at nodes along Tenas Creek and Four Creek located downstream of the West, North and East Management Ponds.
- The stream concentrations peak approximately 25 years after the peak concentrations are expected in each Management Pond, reflecting the delay in seepage migration described in

Section 3.8.3. The period of exceedance varies based on the magnitude of modelled results in relation to the guideline.

- All exceedances in Four Creek and Tenas Creek occur only in post-closure. There are no exceedances in either stream expected during operations. Only the nodes downstream of infrastructure (WQS03DS in Four Creek and WQS02, WQS22 and WQS04 in Tenas Creek) experience changes to water quality in these systems.
- Goathorn Creek exceedances occur from Project discharge during operations and typically are only a single month. These exceedances would be limited or eliminated by mitigation measures such as controlling discharge rates based on pond concentrations and in-stream flow rates.

Total Selenium

The water quality guideline for total selenium is 0.002 mg/l, which is exceeded in Tenas Creek and Four Creek from Management Pond seepage after closure. The Tier 1 SPO for total selenium is 0.008 mg/L, which is not exceeded. Table 4-7 summarizes the exceedances of WQG for total selenium.

Table 4-7: Total Selenium Exceedances for Project Case Conditions

Node	SPO [mg/l]	WQG [mg/l]	Background Concentration [mg/l]		Project Case Modelled Concentrations [mg/l]				Max Multiplier (2)	Project Stage (1)
			P50	P95	Max Summer	Max Winter	Long-term Average Summer	Long-term Average Winter		
Tenas Creek										
WQS02	0.008	0.002	0.000051	0.00020	0.0019	0.0035	0.00029	0.0015	1.8	PC
WQS22	0.008	0.002	0.000051	0.00020	0.0023	0.0041	0.00036	0.0018	2.0	
WQS04	0.008	0.002	0.000051	0.00020	0.0023	0.0041	0.00036	0.0018	2.0	
Four Creek										
WQS03 DS	0.008	0.002	0.000025	0.000095	0.0031	0.0058	0.00054	0.0019	2.9	PC

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Feb2022_NewSourceTerms\Results_Streams_WaterQuality_EAModel_v28_20220128.xlsm

Notes:

1. Project stage acronyms: PC=Post-Closure, OP=Operations, CN=Construction
2. Maximum exceedance multiplier is a ratio of the maximum monthly water quality result over the water quality guideline (WQG)
3. Results are highlighted in green where they exceed the water quality guideline and in red where they exceed the Tier 1 SPO

In Tenas Creek, the WQG is exceeded at all three downstream nodes from November through April during low-flow conditions and in August (the driest summer month) in the two downstream nodes. Dilution during and after freshet (May through July) as well as in October reduces the concentration below the WQG. These exceedances provide conservative representation in terms of potential selenium exposure, as the biological productivity is at its lowest during the winter months. The selenium SPO is not expected to be exceeded in Tenas Creek. Long-term results are below the WQG.

The downstream node in Four Creek (WQS03DS) exceeds the WQG in winter months (November through April) and low flow period of summer (August). The selenium SPO is not expected to be exceeded in Four Creek, and long-term results are below the WQG.

No exceedances of the guideline are expected in Goathorn Creek.

Figure 4-13 presents the modelled total selenium concentrations for nodes that exceed the WQG in the Project Case. Appendix F present selenium model results for all nodes.

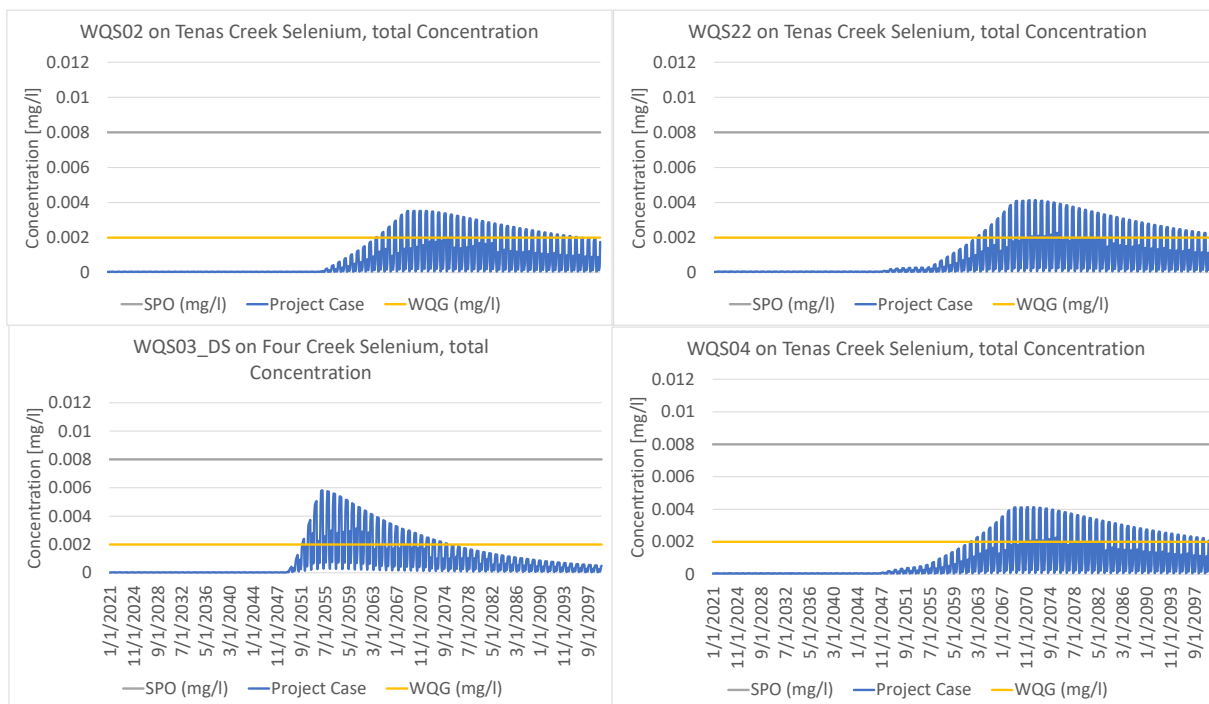


Figure 4-13: Modelled Total Selenium Concentrations for Nodes with Exceedances of WQG in Project Case.

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Results\ModelOutputs_WaterQualityPlots\Water Quality Plots – NewSourceTerms_20220207.xlsx

Nitrite

The WQG for nitrite is 0.02 mg/l, which is exceeded in Tenas Creek and Four Creek because of Management Pond seepage. The SPO for nitrite is 0.0524 mg/l, which is not exceeded in any stream based on Project Case model assumptions. Table 4-8 summarizes the exceedances for nitrite.

Table 4-8: Nitrite Exceedances for Project Case Conditions

Node	SPO [mg/l]	WQG [mg/l]	Background Concentration [mg/l]		Project Case Modelled Concentrations [mg/l]				Max Multiplier (2)	Project Stage (1)
			P50	P95	Max Summer	Max Winter	Long-term Average Summer	Long-term Average Winter		
Tenas Creek										
WQS02	0.0524	0.02	0.00050	0.0020	0.018	0.039	0.0027	0.014	2.0	PC
WQS22	0.0524	0.02	0.00050	0.0020	0.021	0.046	0.0033	0.016	2.3	
WQS04	0.0524	0.02	0.00050	0.0020	0.021	0.045	0.0033	0.017	2.3	
Four Creek										
WQS03DS	0.0524	0.02	0.00050	0.0010	0.024	0.038	0.0043	0.014	1.9	PC

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Feb2022_NewSourceTerms\Results_Streams_WaterQuality_EAModel_v28_20220128.xlsm

Notes:

1. Project stage acronyms: PC=Post-Closure, OP=Operations, CN=Construction
2. Maximum exceedance multiplier is a ratio of the maximum monthly water quality result over the water quality guideline (WQG)
3. Results are highlighted in green where they exceed the water quality guideline and in red where they exceed the SPO

The maximum concentrations in Tenas Creek are experienced downstream at WQS22 with a peak concentration of 0.046 mg/L in post-closure. Winter concentrations are higher than summer months from the reduced dilution capacity. No exceedances occur during operations, and the average post-closure concentration at Tenas Creek during the winter period is below the WQG.

Like Tenas Creek, the maximum concentration of nitrite in Four Creek occurs in the winter during post-closure. Summer months also have exceedances during the peak of the seepage plume from the East Management Pond. The long-term concentrations in Four Creek are below the WQG.

At no point do the Four Creek and Tenas Creek results exceed the SPO for nitrite.

Figure 4-14 presents the modelled nitrite-nitrogen concentrations for nodes that exceed the WQG in the Project Case. Figure F-7 through F-10 in Appendix F present model results for all nodes.

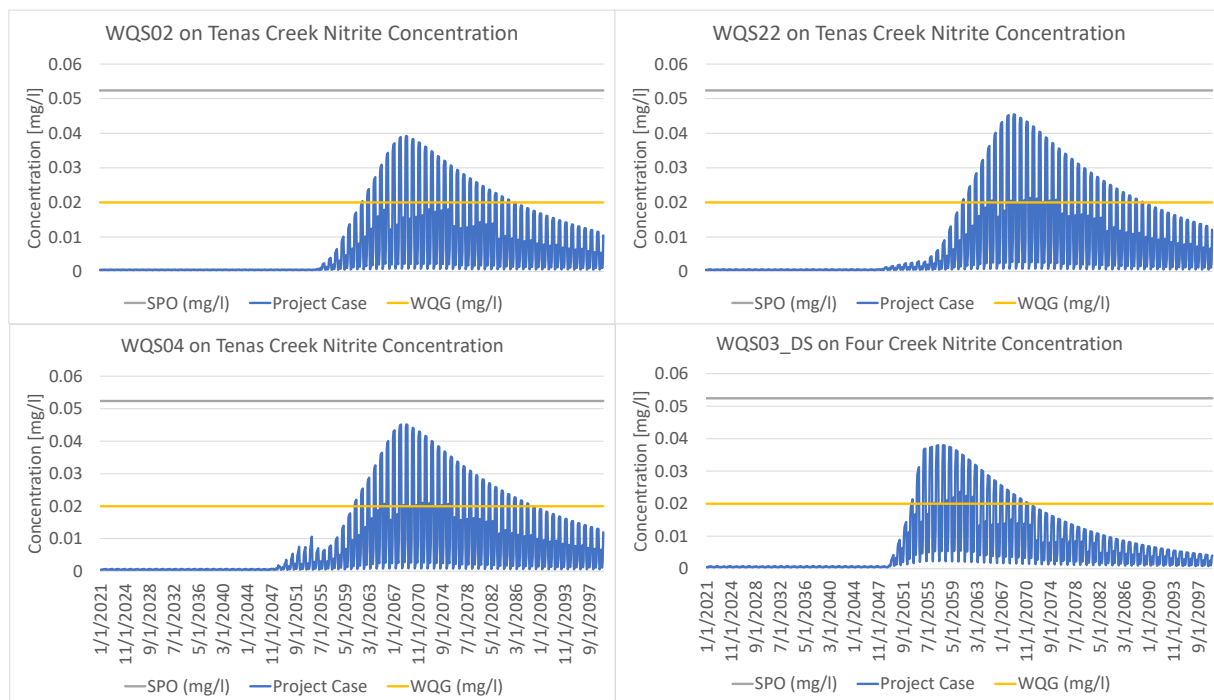


Figure 4-14: Modelled Nitrite-Nitrogen Concentrations for Nodes with Exceedances of WQG in Project Case

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Results\Model\Outputs_WaterQualityPlots\Water Quality Plots - NewSourceTerms_20220202 (copy).xlsx

Dissolved Cadmium

The water quality guideline for dissolved cadmium is dependent on the baseline hardness and is 0.00017 mg/l, 0.00024 mg/l and 0.0016 mg/L for Tenas Creek, Four Creek and Goathorn Creek, respectively. The 50th percentile baseline hardness values for each creek are 73 mg/L, 111 mg/L and 69 mg/L for Tenas, Four and Goathorn creeks, respectively. Exceedances of the guideline occur in Four creek during both the summer and winter from Management Pond seepage. The SPO for dissolved cadmium varies based on the background hardness concentration in each stream. The SPO value is not exceeded in any creek. Table 4-9 summarizes the exceedances for dissolved cadmium.

Table 4-9: Dissolved Cadmium Exceedances for Project Case Conditions

Node	SPO [mg/l]	WQG [mg/l]	Background Concentration [mg/l]		Project Case Modelled Concentrations [mg/l]				Max Multiplier (2)	Project Stage (1)
			P50	P95	Max Summer	Max Winter	Long-term Average Summer	Long-term Average Winter		
Four Creek										
WQS03 DS	0.00026	0.00024	0.0000052	0.000012	0.00014	0.00026	0.000029	0.000086	1.5	PC

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water

Management\500_Water_Balance\Feb2022_NewSourceTerms\Results_Streams_WaterQuality_EAModel_v28_20220128.xlsm

Notes:

1. Project stage acronyms: PC=Post-Closure, OP=Operations, CN=Construction
2. Maximum exceedance multiplier is a ratio of the maximum monthly water quality result over the water quality guideline (WQG)
3. Results are highlighted in green where they exceed the water quality guideline and in red where they exceed the SPO

Four Creek exceeds the WQG up to 1.5 times in winter months. The SPO is not exceeded in Four Creek.

No other exceedances of WQGs or SPOs are expected for dissolved cadmium under Project Case.

Figure 4-15 presents the modelled dissolved cadmium concentrations for nodes that exceed the WQG in the Project Case. Figure F-11 through F-14 in Appendix F present model results for all nodes.

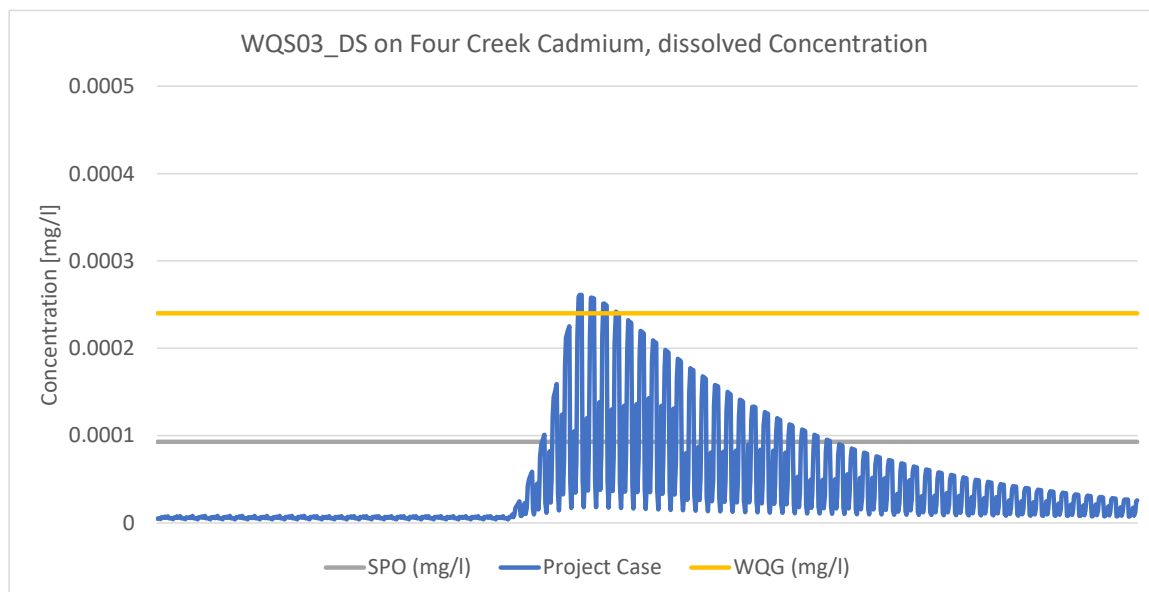


Figure 4-15: Modelled Dissolved Cadmium Concentrations for Nodes with Exceedances of WQG in Project Case

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Results\ModelOutputs_WaterQualityPlots\Water Quality Plots - Updated.xlsx

Sulphate

The WQG for sulphate is dependent on the baseline hardness and is 218 mg/L and 309 mg/L in Tenas Creek and Four Creek, respectively. The 50th percentile baseline hardness values for each creek are 73 mg/L and 111 mg/L for Tenas and Four creeks, respectively. Exceedances of the guideline occur in winter months in Four and Tenas creeks. Table 4-10 summarizes exceedances for sulphate.

Table 4-10: Sulphate Exceedances for Project Case Conditions

Node	WQG [µg/l]	Background Concentration [µg/l]		Project Case Modelled Concentrations [µg/l]				Max Multiplier (2)	Project Stage (1)
		P50	P95	Max Summer	Max Winter	Long-term Average Summer	Long-term Average Winter		
Tenas Creek									
WQS02	218	2.6	7.4	120	220	17	92	1.0	PC
WQS22	218	2.6	7.4	140	250	21	110	1.2	
WQS04	218	2.6	7.4	140	260	22	110	1.2	
Four Creek									
WQS03DS	309	1.9	28	190	360	33	110	1.2	PC

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Feb2022_NewSourceTerms\Results_Streams_WaterQuality_EAModel_v28_20220128.xlsm

Notes:

1. Project stage acronyms: PC=Post-Closure, OP=Operations, CN=Construction
2. Maximum exceedance multiplier is a ratio of the maximum monthly water quality result over the water quality guideline (WQG)
3. Results are highlighted in green where they exceed the water quality guideline and in red where they exceed the SPO

Sulphate WQG exceedances in Tenas Creek occur in winter months only at all three downstream nodes. Winter exceedances of the guideline are up to 1.2 times the WQG. The average winter concentration over the post-closure period is below the WQG.

The trend of Four Creek exceedances is like Tenas Creek, with winter exceedances of the sulphate water quality guideline for a period in post-closure. Long-term concentrations are below the WQG. The maximum concentration exceeds the WQG by up to 1.2 times

Figure 4-16 presents the modelled sulphate concentrations for nodes that exceed the WQG in the Project Case. Figure F-19 through F-22 in Appendix F present model results for all nodes.

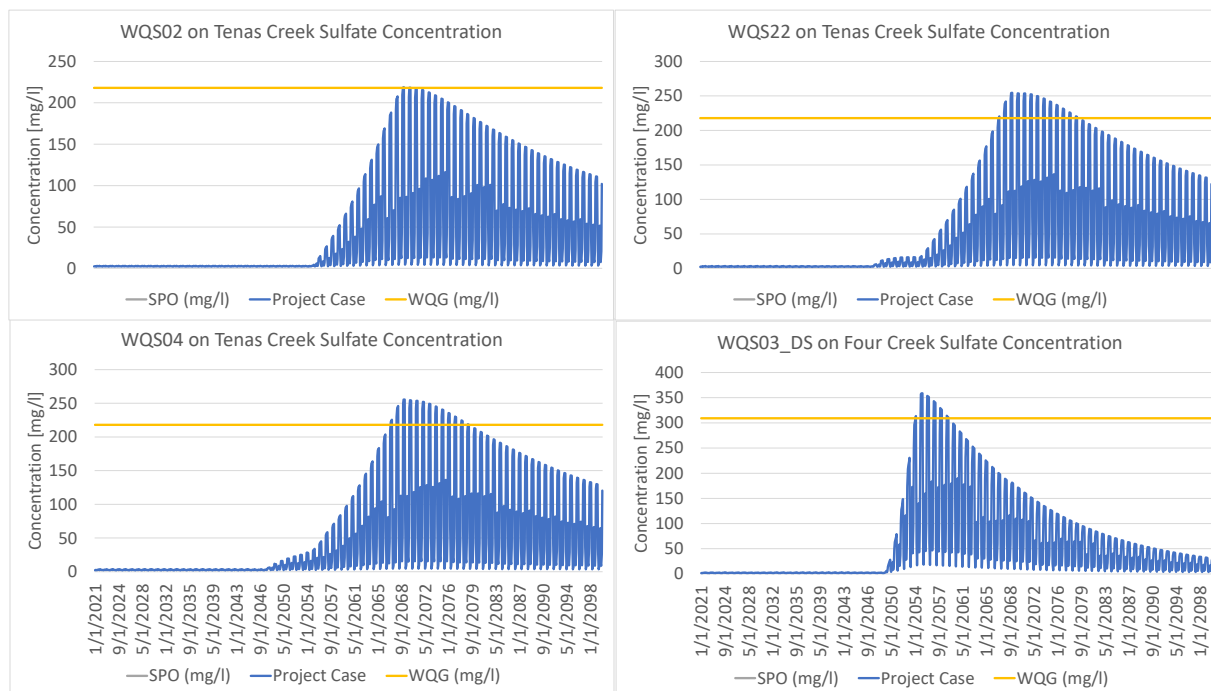


Figure 4-16: Modelled Sulphate Concentrations for Nodes with Exceedances of WQG in Project Case

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Results\ModelOutputs_WaterQualityPlots\Water Quality Plots - Updated.xlsx

Additional Observations

Total and dissolved aluminum concentrations exceed the WQG in all streams during either maximum summer and/or maximum winter periods. In the lower part of Four Creek (WQS03DS) and in Telkwa River, the exceedances are continuous throughout long-term closure in both average summer and winter. Exceedances are predominately driven by naturally elevated concentrations. Telkwa River and Bulkley River baseline 50th percentile concentrations are above the WQG and the 95th percentile of all other streams is above the WQG. An SPO limit was developed, and all model results in all streams are below the SPO in the Project Case.

4.4.2 Alternative Assessment Case Results

Alternative assessment cases include upper and lower range inputs for groundwater, geochemical source terms and hydrology. Each alternative input has been assessed on an individual basis with expected conditions (Project Case) for other parameters. Results focus on the prediction nodes and critical modeling periods associated with each case and are presented in Appendix G, tables G-15 through G-25.

Table 4-11 summarizes the additional changes to water quality under all alternative assessment cases. Results are described in the following sub-sections.

Table 4-11: Water Quality Exceedances under Alternative Assessment Cases

Alternative Assessment Case	Nodes/Streams Affected	Additional Exceedances	Comments
Case 1: High Groundwater Seepage	Tenas Creek	Nitrate (TC-02,22,04) Total Zinc (TC-02,22,04) Dissolved Cadmium (TC-02,22,04) Total Copper (TC-02,22,04)	Increased seepage rates from Management Ponds. Four Creek downstream water quality improves over Project Case due to reduced baseflow from open pit drawdown
Case 2: High Source Terms	All downstream nodes	Dissolved Cadmium (TC-02,22,04, GC-05,06) Total Copper (TC-02,22,04, FC-03DS, GC-05,06) Total Cobalt (FC-03DS) Total Manganese (TC-02,22,04, FC-03DS) Total Selenium (GC-05,06) Total Thallium (TC-02,22,04, FC-03DS, GC-05,06) Total Zinc (TC-02,22,04, GC-05,06)	Critical period during low flow (winter months) when Management Pond seepage and Project discharge dominates streamflow
Case 3: Consecutive Dry Years	no change expected	no change expected	Addressed with Low Flow scenario (Case 5). No results presented
Case 4: Consecutive Wet Years	Goathorn Creek only	no new exceedances	Increased Project discharge rate to Goathorn Creek during critical period at end of mining
Case 5: Low Flow	All nodes	Nitrate (TC-02,22,04, FC-03DS) Fluoride (TC-02,22,04) Dissolved cadmium (TC-02,22,04) Total copper (TC-02,22,04, FC-03DS) Total manganese (TC-2,22,04, FC-03DS) Total selenium (TC-02,22,04, FC-03DS) Total Zinc (TC-02,22,04)	All additional exceedances are driven by groundwater seepage from Management Ponds and effect the downstream nodes on respective creeks only.

Notes:

FC = Four Creek, TC = Tenas Creek, GC = Goathorn Creek, TR = Telkwa River, BR = Bulkley River

Nodes identified for each parameter represent additional exceedances beyond what is expected under Project Case conditions

Alternative Assessment Case 1: High Case Groundwater

Appendix G tables G-15 through G-25 present the stream concentrations under high case groundwater seepage rates for nodes that are downstream of Project facilities. Results reflect a combination of higher seepage rates from the Management Ponds and higher drawdown from the open pit, resulting in an increase in load at some nodes and a decrease in flow at others. This case results in no flow in the upstream Four Creek nodes WQS20 and WQS21 during the winter.

Additional parameters that exceed the WQG beyond those exceeding in the Project Case conditions include: nitrate, dissolved cadmium, total copper and total zinc. Dissolved cadmium and nitrite results exceed the SPOs in winter months. The exceedances occur in Tenas Creek while water quality in the downstream node at WQS03DS in Four Creek improves relative to baseline because of the overall reduction in streamflow from open pit drawdown. Copper concentrations are less than the 95th percentile from monitoring data in Tenas Creek.

Alternative Assessment Case 2: High Source Terms

Case 2 applies high case geochemical source terms. Appendix G tables G-15 through G-25 present the monthly maximum and average long-term concentrations throughout relevant Project stages.

Additional parameters that exceed the WQG beyond what was exceeded in Project Case conditions include: total cobalt, total copper, dissolved cadmium, total manganese, total selenium, total thallium and total zinc.

The high source terms are expected to result in exceedances of the total aluminum SPO in winter months in downstream sections of Tenas Creek and Four Creek, as well as in Telkwa River. In all cases, model results remain below the 95th percentile from respective baseline datasets.

The total selenium and dissolved cadmium SPOs are expected to be exceeded with high source terms in Tenas Creek and Four Creek. In Four Creek, cadmium exceedances are expected in summer and winter through 2100, while in Tenas Creek, only the long-term winter results show exceedances of the SPO. Selenium results show exceedances of the Tier 1 SPO for a period of years in winter months for both creeks as well as summer months in Four Creek.

Goathorn Creek nodes include exceedances of cadmium, copper, selenium, sulphate, thallium, and zinc guidelines for 1-month in operations (summer). No exceedances of the SPOs are expected.

High source term results are incorporated as the worst-case as part of the initial dilution zone modeling for Goathorn Creek downstream of the Project discharge (SRK 2021e) and in groundwater effects assessment and the Human Health effects assessment.

Alternative Assessment Case 4: Three Consecutive Wet Years (2041-2042-2043)

Three 1 in 100-year wet year precipitation scenarios were repeated in year 2041, 2042 and 2043, to simulate a period where all Management Ponds are full, or nearly filled. This results in the maximum Project discharge to Goathorn Creek, when water quality is expected to be its worst for most parameters. In this scenario, no additional exceedances beyond what was presented in Project Case were observed.

Alternative Assessment Case 5: Low Flow Conditions

Case 5 assumes that all streams experience the 7Q10 low flow condition year-round. Results presented in Appendix G tables reflect maximum concentrations from the model results.

Additional parameters that exceed the WQGs beyond what was exceeded in Project Case conditions include: nitrate, fluoride, dissolved cadmium, total copper, total manganese, total selenium, and total zinc.

All downstream Tenas Creek nodes and the downstream Four Creek node present exceedances of the SPOs for nitrite, dissolved cadmium and Tier 1 total selenium. The SPO for total aluminum is also exceeded, however it remains less than the 95th percentile from baseline monitoring in each stream.

Low flow conditions are also evaluated as part of the initial dilution zone modeling for Goathorn Creek downstream of the Project discharge (SRK 2021e).

4.4.3 Additional Water Quality Parameters

Change in water quality to other measurable water quality parameters were evaluated external to the GoldSim model using conservative assumptions and, in some cases, qualitative considerations. Additional parameters include stream temperature, total suspended solids (TSS) and turbidity, pH and alkalinity, conductivity (EC) and total dissolved solids (TDS), and polycyclic aromatic hydrocarbons (PAHs).

This assessment focuses on the smaller streams, including Tenas, Four and Goathorn Creeks. The results presented above for modelled concentrations in Telkwa and Bulkely River show no measurable difference above baseline conditions and therefore the parameters listed above are also expected to remain unchanged.

Stream Temperature

A mass balance approach was utilized to evaluate the change in stream temperature from the Project discharge into Goathorn Creek. Change in temperature is not anticipated to be significant in other streams receiving Project discharge via groundwater pathways.

Temperature predictions in the Tenas Control Pond and management ponds were not developed as part of this work. As a conservative estimate, pond temperature was assumed to be equal to ambient air temperature. Monthly maximum Project temperature derived from long-term time series (SRK

2021a) were applied to the ponds. For air temperatures below freezing, pond water temperature was conservatively assumed to be 0°C. Maximum monthly Project discharge (Table 4-12) was considered from the Tenas Control Pond during operation and the NMP after closure.

Monthly mean flow in Goathorn Creek at node WQS06 (SRK 2021a) was considered for in-stream flow conditions, along with monthly average temperature. Stream temperature was obtained from the 2017-2019 baseline monitoring at WQS06 (ERM 2019). The temperature was highest in August, with average and maximum values of 13.8°C and 14.7°C, respectively.

The maximum increase in stream temperature from Project discharge was determined to be 0.5 °C during operation and 0.6 °C after closure (Table 4-12). These changes are within the natural variability of the stream temperature (i.e. difference between average and maximum recorded temperature). Estimates are expected to be conservative in terms of relative change in temperature to the receiving environment. For example, high temperature in April (post-closure maximum case) is unlikely to occur, since the peak discharge is associated with spring snowmelt, when water temperatures would be close to freezing.

Table 4-12: Estimated monthly temperature change in Goathorn Creek

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tenas Control Pond (OP) ⁽¹⁾												
Pond Temperature (°C) ⁽²⁾	0	0	2.2	7.4	12.9	16.5	19	18.6	13.7	6.5	0	0
Discharge Rate (m³/s) ⁽³⁾	-	-	-	-	0.139	0.104	0.104	0.104	0.104	0.104	-	-
North Management Pond (CL) ⁽¹⁾												
Pond Temperature (°C) ⁽²⁾	0	0	2.2	7.4	12.9	16.5	19	18.6	13.7	6.5	0	0
Discharge Rate (m³/s) ⁽³⁾	0.001	0.001	0.001	0.204	0.135	0.049	0.176	0.002	0.005	0.034	0.001	0.001
Goathorn Creek												
Baseline Temperature (°C) ⁽⁴⁾	0.1	0	0.1	3.3	4.6	7	10.2	13.8	7.7	3.4	1.3	0
Mean Flow (m³/s)	0.4	0.3	0.3	1.1	4.5	4.6	2.9	1.6	1.2	1.3	0.9	0.5
Final Temperature (OP) (°C)	0.1	0	0.1	3.3	4.8	7.2	10.5	14.1	8.2	3.6	1.3	0
Temperature Change (OP) (°C)	0	0	0	0	+0.2	+0.2	+0.3	+0.3	+0.5	+0.2	0	0
Final Temperature (PC) (°C)	0.1	0.0	0.1	3.9	4.8	7.1	10.7	13.8	7.7	3.5	1.3	0.0
Temperature Change (PC) (°C)	0	0	0	+0.6	+0.2	+0.1	+0.5	0	0	+0.1	0	0

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\700_Temperature_Model\Telkwa_TemperatureGHC_rk.xlsx

Notes:

1. Project stage acronyms: OP=Operations, PC=Post-Closure
2. Corresponds to Project maximum air temperature (SRK 2021a)
3. Maximum monthly discharge rate from the pond
4. Corresponds to average temperature at WQS06 based on baseline monitoring (ERM 2019)

Turbidity and Total Suspended Solids

Background concentrations of TSS and turbidity in the Tenas Project streams were obtained from 2017-2019 baseline water quality monitoring (ERM 2019). The 50th and 95th percentile concentrations of these parameters in Tenas Creek, Four Creek and Goathorn Creek are outlined in Table 4-13. A relationship was developed between TSS and turbidity based on linear regression considering the baseline monitoring data of all streams (Figure 4-17).

Table 4-13: Baseline total suspended solids (TSS) and turbidity in the streams

Parameter	Unit	Four Creek		Goathorn Creek		Tenas Creek		All Creeks	
		P50	P95	P50	P95	P50	P95	P50	P95
Total suspended solids	mg/L	1.5	23	3.7	19	1.5	41	3	26.4
Turbidity	NTU	1.4	22	2	14	1.6	37	1.62	22.2

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\100_Data_Analysis\SurfaceWQ_BaselineData_rev10_kmp_smh_njs.xlsx

Note: P50 and P95 corresponds to 50th and 95th percentile concentration, respectively

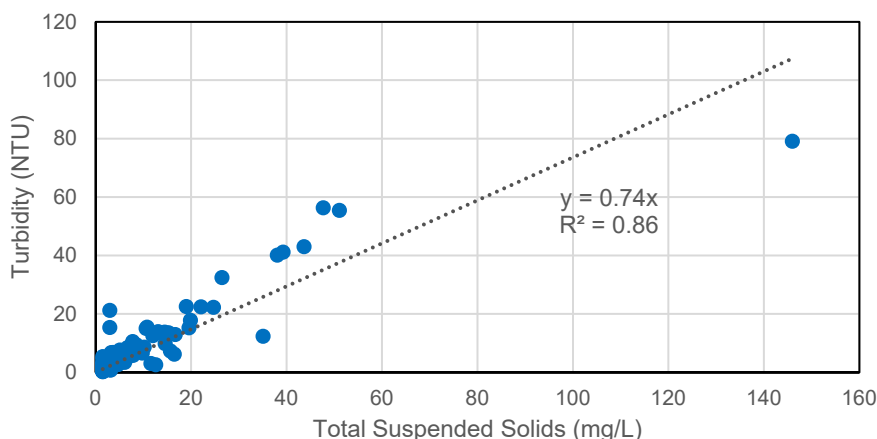


Figure 4-17: Relationship between TSS and turbidity for Goathorn, Tenas and Four creeks

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\100_Data_Analysis\SurfaceWQ_BaselineData_rev10_kmp_smh_njs.xlsx

TSS in Four Creek and Tenas Creek is expected to remain unchanged, as there will be no Project discharge to these streams. Suspended particles are expected to be removed during groundwater transport to these creeks. The Tenas Control Pond only discharges in open water period (May – October) during operation and will be decommissioned after closure. Suspended sediments are settled in the pond prior to discharge to a tributary of Goathorn Creek. It was assumed that TSS is discharged from the Tenas Control Pond towards Goathorn Creek at a constant concentration of 35 mg/L.

