10. ASSESSMENT OF POTENTIAL HEALTH EFFECTS

10.1 AIR QUALITY

10.1.1 Rationale

This section includes a description of the scoping process used to identify air quality for inclusion in the assessment. Air quality is a measure of the presence and quantity of constituents in ambient air, including contaminants in the atmosphere. Air quality is a VC because of the potential risks to human health. A healthy atmosphere helps sustain life and maintain the health and well-being of the biophysical environment. If not properly managed, releases of air contaminants to the atmosphere may cause adverse effects on air, land, and waterways, and on the interacting biological systems that depend on them, in the vicinity of the Project.

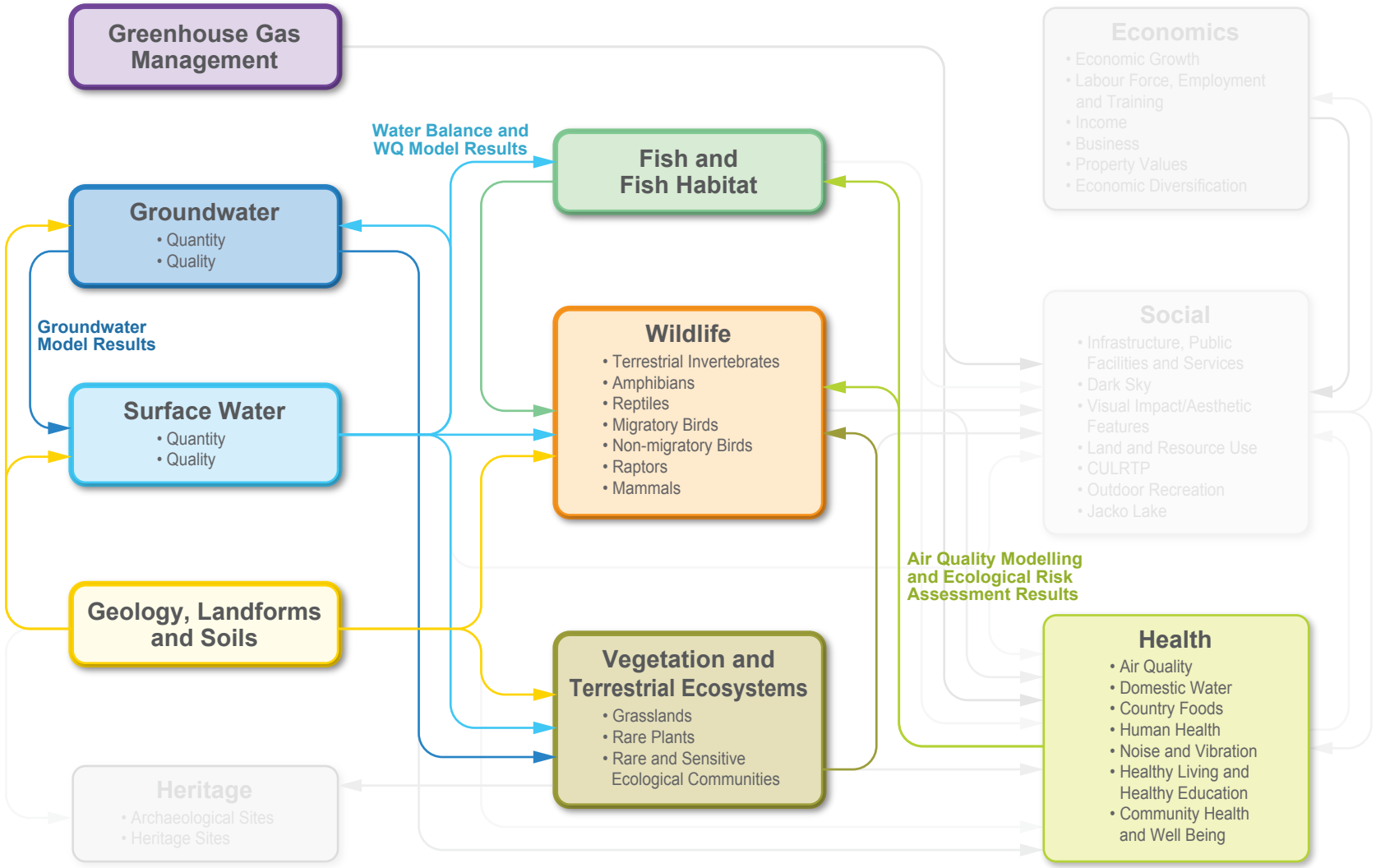
The information developed to support the analysis of this VC also contributes to other analyses for other VCs, as summarized in Figure 10.1-1. Project-related changes in ambient air quality and dustfall are also linked to Surface Water Quality (Section 6.4), Rare Plants (Section 6.8), Rare and Sensitive Ecological Communities (Section 6.9), Grasslands (Section 6.10), Domestic Water Quality (Section 10.2), Country Foods (Section 10.3) and Community Health and Well-being (Section 10.6). Emissions of GHGs are discussed separately in GHG Management (Section 6.1). The Air Quality and Dust Control Management Plan including the associated management and monitoring plan and compliance reporting is Section 11.6.

Air quality was selected as a valued component (VC) for a number of reasons. The justification for including air quality as a VC was based on:

- scientific/professional knowledge;
- Federal and Provincial Ambient Air Quality Objectives and Standards;
- Provincial Interim Ambient Air Quality Objectives for SO_2 and NO_2;
- public or other stakeholder input (e.g., Kamloops Area Preservation Association, Kamloops Food Policy Council); and
- Aboriginal interest.

The oral history surrounding the Jacko Lake area identifies the importance of the relationship between human beings and the environment (e.g., fish, birds, animals, the atmosphere including air quality and the water cycle). This relationship is illustrated in a story called The Trout Children, part of the oral tradition of this area. The story explains the relations between humans and the trout people who are said to live in and under the lake. The story was also connected to a Prayer Tree (which no longer exists) at the entrance to the Peterson Creek/Jacko Lake area in what is now known as Knutsford. The tree, since destroyed by development of a road decades ago, served as a medium for human communication with the sky (atmosphere) world. It was important to communicate and show respect for the land and creatures in this area.

Figure 10.1-1
Air Quality Interactions with Other Valued Components



Traditional knowledge regarding air quality information was incorporated for each Aboriginal group to the extent that it was made available. KAM is committed to integrate traditional knowledge regarding air quality information into mitigation, monitoring, and other project-related activities, as appropriate, should additional information be made available by Aboriginal Groups.

10.1.1.1 Scientific/Professional Knowledge

A change in air quality during Construction or Operation of the Ajax Project ('the Project') may occur due to emission sources from Project components, including emissions from:

- trucks and heavy equipment direct emissions;
- indirect emissions from mine activity and haul-road road traffic (e.g., fugitive road dust);
- emissions from blasting activities;
- stationary equipment (e.g., crushers, conveyors, generators); and
- emissions from area sources such as the Tailings Storage Facility (TSF), disturbed land surfaces and Mine Rock Storage Facilities (MRSFs).

10.1.1.2 Federal and Provincial Ambient Air Quality Objectives and Standards

Air emissions from Project-related activities will primarily be air contaminants, known as criteria air contaminants (CACs):

- total Dustfall (DF);
- total suspended particulate matter (TSP);
- sulphur dioxide (SO_2);
- total oxides of nitrogen (NOx);
- carbon monoxide (CO);
- respirable particulate matter ($PM_{2.5}$); and
- inhalable particulate matter (PM_{10}).

Brief descriptions of the CACs considered in this assessment follow.

Sulphur dioxide (SO_2) is a respiratory irritant with an array of adverse effects, including bronchoconstriction and increased asthma symptoms. Elevated concentrations may also affect vegetation. It is released into the atmosphere from the combustion of sulphur-containing fuels, wood pulping operations, and petroleum refining.

Nitrogen oxides (NOx) include nitrogen dioxide (NO_2) and nitric oxide (NO). NO_2 is a respiratory irritant at high concentrations. Therefore, regulatory ambient air quality criteria exist for NOx or NOx as NO_2 but not for NO. NOx are primarily formed from the combustion of fuels.

Carbon monoxide (CO) at elevated concentrations is known to produce cardiovascular symptoms by displacing oxygen in the bloodstream. CO is released into the atmosphere primarily as a product of incomplete combustion of carbon-based fuels.

Particulate matter (PM) with aerodynamic diameters less than 2.5 microns is known collectively as $PM_{2.5}$. This respirable particulate matter consists of very small particles that have the potential to enter and be retained by the lungs. $PM_{2.5}$ is generally produced by combustion processes rather than physical processes, such as ore crushing. Particulate matter with aerodynamic diameters less than 10 microns (PM_{10}) includes $PM_{2.5}$ as well as particles in the 2.5 to 10 micron range. PM_{10} particles are produced through combustion as well as by physical means, including erosion.

Ultrafine particles (<0.1 μm in diameter) are a sub-set of $PM_{2.5}$ and of emerging interest from a human health perspective. The particles are a sub-set of $PM_{2.5}$, and are thus captured in this assessment. The human health and environmental risk assessment (HHERA) Technical Data Report (Appendix 10.4-A) will include discussion on ultrafine particles.

Ultrafine particles (UFP) are defined as particles less than 0.1 μm (microns) in diameter. UFP have both natural and anthropogenic sources, and include both primary emissions and secondary aerosol formation. Particle size and number vary considerable over space and time owing to rapid assimilation into larger particles and dispersion. In urban areas combustion sources are a major contributor to UFPs. The highest concentrations are observed near sources, and concentrations decrease rapidly with distance from the sources (Solomon 2012).

Over 10 years of health studies have provided suggestive, but often inconsistent, evidence of adverse human health effects of short-term exposures to UFP (HEI 2013). There are no studies of long-term UFP exposure owing to the lack of long-term monitoring and insufficient spatial resolution. In the available short-term studies, it is difficult to discriminate the effects of UFPs from other causal factors (BC Lung 2013).

While UFP are of emerging interest from a human health perspective, the effects of UFP exposures on health are not well enough understood to conclusively assess. There are no applicable regulatory criteria for UFP. As a consequence, this assessment defers to substances for which there are applicable regulatory criteria, and UFP are not considered as a separate species.

Ozone and secondary $PM_{2.5}$ formation will not be modelled in this assessment. The BC Ministry of Environment (BC MOE) has stated that ozone and secondary $PM_{2.5}$ formation will occur far outside the Kamloops airshed. Any secondary pollutants that did form would form two to four hours downwind, which is outside the Kamloops airshed. By that time these substances will be sufficiently dispersed and, therefore, of little concern. In addition, there is no need to consider the generation of secondary pollutants due to the low quantities of precursors emitted by the Project (e.g., NO_x, SO_2, and reactive hydrocarbon species), and the small size of the domain of interest. The detailed justification for not including ozone and secondary $PM_{2.5}$ in the assessment if provided in Appendix 10.1-A, Appendix B (Selected References for the Ajax Mining Project Final Detailed Model Plan).

The change in concentration for the CACs in the atmosphere resulting from the various mining activities is an indicator of a change in air quality. Adequate information is available to estimate the Project emissions and a regulatory agency (BC MOE) approved air dispersion model is used to estimate the worst case ground level concentrations for the CACs. The baseline ambient air quality values are added to the model predictions for the mine to allow comparison to the ambient air quality objectives. The effect of the Project on air quality is determined in part by comparing

predicted concentrations to the applicable ambient air quality objectives for CACs that have been established to protect human health and the environment.

A variety of substances of interest emitted from the Project emission sources were included in the air dispersion modelling for discrete 'special receptors' for the human health and environmental risk assessment (HHERA). From the HHERA perspective these substances are known as contaminants of concern (COCs) and they include trace elements in the ore, mine rock and tailings. The COCs for the HHERA include total dustfall, metals in dustfall, TSP, PM_{10}, $PM_{2.5}$, and hazardous air pollutants (HAPs) that include polynuclear aromatic hydrocarbon species (PAH) which are used as a proxy for diesel particulate matter. The priority is the individual metals and their potential long term deposition. The details of how the air quality model outputs were used in the HHERA are found in the Detailed Model Plan (Appendix 10.1-A, Appendix B, Section 2.2.2 Substances of Interest for the HHERA). The Detailed Model Plan contains a listing and description of the discrete 'special receptors' used for the HHERA. The COCs related to the HHERA are not summarized in this section but they are found in Domestic Water Quality (Section 10.2), Country Foods (Section 10.3) and Community Health and Well-being (Section 10.6).

10.1.1.3 Public or Other Stakeholder Input

The City of Kamloops has been proactive in their efforts to manage ambient air quality. In collaboration with several local stakeholders, the City of Kamloops assembled a technical committee and prepared an Airshed Management Plan (AMP) (City of Kamloops, 2013) to ensure good air quality in the community. Good air quality is essential to human and environmental health. Health concerns, including cardiovascular and respiratory conditions have been linked to degraded air quality. The AMP provides the foundation and direction to preserve air quality in the community through a collaborative effort among government, business, industry, and residents. The priorities of the AMP are:

- ensuring citizens have healthy air to breath by meeting or exceeding Canada-wide standards and provincial air quality objectives;
- ensuring maintenance of good air quality and improvements to air quality where feasible throughout the community/region;
- educating and informing the community on local air quality issues; and
- leading by example by changing behaviors as needed to protect air quality.

A number of key strategies were identified through public consultation and technical review of the air quality issues in the airshed. The following strategies were recommended:

- encourage alternative, sustainable methods of transportation and supportive infrastructure;
- minimize contaminant emissions from wood burning appliances with proper installation and management;
- ensure that open burning is a last resort approach and is undertaken correctly to minimize contaminant emissions;
- limit impact of contaminant emissions from industrial, commercial and institutional sources;

- increase the local government's role in air quality preservation and enhancement through land use planning, by-laws, and programs;
- enhance access to air quality information and increase public awareness; and
- support ongoing air quality research to protect and improve air quality.

The main pollutants present in the Kamloops airshed, and discussed in the AMP, include particulate matter (PM_{10} and $PM_{2.5}$), ground level ozone (GLO), and odorous reduced sulphur gases (ORSG). Emissions of PM and GLO are linked to a variety of heart and lung-related negative health outcomes, including premature death. ORSG are not scientifically proven to be a health hazard but they are a nuisance and can impact economic development due to their odor. Other pollutants of concern in the airshed (should their concentrations increase) were NO_2, SO_2, and VOCs.

The key objectives of the AMP are:

- protect, and where feasible, improve air quality in the City of Kamloops;
- continue to raise awareness and inform the public about air quality issues in the airshed;
- continue to support BC MOE in monitoring emissions of air contaminants in the airshed;
- continue to meet and be consistently better than Canada-wide Standards (the new CAAQS replace the Canada-wide Standards for PM and ozone [O_3]) and Provincial Objectives for air quality except in the case of episodic, natural events such as forest fires; and
- ensure there is no upward trend in any measured air contaminant parameters.

KGHM Ajax Mining Inc. (KAM) will contribute to these five key objectives through compliance with their future waste (air) discharge permit required by the BC Waste Discharge Regulation (BC Reg. 263/2010) under the provisions of the BC *Environmental Management Act* ([SBC 2003] Chapter 53). In addition, KAM is participating in and supporting the Fraser Institute's air quality roundtable. KAM is aware that air quality is a concern for the community and will support improvements through their community engagement programs. To support future air quality improvement initiatives KAM will be providing The City of Kamloops with the air dispersion modelling input files that were used to define the background (Base Case) air quality for the Project.

The mining industry is listed as a 'prescribed' industry under the Waste Discharge Regulation; a Permit is required to authorize the disposition of waste (e.g., air emissions) in compliance with the *Environmental Management Act*. To secure a Permit authorizing emissions to the atmosphere KAM must conduct an air quality assessment consistent with the *Guidelines for Air Quality Dispersion Modelling in British Columbia* ('the *Guidelines*'; BC MOE 2008). The *Guidelines* (BC MOE 2008) recommend the development of a Detailed Model Plan. BC MOE reviewed and approved the Ajax Mining Project Detailed Model Plan on February 27, 2015 and it is included in the Air Quality Technical Data Report (Appendix 10.1-A, Appendix B).

The general public (singly and as members of groups) expressed concern about potential health effects of the mine air emissions (e.g., diesel emissions and fugitive dust from blasting) during poor air quality days. There was also concern that deposition of metals in particulate matter from the

mine activities could potentially contaminate vegetation, livestock, and wildlife. Specific concerns were expressed related to the potential adverse health effects from the fine particulate matter ($PM_{2.5}$) emitted by the mine activities including emissions to the ambient air from blasting. Concerns were raised about the acceptability of the baseline $PM_{2.5}$ and PM_{10} concentrations at the Goose Lake monitoring station operated by BC MOE. Concerns were also raised about the representativeness of meteorological data collected at the KAM meteorological station.

Various stakeholders (singly and in groups) expressed concerns about air quality during the review of the draft Application Information Requirements/Environmental Impact Statement Guidelines (dAIR/EISG) (BC EAO 2015). Interior Health expressed concerns about the baseline ambient air quality in the LSA and specifically the baseline levels for respirable particulate matter (i.e., $PM_{2.5}$). The other stakeholder concerns for air quality were related to degraded air quality in Kamloops resulting from dispersion of particulate matter from the Project (e.g., from proposed unpaved roads, mobile equipment emissions, uncovered mine tailings pile and other installations on the mine site), meteorological data requirements for air dispersion modelling, and the methodology for conducting the air dispersion modelling.

10.1.1.4 Substances of Interest Excluded from the Air Quality Assessment

There are several candidate topics that were considered for inclusion in the air quality VC but were not included because they were not relevant, or are to be addressed by a different VC.

The Project does not include cooling towers or other near-saturated discharges of water vapour (e.g., wet scrubbers). Water losses on site are limited to evaporation from water storage facilities and wetted surfaces (e.g., the TSF surface, roadways sprayed with water for dust control). Additional details relating to site water management are contained in the Detailed Project Description, Section 3.15 Site Water Management. Fogging and icing episodes attributable to evaporation associated with Project activities are not likely to exceed those instances where fogging and icing is already occurring naturally. The potential for fogging and icing due to discharges of water vapour will therefore not be assessed.

In some jurisdictions the presence of crystalline silica in the ore body is cause for concern because excess worker exposure to crystalline silica can cause silicosis, a non-cancerous lung disease. Given the relative absence of crystalline silica in the Ajax Mine Site rock, the Stantec Senior Toxicologist has removed it from further consideration in the HHERA. At the Mine Site, workers that can potentially be exposed to the small amount of respirable SiO_2 (e.g., drilling activities, crushing activities) will be wearing personal protective equipment. Meaningful exposures beyond these work environments are not possible.

The City of Kamloops expressed concerns for the potential air quality effects from the use of two mineral processing reagents. Methyl isobutyl carbinol (MIBC) and potassium amyl xanthate (PAX) are commonly used reagents for mineral processing. MIBC is a liquid used without dilution in mineral processing. PAX is delivered in solid form and mixed with water to make a solution. MIBC and PAX have the potential to evaporate; therefore, to protect workers, proper ventilation and personal protective equipment (PPE) is required for the plant areas associated with preparation and distribution of these reagents. The fate of MIBC and PAX was examined to determine if any

appreciable quantity of MIBC and PAX (or their decomposition products) persists in the water cycle where they may potentially evaporate from open water surfaces on the project site (e.g. from the TSF). Given its ability to naturally degrade through exposure to sunlight and to bacteria, fungi or other biological means, MIBC is not expected to create any environmental exposure and is not a concern for human health (Danon-Schaffer 2012, pers. comm.). Evaporation of PAX is unlikely (Danon-Schaffer 2012, pers. comm.). The Stantec Senior Toxicologist examined the details related to the use of MIBC and PAX and their decomposition products (Danon-Schaffer 2012, pers. comm.) and screened them out of the HHERA. Further details related to the air quality contaminants of concern that were not included in the HHERA can be found in the HHERA Technical Data Report (Appendix 10.4-A).

The focus of this assessment is ambient air quality. Ambient air quality refers to the status of the air around us, and in the context of a mine site it is the air outside of the Plant Boundary (sometimes referred to as the plant fenceline). Ambient air quality is managed differently than occupational (or workplace) air quality. The control and management of air emissions occurring within the Plant Boundary (e.g., occupational air quality) is covered under the statutes of the Occupational Health and Safety Regulations (WorkSafeBC 2015) and the Health, Safety and Reclamation Code for British Columbia (BC MEMPR 2008). These statutes are enforced by WorkSafeBC and the Chief Inspector of Mines, respectively.

With one minor exception the focus of this assessment is the ambient air outside the Plant Boundary. There is one publically accessible area inside the Plant Boundary that required additional analysis. The air dispersion modelling included a special receptor grid for the Jacko Lake area to quantitatively assess the air quality. The model predictions at the Jacko Lake receptors were provided to HHERA to consider exposures from the mine site to the public. Further details are provided in the HHERA Technical Data Report (Appendix 10.4-A).

10.1.2 Background

10.1.2.1 Regional Overview

The Project is located in the Thompson-Okanagan region of BC. The topography consists of a mixture of mountains and valleys. The mountains are largely tree-covered with extensive cut blocks (areas that have been logged) that are in various stages of re-growth. The valley bottoms are dry except for rivers and lakes. The weather in this area tends to be mostly benign and is controlled by the Coastal Mountains. Kamloops is on the lee side of these mountains and subsidence has reduced the precipitation causing much of the area to be arid or semi-arid, characterized by low annual precipitation and high evaporation.

Summer in this area is notably sunny, hot, and dry due to the incursion of the Pacific High. Late afternoon or evening thunderstorms occur mainly along the ridges. Widespread thunderstorms may develop if the Pacific High breaks down. During winter, inversions are common when mountain valleys allow cold air to pool. The Thompson River seldom freezes resulting in abundant moisture that the inversion can trap, supporting the development of low "valley cloud". The dense cold air in the valley can be difficult to remove as the warm coastal air rides over top of the cold air. Warming

can occur with southerly winds, but the respite only lasts a few days as cold air is quickly re-established in the valley bottom (Nav Canada 2001).

Meteorology baseline data is collected at the Project automated meteorology station and long term regional meteorology stations operated by Environment Canada (EC) and BC Ministry of Forests, Lands and Natural Resource Operations (FLNRO). The climate of the LSA is characterized by generally cool, dry winters with occasional cold snaps, and hot, dry summers with low humidity. The boundaries and definition for the LSA are included in Section 10.1.3.1. The long-term average annual temperature is 6.4°C, with average monthly temperatures ranging from -4.9°C in December to 18.7°C in July. Relative humidity varies throughout the year, but it is typically highest in mid-winter and lowest in mid-summer, with respective monthly average values of approximately 88.5% (January) and 48.6% (July; Knight Piesold 2014).

Precipitation at the Project LSA is seasonally variable, with the highest rates occurring in June and July. Based on long term precipitation data from Kamloops Airport and an appropriate scaling factor to account for the higher precipitation at the Project, the mean annual precipitation for the Project LSA is estimated to be 336 mm, with 70% falling as rain (235 mm) and 30% as snow (101 mm). Mean annual lake evaporation was estimated to be 585 mm (Knight Piesold 2014).

Wind speed and direction in the Project LSA varies throughout the year. Wind data measured 10 m above ground was collected at the AJAXMET station between August 2010 and November 2014. Wind data from the AJAXMET station, located northwest of the Project area, indicates dominant north-westerly winds in the summer and south-south-easterly winds in the winter, with an average wind speed of 2.3 m/s (Knight Piesold 2014).

Ambient air quality and meteorology monitoring began at the Ajax Upwind Station in August 2014. The station is located on Lac Le Jeune Road approximately 7.5 km southwest of Aberdeen. The purpose of the station is to provide baseline data for effects assessment analysis as well as upwind monitoring data during Construction and Operation. Ultimately the system will form part of an air quality monitoring network for the Project that will include one upwind station and two downwind stations. The meteorological components were installed in August 2014. A precipitation gauge upgrade was installed in December 2014 with a full suite of air quality monitoring instrumentation.

The meteorology components measure wind speed, wind direction, temperature, delta temperature, barometric pressure, precipitation (including snowfall), relative humidity, and solar radiation. The air quality components measure NO_x, O_3, $PM_{2.5}$, and PM_{10}. All instrumentation uses continuous monitoring technology. Data is processed into 15 minute averages and uploaded to an online network for easy access and data management purposes. Data is automatically filtered to identify outliers and equipment malfunctions so that any problems can be rectified immediately. Weekly inspections of instrumentation occur by KAM staff and quarterly calibrations and inspections are carried out by third party consultants.

10.1.2.2 Historical Activities

The region surrounding the Project has a long history of human activity that contributes to the current 'baseline' condition, which is described in more detail below. The Surface Water Quality

assessment, Section 6.3, also contains a summary of the historical activities because there are legacies from the historical mining activities that were considered for the water quality assessment.

Kamloops derives its name from the Secwepemc word "Tk'emlúps", which refers to the meeting of the North and South Thompson rivers. The area was first inhabited by approximately 3,000 members of the Shuswap tribe, part of the Interior Salish Nation.

Fur trading began in the area in the early 1800s. The fur trading posts were located in various locations in what is now Kamloops.

British Columbia officially became part of Canada in 1871, and construction of the transcontinental railroad was completed in 1885, encouraging the growth of a small village on the shore of the Thompson River. The village grew rapidly and by 1893 the population had risen to approximately 500 and became incorporated as a city with public works. In the following years, there were a number of infrastructural developments, including bridges that connected villages on either side of the river. During this time, the timber industry was growing, and the vegetable and orchard farming industry grew, with most of the land used for this purpose located in the valley.

The Canadian Northern Railway was completed in 1915, and the Kamloops airport was operational in 1939. The Trans-Canada Highway to the west of the Project area was completed in 1962, and the Yellowhead Highway in 1970.

The Kamloops area grew after the First World War until development slowed during the Depression and the Second World War. After this period, the City began to grow again, and much of the land that had formerly been used for farming in the valley was used for residential development. Ranching (including cattle grazing) also developed, and is currently ongoing immediately within and adjacent to the Project.

The Project is located within the Kamloops Forest District, which is part of the Kamloops Timber Supply Area (TSA). Tree-killing bark beetles (including mountain pine beetle, spruce beetle, and Douglas fir beetle) continue to pose a threat to the forests. The Project is located in the Greenstone Beetle Management Unit, where more than 30% of the area is identified as susceptible to the mountain pine beetle. In response to the pine beetle, in 2008, the Annual Allowable Cut for the TSA was determined to be 4 million cubic metres; this harvest level (and priority for beetle management) will remain in place until 2018 unless otherwise altered.

The Domtar Pulp Mill is located immediately west of Kamloops on the Thompson River. This pulp mill was originally built by Weyerhaeuser in 1972 and became part of Domtar in 2007. Numerous capital improvements have been made to the mill over the years. One of the pulp lines was closed in 2013; Domtar reports that this closure has corresponded with a reduction in odour complaints, and in particulate emissions (Domtar 2014).

Mining activity in the Project area can be traced back over 100 years with exploration in the Project area beginning in the 1880s and continuing intermittently to present. Copper, gold, and iron mineralization was discovered at the Iron Mask Mine near Kamloops in 1896. Nearby properties, including the Wheal Tamar, Ajax, and the Monte Carlo claims, were explored in the following years.

The Afton Mine went into operation in 1977. Mining operations were initiated on the Ajax East and Ajax West pits in 1989 and subsequently suspended in 1991 due to depressed metal prices. A second period of production began in 1994 and was again suspended in 1997. The raw ore from the Ajax pits was trucked approximately 10 km west to the processing plant adjacent to the Afton pit. During these periods of production, it is estimated that 17 Mt of ore was mined and 13 Mt of ore was milled. In the late 1990s, the tailings facility and project components were decommissioned and reclaimed by the Afton Mine in accordance with their closure plan. At the Ajax site, this includes reclaimed mine rock storage facilities adjacent to Peterson Creek in the location of the proposed Ore Stockpiles (BC EAO 2015).

The New Afton Mine occupies the site of the historic Afton Mine infrastructure. New Afton began underground mining immediately beneath the historic Afton Mine open pit in June 2012. This mine is able to produce up to 11,000 tonnes per day of raw ore though the processing plant. Currently the New Afton Mine is licenced to draw up to 7,000 m^3/d from Kamloops Lake for water supply to the processing plant.

Several of these historical and current activities have air emissions. These activities include mining exploration and production, oil and gas, forestry, pulp and paper, cement and clay production, production of asphalt and aggregate/concrete paving materials, and production of bonding and surfacing materials. The historical permitted sources in the RSA and their waste discharge permit numbers are (BC MOE 2015):

- Weyerhaeuser Canada Ltd. (PA-1513, PA-1517, PA-3022);
- New Gold Inc. – New Afton Mine (PA-100223);
- BC Gas Inc. (PA-1798);
- Petro-Canada (PA-1806);
- LaFarge Canada Inc. (PA-1894);
- Tolko Industries Ltd. (PA-2524);
- B.A. Blacktop Ltd. (PA-2719);
- Kamloops Scrap Iron (PA-5190);
- Neste Canada Inc. (PA-5225);
- Dawson Construction Ltd. (PA-5499 and PA-14643);
- Moly-Cop Canada Ltd. (PA-7428);
- Western Industrial Clay Products Ltd. (PA-8631);
- Gable Construction Ltd. (PA-8684);
- Paul Creek Slicing Ltd. (PA-11346 and PA-14650);
- Unique Tire Recycling (Canada) Ltd. (PA-13054);
- City of Kamloops (PA-14256);
- Gold Mountain Forest Products and Manufacturing Ltd. (PA-16076);

- Kamloops Animal Cremations (PA-17062);
- Kamloops Forest Products Ltd. (PA-17525);
- Nexterra Energy Corp. (PA-17753);
- Wadlegger Logging and Construction Ltd. (PA-17800);
- Federated Pipelines (Western) Ltd. (PA-15368); and
- Interior Softwood Recoveries Ltd. & 582912 B.C. Ltd. (PA-2019).

The current industrial sources included in the Base Case air dispersion modelling assessment to define the background air quality were listed in the Environment Canada National Pollutant Release Inventory - NPRI (EC 2015). Information on industrial facility pollutant releases and disposals to air, water, and land are available for the region from the NPRI, under the authority of the Canadian Environmental Protection Act (CEPA, Government of Canada 2015a). NPRI also provides emissions estimates for motor vehicles, agricultural activities, and forest fires. The NPRI sources in the air quality RSA (the LSA and RSA are defined in Section 10.1.3.1) include:

- Tolko Industries Ltd. (area source);
- Savona Speciality Plywood (natural gas fired thermal oil system boiler, two veneer dryers, wood waste burner);
- Spectra Energy Transmission (compressor station);
- Thompson River Veneer Products (veneer dryer, cooler stacks, wood waste storage, natural gas burner);
- Absorbent Products Ltd. (three baghouses, rotary kiln);
- Domtar Pulp Mill (high elevation stack, two power boilers, lime kiln gas cooler, CNCG incinerator, and their landfill area source);
- Lafarge Cement Plant (rotary kiln stack, clinker cooler stack, eleven baghouses);
- New Gold (three stacks and a variety of area sources - the Afton TSF, crusher and stockpile, four unpaved plant site roads);
- City of Kamloops Landfill (area source); and
- Owl Road Landfill (area source).

Area sources are defined as emissions from stationary sources that do not meet the reporting requirements for point sources. They are small-scale industrial, commercial, and residential sources that generate emissions. In the context of Base Case model scenario they were wind erosion of storage piles and landfills and dust from paved roads. The non-industrial sources of air emissions in or near Kamloops include commercial and residential heating, on-road mobile vehicles and trucks, rail transportation and paved road dust. The details for these NPRI sources, including the summary of PM emissions and trends, are included in Appendix 10.1-A, Section 4.5 Base Case Emissions Inventory and Appendix F Base Case Emissions Inventory.

10.1.2.3 Baseline Studies

Air quality baseline studies have been conducted to characterize the existing conditions in the vicinity of the Project. The baseline air quality is well understood owing to a strong historic record of air quality measurements, both in Kamloops and in the outlying regions. This includes continuous measurements of a suite of gasses and particulate matter (PM), and intermittent monitoring of PM and dustfall. Baseline air quality is added to modelled concentrations to approximate the additive effects of a modelled source (e.g., the Project) and sources not included in the modelling (e.g., other industries, traffic emissions, natural sources). Site specific meteorology measurements have been collected from a Project automated meteorology station (AJAXMET) that has operated since 2010. In addition, the Ajax Upwind Station has been monitoring baseline meteorology data since August 2014.

Data Sources

Background ambient air quality concentrations are available from two information sources.

Long term baseline information on particulate matter (PM) is available for the project area from the National Air Pollution Surveillance Program (NAPS), a combined federal, provincial, and municipal program established in 1969 to assess ambient air quality in populated regions in Canada.

Background ambient air quality has been measured continuously at three permanent Kamloops air quality monitoring stations (i.e., Brocklehurst, Kamloops Fire Station and the Kamloops Federal Building). Appendix 10.1-A contains a figure showing the location of the NAPS regional background ambient air quality monitoring stations. The NAPS Brocklehurst monitoring station is located approximately 8.1 km from the northern edge of the Project's Plant Boundary. The Kamloops Fire Station monitoring station is located approximately 8.8 km from the northern edge of the Project's Plant Boundary. The Kamloops Federal Building monitoring station is located approximately 5.8 km from the northern edge of the Project's Plant Boundary.

Background dustfall has been monitored monthly at 13 Project-specific dustfall monitoring stations between August 2007 and September 2008, after which quarterly sampling was initiated until October 2009. Seven of the stations were relocated in October 2009 and the sampling frequency returned to monthly. Additional TSP and dustfall data were requested through the BC MOE for 10 locations in the area. This includes historic BC MOE dustfall measurements from the City of Kamloops area, and intermittent particulate monitoring undertaken by the BC MOE and permit holders in the area. These data could not be found in the BC MOE data archives and therefore it could not be included in the air quality baseline studies. The more recent and site specific Project dustfall monitoring data is sufficient for the air quality assessment and lack of data from the BC MOE archives did not negatively affect the accuracy of the assessment.

Methods

A variety of monitoring methods have been employed to measure site specific baseline air quality data. The site specific baseline dustfall data followed the methods provided in the 2004 version of the Standard Test Method for Collection and Measurement of Dustfall (Settleable Particulate Matter) (ASTM 2004). Air quality monitoring at the NAPS stations follows a variety of standard methods that have been through EC's rigorous quality assurance and quality control procedures (EC 2004a). The

specific instrumentation used at the three permanent Kamloops air quality monitoring stations (Kamloops Federal, Brocklehurst and Kamloops Fire Station #2) are summarized in Appendix 10.1-A.

The Project's automated meteorology station (AJAXMET) has been collecting data (e.g., air temperature, relative humidity, atmospheric pressure, precipitation, solar radiation, wind speed and direction) since 2010. The Ajax Upwind automated meteorology and air quality station was installed in August 2014 on Lac Le Jeune Road approximately 7.5 km southwest of Aberdeen. This station monitors the same meteorology parameters as AJAXMET. Data from both of these Project meteorology stations is summarized in Knight Piesold (2014). The meteorology monitoring follows the methods provided in the Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators (BC MOE 2012). The climate of the Project RSA was characterized using the historical and concurrent data from the EC Kamloops Airport station and the BC FLNRO Afton Station (Knight Piesold 2014). The EC climate stations follow standard operating procedures and have a rigorous quality assurance and quality assurance program (EC 2004b, 2012).

Measured Baseline Data

The background air quality concentrations derived from the continuously measured data is summarized in Appendix 10.1-A. The background concentrations from continuously measured data for SO_2, NO_2, CO, PM_{10}, and TSP are below the ambient air quality objectives. However, the annual average concentration of $PM_{2.5}$ (9.1 $\mu g/m^3$) is just above the provincial objective (8 $\mu g/m^3$). The highest values were measured in the valley bottom areas. Areas outside the valley have very low values—as little as one third that found in the valley bottom. The Ajax Upwind Station began monitoring baseline ambient air quality in August 2014. The station monitors NO_x, O_3, $PM_{2.5}$, and PM_{10}. This station has less than one year of data and is therefore not included in the background air quality analysis.

A background dustfall deposition value of 0.8 $mg/dm^2/day$ was calculated as the average from 276 measurements collected at 20 locations on or near the Project for the period from August 2007 to August 2012. Knight Piesold established 13 dustfall monitoring stations around the old Afton Mine Site in August 2007. Dustfall samples were collected monthly between August 2007 and September 2008, after which quarterly sampling was conducted lasting until October 2009. Seven of the dustfall stations were then relocated to characterize baseline conditions in the LSA and the sampling frequency returned to monthly at that time. The lower and upper BC Pollution Control Objective (BC MOE 1979) for monthly dustfall is 1.7 and 2.9 $mg/dm^2/day$, respectively. The measured baseline dustfall deposition value (0.8 $mg/dm^2/day$) is below the most stringent BC Pollution Control Objective (1.7 $mg/dm^2/day$). Appendix 10.1-A Section 2.2.1 Measured Background Consistent with the Guidelines contains details about the Project's baseline dustfall monitoring stations.

Modelled Baseline Data (Base Case)

The *Guidelines* (BC MOE 2008) list three options for establishing background for air quality dispersion modelling:

1. A network of long-term ambient monitoring stations near the source under study;
2. Long-term ambient monitoring at a different location that is adequately representative; and
3. Modelled background.

For this assessment the background values were determined through modelling. The assessment of background values through modelling is referred to as the Base Case scenario. The Base Case scenario included all existing emissions in the RSA. Background air quality values reflective of the global/regional background concentrations (derived from local measurements) are added to the Base Case predictions. The measured background concentrations are provided in Appendix 10.1-A, Section 2.2.1 for reference.

The Base Case results (including background values reflective of the global/regional concentrations) are compared to both the applicable regulatory criteria and to local measurements to place the predictions in perspective. Adding the global/regional concentrations accounts for all emission sources outside of the RSA. Doing this fully accounts for the effects of global/regional) and local emission sources in the RSA.

Modelling the Base Case for all substances included compilation of an inventory of emissions within the air quality RSA from existing sources of information. By source type, these included:

- Industrial Emissions from the Tolko Industries Ltd. sawmill, Savona Speciality Plywood, Spectra Energy Transmission, Thompson River Veneer Products, Absorbent Products Ltd., Domtar Pulp Mill, LaFarge Canada cement plant, New Gold mine, and the Kamloops Terminal facility;
- Transportation Emissions for on-road mobile sources from light duty gasoline vehicles and trucks, including light duty diesel vehicles and trucks, heavy duty gasoline and diesel vehicles, motorcycles, brake lining, tire wear and railway sources;
- Heating Emissions from commercial fuel combustion, residual fuel combustion, and residential fuel wood combustion;
- Paved and Unpaved Roads include fugitive dust from major roads, including the Trans-Canada Highway, the Yellowhead Highway (Hwy 5), Highway 5A, and the Lac Le Jeune road. Unpaved road dust emissions are less than 16% of the paved road emissions (Zhang 2015, pers. comm.) and are not included; and
- Disturbed Lands or fugitive dust from all land where vegetation is absent for all of the year. This includes the historic Afton and New Gold tailings beaches and local landfills. Agricultural lands, industrial sites, and seasonally exposed river beds are not included.

Characterization of Air Quality Baseline Condition

Measured Baseline Data

Table 10.1-1 summarizes the annual emissions in the RSA and LSA. The largest existing source of TSP and PM_{10} in the RSA is paved roads. The largest existing source of $PM_{2.5}$ is industrial emissions. The largest existing source of SO_2 and NOx emissions is industrial emissions. The largest existing source of CO emissions is transportation emissions.

Table 10.1-2 summarizes the background values based upon continuous gas and particulate matter measurements taken at three permanent Kamloops air quality monitoring stations. Background values are listed only for averaging intervals employed in ambient air quality objectives (Table 10.1-3). It is

important to recognize that, consistent with Section 10.1.5 of the *Guidelines* (BC MOE 2008) the 1-hour, 8-hour, and 24-hour values are the 98th percentile of the measured concentrations. The annual values are the maximum measured annual concentrations.

Table 10.1-1. Annual Emissions in the Air Quality Study Areas (tonnes)

Source Group or Activity	Emission Rates (tonnes/year)					
	TSP	PM_{10}	$PM_{2.5}$	SO_2	NOx	CO
Industrial Emissions (55 km by 70 km RSA)	1,024	576.3	339.8	69.4	2248	1,792
Transportation Emissions (30 km by 30 km LSA)	23.3	23.1	16.1	3.5	815.7	7,575
Heating Emissions (30 km by 30 km LSA)	176.2	166.6	165.4	34.6	110.3	1,043
Paved Roads (30 km by 30 km LSA)	3,201	618.8	156.6	-	-	-
Disturbed Lands (30 km by 30 km LSA)	35.9	16.3	2.6	-	-	-
Baseline Total	**4,460**	**1,401**	**680.5**	**107.5**	**3,174**	**10,410**

Table 10.1-2. Background Concentrations of Continuously Monitored Gases and Particulate Matter in Kamloops

Substance	Averaging Period	Background Concentration	Applicable Regulatory Criteria
TSP (µg/m³) Kamloops Federal	24-hours	78.0	120
	Annual	45.0	60
PM_{10} (µg/m³) Brocklehurst	24-hours	**68.7**	50
$PM_{2.5}$ (µg/m³) Brocklehurst R&P TEOM	24-hours	**41.4**	25
	Annual	7.8	8
$PM_{2.5}$ (µg/m³) Brocklehurst BAM	24-hours	21.4	25
	Annual	8.3	8
$PM_{2.5}$ (µg/m³) Kamloops Federal BAM	24-hours	**28.2**	25
	Annual	**9.1**	8
$PM_{2.5}$ (µg/m³) Kamloops Fire Station #2 BAM	24-hours	19.7	25
	Annual	7.5	8
SO_2 (µg/m³) Kamloops Federal	1-hour	16.5	200
	24-hours	10.4	150
	Annual	3.5	30
NO_2 (µg/m³) Brocklehurst	1-hour	65.1	188
	24-hours	55.5	200
	Annual	23.2	60
CO (µg/m³) Brocklehurst	1-hour	931	15,000
	8-hours	815	6,000

Notes: see below

Notes:
TEOM = Tapered Element Oscillating Microbalance
BAM = Beta Attenuation Mass Monitor
*Values in **boldface** identify the selected background concentrations that exceeded the applicable regulatory criteria. Further explanation of these values is included in Appendix 10.1-A, Table 2-1.*
The sources for these data are spreadsheet summaries developed and distributed by the BC MOE annually. Raw data are also available at http://envistaweb.env.gov.bc.ca/ (BC MOE 2013).

Table 10.1-3. Provincial and Federal Ambient Air Quality Objectives and Standards

		Provincial (BC)			National (Canada)		
		AAQO			NAAQO & CAAQS [c d]		
Substance (Units)	Averaging Period	Level A	Level B	Level C	Maximum Desirable	Maximum Acceptable	Maximum Tolerable
Dustfall (mg/dm²/day)	30-day	**1.7** [e]	2.9 [e]	- -	- -	- -	- -
TSP (µg/m³)	24-hour	**120**	200	260	- -	120	400
	Annual	**60**	70	75	60	70	- -
PM_{10} (µg/m³)	24-hour	- -	**50**	- -	- -	- -	- -
$PM_{2.5}$ (µg/m³)	24-hour		**25** [a]			28 (27) [b]	
	Annual		**8** [a]			10 (8.8) [c]	
SO_2 (µg/m³)	1-hour		**200** [f]		**450**	900	- -
	24-hour		- -		**150**	300	800
	Annual		- -		**30**	60	- -
NO_2 (µg/m³)	1-hour		**188** [g]		- -	**400**	1,000
	24-hour		- -		- -	**200**	300
	Annual		**60**		60	100	- -
CO (µg/m³)	1-hour	**14,300**	28,000	35,000	15,000	35,000	- -
	8-hour	**5,500**	11,000	14,300	6,000	15,000	20,000

Notes:
[a] The $PM_{2.5}$ 24-hour average is based on the 98th percentile value for one year.
[b] The CAAQS for 24-hour $PM_{2.5}$ is referenced to the annual 98th percentile of daily 24-hour average concentrations, averaged over three years. The first CAAQS is the standard effective in 2015; the new standard proposed for 2020 is given in brackets (Environment Canada 2013).
[c] The CAAQS for annual $PM_{2.5}$ is referenced to the 3-year mean of annual average concentrations. The first CAAQS shown is the standard effective in 2015; the new standard proposed for 2020 is given in brackets (Environment Canada 2013).
[d] National Ambient Air Quality Objectives, or NAAQO, summarized in (CCME 1999).
[e] BC MOE 1979 Pollution Control Objectives for the Mining, Smelting, and Related Industries (BC MOE 1979). As the dustfall Objective is a daily rate referenced to a 30 day sampling interval, the Objective is referenced to the monthly averaging interval, not the daily.
[f] Achievement is based on the annual 99th percentile of daily 1-hour maxima, averaged over one year. This requires the extraction of the highest predicted 1-hour value at each location for each day, followed by the calculation of the 99th percentile (the fourth highest) of those 365 values.
[g] Achievement is based on the annual 98th percentile of daily 1-hour maxima, averaged over one year. This requires the extraction of the highest predicted 1-hour value at each location for each day, followed by the calculation of the 98th percentile (the eighth highest) of those 365 values.
- Indicates no applicable objective or standard specified for this Jurisdiction
*Values in **boldface** identify the most stringent objectives adopted to evaluate the Project.*

Levels of SO_2, NO_2 and CO are very low and never exceed the applicable regulatory criteria. Particulate matter measurements (total, inhalable, and respirable) are generally low, but occasionally exceed the applicable regulatory criteria. These exceedances are most often driven by external forces (e.g., forest fire), but at times are a consequence of local domestic or industrial emissions that accumulate to concentrations that exceed the applicable regulatory criteria during periods of poor dispersion.

Modelled Baseline Data

The results for the Base Case dispersion modelling scenario are presented in Section 10.1.4.2.

10.1.3 Assessment Boundaries

Assessment boundaries define the maximum limit within which the effects assessment is conducted. They encompass the areas within, and times during which, the Project is expected to interact with the VCs, as well as the constraints that may be placed on the assessment of those interactions due to political, social, and economic realities (administrative boundaries), and limitations in predicting or measuring changes (technical boundaries). The definition of these assessment boundaries is an integral part in scoping for air quality, and encompasses possible direct, indirect, and induced effects of the Project on air quality, as well as the trends in processes that may be relevant.

10.1.3.1 Spatial Boundaries

Figure 10.1-2 summarizes the air quality LSA and RSA.

Local Study Area

The air quality LSA is a 30 by 30 km square, centered on the Project site (referred to as the CALPUFF assessment area in Appendix 10.1-A). It will encompass the Project's predicted air quality effects and depict them in sufficient detail to illustrate important features. Consistent with the *Guidelines* (BC MOE 2008) all predicted ambient air ground-level concentrations greater than 10% of the applicable AAQOs will fall within the LSA. The LSA includes most of the City of Kamloops except the Westsyde and Rayleigh developments to the north in the north Thompson valley, and the Dallas and Barhartvale districts to the east in the south Thompson valley. The location of the air dispersion model receptors is summarized in Appendix 10.1-A, Section 4.4.1 Receptor Grids and Terrain. The receptor grids considered the residential, commercial, and industrial land uses and sensitive sub-populations. The selection of the receptor grids was based on recommendations given in the *Guidelines* (BC MOE 2008) and the distance from each to the project construction and operation components.

The Plant Boundary, shown in Figure 10.1-2, was defined based on Section 6.3 of the *Guidelines* (BC MOE 2008) as a line of receptors that demarcates the areas governed by public versus worker exposure criteria. Often the highest predicted concentrations and/or deposition rates are on the Plant Boundary. Within the Plant Boundary, meeting occupational health and safety criteria are of primary importance. BC AAQO are often applied to areas where there is public access (e.g., on and beyond the Plant Boundary).

Section 6.3 of the *Guidelines* (BC MOE 2008) describes the criteria used to determine the Plant Boundary, which were followed when defining the Plant Boundary. Setting the Plant Boundary for a

mine is less straightforward than for a fenced facility such as a pulp mill. In the instance of a fenced mill, the facility's physical fenceline defines where public access is restricted. Mines are not generally fenced; however public access is often discouraged or prohibited due to safety concerns. The dispersion model receptor spacing along the Plant Boundary is set at 20 m intervals. Specifically, the Plant Boundary is defined by:

- the perimeter of disturbed area that defines where public access is restricted; and
- the perimeter along a road allowance if a public access road passes through the plant

Generally, the Plant Boundary includes a buffer of approximately 500 m from the edge of features such as the Pit, MRSF, Ore Stockpile, TSF, and access road. The west Plant Boundary includes a 500 m buffer from the road allowance of Lac Le Jeune Road, except where the access road joins Highway 5. The southern and eastern Plant Boundaries include a 500 m buffer from the perimeter of the existing and anticipated Project disturbed area. The 500 m buffer also extends from the edge of the anticipated Project disturbed area in the north direction.

There is one publically accessible area inside the Plant Boundary that required additional analysis. The air dispersion modelling included a special receptor grid for the Jacko Lake area to quantitatively assess the air quality. The model predictions at the Jacko Lake receptors were provided to HHERA to consider exposures from the mine site to the public. Further details are provided in the HHERA Technical Data Report (Appendix 10.4-A).

Regional Study Area

The air quality RSA is a rectangular area 70 km in the East-West directions and 55 km in the North-South directions (referred to as the CALPUFF domain in Appendix 10.1-A). The RSA will capture all values of interest as per the *Guidelines* (BC MOE 2008; Sub-Section 6.1). The RSA includes most of the City of Kamloops except the Westsyde and Rayleigh developments in the North Thompson valley.

To facilitate the assessment of human health effects from the Project emissions on air quality the modelling included a wide variety of special receptors. Special receptors are locations of human and ecological importance; sensitive ecosystems (e.g., a lake), nearby homes, and places frequented by sensitive sub-populations of the community (e.g., children, the elderly and those under medical care). The sensitive receptors included in the Community Health and Well-being (Section 10.6) VC included schools, medical treatment facilities, daycares and retirement homes. Further information related to the 209 sensitive receptors included in the air dispersion modelling is available in Appendix 10.1-A, Section 4.4.1 Receptor Grids and Terrain.

10.1.3.2 Temporal Boundaries

The temporal phases of the Project are:

- **Construction**: approximately 2.5 years;
- **Operation**: 23 years;

- **Decommissioning and Closure**: 5 years (includes project decommissioning, abandonment and reclamation activities, as well as temporary closure, and care and maintenance); and
- **Post Closure**: 5+ years (includes ongoing reclamation activities and Post Closure monitoring).

The two phases selected for the air quality assessment were Construction and Operation. The air emissions during Decommissioning and Closure and Post Closure are expected to be negligible compared to Construction and Operation. The intensity of activities that generate air emissions (e.g., primarily surface disturbances and fuel combustion) are much less during Decommissioning and Closure and Post Closure compared to Construction and Operation. The worst case years for Construction and Operation were assessed for air quality with the understanding that the other years will have a lower level of residual air quality effects.

The worst case year of Construction and Operation were selected based upon the estimated annual totals for fuel combustion and the peak in production of mine rock and ore. The Construction year just before operations start was chosen for assessment because it represents a year of earth moving that will produce substantial air emissions. A combination of Years 4 and 8 of Operation was chosen for assessment. The Operation scenario took aspects from both Year 4 and Year 8 of Operation that contribute to a worst-case possible Project year. This is based on the quantity of the equipment fleet, the haulage lengths, the total amount of material moved, and the location of the active MRSF.

10.1.3.3 Administrative Boundaries

The effect of the Project on air quality is determined, in part, by comparing predicted concentrations against the applicable ambient air quality objectives which have been established to protect human health and the environment. British Columbia uses a suite of ambient air quality criteria that have been developed provincially and nationally to inform decisions on the management of air contaminants. These include Provincial Air Quality Objectives (AQOs), the former Pollution Control Objectives (PCOs), National Ambient Air Quality Objectives (NAAQOs) and Canadian Ambient Air Quality Standards (CAAQS; BC MOE 2014). These collectively are referred to as 'applicable regulatory criteria' or 'regulatory criteria.'

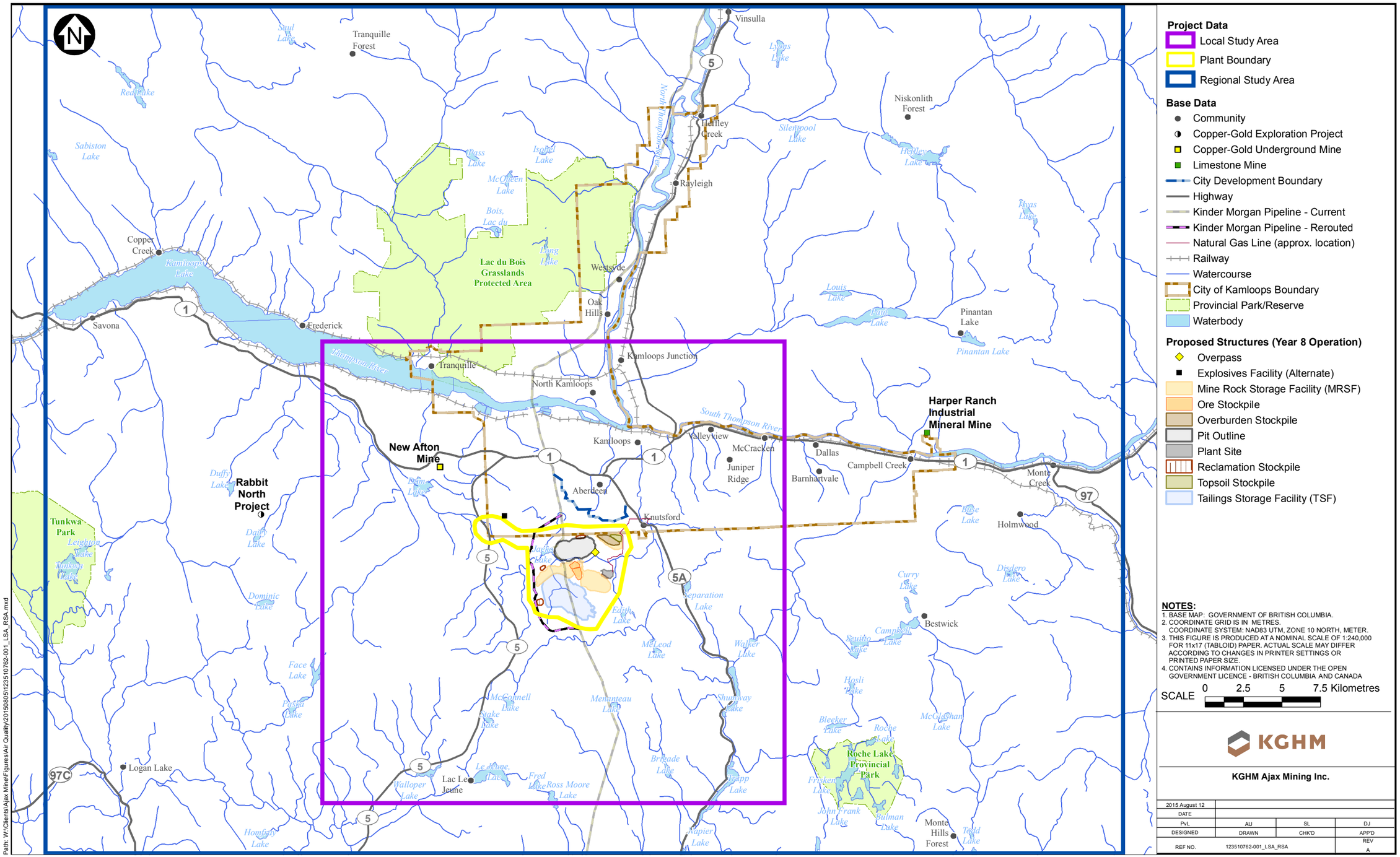
The Canada (Federal) and BC Ambient Air Quality Objectives (AAQO) are summarized in Table 10.1-3. The Canada objectives are denoted as Desirable, Acceptable, and Tolerable. The BC objectives are denoted as Levels A, B and C. Note that the Canada and BC AAQO for some substances are very similar.

The Canada AAQOs are defined as follows:

- the Maximum Desirable Level is the long-term goal for air quality and provides a basis for anti-degradation policy for unpolluted parts of the country, and for the continuing development of control technology;
- the Maximum Acceptable Level is intended to provide adequate protection against effects on soil, water, vegetation, materials, animals, visibility, personal comfort, and well-being and
- the Maximum Tolerable Level denotes time- based concentrations of air contaminants beyond which, due to a diminishing margin of safety, appropriate action is required to protect the health of the general population.

Figure 10.1-2
Air Quality Local and Regional Study Areas

Stantec



Project Data
- Local Study Area
- Plant Boundary
- Regional Study Area

Base Data
- Community
- Copper-Gold Exploration Project
- Copper-Gold Underground Mine
- Limestone Mine
- City Development Boundary
- Highway
- Kinder Morgan Pipeline - Current
- Kinder Morgan Pipeline - Rerouted
- Natural Gas Line (approx. location)
- Railway
- Watercourse
- City of Kamloops Boundary
- Provincial Park/Reserve
- Waterbody

Proposed Structures (Year 8 Operation)
- Overpass
- Explosives Facility (Alternate)
- Mine Rock Storage Facility (MRSF)
- Ore Stockpile
- Overburden Stockpile
- Pit Outline
- Plant Site
- Reclamation Stockpile
- Topsoil Stockpile
- Tailings Storage Facility (TSF)

NOTES:
1. BASE MAP: GOVERNMENT OF BRITISH COLUMBIA.
2. COORDINATE GRID IS IN METRES.
   COORDINATE SYSTEM: NAD83 UTM, ZONE 10 NORTH, METER.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:240,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
4. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - BRITISH COLUMBIA AND CANADA

SCALE 0 2.5 5 7.5 Kilometres

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KGHM Ajax Mining Inc.

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The BC AAQOs are defined as follows:

- Level A is set as the objective for new and proposed discharges and, within the limits of best practicable technology, to existing discharges by planned staged improvements for these operations;
- Level B is set as the intermediate objective for all existing discharges to meet within a period of time specified by the Director (BC MOE), and as an immediate objective for existing discharges which may be increasing in quantity or altered in quality as a result of process expansion or modification; and
- Level C is set as the immediate objective for all existing chemical and petroleum industries to reach within a minimum technically feasible period of time.

In 1979, BC established PCOs for the mining, smelting, and related industries (BC MOE 1979). Table 10.1-3 lists objectives for dustfall that are derived from this document. It specifies a range in values that have been portrayed as Level A and Level B. While the PCOs themselves have been rescinded the dustfall objectives continue to be employed.

In 1995, BC established an Interim Level B 24-hour Objective for PM_{10} of 50 µg/m^3. In 2009, BC adopted AAQO for respirable particulate matter ($PM_{2.5}$) set at 25 µg/m^3 for a 24-hour averaging period (as a 98th percentile value over one year) and 8 µg/m^3 for the annual averaging period (BC MOE 2014). BC also listed a planning goal of 6 µg/m^3 for the annual averaging period. The status of this goal is uncertain given recent changes in $PM_{2.5}$ measurement methodologies, and the uncertainty surrounding historical $PM_{2.5}$ measurements. For the purposes of this assessment the planning goal will not be considered because it is not a recognized regulatory criteria and it is not certain that it will become a regulatory criteria in the future.

The CAAQS for 2015 and 2020 were adopted by the Canadian Council of Ministers of the Environment (EC 2013). The new CAAQS replace the Canada-wide Standards for PM and O_3. A review of the 2020 CAAQS is expected in 2015.

It is important to note that the original Canada-wide Standards were not intended to be used as a standard for predicted concentrations at facility fencelines (CASA 2003). They are intended to be employed as a means of determining potential health effects in a large census metropolitan area (population greater than 100,000). As such, the stations to which the Canada-wide Standards were applied were intended to be representative of the community as a whole. These stations are carefully selected to be free of interference from nearby sources such as highways or industrial facilities (CCME 2000).

It is expected that this same principle applies to the CAAQS. This caveat applies to all objectives and standards to some extent. At a location where predicted concentrations exceed an objective or standard, there needs be a receptor (e.g., resident population, sensitive ecosystem) capable of being affected by that substance for an adverse effect to occur.

Table 10.1-4 summarizes $PM_{2.5}$ criteria from other jurisdictions. While these criteria are not strictly applicable to the Project they serve as a comparison for the criteria summarized in Table 10.1-3 that are adopted to evaluate the Project. The BC regulatory criteria for annual average $PM_{2.5}$ (8 µg/m^3) is more

stringent (i.e., lower) than the corresponding regulatory criteria from the US EPA, WHO, and EU (US EPA 2012; WHO 2005; EC 2000). The BC regulatory criteria for 24-hour average $PM_{2.5}$ (25 µg/m^3) is more stringent (i.e., lower) than the corresponding regulatory criteria from the US EPA.

Table 10.1-4. $PM_{2.5}$ Criteria from Other Jurisdictions

Jurisdiction	Averaging Period	Criteria (µg/m^3)	Jurisdiction	Averaging Period	Criteria (µg/m^3)	Jurisdiction	Averaging Period	Criteria (µg/m^3)
US EPA	24-hour [a]	35.0	WHO	24-hour [d]	25	EU	Annual [f]	25
	Annual [b]	15.0		Annual [e]	10		Annual [g]	20
	Annual [c]	12.0						

Notes:
[a] The U.S. EPA Primary Standard for 24-hour $PM_{2.5}$ was brought into existence in 2006. An area meets the 24-hour standard if the 98th percentile of 24-hour $PM_{2.5}$ concentrations in one year, averaged over 3 years, is less than or equal to 35 µg/m^3.
[b] The U.S. EPA Primary Standard for annual average $PM_{2.5}$ was brought into existence in 1997. An area will meet the standard if the 3-year average of its annual average $PM_{2.5}$ concentration (at each monitoring site in the area) is less than or equal to 15.0 µg/m^3.
[c] The revised U.S. EPA Primary Standard for annual average $PM_{2.5}$ was brought into existence in 2012. An area will meet the standard if the 3-year average of its annual average $PM_{2.5}$ concentration (at each monitoring site in the area) is less than or equal to 12.0 µg/m^3.
[d] The WHO air quality guideline for $PM_{2.5}$ for the 24-hour average was updated in 2005. Achievement is determined based on the 99th percentile of the daily value (three 24-hour exceedances per year allowed). In addition to the guideline the WHO offer three interim targets (IT-1; IT-2; IT-3) that are 35, 25, and 15 µg/m^3, respectively.
[e] The WHO air quality guideline for $PM_{2.5}$ for the annual average was updated in 2005. In addition to the guideline the WHO offer three interim targets (IT-1; IT02; IT03) that are 75, 50, and 37.5 µg/m^3 respectively.
[f] The EU Annual Standard for $PM_{2.5}$ entered into force on 01-Jan-2010.
[g] The EU Annual Limit Value for $PM_{2.5}$ becomes legally binding in 2015. Achievement is determined based on a 3-year average of the annual average for 2013, 2014, and 2015.
Sources: US EPA 2012; WHO 2005; EC 2000.

