Appendix 13.5-J Selenium Management Plan

TELKWA COAL
LIMITED

BC EAO EAC Application – Tenas Project

Section 13 Management Plans
Chapter 5 Discharge Management Plan
Appendix 13.5-J Selenium Management Plan

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Tenas Project

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ABBREVIATIONS AND ACRONYMS

Abbreviation or Acronym	Long Form of Abbreviation or Acronym
AEMP	Aquatic Environmental Monitoring Program
ALG	Aquatic Life Guideline
ARD	acid rock drainage
BC AWQG	BC Approved Water Quality Guidelines
BC MECCS	British Columbia Ministry of Environment and Climate Change Strategy
BC MEMLI	British Columbia Ministry of Energy, Mines and Low Carbon Innovation
BC SDWQG	BC Source Drinking Water Quality Guidelines
BC WWQG	BC Working Water Quality Guidelines
CCME	Canadian Council of Ministers of the Environment
CCME WQG	Canadian Council of Ministers of the Environment Water Quality Guidelines for the Protection of Aquatic Life
CL	confidence limit
CMERs	Coal Mining Effluent Regulations
COPC	Chemicals of Potential Concern
CPP	Coal Processing Plant
CSM	Conceptual Site Model
DFO	Fisheries and Oceans Canada
DMP	Discharge Management Plan
EAC	Environmental Assessment Certificate
EC	effective concentration
EMA	*Environmental Management Act*
EMS	Environmental Management System
IDZ	Initial Dilution Zone
MA	*Mines Act*
ML	metal leaching
Non-PAG	Not potentially acid generating
PAG	potentially acid generating
PCI	Pulverized Coal Injection
Se	Selenium
SELMP	Selenium Management Plan
SPBCR	Semi-Passive Biochemical Reactor
SPO	Site Performance Objective
SPP	Standard Practices and Procedures

Abbreviation or Acronym	Long Form of Abbreviation or Acronym
SRFs	saturated rock fills
TARP	Trigger Action Response Plan
TCL	Telkwa Coal Limited
TCP	Tenas Control Pond
WQG	water quality guidelines
WSC	Water Survey of Canada

EXECUTIVE SUMMARY

TCL has developed this Selenium Management Plan (SELMP), which is appended to the **Discharge Management Plan (DMP)** to support the Tenas Project (Project) application for an Environmental Assessment Certificate (EAC) in British Columbia (BC), and subsequently, *Mines Act (MA)* and *Environmental Management Act (EMA)* permits for the Project.

This SELMP was created to address concerns and provide rationale for selenium (Se) management based on baseline data, predictions from water quality modelling, Se bioaccumulation modelling, and site-specific benchmark development. The SEMP will propose and describe management and mitigation measures to be incorporated into Project design and operations to reduce any potential impacts associated with elevated Se concentrations.

The primary purpose of this SELMP is to minimize effects to the environment and subsequent valued components of Fish and Fish Habitat, Aquatic Life, wildlife and people and land use. Management of the Tenas Project's Se discharges, and the ability to meet compliance objectives, will require diligent operational planning, monitoring and action. Through implementation of the various strategies, activities, monitoring and adaptive management in this SELMP, together with relevant Standard Practices and Procedures (SPPs) that will be developed, TCL will ensure that the primary purpose of this management plan is achieved.

1. INTRODUCTION

The Tenas Project (the Project), which is being developed by Telkwa Coal Limited (TCL), will comprise the development of a surface metallurgical coal mining operation located 25 kilometres (km) south of the town of Smithers and 7 km west of the village of Telkwa, in British Columbia (BC), Canada. The Project is accessed from the community of Telkwa by an all-weather public road. The mine is located intermediate to the Bulkley Range of the Hazelton Mountains and the low-lying gently rolling relief of the Nechako Plateau. The Bulkley Range is clearly visible to the north and west of the property where the landscape is bedrock controlled, while within the property limits, and easterly, topography is rounded and covered with widespread glacial drift. The two primary products to be produced by the Tenas Mine are a semi-soft coking coal and coal for pulverized coal injection (PCI) in a blast furnace.

TCL has developed this Selenium Management Plan (SELMP) to support an application for an Environmental Assessment Certificate (EAC) in BC, and subsequently, *Mines Act (MA)* and *Environmental Management Act (EMA)* permits for the Project. TCL recognizes that effluents from coal mining operations can potentially lead to adverse environmental impacts to aquatic resources including those biological/ecological impacts resulting from elevated selenium (Se) concentrations in water bodies from surface water exposed to waste rock.

This SELMP was created to:

a) address concerns and provide rationale for Se management (based on baseline data, predictions from water quality modelling, Se bioaccumulation modelling, and site-specific benchmark development); and
b) describe management and mitigation measures to be incorporated into Project design and operation to reduce any potential impacts associated with elevated Se concentrations.

The purpose of this SELMP is to minimize risk to the environment and subsequent valued components of Fish and Fish Habitat, Aquatic Life, wildlife and people and land use. This document should be read in conjunction with; the **Minesite Water Management Plan (MWMP) (S13.0-C11)**, and within the **MWMP**, **Appendix 13.11-E - Water Monitoring Program**; and the **DMP**.

This SELMP will be updated a minimum of six months before the commencement of mining activities to account for refinement in engineering design and collection of additional baseline data. Moreover, TCL will be providing the British Columbia Ministry of Environment and Climate Change Strategy (BC MECCS) with updates to this plan, as part of its annual Aquatic Environmental Monitoring Program (AEMP) reporting.