TSS in Goathorn Creek was calculated based on mass balance approach considering maximum Project discharge with background loading estimated from baseline monitoring. TSS corresponding to the 50th percentile value of 3.7 mg/L was used for Goathorn Creek background concentration. With monthly mean flow representing in-stream flow condition, the estimated TSS varied from 4.4 – 6.2

mg/L (Table 4-14). Turbidity was obtained using the linear relationship shown in Figure 4-17. The maximum turbidity in the creek after Project discharge was estimated to be 4.6 NTU.

TSS and turbidity levels in Goathorn Creek are expected to increase due to discharge from Tenas Control Pond, however the results are within the natural variability of baseline monitoring data (i.e., less than 95th percentile baseline concentration).

Table 4-14: Estimated TSS and turbidity in Goathorn Creek due to Tenas Control Pond discharge

Parameter	Open Water Period					
	May	Jun	Jul	Aug	Sep	Oct
Tenas Control Pond						
Maximum discharge rate (m³/s)	0.139	0.104	0.104	0.104	0.104	0.104
Goathorn Creek						
Mean flow (m³/s)	4.5	4.6	2.9	1.6	1.2	1.3
TSS (mg/L) ⁽¹⁾	4.6	4.4	4.8	5.6	6.2	6.0
Turbidity (NTU) ⁽²⁾	3.4	3.2	3.5	4.1	4.6	4.4

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\OtherParameters\Telkwa_OtherWQ_parameters_v1_rk.xlsx

Notes:

1. Estimated based on mass balance approach
2. Estimated from the relationship between TSS and turbidity developed from baseline monitoring data

pH and Alkalinity

Figure 4-18 shows the measured pH and alkalinity in Four Creek, Goathorn Creek and Tenas Creek from the 2017-2019 baseline water quality monitoring (ERM 2019), which includes historical measurements from 2006 to 2008. Measured pH and alkalinity in these streams ranged from 7.2 to 8.5 and 26 to 189 mg-CaCO₃/L, respectively. The mean pH in Four Creek, Goathorn Creek and Tenas Creek was 8.2, 7.9 and 8.1, respectively.

Based on geochemical characterization of mine water, expected pH in the management ponds is 8.0 (Appendix E). Considering the similar pH in management ponds and baseline monitoring data of various streams, the Project is not expected to alter the in-stream pH or alkalinity.

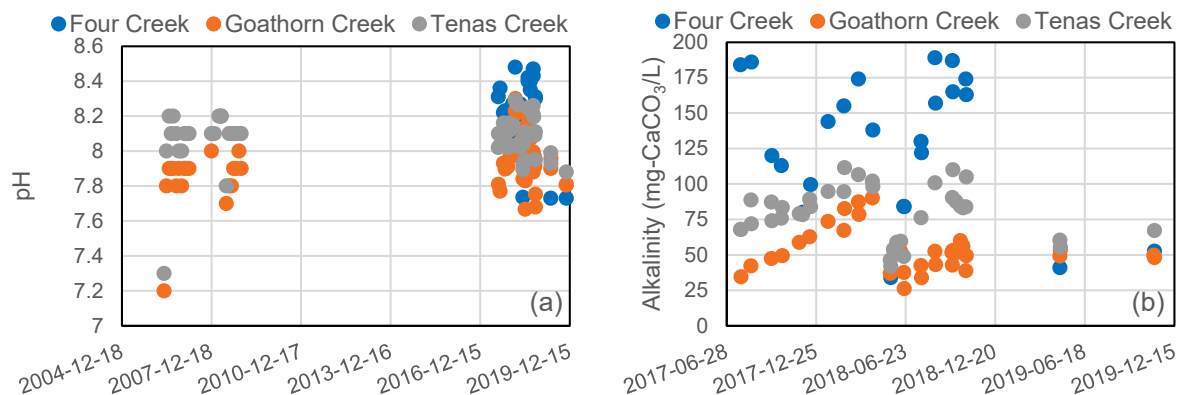


Figure 4-18: Measured (a) pH and (b) Alkalinity in Four Creek, Goathorn Creek and Tenas Creek

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\ 100_Data_Analysis\SurfaceWQ_BaselineData_rev10_kmp_smh_njs.xlsx

Specific Conductance and Total Dissolved Solids

Specific conductance (SC) is correlated with total dissolved solids (TDS) and can be expressed by a linear relationship. Based on the 2017-2019 baseline water quality monitoring (ERM 2019), correlations were developed for Four Creek, Goathorn Creek and Tenas Creek (Figure 4-19). The 50th and 95th percentile background concentrations of TDS and SC in each stream are outlined in Table 4-15.

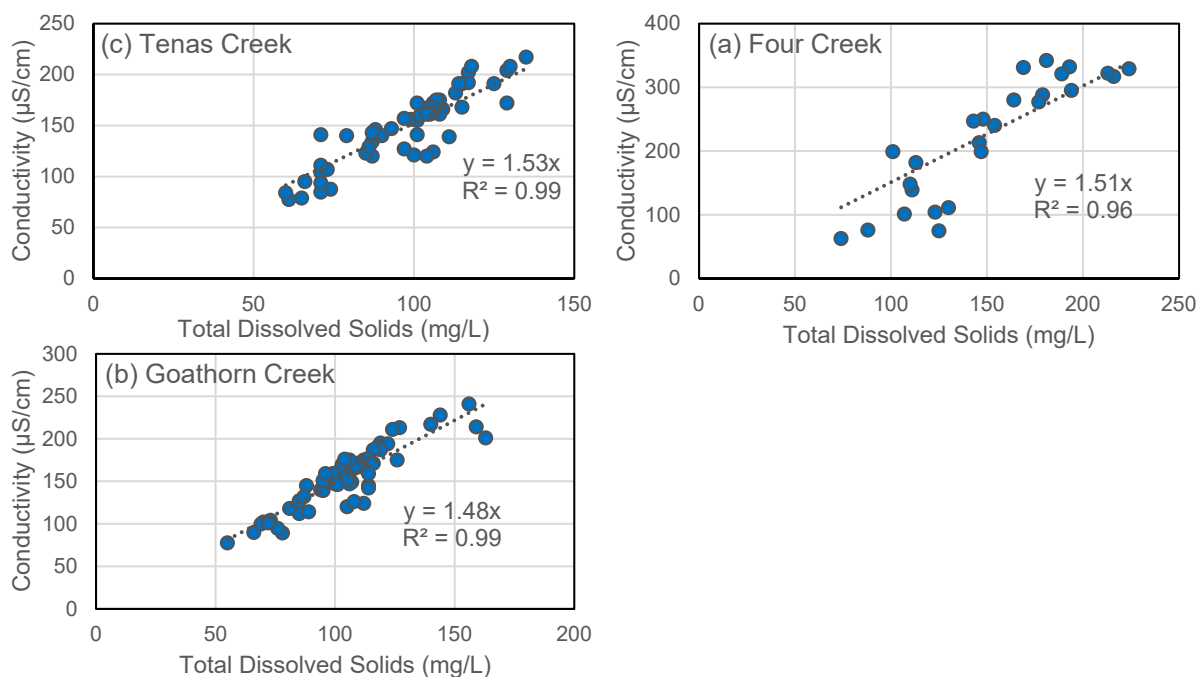


Figure 4-19: Relationship between TDS and specific conductance for (a) Four Creek, (b) Goathorn Creek, and (c) Tenas Creek

The TDS concentrations during Project operations were calculated based on dissolved metal concentrations and alkalinity from the water and load balance model results for the Project Case. The model results from the nodes with the highest concentrations in each stream were selected, including WQS03DS for Four Creek, WQS04 for Tenas Creek and WQS06 for Goathorn Creek. Calculated TDS concentrations are presented in Figure 4-20.

Maximum TDS in Four Creek, Goathorn Creek and Tenas Creek is estimated to be 476 mg/L, 226 mg/L and 397 mg/L, respectively, which exceeds the 95th percentile background concentration of individual streams (Table 4-15). TDS reaches its maximum level in Goathorn Creek in August 2032 when water in the WMP is pumped to the Tenas Control Pond. As discussed in previous sections, this discharge event would be expected to be controlled or prevented through operations of pond water levels. Summer and winter long-term average TDS in Goathorn Creek are below the 50th percentile baseline concentration. In Four Creek and Tenas Creek, TDS reaches its maximum levels in post-closure as a result of seepage from management ponds. The long-term average TDS concentration in Four Creek is within the stream's natural variability (below 95th percentile), however the winter concentrations in Tenas Creek are expected to remain about the 95th percentile baseline value through 2100.

EC was calculated using the regression relationship developed for the Project streams (Figure 4-19) and the calculated TDS concentrations at nodes WQS03DS, WQS04 and WQS06 (Figure 4-20). Long-term average (summer and winter) SC are below the 50th percentile background concentration of individual streams during operation (Table 4-15). The average SC in Goathorn Creek remains below the 50th percentile background level during post-closure as well. The maximum expected SC in

Goathorn Creek is 344 µS/cm, which exceeds the 95th percentile baseline concentration. Similar to TDS, this is expected to occur as a result of Project discharge during a low flow month, which would be controlled through the pond's operations manual. In Four Creek and Tenas Creek, SC increases in winter months in post-closure as a result of groundwater seepage from the management ponds. Concentrations exceed the 95th percentile background concentration in Four Creek during winter months for 26 years in post-closure, however the long-term average concentration (i.e. 2100) is within the baseline range. Tenas Creek concentrations of SC peak in post-closure and are reduced through 2100, however modeling results during winter months continue to exceed the 95th percentile baseline value through 2100.

Table 4-15: TDS and SC estimate for Project Case condition

Parameter	Stream (Node)	Background Concentration		Project Stage (1)	Project Case Concentrations			
		P50	P95		Maximum Summer	Maximum Winter	Long-term Average Summer	Long-term Average Winter
TDS (mg/L)	Four Creek (WQS03DS)	150	220	OP	159	117	134	52
				PC	347	476	172	193
	Goathorn Creek (WQS06)	110	140	OP	226	128	104	80
				PC	110	133	97	89
	Tenas Creek (WQS04)	100	130	OP	109	119	93	68
				PC	267	397	118	209
SC (µS/cm)	Four Creek (WQS03DS)	240	330	OP	241	178	203	79
				PC	525	720	261	292
	Goathorn Creek (WQS06)	160	210	OP	344	195	158	123
				PC	168	203	148	136
	Tenas Creek (WQS04)	160	210	OP	162	176	137	100
				PC	396	588	175	309

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\OtherParameters\Telkwa_OtherWQ_parameters_v1_rk.xlsx

Notes:

1. Project stage acronyms: OP=Operations, PC=Post-Closure

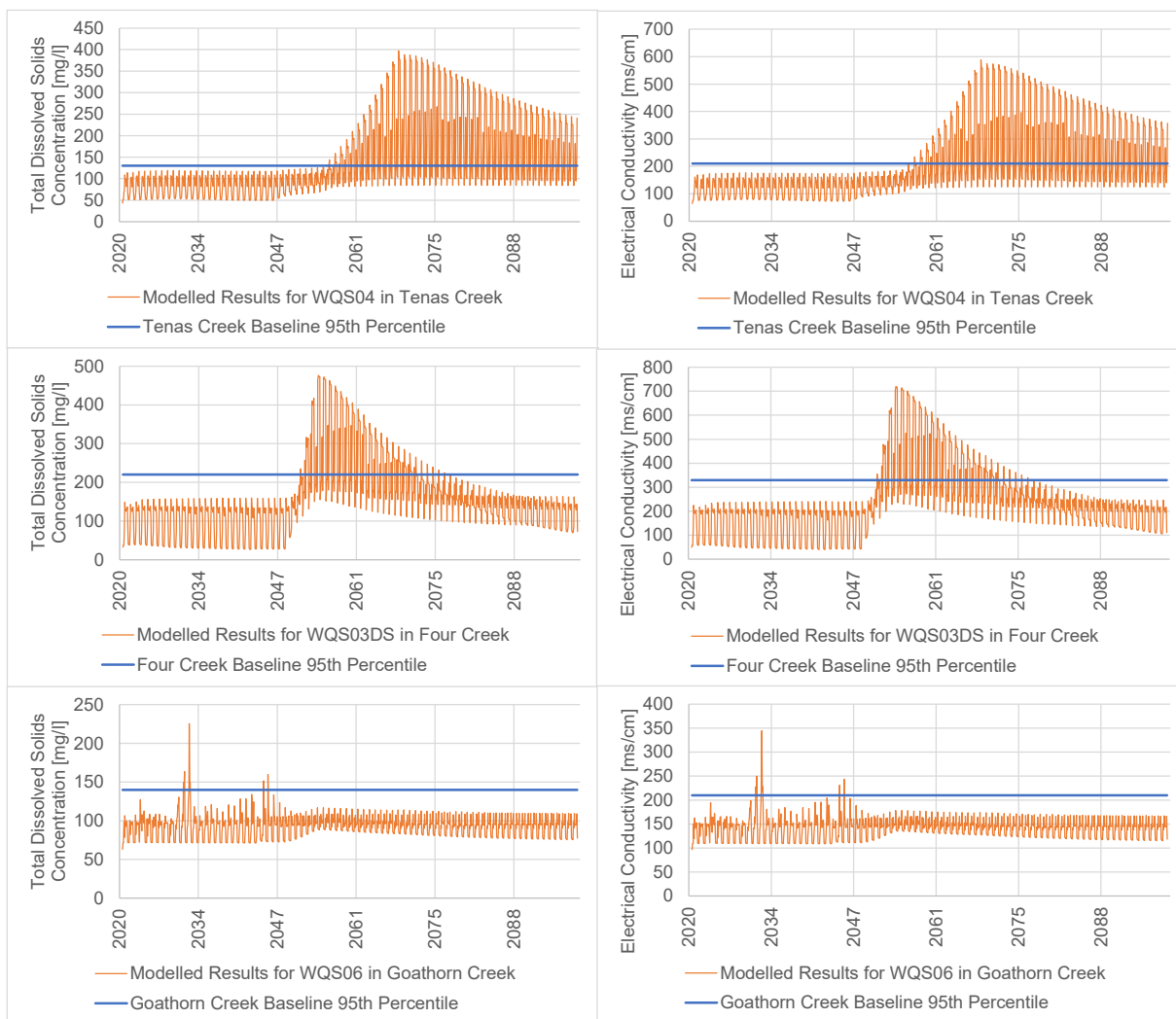


Figure 4-20: Modelled TDS and SC Results for Tenas Creek, Four Creek and Goathorn Creek

PAH

Polycyclic Aromatic Hydrocarbons (PAHs) will be controlled and mitigated through emergency response plans and spill response plans. No change in stream PAH concentrations are expected.

4.4.4 Exceedance Drivers and Mitigation

The sources of total selenium, total cobalt and dissolved cadmium is the runoff and seepage from Non-PAG rock backfill in the open pit, the buttresses, and Management Ponds dams. All Non-PAG areas will be covered with overburden progressively throughout operations and into closure and reclamation. This will limit the long-term loading.

The source of nitrite-nitrogen is the blasting residue released with runoff and seepage from both PAG and Non-PAG rock. The blasting residuals model assumes a fixed percentage of load from the ANFO/Emulsion mixture is released per mass of placed rock. Assumptions are consistent with Best Practice and available literature (Ferguson and Leask 1988) but are expected to be conservative.

5 Summary of Receiving Environment Results

The following sections summarize the model results for the receiving environment Results are discussed by stream (6.1) and in context within the RSA (6.2).

5.1 Summary of Model Results for Streams

5.1.1 Four Creek

Results indicate the following for Four Creek:

- Streamflow is reduced from baseline because the Project footprint occupies a portion of the existing Four Creek catchment.
- During open-water season months, streamflow is increased over baseline by diversions, capturing and diverting upstream runoff to portions of Four Creek.
- During the winter, baseflow is reduced in upstream nodes during winter months from the open pit drawing down the groundwater table.
- Seepage from the Management Ponds may increase the winter baseflow and result in elevated water quality concentrations for constituents of potential concern.

The Project will affect Four Creek. MAD downstream of the C02 channel will increase. MAD will decrease downstream because the project decreases the size of the Four Creek catchment.

Baseline water quality monitoring show that exceedances have occurred in Four Creek for total and dissolved aluminum, total and dissolved iron, and total mercury. After closure, groundwater seepage from the East Management Pond results in exceedances of water quality guidelines and SPOs in the downstream reach of Four Creek (WQS03DS) for the following parameters:

- Exceedances of the total and dissolved aluminum WQG occur in winter and summer during post-closure phase in the Project Case, but results are within the natural variability of baseline monitoring data (i.e. less than the 95th percentile from baseline datasets) and less than the SPO.
- Total selenium WQG is exceeded in both summer and winter months during post-closure by up to 2.9 times. The Tier 1 SPO limit is not exceeded. The long-term winter and summer results in 2100 are below the SPO limit and the guideline.
- The nitrite WQG is exceeded in winter months by up to 1.9 times the guideline with some exceedances in summer months. Results do not exceed the SPO limit in Four Creek.
- The dissolved cadmium WQG is exceeded up to 1.5 times in winter months. No exceedances occur in summer, and no exceedances of the SPO are expected. Long-term average winter and summer results are below the WQG.
- The sulphate WQG is exceeded by up to 1.2 times the limit in winter months during post-closure. Long-term water quality is below the WQG.

Change in water quality in Four Creek was also evaluated for selected additional parameters:

- Stream temperature, TSS and turbidity is expected to remain unchanged, as there will be no Project discharge to this creek. Suspended particles are settled in the management and control ponds, and are expected to be removed during groundwater transport.
- The 95th percentile concentration of TDS and conductivity corresponding to baseline monitoring data is exceeded during post-closure in the Project Case. Long-term average concentrations of these parameters are within the natural variability of baseline monitoring data (i.e., less than 95th percentile baseline concentration).
- No change is expected for in-stream pH, alkalinity and PAH concentration.

High case groundwater seepage rates presented in Alternative Assessment Case 1 could reduce baseflow during winter months at nodes directly downstream of the open pit (WQS20 and 21). High case source terms presented in Alternative Assessment Case 2 could result in additional exceedances during winter and summer for total copper, total cobalt, total manganese, and total thallium. These exceedances are only expected during winter.

The low flow assessment (Case 5) shows that the Project may decrease the 7Q10 in portions of Four Creek. Nitrate, total copper and total manganese concentrations exceed WQG, and total selenium could exceed the Tier 1 SPO under these conditions during winter.

5.1.2 Tenas Creek

Like Four Creek, changes to Tenas Creek streamflow are governed by the following Project interactions:

- Project footprint, which occupies up to 7% of the existing Tenas Creek catchment and reduces the streamflow over baseline conditions in portions of the creek that are downstream of the Project. The change is most apparent during open-water season months when runoff rates govern streamflow.
- Groundwater table drawdown from open pit mining, which will reduce the baseflow contributions to Tenas Creek in nodes adjacent to the open pit by up to 6%.
- Management Pond seepage may be minimized through implementation of liners; however, some seepage is expected to reach Tenas Creek, resulting in net increase in baseflow rates towards the end of mining and into post-closure as well as elevated water quality concentrations for constituents of potential concern.

Streamflow in segments of Tenas Creek will be reduced by less than 10%.

Baseline water quality monitoring shows that exceedances have occurred historically in Tenas Creek for total and dissolved aluminum, total copper, and total iron. Groundwater seepage from the West and North Management Ponds in the post-closure period results in exceedances of WQG and SPOs for the following parameters:

- Exceedances of the total and dissolved aluminum WQG occur only in winter during the post-closure phase in the Project Case, but results are within the natural variability of baseline monitoring data (i.e. less than the 95th percentile from baseline datasets) and less than the SPO.
- The total selenium WQG is exceeded at all three downstream nodes in winter months during post-closure by up to 2 times the guideline. Exceedances in low-flow summer months are also expected. The Tier 1 and 2 SPO limits are not exceeded. The long-term steady-state average winter and summer results are below the guideline.
- The nitrite WQG is exceeded up to 2.3 times the guideline in winter in post-closure. The SPO limit is not exceeded in Tenas Creek and all long-term results are below the guideline.
- The sulphate WQG is exceeded in winter months. Long-term results are below the WQG.

Change in water quality in Tenas Creek was also evaluated for selected additional parameters:

- Stream temperature, TSS and turbidity is expected to remain unchanged, as there will be no Project discharge to this creek. Suspended particles are settled in the management and control ponds, and are expected to be removed during groundwater transport.
- The 95th percentile concentration of TDS and conductivity corresponding to baseline monitoring data is exceeded during post-closure in the Project Case. Long-term average winter concentrations of these parameters remain above the natural variability of baseline monitoring data (i.e., 95th percentile baseline concentration) through 2100.
- No change is expected for in-stream pH, alkalinity and PAH concentration.

High case groundwater seepage rates presented in Alternative Assessment Case 1 could further reduce baseflow during winter at nodes directly downstream of the open pit. The WQG for nitrate, total zinc, dissolved cadmium and total copper will also be exceeded under these conditions. High source terms presented in Alternative Assessment Case 2 could result in additional exceedances during winter and summer for dissolved cadmium, total copper, total manganese, total thallium and total zinc.

The low flow assessment (Case 5) shows that the Project may decrease the 7Q10 in portions of Tenas Creek. Additional exceedances under these conditions were observed during winter for nitrate, fluoride, dissolved cadmium, total copper, total manganese and total zinc.

5.1.3 Goathorn Creek

The Project interacts with Goathorn Creek through surface discharge, open pit mining and Management Pond seepage, however based on the larger catchment area, the change to streamflow is less than in Four Creek and Tenas Creek.

- Groundwater table drawdown from open pit mining will reduce the baseflow contributions in nodes upstream and directly downstream of the open pit. This includes WQS13 and WQS06US. The change relative to baseline is expected to be less than 3%.

- Seepage from Management Ponds counters the drawdown from open pit mining, however an overall reduction in winter baseflow is still expected. Seepage will increase overall water quality concentrations. This does not cause new exceedances in the stream.
- Project discharge from the Tenas Control Pond in operations and the North Management Pond at closure will change streamflow downstream in Goathorn Creek at WQS06 and WQS05. Despite diverting water from Tenas Creek to Goathorn, streamflow is lower in some open water months because of evaporative and seepage losses from the Project facilities. Streamflow increases at closure, when vegetated covers are in-place on Management Ponds. The Tenas Control Pond discharges in May through October. Baseline data indicate freshet usually occurs in April. During operations in April, streamflow at WQS06 decreases. After the Tenas Control Pond is decommissioned, the NMP will discharge by gravity to a tributary of Goathorn Creek, which increases discharge in April after closure.
- Additional withdrawal from Goathorn Creek during operations has been included in model results for up to 2.5% of baseline flows. This water is not used by the Project (i.e., water covers do not depend on this flow rate), and it is included as contingency source only.

Baseline water quality monitoring show exceedances in Goathorn Creek for total and dissolved aluminum, total copper and total iron. Exceedances of water quality guidelines and SPOs are expected to occur for the following parameters, driven by the Project discharge in operations:

- Exceedances of the total aluminum WQG occur in winter and summer during the operation and post-closure phases in the Project Case, but results are within the natural variability of baseline monitoring data (i.e., less than the 95th percentile from baseline datasets) and less than the SPO.
- Exceedances of total iron WQG occur only in summer during the operation phase, but results are within the natural variability of baseline monitoring data (i.e., less than the 95th percentile from baseline datasets) and less than the SPO.

Change in water quality in Goathorn Creek was also evaluated for selected additional parameters:

- Due to Project discharge, maximum increase in stream temperature was estimated to be 0.5 °C during operation and 0.6 °C in post-closure. These changes are within natural variability compared to baseline stream temperature monitoring.
- TSS and turbidity levels are expected to increase due to discharge from Tenas Control Pond, however results are within the natural variability of baseline monitoring data (i.e., less than 95th percentile baseline concentration).
- Maximum TDS and conductivity exceed the 95th percentile concentration corresponding to baseline monitoring data during one month of discharge in the operation phase (August 2032) in the Project Case. This event would be expected to be mitigated through the Tenas Control Pond operations manual. Long-term average concentrations of these parameters are below the 95th percentile baseline value.
- No change is expected for in-stream pH, alkalinity and PAH concentration.

Short term elevated concentrations can be prevented by controlled discharge from the ponds and active monitoring of downstream flow conditions and pond water quality.

High case groundwater seepage rates presented in Alternative Assessment Case 1 do not produce additional exceedances of WQG or SPOs.

High case source terms presented in Alternative Assessment Case 2 could result in additional exceedances of dissolved cadmium, total copper, total manganese, total thallium and total zinc. These exceedances occur in a single month of discharge during operations. No exceedances of SPOs are expected.

An increase in streamflow from consecutive wet years tested in Alternative Assessment Case 4 could result in a net increase of up to 19% in monthly average streamflow at downstream nodes but causes no additional exceedances

5.1.4 Telkwa River

Minor increases in winter flows and decreases in open water season flows could occur during operations at Telkwa River node WQS09, downstream of the confluence with Goathorn Creek. The reduction in open water season flows results from evaporative losses from the Management Ponds and end pit lake. Decreased flow in winter is from less groundwater discharge to the streams. Over time, the water levels in the Management Ponds result in a small (~1%) increase in baseflow conditions (Appendix F, Table F-9).

Baseline water quality exceedances have occurred in Telkwa River for total and dissolved aluminum, total copper, and total iron. Model results show exceedances of the total aluminum WQG in winter and summer during the operation and post-closure phases in the Project Case, with exceedances of the SPO as well. However, the results are less than the natural variability recorded in the baseline monitoring data (i.e. less than the 95th percentile from baseline datasets). Similarly, exceedances of the WQG of total iron are experienced in winter and summer throughout operation and post-closure phases but results are less than the SPO and the 95th percentile from baseline data.

No additional water quality exceedances are expected beyond what has been experienced historically based on Project Case conditions or Alternative Assessment cases.

5.1.5 Bulkley River

The Bulkley River at node WQS11 receives Project discharge from the Rail Infrastructure Sedimentation Pond. The change to MAD is less than a 0.01% increase from the higher runoff coefficient for the stockpile area compared to natural conditions.

WQS12 is located on Bulkley River downstream of the Telkwa River confluence. Changes described for the Telkwa River propagate into the Bulkley River but have a much smaller effect in relation to baseline, with a maximum percent reduction of less than 0.1%.

Baseline water quality monitoring show that exceedances have occurred in the Bulkley River for total and dissolved aluminum, total copper, and total iron. Model results show exceedances of the total aluminum WQG in winter and summer during the operation and post-closure phases in the Project Case. However the results are less than the natural variability recorded in the baseline monitoring data (i.e. less than the 95th percentile from baseline datasets).

No additional water quality exceedances are expected beyond what has been experienced historically. This is consistent for the Project Case as well as the Alternative Assessment cases.

5.2 Summary in Context with Regional Study Area

5.2.1 Change to Streamflow

Table 5-1 and Table 5-2 summarize the change to mean annual discharge and seasonal flow distribution, respectively, with the affected streams' watershed, the LSA and the RSA. Results are based on the Project Case.

The change to mean annual discharge and the seasonal streamflow distribution reflect the area where the annual average flows or the monthly average flows are either reduced by more than 10% or increased by more than 30% relative to pre-mining conditions. The effects are local to Four Creek, however in the case of seasonal flow distribution, the effect propagates further upstream and includes node WQS03.

Table 5-1: Summary of Change to Mean Annual Discharge for Project Case

Stream	Four Creek
Nodes Affected	WQS20, WQS21, WQS03DS
Project Stage	Operation, Post-Closure
Affected Area [km ²]	7.6
Total Stream Area [km ²]	11.0
% of Total Stream Area Affected by Project	69%
% of LSA Affected by Project ⁽¹⁾	3.6%
% of RSA Affected by Project ⁽²⁾	0.5%

Notes:

1. LSA is 208.3 km²
2. RSA is 1430 km²

Table 5-2: Summary of Change to Seasonal Flow Distribution for Project Case

Stream	Four Creek
Nodes Affected	WQS03, WQS20, WQS21, WQS03DS
Project Stage	Operation, Post-Closure
Affected Area [km ²]	11.0
Total Stream Area [km ²]	11.0
% of Total Stream Area Affected by Project	100%
% of LSA Affected by Project ⁽¹⁾	5%
% of RSA Affected by Project ⁽²⁾	0.8%

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Results\Results_Streams_MonthlyChange_07132021_sab.xlsm

Notes:

1. LSA is 208.3 km²
2. RSA is 1430 km²

High flows are expected to be reduced over baseline conditions for all nodes with reduced catchment areas. For the segment of Four Creek with an increase in catchment area, downstream of the diversion channel, an engineering control structure will limit the discharge during extreme events, sending excess water to the East Management Pond. Similarly, the Tenas Control Pond will have the ability to control high flood events by having the capacity to attenuate flows up to the 1 in 10-year flood event. As a result, the change in high flows is expected to be minimal.

Low flows are expected to be reduced in operations along sections of Tenas and Four creeks from the drawdown of the groundwater table around the open pit. Extreme low flows will be similarly affected. The rate of change to low flows is captured in the discussion of winter flow in the seasonal streamflow distribution results (Table 5-2).

5.2.2 Change to Stream Water Quality

Table 5-3 summarizes the change to surface water quality under the Project Case in context within the affected streams' watershed, the LSA and the RSA. The Project Case represents the expected outcomes based on reasonably conservative assumptions and Project characterization. Screening of exceedances is presented in relation to both WQG and SPO limits.

Table 5-3: Summary of Change to Water Quality for Project Case

Stream	Four Creek	Tenas Creek	Total Affected
Nodes Affected	WQS03DS	WQS02, WQS22, WQS04	
Parameters with Exceedances of water quality guidelines⁽¹⁾	Total selenium, nitrite, dissolved cadmium, sulphate	Total selenium, nitrite, sulphate	
Additional Parameter Exceedances⁽²⁾	TDS, EC	TDS, EC	
Parameters with Exceedances of SPOs	-none	-none	
Project Stage	Post-Closure	Post-Closure	
Affected Area [km²]	5.7	23.2	28.9
Total Stream Area [km²]	11.0	70.8	81.9
% of Total Stream Area Affected by Project	52%	33%	35%
% of LSA Affected by Project⁽³⁾	3%	11%	14%
% of RSA Affected by Project⁽⁴⁾	0.4%	1.6%	2.0%

Notes:

1. Exceedances occur for a minimum of 1-month under Project Case
2. Exceedances are in relation to the 95th percentile of baseline monitoring data and occur for a minimum of 1-month under Project Case
3. LSA is 208.3 km²
4. RSA is 1430 km²

6 Conclusions and Recommendations

A water and load balance model has been developed based on Feasibility-level Project characterization, including hydrology, geochemical source terms, groundwater modeling, and the detailed mine plan and associated water management systems. The model produced time series of monthly flows and water quality within the Project infrastructure and in the receiving environment throughout the life of mine to 2100.

Within the Project facilities, the model demonstrates the minimum water cover target of 1.0m within 6 months of PAG rock placement can be maintained in all Management Ponds during operations and post-closure. Temporary water cover reductions may be experienced under extreme dry or highly constrained periods, however sufficient water is expected to be available within other facilities (Tenas Control Pond, other Management Ponds or Goathorn Creek) to manage the water covers and all PAG rock is subsequently covered with 1 m of water within 1-month of placement.

The Project has the potential to interact with receiving environment water quantity and water quality via four primary mechanisms:

- Reduction of natural catchment area, resulting in an equal reduction to streamflow over baseline conditions.
- Change in winter groundwater seepage (baseflow) to streams because of open pit mining (groundwater drawdown) and mounding of groundwater from increased head in Management Ponds and the Tenas Control Pond (increased seepage rates).
- Seepage from Management Ponds, the Tenas Control Pond and the end Pit Lake will have elevated concentrations relative to baseline conditions, resulting in potential exceedances of WQG in the receiving environment for total selenium, dissolved cadmium, nitrite, and total cobalt.
- Project discharge to the downstream environment may result in changes to streamflow and water quality.

Discharging facilities (Rail Infrastructure Sedimentation Pond, Tenas Control Pond and North Management Pond) are expected to meet the proposed end of pipe limits for total selenium (0.076 mg/L) and nitrate-nitrogen (28.4 mg/L) during active discharge periods under Project Case conditions. The high source term case (Alternative Assessment Case 2) may require additional mitigation measures to manage selenium concentrations for short periods of time in the Tenas Control Pond.

Stream results are screened against applicable guidance to evaluate the change resulting from the Project on the environment, which include:

- Whether streamflow is increased by more than 30% or decreased by more than 10% relative to baseline conditions.
- Whether seasonal flow distribution changes.
- Changes to high and low flows.

- Whether stream water quality exceeds relevant water quality guidelines or SPOs when exceedances did not occur historically (within natural variability).