10.1.3.4 Technical Boundaries

The evaluation of potential changes to air quality depends primarily upon the CALPUFF air dispersion model that predicts changes to ground-level CAC concentrations. The model predictions are as accurate as the inputs and assumptions employed in the modelling. Hence, the primary technical boundaries for the air quality assessment were the availability and quality of the background air quality data and the availability and quality of the information required to calculate the emissions. Sufficient quality information was available for defining the background air quality conditions. Sufficiently detailed information was available from the mine planning engineers to quantitatively estimate the worst-case Project Construction and Operation emissions that were modelled. Overall, technical boundaries did not influence the scoping of the air quality assessment.

10.1.4 Potential Effects of the Project and Proposed Mitigation for Air Quality

The potential effects of Project emissions causing a change in the ambient ground-level concentration of CACs is summarized below along with the proposed mitigations.

10.1.4.1 Identifying Potential Effects on Air Quality

Table 10.1-5 summarizes the potential Project interactions and effects on air quality.

Table 10.1-5. Identifying Potential Project Interactions and Effects on Air Quality

Project Activities		Potential Effects on Air Quality Change in Concentration of CACs
Construction	Clearing and Grubbing	H
	Earthworks	H
	Overburden/Topsoil Stockpile	H
	Laydown Areas and Storage Yards	H
	Project Lighting	O
	Site Security and Fencing	O
	Fuel Storage and Filling Area	M
	Hazardous Wastes Transport, Storage, and Disposal	M
	Construction Wastes Transport, Storage, and Disposal	L
	Sewage Infrastructure and Disposal	M
	Public Road Realignment, Use, and Maintenance	H
	Site Road Construction, Use and Maintenance	H
	Haul Road Overpass Construction, Use, and Maintenance	H
	Site Buildings and Process Plant	H
	Explosives Magazine and Storage Facilities	H
	Open Pit Development	H
	Drilling and Blasting	H
	Crushing Mine Rock	H
	Loading, Hauling, and Deposition of Mine Rock	H
	Temporary Ore Stockpile	H
	Tailing Storage Facility Development	H
	Power Transmission, Distribution	O
	Natural Gas Line	L
	Pipeline Utility Corridor (Potable Water, Sewage, and Site Water)	L
	Water Intake from Kamloops Lake	O
	Fire Suppression Infrastructure	M
	Contact Water	O
	Non-contact Water	O
	Haul Road Overpass	H
	Water Management Dams	L
	Mine Staffing (Direct Employment)	O
	Contracted Employment	O
	Taxation	O

(continued)

Table 10.1-5. Identifying Potential Project Interactions and Effects on Air Quality (continued)

Project Activities		Potential Effects on Air Quality: Change in Concentration of CACs
Operation	Open Pit Development	H
	Drilling and Blasting	H
	Hauling Mine Rock and Ore from Pit	H
	Crushing and Conveying Ore	H
	Temporary Ore Stockpile	H
	Development of Mine Rock Management Facilities	H
	Stripping, Loading, Hauling, Deposition, and Contouring of Topsoil and Overburden	H
	Revegetation through Progressive Reclamation	L
	Process Plant Operation	H
	Deposition to Tailing Storage Facility	L
	Site Road Use and Maintenance (Materials, Personnel, Supplies)	H
	Concentrate Transport and Storage	H
	Explosives Magazine and Storage Facilities	M
	Fire Suppression Infrastructure	O
	Fuel Storage and Filling Area	L
	Hazardous Wastes Transport, Storage, and Disposal	M
	General Wastes Transport, Storage, and Disposal	L
	Sewage Infrastructure and Disposal	L
	Laydown Areas and Storage Yards	L
	Power Transmission, Distribution	O
	Project Lighting	O
	Site Access, Security and Fencing	O
	Water Intake from Kamloops Lake	O
	Contact Water	L
	Non-contact Water	L
	Potable Water Treatment and Use	O
	Haul Road Overpass	O
	Mine Staffing (Direct Employment)	L
	Contracted Employment	L
	Taxation	O

(continued)

Table 10.1-5. Identifying Potential Project Interactions and Effects on Air Quality (completed)

Project Activities		Potential Effects on Air Quality
		Change in Concentration of CACs
Decommissioning and Closure	Dismantling of Ancillary Buildings	L
	Pit Lake Planning	L
	Site Road Decommissioning	L
	Tailing Storage Facility Decommissioning and Reclamation	L
	Mine Rock Management Facilities Reclamation	L
	Fuel Storage and Filling Area	O
	Hazardous Wastes Transport, Storage, and Disposal	L
	General Wastes Transport, Storage, and Disposal	L
	Sewage Infrastructure and Disposal	L
	Laydown Areas and Storage Yards	L
	Power Transmission, Distribution	O
	Project Lighting	O
	Site Access, Security and Fencing	O
	Contact Water	O
	Non-contact Water	O
	Potable Water Treatment and Use	O
	Haul Road Overpass	O
	Road use to the Project (Materials, Personnel, Supplies)	L
	Mine Staffing (Direct Employment)	L
	Contracted Employment	L
	Taxation	O
Post Closure	General Site Inspections and Maintenance	L
	Contact Water	L
	Non-contact Water	L
	Road use to the Project (Materials, Personnel, Supplies)	L
	Mine Staffing (Direct Employment)	L
	Contracted Employment	L

Notes:

O	*No interaction anticipated.*
L	*Negligible to minor interaction expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.*
M	*Potential moderate interaction requiring unique active*
H	*Key interaction; warrants further consideration.*

The current mine plan for the Project includes an Operation phase based on an average of 65,000 tonnes of ore milled per day from the Ajax Pit over a 23 year mine life. This assessment however is based on 70 thousand tonnes of ore milled per day to account for possible future increases to the rate of production. The conservative assumption will also allow flexibility to process ore at a higher rate if the plant can process more ore.

The ore will be delivered from the mine utilizing haul trucks to the primary crusher. The primary crusher will be located southwest of the ultimate mine pit limit and remain in this location until the end of the mine life. Ore will be crushed to the size which meets process requirements and will be transferred to the processing plant by a covered conveyor belt. Delivery to the temporary ore stockpile is by haul truck. The Ore Stockpile will be located just south of the Pit.

The processing plant will consist of stage-wise crushing and grinding, followed by a flotation process to recover and upgrade copper from the feed material. A gravity circuit will be included within the flotation circuit to enhance gold recovery. The flotation concentrate will be thickened and filtered and shipped by covered trucks to the Port of Vancouver.

The TSF will be located approximately 2.0 km south of the Pit (measured from center to center). The tailings embankments will be built with mine rock from the open pit. The embankments will take advantage of the rolling nature of the local topography.

Mine rock will be hauled via haul truck to the MRSF. Mine rock will not be crushed by the primary crusher. An end dumping system will fill the SMRSF, EMRSF, and WMRSF. Mine rock will also be used to construct the North, East, and South Embankments.

Topsoil will be stored in the Topsoil Stockpile co-located to the northeast of the EMRSF. The estimated tonnages of mine rock and topsoil placed in these facilities for the air dispersion modelling scenarios is summarized in Appendix 10.1-A, Appendix E Project Case Construction and Operation Emissions Inventory.

The mine plan and general arrangement may be subject to change as work continues. The Project components that were assessed include:

- trucks and heavy equipment direct emissions;
- indirect emissions from mine activity and haul-road traffic (e.g., fugitive road dust);
- open pit (area source);
- emissions from blasting activities;
- crusher pile;
- primary crusher (stationary equipment);
- processing plant (stationary equipment);
- ore stockpile;
- TSF (area source);

- MRSF (area source);
- water management facilities;
- road and bridge upgrades;
- new haul roads;
- borrow sources;
- transmission line and transformer upgrades;
- explosives storage facility;
- process and potable water system, including the intake in Kamloops Lake;
- concentrate storage and shipping area; and
- concentrate transport to the Port of Vancouver.

The key potential interactions and effects on air quality during Construction are:

- clearing, grubbing and earthworks;
- overburden and topsoil stockpile development;
- laydown areas and storage yards;
- public road realignment, use and maintenance;
- site road construction, use and maintenance;
- haul road overpass construction, use and maintenance;
- building the Process Plant, Explosives Magazine and Storage Facilities;
- open pit development, including drilling and blasting, crushing, loading, hauling and deposition of mine rock;
- development of the Temporary Ore Stockpile; and
- development of the TSF.

These Construction activities produce air emissions from fuel combustion for the mobile equipment (e.g., direct emissions) and fugitive dust (indirect) emissions from exposed surfaces.

The key potential interactions and effects on air quality during Operation are:

- open pit development including drilling and blasting, hauling ore and mine rock from the pit;
- crushing and conveying ore;
- temporary ore stockpile;
- development of MRSF;
- stripping, loading, hauling, deposition and contouring of topsoil and overburden;
- operation of the Process Plant;

- site road use and maintenance; and
- concentrate storage and transport.

These Operation activities produce air emissions from fuel combustion for the mobile equipment (e.g., direct emissions), ore processing and concentrate handling and fugitive dust (indirect) emissions from a variety of exposed surfaces (e.g., exposed tailings, disturbed land surfaces and mine rock piles).

The air quality interactions that are negligible to minor during Construction that are not considered further in the assessment are;

- construction waste transport, storage and disposal;
- natural gas line;
- pipeline utility corridor;
- non-contact water;
- water management dams;
- mine staffing; and
- contracted employment.

There are no air emissions from non-contact water, mine staffing and contracted employment. The air emissions from the remaining activities can be adequately controlled through the implementation of best management practices and standard mitigation and management measures. Similarly there are no air emissions from these Operation activities or the air emissions can be adequately controlled so as to not warrant any further monitoring or assessment;

- revegetation through progressive reclamation;
- deposition to TSF;
- fuel storage and filling area;
- general waste, transport, storage and disposal;
- sewage infrastructure and disposal;
- laydown areas and storage yards;
- contact water;
- non-contact water;
- mine staffing; and
- contracted employment.

Not all project phases result in substantial emissions to the atmosphere, or emit substances from a human or ecological health perspective. The activities during the Closure and Reclamation and Post Closure phases do not generate sufficient air emissions to justify a quantitative analysis using an air

dispersion model. The intensity of the activities generating air emissions during Closure and Reclamation and Post Closure is much lower than Construction and Operation. Hence, the air emissions during Closure and Reclamation and Post Closure are not considered further in this assessment. The dispersion assessment considered only those sources and substances of interest (e.g., the CACs that have well established regulatory criteria) for Construction and Operation. Further information related to the emission sources and the rationale for their inclusion in the assessment is summarized in Appendix 10.1-A, Appendix B Ajax Mine Project Final Detailed Model Plan.

Good modelling practice dictated that worst cases be characterized and modelled, understanding that any lesser case has a lesser effect compared to the worst case, and therefore the conclusions of the worst-case modelling exercise hold, with some added degree of conservation. The dispersion modelling considers both the Construction and Operations worst-case emissions. It also accounts for existing emissions through modelling of the Base Case. The modelling scenarios are as follows:

For construction:

- Base Case (all existing emissions in the 70 km (W-E) by 55 km (N-S) RSA);
- Project Case – Construction (only Project Case – Construction-related emissions); and
- Application Case – Construction (Base Case plus Project Case – Construction).

For operation:

- Base Case (all existing emissions in the 70 km (W-E) by 55 km (N-S) RSA);
- Project Case – Operation (only Project Case – Operation-related emissions); and
- Application Case – Operation (Base Case plus Project Case – Operations).

Further information related to the air dispersion modelling scenarios and methods are included in Appendix 10.1-A. The methods used for assessing potential effects on air quality from the Project emissions were described in the Ajax Mining Project Detailed Model Plan that BC MOE approved on February 27, 2015.

10.1.4.2 Effects on Air Quality

The predicted change in ground level concentrations for the CACs related to the three model scenarios (Base Case, Project Case, and Application Case) are summarized below. The full set of isopleth maps summarizing the predicted ground level concentrations for the CACs is included in Appendix 10.1-A. To focus the assessment only the isopleth maps that summarize an exceedance of the applicable regulatory criteria are provided below with an appropriate analysis of the results.

Base Case

Generally the ambient air quality in Kamloops is good. The term 'good' is arguably a fair descriptor for a location where the measured Federal Air Quality Health Index (AQHI) is in the Low Health Risk category 94.1% of the time. Further details about the AQHI in Kamloops are summarized in Appendix 10.1-A, Section 3.3.1 Air Quality Health Index.

Table 10.1-6 summarizes the maximum predicted CAC concentrations associated with the Base Case dispersion modelling scenario. Within the RSA the maximum predicted concentrations for SO_2, NO_2, and CO for all time averaging intervals are less than the applicable regulatory criteria. The maximum predicted concentrations for annual TSP are less than the applicable regulatory criteria. Dustfall, 24-hour TSP, PM_{10}, and $PM_{2.5}$ are predicted to exceed the applicable regulatory criteria. A detailed analysis of the exceedances is provided below.

Table 10.1-6. Maximum Predicted Criteria Air Contaminant Concentrations Associated with the Base Case Dispersion Modelling Scenario

Substance	Averaging Interval	Maximum Predicted Concentration	Applicable Regulatory Objective [a]	Frequency of Exceedance (% of one year)
DF (mg/dm²/d)	30-day	**2.0**	1.7	58
TSP (µg/m³)	24-hour	**151.6**	120	0.8
	Annual	44	60	0
PM_{10} (µg/m³)	24-hour	**89.3**	50	1.6
$PM_{2.5}$ (µg/m³)	24-hour [b]	**34.7**	25	4.4
	24-hour [c]	**36.5**	28 (27) [e]	NA
	Annual	**10.9**	8	100
	Annual [d]	**11.0**	10 (8.8) [e]	NA
SO_2 (µg/m³)	1-hour[f]	15.8	200	0
	1-hour	20.1	450	0
	24-hour	12.7	150	0
	Annual	2.1	30	0
NO_2 (µg/m³) [g]	1-hour [h]	77.5	188	0
	1-hour	117.5	400	0
	24-hour	49.5	200	0
	Annual	15.3	60	0
CO (µg/m³)	1-hour	2,088	14,300	0
	8-hour	1,105	5,500	0

Notes:
*Values in **boldface** identify results greater than the applicable regulatory objective.*
NA = not available. One year was assessed so it is not possible to generate a frequency of exceedance for comparison to this AAQO which requires three years of results.
[a] Applicable AAQO and CAAQS from Table 10.1-3.
[b] Based on the 98th percentile for one year.
[c] Based on the annual 98th percentile of daily 24-hour average concentrations, averaged over three years.
[d] Based on the 3-year mean of annual average concentrations.
[e] The first CAAQS shown is the standard effective in 2015; the new standard proposed for 2020 is given in brackets (Environment Canada 2013).
[f] Based on 99th percentile of daily 1-hour maxima, averaged over one year.
[g] NO_2 based on the Ozone Limiting Method conversion of NOx to NO_2.
[h] Based on the 98th percentile of daily 1-hour maxima, averaged over one year.

Figure 10.1-3 summarizes the Base Case maximum predicted 30-day dustfall (mg/dm^2/day) with the global/regional background value added. The maximum predicted monthly dustfall associated with the Base Case is 2.0 mg/dm^2/d, which marginally exceeds the BC dustfall objective of 1.7 mg/dm^2/d. The area of exceedance predicted within the RSA is over the east side of downtown Kamloops and the frequency of exceedance was 58% of the year (7 months) during February, March, and June through September. The primary Base Case sources contributing to the exceedances are heating, global/regional background, road/rail and industrial.

The maximum predicted 24-hour and annual average ground level TSP concentrations for the Base Case are 151.6 and 44.0 µg/m^3, respectively. The 24-hour maximum (151.6 µg/m^3) exceeds the applicable regulatory criteria (120 µg/m^3). The area of exceedance predicted within the RSA was over north Kamloops, downtown Kamloops and west of the city. The TSP AAQO (120 µg/m^3) is exceeded 0.8% of the year (3 days). The exceedances occur during December and January when dispersion is poorer than in summer. The primary Base Case sources contributing to the exceedance are heating, global/regional background, road/rail and industrial.

The maximum predicted 24-hour average PM_{10} concentrations associated with the Base Case is 89.3 µg/m^3. The 24-hour maximum (89.3 µg/m^3) exceeds the applicable regulatory criteria (50 µg/m^3). The area of exceedance predicted within the RSA was over north Kamloops and downtown Kamloops. The PM_{10} AAQO (50 µg/m^3) is exceeded 1.6% of the year (6 days). The exceedances occur during December, January, and February when the dispersion is poorer than in summer. The primary Base Case sources contributing to the exceedance are heating, global/regional background, road/rail, and industrial.

The maximum predicted 98th percentile 24-hour and annual average $PM_{2.5}$ concentrations associated with the Base Case are 34.7 and 10.9 µg/m^3, respectively. The predicted concentrations exceed the applicable regulatory criteria (25 µg/m^3 and 8 µg/m^3 respectively). Figure 10.1-4 summarizes the Base Case maximum predicted annual average ground-level $PM_{2.5}$ concentrations (µg/m^3) with the global/regional background added.

The areas in exceedance of the regulatory criteria are over north Kamloops and downtown Kamloops. The 24-hour $PM_{2.5}$ AAQO (25 µg/m^3) is exceeded 4.4% of the year (16 days). The exceedances occur during November, December, January, and February when the dispersion is poorer than in summer. The primary Base Case sources contributing to the exceedance are heating, global/regional background, road/rail and industrial.

Additional isopleth maps illustrating the Base Case model results are in Appendix 10.1-A, Appendix G.

The Base Case results show good agreement with local measurements. The maximum predicted concentrations of SO_2, NO_2, and CO are small and do not exceed applicable regulatory criteria, consistent with measurements. The maximum predicted concentrations of dustfall, TSP, PM_{10}, and $PM_{2.5}$ are elevated, and do exceed applicable regulatory criteria; this is consistent with measurements. The frequency of exceedance of these parameters is also consistent with background measurements.

The areal distribution of the maximum predicted concentrations of PM_{10} and $PM_{2.5}$ also match measurements, with the valley bottom locations showing higher concentrations than the upper

reaches of the valley walls, and the plateau region beyond. The exceedances for PM_{10} and $PM_{2.5}$ are less than 5% of the year, are episodic and at times are a consequence of local domestic/industrial emissions that accumulate under periods of poor dispersion during winter to levels greater than the applicable regulatory criteria. Measurements of $PM_{2.5}$ are typically higher in winter than summer months, excepting the influence of forest fires.

Focusing on $PM_{2.5}$, the Base Case predictions and the emissions inventory give an insight into relative importance of sources. While industrial emissions, space heating emissions, and fugitive road dust dominate the Base Case emission inventory, the modelling shows a different picture in terms of their relevant contribution to annual average $PM_{2.5}$.

In the valley bottom the most important contributors to annual average $PM_{2.5}$ are: i) space heating (51.4%); ii) global and regional background (34.9%); iii) road and rail (13.0%); and iv) industrial (1.3%). At the Project site the most important contributors to annual average $PM_{2.5}$ are: i) global and regional background (92.6%); with ii) space heating (3.1%), road and rail (2.9%), and industrial (1.8%) all contributing a small increment. The Base Case contributions for the maximum predicted annual average $PM_{2.5}$ concentrations are summarized in Appendix 10.1-A, Table 5-2 and Figure 5.1-2.

The dispersion modelling and measurements show that valley bottom is affected both by sources outside the region (the global/regional background) and domestic or industrial sources of emissions in Kamloops. In contrast, the Project area is largely unaffected by domestic or industrial sources in Kamloops, and is dominated by the global and regional background.

Project Case – Construction

For the Project Case - Construction model scenario the maximum predicted concentrations for all substances except 24-hour average PM_{10} are less than the applicable regulatory criteria. The maximum predicted 24-hour PM_{10} concentration at the northeast Plant Boundary (78.4 $\mu g/m^3$) exceeds the applicable regulatory criteria (50 $\mu g/m^3$). This area is largely uninhabited and the frequency of exceedance is low (i.e., 0.5% of the year or 2 days). The days when the exceedance occurs are in January when dispersion is frequently poorer than in summer. Isopleth maps illustrating the Project Case - Construction model results are in Appendix 10.1-A, Appendix H Project Case and Application Case Construction Modelling Isopleth Maps.

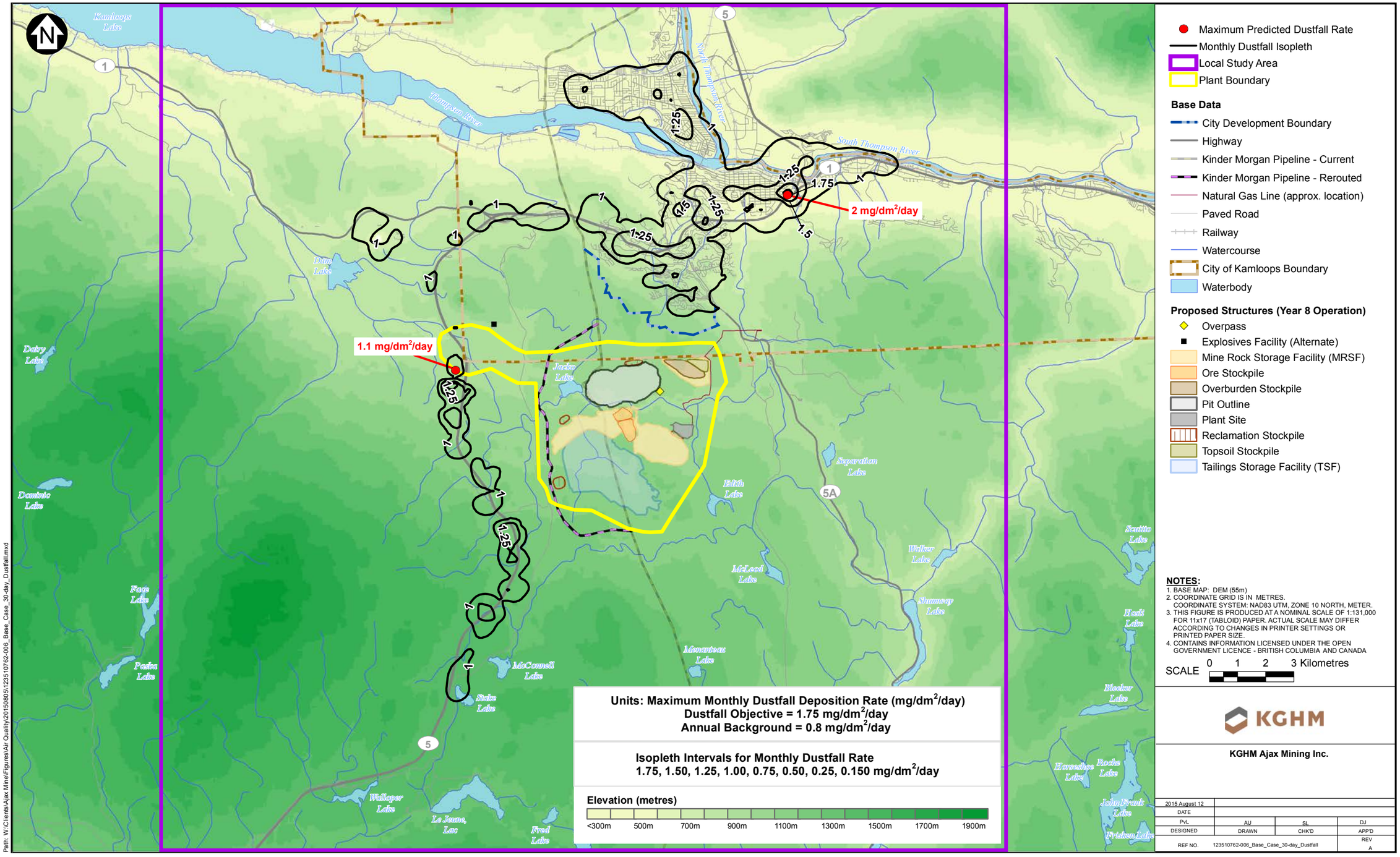
Project Case – Operation

Table 10.1-7 summarizes the maximum predicted ground-level concentrations for Project Case – Operation compared to the ambient air quality objectives. Global/regional background is not included in the results presented for this modelling case, however it was added to the results for the Application Case (see below). The maximum predicted ground-level concentrations for dustfall, NO_2, SO_2, and CO are less than the applicable regulatory criteria. Annual TSP and annual $PM_{2.5}$ are also less than the applicable regulatory criteria. The remaining CACs (24-hour TSP, 24-hour PM_{10}, and 24-hour $PM_{2.5}$) are predicted to exceed the applicable regulatory criteria.

Figure 10.1-3

Base Case Maximum Predicted 30-Day Dustfall (mg/dm²/day)
With Global/Regional Background Added

Stantec



Maximum Predicted Dustfall Rate
Monthly Dustfall Isopleth
Local Study Area
Plant Boundary

Base Data
- City Development Boundary
- Highway
- Kinder Morgan Pipeline - Current
- Kinder Morgan Pipeline - Rerouted
- Natural Gas Line (approx. location)
- Paved Road
- Railway
- Watercourse
- City of Kamloops Boundary
- Waterbody

Proposed Structures (Year 8 Operation)
- Overpass
- Explosives Facility (Alternate)
- Mine Rock Storage Facility (MRSF)
- Ore Stockpile
- Overburden Stockpile
- Pit Outline
- Plant Site
- Reclamation Stockpile
- Topsoil Stockpile
- Tailings Storage Facility (TSF)

Units: Maximum Monthly Dustfall Deposition Rate (mg/dm²/day)
Dustfall Objective = 1.75 mg/dm²/day
Annual Background = 0.8 mg/dm²/day

Isopleth Intervals for Monthly Dustfall Rate
1.75, 1.50, 1.25, 1.00, 0.75, 0.50, 0.25, 0.150 mg/dm²/day

Elevation (metres)

<300m | 500m | 700m | 900m | 1100m | 1300m | 1500m | 1700m | 1900m

NOTES:
1. BASE MAP: DEM (55m)
2. COORDINATE GRID IS IN METRES.
   COORDINATE SYSTEM: NAD83 UTM, ZONE 10 NORTH, METER.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:131,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
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KGHM Ajax Mining Inc.

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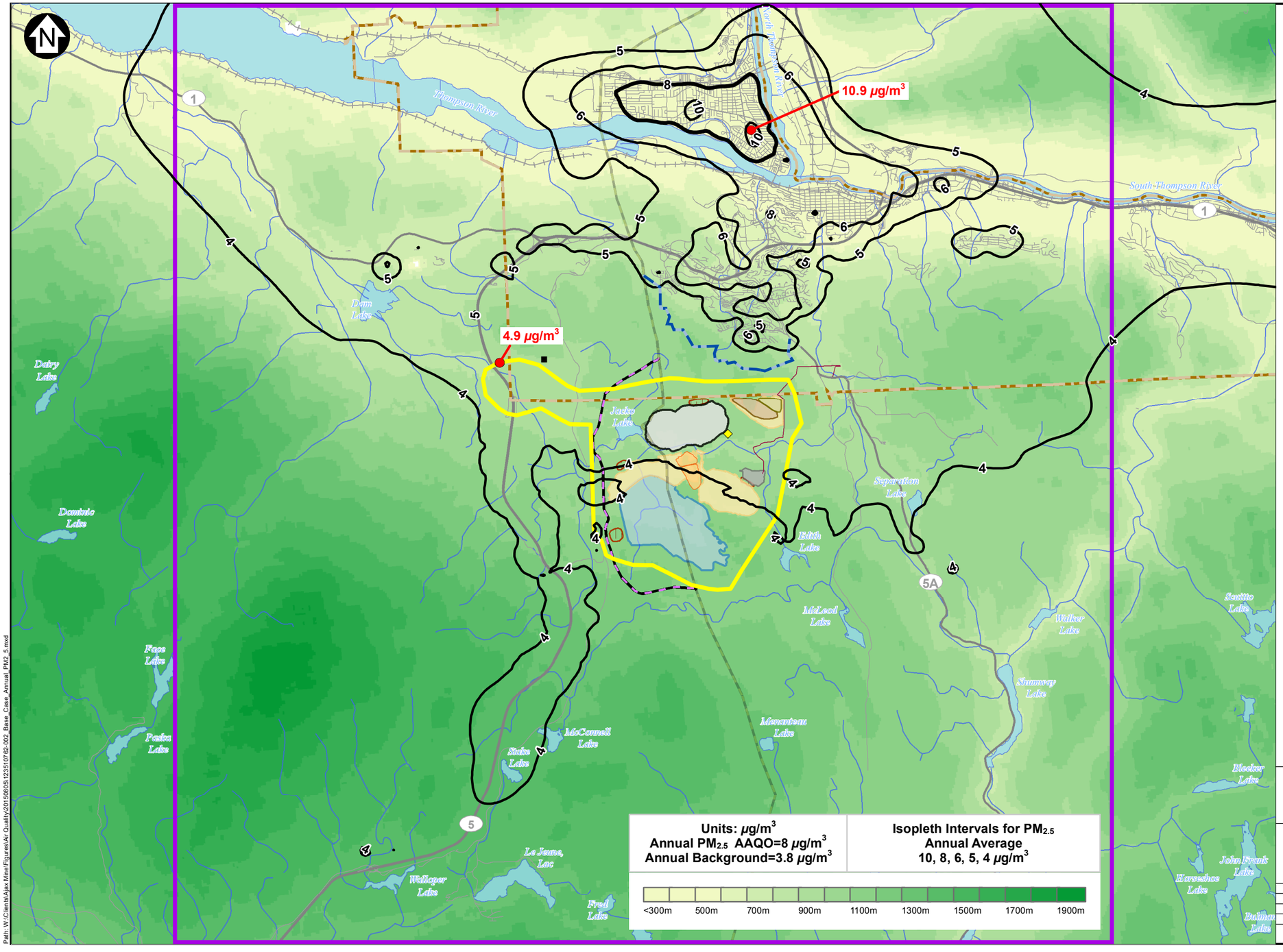
Figure 10.1-4

Base Case Maximum Predicted Annual Average Ground-Level $PM_{2.5}$ Concentrations (µg/m³) With Global/Regional Background Added

Stantec



NOTES:

1. BASE MAP: DEM (55m)
2. COORDINATE GRID IS IN METRES.
   COORDINATE SYSTEM: NAD83 UTM, ZONE 10 NORTH, METER.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:131,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
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Figure 10.1-5 summarizes the Project Case – Operation maximum predicted 30-day dustfall (mg/dm²/day) without the global/regional background added. The maximum predicted monthly dustfall associated with Project operation is 0.4 mg/dm²/day, which is below the BC dustfall objective, 1.7 mg/dm²/day. Although there is no exceedance this figure indicates the Project's contribution to the dustfall in the RSA. Including this figure without the global/regional background allow for a better visualization of the Project's contribution and an easier interpretation of the dustfall exceedances for the Application Case – Operation (e.g., Base Case plus Project Case – Operation). The dustfall exceedances for Application Case – Operation are discussed below.

Table 10.1-7. Maximum Predicted Criteria Air Contaminant Concentrations Associated with the Project Case – Operation Dispersion Modelling Scenario

Substance	Averaging Interval	Maximum Predicted Concentration	Applicable Regulatory Objective[a]	Frequency of Exceedance (% of one year)
DF (mg/dm²/d)	30-day	0.4	1.7	0
TSP (µg/m³)	24-hour	**406.0**	120	3.3
	Annual	13.5	60	0
PM_{10} (µg/m³)	24-hour	**332.9**	50	6.6
$PM_{2.5}$ (µg/m³)	24-hour [b]	**31.4**	25	0.8
	24-hour [c]	19.2	28 (27) [e]	0
	Annual	2.1	8	0
	Annual [d]	1.6	10 (8.8) [e]	0
SO_2 (µg/m³)	1-hour[f]	1.6	200	0
	1-hour	1.8	450	0
	24-hour	1.1	150	0
	Annual	0.04	30	0
NO_2 (µg/m³) [g]	1-hour [h]	142.4	188	0
	1-hour	171.1	400	0
	24-hour	117.4	200	0
	Annual	9.5	60	0
CO (µg/m³)	1-hour	926.5	14,300	0
	8-hour	744.3	5,500	0

Notes:
*Values in **boldface** identify results greater than the applicable regulatory objective.*
NA = not available. One year was assessed so it is not possible to generate a frequency of exceedance for comparison to this AAQO which requires three years of results.
[a] Applicable AAQO and CAAQS from Table 10.1-3.
[b] Based on the 98th percentile for one year.
[c] Based on the annual 98th percentile of daily 24-hour average concentrations, averaged over three years.
[d] Based on the 3-year mean of annual average concentrations.
[e] The first CAAQS shown is the standard effective in 2015; the new standard proposed for 2020 is given in brackets (Environment Canada 2013).
[f] Based on 99th percentile of daily 1-hour maxima, averaged over one year.
[g] NO_2 based on the Ozone Limiting Method conversion of NOx to NO_2.
[h] Based on the 98th percentile of daily 1-hour maxima, averaged over one year.

The maximum predicted 24-hour and annual average ground level TSP concentrations for Operation are 406.0 and 13.5 µg/m^3, respectively. The 24-hour predicted concentrations exceed the applicable regulatory criteria (120 µg/m^3). The TSP regulatory criteria of 120 µg/m^3 is exceeded 3.3% of the year (12 days) at the Plant Boundary. The exceedances occur during December and January when dispersion is poorer than summer. The predicted area of exceedance extends from the northeast Plant Boundary into undeveloped grasslands, however some of the area extends northeast past the City Development Boundary to the southern-most edge of Aberdeen. The area of exceedance is shown in Appendix 10.1-A, Figure I-2. The predicted exceedance area stops approximately 180 m to the southwest of Aberdeen and there are no predicted exceedances of TSP within Aberdeen. The frequency of exceedance at the City Development Boundary (location 2 on Figure 10.1-8) is 1.6% of the year (6 days). The closest receptor with a predicted TSP exceedance is 180 m southwest of Aberdeen. At this receptor the TSP regulatory criteria is exceeded 0.8% of the year (3 days). The predicted 24-hour TSP concentrations fall by 58% (120 µg/m^3 to 50 µg/m^3) over the 200 m from southeast of Aberdeen to upper Aberdeen.

The maximum predicted 24-hour average PM_{10} concentration is 332.9 µg/m^3. The predicted maximum concentration exceeds the applicable regulatory criteria (50 µg/m^3). The PM_{10} regulatory criteria of 50 µg/m^3 is exceeded 6.6% of the time (24 days). The exceedances occur during November through April when dispersion is frequently poorer than summer. The predicted area of exceedance extends west, northeast, and east from the Plant Boundary largely covering undeveloped grasslands. The area in which the predicted exceedance occurs extends northeast past the City Development Boundary and extends 200 m into upper Aberdeen. The PM_{10} regulatory criteria is exceeded is 3.0% of the year (11 days) at the City Development Boundary (location 2 on Figure 10.1-8). The highest predicted PM_{10} concentration within Aberdeen is 71.8 µg/m^3. The location of the Aberdeen maximum has a frequency of exceedance of 0.5% of the year (2 days). The location of the Aberdeen maximum is near the intersection of Abbeyglen Way and Pacific Way. Three other receptors near the southern portion of Abbeyglen Way are predicted to exceed the PM_{10} regulatory criteria 0.3% of the year (1 day).

The area of exceedance is the area which has receptors with maximum predicted concentrations above the regulatory objective. The frequency of exceedance at a receptor within the exceedance area is the frequency a given receptor has predicted concentrations above the regulatory objective within the year. The maximum at an exceeding receptor only occurs once and counts towards one of the exceedances making up the frequency of exceedance. For example, the highest predicted 24-hour average PM_{10} concentration within Aberdeen is 71.8 µg/m^3. The frequency of exceedance at this receptor is 0.5% of the year (2 days). At this receptor there is one 24-hour period during the year when the PM_{10} concentration is 71.8 µg/m^3 (e.g., the maximum) and there is one 24-hour period when the PM_{10} concentration is less than the maximum but exceeding the regulatory objective (50 µg/m^3). For the remaining 363 days of the year the predicted 24-hour PM_{10} concentrations are below the regulatory objective.

Figure 10.1-6 summarizes the Project Case - Operation maximum predicted annual average ground-level $PM_{2.5}$ concentrations (µg/m^3) without the global/regional background value added. The maximum predicted 98th percentile 24-hour and annual average $PM_{2.5}$ concentrations associated with Operation are 31.4 and 2.1 µg/m^3, respectively. The 98th percentile 24-hour predicted concentrations exceed the applicable regulatory criteria (25 µg/m^3). The frequency of exceedance is 0.8% (3 days of the year) during December and January when the dispersion is poorer than summer. The predicted area of exceedance is at the northeast Plant Boundary which is comprised of undeveloped grasslands.

Figure 10.1-5

Project Case Maximum Predicted 30-Day Dustfall (mg/dm² /day)
Without Global/Regional Background Added

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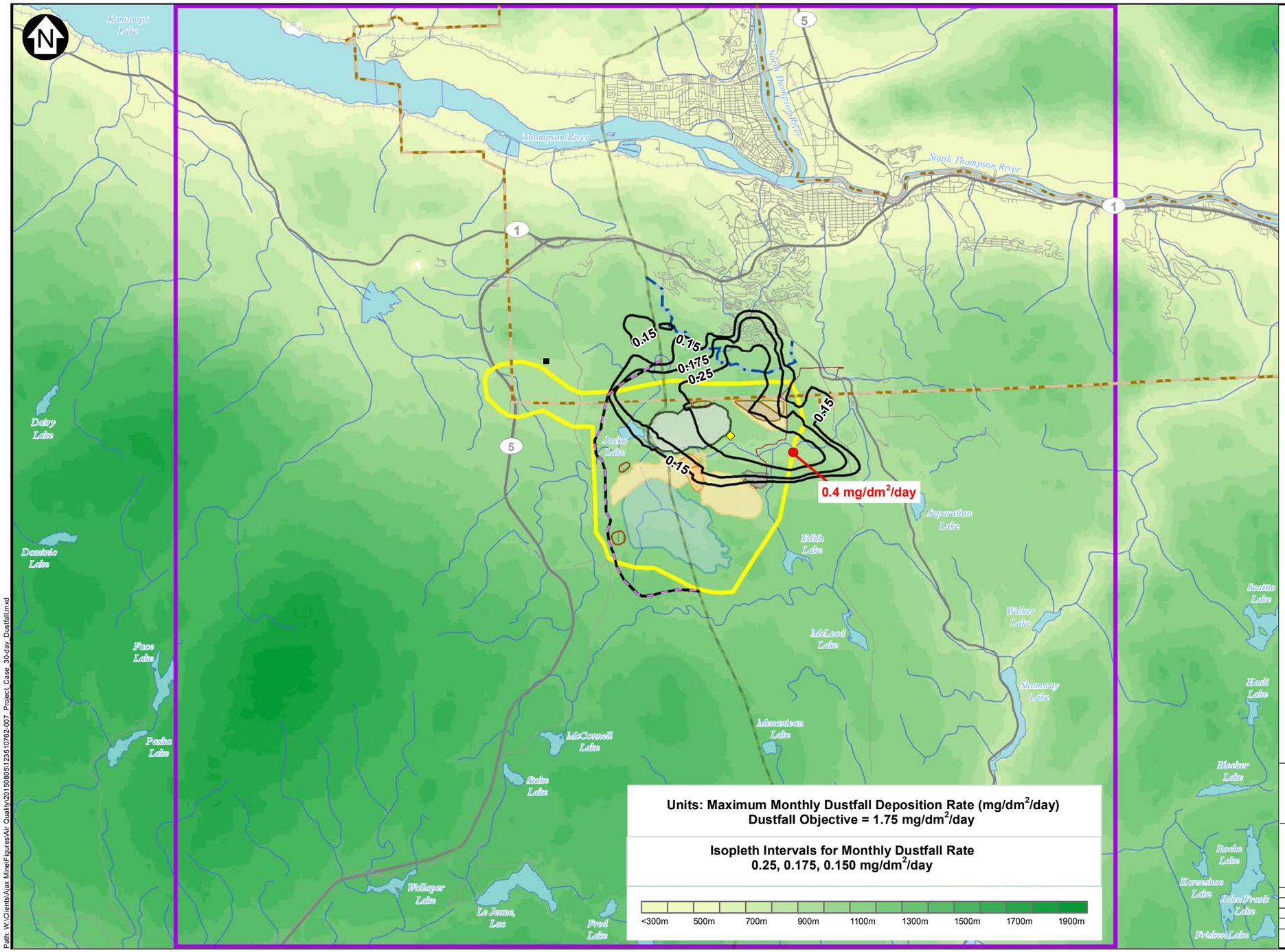

NOTES:
1. BASE MAP: DEM (55m)
2. COORDINATE GRID IS IN METRES.
   COORDINATE SYSTEM: NAD83 UTM, ZONE 10 NORTH, METER.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:131,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
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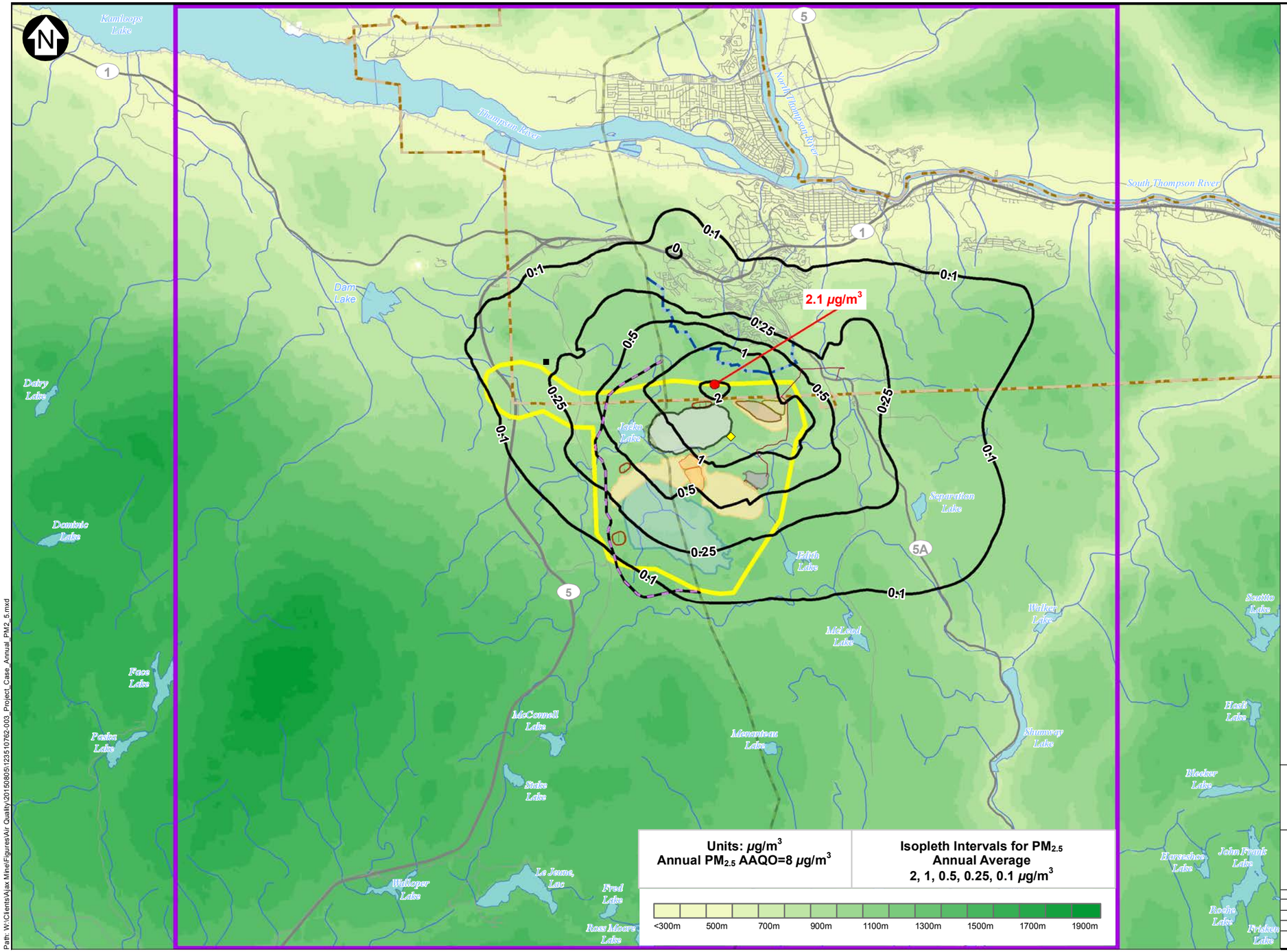
Figure 10.1-6

Project Case Maximum Predicted Annual Average Ground-Level $PM_{2.5}$ Concentrations (µg/m³) Without Global/Regional Background Added

Stantec



- Maximum Concentration
- $PM_{2.5}$ Annual Isopleth
- Local Study Area
- Plant Boundary

Basedata

- City Development Boundary
- Highway
- Kinder Morgan Pipeline - Current
- Kinder Morgan Pipeline - Rerouted
- Natural Gas Line (approx. location)
- Paved Road
- Railway
- Watercourse
- City of Kamloops Boundary
- Waterbody

Proposed Structures (Year 8 Operation)

- Overpass
- Explosives Facility (Alternate)
- Mine Rock Storage Facility (MRSF)
- Ore Stockpile
- Overburden Stockpile
- Pit Outline
- Plant Site
- Reclamation Stockpile
- Topsoil Stockpile
- Tailings Storage Facility (TSF)

NOTES:

1. BASE MAP: DEM (55m)
2. COORDINATE GRID IS IN METRES.
   COORDINATE SYSTEM: NAD83 UTM, ZONE 10 NORTH, METER.
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SCALE 0 1 2 3 Kilometres

Units: µg/m³
Annual $PM_{2.5}$ AAQO=8 µg/m³

Isopleth Intervals for $PM_{2.5}$ Annual Average
2, 1, 0.5, 0.25, 0.1 µg/m³

<300m | 500m | 700m | 900m | 1100m | 1300m | 1500m | 1700m | 1900m

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Application Case – Construction

The Application Case – Construction model scenario is the sum of the Base Case (which includes the global/regional background) and the Project Case – Construction scenario. Table 10.1-8 summarizes the maximum predicted ground-level concentrations for Application Case – Construction compared to the ambient air quality objectives. The full summary of the results for this modelling scenario are in Appendix 10.1-A, Section 5.4. The results are summarized for three locations; in the city of Kamloops, at the Plant Boundary, and over the entire RSA. The isopleth maps showing the model predictions for all areas within and surrounding the city of Kamloops are included in Appendix 10.1-A, Appendix H Project Case and Application Case Construction Modelling Isopleth Maps (Figures H-12 to H-22).

Table 10.1-8. Maximum Predicted Criteria Air Contaminant Concentrations in the city of Kamloops Associated with the Application Case – Construction Dispersion Modelling Scenario

Substance	Averaging Interval	Maximum Predicted Concentration	Applicable Regulatory Objective [a]	Frequency of Exceedance (% of one year)
DF (mg/dm²/d)	30-day	**2.0**	1.7	58
TSP (µg/m³)	24-hour	**151.9**	120	0.8
	Annual	44.1	60	0
PM_{10} (µg/m³)	24-hour	**89.6**	50	1.9
$PM_{2.5}$ (µg/m³)	24-hour [b]	**34.7**	25	4.4
	24-hour [c]	**36.6**	28 (27) [e]	NA
	Annual	**10.9**	8	NA
	Annual [d]	**11.0**	10 (8.8) [e]	NA
SO_2 (µg/m³)	1-hour[f]	15.8	200	0
	1-hour	20.2	450	0
	24-hour	1.3	150	0
	Annual	0.9	30	0
NO_2 (µg/m³) [g]	1-hour [h]	77.8	188	0
	1-hour	117.5	400	0
	24-hour	50.3	200	0
	Annual	15.4	60	0
CO (µg/m³)	1-hour	2,088	14,300	0
	8-hour	1,105	5,500	0

Notes:
*Values in **boldface** identify results greater than the applicable regulatory objective.*
NA = not available. One year was assessed so it is not possible to generate a frequency of exceedance for comparison to this AAQO which requires three years of results.
[a] Applicable AAQO and CAAQS from Table 10.1-3.
[b] Based on the 98th percentile for one year.
[c] Based on the annual 98th percentile of daily 24-hour average concentrations, averaged over three years.
[d] Based on the 3-year mean of annual average concentrations.
[e] The first CAAQS shown is the standard effective in 2015; the new standard proposed for 2020 is given in brackets (Environment Canada 2013).
[f] Based on 99th percentile of daily 1-hour maxima, averaged over one year.
[g] NO_2 based on the Ozone Limiting Method conversion of NO_X to NO_2.
[h] Based on the 98th percentile of daily 1-hour maxima, averaged over one year.

Over the city of Kamloops the maximum predicted concentrations for SO_2, NO_2, and CO for all time-averaging intervals are less than the applicable regulatory criteria. The maximum predicted concentrations for annual TSP are also less than the applicable regulatory criteria. Dustfall, 24-hour TSP, 24-hour PM_{10}, and 24-hour and annual $PM_{2.5}$ concentrations are predicted to exceed the applicable regulatory criteria. Areas potentially in exceedance are over north Kamloops and downtown Kamloops. These exceedances are attributable to existing sources of emissions in Kamloops (e.g., Base Case). The Project emissions are not the cause of the exceedances over north Kamloops and downtown Kamloops.

At the Plant Boundary the maximum predicted concentrations for all substances except for 24-hour average TSP and 24-hour average PM_{10} are less than the applicable regulatory criteria. The predicted 24-hour average TSP and PM_{10} concentrations are predicted to exceed the applicable regulatory criteria on the northeast Plant Boundary. Areas potentially in exceedance are largely uninhabited regions in the RSA. These exceedances are attributable to the Project Case – Construction.

Within the RSA the maximum predicted concentrations of dustfall, 24-hour TSP, 24-hour PM_{10} and 24-hour $PM_{2.5}$ and annual $PM_{2.5}$ exceeded the applicable regulatory criteria.

The maximum predicted dustfall rate over the City of Kamloops is 2.0 mg/dm^2/day. The dustfall regulatory criteria (1.7 mg/dm^2/day) is exceeded 58% of the year (7 months). The exceedances occur during February, March, and June through September and the primary contributor to the dustfall exceedance is the Base Case (i.e., existing sources, not the Project).

The maximum predicted 24-hour TSP concentration over the City of Kamloops is 152 µg/m^3. The TSP regulatory criteria (120 µg/m^3) is exceeded 0.8% of the year (3 days). The exceedances occur during December and January when the dispersion is frequently poorer than during summer. The maximum predicted 24-hour TSP concentration at the Plant Boundary is127 µg/m^3. At the Plant Boundary the TSP regulatory criteria is exceeded 0.3% of the year (1 day). This exceedance occurs during January. The primary contributor to the exceedance over the city of Kamloops is the Base Case; the primary contributor to the exceedance at the Plant Boundary is the Project Case - Construction.

The maximum predicted 24-hour PM_{10} concentration over the City of Kamloops is 89.6 µg/m^3. The PM_{10} regulatory criteria (50 µg/m^3) is exceeded 1.9% of the year (7 days). The exceedances occur during December, January, and February when dispersion is frequently poorer than in summer. The maximum predicted 24-hour PM_{10} concentration at the Plant Boundary is 91.4 µg/m^3. The PM_{10} regulatory criteria is exceeded 1.6 % of the year (6 days). The exceedances occur during December and January. The areas where the exceedances occur are over north Kamloops, downtown Kamloops and the northeast Plant Boundary. The primary contributor to the exceedance over the City of Kamloops is the Base Case and the primary contributor to the exceedance at the Plant Boundary is the Project Case – Construction.

The maximum predicted 98th percentile 24-hour $PM_{2.5}$ concentrations over the city of Kamloops is 34.7 µg/m^3. The $PM_{2.5}$ regulatory criteria (25 µg/m^3) is exceeded 4.4% of the year (16 days). The exceedances occur during November, December, January, and February. The area covered by the predicted exceedance is over north Kamloops and downtown Kamloops. The maximum predicted annual $PM_{2.5}$ concentration (10.9 µg/m^3) occurs over north Kamloops. The primary contributor to the predicted exceedance over north Kamloops is the Base Case.

Application Case – Operation

The Application Case – Operation model scenario is the sum of the Base Case (which includes the global/regional background) and the Project Case – Operation. In Appendix 10.1-A, Section 5.5 the results are summarized at three locations; at the city of Kamloops, at the Plant Boundary and over the entire RSA. The isopleth maps showing the model predictions for all areas within and surrounding the city of Kamloops are included in Appendix 10.1-A, Appendix I Project Case and Application Case Operation Modelling Isopleth Maps (Figures I-12 to I-22).

The Project operations have a limited effect on existing air quality in the city of Kamloops. The Application Case – Operation results are nearly indistinguishable from Base Case results north of Aberdeen Drive. Despite the Projects effects in the Application Case – Operation, air quality in upper Aberdeen is predicted to remain good. Air quality there remains better than in most other areas in the city of Kamloops. The Projects predicted effects in upper Sahali, the Downtown core, and the North Shore are such that a discernable change in air quality will not be measurable in future. These conclusions are supported by the summary tables and figures presented below, including detailed information about the model predictions for air quality in Aberdeen.

Table 10.1-9 summarizes the maximum predicted ground-level concentrations in the city of Kamloops for the Application Case – Operation compared to the ambient air quality objectives. Over the City of Kamloops the maximum predicted concentrations for SO_2, NO_2, and CO for all time-averaging intervals are less than the applicable regulatory criteria. The maximum predicted concentrations for annual TSP are also less than the applicable regulatory criteria. Dustfall, 24-hour TSP, PM_{10}, and $PM_{2.5}$ are predicted to exceed the applicable regulatory criteria. Areas potentially in exceedance are over north Kamloops and downtown Kamloops are primarily due to existing source contributions from the Base Case.

The maximum predicted monthly dustfall in the city of Kamloops (and within the RSA) associated with the Application Case - Operation is 2.0 mg/dm^2/d, which marginally exceeds the BC dustfall objective of 1.7 mg/dm^2/d. The dustfall regulatory criteria is exceeded 58% of the year (7 months). The exceedances occur during February, March, and June through September. Figure 10.1-7 summarizes the Application Case – Operation maximum predicted 30-day dustfall (mg/dm^2/day) with the global/regional background added. The predicted area of exceedance is over downtown Kamloops and the primary contributor is the Base Case (i.e., not the Project). The maximum predicted monthly dustfall at the Plant Boundary (1.2 mg/dm^2/day) did not exceed the BC dustfall objective of 1.7 mg/dm^2/day. There are no predicted exceedances for the dustfall regulatory criteria in Aberdeen.

The maximum predicted 24-hour TSP concentration over the city of Kamloops is 152 µg/m^3. The TSP regulatory criteria (120 µg/m^3) was exceeded 0.8% of the year (3 days) over the City of Kamloops. The exceedances occur during December and January when dispersion is frequently poorer than in summer months. The maximum predicted 24-hour TSP concentration at the Plant Boundary is 436 µg/m^3. The TSP regulatory criteria (120 µg/m^3) was exceeded 4.4% of the year (16 days) at the Plant Boundary. The exceedances occur during December and January when dispersion is frequently poorer than in summer months.

Table 10.1-9. Maximum Predicted Criteria Air Contaminant Concentrations in the city of Kamloops Associated with the Application Case – Operation Dispersion Modelling Scenario

Substance	Averaging Interval	Maximum Predicted Concentration	Applicable Regulatory Objective [a]	Frequency of Exceedance (% of one year)
DF (mg/dm²/d)	30-day	**2.0**	1.7	58
TSP (µg/m³)	24-hour	**152.5**	120	0.8
	Annual	44.3	60	0
PM_{10} (µg/m³)	24-hour	**94.8 (90.2)** [b]	50	1.9
$PM_{2.5}$ (µg/m³)	24-hour [c]	**34.7**	25	4.4
	24-hour [d]	**36.8**	28 (27) [f]	NA
	Annual	**10.9**	8	100
	Annual [e]	**11.1**	10 (8.8) [f]	NA
SO_2 (µg/m³)	1-hour[g]	15.8	200	0
	1-hour	20.2	450	0
	24-hour	12.7	150	0
	Annual	2.1	30	0
NO_2 (µg/m³) [h]	1-hour [i]	78.7	188	0
	1-hour	168.5	400	0
	24-hour	51.4	200	0
	Annual	15.8	60	0
CO (µg/m³)	1-hour	2,088	14,300	0
	8-hour	1,105	5,500	0

Notes:
*Values in **boldface** identify results greater than the applicable regulatory objective.*
NA = not available. One year was assessed so it is not possible to generate a frequency of exceedance for comparison to this AAQO which requires three years of results.
[a] Applicable AAQO and CAAQS from Table 10.1-3.
[b] 94.8 µg/m³ is the maximum over the City of Kamloops, 90.4 µg/m³ is the maximum over the North Shore.
[c] Based on the 98th percentile for one year.
[d] Based on the annual 98th percentile of daily 24-hour average concentrations, averaged over three years.
[e] Based on the 3-year mean of annual average concentrations.
[f] The first CAAQS shown is the standard effective in 2015; the new standard proposed for 2020 is given in brackets (Environment Canada 2013).
[g] Based on 99th percentile of daily 1-hour maxima, averaged over one year.
[h] NO_2 based on the Ozone Limiting Method conversion of NOx to NO_2.
[i] Based on the 98th percentile of daily 1-hour maxima, averaged over one year.

Within the whole LSA, the predicted areas of exceedance are primarily over north Kamloops, downtown Kamloops, west of the limits of urban development for the city of Kamloops, and at the west, north, northeast, and east edges of the Plant Boundary. The area northeast of the Plant Boundary largely covers undeveloped grasslands, however some of this area extends northeast past the City Development Boundary and extends 150 m into upper Aberdeen. At the City Development Boundary (location 2 on Figure 10.1-8) the TSP regulatory criteria (120 µg/m³) was exceeded 1.9%of

the year (7 days). The maximum predicted 24-hour TSP concentration within Aberdeen is 135 µg/m^3. The location of the Aberdeen maximum exceeded the TSP regulatory criteria 0.3% of the year (1 day). The Aberdeen maximum occurs near the intersection of Abbeyglen Way and Pacific Way. One other receptor near the southern portion of Abbeyglen Way is predicted to exceed the TSP regulatory criteria 0.3% of the year (1 day).

The primary contributor to the exceedance over the City is the Base Case while the primary contributor to the exceedance at the Plant Boundary is the Project Case – Operation. The isopleth map showing the maximum predicted 24-hour TSP concentrations for the Application Case – Operation is contained in Appendix 10.1-A, Appendix I Project Case and Application Case Operation Modelling Isopleth Maps (Figure I-13).

The maximum predicted 24-hour PM_{10} concentrations over the city of Kamloops and over the North Shore are 94.8 and 90.2 µg/m^3, respectively. The PM_{10} regulatory criteria (50 µg/m^3) is exceeded 1.9% of the year (7 days) over the city of Kamloops. The exceedances occur during December, January, and February when dispersion is frequently poorer than in summer months. The maximum predicted 24-hour PM_{10} concentration at the Plant Boundary is 346 µg/m^3. The PM_{10} regulatory criteria (50 µg/m^3) is exceeded 9.3% of the year (34 days) at the Plant Boundary. The exceedances occur during November, December, January, and February. Within the LSA, the areas where the predicted exceedance occurs are over north Kamloops, downtown Kamloops, and at the west, north, northeast, and east edges of the Plant Boundary. The area northeast of the Plant Boundary largely covers undeveloped grasslands; however, some 10.1-of this area extends northeast past the City Development Boundary and extends 600 m into upper Aberdeen. The PM_{10} regulatory criteria (50 µg/m^3) is exceeded 1.9% of the year (7 days) at the City Development Boundary (location 2 on Figure 10.1-8). The maximum predicted 24-hour PM_{10} concentration within Aberdeen is 94.8 µg/m^3. The location of the Aberdeen maximum exceeded the regulatory criteria 1.9% of the year (7 days). The location of the Aberdeen maximum is near the intersection of Abbeyglen Way and Pacific Way. The receptor that is in exceedance that extends furthest into Aberdeen exceeds the PM_{10} regulatory criteria 0.3% of the year (1 day).

The primary contributor to the predicted exceedance for the 24-hour PM_{10} concentrations over the City is the Base Case while the primary contributor to the exceedance at the Plant Boundary is the Project Case – Operation. The isopleth map showing the maximum predicted 24-hour PM_{10} concentrations for the Application Case – Operation is contained in Appendix 10.1-A, Appendix I Project Case and Application Case Operation Modelling Isopleth Maps (Figure I-15).

The maximum predicted 98th percentile 24-hour $PM_{2.5}$ concentration over the city of Kamloops is 34.7 µg/m^3. The $PM_{2.5}$ regulatory criteria (25 µg/m^3) was exceeded 4.4% of the year (16 days) over the city of Kamloops. The exceedances occur during November, December, January, and February. The maximum predicted 24-hour $PM_{2.5}$ concentration at the Plant Boundary is 37.8 µg/m^3. The $PM_{2.5}$ regulatory criteria (25 µg/m^3) was exceeded 0.8% of the year (3 days) at the Plant Boundary. The exceedances occur during December and January. The areas where the predicted 24-hour exceedance occur are over north Kamloops, downtown Kamloops, and the northeast Plant Boundary. The area northeast of the Plant Boundary largely covers undeveloped grasslands. The primary contributor to the exceedance over the City is the Base Case while the primary contributor

to the exceedance at the Plant Boundary is the Project Case – Operation. The isopleth map showing the maximum predicted 24-hour $PM_{2.5}$ concentrations for the Application Case – Operation is contained in Appendix 10.1-A, Appendix I Project Case and Application Case Operation Modelling Isopleth Maps (Figure I-16).

Figure 10.1-8 summarizes the Project contribution to locations in the LSA for the Application Case – Operation maximum predicted annual average ground-level $PM_{2.5}$ concentrations ($\mu g/m^3$) with the global/regional background added. Within the city of Kamloops, the maximum predicted annual $PM_{2.5}$ concentration (10.9 $\mu g/m^3$) is over north Kamloops. It is not possible to do a frequency assessment for a maximum predicted annual average $PM_{2.5}$ concentration because it is a single data point for compared with the applicable regulatory criteria. The predicted annual $PM_{2.5}$ concentration at the Plant Boundary is 6.2 $\mu g/m^3$. The areas where the predicted annual $PM_{2.5}$ exceedance occurs is over north Kamloops. The primary contributor to the exceedance over north Kamloops is the Base Case while the primary contributor to the exceedance at the Plant Boundary is the Project Case – Operation.