2. OBJECTIVES

The objectives of this SELMP are to describe TCL's approach to:

- reducing Se loadings in both receiving water bodies downstream and end of pipe discharge in comparison to current (i.e., pre-Project development/baseline) conditions, to limit any potential effects on surface water and groundwater quality to meet existing BC water aquatic life guidelines (ALGs) and/or Site Performance Objectives (SPOs) developed for the Project;
- identifying mitigation techniques and/or technologies that could be employed to achieve the above-mentioned ALG and/or SPOs; and
- monitoring and evaluating the effectiveness of SELMP over time, to implement learnings through research and development (conducted by TCL and/or other similar coal mining operations) to further reduce Se loadings and/or identify any potential downstream effects that will require additional mitigation efforts.

3. SCOPE AND SCALE

The scope of the SELMP is defined within Project Area. It is anticipated that this boundary will not change over the life of the Project; however, if changes are required, this will be discussed with local stakeholders and regulators to obtain input prior to implementation of modifications.

The SELMP will be in effect during all Project phases and ceases to be in force at the final closure of the Project as approved by the regulatory authorities.

4. REGULATORY FRAMEWORK AND COMPLIANCE OBLIGATIONS

4.1 Regulatory Framework

TCL is currently in the process of developing an application for approval of a BC EAC for the Project to include appropriate conditions to activate mining activities. Consistent with other coal mines at which Se concentrations have been observed downstream of mining activities (e.g., Teck's Elk Valley mines), TCL anticipates that the EAC and subsequent mine permits will include the requirement to develop and implement an SELMP, and report on associated mitigation and management activities.

For situations where predicted modelled Se concentrations exceed British Columbia aquatic life guidelines (i.e., ALGs), a scientifically-defensible, Project-specific target water quality objective for Se (identified as a Site Performance Objective (SPO)) were established to understand risk to aquatic receptors, (Windward and Borealis, 2021) (**Section 6.1**).

As described above, predicted Se concentrations in the downstream receiving environment have the potential to be elevated above ALGs during some winter low-flow conditions during the Post-closure phase of the Project. Selenium concentrations modelled at various prediction nodes (i.e., leaving the Project footprint/Area and at various points downstream) may exceed applicable guidelines at various periods of the Project's life, specifically in the Post-closure phase, and during specific seasons, mainly during winter low-flow conditions.

Table 4.1-1: Surface Water Quality Guidelines for the Protection of Aquatic Life (North America) and the Site Performance Objective for Selenium derived for the Tenas Project.

Jurisdiction (Reference)	British Columbia (Beatty and Russo, 2014) Alberta (Government of Alberta, 2018)	CCME Water Quality Guidelines (CCREM 1987)	U.S. EPA Aquatic Life Criteria (US EPA, 2016)	BC SPOs for Se at other mine sites	Project Site Performance Objective (Windward and Borealis, 2021)
Selenium guideline/criterion (mg/L)	0.0020	0.0010	0.0015 (lentic; slow-moving) 0.0031 (lotic; fast-moving)	Murray River 0.010 Trend/Roman 0.010 Red Chris 0.010 Kemess North 0.014	0.0080 (Tier 1; see section 6.2) Tier 2 values are dependent on sulphate concentrations; Table 6.2-1 below.

TCL is confident that the proposed mitigation/management measures described below will result in Se concentrations in the downstream environment below the SPO provided in **Table 4.1-1** above.

4.2 Compliance Obligations

This subsection summarizes the relevant compliance requirements and obligations that the SELMP will address.

Compliance reporting will be subject to the Environmental Assessment Certificate (EAC), and the *Mines Act*, RSBC 1996, c 293 and *Environmental Management Act*, SBC 2003, c 53 permit (*MA/EMA* permit) conditions. The information gathered during monitoring practices will be summarized with information from other management plans into an Annual Environmental Management Summary Report and upon permitting completion, the Annual Environmental Reports, as required by *MA/EMA* permits.

Several legislative requirements are applicable to Se discharge from the site. A list of these, and their major applicable components, are provided in **Table 4.2-1** below.

Table 4.2-1: Legislation, Regulations and Guidelines Relevant to the Selenium Management Plan

Legislation and Regulations (Federal and Provincial)	Applicable Information
Federal	
Fisheries Act (1985) (Federal; DFO)	Prohibits serious harm to fish that are part of a commercial, recreational, or Aboriginal fishery, including the permanent destruction of habitat
Coal Mining Effluent Regulations (*CMER*s) (Federal; ECCC)	Proposed to come into force 2023; will likely not apply to the Tenas Mine until 2026.
Provincial	
BC *Water Act* (1996) (Provincial; MFLNRO)	Provides guidelines for the issuance of approvals to make changes in or about a stream
BC *Water Sustainability Act (2016)* (Provincial; MFLNRO)	Principal provincial act for managing the diversion and use of water resources
BC *Environmental Management Act* (2003) (Provincial; BC MECCS)	Rules regarding environmental management for industry, including effluent permitting
BC *Water Sustainability Regulations* (2021) (Provincial; BC MFLNRO)	Details the requirements in applications for licences and industrial use approvals
BC *Waste Discharge Regulation* (2019) (Provincial; BC MECCS)	Provides details on effluent permitting
Guidelines (Federal and Provincial)	**Applicable Information**
Federal	
Canadian Council of Ministers of the Environment. 2021. Water Quality Guidelines for the Protection of Aquatic Life. (CCME)	National guidance for water quality protection of aquatic life
Provincial	
British Columbia Ministry of Environment. Working Water Quality Guidelines for British Columbia.	Provincial working guidelines for water quality protection
British Columbia Ministry of Environment. Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture Summary Report. Water Protection & Sustainability Branch.	Provincial approved guidelines for water quality protection
British Columbia Ministry of Environment. 2015. Assessing the Design, Size, and Operation of Sediment Ponds Used in Mining. Environmental Protection Division.	Provincial guidelines design and operation of sediment ponds in mining
British Columbia Ministry of Environment. 2016. Annual Reporting under the *Environmental Management Act.* Environmental Protection Division.	Provincial guidelines for annual reporting under the environmental management act
British Columbia Ministry of Environment. 2019. Development and Use of Initial Dilution Zones in Effluent Discharge Authorizations. Environmental Protection Division.	Provincial guidelines for developing an IDZ for discharge authorizations
Joint Application Information Requirements (JAIR) (2019)	Provides guidance on *Mines Act/Environmental Management Act* permit applications and management plans.