Changes to streamflow are summarized as follows:

- Change in streamflow is expected to occur in Four Creek, from an increase in flow from diversion channels and a reduction in flow from groundwater drawdown and catchment reductions. The change relative to baseline is greater than 10% reduction to mean annual discharge, with higher changes monthly.
- Tenas Creek will experience months, predominantly in April and August, with up to 10% reduction to baseline streamflow, however the change to mean annual discharge is less than 10% throughout operations and closure periods.
- Goathorn Creek flows are expected to be reduced by up to 6% in low flow months in operations, while increasing by up to 8% during freshet. The overall change to mean annual discharge is a reduction of 4% in operations and 1% post-closure.
- Both Telkwa and Bulkley Rivers experience less than 1% change relative to baseline conditions due to the relatively small Project footprint with respect to the total catchment areas of each river.

WQG exceedances are expected for total selenium, nitrite, dissolved cadmium, and sulphate. Exceedances of total aluminum and iron are also expected. The baseline water quality records already show exceedances for these parameters as part of the natural variability of the stream. Therefore, aluminum and iron were not identified as a POPC. SPOs were developed for all POPCs as well as aluminum and thallium. No exceedances of SPOs are expected under the Project Case beyond what has been experienced historically.

Elevated levels of TDS and EC are also expected in Tenas and Four Creek downstream of the Project as a result of seepage from management ponds. Results show levels in excess of the streams' natural variability (i.e. 95th percentile from baseline data) during winter months for a period of 26 years in Four Creek, and throughout the majority of the post-closure period in Tenas Creek (i.e. through 2100).

The change to both stream water quantity and quality were further evaluated in terms of the affected area within the spatial boundaries of the Project, including the local stream watersheds, the LSA and the RSA.

- In terms of water quality, the modelled prediction nodes that experience long-term exceedances of the SPO values for total selenium, sulphate, nitrite and dissolved cadmium include the downstream portions of Tenas and Four creeks, encompassing an area equal to 29 km². This affected area represents approximately 14% of the LSA and 2% of the RSA.
- In terms of water quantity, the modelled prediction nodes that experience a change to mean annual discharge greater than 10% reduction or 30% increase include WQS21, WQS20 and WQ03DS, which encompasses an area equal to 7.6 km². This affected area represents approximately 3.6% of the LSA and 0.5% of the RSA.

The results from this study and report will be used as part of the EA Application.

Recommendations:

- Continue to collect water quality and quantity data throughout project implementation.
- Model to be reviewed and updated as-needed annually with results from monitoring.
- Consider additional strategies to reduce concentrations associated with Management Pond seepage, including selenium, thallium and cadmium. Strategies may include increasing dilution of the water quality in the Management Ponds by enabling a thicker water cover layer or by reducing water diversions around the Management Ponds. This may have an associated effect on change to streamflow, which should also be evaluated.

6.1 Risks and Limitations and Opportunities

Risks and limitations of the model are summarized below based on assumptions and data incorporated into the model:

- The Project area rainfall-runoff model simulates an earlier freshet onset than the Goathorn Creek rainfall-runoff model, based on the median elevation and climate correction factors (Section 3.1.7). The modelled increase over pre-mining conditions during freshet at closure may not be as prominent as the model estimates, since the rock covers will likely remain frozen for a longer period once vegetation is established due to the relatively flat slopes in comparison to the natural topography.
- Rainfall-runoff models are developed based on constant monthly runoff coefficients, calibrated from historical records. Changes to the timing of spring freshet or other annual hydrologic phenomenon which may be expected with climate change projections could result in changes to the monthly runoff rates. These types of effects are not currently captured in the water balance model. Additional climate change -related risks include:
 - Increased occurrence of wildfires which could result in higher runoff during rainfall and snowmelt events (because of reduction of vegetative cover, hydrophobic soils, etc.), and could result in greater sediment loading to the receiving environment(s)
 - Changes in hydrograph seasonality, which could result in shifting low flows to the summer months which coincide with planned discharges and could reduce dilution / assimilation capacity in the receiving environment(s)
 - Altered interactions with natural groundwater system, which could result in reduced baseflow contributions and could reduce dilution/ assimilation capacity in the receiving environment(s) during winter or summer months
- Ongoing collection of hydrometric and meteorological data will be completed through the subsequent Project design phases. The Project climatic records, as well as the calibrated rainfall-runoff models should be revisited based on additional data collected on-site, specifically to improve the characterization of Tenas Creek and Four Creek, which have limited records.
- The water balance for the historic years was calibrated based on measured site data. Any error in this data collection would directly affect the reliability of the model calibration.

- Solubility limits were not universally applied in the model. Consequently, some parameters may precipitate prior to reaching the modelled concentrations.
- The model treated all reservoirs as perfectly mixed containers. This mixing occurred instantaneously at every time step and may not be reflective of actual conditions.
- Groundwater and impacted seepage flows are based on hydrogeologic models which are based on a limited hydrogeologic dataset.
- Uncertainty in MAP and evaporation predictions.
- Additional limitations of input data are discussed in topic-specific reports.

Opportunities:

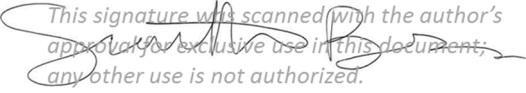
- The primary driver of water quality exceedances in the receiving environment is seepage from Management Ponds and the Tenas Control Pond. The model assumes that 100% of the mass of constituents leaving the Management Ponds via seepage eventually reaches the streams, without any attenuation. Constituents transported through groundwater pathways may be attenuated through dispersion and advection mechanisms, which could ultimately improve the water quality discharging downstream. In addition, the extended period between when seepage leaves the facility and discharges to surface water provides a significant time for intervention or mitigation measures to be employed. Active groundwater monitoring will be incorporated into the monitoring plans to capture the rate and concentrations of migration of the seepage plume.
- Increase efficiency of liners in Management Ponds and the Tenas Control Pond in terms of minimizing seepage rates could be investigated to reduce the amount of load entering the receiving environment via groundwater pathways.
- Active monitoring of pond water quality in tandem with in-stream water quality along with streamflow is expected to enable control of pond discharges to reduce the occurrence of exceedances in Goathorn Creek during operations.
- Employing active water treatment to achieve compliance limits.

Contingencies:

- Organic carbon addition to the covered management ponds post closure to create reducing conditions to decrease selenium mobility.
- Discharging to the Telkwa River instead to Goathorn Creek.
- Active water treatment plant of water collected in management ponds.
- Increasing water stored through low flow period in the summer and discharge more during freshet when dilution capacity is greater.
- Evaluate the construction schedule of the management ponds and potentially build the dams earlier to create additional storage before PAG placement is required.

Closure

This report, Tenas Project – Water and Load Balance Modeling Report, was prepared by


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Senior Consultant

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Tom Sharp, P.Eng
Principal Consultant

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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Appendix A Prediction Node Climate Adjustment Memo

Memo

To:	File	Client:	Telkwa Coal Limited
From:	Camilo Gallard Samantha Barnes	Project No:	1CT027.003
Cc:		Date:	January 12, 2021
Subject:	Prediction Node Streamflow Assessment to Support Water and Load Balance Model		

1 Introduction

An Environmental Assessment (EA) is being completed for the Tenas Project (the “Project”) near Smithers B.C, which includes a water and load balance model to evaluate impacts to downstream creeks and rivers. Prediction nodes included in the model include locations along Tenas Creek, Four Creek, Goathorn Creek, Telkwa River and Bulkley River, as defined in the Tenas Project Water and Load Balance Report (SRK 2021a).

The following memorandum presents the methodology for evaluating streamflow within each watercourse and at each prediction node. Results are incorporated into the water and load balance model to develop water quality and quantity estimates pre- and post-mining.

1.1 Supporting Information

1.1.1 Climate Data

A detailed meteorological analysis was presented in the 2021 Hydrometeorological Baseline and Model Development Report (SRK Consulting, 2021b). The Project climate timeseries described in this work were used as an input for this analysis.

1.1.2 Regional Hydrometric Data

Water Survey of Canada (WSC) is the national authority responsible for the collection, interpretation and dissemination of standardized water resource data in Canada. Four WSC regional stations maintain long term records on streams and locations relevant to the Project as illustrated on Figure 1-1. These stations have more than 10 years of data and catchment areas ranging between 125 km² to 8940 km². Table 1-1 shows a summary of the metadata for these stations.

Table 1-1: Summary of Regional Hydrometric Stations

Station ID	Station Name	Longitude	Latitude	Area (km ²)	First Year	Last Year
08EE008	GOATHORN CREEK NEAR TELKWA	54.65	-127.12	125	1960	2016
08EE020	TELKWA RIVER BELOW TSAI CREEK	54.61	-127.50	367	1975	2018
08EE004	BULKLEY RIVER AT QUICK	54.62	-126.90	7340	1930	2018
08EE005	BULKLEY RIVER NEAR SMITHERS	54.77	-127.13	8940	1945	2018

Source: compiled in text from R code \\srk.ad\dfs\Inal\van\Projects\01_SITES\Telkwa Coal\1CT027.002 2017-18 permitting Support (Phase 2)\0200_SurfaceWater\Hydrology\R files\Flows_update_rev06.Rmd

1.1.3 Project Hydrometric Data

Four hydrometric stations were installed at the Project in 2017.

- Tenas-Hydro was established on Tenas Creek upstream of the confluence with Goathorn.
- Goathorn-Hydro was established on Goathorn Creek upstream of the Goathorn-Tenas confluence.
- Telkwa-Hydro was established on the Telkwa River upstream of the confluence with Goathorn Creek.
- Four-Hydro was established on Four Creek in April 2020, upstream of the confluence with Goathorn Creek.

Table 1-2 summarizes the metadata for these stations, and their location and catchment delineations are shown in Figure 1-1. The Goathorn-Hydro station is located at the same location as the WSC Goathorn station (08EE008).

Table 1-2: Summary of Local Hydrometric Stations

Station Name	Longitude	Latitude	Area (km ²)	Average Catchment Elevation (masl)	Start of Record
Four Hydro	54.62	-127.14	11.0	985	April 2020
Tenas-Hydro	54.62	-127.19	47.4	1181	May 2017
Goathorn-Hydro	54.65	-127.12	121.6	1243	May 2017
Telkwa-Hydro	54.65	-127.17	966.9	1243	May 2017

Source: compiled in text from R code \\srk.ad\dfs\Inal\van\Projects\01_SITES\Telkwa Coal\1CT027.002 2017-18 permitting Support (Phase 2)\0200_SurfaceWater\Hydrology\R files\Flows_update_rev06.Rmd

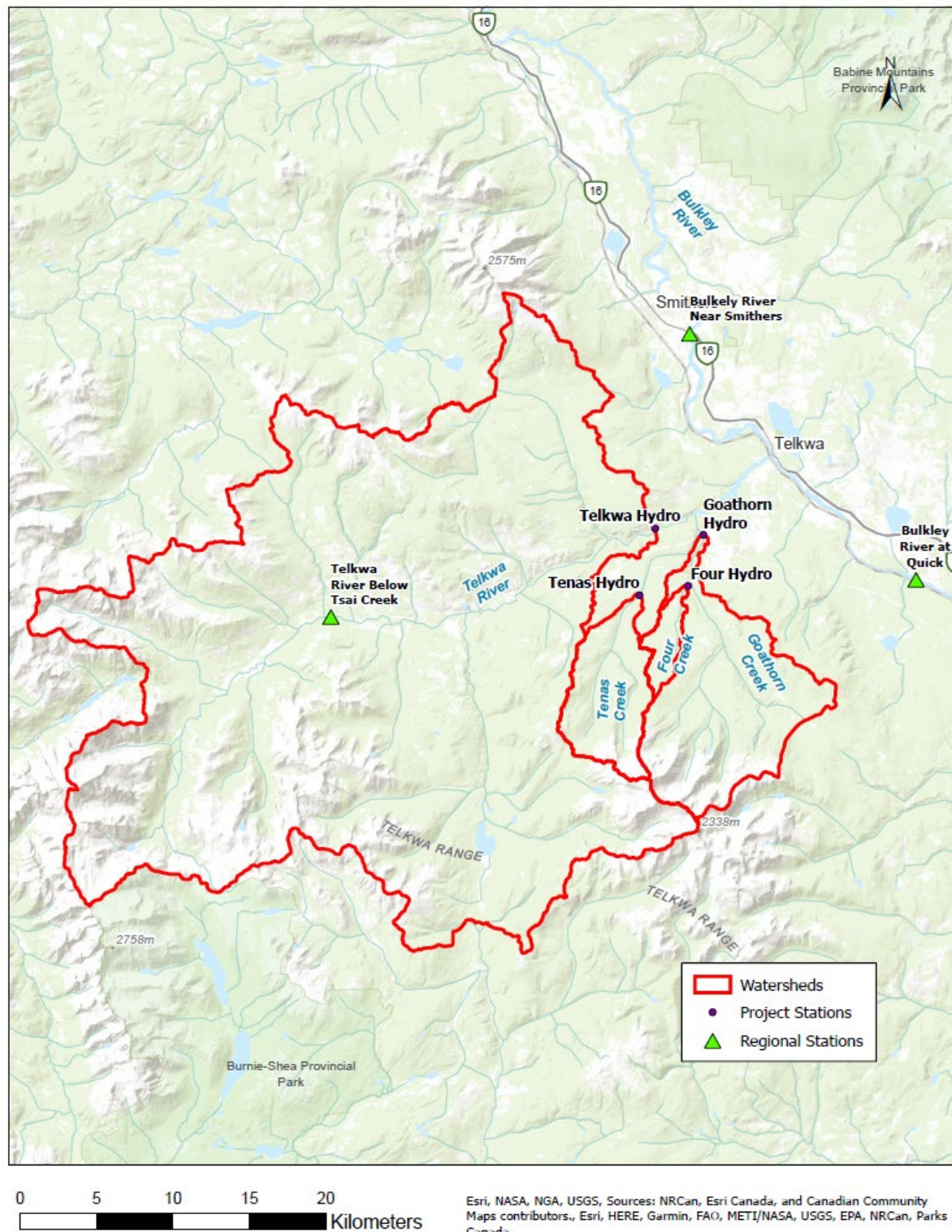


Figure 1-1: Regional and Project Hydrometric Stations

Source: \\srk.ad\dfs\al\van\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\080_Deliverables\Hydromet Baseline Update\040_Figures\Figure3.1_Hydrometric_Stations_20201023.jpg

Project records and regional records were compared and patched together as described in SRK 2021b to provide the long-term flow timeseries that were used in this analysis.

2 Location of Prediction Nodes

A total of 16 in-stream prediction nodes were selected for the water and load balance to evaluate impacts from the Project, including nodes along Tenas Creek, Four Creek, Goathorn Creek, Telkwa River and Bulkley River.

Project infrastructure will result in changes to the catchment area contributing to each prediction node. Table 2-1 summarises the prediction node coordinates, as well as associated catchment area pre- and post-mining. Node locations are presented in Figure 2-1. Figure 2-2 and Figure 2-3, present the catchment area for each node under pre- and post-mining conditions, respectively.

Table 2-1: Receiving Environment Prediction Nodes, from Upstream to Downstream

Prediction Node	Stream and Description	Coordinates NAD 1983 UTM Zone 9N (m)		Total Catchment Area (km ²)	
		Easting	Northing	Pre-mining	Post-mining
WQS01	Tenas Creek, upstream of Project	615,171	6,050,438	40.7	40.7
WQS02	Tenas Creek, adjacent to Project	616,914	6,053,490	47.6	47.0
WQS22	Tenas Creek, upstream of Project discharge (Unnamed Stream below Tenas Pond)	619313	6056222	65.7	61.9
WQS04	Tenas Creek, downstream of Project discharge (Unnamed Stream below Tenas Pond)	620,499	6,057,020	70.8	65.9
WQS03	Four Creek, upstream of Project	619,235	6,049,989	3.3	3.9
WQS21	Four Creek, upstream of East Management Pond	619269	6051446	5.2	4.9
WQS20	Four Creek, downstream of East Management Pond	619344	6052005	5.3	5.0
WQS03DS	Four Creek, downstream of Project, upstream of confluence with Goathorn Creek	620,034	6,054,076	10.9	6.9
WQS13	Goathorn Creek, upstream of Project	620,867	6,049,161	97.9	97.9
WQS06US	Goathorn Creek, upstream of Tenas Creek and Four Creek	620,587	6,053,711	107.1	107.1
WQS06	Goathorn Creek, upstream of Tenas Creek, downstream of Four Creek	621,100	6,057,441	123.5	119.1
WQS05	Goathorn Creek, downstream of Tenas Creek	620,615	6,058,133	195.5	186.2
WQS09	Telkwa River, downstream of Goathorn Creek	621,394	6,058,998	1198.9	1189.6
WQS11	Bulkley River, upstream of Telkwa River, downstream of Rail Load Out Pad	629,601	6,059,221	7175.0	7175.0
WQS12	Bulkley River, downstream of Telkwa River	625,021	6,063,831	8505.8	8496.5
WQS23	Bulkley River, at Smithers	620,102	6,070,765	8609.8	8600.5

Source: Generated in report.

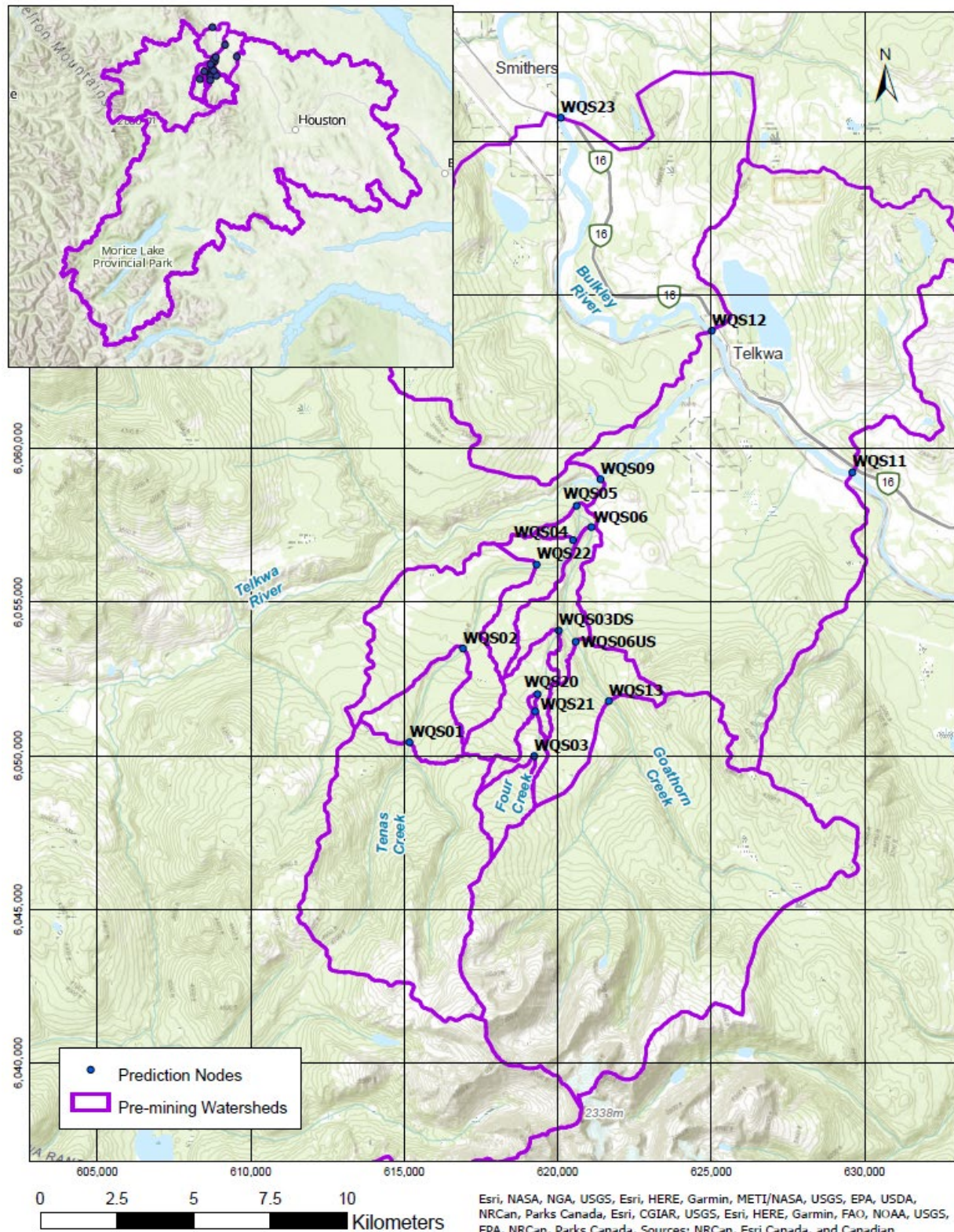


Figure 2-2: Prediction Nodes Catchment Areas Pre-Mining

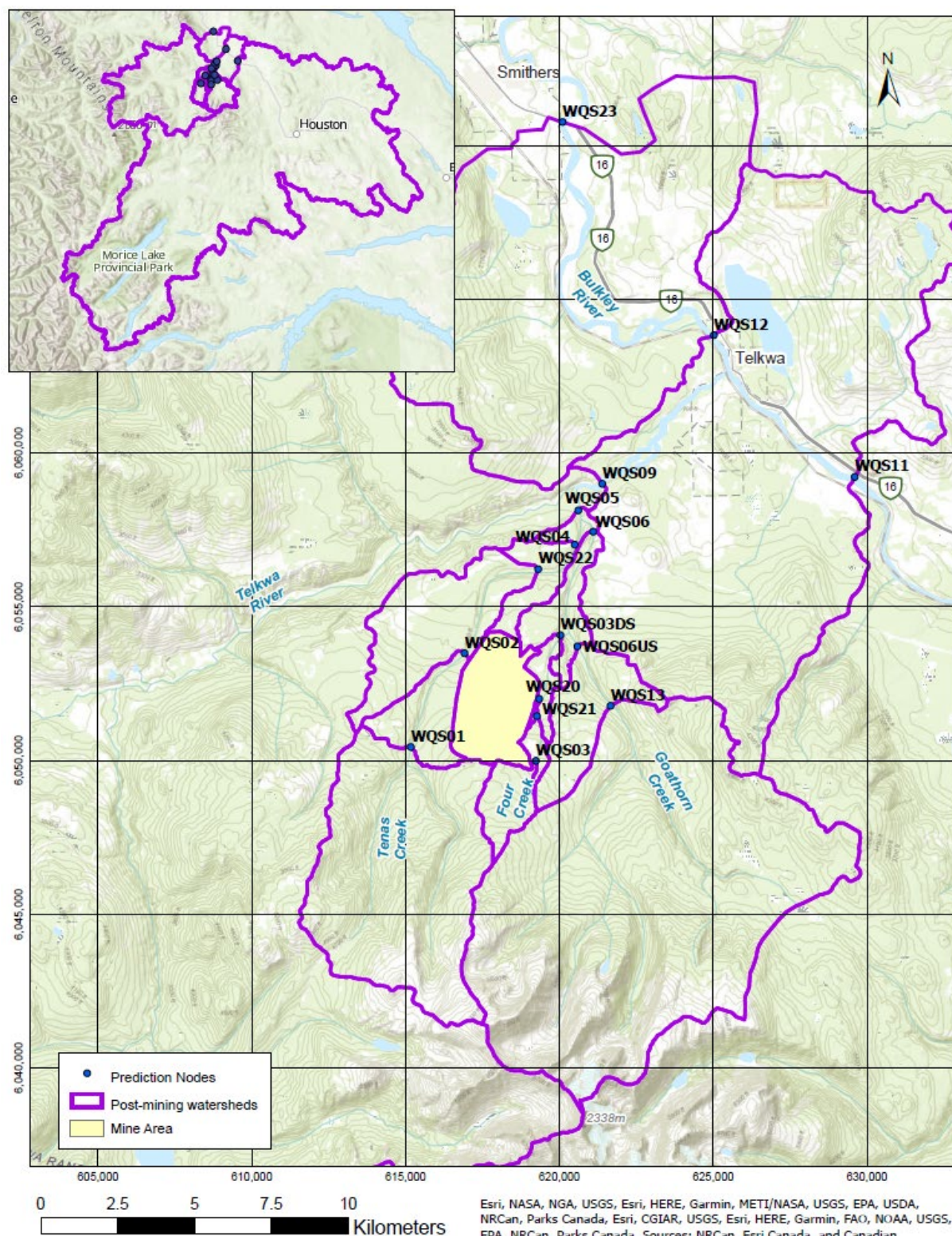


Figure 2-3: Prediction Nodes Catchment Areas Post-Mining

3 Streamflow Methodology

Correction factors were developed to apply the Project climate timeseries (SRK 2021b) for the catchments of Four Creek, Tenas Creek, Goathorn Creek, Telkwa River, and Bulkley River. These corrected climatic datasets, along with extended streamflow time series (SRK 2021b) were used to calibrate monthly runoff coefficients for each stream. Streamflow at each prediction node was then derived from the corresponding watershed climate timeseries and runoff calibration.

3.1 Climate Analysis

3.1.1 Methodology

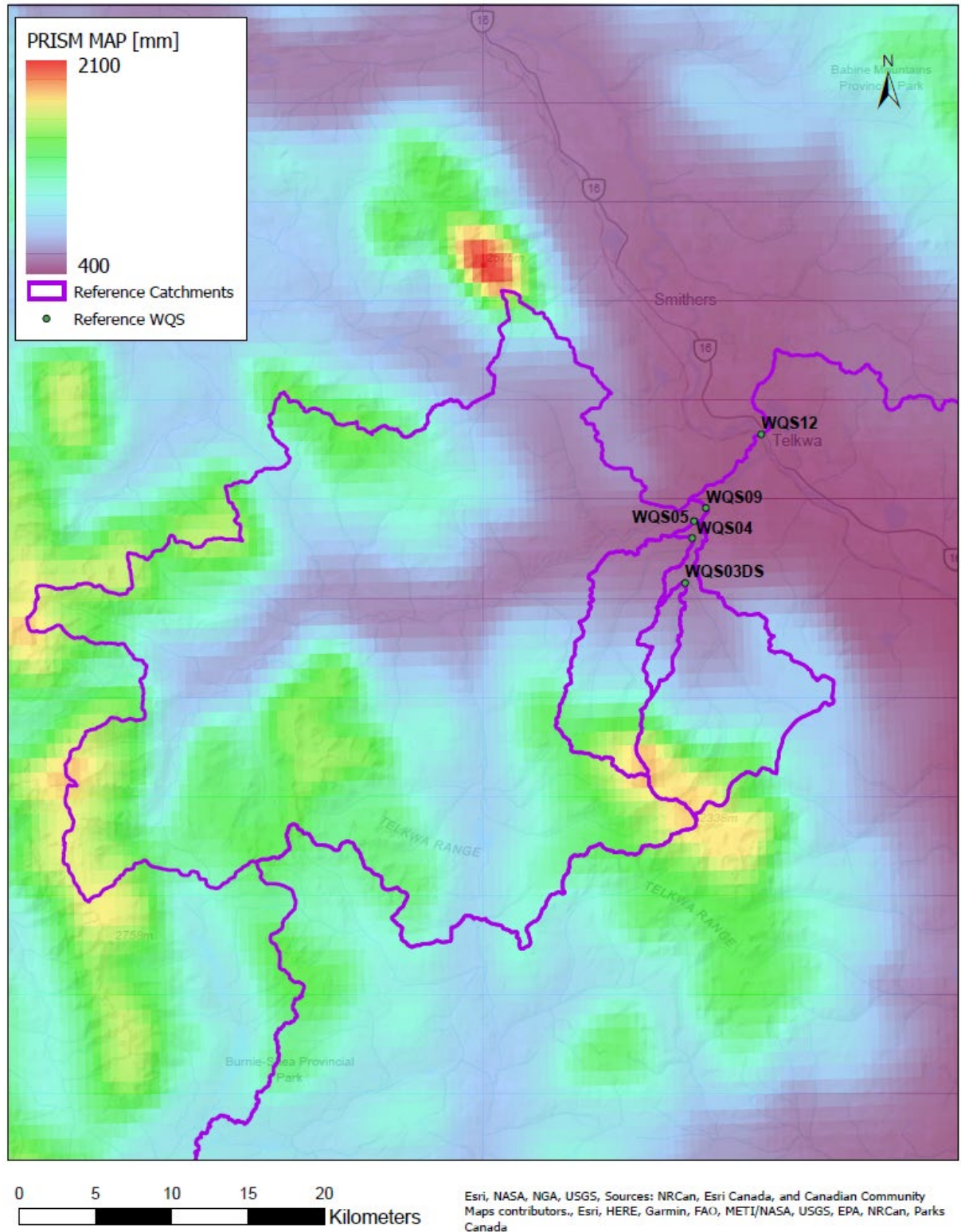
To estimate the average climate conditions for the main Project watersheds accounting for orographic trends, climate correction factors were developed based on the PRISM reanalysis dataset, consistently with SRK 2021b.

PRISM is a climate-elevation regression model, used to generate a reanalysis dataset that provides precipitation and maximum and minimum temperature averages on a monthly timestep for the Pacific Region of Canada and the northwestern USA.

For each stream, a prediction node was selected to define a reference catchment area. PRISM datasets were then averaged over each of these catchments with an iterative raster calculation tool built in ArcGIS Pro (ESRI 2020) to obtain monthly averages for precipitation and temperature parameters for each area. For this analysis:

- Four Creek was represented by WQS03DS catchment area
- Tenas Creek was represented by WQS04 catchment area
- Goathorn Creek was represented by WQS05 catchment area
- Telkwa River was represented by WQS09 catchment area
- Bulkley River was represented by WQS12 catchment area

An illustration of a PRISM dataset and the reference catchments is presented in Figure 3-1.



Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\1040_AutoCAD\1.GIS\Telkwa_PRISMMAP.aprx

Figure 3-1: PRISM Mean Annual Precipitation (MAP) Dataset and Reference WQS and Catchments

The obtained monthly averages were then compared to the reference Project location PRISM results to obtain monthly correction coefficients for each climate parameter.

3.1.2 Climate correction coefficients

Monthly correction coefficients were calculated for the monthly maximum, average and minimum temperatures, as well as precipitation based on the ratio of Project records (SRK 2021b) and the PRISM datasets for each stream. These are presented for each watershed in Table 3-1, Table 3-2, Table 3-3 and Table 3-4 respectively.

Table 3-1: Monthly Precipitation Correction Factors

Month	Four Creek	Tenas Creek	Goathorn Creek	Telkwa River	Bulkley River
Jan	1.30	1.84	1.88	2.06	1.74
Feb	1.19	1.68	1.71	1.89	1.81
Mar	1.42	2.00	2.03	2.29	2.07
Apr	1.39	1.81	1.87	2.05	1.83
May	1.04	1.28	1.26	1.31	1.14
Jun	1.15	1.18	1.23	1.19	1.09
Jul	1.13	1.11	1.16	1.10	1.03
Aug	1.03	1.28	1.28	1.31	1.17
Sep	1.09	1.52	1.53	1.60	1.33
Oct	1.09	1.53	1.56	1.79	1.70
Nov	1.37	1.92	1.94	2.20	1.95
Dec	1.36	1.92	1.96	2.22	1.93

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\PredictionNodes\WQS_Climate_Correction_Coefs_20200420.xlsx

Table 3-2: Monthly Maximum Daily Temperature Correction Addends

Month	Four Creek	Tenas Creek	Goathorn Creek	Telkwa River	Bulkley River
Jan	-0.23	-0.59	-0.67	-0.68	-0.20
Feb	-0.53	-1.32	-1.50	-1.69	-0.81
Mar	-0.71	-1.83	-2.20	-2.37	-1.08
Apr	-1.00	-2.20	-2.67	-2.85	-1.49
May	-1.25	-2.52	-2.93	-3.38	-1.76
Jun	-1.00	-2.38	-2.73	-3.32	-1.64
Jul	-0.97	-2.31	-2.65	-3.18	-1.48
Aug	-0.87	-2.19	-2.53	-3.01	-1.30
Sep	-0.72	-1.89	-2.23	-2.58	-0.86
Oct	-0.82	-1.75	-2.10	-2.32	-0.95
Nov	-0.40	-1.23	-1.39	-1.54	-0.57
Dec	-0.23	-0.67	-0.73	-0.85	-0.35

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\PredictionNodes\WQS_Climate_Correction_Coefs_20200420.xlsx

Table 3-3: Monthly Average Daily Temperature Correction Addends

Month	Four Creek	Tenas Creek	Goathorn Creek	Telkwa River	Bulkley River
Jan	-0.24	-0.45	-0.52	-0.45	-0.27
Feb	-0.37	-0.88	-0.98	-1.03	-0.73
Mar	-0.43	-1.27	-1.54	-1.66	-0.93
Apr	-0.68	-1.64	-1.96	-2.13	-1.19
May	-0.78	-1.74	-2.03	-2.29	-1.26
Jun	-0.74	-1.81	-2.06	-2.46	-1.38
Jul	-0.80	-1.77	-2.00	-2.33	-1.24
Aug	-0.51	-1.48	-1.71	-2.00	-0.92
Sep	-0.43	-1.28	-1.51	-1.73	-0.70
Oct	-0.55	-1.17	-1.46	-1.50	-0.58
Nov	-0.30	-0.93	-1.08	-1.16	-0.43
Dec	-0.04	-0.32	-0.36	-0.37	-0.15

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\PredictionNodes\WQS_Climate_Correction_Coefs_20200420.xlsx

Table 3-4: Monthly Minimum Daily Temperature Correction Addends

Month	Four Creek	Tenas Creek	Goathorn Creek	Telkwa River	Bulkley River
Jan	-0.26	-0.32	-0.37	-0.22	-0.34
Feb	-0.20	-0.44	-0.47	-0.37	-0.65
Mar	-0.14	-0.70	-0.89	-0.94	-0.78
Apr	-0.37	-1.07	-1.25	-1.41	-0.88
May	-0.30	-0.96	-1.12	-1.20	-0.75
Jun	-0.47	-1.23	-1.38	-1.58	-1.12
Jul	-0.63	-1.23	-1.35	-1.48	-1.00
Aug	-0.14	-0.77	-0.88	-0.99	-0.55
Sep	-0.14	-0.67	-0.78	-0.87	-0.54
Oct	-0.27	-0.58	-0.82	-0.66	-0.21
Nov	-0.19	-0.63	-0.78	-0.77	-0.30
Dec	0.16	0.03	0.01	0.10	0.04

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\PredictionNodes\WQS_Climate_Correction_Coefs_20200420.xlsx

3.2 Runoff model

3.2.1 Methodology

Surface runoff is defined as the total amount of surface water discharged from a watershed and is frequently presented as the depth of water distributed evenly throughout the watershed area.