The six pie charts shown on Figure 10.1-8 illustrate the relative contribution of the Base Case and the Project Case – Operation to the total annual $PM_{2.5}$ concentration between the Plant Boundary and downtown Kamloops. The contribution from the Project is at its maximum at the north Plant Boundary (site 1, 34%) and rapidly diminishes moving northward towards the city of Kamloops (site 6, North Shore) where the project only contributes 0.4% to the annual average $PM_{2.5}$ concentration. In upper Aberdeen (site 3) the Project contributes 6.6% to the annual average $PM_{2.5}$ concentration. The total annual $PM_{2.5}$ concentration (6.06 $\mu g/m^3$) does not exceed the applicable regulatory criteria (8 $\mu g/m^3$) and only marginally exceeds the BC Planning Goal (6.0 $\mu g/m^3$).

The remainder of the city of Kamloops is relatively unaffected by the Project. In upper Sahali (site 4, Figure 10.1-8) the Project contribution is 1.2%, in the west end (site 5) the Project contribution is 1%. At sites 4 and 5 (west end) the BC Planning Goal is predicted to be exceeded, although the majority (i.e., greater than 98%) of the total annual $PM_{2.5}$ concentrations are attributable to existing sources (e.g., Base Case).

At the City Development Boundary (site 2, Figure 10.1-8) there is no exceedance of the applicable regulatory criteria and the Project contributes 23.5% to the total annual $PM_{2.5}$ concentration.

Figure 10.1-9 summarizes the Project contribution specifically to the city of Kamloops from the Application Case – Operation maximum predicted annual average ground-level $PM_{2.5}$ concentrations ($\mu g/m^3$) with the global/regional background added. The predicted annual average $PM_{2.5}$ concentration is 6.4 $\mu g/m^3$. Of this the Project contributes 0.15 $\mu g/m^3$ averaged over the city of Kamloops. This represents a 2.3 % increase in the annual average $PM_{2.5}$ concentrations attributable to the Project. This is insubstantial give the long-term year to year variability in annual average $PM_{2.5}$ ($\pm$ 0.92 $\mu g/m^3$) concentrations.

Figure 10.1-7

Application Case Maximum Predicted 30-Day Dustfall (mg/dm²/day) With Global/Regional Background Added

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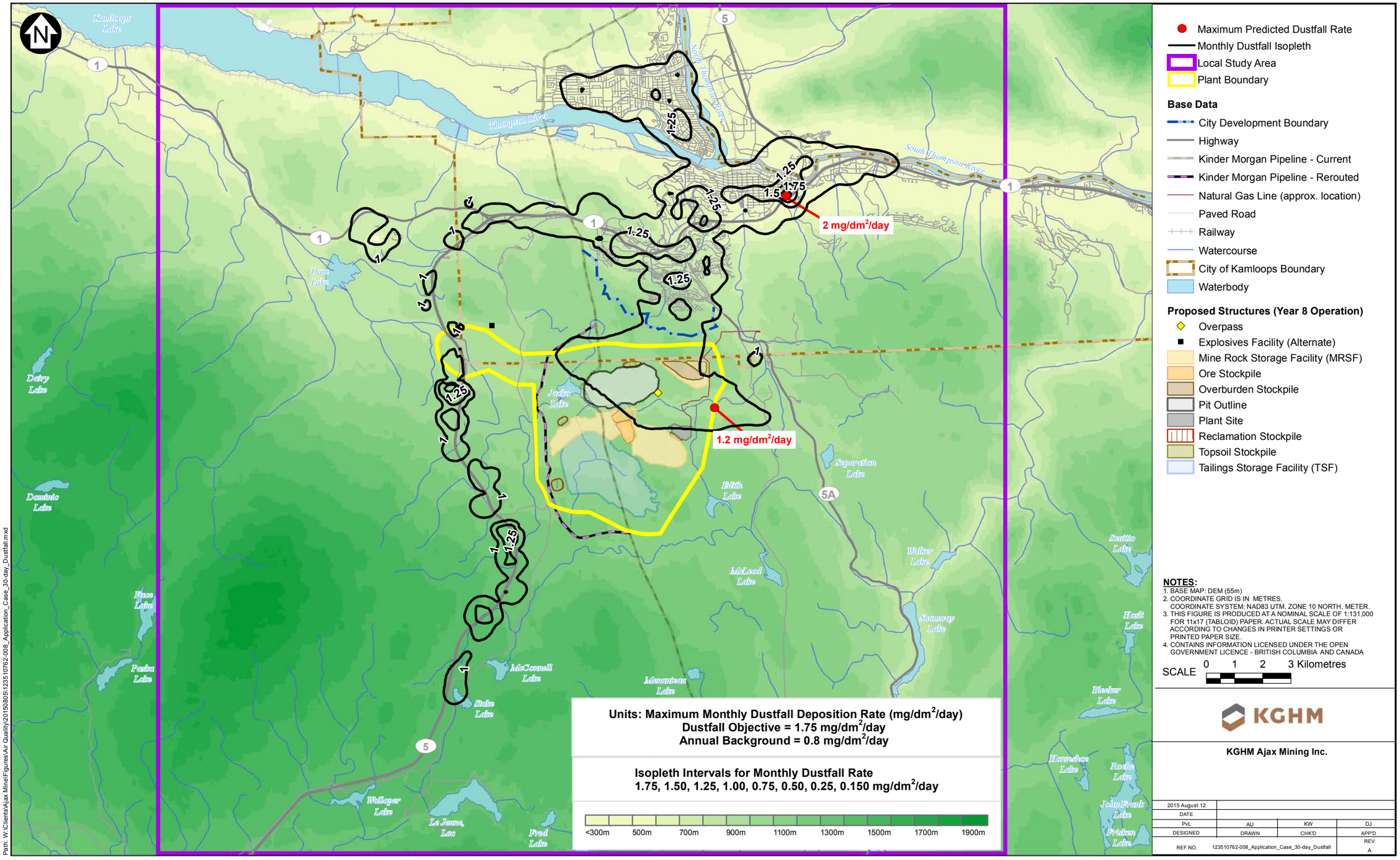

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NOTES:
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Figure 10.1-8

Application Case Maximum Predicted Annual Average Ground-Level $PM_{2.5}$ Concentrations (µg/m³) With Global/Regional Background Added

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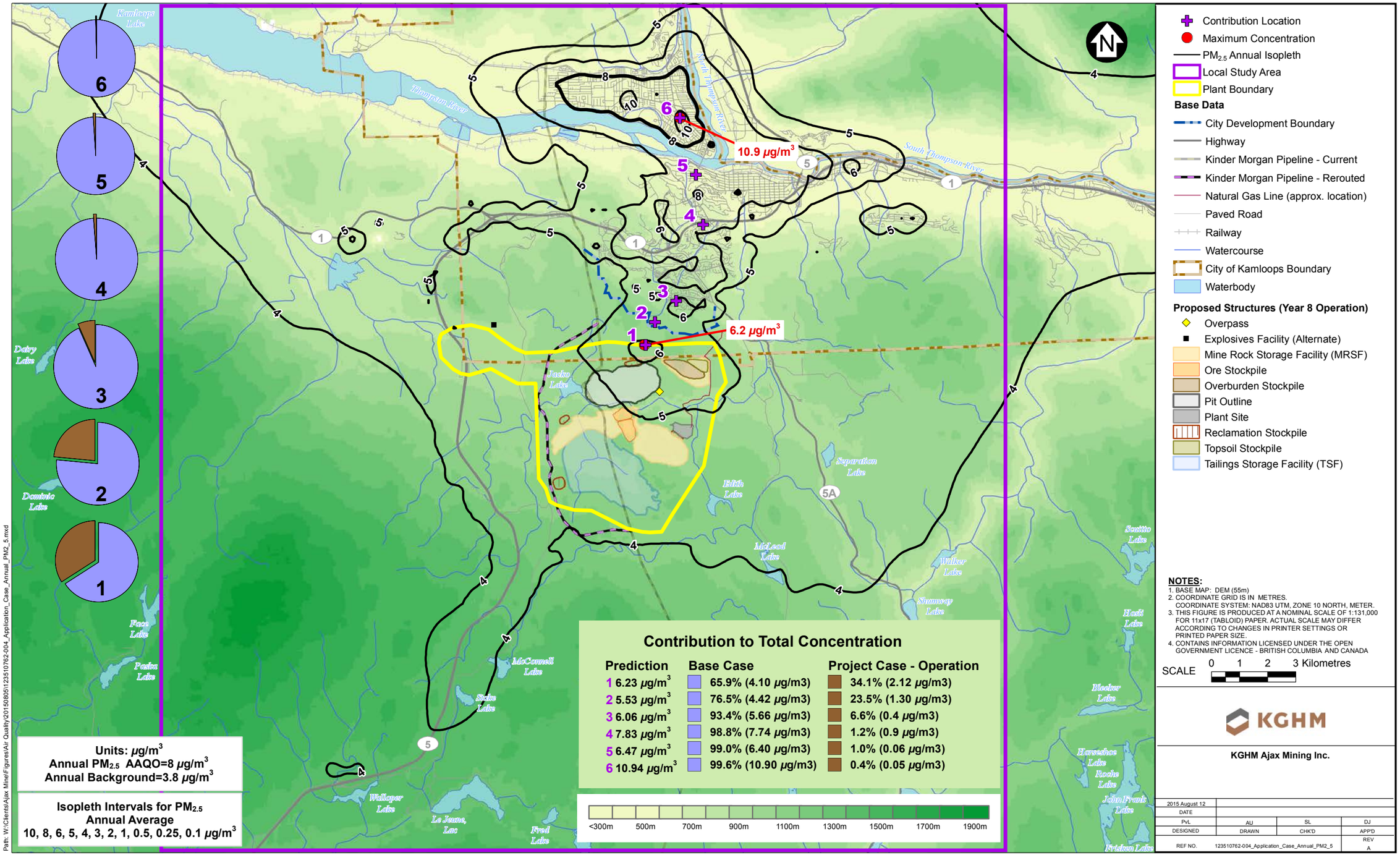

Figure 10.1-9

Application Case Maximum Predicted Annual Average Ground-Level $PM_{2.5}$ Concentrations (ug/m^3) Within the City of Kamloops

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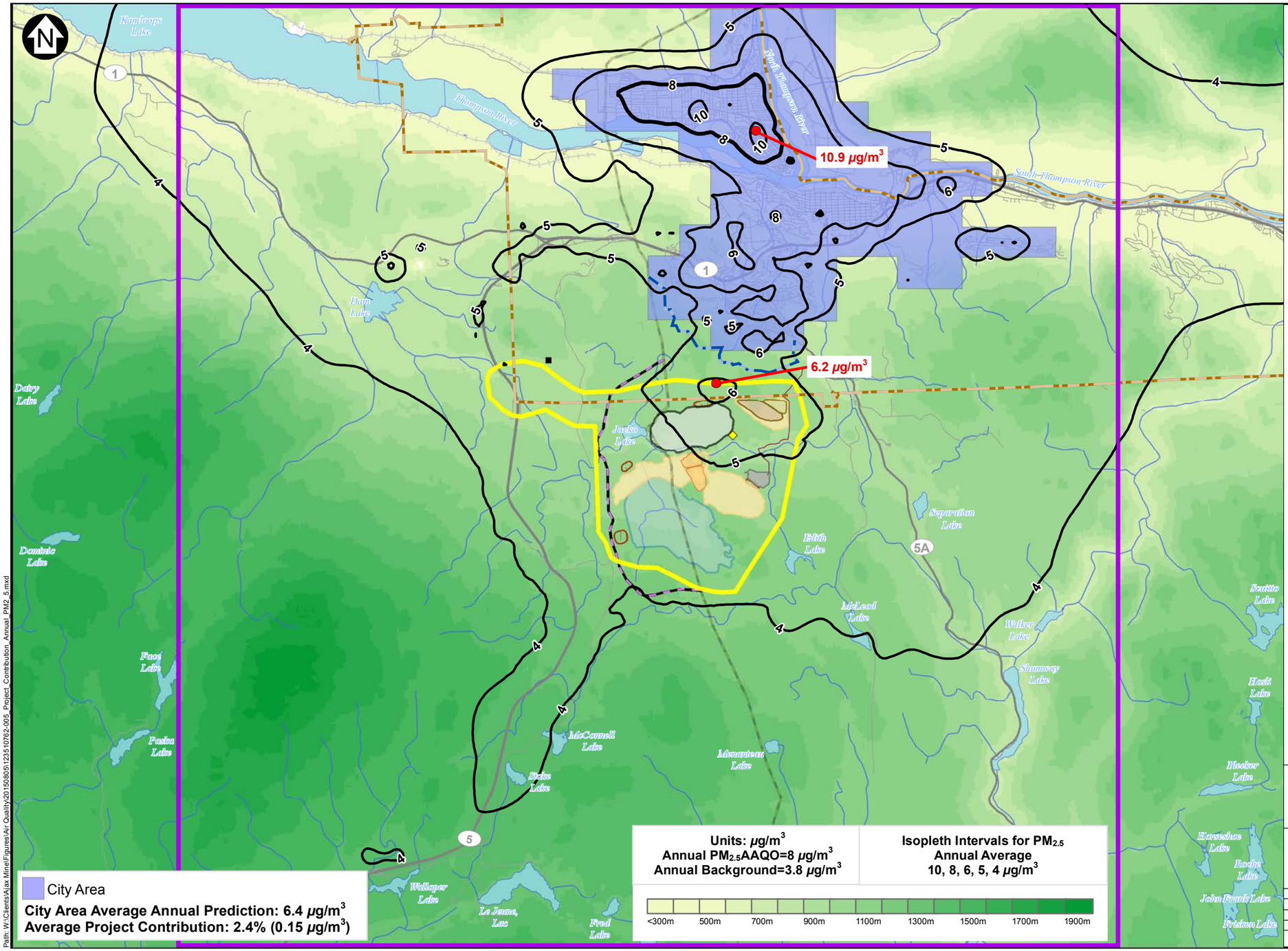

NOTES:

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Modelling Uncertainty

The dispersion model has been run in a conservative fashion, and while uncertainty exists in all dispersion modelling, there is a high degree of confidence the actual effects will be lower than the predicted ones. Continuous maximum emission rates used in the modelling are estimated based on a combination of emission factors, engineering estimates, and maximum emission limits. The CAC emissions were conservatively estimated. In reality, actual emissions vary from hour to hour and day to day. Because of the nature of this approach, there is a high degree of confidence that the Project emissions are overestimated.

Air quality dispersion models also employ assumptions to simplify the random behavior of the atmosphere into short periods of average behavior. These assumptions limit the capability of the model to replicate every individual meteorological event. Regulatory models, such as CALPUFF, are designed to be conservative under most conditions. The US EPA (2005a) states: "models are reasonably reliable in estimating the magnitude of highest concentrations occurring sometime, somewhere within an area. For example, errors in the highest estimated concentrations of 10 to 40% are found to be typical, i.e., certainly well within the often quoted factor-of-two accuracy that has long been recognized for these models."

The US EPA (2005b) provides guidance to decision makers about model uncertainty. Specifically, they recommend that the model predictions be accepted as a "best estimate" until sufficient technical progress has been made to meaningfully implement concepts dealing with uncertainty. Further details about model and emission estimation uncertainty are included in Appendix 10.1-A, Section 6. There is also a detailed discussion about model performance comparisons and the various quality assurance and quality control (QA/QC) methods that were used.

10.1.4.3 Mitigation Measures for Air Quality

Air emissions from the Project will result from activities that generate fugitive dust (e.g., drilling and blasting, traffic along unpaved haul roads, wind erosion of exposed surfaces of the mine rock storage facilities and TSF, material transfer, material loading and unloading). Air emissions will also result from combustion sources (e.g., mobile diesel equipment for mine Construction and Operation especially haul trucks and blasting) and area sources (e.g., mill or process plant). During Operation there are point sources of particulate emissions (e.g., the primary crusher, conveyor drop points, and the baghouses located on the roof of the process plant). The primary crusher and conveyor drop points were modelled as area sources. Further details are in Appendix 10.1-A, Appendix E Project Case Construction and Operation Emission Inventory.

There are two components to managing air emissions:

1. Project design: The selection of appropriate emission control technology will reduce fugitive and combustion emissions. Project design mitigation measures are proposed for various components of the mill and process plant (e.g., conveyor from crusher to plant will be covered with an arch cover to reduce dust generation, construct a cover over the coarse ore and fine ore stockpiles, install dust collectors (baghouses) for the primary crusher, coarse ore

reclaim area, cone crusher area, fine ore stockpile reclaim and high pressure grinding roller (HPGR) area). Other engineered mitigation measures include:

- partially enclose the primary crusher;
- minimizing the height from which materials are dropped;
- use covered concentrate transport trucks;
- optimization of the design for haul roads to minimize haul distances and reduce fugitive dust;
- selection of best achievable technology (technology that can achieve the best emissions standards and that has been shown to be economically feasible through commercial application) for mine equipment;
- construct roads with coarse gravel and aggregate material;
- placement of stockpiles to minimize wind exposure (where practical); and
- use large haul trucks for ore and mine rock transport to minimize the number of trips between the source and destination.

2. Project operation: Prudent operation will ensure that a number of mitigation measures are appropriately applied to reduce air emissions. The mitigation measures for minimizing air emissions during Operation include:

- watering haul road surfaces as appropriate to maintain 4% moisture ratio for suppression of fugitive dust;
- roadways will be properly graded, compacted and maintained to reduce the silt content for the surface material;
- grade snow into the surface of unpaved roads during winter to suppress dust emissions;
- maintaining vehicle speeds within the posted maximum speed limit; to minimize fugitive dust and diesel emissions;
- reduce idling of vehicles and equipment, where practical, and minimize rapid starts and stops;
- maintain mobile equipment in good operating condition to meet emission standards especially catalytic converters;
- where practical, use multi-passenger vehicles for transporting crews to and from job sites;
- if necessary, implement wheel-cleaning for vehicles leaving site to prevent "track-out";
- where applicable use concurrent reclamation and interim reclamation on exposed surfaces prone to wind erosion (e.g., surfaces of MRSF, TSF dams and beach, Overburden Stockpile, Reclamation Stockpile, Topsoil Stockpile, etc.);
- minimize the areas of exposed soil and rock;
- where practical and economically achievable re-vegetate disturbed areas including temporary soil and overburden stockpiles and road cuts (e.g., progressive reclamation);
- adhere to all permits, authorizations and approvals related to air quality;
- select best achievable technology for the mine fleet.

Further details for air quality control and management are provided in the Air Quality and Dust Control Management Plan (Section 11.6). The Air Quality and Dust Control Management Plan includes discussion about the development of a complaint response and resolution policy, monitoring programs, annual reporting, and the assessment methods to determine the effectiveness of the mitigation measures.

10.1.5 Residual Effects and Their Significance

10.1.5.1 Summary of Air Quality Residual Effects

After the application of the various mitigation measures described in Section 10.1.4.3, the Application Case – Operation air dispersion model predicted exceedances for dustfall, 24-hour average TSP, 24-hour average PM_{10}, and 24-hour and annual average $PM_{2.5}$ concentrations. The model predicted exceedances for the same parameters for the Application Case – Construction scenario. The model predictions for Application Case – Operation provide a better indicator of air quality residual effects than the Application Case – Construction because the latter has a shorter duration and there are fewer stationary sources. From a human health perspective the most important of these parameters is $PM_{2.5}$. Dustfall, TSP, and PM_{10} emissions can largely be controlled through adaptive mitigation and are a lower health concern compared to $PM_{2.5}$.

KAM will assess the effectiveness of the air quality mitigation measures during construction, operation, closure and reclamation. KAM will assess whether or not the predicted air quality effects were accurate. The ambient air quality monitoring data will be reviewed on a regular basis to determine if any trends are evident. The key performance indicators that will trigger the need for corrective actions or additional mitigations could include; ambient air quality monitoring concentrations with an upward trend, and/or air quality issues or concerns raised by on-site staff, regulators or the public. Where necessary improvements will be implemented through adaptive management to minimize air emissions and maintain ambient air quality. Changes to the air quality mitigations and management measures may be necessary to respond to technological advances and/or regulatory changes.

The summary of the residual effects for a change in ground-level CAC concentrations is summarized in Table 10.1-10. British Columbia has some of the most stringent regulatory criteria for $PM_{2.5}$ in the world. The BC regulatory criteria for annual average $PM_{2.5}$ (8 $\mu g/m^3$) is more stringent (i.e., lower) than the corresponding regulatory criteria established by the US EPA, WHO, and EU (US EPA 2012; WHO 2005; EC 2000). The BC regulatory criteria for 24-hour average $PM_{2.5}$ (25 $\mu g/m^3$) is more stringent (i.e., lower) than the corresponding regulatory criteria from the US EPA (35 $\mu g/m^3$; US EPA 2012).

The area covered by the predicted 24-hour $PM_{2.5}$ exceedances (outside of the Plant Boundary) for the Application Case – Operation scenario is 1,274 ha. The areas covered by the predicted exceedances are over north Kamloops, downtown Kamloops, and the northeast Plant Boundary. The predicted exceedance area northeast of the Plant Boundary is primarily undeveloped grassland and the primary contributor is the Project. The primary contributor to the predicted exceedance over the city of Kamloops is the Base Case (i.e., existing sources), not the Project. At the City Development Boundary the Project's contribution to the annual average $PM_{2.5}$ concentration is 23.5% (1.3 $\mu g/m^3$)

and there is no exceedance of applicable regulatory criteria (8 µg/m^3). The city of Kamloops is relatively unaffected by the Project. In the built-up urban area the predicted annual average $PM_{2.5}$ concentration is 6.4 µg/m^3 and the Project only contributes 0.15 µg/m^3 to this region. This represents a 2.3% increase in annual average $PM_{2.5}$ concentration attributable to the Project. This is insubstantial give the long-term year to year variability in annual average $PM_{2.5}$ (± 0.92 µg/m^3) concentrations.

The primary contributor to the maximum predicted dustfall rate over Downtown Kamloops for the Application Case – Operation scenario is the Base Case (i.e., existing sources). The maximum predicted dustfall rate at the Plant Boundary (1.2 mg/dm^2/day) is below the applicable regulatory criteria (1.7 mg/dm^2/day).

10.1.5.2 Criteria for Characterization of Air Quality Residual Effects

Table 10.1-11 summarizes the definitions of quantitative measures or qualitative categories for the characterization of residual effects on air quality.

10.1.5.3 Characterization of Air Quality Residual Effects

Table 10.1-12 summarizes the characterization of residual effects, significance, likelihood and confidence for air quality. The characterization of residual effects for a change in the concentration for the CACs during Construction and Operation are identical.

The magnitude of the air quality residual effect is medium because, although some of the ambient air quality objectives are predicted to be exceeded, the Project itself does not singly or in substantial combination with other sources cause exceedances of the objectives in populated areas beyond the Plant Boundary. Considering the conservative nature of the dispersion assessment, concentrations in excess of the applicable regulatory criteria attributable to the Project Operation will likely be limited to the northeast Plant Boundary, nearby undeveloped grasslands, and to a lesser extent in upper Aberdeen. The remainder of the City is largely unaffected by Project Operation.

The duration of the air quality residual effect is long-term because there will be air emissions from the Project activities causing a change in the ground-level CAC concentrations for between 2 years and the expected life of the Project. The frequency for the air quality residual effect is regular because the air emissions from the Project activities occur at regular intervals. The geographic extent for the air quality residual effect is regional because the predicted change for the ground-level CAC concentrations remains within the boundaries of the RSA. The reversibility of the air quality residual effect is reversible short-term because the ground-level CAC concentrations will recover immediately after Project closure and reclamation. The resiliency for the air quality residual effect is high because ambient air has a high capacity to recover from a perturbation, with consideration of the baseline level of disturbance. The context for the air quality residual effect is neutral because the change in ground level CAC concentrations occurs in a stable ecosystem or a moderately disturbed environment. The ambient air quality in the RSA is already affected by the existing air emissions and the global /regional background.

Table 10.1-10. Summary of Residual Effects on Air Quality

Potential Effect	Project Phase (timing of effect)	Project Component/Physical Activity	Description of Cause-Effect[1]	Description of Mitigation Measure(s)	Description of Residual Effect
Change in CAC concentrations (TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO)	Construction	Clearing and grubbing; earthworks; overburden/topsoil stockpile; laydown area and storage yards; access road realignment use and maintenance; site road construction use and maintenance; haul road overpass construction use and maintenance; site buildings and process plant; explosives magazine and storage facilities; open pit development; drilling and blasting; crushing mine rock; loading hauling, and deposition of mine rock; temporary ore stockpile; TSF development; haul road overpass.	Project Construction emissions increase the CAC concentrations (TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO) and dustfall in the LSA	Minimize material drop heights, watering road surfaces prone to generating fugitive dust, proper road maintenance, if necessary implement wheel cleaning to prevent "track-out", minimize area of exposed rock and soil, reduce vehicle idling and rapid starts and stops, use multi-passenger vehicles to transport crews, operate vehicles within posted maximum speed limits, maintain vehicles in good operating condition.	Increase in ground level concentration for CACs (TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO) and dustfall in the LSA[2]
Change in CAC (TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO) concentrations	Operation	Open pit development; drilling and blasting; hauling mine rock and ore from pit; crushing and conveying ore; temporary ore stockpile; development of MRSF; stripping, loading, hauling, deposition, and contouring of topsoil and overburden; process plant operation; site road use and maintenance; concentrate transport and storage.	Project Operation emissions increase the CAC concentrations (TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO) and dustfall in the LSA	In addition to those listed above – arch cover over conveyor from crusher to plant, cover over the coarse ore and fine ore stockpiles, partially enclose the primary crusher, use covered and well-sealed concentrate transport trucks, use large trucks for ore and mine rock transport to minimize the number of trips, water haul road surfaces to maintain the optimum 4% moisture ratio for dust control, select best achievable technology for the mine fleet, adhere to all permits, authorizations and approvals related to air quality.	Increase in ground level concentrations for CACs (TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO) increase in dustfall in the LSA[3]

[1] *"Cause-effect" refers to the relationship between the Project component/physical activity that is causing the change or effect in the condition of the VC.*
[2] *The predicted increase in ground-level concentrations for Construction are summarized in Tables 10.1-8.*
[3] *The predicted increase in ground-level concentrations for Operation are summarized in Tables 10.1-7 and 10.1-9.*

Table 10.1-11. Criteria for Characterization of Air Quality Residual Effects

Magnitude	Duration	Frequency	Geographic Extent	Reversibility	Resiliency	Context	Significance of Adverse Residual Effects	Likelihood of Effects	
								Probability	Confidence Level
The expected size or severity of effect. Low-magnitude effects may have negligible to little effect, while high-magnitude effects may have a substantial effect.	*The length of time the residual effect persists. The duration of an effect can be short term or longer term.*	*How often the effect occurs. The frequency of an effect can be frequent or infrequent. Short-term and/or infrequent effects may have a lower effect than long-term and/or frequent effects.*	*The spatial scale over which the residual effects of the Project are expected to occur. The geographic extent of effects can be local or regional. Local effects may have a lower effect than regional effects.*	*Whether or not the residual and/or cumulative effect on the VC can be reversed once the physical work or activity causing the disturbance ceases. Effects can be reversible or permanent. Reversible effects may have a lower effect than irreversible or permanent effects.*	*Whether or not the atmospheric environment is considered to have low, moderately, or high resilience to imposed stresses depending on the existing environment and the distance between the emission sources and the receptors*	*Refers primarily to the sensitivity of the VC. Consideration of context draws heavily on the description of existing conditions of the VC, which reflect cumulative effects of other projects and activities that have been carried out, and information about the impact of natural and human-caused trends on the condition of the VC. Project effects may have a higher effect if they occur in areas or regions that have already been adversely affected by human activities (i.e., disturbed or undisturbed)*	*Effects on air quality are determined using both dispersion modelling and professional judgment.*	*Whether or not a residual and/or cumulative effect is likely to occur*	*Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation, and assumptions made*
Negligible: no measurable change	**Short-term:** effects are measurable for less than 1 month.	**Once:** occurs once	**Local:** effects are restricted to the Project footprint	**Reversible Short-term:** recovery occurs immediately after Project closure and reclamation	**Low:** low capacity for the VC to recover from a perturbation, with consideration of the baseline level of disturbance	**Low:** occurs in a fragile ecosystem and/or highly disturbed environment	**Not Significant (minor):** an effect is considered not significant if ambient concentrations of air contaminants are predicted to be of low to moderate magnitude throughout the LSA	**Low:** low likelihood that there will be a residual effect.	**Low:** low level of confidence
Minor: within normal variability of baseline conditions	**Medium-term:** effects are measurable for greater than 1 month but less than 2 years	**Sporadic:** occurs at multiple irregular intervals (no set schedule)	**Landscape:** effects extend into the LSA	**Reversible Long-term:** recovery occurs long after Project closure and reclamation	**Neutral:** neutral capacity for the VC to recover from a perturbation, with consideration of the baseline level of disturbance.	**Neutral:** occurs in a stable ecosystem and/or moderately disturbed environment	**Not Significant (moderate):** an effect is considered not significant if ambient concentrations of air contaminants are predicted to be of low to moderate magnitude throughout the RSA	**Medium:** moderate likelihood that there will be a residual effect.	**Medium:** moderate level of confidence
Medium: increase or decrease with regard to baseline but within regulatory levels and objectives, or if objectives are exceeded, the change does not meet the definition of major magnitude	**Long-term:** effects are measurable for between 2 years and the life of the Project (approximately 25 years)	**Regular:** occurs regularly and at regular intervals	**Regional:** effects extend into the RSA	**Irreversible:** no recovery, effects are permanent	**High:** high capacity for the VC to recover from a perturbation, with consideration of the baseline level of disturbance.	**High:** occurs in viable ecosystem and/or undisturbed environment	**Significant (major):** see definition below	**High:** high likelihood that there will be a residual effect.	**High:** high level of confidence
Major: singly or as a substantial contribution in combination with other sources causing exceedances of objectives beyond the Project boundaries	**Far Future:** effects are measurable for long after the end of life of the Project	**Continuous:** occurs continuously	**Beyond Regional:** effects extend beyond the RSA						

*Definition **of significant:***
An effect is considered significant if ambient concentrations of air contaminants will exceed relevant regulatory criteria (i.e., are high in magnitude) and are of concern relative to the geographic extent of predicted exceedances, their frequency of occurrence, and the presence of potentially susceptible receptors (e.g., human, wildlife, vegetation, soils, or water bodies) that uptake ambient air.
The significance determination is based on a comparison of Project emissions with existing emissions in the LSA. The characteristics of the emission (mass, rate, location, frequency) and the setting into which the emissions are introduced were determined and studied. Where professional judgment alone is insufficient to arrive at a conclusion, a dispersion modelling exercise is undertaken. In all instances, the background levels of the substances of interest are considered.
A predicted concentration that is greater than the applicable AAQO and the interim objectives does not imply that the Project's effect on air quality is significant. Dispersion models often produce results that are highly conservative (see Stantec 2014; Section 8). As such, dispersion models should be used primarily as tools to understand the interaction of the emission sources with meteorology, terrain, and receptors. Professional judgment and the consideration of aspects such as magnitude, geographic extent, frequency, and reversibility are important considerations in determining significance.
Air quality effects that are assessed as significant warrant a comprehensive human health and ecological risk assessment for the affected receptors.

10.1.5.4 Characterization of Air Quality Residual Effects

Table 10.1-12 summarizes the characterization of residual effects, significance, likelihood and confidence for air quality. The characterization of residual effects for a change in the concentration for the CACs during Construction and Operation are identical.

The magnitude of the air quality residual effect is medium because, although some of the ambient air quality objectives are predicted to be exceeded, the Project itself does not singly or in substantial combination with other sources cause exceedances of the objectives in populated areas beyond the Plant Boundary. Considering the conservative nature of the dispersion assessment, concentrations in excess of the applicable regulatory criteria attributable to the Project Operation will likely be limited to the northeast Plant Boundary, nearby undeveloped grasslands, and to a lesser extent in upper Aberdeen. The remainder of the City is largely unaffected by Project Operation.

The duration of the air quality residual effect is long-term because there will be air emissions from the Project activities causing a change in the ground-level CAC concentrations for between 2 years and the expected life of the Project. The frequency for the air quality residual effect is regular because the air emissions from the Project activities occur at regular intervals. The geographic extent for the air quality residual effect is regional because the predicted change for the ground-level CAC concentrations remains within the boundaries of the RSA. The reversibility of the air quality residual effect is reversible short-term because the ground-level CAC concentrations will recover immediately after Project closure and reclamation. The resiliency for the air quality residual effect is high because ambient air has a high capacity to recover from a perturbation, with consideration of the baseline level of disturbance. The context for the air quality residual effect is neutral because the change in ground level CAC concentrations occurs in a stable ecosystem or a moderately disturbed environment. The ambient air quality in the RSA is already affected by the existing air emissions and the global/regional background.

10.1.5.5 Significance of Air Quality Residual Effects

A predicted concentration that is greater than the applicable regulatory criteria does not imply that the Project's effect on air quality is significant. An effect is considered significant if ambient concentrations of air contaminants will exceed relevant regulatory criteria (i.e., are high in magnitude) and are of concern relative to the geographic extent of predicted exceedances, their frequency of occurrence, and the presence of potentially susceptible receptors (e.g., human, wildlife, vegetation, soils, or water bodies) that uptake ambient air.

The significance determination is based on a comparison of Project emissions with existing emissions in the RSA. The characteristics of the emission (mass, rate, location, frequency) and the setting into which the emissions are introduced were determined and studied. The detailed description of the characteristics of the emissions and the background ambient air quality are summarized in Appendix 10.1-A. In Appendix 10.1-A the background ambient air quality is described in Section 2.2 and the characteristics of the Project emissions are described in Section 4.6 and Appendix E Project Case Construction and Operation Emissions Inventory. Where professional judgment alone is insufficient to arrive at a conclusion, a dispersion modelling exercise is undertaken. In all instances, the background levels of the substances of interest are considered.

Table 10.1-12. Characterization of Residual Effects, Significance, Likelihood and Confidence on Air Quality

Residual Effect	Residual Effects Characterization Criteria							Significance of Adverse Residual Effects	Likelihood and Confidence	
	Magnitude	Duration	Frequency	Geographic Extent	Reversibility	Resiliency	Context		Probability	Confidence
Change in CACs	Medium	Long-term	Regular	Regional	Reversible Short-term	High	Neutral	Not Significant (moderate)	High	High

A predicted CAC concentration that is greater than the applicable regulatory criteria does not imply that the Project's effect on air quality is significant. Dispersion models often produce results that are highly conservative (see Section 10.1.4.3 for a discussion of modelling uncertainty). As such, dispersion models should be used primarily as tools to understand the interaction of the emission sources with meteorology, terrain, and receptors. Professional judgment and the consideration of aspects such as magnitude, geographic extent, frequency, and reversibility are important considerations in determining significance. Air quality effects that are assessed as significant warrant a comprehensive human health and ecological risk assessment for the affected receptors.

The predicted change in the ground-level concentrations of CACs due to emissions from the Project Construction and Operation activities is considered not significant (moderate) because the maximum predicted ground-level concentrations for SO_2, NO_2, CO, and dustfall were all below the applicable regulatory criteria for the Application Case at the Plant Boundary. Although there were exceedances for the 24-hour TSP, 24-hour PM_{10}, and 24-hour $PM_{2.5}$ concentrations at the Plant Boundary the area of the exceedances is small and it corresponds to undeveloped grassland (i.e., it is not a populated area). At the City Development Boundary there is no exceedance for the annual $PM_{2.5}$ regulatory criteria (8 $\mu g/m^3$) even though the Project contribution (during Operation) to the annual $PM_{2.5}$ concentrations is 1.3 $\mu g/m^3$ (23.5%). For the built up area in the city of Kamloops the predicted annual average $PM_{2.5}$ concentration is 6.4 $\mu g/m^3$ and the Project only contributes 0.15 $\mu g/m^3$ to this value (2.3%). This is insubstantial give the long-term year to year variability in annual average $PM_{2.5}$ (± 0.92 $\mu g/m^3$).

It is also worth re-iterating that BC has a more stringent (i.e., lower) regulatory criteria for annual average $PM_{2.5}$ concentrations (8 $\mu g/m^3$) than the US EPA (12 $\mu g/m^3$), WHO (10 $\mu g/m^3$) and the EU (20 $\mu g/m^3$).

10.1.5.6 Characterization of Likelihood and Confidence

There is a high probability of the residual air quality effect occurring because of the nature of the mining activities. There is high confidence in the characterization of the residual air quality effects because the air quality assessment was conducted in accordance with the *Guidelines* (BC MOE 2008). The assessment employed a regulator-approved air dispersion model, CALPUFF, to predict the worst-case ground level concentrations from the Project emissions. The methodology for conducting the air quality assessment was summarized in the Detailed Model Plan that was reviewed by BC MOE and approved on February 27, 2015. The approved Detailed Model Plan is included in Appendix 10.1-A, Appendix B.

There are a number of assumptions that were made that resulted in a conservative estimate of the Project emissions for this air quality assessment. The Project model assessment for Operation consisted of aspects from Year 4 and Year 8 because the mine plan indicated that the combination of these two years will experience the greatest amount of machine activity, blasting, earthmoving, and resulting air emissions. In reality, the combination of these aspects will not occur simultaneously but this combination of variables allows for a conservative estimate of the emissions and the resulting predictions for ground-level CAC concentrations.

There are emission sources that were conservatively estimated for the air quality assessment. The access road was assumed to be unpaved for the hourly and daily fugitive dust emissions and no

natural mitigation was applied. The Project design includes a paved access road therefore the fugitive dust emissions were conservatively estimated. It was assumed that there were two open pit blasts per day when in reality there will be an average of one blast per day. If two or three blasts occur in one day, they will be followed by days without blasting. The mobile equipment emissions were conservatively assumed to be equivalent to Tier 3. In Canada compliance with the Tier 3 off-road compression-ignition engine emissions standards was not mandatory until the 2006 model year. The Canadian Tier 4 standards came into force on January 16, 2012 and apply to engines of the 2012 and later model years manufactured on or after January 16, 2012 (Dieselnet 2015). The mining off-road equipment purchased for the Project will most likely be Tier 4 emissions compliant because new mine equipment will be purchased prior to construction commencing after permitting is completed.

10.1.5.7 Summary of Air Quality Residual Effects Assessment and Significance

Table 10.1-13 summarizes the air quality residual effects, mitigation and significance. The change in CAC concentrations is considered not significant (moderate) for Construction and Operation. Although there are predicted exceedances for 24-hour TSP, 24-hour PM_{10}, and 24-hour $PM_{2.5}$ concentrations at the Plant Boundary the area of the exceedances is small and it corresponds to undeveloped grassland (i.e., this is not a populated area). At the Plant Boundary for the Application Case Operation model scenario the frequency of exceedance for 24-hour $PM_{2.5}$ was 0.8% (3 days of the year). In addition, the Project has a very limited effect on the air quality in the built-up urban area of Kamloops. Within that area the Project contributes 0.15 $\mu g/m^3$ (an increase of 2.3%) to the annual average $PM_{2.5}$ concentration (6.4 $\mu g/m^3$). This is insubstantial give the long-term year to year variability in annual average $PM_{2.5}$ ($\pm$ 0.92 $\mu g/m^3$) concentrations.

10.1.6 Cumulative Effects Assessment

10.1.6.1 Introduction

Air emissions from industrial activities, the city of Kamloops, Aboriginal activities, natural resource extraction and land use, tourism and commercial recreation activities, and transportation have the potential to interact with the Project air emissions and cause a cumulative effect for the ground-level concentrations for the CACs.

10.1.6.2 Identification of Other Actions that May Affect Air Quality

Table 10.1-14 summarizes screening of other actions for potential inclusion in the cumulative effects for the air quality assessment.

None of the projects listed in Table 10.1-14 need to be carried further into the cumulative effects assessment because their air quality effects were captured in the Base Case modelling or the global and regional background that were previously considered in the assessment of residual effects.

Table 10.1-13. Summary of Residual Effects, Mitigation, and Significance on Air Quality

Residual Effects	Project Phase	Mitigation Measures	Significance
Change in CAC concentrations	Construction	Minimize material drop heights, watering road surfaces prone to generating fugitive dust, natural mitigation from precipitation, proper road maintenance, if necessary implement wheel cleaning to prevent "track-out", minimize area of exposed rock and soil, reduce vehicle idling and rapid starts and stops, use multi-passenger vehicles to transport crews, operate vehicles within posted maximum speed limits, maintain vehicles in good operating condition,	Not Significant (Moderate)
Change in CAC concentrations	Operation	In addition to those listed above – arch cover over conveyor from crusher to plant, cover over the coarse ore and fine ore stockpiles, partially enclose the primary crusher, use covered and well-sealed concentrate transport trucks, use large trucks for ore and mine rock transport to minimize the number of trips, water haul road surfaces to maintain the optimum 4% moisture ratio for dust control, select best achievable technology for the mine fleet, adhere to all permits, authorizations and approvals related to air quality.	Not Significant (Moderate)

The Base Case model scenario incorporated the effects of air emissions from existing sources in the RSA. The Application Case model scenario (for Construction and Operation) that is the basis for the assessment of residual effects is the sum of the Base Case and Project Case model scenarios. The existing air emission sources that were included in the Base Case modelling scenario related to industrial activities, rail transportation emissions, on-road mobile emissions, heating emissions, paved roads, and disturbed lands. The Base Case model scenario is summarized in Appendix 10.1-A, Section 4.5 and it considered emissions from the following sources:

- New Afton Mine;
- Domtar Kamloops Pulp Mill;
- Tolko-Hefey Creek Plywood and Veneer;
- LaFarge Cement plant;
- city of Kamloops municipal discharge (e.g., local landfills);
- Kamloops Forest District (e.g., Savona Speciality Plywood, Thompson River Veneer Products);
- rail yards and lines (CN and CP);
- Lac Le Jeune road; and
- Coquihalla Highway (Highway 5A).

The global and regional background used for the air quality assessment considered emissions from these sources:

- Highland Valley Copper Mine;
- Vidette Lake Mine (decommissioned);
- agriculture;
- ranching;
- recreational hunting, fishing, foraging;
- Lac Le Jeune Resort;
- Tobiano Golf Course; and
- Kamloops Airport.

The following activities have negligible air emissions and therefore do not warrant further consideration:

- Kinder Morgan Pipeline (would only have air emissions in an accidental release);
- city of Kamloops Domestic Water Supply; and
- Aboriginal land use (including Treaty rights, title, and other land use and resource planning).

Table 10.1-14. Screening of Other Actions for Inclusion in the CEA for Air Quality

Description	Status or Likelihood	Geographic Boundaries (proximity to Project)	Temporal Boundaries	Common Resources and VCs Affected	Include in CEA (Y/N)
Industry					
New Afton Mine	Active	9 km northwest	construction and Operation	Air quality (CACs)	N[a]
Highland Valley Copper Mine	Active	31 km southwest	Construction and Operation	Air quality (CACs)	N[b]
Domtar Kamloops Pulp Mill	Active	9 km north	Construction and Operation	Air quality (CACs)	N[a]
Tolko-Hefey Creek Plywood and Veneer	Active	19 km north	Construction and Operation	Air quality (CACs)	N[a]
LaFarge Cement plant	Active	14 km northeast	Construction and Operation	Air quality (CACs)	N[a]
Kinder Morgan Pipeline	Active	Within Mine Site	Construction and Operation	Air quality (CACs)	N
Vidette Lake Mine	Decommissioned 1939	34 km northwest	Not applicable	Air quality (CACs)	N[b]
City of Kamloops					
Municipal discharge	Active	9 km north	Construction and Operation	Air quality (CACs)	N[a]
Domestic water supply	Active	9 km north	Construction and Operation	Air quality (CACs)	N
City expansion and growth	Active	3-4 km north	Construction and Operation	Air quality (CACs)	N
Aboriginal Activities					
Aboriginal land use (including Treaty rights, title, and other land use and resource planning)	Active	Various locations	Construction and Operation	Air quality (CACs)	N
Natural Resource Extraction and Land Use					
Kamloops Forest District	Active	Within 4 km	Construction and Operation	Air quality (CACs)	N[a]
Agriculture	Active	Immediately adjacent	Construction and Operation	Air quality (CACs)	N[b]
Ranching	Active	Within Mine Site	Construction and Operation	Air quality (CACs)	N[b]
Tourism and Commercial Recreation Activities					
Recreational Hunting, Fishing, Foraging	Active	Immediately adjacent	Construction and Operation	Air quality (CACs)	N[b]
Lac Le Jeune Resort	Active (check)	19 km south	Construction and Operation	Air quality (CACs)	N[b]
Tobiano Golf Course	Active	22 km northwest	Construction and Operation	Air quality (CACs)	N[b]

Description	Status or Likelihood	Geographic Boundaries (proximity to Project)	Temporal Boundaries	Common Resources and VCs Affected	Include in CEA (Y/N)
Transportation					
Kamloops airport	Active	10 km north	Construction and Operation	Air quality (CACs)	N[b]
Rail yards and lines (CP and CN)	Active	9 km north	Construction and Operation	Air quality (CACs)	N[a]
Lac le Jeune Road	Active	3 km west	Construction and Operation	Air quality (CACs)	N[a]
Coquihalla Highway	Active	5 km west	Construction and Operation	Air quality (CACs)	N[a]

Notes:

[a] *Emissions from this source are incorporated into the Base Case model scenario that is used to determine residual Project air quality effects and their significance.*

[b] *Emissions from this source are incorporated into the global and regional background that is used to determine residual Project air quality effects and their significance.*

The air emissions from reasonably foreseeable projects and activities (e.g., city of Kamloops expansion and growth) have not been quantified because these projects have not developed a sufficiently detailed project description and have not entered into a formal project approval or permitting process.

A review was conducted to determine if there are any approved, announced, or foreseeable future projects outside the RSA that would have the potential to interact with the Project in a cumulative manner. The projects outside the RSA that were considered included the Vidette Lake Mine, Bonaparte Mine, proposed expansion at the Highland Valley Copper Mine and the Harper Creek Mine. All of these proposed projects on the project inclusion list are well outside of the RSA. These proposed projects have been deemed through application of professional judgement to be incapable of resulting in a potentially deleterious air quality effect in the RSA or LSA in combination with the Project. They were discounted based upon the quantities emitted (whether large or small) and previous experience with similar projects. Similarly the proposed expansion at the Tobiano Golf Course, located approximately 22 km north of the Project, is incapable of resulting in a potentially deleterious air quality effect in the RSA or LSA in combination with the Project. Based on professional judgement the 22 km distance between the Project and the Tobiano Golf Course will not result in any substantial cumulative interactions for the two plumes.

The effect on air quality of wildfires, be they distant or local, is implicitly accounted for through the addition of the global/regional background. The short-term effect of rare circumstances such as a large forest fire in the RSA was not modelled as part of the Base Case. Nor were accidents or malfunctions such as an industrial or transportation incident (e.g., fire, explosion), structural fires, or events cause by severe weather such as an intense wind storm. Such phenomenon, while well within the capability of the CALPUFF model to simulate, are random and rare events. Their effects are well understood through other means (measurement), and only increase the Base Case contribution. The Projects effects remain constant, leading to the conclusion that the Projects proportion of the total effect actually decreases relative to the existing air quality.

10.1.6.3 Interactions between Residual Project Effects and Other Project or Activity Effects

None of the projects listed in Table 10.1-14 are carried forward in the air quality cumulative effects assessment. The potential cumulative air quality effects from past, present and reasonably foreseeable future projects within the RSA were considered in the Base Case model scenario or the global and regional background air quality values that were incorporated into the Application Case model scenario for the assessment of residual air quality effects. A review of reasonably foreseeable projects outside the RSA was conducted and concluded that there would be no cumulative effects with the Project. The reasonably foreseeable projects outside the RSA were discounted based on the professional judgement of the quantities emitted (whether large or small) and previous experience with similar projects.

10.1.6.4 Proposed Air Quality Mitigation Measures

The air quality mitigation measures presented in Section 10.1.4.3 are applicable and relevant for reducing the potential cumulative effects for a change in the ground-level CAC concentrations. No additional mitigation measures are suggested.

10.1.6.5 Evaluation of Significance of Air Quality Residual Cumulative Effects

The cumulative air quality effects assessment for future projects was completed and it was determined that there was no Project interactions with approved, announced or foreseeable future projects. The assessed residual cumulative effect on the CAC concentrations for the Construction phase and Operation phase was considered not significant.

10.1.7 Conclusion

Air quality has intrinsic value in terms of human health, wildlife, vegetation, odour, and visibility. Air quality was identified as a VC in this assessment. The assessment of the change in ground-level CAC concentrations required:

- a definition of the current global and regional baseline air quality conditions (to account for all emission sources outside the air dispersion RSA);
- selection of Base Case, Project Case (Construction and Operation) and Application Case (Construction and Operation) modelling scenarios;
- the Application Case model scenario is the sum of the Base Case and Project Case;
- calculation of air emissions inventories for the three modelling scenarios;
- dispersion modelling of the various sources for the three modelling scenarios incorporating the terrain and three years of meteorology;
- comparison of the dispersion modelling results for ground-level CAC concentrations to the applicable regulatory criteria; and
- a determination of the significance of the Project related residual and cumulative effects for ground-level CAC concentrations.

Table 10.1-15 summarizes the Project and Cumulative residual effects, mitigation, and significance assessment for a change in CAC concentrations during Construction and Operation.

The change in CAC concentrations due to Project Construction and Operation emissions were evaluated after mitigation measures were incorporated. The assessed effect on the CAC concentrations for the Construction phase and Operation phase was considered not significant (moderate).

The cumulative air quality effects assessment for future projects was completed and it was determined that there was no Project interactions with approved, announced or foreseeable future projects. The assessed residual cumulative effect on the CAC concentrations for the Construction phase and Operation phase was considered not significant.

Table 10.1-15. Summary of Project and Cumulative Residual Effects, Mitigation, and Significance for Air Quality

Residual Effects	Project Phase	Mitigation Measures	Residual Effect Significance	Residual Cumulative Effect Significance
Change in CAC concentrations	Construction	Minimize material drop heights, watering road surfaces prone to generating fugitive dust, natural mitigation from precipitation, proper road maintenance, if necessary implement wheel cleaning to prevent "track-out", minimize area of exposed rock and soil, reduce vehicle idling and rapid starts and stops, use multi-passenger vehicles to transport crews, operate vehicles within posted maximum speed limits, maintain vehicles in good operating condition,	Not Significant (moderate)	Not Significant (moderate)
Change in CAC concentrations	Operation	In addition to those listed above – arch cover over conveyor from crusher to plant, cover over the coarse ore and fine ore stockpiles, partially enclose the primary crusher, use covered and well-sealed concentrate transport trucks, use large trucks for ore and mine rock transport to minimize the number of trips, water haul road surfaces to maintain the optimum 4% moisture ratio for dust control, select best achievable technology for the mine fleet, adhere to all permits, authorizations and approvals related to air quality.	Not Significant (moderate)	Not Significant (moderate)

10.2 DOMESTIC WATER QUALITY

10.2.1 Rationale

Domestic water quality is a valued component (VC) because it is a key resource for human life. Project activities may influence trace metal, nitrate and anion concentrations in domestic water through atmospheric emissions and seepages. Domestic water refers to public (municipal) and private (onsite wells, and surface water) waters used for human domestic purposes (e.g., drinking water and other domestic uses), agriculture (i.e., irrigation and livestock) and recreational purposes. The provincial and federal governments have established water quality guidelines to protect water resources used for these purposes.

In the local study area (LSA) for the Project, domestic water refers to municipally-sourced water from the City of Kamloops, groundwater from domestic drinking wells in the Peterson Creek aquifer in Knutsford and surface water from Peterson Creek. Domestic water does not refer to surface water (i.e. lake and river water) that may be consumed on an occasional basis by people engaged in traditional or recreational activities within the LSA, and groundwater that is not consumed by people. The assessment of water resources for general use has been considered in the assessment of surface water quality (Section 6.3) and groundwater quality (Section 6.5).

Domestic water quality may be influenced by human activities such as sewage discharge, garbage, accidental chemical releases (e.g., fuel spills), and commercial and industrial activities (i.e. forestry, agriculture, mining, construction, and transportation). Domestic water quality may also fluctuate as a result of naturally occurring climate and weather conditions and seasonal effects such as spring freshet. The quality of domestic water contributes to the population's exposure to chemicals in the environment, which influences the health risk to people. The human health effects assessment (Section 10.4) quantifies the health risk to people in the LSA from multiple exposure pathways (e.g., inhalation, ingestion of country foods, and consumption of domestic drinking water). The domestic water quality effects assessment provides a summary of the predicted change in domestic water quality and it is a supporting component of the human health effects assessment. The domestic water quality effects assessment provides a summary of the predicted change in water quality as it relates to domestic and agricultural use. The determination of significance is made in the human health effects assessment (Section 10.4), which incorporates the changes to domestic water quality in the assessment.

10.2.2 Background

10.2.2.1 Regional Overview

The City of Kamloops has an approximate population of 85,000 people and it is located adjacent and northeast of the Project tenure area. The regional topography consists of mountains and valleys, and the area is arid or semi-arid, characterized by low annual precipitation and high evaporation. The Kamloops Indian Reserve is located on the outskirts of the city to the northeast.

The South Thompson River, which runs through Kamloops, is the primary source of municipal drinking water. The water quality of the South Thompson River is influenced by human activities (e.g., construction and road sedimentation), natural geological events (e.g., landslides, erosion) and

local climate conditions (e.g., heavy rains or spring freshet), leading to high variability in water turbidity and suspended solids throughout the year (City of Kamloops 2012). Municipal water is piped to all urbanized communities in Kamloops for drinking and irrigation use, although some people along the outskirts of Kamloops may draw groundwater from private wells, or surface water from Peterson Creek to supply their livestock.

10.2.2.2 Historical Activities

Surface and Municipal Water

Domestic water in this region has historically been sourced from the South Thompson River, which provided drinking water to local Aboriginal groups and early settlers. As human activities increased with the increasing population in Kamloops, the city began treating raw water from the South Thompson River with chlorine in the early 1940's, in accordance with the BC Drinking Water Protection Act to supply residents with potable water (BC Laws 2015). Chlorination reduces the risk of water-borne pathogens such as Giardia and Cryptosporidium, but does not remove suspended solids, dissolved salts, or trace metals. Some suspended solids were partially removed with a 3 mm screen at the South Thompson River intake, but boil-water advisories were occasionally announced to the public during periods of high seasonal increases in suspended solids corresponding to spring freshet from the melting of mountain snowpack.

In 2005, Kamloops implemented a new membrane filtration treatment at its water treatment centre. The new process improved municipal water quality by reducing levels of turbidity, water-borne microorganisms, total organic carbon and colour. The new water treatment centre virtually eliminates the potential for boil-water advisories for municipally-sourced tap water, which is piped throughout the City of Kamloops.

Drinking water at the Kamloops Indian Reserve is also drawn from the South Thompson River and is treated at the Tk'emlúps Indian Band Water Treatment Plant since 1999. The process begins with sedimentation to remove suspended solids which is followed by a clarification process using an anthracite and sand filtration process and a chlorination process for disinfection. The finished water is piped throughout the community.

Kamloops Indian Reserve #2, a 6 hectare site at the outlet of Trapp Lake, and Kamloops Indian Reserve #3, a 3 hectare site on the western shore of Trapp Lake, are located in the south east corner of the LSA. These locations lie outside the Peterson Creek Watershed and the Peterson Creek Aquifer and therefore the drinking water sources for these areas would not be affected by surface water or groundwater from Project operations.

Knutsford Groundwater and Surface Water

The British Columbia Water Resources Atlas database documents 125 groundwater wells in the Knutsford community. Among these wells, 84 are registered for private domestic use and only one is registered as currently active. There are also 10 domestic water use licences for drawing surface water from Peterson Creek.

The assessment assumes that Knutsford residents drink both surface water from Peterson Creek and groundwater from private domestic wells even though municipal water is piped into the Knutsford

community and is available to all residents. These waters are also assumed to be used for irrigational and livestock application.

10.2.2.3 Baseline Data

Baseline domestic water quality is represented by the quality of water regularly used by the people in Kamloops within the LSA. For municipally-sourced water, this includes water drawn from the South Thompson River after it has been treated at the Kamloops Water Treatment Centre. Raw untreated water from the South Thompson River may not represent the quality of water that people in the City of Kamloops regularly consume. Raw water from the Thompson River may have high seasonal turbidity from silt and suspended solids during spring freshet and periods of high flow. It may also contain Giardia and Cryptosporidium which can cause water-borne illnesses, making it unsuitable for human consumption.

The baseline quality of untreated surface and groundwater in Knutsford is based on surface water samples from Peterson Creek and well samples collected in within the Peterson Creek aquifer, which are within the LSA for the Project. Knutsford was selected to represent the potential changes to surface and groundwater quality because it is the nearest populated area to the Project, and would experience the greatest potential change to surface and groundwater quality used for domestic purposes. There are also registered groundwater wells in this area which may be used by residents for livestock water or drinking water.

Table 10.2-1 presents the measured chemical concentrations in water samples from the Kamloops Water Treatment Centre, surface water from Peterson Creek and groundwater from the Peterson Creek aquifer in Knutsford. Water quality from the Kamloops Water Treatment Centre is based on post-treatment processing at the facility, noting that water quality at the tap in residential households may differ depending on water transport conditions (e.g., residential pipe material, pipe corrosion). Surface and groundwater quality in Knutsford was based on the lowest measured concentrations between the two water sources, which were from groundwater samples at well site RES-2 (Figure 10.2-1). The approach of using the lowest measured baseline concentration is conservative because it is compared to the maximum predicted concentration for the Project. This comparison will result in the highest predicted change in water quality between the current baseline conditions and future predicted conditions to avoid underestimating the potential change in water quality.

Table 10.2-1. Baseline Concentration of Chemicals in Municipal Water and Knutsford Surface and Groundwater

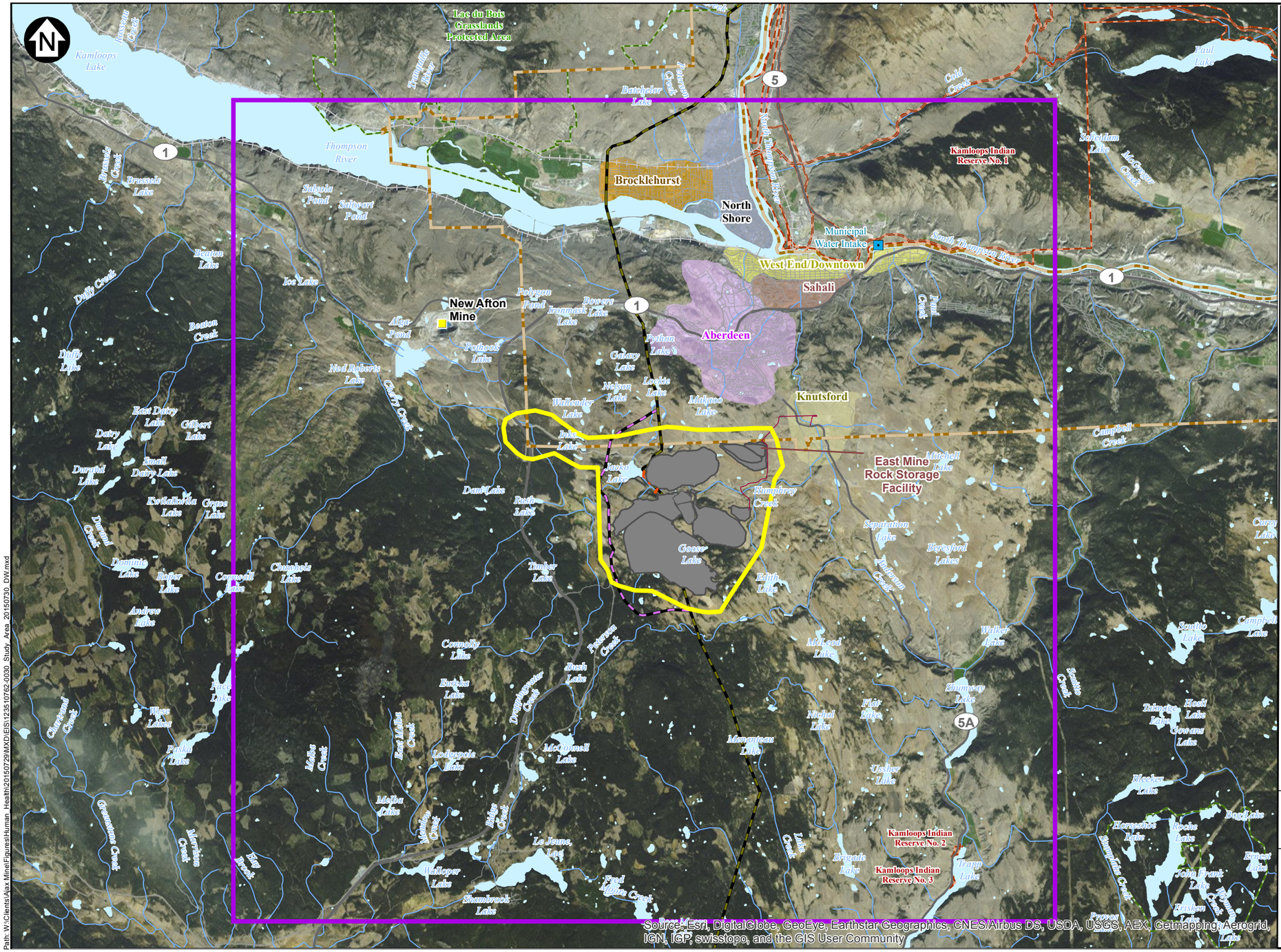
Parameter	Canadian Drinking Water Quality Guideline (mg/L)	Water Quality Guidelines for the Protection of Agriculture (mg/L)		Concentration in Municipal Water (mg/L)	Concentration in Knutsford Surface and Groundwater (mg/L)
		Irrigation	Livestock	Baseline Case	Baseline Case
Metal					
Aluminum	1.00×10^{-1} (Operational)	5.00×10^{0}	5.00×10^{0}	8.00×10^{-3}	3.00×10^{-3}
Arsenic	1.00×10^{-2}	1.00×10^{-1}	2.50×10^{-2}	5.00×10^{-4}	9.30×10^{-4}
Barium	1.00×10^{0}	None	None	1.00×10^{-2}	2.94×10^{-2}

Parameter	Canadian Drinking Water Quality Guideline (mg/L)	Water Quality Guidelines for the Protection of Agriculture (mg/L)		Concentration in Municipal Water (mg/L)	Concentration in Knutsford Surface and Groundwater (mg/L)
		Irrigation	Livestock	Baseline Case	Baseline Case
Beryllium	None	1.00×10^{-1}	1.00×10^{-1}	1.00×10^{-4}	1.00×10^{-4}
Boron	5.00×10^{0}	Variable	5.00×10^{0}	1.10×10^{-2}	4.00×10^{-2}
Cadmium	5.00×10^{-3}	5.10×10^{-3}	8.00×10^{-2}	1.00×10^{-5}	1.00×10^{-5}
Chromium	5.00×10^{-2}	8.00×10^{-3}	5.00×10^{-2}	5.00×10^{-4}	1.10×10^{-4}
Cobalt	None	5.00×10^{-2}	1.00×10^{0}	5.00×10^{-5}	1.20×10^{-4}
Copper	1.00×10^{0} (Aesthetic)	Variable	Variable	3.43×10^{-1}	3.29×10^{-3}
Iron	3.00×10^{-1} (Aesthetic)	5.00×10^{0}	None	2.00×10^{-2}	$\underline{1.08 \times 10^{-1}}$
Lead	1.00×10^{-2}	2.00×10^{-1}	1.00×10^{-1}	3.00×10^{-4}	5.36×10^{-5}
Lithium	None	2.50×10^{0}	None	9.00×10^{-4}	7.70×10^{-3}
Manganese	5.00×10^{-2} (Aesthetic)	2.00×10^{-1}	None	1.30×10^{-3}	3.70×10^{-2}
Mercury	1.00×10^{-3}	None	3.00×10^{-3}	2.00×10^{-5}	1.00×10^{-5}
Molybdenum	None	Narrative	5.00×10^{-1}	7.00×10^{-4}	1.56×10^{-2}
Nickel	None	2.00×10^{-1}	1.00×10^{0}	4.00×10^{-4}	1.91×10^{-3}
Selenium	5.00×10^{-2}	Variable	5.00×10^{-2}	5.00×10^{-4}	1.10×10^{-4}
Uranium	2.00×10^{-2}	1.00×10^{-2}	2.00×10^{-1}	7.00×10^{-5}	1.36×10^{-3}
Vanadium	None	1.00×10^{-1}	1.00×10^{-1}	2.00×10^{-3}	1.8×10^{-3}
Zinc	5.00×10^{0} (Aesthetic)	Equation	5.00×10^{1}	5.00×10^{-3}	3.00×10^{-3}
Anions and Nitrate					
Chloride	2.50×10^{2} (Aesthetic)	Variable	None	2.95×10^{0}	1.40×10^{1}
Fluoride	1.50×10^{0}	1.00×10^{0}	Variable	$\mathbf{\underline{1.00 \times 10^{1}}}$	2.54×10^{-1}
Nitrite (as N)	3.00×10^{0}	None	1.00×10^{1}	1.00×10^{-2}	1.00×10^{-2}
Sulphate	5.00×10^{2} (Aesthetic)	None	1.00×10^{3}	7.50×10^{0}	1.53×10^{2}

Underlined = above drinking water quality guidelines.
***Bold** = above agricultural use guidelines.*
Operational guideline applies to treatment plants using aluminum-based coagulants. Does not apply to naturally occurring aluminum found in groundwater.
Aesthetic guidelines for copper, iron and manganese based on taste and staining of laundry and plumbing fixtures.
Aesthetic guidelines for zinc and sulphate based on taste.
Aesthetic guideline for chloride based on taste and potential for corrosion in the distribution system.

