Water and the Tenas Coal Project: Current status and potential impacts to Wet'suwet'en interests

Prepared for the
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1. INTRODUCTION

1.1 Background and context

Telkwa Coal Limited (TCL) has proposed development of the Tenas Coal Project (the "Project"), a surface metallurgical coal mine, within the Wet'suwet'en Yintah approximately 7 km southwest of Telkwa, B.C. (Figure 1). The Project will occupy the territories of Cas Yex House (Gitdumden Clan) and Kwen Bea Yex House (Laksilyu Clan). The main Project area will be located between Tenas Creek and Goathorn Creek, a tributary to the Telkwa River, and includes an open pit mine, a coal processing facility, four containment ponds, a camp, and other operations facilities. In addition, a haul road will connect the main project to a rail infrastructure facility that will include a waste treatment pond and rail loading facility along the Bulkley River. The Project will produce processed metallurgical coal at a rate of 775,000 to 825,000 metric tonnes per year. The estimated life-of-mine is 26.5 years, with post-closure impacts continuing for centuries.

The TCL submitted an BC EAO EAC Application for the Project in February 2022. The Office of the Wet'suwet'en Natural Resource Department (OWNR) is participating in the BCEAO process for the Project. Water quality, aquatic habitat, and fish are priority values for the Wet'suwet'en, and the OWNR seeks further information on the status of these values in the Project area as well as potential Project impacts on Wet'suwet'en interests in relation to these values.

1.2. Objectives

The following report is intended to support decision-making processes by the affected House Groups by summarizing and presenting existing information on water quality and water quality impacts relevant to the Project. To the extent that data are available, this report summarizes existing water quality within the proposed Project area, identifies gaps and issues with water quality data and related methods included in the Project Application, and describes potential impacts of the Project on water quality.

This report is based on review of the relevant sections of the Project Application and relevant historical documents provided by the OWNR, and provides my best professional opinion on potential impacts to water quality and water resources as they relate to Wet'suwet'en interests. This report focuses on water quality, although discussion of impacts to water quantity is also included as these impacts have direct implications for water quality. A separate report was developed for fish and fish habitat resources.

1.3. Description of study area

The Project is located within the Telkwa River watershed. The Telkwa River is a tributary to the Bulkley River, which flows to the Skeena River and then approximately 180 km to the Pacific Ocean. Proposed development of the Project is between Tenas Creek and Goathorn Creek, and includes Four Creek, a tributary to Goathorn Creek as well as multiple unnamed small tributaries. Tenas Creek and Goathorn Creek form Goathorn Creek before its confluence with the Telkwa River. A portion of each of these watersheds will be developed for the Project.

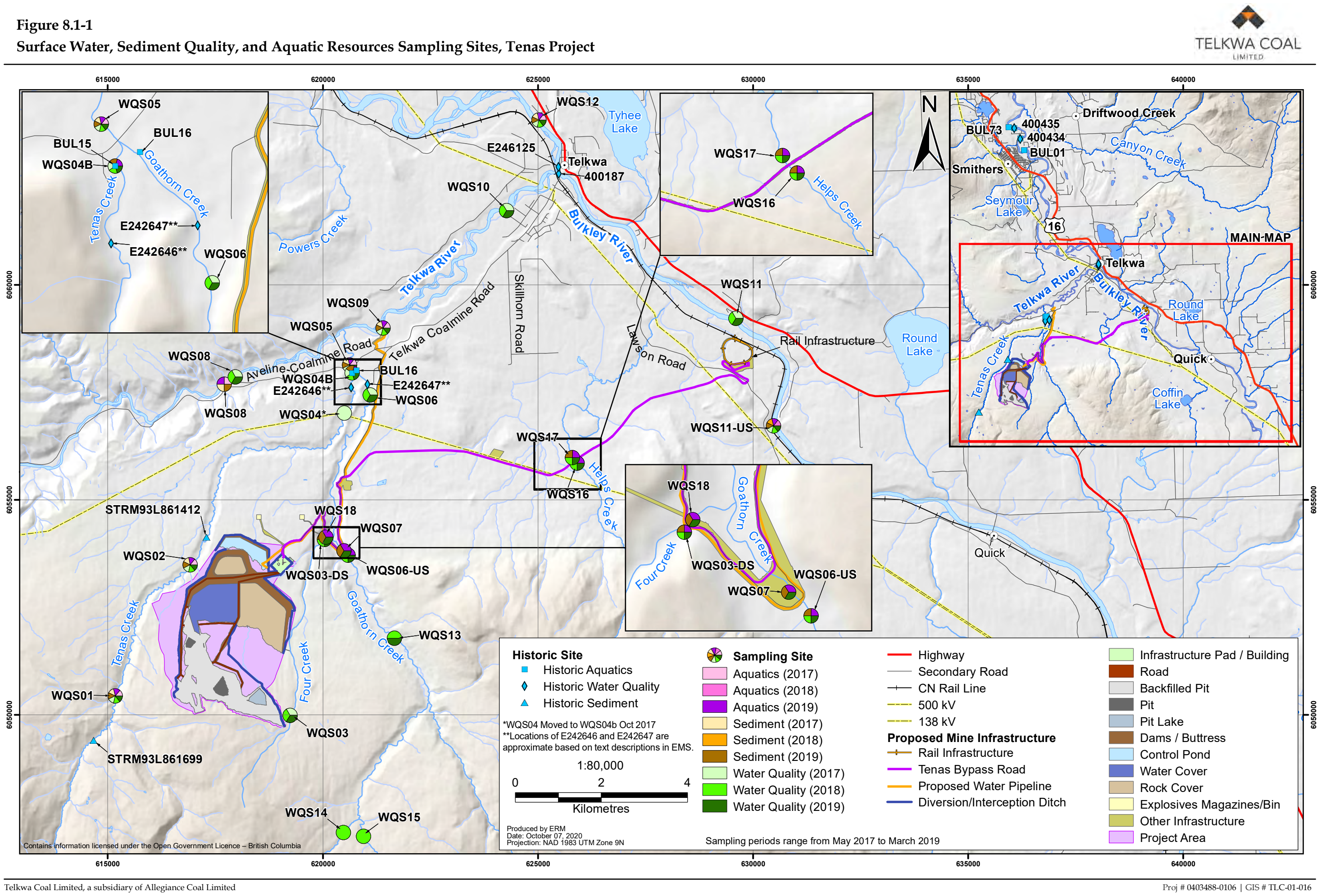

Figure 1: Map of proposed Tenas Coal Project ("the Project") location and infrastructure, along with water quality sampling locations assessed in this report. Map reproduced from Figure 8.1.-1 in "Tenas Project 2017-2019 Baseline Report" prepared for Telkwa Coal Limited by ERM, Smithers, B.C., in November 2020.

The proposed Project area is within the transition zone between the Coast Mountains and the Interior Plateau, and characterized by mountainous terrain with elevations ranging from approximately 500 m to 2500 m above sea level. The surrounding Biogeoclimatic Zone is sub-boreal spruce, which represents a montane continental zone of rolling plateaus and wetlands, and a growing season longer than found in boreal areas. Underlying regional geology is dominated by the lower Jurassic volcanic rocks of the Hazelton Group (Telkwa Formation). This formation was unconformably overlain by the coal-bearing sedimentary rocks of the Bulkley Canyon Formation, which were intruded by Late Cretaceous to Eocene feldspar porphyry, quartz feldspar porphyry, granodiorite and quartz diorite. These underlying formations are often naturally high in metals and other compounds (e.g., sulfur-bearing minerals) that contribute to acid rock drainage (ARD; also known as acid mine drainage).

The hydrologic regime in this region is dominated by snowmelt, and therefore the majority and peak of runoff occurs in the spring and early summer. In autumn, large rain events and high flows are increasingly common. Low flows typically occur in late summer and early autumn, and the lowest baseflows occur in winter, when precipitation is stored in the snowpack and groundwater dominates contributions to streamflow.

1.4 Historical and current impacts

Development of the Tenas Coal Project would represent a new, substantial disturbance in the Telkwa River watershed, however numerous previous anthropogenic activities have occurred in this watershed, and include mining, forestry, and agriculture, as well some urbanization. From 1918 through 1985, numerous small-scale underground and surface mining operations operated in this area and extracted roughly 400,000 tonnes of coal. In the immediate Project area, modern exploration began around 1978, including the development of over 800 exploration drill holes. Other ancillary mining activities such as trenching, geotechnical drilling, and geotechnical test pits have also been carried out in the Project area. Since 2018, TCL has also completed supplemental exploration programs to augment geotechnical data on the property, including additional drilling. Mining and drilling activities contribute to erosion and sediment loading to rivers, as well as exposure of acids to air and water, resulting in ARD and leaching of metals. These activities also change flow paths, which can alter watershed hydrology.

The Project region has high timber values and forestry is active on the landscape. The Project is located within the Bulkley Timber Supply Area, where current land use is primarily commercial forestry operations. Forestry activities such as road development and clear cutting contribute to erosion and sediment loading to rivers, as well as reduced soil infiltration and evapotranspiration loss, increasing surface runoff and maximum flows. These impacts can increase surface water temperatures and in-stream concentrations of total suspended solids, turbidity, total dissolved solids, conductivity, organic carbon, as well as parameters associated with erosion and dust, like certain metals. Forestry operations are planned to continue within the watershed throughout the life of the Project.