4.3 Standard Practices and Procedures

TCL Standard Practices and Procedures (SPPs) will conform to the Code. In addition to regulatory requirements, the Project will implement SPPs that meet or exceed the required laws and regulations.

5. RELATIONSHIP TO OTHER MANAGEMENT PLANS

The Project is governed by an Environmental Management System (EMS), an overarching management plan strategy comprising a set of processes and practices which enable TCL to manage its environmental and safety performance in a holistic way, within an integrated framework. In addition to the overall guidance of the EMS, this SELMP has a relationship with other management plans that also present mitigation measures. Those management plans and their relationship to this SELMP are listed below in **Table 5-1**.

Table 5-1: Management Plans with Relationship to the Selenium Management Plan (SELMP)

Management Plan	Nature of Relationship
Environmental Management System (S13.0-C1) (EMS)	All management plans are part of the EMS.
Construction Environmental Management Plan (S13.0-C4) (CEMP)	The plan describes activities that will facilitate water management activities during the construction of the Project. It will use this SELMP for any items specifically related to Selenium (Se).
Discharge Management Plan (S13.0-5) (DMP)	The plan describes activities that will facilitate water management activities during the Operation Phase of the Tenas Project (Project). It will use this SELMP for any items specifically related to Se.
Minesite Water Management Plan (S13.0-C11) (MWMP)	Detailed site water management and monitoring programs to handle site discharges. It will use this SELMP for any items specifically related to Se.
Metal Leaching (ML)/Acid Rock Drainage (ARD) Management Plan (S13.0-C12) (ML/ARDMP)	Detailed management of constituent leaching which could affect discharge water quality, including metals. This may include any specific mitigations and additional monitoring related to Se.
Reclamation and Closure Plan (S13.0-C15) (RCP)	Site water effluent will continue into the Post-closure Phase of the Project. This may include any specific mitigations for Se.

6. DETAILS OF THE SELENIUM MANAGEMENT PLAN (SELMP)

In the Project Area, there are two potential discharge pathways to the downstream receiving environment:

- mine-affected groundwater discharge through infiltration and seepage from the open pit, Tenas Control Pond (TCP), sedimentation ponds, water storage ponds, and management ponds; and
- surface water discharge from the TCP, selected sedimentation ponds, during the Operation Phase, and the North Management Pond during the Post-closure Phase.

The travel time for Project-affected groundwater to reach receptors with the Project Area exceeds the duration of the Operational Phase of the Project; therefore, this SELMP focuses on controlled surface water effluent releases.

6.1 Effluent Discharge Limits

In the Canadian federal jurisdiction, end-of-pipe limits for discharge of mine effluent to the environment are not currently specified for the coal mining sector; however, the federal *Fisheries Act* (s. 35) still applies with respect to effluent not being acutely lethal to fish. The Coal Mining Effluent Regulations (CMERs), to be regulated under the federal *Fisheries Act*, are currently in development and are expected to come into effect sometime in the future. The CMERs are expected to specify end-of-pipe limits for pH, total suspended solids (TSS), nitrate and total Se for both existing and new coal mines (ECCC, 2022). The current proposed parameters by the federal government for BMERs are as follows for an existing coal mine, which would be the designation of this Project:

- Nitrate;
- Selenium;
- TSS; and
- Ph.

The calculated end-of-pipe discharge concentrations for total Se were developed considering in-stream water quality objectives for Goathorn Creek, which is the primary discharge location for the Project, corresponding to BC AWQGs and SPOs, respectively. The end-of-pipe concentrations were estimated based on IDZ modeling (SRK 2021a) to meet TG11 guidance for flow conditions representing reasonable-worst case during Post-closure (Table 6.1-1), since it represents a conservative, yet realistic, scenario. For a conservative estimate, Goathorn Creek background concentrations corresponding to the 95th percentile concentration were determined at 0.00020 mg/l. Based on the SPO developed for total Se in the receiving environment, the end-of-pipe concentration was back-calculated to be 0.050 mg/L.

Table 6.1-1: Calculated End-of-pipe Discharge Concentrations for Total Selenium

Parameter	Goathorn Creek Background Concentration, 95th percentile (µg/L)	In-stream Water Quality Requirement (µg/L)		Calculated end-of-pipe concentration based on SPO (µg/L)	Calculated end-of-pipe concentration based on the BC ALG (µg/L)	Max end of pipe concentration during Post Closure Phase (µg/L)
		Source	Value			
Total Se	0.20	SPO (Tier 1)	8.0	50.0	12.5	15

6.2 Site Performance Objective (SPO) for Selenium

The aquatic effects assessment under the Aquatic Resources Valued Component (VC) is a key component of the mine's comprehensive Environmental Assessment (EA) and includes the establishment of a site-wide water balance and various water management plans and supports effluent permitting and regulatory approval efforts and is based on water quality modelling results developed by SRK Consulting (SRK 2021b). These modelling results indicate that effluents (i.e., end-of-pipe discharges) from the mining operation, and several Post-closure scenarios, may result in downstream Se concentrations in the receiving environment that could have the potential to exceed the BC aquatic life guidelines. Based on this result a site-specific Se bioaccumulation model was developed for the Project Area to determine a Se SPO for the Project. In addition to complementing the Aquatic Resources Valued Component effects assessment for the Tenas Project EA, this model also supported the development of site-specific water quality objectives for provincial surface water permitting and other regulatory approvals (i.e., Site Performance Objectives (SPO); the latter can be used in the development of both final discharge point (FDP) concentration limits and in-stream environmental compliance point (ECP) monitoring Se benchmarks.