Figure 10.2-1
Domestic Water Quality Local and Regional Study Area

Stantec



Domestic Water Quality LSA and RSA
Plant Boundary

Proposed Structure
Project Footprint

Base Data
New Afton Mine
Municipal Water Intake
Highway
Paved Road
Railway
Natural Gas Line (approx. location)
Kinder Morgan Pipeline - Current
Kinder Morgan Pipeline - Rerouted
City of Kamloops Boundary

Communities
Aberdeeen
Brocklehurst
Sahali
Knutsford
West End/Downtown
North Shore
First Nation Reservation
Provincial Park/Reserve
Waterbody

NOTES:
1. BASE MAP: GOVERNMENT OF BRITISH COLUMBIA; ESRI World Imagery
2. COORDINATE GRID IS IN METRES.
   COORDINATE SYSTEM: NAD83 UTM, ZONE 10 NORTH, METER.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:150,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
4. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - BRITISH COLUMBIA AND CANADA

SCALE 0 1.5 3 4.5 Kilometres

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KGHM Ajax Mining Inc.

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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The parameters selected for the assessment of domestic water quality include those chemicals that may be influenced by project activities and which have provincial or federal water quality guidelines for human drinking water or agricultural use. These primarily include trace metals, anions and nitrate. Other water quality parameters (e.g., pH, total suspended solids, salinity) do not cause toxicological effects and therefore are not included in the assessment of domestic water quality; however, these parameters have been assessed as part of the surface water quality effects assessment (Section 6.3). Water quality guidelines for recreational use were considered, but not applied because these guidelines typically apply to microbiological parameters (i.e., bacteria, viruses, protozoans) often associated with nutrient loading from agricultural runoff, fertilizer use or sewage waste water, which are not influenced by the Project. The water quality guidelines for recreational use are included in the surface water quality effects assessment for the local assessment area for that VC, which extends beyond the spatial extent of the domestic water quality effects assessment.

The baseline data in Table 10.2-1 indicates that post-treated municipal water quality is below all health, operational and aesthetic based guidelines with the exception of fluoride.

Baseline surface and groundwater data from the Knutsford area indicates that the water quality is below the health-based drinking water guidelines for trace metals, anions and nitrate parameters. Concentrations of iron were marginally above the aesthetic guidelines, which are based on taste and the potential for water to stain laundry and plumbing fixtures. Groundwater from Knutsford may have an unfavorable taste due to natural levels of iron, and may stain laundry and plumbing fixtures. The minimum concentration of sulphate is below the applicable guidelines, however, the surface and groundwater effects assessment indicates that naturally occurring sulphate concentrations are usually greater than the drinking water quality guideline (500 mg/L) and the agricultural use guideline for livestock water (1,000 mg/L) during periods of low flow due to naturally high concentrations in the groundwater. This may further influence the taste of water and influence the productivity of livestock at certain times of the year.

Freshwater will be pumped from Kamloops Lake to supply the explosives facility, primary crusher, truck shop, plant site and other buildings and facilities as required. A portion of the freshwater delivered from Kamloops Lake will be treated for potable use during all project phases and stored in potable water storage tanks at the plant and truck shop prior to delivery to various service points. Treatment will consist of pre-packaged conventional potable water treatment plants. Treatment plants will be designed to meet or exceed Guidelines for Canadian Drinking Water Quality – Summary Table (2014) and will be compliant with the B.C. Water Protection Act and Regulations as well as other applicable codes and standards such as the BC Building Code, American Water Works Association (AWWA), National Sanitation Foundation International (NSF International) and American National Standards Institute (ANSI).

10.2.3 Assessment Boundaries

Assessment boundaries define the limits within which the effects assessment is conducted. They include the areas (spatial boundaries) and the time periods (temporal boundaries) that the Project is predicted to interact with the VC. Administrative boundaries define the political, social and economic limitations, while technical boundaries define the scientific or regulatory limitations in predicting or measuring changes to the VC.

10.2.3.1 Spatial Boundaries

Local Study Area

The LSA for the assessment of domestic water quality includes portions of the LSA described in the surface water quality and groundwater quality effects assessment where local people regularly access these waters. For surface water from the South Thompson River used for municipal water, the LSA encompasses the City of Kamloops and the Kamloops Indian Reserve (Figure 10.2-1). For surface water from Peterson Creek and groundwater from the Peterson Creek aquifer, the LSA encompasses the southern area of Kamloops where the community of Knutsford is the closest to the Project. The Knutsford area is the most likely populated area to experience potential changes in surface and groundwater quality. The potential changes would also be the highest in Knutsford relative to other populated areas in Kamloops which are more distal to the Project. Therefore, groundwater from Knutsford is applied as a surrogate for other populated areas in the LSA.

Surface and groundwater quality from areas where water is not regularly accessed by people for domestic purposes (e.g. unpopulated rural areas, or areas with no groundwater wells) is characterized in the surface water quality and groundwater quality effects assessment.

Regional Study Area

The regional study area (RSA) for the assessment of domestic water quality is the same as the LSA. The study areas are identical because potential changes to domestic water quality is limited to areas where people regularly access water sourced from the City of Kamloops, Peterson Creek or private domestic wells within the Peterson Creek aquifer (i.e., Knutsford).

10.2.3.2 Temporal Boundaries

The temporal boundaries for the lifespan of the Project includes four phases, as listed below:

- **Construction**: 2 years;
- **Operation**: 23 years;
- **Decommissioning and Closure**: 2 years (includes project decommissioning, abandonment and reclamation activities, as well as temporary closure, and care and maintenance); and
- **Post Closure**: 5+ years (includes ongoing reclamation activities and post closure monitoring).

The domestic water quality effects assessment evaluates the worst case phase of the Project from operation through to the post closure phase. The worst case domestic water quality is represented by the post closure phase, which includes the combined potential changes in domestic water that may result from activities at the mine from the operation phase through to the post closure phase. These activities include atmospheric, seepage and effluent emissions during the operation phase, and seepage emissions during decommissioning and closure, and post closure phases.

The assessment of domestic water quality does not include the construction phase, which is consistent with the surface water quality and the groundwater quality effects assessment. The

influence of the construction phase on water quality is minor compared to the other phases. Major influences to water quality such as mine seepage do not occur during the construction phase.

10.2.3.3 Administrative Boundaries

There are no administrative boundaries for the domestic water quality effects assessment.

10.2.3.4 Technical Boundaries

Technical boundaries are the scientific limitations of the assessment of domestic water quality. The results of the domestic water quality effects assessment are used in the human health effects assessment (Section 10.4). Although domestic water quality may be assessed for potential changes and compared to the drinking water quality guidelines, it does not independently inform on the potential for human health risks. The consumption of drinking water is only one contributing factor in the human health effects assessment because people may be exposed to chemicals from other sources such as the consumption of country foods (e.g., wild meat, vegetation, fish, and domestic cattle). Therefore, the domestic water quality effects assessment will only describe the potential change to water quality. The human health effects assessment will evaluate the additive human health risk of a chemical from multiple exposure pathways, including the contribution from drinking water.

Some drinking water guidelines are operational or aesthetic guidelines which do not influence human health. For example, the drinking water guideline for aluminum is an operational guideline which is applicable to water treatment plants that add aluminum as a flocculant, and is not applicable to naturally occurring aluminum in groundwater. Aesthetic guidelines are typically based on taste, or the potential for the water to stain laundry and pipe fixtures. Operational and aesthetic guidelines are not based on potential health effects and do not suggest a potential health risk if exceeded.

10.2.4 Potential Effects of the Project and Proposed Mitigation for Domestic Water Quality

10.2.4.1 Identifying Potential Effects to Domestic Water Quality

Project activities and physical works may have the potential to change domestic water quality. The interaction pathways where Project activities could influence domestic water quality include:

- dust containing trace metals depositing into the South Thompson River used for municipal water.
- seepage of water containing metals into surface water and groundwater in the Peterson Creek watershed.

These interaction pathways may influence trace metal, anion and nitrate concentrations in domestic waters. The potential effects to domestic water quality are based on the results from the surface water quality and groundwater quality effects assessment for the post closure phase. This includes all Project-related effects (e.g., dust deposition, seepage) from the operation phase through to post closure phase and the combined effect from these phases is collectively referred to as the Future Case conditions at post closure. Table 10.2-2 presents the interactions matrix defining the potential for project activities to influence domestic water quality.

Table 10.2-2. Identifying Potential Project Interactions and Effects on Domestic Water Quality

	Project Component/Physical Activity	Potential Effects on Domestic Water Quality	
		Municipal Water	Knutsford Surface and Groundwater
Construction	Clearing and Grubbing	O	O
	Earthworks	O	O
	Overburden/Topsoil Stockpile	O	O
	Laydown Areas and Storage Yards	O	O
	Project Lighting	O	O
	Site Security and Fencing	O	O
	Fuel Storage and Filling Area	O	O
	Hazardous Wastes Transport, Storage, and Disposal	O	O
	Construction Wastes Transport, Storage, and Disposal	O	O
	Sewage Infrastructure and Disposal	O	O
	Public Road Realignment, Use, and Maintenance	O	O
	Site Road Construction, Use and Maintenance	O	O
	Peterson Creek Bridge Construction, Use, and Maintenance	O	O
	Site Buildings and Process Plant	O	O
	Explosives Magazine and Storage Facilities	O	O
	Open Pit Development	O	O
	Drilling and Blasting	O	O
	Crushing Waste Rock	O	O
	Loading, Hauling, and Deposition of Waste Rock	O	O
	Temporary Ore Stockpile	O	L
	Tailing Storage Facility Development	O	L
	Power Transmission, Distribution	O	O
	Natural Gas Line	O	O
	Pipeline Utility Corridor (Potable Water, Sewage, and Site Water)	O	O
	Water Intake from Kamloops Lake	O	O
	Fire Suppression Infrastructure	O	O
	Contact Water	O	L
	Non-contact Water	O	O
	Peterson Creek Diversion	O	O
	Water Management Dams	O	O
	Mine Staffing (Direct Employment)	O	O
	Contracted Employment	O	O
	Taxation	O	O

	Project Component/Physical Activity	Potential Effects on Domestic Water Quality	
		Municipal Water	Knutsford Surface and Groundwater
Operation	Open Pit Development	O	H
	Drilling and Blasting	O	L
	Hauling Waste Rock and Ore from Pit	O	O
	Crushing and Conveying Ore	O	L
	Temporary Ore Stockpile	O	L
	Development of Waste Rock Management Facilities	O	M
	Stripping, Loading, Hauling, Deposition, and Contouring of Topsoil and Overburden	O	L
	Revegetation through Progressive Reclamation	O	O
	Process Plant Operation	O	O
	Deposition to Tailing Storage Facility	O	L
	Site Road Use and Maintenance (Materials, Personnel, Supplies)	O	O
	Concentrate Transport and Storage	O	L
	Explosives Magazine and Storage Facilities	O	O
	Fire Suppression Infrastructure	O	O
	Fuel Storage and Filling Area	O	O
	Hazardous Wastes Transport, Storage, and Disposal	O	O
	General Wastes Transport, Storage, and Disposal	O	O
	Sewage Infrastructure and Disposal	O	O
	Laydown Areas and Storage Yards	O	O
	Power Transmission, Distribution	O	O
	Project Lighting	O	O
	Site Access, Security and Fencing	O	O
	Water Intake from Kamloops Lake	O	O
	Contact Water	O	M
	Non-contact Water	O	O
	Potable Water Treatment and Use	O	O
	Peterson Creek Diversion	O	O
	Mine Staffing (Direct Employment)	O	O
	Contracted Employment	O	O
	Taxation	O	O

	Project Component/Physical Activity	Potential Effects on Domestic Water Quality	
		Municipal Water	Knutsford Surface and Groundwater
Decommissioning and Closure	Dismantling of Ancillary Buildings	O	O
	Pit Lake Planning	O	O
	Site Road/Bridge Decommissioning	O	O
	Tailing Storage Facility Decommissioning and Reclamation	O	L
	Waste Rock Management Facilities Reclamation	O	L
	Fuel Storage and Filling Area	O	L
	Hazardous Wastes Transport, Storage, and Disposal	O	L
	General Wastes Transport, Storage, and Disposal	O	O
	Sewage Infrastructure and Disposal	O	O
	Laydown Areas and Storage Yards	O	O
	Power Transmission, Distribution	O	O
	Project Lighting	O	O
	Site Access, Security and Fencing	O	O
	Contact Water	O	H
	Non-contact Water	O	O
	Potable Water Treatment and Use	O	O
	Peterson Creek Diversion	O	O
	Road use to the Project (Materials, Personnel, Supplies)	O	O
	Mine Staffing (Direct Employment)	O	O
	Contracted Employment	O	O
	Taxation	O	O
Post Closure	General Site Inspections and Maintenance	O	O
	Contact Water	O	H
	Non-contact Water	O	O
	Road use to the Project (Materials, Personnel, Supplies)	O	O
	Mine Staffing (Direct Employment)	O	O
	Contracted Employment	O	O

Notes:

O	*No interaction anticipated.*
L	*Negligible to minor interaction expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.*
M	*Potential moderate interaction requiring unique active management/monitoring/mitigation; warrants further consideration.*
H	*Key interaction; warrants further consideration.*

Municipal Water Quality

Municipal drinking water is drawn from the South Thompson River by the Kamloops Water Treatment Centre and the Tk'emlúps Indian Band Water Treatment Plant and piped to the residents of Kamloops and the Kamloops Indian Reserve, respectively. During the operation phase of the Project, ore dust containing traces of metals will deposit to the surrounding environment. However, based on deposition modelling, the spatial extent of dustfall from the Project only extends several hundred meters beyond the project footprint and does not reach the South Thompson River or the majority of Kamloops (Figure 10.2-2). The magnitude of dustfall would also be too low to influence the water quality of a major river such as the Thompson River. Further, treatment of the raw water from both water treatment facilities would remove suspended solids and further reduce the potential for Project-related metal-bearing dust to alter the quality of the Kamloops municipal water supply. The surface water quality effects assessment determined that the Project will not affect water quality in the South Thompson River. Therefore, the potential effect of the Project to municipal water quality is not evaluated further.

Knutsford Surface and Groundwater Quality

Surface and groundwater quality in Knutsford is based on the Peterson Creek aquifer, which may be influenced by project activities over the operational life of the mine through to the post closure phase. Seepage from project facilities (e.g., MRSFs, TSF) may occur over time and eventually contact surface and groundwater supplies. As described in the surface water quality and groundwater quality VCs (Section 6.3 and Section 6.5, respectively), numerical models have been developed using baseline conditions, the Project water balance, and geochemical inputs to predict Future Case surface water quality in Peterson Creek (Section 6.3; Appendix 6.3-C) and Future Case groundwater quality at the nearest residential well (Section 6.5; Appendix 6.5-A).. The domestic water quality effects assessment presents these modelling results compared to the applicable provincial and federal water quality guidelines for drinking water (i.e. health-based, aesthetic and operational objectives) and agricultural use (i.e., irrigation and livestock water). This predicted water quality is subsequently used as an input to the Human Health and Ecological Risk Assessment (Section 10.4; Appendix 10.4-A).

10.2.4.2 Effects on Domestic Water Quality

The Baseline and Future Case surface and groundwater quality for the Knutsford community are presented in Table 10.2-3. These results are compared to the water quality guidelines for drinking and agricultural use. The Future Case groundwater quality is based on the worst case conditions (i.e., maximum concentrations) occurring through the operational life of the project though to the post closure phase. The worst case conditions for groundwater quality for all parameters occur in the post closure phase.

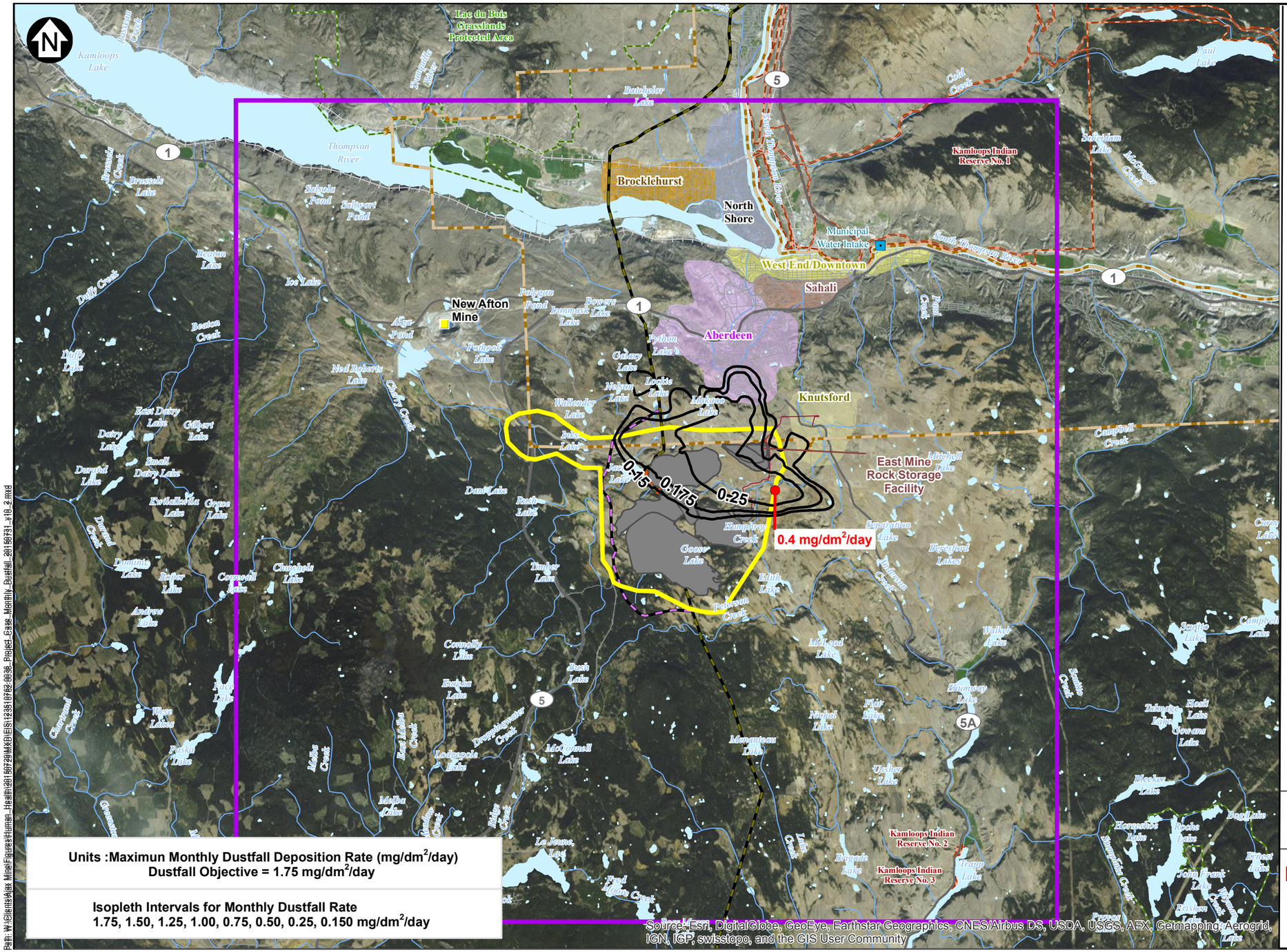
Table 10.2-3. Baseline and Future Case Chemical Concentration in Knutsford Surface and Groundwater

Parameter	Canadian Drinking Water Quality Guideline (mg/L)	Water Quality Guidelines for the Protection of Agriculture (mg/L)		Concentration in Knutsford Surface and Groundwater (mg/L)	
		Irrigation	Livestock	Baseline Case	Future Case
Metal					
Aluminum	1.00×10^{-1} (Operational)	5.00×10^{0}	5.00×10^{0}	3.00×10^{-3}	8.84×10^{-1}
Arsenic	1.00×10^{-2}	1.00×10^{-1}	2.50×10^{-2}	9.30×10^{-4}	3.19×10^{-3}
Barium	1.00×10^{0}	None	None	2.94×10^{-2}	8.07×10^{-2}
Beryllium	None	1.00×10^{-1}	1.00×10^{-1}	1.00×10^{-4}	1.82×10^{-4}
Boron	5.00×10^{0}	Variable	5.00×10^{0}	4.00×10^{-2}	1.80×10^{-1}
Cadmium	5.00×10^{-3}	5.10×10^{-3}	8.00×10^{-2}	1.00×10^{-5}	3.47×10^{-5}
Chromium	5.00×10^{-2}	8.00×10^{-3}	5.00×10^{-2}	1.10×10^{-4}	3.25×10^{-3}
Cobalt	None	5.00×10^{-2}	1.00×10^{0}	1.20×10^{-4}	1.01×10^{-3}
Copper	1.00×10^{0} (Aesthetic)	Variable	Variable	3.29×10^{-3}	9.19×10^{-2}
Iron	3.00×10^{-1} (Aesthetic)	5.00×10^{0}	None	$\underline{1.08 \times 10^{-1}}$	$\underline{3.32 \times 10^{0}}$
Lead	1.00×10^{-2}	2.00×10^{-1}	1.00×10^{-1}	5.36×10^{-5}	5.33×10^{-4}
Lithium	None	2.50×10^{0}	None	7.70×10^{-3}	1.20×10^{-2}
Manganese	5.00×10^{-2} (Aesthetic)	2.00×10^{-1}	None	3.70×10^{-2}	$\underline{\mathbf{1.08 \times 10^{0}}}$
Mercury	1.00×10^{-3}	None	3.00×10^{-3}	1.00×10^{-5}	4.36×10^{-5}
Molybdenum	None	Narrative	5.00×10^{-1}	1.56×10^{-2}	2.30×10^{-2}
Nickel	None	2.00×10^{-1}	1.00×10^{0}	1.91×10^{-3}	3.30×10^{-3}
Selenium	5.00×10^{-2}	Variable	5.00×10^{-2}	1.10×10^{-4}	9.46×10^{-4}
Uranium	2.00×10^{-2}	1.00×10^{-2}	2.00×10^{-1}	1.36×10^{-3}	2.51×10^{-3}
Vanadium	None	1.00×10^{-1}	1.00×10^{-1}	1.8×10^{-3}	5.05×10^{-3}
Zinc	5.00×10^{0} (Aesthetic)	Equation	5.00×10^{1}	3.00×10^{-3}	4.91×10^{-2}
Anions and Nutrients					
Chloride	2.50×10^{2} (Aesthetic)	Variable	None	1.40×10^{1}	6.03×10^{1}
Fluoride	1.50×10^{0}	1.00×10^{0}	Variable	2.54×10^{-1}	3.48×10^{-1}
Nitrite (as N)	3.00×10^{0}	None	1.00×10^{1}	1.00×10^{-2}	1.41×10^{-2}
Sulphate	5.00×10^{2} (Aesthetic)	None	1.00×10^{3}	1.53×10^{2}	$\underline{\mathbf{1.05 \times 10^{3}}}$

Underlined = above drinking water quality guidelines.
***Bold** = above agricultural use guidelines.*
Operational guideline applies to treatment plants using aluminum-based coagulants.
Does not apply to naturally occurring aluminum found in groundwater.
Aesthetic guidelines for copper, iron and manganese based on taste and staining of laundry and plumbing fixtures.
Aesthetic guidelines for zinc and sulphate based on taste.
Aesthetic guideline for chloride based on taste and potential for corrosion in the distribution system.

Figure 10.2-2
Project Alone Maximum Predicted Monthly Average Dustfall Rate (mg/dm²/day)

Stantec


Lac du Bois Grasslands Protected Area
Kamloops Lake
Thompson River
Batchelor Lake
Brocklehurst
North Shore
Kamloops Indian Reserve No.1
Municipal Water Intake
West End/Downtown
Sahali
New Afton Mine
Aberdeen
Knutsford
East Mine Rock Storage Facility
0.4 mg/dm²/day
0.175
0.25
Paul Lake
Schubert Lake
McGregor Creek
Cold Creek
South Thompson River
Campbell Creek
Brussels Lake
Beaton Lake
Duffy Lake
Ice Lake
Polygon Pond
Ironmask Lake
Python Lake
Galaxy Lake
Wallender Lake
Nelson Lake
Lockie Lake
Marjorie Lake
Ned Roberts Lake
Pothook Lakes
Alger Pond
Dunn Lake
Rush Lake
Humphrey Creek
Goose Lake
Separation Lake
Berglund Lakes
Edith Lake
McLeod Lake
Walker Lake
Connelly Lake
Eureka Lake
Shumway Lake
Nicola Lake
Flat Bay
Meadowlands
Usher Lake
McDonnell Lake
Lodgepole Lakes
Dragonhouse Creek
Kamloops Indian Reserve No. 2
Kamloops Indian Reserve No. 3
Trapp Lake
Bryant Lake
Hosmer Lake
Loche Lake
Bog Lake
John Brant Lake
Tranquille River
Tranquille Creek
Dairy Lake
Small Dairy Lake
Gilbert Lake
Grass Lake
Campbell Lake
Curry Lake
Scotch Creek
Heidi Lake
Owens Lake
Bleeker Lake
Ernest Lake
Mitchell Lake
Separation Creek
Anderson Creek
Jamieson Creek
Lemieux Creek
Lee Marie Creek
Lodgepole Creek
Duteau Creek
Dunn Creek
Criss Creek
Halston Creek
Dairy Creek
Beaton Creek
Ned Roberts Creek
Jacko Lake
Dunsmuir Lake
Dominic Lake
Roper Lake
Cornwall Lake
Chumpels Lake
Andrew Lake
Wyse Lakes
Pashley Lakes
Mahood Lake
Mahood Creek
Criss Creek
Le Jeune Bay
Fred Lake
Fred Lake Creek
Tunkwa Lake
Tunkwa Creek
Heffley Creek
Deadman River
Jacko Lake
Hosmer Lake
Bleeker Lake
Ernest Lake
John Brant Lake
Bog Lake
Campbell Lake
Scotch Creek
Owens Lake
Heidi Lake
Tranquille Lake
Tranquille Creek
Dairy Creek
Beaton Creek
Ned Roberts Creek
Duffy Lake
Brussels Creek
Thompson River
Kamloops Lake
Lac du Bois Grasslands Protected Area
Batchelor Lake
Cold Creek
Paul Lake
Schubert Lake
McGregor Creek
Brussels Lake
Beaton Lake
Duffy Lake
Ice Lake
Polygon Pond
Ironmask Lake
Python Lake
Galaxy Lake
Wallender Lake
Nelson Lake
Lockie Lake
Marjorie Lake
Ned Roberts Lake
Pothook Lakes
Alger Pond
Dunn Lake
Rush Lake
Humphrey Creek
Goose Lake
Separation Lake
Berglund Lakes
Edith Lake
McLeod Lake
Walker Lake
Connelly Lake
Eureka Lake
Shumway Lake
Nicola Lake
Flat Bay
Meadowlands
Usher Lake
McDonnell Lake
Lodgepole Lakes
Dragonhouse Creek
Kamloops Indian Reserve No. 2
Kamloops Indian Reserve No. 3
Trapp Lake
Bryant Lake
Hosmer Lake
Loche Lake
Bog Lake
John Brant

Domestic Water Used for Human Drinking Water

The Future Case surface and groundwater quality in the Knutsford community was below drinking water quality guidelines for all health-based parameters shown in Table 10.2-3. The Future Case surface and groundwater quality was above the aesthetic guidelines for iron, manganese and sulphate. Concentrations of iron are already above the aesthetic guideline in the baseline surface and groundwater quality. These aesthetic guidelines are all based on taste, while the iron and manganese guidelines are also based on the potential for water to stain laundry and plumbing fixtures.

Using the Future Case surface and groundwater in Knutsford as a drinking water source is not predicted to present a health risk for chemical parameters influenced by the Project. Existing iron concentrations in surface and groundwater may affect the taste of the water and may result in the staining of laundry and plumbing fixtures. These conditions exist under baseline conditions and are expected to continue in the Future Case.

Domestic Water Used for Agriculture

The predicted Future Case surface and groundwater quality in the Knutsford community was below the water quality guidelines for agricultural use (irrigation and livestock water) for all parameters except for sulphate when applied to livestock water and manganese when applied to irrigation water.

The baseline concentration of sulphate in Knutsford surface and groundwater was based on the minimum concentration of 159 mg/L. The surface water quality and groundwater quality effects assessments indicate that baseline concentrations of sulphate may be higher than 1,000 mg/L at low flow periods of the year. High concentrations of sulphate may occur naturally from groundwater, and influence surface water quality during these low flow periods. Under the Future Case conditions, the maximum predicted sulphate concentration is 1,050 mg/L. Based on the water quality guidelines for agricultural use, sulphate concentrations used for livestock should not exceed 1,000 mg/L. Higher concentrations of sulphate can be tolerated, but may result in a loss of productivity as high doses of sulphate may lead to deficiencies of essential trace elements such as copper, zinc, iron and manganese in livestock (CCME 2008). For domestic waters used in irrigation applications, the Future Case concentration of manganese was above the guideline. Although manganese is an essential element, it can be harmful to crops in acidic soils (CCME 2008).

10.2.4.3 Mitigation Measures for Domestic Water Quality

The mitigation measures described in the surface water quality (Section 6.3) and groundwater quality effects assessment (Section 6.5) will reduce the potential for changes to the quality of water in the Peterson Creek watershed, used as a source of domestic water in Knutsford. In particular, these mitigations will control the seepage of effluent containing trace metals into the environment and subsequent effects to surface and groundwater quality.

The mitigation measures described in the surface water quality effects assessment will reduce the potential for changes to surface water quality in the surrounding lakes, streams and rivers in the LSA that species of country food are exposed to. These measures are part of the Water Management Plan (Section 11.7), and include:

- design mitigation measures for the Peterson Creek Diversion to direct excess water into the Peterson Creek Downstream Pond, and away from influences from mining activities;
- design mitigation measures for the mine rock storage facilities (MRSF) to divert and collect runoff and seepage water into collection ponds; and
- design mitigation measures for the tailings storage facility to divert and collect runoff and seepage water into collection ponds.

The mitigation measures recommended for the protection of groundwater in the vicinity of the East MRSF include the following design features:

- East MRSF Pond will be located down-gradient of the East MRSF. The primary function of this pond is to intercept seepage and runoff from the East MRSF. The pond foundation will be lined with a synthetic liner, the performance of which will be monitored using an under liner drainage system;
- Foundation preparation under the East MRSF; and
- Reclamation of the East MRSF.

A resolution policy will also be developed to address complaints regarding groundwater quality from Knutsford groundwater users, which will outline how people may file a complaint, and the protocol to respond to these complaints. These mitigations are considered to be effective in addressing the potential chemical effects to domestic water quality.

10.2.5 Residual Effects and Their Significance

Municipal drinking water is drawn from the South Thompson River by the Kamloops Water Treatment Centre and the Tk'emlúps Indian Band Water Treatment Plant and piped to the residents of Kamloops and the Kamloops Indian Reserve, respectively. During the operation phase of the Project, fugitive dust from mine haul roads and other sources contain traces of metals, and some portion of this dust will deposit to the surrounding environment. However, based on deposition modelling, the spatial extent of most of the dustfall is localized and does not reach the South Thompson River or the majority of Kamloops (Figure 10.2-2). The magnitude of dustfall would also be too low to influence the water quality of a major river such as the Thompson River. Further, treatment of the raw water from both water treatment facilities would remove suspended solids and further reduce the potential for Project-related metal-bearing dust to alter the quality of the Kamloops municipal water supply. The surface water quality effects assessment determined that the Project will not affect water quality in the South Thompson River. Therefore, residual effects are not predicted for municipal drinking water. The results of the domestic water quality effects assessment included Future Case surface and groundwater quality in the Peterson Creek watershed for the Knutsford community. This water is applicable to Knutsford residents who draw surface water from

Peterson Creek or groundwater from wells for drinking water, or for irrigation and livestock watering.

Metal concentrations in surface water in Peterson Creek and groundwater in the Peterson Creek Aquifer are predicted to increase between Baseline Case and Future Case conditions. Therefore, the residual effect for surface water and groundwater in the Knutsford community is an increase in metal concentration between Baseline Case and Future Case. Although metal concentrations in surface and groundwater are predicted to increase from Baseline Case conditions in the Knutsford community, Future Case water quality is predicted to be below drinking water quality guidelines for the health-based parameters. Future Case concentrations of iron, manganese and sulphate are predicted to be above the aesthetic drinking water objectives. Therefore, the residual effect on drinking water is not significant.

A determination of significance is made in the human health effects assessment (Section 10.4), which incorporates the modelling results of domestic water quality. The exposure to trace metals through the consumption of domestic drinking water represents only one component of a person's total exposure to trace metals. The human health effects assessment evaluates the health risk based on the total exposure to trace metals, which also includes exposures from the consumption of country foods and direct contact or incidental ingestion of soil. The significance to residual effects to human health is based on the combined exposure to trace metals from these exposure pathways considering both non-carcinogenic and carcinogenic chemicals. Assessing the significance of residual effects on a single exposure pathway such as the consumption of domestic drinking water, will underestimate the change in potential health risk that would be associated with the combined exposures. Therefore, an assessment of the significance of residual effects associated with the changes in domestic water quality in isolation has not been undertaken and the determination of significance is made for the human health effects assessment (Section 10.4) as a whole – incorporating domestic water quality.

10.2.6 Cumulative Effects Assessment

10.2.6.1 Introduction

Cumulative effects assessment considers the influence to domestic water quality from other projects within the RSA. There are three steps in the cumulative effects assessment: (1) establishing the context by providing an overview of the cumulative effects of other projects and activities on domestic water quality; (2) determining the potential for Project-specific residual effects to interact with the effects of other projects and activities; and if the Project does interact cumulatively with other actions, (3) assessing the significance of the resulting overall cumulative effect, and characterizing the change in cumulative effects due to the Project.

The first step establishes the context by summarizing the relevant baseline information on each VC within the RSA, as well as baseline effects that have resulted or are resulting from other past and present physical works and activities. Reasonably foreseeable future-project effects that may interact cumulatively with the proposed Project's residual effects will also be factored in for establishing an overview of cumulative effects prior to the potential contribution of Project residual effects.

As noted in Section 10.2.4, the quality of domestic water sourced from the South Thompson River will not be affected by Project activities. Therefore, an assessment of cumulative effects on municipal water supplies to the City of Kamloops and the Kamloops Indian Reserve is not required.

10.2.6.2 Identification of Other Actions that May Affect Domestic Water Quality

The second stage, determining whether Project effects have the potential to interact with the effects of other projects and activities, proceeds with an analysis of whether the following two conditions are met:

- the Project results in a demonstrable or measurable change to domestic water quality; and
- the project-specific effects to domestic water quality does, or is likely to act in a cumulative fashion with the effects of other past, existing or future projects and activities in the RSA (i.e., there is an overlap of effects).

If either of these conditions are not met, further assessment is not warranted because the Project does not contribute to the cumulative effect being considered.

The domestic water quality effects assessment indicates that there is a demonstrable and measurable change to surface and groundwater in the Peterson Creek watershed that residents of Knutsford may access. Nearby projects that could influence surface and groundwater quality includes the New Afton Project and the Kinder Morgan Pipeline Project. Based on the assessment of cumulative effects in the groundwater quality effects assessment (Section 6.5.6), the New Afton Project is within the Cherry Creek watershed and does not influence groundwater quality in the Peterson Creek watershed that Knutsford residents may access. The Kinder Morgan Pipeline Project may cross the Peterson Creek aquifer, but during normal operations, the pipeline contents are contained. Any potential oil leaks or spills associated with the pipeline are not expected to influence the concentrations of trace metals, anions or nitrates in the groundwater that the Project may affect. Therefore, an assessment of the cumulative effects on surface and groundwater within the Peterson Creek watershed from the New Afton Project and the Kinder Morgan Pipeline Project is not required.

Other potential cumulative effects include nearby lands used for agriculture and ranching in the Knutsford community. However, agriculture and ranching activities are not anticipated to affect trace metal concentrations in the groundwater, suggesting that there is no overlap of effects. Agriculture and ranching activities may influence nutrient influx into the groundwater, which primarily includes nitrogen, phosphorous and potassium from fertilizer use or from animal waste. The manner in which agriculture and ranching may influence groundwater does not overlap with the type of water quality changes associated with the Project. Therefore, an assessment of the cumulative effects on domestic water quality in the Peterson Creek watershed from agriculture and ranching is not required.

The screening results examining the potential for cumulative effects from other projects or activities are presented in Table 10.2-4. This table indicates that other projects and activities in the RSA do not have overlapping effects to domestic water quality as it relates to potential changes in trace metals, anions and nitrate in groundwater.

Table 10.2-4. Screening of Other Action Items for Inclusion in the CEA for Domestic Water Quality

Description	Status or Likelihood	Geographic Boundaries (proximity to Project)	Temporal Boundaries	Common Resources and VCs Affected	Include in CEA (Y/N)
Industry					
New Afton Mine	Active	9 km northwest	Construction and Operation	N	N
Kinder Morgan Pipeline	Active	Within mine site	Construction and Operation	N	N
Natural Resource Extraction and Land Use					
Agriculture	Active	Immediately adjacent	Construction and Operation	N	N
Ranching	Active	Within mine site	Construction and Operation	N	N

10.2.6.3 Proposed Mitigation Measures

Based on the identification of other projects or actions that may affect domestic water quality, there are no interactions identified.

10.2.6.4 Evaluation of Significance of Residual Cumulative Effects

There are no residual cumulative effects on domestic water quality, therefore, a significance determination is not required.

The cumulative effects assessment has determined that cumulative effects on domestic water quality will not occur because there are no spatial or temporal overlaps with other projects or activities. Therefore, mitigation measures to address residual cumulative effects on domestic water quality are not necessary.

10.2.7 Conclusion

The assessment of domestic water quality indicates that there is no potential for the Project to influence municipal water supplies to residents in the City of Kamloops and the Kamloops Indian Reserve.

When considering surface and groundwater quality in the Peterson Creek watershed that Knutsford residents may access for human drinking water and other domestic purposes, the assessment indicates that the Future Case water quality is below the applicable health-based guidelines. There are no significant adverse health risks from trace metals, anions or nitrates to people drinking Knutsford groundwater. However, some aesthetic guidelines were exceeded, which influences the taste of the water and the potential for water to stain laundry and plumbing fixtures. These effects are already present under existing baseline conditions, and will continue to be present in the Future Case. The exposure to trace metals through the consumption of domestic water represents one component of the overall human exposure to trace metals from the Project. The potential human

health risks associated with exposures to trace metals from multiple sources are evaluated in detail in the human health and ecological risk assessment technical data report (Appendix 10.4-A) and the significance of these exposures is evaluated in the human health effects assessment (Section 10.4).

When applying surface and groundwater from the Peterson Creek watershed for agricultural use, the assessment indicates that Future Case water quality is above the applicable manganese guidelines for irrigation water, which may affect crop productivity in acidic soils. Plants are more tolerant of high manganese concentrations in neutral soils.

For livestock water, sulphate concentrations are above the guideline in the Future Case although the may also be above the guideline during low flow periods in the existing Baseline Case. Higher concentrations of suphate can be tolerated, but may result in a loss of productivity as high doses of sulphate may lead to deficiencies of essential trace elements such as copper, zinc, iron and manganese in livestock (CCME 2008).

For the cumulative effects assessment, there were no interactions between residual effects from the Project with other nearby projects and activities. The potential cumulative effect from other projects and activities is not significant.

10.3 COUNTRY FOODS

10.3.1 Rationale

This section includes a description of the scoping process used to identify country foods for inclusion in the assessment. Scoping is fundamental to focusing the Environmental Assessment Application/Environmental Impact Statement (Application/EIS) on those issues where there is the greatest potential to cause significant adverse effects. Valued Components (VCs) are components of the natural and human environment that are considered to be of scientific, ecological, economic, social, cultural, or heritage importance (CEAA 2006, EAO 2013). To be included in the assessment, there must be a perceived likelihood that the VC will be affected by the proposed Project. Valued components are scoped into the environmental assessment based on issues raised during consultation with Aboriginal communities, government agencies, the public and stakeholders. Consideration of certain VCs may also be a legislated requirement, or known to be a concern because of previous project experience.

Country foods refer to foods that are harvested locally through hunting, fishing, trapping, gathering, and growing activities (i.e., community and backyard gardens). For this assessment, country foods also include domestic cattle from local ranches in the Knutsford community that graze on local grasses (i.e., not fed imported or purchased grain and hay) and drink water supplied from local groundwater wells. Domestic cattle are included to address public concerns regarding the potential for the Project to affect the quality of beef from local cattle ranching operations. Country foods do not include other foods produced in commercial operations (e.g., commercial farms and greenhouses) or purchased foods.

Self-provisioning of country foods is a culturally embedded activity that is an important component of life for many rural households (e.g., hunting, fishing, foraging for wild edibles). However, it is recognized that Aboriginal communities tend to have a greater reliance on country foods than the general population, rely on more species, and require certain species for traditional medicinal, cultural and spiritual purposes.

Country foods are a VC that contributes to the assessment of human health (Section 10.4) based on exposure to naturally occurring and anthropogenic chemicals. To address the potential health risk associated with the consumption of country foods, Health Canada has developed guidance documents to assess health risk (Health Canada 2010a, 2010b, 2010c). The assessment of the country food VC will provide a summary of the predicted change in country food quality and the potential change in chemical exposure to people who consume country foods.

10.3.2 Background

10.3.2.1 Regional Overview

The Project is located 3 km southwest of the City of Kamloops in the Thompson-Okanagan region of British Columbia. The regional topography consists of mountains and valleys, and the area is arid or semi-arid, characterized by low annual precipitation and high evaporation. The Thompson River runs through Kamloops, but there are no major rivers in the Project area (Figure 10.3-1). Small lakes

are common in the area. Jacko Lake is the largest natural lake in the area and is popular for recreational fishing. Other lakes nearby include Inks Lake, Goose Lake, and Edith Lake. Peterson Creek crosses the central portion of the Project between the proposed pit to the north and the infrastructure located further south (i.e., tailings storage facility and the plant site).

The City of Kamloops has an approximate population of 85,000. For the purposes of assessing human exposures to chemicals in country foods, the city has been divided into six community areas located on either side of the Thompson River: Aberdeen, Brocklehurst, Knutsford, North Shore, Sahali and the West End/Downtown (Figure 10.3-1). The purpose of distinguishing the six communities is to identify the potential change in the quality of garden produce grown in each area. When considering other types of country foods (e.g., wild meat, fish and other plants), the potential change in the quality is dependent on the location where they are hunted or harvested. The assessment of country foods assumes that people can access all land and water areas at any time.

Local Aboriginal Groups

The BC Environmental Assessment Office and Canadian Environmental Assessment Agency have identified the following Aboriginal Groups that could be affected by the Project:

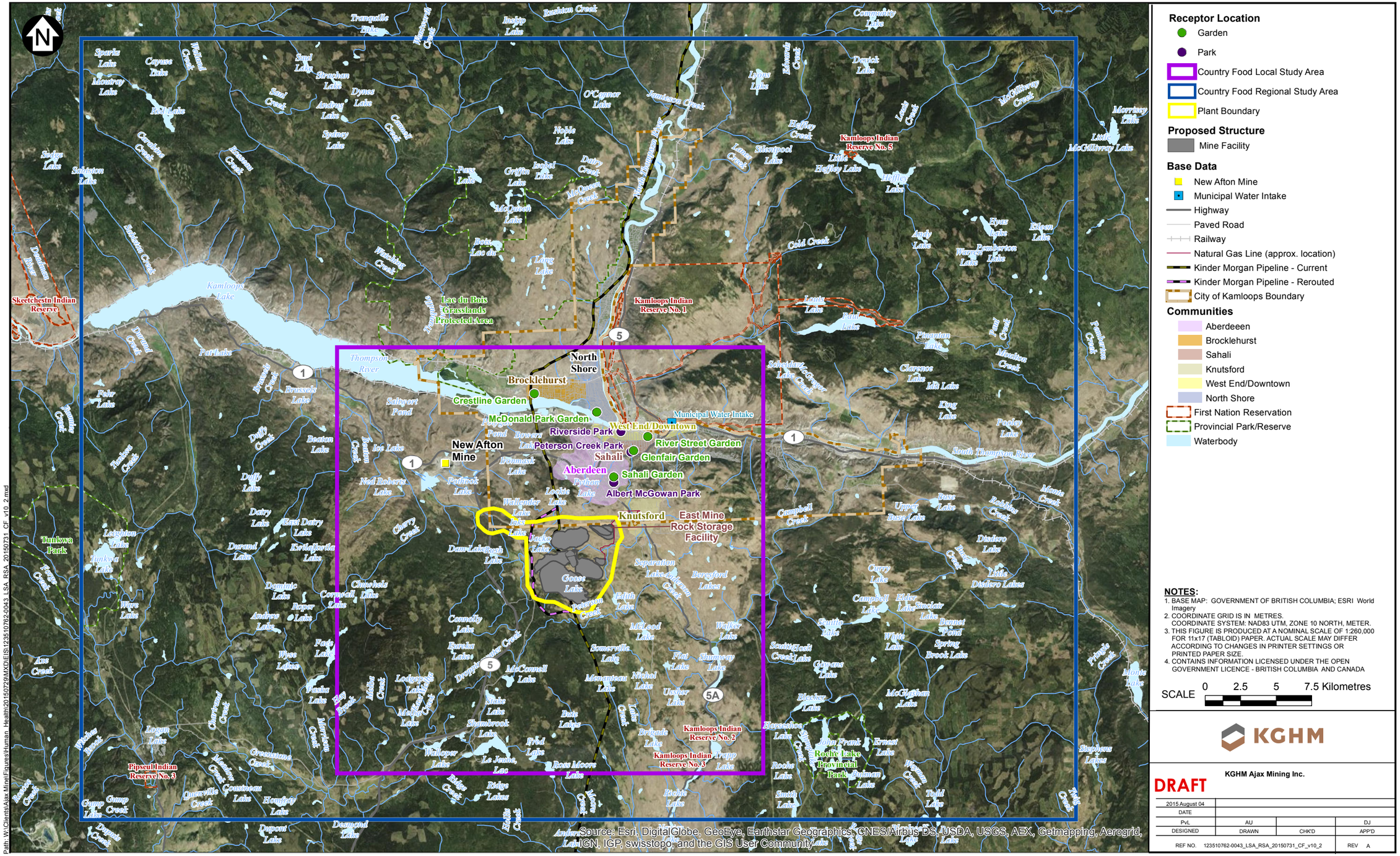
- Stk'emlupsemc te Secwépemc Nation (SSN);
- Lower Nicola Indian Band;
- Ashcroft Indian Band;
- Whispering Pines/Clinton Indian Band; and
- Métis Nation of British Columbia.

Information on traditional harvesting of country foods from these Aboriginal Groups was included in the country foods effects assessment, which was used to inform the selection of plant and animal species to assess.

10.3.2.2 Historical and Current Country Food Harvesting Activities

Historical and current country food harvesting activities related to the traditional harvesting of country foods is based on traditional use and traditional knowledge studies conducted for the Project, and information available from the scientific literature. As described in Section 12, early records of country food harvesting indicate that local Aboriginal Groups were semi-nomadic and would follow food sources based on the migration patterns of fish and large ungulates. Historical records indicate the preferred animals harvested for food included (from most preferred to least preferred): deer, elk, caribou, marmot, sheep, hare, beaver, grouse, bear, moose, duck, goose, crane, squirrel, and porcupine (Ignace 2014). The hunting of ungulates was more prevalent at higher elevations because these areas offered more open rangeland for deer, elk and moose. Popular lower elevation areas include Jacko Lake, Six Mile Hill, Tranquille River, Lac Le Jeune Park, and Greenstone Mountain.

Figure 10.3-1
Country Food Local and Regional Study Area



NOTES:
1. BASE MAP: GOVERNMENT OF BRITISH COLUMBIA; ESRI World Imagery
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD83 UTM, ZONE 10 NORTH, METER.
3. THIS FISURE IS PRODUCED AT A NOMINAL SCALE OF 1:260,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
4. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - BRITISH COLUMBIA AND CANADA

SCALE 0 2.5 5 7.5 Kilometres

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KGHM Ajax Mining Inc.

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Fishing in the area was primarily for salmon in the Thompson River (Ignace 2014). Jacko Lake was occasionally fished for stocked rainbow trout and kokanee beginning in mid-April when the lake is free of ice (Ignace 2014). All fish in Jacko Lake are stocked because steep waterfalls on Peterson Creek downstream of Jacko Lake prevent fish migration from the Thompson River. No evidence of historical or current fishing in Goose Lake has been documented (Ignace 2014).

Many species of traditional plants were used for nutritional, medicinal, ceremonial, spiritual, and technological purposes (e.g., dyes, wood carving). Most parts of the plant were utilized including the stems, shoots, bark, roots, seeds, and nuts. Mushrooms and lichens were also harvested (Ignace 2014). The area around Jacko Lake was a preferred harvesting ground for traditional plants. Species of plants harvested as a country food for nutritional purposes varied throughout the year, but included: balsamroot, nodding onion, biscuit-root, various lily species, soapberries, Saskatoon berries, strawberries, huckleberries, blueberries, and cranberries.

Plant harvesting opportunities for roots and stems usually began at lower elevations that are free of snow by February or March and lasted to the Fall. By May, the cambium of various tree species are harvested and by late summer, various species of berries, mushrooms, and wild vegetables are picked (Ignace 2014).

10.3.2.3 Baseline Data

The baseline data for the country foods effects assessment includes measured or modelled concentrations of trace metals in the tissues of wild meat (i.e., deer, snowshoe hare, grouse), rainbow trout, cattle, and garden produce (i.e., root vegetable, leafy vegetable, and fruits). Each species of country food evaluated in the assessment represents a food class that is typically harvested from the study area. Representative species for each food class are selected for the assessment of country foods.

This section summarizes the collection methods and modelling used to establish the baseline concentrations of trace metals in country foods.

Cattle and Wild Meat (Deer, Snowshoe Hare, Grouse)

Cattle, deer, snowshoe hare, and grouse were selected as representative species for wild meat. Domestically-raised cattle were selected to evaluate the potential Project-related effects to the quality of beef from the surrounding ranches. Deer were selected because they are the most popular large mammal that is harvested by local Aboriginal Groups (Ignace 2014). Snowshoe hare and grouse represent popular small mammal and avian species that are harvested as country food from the study area (Ignace 2014).

Trace metal concentrations in the tissues of domestic cattle and wild meat (represented by deer, snowshoe hare, and grouse) at baseline were modelled by applying chemical-specific uptake factors for each food type. Uptake factors are specific to an animal type (i.e. mammalian or avian uptake factor), chemical type (e.g., copper or selenium uptake factor), and exposure media (i.e., water, soil, food). For example, the copper concentration in grouse meat was modelled by applying avian uptake factors (e.g. soil-to-meat and water-to-meat) for copper from baseline soil and water quality.

The methods used to model metal uptake in cattle and wild meat is discussed in greater detail in the Human Health and Ecological Risk Assessment Technical Data Report (Appendix 10.4-A)

Fish

In 2014, 20 rainbow trout *(Oncorhynchus mykiss)* were collected from Peterson Creek (n = 3), Jacko Lake (n = 9), and Edith Lake (n = 8). Both Jacko Lake and Edith Lake are stocked with rainbow trout, while Edith Lake is also stocked with brook trout. Peterson Creek is not stocked, but may contain fish that have escaped from Jacko Lake.

Rainbow trout were used to represent all types of fish that are harvested in the study area. Salmon harvested from the Thompson River are an important food source for local Aboriginal Groups (Ignace 2014). Salmon species migrating up the Thompson River may be harvested by people; however, these mature salmon have spent the majority of their lives in the ocean. Furthermore, the proximity of the Project to Jacko Lake and Peterson Creek means that there is a greater potential for the Project to influence trace metal concentrations in fish tissue at these locations than in the Thompson River. Therefore, the assessment of fish has focused on rainbow trout in Jacko Lake and Peterson Creek.

The analysis of trace metals in rainbow trout is based on whole body analysis (i.e., including bones, scales, skin, and other organs). Consumers of fish typically eat the fillet and do not eat the bones or other organs such as the liver. Whole body analysis will overestimate the trace metal concentrations in the consumed portion of the fish due to the added mineralization content of the bones and liver, which accumulate metals.

Traditional Use Vegetation

In 2011 and 2012, browse and forage vegetation samples were collected in the local assessment area. These samples represent baseline quality of country food plant species that local Aboriginal Groups harvest and consume. Twelve samples of forage (i.e., any edible part of the plant) and twelve samples of browse (i.e., leaves and twigs) were collected from a variety of species and pooled together. These vegetation samples were analyzed for trace metals. Forage samples were also applied as surrogates to represent local berries because berries were not found or not in season within the local assessment area during field collection.

Garden Produce

In August 2012, garden produce was collected from five community gardens and analyzed for trace metals. One garden was sampled in each community (i.e., Aberdeen, Brocklehurst, North Shore, Sahali, and West End/Downtown). Aberdeen and Knutsford are approximately equal distance from the Project; therefore, samples collected in Aberdeen were used as a surrogate representing the Knutsford community because no community gardens were identified in Knutsford. West End/Downtown samples were surrogates for the Kamloops Indian Reserve because no community gardens were identified in these communities. Garden produce samples included the commonly edible parts of beets, radishes, lettuce, chard, tomatoes, pears, and apples. Each type of garden produce was categorized as a root vegetable, leafy vegetable, or fruit.

Summary of Baseline Data

The baseline quality of country foods is presented in Section 10.3.4.2 with the predicted Future Case quality of country foods. The metals selected for the assessment are identified as chemicals of potential concern (COPC). COPCs are chemicals that will be released by the Project and evaluated in the human health effects assessment for potential health risk. The COPCs include: aluminum, antimony, arsenic, barium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, thallium and uranium.

10.3.3 Assessment Boundaries

Assessment boundaries define the limits within which the effects assessment is conducted. They include the areas (spatial boundaries) and the time periods (temporal boundaries) that the Project is predicted to interact with country foods. Administrative boundaries define the political, social and economic limitations, while technical boundaries define the scientific or regulatory limitations in predicting or measuring changes to country food quality.

10.3.3.1 Spatial Boundaries

Local Study Area

The local study area (LSA) for the country foods effects assessment is a 30 km × 30 km area centered on the Project (Figure 10.3-1). The LSA for the country foods effects assessment is the maximum area within which Project-related environmental effects from dustfall or seepage containing trace metals can be predicted or measured with a reasonable degree of accuracy and confidence. The LSA is based on the combined modelling domains applied in the assessment of air quality, surface water quality and groundwater quality. The spatial extent of the air quality modelling domain also includes the modelling domain for the other VCs. Consequently, the LSA for the country foods and air quality VC are identical.

Regional Study Area

The regional study area (RSA) for the country foods assessment is a 70 km × 55 km area, positioned to the north of the Project. The RSA is the area within which the Project's environmental effects to the atmosphere, surface water and groundwater may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out. The RSA is positioned to the north of the Project area because the prevailing wind direction is from the southwest – blowing northeast. Therefore, air emissions will have a tendency to disperse northward. The RSA is based on the combined RSAs of the air quality, surface water quality and groundwater quality VCs. The spatial extent of the air quality RSA also includes the RSA for the other VCs. Consequently, the RSA for the country foods and air quality VC are identical.

Temporal Boundaries

The temporal boundaries include the Baseline Case and the Future Case. The Baseline Case represents current or pre-Project conditions, while the Future Case encompasses all four Project

phases and future conditions beyond the cessation of Project activities: The four Project phases and their associated time-frames are listed below:

- **Construction**: 2 years;
- **Operation**: 23 years;
- **Decommissioning and Closure**: 5 years (includes project decommissioning, abandonment and reclamation activities, as well as temporary closure, and care and maintenance); and
- **Post Closure**: 5+ years (includes ongoing reclamation activities and post-closure monitoring).

The country food VC evaluates the change in quality of country foods resulting from Project activities. The change in quality is driven largely by changes in metal concentrations in the soil and water. Because changes in soil quality are caused by deposition of dust, the post closure phase represents the point where metal accumulation in the soil will have reached its maximum. Therefore, the post closure conditions for soil represent the most conservative assessment of changes in country food quality. For water, the water quality modelling results used to model country food quality is based on the worst year of all Project phases, defined as the water with the highest concentration of COPCs.

The Future Case represents the combined baseline and highest Project effects associated with all Project phases. Therefore, if the health risk associated with the consumption of country foods in the Future Case is below the benchmark risk level determined in the human health effects assessment (Section 10.4), the health risk for all project phases would also be below the benchmark risk level.

10.3.3.2 Administrative Boundaries

There are no administrative boundaries for the country foods effects assessment.

10.3.3.3 Technical Boundaries

There are a number of technical boundaries associated with estimating changes in metal concentrations in country foods. These include:

- Technical boundaries associated with the air quality modelling predictions of dust deposition rates which influences predicted changes in metal concentrations in soils and country foods, as described in the air quality effects assessment (Section 10.1); and
- Technical boundaries associated with the water quality modelling that predict metal concentrations in surface water and groundwater which influences the predicted changes in metal concentrations in country foods, as described in the surface water quality and groundwater quality effects assessments (Section 6.3 and Section 6.5).

The results of the country foods effects assessment include estimating the change in chemical quality of country foods associated with Project-related emissions. However, in the absence of specific guidelines or standards for country food quality, the significance of those changes can only be evaluated in terms of the effects to human health. Accordingly, the results of the country foods

effects assessment are applied in the assessment of potential environmental effects to human health (Section 10.4) to evaluate the significance of these changes.

The exposure to trace chemicals from the consumption of country foods represents one exposure pathway contributing to human health. Other exposure pathways contributing to human health include the consumption of drinking water and the inhalation of dust containing trace chemicals. These exposure pathways (i.e., consumption of country foods, drinking water and inhalation of dust, incidental soil ingestion and dermal contact with soil) are components of the human health effects assessment (Section 10.4).

10.3.4 Potential Effects of the Project and Proposed Mitigation for Country Foods

10.3.4.1 Identifying Potential Effects to Country Foods

The potential effects to country food are the changes to the chemical quality of the food. The quality of country foods may be affected by Project activities that influence the surrounding environment. Table 10.3-1 presents the interaction matrix for potential Project interactions with country foods. The assessment is based on the worst case environmental conditions throughout all phases of the Project. This considers the total change in metal concentrations in the environment resulting from dust deposition and the worst case year that seepage would affect water quality. Therefore, the Future Case conservatively evaluates the potential for change to the quality of country foods.