Agriculture is an important activity in the greater Telkwa River and Bulkley River watersheds and includes grazing as well as crop production. While agriculture land use is relatively minor in the Project area, the impacts on water quality can be more long-lasting than some forestry activities. Agriculture can have a range of impacts on water bodies, as it often requires some extent of land-clearing and/or providing range for livestock. This can have similar impacts to water quality as clear-cutting in forestry operations, including changes in sediment, nutrient, temperature, and dissolved oxygen regimes, as well as possible addition of biologicals from grazing livestock. Agriculture can impact local hydrology by increasing surface runoff, as well as reducing flows if water is used for irrigation or livestock.

Other historical and current activities contributing to water quality changes include small scale quarry operation (e.g., sediments, metals, etc.), and impacts from urbanization such as linear development, sewage treatment, and impervious surfaces runoff (e.g., sediments, temperature, conductivity, nutrients, metals, hydrocarbons, etc.).

2. CURRENT STATUS OF WATER QUALITY

2.1 Methods

Data on surface water quality were reviewed from sources provided by the OWNR[1]. An extensive number of reports were included in the data review, however many of these data sources were deemed ineligible for consideration in the review of status of water quality, either because data or sites were irrelevant or incomplete, or analytical methods and analytical limits of detection (LOD) have changed substantially. Qualitative information from historic reports was also considered in overall impressions of baseline conditions.

Data were assessed for sites representing locations upstream, within, and downstream of project impacts in Tenas Creek, Goathorn Creek, Four Creek, and the Telkwa River (site locations shown in Figure 1). These sites are consistent with sites evaluated in “BC EAO EAC Application – Tenas Project Appendix 4.1-C Tenas Project 2017-2019 Baseline Report” (Section 8, Surface Water Quality). A total of 638 samples across 21 sites were included. The range of dates for sites on Tenas Creek, Goathorn Creek, and Four Creek included monthly data from May 2017 to March 2019, as well as monthly data from Goathorn Creek and Tenas Creek, from May 2006 to December 2008. The Telkwa River has a small amount of data from 1974 and 1975, as well as periodic monthly sampling from February 1985 to March 1988, and May 2006 to December 2008. All data collected before 2017 is referred to as “historic”. Not all historic data are comparable with data collected in the more recent 2017-2019 baseline assessment, due to changes in methods and LOD over time. However, several parameters with comparable methods and all values well above LOD were compared to assess potential change over time.

Field duplicates were averaged prior to analysis, and all 5-in-30 samples were treated as discrete samples. Missing samples were left as gaps in the dataset. Samples with values below the analytical limit of detection (LOD) were replaced with half the value of the LOD. Data are excluded from comparison with WQG for parameters where WQG are below LOD. All work was performed in R (R Core Group, 2022).

Seasonal designations are used to represent different general hydrologic and biological periods: Spring (April-June), Summer (July-September), Autumn (October-December), Winter (January – March).

[1] A list of files deemed suitable for review of water quality status, including historical and baseline data as well as relevant site information and relevant sections of each report is provided in a workbook accompanying this report, “Telkwa_Coal_WQ_Database_2022.xlsx”

Where relevant, results are discussed in context with current BC Water Quality Guidelines (WQG)[2] or Canadian Council of Ministers of the Environment Water Quality Guidelines (CCME WQG)[3] for the protection of freshwater aquatic life.

2.2 Current conditions

All water quality baseline data from 2017-2019 are included in the Project application Appendix 4.1-C Tenas Project 2017-2019 Baseline Report. This report includes graphs of baseline data and tables of calculated WQG and exceedances for each of parameter of concern. To avoid redundancy, similar information (e.g., graphs of baseline monitoring data and detailed coverage of samples exceeding WQG) will not be presented here. The following sections summarize water quality baseline data collected within the Project area from 2017-2019.

2.2.1 Physicochemical

Streams in the project area have cold waters of neutral to basic pH in the range of natural waters and are well-buffered indicating low-sensitivity to acid-inputs (alkalinity >20 mg $CaCO_3$/L). This means that these streams are more resistant to changes in pH with further addition of acidic substances. Total hardness in streams ranges from hard to soft, with Four Creek, followed by Tenas Creek and Goathorn Creek, having higher total hardness (i.e., harder water) than the Telkwa River. The Bulkley River has the lowest total hardness (i.e., softest water). Total alkalinity and conductivity also follow this pattern of high to low values. Seasonal patterns are observed in these parameters; for example, conductivity is the highest in the winter months when flows are the lowest. Data on dissolved oxygen is incomplete, but the limited data available suggest that waters are generally well-oxygenated.

Concentrations of suspended materials (i.e., TSS, turbidity) peak during spring snowmelt but are otherwise low throughout the year on all streams except the Telkwa River. The Telkwa River exhibits higher suspended materials during many months except winter. Isolated periods of high sediments are also observed during some late summer and autumn rain events on Four Creek, Tenas Creek, and the Bulkley River.

2.2.2 Nutrients and Ions

Nutrient concentrations (TN, TP) are similar to other systems in this region (Oliver, 2018; Oliver, 2020). The TN pool is on average dominated by total organic nitrogen (TON), with Four Creek and Tenas Creek having the highest proportion of TN as TON. Dissolved inorganic nitrogen is largely comprised of nitrate-nitrogen (NO_3^--N), as nitrite nitrogen (NO_2^- -N) and ammonium-nitrogen (NH_4^+-N) were mostly below detection. Nitrogen exhibits seasonal patterns with concentrations increasing in winter and declining in the mid-summer months.

Total phosphorus (TP) is highest during spring snowmelt, when higher flows transport more sediment. Concentrations during other times of the year are much lower, and during low flows systems are very

[2] Available at: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines
[3] Available at: https://ccme.ca/en/current-activities/canadian-environmental-quality-guidelines

low in TP and considered oligotrophic or ultra-oligotrophic. Soluble reactive phosphorus (SRP), the most readily available form of P, is typically below detection.

Sulfate concentrations are the highest year-round on Four Creek and Goathorn Creek, and the lowest in Tenas Creek. Sulfate is generally the highest in the winter months, except for Goathorn Creek where concentrations are typically higher in the summer and autumn. Sulfates are often produced naturally from rock during mining operations as acidic rocks come in contact with water and form sulfide (i.e., ARD), which then oxidizes into sulfates within well-oxygenated water bodies. Water quality issues with sulfates are often related to their ability to form strong acids that change water pH, and involvement in complexation and precipitation reactions that can affect the solubility of metals and other substances.

2.2.3 Metals

Most of the sampled waterbodies are high in background concentrations of some metals and concentrations occasionally exceed BC WQG or CCME WQG. Examples include all waterbodies for total and dissolved aluminum (Al), copper (Cu), and iron (Fe; except Goathorn Creek), Goathorn Creek and the Telkwa River for total and dissolved cadmium (Cd) and zinc (Zn), and the Telkwa River for total lead (Pb). There appears to be a seasonal component to elevated concentrations and WQG exceedance, for example, Al and Cu are highest during spring high flows and in winter during low baseflows. In contrast, Cd is often elevated and exceeded BC WQG during mid-summer months. These changing periods of peak concentrations suggest different mechanisms influencing elevated concentrations, where some metals are likely mobilized with sediments during high flow periods, and others are more prevalent in groundwater and therefore elevated when surface water flows are low in the winter or summer.

Elevated metal concentrations are often present in waters that drain the type of regional geology found in the Project area. It is likely that more than a century of mine exploration, mining, forestry, agriculture, and other development have altered many of these metals from their pre-disturbance concentrations but even pre-disturbance values may have been naturally elevated in some of these systems.

2.3 Historical conditions

Comparisons were made for sites on Tenas Creek, Goathorn Creek, and the Telkwa River representing upstream (above proposed mine impact) and downstream (below proposed mine impact) locations where historical data were collected within a similar and relevant area (Table 1). Coordinates were incorrect on the Provincial Environmental Monitoring System (EMS) database for historical sites on Goathorn and Tenas Creek, but descriptions of the locations and knowledge of stream access points were used to approximate the general reach location of sample collection for comparison. In general, these sites can be used to approximate conditions at the lower end of each of these stream reaches, before confluence between Goathorn and Tenas Creeks. Sites were compared for parameters whose historic and current methods are reasonable to compare, and where changes in LOD have not impacted sample sizes and data interpretation. Comparisons of conductivity, turbidity, sulfate, and total aluminum reveal changes from upstream to downstream locations within each watershed, with the greatest upstream to downstream trends observed in Goathorn Creek and Tenas Creek. Less of a trend is observed within the Telkwa River (Figures 2-4). There are also clear differences between seasons at all sites, likely driven by source interaction with flow paths and flow volume influencing the mobilization of materials. This has implications for mining impacts and points to the need for establishing regulations for in-stream objectives and permit requirements that are seasonal and flow-based.

When compared with historical data, the most recent baseline data (2017-2019) suggests potential shifts away from conditions measured in the previous decade (2006-2008) on Tenas Creek and Goathorn Creek (Figures 2-3). Notably, on Goathorn Creek conductivity appears to have increased in the winter, along with increases in sulfate in both winter and summer months. Al may have also increased across multiple seasons, potentially in association with increased turbidity or leaching from groundwater. On Tenas Creek, the greatest changes were in turbidity and total Al during spring high flows, and autumn (likely rain events and higher flows). On the Telkwa River, historical conditions appear relatively similar to the most recent baseline (Figure 4). Some increases in turbidity and total Al may have occurred since the 1970's and 1980's, but there is relatively little difference between observations in the 2000's versus the 2017-2019 baseline.