While details are provided in the Technical Memorandum by Windward and Borealis Environmental Inc. (2021), a summary of the Se bioaccumulation model development, and the resulting SPO is provided below.

Paired water and invertebrate Se data were compiled from receiving waters downstream from three coal mining regions in British Columbia and Alberta (northeast and southeast BC and central Alberta). A 75th quantile hockey stick regression model was fit to this data and coupled with a 75th quantile invertebrate-to-rainbow trout egg Se model to develop a two-step relationship between Se concentrations in water and the rainbow trout egg Se EC10 of 24.5 mg/kg dw. The two-step 75th quantile model resulted in a back-calculated water Se concentration of 8.0 µg/L (CI: 6.7-11.2 µg/L), which is the Tier 1 SPO selected by this study (**Table 6.2-1**).

The back-calculated water Se concentration of 8.0 µg/L is comparable to the water Se screening guideline of 6.5 µg/L for lotic waters, recommended by DeForest et al. (2017) and other SPO values of 0.10 µg/L developed for other existing coal mines in British Columbia (see **Table 4.1-1**). In the latter study, sulphate-dependent water Se guidelines were also recommended for lotic sites in which Se was present as selenate. Given the similarity of the back-calculated water Se concentration of 8.0 µg/L in the present analysis, compared to the lotic screening guideline of 6.5 µg/L recommended in DeForest et al. (2017), the sulphate-dependent guideline from that study was identified as the Tier 2 SPO for this Project to account for the mitigating influence of sulphate on Se bioaccumulation (for example, use of a conservative 90th quantile

model results in a recommended sulphate-dependent guideline of 34.0 µg/L when the sulphate concentration is 250.0 mg/L) (**Table 6.2-1**).

The Tier 1 and Tier 2 water Se SPOs are both based on conservative assumptions. Modelled Se concentrations in certain receiving waters downstream of the Project are not expected to exceed the Tier 1 SPO of 8.0 µg/L. However, if exceedances could occur, they will occur during late fall and winter, which are mostly likely to overstate potential Se exposure during which biological productivity is at its lowest. Further, the periods with highest modelled Se concentrations also have the highest modelled sulphate concentrations (e.g., >250 mg/L at WQS03_DS), such that no Se concentrations will exceed the Tier 2 sulphate dependent Se SPO.

Table 6.2-1: Recommended Tier 1 and Tier 2 Selenium SPOs (Windward and Borealis, 2021).

Selenium SPO (µg/L)	Basis
Tier 1: 8.0 µg/L	Back calculated from two-step model described in present study (90% CI: 0.0067-0.0112).
Tier 2: Sulphate-dependent µg/L	Based on 90th quantile model in DeForest et al. (2017). For example: Tier 2 SPOs are 14.0, 20.0, 27.0, and 34.0 at sulphate concentrations of 1,000,000, 1,500,000, 2,000,000, and 2,500,000 mg/L, respectively.

6.3 Selenium Mitigation Strategies

The main objective of this SELMP, together with relevant SPPs, is the implementation of various mitigation strategies, activities, monitoring, and adaptive management, to ensure that all objectives are met**.** Selenium mitigation strategies will be employed using the multiple-lines-of-defense approach, as outlined in Gilron and McKenna (2021). The following section (**6.4**) includes descriptions of additional mitigation strategies and contingency measures to be implemented in response to exceedances of the above-described SPOs for Se for a two-year duration; the latter will be based on on-going Se monitoring for the Project.

6.4 Project Implemented Mitigation Strategies

The following sections provide additional information on the mitigation strategies that are currently implemented as part of the Project. Some of these mitigations while being put in place were not recognized by the Water and Load Balance (SRK, 2021b). **Table 6.4-1** below summarizes the mitigation measures implemented with how they were accounted for in the Water and Load Balance (SRK 2021b).

Table 6.4-1: Mitigation Measures in Relation to Water and Load Balance for the Tenas Project

Mitigation Measures Currently Employed	Accounted for in the Water and Load Balance
Saturated Mine Rock Backfill Reactors	No
Material Pile Design to limit oxygen and water ingress	Included in Decommissioning and Reclamation and Post-Closure phases, progressive reclamation not included in Operation and Construction phases this should produce lower actual concentrations versus current water and load balance model (SRK 2021)
Non-contact water channels	Yes
Cross Valley Fills	Yes
Impoundments to ensure more material is underwater	Yes
Wetlands in Operation and subsequent Project phases	No
Rock Drains	Yes
Source Control	No
Material submerged below water	Partially, as only management ponds are included, and open pit flooding are not considered until the Post-closure Phase of the Project, this should produce lower actual concentrations versus current water and load balance model (SRK 2021)

6.4.1 Saturated Mine Rock Backfill Reactors

Background. Saturated (or near-saturated) conditions provide the low-oxygen environment required for the reduction of Se. In addition, storing mine rock under water-saturated conditions in open pits or impoundments that have been constructed eliminates exposure of submerged rock to oxygen, greatly limiting Se oxidation and, therefore, the release of Se to effluent discharged to the receiving environment. Saturated rock fills (SRFs) have more recently been employed at coal mines in western Canada (e.g., Teck 2021) as a water management strategy to reduce elevated concentrations of Se derived from the oxidation of minerals in coal and mine rock. Teck recently announced a doubling of the water treatment capacity at its Elkview operations.[1] Claridge et al. (2012) show how saturated zones may be constructed at the base of mine rockpiles in the thalweg of valleys.