A daily rainfall-runoff model was generated to support streamflow estimations and to provide Project-specific runoff rates. The runoff model for the Project Area was developed using a

snowmelt model, a minimum baseflow function, a lag time, recession coefficient and monthly runoff coefficients for each of the main catchments. Monthly runoff coefficients were calibrated automatically within GoldSim by optimizing the Nash Sutcliffe Efficiency, based on the difference between observed and modelled daily flow. Observed flows, in this case, were the extended records for each of the local hydrometric stations, described in Section 1.1.3. The calibration is described in SRK 2021b.

Precipitation was converted to runoff using a two-step process. The first step converts precipitation to either rainfall or snowfall using the SNOW-17 snow accumulation and ablation model described in SRK 2021b. The output from the snowmelt model is a daily effective precipitation value, representing the sum of rainfall and snowmelt available for runoff.

The second step uses a function from the Snowmelt Runoff Model (SRM), a program and methodology designed to simulate and forecast daily streamflow in mountain basins (J. Martinec, 2008). Each day, water produced from snowmelt and rainfall is superimposed on the calculated recession flow and transformed into a daily discharge from the basin. The discharge is calculated as the minimum of baseflow or runoff from snowmelt and rainfall, according to Equation 1:

$$Q_{n+1} = \text{minimum of} \left\{ \begin{array}{l} C \times P_{eff} \times \frac{A \times 10,000}{86,400} \times (1 - k_{n+1}) + Q_n \times k_{n+1} \\ B \times A \end{array} \right. \quad \text{Eq [1]}$$

- Where:
- Q = average daily discharge [m^3/s]
 - C = monthly runoff coefficient expressing losses as a ratio (runoff/precipitation)
 - P_{eff} = Effective precipitation as the sum of snowmelt and rainfall
 - A = area of the basin [km^2]
 - k = recession coefficient indicating the decline of discharge in a period without snowmelt or rainfall, $k = \frac{Q_{m+1}}{Q_m}$ where $m, m+1$ are the sequence of days during a true recession flow period
 - n = sequence of days during the discharge computation period, also referred to as the lag time.
 - B = unit baseflow [m^3/s]

Calibration of recession coefficients, k , monthly runoff coefficients, C , and unit baseflow, B , were developed in GoldSim by optimizing the Nash Sutcliffe Efficiency based on the difference between observed and modelled daily discharge. A separate calibration model was prepared for Four Creek, Goathorn Creek, Telkwa River, Bulkley River, and Tenas Creek.

Long term daily flow records at each prediction node were calculated based on corresponding hydrometric station synthetic flow records, minimum unit baseflow values (SRK 2021b), n values and Equation (1).

3.2.2 Rainfall-Runoff Model Inputs

Table 3-3 presents the rainfall-runoff model parameters calibrated for each stream, also presented in SRK 2021b.

Table 3-5: Rainfall-Runoff Model Inputs

Location		Goathorn	Telkwa	Tenas	Bulkley	Four	Project
Minimum Unit Baseflow [L/s/km ²]		1.8	4.1	0.43	3.0	0.3	1.1
Lag Time [days]		1	1	1	1	1	1
Recession		0.9	0.92	0.91	0.96	0.90	0.905
Runoff Coefficient	January	1	1	1	1	1	1
	February	1	1	1	1	1	1
	March	1	1	1	1	1	1
	April	0.42	1	0.45	0.76	0.5	0.43
	May	0.27	0.83	0.32	0.50	0.01	0.30
	June	0.20	0.38	0.17	0.36	0.1	0.18
	July	0.46	0.59	0.09	0.88	0.05	0.28
	August	0.33	0.74	0.03	0.22	0.05	0.18
	September	0.29	0.54	0.19	0.48	0.08	0.24
	October	0.29	0.69	0.28	0.47	0.03	0.28
	November	0.56	0.5	0.88	0.81	0.9	0.72
	December	1	1	1	1	0.4	1

Source: \\srk.ad\dfs\in\van\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Model\RunoffCalibration\Project_RunoffModel.gsm

Parameters were assigned to each node as follows:

- Tenas Creek runoff coefficients were applied to all Tenas Creek nodes including WQS01, WQS02, WS22, WQS04, as well as nodes on Four Creek, due to a lack of continuous Four Creek flow data at this time of the study, including WQS03, WQS21, WQS20, WQS03DS.
- Goathorn Creek runoff coefficients were applied to all Goathorn nodes including WQS13, WQS06US, WQS06, WQS05.
- Telkwa River runoff coefficients were applied to WQS09.
- Bulkley River runoff coefficients were applied to WQS11, WQS12 and WQS23.

4 Summary

The water and load balance model, developed in support of the Telkwa Project EA, uses a daily precipitation and temperature record generated for the Project (SRK 2021b) to simulate water volumes within the Project facilities and in the receiving environment. In order to account for the range in topography, from the Telkwa River valley to the upper reaches of the Goathorn and Tenas Creek watersheds, correction factors are required to account for orographic gradients of temperature and precipitation. These correction factors were established based on a published climate-elevation regression model (PRISM), that provides precipitation and maximum and minimum temperature averages on a monthly timestep for the Pacific Region of Canada and the northwestern USA.

Monthly climate correction factors were developed for each of the five watercourses surrounding the Telkwa Project, including Four Creek, Tenas Creek, Goathorn Creek, Telkwa River and Bulkley River, based on the Project-specific records for daily maximum and minimum temperature, and daily precipitation. A calibrated rainfall-runoff model was developed for each stream using the adjusted climate parameters and a series of other runoff-related constants, as described in SRK 2021b. The model allows for estimation of streamflow based on precipitation and temperature inputs for the Project.

Note that based on the methodology applied, the low flow conditions are governed by a constant baseflow value which was selected to match the average low flow in summer and winter months. Extreme low flow conditions, such as the 7-day low flow event for a range of return periods, cannot be directly estimated from this method. Extreme low flows are calculated externally from this modeling approach and are presented in SRK 2021b and utilized in water balance modeling.

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The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

5 References

[ESRI 2020] ArcGIS Pro 2.6.0 Copyright ©2020, Esri Inc. <https://www.esri.com/en-us/arcgis/products/arcgis-pro/overview>

[Martinec *et al*] J. Martinec, A. Rango, R. Roberts, 2008. Snowmelt Runoff Model (SRM) User's Manual. Version 1.11. USDA Jornada Experimental Range, New Mexico State University.

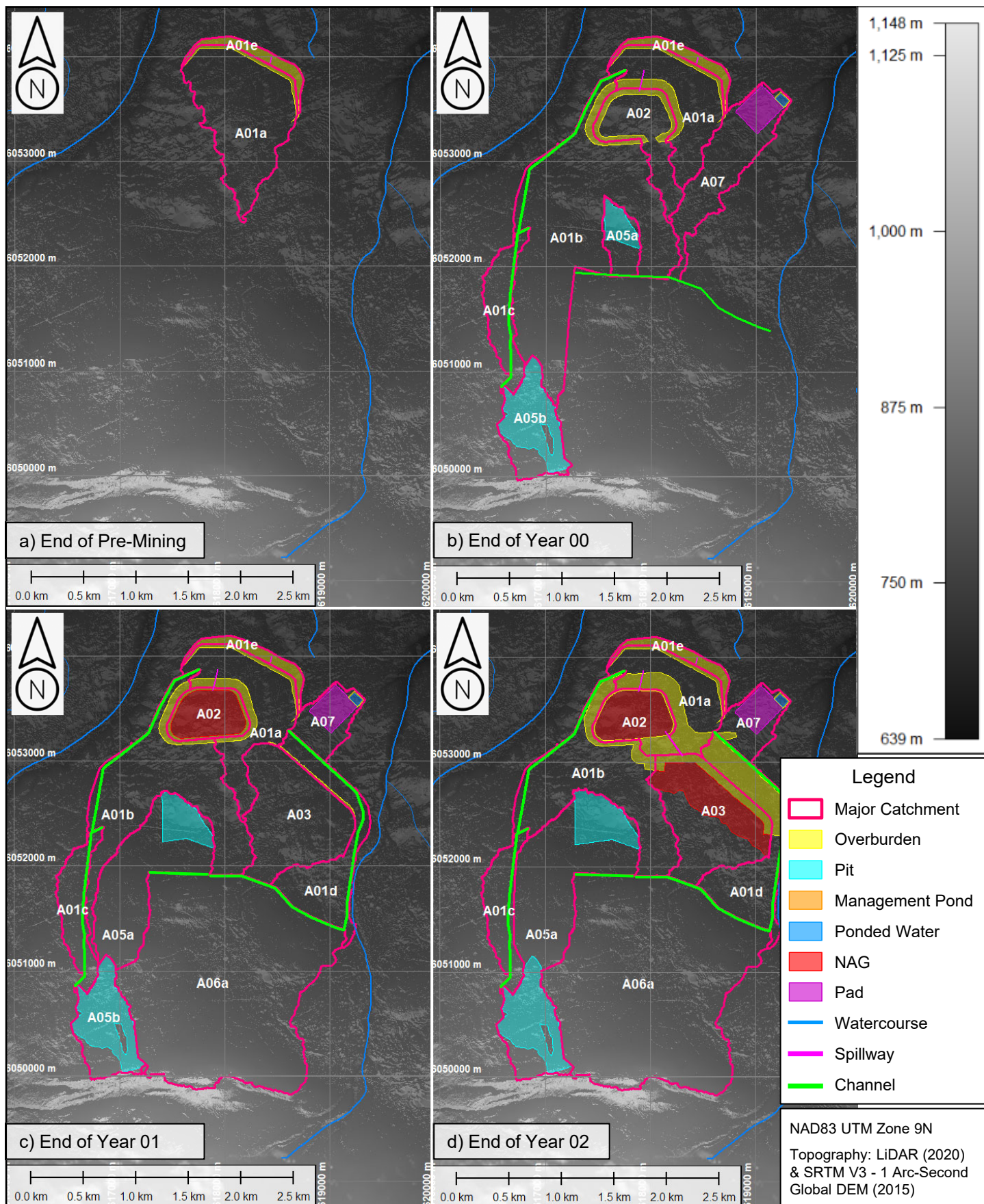
[Obedkoff *et al*] C. H. Coulson & W. Obedkoff, 1998. British Columbia Streamflow Inventory. Province of British Columbia, Ministry of Environment Lands and Parks.

[PCIC 2020] Pacific Climate Impacts Consortium. "Data Portal." Accessed: 20 March 2020. URL: www.pacificclimate.org/data

[SRK 2021a] Tenas Project Water and Load Balance Report. SRK, 2021. Prepared for Telkwa Coal Limited. Vancouver BC

[SRK 2021b] Tenas Project Hydrometeorological Baseline and Model Development Report. SRK, 2021. Prepared for Telkwa Coal Limited. Vancouver BC

Appendix B Catchment Area Summaries



Water Management Design

Major Catchments

End of Pre-Mining to End of Year 02

Job No: 1CT027.003

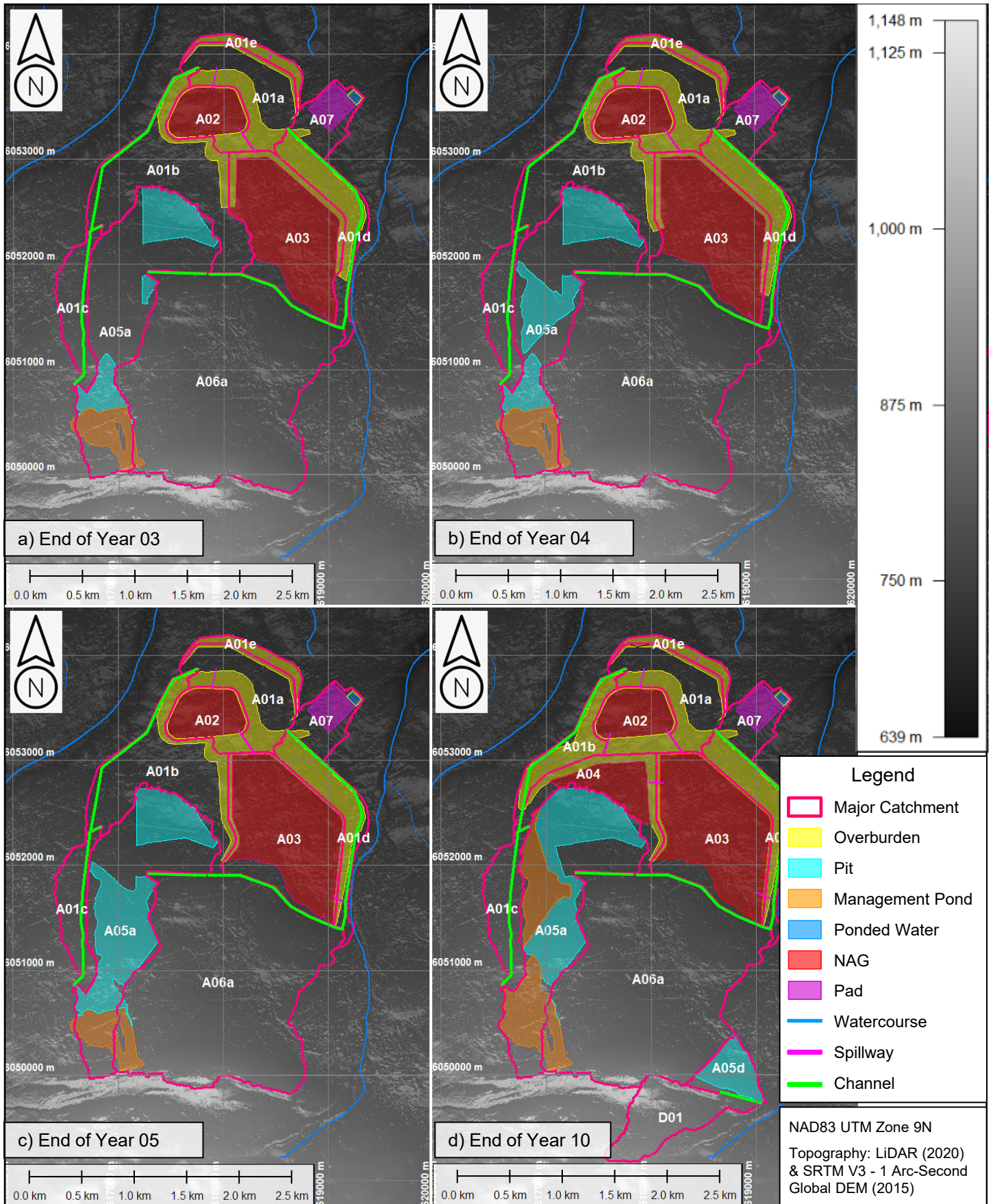
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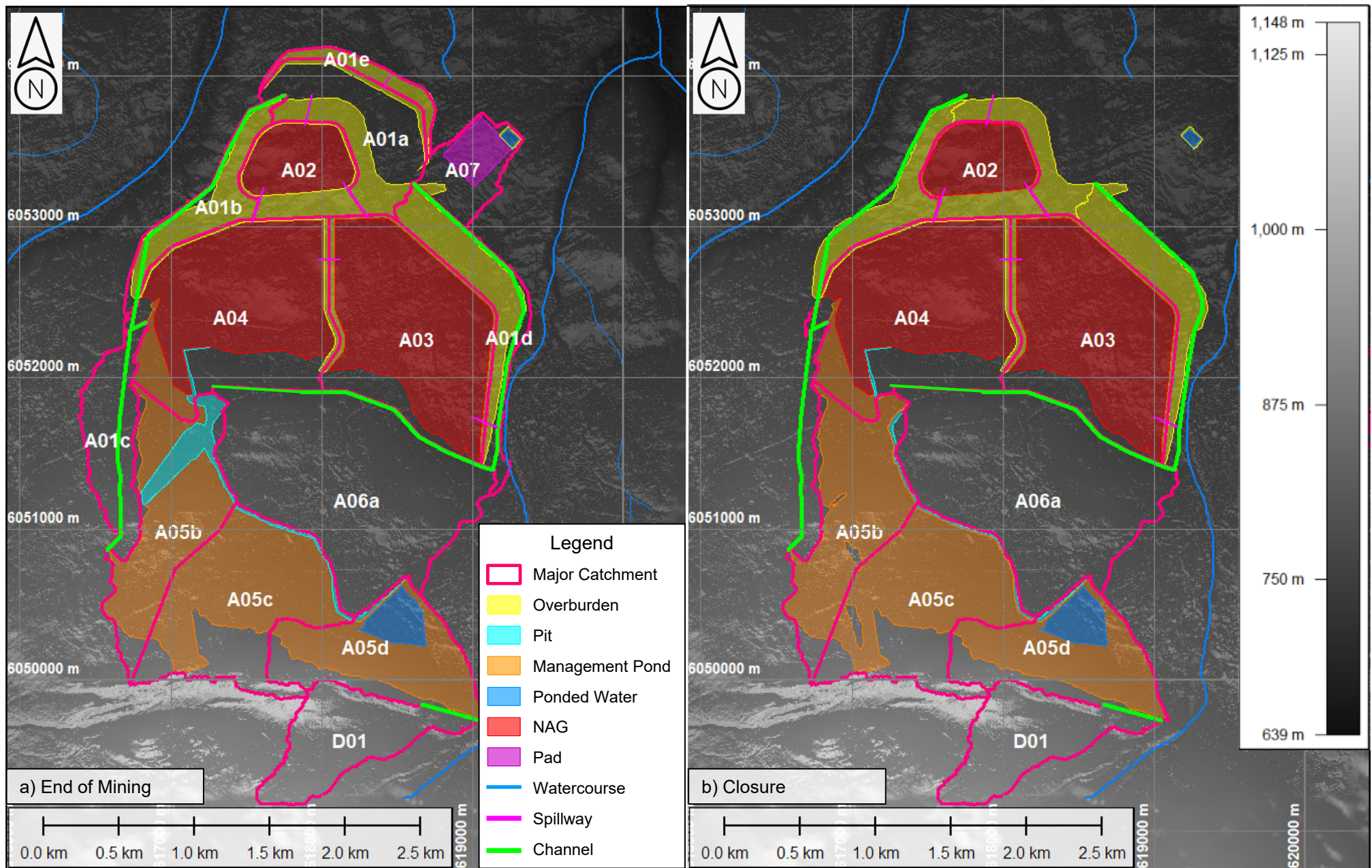
Tenas Project – EA Water Management

Date:
July 2021

Approved:
SAB

Figure:
B-1





Datum: NAD83 UTM Zone 9N

Topography: LiDAR (2020) & SRTM V3 - 1 Arc-Second
Global DEM (2015)

srk consulting

Job No: 1CT027.003

Filename: Telkwa_WMCatchments_1CT027-003_rev00_nf.pptx

TELKWA COAL
LIMITED

Tenas Project – EA Water Management

Water Management Design

Major Catchments
End of Mining and Closure

Date:
July 2021

Approved:
SAB

Figure: **B-3**

Table B 1: A01a (Tenas Control Pond) Sub-Catchment Summary through the LOM

Area	Phase	Start Date	Major Catchment Area (km ²)	Sub-Catchment Area (km ²)						
				Natural	Overburden	Pit	Non-Acid Generating Rock	Management Pond	Ponded Water	Pad
A01a	Start	2021-01-01	0	0	0	0	0	0	0	0
	EOPM	2021-12-31	1	0.99	0.049	0	0	0	0	0
	EOY0	2022-12-31	0.67	0.54	0.13	0	0	0	0	0
	Y1	2023-03-01	0.74	0.59	0.14	0	0	0	0	0
	EOY1	2023-12-31	0.74	0.59	0.14	0	0	0	0	0
	EOY2	2024-12-31	0.59	0.33	0.25	0	0	0	0	0
	EOY3	2025-12-31	0.59	0.33	0.25	0	0	0	0	0
	EOY4	2026-12-31	0.59	0.33	0.25	0	0	0	0	0
	EOY5	2027-12-31	0.59	0.33	0.25	0	0	0	0	0
	EOY10	2032-12-31	0.59	0.33	0.25	0	0	0	0	0
	EOM	2043-12-31	0.59	0.33	0.25	0	0	0	0	0
	SOC	2044-01-01	0	0	0	0	0	0	0	0
	Closure	2100-01-01	0	0	0	0	0	0	0	0

Sources: \\srk.ad\dfs\anal\van\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Catchments\Telkwa_WM\Catchments_1CT027-003_rev10_sab_nf.xlsx

Table B 2: A01b (Channel C03 South to Tenas Control Pond) Sub-Catchment Summary through the LOM

Area	Phase	Start Date	Major Catchment Area (km ²)	Sub-Catchment Area (km ²)						
				Natural	Overburden	Pit	Non-Acid Generating Rock	Management Pond	Ponded Water	Pad
A01b	Start	2021-01-01	0	0	0	0	0	0	0	0
	EOPM	2021-12-31	0	0	0	0	0	0	0	0
	EOY0	2022-12-31	2.7	2.7	0.065	0	0	0	0	0
	EOY1	2023-12-31	1.3	1.2	0.065	0	0	0	0	0
	EOY2	2024-12-31	1.1	1	0.12	0	0	0	0	0
	EOY3	2025-12-31	1.1	0.92	0.15	0	0	0	0	0
	EOY4	2026-12-31	0.98	0.81	0.17	0	0	0	0	0
	EOY5	2027-12-31	0.97	0.8	0.18	0	0	0	0	0
	EOY7	2029-12-31	0.3	0.051	0.25	0	0	0	0	0
	EOY10	2032-12-31	0.3	0.051	0.25	0	0	0	0	0
	EOM	2043-12-31	0.3	0.051	0.25	0	0	0	0	0
	SOC	2044-01-01	0	0	0	0	0	0	0	0
	Closure	2100-01-01	0	0	0	0	0	0	0	0

Sources: \\srk.ad\dfs\na\van\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Catchments\Telkwa_WM\Catchments_1CT027-003_rev10_sab_nf.xlsx

Table B 3: A01c (Channel C03 North to Tenas Control Pond) Sub-Catchment Summary through the LOM

Area	Phase	Start Date	Major Catchment Area (km ²)	Sub-Catchment Area (km ²)						
				Natural	Overburden	Pit	Non-Acid Generating Rock	Management Pond	Ponded Water	Pad
A01c	Start	2021-01-01	0	0	0	0	0	0	0	0
	EOPM	2021-12-31	0	0	0	0	0	0	0	0
	EOY0	2022-12-31	0.33	0.33	0	0	0	0	0	0
	EOY1	2023-12-31	0.33	0.33	0	0	0	0	0	0
	EOY2	2024-12-31	0.34	0.34	0	0	0	0	0	0
	EOY3	2025-12-31	0.34	0.34	0	0	0	0	0	0
	EOY4	2026-12-31	0.34	0.34	0	0	0	0	0	0
	EOY5	2027-12-31	0.34	0.34	0	0	0	0	0	0
	EOY10	2032-12-31	0.4	0.4	0	0	0	0	0	0
	EOM	2043-12-31	0.4	0.4	0	0	0	0	0	0
	SOC	2044-01-01	0	0	0	0	0	0	0	0
	Closure	2100-01-01	0	0	0	0	0	0	0	0

Sources: \\srk.ad\dfs\Inal\van\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Catchments\Telkwa_WM\Catchments_1CT027-003_rev10_sab_nf.xlsx

Table B 4: A01d (Channel C01 to Tenas Control Pond) Sub-Catchment Summary through the LOM

Area	Phase	Start Date	Major Catchment Area (km ²)	Sub-Catchment Area (km ²)						
				Natural	Overburden	Pit	Non-Acid Generating Rock	Management Pond	Ponded Water	Pad
A01d	Start	2021-01-01	0	0	0	0	0	0	0	0
	EOPM	2021-12-31	0	0	0	0	0	0	0	0
	EOY0	2022-12-31	0	0	0	0	0	0	0	0
	Y1	2023-03-01	0.6	0.58	0.018	0	0	0	0	0
	EOY1	2023-12-31	0.6	0.58	0.018	0	0	0	0	0
	EOY2	2024-12-31	0.7	0.43	0.27	0	0	0	0	0
	EOY3	2025-12-31	0.44	0.14	0.3	0	0	0	0	0
	EOY4	2026-12-31	0.43	0.12	0.31	0	0	0	0	0
	EOY5	2027-12-31	0.43	0.11	0.32	0	0	0	0	0
	EOY10	2032-12-31	0.43	0.11	0.32	0	0	0	0	0
	EOM	2043-12-31	0.43	0.11	0.32	0	0	0	0	0
	SOC	2044-01-01	0	0	0	0	0	0	0	0
	Closure	2100-01-01	0	0	0	0	0	0	0	0

Sources: \\srk.ad\dfs\na\van\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Catchments\Telkwa_WM\Catchments_1CT027-003_rev10_sab_nf.xlsx

Table B 5: A02 (North Management Pond) Sub-Catchment Summary through the LOM

Area	Phase	Start Date	Major Catchment Area (km ²)	Sub-Catchment Area (km ²)						
				Natural	Overburden	Pit	Non-Acid Generating Rock	Management Pond	Ponded Water	Pad
A02	Start	2021-01-01	0	0	0	0	0	0	0	0
	EOPM	2021-12-31	0	0	0	0	0	0	0	0
	EOY0	2022-12-31	0.48	0.38	0.1	0	0	0	0	0
	EOY1	2023-12-31	0.32	0	0.06	0	0	0.26	0	0
	EOY2	2024-12-31	0.38	0	0.086	0	0	0.29	0	0
	EOY3	2025-12-31	0.38	0	0.086	0	0	0.29	0	0
	EOY4	2026-12-31	0.38	0	0.086	0	0	0.29	0	0
	EOY5	2027-12-31	0.38	0	0.086	0	0	0.29	0	0
	EOY10	2032-12-31	0.43	0	0.14	0	0	0.29	0	0
	EOM	2043-12-31	0.43	0	0.14	0	0	0.29	0	0
	SOC	2044-01-01	0.43	0	0.14	0	0	0.29	0	0
	Closure	2100-01-01	0.43	0	0.14	0	0	0.29	0	0

Sources: \\srk.ad\dfs\Inalvan\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Catchments\Telkwa_WM\Catchments_1CT027-003_rev10_sab_nf.xlsx

Table B 6: A03 (East Management Pond) Sub-Catchment Summary through the LOM

Area	Phase	Start Date	Major Catchment Area (km ²)	Sub-Catchment Area (km ²)						
				Natural	Overburden	Pit	Non-Acid Generating Rock	Management Pond	Ponded Water	Pad
A03	Start	2021-01-01	0	0	0	0	0	0	0	0
	EOPM	2021-12-31	0	0	0	0	0	0	0	0
	EOY0	2022-12-31	0	0	0	0	0	0	0	0
	Y1	2023-03-01	0.92	0.92	0	0	0	0	0	0
	EOY1	2023-12-31	0.92	0.92	0	0	0	0	0	0
	EOY2	2024-12-31	0.91	0.43	0.12	0	0	0.35	0	0
	EOY3	2025-12-31	1.2	0.099	0.14	0	0	0.94	0	0
	EOY4	2026-12-31	1.3	0.14	0.14	0	0	1	0	0
	EOY5	2027-12-31	1.3	0.13	0.096	0	0	1.1	0	0
	EOY10	2032-12-31	1.3	0.13	0.096	0	0	1.1	0	0
	EOM	2043-12-31	1.3	0.13	0.096	0	0	1.1	0	0
	SOC	2044-01-01	1.3	0.13	0.096	0	0	1.1	0	0
	Closure	2100-01-01	1.3	0.13	0.096	0	0	1.1	0	0

Sources: \\srk.ad\dfs\na\van\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Catchments\Telkwa_WM\Catchments_1CT027-003_rev10_sab_nf.xlsx

Table B 7: A04 (West Management Pond) Sub-Catchment Summary through the LOM

Area	Phase	Start Date	Major Catchment Area (km ²)	Sub-Catchment Area (km ²)						
				Natural	Overburden	Pit	Non-Acid Generating Rock	Management Pond	Ponded Water	Pad
A04	Start	2021-01-01	0	0	0	0	0	0	0	0
	EOPM	2021-12-31	0	0	0	0	0	0	0	0
	EOY0	2022-12-31	0	0	0	0	0	0	0	0
	EOY1	2023-12-31	0	0	0	0	0	0	0	0
	EOY2	2024-12-31	0	0	0	0	0	0	0	0
	EOY3	2025-12-31	0	0	0	0	0	0	0	0
	EOY4	2026-12-31	0	0	0	0	0	0	0	0
	EOY5	2027-12-31	0	0	0	0	0	0	0	0
	EOY7	2029-12-31	0.56	0.12	0.17	0	0	0.27	0	0
	EOY10	2032-12-31	0.56	0.12	0.17	0	0	0.27	0	0
	EOM	2043-12-31	1.4	0.25	0.058	0.0099	0.12	0.95	0	0
	SOC	2044-01-01	1.4	0.25	0.058	0.0067	0.12	0.95	0	0
	Closure	2100-01-01	1.4	0.25	0.058	0.0067	0.12	0.95	0	0

Sources: \\srk.ad\dfs\na\van\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Catchments\Telkwa_WM\Catchments_1CT027-003_rev10_sab_nf.xlsx

Table B 8: A05a (Pit Backfill Area North) Sub-Catchment Summary through the LOM

Area	Phase	Start Date	Major Catchment Area (km ²)	Sub-Catchment Area (km ²)						
				Natural	Overburden	Pit	Non-Acid Generating Rock	Management Pond	Ponded Water	Pad
A05a	Start	2021-01-01	0	0	0	0	0	0	0	0
	EOPM	2021-12-31	0	0	0	0	0	0	0	0
	EOY0	2022-12-31	0.27	0.18	0	0.092	0	0	0	0
	EOY1	2023-12-31	1.4	0.92	0	0.51	0	0	0	0
	EOY2	2024-12-31	1.6	1	0	0.57	0	0	0	0
	EOY3	2025-12-31	1.6	1.2	0	0.42	0	0	0	0
	EOY4	2026-12-31	1.7	0.98	0	0.67	0	0	0	0
	EOY5	2027-12-31	1.6	0.78	0	0.87	0	0	0	0
	EOY10	2032-12-31	1.7	0.41	0	0.75	0.5	0	0	0
	EOM	2043-12-31	0	0	0	0	0	0	0	0
	SOC	2044-01-01	0	0	0	0	0	0	0	0
	Closure	2100-01-01	0	0	0	0	0	0	0	0

Sources: \\srk.ad\dfs\Inalvan\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Catchments\Telkwa_WM\Catchments_1CT027-003_rev10_sab_nf.xlsx

Table B 9: A05b (Pit Backfill Area West) Sub-Catchment Summary through the LOM

Area	Phase	Start Date	Major Catchment Area (km ²)	Sub-Catchment Area (km ²)						
				Natural	Overburden	Pit	Non-Acid Generating Rock	Management Pond	Ponded Water	Pad
A05b	Start	2021-01-01	0	0	0	0	0	0	0	0
	EOPM	2021-12-31	0	0	0	0	0	0	0	0
	EOY0	2022-12-31	0.48	0.13	0	0.35	0	0	0	0
	EOY1	2023-12-31	0	0	0	0	0	0	0	0
	EOY2	2024-12-31	0	0	0	0	0	0	0	0
	EOY3	2025-12-31	0	0	0	0	0	0	0	0
	EOY4	2026-12-31	0	0	0	0	0	0	0	0
	EOY5	2027-12-31	0	0	0	0	0	0	0	0
	EOY10	2032-12-31	0	0	0	0	0	0	0	0
	EOM	2043-12-31	0.81	0.21	0	0.12	0.47	0	0	0
	SOC	2044-01-01	0.81	0.098	0	0.015	0.69	0	0	0
	Closure	2100-01-01	0.81	0.098	0	0.015	0.69	0	0	0

Sources: \\srk.ad\dfs\Inalvan\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Catchments\Telkwa_WM\Catchments_1CT027-003_rev10_sab_nf.xlsx

Table B 10: A05c (Pit Backfill Area South) Sub-Catchment Summary through the LOM

Area	Phase	Start Date	Major Catchment Area (km ²)	Sub-Catchment Area (km ²)						
				Natural	Overburden	Pit	Non-Acid Generating Rock	Management Pond	Ponded Water	Pad
A05c	Start	2021-01-01	0	0	0	0	0	0	0	0
	EOPM	2021-12-31	0	0	0	0	0	0	0	0
	EOY0	2022-12-31	0	0	0	0	0	0	0	0
	EOY1	2023-12-31	0	0	0	0	0	0	0	0
	EOY2	2024-12-31	0	0	0	0	0	0	0	0
	EOY3	2025-12-31	0	0	0	0	0	0	0	0
	EOY4	2026-12-31	0	0	0	0	0	0	0	0
	EOY5	2027-12-31	0	0	0	0	0	0	0	0
	EOY10	2032-12-31	0	0	0	0	0	0	0	0
	EOM	2043-12-31	1	0.27	0	0.023	0.73	0	0	0
	SOC	2044-01-01	1	0.29	0	0.021	0.71	0	0	0
	Closure	2100-01-01	1	0.29	0	0.021	0.71	0	0	0