Table 1: Site descriptions for data used in upstream-downstream, seasonal, and historical comparison.

Site ID	Waterbody	Easting (m)	Northing (m)	Description	Period of data
WQS02	Tenas Creek	616914	6053490	Near-field downstream of deposits and proposed Tenas Coal infrastructure	2017-2019
WQS04B	Tenas Creek	620676	6057950	Downstream of WQS02 as well as deposits and proposed infrastructure, above confluence with Goathorn Creek.	2017-2019
E242646	Tenas Creek	620427*	6057937*	EMS Site. *Location given is not in stream, but description is "Tenas Creek". Likely nearby to points as road access here; assumed in general lower reach.	2006-2008
WQS06-US	Goathorn Creek	620587	6053711	Above confluence with Four Creek and may have been influenced by historical activity in area.	2017-2019
WQS06	Goathorn Creek	621100	6057441	Downstream of WQS06 and project area, above confluence with Tenas Creek.	2017-2019
E242647	Goathorn Creek	619898*	6057431*	EMS Site. *Location given is not in stream, but description is "Goathorn Creek above Tenas Creek confluence". Likely nearby as road access here; assumed in general lower reach.	2004, 2006-2008
WQS08	Telkwa River	617964	6057860	Upstream of confluence with Goathorn Creek.	2017-2019
WQS10	Telkwa River	624269	6061725	Downstream of Goathorn Creek, above confluence with Bulkley River.	2017-2019
400187	Telkwa River	625481	6062592	Just downstream of WQS10, above confluence with Bulkley River.	1974-1987 2006-2008

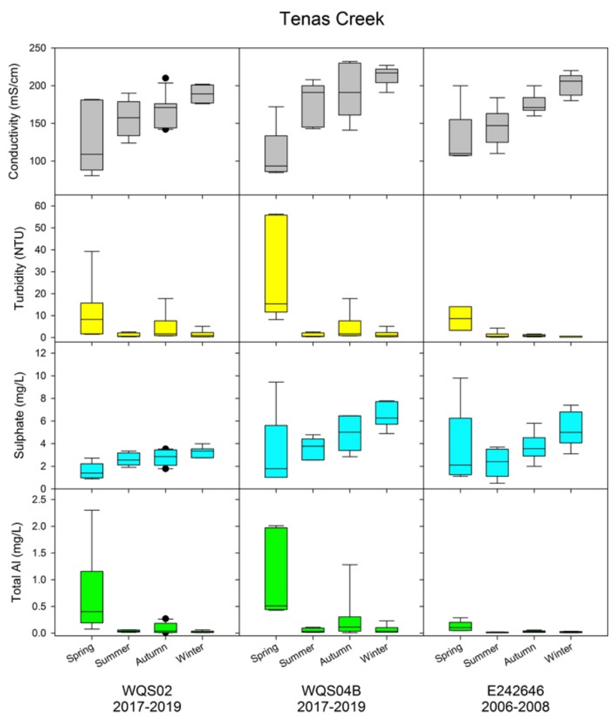

Figure 2: Seasonal-water quality baseline data for Tenas Creek. Boxes are 25th and 75th percentile, whiskers are 5th and 95th percentile, and the line within the box is the median. Black dots are outliers.

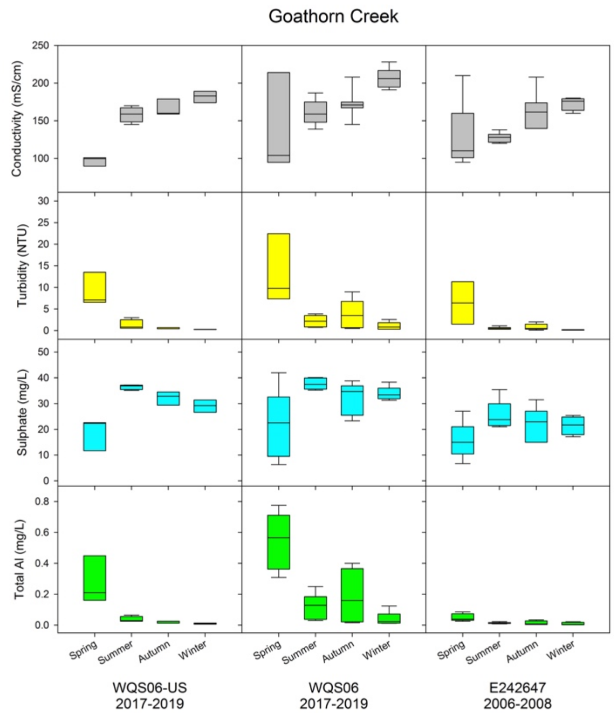

Figure 3: Seasonal-water quality baseline data for Goathorn Creek. Boxes are 25th and 75th percentile, whiskers are 5th and 95th percentile, and the line within the box is the median.

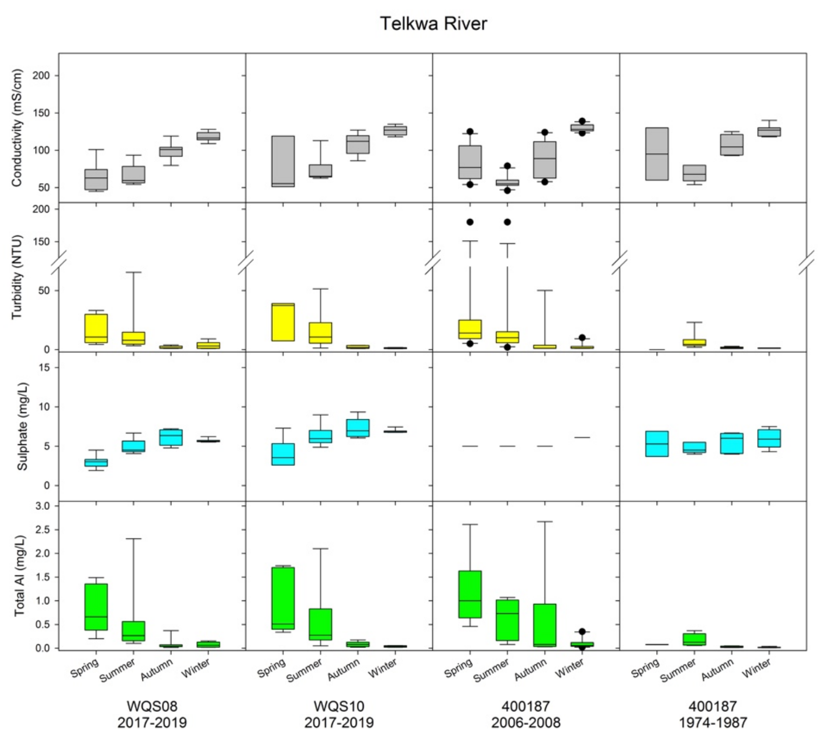

Figure 4: Seasonal-water quality baseline data for the Telkwa River. Boxes are 25th and 75th percentile, whiskers are 5th and 95th percentile, and the line within the box is the median. Black dots are outliers.

2.4 Overall context for ecological health

Current water quality conditions are good for fish and aquatic species health, although historical impacts have likely altered these conditions from their natural state. Baseline assessment of aquatic macroinvertebrates indicates most streams have a high species richness of species that are sensitive to disturbance, which indicates overall good water quality. Surface waters in streams within the Project area appear to be cold and well-oxygenated, although some have elevated background levels of certain metals. Some of the higher metal concentrations appear to be associated with periods of higher runoff and higher turbidity, such as during spring snow melt or large autumn rain events. Others appear to be elevated during low flow periods of winter and summer, when groundwater is the dominate contributor to baseflows.

The underlying watershed geology represents a natural source of metals and is common in this region. However, it is likely that human activities within the watershed, such as mining, including drilling and other exploration, forestry, and linear development, as well as some natural processes may have increased exposure of acidic material and leaching of metals. While organisms in this region may have adapted to natural baseline conditions (e.g., higher metals concentrations during certain periods), further increases in metals concentrations and changes in acidity, temperature, and nutrients should be avoided. It is also likely that restoration in some areas may be beneficial for stream stabilization and expanding cold water habitat, especially for aquatic organisms use during periods of low flow.

3. DATA NEEDS

3.1 Gaps and recommendations

The Project baseline datasets are appropriate for a bare minimum assessment of baseline conditions for water quality at some of the sites monitored within the Project area. However, some aspects of the existing dataset do not provide sufficient information and should be expanded for appropriate and responsible analysis of baseline conditions. These recommendations primarily focus on the scope of baseline water quality and aquatic resources data provided, but also addresses some concerns associated with the evaluation of water quality monitoring data and options for water management discussed in the Project Application.

- The proponent should provide better maps of the Project area that clearly show locations of specific discharge points to the environment along with locations of site facilities and management ponds, and in conjunction with locations of water quality and aquatic resources sampling sites. Many of the maps are poor resolution and include undefined information.

- The Project needs to provide specific locations for water discharges from management ponds. These are not clearly shown on the map and no coordinates are given in the Project application.

- Existing water monitoring locations are located a substantial distance downstream from (estimated) planned discharge locations. Additional water sampling sites for baseline determination and future monitoring should be established proximal to these discharge points, as well as at points further downstream already monitored. Locations below discharge points will be severely impacted if they are within an initial dilution zone, and impacts to surface waters cannot be accurately described without information on baseline conditions directly below the point of discharge.