Tenas Project Implementation. The management ponds for the Tenas Project have been designed to function as saturated mine rock backfill reactors with processed coal rock containing a carbon source being added to these systems as they are constructed with the addition of pipes being incorporated into the backfills to allow for the addition of mine-affected water near the bottom of the saturated mine rock backfills. These backfills are expected to be an anoxic environment, with the addition of supplemental carbon sources such as ethanol and/or methanol via pipes near the mid elevation point of the saturated mine rock backfills and pipes to draw treated water out from the bottom of the pond. The current load and water balance (SRK 2021b) for the Project does not provide any attenuation of chemical parameters for this mitigation including Se.

[1] https://www.teck.com/news/news-releases/2021/teck-doubles-water-treatment-capacity-at-elkview-operations

6.4.2 Pile Design to Limit Oxygen and Water Ingress

Background. Selenium source control is accomplished by limiting the:

- ingress of water (i.e., run-off water onto the mine rock pile, net percolation through the plateau or slopes of the mine rock pile, and groundwater coming from the hillslope);
- ingress of oxygen into the mine rock pile during construction and after placement of the cover system and reclamation phase; and,
- movement of oxygen within the mine rock pile.

Large mine rockpiles, based on recent research from seasonal sub-oxic zones, can yield oxygen levels <5% (vs 21% in the air) due to the oxidation of carbon and pyrite within the mine rock pile (Barbour et al. 2016). Rates of Se oxidation in these sub-oxic zones are much lower in comparison with well-oxygenated areas of the mine rockpile. For those rockpiles in which the transport via air is restricted through various methods (e.g., use of internal structures, covers on the mine rock, material compaction), field observations and modelling have indicated that the sub-oxic zone expands to include most of the mine rockpile (Meiers et al. 2018; O'Kane et al. 2019); and therefore, this has the potential to reduce the amount of Se oxidation, and the mobility of Se within the mine rockpile that could be mobilized into the surrounding environment. If practical, an excellent method of source control is the permanent submergence of mine materials with an identified potential for acid rock drainage (ARD) or metal leaching (ML) as there is almost no oxygen, and, as a result, the Se cannot oxidize and hence is prevented from entering the surrounding environment.

Tenas Project Implementation. Non-Pag rockpile design (backfills, management and control pond embankments and buttresses) developed as part of the Project's material management plan will incorporate various methods aimed at optimizing the reduction of the ingress of oxygen and water (bottom up construction of backfills, embankments and buttresses, lower lift thicknesses to promote compaction, alternating overburden and non-Pag rock lifts) to minimize the oxidization of Se; this will reduce additional Se inputs to the aquatic environment. This will be accomplished through building piles and backfill from the bottom up in semi-compacted lifts and covering these piles with overburden and surface soils to reduce the volume of water and oxygen entering these piles. The current water load balance model (SRK 2021b) does not provide any attenuation of chemical parameters for this mitigation until the Decommissioning and Reclamation Phase of the Project.

6.4.3 Non-contact Water Channels

Background. Diversion channels in mountainous environments are usually dug into bedrock and could also cross talus fans and zones of fractured bedrock, both of which require measures to avoid unacceptably high losses of water from the channels. Diversion channels which keep non-contact water out of mining areas, have high capital and maintenance costs and are prone to blockage by debris flows, ice accumulation, and snow avalanches. In some cases, the diversion channels can be moved on top of reclaimed mine rockpiles with the use of large, lined channels constructed as part of the cover system.

Tenas Project Implementation. Surface water diversion channels will be established at the Tenas Project and used to intercept non-contact water runoff from upslope of the open pit, coal processing facilities, and mine rockpiles, to minimize the volume of contact water entering the Project Area and to reduce the transport of Se.

6.4.4 No Cross Valley Fills

Background. In the document entitled A Strategic Plan for the Management of Selenium at Teck Coal Operations (Swanson et al., 2010), avoidance of cross valley fills was recommended as a mitigation practice, as it relates to the reduction of Se in the aquatic ecosystem.

Tenas Project Implementation. Cross valley fills will not be used for the placement of mine rock for the Tenas Project.

6.4.5 Impoundments to Put More Material Under Water

Background. Reduction of Se oxidation to very low levels can be accomplished by the placement of mine rock below the water table. A common method to prevent or reduce oxidation is to design open pit backfills to create large saturated zone(s). Another useful strategy may be to flood mine rock in an engineered impoundment constructed by embankments or excavation, or a combination of both. It needs to be demonstrated that any strategy that relies on submergence under water to prevent the above-mentioned oxidation is permanent, and that any potential leaks through the foundation would not compromise such a system. Based on the current state-of-practice internationally, the submerging of mine material under water (as is applied to limit ARD at mines) to limit oxidation is considered a mature technology, backed by years of experience and has a solid technical basis. It is also a commercial-scale technology for managing Se production from mines.

Tenas Project Implementation. In the current mine plan, TCL has included management ponds that will allow all potentially acid-generating (PAG) materials and some non-PAG rock to be placed under water and keep them saturated for permanent storage. Furthermore, internal embankments will be constructed within the open pit to allow water levels to be raised up towards the Pre-Project water table. The current water and load balance (SRK 2021b) does not account for any internal open pit embankments and subsequent flooding of NAG rock and attenuation of chemical parameters.

6.4.6 Use of Non-Se material for Rock Drains

Tenas Project Implementation. Non-Se material will be used for the construction of rock drains to mitigate the potential impact of any additional Se into surface water at the Tenas Project. The current mine plan does not have any rock drains outside of the open pit for external piles.