Sources: \\srk.ad\dfs\Inalvan\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Catchments\Telkwa_WM\Catchments_1CT027-003_rev10_sab_nf.xlsx

Table B 11: A05d (Pit Backfill Area East and Pit Lake) Sub-Catchment Summary through the LOM

Area	Phase	Start Date	Major Catchment Area (km ²)	Sub-Catchment Area (km ²)						
				Natural	Overburden	Pit	Non-Acid Generating Rock	Management Pond	Ponded Water	Pad
A05d	Start	2021-01-01	0	0	0	0	0	0	0	0
	EOPM	2021-12-31	0	0	0	0	0	0	0	0
	EOY0	2022-12-31	0	0	0	0	0	0	0	0
	EOY1	2023-12-31	0	0	0	0	0	0	0	0
	EOY2	2024-12-31	0	0	0	0	0	0	0	0
	EOY3	2025-12-31	0	0	0	0	0	0	0	0
	EOY4	2026-12-31	0	0	0	0	0	0	0	0
	EOY5	2027-12-31	0	0	0	0	0	0	0	0
	EOY10	2032-12-31	0.24	0.035	0	0.21	0	0	0	0
	EOM	2043-12-31	0.73	0.15	0	0.0073	0.47	0	0.1	0
	SOC	2044-01-01	0.73	0.15	0	0.0064	0.47	0	0.1	0
	Closure	2100-01-01	0.73	0.15	0	0.0064	0.47	0	0.1	0

Sources: \\srk.ad\dfs\in\van\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Catchments\Telkwa_WM\Catchments_1CT027-003_rev10_sab_nf.xlsx

Table B 12: A06a (Channel C02 to Four Creek) Sub-Catchment Summary through the LOM

Area	Phase	Start Date	Major Catchment Area (km ²)	Sub-Catchment Area (km ²)						
				Natural	Overburden	Pit	Non-Acid Generating Rock	Management Pond	Ponded Water	Pad
A06a	Start	2021-01-01	0	0	0	0	0	0	0	0
	EOPM	2021-12-31	0	0	0	0	0	0	0	0
	EOY0	2022-12-31	0	0	0	0	0	0	0	0
	Y1	2023-03-01	3.2	3.2	0	0	0	0	0	0
	EOY1	2023-12-31	3.2	3.2	0	0	0	0	0	0
	EOY2	2024-12-31	3.2	3.2	0	0	0	0	0	0
	EOY3	2025-12-31	3.2	3.2	0	0	0.015	0	0	0
	EOY4	2026-12-31	3.2	3.2	0	0	0.015	0	0	0
	EOY5	2027-12-31	3.2	3.1	0	0.0069	0.082	0	0	0
	EOY10	2032-12-31	3.1	3	0	0.0026	0.087	0	0	0
	EOM	2043-12-31	1.6	1.6	0	0	0	0	0	0
	SOC	2044-01-01	1.6	1.6	0	0	0	0	0	0
	Closure	2100-01-01	1.6	1.6	0	0	0	0	0	0

Sources: \\srk.ad\dfs\na\van\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Catchments\Telkwa_WM\Catchments_1CT027-003_rev10_sab_nf.xlsx

Table B 13: A07 (Coal Processing Plant) Sub-Catchment Summary through the LOM

Area	Phase	Start Date	Major Catchment Area (km ²)	Sub-Catchment Area (km ²)						
				Natural	Overburden	Pit	Non-Acid Generating Rock	Management Pond	Ponded Water	Pad
A07	Start	2021-01-01	0	0	0	0	0	0	0	0
	EOPM	2021-12-31	0	0	0	0	0	0	0	0
	EOY0	2022-12-31	1.5	1.4	0.0047	0	0	0	0.007	0.11
	Y1	2023-03-01	0.28	0.17	0.0047	0	0	0	0.007	0.11
	EOY1	2023-12-31	0.28	0.17	0.0047	0	0	0	0.007	0.11
	EOY2	2024-12-31	0.28	0.16	0.014	0	0	0	0.007	0.11
	EOY3	2025-12-31	0.28	0.16	0.014	0	0	0	0.007	0.11
	EOY4	2026-12-31	0.28	0.16	0.014	0	0	0	0.007	0.11
	EOY5	2027-12-31	0.28	0.16	0.014	0	0	0	0.007	0.11
	EOY10	2032-12-31	0.28	0.16	0.014	0	0	0	0.007	0.11
	EOM	2043-12-31	0.28	0.16	0.014	0	0	0	0.007	0.11
	SOC	2044-01-01	0	0	0	0	0	0	0	0
	Closure	2100-01-01	0	0	0	0	0	0	0	0

Sources: \\srk.ad\dfs\na\van\Projects\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\500_Water_Balance\Inputs\Catchments\Telkwa_WM\Catchments_1CT027-003_rev10_sab_nf.xlsx

Appendix C Stage-Storage Relationships

Tenas Project – Water and Load Balance Report
Appendix C: Stage-Storage-Elevation Relationships

Table C- 1: Management Pond Stage-Storage-Elevation Relationships

Elevation [masl]	Cumulative volumes [m3]			Surface Area [m2]		
	North MP	East MP	West MP	North MP	East MP	West MP
753.0	-	-	1	-	-	-
753.5	-	-	158	-	-	-
754.0	-	-	906	-	-	-
754.5	-	-	2,332	-	-	3,085
755.0	-	-	4,404	-	-	4,363
755.5	-	-	7,105	-	-	5,670
756.0	-	-	10,512	-	-	7,150
756.5	-	-	14,868	-	-	9,240
757.0	-	-	20,458	-	-	11,650
757.5	-	-	27,329	-	-	14,210
758.0	-	-	36,011	-	-	16,740
758.5	-	-	46,879	-	-	22,650
759.0	-	-	59,579	-	-	26,000
759.5	-	-	73,865	-	-	29,350
760.0	-	-	89,696	-	-	32,330
760.5	-	-	106,984	-	-	35,040
761.0	-	-	125,555	-	-	37,650
761.5	-	-	145,444	-	-	40,240
762.0	-	-	166,661	-	-	42,880
762.5	-	-	189,282	-	-	45,680
763.0	-	-	213,354	-	-	48,560
763.5	-	-	238,832	-	-	51,300
764.0	-	-	265,706	-	-	54,100
764.5	-	-	293,983	-	-	56,800
765.0	-	-	323,643	-	-	59,500
765.5	-	-	354,661	-	-	62,100
766.0	-	-	387,023	-	-	64,800
766.5	-	-	420,676	-	-	67,200
767.0	-	-	455,502	-	-	69,500
767.5	-	-	491,462	-	-	71,700
768.0	-	-	528,531	-	-	74,000
768.5	-	-	566,688	-	-	76,100
769.0	-	-	605,936	-	-	78,300
769.5	-	-	646,276	-	-	81,900
770.0	-	-	687,695	-	-	85,500
770.5	-	-	730,173	-	-	87,900
771.0	-	-	773,697	-	-	90,100
771.5	-	-	818,248	-	-	92,100
772.0	-	-	863,781	-	-	94,100

Tenas Project – Water and Load Balance Report
Appendix C: Stage-Storage-Elevation Relationships

Elevation [masl]	Cumulative volumes [m3]			Surface Area [m2]		
	North MP	East MP	West MP	North MP	East MP	West MP
772.5	-	-	910,295	-	-	96,100
773.0	-	-	957,801	-	-	98,200
773.5	-	-	1,006,315	-	-	100,200
774.0	-	-	1,055,844	-	-	102,300
774.5	-	-	1,106,399	-	-	104,400
775.0	-	-	1,157,984	-	-	106,500
775.5	-	-	1,210,602	-	-	108,700
776.0	-	-	1,264,266	-	-	110,800
776.5	-	-	1,322,177	-	-	113,000
777.0	-	-	1,381,203	-	-	115,100
777.5	-	-	1,441,272	-	-	117,100
778.0	-	-	1,502,357	-	-	119,100
778.5	-	-	1,564,448	-	-	121,100
779.0	-	-	1,627,554	-	-	123,100
779.5	-	-	1,691,688	-	-	125,100
780.0	-	-	1,756,845	-	-	127,100
780.5	-	-	1,823,031	-	-	129,100
781.0	-	-	1,890,246	-	-	131,100
781.5	-	-	1,958,490	-	-	133,200
782.0	-	-	2,027,767	-	-	135,200
782.5	-	-	2,098,078	-	-	137,200
783.0	-	-	2,169,433	-	-	139,200
783.5	-	-	2,241,912	-	-	141,500
784.0	-	-	2,315,618	-	-	143,900
784.5	-	-	2,390,689	-	-	146,900
785.0	-	-	2,467,148	-	-	149,600
785.5	-	-	2,545,068	-	-	152,600
786.0	-	-	2,624,532	-	-	155,600
786.5	-	-	2,705,621	-	-	158,900
787.0	-	-	2,788,365	-	-	162,200
787.5	-	-	2,872,732	-	-	165,300
788.0	-	-	2,958,701	-	-	168,500
788.5	-	-	3,046,286	-	-	171,800
789.0	-	-	3,135,510	-	-	175,100
789.5	-	-	3,226,391	-	-	181,100
790.0	-	-	3,319,017	-	-	186,900
790.5	-	-	3,413,568	-	-	191,000
791.0	-	-	3,510,406	-	-	194,800
791.5	-	-	3,609,548	-	-	201,700
792.0	-	-	3,711,020	-	-	206,800
792.5	-	-	3,815,026	-	-	212,700

Tenas Project – Water and Load Balance Report
Appendix C: Stage-Storage-Elevation Relationships

Elevation [masl]	Cumulative volumes [m3]			Surface Area [m2]		
	North MP	East MP	West MP	North MP	East MP	West MP
793.0	-	-	3,921,701	-	-	218,000
793.5	-	-	4,030,771	-	-	222,300
794.0	-	-	4,141,625	-	-	225,700
794.5	-	-	4,254,107	-	-	229,000
795.0	-	-	4,368,103	-	-	232,000
795.5	-	-	4,483,523	-	-	234,800
796.0	-	-	4,599,998	-	-	236,900
796.5	-	-	4,717,374	-	-	238,800
797.0	-	-	4,835,632	-	-	240,600
797.5	-	-	4,954,783	-	-	242,300
798.0	-	-	5,075,065	-	-	244,000
798.5	-	-	5,196,508	-	-	246,700
799.0	-	-	5,319,055	-	-	248,700
799.5	-	-	5,442,668	-	-	250,600
800.0	-	-	5,567,360	-	-	252,500
800.5	-	-	5,703,541	-	-	254,500
801.0	-	-	5,840,754	-	-	256,400
801.5	-	-	5,978,984	-	-	258,400
802.0	-	-	6,118,222	-	-	260,300
802.5	-	-	6,258,458	-	-	262,200
803.0	-	-	6,399,688	-	-	264,200
803.5	-	-	6,541,941	-	-	266,300
804.0	-	-	6,685,320	-	-	268,400
804.5	-	-	6,829,891	-	-	271,000
805.0	-	-	6,975,848	-	-	273,400
805.5	-	-	7,123,275	-	-	276,200
806.0	-	-	7,272,139	-	-	278,700
806.5	-	-	7,422,418	-	-	281,400
807.0	-	-	7,574,057	-	-	283,900
807.5	-	-	7,727,015	-	-	286,500
808.0	-	-	7,881,221	-	-	288,900
808.5	-	-	8,036,607	-	-	291,100
809.0	-	-	8,193,067	1,623	-	293,400
809.5	466	-	8,350,557	3,093	-	301,900
810.0	1,123	-	8,509,021	5,470	-	310,200
810.5	6,738	-	8,668,394	12,480	-	313,600
811.0	14,942	-	8,828,629	20,760	-	315,500
811.5	25,958	-	8,989,676	37,090	-	317,100
812.0	40,193	-	9,151,508	59,600	-	318,500
812.5	76,609	-	9,322,278	72,200	-	319,900
813.0	118,602	-	9,493,790	85,900	-	321,300

Tenas Project – Water and Load Balance Report
Appendix C: Stage-Storage-Elevation Relationships

Elevation [masl]	Cumulative volumes [m3]			Surface Area [m2]		
	North MP	East MP	West MP	North MP	East MP	West MP
813.5	166,062	-	9,666,027	97,600	-	322,700
814.0	218,864	-	9,838,972	112,400	-	323,900
814.5	282,474	-	10,012,613	127,800	-	325,200
815.0	350,375	-	10,186,927	140,500	-	326,500
815.5	422,631	-	10,361,900	152,100	-	327,800
816.0	499,164	-	10,537,565	160,600	-	329,100
816.5	583,548	-	10,713,986	169,400	-	330,700
817.0	671,440	-	10,891,236	180,300	-	332,300
817.5	763,219	-	11,069,348	191,700	-	333,900
818.0	859,037	-	11,248,364	201,200	-	335,600
818.5	965,501	-	11,428,354	211,800	-	337,600
819.0	1,076,237	-	11,609,434	224,100	-	339,900
819.5	1,190,980	-	11,791,627	234,400	-	342,500
820.0	1,309,466	-	11,974,937	241,900	-	346,000
820.5	1,434,190	42	12,159,426	249,100	337	351,000
821.0	1,561,375	320	12,345,385	255,800	1,451	359,400
821.5	1,690,649	1,051	12,533,323	259,400	3,827	368,800
822.0	1,821,642	2,547	12,724,378	262,100	8,610	378,000
822.5	1,953,991	10,772	12,920,878	264,600	16,980	389,400
823.0	2,087,586	23,020	13,121,001	267,100	28,270	398,200
823.5	2,222,431	42,014	13,325,122	269,600	47,530	407,200
824.0	2,358,531	69,014	13,533,487	272,100	66,400	421,800
824.5	2,495,890	108,864	13,773,078	274,600	83,200	432,700
825.0	2,634,515	155,702	14,017,326	277,100	101,600	444,900
825.5	2,774,409	209,671	14,266,365	279,600	118,300	456,600
826.0	2,915,579	270,911	14,520,354	282,200	133,200	468,200
826.5	3,058,027	343,147	14,782,602	284,700	147,800	479,000
827.0	3,201,761	422,036	15,049,146	287,300	163,100	490,400
827.5	3,346,783	507,460	15,320,163	289,900	177,800	501,000
828.0	3,493,100	599,289	15,595,810	292,400	192,400	513,000
828.5	3,640,717	703,243	15,879,423	295,000	208,400	527,000
829.0	3,789,638	813,949	16,167,983	297,600	224,300	541,000
829.5	3,939,867	931,380	16,461,317	300,200	241,100	564,000
830.0	4,091,411	1,055,505	16,759,159	304,100	258,100	587,000
830.5	4,091,411	1,192,641	17,063,436	304,100	275,600	600,000
831.0	4,091,411	1,336,892	17,372,266	304,100	295,200	613,000
831.5	4,091,411	1,488,259	17,685,485	304,100	314,000	626,000
832.0	4,091,411	1,646,749	18,003,104	304,100	332,600	638,000
832.5	4,091,411	1,824,665	18,325,865	304,100	354,900	649,000
833.0	4,091,411	2,011,258	18,653,252	304,100	384,600	660,000
833.5	4,091,411	2,206,866	18,985,405	304,100	406,100	671,000

Tenas Project – Water and Load Balance Report
Appendix C: Stage-Storage-Elevation Relationships

Elevation [masl]	Cumulative volumes [m3]			Surface Area [m2]		
	North MP	East MP	West MP	North MP	East MP	West MP
834.0	4,091,411	2,411,944	19,322,219	304,100	426,200	682,000
834.5	4,091,411	2,638,892	19,664,854	304,100	453,800	694,000
835.0	4,091,411	2,875,363	20,012,850	304,100	481,300	706,000
835.5	4,091,411	3,121,632	20,366,250	304,100	511,000	718,000
836.0	4,091,411	3,378,045	20,724,973	304,100	538,000	731,000
836.5	4,091,411	3,657,995	21,103,457	304,100	560,000	744,000
837.0	4,091,411	3,945,452	21,488,639	304,100	581,000	761,000
837.5	4,091,411	4,240,427	21,880,228	304,100	604,000	777,000
838.0	4,091,411	4,542,927	22,277,967	304,100	626,000	795,000
838.5	4,091,411	4,868,144	22,684,794	304,100	650,000	810,000
839.0	4,091,411	5,200,592	23,095,603	304,100	682,000	823,000
839.5	4,091,411	5,540,912	23,510,114	304,100	705,000	834,000
840.0	4,091,411	5,889,745	23,928,082	304,100	732,000	846,000
840.5	4,091,411	6,268,822	24,349,506	304,100	760,000	853,000
841.0	4,091,411	6,655,128	24,774,109	304,100	784,000	860,000
841.5	4,091,411	7,049,047	25,201,772	304,100	808,000	868,000
842.0	4,091,411	7,450,979	25,632,372	304,100	831,000	875,000
842.5	4,091,411	7,879,514	26,066,229	304,100	855,000	882,000
843.0	4,091,411	8,316,596	26,502,750	304,100	880,000	890,000
843.5	4,091,411	8,762,626	26,941,945	304,100	904,000	899,000
844.0	4,091,411	9,218,008	27,384,013	304,100	931,000	909,000
844.5	4,091,411	9,692,452	27,829,546	304,100	948,000	918,000
845.0	4,091,411	10,172,779	28,278,292	304,100	962,000	927,000
845.5	4,091,411	10,659,065	28,730,361	304,100	975,000	936,000
846.0	4,091,411	11,151,404	29,185,855	304,100	988,000	945,000
846.5	4,091,411	11,652,757	29,645,829	304,100	1,003,000	955,000
847.0	4,091,411	12,160,557	30,109,510	304,100	1,017,000	964,000
847.5	4,091,411	12,674,872	30,576,987	304,100	1,030,000	974,000
848.0	4,091,411	13,195,774	31,048,346	304,100	1,044,000	985,000
848.5	4,091,411	13,724,465	31,534,080	304,100	1,058,000	996,000
849.0	4,091,411	14,259,242	32,023,612	304,100	1,071,000	1,008,000
849.5	4,091,411	14,800,183	32,517,015	304,100	1,084,000	1,023,000
850.0	4,091,411	15,347,364	33,014,397	304,100	1,096,000	1,040,000
850.5	4,091,411	15,902,340	33,517,598	304,100	1,110,000	1,051,000
851.0	4,091,411	16,463,011	34,025,340	304,100	1,121,000	1,063,000
851.5	4,091,411	17,029,425	34,538,001	304,100	1,132,000	1,075,000
852.0	4,091,411	17,601,633	35,055,618	304,100	1,145,000	1,089,000

Tenas Project – Water and Load Balance Report
Appendix C: Stage-Storage-Elevation Relationships

Table C- 2: Tenas Control Pond Stage-Storage-Elevation Relationship

Elevation [masl]	Cuml. Volume [m ³]	Surface Area [m ²]
785.5	-	-
786.0	87	202
786.5	534	837
787.0	1,321	1,751
787.5	2,541	3,043
788.0	4,450	5,052
788.5	8,418	9,207
789.0	14,799	15,886
789.5	24,228	21,913
790.0	36,986	29,776
790.5	55,181	38,774
791.0	77,681	49,509
791.5	105,167	59,643
792.0	137,796	71,412
792.5	178,238	83,315
793.0	224,187	96,529
793.5	275,891	108,818
794.0	333,501	122,351
794.5	399,936	135,701
795.0	472,619	150,138
795.5	551,708	164,821
796.0	637,362	180,687
796.5	733,838	195,054
797.0	836,404	210,125
797.5	945,189	224,448
798.0	1,060,335	239,564
798.5	1,187,144	256,691
799.0	1,321,141	274,806
799.5	1,462,424	290,253
800.0	1,611,092	306,428

Tenas Project – Water and Load Balance Report
Appendix C: Stage-Storage-Elevation Relationships

Table C- 3: Pit Lake Stage-Volume Relationship

Elevation [masl]	Volume [m ³]	Elevation [masl]	Volume [m ³]	Elevation [masl]	Volume [m ³]
823	-	861	703,627	899	4,817,737
824	1,013	862	740,918	900	5,031,452
825	3,080	863	779,333	901	5,252,152
826	6,375	864	819,038	902	5,478,455
827	10,887	865	860,129	903	5,710,202
828	16,526	866	902,719	904	5,947,304
829	23,203	867	947,026	905	6,189,626
830	30,886	868	993,339	906	6,437,193
831	39,526	869	1,041,923	907	6,689,938
832	49,059	870	1,095,005	908	6,947,581
833	59,429	871	1,153,134	909	7,209,925
834	70,600	872	1,214,687		
835	82,554	873	1,279,964		
836	95,292	874	1,349,137		
837	108,821	875	1,422,472		
838	123,122	876	1,500,607		
839	138,177	877	1,583,875		
840	153,974	878	1,672,615		
841	170,595	879	1,766,753		
842	187,854	880	1,866,647		
843	205,785	881	1,972,436		
844	224,453	882	2,083,348		
845	243,890	883	2,199,315		
846	264,108	884	2,320,391		
847	285,126	885	2,446,467		
848	306,981	886	2,577,434		
849	329,726	887	2,713,361		
850	354,571	888	2,854,404		
851	381,678	889	3,000,718		
852	409,754	890	3,155,048		
853	438,772	891	3,317,654		
854	468,710	892	3,485,835		
855	499,551	893	3,659,558		
856	531,296	894	3,838,809		
857	563,937	895	4,023,575		
858	597,486	896	4,213,854		
859	631,936	897	4,409,654		
860	667,315	898	4,610,917		

Appendix D Background Water Quality

Parameter	Units	Overburden Water Quality				Bedrock Water Quality				Groundwater - Combined			
		Average	P50	P95	Count	Average	P50	P95	Count	Average	P50	P95	Count
Chloride	mg/L	1.5	0.52	3.3	48	4.2	2.5	10	69	3.1	2.5	10	120
Fluoride	mg/L	0.17	0.13	0.35	41	1.7	1.5	5.1	61	1.1	0.5	5.0	100
Ammonia, total	mg-N/L	0.15	0.025	0.61	44	0.32	0.32	0.69	69	0.25	0.22	0.68	110
Nitrate	mg-N/L	0.04	0.005	0.17	41	0.07	0.025	0.16	58	0.058	0.025	0.170	99
Nitrite	mg-N/L	0.0016	0.001	0.005	41	0.0072	0.005	0.02	58	0.005	0.005	0.020	99
Nitrogen, total	mg/L	1.3	0.54	5.9	40	0.81	0.38	2.2	64	1.000	0.410	5.000	100
Sulfate	mg/L	18	11	42	48	24	6	75	69	21	9	67	120
Aluminum, total	mg/L	6.2	0.64	26	47	1.3	0.24	6.2	69	3.3	0.3	9.6	120
Aluminum, dissolved	mg/L	0.032	0.005	0.034	44	0.033	0.0086	0.1	69	0.033	0.005	0.091	110
Antimony, total	mg/L	0.00053	0.0005	0.00071	40	0.00049	0.0005	0.0005	61	0.00051	0.00050	0.00053	100
Antimony, dissolved	mg/L	0.00052	0.0005	0.00054	37	0.0022	0.0005	0.00097	61	0.014	0.001	0.00072	98
Arsenic, total	mg/L	0.01	0.002	0.02	47	0.0042	0.001	0.0058	69	0.007	0.001	0.012	120
Arsenic, dissolved	mg/L	0.0034	0.00081	0.011	44	0.0011	0.0006	0.002	69	0.002	0.001	0.010	110
Barium, total	mg/L	0.29	0.13	0.86	47	1.6	0.4	4.1	68	1	0.24	3.8	120
Barium, dissolved	mg/L	0.12	0.093	0.25	45	0.85	0.33	3.6	69	0.56	0.14	3.5	110
Beryllium, total	mg/L	0.00099	0.0001	0.005	47	0.00089	0.00015	0.005	69	0.00093	0.0001	0.0050	120
Beryllium, dissolved	mg/L	0.00034	0.0001	0.0002	44	0.00079	0.0001	0.005	69	0.00062	0.00010	0.00500	110
Boron, total	mg/L	0.091	0.10	0.10	47	0.21	0.18	0.38	69	0.16	0.13	0.35	120
Boron, dissolved	mg/L	0.084	0.10	0.10	44	0.19	0.16	0.34	69	0.15	0.11	0.33	110
Cadmium, total	mg/L	0.00036	0.000056	0.00075	47	0.00029	0.000042	0.0026	69	0.00032	0.00005	0.00230	120
Cadmium, dissolved	mg/L	0.00012	0.000021	0.00027	45	0.00022	0.000012	0.0016	69	0.00018	0.000015	0.00087	110
Calcium, total	mg/L	63	55	130	47	16	16	36	68	36	25	91	120
Calcium, dissolved	mg/L	51	50	86	46	16	14	35	68	30	22	85	110
Chromium, total	mg/L	0.0065	0.001	0.033	47	0.0034	0.001	0.01	69	0.0046	0.0010	0.0150	120
Chromium, dissolved	mg/L	0.0015	0.001	0.001	44	0.0011	0.001	0.002	69	0.0013	0.0010	0.0020	110
Cobalt, total	mg/L	0.0082	0.00044	0.017	47	0.32	0.0005	0.0043	69	0.19	0.00048	0.01200	120
Cobalt, dissolved	mg/L	0.0009	0.0003	0.0041	44	0.00057	0.0003	0.0026	69	0.0007	0.00030	0.00300	110
Copper, total	mg/L	0.018	0.0016	0.025	47	0.0049	0.0018	0.014	69	0.01	0.002	0.023	120
Copper, dissolved	mg/L	0.0016	0.001	0.005	45	0.0019	0.001	0.0039	69	0.002	0.001	0.005	110
Iron, total	mg/L	17	0.5	20	47	1.4	0.53	3.9	69	7.6	0.51	17	120
Iron, dissolved	mg/L	0.043	0.03	0.099	44	0.2	0.065	0.59	69	0.14	0.05	0.55	110
Lead, total	mg/L	0.014	0.00062	0.046	47	0.0029	0.00085	0.02	69	0.0073	0.00074	0.02	120
Lead, dissolved	mg/L	0.0021	0.0005	0.00093	44	0.0014	0.0005	0.001	69	0.002	0.001	0.001	110
Lithium, dissolved	mg/L	0.0048	0.0028	0.0067	45	0.054	0.05	0.1	66	0.034	0.018	0.099	110
Lithium, total	mg/L	0.011	0.0041	0.05	47	0.07	0.051	0.11	66	0.046	0.020	0.11	110
Magnesium, total	mg/L	26	19	57	47	3.3	2.1	8.6	68	12	6	53	120
Magnesium, dissolved	mg/L	21	14	51	46	3	1.9	8.6	68	10	5.5	48	110
Manganese, total	mg/L	0.61	0.12	3.6	47	0.079	0.036	0.23	69	0.300	0.058	0.910	120
Manganese, dissolved	mg/L	0.13	0.052	0.57	45	0.061	0.017	0.25	69	0.089	0.022	0.300	110
Mercury, total	mg/L	0.0011	0.000005	0.00017	47	0.034	0.000011	0.03	69	0.021	0.000008	0.000	120
Mercury, dissolved	mg/L	0.0012	0.000005	0.00018	44	0.0029	0.000005	0.03	69	0.002	0.000005	0.000	110
Molybdenum, total	mg/L	0.0049	0.0014	0.014	47	0.0054	0.001	0.015	69	0.0052	0.0010	0.0140	120
Molybdenum, dissolved	mg/L	0.0053	0.001	0.015	45	0.0044	0.001	0.015	69	0.0047	0.0010	0.0150	110
Nickel, total	mg/L	0.0083	0.001	0.045	47	0.0036	0.0012	0.0084	69	0.0055	0.0011	0.0200	120
Nickel, dissolved	mg/L	0.0027	0.001	0.017	44	0.0021	0.001	0.005	69	0.0023	0.0010	0.0050	110
Phosphorus, total	mg/L	0.66	0.044	1.1	47	0.051	0.039	0.11	69	0.30	0.04	0.92	120
Phosphorus, dissolved	mg/L	0.18	0.012	0.89	40	0.023	0.016	0.06	61	0.08	0.01	0.79	100
Potassium, total	mg/L	2.6	2	3.6	47	2.3	2	3.8	68	2.4	2.0	3.8	120
Potassium, dissolved	mg/L	1.8	2	2	44	2.2	2	3.5	68	2.1	2.0	3.2	110
Selenium, total	mg/L	0.00037	0.0002	0.00099	47	0.00065	0.0001	0.001	69	0.0005	0.00012	0.0010	120
Selenium, dissolved	mg/L	0.00032	0.0002	0.00096	45	0.00026	0.00014	0.001	69	0.0003	0.00017	0.0010	110
Silica, dissolved	mg/L	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	n.a.	n.a.	n.a.	n.a.
Sodium, total	mg/L	44	20	110	47	350	310	750	68	220	190	730	120
Sodium, dissolved	mg/L	46	20	110	45	350	320	720	68	230	180	710	110
Silver, total	mg/L	0.00016	0.00002	0.00087	47	0.023	0.00002	0.0016	69	0.014	0.00002	0.0011	120
Silver, dissolved	mg/L	0.0001	0.00002	0.00027	44	0.059	0.00002	0.0001	69	0.036	0.00002	0.000	110
Thallium, dissolved	mg/L	0.00019	0.0002	0.0002	37	0.0002	0.0002	0.0002	58	0.0002	0.0002	0.000	95
Thallium, total	mg/L	0.000036	0.00001	0.0002	40	0.000047	0.00002	0.0002	58	0.000043	0.000014	0.000	98
Tin, total	mg/L	0.0015	0.0005	0.005	38	0.00073	0.0005	0.0013	51	0.0011	0.0005	0.0042	89
Tin, dissolved	mg/L	0.001	0.0005	0.0049	36	0.00061	0.0005	0.00053	51	0.0008	0.0005	0.0026	87
Titanium, dissolved	mg/L	0.012	0.01	0.024	44	0.013	0.01	0.05	66	0.0130	0.0100	0.0500	110
Titanium, total	mg/L	0.038	0.014	0.12	47	0.02	0.01	0.05	66	0.0270	0.0100	0.0650	110
Uranium, total	mg/L	0.0033	0.0018	0.0083	47	0.023	0.0004	0.0069	69	0.0150	0.0010	0.0080	120
Uranium, dissolved	mg/L	0.0017	0.0011	0.0032	45	0.023	0.0004	0.0071	69	0.0140	0.00068	0.0067	110
Vanadium, total	mg/L	0.016	0.0023	0.041	47	0.0055	0.001	0.03	69	0.010	0.002	0.030	120
Vanadium, dissolved	mg/L	0.0027	0.001	0.005	45	0.0039	0.00053	0.03	69	0.003	0.001	0.030	110
Zinc, total	mg/L	0.051	0.005	0.11	47	0.016	0.0073	0.05	69	0.03	0.006	0.081	120
Zinc, dissolved	mg/L	0.011	0.005	0.012	44	0.0067	0.005	0.011	69	0.008	0.005	0.012	110

Tenas Project – Water and Load Balance Report
Appendix D: Receiving Environment Water Quality