- The recommendation for baseline data collection used for EA and by the Joint AIR for Mines Act and Environmental Management Act Permits (Joint AIR for MA/EMA Permits) is a "minimum one year of monthly data; two years of data are preferred for the baseline study." In the case of the Project application, only the minimum (one year) has been collected for water quality parameters at many sites, as well as for other aquatic health indicators such as benthic macroinvertebrates at almost all sites. I recommend a minimum of three to five years of monthly sampling to more accurately assess baseline conditions and assessment of seasonal trends and monthly variability.

- Additional years of collection of periphyton, sediments, and benthic macroinvertebrates at the same sites using the same methods as previously sampled, to better assess baseline conditions with interannual estimates of range of variability.

- The Joint AIR for MA/EMA Permits requires 5-in-30 sampling (five samples collected over 30 days) be conducted during critical flows and biologically relevant periods. The Project application baseline data only includes 5-in-30 sampling for two periods that represent periods typical of high variability due to increases in stream discharge: "freshet" and "autumn rains". However, all seasonal periods are biologically-relevant in aquatic ecosystems, especially when these systems are part of salmon-bearing watersheds, so all periods should be represented. Therefore, 5-in-30 baseline data should also be collected over baseflow conditions in summer and winter. This is especially relevant as current baseline data and modelling results suggest impacts from mine development include increases in many metals and contaminants occurring during baseflow periods due to seepage from ponds and lower dilution factors. The 5-in-30 sampling is also never discussed on its own in a seasonal context, or highlighted in the results where it might provide additional information on seasonal variability.

- For the most part, appropriate parameters were collected for directly assessing water chemistry and some components of instream aquatic life. However, when evaluated on their own, these datasets provide limited context to evaluate the impacts of historical disturbances to these watersheds and possible restoration needs, or to assess cumulative effects on aquatic ecosystems within the regional Project area, as well as aquatic ecosystems located downstream in the broader watershed. I recommend additional assessment of how the Project will impact aquatic resources framed within a historical context that includes cumulative effects. A framework for an evaluation of cumulative effects is given in, "Assessment protocol for fish and fish habitat in the Skeena Sustainability Forum Study Area", by the Skeena Sustainability Forum in August 2021, and can be provided by the OW.

- Authors excluded data where detection limits were above water quality guidelines, although they were not specific about whether this was recent or historical data (or both). They do not state whether all data were below detection or some proportion of the data. If the latter, I recommend they explore other approaches to handle data where some proportion is below detection limits (e.g., impute values below detection, mixture models, etc.), especially if these data are to be incorporated into models for load predictions.

- The proponent should incorporate historical data, with caveats if necessary, to provide some assessment regarding if/how conditions may have changed over time due to historical disturbance.

- There are clear differences in water quality baseline concentrations between seasons at all sites, likely driven by source interaction with flow paths and flow volume. This has implications for mining impacts and points to the need for establishing seasonal and flow-based in-stream objectives for water quality monitoring within the proposed Project, especially if the Wet'suwet'en prioritize no change (i.e., degradation) to existing water quality conditions.

- Following additional data collection, current baseline seasonal trends should be evaluated to establish relationships between flows and water quality concentrations and seek to create instream water quality objectives that preserve existing conditions and variability, including "no change" from baseline conditions if that objective is deemed of Wet'suwet'en interest.

- Additional samples (minimum of 1 year) should be conducted to further evaluate potential seasonality in Se species. Although results on the single sample date were all below detection, total selenium concentrations are not always below detection.

- Sediment data did not include analysis for polyaromatic hydrocarbons (PAHs), one of the parameters recommended for sampling for coal projects where there may be naturally high PAHs in sediments. Additional years of sediment samples should be collected for evaluation of PAHs concentrations in sediments.

- All parameters required for the copper Biotic Ligand Model should be collected to evaluate WQGs for a minimum of one year, to help compare outcomes of running the full model compared to running the simplified model. This should include appropriate temperature inputs, instead of median values taken from across a six-month period of wide-ranging temperatures. The use of median temperatures for two seasons designated as summer (May to September) and winter (October to April). The use of these extended periods likely mis-represents temperatures in the model, especially summer, as May to September water temperatures range from cold (as snow melts) to maximums in mid-late summer during summer baseflow.

- The use of Project-specific Site Performance Objectives (SPOs) for water quality concentrations below discharge locations allows the proponent to discharge higher concentrations of certain constituents than given in the BC WQG and CCME WQG. Discharge concentrations should be maintained at levels that at minimum, do not alter background conditions and do not exceed BC or CCME WQG, as well as follow Environment and Climate Change Canada's Proposed Approach for Coal Mining Effluent Regulations (2022).

- There is no water treatment proposed other than sediment control. Water discharge objectives should be established to maintain baseline conditions and options for additional water quality treatment to achieve these objectives should be reviewed.

4. PRIMARY PROJECT IMPACTS

This report is meant to provide the best available information on the impacts of the Project on water quality relevant to Cas Yex House and Kwen Bea Yex House, for utilization in decision-making processes. A complete discussion of water quality requires discussion of water quantity and hydrology, as the amount and timing of water impact water quality conditions. Therefore, this report assesses major impacts of the Project on both the quantity (hydrology) and quality of surface water resources.

Major hydrology impacts are assessed by considering changes in the amount of water and the timing of water availability. Assessment of major water quality impacts consider how the Project activities (including impacts to hydrology) will impact conditions relative to the current baseline (assessed from data collected in 2017-2019), as well as in excess of BC Water Quality Guidelines (WQG[4]), Canadian Council for Minister of the Environment (CCME[5]), and proposed recommendations for Coal Mining Effluent Regulations (ECCC, 2022). Water quality parameters evaluated include general stream chemistry properties such as temperature, pH, hardness, turbidity, total suspended sediments (TSS), total dissolved solids (TDS), and increases in concentrations of metals and acids that can be toxic and deleterious to aquatic and human life (e.g., selenium, cadmium, sulfate, etc.).

The following is a technical review of potential Project impacts on water quality and relevant water quantity. A separate, plain-language summary report is also provided to the OWNR that discusses impacts to Cas Yex House and Kwen Bea Yex House (see "Water and the Tenas Coal Project: Potential Impacts to the Territories of Cas Yes House and Kwen Bea Yex House" (Oliver, 2022)). The following discussion of impacts focuses specifically on surface water impacts relevant to Wet'suwet'en rights and interests but does not include detailed assessment of wetland environments or direct groundwater impacts other than minor discussion of their potential role in impacting downstream surface water hydrology and water quality.

4.1 Overview of impacts on hydrology

The Project will impact hydrology on streams within and downstream of the Project area by altering the flow regime of surface waters, this includes changes to the overall quantity and seasonal timing of water delivery in local streams. Hydrology impacts are attributed to the reduction of overall catchment area due to mining operations, direct water capture and use by the Project for waste management ponds and overall site operations, discharge of wastewater from management ponds, landscape alteration of the watershed, and diversion of surface water away from the project site and into peripheral ditches (i.e., reduction in infiltration).

Surface water management will include infrastructure to catch and retain water, as well as move water between facilities. This includes a system of engineered channels, management ponds with associated spillways for wastewater storage and treatment, sedimentation ponds, culvert road crossings, and water pumping systems. Surface water management will capture and retain water from rainfall, streamflow, and groundwater to use in project operations and in the post-closure phase for storage of waste

[4] Available at: https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines

[5] Available at: https://ccme.ca/en/current-activities/canadian-environmental-quality-guidelines

materials in permanent ponds. Some of this water will re-enter the surrounding environment via surface water discharge and groundwater seepage, as well as evaporation.

The location and timing of surface water storage and release will have direct downstream impacts on natural flow regimes. The Project will also impact groundwater flow paths, which also directly impact surface water as groundwater is critical for recharging streamflow. Modifications to the landscape in the Project area will reduce infiltration from rain and snowmelt runoff, alter site drainage patterns, and include development of large wastewater management ponds that can increase downhill groundwater flow rates. These impacts will continue through the entire life-of-mine, including the operations phase (26.5 years of operation) through the post-closure phase (currently only modelled through 2100 within the Project application, but likely to continue for centuries).

Environmental flow needs (EFN) are used to describe the instream needs of an aquatic ecosystem to retain natural structure and function, this includes the quantity and timing of delivery of water to streams that represent the natural flow regime of a given system. Alterations to the natural flow regime that impact EFNs will impact natural processes and organisms, with greater alterations having greater impacts. A major hydrologic impact of the Project is alteration of seasonal timing of streamflow. Flows in catchments impacted by the Project will increase or decrease from baseline conditions depending on the location of interest and the time of year. Much of the seasonal changes are is in response to a shift in the proportion of groundwater to rainfall/snowmelt contributing to streamflow. The BC Environmental Flow Needs environmental risk framework uses a 10% reduction in flows as an indicator of high stream sensitivity for fish habitat (BC ENV, 2022).

The greatest impacts on the natural hydrologic regime will be on Four Creek, followed by Tenas Creek, and Goathorn Creek. There will be minor impacts on the hydrology of the Telkwa River, and likely little impact on the hydrologic regime of the Bulkley River. The following sections describe more specific hydrology impacts for each stream.