Table 10.3-1. Identifying Potential Project Interactions and Effects on Country Foods

Project Activities		Potential Effects on Country Foods
Construction	Clearing and Grubbing	O
	Earthworks	O
	Overburden/Topsoil Stockpile	O
	Laydown Areas and Storage Yards	O
	Project Lighting	O
	Site Security and Fencing	O
	Fuel Storage and Filling Area	O
	Hazardous Wastes Transport, Storage, and Disposal	O
	Construction Wastes Transport, Storage, and Disposal	O
	Sewage Infrastructure and Disposal	O
	Public Road Realignment, Use, and Maintenance	O
	Site Road Construction, Use and Maintenance	O
	Peterson Creek Bridge Construction, Use, and Maintenance	O
	Site Buildings and Process Plant	O
	Explosives Magazine and Storage Facilities	O
	Open Pit Development	O

(continued)

Table 10.3-1. Identifying Potential Project Interactions and Effects on Country Foods (continued)

Project Activities		Potential Effects on Country Foods
Construction (*cont'd*)	Drilling and Blasting	O
	Crushing Mine Rock	L
	Loading, Hauling, and Deposition of Mine Rock	L
	Temporary Ore Stockpile	M
	Tailing Storage Facility Development	L
	Power Transmission, Distribution	O
	Natural Gas Line	O
	Pipeline Utility Corridor (Potable Water, Sewage, and Site Water)	O
	Water Intake from Kamloops Lake	O
	Fire Suppression Infrastructure	O
	Contact Water	L
	Non-contact Water	O
	Peterson Creek Diversion	O
	Water Management Dams	O
	Mine Staffing (Direct Employment)	O
	Contracted Employment	O
	Taxation	O
Operation	Open Pit Development	H
	Drilling and Blasting	H
	Hauling Mine Rock and Ore from Pit	H
	Crushing and Conveying Ore	H
	Temporary Ore Stockpile	M
	Development of Mine Rock Management Facilities	M
	Stripping, Loading, Hauling, Deposition, and Contouring of Topsoil and Overburden	M
	Revegetation through Progressive Reclamation	O
	Process Plant Operation	H
	Deposition to Tailing Storage Facility	M
	Site Road Use and Maintenance (Materials, Personnel, Supplies)	L
	Concentrate Transport and Storage	L
	Explosives Magazine and Storage Facilities	O
	Fire Suppression Infrastructure	O
	Fuel Storage and Filling Area	O
	Hazardous Wastes Transport, Storage, and Disposal	O

(continued)

Table 10.3-1. Identifying Potential Project Interactions and Effects on Country Foods (continued)

Project Activities		Potential Effects on Country Foods
Operation *(cont'd)*	General Wastes Transport, Storage, and Disposal	O
	Sewage Infrastructure and Disposal	O
	Laydown Areas and Storage Yards	O
	Power Transmission, Distribution	O
	Project Lighting	O
	Site Access, Security and Fencing	O
	Water Intake from Kamloops Lake	O
	Contact Water	O
	Non-contact Water	O
	Potable Water Treatment and Use	O
	Peterson Creek Diversion	O
	Mine Staffing (Direct Employment)	O
	Contracted Employment	O
	Taxation	O
Decommissioning and Closure	Dismantling of Ancillary Buildings	O
	Pit Lake Planning	O
	Site Road/Bridge Decommissioning	O
	Tailing Storage Facility Decommissioning and Reclamation	L
	Mine Rock Management Facilities Reclamation	L
	Fuel Storage and Filling Area	L
	Hazardous Wastes Transport, Storage, and Disposal	L
	General Wastes Transport, Storage, and Disposal	O
	Sewage Infrastructure and Disposal	O
	Laydown Areas and Storage Yards	O
	Power Transmission, Distribution	O
	Project Lighting	O
	Site Access, Security and Fencing	O
	Contact Water	H
	Non-contact Water	O
	Potable Water Treatment and Use	O
	Peterson Creek Diversion	O
	Road use to the Project (Materials, Personnel, Supplies)	L
	Mine Staffing (Direct Employment)	O
	Contracted Employment	O
	Taxation	O

(continued)

Table 10.3-1. Identifying Potential Project Interactions and Effects on Country Foods (completed)

	Project Activities	Potential Effects on Country Foods
Post Closure	General Site Inspections and Maintenance	O
	Contact Water	H
	Non-contact Water	O
	Road use to the Project (Materials, Personnel, Supplies)	O
	Mine Staffing (Direct Employment)	O
	Contracted Employment	O

Notes:

O	*No interaction anticipated.*
L	*Negligible to minor interaction expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.*
M	*Potential moderate interaction requiring unique active management/monitoring/mitigation; warrants further consideration.*
H	*Key interaction; warrants further consideration.*

The main pathways for changes to the quality of country food include:

- deposition of metals in mine dust (e.g., mine rock, ore, and tailings) onto the surrounding soil and surface water as a result of mining activities; and
- seepage of water containing metals may enter surface waters or groundwater.

Dust containing metals deposited onto soils or discharged into the water may be taken up directly by plants and retained in their tissues. Dustfall onto the surface of plants is not absorbed into the plant tissues, and are assumed to be removed by rainfall or manual washing prior to consumption by people. Terrestrial animals may also ingest soil, water, and vegetation containing metals from dust and seepage, while fish may take up metals directly from the water. The uptake and retention of metals in the tissues of plants and animals constitutes a change in chemical quality that could alter the exposures experienced by people consuming country.

The potential effects on country food quality are predicted from modelled chemical changes to the soil, water, and wildlife. The fate and transport of chemicals in the environment is based on chemical uptake factors (e.g. water-to-plant and soil-to-plant uptake factors), which are applied to predict the chemical concentrations that plants and wildlife are exposed to during the post closure phase. Technical details of this modelling, including chemical uptake factors, ingestion rates of soil, food and water for each representative country food species, and modelling assumptions are presented in the technical data report for the human health effects assessment (Appendix 10.4-A).

10.3.4.2 Effects on Country Foods

The key effect on country foods is the change in trace metal concentrations in tissue, between Baseline Case and Future Case. Changes in trace metal concentrations in the tissues of country foods may occur as a result of changes in trace metal concentrations in the soil, surface water,

groundwater (for domestic cattle only), with subsequent change in the quality of vegetation and prey items (i.e., fish, soil invertebrates) that are consumed by animal species.

Changes in trace metal concentrations in soil attributable to the Project are driven by the Project's cumulative contribution of metal-bearing fugitive dust depositing to surface soil over the operational life of the mine. Fugitive dust is not generated during the decommissioning and closure and post-closure phases. Changes in trace metal concentrations in surface water in the Peterson Creek watershed, attributable to the Project, are driven by seepage of water from mine operations to Jacko Lake and Peterson Creek from the operation phase through to post closure. Changes in trace metal concentrations in vegetation are attributable to absorption of trace metals through the roots of the plant.

The modelling of country food quality applies conservative assumptions to reduce the potential of underestimating the Project's influence on country foods. The model assumes that species of wildlife are exposed the worst case environmental media, regardless of spatial or temporal conditions. For example, the modelling of country foods assumes that wildlife species are exposed to:

- The worst case soil quality (i.e., soil quality at the end of the mine's operational life where total fugitive dust deposition is at its maximum);
- The worst case surface water quality (i.e., the water quality at the post closure phase where cumulative Project effects to surface water quality is at its maximum);
- The worst case groundwater quality (i.e., the groundwater quality at the post closure phase where cumulative Project effects to groundwater quality is at its maximum); and,
- The worst case food quality (i.e., based on vegetation, fish, small mammal prey, soil invertebrates that were exposed to the worst case soil and water quality).

This approach is conservative because the worst case environmental media will occur at different locations within the LSA and at different periods of time, while the modelling assumes that species of country foods are exposed to all worst case media simultaneously.

A detailed discussion of the derivation of the predicted change in trace metal concentrations in soil is provided in the Human Health and Ecological Risk Assessment Technical Data Report (Appendix 10.4-A). A more detailed discussion of the derivation of the predicted Future Case water quality in Jacko Lake and Peterson Creek is provided in the surface water quality effects assessment (Section 6.3) and the groundwater quality effects assessment (Section 6.5). These data have been used to predict trace metal concentrations in plant and animal tissue for Baseline and Future Cases.

The prediction of trace metal concentrations in cattle, wild meat, and fish tissue is based on the assumption that these animals remain in Jacko Lake and LSA for their entire lifetime. Trace metal concentrations in backyard garden produce were predicted for the five communities in Kamloops where baseline samples were collected from community gardens. Community garden samples were not available from either the Aboriginal or Knutsford communities. Community garden data from the West End/Downtown was used as a surrogate for the Aboriginal community while community garden data from Aberdeen was used as a surrogate for Knutsford. Trace metal concentrations in

traditional plants were modelled based on trace metal concentrations in vegetation collected from the LSA. Detailed discussion of the methods used to determine the change in trace metal concentrations between the Baseline Case and the Future Case is provided in the Human Health and Ecological Risk Assessment Technical Data Report (Appendix 10.4-A).

Summaries of the trace metal concentrations in animal and plant country foods are provided in Tables 10.3-2 through 10.3-8. Table 10.3-2 presents the predicted change in trace metal tissue concentrations for mule deer, snowshoe hare, and ruffed grouse. Table 10.3-3 presents the predicted change in trace metal concentrations in the tissues of domestic cattle, rainbow trout, and traditional plants. Tables 10.3-4 through 10.3-8 present the predicted changes in trace metal concentrations in the tissues of backyard garden produce (i.e., root vegetables, leafy vegetables, and fruit) for each of the community garden areas (Aberdeen, Brocklehurst, North Shore, Sahali, and West End/ Downtown). Technical details describing the modelling assumptions and chemical uptake factors for each species of country food are presented in the technical data report of the human health effects assessment (Appendix 10.4-A).

In animal tissues, the increases in trace metal concentrations between the Baseline and Future cases are governed by changes in metal concentrations in soil, vegetation, and surface water (Tables 10.3-2 and 10.3-3). Increases in trace metal concentrations in wild meat (i.e., mule deer, snowshoe hare, and grouse) were modelled assuming these animals spend their entire lifetime in the immediate vicinity of Jacko Lake and LSA. Increases in trace metal tissue concentrations are also noted for rainbow trout. For traditional plants (Table 10.3-3) and backyard garden produce (Tables 10.3-4 through 10.3-8) increases in trace metal concentrations between Baseline and Future cases are smaller than those noted animal and fish tissue and reflect the very small increases in metal concentrations in soil that occur over the life of the mine.

Table 10.3-2. Baseline and Future Case COPC Concentrations in Country Foods (Mule Deer, Snowshoe Hare, and Ruffed Grouse)

Chemical of Potential Concern	Baseline and Future Case COPC Concentrations in Country Foods (mg/kg ww)					
	Mule Deer		Snowshoe Hare		Ruffed Grouse	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	9.93×10^{-1}	9.99×10^{-1}	1.56×10^{-2}	6.10×10^{-2}	5.48×10^{-3}	5.53×10^{-3}
Antimony	2.45×10^{-5}	2.58×10^{-5}	3.42×10^{-7}	1.36×10^{-6}	2.58×10^{-7}	2.70×10^{-7}
Arsenic	8.34×10^{-4}	8.42×10^{-4}	1.02×10^{-5}	4.03×10^{-5}	1.29×10^{-5}	1.30×10^{-5}
Barium	6.32×10^{-3}	6.33×10^{-3}	8.22×10^{-5}	2.64×10^{-4}	7.19×10^{-5}	7.20×10^{-5}
Chromium	1.73×10^{-2}	1.74×10^{-2}	2.40×10^{-4}	9.39×10^{-4}	1.82×10^{-4}	1.83×10^{-4}
Cobalt	4.89×10^{-2}	4.90×10^{-2}	5.42×10^{-4}	2.00×10^{-3}	8.76×10^{-4}	8.77×10^{-4}
Copper	9.33×10^{-2}	9.35×10^{-2}	1.24×10^{-3}	4.90×10^{-3}	1.50×10^{-3}	1.51×10^{-3}
Lead	7.14×10^{-5}	7.16×10^{-5}	1.02×10^{-6}	3.92×10^{-6}	6.30×10^{-7}	6.32×10^{-7}
Manganese	4.22×10^{-2}	4.24×10^{-2}	5.73×10^{-4}	2.65×10^{-3}	9.94×10^{-4}	9.97×10^{-4}
Mercury	7.75×10^{-5}	7.92×10^{-5}	9.16×10^{-7}	8.38×10^{-6}	1.78×10^{-6}	3.64×10^{-6}
Molybdenum	2.75×10^{-2}	2.77×10^{-2}	3.92×10^{-4}	1.02×10^{-3}	1.14×10^{-4}	1.17×10^{-4}

(continued)

Table 10.3-2. Baseline and Future Case COPC Concentrations in Country Foods (Mule Deer, Snowshoe Hare, and Ruffed Grouse; completed)

Chemical of Potential Concern	Baseline and Future Case COPC Concentrations in Country Foods (mg/kg ww)					
	Mule Deer		Snowshoe Hare		Ruffed Grouse	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Nickel	2.28×10^{-2}	2.29×10^{-2}	3.10×10^{-4}	1.20×10^{-3}	2.92×10^{-4}	2.93×10^{-4}
Selenium	7.66×10^{-4}	7.73×10^{-4}	1.03×10^{-5}	3.95×10^{-5}	1.38×10^{-5}	1.39×10^{-5}
Thallium	1.64×10^{-4}	1.67×10^{-4}	2.40×10^{-6}	9.22×10^{-6}	1.39×10^{-6}	1.42×10^{-6}
Uranium	6.17×10^{-6}	7.25×10^{-6}	7.84×10^{-8}	3.18×10^{-7}	4.44×10^{-8}	5.37×10^{-8}

Table 10.3-3. Baseline and Future Case COPC Concentrations in Country Foods (Domestic Cattle, Rainbow Trout, and Traditional Plants)

Chemical of Potential Concern	Baseline and Future Case COPC Concentrations in Country Foods (mg/kg ww)					
	Domestic Cattle		Rainbow Trout		Traditional Plants	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	7.40×10^{-1}	7.43×10^{-1}	1.00×10^{0}	5.28×10^{0}	2.55×10^{1}	2.55×10^{1}
Antimony	2.00×10^{-3}	2.24×10^{-3}	2.00×10^{-3}	2.00×10^{-3}	2.08×10^{-3}	2.11×10^{-3}
Arsenic	4.00×10^{-3}	4.14×10^{-3}	1.44×10^{-1}	1.73×10^{-1}	1.58×10^{-2}	1.58×10^{-2}
Barium	1.30×10^{-2}	1.31×10^{-2}	3.23×10^{-2}	4.37×10^{-2}	7.22×10^{0}	7.23×10^{0}
Chromium	1.94×10^{-1}	1.95×10^{-1}	4.00×10^{-2}	1.92×10^{-1}	5.42×10^{-2}	5.43×10^{-2}
Cobalt	4.00×10^{-3}	4.02×10^{-3}	5.86×10^{-2}	1.24×10^{-1}	3.70×10^{-2}	3.71×10^{-2}
Copper	4.16×10^{-1}	4.39×10^{-1}	5.30×10^{-1}	9.30×10^{-1}	2.38×10^{0}	2.38×10^{0}
Lead	4.00×10^{-3}	4.04×10^{-3}	3.15×10^{-1}	4.47×10^{-1}	5.64×10^{-3}	5.65×10^{-3}
Manganese	7.10×10^{-2}	7.58×10^{-2}	2.32×10^{-1}	3.05×10^{-1}	5.82×10^{1}	5.82×10^{1}
Mercury	1.20×10^{-3}	1.24×10^{-3}	5.69×10^{-2}	6.01×10^{-2}	2.42×10^{-2}	2.51×10^{-2}
Molybdenum	1.19×10^{-2}	1.20×10^{-2}	5.72×10^{-2}	1.06×10^{-1}	1.04×10^{0}	1.05×10^{0}
Nickel	8.40×10^{-2}	8.42×10^{-2}	1.53×10^{0}	2.48×10^{0}	4.20×10^{-1}	4.21×10^{-1}
Selenium	1.08×10^{-1}	1.10×10^{-1}	9.37×10^{-1}	1.66×10^{0}	1.40×10^{-1}	1.41×10^{-1}
Thallium	4.00×10^{-4}	4.11×10^{-4}	3.05×10^{-3}	3.05×10^{-3}	3.61×10^{-4}	3.64×10^{-4}
Uranium	4.00×10^{-4}	4.58×10^{-4}	5.60×10^{-4}	6.96×10^{-4}	1.03×10^{-3}	1.03×10^{-3}

Table 10.3-4. Baseline and Future Case COPC Concentrations in Aberdeen Garden Produce

Chemical of Potential Concern	Baseline and Future Case COPC Concentrations in Aberdeen Garden Produce (mg/kg ww)					
	Root Vegetables		Leafy Vegetables		Fruits	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	2.57×10^{2}	2.57×10^{2}	2.53×10^{1}	2.53×10^{1}	3.20×10^{0}	3.20×10^{0}
Antimony	6.10×10^{-3}	6.19×10^{-3}	2.00×10^{-3}	2.03×10^{-3}	2.00×10^{-3}	2.03×10^{-3}
Arsenic	6.19×10^{-2}	6.20×10^{-2}	1.09×10^{-2}	1.09×10^{-2}	4.00×10^{-3}	4.01×10^{-3}

(continued)

Table 10.3-4. Baseline and Future Case COPC Concentrations in Aberdeen Garden Produce (completed)

Chemical of Potential Concern	Baseline and Future Case COPC Concentrations in Aberdeen Garden Produce (mg/kg ww)					
	Root Vegetables		Leafy Vegetables		Fruits	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Barium	7.81×10^{0}	7.82×10^{0}	1.26×10^{0}	1.26×10^{0}	3.06×10^{-1}	3.06×10^{-1}
Chromium	2.92×10^{-1}	2.93×10^{-1}	1.10×10^{-1}	1.10×10^{-1}	1.55×10^{-2}	1.55×10^{-2}
Cobalt	1.84×10^{-1}	1.84×10^{-1}	1.98×10^{-2}	1.98×10^{-2}	4.05×10^{-3}	4.06×10^{-3}
Copper	1.82×10^{0}	1.83×10^{0}	9.56×10^{-1}	9.59×10^{-1}	5.13×10^{-1}	5.15×10^{-1}
Lead	1.06×10^{-1}	1.06×10^{-1}	1.76×10^{-2}	1.76×10^{-2}	4.00×10^{-3}	4.01×10^{-3}
Manganese	1.30×10^{1}	1.30×10^{1}	3.89×10^{0}	3.89×10^{0}	6.42×10^{-1}	6.42×10^{-1}
Mercury	1.00×10^{-3}	1.01×10^{-3}	1.00×10^{-3}	1.01×10^{-3}	1.00×10^{-3}	1.01×10^{-3}
Molybdenum	7.61×10^{-2}	7.66×10^{-2}	9.40×10^{-1}	9.47×10^{-1}	1.02×10^{-1}	1.02×10^{-1}
Nickel	7.39×10^{-1}	7.41×10^{-1}	1.06×10^{-1}	1.06×10^{-1}	1.90×10^{-2}	1.90×10^{-2}
Selenium	2.00×10^{-2}	2.02×10^{-2}	2.00×10^{-2}	2.02×10^{-2}	2.00×10^{-2}	2.02×10^{-2}
Thallium	2.27×10^{-3}	2.29×10^{-3}	4.00×10^{-4}	4.03×10^{-4}	4.00×10^{-4}	4.03×10^{-4}
Uranium	1.34×10^{-2}	1.34×10^{-2}	1.92×10^{-3}	1.92×10^{-3}	4.00×10^{-4}	4.01×10^{-4}

Note:
Aberdeen applied as a surrogate for the Knutsford community.

Table 10.3-5. Baseline and Future Case COPC Concentrations in Brocklehurst Garden Produce

Chemical of Potential Concern	Baseline and Future Case COPC Concentrations in Brocklehurst Garden Produce (mg/kg ww)					
	Root Vegetables		Leafy Vegetables		Fruits	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	1.14×10^{1}	1.14×10^{1}	1.87×10^{1}	1.87×10^{1}	4.50×10^{-1}	4.50×10^{-1}
Antimony	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}
Arsenic	4.00×10^{-3}	4.00×10^{-3}	5.50×10^{-3}	5.50×10^{-3}	3.00×10^{-3}	3.00×10^{-3}
Barium	3.66×10^{0}	3.66×10^{0}	1.50×10^{0}	1.50×10^{0}	6.42×10^{-1}	6.42×10^{-1}
Chromium	3.60×10^{-2}	3.60×10^{-2}	6.20×10^{-2}	6.20×10^{-2}	1.60×10^{-2}	1.60×10^{-2}
Cobalt	1.16×10^{-2}	1.16×10^{-2}	1.81×10^{-2}	1.81×10^{-2}	1.69×10^{-2}	1.69×10^{-2}
Copper	9.86×10^{-1}	9.86×10^{-1}	1.06×10^{0}	1.06×10^{0}	1.17×10^{0}	1.17×10^{0}
Lead	1.06×10^{-2}	1.06×10^{-2}	1.43×10^{-2}	1.43×10^{-2}	4.00×10^{-3}	4.00×10^{-3}
Manganese	3.01×10^{0}	3.01×10^{0}	1.37×10^{1}	1.37×10^{1}	6.69×10^{-1}	6.69×10^{-1}
Mercury	1.00×10^{-3}	1.00×10^{-3}	1.00×10^{-3}	1.00×10^{-3}	1.00×10^{-3}	1.00×10^{-3}
Molybdenum	4.89×10^{-2}	4.89×10^{-2}	7.39×10^{-1}	7.39×10^{-1}	4.16×10^{-2}	4.16×10^{-2}
Nickel	3.10×10^{-2}	3.10×10^{-2}	5.40×10^{-2}	5.40×10^{-2}	7.35×10^{-2}	7.35×10^{-2}
Selenium	2.00×10^{-2}	2.00×10^{-2}	3.60×10^{-2}	3.60×10^{-2}	2.00×10^{-2}	2.00×10^{-2}
Thallium	4.00×10^{-4}	4.00×10^{-4}	5.10×10^{-4}	5.10×10^{-4}	4.00×10^{-4}	4.00×10^{-4}
Uranium	1.33×10^{-3}	1.33×10^{-3}	2.24×10^{-3}	2.24×10^{-3}	4.00×10^{-4}	4.00×10^{-4}

Table 10.3-6. Baseline and Future Case COPC Concentrations in Sahali Garden Produce

Chemical of Potential Concern	Baseline and Future Case COPC Concentrations in Sahali Garden Produce (mg/kg ww)					
	Root Vegetables		Leafy Vegetables		Fruits	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	2.34×10^{1}	2.34×10^{1}	5.53×10^{0}	5.53×10^{0}	4.00×10^{-1}	4.00×10^{-1}
Antimony	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}
Arsenic	9.30×10^{-3}	9.30×10^{-3}	1.00×10^{-2}	1.00×10^{-2}	4.00×10^{-3}	4.00×10^{-3}
Barium	1.12×10^{0}	1.12×10^{0}	4.97×10^{-1}	4.97×10^{-1}	4.00×10^{-2}	4.00×10^{-2}
Chromium	9.60×10^{-2}	9.60×10^{-2}	2.70×10^{-2}	2.70×10^{-2}	1.40×10^{-2}	1.40×10^{-2}
Cobalt	1.65×10^{-2}	1.65×10^{-2}	5.80×10^{-3}	5.80×10^{-3}	4.00×10^{-3}	4.00×10^{-3}
Copper	1.09×10^{0}	1.09×10^{0}	1.14×10^{0}	1.14×10^{0}	7.71×10^{-1}	7.71×10^{-1}
Lead	1.22×10^{-2}	1.22×10^{-2}	7.90×10^{-3}	7.90×10^{-3}	4.00×10^{-3}	4.00×10^{-3}
Manganese	2.52×10^{0}	2.52×10^{0}	2.37×10^{0}	2.37×10^{0}	6.26×10^{-1}	6.26×10^{-1}
Mercury	1.00×10^{-3}	1.00×10^{-3}	1.00×10^{-3}	1.00×10^{-3}	1.00×10^{-3}	1.00×10^{-3}
Molybdenum	5.04×10^{-2}	5.04×10^{-2}	7.82×10^{-1}	7.82×10^{-1}	1.21×10^{-1}	1.21×10^{-1}
Nickel	7.40×10^{-2}	7.40×10^{-2}	3.10×10^{-2}	3.10×10^{-2}	1.00×10^{-2}	1.00×10^{-2}
Selenium	2.00×10^{-2}	2.00×10^{-2}	2.00×10^{-2}	2.00×10^{-2}	2.00×10^{-2}	2.00×10^{-2}
Thallium	9.10×10^{-4}	9.11×10^{-4}	4.00×10^{-4}	4.01×10^{-4}	4.00×10^{-4}	4.01×10^{-4}
Uranium	1.82×10^{-3}	1.82×10^{-3}	4.00×10^{-4}	4.00×10^{-4}	4.00×10^{-4}	4.00×10^{-4}

Table 10.3-7. Baseline and Future Case COPC Concentrations in North Shore Garden Produce

Chemical of Potential Concern	Baseline and Future Case COPC Concentrations in North Shore Garden Produce (mg/kg ww)					
	Root Vegetables		Leafy Vegetables		Fruits	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	1.74×10^{1}	1.74×10^{1}	1.74×10^{1}	1.74×10^{1}	4.30×10^{-1}	4.30×10^{-1}
Antimony	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}
Arsenic	1.60×10^{-2}	1.60×10^{-2}	6.20×10^{-3}	6.20×10^{-3}	4.00×10^{-3}	4.00×10^{-3}
Barium	1.38×10^{0}	1.38×10^{0}	5.20×10^{-1}	5.20×10^{-1}	1.28×10^{-1}	1.28×10^{-1}
Chromium	7.45×10^{-2}	7.45×10^{-2}	4.50×10^{-2}	4.50×10^{-2}	2.90×10^{-2}	2.90×10^{-2}
Cobalt	2.55×10^{-2}	2.55×10^{-2}	1.72×10^{-2}	1.72×10^{-2}	5.50×10^{-3}	5.50×10^{-3}
Copper	7.46×10^{-1}	7.46×10^{-1}	1.10×10^{0}	1.10×10^{0}	6.26×10^{-1}	6.26×10^{-1}
Lead	9.85×10^{-3}	9.85×10^{-3}	1.61×10^{-2}	1.61×10^{-2}	4.00×10^{-3}	4.00×10^{-3}
Manganese	2.25×10^{0}	2.25×10^{0}	5.74×10^{0}	5.74×10^{0}	5.48×10^{-1}	5.48×10^{-1}
Mercury	1.00×10^{-3}	1.00×10^{-3}	1.20×10^{-3}	1.20×10^{-3}	1.00×10^{-3}	1.00×10^{-3}
Molybdenum	2.02×10^{-1}	2.02×10^{-1}	4.96×10^{-1}	4.96×10^{-1}	7.19×10^{-2}	7.19×10^{-2}
Nickel	8.05×10^{-2}	8.05×10^{-2}	6.50×10^{-2}	6.50×10^{-2}	3.30×10^{-2}	3.30×10^{-2}
Selenium	2.00×10^{-2}	2.00×10^{-2}	2.00×10^{-2}	2.00×10^{-2}	2.00×10^{-2}	2.00×10^{-2}
Thallium	9.30×10^{-4}	9.31×10^{-4}	4.70×10^{-4}	4.70×10^{-4}	4.00×10^{-4}	4.00×10^{-4}
Uranium	7.70×10^{-4}	7.70×10^{-4}	1.84×10^{-3}	1.84×10^{-3}	4.00×10^{-4}	4.00×10^{-4}

Table 10.3-8. Baseline and Future Case COPC Concentrations in West End/Downtown Garden Produce

Chemical of Potential Concern	Baseline and Future Case COPC Concentrations in West End/Downtown Garden Produce (mg/kg ww)					
	Root Vegetables		Leafy Vegetables		Fruits	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	1.14×10^{1}	1.14×10^{1}	9.23×10^{0}	9.23×10^{0}	4.00×10^{-1}	4.00×10^{-1}
Antimony	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}	2.00×10^{-3}
Arsenic	4.00×10^{-3}	4.00×10^{-3}	6.70×10^{-3}	6.70×10^{-3}	4.00×10^{-3}	4.00×10^{-3}
Barium	3.66×10^{0}	3.66×10^{0}	8.74×10^{-1}	8.74×10^{-1}	2.80×10^{-2}	2.80×10^{-2}
Chromium	3.60×10^{-2}	3.60×10^{-2}	4.60×10^{-2}	4.60×10^{-2}	1.00×10^{-2}	1.00×10^{-2}
Cobalt	1.16×10^{-2}	1.16×10^{-2}	8.60×10^{-3}	8.60×10^{-3}	4.00×10^{-3}	4.00×10^{-3}
Copper	9.86×10^{-1}	9.86×10^{-1}	1.15×10^{0}	1.15×10^{0}	2.37×10^{-1}	2.37×10^{-1}
Lead	1.06×10^{-2}	1.06×10^{-2}	1.26×10^{-2}	1.26×10^{-2}	4.00×10^{-3}	4.00×10^{-3}
Manganese	3.01×10^{0}	3.01×10^{0}	4.60×10^{0}	4.60×10^{0}	2.96×10^{-1}	2.96×10^{-1}
Mercury	1.00×10^{-3}	1.00×10^{-3}	1.00×10^{-3}	1.00×10^{-3}	1.00×10^{-3}	1.00×10^{-3}
Molybdenum	4.89×10^{-2}	4.89×10^{-2}	8.10×10^{-1}	8.10×10^{-1}	6.28×10^{-2}	6.28×10^{-2}
Nickel	3.10×10^{-2}	3.10×10^{-2}	3.50×10^{-2}	3.50×10^{-2}	1.00×10^{-2}	1.00×10^{-2}
Selenium	2.00×10^{-2}	2.00×10^{-2}	2.00×10^{-2}	2.00×10^{-2}	2.00×10^{-2}	2.00×10^{-2}
Thallium	4.00×10^{-4}	4.00×10^{-4}	4.00×10^{-4}	4.00×10^{-4}	4.00×10^{-4}	4.00×10^{-4}
Uranium	1.33×10^{-3}	1.33×10^{-3}	9.60×10^{-4}	9.60×10^{-4}	4.00×10^{-4}	4.00×10^{-4}

Note:
West End/Downtown applied as a surrogate for the Kamloops Indian Reserve.

The Baseline and Future Case trace metal tissue concentrations are used in conjunction with estimated metal concentrations in other environmental media (e.g., domestic water) to estimate human exposures to trace metals from multiple sources for Baseline and Future Cases. The potential human health risks associated with exposures to trace metals from multiple sources are evaluated in detail in the Human Health and Ecological Risk Assessment Technical Data Report (Appendix 10.4-A) and the significance of these exposures is evaluated in the human health effects assessment (Section 10.4).

A detailed quantitative ecological risk assessment that evaluates ecological receptor exposures to Project-related metals from multiple sources (air, soil, water, vegetation, prey) is provided in the Human Health and Ecological Risk Assessment Technical Data Report (Appendix 10.4-A). This assessment includes an evaluation of cumulative contaminant loads (dust deposition) to soil and the effect that the accumulation of metals has on the concentrations of metals in local forage over the predicted operating life of the Project. In addition to species of interest for Country Foods (and Human Health), risk assessors worked with wildlife biologists to identify other species of ecological interest. The results of the detailed quantitative ecological risk assessment are incorporated into the Wildlife VCs (Migratory Birds – Section 6.14, Raptors – Section 6.15, Non-Migratory Gamebirds – Section 6.16 and Mammals – Section 6.17) to contribute to the assessment of ecological health risks associated with exposures to Project-related metals for the identified ecological receptors. The

determination of the significance of the residual ecological effects for migratory birds, raptors, non-migratory game birds and mammals is also provided in the corresponding Wildlife VC chapters.

10.3.4.3 Mitigation Measures for Country Foods

Country foods quality is influenced by Project activities that directly change the chemical conditions in the atmospheric, terrestrial and aquatic environment. The mitigation measures described in the air quality (Section 10.1), surface water quality (Section 6.3) and groundwater quality (Section 6.5) effects assessment will reduce the potential for changes to the atmospheric, terrestrial and aquatic environment. In particular, these mitigation measures will control levels of metal-bearing dust in the atmosphere that will subsequently deposit onto the surrounding soil and surface water. These mitigation measures will also control seepage containing trace metals into the environment and subsequent effects to groundwater quality.

The mitigation measures described in the air quality effects assessment (Section 10.1) will reduce the effects of the Project on country foods by reducing dust deposition, as well as reducing potential metal loading to streams and lakes. These measures include:

- design mitigation measures such as installation of covers over coarse and fine ore stockpiles;
- dust collectors and use of covered concentrate transport trucks; and
- haul road-associated dust mitigated with use of coarse gravel and aggregate material on road beds and minimizing haul distances.

The mitigation measures described in the surface water quality effects assessment (Section 6.3) will reduce the potential for changes to surface water quality in the surrounding lakes, streams and rivers in the LSA that animals that may be harvested as country foods, could use as a source of drinking water. These measures are part of the Water Management and Hydrometric Monitoring Plan (Section 11.7), and include:

- design mitigation measures for the Peterson Creek Diversion to direct excess water into the Peterson Creek Downstream Pond, and away from influences from mining activities;
- design mitigation measures for the mine rock storage facility (MRSF) to divert and collect runoff and seepage water into collection ponds; and
- design mitigation measures for the tailings storage facility to divert and collect runoff and seepage water into collection ponds.

The mitigation measures described in the groundwater quality effects assessment (Section 6.5) will reduce the potential for changes to the quality of groundwater in Knutsford. In particular, these mitigations will control the release of seepage containing trace metals into the environment and subsequent effects to groundwater quality. The mitigation measures recommended for the protection of groundwater in the vicinity of the East MRSF near Knutsford include the following design features:

- water management ponds lined with a synthetic liner to intercept seepage and runoff from the East MRSF and tailings storage facility. The performance of which is monitored using an under liner drainage system; and

- reclamation of the East MRSF.

The mitigation measures from the effects assessment of these other VCs are intended to reduce environmental effects to a level which does not adversely affect the environment and are considered to be effective in addressing the potential effects to country foods.

10.3.5 Residual Effects and Their Significance

The results of the country foods effects assessment include the modelled quality of country foods in the Future Case, which considered emissions during all phases of the Project. A residual effect on country food quality is defined as a change in tissue metal concentrations between Baseline Case and Future Case conditions. The assessment considered a number of country foods. Changes in tissue metal concentrations were predicted between Baseline Case and Future Case conditions (see Tables 10.3-2 through 10.3-8). Increases in tissue metal concentrations between Baseline Case and Future Case are predicted to occur. Thus, the residual effect on country food is a predicted increase in tissue metal concentrations. Although the predicted quality of country foods was estimated, there is no regulatory guideline or standard applicable to assess the country food quality based on metal concentrations, or to provide context for determining the significance of the changes relative to baseline conditions.

A determination of significance is made in the human health effects assessment (Section 10.4), which incorporates the modelling results of country food quality. The exposure to trace metals through the consumption of country foods and backyard garden produce represents only one exposure pathway for a person's total exposure to trace metals. The human health effects assessment evaluates the health risk based on the total exposure to trace metals, including exposures from the consumption of country foods, drinking water, and direct skin contact or incidental ingestion of soil. The significance to human health is based on the total exposure to trace metals from these exposure pathways. Assessing the significance of residual effects on a single exposure pathway such as the consumption of country foods, will underestimate the change in potential health risk that would be associated with the combined exposures. Therefore, an assessment of the significance of residual effects associated with the changes in country food quality in isolation has not been undertaken and the determination of significance is made for the human health effects assessment (Section 10.4) as a whole – incorporating country food quality.

Determinations of the significance for ecological health risks are made in the Wildlife VCs (Migratory Birds – Section 6.14, Raptors – Section 6.15, Non-Migratory Gamebirds – Section 6.16 and Mammals – Section 6.17). The potential ecological health risks associated with exposures to trace metals in environmental media (soil, water, vegetation *etc.*) represents only one component of the assessment of Project residual effects on ecological receptors. The detailed quantitative ecological risk assessment presented in the Human Health and Ecological Risk Assessment Technical Data Report (Appendix 10.4-A) evaluates the potential ecological health risks based on cumulative exposures to trace metals. This information is used in conjunction with other effects (including for example, habitat loss and/or alteration, exposure to attractants and exposure to chemical hazards) to provide a comprehensive assessment of the overall significance of Project residual effects on ecological receptors.

10.3.6 Cumulative Effects Assessment

10.3.6.1 Introduction

Cumulative effects are considered for each VC. Three stages are involved: 1) establishing context by providing an overview of the cumulative effects of other projects and activities on the VC; 2) determining the potential for Project-specific residual effects to interact with the effects of other projects and activities; and if the Project does interact cumulatively with other actions; and 3) assessing the significance of the resulting overall cumulative effect, and characterizing the change in cumulative effects due to the Project.

The first stage, establishment of context, summarizes relevant baseline information on each VC within the RAA, as well as baseline effects that have resulted or are resulting from other past and present physical works and activities. Reasonably foreseeable future-project effects that may interact cumulatively with the proposed Project's residual effects will also be factored in for establishing an overview of cumulative effects prior to the potential contribution of Project residual effects.

Residual Project effects on country foods are driven by dustfall and seepage that contain trace metals. Therefore, the assessment of potential cumulative effects on changes in country foods depends on the assessment of cumulative effects presented for air quality (Section 10.1) and surface water quality (Section 6.3).

Contributions from other industrial facilities and activities of metal-containing dustfall that overlaps with metal dustfall attributed to the Project have the potential to result in cumulative changes in country foods. Likewise the effects that other industrial facilities and activities have on water quality have the potential to result in cumulative effects if the effects overlap with predicted Project effects. If there are no overlaps in dustfall between the Project and the other industrial facilities there are no cumulative changes in country food quality and an assessment of cumulative effects would not be required. Additionally, if there are no overlaps in effects on surface or groundwater quality in the LSA, there will be no cumulative changes in country food quality and an assessment of cumulative effects would not be necessary,

10.3.6.2 Identification of Other Actions that May Affect Country Foods

The second stage, determining whether Project effects have the potential to interact with the effects of other projects and activities, proceeds with an analysis of whether the following two conditions are met:

- the Project results in a demonstrable or measurable change to country food quality; and
- the project-specific effect to country food quality does, or is likely to, act in a cumulative fashion with the effects of other past, existing or future projects and activities in the area (i.e., there is an overlap of effects).

If either of these conditions is not met, further assessment is not warranted—the Project does not have the potential of contributing to the cumulative effect being considered.

As noted above, industrial and other activities in Kamloops and the surround area that may contribute to the deposition of metal-containing dust in areas that overlap with dustfall attributable to the Project have the potential to result in a cumulative change in country food quality. A number of industrial and other activities were incorporated into the air quality modelling including:

- Tolko Industries Ltd.;
- Savona Specialty Plywood;
- Spectra Energy Transmission
- Thompson River Veneer Products;
- Absorbent Products;
- Domtar Pulp Mill;
- Lafarge Cement Plant;
- New Gold;
- Kamloops Terminal;
- New Afton Mine Tailings Storage Facility;
- City Landfill;
- Domtar Landfill; and
- Owl Road Landfill

Dustfall from these industries and activities has been included in the air quality effects assessment during the Baseline Case, which are carried into the Future Case and does not need to be included in the cumulative effects assessment.

Industries and activities not already included in the effects assessment that do not contribute to metals in dustfall will not contribute to a cumulative change in metal-related country food quality and do not need to be included in the assessment of cumulative effects for country foods. Similarly, industries and activities that contribute to metals in dustfall in areas that do not overlap with the areas affected by Project activities will not contribute to cumulative change in metal-related country food quality and do not need to be included in the assessment of cumulative effects for country foods.

A summary of the screening used to identify industrial operations and other activities for inclusion in the cumulative effects assessment is provided in Table 10.3-9 This screening is limited to industrial operations and other activities that were not incorporated in the air quality modelling. Dustfall from the Highland Valley Copper mine and the Vidette Lake Mine will not overlap with dustfall from the Project and thus will not contribute to cumulative changes in country food quality. The remaining operations and activities will not contribute to metal dustfall and thus, will not contribute to cumulative changes in the metal concentrations in country food.

There are no industrial operations or activities that have the potential to alter surface or groundwater quality within the LSA. Therefore an assessment of residual cumulative effects of water quality changes in country food quality is not necessary.

Table 10.3-9. Ranking Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Country Foods

Residual Effect	Industrial Projects/Activities													Natural Resources and Land Use			Tourism and Commercial Recreation Activities					Community Infrastructure			Transportation					
	Vidette Lake Mine	Afton Mine (Historical)	Iron Mask Mine	Bonaparte Mine	New Afton Mine (New Gold)	Highland Valley Copper Mine (Teck)	Domtar Kamloops Pulp Mill	Tolko-Hefley Creek Plywood and Veneer	LaFarge Cement Plant	Trans Mountain Pipeline System (Kinder Morgan)	Trans Mountain Pipeline System - Expansion (Kinder Morgan)	Harper Creek	Highland Valley Copper – Bethlehem Expansion	Kamloops Forest District	Agriculture	Ranching	Tranquille on the Lake	Lac Le Jeune Resort	Tobiano Golf Course	Recreational Hunting, Fishing, Foraging	Recreational Trails	City of Kamloops Wastewater Management	Water Treatment Centre	City Expansion and Growth	Lac le Jeune Road	Highway 1	Highway 5A	Highway 5 (Coquihalla Highway)	Kamloops Airport	Rail Yards and Lines (CP and CN)
Change in dustfall influencing metal concentrations in Country Foods	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Change in water quality influencing Country Foods	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

Notes:

(-) *No spatial or temporal overlap.*

O *Spatial or temporal overlap, but no interaction anticipated OR No change from current condition anticipated, and already captured as part of baseline characterization. No further consideration warranted.*

L *Negligible to minor interaction expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.*

M *Potential moderate interaction requiring unique active management/monitoring/mitigation; warrants further consideration.*

H *Key interaction; warrants further consideration.*

10.3.6.3 Interactions between Residual Project Effects and Other Project or Activity Effects

Based on the identification of other projects or actions that may affect country foods, there are no interactions identified.

10.3.6.4 Proposed Mitigation Measures

The cumulative effects assessment has determined that cumulative effects on country food quality will not occur because there are no spatial or temporal overlaps with other projects or activities. Therefore, mitigation measures to address residual cumulative effects on country food quality are not necessary.

10.3.6.5 Evaluation of Significance of Residual Cumulative Effects

There are no residual cumulative effects on country food quality.

10.3.7 Conclusion

Exposure to trace metals through the consumption of country foods represents one component of the overall exposure to trace metals from the Project. Increases in trace metals tissue concentrations between Baseline and Future Cases are noted for mule deer, snowshoe hare, ruffed grouse, and domestic cattle. Increases in trace metal tissue concentrations are also noted for rainbow trout. For traditional plants and backyard garden produce, increases in trace metal concentrations between Baseline and Future Cases are smaller than those noted animal and fish tissue and reflect the very small increases in metal concentrations in soil associated with the Project.

The Baseline and Future Case trace metal tissue concentrations are used in conjunction with estimated metal concentrations in other environmental media (e.g., drinking water) to estimate human exposures to trace metals from multiple sources for Baseline and Future Cases. The potential human health risks associated with exposures to trace metals from multiple sources are evaluated in detail in the Human Health and Ecological Risk Assessment Technical Data Report (Appendix 10.4-A) and the significance of these exposures is evaluated in the human health effects assessment (Section 10.4).

10.4 HUMAN HEALTH

10.4.1 Rationale

This section includes a description of the scoping process used to identify human health for inclusion in the Application/EIS. Scoping is fundamental to focusing the Application/EIS on those issues where there is the greatest potential to cause significant adverse effects. Valued Components (VCs) are components of the natural and human environment that are considered to be of scientific, ecological, economic, social, cultural or heritage importance (CEAA 2006, EAO 2013). To be included in the EA there must be a perceived likelihood that the VC will be affected by the proposed Project. Valued components are scoped into the environmental assessment based on issues raised during consultation with Aboriginal communities, government agencies, the public and stakeholders.

The general public and Aboriginal groups have expressed concern about potential health effects of mine air emissions (e.g., diesel emissions and fugitive dust from mine operations including blasting). Specific concerns were expressed related to the potential for adverse health effects from fine particulate matter ($PM_{2.5}$) emitted by mine activities, including emissions to the ambient air from mine operations. There is also concern that deposition of metals in particulate matter from mine activities could contaminate vegetation, livestock, and wildlife. Aboriginal groups and the public are concerned that trapping, hunting, fishing, and harvesting of country foods may be contaminated by mine activities. In addition, the potential for mine activities to affect backyard garden produce has been identified as a health concern by the public because community and backyard gardens are common throughout the City of Kamloops.

Human health depends on the surrounding environment, particularly biophysical components such as air, soil, vegetation, water, fish, and wildlife. Project activities may release chemicals to the atmosphere or water thereby increasing human exposures to those chemicals, which could have implications for human health. The release of Project-related chemicals to the atmosphere may increase human health risks associated with inhalation exposures to the chemicals in the air. In addition, the deposition of Project-related particulate-bound metals onto soils may alter trace metal concentrations in the soil. This change in metal concentrations in soil may, in turn, alter trace metal concentrations in country foods (i.e., wild meat, cattle, vegetation, and garden produce). This change in country food quality could, in turn, alter the human health risks associated with exposures to trace metals that occur from eating country foods.

The human health effects assessment considers changes to human health as a result of exposure to project-related chemicals for people living or spending time within the Local Study Area (LSA; Section 10.4.3.1) and Regional Study Area (RSA; Section 10.4.3.1). The human health effects assessment evaluates the health risks to humans under existing baseline environmental conditions and the predicted conditions (i.e. Future Case) represented by the Project during the construction, operation, closure, and post-closure phases.

The Human Health VC receives inputs from the effects assessments of other VCs, including surface water quality (see Section 6.4), groundwater quality (see Section 6.5), air quality (see Section 10.1),

domestic water (see Section 10.2) and country foods (see Section 10.3) This chapter presents a summary of the predicted change in human health risk for people in the LSA and RSA.

The health risks to workers employed by the Project that live or enjoy recreational and traditional activities in the LSA and RSA are assessed in the Human Health and Ecological Risk Assessment Technical Data Report. While on the site, the health of mine workers is protected by occupational health and safety standards, codes and regulations established by various provincial and federal governments.

10.4.2 Background

10.4.2.1 Regional Overview

The Ajax Project is located 3 km southwest of the City of Kamloops in the Thompson-Okanagan region of British Columbia. The regional topography consists of mountains and valleys, and the area is arid or semi-arid, characterized by low annual precipitation and high evaporation. The Thompson River runs through Kamloops, but there are no major rivers in the Project tenure area (see Figure 10.4-1). Small lakes are common in the area. Jacko Lake is the largest lake in the area and is popular for recreational fishing. Other lakes nearby include Inks Lake, Goose Lake and Edith Lake. Peterson Creek crosses the southern portion of the proposed mine site.

The City of Kamloops is located northeast of the Project tenure area, with an approximate population of 85,000. For the purposes of assessing human exposures to country foods, the city has been divided into five community areas located on either side of the Thompson River: Aberdeen; Sahali; West-End/Downtown; North Shore and Brocklehurst (see Figure 10.4-1).

In addition to the human receptor areas located within Kamloops, three additional human receptor areas were included in the assessment: the Kamloops Indian Reserve #1, located on the outskirts of the city to the northeast, north of the South Thompson River; several ranching residences in the Knutsford community; and the Project tenure area, which is within the traditional territories of several First Nations.

The Traditional Knowledge and Traditional Use studies conducted for the Project (Section 12 of Part C of the application) were used to inform the assessment of human health. Information from these studies provided insight into the locations where members of the Aboriginal community harvest country foods from within the local study area. The information indicates that terrestrial and aquatic country foods are harvested from across the region and includes the lands around Peterson Creek and Jacko Lake. The selection of country foods was based, in part on traditional knowledge provided by Aboriginal Groups. For the purposes of evaluating Project effects on human health, the assessment has focused on terrestrial and aquatic country foods harvested from Peterson Creek because these areas are expected to experience the greatest Project-related effects.

<u>Local Aboriginal Groups</u>

The BC EAO formally delegated aspects of its consultation responsibilities to KGHM Ajax Mine (KAM) through an Order issued under section 11 of the BC *Environmental Assessment Act*. The

section 11 Order identifies the Project "First Nations" as the Stk'emlupsemc te Secwépemc Nation (SSN), which is comprised of the Tk'emlúps te Secwépemc (TteS) and Skeetchestn Indian Band (SIB), whom KAM is required to consult regarding potential Project effects on their Aboriginal interests. The section 11 Order also identifies "Working Group First Nations" comprised of the Lower Nicola Indian Band (LNIB) and Ashcroft Indian Band (AIB). The section 11 Order directs KAM to provide information to the LNIB and AIB regarding the Project, specifically the Application/EIS. On July 23, 2015, the BC EAO issued a section 13 Order directing KAM to provide information to the WP/CIB regarding the Project as the "Notification First Nation".

In addition to the Aboriginal Groups identified above, the CEA Agency identifies the Métis Nation British Columbia (MNBC) as an Aboriginal Group potentially affected by the Project. Information on traditional harvesting of country foods from these Aboriginal groups was included in the country foods effects assessment, which was used to inform the selection of plant and animal species to assess.

Land Use

Land use in the LSA includes urban industrial, commercial, and residential development within the City of Kamloops and recreational hunting, fishing, agriculture, and ranching development on the lands in close proximity to the Project. Within Kamloops, the closest residential area to the Project is Aberdeen, situated in the hills in the southwestern portion of Kamloops and is located approximately northeast of the Project tenure area. Other residential areas within Kamloops are located in the hills below Aberdeen and on Thompson River Valley on the north and south sides of the Thompson River. The Kamloops Indian Reserve No. 1 is located northeast of the city. The community of Knutsford and several ranching residences are within a kilometer of the proposed mine infrastructure. For the purpose of the human health assessment, a total of eight human receptor areas from residential, farm, Aboriginal, and Project tenure area lands were defined (see Figure 10.4-1):

- residential (Aberdeen, Sahali, West-End/Downtown, North Shore, Brocklehurst);
- farm (Knutsford);
- Aboriginal lands (Kamloops Indian Reserve No. 1); and
- Mine Site (recreational use including Jacko Lake).

10.4.2.2 Historical Activities

The Project is located in an area with historical open pit mining activity. Exploration in the area began in the 1880s and has continued intermittently until the present. Five copper-gold deposits located approximately 10 km northwest of the Project have been mined by open pit methods since the 1970s. Between 1989 and 1991, and again between 1994 and 1997, the former Afton gold-copper mine was in operation. In the late 1990s, the tailing facility and project components were decommissioned and reclaimed by the Afton Mine, with a focus on developing suitable forage for wildlife and cattle and stabilizing disturbed areas. At the current Project site, reclamation activities included mine rock storage facilities adjacent to Peterson Creek in the location of the proposed ore stockpiles. New Afton began underground mining immediately beneath the historic Afton Mine open pit in June 2012.

Other current and historical human activities in the area include ranching, forestry, and vegetable and orchard farming. The Domtar Pulp Mill, originally built by Weyerhaeuser in 1972, is located immediately west of Kamloops on the Thompson River. Several other current industrial sources of air emissions in the Kamloops area are detailed in the air quality section (Section 10.1).

10.4.2.3 Baseline Data

This section provides a summary of baseline studies and sample collection. Baseline environmental samples, including soil, groundwater, surface water, community garden produce, and local beef, were collected from the local study area for trace metals analysis. Baseline air quality data were measured at local monitoring stations, as well as modelled. The baseline methods outlined in the Application Information Requirements / Environmental Impact Statement Guidelines (AIR/EISG) for air and water quality modelling and sampling and sampling of soil, country foods, and backyard produce were followed.

Air Quality

For the air quality assessment, baseline concentrations were modelled for the following criteria air contaminant (CAC), (sulphur dioxide (SO_2) nitrogen dioxide (NO_2), carbon monoxide (CO) and particulate matter (as PM_{10} and $PM_{2.5}$)). CAC concentrations were modelled in each of the five residential areas in the City of Kamloops (Aberdeen, Sahali, West-End/Downtown, North Shore, Brocklehurst as well as for the Kamloops Indian Reserve No. 1, Knutsford and the recreational lands at the maximum point of impingement (location of maximum predicted concentration) which is located on the Project boundary (Figure 10.4-1). This last location was used to represent Aboriginal and recreational uses of Jacko Lake and the lands immediately adjacent to the Project Boundary.

For CACs where human health-based air quality guidelines are based on 1-hour or 24-hour exposure averaging periods (SO_2, NO_2), the maximum predicted 1-hour or 24-hour concentration was used for screening. For CACs where the 1-hour or 24-hour air quality guidelines are based on the 99^{th} or 98^{th} percentile concentration (SO_2, NO_2), the 99^{th} or 98^{th} percentile concentration was used for screening. For CACs where an annual average human health-based air quality guideline is available, annual average CAC concentrations were calculated using data from the 2003 modelling year, which represents the worst year of the three for which air quality modelling was completed (Section 10.1). Baseline metal concentrations in air were assumed to be negligible based on measurements from total dustfall monitoring stations in the LSA.

For reference purposes and to provide a point of comparison against modelling results, baseline ambient air quality levels were obtained from three monitoring stations operated by the National Air Pollution Surveillance Program (NAPS), located between 5.8 km and 8.8 km from the northern edge of the plant boundary. In addition, long-term baseline information on particulate matter (PM) is available for the Project tenure area from the National Air Pollution Surveillance Program (NAPS), and background dustfall has been monitored at 20 different project-specific monitoring stations since 2007. A detailed discussion of the baseline air quality assessment is provided in Section 10.1.

Figure 10.4-1
Human Health Study Areas and Receptor Areas

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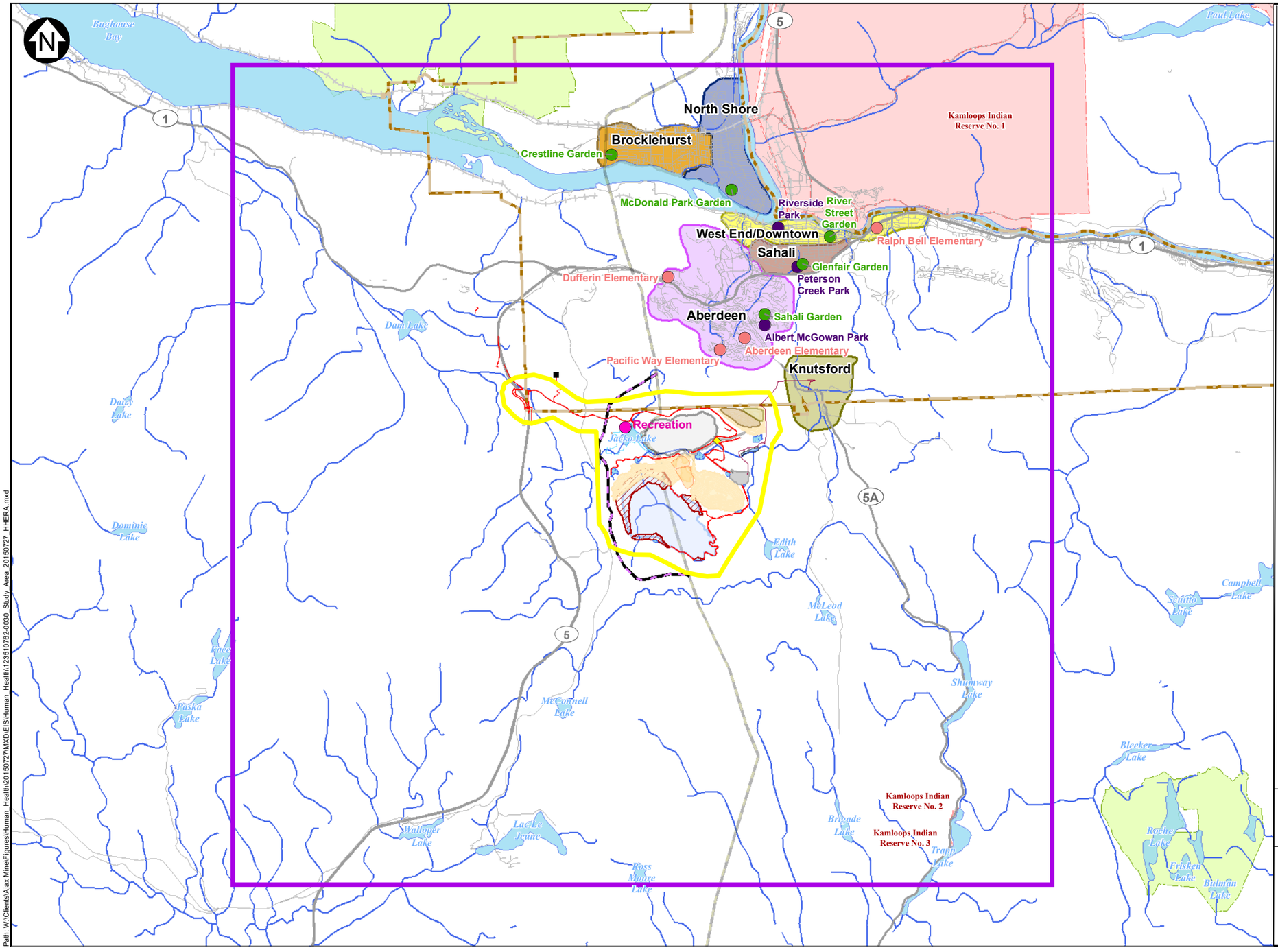

Receptor Location
- Gardens
- Parks
- Recreation
- Schools
- Local Study Area
- Plant Boundary

Base Data
- Highway
- Paved Road
- Kinder Morgan Pipeline - Current
- Kinder Morgan Pipeline - Rerouted
- Natural Gas Line (approx. location)
- Railway
- Watercourse
- City of Kamloops Boundary

Proposed Structure (Year 8 Operation)
- Explosives Facility (Alternate)
- Overpass
- Road
- Mine Rock Storage Facility (MRSF)
- Pit Outline
- Tailings Storage Facility (TSF)
- TSF Embankment
- Ore Stockpile
- Overburden Stockpile
- Topsoil Stockpile

Water Management
- Water Management Pond

Jacko Lake
- Dam Outline

NOTES:
1. BASE MAP: GOVERNMENT OF BRITISH COLUMBIA
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD83 UTM, ZONE 10 NORTH, METER.
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Soil Quality

Surface soil samples were collected from the Project tenure area and areas outside the Plant Boundary between 2011 and 2014 (see Figure 10.4-2). Baseline surface soil samples were also collected from community gardens, schools, and parks within five residential areas (Aberdeen, Sahali, West End/Downtown, North Shore, and Brocklehurst) including from five community gardens operated by the City of Kamloops (Sahali, Sahali, River Street, North Shore Park, Brocklehurst), from four elementary schools (Dufferin, Aberdeen, Pacific Way, Ralph Bell), and from three City parks (West End/Downtown, Albert McGowan, Peterson Creek). Surface soil sampling locations are provided in Figure 10.4-2.

The means of the baseline soil results for garden soil, school soil and park soil from each area were adopted as the Baseline Case soil exposure point concentrations (EPCs) for that area. Exposure point concentrations are defined as the concentration of a given chemical in a given medium, to which human and ecological receptors may be exposed. The EPC can be either measured or calculated. Baseline soil data was not available for Knutsford or Kamloops Indian Reserve No. 1. Baseline Case soil concentrations from Aberdeen were adopted as soil EPCs for Knutsford and Baseline Case soil concentrations for West End/Downtown were adopted as the Baseline Case concentrations for the Kamloops Indian Reserve No. 1. The approach of adopting the Baseline data from a nearby location when specific data are not available for a given location, is considered reasonable as the soil concentrations across the LSA were generally comparable.

Surface Water

Surface water samples were collected from the Peterson Creek watershed between 2007 and 2014 (Figure 10.4-3). The locations sampled include Peterson Creek, Humphrey Creek, the South Catchment of Peterson Creek, Keynes Creek, Jacko Lake, Edith Lake and Goose Lake. Water quality predictions for the Future Case were completed for locations in Peterson Creek (PC02, PC02.3), Jacko Lake (JACL), Humphrey Creek (HUMPH02) and Peterson Creek downstream pond (PCDP) as well as multiple site water management ponds. The predictions for locations PC02, PC02.3 and JACL were used to estimate exposure concentrations for the Future Case as these locations are accessible to human and ecological receptors and represent either sensitive locations (i.e., Jacko Lake) or are expected to undergo the greatest changes in water quality (e.g., PC02).

The annual weighted average of surface water samples from PC02, PC02.3 and JACL collected between 2012 and 2014 were used to estimate the EPC for the Baseline Case. Earlier samples were excluded as the data from 2012 to 2014 is considered more reflective of current conditions. The maximum predicted annual average surface water concentrations for PC02, PC02.3 and JACL were used to estimate the EPC for the Future Case.

Domestic Water Quality

Domestic water refers to water that is used for human consumption, (both for drinking and other domestic uses). In the LSA, domestic water refers to municipally sourced water from the City of Kamloops and privately sourced water from potable domestic wells and surface water (Peterson Creek) in the Knutsford area. Domestic water does not refer to surface water (i.e., lake and river

water) or groundwater that is not consumed by people on a regular daily basis. The use of surface water from lakes or streams as drinking water on an occasional or casual basis by people engaged in traditional or recreational activities represents a very minor component of the exposures that occur through the consumption of domestic water in the home. Therefore, the occasional consumption of surface water during traditional or recreational activities, is not considers further in the assessment.

Water drawn from the South Thompson River is treated and piped throughout the City of Kamloops, including the community of Knutsford. Drinking water at the Kamloops Indian Reserve is also drawn from the South Thompson River but is independently treated at the Tk'emlúps Indian Band Water Treatment Plant. There are 84 groundwater wells registered for private domestic use in the community of Knutsford, but only one is registered as currently active.

Municipal Water

Three post-treatment water samples were collected from the City of Kamloops staff from the Water Treatment Plant for trace metal analysis between February 2014 and April 2015. The maximum concentrations measured in these samples were used as baseline municipal water concentrations for the human health assessment. Trace metal analyses results for the City of Kamloops water are provided in the Domestic Water Quality VC (Section 10.2). The location of the inlet pipe for the Water Treatment Plant is in the South Thompson River (Figure 10.4-3).

Groundwater

Eight groundwater samples were collected at six residential well locations in Knutsford in October 2014. Baseline groundwater concentrations for the human health assessment were based on one residential well in Knutsford, RES-2 (see Section 10.2). This active domestic well is expected to be most affected by the Project, and groundwater modelling was completed to predict Future Case concentrations for this well. The groundwater sampling locations and modelling nodes are provided in Figure 10.4-4.

Additional information about the domestic water quality baseline sampling program and water quality results are provided under the Domestic Water Quality VC (see Section 10.2).

Country Foods Quality

To establish existing trace metal concentrations in country food tissues, baseline country foods samples (vegetation, fish, beef) were collected from the Project tenure area and adjacent agricultural lands, and produce was collected from community gardens (Figure 10.4-2).

Traditional Vegetation

Aboriginal people are reported to consume berries and medicinal plants in the LSA. Berries and other traditional use vegetation were not collected during baseline sampling, but instead baseline trace metal concentrations in berries were estimated from baseline soil concentrations and published uptake factors from soil to vegetation (Appendix 10.4-A).