Parameter	Units	Receiving Water Quality																			
		Four Creek				Goathorn Creek				Tenas Creek				Telkwa River				Bulkley River			
		Average	P50	P95	Count	Average	P50	P95	Count	Average	P50	P95	Count	Average	P50	P95	Count	Average	P50	P95	Count
pH		8	8	9	26	8	8	8	85	8	8	8	76	8	8	8	136	8	8	8	116
Temperature	°C	9	9	15	83	9	9	15	83	9	9	15	83	9	9	15	83	9	9	15	83
Conductivity	µS/cm	220	240	330	26	150	160	210	85	150	160	210	76	90	87	130	138	60	56	77	89
Total Dissolved Solids	mg/:	150	150	220	26	110	110	140	63	98	100	130	53	64	66	88	73	49	47	68	56
Total Suspended Solids	mg/L	9	2	23	26	7	4	19	63	8	2	41	53	11	5	40	73	14	4	50	56
Alkalinity, total	mg-CaCO3/L	120	130	190	26	53	52	87	63	79	83	110	53	40	38	62	73	29	27	35	56
Hardness	mg-CaCO3/L	110	110	170	28	70	69	110	92	75	73	110	82	42	37	66	109	29	27	37	76
Chloride	mg/L	0.30	0.25	0.50	28	0.34	0.25	0.50	92	0.35	0.25	0.50	82	0.34	0.25	0.50	108	0.43	0.25	0.86	66
Fluoride	mg/L	0.05	0.06	0.07	28	0.03	0.03	0.04	78	0.03	0.03	0.05	69	0.03	0.03	0.04	94	0.02	0.02	0.04	60
Ammonia, total	mg-N/L	0.004	0.003	0.009	28	0.004	0.003	0.007	86	0.004	0.003	0.007	76	0.005	0.003	0.010	137	0.006	0.005	0.017	130
Nitrate	mg-N/L	0.021	0.013	0.058	28	0.044	0.041	0.076	80	0.019	0.005	0.060	71	0.024	0.013	0.076	99	0.018	0.013	0.041	75
Nitrite	mg-N/L	0.001	0.001	0.001	28	0.001	0.001	0.002	80	0.002	0.001	0.002	71	0.001	0.001	0.005	99	0.003	0.002	0.005	134
Sulfate	mg/L	5.9	1.9	28.0	28	24	24	37	92	3.1	2.6	7.4	82	5.6	5.6	9.0	107	4.1	4.0	5.0	64
Aluminum, total	mg/L	0.32	0.10	1.20	28	0.21	0.09	0.75	92	0.31	0.06	1.80	82	0.39	0.17	1.70	103	0.34	0.13	1.30	68
Aluminum, dissolved	mg/L	0.12	0.03	0.49	28	0.04	0.01	0.13	78	0.04	0.02	0.14	70	0.04	0.03	0.09	94	0.08	0.02	0.13	60
Antimony, total	mg/L	0.00006	0.00005	0.00012	28	0.00008	0.00007	0.00014	92	0.00013	0.00013	0.00024	82	0.00005	0.00005	0.00005	103	0.00008	0.00005	0.00011	68
Antimony, dissolved	mg/L	0.00006	0.00005	0.00010	28	0.00006	0.00005	0.00011	78	0.00012	0.00011	0.00023	70	0.00005	0.00005	0.00005	94	0.00006	0.00005	0.00010	60
Arsenic, total	mg/L	0.0008	0.0007	0.0011	28	0.0003	0.0002	0.0007	92	0.0005	0.0005	0.0009	82	0.0003	0.0002	0.0006	103	0.0003	0.0002	0.0007	68
Arsenic, dissolved	mg/L	0.0006	0.0006	0.0009	28	0.0002	0.0002	0.0004	78	0.0004	0.0004	0.0005	70	0.0002	0.0002	0.0003	94	0.0002	0.0002	0.0003	60
Barium, total	mg/L	0.08	0.07	0.13	28	0.06	0.06	0.07	92	0.04	0.03	0.05	82	0.04	0.04	0.05	103	0.03	0.03	0.04	68
Barium, dissolved	mg/L	0.08	0.08	0.13	28	0.06	0.06	0.07	78	0.03	0.03	0.04	70	0.04	0.03	0.05	94	0.02	0.02	0.03	60
Beryllium, total	mg/L	0.00006	0.00005	0.00010	28	0.00004	0.00005	0.00010	92	0.00004	0.00005	0.00010	82	0.00004	0.00005	0.00005	103	0.00006	0.00005	0.00010	68
Beryllium, dissolved	mg/L	0.00006	0.00005	0.00010	28	0.00005	0.00005	0.00010	78	0.00005	0.00005	0.00010	70	0.00005	0.00005	0.00005	94	0.00006	0.00005	0.00010	60
Boron, total	mg/L	0.012	0.012	0.020	28	0.011	0.005	0.050	92	0.017	0.015	0.050	82	0.010	0.005	0.050	103	0.008	0.005	0.010	65
Boron, dissolved	mg/L	0.012	0.011	0.019	28	0.011	0.005	0.050	78	0.017	0.013	0.050	70	0.010	0.005	0.050	94	0.006	0.005	0.010	60
Cadmium, total	mg/L	0.000008	0.000006	0.000019	28	0.000015	0.000010	0.000049	92	0.000007	0.000005	0.000021	82	0.000016	0.000011	0.000036	103	0.000009	0.000008	0.000021	68
Cadmium, dissolved	mg/L	0.000006	0.000005	0.000012	28	0.000012	0.000008	0.000036	78	0.000003	0.000003	0.000006	70	0.000006	0.000006	0.000010	94	0.000004	0.000003	0.000007	60
Calcium, total	mg/L	23	24	34	28	22	21	30	91	22	22	31	79	13	12	20	102	9	9	11	74
Calcium, dissolved	mg/L	23	23	36	28	22	22	32	78	22	21	31	70	13	12	21	94	10	9	12	64
Chromium, total	mg/L	0.0005	0.0003	0.0016	28	0.0003	0.0002	0.0009	92	0.0006	0.0003	0.0018	82	0.0004	0.0002	0.0010	103	0.0004	0.0003	0.0012	68
Chromium, dissolved	mg/L	0.0002	0.0002	0.0008	28	0.0001	0.0001	0.0003	78	0.0003	0.0003	0.0004	70	0.0001	0.0001	0.0002	94	0.0001	0.0001	0.0002	60
Cobalt, total	mg/L	0.0002	0.0001	0.0005	28	0.0002	0.0001	0.0006	92	0.0002	0.0001	0.0010	82	0.0002	0.0001	0.0009	103	0.0002	0.0001	0.0007	68
Cobalt, dissolved	mg/L	0.0001	0.0001	0.0002	28	0.0001	0.0001	0.0001	78	0.0001	0.0001	0.0001	70	0.0001	0.0001	0.0001	94	0.0001	0.0001	0.0001	60
Copper, total	mg/L	0.002	0.001	0.004	28	0.0021	0.0015	0.0054	92	0.0018	0.0011	0.0050	82	0.0015	0.0011	0.0042	103	0.0013	0.0009	0.0029	68
Copper, dissolved	mg/L	0.0016	0.0014	0.0034	28	0.0018	0.0014	0.0039	78	0.0013	0.0011	0.0030	70	0.0008	0.0007	0.0017	94	0.0009	0.0007	0.0020	62
Iron, total	mg/L	0.29	0.10	1.1	28	0.22	0.09	0.78	92	0.26	0.05	1.2	82	0.49	0.31	1.5	103	0.39	0.18	1.3	71
Iron, dissolved	mg/L	0.09	0.02	0.41	28	0.04	0.02	0.13	79	0.04	0.02	0.14	71	0.11	0.08	0.27	95	0.09	0.02	0.16	62
Lead, total	mg/L	0.00008	0.00003	0.00028	28	0.00008	0.00003	0.00023	92	0.00008	0.00003	0.00039	82	0.00037	0.00014	0.00140	103	0.00017	0.00010	0.00051	68
Lead, dissolved	mg/L	0.00004	0.00003	0.00009	28	0.00003	0.00003	0.00005	78	0.00003	0.00003	0.00005	70	0.00004	0.00003	0.00010	94	0.00004	0.00003	0.00005	60
Lithium, total	mg/L	0.00140	0.00150	0.00190	28	0.00059	0.00050	0.00110	92	0.00065	0.00050	0.00120	82	0.00054	0.00050	0.00100	103	0.00057	0.00050	0.00100	65
Lithium, dissolved	mg/L	0.00130	0.00140	0.00190	28	0.00055	0.00050	0.00100	78	0.00055	0.00050	0.00100	70	0.00052	0.00050	0.00050	94	0.00056	0.00050	0.00100	60
Magnesium, total	mg/L	13	14	19	28	4	4	7	91	4	4	6	79	2	2	4	102	1	1	3	74
Magnesium, dissolved	mg/L	13	13	20	28	4	4	7	78	4	4	6	70	2	2	4	94	2	1	3	64

Tenas Project – Water and Load Balance Report
Appendix D: Receiving Environment Water Quality

Parameter	Units	Receiving Water Quality																			
		Four Creek				Goathorn Creek				Tenas Creek				Telkwa River				Bulkley River			
		Average	P50	P95	Count	Average	P50	P95	Count	Average	P50	P95	Count	Average	P50	P95	Count	Average	P50	P95	Count
Manganese, total	mg/L	0.007	0.003	0.024	28	0.010	0.006	0.033	92	0.012	0.005	0.058	82	0.027	0.020	0.078	103	0.023	0.016	0.059	68
Manganese, dissolved	mg/L	0.002	0.001	0.007	28	0.004	0.003	0.008	79	0.003	0.002	0.006	71	0.009	0.007	0.021	95	0.007	0.005	0.020	62
Mercury, total	mg/L	0.000006	0.000003	0.000013	28	0.000003	0.000003	0.000006	67	0.000004	0.000003	0.000009	58	0.000003	0.000003	0.000007	81	0.000003	0.000003	0.000006	60
Mercury, dissolved	mg/L	0.000004	0.000003	0.000009	28	0.000004	0.000003	0.000005	67	0.000003	0.000003	0.000006	58	0.000003	0.000003	0.000005	81	0.000003	0.000003	0.000005	60
Molybdenum, total	mg/L	0.0002	0.0002	0.0004	28	0.0005	0.0005	0.0006	92	0.0001	0.0001	0.0002	82	0.0005	0.0005	0.0007	103	0.0004	0.0004	0.0006	68
Molybdenum, dissolved	mg/L	0.0002	0.0002	0.0004	28	0.0005	0.0005	0.0006	78	0.0001	0.0001	0.0002	70	0.0005	0.0005	0.0007	94	0.0004	0.0004	0.0005	60
Nickel, total	mg/L	0.0007	0.0003	0.0018	28	0.0004	0.0003	0.0011	92	0.0005	0.0003	0.0017	82	0.0004	0.0003	0.0011	103	0.0006	0.0003	0.0014	68
Nickel, dissolved	mg/L	0.0005	0.0003	0.0011	28	0.0003	0.0003	0.0006	78	0.0003	0.0003	0.0005	70	0.0002	0.0003	0.0003	94	0.0006	0.0003	0.0013	62
Phosphorus, total	mg/L	0.011	0.004	0.044	28	0.007	0.005	0.019	78	0.011	0.004	0.046	70	0.012	0.006	0.050	130	0.013	0.006	0.043	77
Orthophosphate, dissolved	mg/L	0.001	0.001	0.001	25	0.001	0.001	0.004	80	0.001	0.001	0.004	69	0.002	0.002	0.003	124	0.002	0.001	0.004	76
Potassium, total	mg/L	0.42	0.36	0.77	28	0.48	0.39	1.00	91	0.35	0.23	1.00	79	0.39	0.31	1.00	102	0.40	0.33	0.68	65
Potassium, dissolved	mg/L	0.42	0.35	0.84	28	0.37	0.36	0.48	78	0.20	0.19	0.30	70	0.28	0.28	0.35	94	0.35	0.32	0.52	60
Selenium, total	mg/L	0.00005	0.00003	0.00010	28	0.00011	0.00009	0.00020	92	0.00007	0.00005	0.00020	82	0.00009	0.00008	0.00020	103	0.00005	0.00003	0.00020	68
Selenium, dissolved	mg/L	0.00005	0.00003	0.00011	28	0.00008	0.00008	0.00012	78	0.00004	0.00004	0.00007	70	0.00007	0.00007	0.00010	94	0.00003	0.00003	0.00005	60
Silica, dissolved	mg/L	n.a.	n.a.	n.a.	0	5.5	5.6	6.2	13	7.2	7.0	8.0	12	6.2	6.7	8.6	18	n.a.	n.a.	n.a.	0
Sodium, total	mg/L	7.2	7.0	13.0	28	2.4	2.3	4.8	91	3.4	3.5	4.8	79	1.5	1.0	2.9	102	1.3	1.0	2.5	65
Sodium, dissolved	mg/L	7.3	7.4	13.0	28	2.5	2.4	4.8	78	3.3	3.5	4.8	70	1.5	1.0	2.9	94	1.3	1.0	2.5	62
Strontium, total	mg/L	0.2	0.2	0.2	28	0.1	0.1	0.1	92	0.1	0.1	0.1	82	0.1	0.1	0.1	103	0.0	0.0	0.1	68
Strontium, dissolved	mg/L	0.2	0.2	0.2	28	0.1	0.1	0.1	78	0.1	0.1	0.1	70	0.1	0.1	0.1	94	0.0	0.0	0.1	60
Silver, total	mg/L	0.000008	0.000005	0.000022	28	0.00001	0.00001	0.00002	92	0.00001	0.00001	0.00002	82	0.00001	0.00001	0.00002	103	0.00001	0.00001	0.00002	68
Silver, dissolved	mg/L	0.00001	0.00001	0.00001	28	0.00001	0.00001	0.00001	78	0.00001	0.00001	0.00001	70	0.00001	0.00001	0.00001	94	0.00001	0.00001	0.00001	60
Tin, total	mg/L	0.00006	0.00005	0.00010	28	0.00005	0.00005	0.00010	92	0.00005	0.00005	0.00010	82	0.00005	0.00005	0.00010	103	0.00027	0.00005	0.00012	68
Tin, dissolved	mg/L	0.00006	0.00005	0.00010	28	0.00005	0.00005	0.00010	78	0.00005	0.00005	0.00010	70	0.00005	0.00005	0.00005	94	0.00006	0.00005	0.00010	60
Tin, dissolved	mg/L	0.00001	0.00001	0.00001	28	0.00000	0.00001	0.00001	92	0.00000	0.00001	0.00001	82	0.00000	0.00001	0.00001	103	0.00001	0.00001	0.00001	68
Tin, dissolved	mg/L	0.00001	0.00001	0.00001	28	0.00001	0.00001	0.00001	78	0.00000	0.00001	0.00001	70	0.00000	0.00001	0.00001	94	0.00001	0.00001	0.00001	60
Uranium, total	mg/L	0.00010	0.00008	0.00025	28	0.00006	0.00005	0.00014	92	0.00012	0.00011	0.00025	82	0.00006	0.00006	0.00009	103	0.00004	0.00004	0.00009	68
Uranium, dissolved	mg/L	0.00010	0.00008	0.00025	28	0.00006	0.00005	0.00014	78	0.00011	0.00011	0.00024	70	0.00005	0.00004	0.00008	94	0.00003	0.00003	0.00005	60
Vanadium, total	mg/L	0.0010	0.0006	0.0027	28	0.0006	0.0003	0.0020	92	0.0012	0.0009	0.0037	82	0.0010	0.0006	0.0036	103	0.0013	0.0006	0.0050	68
Vanadium, dissolved	mg/L	0.0005	0.0003	0.0013	28	0.0003	0.0003	0.0005	78	0.0007	0.0007	0.0010	70	0.0003	0.0003	0.0006	94	0.0004	0.0003	0.0006	60
Zinc, total	mg/L	0.0026	0.0015	0.0059	28	0.0035	0.0015	0.0061	92	0.0017	0.0015	0.0060	82	0.0024	0.0015	0.0072	103	0.0025	0.0015	0.0055	68
Zinc, dissolved	mg/L	0.0014	0.0015	0.0025	28	0.0013	0.0015	0.0021	78	0.0010	0.0015	0.0015	70	0.0011	0.0015	0.0015	94	0.0013	0.0013	0.0045	62

Source: Z:\01_SITES\Telkwa Coal\1CT027.003_2020 EA Water Management\100_Data_Analysis\SurfaceWQ_BaselineData_rev11_kmp_smh_njs.xlsx

Appendix E Geochemical Source Term Analysis

(to be issued separately)

FINAL

Water Quality Model Source Term Derivation Methods

Tenas Project, British Columbia, Canada
Allegiance Coal Ltd



SRK Consulting (Canada) Inc. ■ 1CT027.007 ■ February 2022



FINAL

Water Quality Model Source Term Derivation Methods

Tenas Project, British Columbia, Canada

Prepared for:

1410 – 409 Granville Street
Vancouver, BC, V6C 1T2
Canada

+1 778 643 2843

www.telkwacoal.com

Prepared by:

SRK Consulting (Canada) Inc.
1066 West Hastings Street, Suite 2200
Vancouver, BC V6E 3X2
Canada

+1 604 681 4196

www.srk.com

Lead Author: Michael Herrell, MSc, PGeo **Initials:** MKH

Reviewer: Chris Kennedy, PhD, PGeo **Initials:** CBK

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Useful Definitions

This list contains definitions of symbols, units, abbreviations, and terminology that may be unfamiliar to the reader.

EMA	Environmental Management Act
EMP	East Management Pond
EOM	End of Mining
FS	Feasibility Study
HCT	Humidity cell testing
MA	Mines Act
NAG	Non-potentially acid generating
NMP	North Management Pond
PAG	Potentially acid generating
TCL	Telkwa Coal Limited
TSS	Total suspended solids

1 Introduction

Telkwa Coal Limited (TCL) proposes to mine metallurgical coal from the Tenas Project (Project), located near the village of Telkwa, approximately 15 km south-east of Smithers, west-central British Columbia. TCL is currently preparing an Environmental Assessment Certificate (EAC) application. A component of the EAC application is to evaluate the future Project effluent and receiving environment water quality through development of a water quality model. The results of the model are used for the following:

- Inform the mine material and water management plan design (i.e., design material and water management plans that minimize the chemical load in the effluent to minimize changes to water quality downstream and subsequent receptors);
- Develop further mitigation strategies should they be required; and,
- Evaluate water quality treatment requirements and costs should treatment be identified as the most appropriate mitigation strategy.

A key input into the site water quality model is the drainage water quality from mine site facilities (e.g., external rock piles, backfills within the open pit, coarse and fine coal processed rock piles and open pit wall surfaces). These are referred to as source term water chemistries. Source term water qualities were estimated through combining results of the mine plan (e.g., rock volumes and processed rock, run of mine coal and processed coal tonnages), water balance and geochemical test results.

This report describes the conceptual models, methods and assumptions used to derive the site water quality model source term inputs. The site wide water quality model development and results are described in SRK (2021).

2 Project Background

2.1 Geological Setting

2.1.1 Bedrock Geology

The Tenas project is located within the northeast/southwest trending Skeena Arch, which separates Jurassic-age sedimentary rocks of the Bowser Basin in the north from the Jurassic to Cretaceous-age sedimentary rocks of the Nechako Basin to the south. The coal-bearing sedimentary rock sequence of the Project is associated with the Lower Cretaceous age Skeena Group, and unconformably overlies the Jurassic-age Hazelton volcanic group, which will be below the proposed pit limit. A simplified stratigraphic column of the Project's deposit is presented in Figure 2-1.

Jurassic Hazelton Volcanic Group

The volcanic rocks include andesite, trachyte, and basalt with associated tuffs and breccias.

Lower Cretaceous Skeena Group

The Lower Cretaceous Skeena Group includes marine and continental sediments interbedded with coal seams, often correlated over long lateral distances. It is subdivided into four units (Units I through IV) and a unit of undivided sediments overlying the four units (Figure 2-1).

The economic coal seams in the Tenas area are located within Coal Zone 1 of Unit I and include two seams: C seam and 1 seam (upper and lower). Coal Zones 2 through 10, located in Unit III (Figure 2-1), are absent from the Tenas area. Units I through IV are summarized below.

- The Unit I consists of more than 100 m of fine to coarse-grained cross-bedded sandstone, conglomerate, siltstone, mudstone and coal (coal zone 1). Overall, Unit I fines upward, from primarily conglomerate and sandstone to almost entirely carbonaceous mudstone, seatearth and coal (1A to 1G). The conglomerate and sandstone were deposited in braided channels and bars, and mudstone accumulated in floodplains. Thin coal seams formed in poorly drained, peat-forming backswamps, and seatearths formed under leaching conditions in less submerged areas. With denudation of the volcanic source area, braid plains were abandoned and extensive low-energy, peat-forming swamps were established, resulting in the formation of thick coal seams in the upper part of the Unit.
- The Unit II separates coal zone 1 and coal zone 2. It consists of up to 140 m of primarily monotonous silty mudstone, occasionally interbedded with beds of chert-rich, micaceous, bioturbated or cross-bedded sandstone. The sediments were deposited in a deltaic/shallow marine environment following a regional marine transgression. The mudstone accumulated in bays, and the sandstones in distributary channels and mouthbars. Locally, thin discontinuous peat beds formed in salt marshes.
- Unit III comprises about 90 m of chert-rich, micaceous sandstone, siltstone and mudstone, and up to nine coal zones (coal zones 2 through 10). The sandstone and mudstone were deposited and biogenically reworked in a tidal flat environment; siltstone accumulated in a restricted, nearshore

marine environment. Peat accumulated in freshwater coastal marshes which periodically prograded over tidal flats.

- Unit IV consists of approximately 150 m of a laterally extensive, bright green, chert-rich, chloritic sandstone or siltstone bed at the base, overlain by massive grey silty mudstone similar to that of Unit II. The basal sandstone is a transgressive lag deposit, and silty mudstone, the predominant lithofacies, was deposited in a quiet, nearshore, shallow marine environment.

Intrusions

Tertiary and Cretaceous-age porphyritic dykes and sills commonly intrude this sequence, the most notable of which includes a Tertiary granodiorite intrusion located on the north side of the Telkwa River. These intrusions are not present in the Tenas area.

Geological Structures

The sedimentary sequence in the Tenas area is folded into a syncline in which the gently (typically 10 to 20°) northeast-dipping western limb of the syncline subcrops on the western side of the pit area, while the moderately (40 to 45°) southwest-dipping eastern limb subcrops on the eastern side of the pit. Faulting is generally near-vertical, and can be subdivided into two main groups, one which strikes approximately northwest/southeast and the other which strikes approximately northeast/southwest. A few east/west striking faults have also been interpreted.

The Goathorn area is located within an outlier of the Lower Cretaceous Skeena Group. The structural geology is somewhat more complex than the Tenas area and is characterized by a complex series of sub-parallel north-south trending reverse faults, and to a lesser extent east-west, trending normal faults.

Northeast striking faults are related to emplacement of the Bulkley intrusions in the Late Cretaceous.

2.1.2 Surficial Geology

The surficial geology in the Project area consists primarily of two types of deposits, glacial clay- or silt-rich till, and sand and glaciofluvial sand and gravel outwash. At upper elevations and south of the proposed pit, the terrain is mapped as having bedrock outcrops to a limited extent or thin mantles of clay- and silt-rich tills deposits, between 3 m and 10 m thick. North of the proposed pit and towards Tenas Creek and Goathorn Creek, drillholes report thin mantles of clay- and silt-rich tills deposits, between 3 m and 10 m thick underlain by a thick sand and gravel outwash deposit that can exceed 100 m.

Other types of deposits are present locally. Patches of glaciolacustrine deposits are scattered throughout the morainal landscape in low ridges and in depressions; the sediments comprise bedded and laminated mud, and minor sand and gravel (Clague 1984). Recent fluvial deposits form the narrow floodplains of Goathorn Creek and Tenas Creek, which are 40 m to 80 m deep incised into the subdued morainal landscape, and the wide floodplains of the Telkwa and Bulkley Rivers. The fluvial deposits range from extremely coarse, poorly sorted gravel on steep alluvial fans to moderately to well-sorted sand and mud on low-gradient floodplains (Clague 1984).

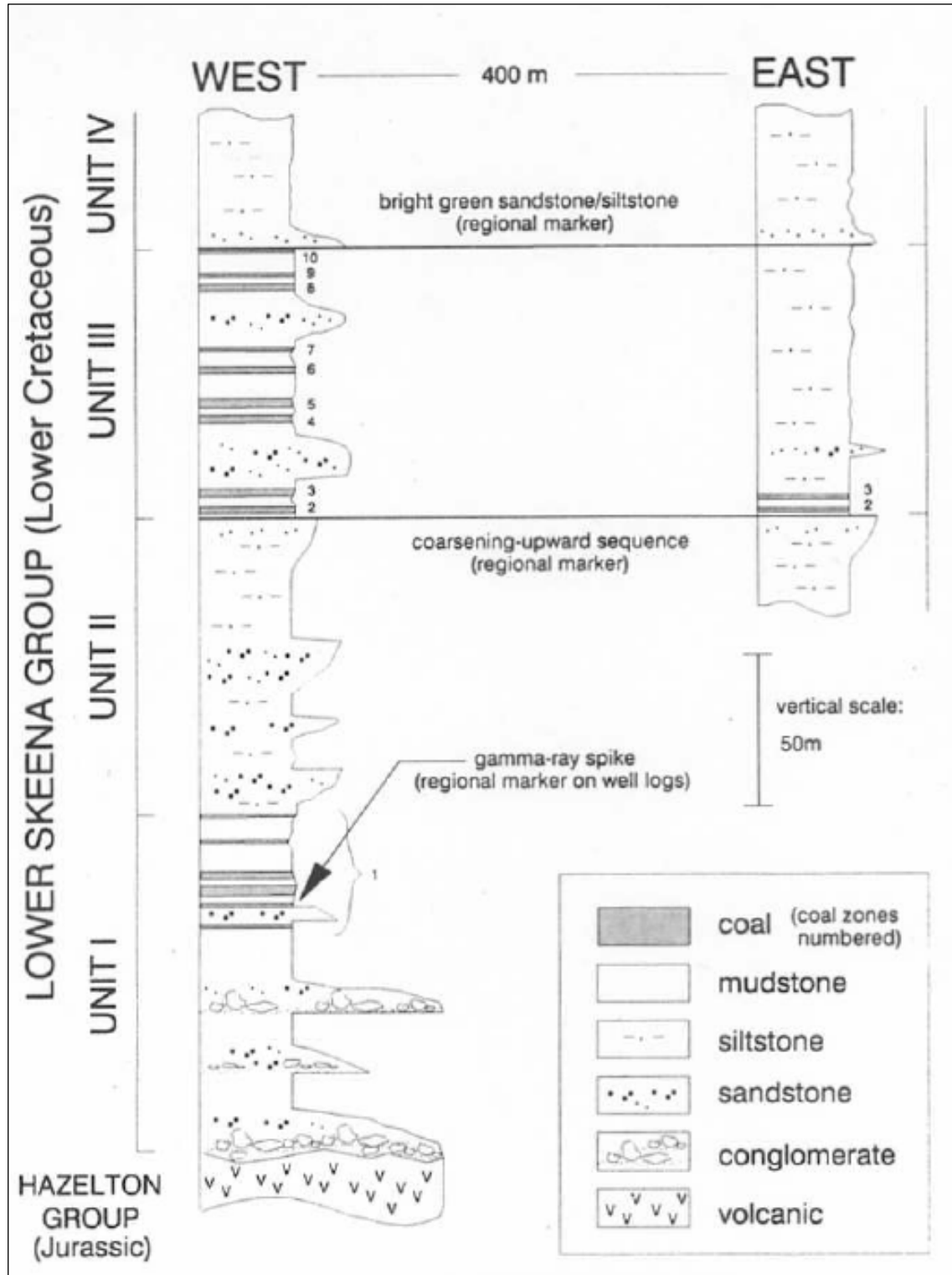


Figure 2-1. Stratigraphic Sequence of Lower Cretaceous Skeena Group Sediments. Source: Telkwa Coal Ltd.

2.2 Geochemical Characterization Study

Two geochemical studies have been completed to characterize the acid generating and metal leaching potential of the Tenas deposit:

- Norecol Dames and Moore (1999). Draft Report. Assessment of ARD Potential and Water Quality Predictions. Telkwa Coal Project.
- SRK (2022). Telkwa Coal – Tenas Project Supplemental Geochemical Characterization.

The Norecol Dames and Moore (1999) study included the collection and analysis of over 700 samples. An additional 173 samples were collected as part of the supplemental geochemical characterization study (SRK 2022). The supplemental samples were used to confirm the results of the 1999 study and correlate the test results to more up-to-date testing methods. For example, samples collected as part of the Norecol Dames and Moore (1999) study were analyzed for total sulfur only and neutralization potential was determined using the Sobek-NP (1978) method. Results from both studies were combined to form a robust geochemical characterization that is reported in SRK (2022). The reader is referred to SRK (2022) for additional detail on the geochemical characterization program including sample selection, collection, testing and results.

The outcomes of these studies indicated that a large volume of the mine rock to be mined from the Tenas deposit is potentially ARD generating (PAG) and that acid generating potential is stratigraphically constrained in zones generally separated by the coal seams. The geochemical properties of the deposit were therefore described based on mineable stratigraphical zones. The geochemical testing results indicate that all zones contain some PAG rock; however, there are units that are predominantly PAG versus non-PAG. Based on the site-specific neutralization potential ratio (NPR) (SRK 2022) and the average bulk geochemical properties, the following zones were characterized as PAG and non-PAG:

- Non-PAG: Zone 1, Zone 4, Zone 5 and Zone 55 and Zone 6;
- PAG: Zone 1a and Zone 2/3.

The geochemical characterization results also indicate that coarse and fine processed rock are PAG and all overburden samples tested are non-PAG, including all construction materials.

As noted above, the above classification is based on a site-specific NPR (1.2) established for the project. However, the mine plan was developed using a generic NPR criterion of 2 prior to the site-specific NPR being developed. Using an NPR of 2, the following zones are characterized as PAG and non-PAG based on the average bulk properties of each zone (SRK 2022):

- Non-PAG: Zone 1 and portions of Zone 4;
- PAG: Zone 1a, Zone 2/3, Zone 5, Zone 55 and Zone 6.

Since the mine plan PAG versus non-PAG rock volume estimates are based on an NPR cut-off of two, the PAG classification using this criterion was carried forward into the source term estimates when selecting geochemical inputs into the source term calculations (e.g., selection of non-PAG versus non-PAG humidity cell tests).

2.3 Summary of Mine Material Management Plan

Mining of the Tenas deposit will produce mine rock and processed rock materials. Previous geochemical testing (Norecol Dames & Moore 1999) indicates that the coarse and fine processed rock and a component of the mine rock will be PAG, and management will be required. Management of mine rock and coarse and fine processed rock are summarized in the following sections.

2.3.1 Management of PAG Rock

In advance of, and during mining, TCL proposes to progressively construct Management Ponds with a combination of excavation and embankments with buttresses. The purpose of the management ponds is to store PAG and processed rock in saturated conditions preventing sulfide oxidation, limiting acidic drainage from occurring. Three management ponds will be constructed. The North Management pond will be constructed first and is located north of the West Management Pond and is external to the open pit. The East Management is constructed next and is south of the NMP and external of the open pit. The last management pond which is the West Management Pond which is constructed from a combination of excavation for the open pit for the North Phase and construction of an embankment external to the open pit.

PAG rock will first be placed in North Management Pond. PAG rock will be progressively placed in lifts and flooded as each lift is completed so that exposure of rock to atmospheric oxygen is minimized. TCL is proposing to place all PAG rock underwater before it becomes acid generating.

Once the storage capacity of the pond has been reached, storage will begin in the East Management pond and then the West Management Pond. The three management ponds will be independent for one another allowing different water levels and PAG material levels in each of the ponds as conditions require. The Management Ponds will be maintained with at least a two-metre water cover once PAG material disposition has been completed.

2.3.2 Management of NAG Rock and Overburden

NAG rock will be used to progressively backfill the open pit during operations and for constructing portions of the embankments and buttresses for the Management Ponds and Control Ponds. Some NAG rock will also be used to cap PAG material in the management ponds once the PAG material has reached its designed elevation. NAG rock will be placed in 1.5 metre lifts into water, keeping the water level at least 1 metre above PAG rock and at or below the NAG placement platform. A 1.5 metre thickness was selected for NAG as this is below the expected change in water levels during the Post Closure phase so that this material is never above water. If during the placement of the lift there is concern with this requirement, the NAG lift can be reduced to be only 1 metre in thickness.

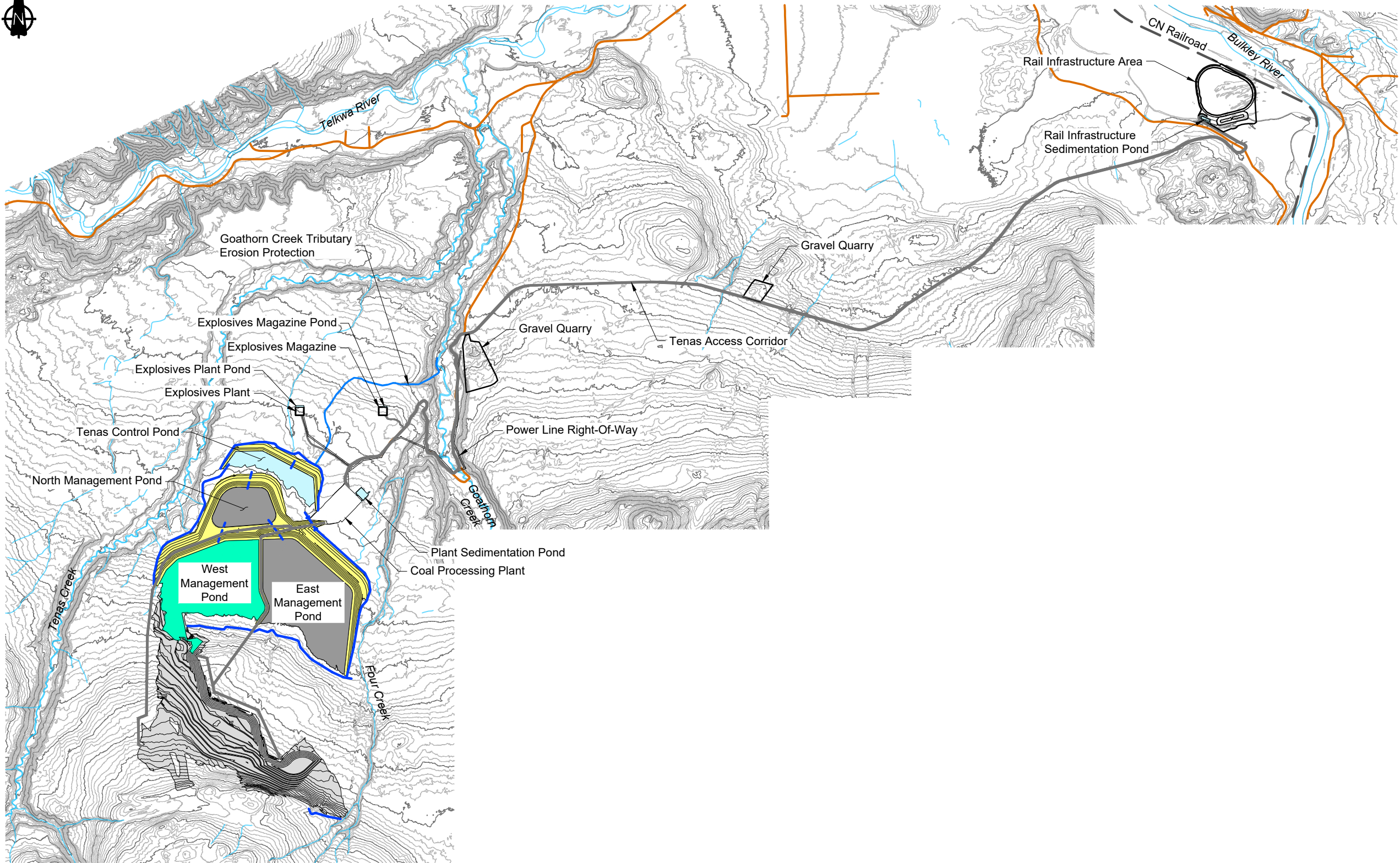
Overburden will be stored in the buttresses during operation and used as a cover material over NAG rock placed in the management ponds.