4.1.1 Tenas Creek

Operations phase

The Project will impact the hydrology of Tenas Creek. The Project will occupy an estimated 7% of the Tenas Creek catchment and capture and divert runoff from within that area to Project operations. As a result, streamflow in Tenas Creek will be reduced downstream of the Project. This impact will likely be the greatest during open-water season months. The open pit mine is adjacent to Tenas Creek, and will reduce groundwater contributions to Tenas Creek. This impact will likely be the greatest during low flow periods of winter and summer. Based on modelling developed by SRK Consulting for the Tenas Project application, they estimate overall streamflow in Tenas Creek will be reduced by less than 10%, but up to 10% during low flow periods[6].

An unnamed tributary of Tenas Creek will receive a maximum monthly discharge of 2,600 m^3/day via pump or spillway from the Explosive Magazine Sedimentation Pond. The application does not describe the specific impacts of this discharge on the unnamed tributary or Tenas Creek but based on 7-day low

[6] Tenas Project Application Appendix 1.0E SRK, Tenas Project Water and Load Balance Modeling Report

flows determined at baseline hydrometric monitoring stations on Tenas Creek[7], this amount may sometimes represent 75% of baseflow in the mainstem of Tenas Creek, and would result in an almost doubling of flows within Tenas Creek from sedimentation pond discharge contributions if maximum releases occurred during low flow periods. This will likely impact the natural hydrologic regime of the unnamed tributary as well as downstream reaches of Tenas Creek.

Post-closure phase

Following closure of the mine, there will be ongoing impacts to seasonal and total streamflow within Tenas Creek. Seepage from the management ponds adjacent to Tenas Creek will likely result in an overall increase in baseflows relative to current baseline conditions, yet overall streamflow will still be reduced due to the permanent reduction in catchment size. Based on modelling developed by SRK Consulting for the Tenas Project application, overall streamflow in Tenas Creek will be permanently reduced by up to 10% during low flow periods and less than 10% annually. Recall that the BC Environmental Flow Needs environmental risk framework uses a 10% reduction in flows as an indicator of high stream sensitivity for fish habitat (BC ENV, 2022).

4.1.2 Four Creek

Operations phase

The Project will have the greatest impact on the hydrology of Four Creek. Both mean annual discharge and seasonal discharge will be dramatically affected in Four Creek, with seasonal flows impacted in 100% of the total stream area. The Project will occupy a substantial portion of the Four Creek catchment and capture and divert runoff from within that area to Project operations. Most of the water that would have drained to Four Creek will be diverted through ponds or channels to the Tenas Control Pond and eventually discharged into Goathorn Creek, a downstream tributary of Four Creek. As a result, streamflow in Four Creek will be reduced downstream of the Project by as much as 34%. The greatest monthly reductions will occur during low flow periods in winter and summer, when the open pit and management ponds draw down the ground water table and capture surface runoff from a substantial area of the natural catchment. In contrast, increases of up to 45% in stream flow may also occur in Four Creek downstream of the project during open water months as a result of diversions, this is most likely to occur during periods of high runoff at some sites. Seasonal variability via monthly flow varies from upstream to downstream; sites adjacent to the East Management Pond (i.e., WQS21 and WQS20) either gain or lose flow during the open water season, but decrease in flow during low flow winter periods. However, flows decrease year-round at the most downstream monitored site on Four Creek (WQS03DS) due to groundwater drawdown.

As a planned mitigation measure, the Project design includes installation of an engineering control structure to limit discharge to the upstream portion of Four Creek during “extreme events”, although the application is not specific about the definition of “extreme events” in all sections where this is mentioned, so to the extent this will buffer Four Creek from large runoff events is unclear.

Post-closure phase

[7] Tenas Project Application Appendix 4.1-C Tenas Project 2017 to 2019 Baseline Report

During the Project post-closure phase, there will be ongoing impacts to seasonal and total streamflow within Four Creek. Baseline flow conditions in Four Creek will be permanently reduced due to sustained drawdown of the groundwater table. This will be the most substantial during low flow periods in winter and summer. Flows will increase at sites adjacent to the open pit during open water season, due to divergence of water away from the reclaimed Project area and direct discharge to Four Creek, as well as from a portion of the backfilled open pit draining towards the diversion channel. Model results by SRK Consulting Inc., suggest that during the open water season this will increase flows by ~30% in the long term, whereas in winter months, groundwater drawdown will reduce low flows at these sites during winter months by an average of 25%. At the most downstream monitored site on Four Creek, a net increase of winter streamflow by 4% is predicted to occur due to mounding of groundwater under the East and North Management Ponds, which will increase seepage from these ponds to Four Creek in perpetuity after mine closure; an average decrease of 14.4% in monthly flows is predicted during the open water period.

4.1.3 Goathorn Creek

Operations phase

The Project will impact the hydrology of Goathorn Creek. The impacted catchment area of Goathorn Creek is proportionally smaller than Tenas Creek or Four Creek, and therefore changes to streamflow are predicted to be lower. However, the project will impact Goathorn Creek through surface water discharge, drawdown of groundwater, and seepage from both the open pit and management ponds. Groundwater draw down from the open pit mine will reduce baseflow contributions to Goathorn Creek. As a result, streamflow in Goathorn Creek will be reduced downstream of the Project during low flow periods of operation, both in summer and winter, despite seepage from the pit contributing during that period. Model results from SRK Consulting Inc., suggest that overall streamflow in Goathorn Creek will be reduced by up to 6% during low flow periods, and up to 8% during freshet, but may also increase up to 19% due to rerouting of water that would have otherwise been delivered to Tenas Creek. The Project has allocated a 2.5% of baseflow withdrawal from Goathorn Creek during operations as a contingency for source water, and this amount was included in the SRK Consulting modelling exercise.
During Project operation, Goathorn Creek will receive discharge from the Tenas Control Pond. Some of this water will have been diverted from Tenas Creek to Goathorn, however despite this addition, overall streamflow will remain lower in some open water months due to seepage lose from Project facilities and evaporation.

In addition to discharge from the Tenas Control Pond, an unnamed tributaries of Goathorn Creek will also receive discharge from the Explosive Magazine Sedimentation Pond and Sewage Treatment Pond, for maximum monthly discharges of 2,600 m^3/day and 41.5 m^3/day, respectively. The application does not describe the specific impacts on the unnamed tributary or Goathorn Creek but based on 7-day low flows determined at baseline hydrometric monitoring stations on Goathorn Creek[8], at times, this amount may represent ~25% of baseflow in the mainstem at some sites on Goathorn Creek. While this increase would likely be relatively small compared to the majority of flows during the year, the seasonal timing of delivery could have potential to impact low flow periods.
The Tenas Control Pond is designed to maintain sufficient capacity to attenuate flows up to a 1-in-10 year storm event, which has a relatively high probably to occur in any given year, especially under

[8] Tenas Project Application Appendix 4.1-C Tenas Project 2017 to 2019 Baseline Report

current climate change predictions of increased summer precipitation and warmer winters. This means that overflow, and from other similar structures, should be expected over the 26.5 years of operation. Multiple wet years during Project operation could result in high increases in downstream average streamflow.

Post-closure phase

Following Project closure, Goathorn Creek will receive discharge from the North Management Pond at a maximum discharge rate of 17,600 m^3/day. This is 142% of possible annual 7-day low flows and 33% of possible summer low flows (based on minimum measurements from three years of baseline monitoring). Again, the timing of discharge releases has potential to greatly impact the natural flow regime of Goathorn Creek. This type of management will be expected to continue in perpetuity; however discharge will occur via spillway, and in wet years or in years with large storm events its likely the natural flow regime of Goathorn Creek could be highly impacted. SRK Consulting examined the impact of multiple wet years (three 1-in-100-year events) on discharge to Goathorn Creek (and subsequently the Telkwa River) and concluded that discharge from the North Management Pond in post-closure may increase streamflow in Goathorn Creek over baseline conditions by 19% at WQS06, downstream of the project area and upstream of the confluence with Tenas Creek. They did not discuss the impact below the confluence but suggested the change relative to baseline for the Telkwa River was negligible.

Flows on Goathorn Creek downstream of the project discharge may increase by up to 8% in the post-closure phase due to routing of water that would otherwise have been delivered to Tenas Creek, but overall mean annual discharge is estimated to be reduced by 1% post-closure.

4.1.4 Telkwa River

The Project will have a small impact on the hydrology of the Telkwa River. Hydrological modifications to the Telkwa River are a result of changes to catchment hydrology within Goathorn Creek, Tenas Creek and Four Creek, which converge to become Goathorn Creek before confluence with the Telkwa River. At the Telkwa River downstream of the confluence with Goathorn Creek, small changes in seasonal hydrology are likely to occur during Project operation. Winter baseflows will be reduced because of less groundwater recharge to streams, and small decreases in open-water season flows will occur due to evaporative loss from management ponds and the open pit lake. Over the long term, post-closure water levels in the management ponds may slightly increase baseflows in the Telkwa River (2.9-5.3%), mostly in the winter months.

4.1.5 Bulkley River

The Project will have a negligible impact on the hydrology of the Bulkley River. Impacts on hydrology of the Bulkley River will be from upstream impacts on the Telkwa River and possible impacts from the Rail Infrastructure located upstream of the Telkwa River confluence. The Bulkley River will receive Project discharge of a maximum of 210 m^3/day from the Rail Infrastructure Sedimentation Pond, equivalent to less than 0.01% increase in mean annual discharge of the Bulkley River at this location.

Changes described above for the Telkwa River will propagate downstream to the larger Bulkley River, but due to the increase in total catchment area and volume, will result in very small impacts. Model results suggest a maximum reduction of annual flows in the long term of less than 0.1%.