Figure 10.4-2
Human Health Baseline Terrestrial Sampling Locations

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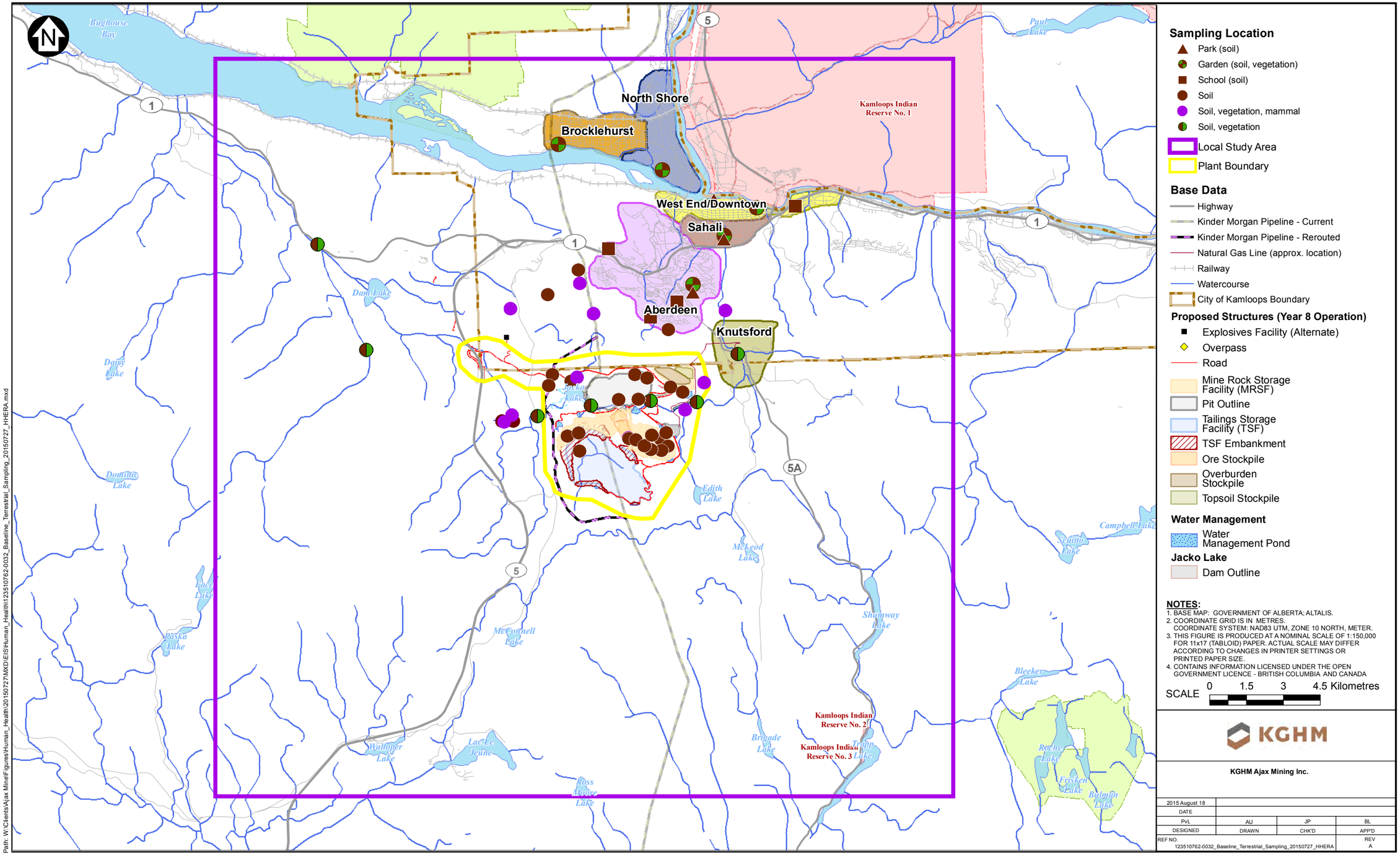

Figure 10.4-3
Location of Baseline Surface Sampling, Fish Sampling and Water Modelling Nodes

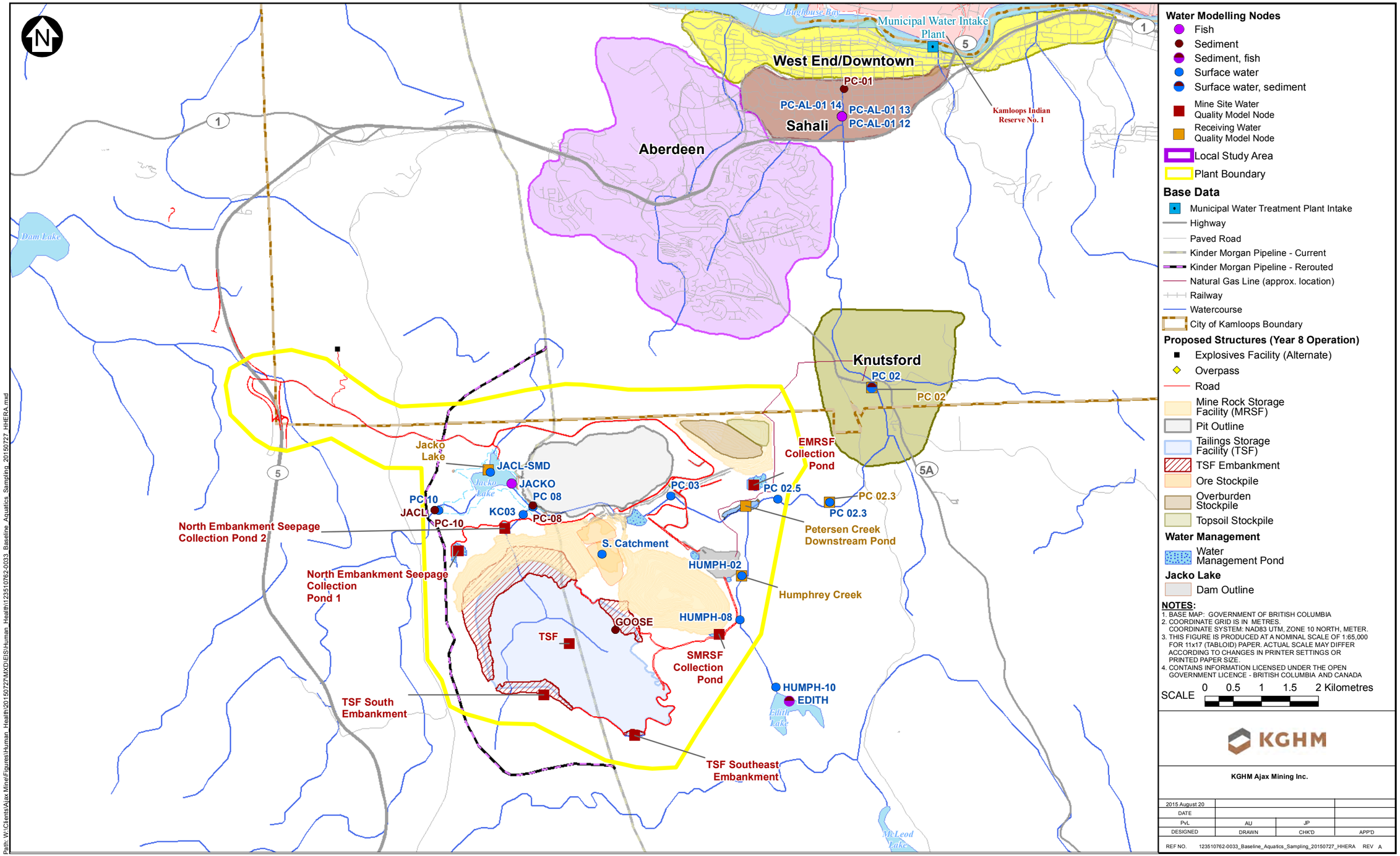

Figure 10.4-4
Location of Baseline Groundwater Sampling and Water Modelling Nodes

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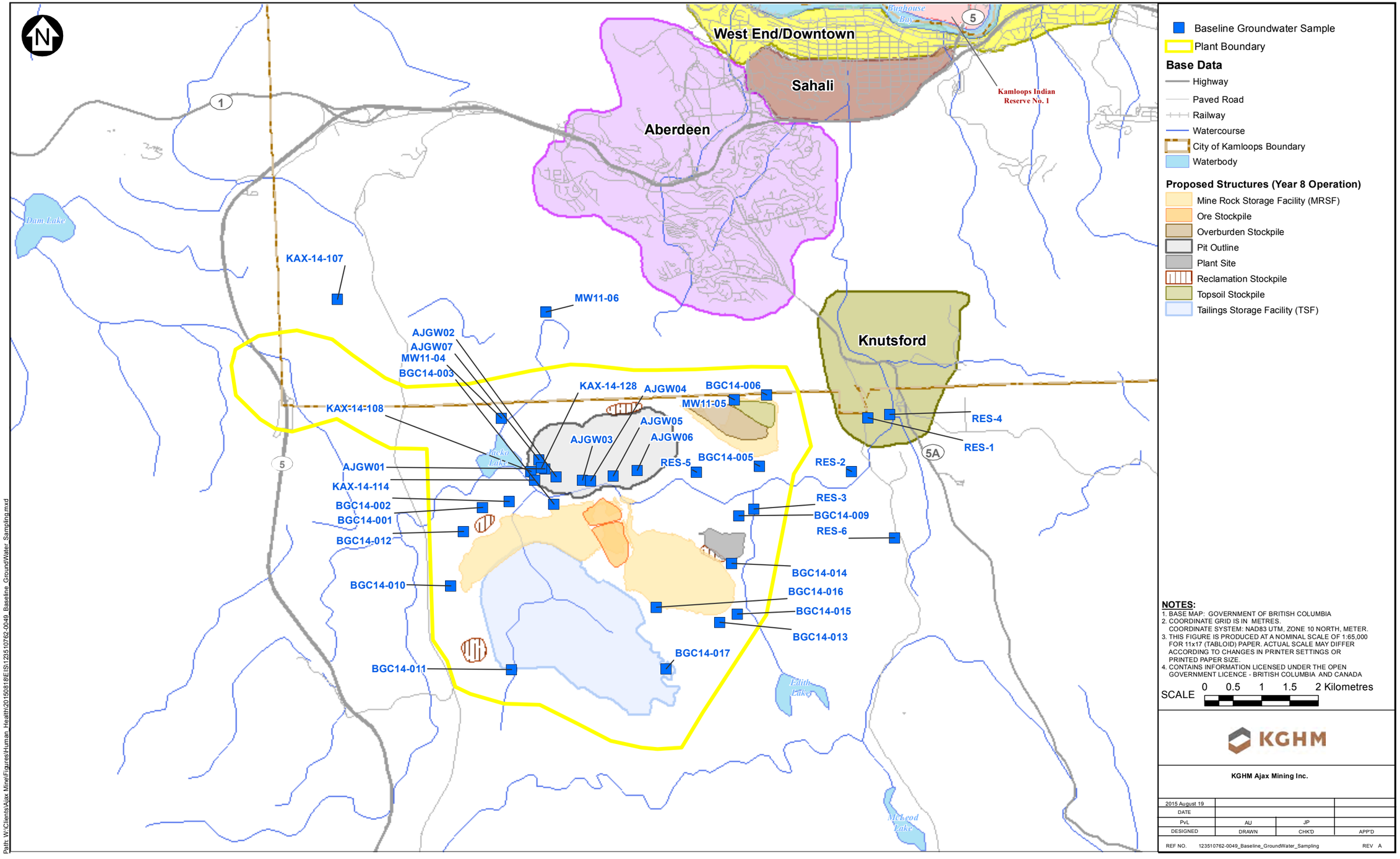

NOTES:
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Cattle and Wild Meat

Four beef samples were obtained from local cattle and analyzed for trace metal concentrations. Tissue samples of wild meat were not available for analysis; therefore, concentrations of chemicals of potential concern (COPCs) in wild meat for the Baseline Case were estimated using measured concentrations in forage and browse, soil (incidental ingestion), and surface water from Jacko Lake and Peterson Creek, along with estimated COPC concentrations in berries (Appendix 10.4-A).

Fish

Ten fillet samples were collected from Jacko Lake and Peterson Creek in 2014 and submitted for trace metal analysis to establish existing trace metal concentrations in fish relevant to human consumption (Section 10.3). Fish sampling locations correspond with the locations of surface water sampling (Figure 10.4-3).

Community Garden Produce

Garden produce (roots, leaves, fruit) was collected from five community gardens in August 2012 (Figure 10.4-2). As garden produce samples were not collected from the Knutsford assessment area data from Aberdeen were used as surrogates. Similarly, data from the West End/Downtown assessment area were used as surrogates for the Kamloops Indian Reserve.

Additional information and results for the Baseline Case country food quality are provided under the Country Foods VC (see Section 10.3).

10.4.3 Assessment Boundaries

The assessment boundaries for the human health VC define the maximum limit within which the effects assessment is conducted. They encompass the areas within, and times during which, the Project is expected to interact with human health, as well as the constraints that may be placed on the assessment of those interactions due to political, social, and economic realities (administrative boundaries), and limitations in predicting or measuring changes (technical boundaries). The definition of these assessment boundaries is an integral part in scoping for human health, and encompasses possible direct, indirect and induced effects of the Project on human health, as well as the trends in processes that may be relevant.

10.4.3.1 Spatial Boundaries

Local Study Area

The human health effects assessment relies on environmental quality data provided by the air quality and water quality assessments. Therefore, the LSA for the human health effects assessment incorporates the LSAs for the air quality and water quality assessments so that the necessary predictive air quality and water quality information is available for the human health effects assessment. The LSA for the assessment of human health effects is based on the air quality LSA which is a 30 km x 30 km square centered on the Project (see Figure 10.4-5; Section 10.4.2.1). The LSA is based on the spatial boundaries defined in the air quality assessment, and incorporates the LSA for the water quality assessment. The LSA incorporates the potential changes in environmental

media from air emissions, as well as from other project-related emissions (i.e., seepage to groundwater and surface water).

The LSA includes the eight human receptor areas considered in the Human Health VC (see Figure 10.4-1); including the portion of the Kamloops Indian Reserve No. 1that lies within the LSA, five city residential areas with backyard and community gardens, and the Project tenure area. Project tenure area includes the "Plant Boundary" as indicated on Figure 10.4-2 and encompasses the proposed mine site as well as associated infrastructure. Jacko Lake is included in the Project tenure area.

Regional Study Area

The human health effects assessment relies on environmental quality data provided by the air quality and water quality assessments. Therefore, the RSA for the human health effects assessment incorporates the RSAs for the air quality and water quality assessments so that the necessary predictive air quality and water quality information is available for the human health effects assessment. The RSA for the human health effects assessment is a rectangular area 70 km along the east-west axis and 55 km along the north-south axis, positioned to the north of the Project tenure area (Figure 10.4-5) The RSA for the human health effects assessment is based on the spatial boundaries for the RSA defined in the air quality assessment, as this area incorporates the potential changes in environmental media from air emissions, and also considers the spatial boundaries of other project-related emissions (i.e., discharges to groundwater and surface water). The RSA is positioned to the north of the Project tenure area because the prevailing wind direction is from the southwest during the summer, and, therefore, air emissions and dust will have a tendency to disperse northward from the Project.

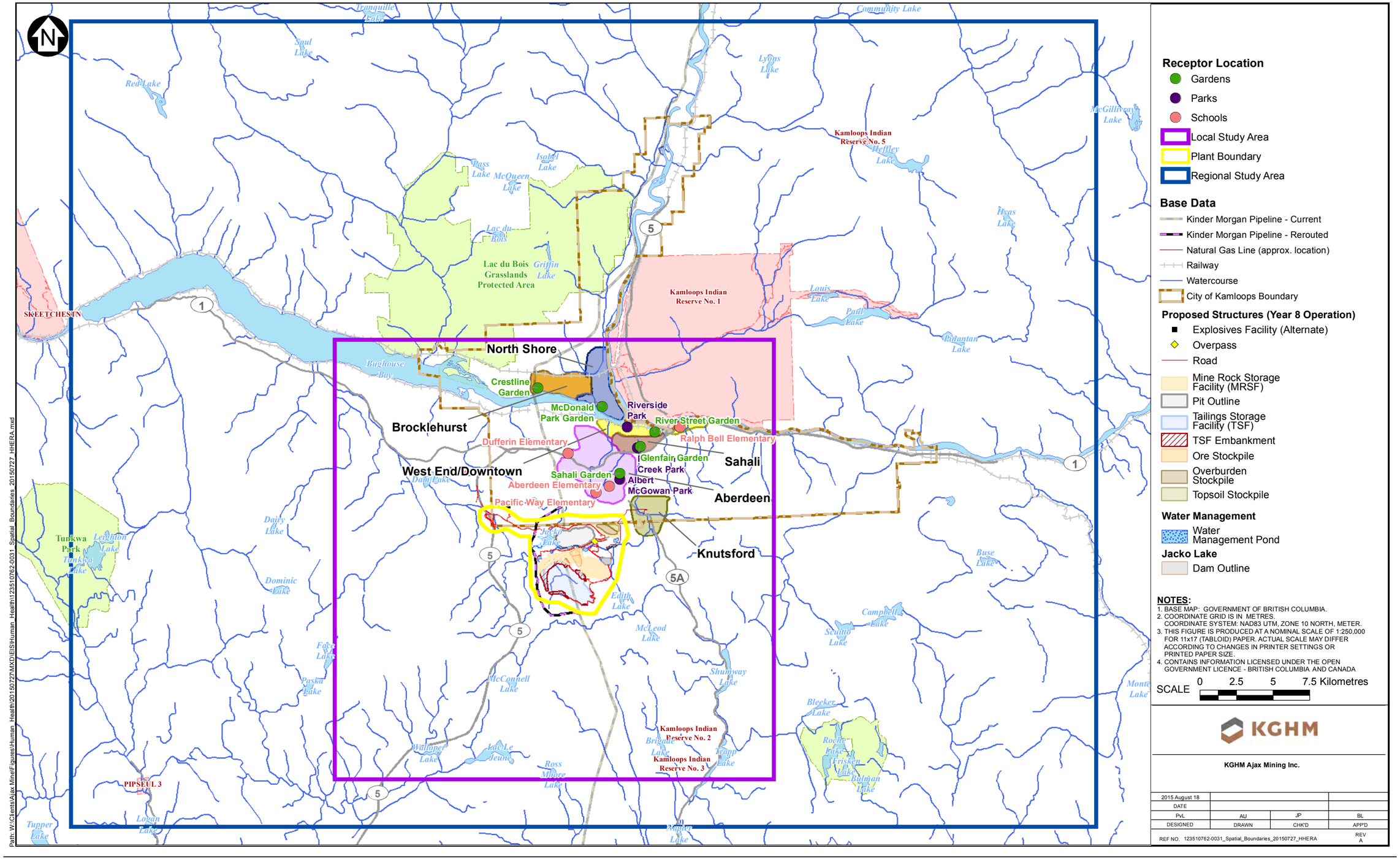
10.4.3.2 Temporal Boundaries:

The temporal boundaries for the human health effects assessment include all four phases of the Project, as listed below:

- Construction: 2 years;
- Operation: 23 years;
- Decommissioning and Closure: 5 years (includes project decommissioning, abandonment and reclamation activities, as well as temporary closure, and care and maintenance); and,
- Post Closure: 5+ years (includes ongoing reclamation activities and post-closure monitoring).

The human health effects assessment for inhalation exposures considered the air quality modelling data for CACs for the worst years of operation and applied these results to all the Construction, Operations and Decommissioning and Closure phases of the Project. These results were used to estimate the potential change in human health risk associated with changes in air quality associated with Project activities.

Figure 10.4-5
Human Health Spatial Boundaries



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The human health effects assessment for ingestion (country foods, domestic water and incidental ingestion of soil) and direct contact exposures were modelled for Post Closure phase of the project when dust deposition over the entire life of the project will have reached the maximum level. The highest predicted annual dust deposition rates for the Operations phase were assumed to occur every year of the Construction, Operation and Decommissioning and Closure phases to provide an upper-bound estimate of potential dust accumulation over the life of the Project.

10.4.3.3 Administrative Boundaries

Administrative boundaries for the assessment of human health are governed by the accepted methodologies and guidelines for the conduct of HHRA in Canada. Guidance and supporting documents include:

- Federal Contaminated Sites Risk Assessment in Canada, Part V: Guidance on Complex Human Health Detailed Quantitative Risk Assessment For Chemicals ($DQRA_{CHEM}$) (Health Canada 2010a);
- Federal Contaminated Sites Risk Assessment in Canada, Part I: Guidance on Human Health Risk Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 (Health Canada 2012);
- Federal Contaminated Sites Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors Version 2.0 (Health Canada 2010b);
- Federal Contaminated Site Risk Assessment in Canada. Supplemental Guidance on Human Health Risk Assessment for Country Foods (HHRAAIR). Draft. Version 1.2. October 2010. Contaminated Sites Division – (Health Canada 2010c);
- Guidelines for Canadian Drinking Water Quality (Health Canada); and
- Approved, Working Water Quality Guidelines (Criteria) Reports for drinking water, irrigation, and recreation and aesthetics Professional judgement based on relevant best practices.

Technical boundaries for the human health effects assessment include:

- The inherent uncertainties in all HHRAs due to gaps in data or knowledge lead to the use of conservative assumptions that err on the side of over-estimated exposures and risks. For example, the uncertainties associated with using animal toxicity data to estimate the toxicity of chemical in humans leads to an over estimation of the chemicals toxicity in humans. Gaps in knowledge related to human activity (time spent in any given location) and behaviour (types and amounts of country foods consumed) require that assumptions that are likely to over-estimate potential exposures, be used to assess potential human health risks; and
- The inherent uncertainty of fate and transport models used to predict future concentrations.

10.4.3.4 Technical Boundaries

10.4.4 Potential Effects of the Project and Proposed Mitigation for Human Health

The potential effects of the Project on human health are summarized below.

10.4.4.1 Identifying Potential Effects on Human Health

The environmental assessment of human health is focused on the change in human health associated with Project activities. A change in biophysical human health refers to the health of those people living, working or enjoying recreational or traditional activities in the vicinity of the Project, including workers employed by the Project that live or enjoy recreational activities near the Project. While on the site, workers employed by the Project will be subject to applicable provincial occupational health and safety laws (WorksafeBC Occupational Health and Safety Regulations). The assessment of a change in human health is based on the risk characterization predictions derived in the human health and ecological risk assessment (Appendix 10.4-A).

A change in human health may be caused by Project activities that could release or emit chemicals of potential concern to which human receptors may be exposed. Human health may be affected directly through changes to air quality and drinking water quality, and indirectly by consumption of country foods (e.g., vegetation, wild meat, fish) that have taken up Project-related chemicals. The following pathways have the potential to affect human health thereby resulting in a change to human health:

- Emission and dispersion of CACs, PAH and metals from Project activities have the potential to affect air quality, potentially affecting human health.
- Deposition of metals from dust onto soil as a result of Project activities has the potential to affect soil quality and surface water quality, with subsequent chemical uptake by wildlife and vegetation, including country foods.
- Discharges and runoff from Project operations may release chemicals into groundwater or surface water, affecting water quality, and thereby potentially affect drinking water and country foods.

Table 10.4-1 summarizes the potential project interactions and effects on human health.

Project activities can interact with human health in several ways:

- The release of CACs and PAH to the air represents a potential interaction for people who may inhale the CACs from the air;
- The deposition of Project-derived metal-bearing dust to soil has the potential to increase the amount of metal present in surface soil in the LSA. This increase in metal concentrations in soil has the potential to alter the metal concentrations in backyard garden produce and country foods (wild meat, domestic cattle and vegetation) that are grown or are raised on soils where deposition occurs;

- The deposition of Project-derived metal-bearing dusts to surface soil could also increase direct contact exposures (incidental soil ingestion and dermal contact) to metals in soil; and
- Project activities that could result in changes to surface water and/or groundwater quality also have the potential to interact with human health by altering metal concentrations in surface water or groundwater that may be used as sources of domestic (potable) water.

- Project interactions ranked as "O" in Table 10.4-1 have no anticipated interactions with human health (either directly, or through effects on Domestic Water (Section 10.2) or Country Foods (Section 10.3)) and have not been evaluated in the assessment of potential effects on human health.

Table 10.4-1. Identifying Potential Project Interactions and Effects on Human Health

Project Activities		Potential Effects on Human Health Change in Human Health
Construction	Clearing and Grubbing	O
	Earthworks	O
	Overburden/Topsoil Stockpile	O
	Laydown Areas and Storage Yards	O
	Project Lighting	O
	Site Security and Fencing	O
	Fuel Storage and Filling Area	O
	Hazardous Wastes Transport, Storage, and Disposal	O
	Construction Wastes Transport, Storage, and Disposal	O
	Sewage Infrastructure and Disposal	O
	Public Road Realignment, Use, and Maintenance	O
	Site Road Construction, Use and Maintenance	O
	Peterson Creek Bridge Construction, Use, and Maintenance	O
	Site Buildings and Process Plant	O
	Explosives Magazine and Storage Facilities	O
	Open Pit Development	O
	Drilling and Blasting	O
	Crushing Waste Rock	L
	Loading, Hauling, and Deposition of Waste Rock	L
	Temporary Ore Stockpile	M
	Tailing Storage Facility Development	L
	Power Transmission, Distribution	O
	Natural Gas Line	O
	Pipeline Utility Corridor (Potable Water, Sewage, and Site Water)	O
	Water Intake from Kamloops Lake	O

	Project Activities	Potential Effects on Human Health Change in Human Health
Construction (*cont'd*)	Fire Suppression Infrastructure	O
	Contact Water	L
	Non-contact Water	O
	Peterson Creek Diversion	O
	Water Management Dams	O
	Mine Staffing (Direct Employment)	O
	Contracted Employment	O
	Taxation	O
Operation	Open Pit Development	H
	Drilling and Blasting	H
	Hauling Waste Rock and Ore from Pit	H
	Crushing and Conveying Ore	H
	Temporary Ore Stockpile	M
	Development of Mine Rock Management Facilities	M
	Stripping, Loading, Hauling, Deposition, and Contouring of Topsoil and Overburden	M
	Revegetation through Progressive Reclamation	O
	Process Plant Operation	H
	Deposition to Tailing Storage Facility	M
	Site Road Use and Maintenance (Materials, Personnel, Supplies)	L
	Concentrate Transport and Storage	L
	Explosives Magazine and Storage Facilities	O
	Fire Suppression Infrastructure	O
	Fuel Storage and Filling Area	O
	Hazardous Wastes Transport, Storage, and Disposal	O
	General Wastes Transport, Storage, and Disposal	O
	Sewage Infrastructure and Disposal	O
	Laydown Areas and Storage Yards	O
	Power Transmission, Distribution	O
	Project Lighting	O
	Site Access, Security and Fencing	O
	Water Intake from Kamloops Lake	O
	Contact Water	M
	Non-contact Water	O
	Potable Water Treatment and Use	O
	Peterson Creek Diversion	O
	Mine Staffing (Direct Employment)	O
	Contracted Employment	O
	Taxation	O

	Project Activities	Potential Effects on Human Health Change in Human Health
Decommissioning and Closure	Dismantling of Ancillary Buildings	O
	Pit Lake Planning	O
	Site Road/Bridge Decommissioning	O
	Tailing Storage Facility Decommissioning and Reclamation	L
	Mine Rock Management Facilities Reclamation	L
	Fuel Storage and Filling Area	O
	Hazardous Wastes Transport, Storage, and Disposal	O
	General Wastes Transport, Storage, and Disposal	O
	Sewage Infrastructure and Disposal	O
	Laydown Areas and Storage Yards	O
	Power Transmission, Distribution	O
	Project Lighting	O
	Site Access, Security and Fencing	O
	Contact Water	H
	Non-contact Water	O
	Potable Water Treatment and Use	O
	Peterson Creek Diversion	O
	Road use to the Project (Materials, Personnel, Supplies)	L
	Mine Staffing (Direct Employment)	O
	Contracted Employment	O
	Taxation	O
Post-Closure	General Site Inspections and Maintenance	O
	Contact Water	H
	Non-contact Water	O
	Road use to the Project (Materials, Personnel, Supplies)	O
	Mine Staffing (Direct Employment)	O
	Contracted Employment	O

Notes:

O *No interaction anticipated.*

L *Negligible to minor interaction expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.*

M *Potential moderate interaction requiring unique active management/monitoring/mitigation; warrants further consideration.*

H *Key interaction; warrants further consideration.*

Project interactions ranked as "L" (green) are anticipated to have negligible to minor effects on CAC concentrations in air, dust deposition rates and/or effects on surface water or groundwater quality. The contributions that these Project interactions could make to changes in human health associated with inhalation exposures to CACs or through alterations in domestic water, country food and/or surface soil quality would make minor contributions to the overall change in conditions when

compared to the Project interactions ranked as "M" or "H". In addition, the effects of Project interactions ranks as "L" can be addressed through the implementation of best management practices, standard mitigations and management measures. For these reasons interactions marked in green are expected to have negligible or minor interactions with human health and will not be discussed in detail. The potential

Interactions ranked "M" or "H" (marked red or yellow) in Table 10.4-1 have the potential to interact with human health and were carried forward for further analysis in the assessment.

The following effects are considered in more detail below:

- change in human health via inhalation of CACs and PAH (construction, operation, decommissioning and closure);
- change in human health via direct contact with soil through incidental soil ingestion and dermal contact with soil (operation, decommissioning and closure and post closure);
- change in human health via ingestion of groundwater and surface water (operation, decommissioning and closure and post closure); and
- change in human health via ingestion of country foods (operation and decommissioning and closure).

10.4.4.2 Effects on Human Health

Potential changes in human health associated with Project activities consider changes in health risks caused by changes in air quality related to CACs (sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter (PM_{10} and $PM_{2.5}$) and PAH from diesel particulate), released to the atmosphere by Project activities and change in soil quality, domestic water quality, and country foods quality related to changes in metal concentrations in these media. The selection of the chemicals to be considered in the assessment of Project effects on human health risk is provided in Section 3 of Appendix 10.4-A. Atmospheric emissions (e.g., vehicle exhaust and dust) have the potential to increase chemical concentrations in soil. Project activities can lead to water discharges including effluent and seepage, which can increase chemical concentrations in water. These changes to chemical concentrations in soil and water can, in turn, lead to changes in the concentrations of these chemicals in country foods (e.g., vegetation, wild meat, fish tissue, and beef cattle). Changes in air, soil, water and backyard garden produce may alter the health risk for Aboriginal and non-aboriginal people who live or spend time in the LSA or RSA. In addition, changes in country food quality may alter the health risks for people who engaged in fishing, hunting, trapping, and traditional and recreational activities within the LSA and RSA.

Based on current and anticipated future land use in the Project area, human receptors fall into four major categories:

1. Residential Receptors: people who reside in the RSA. Residential receptors may have backyard gardens, and consume wild meat, fish or plants collected from within the LSA.

2. Farmer or Rancher Receptors: people who reside in the RSA, have backyard gardens, and raise cattle. The Farmer or Rancher receptors are expected to consume more local cattle than a typical Residential receptor in Kamloops, and may also hunt and fish.
3. Aboriginal Receptors: Aboriginal people who reside at the Kamloops Indian Reserve No.1. Aboriginal receptors may have backyard gardens, but also hunt, fish, and collect traditional vegetation from the LSA. Other Aboriginals in the region may also use the land in the RSA for traditional purposes, but their exposure would be less than those who reside at the Kamloops Indian Reserve No. 1. because the deposition of Project-related metal-bearing dust onto soil at this location will be higher than at other locations, meaning that changes in metal concentrations in backyard garden produce will be higher at the Kamloops Indian Reserve No. 1. than at other Reserve locations.
4. Recreational Receptor: people that may be present near the Plant Boundary and who may hunt or fish in the LSA (e.g., someone fishing in Jacko Lake) or use the area for other recreational activities (e.g. mountain biking). This receptor is evaluated for inhalation exposures only, as other exposures are assumed to be the same as those of the Residential receptor.

As discussed in Section 10.4.2, a total of eight human receptor areas were considered. In some cases the principal receptors for each area differed based on land use. The areas and the receptors that apply to each include:

- Aberdeen: Residential receptors
- Sahali: Residential receptors
- West-End/Downtown: Residential receptors
- North Shore: Residential receptors
- Brocklehurst: Residential receptors
- Knutsford: Farmer-Rancher receptors. Knutsford contains a number of cattle ranches. Due to the lack of baseline data for this area, soil data and backyard produce data from Aberdeen was used to estimate exposure for the Farmer-Rancher receptor.
- Aboriginal Receptors: Residents of Kamloops Indian Reserve No. 1 have been used to represent Aboriginal receptors. The West End/Downtown area of Kamloops, which is downwind of the Project, is used to estimate exposure for the Aboriginal receptor.
- The Plant Boundary: Recreational receptor. The Recreational receptor has been chosen to represent members of the Aboriginal community who may engage in hunting, fishing, collecting traditional plants and medicines, or other traditional or ceremonial activities near the Project tenure area. It has also been chosen to represent members of the non-aboriginal community who may be present near the Project tenure area (e.g., someone fishing in Jacko Lake). This receptor is evaluated for inhalation exposures only, as other exposures, such as the consumption of country food or backyard garden produce are assumed to be the same as the Aboriginal Residential receptor.

The assessment of environmental effects to human health considers the human health risks from three cases:

- The "Baseline Case" evaluates the health risk from exposure to the existing chemical concentrations in environmental media and does not include the effects of the Project. Existing chemical concentrations in air, soil, water, sediment, plants, benthic invertebrates, and fish are based on laboratory analysis of samples. Chemical concentrations for wild meat (e.g, mule deer), and small mammals (snowshoe hare) are estimated based upon measured concentrations of chemicals in other media.
- The "Project-alone Case" evaluates the health risk for exposures to chemical concentrations in environmental media at concentrations that reflect only the Project's contribution to the environmental loading of project-related chemicals. The Project-alone Case does not include the environmental loading associated with the Baseline Case and is used to evaluate potential changes in human health risk associated with inhalation exposures to chemicals in the air for which baseline monitoring and modelling data are not available. This applies to dust-bound metals contained in dust release by Project activities and to polycyclic aromatic hydrocarbons (PAH) released in diesel particulate matter.
- The "Future Case" evaluates the health risks from predicted chemical concentrations (including contributions from the Project) in environmental media, as determined through detailed predictive modelling. These modelling results are used to determine the future chemical concentrations in exposure media that human receptors are exposed to (i.e., air, water, soil, sediment, vegetation, wild meat, and fish).

The Future Case considers all Project phases: construction, operation, decommissioning and closure, and post-closure. As part of the conservatism applied in the risk assessment framework, the health risks for the Future Case focused on the Project phase that would have the greatest influence on concentrations of Project-related chemicals in a given environmental medium. Specifically:

- because CAC, PAH and particulate-bound metal concentrations in air will be highest during the operations phase (Section 10.1), the assessment of potential human health risks associated with inhalation exposures is based on the operation phase and the results are conservatively assumed to apply to all phased of the Project;
- human ingestion and direct contact exposures are driven by metal concentrations in soil. Dust deposition to soil will continue over the life of the Project, meaning that metal levels concentrations in soil will reach their maximum level at post-closure once Project operation activities cease. A similar situation exists for terrestrial ecological receptors. Therefore, the assessment of Project effects on soil-related exposures has been based on Post-closure and
- metal concentrations in surface water and groundwater could be affected during all Project phases as well as Post-Closure. Potential Project effects for water-related exposures for human and ecological receptors have been based on the water quality modelling completed in the water quality VCs (Section 6.3 and Section 6.5 and the Water Quality Modelling report (Appendix 6.3-C) , the Groundwater Quality Predictions for

Res-2 (Appendix 6.5-B) , which evaluated potential changes in water quality during operations operation, decommissioning and closure, and post-closure.

Potential health risks were estimated for each of the five principal age groups (i.e., infant, child, toddler, teen and adult) for each receptor type and case. The HHRA incorporated a number of assumptions to provide conservative estimates of possible exposures and the associated potential human health risks such as:

- during the infant life stage, humans are only expected to consume milk/formula and are not expected to consume solid foods such as local cattle and backyard produce;
- ingestion rates of cattle are not provided by Canadian regulators. Instead the ingestion rate of cattle was estimated from the total intake rate of meat for the general Canadian population provided in Richardson (1997). Ingestion of local cattle was assumed to account for 10% of the total meat intake rate for Residential receptors, and it was assumed that Aboriginal receptors consumed a similar amount of local cattle. Farmer-Rancher receptors were assumed to obtain 50% of their total meat intake rate from local cattle;
- fish ingestion rates for Aboriginal and non-aboriginal people were adopted from Health Canada (2004). The major fishing location within the LSA is Jacko Lake, and fish (e.g., trout) from this stocked lake can only be obtained using rod and reel because nets are prohibited. In addition the fish sampled from Jacko Lake and Peterson Creek were generally small (<250 g). While Jacko Lake is a popular fishing spot it is unlikely that Aboriginals or non-aboriginal people obtain a substantial portion of their fish intake from Jacko Lake or Peterson Creek. If Aboriginal or non-aboriginal people were to obtain a substantial portion of their fish intake from the general Kamloops area, it is more likely they would obtain it from the Thompson River, where the principal target species is salmon and devices such as nets and fishing wheels are permitted. As a result, Aboriginal and non-aboriginal residents are assumed to obtain 10% of their total fish intake from Jacko Lake;
- wild meat ingestion rates for the Aboriginal receptor were adopted from Health Canada (2012), and Aboriginal people are assumed to obtain 100% of their wild meat intake from the LSA. Health Canada does not provide wild meat intake rates for the general population. Instead it was assumed that the intake rate of wild meat for the Residential and the Farmer-Rancher receptor was 10% of the daily intake rate of meat for the general Canadian population, as provided in Richardson (1997);
- the intakes of three types of wild meat are assessed in this risk assessment: deer; snowshoe hare; and grouse. These species were identified to be potentially present in the LSA and testimonials from local hunters indicate that these species are hunted in the area. It was assumed that intake rates of deer, snowshoe hare, and grouse account for 80%, 10% and 10% of the total intake of wild meat, respectively;
- the intake rates for traditional plants for members of the Aboriginal community are based on information provided in Chan et al. 2011. Based on Chan et al (2011), the site is located in Ecozone 3, which corresponds to the Montane Cordillera/Plateau. The mean

grams of each traditional plant consumed per day by an Aboriginal in Ecozone (Chan, 2011) was combined with information from Richardson (1997) about the relative amounts of leafy vegetables consumed by each age group, to estimate overall intake of traditional plants for each age group. The information in Chan et. al (2011) was also used to determine that the intake of traditional plants is comprised of 80% berries and 20% forage (leafy plants).

- intake rates of backyard produce including root vegetables and other vegetables were adopted from Health Canada (2010). Residential and Aboriginal receptors are assumed to obtain 10% of their intakes of root vegetables and other vegetables from backyard gardens;
- The intake rate of fruits was adopted from Richardson (1997). As with vegetables, Residential, Farm and Aboriginal receptors are assumed to obtain 10% of their intake of fruits from backyard gardens.

In order to determine the magnitude of potential human health risks, predicted chemical exposures are compared to toxicity reference values (TRVs). For non-carcinogenic compounds, the TRV represents the concentrations below which adverse health effects are not expected. The ratio of the predicted chemical exposure to the non-carcinogenic TRV is called the concentration ratio (CR) for chemicals in air, and hazard quotient (HQ) for chemicals that are ingested. Concentration ratio is defined as the ratio of the concentration of a chemical in the exposure media to the concentration of the chemical considered to be protective of human or ecological health. Hazard quotient is defined as the ratio between the predicted estimated daily averaged exposure to a chemical in environmental media (e.g. country foods, soil and/or water) and the human health-based toxicity reference value as defined by regulatory agencies such as Health Canada. For non-carcinogens, CRs and total HQs were compared to a benchmark of 1.0 consistent with the approach used by the British Columbia Ministry of the Environment in assessing human exposures to chemicals on contaminated sites. When the CR or HQ is less than 1.0, the health risk is considered negligible and health effects are not expected.

For carcinogenic chemicals, the TRV represents the potential change in lifetime cancer risk associated with a lifetime averaged daily exposure to a carcinogen at a dose of 1 mg of chemical per kilogram of body weight per day (for ingestion exposures) or at a concentration of 1 mg of chemical per cubic meter of air (for inhalation exposures). Exposures to cancer-causing COPCs through either inhalation or ingestion were expressed as the incremental increase in lifetime cancer risks (IILCRs), representing the increased risk of a person in a given population developing cancer over their lifetime as a result of the Project. The IILCRs are calculated as the product of the carcinogenic TRV and the estimated lifetime averaged daily exposure (LADD). The IILCRs were compared to an acceptability benchmark for increased cancer risk of 0.00001 (i.e., 1×10^{-5}), or 1 person in a population of 100,000 predicted to develop cancer as a result of Project-related exposure.

Non-carcinogenic health endpoints are assessed for different receptor groups (i.e., infant, toddler, child, teen, and adult), and results for the toddler receptor are presented below. The toddler stage (six months through four years) is considered more susceptible to oral exposures than other age groups due to their higher ratio of ingestion rate to body weight (Health Canada 2012). If assessment

of exposure to COPCs for the toddler receptor group finds acceptable risk levels, the risk to other life stages will also be acceptable.

Carcinogenic endpoints are assessed over the lifetime of an individual, and not for any particular life stage. Arsenic was identified as the only carcinogenic COPC via the ingestion pathway.

Human Health Risks via Inhalation

The dispersion of CACs and other COPCs (PAH and metals) in ambient air were modelled for the construction (CACs) and operation phases of the Project (CACs PAH and metals). For the CACs, the predicted air concentrations were compared to the human health-based ambient air quality criteria for the appropriate exposure averaging period (1-hour, 24-hour or annual average) to determine if the predicted CAC concentrations represented potential human health risks. For the metals, the predicted concentrations in air were compared to the inhalation TRVs for long-term (annual-average) exposure to determine if the predicted metal concentrations represented a potential human health risk. These comparisons are expressed as CRs. The predicted CAC and metal concentrations in air used in the assessment are provided in Section 3.3.3.1 of Appendix 10.4-A. The human health-based ambient air quality criteria and the inhalation TRVs selected for use in the assessment are presented in Section 4.2.1 of Appendix 10.4-A. This section also identifies the health effect that each air quality criterion or TRV is based upon and lists the agencies used as the sources of the air quality criteria and TRVs. The calculation of the CRs is provided in Section 4.4.3 of Appendix 10.4-A. The health risk estimates (CRs) were used to evaluate the potential magnitude of the residual effects associated with the Project. Health risks were evaluated for the eight identified human receptor areas including Aberdeen (including Upper Aberdeen), Brocklehurst, Sahali, North Shore, West End/Downtown, Knutsford, the Kamloops Indian Reserve No. 1, and the Jacko Lake recreational area (which included the maximum point of impingement (MPOI) locations around the Project boundary). The maximum point of impingement is defined as the location with the highest predicted ground-level chemical concentration, determined using air dispersion modelling. Although Upper Aberdeen is part of Aberdeen, the community identified the area in the vicinity of Pacific Way Elementary School as an area of particular concern with respect to the effect mine operations could have on fine particulate matter ($PM_{2.5}$ and PM_{10}) levels in the area. To address these concerns, Project-related effects on $PM_{2.5}$ and PM_{10} and other CACs have been considered for the Upper Aberdeen area in addition to the assessment completed for the Aberdeen community in general.

Criteria Air Contaminants

Concentration ratios for the Recreational receptor at the location of the MPOI, the Residential receptor in Aberdeen (including Upper Aberdeen), and the Aboriginal receptor are presented in Tables 10.4-2 to Table 10.4-4. Results for the other human receptor areas are provided in Appendix 10.4-A.

Predicted CRs for Baseline Case, Project-alone Case, and Future Case at the MPOI, Aberdeen (including Upper Aberdeen) and Kamloops Indian Reserve # 1 (Table 10.4-2, Table 10.4-3, Table 10.4-4) and the rest of the areas (Appendix 10.4-A) were less than 1 for SO_2, NO_2, and CO. Predicted CRs of $PM_{2.5}$ for the reasonable upper limit exposure scenario at the MPOI were also below 1. Predicted CRs of PM_{10} exceed 1.0 under Future Case. These results are assessed further below. One or more predicted

maximum CRs for $PM_{2.5}$ and PM_{10} were above 1 for Aberdeen (including Upper Aberdeen), Brocklehurst, Sahali, West End/Downtown, North Shore and Knutsford (Appendix 10.4-A).

Table 10.4-2. Concentration Ratios for Inhalation Exposures to Criteria Air Contaminants at the Maximum Point of Impingement

Criteria Air Contaminant (CAC)	Averaging Period	Concentration Ratio (CR)		
		Reasonable Upper Limit Exposure		
		Baseline Case	Project-alone Case	Future Case
SO_2	1-hour	1.87E-02	6.43E-03	1.95E-02
NO_2	1-hour	1.69E-01	6.18E-01	7.78E-01
CO	8-hour	4.18E-02	5.84E-02	7.66E-02
$PM_{2.5}$	24-hour[a]	6.58E-02	1.61E-01	2.95E-01
PM_{10}	24-hour[a]	6.79E-02	**1.35E+00**	**1.41E+00**

Notes:
Bold CR exceeds benchmark of 1.
[a] *Adjusted for a realistic exposure time of 5 hours per 24 hour period.*

Table 10.4-3. Concentration Ratios for Inhalation Exposures to Criteria Air Contaminants in Aberdeen and Upper Aberdeen

Criteria Air Contaminant (CAC)	Averaging Period	Concentration Ratio (CR)					
		Baseline Case	Project-alone Case	Future Case	Baseline Case	Project-alone Case	Future Case
		Aberdeen			Upper Aberdeen		
SO_2	1-hour	6.27E-02	6.12E-03	6.28E-02	5.17E-02	2.91E-03	5.18E-02
NO_2	1-hour	3.50E-01	4.52E-01	5.34E-01	2.87E-01	4.52E-01	5.34E-01
	annual	5.35E-01	1.38E-01	5.83E-01	4.83E-01	1.38E-01	5.83E-01
CO	8-hour	1.12E-01	2.23E-02	1.13E-01	1.04E-01	2.23E-02	1.04E-01
$PM_{2.5}$	24-hour	**1.16E+00**	7.23E-01	**1.17E+00**	8.05E-01	3.10E-01	8.69E-01
	annual	9.58E-01	7.67E-02	9.67E-01	8.29E-01	7.67E-02	8.55E-01
PM_{10}	24-hour	**1.39E+00**	**1.44E+00**	**1.90E+00**	8.50E-01	**1.44E+00**	**1.90E+00**
	annual	3.23E-01	1.23E-01	3.37E-01	2.31E-01	1.23E-01	2.94E-01

Note:
Bold *CR exceeds benchmark of 1.*

Table 10.4-4. Concentration Ratios for Inhalation Exposures to Criteria Air Contaminants in Kamloops Indian Reserve #1

Criteria Air Contaminant (CAC)	Averaging Period	Concentration Ratio (CR)		
		Baseline Case	Project-alone Case	Future Case
SO_2	1-hour	7.30E-02	1.42E-03	7.30E-02
NO_2	1-hour	3.58E-01	1.40E-01	3.62E-01
	annual	5.33E-01	2.25E-02	5.49E-01
CO	8-hour	1.10E-01	2.97E-03	1.10E-01
$PM_{2.5}$	24-hour	**1.24E+00**	1.17E-01	**1.30E+00**
	annual	9.67E-01	7.47E-03	9.74E-01
PM_{10}	24-hour	**1.57E+00**	7.06E-02	**1.59E+00**
	annual	3.07E-01	9.86E-03	3.16E-01

Note:
Bold *CR exceeds benchmark of 1.*

The CRs and percent increase for 24-hour and annual $PM_{2.5}$ in Aberdeen and West End/Downtown are provided in Table 10.4-5 and Table 10.4-6. The CRs for the remaining areas are provided in Appendix G of the HHERA TDR (Appendix 10.4-A), but the results are discussed herein. The CRs based on the maximum 24-hour $PM_{2.5}$ concentrations, for Baseline and Future Cases, exceed the benchmark of 1.0 in Aberdeen, Sahali, West End/Downtown, Northshore and Brocklehurst, but are below 1.0 in Upper Aberdeen and Knutsford. The CRs based on the annual average $PM_{2.5}$ concentrations, for Baseline and Future Cases, exceed the Benchmark of 1.0 in Brocklehurst, Northshore and Sahali, but are below 1.0 in Aberdeen (including Upper Aberdeen), Knutsford and West End/Downtown. In all cases the increase in $PM_{2.5}$ concentration that occurs between Baseline and Future cases are small with the increases in CRs for 24-hour $PM_{2.5}$ ranging between 0.1% in Sahali and North Shore and 12.4% in Knutsford and the increases in CRs for annual average $PM_{2.5}$ ranging between 0.4% in Brocklehurst and North Shore and 8.1% in Knutsford. Although the largest increases in CRs associated with 24-hour and annual average $PM_{2.5}$ concentrations are seen in Knutsford, the 24-hour $PM_{2.5}$ concentrations are below the air quality guideline of 25 $\mu g/m^3$ and the annual average $PM_{2.5}$ concentrations are below the air quality guideline of 8 $\mu g/m^3$ for both Baseline and Future Cases. These small changes between Baseline Case and Future Case suggest that Project related $PM_{2.5}$ emissions are not expected to contribute substantially to overall $PM_{2.5}$ concentrations in Kamloops and therefore will not make a meaningful contribution to the health risk associated with the inhalation of $PM_{2.5}$.

The CRs and percent increase for 24-hour and annual PM_{10} in Aberdeen (including Upper Aberdeen) and West End/Downtown are provided in Table 10.4-7 and Table 10.4-8. Similar to $PM_{2.5}$, the CRs for the remaining areas are provided in Appendix G of the HHERA TDR (Appendix 10.4-A), but the results are discussed herein. The CRs based on the maximum 24-hour PM_{10} concentrations for Baseline and Future Cases, exceed the benchmark of 1.0 in Aberdeen (including Upper Aberdeen), Sahali, West End/Downtown, North Shore and Brocklehurst, but are below 1.0 in Knutsford. In Upper Aberdeen the CRs based on the maximum 24-hour PM_{10} concentrations are below 1.0 in the Baseline Case and above 1.0 in the Future Case. The CRs based on the annual average PM_{10} concentrations are below the benchmark of 1.0 across all communities including Upper Aberdeen.

Table 10.4-5. Maximum Concentration Ratios and Percent Increase from Baseline to Future Case for Aberdeen for $PM_{2.5}$

Aberdeen					
		Concentration Ratios (CR)			
Criteria Air Contaminant	Averaging Period	Baseline Case	Project-alone Case	Future Case	% Increase
$PM_{2.5}$	24-hour	**1.16E+00**	7.23E-01	**1.17E+00**	1.1%
	annual	9.58E-01	7.67E-02	9.67E-01	1.0%
Upper Aberdeen					
$PM_{2.5}$	24-hour	8.05E-01	3.10E-01	8.69E-01	8.0%
	annual	8.29E-01	7.67E-02	8.55E-01	3.2%

*Note: **Bold** CR exceeds benchmark of 1.*

Table 10.4-6. Maximum CRs and Percent Increase from Baseline to Future Case for West End/Downtown (Surrogate for Aboriginal Exposure) for $PM_{2.5}$

West End/Downtown					
		Concentration Ratios (CR)			
Criteria Air Contaminant	Averaging Period	Baseline	Project-alone Case	Future Case	% Increase
$PM_{2.5}$	24-hour	**1.24E+00**	1.17E-01	**1.30E+00**	4.6%
	annual	9.67E-01	7.47E-03	9.74E-01	0.7%

*Note: **Bold** CR exceeds benchmark of 1.*

Table 10.4-7. Maximum Concentration Ratios and Percent Increase from Baseline to Future Case for Aberdeen for PM_{10}

Aberdeen					
		Concentration Ratio (CR)			
Criteria Air Contaminants	Averaging Period	Baseline Case	Project-alone Case	Future Case	% Increase
PM_{10}	24-hour	**1.39E+00**	**1.44E+00**	**1.90E+00**	36.2%
	annual	3.23E-01	1.23E-01	3.37E-01	4.5%
Upper Aberdeen					
PM_{10}	24-hour	8.50E-01	**1.44E+00**	**1.90E+00**	123.2%
	annual	2.31E-01	1.23E-01	2.94E-01	26.8%

*Note: **Bold** CR exceeds benchmark of 1.*

Table 10.4-8. Maximum Concentration Ratios and Percent Increase from Baseline to Future Case for West End/Downtown (Surrogate for Aboriginal Exposure) for PM_{10}

West End/Downtown					
		Concentration Ratio (CR)			
Criteria Air Contaminant	Averaging Period	Baseline	Project-alone Case	Future Case	% Increase
PM_{10}	24-hour	**1.57E+00**	7.06E-02	**1.59E+00**	1.0%
	annual	3.07E-01	9.86E-03	3.16E-01	3.1%

Note: ***Bold*** *CR exceeds benchmark of 1.*

In Aberdeen, the CR for the 24-hour PM_{10} concentration increased from 1.39 to 1.90 between Baseline Case and Future Case. In Upper Aberdeen the CRs for the 24-hour PM_{10} concentrations increased from 0.85 to 1.90 between Baseline Case and Future Case. A review of the time-series air quality data shows that the days when CRs for PM_{10} exposures are predicted to be higher than 1.0 occur during the winter months (February and December; Appendix 10.4-A). The calculated CRs are directly related to the number of hours of exposure that people experience. The PM_{10} CRs listed in Table 10.4-4 are based on the assumption that a person would be exposed to PM_{10} 24 hours per day. During the summer months when people may spend more time outdoors than indoors or when they may have the windows open, it is reasonable to assume that exposures to PM_{10} could occur 24 hours per day. During the winter months, it is reasonable to expect that people will spend the majority of their time indoors with the windows closed. This would limit their exposure to PM_{10} in ambient air to the time spend outdoors. This reduction in exposure time would lower the CRs for both Baseline Case and Future Case by a factor that is directly proportional to the amount of time spend outdoors on any given day. For example, assuming a person spends 12 hours per day outdoors during the winter (the time when the PM_{10} exceedance occurred) would lower the CRs for Baseline Case and Future Case by 50% from 1.39 and 1.90, to 0.70 and 0.95, respectively. For Upper Aberdeen, the CRs for Baseline and Future Case would also be lowered by 50% from 0.85 and 1.90 to 0.43 and 0.95, respectively. A more realistic assumption of 3 hours per day lowers the CRs to 12.5% (3 hours/24 hours) of the calculated values (the Baseline Case CR would change from 1.39 to 0.17 (1.39 x 0.125) and the Future Case would change from 1.90 to 0.24). In Upper Aberdeen the CRs for Baseline Case would change from 0.85 to 0.11 and Future Case would change from 1.90 to 0.24). Because PM_{10} levels are below the ambient air quality criterion during the summer months (when exposures could be expected to be continuous) the CRs calculated for exposures that occur during the summer months would be below 1.0. In addition, as noted above, accounting for the reduction in hours of exposure that would occur during the winter months would lower the predicted CRs to below 1.0 – even if someone spent 12 hours per day outdoors in the winter. In addition, the USEPA no longer recommends the use of PM_{10} as a monitoring metric for human health evaluations, since $PM_{2.5}$ provides a stronger linkage to the evaluation of potential health effects (USEPA 2006). As noted above, Project-related $PM_{2.5}$ concentrations will not make a meaningful contribution to the health risk associated with the inhalation of $PM_{2.5}$. Based on this, it is reasonable to conclude that Project-related PM_{10} levels will not make a meaningful contribution to inhalation health risk.

Metals

The predicted annual concentration ratios for metal inhalation in Recreational receptors at the location of the MPOI, the Residential receptor in Aberdeen, and the Aboriginal receptor are provided in Table 10.4-9.

Table 10.4-9. Predicted Concentration Ratios for Dust-Bound Metal Inhalation for the Maximum Point of Impingement, Aberdeen and Kamloops Indian Reserve #1.

Contaminant of Potential Concern (COPC)	Concentration Ratio (CR)		
	Maximum Point of Impingement (MPOI) (Reasonable Upper Limit of Exposure)	Aberdeen	Kamloops Indian Reserve #1
Aluminum	1.1E-06	1.65E-06	1.65E-07
Antimony	3.4E-09	4.92E-09	4.94E-10
Arsenic	2.0E-07	2.94E-07	2.95E-08
Barium	1.1E-06	1.68E-06	1.68E-07
Chromium	1.4E-05	2.09E-05	2.10E-06
Cobalt	2.7E-06	3.95E-06	3.96E-07
Copper	1.1E-05	1.58E-05	1.58E-06
Lead	3.3E-07	4.84E-07	4.86E-08
Manganese	5.0E-05	7.27E-05	7.29E-06
Mercury	3.0E-07	4.33E-07	4.35E-08
Molybdenum	1.8E-08	2.62E-08	2.63E-09
Nickel	1.4E-05	2.12E-05	2.13E-06
Selenium	1.7E-09	2.51E-09	2.52E-10
Thallium	2.7E-07	4.01E-07	4.02E-08
Uranium	3.1E-07	4.57E-07	4.58E-08

The toxicity reference values (TRVs) used to assess the potential human health risks associated with inhalation exposures to Project-related dust-bound metals are averaged daily exposure values and represent daily exposures that can occur over a life-time without resulting in adverse human health effects or unacceptable increases in life-time cancer risk. The inhalation exposures that could be experienced by members of the Aboriginal community engaged in traditional activities or harvesting country foods in the vicinity of Jacko Lake or Peterson Creek, and those experienced by members of the non-aboriginal community engaged in recreational activities in the vicinity of the Project, are considered to be intermittent exposures, because exposures will only occur on the days when people are in these areas. Before these intermittent exposures can be compared to the appropriate TRVs, the intermittent exposures must be adjusted to account for the differences in exposure duration between the intermittent exposures that could occur and the continuous exposures that were assumed in the development of the TRVs. For example, inhalation occurs on a continuous 24-hour basis. For the Aboriginal and recreational users of the Jacko Lake and Peterson Creek areas, this means that inhalation occurs when they are in these areas and when they are elsewhere. Therefore, the inhalation exposure experienced by the Aboriginal and recreational receptors while they are in the vicinity of

the Project is a function of the both the time spent on-site in a given day and the number of days spent on-site in a given year. Members of the Aboriginal community who engage in traditional activities and harvest country foods as well as members of the non-aboriginal community who engage in recreational activities in the vicinity of the project were assumed to be present at the location of the MPOI for 5 hours per day 5 days per week (25 hours per week) for 52 weeks per year (1300 hours per year). This represents approximately 15% of the year (1300 hours/8760 hours per year). This 15% (0.15) adjustment factor was applied to the metal concentrations predicted for the MPOI location, to provide the equivalent yearly-averaged concentrations necessary for comparing the exposures predicted for the Aboriginal and non-aboriginal receptors who spend time in the vicinity of the Project. It should be noted that an exposure adjustment factor has not been applied to residential and farmer-rancher receptors because residential receptors are assumed to be present in the home on a continuous year-round basis (8760 hours per year). Therefore, air dispersion modelling results for the residential and farmer-rancher receptor areas can be compared directly to the TRVs.

For carcinogenic metals, the lifetime averaged daily concentration was calculated based on the annual average MPOI, multiplied by the inhalation TRV for assessing cancer risk, to determine the IILCR. The life-time averaged daily concentration was calculated using a 23-year operational life of the mine and Health Canada's recommended 80-year lifetime (Health Canada 2012). The predicted IILCRs for Residential receptors in Aberdeen, Aboriginals and Recreational receptors at the MPOI are provided in Table 10.4-10; the results for the remaining locations are provided in Appendix 10.4-A.

Table 10.4-10. Predicted Incremental Increase in Lifetime Cancer Risk for Metal Inhalation

Contaminant of Potential Concern (COPC)	Incremental Increase in Lifetime Cancer Risk (IILCR	
	Aberdeen	West End/Downtown (As a Surrogate for Aboriginal Exposure)
Arsenic	3.63E-10	3.65E-11
Chromium	6.61E-09	6.63E-10
Nickel	7.94E-10	7.97E-11

Carcinogenic compounds are generally considered to work through a non-threshold mechanism. This means that there is no dose below which and adverse effect will not occur. Any exposure to a carcinogen is considered to be associated with some level of risk. At very low levels of exposure the probability that an adverse effect (cancer) will occur is extremely small. The probability of developing cancer increases as the level of exposure increases. In evaluating the IILCR associated with exposure to a carcinogenic chemical released by Project activities Health Canada has established a risk acceptability benchmark of 1×10^{-5} (1.0E-5), (Health Canada 2012). This means that IILCRs that are less than 1×10^{-5} (0.00001) do not represent an unacceptable change in human health risk. This benchmark is also applied by the BC Ministry of the Environment (BCMOE 2014).

The predicted IILCRs at all locations were below the benchmark of 1×10^{-5} (1.0E-05), indicating that changes in cancer risk associated with the inhalation of Project-related dust-bound metals are below the cancer risk acceptability benchmark of 0.00001 (1×10^{-5}) and therefore do not represent an unacceptable change in human health risk.

PAH

Health risks for PAHs are assessed based on the concentrations of benzo[a]pyrene total potency equivalents ($B[a]P_{TPE}$). The derivation of the $B[a]P_{TPE}$ concentration for the Project-alone Case is provided in Section 3.3.3.1 of Appendix 10.4-A. The $B[a]P_{TPE}$ concentrations based on diesel emissions predicted to occur as a result of the project were multiplied by the cancer-based inhalation TRV for B[a]P in order to estimate the IILCR for receptors in each community. IILCRs for exposure at each of the communities are provided Table 10.4-11; the IILCRs for the MPOI and for all areas are below the threshold of 1.0E-05, indicating that potential carcinogenic health effects due to inhalation of PAHs from diesel exhaust are not expected.

Table 10.4-11. Predicted Incremental Increase in Lifetime Cancer Rates for PAHs

Area	Incremental Increase in Lifetime Cancer Risk (IILCR)
Aberdeen	6.31E-10
Brocklehurst	1.64E-10
Sahali	9.60E-11
Knutsford	1.66E-10
North Shore	9.17E-11
West End/Downtown	5.29E-11

Human Health Risks Via Ingestion and Direct Contact Exposures

Human Health Risks via Ingestion of Country Foods

Individual HQs for the consumption of country foods (i.e. cattle, wild meat, fish, backyard produce and traditional plants) were estimated for receptors in each human receptor area. The exposure estimates for the Future Case are based on the predicted change in metal concentrations in country foods between Baseline Case and Future Case. The predicted change in metal concentrations in country foods is discussed in the Country Foods VC (Section 10.3). The HQs estimated for the toddlers in Aberdeen and Knutsford as well as the Aboriginal toddler are provided as examples in Tables 10.4-12 through 10.4-14. Aberdeen and Knutsford are the closest areas to the Project, and would be expected to have the highest rates of Project-related metal deposition and therefore, could be expected to experience the greatest change in metal concentrations in country foods and backyard garden produce. The toddler receptor is presented because this age group generally experiences the highest level of exposure on a milligram of chemical per kilogram body weight per day basis. The HQs calculated for the other age groups (*e.g.*, child, teen adult) for the Aberdeen, Knutsford and Aboriginal receptors and the HQs for all age groups for the other community areas, are provided in Appendix 10.4-A.

The HQs associated with country food consumption are used in conjunction with the HQs from the other ingestion and direct contact pathways (i.e., soil, drinking water) to estimate the overall change in potential human health risk for each receptor age group. It is this combined exposure estimate that is used to determine the significance of the change in health risk associated with the Project.