2.3.3 Management of Processed Rock

Coarse and fine processed rock materials are expected to be PAG and will also be placed in the Management Ponds with the PAG rock (Figure 2-2).

2.3.4 Open Pit Walls

The majority of the open pit will be backfilled during the Operation phase. However, a small portion of the hanging wall will exist at post-closure. Meteoric water contacting the open pit walls will report to the end pit lakes (Figure 2-2), with one of them draining northwards by gravity and mix with Management Pond water prior to discharging into the surrounding environment while the other one discharges to Four Creek once its water quality meets regulatory requirements. Until this time, this end pit lake also drains toward the north.



LEGEND

- Water Management Feature
- Spillway
- Existing Watercourse
- Existing Road
- Proposed Road
- Dams and Buttresses
- Sedimentation Pond
- Active Management Pond
- Backfill / NAG Pile
- Covered Inactive Management Pond

NOTES

- Contours shown at 5.0m intervals.
- All dimensions shown in meters unless otherwise stated.
- Pile designs by SRK Consulting Ltd.

REFERENCE

NAD83 UTM Zone 9.



SRK JOB NO.: 1CT027.007
FILE NAME: 1CT027.003 Overview.dwg



Telkwa Coal

Environmental Assessment

Mine Site Facilities

DATE:
2021/05/12

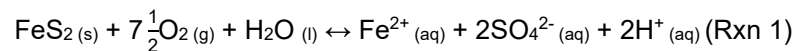
APPROVED:
MKH

FIGURE:
3-1

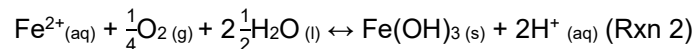
3 Conceptual Model

3.1 Saturated Mine Rock & Processed Rock

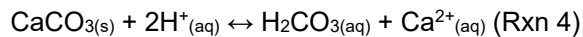
Pyrite (FeS_2) is the main sulfide mineral in PAG rock and processed rock at the project (SRK 2022). Under natural conditions, the pyrite is stable in bedrock where it is isolated from atmospheric oxygen. However, following blasting and excavation of the bedrock, pyrite in the rock mined at the project will be exposed to atmospheric oxygen prior to being placed in the management ponds and will begin to oxidize producing sulfate, ferrous iron and acidity (Rxn1).



Under oxidizing conditions, ferrous iron liberated during sulfide oxidation will subsequently oxidize to ferric iron in neutral pH producing additional acidity according to the following reaction:



Although oxidation of mine rock and processed rock for the Project will release acidity, acidic conditions are not predicted to occur immediately since these materials also contain carbonate minerals that will neutralize the acid according to the following reactions:



Depletion calculations (SRK 2022) indicate that the lag times to acid generation are on the orders of years (>5 years based on the average bulk rock properties). TCL proposes to place all PAG rock and processed rock in the management ponds under saturated conditions within an average of six months after blasting but no more than 12 months. Theoretically, this will limit sulfide oxidation (i.e., oxygen becomes a limited reactant in reaction 1) and sterilize the PAG rock and coarse and fine rock precluding acidic conditions at the Project. However, any oxidation products that are produced prior to placement of PAG rock and processed rock underwater will be flushed and dissolve in water stored in the management ponds.

At closure TCL will cap saturated PAG rock and coarse and fine processed rock in the management ponds with NAG rock. The NAG rock will be below the active water level in the management ponds and will be saturated. Any oxidation products that have accumulated on NAG rock surfaces will also be flushed when the rock is placed in the management pond.

3.2 Unsaturated NAG Rock

NAG rock that is not used in the management pond cover will be used to backfill the open pit and used in portions of the embankments and buttresses with approximately 50% remaining unsaturated in post-closure. Under these conditions, the rock will continually oxidize according to Reaction 1 (see Section 3.1) producing oxidation products that will be dissolved in meteoric water contacting the rock. However,

NAG rock contains more neutralization potential than acid generating potential and the sulfide is predicted to be consumed prior to the neutralization potential (SRK 2022) and acidic drainage from exposed NAG rock will not occur. The NAG rock will provide a continuous source of element load that is soluble under neutral conditions.

3.3 Open Pit Wall Rock Runoff

Mining of the Tenas project will result in open pit walls that are exposed to atmospheric oxygen until the Decommissioning and Reclamation Phase where the majority of the open pit walls will be covered with NAG rock and/or overburden. Sulfides that are present in the wall rock will oxidize according to reaction 1 (Section 3.1) producing sulfate, acidity, ferrous iron and release of trace chalcophile elements. Soluble oxidation products will be flushed from exposed open pit wall surfaces in meteoric water contacting the wall rock.

The open pit will progressively be backfilled during operations reducing the exposure of open pit wall to atmospheric oxygen. Oxidation of wall rock that is covered with backfill will be limited by limiting oxygen ingress.

At closure, two end pit lakes will form in the backfilled open pit. A footwall will exist above the end pit lakes composed mainly of Zone 6 sedimentary rock. Based on the site specific NPR criterion (1.2), this unit is NAG. The end pit lake will be a mixture of wall rock runoff, direct precipitation and runoff from NAG backfill.

The pit lake will drain by gravity and mix with the Management Pond before being discharged during closure.

3.4 Processed Coal Stockpile Runoff

Processed coal will be temporarily stored at the Rail Infrastructure area in two stockpiles prior to be transported from the site to Ridley terminals. While the processed coal is stored, it will oxidize but long-term oxidation is not a concern since coal will only be stored for short durations prior to being loaded into rail cars. Soluble load from the processed coal stockpiles will be collected in the Rail Infrastructure Sedimentation Pond to allow suspended solids to settle. If the quality of the sedimentation pond water meets the regulatory effluent quality criteria, water stored in the sedimentation pond will be directly discharged to the Bulkley River.

4 Source Term Derivation Methods

Source terms were developed in two ways: concentrations and load flushing rates. Unsaturated mine rock and wall rock runoff were expressed as concentrations. Concentrations were estimated by scaling humidity cell testing (HCT) results to field conditions and mixing released mass in predicted annual volumes of water and evaluating if the predicted concentrations would be limited by secondary mineral precipitation. PAG rock, coarse and fine processed rock and some NAG rock will be stored permanently underwater in the management ponds. Solute produced through oxidative weathering once these materials have been exposed will be flushed from rock surfaces when they are placed in the management ponds. The source term for these materials is therefore represented by a flushing term in milligrams per bank cubic metre (mg/bcm) of rock, also estimated using scaled HCT results. The following subsections provide the inputs and assumptions for each of the source terms.

4.1 Mine Rock Solute Release Rates

A key input into the source term calculations is the mine rock solute release rates. Solute release rates were estimated by scaling stable humidity cell test (HCT) loading rates to field conditions. As part of the baseline geochemical characterization (SRK 2022), HCTs were initiated for each rock zone. The objective of the HCT sample selection was to bracket the full extent of geochemical conditions (e.g., minimum times to acid onset) of mine rock and not all HCTs were representative of the bulk geochemical properties of the zone the sample was selected from. In the source term calculations, HCTs were assigned to each zone by first ranking them by sulfide concentrations (Table 4-1) and assigning an HCT to each zone based on the average weighted sulfide concentration for that zone (Table 4-2). HCTs were assigned with the closest, but higher than or equal sulfide concentration.

Assigning HCTs from different zones was done for two reasons:

- Several of the HCTs had high sulfur percent ranks and lower neutralization percent ranks to conservatively evaluate the onset to acid generation in PAG samples. For example, the Zone 2/3 HCT sample contained the 95th percentile sulfide concentration and the 5th percentile neutralization potential. This sample was selected to determine how quickly mine rock could become acid generating but it is not representative of the bulk properties of that zone.
- Each zone has similar sedimentary units formed in the same environment and the HCTs from one zone can reasonably be used to represent the release rates from other zones with similar sulfur content.

Table 4-1. Tenas Project Humidity Cell Test Sulfide Concentrations

Zone	HCT	Sulfide (%)
55	HC-09	0.18
1	HC-04	0.71
4	HC-07	1.43
5	HC-08	1.8
6	HC-10	2.1
1a	HC-05	2.3
2/3	HC-06	3.3

Table 4-2. Weighted Average Zone Sulfide Concentrations and Selected HCT

Zone	Sulfide (%)	Selected HCT
1	0.4	HC-12
1a	1.6	HC-11
2/3	0.9	HC-04
4 (PAG)	0.6	HC-12
4 (non-PAG)	0.3	HC-12
5	1.1	HC-04
55	0.9	HC-04
6	1.0	HC-04

Note: Weighted average zone sulfide concentrations from SRK (2022)

The average of the last 10 weeks of testing, when rates had stabilized, was used to calculate solute release rates from HCTs. For PAG samples that became acid generating during the testing period, the average of the stable rates when the pH was near neutral were included in the flushing solute release rate calculations since the conceptual model (Section 3) is that all PAG material will be inundated in the management ponds prior to the onset of acidic conditions. This only applied to the zone 2/3 HCT (HC-06), which became acidic after 13 weeks of testing. This does not influence the input release rate calculations since this HCT was not selected to represent the zone loadings (Table 4-2).

Laboratory solute release rates are not representative of release rates under ambient conditions due to several factors (e.g., temperature, grain size, water to rock ratio, etc.). Scaling factors are applied to correct for laboratory and field release rate differences. The scaling factors are dependent of storage of mine rock. Scaling factors are discussed in the following subsections.

4.2 Unsaturated Mine Rock

4.2.1 Base Case Source Term

Unsaturated NAG rock and overburden will be used as backfill in the open pit. The backfill will become partially saturated as the open pit floods at closure. Unsaturated portions of the backfill will continue to oxidize and produce soluble load that will be mobilized in meteoric water interacting with the mine rock.

Annual unsaturated mine rock concentrations were estimated as follows:

$$C_j = \frac{L_{j,annual}}{Q_{annual}} \quad (\text{Eq 1})$$

Where: C_j is the concentration of constituent j

$L_{j,annual}$ is the annual load of constituent j released from exposed mine rock

Q_{annual} is the annual average flow contacting exposed mine rock

Source term concentrations were only estimated at the end of the Operation Phase prior to flooding of the open pit (i.e., when all of the NAG rock produced during operations is unsaturated). This provides a conservative estimate of the unsaturated NAG rock drainage water quality since this timing corresponds to the maximum mining disturbance (i.e., the maximum of amount of exposed unsaturated NAG rock) and prior to rock becoming saturated reducing the total load from the backfill. In addition, all of the mine rock was assumed to be unsaturated and produce soluble load in the calculation.

The mine plan indicates approximately 29.7 million bank cubic metres cubed (Mbcm) of NAG rock will be used as backfill. At an assumed density of 2.55 grams per bank cubic centimetre (g/bcc) this results in approximately 74.2 million tonnes (Mt) of NAG rock that will be used to backfill the open pit. Unsaturated mine rock will be non-PAG and the mine plan (TCL 2020, pers. comm) indicates approximately 77% will originate from zone 1 and the remaining 23% from zone 4. The HCTs assigned to these zones (Table 4-2) were prorated in these proportions to estimate the unit solute release rates for the backfill. This rate was multiplied by the total mass to estimate the annual load produced.

As noted in Section 4.1, scaling factors were applied to the HCT solute release rates to account for laboratory and field differences. Table 4-3 provides a summary and a rationale of the scaling factors that were used in the unsaturated mine rock source term calculations.

Table 4-3. Humidity Cell Release Rate Scaling Factors

Scaling Factor	Value	Rationale
Channelization Factor	0.5	Factor to account for preferential flow through unsaturated mine rock. A component of the mine rock will not be contacted and soluble load produced from oxidation of this rock will not be mobilized
Grain Size Factor	0.2	Factor to account for grain size differences between the HCT (i.e., <1/4") and the grain size of the pit backfill, which will be variable.
Temperature Factor	0.15	Accounts for the difference in lab and field temperatures. The factor is calculated using the Arrhenius equation assuming an activation energy of 88,000 J/mol (Nicholson et. al., 1988) and an internal mine rock temperature of 10°C. The internal temperature is higher than the average annual temperature to account for internal heating through oxidation of sulfide and carbonaceous rock.

The annual scaled release rate was divided by the annual average volume of water contacting unsaturated mine rock (SRK 2022) using Equation 1 to estimate the annual average constituent concentrations in drainage from unsaturated mine rock. Predicted water qualities were entered into the publicly available speciation and mass transfer code PHREEQC v.3 (Parkhurst and Appelo 1999), developed by the United States Geological Survey (USGS), to evaluate mineral and gas phases that were supersaturated in solution. The mineral and gas phases included in the model are presented in Table 4-4. Supersaturated mineral phases were allowed to precipitate from solution and sorption to ferrihydrite was also considered using the default values of Dzombak and Morel (1990). Sorption to ferrihydrite will limit parameters that form oxyanions (e.g., arsenic) and other ligands from remaining in solution.

Table 4-4. Model Equilibrium Phases

Mineral	Empirical Formula	Mineral	Empirical Formula	Mineral	Empirical Formula
Carbon Dioxide	CO ₂ (g)	Azurite	Cu ₃ (CO ₃) ₂ (OH) ₂	Lead Molybdenum Oxide	PbMoO ₄
Gibbsite	Al(OH) ₃	Chalcanthite	CuSO ₄ ·5H ₂ O	Calcium Molybdenum Oxide	CaMoO ₄
Otavite	CdCO ₃	Ferrihydrite	Fe(OH) ₃	Nickel Hydroxide	Ni(OH) ₂
Barite	BaSO ₄	Melanterite	FeSO ₄ ·7H ₂ O	Zinc Hydroxide	Zn(OH) ₂
Calcite	CaCO ₃	Anglesite	PbSO ₄	Smithsonite	ZnCO ₃
Brochantite	Cu ₄ SO ₄ (OH) ₆	Birnessite	MnO ₂ ·nH ₂ O	Goslarite	ZnSO ₄ ·7H ₂ O
Copper Hydroxide	Cu(OH) ₂	Manganite	MnO(OH)	Gypsum	CaSO ₄ ·2H ₂ O
Malachite	Cu ₂ (CO ₃)(OH) ₂				

4.2.2 High Case Source Term

To account for variability in the source term inputs, a high case source term was developed. The high case source term was estimated by increasing sulfate concentrations to concentrations that are in equilibrium with gypsum (i.e., sulfate concentrations are assumed to be saturated in solution) under the assumed pH and redox conditions. Equilibrium with gypsum was achieved by incrementally adding anhydrite (CaSO₄) to the predicted base case solution (Section 4.2.1) until sulfate concentrations reached steady state. Concentrations of all other elements were scaled up in the high source term by preserving the metal sulphate ratios (M/SO₄) in the base case source term. A key assumption in this approach is that all elements in the solution are chalcophile which could result in an overprediction of non-chalcophile elements. Mineral saturation was evaluated by equilibrating the high case unsaturated mine rock water quality with the same mineral phases (Table 4-4) as the base case solution.

4.3 Saturated Mine Rock

4.3.1 PAG Rock Flushing Source Term

All PAG rock produced during mining of the Tenas deposit will be permanently stored in saturated conditions in the management ponds. Placement of PAG rock in the management ponds will result in flushing of oxidation products accumulating on the surfaces of the PAG following exposure during mining. A unit annual flushing rate, in kilograms per tonne of rock (kg/tonne), was estimated by proportioning scaled HCT solute release rates (Section 4.1) in the relative proportion of each zone to be mined in each year (Table 4-5).

As noted in Section 4.1, HCT are scaled to account for release rate differences between laboratory and field conditions. Grain size and temperature scaling factors (Table 4-3) were applied to saturated PAG

rock. A channelization factor was not applied since conceptual exposed surfaces will be flushed as the rock is inundated in the management ponds.

A key input to the PAG rock flushing source term is the exposure time prior to placement in the management ponds. TCL proposes to have all rock placed in the management ponds within an average of six months which was used when developing the PAG rock flushing source term. Similar to the unsaturated mine rock source term, a high case was also developed where PAG mine rock was assumed to be exposed for 12 months.

Table 4-5. Annual PAG Rock Volumes and Relative Proportions

Year	Mine Rock Volume (bcm)								Mine Rock Proportion						
	Zone 1a	Zone 2	Zone 3	Zone 4 (PAG)	Zone 5	Zone 55	Zone 6	Total	Zone 1A	Zone 2	Zone 3	Zone 4 (PAG)	Zone 5	Zone 55	Zone 6
1	---	---	---	77,481	120,526	129,135	---	327,142	---	---	---	0.24	0.37	0.39	---
2	---	101,036	116,673	276,461	270,055	271,264	178,523	1,214,012	---	0.083	0.096	0.23	0.22	0.22	0.15
3	---	179,056	229,804	620,602	320,738	99,933	99,320	1,549,453	---	0.12	0.15	0.4	0.21	0.064	0.064
4	21,889	285,673	321,699	472,335	345,853	151,588	112,489	1,711,526	0.013	0.17	0.19	0.28	0.2	0.089	0.066
5	27,407	155,626	308,582	663,762	353,038	165,727	94,900	1,769,042	0.015	0.088	0.17	0.38	0.2	0.094	0.054
6	130,618	312,373	397,354	613,605	290,367	160,116	75,573	1,980,006	0.066	0.16	0.2	0.31	0.15	0.081	0.038
7	68,844	381,138	593,269	214,295	250,877	182,880	79,710	1,771,013	0.039	0.22	0.33	0.12	0.14	0.1	0.045
8	52,353	327,938	705,510	---	321,128	178,341	175,380	1,760,650	0.03	0.19	0.4	---	0.18	0.1	0.10
9	18,042	198,457	378,872	---	378,932	89,907	66,893	1,131,103	0.016	0.18	0.33	---	0.34	0.079	0.059
10	37,018	388,733	629,396	---	439,200	71,890	151,249	1,717,486	0.022	0.23	0.37	---	0.26	0.042	0.088
11	55,727	316,821	466,150	---	428,117	74,035	97,842	1,438,692	0.039	0.22	0.32	---	0.3	0.051	0.068
12	98,303	381,613	547,361	238,780	386,869	55,623	148,670	1,857,219	0.053	0.21	0.29	0.13	0.21	0.03	0.08
13	76,587	223,829	298,043	569,289	532,297	16,062	116,153	1,832,260	0.042	0.12	0.16	0.31	0.29	0.0088	0.063
14	308,172	257,049	167,938	---	264,424	29,924	119,692	1,147,199	0.27	0.22	0.15	---	0.23	0.026	0.1
15	146,459	198,589	397,430	---	523,609	---	61,069	1,327,156	0.11	0.15	0.3	---	0.39	---	0.046
16	325,128	307,724	365,342	---	495,915	---	95,471	1,589,580	0.2	0.19	0.23	---	0.31	---	0.06
17	201,789	146,756	226,844	---	481,190	---	102,576	1,159,155	0.17	0.13	0.2	---	0.42	---	0.088
18	377,112	302,140	282,975	---	186,028	36,948	55,034	1,240,237	0.3	0.24	0.23	---	0.15	0.03	0.044
19	162,336	261,355	238,266	419,874	434,193	49,875	136,393	1,702,292	0.095	0.15	0.14	0.25	0.26	0.029	0.08
20	55,193	165,578	202,373	386,347	183,975	143,569	69,979	1,207,014	0.046	0.14	0.17	0.32	0.15	0.12	0.058
21	33,669	271,177	390,325	437,687	185,176	101,005	55,193	1,474,232	0.023	0.18	0.26	0.3	0.13	0.069	0.037
22	---	---	---	495,776	188,053	102,575	135,720	922,124	---	---	---	0.54	0.2	0.11	0.15

Source: P:\01_SITES\Telkwa Coal\1CT027.007_2021 Geochemistry Support\Task 500 - Source Term Memo\Tenas_source_term_rpt_tables_1ct027.007_MKH_r1.xlsx

4.3.2 Processed Rock Flushing Source Term

Processed rock has been classified as PAG (SRK 2022) and TCL proposes to store these materials with PAG rock under saturated conditions. Similar to PAG rock, oxidation products that accumulate on the processed rock will be flushed from the surfaces as these materials are placed in the management ponds. A processed rock flushing source term, in kg/tonne, was estimated by scaling HCT results to field conditions using the same scaling factors as the PAG rock flushing term.

One fine processed rock and one coarse coal processed rock HCT was initiated in August 2018 and 74 weeks of testing results were available when the source terms were developed. The average of the last 10 weeks of results when the humidity cell pH was stable were used to calculate loadings from the reject HCTs. The coarse and fine processed rock loadings were mixed in their relative proportions of 72% and 28%, respectively (TCL 2019, pers. comm.). The mixed processed rock loading was scaled to field conditions using the same scaling factors as the PAG rock (i.e., grain size and temperature scaling factors). Consistent with PAG rock, the processed rock flushing source term was estimated for six- and 12-month exposure periods.

4.3.3 NAG Rock Flushing Source Term

As PAG material reaches its designed elevation, NAG rock will then be placed in a 1.5 metre lift above the saturated PAG. Once this lift is completed, overburden is then placed in a 1 to 3 metre lift to form dry land reclamation. Surface soils will then be placed in a lift thickness of approximately 30 centimetres. The NAG rock will be placed in aqueous conditions and the majority of the overburden will be unsaturated. Oxidation products that have accumulated on the NAG mine rock following exposure during mining will be flushed from the surfaces as the rock is placed in the management pond.

TCL proposes to use NAG rock source from zone 1 in the management pond cover. A unit flushing rate, in kg/tonne, was estimated by scaling the zone 1 HCT results to account for differences between laboratory and field conditions. The same scaling factors used to estimate the PAG rock flushing term were applied (i.e., grain size and temperature factors). Flushing rates were estimated for six- and 12-month exposure periods.

4.3.4 Flooded NAG Rock Backfill

Approximately 50% of the NAG rock in the backfill will become flooded in post-closure. As discussed in Section 4.2.1, unsaturated mine rock is assumed to have a channelization factor of 0.5 to account for portions of the rock that will not be contacted by water. The residual mass that is not flushed from the backfill by meteoric water contact can be dissolved during flooding. The water balance model (SRK 2021) indicates there is no hydraulic connection of water stored in the flooded backfill to the management ponds. However, a small volume of the flooded backfill water will report to the groundwater system. Water balancing modelling indicates that the water losses from the flooded backfill represent less than one percent (i.e., 0.4%) of the total flow to the groundwater system. There is a high degree of uncertainty in estimating the residual load that will be flushed from the flooded

backfill and since the flow is effectively negligible to other flows, a source term was not developed for the flooded NAG rock backfill.

4.4 Wall Rock Runoff

Exposed wall rock surfaces will produce oxidative load that will be flushed by meteoric water. An annual pit wall drainage water quality was estimated using equation 1; however, in this instance $L_{j,annual}$ is the annual load of constituent j released from exposed wall rock surfaces and Q_{annual} is the annual average flow contacting the exposed wall rock. TCL proposed to progressively backfill the open pit during operations. This will continually change the areas of rock exposed in the pit walls. To evaluate changes to the wall rock runoff composition, source terms were developed for the following time periods, which correspond to backfilling of different areas and volumes placed in the open pit:

- End of placement of PAG rock in the North Management Pond (NMP)
- End of placement of PAG rock in the East Management Pond (EMP)
- End of the Operation Phase (EOM)

The reactive mass of each stratigraphic zone in the open pit walls was estimated by multiplying the exposed surface area of each of the zones in the open pit walls by an assumed depth of fractured rock for each of the above time periods. Surface areas for each time period are provided in Table 4-6. The fractured rock depth was assumed to be two metres for blasted areas and five centimetres for free dig areas and the floor of the pit. A density of 2.55 g/cc was assumed to estimate the reactive mass exposed in the pit walls.

The HCTs assigned to each zone (Table 4-2) were prorated in relative proportions calculated based on the exposed surface areas (Table 4-6) to estimate the unit solute release rates for the backfill. A coal sample was not submitted for HCT and the combined processed rock HCT (see Section 4.3.2) was used to represent loadings from exposed coal seams. This rate was multiplied by the total reactive mass in the open pit walls to estimate the annual load produced. The annual load was scaled to field conditions using the grain size and temperature factors presented in Table 4-6. It was assumed that the entire fractured rock zone in the open pit walls would be flushed and a channelization factor was not included.

The annual scaled release rate was divided by the annual average volume of water contacting wall rock runoff (SRK 2022) to estimate drainage concentrations using Equation 1. The annual volume for each time period is presented in Table 4-7. Mineral solubility was evaluated and phases that were identified to be supersaturated in solution were allowed to precipitate or off-gas (for gas phases). Mineral phases that were considered are provided in Table 4-4. Sorption to ferrihydrite was also included when this mineral phase precipitated.

Similar to the unsaturated mine rock source term, a high case wall rock source term was estimated by forcing the predicted solutions to gypsum saturation through incremental anhydrite addition in PHREEQC. Element sulfate ratios in the base case source term were assumed when calculating concentrations of other constituents. The scaled-up solution was subsequently equilibrated with the

mineral phases presented in Table 4-4 and sorption to ferrihydrite was permitted when this mineral phase precipitated.

Table 4-6. Open Pit Wall Surface Areas (m²)

Layer	Type	End of NMP	End of EMP	EOM
Zone 1	Blasted Wall	34,151	92,219	15,722
Zone 1a	Blasted Wall	---	3,711	---
Zone 2	Blasted Wall	6,392	22,127	---
Zone 3	Blasted Wall	5,780	33,410	---
Zone 4	Blasted Wall	10,798	48,741	---
Zone 5	Blasted Wall	8,489	26,942	---
Zone 6	Free Dug Wall	356,326	948,129	---
Overburden	Free Dug Wall	81,128	253,429	27,065
Seam C	Free Dug Wall	554	3,290	---
Seam 1U	Free Dug Wall	841	4,645	---
Zone 55	Free Dug Wall	2,697	12,171	---
Seam 1L	Free Dug Wall	1,200	7,224	---

Note: Areas presented in m²

Table 4-7. Annual Wall Rock Runoff Volumes

Time Period	Volume (m ³ /year)
End of NMP	247,264
End of EMP	708,217
EOM	20,812

4.5 Processed Coal Stockpile Runoff

Coal will be temporarily stored in a coal stockpile in the rail loadout area where it will be loaded onto railcars and transported off site. The annual load from the coal stockpile was estimated by multiplying HCT loading rates by the maximum amount of coal (90,000 tonnes) that will be stored in the stockpile (TCL 2020b, pers. comm.). A coal sample was not submitted for HCT as part of the SRK (2022) geochemical characterization and the coal reject solute release rate (see Section 4.3.2) was used as a surrogate. The annual load release was scaled to field conditions applying the scaling factors presented in Table 4-3.

The annual scaled release rate was divided by the annual average volume of water (3,857 m³) contacting wall rock runoff (SRK 2022) to estimate annual average drainage concentrations using Equation 1. Mineral solubility was evaluated and phases that were identified to be supersaturated in solution were allowed to precipitate or off-gas (for gas phases). The same mineral phases used in the

unsaturated mine rock and wall rock runoff source terms (Table 4-4) were used in the coal stockpile source term equilibrations. If ferrihydrite was predicted to precipitate from solutions, sorption to this mineral phase was permitted.

Similar to the unsaturated mine rock and wall rock source terms, a high case source term was estimated through incrementally dissolving anhydrite until gypsum saturation was achieved. All other constituent concentrations were calculated assuming the base case source term element sulfate ratios would be preserved. The scaled-up solution was subsequently equilibrated with the phase in Table 4-4 and sorption to ferrihydrite was included when this mineral precipitated from solution.

4.6 Particulate Concentrations

The source terms discussed in the previous sections will provide an estimate of dissolved concentrations when carried forward into the site water and load balance model. To provide a mechanism for estimating total concentrations in surface discharge from the project, particulate concentrations were calculated for overburden, PAG and NAG mine rock to account for changes to sediment quality as a result of exposing these materials. Average solid-phase concentrations (SRK 2022) were prorated based on the relative volumes of each rock type at the end of mining to estimate the solid-phase concentrations of each material (e.g., PAG mine rock, etc.). The solid-phase concentrations were multiplied by an assumed total suspended solids (TSS) concentration to estimate the particulate concentration according to the following formula:

$$[J]_{particulate} = [J]_{ICP} \times [TSS]$$

Where: $[J]_{particulate}$ is the particulate concentration of parameter J in mg/L

$[J]_{ICP}$ is the prorated solid-phase concentration of parameter J in mg/kg

$[TSS]$ is the assumed total suspended solids concentration in the project discharge

Particulate concentrations were estimated for an assumed TSS concentration of 35 mg/L, which corresponds to the maximum monthly mean concentration in the proposed Coal Mining Effluent Regulation.

5 Source Terms

The following sections present the Tenas project source terms. The source terms do not represent discharge water quality and how the mine rock flushing source terms influence site drainage water quality cannot be quantified until they are carried forward into the site wide water and load balance. Therefore, limited interpretation of the source terms is included in the following sections. Detailed interpretations of the site wide water and load balance model results using these source terms is included in SRK (2022).

5.1 Unsaturated Mine Rock

The base case and high case unsaturated mine rock source terms are provided in Table 5-1. The charge imbalance for the base case and high case solutions were less than 10%. This is considered acceptable for a modelled solution mixing together average inputs from multiple HCTs and charge imbalances were not corrected.

The pH of both solutions is alkaline and in general, most of the modelled constituent concentrations are higher in the high case in comparison to the base case. Aluminum, barium and lead are the exceptions and are lower in the high case source term. Concentrations of these constituents are low in both scenarios since they are solubility constrained. Lower concentrations can occur in the high case source term as a result of additional mineral precipitation or sorption as a result of an increase in a limiting reactant.

Table 5-1. Unsaturated Mine Rock Source Terms

Parameter	Units	NAG Mine Rock Runoff/Seepage	
		NAG Typical	NAG High
Conventional			
pH	s.u.	7.8	8.1
% Error	%	0.9	1.0
Alkalinity	mg CaCO ₃ /L	2885	5668
Major Ions			
Calcium	mg/L	7	3
Magnesium	mg/L	48	95
Potassium	mg/L	90	177
Sodium	mg/L	2207.0	4357.3
Chloride	mg/L	83	164
Sulfate	mg/L	1971	3891
Dissolved Elements			
Aluminum	mg/L	0.0026	0.0042
Antimony	mg/L	0.004	0.008
Arsenic	mg/L	0.002	0.004
Barium	mg/L	0.0043	0.0035
Boron	mg/L	1.2	2.3
Cadmium	mg/L	0.00037	0.00073
Chromium	mg/L	0.0111	0.0218
Cobalt	mg/L	0.003	0.006
Copper	mg/L	0.0131	0.0259
Iron	mg/L	0.00021	0.00014
Lead	mg/L	0.00115	0.00227
Lithium	mg/L	0.79	1.56
Manganese	mg/L	0.147	0.29
Mercury	mg/L	<0.00001	<0.00001
Phosphorus	mg/L	0.445	0.88
Molybdenum	mg/L	0.017	0.03
Nickel	mg/L	0.015	0.03
Selenium	mg/L	0.036	0.07
Silica	mg/L	43	85
Silver	mg/L	<0.000005	<0.000005
Strontium	mg/L	4	7
Tin	mg/L	<0.002	<0.002
Thallium	mg/L	0.00	0.001
Uranium	mg/L	0.013	0.0256
Vanadium	mg/L	0.035	0.07
Zinc	mg/L	0.023	0.045

Source: P:\01_SITES\Telkwa Coal\1CT027.007_2021 Geochemistry Support\Task 500 - Source Term Memo\Tenas_source_term_rpt_tables_1ct027.007_MKH_r1.xlsx

5.2 Saturated Mine Rock

Saturated rock flushing terms are presented in kg/tonne. The influence of flushing of rock as it is placed in the management ponds cannot be quantified until it is carried forward into the water and load balance. Annual PAG rock flushing rates for the six- and 12-month exposure periods are provided in Table 5-2 and Table 5-3. Processed and NAG rock flushing source terms are provided in Table 5-4 and Table 5-5, respectively.