4.1.6 Helps Creek and Hubert Creek

The Project should not impact have major impacts on the hydrology of Helps Creek or Hubert Creek. There are no withdrawals described for these creeks, as the only interaction with the Project is the development of a road linking the main Project site with the Rail Infrastructure site. Development should protect the natural flow of the creek as bridges will not include culverts. The road may have localized effects on drainage from wet areas and other small tributaries if care is not taken to preserve the drainage of these systems during road construction.

4.2 Overview of impacts on water quality

Overarching impacts on water quality from the Project include major changes to stream chemistry in catchments draining the Project area, including Tenas Creek, Four Creek, and Goathorn Creek. It is likely these impacts will also propagate to some extent downstream to the Telkwa and Bulkley Rivers, particularly during periods when flows are reduced and groundwater represents a larger proportion of surface water runoff, such as during winter and summer low flow periods. Changes in stream chemistry will reflect the dominant impacts of coal mine disturbance, including changes in base physicochemical properties (e.g., hardness, pH, temperature, and conductivity), increased erosion and delivery of erosional materials to surface waters (e.g., turbidity, TDS, TSS), increased transport and exposure to major metals (e.g., arsenic, aluminum, cadminum, chromium, copper, manganese, selenium, etc.), sulfate, nitrate-nitrogen and nitrite-nitrogen, and polyaromatic hydrocarbons (PAHs). Values outside of natural baseline conditions can cause shifts in habitat, changes in biological communities, altered nutrient and metals cycling, or more severe impacts. Exposure to many of these parameters above WQG criteria can have deleterious sub-lethal or lethal effects on life. For example, selenium is a naturally occurring heavy metal in the environment that is often found as a by-product of coal mining. Selenium is required for life in trace amounts, however selenium can bioaccumulate, meaning it accumulates in concentration within organisms directly, such as through water, or through diet. At higher concentrations, selenium can cause acute toxicity and poisoning or chronic sub-lethal effects through the alteration of proteins and interruption of various biological pathways (Davis et al., 1988)[9].

Changes in water quality are associated with the development and operation of the mine, as well as storage of waste and leaching of groundwater following closure. During mine development water quality may be impacted by landscape disturbances including site clearing, and road and infrastructure development. These impacts will largely be from erosion, especially adjacent to stream channels and natural pathways of water runoff. Increased compaction of soil and impervious surface development will also facilitate transport of material to waterways. The Project plans to have measures in place to control erosion to mitigate changes in water quality associated with this work, but any land disturbance will likely result in downstream changes, especially for major excavation activities.
During normal Project operation, water quality may be impacted by drainage from by-products of the open pit mine, wastewater from explosives and sewage, reduced infiltration (higher amounts of surface

[9] For a more complete review on water quality impacts on fish, please see the Fish and Fish Habitat Impact Assessment, Kyla Warren, Skeena Fisheries Commission

runoff and transport of sediments, salts, etc.), and water withdrawals (resulting in lower dilution capacity). The most severe impacts on water quality are typically associated with the mine waste itself. During the mining process, excavated materials lead to the exposure of potentially acid generating (PAG) rock with an oxygenating environment (i.e., atmosphere) and the subsequent generation and leaching of materials into the environment, often termed metal leaching or acid rock drainage (ARD). Coal mining targets geology high in PAG materials that are prone to ARD, and therefore responsible waste management is required to ensure that these materials do not contaminate adjacent environments. The Project proposes to use open pit mining in combination with various management ponds to both cover waste with water for permanent storage, and to treat project water through settling of suspended solids, before discharging this water into the environment. There are no additional water treatment options proposed other than a sewage treatment plan for secondary treatment of sewage prior to discharge along with the effluent from management ponds. The main location of point-source wastewater discharge will be an unnamed tributary of Goathorn Creek, and the specific location(s) of discharge point or points remains unclear based on information provided in the Project application. Other specific point-source wastewater discharge locations include unnamed tributaries of Tenas Creek and the Bulkley River.[10]

Surface water quality is also impacted through groundwater contributions. Main concerns from the Project are the impacts of groundwater seepage from waste management ponds. Groundwater seepage from the Project will contribute highly acidic water containing heavy metals, sulfide, sulfate, nitrate-nitrogen, nitrite-nitrogen, as well as other materials that contribute to an increase in total dissolved solids (TDS), total hardness, and conductivity. Projected impacts are less clear for parameters like pH, alkalinity, and ammonium nitrogen, but it is likely these parameters will also show some response as conditions become more acidic.

Potential impacts of the Project on temperature regimes of Tenas Creek, Four Creek, and Goathorn Creek are not well characterized in the Project Application, and the proponents suggest that changes in overall temperatures will be relatively small. However, it likely that shifting water sources from natural flow paths to diverted channels, storage ponds, and changing seasonal proportions of groundwater contributions will impact seasonal and spatial thermal regimes in these streams, which may have cascading effects for aquatic life.

The main source of water quality issues during the post-closure phase of the Project is acidic groundwater seepage and contribution of constituents of potential concern (CPC) including heavy metals, sulfate, nitrate-nitrogen, and nitrite-nitrogen from the waste management ponds to the downstream surface waters of Tenas Creek, Four Creek, and Goathorn Creek. Increases are also expected for TDS, total hardness, and conductivity. These impacts will propagate downstream to the Telkwa and Bulkley Rivers, with impacts lessening due to increased water volume and dilution capacity. There will also be some direct discharge via spillway from the North Management Pond to the unnamed tributary of Goathorn Creek (same location as discharge from Tenas Control Pond during operations).

Predictions for mining impacts to water quality concentrations are compared with background (baseline, or pre-mining) water quality conditions as well as with the most conservative-available BC WQG or CCME WQG. Model results suggest that under best-case scenarios, a number of parameters will exceed baseline conditions, BC WQG, and CCME WQG over the life of mine and in the post-closure phase (e.g.,

[10] Table 6.2-1: Summary of Project Discharge Facilities, in Tenas Project Application Section 13.0 Management Plans, Chapter 5 Discharge Management Plan.

total selenium, nitrite, dissolved cadmium, sulphate, etc.). The Project proponent also developed Site Performance Objectives (SPO), intended as site-specific water quality objectives for use in provincial surface water permitting; the proposed SPO are higher than BC WQG or CCME WQG for all parameters. Some parameters, (e.g., total selenium, dissolved cadmium, total thallium), are also predicted to exceed the proposed SPO, especially during low flow periods. Predicted discharge values are also higher than the proposed recommendations for Coal Mining Effluent Regulations (ECCC, 2022) for several parameters, including total selenium and nitrate.

Although WQG are intended to protect aquatic life from major deleterious effects, they are based on toxicological information regarding thresholds of impacts to specific organisms, and typically exceed the concentrations found in most undisturbed aquatic environments, including within the proposed Project area. While these guidelines may protect the aquatic environment from impacts to some extent, they are an upper bound for tolerated conditions, do not consider directional deviations away from the range of natural, undisturbed conditions present in that environment. Any change relative to background conditions should be considered an impact that results in some level of degradation that may be further exacerbated by cumulative effects.

The watersheds around the Project site have endured decades of disturbance from mining, mine exploration, forestry, and other activities. Baseline conditions within these watersheds reflect the legacy of those disturbances and may not reflect true undisturbed baseline conditions. Comprehensive historical water quality data from this area is rare, and baseline data that references a previous two years of monthly water data collection likely does not reflect true long-term variability, or pre-disturbance baseline conditions. Creating quantifiable objectives for water quality targets should be based off the range of variability of the current natural system and include targets that maintain water quality at or below the existing natural range.

The greatest impacts on water quality will occur within Four Creek, Tenas Creek, and Goathorn Creek. These impacts will propagate downstream to the Telkwa River and the Bulkley River, but reduced due to the higher volume of water and greater dilution effect of those waterbodies. Some smaller impacts associated with the development of a road crossing may occur on Helps Creek and Hubert Creek (and other similar small creeks). The following sections describe more specific water quality impacts for each stream.

4.2.1 Tenas Creek

Operations phase

The Project will impact water quality of Tenas Creek through groundwater seepage from waste management ponds and from discharge from the Explosive Facility Sedimentation Pond. Groundwater seepage to Tenas Creek will be greater towards the end of mining and in the post-closure phase as management ponds are filled to capacity. Seepage of acidic mining waste will increase concentrations of CPC in Tenas Creek over baseline conditions, including metals, sulfate, nitrate-nitrogen, nitrite-nitrogen, hardness, TDS and conductivity.

Direct project discharge to Tenas Creek is planned via discharge from the Explosive Facility Sedimentation Pond to an unnamed tributary. Tenas Creek already has the highest baseline concentrations of TSS and turbidity for any of the streams directly impacted by the project, indicating the underlying stream geology may be more prone to mobilization, or historic disturbance has increased erosion capacity in this watershed relative to the others. If maximum daily discharge from this pond occurs during a period of low baseflow, higher flows may contribute to additional downstream erosion and further transport of sediment, which may be problematic for downstream aquatic communities. The Explosive Facility Sedimentation Pond may also have potential to contribute additional levels of nitrite-nitrogen and nitrate-nitrogen (by-products of blasting material), which even at small increases can alter primary production and community composition in downstream reaches. Temperature regimes in this small tributary are also likely to change due to release of management pond water, with temperatures being warmer during the summer months (water discharge releases from the management pond are likely from the upper portion of the water column). However, it is unknown what direct impact these discharges will have on the water quality of this small unnamed tributary to Tenas Creek, as no baseline data was collected there.