6.4.7 Engineered Liners to Reduce Seepage from Management Ponds

Background. During the planning phases for the Tenas Project, it was determined that a liner should be incorporated into the design of management ponds that are based in overburden materials to reduce the amount of seepage from these ponds and subsequent effects on baseflow parameter concentrations. Another requirement of the liner is to reduce the quantity of seepage flows from the management ponds to ensure a positive water balance for these structures and allow PAG material to stay saturated underwater in perpetuity. SRK also conducted a sensitivity analysis on the water balance for the management ponds and determined that liners are not required for the majority of the area based on metrological conditions for the Project; however, we will incorporate them which will demonstrate the robustness of the plan.

Tenas Project Implementation. In the current plan for the management ponds, TCL has incorporated a 30.5-centimeter (cm) thickness of liner material comprised of approximately 5 percent (%) bentonite material and insitu till/overburden materials on overburden material that is comprising the inside of each management pond.

6.5 Additional Mitigations

TCL is confident that the above-described measures will ensure that receiving environment Se concentrations will not exceed the SPOs developed for the Project (Windward and Borealis, 2021), which are based on a scientific evaluation of the existing conditions. However, if monitoring demonstrates that the mitigations provided above are not attenuating Se in relation to the predicted concentrations and that there is a potential to exceed the proposed SPOs, TCL is suggesting six (6) additional mitigations to be employed through the adaptive management process based on the order that they will be applied, as follows:

1. Source control with Microbes
2. Thicker engineered liners for management ponds;
3. Semi-Passive Biochemical Reactors;
4. Advanced Covers for non-PAG rock;
5. Wetland development, and
6. Active Treatment.

6.5.1 Source Control with Microbes

Background. Enhancing the activity of Se-reducing bacteria, particularly in SRF reactors (described in Section 6.4.1), by adding carbon that is readily available for consumption, may be an important aspect of mine design (Kirk et al., 2017). The current state of practice indicates that a wide variety of carbon sources can be used (e.g., ethanol, hay, molasses). Mudstones and coal in the mine rock already act as a carbon source for bacteria; however, whether these sources are sufficient is not yet well understood. Carbon can also be added using a number of differing methods to material being backfilled into saturated conditions to assist with this option. It should be noted that carbon enhancement using the examples provided, can influence effluent water quality; therefore, a site-specific evaluation would need to be conducted in order to establish implications for effluent water quality.

Tenas Project Implementation. It is currently envisioned that additional carbon will be added to the saturated rock fill material in the form of ethanol, methanol or other forms and Se-reducing bacteria can even be added directly during the construction and operation of the saturated rock fills. The current water load balance model (SRK 2021b) does not provide any attenuation for this mitigation.

6.5.2 Engineered Liners to Reduce Seepage Amounts from Management Ponds

Background. Please see **Section 6.4.8** for a background discussion on engineered liners.

Tenas Project Implementation. In the current plan for the management ponds, TCL has incorporated a 30.5 cm thickness of liner material, comprised of approximately 5% bentonite material by mass and insitu till/overburden materials on overburden material that will encompass the inside of each management pond. However, based on work completed to date, TCL will commit to a 51 cm thickness liner for all overburden locations within the North and East Management ponds but remain with a 30.5 cm thickness in the West Management Pond. TCL is currently planning on completing a bench scale lab program to determine the optimized bentonite mass requirements to minimize seepage rates. TCL is also planning to complete a 50 m by 50 m pilot program at the Project at least one (1) year prior to construction to confirm the optimized quantity of bentonite to add and measure field permeability rates to adjust the final design of the liner for the first management pond. This has not been accounted for in the current Water and Load Balance (SRK 2021b)

6.5.3 Semi-Passive Biochemical Reactors (SPBCR)

Background. The general concept behind a semi-passive biochemical reactor system (SPBR) is to set up a pond that will encourage the growth of naturally occurring bacteria to form a reducing environment, thereby allowing microbial communities to transform selenium, nitrates and sulphates into stable inert compounds that will precipitate out of treated water within the Pond.

Tenas Project Implementation. It is currently envisioned that a pilot project will be completed by the end of Year 1 of the Operation Phase to assess this semi passive methodology for the Project and provide actual monitoring results and operational parameters for a detailed design to be completed by the end of Year 1 and, if monitoring indicates the Se levels are expected to be above Tier 1 and Tier 2 SPO levels, after the incorporation of mitigations provided in Sections 6.5.1, and 6.5.2, that this mitigation would be incorporated into Year 2 of the Operation Phase with the construction of a full scale SPBCR.

6.5.4 Advanced Covers for non-Pag rock

Background. During the detailed engineering phase, a simple overburden and surface soil cover is planned for all NAG-rock backfill and materials within the management pond embankments and buttresses; however, this cover methodology must wait for the Decommissioning and Reclamation Phase as the features are built as bottom-up structures from the toe up to the final crest. Additionally, the implementation of temporary geomembrane covers that have almost a 100% reduction in infiltration can be implemented progressively as these covers do not need to last beyond the end of the Operation Phase. Conceptually, the plan would be to install a geomembrane in Years 5, 10, and 15 to cover whatever exposed NAG-Rock is present, and then continue to build subsequent lifts of NAG Rock on these covers. The installation of the cover will require the following:

- installation of protective filter fabric on both sides of the geomembrane if required, and
- incorporation in thinner lifts of NAG-Rock for the layers immediately above the geomembrane liner.

Tenas Project Implementation. It is currently envisioned that a detailed design for this methodology will be completed by the end of Year 2 of the Operation Phase. Should monitoring indicate that Se levels are expected to be above Tier 1 and 2 SPO levels in the Post-closure Phase, along with the additional mitigation methodologies provided in Sections 6.5.1, 6.5.2 and 6.5.3 being incorporated into the Se management plan, this mitigation will be incorporated into Year 4 of the Operation phase by covering NAG rock with geomembrane covers.