Table 10.4-12. Non-Carcinogenic Human Health Risks Associated with Ingestion of Country Foods: Aberdeen Toddler

Contaminant of Potential Concern (COPC)	Hazard Quotient (HQ)									
	Garden Produce		Cattle Consumption		Fish Consumption		Wild Meat Consumption		Total for Country Food Consumption	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	1.78E-01	1.78E-01	3.86E-04	3.87E-04	3.39E-04	1.79E-03	3.35E-04	3.90E-04	1.79E-01	1.81E-01
Antimony	1.88E-02	1.91E-02	2.61E-03	2.83E-03	1.70E-03	1.70E-03	1.43E-05	2.15E-05	2.31E-02	2.36E-02
Arsenic	1.65E-01	1.65E-01	6.95E-03	7.06E-03	1.63E-02	1.95E-02	1.16E-03	1.16E-03	1.89E-01	1.93E-01
Chromium	1.68E-04	1.69E-04	6.74E-05	6.78E-05	9.05E-06	4.35E-05	2.92E-06	3.39E-06	2.48E-04	2.84E-04
Cobalt	1.31E-01	1.31E-01	2.08E-03	2.09E-03	1.99E-02	4.22E-02	3.74E-03	8.54E-03	1.57E-01	1.84E-01
Copper	2.50E-02	2.51E-02	2.38E-03	2.39E-03	1.98E-03	3.47E-03	1.20E-04	2.95E-04	2.95E-02	3.12E-02
Lead	1.34E-01	1.34E-01	3.47E-03	3.48E-03	1.78E-01	2.53E-01	3.10E-05	3.97E-05	3.15E-01	3.91E-01
Manganese	7.69E-02	7.69E-02	2.64E-04	2.82E-04	5.62E-04	7.38E-04	2.76E-05	7.26E-05	7.77E-02	7.80E-02
Mercury	8.20E-03	8.32E-03	2.08E-03	2.16E-03	6.44E-02	6.80E-02	9.79E-06	5.23E-05	7.47E-02	7.86E-02
Molybdenum	1.15E-01	1.16E-01	1.24E-03	1.24E-03	3.88E-03	7.20E-03	3.81E-05	2.98E-03	1.20E-01	1.27E-01
Nickel	2.70E-02	2.71E-02	2.19E-03	2.19E-03	2.60E-02	4.21E-02	2.08E-04	3.40E-04	5.54E-02	7.17E-02
Selenium	9.84E-03	9.96E-03	1.13E-02	1.14E-02	6.36E-02	1.13E-01	2.71E-06	5.25E-05	8.47E-02	1.34E-01
Thallium	1.55E-01	1.57E-01	1.49E-02	1.53E-02	7.39E-02	7.39E-02	3.03E-03	4.96E-03	2.47E-01	2.51E-01
Uranium	3.29E-03	3.30E-03	6.95E-05	7.56E-05	6.34E-05	7.88E-05	6.21E-07	9.68E-07	3.42E-03	3.45E-03

Table 10.4-13. Non-Carcinogenic Human Health Risks Associated with Ingestion of Country Foods: Knutsford Toddler

Contaminant of Potential Concern (COPC)	Hazard Quotient (HQ)									
	Garden Produce		Cattle Consumption		Fish Consumption		Wild Meat Consumption		Total for Country Food Consumption	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	1.78E-01	1.78E-01	1.93E-03	1.94E-03	3.39E-04	1.79E-03	4.15E-04	4.20E-04	1.81E-01	1.82E-01
Antimony	1.88E-02	1.91E-02	1.30E-02	1.46E-02	1.70E-03	1.70E-03	2.56E-05	2.71E-05	3.36E-02	3.50E-02
Arsenic	1.65E-01	1.65E-01	3.47E-02	3.60E-02	1.63E-02	1.95E-02	1.16E-03	1.18E-03	2.17E-01	2.21E-01
Chromium	1.68E-04	1.69E-04	3.37E-04	3.39E-04	9.05E-06	4.35E-05	4.83E-06	4.88E-06	5.17E-04	5.55E-04
Cobalt	1.31E-01	1.31E-01	1.04E-02	1.05E-02	1.99E-02	4.22E-02	2.05E-02	2.06E-02	1.65E-01	1.92E-01
Copper	2.50E-02	2.51E-02	1.19E-02	1.19E-02	1.98E-03	3.47E-03	4.29E-04	4.32E-04	3.90E-02	4.08E-02
Lead	1.34E-01	1.34E-01	1.74E-02	1.74E-02	1.78E-01	2.53E-01	4.98E-05	5.02E-05	3.29E-01	4.04E-01
Manganese	7.69E-02	7.69E-02	1.32E-03	1.41E-03	5.62E-04	7.38E-04	1.26E-04	1.28E-04	7.88E-02	7.91E-02
Mercury	8.20E-03	8.32E-03	1.04E-02	1.08E-02	6.44E-02	6.80E-02	1.08E-04	1.12E-04	8.30E-02	8.72E-02
Molybdenum	1.15E-01	1.16E-01	6.20E-03	6.22E-03	3.88E-03	7.20E-03	2.30E-03	2.32E-03	1.25E-01	1.32E-01
Nickel	2.70E-02	2.71E-02	1.09E-02	1.10E-02	2.60E-02	4.21E-02	4.78E-04	4.82E-04	6.41E-02	8.05E-02
Selenium	9.84E-03	9.96E-03	5.63E-02	5.71E-02	6.36E-02	1.13E-01	6.42E-05	6.50E-05	1.30E-01	1.80E-01
Thallium	1.55E-01	1.57E-01	7.45E-02	7.65E-02	7.39E-02	7.39E-02	4.89E-03	5.01E-03	3.07E-01	3.12E-01
Uranium	3.29E-03	3.30E-03	3.47E-04	3.78E-04	6.34E-05	7.88E-05	8.60E-07	1.01E-06	3.70E-03	3.75E-03

Table 10.4-14. Non-Carcinogenic Human Health Risks Associated with Ingestion of Country Foods: Aboriginal Toddler

Contaminant of Potential Concern (COPC)	Hazard Quotient(HQ)											
	Garden Produce		Cattle Consumption		Fish Consumption		Wild Meat Consumption		Traditional Plant Consumption		Total for Country Food Consumption	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	1.16E-02	1.16E-02	3.86E-04	3.87E-04	5.76E-04	3.04E-03	4.10E-03	4.15E-03	3.56E-03	3.56E-03	2.02E-02	2.27E-02
Antimony	1.23E-02	1.23E-02	2.61E-03	2.83E-03	2.88E-03	2.88E-03	2.53E-04	2.67E-04	7.28E-04	7.37E-04	1.88E-02	1.91E-02
Arsenic	3.65E-02	1.65E-01	6.95E-03	7.19E-03	2.76E-02	3.31E-02	1.15E-02	1.16E-03	7.36E-03	7.37E-03	8.99E-02	9.58E-02
Chromium	3.72E-05	3.72E-05	6.74E-05	6.78E-05	1.54E-05	7.39E-05	4.77E-05	4.82E-05	5.06E-06	5.07E-06	1.73E-04	2.32E-04
Cobalt	1.65E-02	1.66E-02	2.08E-03	2.09E-03	3.37E-02	7.17E-02	2.02E-01	2.03E-01	5.18E-03	5.19E-03	2.60E-01	2.99E-01
Copper	1.57E-02	1.57E-02	2.38E-03	2.39E-03	3.35E-03	5.88E-03	4.24E-03	4.27E-03	3.65E-03	3.66E-03	2.93E-02	3.19E-02
Lead	2.92E-02	2.92E-02	3.47E-03	3.48E-03	3.02E-01	4.29E-01	4.92E-04	4.96E-04	1.32E-03	1.32E-03	3.37E-01	4.64E-01
Manganese	3.00E-02	3.00E-02	2.64E-04	2.82E-04	9.54E-04	1.25E-03	1.25E-03	1.26E-03	5.82E-02	5.82E-02	9.06E-02	9.10E-02
Mercury	8.20E-03	8.21E-03	2.08E-03	2.16E-03	1.09E-01	1.15E-01	1.07E-03	1.11E-03	1.13E-02	1.17E-02	1.86E-01	1.96E-01
Molybdenum	8.98E-02	8.99E-02	1.24E-03	1.24E-03	6.59E-03	1.22E-02	2.27E-02	2.29E-02	2.92E-02	2.94E-02	1.50E-01	1.56E-01
Nickel	2.41E-03	2.41E-03	2.19E-03	2.19E-03	4.40E-02	7.14E-02	4.72E-03	4.76E-03	2.94E-03	2.95E-03	5.63E-02	8.37E-02
Selenium	9.84E-03	9.85E-03	1.13E-02	1.14E-02	1.08E-01	1.91E-01	6.34E-04	6.43E-04	3.91E-03	3.94E-03	1.34E-01	2.17E-01
Thallium	7.03E-02	7.04E-02	1.49E-02	1.53E-02	1.25E-01	1.25E-01	4.84E-02	4.95E-02	3.61E-03	3.64E-03	2.63E-01	2.64E-01
Uranium	6.01E-04	6.01E-04	6.95E-05	7.56E-05	1.07E-04	1.34E-04	8.50E-06	1.00E-05	4.82E-05	4.83E-05	8.35E-04	8.69E-04

For those cancer-causing COPC evaluated as part of the soil, water, or country food pathway assessment, the estimated change in lifetime cancer risk resulting from a lifetime of exposure through multiple pathways were calculated by estimating a lifetime average daily dose over an assumed lifetime for a person of 80 years), and multiplying that dose by the carcinogenic potency for oral and dermal exposures (carcinogenic TRV). Consistent with Health Canada (2010a) guidance, the IILCR calculated for Project-related exposures was compared to cancer risk acceptability benchmark of 1×10^{-5} (which represents an increase in an individual's lifetime cancer risk (LCR) of 0.00001). The incremental increase in lifetime cancer risk (IILCR) associated with Project-related exposures to arsenic through the consumption of country foods for the Residential (Aberdeen), Farmer-Rancher (Knutsford) and Aboriginal (Kamloops Indian Reserve No. 1) receptors are summarized in Table 10.4-15, respectively. The tables list the IILCRs for the individual food groups incorporated in the country foods assessment. These data help to identify the country foods that make the largest contributions to the overall risk associated with arsenic exposure through the consumption of country foods. The IILCR results for the remaining human receptor areas are provided in Appendix 10.4-A. The data show that for all receptor groups, the predicted IILCRs associated with Project-related exposures to arsenic are below the Health Canada cancer risk acceptability benchmark of 1×10^{-5} for each of the individual country food groups and for total country foods.

Table 10.4-15. Incremental Increase in Lifetime Cancer Risk for Ingestion of Country Foods: Residential, Farmer-Rancher and Aboriginal Receptors

Receptor and Location	Incremental Increase in Lifetime Cancer Risk (IILCR)					
	Garden Produce	Cattle Consumption	Fish Consumption	Wild Meat Consumption	Traditional Plant Consumption	Total for Country Food Consumption
	Future Case					
Residential Receptor: Aberdeen	8.40E-08	5.93E-08	7.66E-07	4.04E-09	N.A.	9.14E-07
Farmer-Rancher Receptor: Knutsford	8.40E-08	2.96E-07	7.66E-07	4.04E-09	N.A.	1.15E-06
Aboriginal Receptor: Kamloops Indian Reserve #1	1.78E-09	2.77E-08	5.93E-08	5.38E-08	3.10E-09	1.60E-06

N.A. = Not applicable for this receptor

Human Health Risks via Ingestion of Water

Farmer-Rancher receptors in Knutsford are assumed to use groundwater as the source of domestic water. Concentrations of COPCs in groundwater are based on the measured and the predicted concentrations for location RES-2, which is the location that was identified to be most likely affected by the Project. Water modelling results indicate that the baseline concentrations at RES-2 are predicted to increase due to the Project. People located in the other areas, including on First Nations reserve lands are assumed to obtain their water from municipal distribution systems which use the Thompson River as the source of raw water. Water quality from the municipal distribution systems is not expected to be affected by the Project.

Hazard quotients (HQs) for ingestion of municipal water for a toddler in Aberdeen and ingestion of groundwater for a toddler in Knutsford are provided in Table 10.4-16. The HQs for toddlers in Aberdeen are also applicable to Aboriginal toddlers and toddlers in areas that use the municipal distribution system as a potable source. The HQs for water ingestion for the other receptor age groups and locations are provided in Appendix 10.4-A.

Table 10.4-16. Non-Carcinogenic Human Health Risks Associated with Domestic Water Consumption: Aberdeen Residential and Knutsford Farmer-Rancher Receptors

Contaminant of Potential Concern (COPC)	Hazard Quotient (HQ)			
	Aberdeen (Municipal System)		Knutsford (Groundwater)	
	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	2.91E-04	2.91E-04	1.09E-04	3.21E-02
Antimony	1.82E-02	1.82E-02	9.63E-03	6.93E-02
Arsenic	6.06E-02	6.06E-02	1.13E-01	3.86E-01
Chromium	1.21E-05	1.21E-05	2.67E-06	7.88E-05
Cobalt	1.82E-03	1.82E-03	4.36E-03	3.66E-02
Copper	1.37E-01	1.37E-01	1.32E-03	3.67E-02
Lead	1.82E-02	1.82E-02	3.25E-03	3.23E-02
Manganese	3.38E-04	3.38E-04	9.61E-03	2.80E-01
Molybdenum	2.42E-03	2.42E-03	1.21E-03	5.28E-03
Mercury	5.09E-03	5.09E-03	1.13E-01	1.67E-01
Nickel	7.27E-04	7.27E-04	3.47E-03	5.99E-03
Selenium	3.64E-03	3.64E-03	8.00E-04	6.88E-03
Thallium	5.19E-02	5.19E-02	2.60E-02	8.02E-02
Uranium	8.48E-04	8.48E-04	1.65E-02	3.04E-02

The HQs associated with drinking water consumption are used in conjunction with the HQs from the other ingestion and direct contact pathways (i.e., soil, country foods) to estimate the overall change in potential human health risk for each receptor age group. It is this combined exposure estimate that is used to determine the significance of the change in health risk associated with the Project.

Arsenic is the only metal COPC that would be considered to be carcinogenic when ingested. Arsenic concentrations in the City of Kamloops municipal water and from the Peterson Creek aquifer for Baseline Case (RES-4) and Future Case (RES-2) are below the BC drinking water guidelines and the Canadian Drinking Water Quality Guidelines (Table 10.4-17). The RES-2 location which is the well interpreted to be within the Peterson Creek aquifer located closest to the Project boundary. RES-4 is the well most likely to be affected by Project activities that may affect groundwater quality. Predicted Future Case arsenic concentrations at the RES-2 location are lower than the Baseline Case arsenic concentrations measured at RES-4. These results suggest that Project activities will not alter arsenic concentrations in the Peterson Creek aquifer beyond what would be considered to be naturally occurring in the area. Further arsenic concentrations in the City of Kamloops municipal water supply will not be influenced by Project activities. Based on the results, the potential cancer health risks associated with arsenic in domestic water are considered to be negligible.

Table 10.4-17. Comparison of Canadian and BC Drinking Water Guidelines with Baseline Case and Future Case Arsenic Concentrations in Domestic Water

Contaminant of Potential Concern (COPC)	Canadian Drinking Water Quality Guidelines mg/L	British Columbia Drinking Water Quality Guideline mg/L	City of Kamloops Municipal Water Baseline & Future Case mg/L	Knutsford - Peterson Creek Aquifer		
				Res-41 Baseline Case mg/L	RES-2	
					Baseline Case mg/L	Future Case mg/L
Arsenic	1.00E-02	2.50E-02	5.00E-04	4.48E-03	9.30E-04	1.82E-03

[1] Res-2 is closer to the Project boundary than Res-4 and would subject to Project-related effects on groundwater quality. Therefore Future Case predicted concentrations have not been calculated for Res-4.

Human Health Risks via Direct Soil Contact

Direct soil contact includes incidental ingestion and dermal contact. HQs were estimated for each pathway, and the sum of these HQs represents the non-carcinogenic risk for soil contact. Aberdeen and Knutsford are the closest areas to the Project, and therefore would be expected to have the highest rates of Project-related metal deposition. Results for Aberdeen, Knutsford, and the Aboriginal toddler are provided in Table 10.4-18 to Table 10.4-20. The results show that the HQs for direct soil contact are below 1.0 for each of the metals for the Aberdeen, Knutsford and Aboriginal toddler receptors HQs calculated for the other age groups and other human health areas are provided in Appendix 10.4-A.

Table 10.4-18. Non-Carcinogenic Human Health Risks Associated with Direct Contact with Soil: Aberdeen Toddler

Contaminant of Potential Concern (COPC)	Hazard Quotient (HQ)					
	Soil Ingestion		Dermal Contact		Total for Soil Contact (Ingestion + Dermal)	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	7.46E-02	7.46E-02	6.41E-04	6.41E-04	7.52E-02	7.52E-02
Antimony	4.36E-03	4.43E-03	3.75E-04	3.81E-04	4.74E-03	4.81E-03
Arsenic	8.98E-02	8.99E-02	2.32E-03	2.32E-03	9.21E-02	9.23E-02
Chromium	1.58E-04	1.58E-04	1.36E-05	1.36E-05	1.72E-04	1.72E-04
Cobalt	5.82E-02	5.83E-02	5.00E-04	5.01E-04	5.87E-02	5.88E-02
Copper	2.34E-03	2.36E-03	1.21E-04	1.22E-04	2.46E-03	2.48E-03
Lead	4.36E-02	4.37E-02	2.25E-04	2.26E-04	4.38E-02	4.40E-02
Manganese	1.95E-02	1.95E-02	1.68E-04	1.68E-04	1.97E-02	1.97E-02
Mercury	6.60E-04	6.82E-04	2.65E-04	2.73E-04	9.25E-04	9.56E-04
Molybdenum	9.85E-04	9.91E-04	8.47E-06	8.52E-06	9.94E-04	9.99E-04
Nickel	1.06E-02	1.06E-02	3.19E-03	3.20E-03	1.38E-02	1.38E-02
Selenium	2.17E-04	2.20E-04	1.87E-06	1.89E-06	2.19E-04	2.21E-04
Thallium	3.56E-02	3.59E-02	3.06E-04	3.08E-04	3.59E-02	3.62E-02
Uranium	1.22E-03	1.22E-03	1.05E-05	1.05E-05	1.23E-03	1.24E-03

Table 10.4-19. Non-Carcinogenic Human Health Risks Associated with Direct Contact with Soil: Knutsford Toddler

Contaminant of Potential Concern (COPC)	Hazard Quotient (HQ)					
	Soil Ingestion		Dermal Contact		Total for Soil Contact (Ingestion + Dermal)	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	7.46E-02	7.46E-02	6.41E-04	6.41E-04	7.52E-02	7.52E-02
Antimony	4.36E-03	4.41E-03	3.75E-04	3.79E-04	4.74E-03	4.79E-03
Arsenic	8.98E-02	8.99E-02	2.32E-03	2.32E-03	9.21E-02	9.22E-02
Chromium	1.58E-04	1.58E-04	1.36E-05	1.36E-05	1.72E-04	1.72E-04
Cobalt	5.82E-02	5.83E-02	5.00E-04	5.01E-04	5.87E-02	5.88E-02
Copper	2.34E-03	2.36E-03	1.21E-04	1.22E-04	2.46E-03	2.48E-03
Lead	4.36E-02	4.37E-02	2.25E-04	2.26E-04	4.38E-02	4.39E-02
Manganese	1.95E-02	1.95E-02	1.68E-04	1.68E-04	1.97E-02	1.97E-02
Mercury	6.60E-04	6.77E-04	2.65E-04	2.71E-04	9.25E-04	9.49E-04
Molybdenum	9.85E-04	9.89E-04	8.47E-06	8.51E-06	9.94E-04	9.98E-04
Nickel	1.06E-02	1.06E-02	3.19E-03	3.19E-03	1.38E-02	1.38E-02
Selenium	2.17E-04	2.19E-04	1.87E-06	1.88E-06	2.19E-04	2.21E-04
Thallium	3.56E-02	3.58E-02	3.06E-04	3.08E-04	3.59E-02	3.61E-02
Uranium	1.22E-03	1.22E-03	1.05E-05	1.05E-05	1.23E-03	1.23E-03

Table 10.4-20. Non-Carcinogenic Human Health Risks Associated with Direct Contact with Soil: Aboriginal Toddler

Contaminant of Potential Concern (COPC)	Hazard Quotient (HQ)					
	Soil Ingestion		Dermal Contact		Total for Soil Contact (Ingestion + Dermal)	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	7.03E-02	7.03E-02	6.05E-04	6.05E-04	7.09E-02	7.09E-02
Antimony	6.75E-03	6.75E-03	5.80E-04	5.81E-04	7.33E-03	7.34E-03
Arsenic	6.74E-02	6.74E-02	1.74E-03	1.74E-03	6.91E-02	6.91E-02
Chromium	1.42E-04	1.42E-04	1.22E-05	1.22E-05	1.54E-04	1.54E-04
Cobalt	6.73E-02	6.73E-02	5.79E-04	5.79E-04	6.79E-02	6.79E-02
Copper	4.50E-03	4.50E-03	2.32E-04	2.32E-04	4.74E-03	4.74E-03
Lead	2.76E-01	2.76E-01	1.42E-03	1.42E-03	2.78E-01	2.78E-01
Manganese	1.88E-02	1.88E-02	1.62E-04	1.62E-04	1.90E-02	1.90E-02
Mercury	1.29E-03	1.29E-03	5.17E-04	5.18E-04	1.81E-03	1.81E-03
Molybdenum	1.35E-03	1.35E-03	1.16E-05	1.17E-05	1.37E-03	1.37E-03
Nickel	1.36E-02	1.36E-02	4.08E-03	4.08E-03	1.76E-02	1.76E-02
Selenium	4.17E-04	4.17E-04	3.59E-06	3.59E-06	4.21E-04	4.21E-04
Thallium	3.56E-02	3.56E-02	3.06E-04	3.06E-04	3.59E-02	3.59E-02
Uranium	1.66E-03	1.67E-03	1.43E-05	1.43E-05	1.68E-03	1.68E-03

The HQs associated with soil contact are used in conjunction with the HQs from the other ingestion and direct contact pathways (*i.e.* drinking water, country foods) to estimate the overall change in potential human health risk for each receptor age group. It is this combined exposure estimate that is used to determine the significance of the change in health risk associated with the Project.

Summaries of IILCRs for the Residential lifetime receptor in Aberdeen, the Farmer-Rancher lifetime receptor in Knutsford and the Aboriginal lifetime receptor exposed to COPCs in soil are provided in Tables 10.4-21 to Table 10.4-23. The IILCRs associated with arsenic for the soil pathway for all receptors were less than the relevant benchmark of 1 in 100, 000 (i.e. IILCR <1E-05) for the Future Case.

Table 10.4-21. Carcinogenic Human Health Risks Associated with Soil Exposure for a Residential Lifetime Receptor in Aberdeen

Contaminant of Potential Concern (COPC)	Incremental Increase in Lifetime Cancer Risk (IILCR)		
	Soil Ingestion	Dermal Contact	Total for Soil Contact (Ingestion + Dermal)
	Future Case		
Arsenic	8.42E-09	1.13E-09	9.55E-09

Table 10.4-22. Carcinogenic Human Health Risks Associated with Soil Exposure for a Farmer-Rancher Lifetime Receptor in Knutsford

Contaminant of Potential Concern (COPC)	Incremental Increase in Lifetime Cancer Risk (IILCR)		
	Soil Ingestion	Dermal Contact	Total for Soil Contact (Ingestion + Dermal)
	Future Case		
Arsenic	6.59E-09	8.82E-10	7.47E-09

Table 10.4-23. Carcinogenic Human Health Risks Associated with Soil Exposure for the Aboriginal Lifetime Receptor

Contaminant of Potential Concern (COPC)	Incremental Increase in Lifetime Cancer Risk (IILCR)		
	Soil Ingestion	Dermal Contact	Total for Soil Contact (Ingestion + Dermal)
	Future Case		
Arsenic	9.16E-10	1.23E-10	1.04E-09

Human Health Risks via Ingestion (Total)

The HQs associated with total ingestion for non-carcinogenic COPCs (includes exposure to metals in soil, water, and country food) for the Aberdeen toddler, the Knutsford toddler and the Aboriginal toddler are shown in Table 10.4-24. The results for the other areas and receptors are provided in Appendix 10.4-A. Total HQs for the toddler were below the benchmark of 1.0, indicating that potential health risks are not expected. The change in HQ between Baseline Case and Future Case (which is represented by the Post-Closure phase) for toddlers from Aberdeen, Knutsford, and the Kamloops Indian Reserve No. 1 are shown graphically in Figure 10.4-6 through Figure 10.4-11. The

figures show the relative contribution that each exposure pathway makes to the total risk for each metal. The change in HQ between Baseline Case and Future Case for adult receptors from Aberdeen, Knutsford, and Kamloops Indian Reserve No. 1 are provided for comparison.

Table 10.4-24. Total Non-Carcinogenic Human Health Risks for the Toddler Associated with Ingestion

Contaminant of Potential Concern (COPC)	Hazard Quotient (HQ)					
	Aberdeen Toddler		Knutsford Toddler		Aboriginal Toddler	
	Baseline Case	Future Case	Baseline Case	Future Case	Baseline Case	Future Case
Aluminum	2.55E-01	2.56E-01	2.56E-01	2.90E-01	9.14E-02	9.39E-02
Antimony	4.61E-02	4.67E-02	4.79E-02	1.10E-01	4.43E-02	4.46E-02
Arsenic	3.42E-01	3.46E-01	4.22E-01	7.00E-01	2.20E-01	2.25E-01
Chromium	4.33E-04	4.69E-04	6.94E-04	8.07E-04	3.39E-04	3.98E-04
Cobalt	2.34E-01	2.57E-01	2.45E-01	3.00E-01	3.30E-01	3.69E-01
Copper	1.69E-01	1.71E-01	4.31E-02	8.01E-02	1.71E-01	1.74E-01
Lead	3.78E-01	4.53E-01	3.76E-01	4.81E-01	6.32E-01	7.59E-01
Manganese	9.79E-02	9.81E-02	1.08E-01	3.78E-01	1.10E-01	1.10E-01
Mercury	1.10E-01	1.16E-01	1.17E-01	1.28E-01	1.91E-01	2.01E-01
Molybdenum	1.28E-01	1.32E-01	2.42E-01	2.99E-01	1.56E-01	1.62E-01
Nickel	7.01E-02	8.64E-02	8.16E-02	1.00E-01	7.47E-02	1.02E-01
Selenium	8.86E-02	1.38E-01	1.31E-01	1.87E-01	1.38E-01	2.21E-01
Thallium	3.37E-01	3.39E-01	3.70E-01	4.28E-01	3.50E-01	3.52E-01
Uranium	5.51E-03	5.53E-03	2.15E-02	3.54E-02	3.36E-03	3.40E-03

As noted in the discussion under Human Health Risks vis Ingestion of Water (see Table 10.4-17) Project activities will not alter arsenic concentrations in municipally supplied water and the change in arsenic concentrations in the Peterson Creek aquifer are predicted to reflect existing measured concentrations. Further, measured arsenic concentrations in the municipal supply and measured and predicted arsenic concentrations in the Peterson Creek aquifer meet the drinking water guideline. Therefore, for arsenic, the assessment of combined cancer risk is based on exposures that occur through direct contact with soil and the ingestion of country foods. The IILCR for the combined ingestion of soil and country food for the Residential receptor, the Knutsford Farmer/Rancher receptor and the Aboriginal receptor were below the benchmark of 1.0E-05 (Table 10.4-25), indicating potential health risks are not expected. Similar results were found for the Sahali, West End/Downtown, North Shore and Brocklehurst residential receptor groups (see Appendix 10.4-A). These results suggest that ingestion and direct contact exposures to arsenic in the LSA do not pose unacceptable risks in the Future Case.

Figure 10.4-6

Non-carcinogenic Risk Estimates for a Toddler in Aberdeen

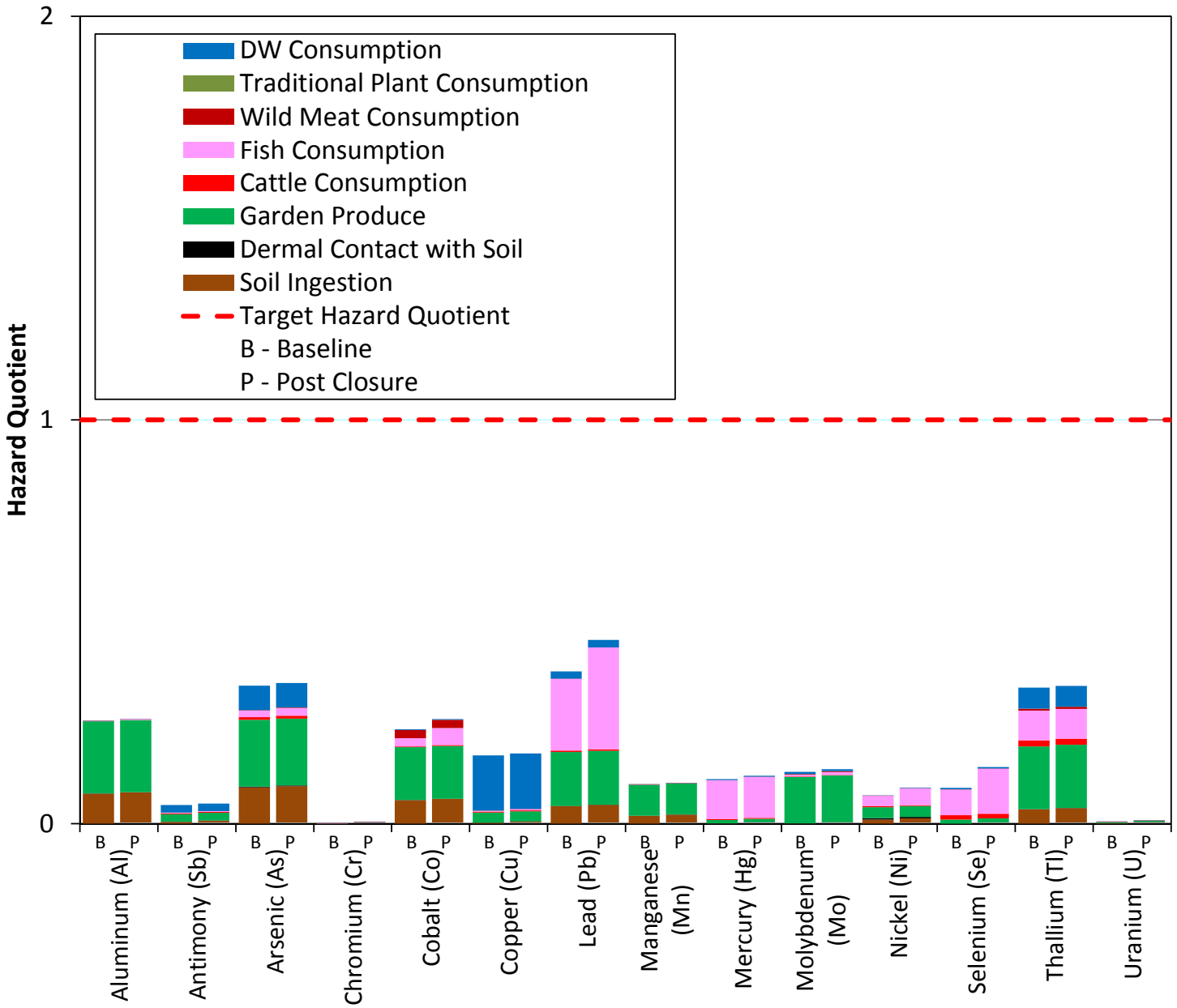


Figure 10.4-7

Non-carcinogenic Risk Estimates for a Toddler in Knutsford

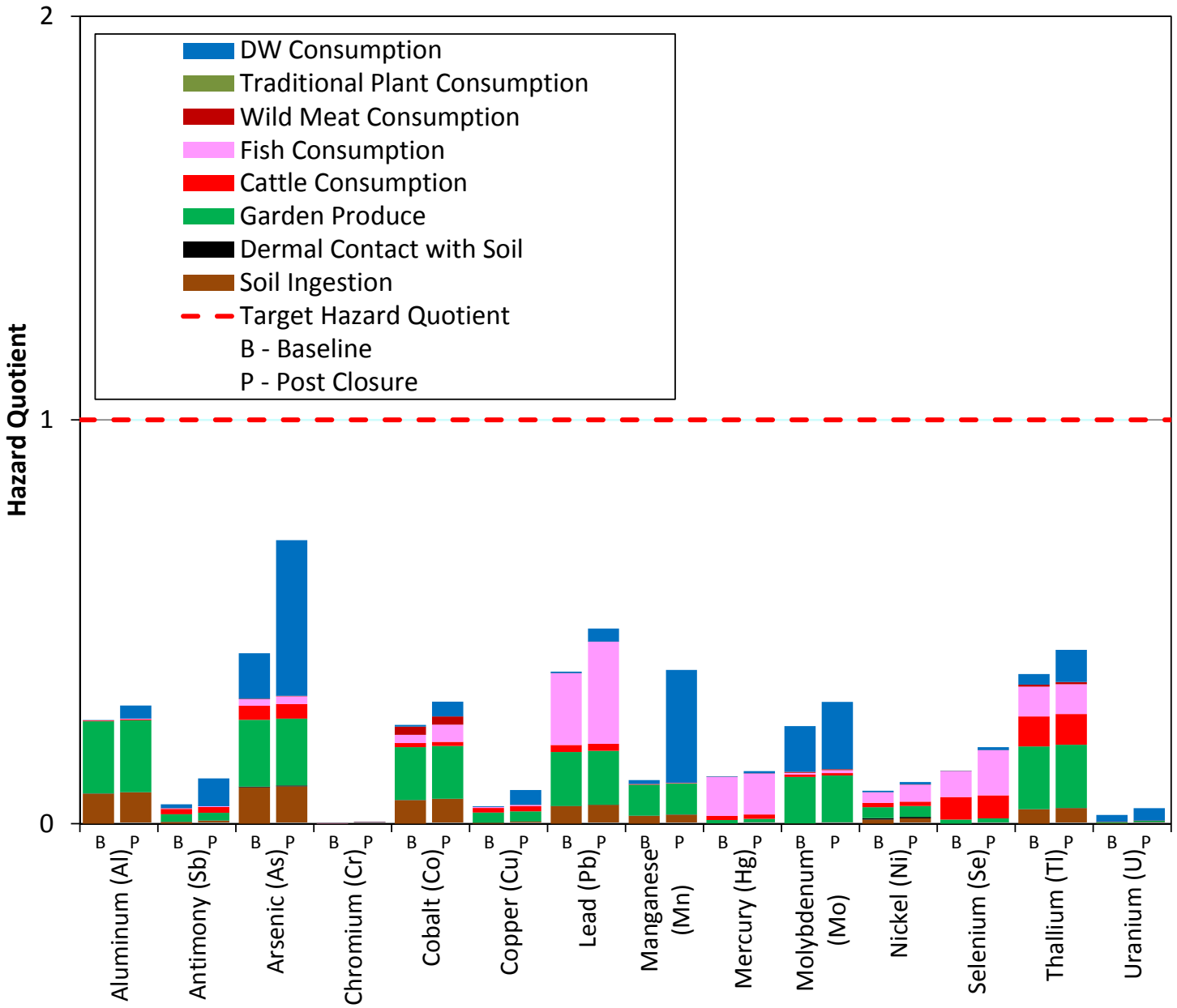


Figure 10.4-8

Non-carcinogenic Risk Estimates
for an Aboriginal Toddler in Kamloops Indian Reserve #1

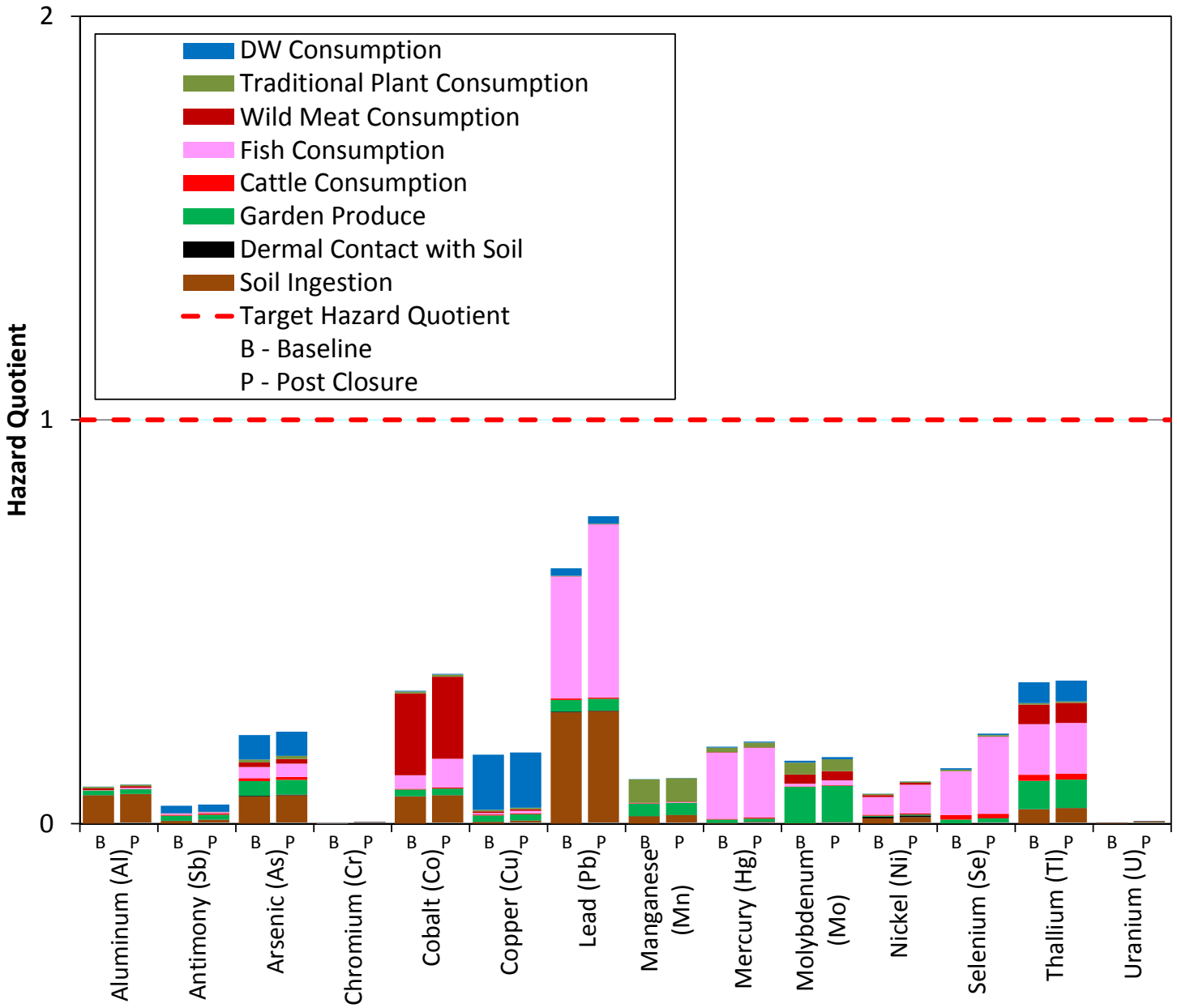


Figure 10.4-9

Non-carcinogenic Risk Estimates for an Adult in Aberdeen

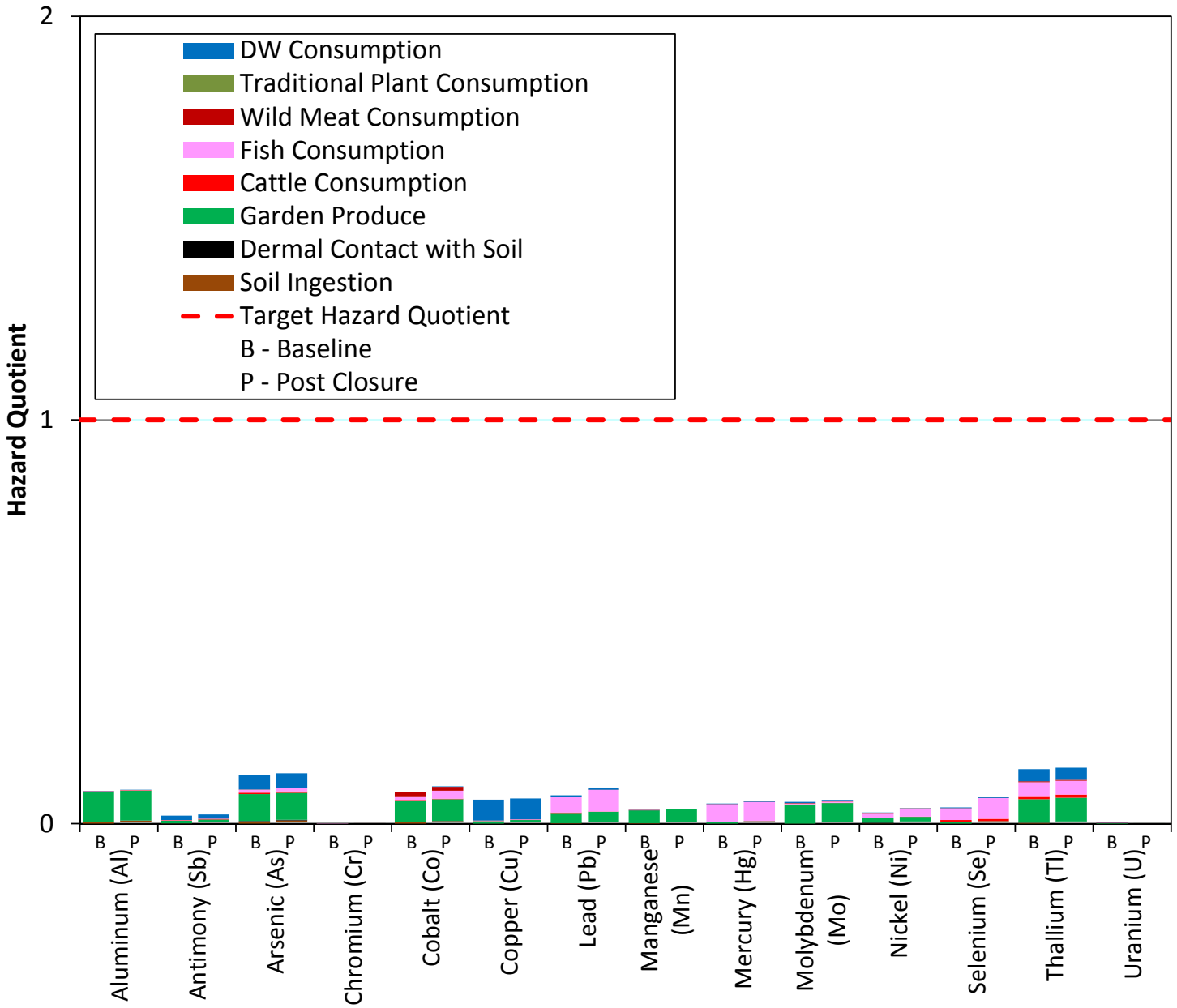


Figure 10.4-10

Non-carcinogenic Risk Estimates for an Adult in Knutsford

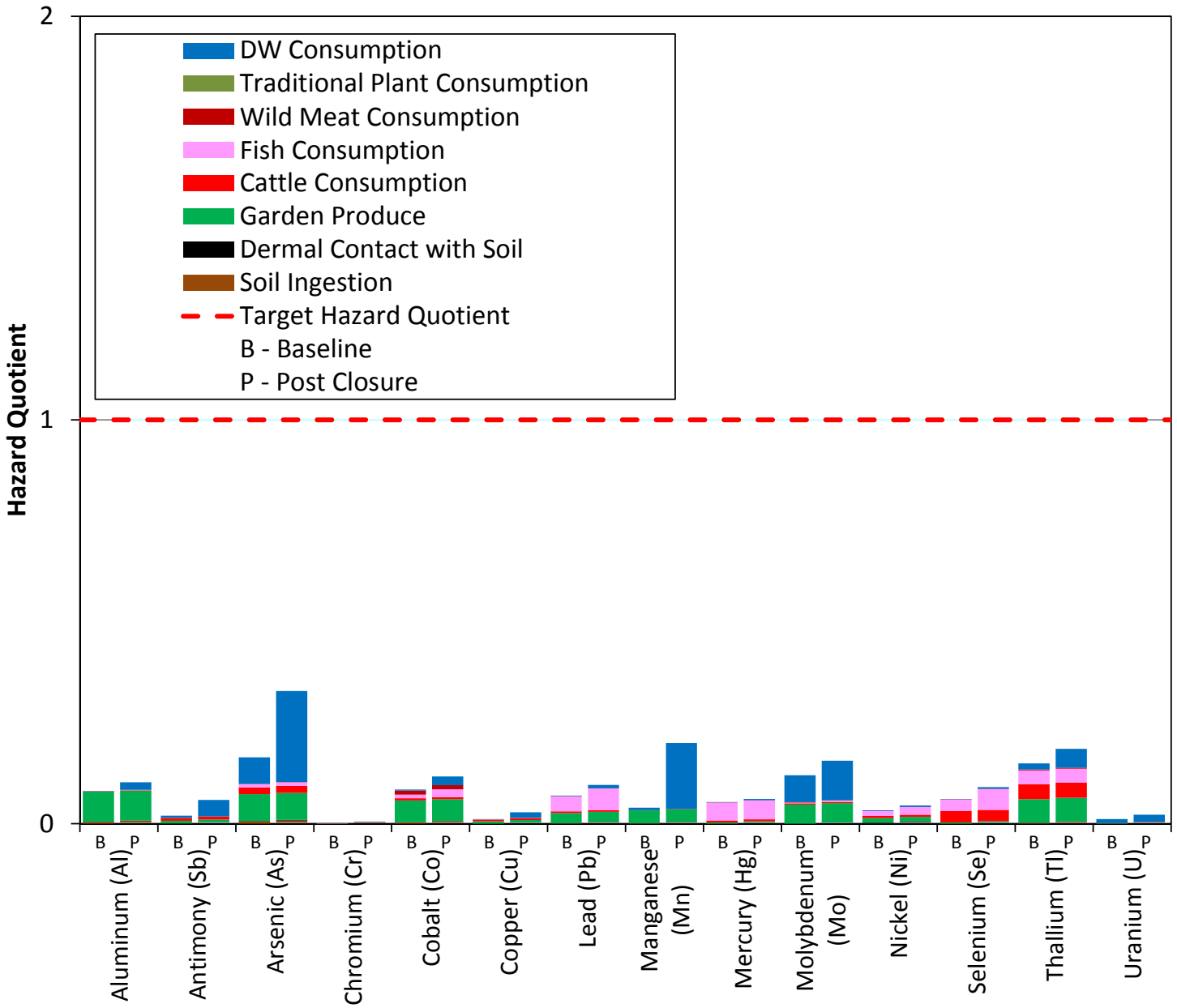


Figure 10.4-11

Non-carcinogenic Risk Estimates for an Aboriginal Adult in Kamloops Indian Reserve #1

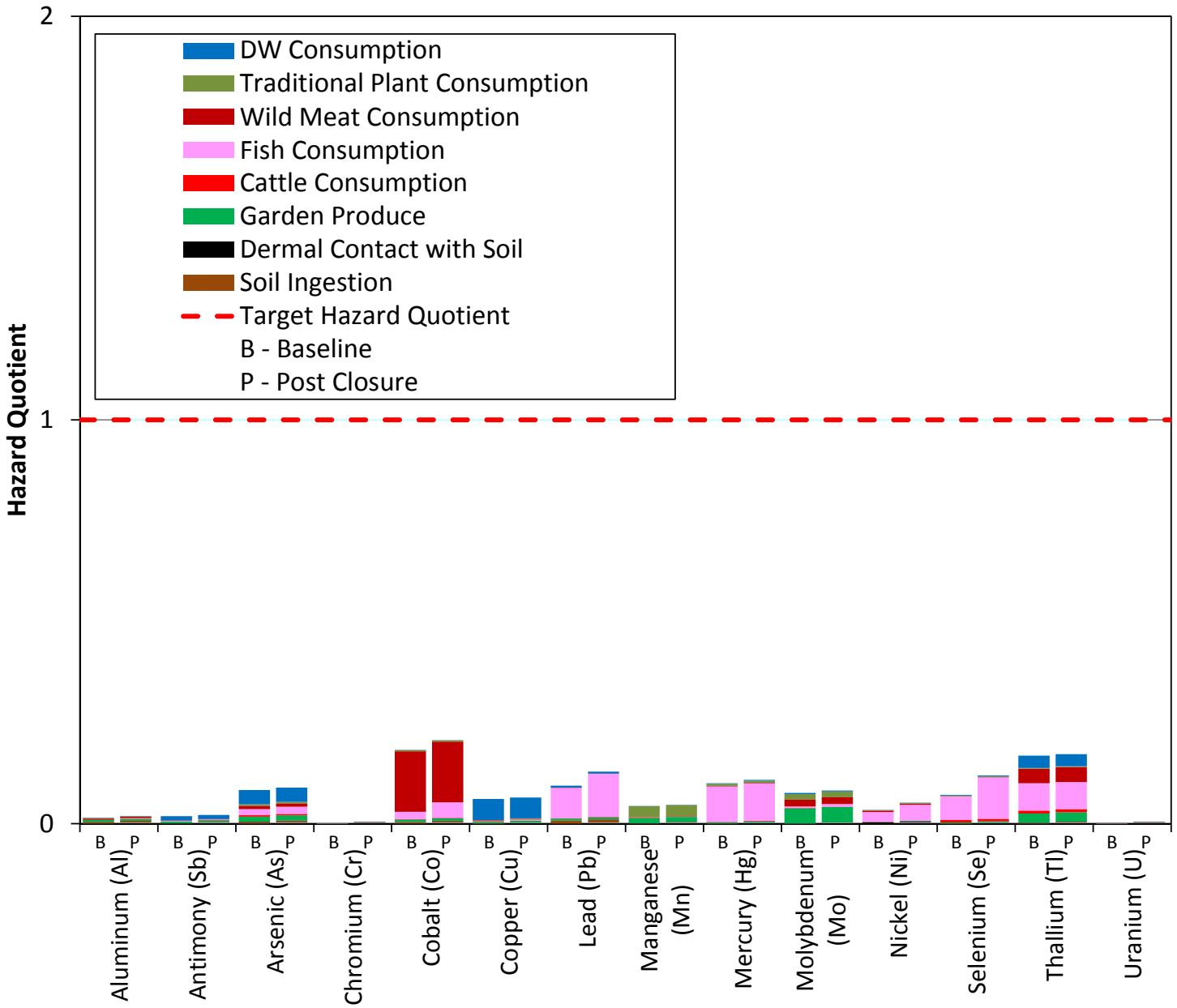


Table 10.4-25. Incremental Increase in Lifetime Cancer Risk for Total Ingestion Exposure

Contaminant of Potential Concern (COPC)	Incremental Increase in Lifetime Cancer Risk (IILCR) for Total Ingestion		
	Aberdeen (Residential Receptor)	Knutsford (Farmer-Rancher Receptor)	Kamloops Indian Reserve #1 (Aboriginal Receptor)
	Future Case		
Arsenic	9.23E-07	1.16E-06	1.60E-06

Sources of Uncertainty

All HHRAs have inherent uncertainties, which are addressed by incorporating conservative assumptions into the different aspects of the risk assessment. Although many factors contribute to a risk estimate, results are generally sensitive to only a few of these factors, which are described below.

Uncertainties in Toxicological Information

There is limited toxicological information on the effects associated with low-level chemical exposures to humans. Most of the information available is based on epidemiological studies of occupationally exposed workers. These are usually based on an 8 hours per day or 40 hours per week, higher-level exposure regimes and do not apply well to low-level, chronic exposures. Additionally TRVs and cancer potency estimates for many contaminants are based on laboratory dose-response estimates in animals. The use of animals requires certain assumptions to be made, which introduces further uncertainty. Assumptions include:

- the toxicological effect in animals also occurs in humans;
- the short-term exposures used in animal studies can be extrapolated to chronic or long-term human exposures;
- the chemical is processed in the same way in animal and human;
- the uptake of the contaminant from the test vehicle (the medium within which the test compound is delivered to the animals, [e.g., water]) will be representative of the uptake of the contaminant from real-world environmental media (e.g., soil, biota); and
- the assumption that extrapolation from high-dose laboratory studies to low-dose environmental studies accurately reflects the shape of the dose response curve at the low dose-response range.

To account for these and other related uncertainties, regulatory agencies such as Health Canada (Health Canada 2010b) adopt conservative assumptions to account for uncertainties. The use of uncertainty factors accounts for uncertainties by lowering the reference dose, used in the hazard quotient calculation, well below the level where no effects were seen in animals. Uncertainty factors are applied by factors of 10 to account for uncertainties such as interspecies differences (e.g., physiology), individual variation (e.g., unusually sensitive individuals), limitations in toxicological information, and extrapolation from acute exposures to chronic exposures. Depending on the degree of uncertainty, typical factors will range from 100 to 10,000, with some being lower than 10 (in the case where reliable human data are available). The incorporation of these factors results in TRVs that

are extremely conservative. The use of these TRVs means that potential risks are over estimated and that limited exposures above reference doses (for oral and dermal exposures) or reference concentrations (for inhalation exposures) will not result in adverse human health effects.

Further, the human health effects assessment has assumed that the relative absorption rate for each COPC via inhalation and ingestion is 100%. Some of the TRVs used in this VC were determined from studies in which the effects were based on administered doses rather than absorbed doses. Because studies administer COPCs in forms that are more readily absorbed that would be found in environmental media, the TRVs derived from these studies may over-estimate the amount of COPC that would be absorbed by the human receptor. Thus, using these TRVs over-predicts the potential effects associated with the exposures experienced by the human receptors.

Sensitive Populations

A sensitive population will exhibit a different or enhanced response to a COPC than will most people exposed to the same level of the contaminant in the environment. The reasons for this may include genetic makeup, age (e.g., children or seniors), health and nutritional status, behaviour, and exposure to other toxic substances (e.g., cigarette smoke; ATSDR 2014). Human receptors are selected such that the most sensitive individuals and individuals having the greatest potential for exposure to COPCs and adverse responses from such exposures are represented. The toddler represents the most sensitive individual for non-carcinogens for the reasons just mentioned plus the physiological (nutritional needs) and behavioural (frequent hand to mouth transfer) considerations associated with children of that age. The non-cancer TRVs used in this risk assessment were estimates of a continuous exposure to the human population, including sensitive subgroups that are to be without appreciable risk of adverse non-cancer effects during a lifetime.

Carcinogenic COPCs exposures were assessed over the entire lifetime of a receptor and incorporating all life stages. Toxicity doses and cancer slope factors used in the assessment have accounted for sensitive populations by applying uncertainty factors (see toxicity assessment in Appendix 10.4-A).

Uncertainties in Exposure Assessment

The air concentrations and deposition rates used in the HHRA were obtained directly from the air dispersion modelling results, while future surface water concentrations were obtained directly from water quality modelling results. Conservative assumptions were used in the development of the air model (Appendix 10.1-A) and the predictive water quality model (Appendix 6.3-C).

Maximum predicted 1-hour, 24-hour, and annual average concentrations in air at each HHERA receptor location were used to evaluate inhalation health risks associated with both short-term and long-term exposures. In reality, the frequency with which the maximum concentration would occur at any one receptor location is relatively low for most COPC. Therefore, the risk estimates tend to overestimate, rather than underestimate, health risks.

Estimation of COPC uptake through the food chain involves the use of assumptions regarding many factors, including the various uptake factors that estimate the amount of a chemical that a receptor would absorb from an environmental medium such as soil or water. Typically, these uptake factors

are conservative and tend to overestimate, rather than underestimate, concentrations in biota. In addition, these uptake factors were applied to the predicted concentrations (e.g., soil concentrations at the end of operation, maximum annual average surface water concentrations), and are assumed to remain constant throughout the lifetime of the receptor (e.g. 80 years for lifetime exposure when assessing exposures to carcinogens); thus, the resulting exposure predictions are very conservative.

Receptor Characteristics

For each receptor scenario, published characteristics and professional judgment were used in determining exposure durations, consumption patterns, and ingestion rates (e.g., Health Canada 2009, 2012a). Although the wild meat and fish consumption rates are specific to Aboriginal populations, the vegetation consumption rate used represents the consumption rate of all vegetation by the general population (including leafy vegetation, root vegetables, berries, and fruit). It is ideal to have receptor characteristics that are representative of site-specific conditions; however, it is not the most critical factor in assessing potential health risks due to the Project. While the focus of an HHERA for a contaminated site is to estimate the absolute risk, the ultimate goal of the HHERA in support of a human health effects assessment in an EA is to determine the change in risk between baseline and future conditions, and to evaluate if this change represents a concern. As a result selection of receptor characteristics that may not be site specific is not expected to substantially increase the uncertainty of the results.

10.4.4.3 Mitigation Measures for Human Health

Mitigation measures specific to human health have not been recommended; however, a number of mitigation measures recommended in other sections will reduce effects on human health. Mitigation measures recommended in the air quality effects assessment chapter (Section 10.1) will reduce the effects of the Project on human health by reducing air emissions and dust deposition, as well as reducing potential metal loading to streams and lakes. These measures include:

- design mitigation measures such as installation of covers over coarse and fine ore stockpiles;
- dust collectors, and use of covered concentrate transport trucks;
- haul road-associated dust will be mitigated with use of coarse gravel and aggregate material on road beds and minimizing haul distances; and
- other operational mitigation measures include watering haul roads, reducing idling of vehicles and equipment, and maintaining mobile equipment to meet emission standards.

The mitigation measures described in the groundwater effects assessment chapter (Section 6.5) will reduce the potential for changes to the quality of groundwater in the Peterson Creek aquifer, used as a source of domestic water in Knutsford. In particular, these mitigations will control the release of effluent containing trace metals into the environment and subsequent effects to groundwater quality. The mitigation measures recommended for the protection of groundwater in the vicinity of the East Mine Rock Storage Facility (East MRSF) include the following design features:

- East MRSF Pond, located down-gradient of the East MRSF. The primary function of this pond is to intercept seepage and runoff from the East MRSF. The pond will be lined with a synthetic liner, the performance of which is monitored using an under liner drainage system;
- foundation preparation under the East MRSF; and
- Cover and reclamation of the East MRSF.

These mitigations are considered to be effective in limiting the potential effects to domestic water quality. A more detailed discussion of the mitigation measures to protect groundwater quality in the Peterson Creek Aquifer, can be found in the groundwater effects assessment (Section 10.2.4).

The mitigations from other VCs are intended to reduce environmental effects to a level which does not adversely affect the environment.

10.4.5 Residual Effects and Their Significance

10.4.5.1 Summary of Human Health Residual Effects

Project activities will increase metal concentrations in soil, surface water, and groundwater in the LSA. These increases will increase human exposures to metals in country foods and domestic water over the life of the Project. These changes in exposure have the potential to alter the human health risk associated with metal exposures above what currently exists under baseline conditions. The significance of the potential increase in health risk associated with this exposures, are discussed in the following sections.

The residual effects of the Project on human health resulting from exposures to chemicals released to the environment as a result of Project activities are summarized in Table 10.4-26. With application of mitigation measures for air quality (Section 10.1.4.3) and water quality (Section 6.3.4.3), residual effects on human health are not expected (see Section 10.4.4.3).

10.4.5.2 Criteria for Characterization of Residual Effects

The criteria used to characterize residual effects on human health are defined in Table 10.4-27.

10.4.5.3 Characterization of Residual Effects

Table 10.4-28 summarizes the characterization of residual effects on human health risk associated with inhalation and direct contact/ingestion exposures. The magnitude, duration, frequency, geographic extent, reversibility, resiliency, ecological context and significance of the residual effects are listed. Estimates of the likelihood of residual effect occurring and a ratings of the confidence in the predictions are also provided. Discussions of the characterization of the residual effects are provided below.

Table 10.4-26. Summary of Residual Effects on Human Health

Valued Component	Project Phase (timing of effect)	Project Component/ Physical Activity	Description of Cause-Effect[1]	Description of Mitigation Measure(s)	Description of Residual Effect
Human Health	Construction Operation Closure	All Project activities that generate dust and diesel emissions	Change in air quality that could result in a change in human health risk associated with inhalation exposures to CACs and particulate-bound metals.	Mitigation measures specific to human health have not been recommended. Mitigation measures to control air and dust emissions outlined in the air quality effects assessment (Section 10.1) and mitigation measures to control surface water and groundwater discharges outlined in the water quality effects assessment (Section 6.3) will reduce Project emissions to levels that are protective of human health.	Changes in human health risk associated with changes in exposures to metals. With the application of mitigation measures, no residual effects on human health are expected.
	Post-Closure	All Project activities that generate dust or result in the release of water to surface water or groundwater	Changes in soil, surface water, groundwater and country food quality could result in a change in human health risk associated with direct contact and ingestion exposures to metals.		

[1] *"Cause-effect" refers to the relationship between the Project component/physical activity that is causing the change or effect in the condition of the VC.*

Characterization of Residual Effects for Inhalation-Related Human Health Risks

Residual Project effects associated with inhalation exposures to CACs and metals during the construction, operations, and closure phases of the Project are characterized as being:

- Negligible in magnitude:

  Predicted CRs for SO_2, NO_2 and CO and particulate-bound metal inhalation exposures across the LSA are well below the effects threshold of 1.0 for the non-carcinogenic chemicals and the effects threshold of 1×10^{-5} for carcinogenic chemicals.
  Predicted CRs for PM_{10} and $PM_{2.5}$ are above 1.0 in both the Baseline and Future Cases. The analysis shows that when CRs are above 1.0, the change in CR between the Baseline Case and the Future Case are small. Further the air quality effects assessment shows that the Project makes a very small contribution to PM_{10} and $PM_{2.5}$ concentrations.

- Long-term in duration:

  Changes in air quality related to Project activities will occur over the lifetime of the Project.