Baseline water quality data collected on the mainstem of Tenas Creek from 2017-2019 shows WQG exceedances for total and dissolved aluminum, total copper, and total iron in Tenas Creek. Further additions of metals from mine waste will facilitate more rapid deterioration of stream conditions and care should be taken to protect and maintain existing water quality. For evaluating change in water quality conditions, is often more appropriate to compare future predictions of parameters to their range of natural variability, rather than WQG, to ensure concentrations don't become further elevated as a result of mining disturbance. Mitigation strategies that treat effluent prior to release into the natural environment, or additional measures for storage and treatment of rock waste, would help ameliorate some impacts.

Post-closure phase

The Project will impact water quality of Tenas Creek in the long-term through groundwater seepage from management ponds and these impacts will be greater in the post-closure phase. Elevated concentrations are expected for TDS, conductivity, hardness, nitrite/nitrate nitrogen, sulfate, and metals. Predictive load balance modeling by SKR Consulting, estimates that under best-case scenarios, concentrations of total and dissolved aluminum, total selenium, nitrite, and sulfate will exceed WQG during low-flow periods. This includes exceedances of up to 2 times the WQG for total selenium and up to 2.3 times the WQG for nitrite-nitrogen in the winter and summer months. Total and dissolved aluminum are expected to exceed WQG but will still be within the 95^{th} percentile of range of natural variability. Nitrite-nitrogen is readily oxidized into nitrate-nitrogen, which may also contribute to unaccounted increases in nitrate in Tenas Creek during low flow periods, especially in winter when biological uptake of inorganic nitrogen is reduced. Sulfate is also predicted to exceed WQG in winter months. Conductivity and TDS are predicted to increase above the 95^{th} percentile of the range of natural variability through at least the year 2100.

Under alternative model scenarios, such as higher rates of groundwater seepage than predicted, multiple years of low flows, higher than predicted source rock contributions to stream chemistry, etc., WQG may also be exceeded for dissolved cadmium, total copper, total manganese, total thallium, total zinc, and nitrate-nitrogen. Note that none of these predictions are presented relative to maintaining baseline levels of water quality but are rather focused on elevating concentrations above WQG thresholds representing deleterious conditions for aquatic life and drinking water consumption.

Preventing permanent degradation of water quality in Tenas Creek (for the next 100 years +) requires alternative design of mine waste management that eliminates potential sources of groundwater pollution.

4.2.2 Four Creek

Operations phase

The Project will impact water quality of Four Creek through groundwater seepage from waste management ponds and surface water contributions from diversion channels intended to capture and divert upstream runoff to portions of Four Creek. Similar to Tenas Creek, groundwater seepage to Four Creek will be greater towards the end of mining and in the post-closure phase as management ponds are filled to capacity. Seepage of acidic mining waste will increase concentrations of CPC in Four Creek, including metals, sulfate, nitrate-nitrogen, nitrite-nitrogen, hardness, TDS and conductivity.
During the operations phase, are no point-source discharges to Four Creek. However, the CPP Sedimentation Pond, which normally flows into the Tenas Control Pond, will discharge into Four Creek during a 1-in-25 year storm event and may result in contributions of waste pond water to Four Creek during high flow periods. A series of diversion channels are also proposed to route surface water runoff from upstream around the Project footprint and shunt these flows to Four Creek. During high runoff periods, these diverted flows along with contributions from the CPP Sedimentation Pond, may contribute quite a bit of extra discharge of Four Creek. In addition to transporting additional material collected via surface runoff and pond waste, high flows may exacerbate erosion and scour of instream habitat, which will increase the mobilization and transport of materials downstream and elevate levels of TSS and turbidity. The Project design also indicates there is a small tributary of Four Creek with a 30 m offset to the open pit; given this relatively short distance, it's possible that this tributary may receive direct transport of materials that may alter water quality both from surface runoff and aerial deposition associated with construction and operations, including blasting and mining.

Baseline water quality data collected on the mainstem of Four Creek from 2017-2019 shows WQG exceedances for total and dissolved aluminum, total and dissolved iron, and total mercury. Further additions of metals from mine waste will facilitate deterioration of stream conditions and care should be taken to protect and maintain existing water quality. It is more appropriate to compare future predictions of parameters to their existing range of natural variability, rather than WQG, to ensure concentrations are not further elevated as a result of mining disturbance. Mitigation strategies that treat effluent prior to releasing it into the natural environment, or additional measures for the storage and treatment of rock waste, would help ameliorate some of these impacts.

Post-closure phase

The Project will impact water quality in Four Creek in the long-term through groundwater seepage from the East Management Pond. Elevated concentrations are expected for metals, sulfate, nitrate-nitrogen, nitrite-nitrogen, hardness, TDS and conductivity. In addition, during the post-closure phase, the CPP Sedimentation Pond will discharge directly to Four Creek via a spillway. Models by SKR Consulting Ltd., estimate that under best-case scenarios, concentrations of total and dissolved aluminum, total selenium, dissolved cadmium, nitrite, and sulfate will exceed WQG during low-flow periods. This includes exceedances of up to 2.9 times the WQG for total selenium, up to 1.9 times the WQG for nitrite-nitrogen, up to 1.5 times the WQG for dissolved cadmium, and up to 1.2 times the WQG for sulfate. Total and dissolved aluminum are expected to exceed WQG but still be within the 95th percentile of the range of natural variability estimated from the 2017-2019 baseline data. Nitrite-nitrogen is readily oxidized into nitrate-nitrogen, which may also further contribute to elevated levels of nitrate in Four Creek during low flow periods. Conductivity and TDS are predicted to increase above the 95th percentile of the range of natural variability through at least the year 2100.

Similar to alternative modelling scenarios discussed above for Tenas Creek, variability in source rock contributions to groundwater chemistry resulted in additional WQG exceedances for total copper, total cobalt, total manganese, and total thallium during winter low flows. Under low flow conditions, nitrate-nitrogen, total copper, and total manganese also exceeded WQG, and total selenium could exceed the proposed SPO during winter months. Note that none of these predictions are presented relative to maintaining baseline levels of water quality but are rather focused on elevating concentrations above WQG thresholds representing deleterious conditions for aquatic life and drinking water consumption. Preventing permanent degradation of water quality in Four Creek (for the next 100 years +) requires alternative design of mine waste management that eliminates potential sources of groundwater pollution.

4.2.3 Goathorn Creek

Operations phase

The Project will impact water quality of Goathorn Creek through direct surface discharge of waste management ponds and groundwater seepage from waste management ponds. The main discharge location for the Project is an unnamed tributary of Goathorn Creek; during operations, effluent will be discharged via pump or spillway from the Tenas Control Pond, the Explosive Magazine Sedimentation Pond, and the Sewage Treatment Pond. The specific location of this discharge point is unclear, although it appears to be quite far upstream (i.e., kms) from the closest baseline water quality monitoring location. The Project claims that discharge from the ponds will be managed to control downstream impacts on Goathorn Creek, however discharged waste water will be minimally treated. Planned treatment involves only the settling of materials in the ponds (including addition of flocculants to aid in settling) and secondary sewage treatment.

Direct addition of wastewater effluent from the mine waste management and sewage treatment ponds to the tributary of Goathorn Creek will increase metals, sulfate, inorganic nitrogen (nitrate, nitrite, ammonia), phosphorus, hardness, TDS, conductivity, TSS, and turbidity. Addition of nutrients such as nitrogen and phosphorus (from sewage) may change downstream production of algal communities. Increased algal biomass can increase the downstream occurrence of low dissolved oxygen, especially during warm, low flow periods. Baseline total phosphorus concentrations classify Goathorn Creek as oligotrophic for most of the year, with mesotrophic to meso-eutrophic conditions in late spring. Increased phosphorus concentrations may cause eutrophication in this system. Effluent from the waste management ponds may also contain reduced compounds that can consume oxygen downstream through oxidation reactions. Sewage treatment additions will also contribute an unknown load of pharmaceuticals into an environment that currently experiences little contact with human waste.

Discharge of pond effluent, in combination with changes in hydrology (discussed above) will likely change the thermal regime directly downstream of the discharge location, and these changes may propagate downstream to Goathorn Creek.

Predictive load balance modeling by SKR Consulting, estimates that under best-case scenarios, Goathorn Creek would exceed WQG for total aluminum in both winter and summer, and total iron in summer; note that both of those parameters had high background concentrations measured in 2017-2019 baseline data, and that future exceedances are predicted to fall within the range of variability (<95th percentile) measured over that period. Under alternative case models where source terms were elevated or consecutive wet years were included as conditions, they predicted additional WQG exceedances of dissolved cadmium, total copper, total manganese, total thallium and total zinc. The model also estimated TSS and turbidity would increase, and that TDS and conductivity would increase beyond the range of variability measured in the baseline data. Temperature is also predicted to increase by a small amount. It is important to consider that all model predictions were calculated for water quality monitoring stations located on Goathorn Creek over 3 km downstream of the approximate confluence location of the unnamed tributary receiving the effluent discharge. No estimates were made for changes to water quality on the tributary receiving effluent inputs.