6.5.5 Wetland Development During the Operation, Decommissioning and Reclamation and Post-closure Phases of the Project

Conditions conducive to the attenuation of Se, should concentrations exceed the developed SPO will be enhanced through “bio-engineered” treatment techniques (e.g., wetlands, semi-passive biochemical reactors, and end pit lakes). These are often a viable alternative, as they capitalize on natural landscape features, have significant advantages and are generally more aesthetically pleasing than engineered, active treatment systems (e.g., water treatment system). These can also pose challenges, as monitoring and management are required to ensure effective Se removal from surface waters. Two case studies of wetlands systems (with demonstrated Se removal Se (as %)) are summarized below in **Table 6.4.6-1.**

Table 6.5-1: Case Studies of Wetland Selenium Treatment (modified from Martin *et al*. 2010)

Project	Location	System Type	Treatment Methodology	Se concentration (in µg/L)		% Removal
				Inflow Concentration	Final Outflow	
Chevron Marsh	San Francisco Bay, CA	Constructed surface-flow wetland	Adsorption/precipitation, biological uptake by plants, and volatilization to the atmosphere	20.0 to 30.0	< 5.0	85%
Benton Marsh	Great Falls, MT	Engineered natural system comprising perennial and seasonal wetlands	Adsorption/precipitation, biological uptake by plants, and volatilization to the atmosphere	26.0	< 1.0	97%

Tenas Project Implementation. It is currently envisioned that a detailed design for this wetland methodology will be completed by the end of Year 3 of the Operation Phase and if monitoring indicates that Se concentrations are expected to be above Tier 1 and 2 SPO values in the Post-closure Phase with the mitigations implemented as part of **Sections 6.5.1, 6.5.2, 6.5.3**, and **6.5.4** above than this mitigation will be incorporated into Year 5 of the Operation Phase.

6.5.6 Active Treatment Options

Background. There are several active treatment options for Se that are in current operation or in approved EA certificates in BC as follows:

- GE Biological (Suez Abmet) at Trend Mine, Tumbler Ridge, BC;
- BQE Selen-IX (BQE Water) at Kemess North Mine, Williams Lake, BC;
- Fluidized Bed Reactor (Envirogen), modified to advanced oxidization pathway, at Elkview and Line Creek mines, Elk Valley, BC; and
- Frontier SeHawk, proposed for Hermann Mine, Tumbler Ridge, BC.

Based on TCL's review of the current methods provided above and actual operating history and results from North America, the SeHawk method from Frontier Water is considered a viable option that will be pursued further by TCL.

Tenas Project Implementation. It is currently envisioned that a detailed design for an Active Treatment option for selenium will be completed by the end of Year 4 of the Operation Phase and if monitoring indicates the Se levels are expected to be above Tier 1 and 2, SPO levels with mitigations implemented as part of **Sections 6.5.1, 6.5.2, 6.5.3, 6.5.4** and **6.5.5** above are incorporated into the Se management plan then this mitigation would be incorporated into Year 6 of the Operation Phase with the construction of an active treatment plant.

7. ROLES AND RESPONSIBILITIES

Primary responsibilities have been assigned to the following groups:

7.1 Mine Manager

The Mine Manager bears overall responsibility for all phases of the Project, and responsibility for on-site environmental monitoring and compliance. The Mine Manager reports to the TCL executive steering committee and will coordinate with this group to ensure that Project objectives are being met.

Specifically, the Mine Manager has the overall responsibility to ensure:

- implementation of the SELMP;
- provision of the necessary budget and resources to allocate sufficient resources to carry out the SELMP;
- completion of an annual inspection of water management infrastructure;
- participation in periodic risk assessments associated with SELMP; and
- facilitation of the annual review of the SELMP.

7.2 Mine Superintendent

The Mine Superintendent will:

- complete an annual review of the SELMP;
- complete quarterly inspections of water management infrastructure; and
- provide equipment and personnel to carry out maintenance of water management infrastructure, when requested.

7.3 Environmental Coordinator

The Environmental Coordinator will:

- complete an annual review of the environmental aspects SELMP;
- complete reporting to regulatory agencies and for the Annual Environmental Management Summary Report related to the SELMP; and
- complete quarterly inspections of environmental aspects water management infrastructure.

7.4 Environmental Scientist

The Environmental Scientist will:

- provide vacation cover for the Environmental Coordinator;
- assist Environmental Coordinator, as required, with the Annual Environmental Management Summary Report; and

- assist the Environmental Coordinator with inspection and monitoring related to the SELMP.

7.5 Quality Assurance/Quality Control (QA/QC) Technician

The Quality Assurance/Quality Control (QA/QC) Technician will:

- collect water, soil, coal, rock, overburden, and dust samples using standard industry BMPs and QA/QC methodologies;
- assist the Environmental Co-ordinator as required with the Annual Environmental Management Summary Report;
- assist the Environmental Co-ordinator with monitoring related to the SELMP;
- provide vacation coverage for the Environmental Scientist; and
- complete monthly inspections of water management infrastructure.

7.6 Employees and Contractors

Employees and contractors will:

- complete a site-specific environmental induction and training appropriate to their role; and
- understand and implement the SELMP, as appropriate to their role.

8. COMMUNICATION

Communication of the SELMP at TCL will be based on internal requirements and will primarily take place through this SELMP and relevant SPPs. Any significant change to the SELMP will be communicated to the Project's employees and contractors through a site-wide email, announcements over radio channels by Minesite supervision and bulletins posted around the Project's Minesite. When effective to do so, maps will be marked with changes. Change management is detailed in **Section 12**.