Table 5-2. PAG Rock Annual Flushing Source Term – Six Month Exposure

Parameter	Units	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
<i>Conventional</i>																							
Alkalinity	kg CaCO3/tonne	0.029	0.03	0.03	0.03	0.03	0.028	0.03	0.031	0.032	0.032	0.031	0.03	0.03	0.024	0.029	0.026	0.027	0.023	0.028	0.029	0.03	0.029
<i>Major Ions</i>																							
Calcium	kg/tonne	0.0027	0.0035	0.0034	0.0042	0.0038	0.0056	0.0056	0.0059	0.0056	0.0059	0.0063	0.0063	0.0052	0.0129	0.0086	0.0112	0.0104	0.0139	0.0069	0.0048	0.0045	0.0026
Magnesium	kg/tonne	0.00224	0.00314	0.0031	0.0037	0.0032	0.0041	0.00466	0.00518	0.00516	0.0054	0.00552	0.00513	0.0042	0.0079	0.00649	0.0074	0.0071	0.0083	0.005	0.0037	0.0038	0.0022
Potassium	kg/tonne	0.00067	0.00064	0.00064	0.00063	0.00065	0.00064	0.0006	0.00058	0.00057	0.00057	0.00057	0.00059	0.00062	0.0006	0.00057	0.00058	0.00058	0.0006	0.00062	0.00064	0.00063	0.00068
Sodium	kg/tonne	0.012	0.008	0.009	0.007	0.009	0.007	0.004	0.002	0.002	0.001	0.001	0.003	0.006	0.001	0.00	0.00	0.00	0.001	0.005	0.008	0.007	0.012
Chloride	kg/tonne	0.00047	0.00036	0.00037	0.00031	0.00037	0.00033	0.00023	0.00016	0.00014	0.00012	0.00013	0.00019	0.00028	0.00011	0.0001	0.0001	0.0001	0.00011	0.00026	0.00036	0.00031	0.00048
Sulfate	kg/tonne	0.016	0.016	0.016	0.018	0.018	0.024	0.021	0.02	0.018	0.019	0.021	0.022	0.021	0.049	0.029	0.041	0.037	0.053	0.028	0.022	0.019	0.016
<i>Elements</i>																							
Aluminum	kg/tonne	0.00008	0.000059	0.000061	0.000049	0.000061	0.000051	0.00003	0.00002	0.00001	0.00001	0.00001	0.00002	0.000043	0.000007	0.0000	0.000004	0.0000	0.000007	0.000038	0.000057	0.000049	0.000082
Antimony	kg/tonne	2.2E-08	1.7E-08	0.00000002	1.5E-08	0.00000002	1.5E-08	1.0E-08	6.8E-09	6.2E-09	5.1E-09	5.3E-09	8.5E-09	1.3E-08	4.6E-09	3.8E-09	3.8E-09	3.8E-09	4.7E-09	1.2E-08	0.00000002	1.5E-08	0.00000002
Arsenic	kg/tonne	2.3E-08	2.7E-08	0.00000003	2.8E-08	2.6E-08	2.7E-08	3.0E-08	3.3E-08	3.3E-08	3.4E-08	3.3E-08	3.1E-08	2.8E-08	3.1E-08	3.3E-08	3.2E-08	3.3E-08	3.1E-08	2.9E-08	2.6E-08	2.8E-08	0.00000002
Barium	kg/tonne	0.0000066	0.0000072	0.000007	0.000007	0.000007	0.000007	0.0000077	0.0000082	0.0000083	0.0000084	0.0000083	0.0000079	0.000007	0.0000075	0.0000082	0.0000079	0.000008	0.0000074	0.0000074	0.000007	0.000007	0.000007
Boron	kg/tonne	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096	0.0000096
Cadmium	kg/tonne	3.3E-09	3.4E-09	3.4E-09	3.7E-09	3.7E-09	5.0E-09	4.5E-09	4.3E-09	4.0E-09	4.1E-09	4.5E-09	4.8E-09	4.5E-09	1.0E-08	6.4E-09	8.7E-09	8.0E-09	1.1E-08	5.8E-09	4.5E-09	4.0E-09	3.3E-09
Chromium	kg/tonne	6.5E-08	5.2E-08	5.3E-08	4.6E-08	5.3E-08	4.7E-08	3.5E-08	2.7E-08	2.5E-08	2.2E-08	2.3E-08	3.1E-08	4.2E-08	2.1E-08	1.9E-08	1.9E-08	1.9E-08	2.1E-08	3.9E-08	5.1E-08	4.6E-08	6.6E-08
Cobalt	kg/tonne	0.00000003	0.00000003	0.00000003	0.00000004	0.00000005	0.00000011	0.00000007	6.3E-08	4.6E-08	5.3E-08	7.4E-08	0.00000009	0.00000008	0.00000035	0.00000016	0.00000027	0.00000024	0.00000039	0.00000014	0.00000008	0.00000005	0.00000003
Copper	kg/tonne	9.0E-08	8.1E-08	8.1E-08	7.6E-08	8.2E-08	7.8E-08	0.00000007	0.00000006	0.00000006	0.00000006	0.00000006	6.6E-08	7.4E-08	5.9E-08	0.00000006	5.7E-08	5.7E-08	5.9E-08	7.2E-08	8.0E-08	7.6E-08	9.1E-08
Iron	kg/tonne	0.00002	0.000015	0.000015	0.000012	0.000015	0.000013	0.000008	0.000004	0.000003	0.000002	0.000003	0.000006	0.000011	0.000003	0.000001	0.000002	0.000002	0.000003	0.00001	0.000015	0.000012	0.000021
Lead	kg/tonne	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09	9.6E-09
Lithium	kg/tonne	0.0000057	0.0000053	0.0000053	0.0000051	0.0000053	0.0000051	0.0000047	0.0000044	0.0000044	0.0000043	0.0000043	0.0000046	0.0000049	0.000004	0.0000041	0.000004	0.0000041	0.000004	0.0000048	0.0000052	0.0000051	0.0000057
Manganese	kg/tonne	0.00000167	0.00000189	0.00000188	0.0000038	0.0000041	0.0000115	0.0000078	0.0000066	0.0000046	0.0000055	0.000008	0.0000099	0.0000081	0.0000411	0.0000184	0.0000319	0.0000275	0.0000462	0.0000159	0.0000085	0.0000053	0.00000165
Mercury	kg/tonne	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09
Phosphorus	kg/tonne	0.0000026	0.0000021	0.0000021	0.0000018	0.0000021	0.0000019	0.0000014	0.0000011	0.000001	0.0000009	0.0000009	0.0000012	0.0000017	0.0000007	0.0000007	0.0000007	0.0000007	0.0000007	0.0000015	0.000002	0.0000018	0.0000027
Molybdenum	kg/tonne	0.0000001	0.00000008	0.00000009	0.00000008	0.00000009	0.00000008	0.00000006	0.00000005	0.00000005	0.00000004	0.00000004	0.00000005	0.00000007	0.00000003	0.00000004	0.00000003	0.00000003	0.00000003	0.00000006	0.00000008	0.00000008	0.0000001
Nickel	kg/tonne	0.00000014	0.00000015	0.00000015	0.00000022	0.00000023	0.00000049	0.00000036	0.00000032	0.00000025	0.00000028	0.00000037	0.00000044	0.00000037	0.00000156	0.00000074	0.00000123	0.00000107	0.00000175	0.00000065	0.00000039	0.00000027	0.00000014
Selenium	kg/tonne	0.00000021	0.00000017	0.00000017	0.00000015	0.00000018	0.00000016	0.00000012	0.00000009	0.00000009	0.00000008	0.00000008	0.00000011	0.00000014	0.0000001	0.00000008	0.00000009	0.00000009	0.00000011	0.00000014	0.00000017	0.00000015	0.00000022
Silica	kg/tonne	0.00026	0.00022	0.00022	0.0002	0.00022	0.00021	0.00016	0.00013	0.00012	0.00012	0.00012	0.00015	0.00019	0.00012	0.00011	0.00011	0.00011	0.00012	0.00018	0.00022	0.0002	0.00027
Silver	kg/tonne	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10	9.6E-10
Strontium	kg/tonne	0.000045	0.000053	0.000052	0.000057	0.000053	0.00006	0.000065	0.000069	0.000069	0.000071	0.000072	0.000069	0.000061	0.000092	0.00008	0.000088	0.000085	0.000095	0.000068	0.000057	0.000058	0.000044
Tin	kg/tonne	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038	0.00000038
Thallium	kg/tonne	3.1E-09	3.1E-09	3.1E-09	3.4E-09	3.4E-09	4.1E-09	3.8E-09	3.7E-09	3.5E-09	3.6E-09	3.9E-09	4.0E-09	3.8E-09	7.1E-09	4.9E-09	6.2E-09	5.8E-09	7.6E-09	4.6E-09	3.8E-09	3.5E-09	3.0E-09
Uranium	kg/tonne	7.4E-08	5.8E-08	6.0E-08	5.0E-08	6.0E-08	5.2E-08	3.7E-08	0.00000003	0.00000002	0.00000002	0.00000002	3.1E-08	4.6E-08	1.6E-08	1.6E-08	1.4E-08	1.5E-08	1.5E-08	4.1E-08	5.6E-08	5.0E-08	7.6E-08
Vanadium	kg/tonne	0.0000002	0.00000015	0.00000016	0.00000013	0.00000016	0.00000014	0.0000001	0.00000006	0.00000006	0.00000005	0.00000005	0.00000008	0.00000012	0.00000004	0.00000004	0.00000004	0.00000004	0.00000005	0.00000011	0.00000015	0.00000013	0.0000002
Zinc	kg/tonne	0.00000019	0.00000019	0.00000019	0.00000024	0.00000025	0.00000046	0.00000035	0.00000031	0.00000026	0.00000028	0.00000035	0.00000041	0.00000036	0.0000013	0.00000064	0.000001	0.00000091	0.0000014	0.00000058	0.00000038	0.00000029	0.00000019

Source: P:\01_SITES\Telkwa Coal\1CT027.007_2021 Geochemistry Support\Task 500 - Source Term Memo\Tenas_source_term_rpt_tables_1ct027.007_MKH_r1.xlsx

Table 5-3. PAG Rock Annual Flushing Source Term – 12 Month Exposure

Parameter	Units	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
Conventional																							
Alkalinity	kg CaCO ₃ /tonne	0.058	0.06	0.06	0.061	0.059	0.057	0.061	0.063	0.064	0.064	0.063	0.061	0.059	0.049	0.059	0.053	0.055	0.046	0.056	0.058	0.06	0.058
Major Ions																							
Calcium	kg/tonne	0.0053	0.0069	0.0068	0.0084	0.0076	0.0112	0.0112	0.0117	0.0112	0.0118	0.0127	0.0125	0.0105	0.0259	0.0172	0.0225	0.0208	0.0278	0.0139	0.0096	0.009	0.005
Magnesium	kg/tonne	0.0045	0.0063	0.0061	0.0074	0.0064	0.0082	0.0093	0.0104	0.01031	0.0108	0.011	0.0103	0.0084	0.0158	0.013	0.0148	0.0142	0.0165	0.0099	0.0073	0.0076	0.0043
Potassium	kg/tonne	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0012	0.0012	0.0012	0.0011	0.0012	0.0012	0.0012	0.0012	0.0013	0.0013	0.0014
Sodium	kg/tonne	0.023	0.017	0.017	0.014	0.017	0.015	0.009	0.004	0.004	0.002	0.003	0.006	0.012	0.002	0.001	0.001	0.001	0.002	0.011	0.016	0.014	0.024
Chloride	kg/tonne	0.0009	0.0007	0.0007	0.0006	0.0007	0.0007	0.0005	0.0003	0.0003	0.0002	0.0003	0.0004	0.0006	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0007	0.0006	0.001
Sulfate	kg/tonne	0.032	0.032	0.032	0.035	0.036	0.048	0.042	0.039	0.036	0.037	0.041	0.045	0.042	0.098	0.059	0.082	0.074	0.106	0.055	0.043	0.038	0.032
Elements																							
Aluminum	kg/tonne	0.00016	0.00012	0.00012	0.0001	0.00012	0.0001	0.00006	0.00003	0.00003	0.00002	0.00002	0.00005	0.00009	0.00001	0.00001	0.00001	0.00001	0.00001	0.00008	0.00011	0.0001	0.00016
Antimony	kg/tonne	0.00000004	0.00000003	0.00000003	0.00000003	0.00000004	0.00000003	0.00000002	1.4E-08	1.2E-08	1.0E-08	1.1E-08	0.00000002	0.00000003	9.2E-09	7.7E-09	7.7E-09	7.7E-09	9.4E-09	0.00000002	0.00000003	0.00000003	0.00000005
Arsenic	kg/tonne	0.00000005	0.00000005	0.00000005	0.00000006	0.00000005	0.00000005	6.0E-08	6.5E-08	6.6E-08	6.7E-08	6.7E-08	6.3E-08	0.00000006	6.2E-08	6.7E-08	6.5E-08	6.6E-08	6.2E-08	0.00000006	0.00000005	0.00000006	0.00000005
Barium	kg/tonne	0.000013	0.000014	0.000014	0.000015	0.000014	0.000014	0.000015	0.000016	0.000017	0.000017	0.000017	0.000016	0.000015	0.000015	0.000016	0.000016	0.000016	0.000015	0.000015	0.000014	0.000015	0.000013
Boron	kg/tonne	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019	0.000019
Cadmium	kg/tonne	6.5E-09	6.7E-09	6.7E-09	7.5E-09	7.5E-09	1.0E-08	8.9E-09	8.6E-09	7.9E-09	8.2E-09	9.1E-09	9.7E-09	9.0E-09	2.1E-08	1.3E-08	1.7E-08	1.6E-08	2.2E-08	1.2E-08	9.0E-09	8.0E-09	6.5E-09
Chromium	kg/tonne	0.00000013	0.0000001	0.00000011	0.00000009	0.00000011	0.00000009	0.00000007	0.00000005	0.00000005	0.00000004	0.00000005	0.00000006	0.00000008	0.00000004	0.00000004	0.00000004	0.00000004	0.00000004	0.00000008	0.0000001	0.00000009	0.00000013
Cobalt	kg/tonne	0.00000005	0.00000005	0.00000005	0.00000008	0.00000009	0.00000021	0.00000015	0.00000013	9.2E-08	1.1E-07	0.00000015	0.00000018	0.00000015	0.0000007	0.00000032	0.00000055	0.00000047	0.00000079	0.00000028	0.00000016	0.00000011	0.00000005
Copper	kg/tonne	0.00000018	0.00000016	0.00000016	0.00000015	0.00000016	0.00000016	0.00000014	0.00000013	0.00000012	0.00000012	0.00000012	0.00000013	0.00000015	0.00000012	0.00000011	0.00000011	0.00000011	0.00000012	0.00000014	0.00000016	0.00000015	0.00000018
Iron	kg/tonne	0.000041	0.00003	0.000031	0.000025	0.000031	0.000027	0.000016	0.000008	0.000007	0.000005	0.000005	0.000012	0.000022	0.000006	0.000003	0.000004	0.000003	0.000006	0.00002	0.000029	0.000025	0.000042
Lead	kg/tonne	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08
Lithium	kg/tonne	0.000011	0.000011	0.000011	0.00001	0.000011	0.00001	0.000009	0.000009	0.000009	0.000009	0.000009	0.000009	0.00001	0.000008	0.000008	0.000008	0.000008	0.000008	0.00001	0.00001	0.00001	0.000011
Manganese	kg/tonne	0.0000033	0.0000038	0.0000038	0.0000077	0.0000082	0.0000229	0.0000155	0.0000132	0.0000093	0.000011	0.0000159	0.0000198	0.0000162	0.0000823	0.0000367	0.0000638	0.0000551	0.0000925	0.0000317	0.000017	0.0000106	0.0000033
Mercury	kg/tonne	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09	3.8E-09
Phosphorus	kg/tonne	0.0000052	0.0000042	0.0000043	0.0000037	0.0000043	0.0000038	0.0000028	0.0000021	0.000002	0.0000018	0.0000018	0.0000024	0.0000034	0.0000015	0.0000015	0.0000014	0.0000014	0.0000015	0.0000031	0.0000041	0.0000037	0.0000053
Molybdenum	kg/tonne	0.0000002	0.00000017	0.00000017	0.00000015	0.00000017	0.00000015	0.00000012	0.0000001	0.00000009	0.00000009	0.00000009	0.00000011	0.00000014	0.00000007	0.00000007	0.00000007	0.00000007	0.00000007	0.00000013	0.00000016	0.00000015	0.00000021
Nickel	kg/tonne	0.00000028	0.00000029	0.00000029	0.00000043	0.00000045	0.00000099	0.00000072	0.00000064	0.00000049	0.00000056	0.00000073	0.00000087	0.00000074	0.00000313	0.00000148	0.00000246	0.00000215	0.0000035	0.0000013	0.00000077	0.00000054	0.00000028
Selenium	kg/tonne	0.00000043	0.00000034	0.00000035	0.0000003	0.00000035	0.00000033	0.00000024	0.00000018	0.00000017	0.00000015	0.00000016	0.00000022	0.00000029	0.0000002	0.00000016	0.00000018	0.00000017	0.00000021	0.00000028	0.00000035	0.00000031	0.00000043
Silica	kg/tonne	0.00053	0.00044	0.00044	0.00039	0.00045	0.00041	0.00032	0.00026	0.00025	0.00023	0.00024	0.00029	0.00037	0.00023	0.00021	0.00022	0.00022	0.00024	0.00035	0.00043	0.0004	0.00054
Silver	kg/tonne	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09	1.9E-09
Strontium	kg/tonne	0.00009	0.000105	0.0001	0.00011	0.00011	0.00012	0.00013	0.000139	0.000138	0.000142	0.000144	0.000138	0.00012	0.00018	0.00016	0.00018	0.000171	0.00019	0.00014	0.00011	0.00012	0.00009
Tin	kg/tonne	0.00000076	0.00000077	0.00000077	0.00000077	0.00000077	0.00000077	0.00000077	0.00000077	0.00000077	0.00000077	0.00000077	0.00000077	0.00000077	0.00000076	0.00000077	0.00000077	0.00000077	0.00000076	0.00000077	0.00000077	0.00000077	0.00000076
Thallium	kg/tonne	6.1E-09	6.3E-09	0.00000001	6.7E-09	6.7E-09	8.2E-09	7.6E-09	7.4E-09	7.1E-09	7.3E-09	7.7E-09	8.0E-09	7.6E-09	1.4E-08	9.8E-09	1.2E-08	1.2E-08	1.5E-08	9.1E-09	7.6E-09	7.0E-09	0.00000001
Uranium	kg/tonne	0.00000015	0.00000012	0.00000012	0.0000001	0.00000012	0.0000001	0.00000007	0.00000005	0.00000005	0.00000004	0.00000004	0.00000006	0.00000009	0.00000003	0.00000003	0.00000003	0.00000003	0.00000003	0.00000008	0.00000011	0.0000001	0.00000015
Vanadium	kg/tonne	0.0000004	0.00000031	0.00000031	0.00000026	0.00000032	0.00000028	0.00000019	0.00000013	0.00000012	0.0000001	0.0000001	0.00000016	0.00000024	0.00000009	0.00000008	0.00000008	0.00000008	0.00000009	0.00000022	0.0000003	0.00000026	0.00000041
Zinc	kg/tonne	0.00000038	0.00000038	0.00000038	0.00000049	0.00000051	0.0000009	0.0000007	0.00000063	0.00000051	0.00000056	0.0000007	0.00000082	0.00000073	0.0000026	0.0000013	0.0000021	0.0000018	0.0000029	0.0000012	0.00000076	0.00000057	0.00000038

Source: P:\01_SITES\Telkwa Coal\1CT027.007_2021 Geochemistry Support\Task 500 - Source Term Memo\Tenas_source_term_rpt_tables_1ct027.007_MKH_r1.xlsx

Table 5-4. Processed Rock Flushing Source Term

Parameter	Units	Six Month Exposure	Twelve Month Exposure
Conventional			
Alkalinity	kg CaCO ₃ /tonne	0.0023	0.0045
Major Ions			
Calcium	kg/tonne	0.021	0.042
Magnesium	kg/tonne	0.0063	0.013
Potassium	kg/tonne	0.00018	0.00036
Sodium	kg/tonne	0.000078	0.00016
Chloride	kg/tonne	0.000095	0.00019
Sulfate	kg/tonne	0.083	0.17
Elements			
Aluminum	kg/tonne	0.0000068	0.000014
Antimony	kg/tonne	3.8E-09	7.6E-09
Arsenic	kg/tonne	3.8E-09	7.6E-09
Barium	kg/tonne	0.000007	0.000014
Boron	kg/tonne	0.0000095	0.000019
Cadmium	kg/tonne	0.00000011	0.00000022
Chromium	kg/tonne	1.9E-08	3.8E-08
Cobalt	kg/tonne	0.000001	0.0000021
Copper	kg/tonne	0.00000032	0.00000063
Iron	kg/tonne	0.00013	0.00025
Lead	kg/tonne	5.5E-08	0.00000011
Lithium	kg/tonne	0.0000027	0.0000053
Manganese	kg/tonne	0.000061	0.00012
Mercury	kg/tonne	1.9E-09	3.8E-09
Phosphorus	kg/tonne	0.00000086	0.0000017
Molybdenum	kg/tonne	0.00000018	0.00000037
Nickel	kg/tonne	0.0000024	0.0000049
Selenium	kg/tonne	0.00000039	0.00000079
Silica	kg/tonne	0.00019	0.00038
Silver	kg/tonne	9.5E-10	1.9E-09
Strontium	kg/tonne	0.000077	0.00015
Tin	kg/tonne	0.00000038	0.00000076
Thallium	kg/tonne	0.00000013	0.00000026
Uranium	kg/tonne	2.2E-08	4.5E-08
Vanadium	kg/tonne	3.8E-08	7.6E-08
Zinc	kg/tonne	0.0000048	0.0000095

Source: P:\01_SITES\Telkwa Coal\1CT027.007_2021 Geochemistry Support\Task 500 - Source Term Memo\Tenas_source_term_rpt_tables_1ct027.007_MKH_r1.xlsx

Table 5-5. NAG Rock Flushing Source Term

Parameter	Units	Six Month Exposure	Twelve Month Exposure
Conventional			
Alkalinity	kg CaCO ₃ /tonne	0.027	0.054
Major Ions			
Calcium	kg/tonne	0.001	0.002
Magnesium	kg/tonne	0.0004	0.0008
Potassium	kg/tonne	0.00074	0.00148
Sodium	kg/tonne	0.018279	0.036558
Chloride	kg/tonne	0.00069	0.0014
Sulfate	kg/tonne	0.016	0.033
Elements			
Aluminum	kg/tonne	0.0001242	0.0002484
Antimony	kg/tonne	0.00000003	0.00000007
Arsenic	kg/tonne	0.00000002	0.00000003
Barium	kg/tonne	0.000005	0.000011
Boron	kg/tonne	0.0000095	0.000019
Cadmium	kg/tonne	3.1E-09	6.1E-09
Chromium	kg/tonne	9.2E-08	1.8E-07
Cobalt	kg/tonne	0.00000003	0.00000005
Copper	kg/tonne	1.1E-07	0.00000022
Iron	kg/tonne	0.00003183	0.0000637
Lead	kg/tonne	9.5E-09	1.9E-08
Lithium	kg/tonne	0.0000065	0.0000131
Manganese	kg/tonne	0.00000122	0.00000243
Mercury	kg/tonne	1.9E-09	3.8E-09
Phosphorus	kg/tonne	0.00000368	0.0000074
Molybdenum	kg/tonne	0.00000014	0.0000003
Nickel	kg/tonne	0.00000012	0.0000002
Selenium	kg/tonne	0.0000003	0.0000006
Silica	kg/tonne	0.00036	0.00072
Silver	kg/tonne	9.5E-10	1.9E-09
Strontium	kg/tonne	0.00003	0.00006
Tin	kg/tonne	0.00000038	0.00000076
Thallium	kg/tonne	0.0000000	0.00000001
Uranium	kg/tonne	1.1E-07	2.1E-07
Vanadium	kg/tonne	2.9E-07	0.00000059
Zinc	kg/tonne	0.00000019	0.00000038

Source: P:\01_SITES\Telkwa Coal\1CT027.007_2021 Geochemistry Support\Task 500 - Source Term Memo\Tenas_source_term_rpt_tables_1ct027.007_MKH_r1.xlsx

5.3 Open Pit Wall Rock Runoff

The base case and high case open pit wall rock runoff source terms for the End of NMP, End of EMP and EOM are provided in Table 5-6. The charge balance in all of the wall rock source terms is less than 10%, which is considered reasonable for solutions based on mixing of several averaged HCT loading rates and charge balances were not corrected.

The pH of all solutions was alkaline and the majority of the constituents were higher in the high case source term in comparison to the base case. Concentrations of the following constituents were lower in the high case scenario:

- End of NMP – barium
- End of EMP – calcium and barium
- EOM – aluminum and barium

As noted in Section 5.1, lower concentrations can occur in the high case source term as a result of additional mineral precipitation or sorption as a result of an increase in a limiting reactant.

Table 5-6. Open Pit Wall Rock Runoff Source Terms

Parameter	Units	Open Pit Wall Runoff - End of NMP		Open Pit Wall Runoff - End of EMP		Open Pit Wall Runoff - EOM	
		Typical	High	Typical	High	Typical	High
Conventional							
pH	s.u.	6.4	7.4	6.5	7.4	6.8	7.7
% Error	%	-5.3	-7.3	-5.4	-7.6	0.3	0.4
Alkalinity	mg CaCO ₃ /L	92	901	107	898	211	1815
Major Ions							
Calcium	mg/L	18	49	22	49	15	15
Magnesium	mg/L	10.2	171	12.7	185	5	54
Potassium	mg/L	2.2	37	2.5	37	6.0	61
Sodium	mg/L	36	601	39	575	146.68	1499.8
Chloride	mg/L	1.5	25	1.7	24	5.5	57
Sulfate	mg/L	89	1491	103	1505	158	1620
Dissolved Elements							
Aluminum	mg/L	0.002	0.0014	0.0018	0.001	0.0014	0.0019
Antimony	mg/L	0.0011	0.018	0.0021	0.031	0.0003	0.003
Arsenic	mg/L	0.0011	0.018	0.0021	0.031	0.0001	0.001
Barium	mg/L	0.019	0.0038	0.017	0.0038	0.013	0.0041
Boron	mg/L	0.035	0.59	0.042	0.61	0.08	0.81
Cadmium	mg/L	0.001	0.017	0.0021	0.031	0.00006	0.00062
Chromium	mg/L	0.0012	0.02	0.0023	0.033	0.00074	0.0076
Cobalt	mg/L	0.0015	0.026	0.0027	0.039	0.0006	0.006
Copper	mg/L	0.0014	0.0235	0.0025	0.0367	0.00098	0.010
Iron	mg/L	0.004066	0.000562	0.003536	0.000565	0.001858	0.0003
Lead	mg/L	0.001	0.0095	0.0021	0.007	0.000095	0.00097
Lithium	mg/L	0.02	0.34	0.024	0.35	0.053	0.55
Manganese	mg/L	0.034	0.57	0.043	0.63	0.03	0.31
Mercury	mg/L	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Phosphorus	mg/L	0.0094	0.16	0.0114	0.17	0.0298	0.305
Molybdenum	mg/L	0.0014	0.02	0.0025	0.025	0.0012	0.012
Nickel	mg/L	0.0025	0.043	0.0039	0.058	0.0018	0.018
Selenium	mg/L	0.0018	0.03	0.003	0.043	0.0025	0.026
Silica	mg/L	0.91	15	1.0	15	2.9	30
Silver	mg/L	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005	<0.000005
Strontium	mg/L	0.18	3.0	0.22	3.2	0.27	2.7
Tin	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Thallium	mg/L	0.001	0.018	0.0021	0.031	0.0001	0.001
Uranium	mg/L	0.0012	0.02	0.0023	0.034	0.00087	0.0089
Vanadium	mg/L	0.0016	0.027	0.0028	0.04	0.00237	0.0242
Zinc	mg/L	0.0038	0.063	0.0051	0.074	0.0031	0.032

Source: P:\01_SITES\Telkwa Coal\1CT027.007_2021 Geochemistry Support\Task 500 - Source Term Memo\Tenas_source_term_rpt_tables_1ct027.007_MKH_r1.xlsx

5.4 Processed Coal Stockpile Runoff

The base case and high case coal stockpile runoff source term is provided in Table 5-7. Charge imbalances for the base and high case source terms were -7.7% and -8.7%, respectively. This charge imbalance is considered reasonable and was not corrected. The pH of the coal stockpile runoff was alkaline in both the base and high case source terms. Barium and iron were lower in the high case source term. As discussed previously, this can occur through an increase of a limiting reactant resulting in additional mineral precipitation in the high source term.

Table 5-7. Coal Stockpile Runoff Source Term

Parameter	Units	Processed Coal Stockpile	
		Typical	High
Conventional			
pH	s.u.	7.8	7.9
% Error	%	-7.7	-8.7
Alkalinity	mg CaCO ₃ /L	24	31
Major Ions			
Calcium	mg/L	170	398
Magnesium	mg/L	51	123
Potassium	mg/L	1.6	3.8
Sodium	mg/L	0.64	1.5
Chloride	mg/L	0.95	2.3
Sulfate	mg/L	670	1608
Dissolved Elements			
Aluminum	mg/L	0.0023	0.0026
Antimony	mg/L	0.00011	0.00027
Arsenic	mg/L	0.00011	0.00026
Barium	mg/L	0.0049	0.0033
Boron	mg/L	0.079	0.19
Cadmium	mg/L	0.00087	0.0021
Chromium	mg/L	0.00016	0.00038
Cobalt	mg/L	0.0084	0.02
Copper	mg/L	0.0025	0.0061
Iron	mg/L	0.13	0.044
Lead	mg/L	0.00044	0.0011
Lithium	mg/L	0.023	0.055
Manganese	mg/L	0.49	1.2
Mercury	mg/L	<0.00001	<0.00001
Phosphorus	mg/L	0.007	0.017
Molybdenum	mg/L	0.0017	0.0041
Nickel	mg/L	0.02	0.048
Selenium	mg/L	0.0033	0.008
Silica	mg/L	1.6	3.8
Silver	mg/L	0.0000079	0.000019
Strontium	mg/L	0.65	1.6
Tin	mg/L	0.0032	0.0076
Thallium	mg/L	0.0011	0.0026
Uranium	mg/L	0.00019	0.00045
Vanadium	mg/L	0.00034	0.00081
Zinc	mg/L	0.038	0.092

Source: P:\01_SITES\Telkwa Coal\1CT027.007_2021 Geochemistry Support\Task 500 - Source Term Memo\Tenas_source_term_rpt_tables_1ct027.007_MKH_r1.xlsx

5.5 Particulate Concentrations

Overburden, PAG and NAG mine rock particulate concentrations assuming a TSS concentration of 35 mg/L are provided in Table 5-8.

Table 5-8. Particulate Source Term Concentrations

Parameter	Units	Overburden	PAG Rock	NAG Rock
Aluminum	ppm	0.71	0.033	0.37
Antimony	ppm	0.000013	0.00000048	0.0000019
Arsenic	ppm	0.00062	0.00014	0.00051
Barium	ppm	0.0078	0.00097	0.0066
Bismuth	ppm	0.0000062	0.0000012	0.0000062
Boron	ppm	0.00035	0.000065	0.00035
Cadmium	ppm	0.00001	0.00000054	0.0000025
Calcium	ppm	0.53	0.071	0.6
Chromium	ppm	0.0015	0.00011	0.0012
Cobalt	ppm	0.00054	0.00011	0.00064
Copper	ppm	0.0016	0.0002	0.0013
Iron	ppm	1.3	0.25	1.5
Lead	ppm	0.00074	0.000088	0.00039
Magnesium	ppm	0.33	0.041	0.32
Manganese	ppm	0.032	0.0051	0.025
Mercury	ppm	0.0016	0.0000006	0.0000031
Molybdenum	ppm	0.000023	0.0000055	0.000027
Nickel	ppm	0.001	0.00023	0.0018
Phosphorus	ppm	0.024	0.0012	0.015
Potassium	ppm	0.051	0.0085	0.064
Selenium	ppm	0.0000018	0.0000012	0.0000055
Sodium	ppm	0.02	0.0083	0.077
Strontium	ppm	0.0034	0.00052	0.0033
Thallium	ppm	0.0000023	0.00000034	0.0000019
Thorium	ppm	0.00006	0.000005	0.000096
Titanium	ppm	0.023	0.000047	0.00049
Tungsten	ppm	0.00000088	0.00000032	0.0000018
Uranium	ppm	0.000018	0.0000018	0.000012
Vanadium	ppm	0.0025	0.00021	0.0014
Zinc	ppm	0.0036	0.00066	0.0036

Source: P:\01_SITES\Telkwa Coal\1CT027.007_2021 Geochemistry Support\Task 500 - Source Term Memo\Tenas_source_term_rpt_tables_1ct027.007_MKH_r1.xlsx

6 Summary

Base case and high case source terms were developed for the following:

- Unsaturated NAG rock
- Saturated NAG rock
- PAG rock
- Processed rock
- Open pit wall rock runoff
- Processed coal stockpile runoff
- Particulate concentrations

The above source terms will be carried forward into the site wide water and load balance to evaluate the mixed project discharge water quality. To evaluate uncertainty in the model, both the base case and high case scenarios should be evaluated.

Particulate concentrations should be applied to the corresponding material. For example, when PAG rock is being placed in the management ponds, the PAG particulate concentration should be used. The NAG particulate source term should for drainage from the backfill, management pond embankments, buttresses, open pit wall rock and also in the management ponds when NAG rock is being placed at closure. The overburden particulate concentrations should be applied to overburden piles and facilities that use overburden as a cover.

Closure

This report, Water Quality Model Source Term Derivation Methods, was prepared by



Michael Herrell, MSc, PGeo
Principal Consultant (Geochemistry)

and reviewed by



Signed on Behalf of

Chris Kennedy, PhD, PGeo
Principal Consultant (Geochemistry)

SRK Consulting (Canada) Inc Engineers and Geoscientist BC Permit to Practice No: 1003655

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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