The Project plans to prevent short term elevated concentrations from entering Goathorn Creek by controlling discharge from the ponds and active monitoring of pond water quality and downstream conditions. This level of prevention may not prevent short-term discharge of toxic pond waste, but instead attempt to curtail it after it happens. In addition, during periods of high flow, discharge will occur via the spillway and even if stream levels are elevated and dilution capacity is greater, metals like selenium, mercury, etc., will still be transported into the environment and taken up by organisms or entrained in sediments for future release.

Similar to Tenas and Four Creeks, groundwater seepage to Goathorn Creek will be greater towards the end of mining and in the post-closure phase as management ponds are filled to capacity. The impacts of groundwater seepage will likely be lower in Goathorn Creek compared to Tenas and Four Creeks, Seepage of acidic mining waste will increase concentrations of CPC in Goathorn Creek, including metals, sulfate, nitrate-nitrogen, nitrite-nitrogen, hardness, TDS and conductivity.

Post-closure phase

The Project will impact water quality in Goathorn Creek in the long-term through direct discharge of waste management ponds via gravity from a spillway at the North Management Pond, and groundwater seepage. Discharge during the post-closure phase will be to the same unnamed tributary of Goathorn Creek. Predicted exceedances are few if any during the post-closure phase, as the best-case scenario model assumes optimal performance of the North Management Pond and spillway, and while groundwater seepage is predicted to increase overall concentrations of water quality parameters, including temperature, the Project application does not state specifically which parameters are predicted to increase or if these increases will be outside current baseline range of variability. Without alternative management of pond waste discharge to Goathorn Creek, impacts on water quality will likely occur for at least the next few centuries, even if groundwater seepage is mitigated.

4.2.4 Telkwa River

Operations phase

The Project will impact water quality of the Telkwa River, although less so than the smaller upstream tributaries located directly within the Project area. Water quality in the Telkwa River will be impacted downstream of the confluence with Goathorn Creek, which receives all contributions from Tenas Creek and Four Creek, as well as other small tributaries. The larger size of the Telkwa River increases dilution capacity, resulting in lower concentrations of constituents delivered via Goathorn Creek. However, these constituents are still incorporated into the sediments and foodweb of the Telkwa River, as well as downstream ecosystems.

The Telkwa River baseline data from 2017-2019 show elevated concentrations and WQG exceedances for total and dissolved aluminum, total copper, and total iron. There is also a decrease in some metals downstream of the Goathorn confluence, especially during higher flow periods of the year. This suggests that Goathorn Creek may currently contribute to a reduction in the concentrations of some metals, likely from dilution. Increases in metals within Goathorn Creek because of contributions from the Project mine and acid mine waste could offset some of this dilution effect, especially as open season water flows are predicted to decrease slightly during project operations. Higher concentrations of some metals in the Telkwa River may represent naturally high background concentrations or could be a result of historical and current disturbances within the watershed. Further inputs of degraded water quality will continue to shift conditions away from undisturbed, underlying natural baseline conditions and predictions do not account for other future disturbances that may occur in the upper portions of this watershed and subsequent propagation of cumulative effects.

Post-closure phase

The Project will impact water quality in the Telkwa River in the long-term by impacting the watersheds that contribute to Goathorn Creek, as described in previous sections. Impacts of groundwater seepage are predicted to be greater in the post-closure phase and will likely have larger impacts on the Telkwa River over time, especially during low flow periods. These impacts will likely be the greatest around the confluence with Goathorn Creek and ameliorate with distance, however local impacts around the confluence may be notable. In addition, accumulation in sediments and biota, as well as biogeochemical cycling can result in mobilization and downstream transport of contaminants, especially metals, that are unaccounted for in the current models.

4.2.5 Bulkley River

Operations and post-closure phase

The Project will directly impact water quality on the Bulkley River from discharge at the Rail Infrastructure Sedimentation Pond. This pond is used to provide sediment retention for runoff from the Rail Infrastructure area, which includes processed stockpiles and a topsoil stockpile. Volume-wise, contributions will be small in comparison to the total volume of the Bulkley River, however there will be no treatment of this wastewater outside of settling and local impacts in the initial dilution zone before mixing with receiving water should be expected. Aquatic organisms within this mixing zone may be impacted by CPC, such as metals, nitrate, sulfate, higher turbidity, TSS, TDS, etc.

Project impacts to the Bulkley River from the main Project site will be smaller relative to the other systems discussed in previous sections, however upstream impacts to the Telkwa River will likely propagate downstream but become less acute as distance from the Telkwa River confluence flow increases. The larger volume of the Bulkley River has a greater dilution effect on contaminant concentrations, and while a notable increase in CPC over baseline conditions as determined in 2017-2019 is possible, it is unlikely if future conditions remain the same as today. However, the time scale of post-closure impacts extends potentially centuries into the future, and future environmental and disturbance conditions are unknown. Upstream development of projects with high environmental risk, like coal mines, contribute to long-term cumulative effects.

4.2.6 Helps Creek and Hubert Creek

Operations and post-closure phase

The Project impacts on Helps Creek and Hubert Creek are associated with the development of a haul road that crosses these creeks and links the main Project site to the Rail Infrastructure. This road will be used primarily to transport coal to the railroad via truck. Water quality impacts along the haul road will most likely be associated with erosion, surface runoff of dust suppressant and de-icing materials, and aerial transport of coal dust to proximal water bodies. There is very little baseline water quality data for the streams in this area. Effects are likely to be minimal but may be more pronounced in the immediate vicinity of the road. Once the road is decommissioned, any ongoing effects from road surface erosion will reduce over time.

5. ACCIDENTS AND UNKNOWNS

5.1 Containment Pond Breach

One of the greatest risks to hydrology, water quality, and aquatic ecosystems within and downstream of the Project is breaching of waste management ponds. A failure of any management pond dam that breaches a pond would be a catastrophic event that would severely and permanently compromise the hydrology, water quality, and habitat of downstream waters. The removal of water covers during a breach will expose reduced acid mine waste substrates to the atmosphere, contributing to oxidation and mobilization of many compounds, including metals, sulfate, nitrate, etc., into the environment. This source of material would continue to leech ARD in perpetuity, especially if the breach happens later in the operations phase or in the post-operations phase. In addition, the physical destruction associated with a downstream surge in water and sludge, would not only mechanically decimate and smother habitat, but also kill most aquatic life, as well as any other organisms including humans. The Project application rates failure of any of the management pond dams as “Very high” risk, based on their estimate of loss of life, population impacts, and risk to environmental and cultural values[11].

Another form of containment pond breach is the failure of the pond liners, which would result in increased mobilization of acid mine waste and contaminants into groundwater. The management ponds are designed to contain mine waste, submerged under water, forever. Over time, the pond liners may degrade and/or compromised, resulting in increased rates of leeching and increased delivery of contaminants to the surrounding aquatic waterbodies.

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[11] Table 6.2-12: Consequence Classification for Management Ponds and Tenas Control Pond in Tenas Project Application Section 13.0 Management Plans, Chapter 11: Minesite Water Management Plan

5.2 Rail Spill

Impacts to water quality may result from spills from hauling trucks or rail cars on the way to/from or at the rail loadout area. These types of spills would likely involve processed coal and/or diesel or gasoline fuel. However, there are numerous other hazardous chemicals that will be used on site, and if transported in by rail, may also have spill potential. Spills at the Rail Infrastructure Site would most likely impact the Bulkley River, especially if the spill was substantial. A breach of the Rail Infrastructure Sedimentation Pond would also contribute contaminated waste to the Bulkley River, although the overall size is relatively small. Rail spills could also happen downstream anywhere on the railroad, although the extent of damage would be location and accident specific.

5.3 Other spills

Unexpected spills due to operations could result in elevated concentrations of hydrocarbons and other chemicals in surface water and groundwater. There are other proposed hazardous materials stored on site that have risk of spillage, most likely during transit. The proposed hazardous materials stored on site are provided in Table 1.18-2, of the Tenas Project Application, “Part A Introduction, Section 1.0 Overview of Project Proponent Description”. The materials vary but are largely comprised of hydrocarbons and therefore could have impacts on PAH concentrations should they enter waterbodies. Currently all waterbodies sampled had levels of PAH below the analytical limit of detection. Care should be taken to continue monitoring for these compounds to ensure they are not entering the environment.

5.4 Climate Change

Future environmental conditions insert unpredictability to assumptions about how hydrology and water quality will respond to the development of the Project. Future projections for the region under climate change scenarios include greater summer precipitation, warmer temperatures, more precipitation as rain versus snow, and a higher degree in the range of variability within year-to-year weather, with expansions on extremes at both ends (i.e., record warm and dry years, record cold and wet years, etc.) (Foord, 2016). More rain and runoff from rain could result in increased contributions of runoff from mine operations, but also more dilution of downstream impacts during summer months. However, predictions of poor water quality associated with low flows during winter months will likely remain accurate over the next century, unless winter rain becomes more prolific in the region. Years of very low flow may require additional water removal from surrounding creeks to maintain water covers in the management ponds, especially if multiple dry years happen to occur in a row.

Wildfire risk has been increasing in recent years, and wildfires can destabilize soils, increasing erosion potential to streams and elevating TSS, turbidity, conductivity, TDS, nutrient concentrations, and metals. If a wildfire occurs in the Project area, water may be needed to fight fire to protect structures and may compromise the amount of water needed to maintain pond cover. Evacuation of the Project area may also lead to missed opportunities for monitoring, and downstream water quality may become compromised if operations are unable to resume due to risk of wildfire hazard. These scenarios are unlikely but worth consideration in potential risks.

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