8.1 Training and Awareness

Employees and contractors will have training and awareness of the Project responsibilities to meet the objectives of the SELMP for Project phases. Training will include an overview of the objectives, mitigation measures, monitoring, and reporting requirements to meet SELMP targets.

Employees and contractors will receive training on the SELMP during a general site safety orientation. SELMP training will occur before individuals begin work on the Project and for new personnel arriving on site.

Additional training will be provided to employees and contractors delegated to specific work tasks (e.g., clearing, reclamation or herbicide application) and will occur through site-specific orientation and/or in-person communication with the Environmental Coordinator.

8.2 Communication Policy

Personnel and contractors operating and/or inspecting any part of the SELMP system shall follow the site's communication policy.

8.3 Visual

Personnel and contractors operating, maintaining, or monitoring the site discharge system must be knowledgeable of the site water management plan. Any visual are to be reported to the Environmental Coordinator.

8.4 Verbal

Non-operating personnel must contact water management system operators and obtain permission before entering an active work area. Only persons needing to perform work in an active work area are authorized to enter this work area and only for the time required to perform the task at hand.

9. REPORTING

9.1 General Reporting

Reporting completed by TCL will ensure consistent implementation of the SELMP. Summary reports of monitoring activities and results will be compiled and reviewed annually, per **Section 6**.

9.2 Compliance Reporting

Compliance reporting will be subject to the specifications and conditions of the Environmental Assessment Certificate (EAC), and *MA/EMA* permit conditions. The information gathered during monitoring practices will be summarized with information from other management plans into an Annual Environmental Management Summary Report and, upon permit completion, the Annual Environmental Reports as required by *MA/EMA* permits. Community engagement activities will be an aspect of the **Socio-economic Management Plan (S13-C16) (SEMP)**. The **SEMP** will have requirements related to reporting on community engagement programs**.**

9.3 Internal Reporting

Details of the monitoring will be reported internally on an annual basis according to the adaptive management framework of the EMS. The report will provide results of monitoring, assessment of Performance Objectives in **Section 10.1** and including any other pertinent information.

TCL staff or contractors will be strongly encouraged to report any inefficiencies to management for evaluation consideration.

9.4 Annual Reporting Requirements

In accordance with the **Minesite Water Management Plan (S13.0-C11) (MWMP)**, TCL will prepare an annual report to the BC MOE summarizing the results of monitoring required under the *EMA* permits.

Key information requirements to be outlined in the annual report are provided in TCL's **DMP**.

10. MONITORING

TCL will conduct regular inspections of the water management system to ensure that structures are in good condition. TCL will also conduct regular audits to ensure that the SELMP is being followed and gather input from users.

10.1 Performance Objectives

Performance objectives to ensure the proper implementation of this SELMP are detailed in **Table 10.1-1**, which highlights the Performance Objectives and targets required to ensure the proper implementation of this SELMP.

Table 10.1-1: Performance Objectives

Performance Objective	Target
Predicted concentrations of Selenium (Se) at downstream stream nodes are achieved	Achieve below or equal to the site performance objectives (SPO) concentrations at downstream water quality monitoring locations.
Predicted concentrations of effluent quality parameters (end of pipe) are achieved	Achieve below or equal to the calculated end of pipe Se concentration based on the SPO and initial dilution zone information for receiving environment.
Effect on fish annual monitoring completed	Demonstrate no measurable effect on fish by conducting an annual monitoring program of fish in the downstream environment focussing on fish tissue and egg parameter concentrations.
Annual review of Selenium Management Plan (SELMP) completed	Conduct annual review of the SELMP and update as needed.

11. EVALUATION AND ADAPTIVE MANAGEMENT

11.1 Evaluation

A review of the SELMP will be completed by the Environmental Co-ordinator on an annual basis to compare data, trends, and implementation of the management plans and their objectives. This process will include a review of DMP deliverables and input received from Indigenous groups through the **SELMP.**

11.2 Adaptive Management

Adaptive management will be adopted to verify that management plans and mitigation measures are consistently meeting or exceeding performance objectives and targets. This will be achieved through periodic reviews of the SELMP and the results of Se monitoring programs in comparison with expected concentrations from the predictive models (**Appendix 13.5-A**). The SELMP is intended to be a living document which will be reviewed and improved as site conditions change and following the evaluation of monitoring and sampling data collected throughout the life of the Project.

11.3 Continuous Improvement

TCL will work towards continuous improvement throughout the Project. The Mine Manager (or designate) will investigate improvements in any trend and assess whether the practices responsible for the improvements can be applied to other areas of the Project. Deteriorating trends will be studied to determine root causes.

When the cause is identified, the Mine Manager (or designate) will implement a suitable corrective action. Examples of corrective actions could include (but are not limited to):

- update the water and load balance model;
- additional training of employees and contractors on procedures;
- enhancement of maintenance or monitoring measures;
- construction of additional water management infrastructure;
- additional supervisory oversight; and,
- construction of active water treatment facilities.

TCL will amend the SELMP, as required, based on annual evaluations, monitoring, and feedback from stakeholders and the Indigenous groups. Any proposed changes will be sent out for review by regulators, selected stakeholders, and Indigenous groups, before being finalized and implemented into the SELMP.

12. CHANGE MANAGEMENT

While the SELMP is a living document, changing any part of the SELMP will require a formalized process. If significant changes are being planned to objectives, management plan structure, operational milestones, communication and/or information management, it is required that the Management of Change Procedure in the **EMS** be followed. Minor edits and/or updates to this SELMP will be facilitated through version control and content approval functions.

13. CONCLUSION

Management of the Project's Se discharge and meeting compliance objectives will require diligent operation and planning. Through implementation of the various strategies, activities, monitoring and adaptive management in this SELMP, together with relevant SPPs, TCL will ensure that all objectives are met.

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