Table 10.4-27. Definitions of Characterization Criteria for Residual Effects on Human Health

Magnitude	Duration	Frequency	Geographic Extent (Physical/Biophysical)	Reversibility	Social Context	Likelihood of Effects	
						Probability	Confidence Level
How severe will the effect be?	*How long will the effect last?*	*How often will the effect occur?*	*How far will the effect reach?*	*To what degree is the effect reversible?*		*How likely is the effect to occur?*	*How certain is this analysis?*
Negligible: Health risk is not affected or slightly affected but exposure ratios for Project-related exposures are below the benchmarks established by a recognized health organization. (i.e., HQ<1.0 (for total exposure via ingestion), CR<1.0; IILCR<1E-05)	**Short-term:** Effect lasts for 24 hours	**Once:** Effect is confined to one discrete period in time during the life of the Project.	**Local:** Effect extends less than 500 m from infrastructure or activity.	**Reversible:** Effect can be reversed after Project closure.	**Low:** There area is subject to extensive human activity.	**High:** It is highly likely that this effect will occur.	**High:** > 80% confidence. There is a good understanding of the cause-effect relationship and all necessary data are available for the Project area. There is a low degree of uncertainty and variation from the predicted effect is expected to be low.
Minor: Project-related environmental exposures marginally exceed the benchmarks established by a recognized health organization (i.e., 1<HQ≤2.0; 1.0<CR≤2.0; 1E-05<IILCR≤1E-04;	**Medium-Term:** Effect lasts over a specific Project phase (construction, operations or closure)	**Sporadic:** Effect that occurs at sporadic or intermittent intervals during any phase of the Project.	**Landscape:** Effect is limited to the LSA.			**Medium:** This effect is likely, but may not occur.	**Medium:** 50 to 80% confidence. The cause-effect relationships are not fully understood, there are a number of unknown external variables, or data for the Project area are incomplete. There is a moderate degree of uncertainty; while results may vary, predictions are relatively confident.
Medium: Project-related environmental exposures are predicted to exceed the benchmarks established by a recognized health organization. (i.e., 2.0<HQ≤10.0; 2.0<CR≤10.0; 1E-04<IILCR≤1E-03; 2.0<RQ≤10)	**Long-Term:** Effect lasts over the operational life of the Project (i.e., construction, operations and closure)	**Regular:** Effect occurs on a regular basis during the life of the Project.	**Regional:** Effect extends across the broader region (e.g., RSA).	**Irreversible:** Effect cannot be reversed (i.e., is permanent).	**High:** The area is relatively undisturbed or unaffected by human activity.	**Low:** This effect is unlikely but could occur.	**Low:** < 50% confidence. The cause-effect relationships are poorly understood, there are a number of unknown external variables, and data for the Project area are incomplete. High degree of uncertainty and final results may vary considerably.
Major: Project-related environmental exposures are predicted to substantially exceed the benchmarks established by a recognized health organization. (i.e., HQ>10.0; CR>10.0; IILCR>1E-03; RQ>10)	**Permanent:** Effect is permanent	**Continuous:** Effect occurs constantly during the life of the Project.	**Beyond Regional:** Effect extends beyond the regional scale, and may extend across or beyond the province.				

Table 10.4-28. Characterization of Residual Effects, Significance, Likelihood and Confidence on Human Health

Residual Effect	Residual Effects Characterization Criteria							Significance of Adverse Residual Effects	Likelihood and Confidence	
	Magnitude	Duration	Frequency	Geographic Extent	Reversibility	Social Context	Context		Probability	Confidence
Change in human health risk due to inhalation	Negligible	Short-term	Sporadic	Landscape	Reversible	High	Low	Not significant (minor)	Low	High
Change in human health risk due to direct contact and ingestion	Negligible	Permanent	Continuous	Landscape	Irreversible	High	Low	Not significant (minor)	Low	High

- Sporadic in frequency:

  The Air Quality assessment shows that instances where predicted PM_{10} and $PM_{2.5}$ loadings would result in estimated CRs above 1.0 in the Baseline and Future Cases occur infrequently, usually in the winter months.

- Landscape in geographic extent:

  The Air Quality assessment shows that changes in air quality resulting from Project-related activities are limited to the LSA. Therefore, changes in inhalation human health risks will also be limited to the LSA.

- Reversible

  Changes in human health risk associated with Project-related changes in air quality will be reversible when Project activities cease.

- Low in social context:

  The Project is located in an area of existing urban development with a number of existing human activities that contribute similar chemicals to the environment as those released by Project-related activities. Project-related activities are not predicted to alter human health risks associated with inhalation exposures to CACs and metals beyond what currently exists.

Based on the above rationale, the residual effect on the potential change in inhalation-related human health risk is not significant (minor). For exposure through the inhalation pathway, the likelihood that a change in human health would occur is low and the confidence in this prediction is high.

Characterization of Residual Effects for Direct Contact and Ingestion-Related Human Health Risks

Residual Project effects associated with direct contact and ingestion-related exposures to metals are characterized as being:

- Negligible in magnitude:

  The predicted change in human health risk associated with direct contact and ingestion exposures between Baseline and Future Cases is negligible. For the non-carcinogenic metals the HQs calculated for Baseline and Future Cases are below the threshold of 1.0 for each receptor age group from Aberdeen, Sahali, West End/Downtown, MacDonald, Brocklehurst, Knutsford and the Kamloops Indian Reserve No. 1. The IILCRs associated with exposures to arsenic are below the Health Canada cancer risk acceptability benchmark of 10^{-5} in the Future Case for each of the receptor groups considered. This suggests that ingestion exposures to arsenic in the LSA do not pose an unacceptable risk in the Future Case.

- Permanent in duration:

  Deposition of Project-related particulate metals to soil will increase metal concentrations in the receiving soils over the lifetime of the Project. Contact water seepage may increase metal concentrations of surface water in Peterson Creek and groundwater. These increases in metal concentrations will remain in the soil and water well into the future. The continued presence of metals in the soil and water are considered to be a permanent change in human health risk associated with direct contact and ingestion exposures to metals.

- Continuous in frequency:

  The accumulation of metals in soil will be continuous over the lifetime of the Project. Deposition will cease at post closure when reclamation activities are complete. However, the metals deposited on the soils will remain in the soils well into the future. The continued presence of metals in the soil will, in turn, result in a permanent change in human health risk associated with direct contact and ingestion exposures to metals. The release of seepage to surface water and groundwater will be continuous over the lifetime of the Project and will continue once reclamation has ceased. The continued presence of metals in the surface water of Peterson Creek and the Peterson Creek aquifer will result in a permanent change in human health risk associated with direct contact and ingestion exposures to metals.

- Landscape in geographic extent:

  The air quality effects assessment (Section 10.1) shows that the deposition of Project-related particulate-bound metals is limited to the LSA. Therefore, changes in direct contact and ingestion exposure-related health risks will also be limited to the LSA.

- Irreversible

  Deposition of Project-related particulate metals to soil will increase metal concentrations in the receiving soils over the lifetime of the Project. These increases in metal concentrations are permanent and will remain in the soil well into the future. Seepage to the surface water of Peterson Creek and to the Peterson Creek aquifer will increase metal concentrations in surface water and groundwater. These increases will be permanent and will remain in the surface water and groundwater well into the future. The continued presence of metals in the soil, surface water and groundwater will, in turn, result in a permanent change in human health risk associated with direct contact and ingestion exposures to metals.

- Low in social context:

  The Project is located in an area of existing urban development with a number of existing human activities that contribute similar chemicals to the environment as those released by Project-related activities. Project-related activities are predicted to result in minor increases in human health risk associated with direct contact and ingestion exposures above what currently exists. However, these increased human

health risks do not exceed the risk acceptability benchmarks established by regulatory agencies.

Based on the above rationale, the residual effect on the potential change in direct contact and ingestion human health risk is not significant (minor). The likelihood that a change in inhalation health risk would occur is low and the confidence in this prediction is high.

10.4.5.4 Significance of Human Health Residual Effects

Project activities are predicted to result in a minor increase in human health risk. However, with the exception of exposure to $PM_{2.5}$ and PM_{10}, exposure of receptors to the CACs or COPCs via inhalation and non-carcinogenic COPCs via direct contact and ingestion resulted in predicted risk estimates (CRs and HQs) that were below relevant benchmarks for both Baseline Case and Future Case conditions.

Exposures to $PM_{2.5}$ and PM_{10} that exceed the CR benchmark of 1.0 were predicted for both Baseline Case and Future Case conditions. In both cases the events occur infrequently and the change in inhalation-related health risks between Baseline Case and Future Case is negligible. Thus, a change in human health risks associated with exposures to Project-related PM_{10} and $PM_{2.5}$ emissions is expected to be not significant.

Direct contact and ingestion exposures to carcinogenic COPCs (i.e., arsenic) were predicted to result in IILCRs that were below the cancer risk acceptability benchmark of 10^{-5} for Future Case exposures.

10.4.5.5 Characterization of Likelihood and Confidence

There is a high probability that there will be no significant residual effects for human health due to the following reasons:

- the baseline dataset was comprehensive and is assumed to be representative of site conditions;
- the statistical methods used for data analysis are supported by Health Canada and the US EPA;
- air quality and was conducted in accordance with BC guidelines and used regulatory-approved models that are designed to over-predict concentrations in media;
- the risk assessment was conducted based on a widely accepted framework and using methods accepted by Health Canada (Health Canada 2010a);
- the assumptions made in the risk assessment (Appendix 10.4-A) were reasonable and representative of site conditions;
- the TRVs and benchmarks used to estimate risk were selected based on recommendations by the US EPA, Health Canada and the BC MOE; and,
- the risk assessment calculations are designed to be conservative in nature and likely over-predict potential risk.

10.4.5.6 Summary of Residual Effects Assessment and Significance

Table 10.4-29 summarizes the human health residual effects, which are not expected to be significant with application of the mitigation measures outlined in Section 10.4.4.3.

Table 10.4-29. Summary of Residual Effects, Mitigation, and Significance on Human Health Risk

Residual Effects	Project Phase	Mitigation Measures	Significance
Change in human health risk	Construction, Operation, Closure, Post Closure	Mitigation measures specific to human health have not been recommended. Mitigation measures to control air and dust emissions outlined in the air quality effects assessment (Section 10.1) and mitigation measures to control surface water and groundwater discharges outlined in the water quality effects assessment (Section 6.3) will reduce Project emissions to levels that are protective of human health.	Not significant (minor)

10.4.6 Cumulative Effects Assessment

10.4.6.1 Introduction

Residual Project effects on human health are driven by changes in air quality, dustfall, and water quality. Therefore, effects that other industrial facilities have on dustfall and air and water quality that overlap with effects attributed to the Project have the potential to result in cumulative changes in human health. If there are no overlaps in air, dustfall or water quality effects between the Project and the other industrial facilities, there is no chance for cumulative change in human health and an assessment of cumulative effects would not be required.

10.4.6.2 Identification of Other Actions that May Affect Human Health

Table 10.4-30 summarizes screening of other actions for potential inclusion in the cumulative effects for human health. Since potential changes in human health are related to changes in air quality (including dust) and water quality, this table was completed based on information provided in the air quality effects assessment (Section 10.1) and the water quality effects assessment (6.3). If the industry or activity in question is not expected to significantly affect air quality or water quality, then it is also not expected to have a significant cumulative effect on human health.

With respect to air quality, none of the projects listed in Table 10.4-30 were carried further into the cumulative effects assessment because these potential air quality effects were captured in the baseline modelling or within the global and regional background conditions considered in the assessment of residual effects (Section 10.1). Similarly, with respect to water quality, none of the projects listed in Table 10.4-30 were carried further into the cumulative effects assessment because these potential water quality effects were captured in the baseline water quality data used to predict

water quality concentrations in the water quality assessment (Section 6.3). In addition, the Project and other projects would be required to meet regulatory acceptable standards for discharge to waterbodies or site specific water quality benchmarks that provide a similar level of protection. Specifically, predicted changes in chemical concentrations of environmental media associated with the Project will not overlap with potential changes associated with other projects.

The air emissions and or water releases from reasonably foreseeable projects and activities (e.g., City of Kamloops expansion and growth) have not been quantified because these projects have not developed a sufficiently detailed project description and have not entered into a formal project approval or permitting process.

10.4.6.3 Interactions between Residual Project Effects and Other Project or Activity Effects

The air quality (Section 10.1) and water quality (Section 6.3) effects assessments have concluded the potential cumulative effects on dustfall, air quality, and water between the Project and other projects and activities will not overlap and therefore are not significant. In the absence of cumulative effects on dustfall, air quality, and water quality, there is no potential for cumulative effects for the Project and other projects and activities on human health.

10.4.6.4 Proposed Mitigation Measures

No additional mitigation measures are required for human health as no potential cumulative effects were identified.

10.4.6.5 Evaluation of Significance of Residual Cumulative Effects

There are no spatial or temporal overlaps with other projects or activities so there are no cumulative effects. Therefore, an evaluation of significance of human health residual cumulative effects is not required.

Table 10.4-30. Screening of Other Actions for Inclusion in the CEA for Human Health

Residual Effect	Industrial Projects/Activities													Natural Resources and Land Use			Tourism and Commercial Recreation Activities					Community Infrastructure			Transportation						
	Vidette Lake Mine	Afton Mine (Historical)	Iron Mask Mine	Bonaparte Mine	New Afton Mine (New Gold)	Highland Valley Copper Mine (Teck)	Domtar Kamloops Pulp Mill	Tolko-Hefley Creek Plywood and Veneer	LaFarge Cement Plant	Trans Mountain Pipeline System (Kinder Morgan)	Trans Mountain Pipeline System - Expansion (Kinder Morgan)	Harper Creek	Highland Valley Copper – Bethlehem Expansion	Kamloops Forest District	Agriculture	Ranching	Tranquille on the Lake	Lac Le Jeune Resort	Tobiano Golf Course	Recreational Hunting, Fishing, Foraging	Recreational Trails	City of Kamloops Wastewater Management	Water Treatment Centre	City Expansion and Growth	Lac le Jeune Road	Highway 1	Highway 5A	Highway 5 (Coquihalla Highway)	Kamloops Airport	Rail Yards and Lines (CP and CN)
Change in Human Health Risk	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

Notes:

(-)	*No spatial or temporal overlap.*
O	*Spatial or temporal overlap, but no interaction anticipated OR No change from current condition anticipated, and already captured as part of baseline characterization. No further consideration warranted.*
L	*Negligible to minor interaction expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.*
M	*Potential moderate interaction requiring unique active management/monitoring/mitigation; warrants further consideration.*
H	*Key interaction; warrants further consideration.*

10.4.7 Conclusion

Residual effects from the Project on human health are assessed to be not significant (minor). Project activities will result in negligible changes in air quality and in the levels of metals in the terrestrial environment (i.e., soil, vegetation, and country foods). Project activities may result in changes in water quality. However, with mitigation measures in place, the changes in metal concentrations in the surface water of Peterson Creek and groundwater in the Peterson Creek aquifer are expected to be negligible. These changes in metal concentrations in soil, vegetation country foods, surface water and groundwater result in a negligible increase in exposure to metals above what currently exists under baseline conditions. This also results in a negligible increase in the human health risk above the baseline human health risks. Because changes in human health risk are concluded to be negligible, changes to human health are concluded to be not significant.

Confidence in the predictions of residual effects and cumulative effects of the Project on human health depends on the quantity and quality of the baseline data, an understanding of how the Project could interact with human health and the underlying assumptions made in estimating human exposure to Project-related chemical releases. Uncertainties associated with assessing changes in human health risk associated with exposures to Project-related chemicals are addressed through the use of conservative assumptions that are designed to over-estimate exposures and the associated human health risks.

The quality and quantity of the underlying air quality and water quality data, from measured and modelled predications, for Baseline, Operations and Post-Closure conditions are sufficient to have a high degree of confidence in the conservatism of the exposure and human health risk predictions for residual effects of the Project and from cumulative effects from other projects and/or activities that can reasonably be expected to overlap with Project activities and contribute to human exposure and health risk with the LSA and RSA.

The human health-based criteria uses in the assessment of human health risk have been developed by regulatory agencies and are designed to be protective of sensitive members of the population, including children, the elderly and women of child-bearing age. Therefore, there is a high degree of confidence that the toxicological reference values used in assessing residual human health risks will over-predict potential human health risks.

There are no spatial or temporal overlaps with other projects or activities so there are no cumulative effects. Therefore, an evaluation of significance of human health residual cumulative effects is not required.

10.5 NOISE AND VIBRATION

10.5.1 Rationale

This section includes a description of the scoping process used to identify Noise and Vibration for inclusion in the assessment. Scoping is fundamental to focusing the Application/EIS on those issues where there is the greatest potential to cause significant adverse effects. Valued components (VCs) are components of the natural and human environment that are considered to be of scientific, ecological, economic, social, cultural, or heritage importance (CEAA 2006; EAO 2013). To be included in the EA, there must be a perceived likelihood that the VC will be affected by the proposed Project. Valued components are scoped into the environmental assessment based on issues raised during consultation with Aboriginal communities, government agencies, the public and stakeholders. Consideration of certain VCs may also be a legislated requirement, or known to be a concern because of previous project experience.

The rationale for including Noise and Vibration as a human health, wildlife, ranching and livestock, traditional land use, and aquatic life VC is based on the following:

- provincial noise guideline, federal and international noise guidance;
- provincial, federal, and international vibration guideline;
- Aboriginal interest;
- public or other stakeholder input; and
- scientific/professional knowledge.

The general public (singly and as members of groups) and stakeholder expressed concern about potential noise and vibrations effects due to the proximity of the Project to the city of Kamloops and rural residences. Specific concerns were expressed on the blast-related vibration effects on structural integrity of building, slope stability in the Aberdeen area, underground pipelines. There was also concern that blast effect on human health, livestock, wildlife, and aquatic life and recreation activities at Jacko Lake. Concerns were raised about the noise effect on the nearby community (i.e., Aberdeen, Knutsford), ranchers, livestock, and wildlife. Concerns were also raised about the effect on property values due to noise and vibration effects. Aboriginal groups identified noise and vibration effects as a cause for concern on their ability to enjoy the reserve land and to exercise their hunting and fishing rights.

Noise effects are generally associated with "unwanted" sound. Project components that will have noise emissions include the following:

- stationery equipment in plant facilities;
- haul road and access road traffic;
- mobile equipment activities; and
- construction works.

The vibration effects assessment focuses on blast-induced ground vibration and air blast overpressure effects on aquatic life, human health, and structures. In addition to blasting, ground vibration effects from construction equipment and piling are also assessed.

The assessment will cover a broad geographic area with a wide array of residential receptors ranging from urban and suburban to rural locations.

10.5.2 Background

10.5.2.1 Regional Overview

The Project is located in the Thompson-Okanagan region of BC. The topography of the area consists of hills and valleys. The hills are largely tree-covered with extensive cut blocks (areas that have been logged) that are in various stages of re-growth. The valley bottoms are dry except for rivers and lakes.

The Project is situated at the historic Afton Mining Camp to the south of the city of Kamloops. The city of Kamloops itself occupies the valley bottom, with neighborhoods extending up the south valley wall towards the Project up to approximately 900 metres above sea level (masl). The urban areas of Kamloops are physically separated from the Project site by Coal Hill (1,092 masl), Ironmask Hill (995 masl), and Sugarloaf Mountain (1,130 masl). These features form a natural barrier between the Project and the City that will help confine some of the potential noise and vibration effects from the Project.

There are developed and undeveloped areas near the Project. Many environmental factors such as meteorological conditions, seasonality, vegetation cover and the intensity of human activity can affect the existing acoustic environment (i.e., baseline sound level) in both developed and undeveloped areas. These factors can vary to the minute because of changing natural forces and human activities.

In most rural acoustic environments, the sound level is characterized by a combination of sounds from farming activities, traffic, and natural sounds. Natural sound sources include insects, animals, birds, water fowl, wind, and rain interacting with natural surfaces. In developed urban and suburban areas with more human activities, the acoustic environment may vary from one location to another due to the level of activities during different time periods. Regional transportation infrastructures such as the Kamloops airport, the Trans-Canada Highway, and the railways are noise emission sources that contribute to the existing acoustic environment.

10.5.2.2 Historical Activities

The area around the Project has a long history of human activity. The area was first inhabited by approximately 3,000 members of the Shuswap tribe, part of the Interior Salish Nation. Fur trading began in the area in the early 1800s. The fur trading posts were located in various locations in what is now Kamloops.

Construction of the transcontinental railroad was completed in 1885, encouraging the growth of a small village on the shores of the Thompson River. The village grew rapidly and by 1893 the population had risen to approximately 500 and became incorporated as a city with public works.

The Canadian Northern (CN) Railway was completed in 1915. The Kamloops airport became operational in 1939. The Trans-Canada Highway to the west of the Project was completed in 1962, and the Yellowhead Highway in 1970. After the Second World War, the City began to grow, and much of the land that had formerly been used for ranching and farming in the valley was used for residential development. Ranching (including cattle grazing) also developed, and is currently ongoing in and around the Project.

Mining activity within the Project area can be traced back over 100 years beginning with exploration in the 1880s and continuing intermittently to present day. Copper, gold, and iron mineralization was discovered at the Iron Mask Mine near Kamloops in 1896. Nearby properties, including the Wheal Tamar, Ajax, and Monte Carlo claims, were explored over the following years.

The Afton Mine went into operation in 1977. Mining operations were initiated on the Ajax East and Ajax West pits in 1989 and subsequently suspended in 1991 due to depressed metal prices. A second period of production began in 1994 and was again suspended in 1997. In the late 1990s, the tailings facility and project components were decommissioned and reclaimed by the Afton Mine in accordance with their closure plan. The New Afton Mine occupies the site of the historic Afton Mine infrastructure. New Afton Mine began underground mining immediately beneath the historic Afton Mine open pit in June 2012.

Current industrial sources of noise within the regional study area (RSA see section 10.5.3.1) include activities from power transmission, a pulp mill, a cement plant, mining, landfill, and other industrial product manufacturing facilities. Non-industrial sources of noise in or near Kamloops include commercial and residential activities, vehicular traffic, an airport, and rail transportation.

10.5.2.3 Baseline Studies

The objective of the noise baseline studies is to quantify the baseline sound levels at selected locations within the Project RSA through field measurements. The studies were conducted in 2012 and 2014. The AIR specifies a Type 1 or Type 2 sound level for direct 24 hours continuous monitoring of comprehensive sound parameters ("slow" response, "A"- weighting network, one minute intervals) and measurement method should be consistent with ISO 1996-2:2007. Baseline measurement equipment meets the minimum specifications and the ISO 1996-2:2007 methods were followed.

The baseline monitoring program included six locations that represented different areas (Table 10.5-1; Figure 10.5-1). Two of the locations were in a rural area. Two locations were near the Aberdeen development boundary, representative of a transition area between rural and suburban environments. The final two locations were within the suburban residential community of Aberdeen.

The BC Oil & Gas Commission (BC OGC) Noise Control Best Practices Guideline (the 'BC OGC noise guideline'; 2009) and the United States Environmental Protection Agency (US EPA) Office of Noise Abatement and Control Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety noise guidelines (1974) were used as reference noise guidelines for the noise VC in the AIR. Both guidelines provide methods and information on noise baseline studies.

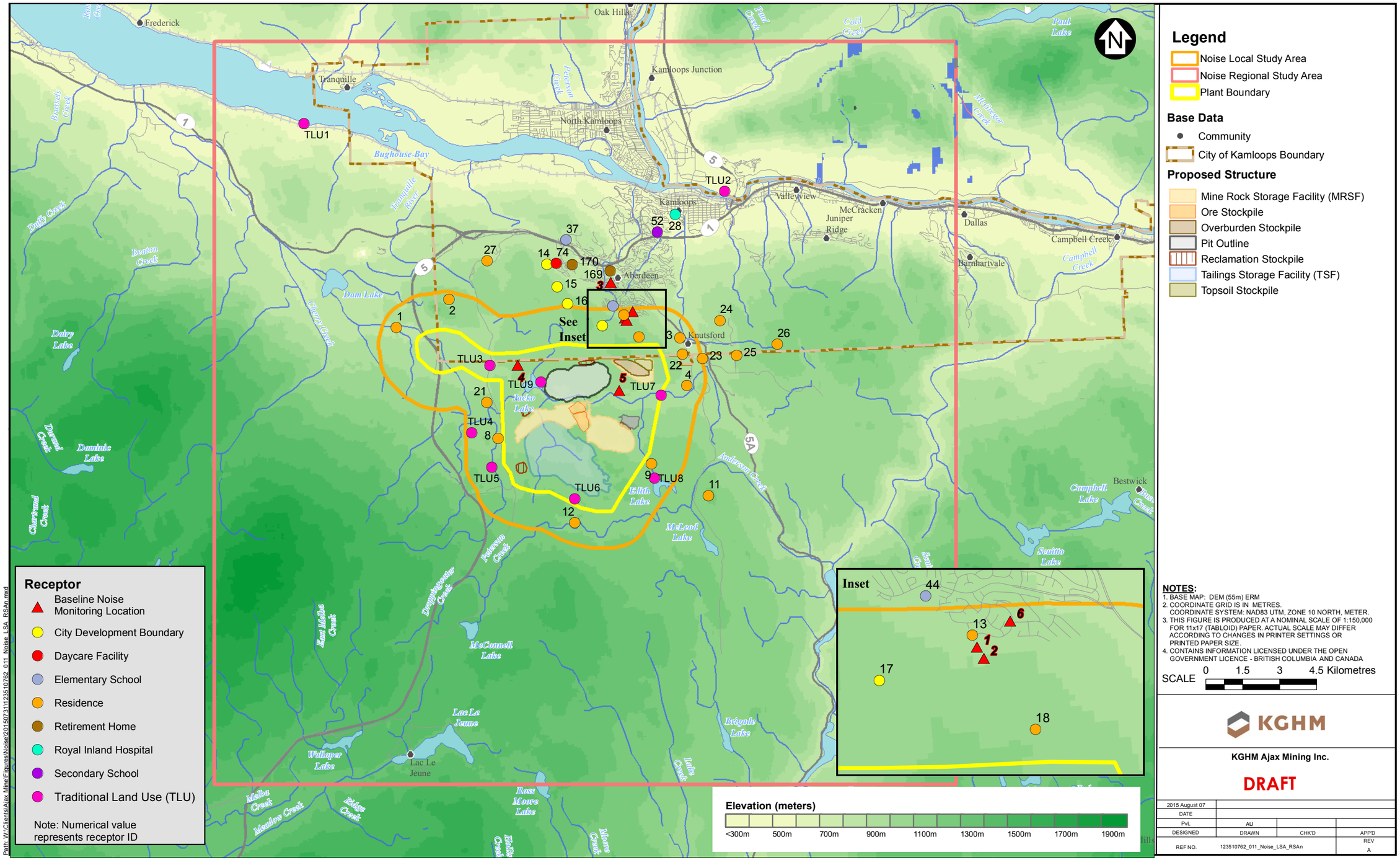
Table 10.5-1. Noise Baseline Studies Monitoring Locations

ID	Location	Acoustic Environment	Description	Measurement Period	Easting [a] (m)	Northing [a] (m)
1	Abbeyglen/Pacific way intersection	Rural to suburban transition	South end of the Aberdeen development, at the intersection of Pacific Way and Abbeyglen Way.	December 1 to 5, 2012	686,325	5,612,358
2	South of the Aberdeen community	Rural to suburban transition	South end of the Aberdeen development, at the end of Pacific Way (south of location 1).	December 5 to 12, 2012	686,390	5,612,252
3	Pacific Way and Howe Road intersection	Suburban	Open field at the intersection of Pacific Way and Howe Road, close to the City of Kamloops road weather information system (RWIS) meteorological station.	December 16 to 21, 2012	685,751	5,613,789
4	Jacko Lake	Rural	Location approximately 600 m northwest of Jacko Lake, inside the LSA (see Section 10.5.3.1), north of the main haul road.	June 10 to 15, 2014	681,985	5,610,442
5	Straw House	Rural	2560 Goose Lake Rd, Kamloops, BC (approximately 3 km north-northeast of Goose Lake) inside the LSA.	June 10 to 15, 2014	686,088	5,609,417
6	Aberdeen residence	Suburban	Residential area in the community of Aberdeen, south of Aberdeen Drive and inside the LSA (see Section 10.5.3.1)	June 10 to 15, 2014	686,639	5,612,604

Note:
[a] *UTM Zone 10U NAD 83*

Figure 10.5-1
Noise Study Area and Receptor Location

Stantec



In contrast to audible noise, the background environmental ground-borne vibration levels in an outdoor rural area without any local human activities is typically below the threshold of human perception (FTA 2006). The typical threshold of human perception of ground vibration is 0.5 mm/s peak particle velocity (Blasters' Handbook 2011); however, the perceptibility threshold varies from person to person. In an urban and suburban environment, a person may be subjected to a wide range of vibration effect, depending on the location, time of the day, proximity to day-to-day vibration sources (i.e., vehicle, train, construction activities). Vibration level in an indoor residential environment is created by local events such as vacuum cleaning, washing machine, movement of people or slamming of doors. Such indoor events will create different levels of perceptible vibration. The structural integrity of the building will also affect the indoor vibration level.

The vibration assessment is based on comparing the Project event only (i.e., blasting) effect to a guideline or threshold. The masking effect from background vibration level or cumulative vibration level from another event is typically not included. A vibration baseline study for the Project was not performed because it would unlikely to provide meaningful baseline vibration data for the assessment.

The following sections present the data sources, methods and characterization of baseline conditions for noise.

Data Sources

Results from the baseline studies are based on two multiday noise monitoring studies conducted for a total of six monitoring locations. The first study was conducted during winter (December 2012) and the second study was conducted during summer, June 2014. Table 10.5-1 details the six measurement locations including the Universal Transverse Mercator (UTM) coordinates. Figure 10.5-1 shows the six noise monitoring locations chosen for the baseline analysis. In addition, recommended background sound level for different acoustic environments as prescribed in the BC OGC noise guideline and US EPA noise guidelines are used as data sources for comparable to the measurement results.

Methods

The methods used during the baseline noise monitoring programs were consistent with the requirements outlined in the AIR/EISG. In the AIR/EISG, the only noise guideline which provides baseline noise monitoring specification is the BC OGC noise guideline (BC OGC 2009). Therefore, the BC OGC noise guideline was used as the primary reference for the baseline noise monitoring programs. Furthermore, where information such as measurement instrumentation and representative weather condition was not specified in the BC OGC noise guideline, specifications were taken from the Alberta Energy Regulator (AER) Directive 038: Noise Control, which the BC OGC noise guideline is based on. Directive 038 requires that a noise survey be conducted with a minimum Type 2 integrating sound level meter under weather conditions acceptable for noise measurements. Precipitation and high wind speed exceeding 15 km/hr are not considered acceptable weather conditions.

The Useful Information for Environmental Assessments set out by Health Canada, 2010 (HC Guidance 2010) does not make recommendations on how baseline noise monitoring is to be

conducted; however, the guidance recognizes that both measurements and estimates are acceptable methods in establishing the baseline sound levels for RSA.

Type 1 integrating sound level meters meeting the American National Standards Institute (ANSI) S1.43-1997 standard were used for the sound monitoring studies. Weather stations and weather meters were used in collecting meteorological information during the monitoring periods. Audio recordings were reviewed to identify noise sources such as natural sounds (e.g., high wind, rain interacting with natural surfaces) and anthropogenic noise from local activities for each monitoring period. Data that was not representative of day-to-day activity at the monitoring location or measured outside acceptable weather conditions was filtered from the dataset prior to the calculation of any averages or other statistics. Hourly daytime and nighttime sound levels were subsequently calculated for the duration of the measurement period. As per the BC OGC noise guideline, the daytime period was defined as 07:00 to 22:00 and the nighttime period was from 22:00 to 07:00.

Additional details of methods used in the baseline monitoring program are presented in Appendix 10.5-A: Noise and Vibration Technical Data Report.

Characterization of Baseline Condition

Noise

Table 10.5-2 summarizes the measured baseline sound level results at the six noise monitoring locations relative to recommended sound levels recommended by the BC OGC and the US EPA. The daytime (L_d), nighttime (L_n) and day-night (L_{dn}) equivalent sound levels are presented for the entire measurement period for each location. Detailed information on the hourly ($L_{eq, 1hr}$), daytime (L_d) and nighttime (L_n) equivalent sound level at all monitoring locations during each 24-hour measurement period is summarized in the Appendix 10.5-A: Noise and Vibration Technical Data Report.

Table 10.5-2. Daytime, Nighttime, and Day-Night Equivalent Sound Level Summary for the Entire Baseline Monitoring Period

Monitoring Location	Time Period	Measured Baseline Sound Level [1]			BC OGC Recommended Baseline Sound Level [1]			US EPA Recommended Baseline Sound Level [1]
		L_d (dBA)	L_n (dBA)	L_{dn} (dBA)	L_d (dBA)	L_n (dBA)	L_{dn} (dBA)	L_{dn} (dBA)
1	December 1 to 5, 2012	44	36	45	51	41	51	48 to 52
2	December 5 to 12, 2012	39	36	43	51	41	51	48 to 52
3	December 16 to 21, 2012	50	43	51	61	51	61	48 to 52
4	June 10 to 15, 2014	39	36	43	45	35	45	44
5	June 10 to 15, 2014	39	34	42	45	35	45	44
6	June 10 to 15, 2014	53	45	54	51	41	51	53 to 57

Note:

[1] The determination of these values are presented in Appendix 10.5-A: Noise and Vibration Technical Data Report.

The measurement results were compared to the recommended baseline sound levels described in the BC OGC noise guideline and the US EPA (1974) document. These recommended values quantify the expected baseline sound level for different communities within the RSA based on population density and proximity to transportation sources.

These baseline results were incorporated in the effects assessment (Section 10.5.4) to quantify the change in acoustic environment due to Project-related noise.

Variability in seasonal and meteorological conditions will affect the baseline sound level at all the measurement locations. In most rural acoustic environments, the baseline sound level is characterized by natural sound sources including wind and rain interacting with natural surfaces (e.g., wind noise, vegetation rustling), stream and creek movement, and animal noises (e.g., from birds and insects). These sources are somewhat variable down to the minute because of changing natural forces. In developed areas with more human activities (i.e., suburban areas, business and commercial districts), the acoustic environment may vary from one location to another during different time periods.

The measured baseline sound levels are based on approximately one week of measurement data. The measurement result may be different from the recommended baseline sound level in noise guideline; however, it provides an indication of the average acoustic environment for the location. A longer monitoring period (monthly or annually) or a permanent monitoring program may provide a larger statistical sample. The BC OGC and Health Canada guideline does not prescribe minimum monitoring duration for baseline sound level program. The Alberta AER Directive 038 noise regulation recommended monitoring period varies from 9 to 24 hours, depending on the type, time, and duration of the noise. A minimum of 3 hours per daytime or nighttime period of acceptable data (by the AER) is required for the baseline monitoring to be considered valid. Based on professional judgement, the 5 to 6 days long program provides a reasonable amount of data for an evaluation of the existing acoustic environment at the monitoring locations.

The BC OGC noise guideline recommends that baseline sound levels should be calculated on the basis of dwelling density and proximity to transportation sources. In determining the baseline sound level at a receptor for BC OGC noise guideline comparison, recommended basic sound values in the guideline will be used rather than measurement results.

Health Canada recognizes sound measurement in establishing the baseline sound levels for noise assessment. In determining the baseline sound level at different receptors for Health Canada noise guideline comparison, the measurement results from the monitoring program can be used. One of the six monitoring locations was assigned as the representative acoustic environment for each receptor. The lower baseline sound level of the two (BC OGC recommended sound level or measured sound level presented in Table 10.5-2 above) will be used for the receptor. This is considered a conservative approach as a lower baseline sound level will cause a greater change in the acoustic environment when the Project noise effect is assessed.

A detailed discussion of the baseline results is presented in Appendix 10.5-A: Noise and Vibration Technical Data Report.

Vibration

Baseline ground vibration level at all receptors is not quantified. Vibration level is typically assessed for the event (i.e., blasting) without the consideration of a baseline level. In addition, most guidelines and regulatory limits are only applicable to the event only without the consideration of a baseline level.

10.5.3 Assessment Boundaries

The assessment boundaries define the maximum limit within which the effects assessment is conducted. They encompass the areas within, and times during which, the Project is expected to interact with the VCs, as well as the constraints that may be placed on the assessment of those interactions due to political, social, and economic realities (administrative boundaries), and limitations in predicting or measuring changes (technical boundaries).

Figure 10.5-1 summarizes the noise local study area (LSA) and regional study area (RSA) for the noise assessment. Figure 10.5-2 summarizes the vibration LSA and RSA for the vibration assessment. There are separate study areas for noise and vibration because the maximum limits for both effects are different.

10.5.3.1 Spatial Boundaries

This section presents both the LSA and RSA to be used for the effects assessment. In total, 37 noise receptors and 41 vibration receptors were included in the assessment. The selection of noise receptors considered recommendations from the BC OGC and Health Canada noise guideline, as well as input from the working group, community, and Aboriginal groups. The selection of vibration receptors are based primarily on locations where a structure would be subject to blast-induced ground vibrations and air blast. Other locations such as the fish habitat area, open recreation area and traditional land use area where potential blast induced vibration effects might occur are included. Therefore, the vibration receptors are not identical to noise receptors.

These noise and vibration receptors are located within the RSA, as shown on Figures 10.5-1 and 10.5-2, respectively. Details on the noise and vibration receptor selection are summarized in the Noise and Vibration Technical Data Report (Appendix 10.5-A).

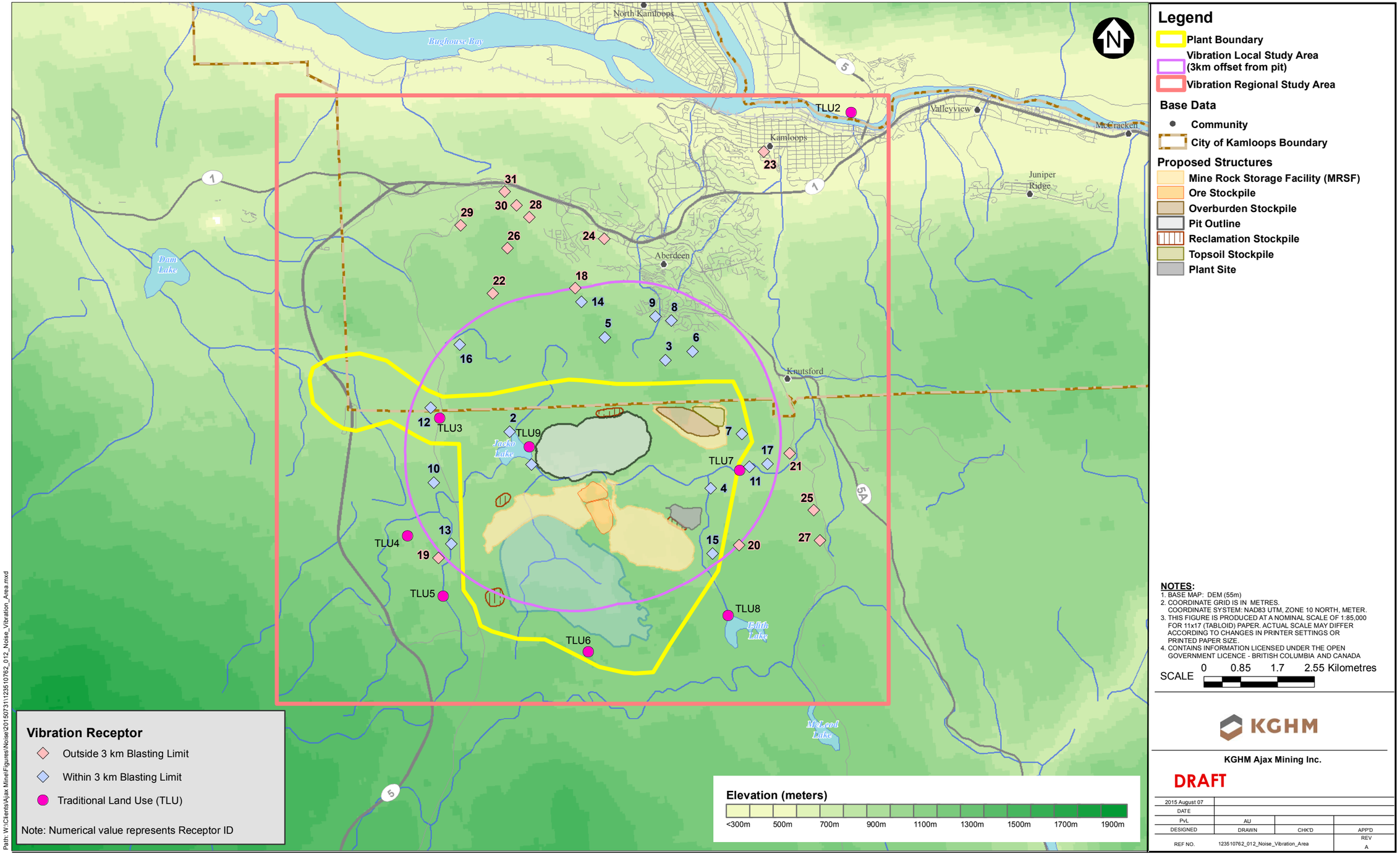
Local Study Area

The noise LSA is defined as an area extending 1.5 km from the Plant boundary. The distance of 1.5 km is based on the BC OGC noise guideline recommendations that nighttime sound levels from regulated industrial facilities not exceed a specified limit of 40 dBA at a distance of 1.5 km from the facility boundary or at the nearest receptor, whichever is closer.

The Plant boundary defines where public access is restricted. Mines are not generally fenced; however public access is often discouraged or prohibited due to safety concerns. The Plant boundary was determined based on the advice in Section 6.3 of the BC MOE Guidelines for Air Quality Dispersion Modelling in British Columbia (BC MOE 2008). Specifically, the Plant boundary is defined by:

- the perimeter of disturbed area that defines where public access is restricted; and
- the perimeter along a road allowance if a public access road passes through the plant.

Figure 10.5-2
Vibration Assessment Area and Receptor Location



The western Plant boundary is defined by the road allowance of Lac Le Jeune Road except where the access road joins Highway 5. The southern and eastern Plant boundaries are defined as the perimeter of the future Project-disturbed area. The noise LSA includes a buffer of 1.5 km from the Plant boundary.

The vibration LSA is defined as a 3 km distance from the Open Pit boundary. Vibration effects decrease with increasing distance from the blast activities. Based on professional judgement and the blast design, a distance of 3 km will include the maximum vibration effects from a structural damage and annoyance perspective. Vibration levels are predicted to be well below the structural damage and annoyance threshold at 3 km from the pit.

Regional Study Area

The noise regional study area RSA is defined as a 30 km × 30 km square area extending at least 8 km from the Plant boundary. This RSA includes all receptors of interest and it will include the maximum effect from noise at the receptors.

The vibration RSA is defined as a 14 km × 14 km square area, at least 4.5 km distance from the Open Pit boundary. The RSA will include area beyond the maximum vibration effects from a structural damage and annoyance perspective. Predicted noise and vibration results within the modelling domain will be depicted in this assessment.

10.5.3.2 Temporal Boundaries

The temporal phases of the Project are:

- **Construction**: 2 years;
- **Operation**: 23 years;
- **Decommissioning and Closure**: 5 years (includes Project decommissioning, abandonment and reclamation activities, as well as temporary closure, and care and maintenance); and
- **Post Closure**: 5+ years (includes ongoing reclamation activities and post-closure monitoring).

The two phases selected for the noise and vibration assessment were Construction and Operation. The noise and vibration effects during decommissioning and closure and post closure are expected to be lower than those for the Construction and Operation phases. The years with the highest expected noise emissions for Construction and Operation were assessed.

The worst case year of Construction and Operation were selected on the basis of mobile equipment activities and the peak in production of mine rock and ore. The Construction year just before operations start (Year -1) was chosen for assessment because it represents a worst case year of earth moving equipment. In addition, piling activities prior to the Construction phase is also included in the noise assessment.

Based on the review of the mine plan and equipment list, the two Operation phase scenarios that were considered representative of the worst cases for noise emissions were modeled. These were Year 2 and a combination scenario of Years 4 and 8.

Year 2 of the Operation phase was chosen because it represented the production year with in-pit equipment operating at higher elevation. Thus, noise is subjected to lower screening effects from pit walls and subsequently greater potential noise effects at the receptors.

A combination of Years 4 and 8 of Operation was chosen for assessment. This scenario took aspects from both Year 4 and Year 8 of the Operation phase that contribute to a worst case possible mine year. This is based on the quantity of the equipment fleet, the haulage lengths, the total amount of material moved, and the location of the active mine rock storage facilities. Details on Year 4 and 8 of the Operation phase were presented in the Noise and Vibration Technical Data Report (Appendix 10.5-A).

10.5.3.3 Administrative Boundaries

There are no administrative boundaries for noise and vibration and no applicable municipal requirements.

10.5.3.4 Technical Boundaries

Technical boundaries associated with this assessment are primarily related to inherent uncertainties and assumptions associated with noise and vibration modelling. Detailed information on these uncertainties and assumptions were presented in the Noise and Vibration Technical Data Report (Appendix 10.5-A).

10.5.4 Potential Effects of the Project and Proposed Mitigation for Noise and Vibration

10.5.4.1 Identifying Potential Effects on Noise and Vibration

The potential noise effect from the Project is a change in the existing acoustic environment that may affect humans and wildlife. This assessment focused on noise effects from a human perspective. The noise effect is quantified by measurable parameters such as daytime (L_d), nighttime (L_n), day-night (L_{dn}) equivalent sound level, and percent highly annoyed (%HA) at a receptor.

The potential vibration effect from the Project is a change in the existing vibration environment that may affect humans, structures, wildlife, and aquatic life. The vibration effect is quantified by ground vibration level and air blast overpressure level.

Ground vibration is an oscillatory motion which can be measured in terms of displacement, velocity or acceleration. Because of the oscillatory nature of the vibrating elements, the average of any of the motion descriptors (i.e., displacement, velocity or acceleration) is zero. The ground vibration level in this assessment is defined in terms of peak particle velocity (PPV) and is measured in millimeters per second (mm/s), representing the maximum instantaneous positive or negative peak of the vibration signal.

Air blast overpressure is measured in decibels (dBL). Air blast overpressure is the additional pressure above normal atmospheric pressure that is generated from a blast. Air blast often feels like a gust of wind by a receptor as confined blast will generally result in inaudible air blast. Air blast overpressure and sound are different in terms of frequency although both are measured in the units of decibels (dBL or dBA). An event with an air blast overpressure value of 115 dBL, which is inaudible due to the low frequency content, is entirely different from a sound event with the level of 115 dBA. The usual

rating terms associated with community noise standards are based on A-weighted noise (dBA), an adjustment scale that accounts for the human ear sensitivity to different frequencies (i.e., less at lower frequencies). This A-weight noise unit does not apply to air blast overpressure.

This assessment focuses on vibration effects from human and structural perspectives.

Not all Project components result in substantial noise effects from a human perspective. Similarly, not all Project components result in substantial ground vibration and air blast effects from a human and structural perspective. Therefore, the noise and vibration assessment considered only those noise emissions and vibration sources for which effects have potential moderate and key interaction. Table 10.5-3 summarizes the potential Project interactions and effects on noise and vibration.

Table 10.5-3. Identifying Potential Project Interactions and Effects on Noise and Vibration

Project Activities		Potential Effects on Noise and Vibration	
		Change in Acoustic Environment	Change in Vibration Environment
Construction	Clearing and Grubbing	H	L
	Earthworks	H	M
	Overburden/Topsoil Stockpile	O	O
	Laydown Areas and Storage Yards	O	O
	Project Lighting	L	O
	Site Security and Fencing	O	O
	Fuel Storage and Filling Area	O	O
	Hazardous Wastes Transport, Storage, and Disposal	M	L
	Construction Wastes Transport, Storage, and Disposal	M	L
	Sewage Infrastructure and Disposal	O	O
	Public Road Realignment, Use, and Maintenance	O	O
	Site Road Construction, Use and Maintenance	H	M
	Haul Road Overpass	L	O
	Site Buildings and Process Plant	M	O
	Explosives Magazine and Storage Facilities	O	O
	Open Pit Development	H	M
	Drilling and Blasting	M	H
	Crushing Mine Rock	M	O
	Loading, Hauling, and Deposition of Waste Rock	H	L
	Temporary Ore Stockpile	O	O
	Tailing Storage Facility Development	H	L
	Power Transmission, Distribution	L	O
	Natural Gas Line	O	O
	Pipeline Utility Corridor (Potable Water, Sewage, and Site Water)	O	O
	Water Intake from Kamloops Lake	O	O

Project Activities		Potential Effects on Noise and Vibration	
		Change in Acoustic Environment	Change in Vibration Environment
Construction *(cont'd)*	Fire Suppression Infrastructure	O	O
	Contact Water	O	O
	Non-contact Water	O	O
	Peterson Creek Diversion	O	O
	Mine Staffing (Direct Employment)	O	O
	Contracted Employment	O	O
	Taxation	O	O
Operation	Open Pit Development	H	L
	Drilling and Blasting	H	H
	Hauling Mine Rock and Ore from Pit	H	O
	Crushing and Conveying Ore	H	O
	Temporary Ore Stockpile	O	O
	Development of Waste Rock Management Facilities	O	O
	Stripping, Loading, Hauling, Deposition, and Contouring of Topsoil and Overburden	H	O
	Revegetation through Progressive Reclamation	O	O
	Process Plant Operation	M	O
	Deposition to Tailing Storage Facility	O	O
	Site Road Use and Maintenance (Materials, Personnel, Supplies)	M	O
	Concentrate Transport and Storage	M	L
	Explosives Magazine and Storage Facilities	O	O
	Fire Suppression Infrastructure	O	O
	Fuel Storage and Filling Area	O	O
	Hazardous Wastes Transport, Storage, and Disposal	M	L
	General Wastes Transport, Storage, and Disposal	M	L
	Sewage Infrastructure and Disposal	O	O
	Laydown Areas and Storage Yards	O	O
	Power Transmission, Distribution	O	O
	Project Lighting	L	O
	Site Access, Security and Fencing	O	O
	Water Intake from Kamloops Lake	L	O
	Contact Water	O	O
	Non-contact Water	O	O
	Potable Water Treatment and Use	O	O
	Peterson Creek Diversion	O	O
	Mine Staffing (Direct Employment)	O	O
	Contracted Employment	O	O
	Taxation	O	O

Project Activities		Potential Effects on Noise and Vibration	
		Change in Acoustic Environment	Change in Vibration Environment
Decommissioning and Closure	Dismantling of Ancillary Buildings	L	O
	Pit Lake Planning	O	O
	Site Road/Bridge Decommissioning	O	O
	Tailing Storage Facility Decommissioning and Reclamation	M	M
	Mine Rock Management Facilities Reclamation	L	O
	Fuel Storage and Filling Area	O	O
	Hazardous Wastes Transport, Storage, and Disposal	L	O
	General Wastes Transport, Storage, and Disposal	L	O
	Sewage Infrastructure and Disposal	O	O
	Laydown Areas and Storage Yards	O	O
	Power Transmission, Distribution	O	O
	Project Lighting	O	O
	Site Access, Security and Fencing	O	O
	Contact Water	O	O
	Non-contact Water	O	O
	Potable Water Treatment and Use	O	O
	Peterson Creek Diversion	O	O
	Road use to the Project (Materials, Personnel, Supplies)	L	O
	Mine Staffing (Direct Employment)	O	O
	Contracted Employment	O	O
	Taxation	O	O
Post Closure	General Site Inspections and Maintenance	O	O
	Contact Water	O	O
	Non-contact Water	O	O
	Road use to the Project (Materials, Personnel, Supplies)	L	O
	Mine Staffing (Direct Employment)	O	O
	Contracted Employment	O	O

Notes:

O	*No interaction anticipated.*
L	*Negligible to minor interaction expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.*
M	*Potential moderate interaction requiring unique active management/monitoring/mitigation; warrants further consideration.*
H	*Key interaction; warrants further consideration.*

Noise and/or vibrations effects are discussed in other VCs in the Application/EIS. These include:

- Geology, Landforms and Soils (Section 6.2);

- MammalsVC (Section 6.17);
- Fish Populations and Fish Habitat VC (Section 6.7);
- Land and Resource VC (Section 8.4);
- CULRTP VC (Section 8.5); and
- Other Potential Effects on Aboriginal Interests (Section 14).

Noise

Construction activities at the Project site will include typical machinery such as backhoes, bulldozers, front end loaders, excavators, and haul trucks. Construction will also include transportation activities related to material supplies and waste disposal in addition to on-site equipment and vehicles. Most construction activities will occur during both daytime and nighttime hours.

As discussed in Section 10.5.3.2, the noise assessment included the "worst case" years (Year -1) of the Construction phase. The following Project construction activities were considered to have key or potential moderate interaction with noise effects during the Year -1 scenario:

- clearing and grubbing;
- earthworks;
- hazardous wastes transport, storage, and disposal;
- construction wastes transport, storage, and disposal;
- site road construction, use and maintenance;
- site buildings and process plant;
- open pit development;
- drilling and blasting;
- crushing mine rock;
- loading, hauling, and deposition of mine rock; and
- tailings storage facility development.

The Year -1 scenario included noise emissions from site preparation, construction of infrastructure (i.e., site buildings, process plant, roads), and material transportation as listed above. Some of the equipment within the processing area (i.e., crushers) will be in operation prior to commercial production. As a conservative assumption, noise emissions associated with the full built-out processing facility were included as well. In addition, sheet piling activities near the east arm of Jacko Lake prior to construction year -2 were included in the assessment.

Based on the review of the mine plan and equipment list, two Operation phase scenarios were considered representative of the worst case. These are Year 2 and the combination of Year 4 and 8 of the Project. The following Project operation activities were considered to have key or potential moderate interaction with noise effect during the life of the project as represented by using Year 2 along with Year 4 and 8 of the Project in the analysis:

- open pit development;
- drilling and blasting;
- hauling mine rock and ore from pit;
- crushing and conveying ore;
- stripping, loading, hauling, deposition, and contouring of topsoil and overburden;
- process plant operation;
- site road use and maintenance (materials, personnel, supplies);
- concentrate transport and storage;
- hazardous wastes transport, storage, and disposal;
- general wastes transport, storage, and disposal; and
- water intake from Kamloops Lake.

The noise assessment of the processing plant facility considered the full built-out phase (i.e., all equipment in operation). The facility will operate continuously during a 24-hour period. Mine fleet activities at the Project site include machinery such as shovels, loaders, drills, tractor dozers, front end loaders, graders, water trucks, haul trucks, and supporting equipment. The mine fleet's operation will occur during both the daytime and nighttime periods. Transportation related activities (i.e., haul trucks, concentrate transportation trucks) have been considered in the noise assessment. Other noise emissions such as the water intake pump station, portable lighting tower, and conveyors are included.

Decommissioning, Closure, and Post Closure activities are expected to produce negligible to minor noise levels relative to that predicted for the construction and operation phases. The quantity of equipment required for decommissioning and reclamation is expected to be below the requirement for the construction phase, thus it is assumed for that noise produced during these phases will be at a lower magnitude than the construction phase. Furthermore, noise effects during dismantling, site cleanup and reclamation activities can be managed to acceptable levels by implementation of best practices, standard mitigation and management measures used for the construction phase.

Vibration

The following Project construction activities were considered to have key or potential moderate interaction with vibration effects:

- earthworks;
- site road construction, use and maintenance;
- open pit development; and
- drilling and blasting.

The drilling and blasting activities during the operation phase were considered to have key or potential moderate interaction with vibration effects.

The vibration assessment focused on receptor locations where a structure could be subject to blast-induced ground vibrations and air blast. The annoyance effects from ground vibration and air blasts on human receptors were also considered. No air blast effect is expected from any activities other than blasting. Ground vibration and air blast effects were predicted for blast activities during the Operation phase.

The blast-related vibration sources are quantified by blast design parameters such as blast charge, blast bore holes diameter, and delay time. In the blast design, three blast zones (Z1, Z2, and Z3) are proposed. Zone 3 (Z3) is closest to Jacko Lake and Zone 1 (Z1) is furthest from Jacko Lake. The blast design and procedures will be modified for different zones. Within Zone 3, the vibration effect will meet the guidance for aquatic life protection at Jacko Lake. Detailed discussion of blast procedure modification to address the vibration effect at Jacko Lake is presented in the Noise and Vibration TDR Ajax Mine Blast Review (Appendix D of Appendix 10.5-A). Vibration assessment was conducted for the Jacko Lake aquatic life receptors using Z3 blast design parameters. Assessment for all other vibration receptors (structure and human) was based on Z1 blast design parameters.

In addition to blasting, the vibration effects from heavy equipment required in other activities such as earth works, piling, open pit development, drilling, and road construction were also assessed.

Decommissioning, Closure, and Post Closure activities are expected to have less interaction with the vibration effect. Drilling and blasting will be required to construct the channel between the TSF and Humphrey Creek that allows the TSF surface to drain at closure. The blasting that will occur in decommissioning will be much less than the blasting during both construction and operation phases. The quantity of equipment required for the decommissioning is expected to be well below the requirement for the construction phase, thus vibration effects exceeding acceptable levels are not expected.

10.5.4.2 Effects on Noise and Vibration

Noise

Methods

The noise assessment was performed in accordance with the recommendations and requirements of the BC Oil & Gas Commission Noise Control Best Practices Guideline (2009) and Health Canada Useful Information for Environmental Assessments document (2010) noise guidance. In areas where the BC OGC noise guideline and Health Canada guidance does not provide any guidance, the following documents were adopted as supplemental guidelines in the assessment:

- American National Standards Institute (ANSI) S12.9-2005 Quantities and Procedures for description and Measurement of Environmental Sound – Part 4: Noise Assessment and Prediction of Long-term Community Response;
- International Standard Organization (ISO) 1996-1:2003 Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures (ISO 1996-1:2003 Part 1); and
- World Health Organization (WHO) 2009. Night Noise Guidelines for Europe.

The noise assessment used the following approach:

- conducted noise baseline study at selected locations;
- reviewed information provided by KAM including mine and site plans, equipment lists; information from major equipment vendors; and topographical data for the area around the mine;
- established the LSA, RSA, and modelling domain including urban and suburban residential areas in the city of Kamloops, rural and remote residences surrounding the Project, and traditional land use area;
- selected noise-sensitive receptors within the RSA.
- established noise assessment criteria and threshold for all noise receptors;
- identified modelling scenarios (Operation and Construction) that will reflect worst case scenario in terms of noise emissions;
- identified noise sources for the modelling scenarios and established corresponding noise emission levels;
- developed an acoustic model for each modelling scenario and predicted noise levels within the modelling domain including at all noise-sensitive receptor locations;
- compared the prediction results with applicable regulatory guidelines and guidance; and
- provided noise mitigation and noise management plan.

The BC OGC noise guideline and Health Canada noise guidance do not endorse any specific standards or modelling software; however, international calculation standards are recommended. Sound modelling in this assessment is based on sound propagation calculations in accordance with ISO Standards 9613 Part 1 and Part 2 (ISO 9613-1 1993, ISO 9613-2 1996), which are commonly used by noise practitioners and are accepted by BC OGC and Health Canada.

The latest version of the Cadna/A computer modelling program (Version 4.5.145) from DataKustik (2015), which incorporates ISO 9613 algorithms, was used for the noise assessment. The modelling software accounts for many factors including terrain effects, ground absorption, atmospheric absorption, and meteorological condition.

Additional details regarding calculation methods and noise sources used for assessing potential effects on noise from the Project are described in the Noise and Vibration Technical Data Report (Appendix 10.5-A).

Baseline Sound Level at Receptors

Baseline sound levels at a receptor were used in the noise effect assessment. BC OGC and Health Canada have different approaches in the determination of baseline sound levels at a receptor. The BC OGC noise guideline advises that the nighttime ambient sound level (ASL) at a given location is defined on the basis of population density (dwelling density) and proximity to transportation; it is set at 5 dB below the basic sound level (BSL) defined in the guideline. For daytime periods, the ambient

sound levels are set at 10 dB above those for nighttime periods. Table 10.5-4 summarizes the estimated L_{dn} for each noise receptor based on the BC OGC method.

Table 10.5-4. Noise Receptors Baseline Sound Level

ID	Receptor Type	Baseline Sound Level Used in Health Canada Noise Guideline			Sources
		L_d (dBA)	L_n (dBA)	L_{dn} (dBA)	
1	Residence	39	34	42	Monitoring Location 5
2	Residence	39	34	42	Monitoring Location 5
3	Residence	39	36	43	Monitoring Location 2
4	Residence	39	34	42	Monitoring Location 5
8	Residence	39	34	42	Monitoring Location 5
9	Residence	39	34	42	Monitoring Location 5
11	Residence	39	34	42	Monitoring Location 5
12	Residence	39	34	42	Monitoring Location 5
13	Aberdeen Development	51	41	51	BC OGC
14	CDB 1	39	36	43	Monitoring Location 2
15	CDB 2	39	36	43	Monitoring Location 2
16	CDB 3	39	36	43	Monitoring Location 2
17	CDB 4	39	36	43	Monitoring Location 2
18	CDB 5	39	36	43	Monitoring Location 2
21	Residence	39	34	42	Monitoring Location 5
22	Residence	39	34	42	Monitoring Location 5
23	Residence	39	36	43	Monitoring Location 2
24	Residence	39	34	42	Monitoring Location 5
25	Residence	39	34	42	Monitoring Location 5
26	Residence	39	34	42	Monitoring Location 5
27	Residence	39	36	43	Monitoring Location 2
28	Royal Inland Hospital	50	43	51	Monitoring Location 3
37	Dufferin Elementary	50	43	51	Monitoring Location 3
44	Pacific Way Elementary	50	43	51	Monitoring Location 3
52	Sa-Hali Secondary	50	43	51	Monitoring Location 3
74	Tots & Teddies	50	43	51	Monitoring Location 3
169	Kamloops Senior Village	50	43	51	Monitoring Location 3
170	Ridgepointe at Pineview Retirement Home	50	43	51	Monitoring Location 3

(continued)

Table 10.5-4. Noise Receptors Baseline Sound Level (completed)

ID	Receptor Type	Baseline Sound Level Used in Health Canada Noise Guideline			Sources
		L_d (dBA)	L_n (dBA)	L_{dn} (dBA)	
TLU1	Kamloops Lake Pump house	39	34	42	Monitoring Location 5
TLU2	TK'emlups te Secwepemc First Nation Reserve (Kamloops 1)	48	38	48	BC OGC
TLU3	Inks Lake	39	34	42	Monitoring Location 5
TLU4	Jacko Creek	39	34	42	Monitoring Location 5
TLU5	Upper Peterson Creek	39	34	42	Monitoring Location 5
TLU6	Goose Lake Road	39	34	42	Monitoring Location 5
TLU7	Peterson Creek Discharge	39	34	42	Monitoring Location 5
TLU8	Edith Lake	39	34	42	Monitoring Location 5
TLU9	Jacko Lake Prayer Tree	39	36	43	Monitoring Location 4

Note:
[1] In comparing the two data source approaches (BC OGC and monitoring), the lower value baseline L_d or L_n was used. A more conservative (more protective) approach as a lower baseline value will result in a higher change or noise effect in the assessment.

The Health Canada noise guideline recognizes that both measurements and estimates are acceptable methods in establishing the baseline sound levels for receptors. The baseline L_d, L_n, and L_{dn} at the receptors can be estimated by two data sources. The first data source uses the prescribed ASL in the BC OGC noise guideline for a receptor location. The second data source uses the measurement results from the baseline monitoring program as presented in Section 10.5.2.3. The acoustic environment at each of the receptors is assumed to be similar to one of the six monitoring locations. In comparing the two data source approaches, the lower value baseline L_{dn} will be used. This is considered a more conservative (more protective) approach as use of a lower baseline value for comparison to predicted values will result in a higher change or noise effect in the assessment. Table 10.5-4 summarizes the estimated L_d, L_n, and L_{dn} for each noise receptor based on the BC OGC prescribed ASL or measurement results. These values will be used in the noise effect assessment in accordance with the Health Canada noise guideline.

Additional details regarding the estimation of baseline sound level are described in the Noise and Vibration Technical Data Report (Appendix 10.5-A).

Noise Effects during Construction and Operation

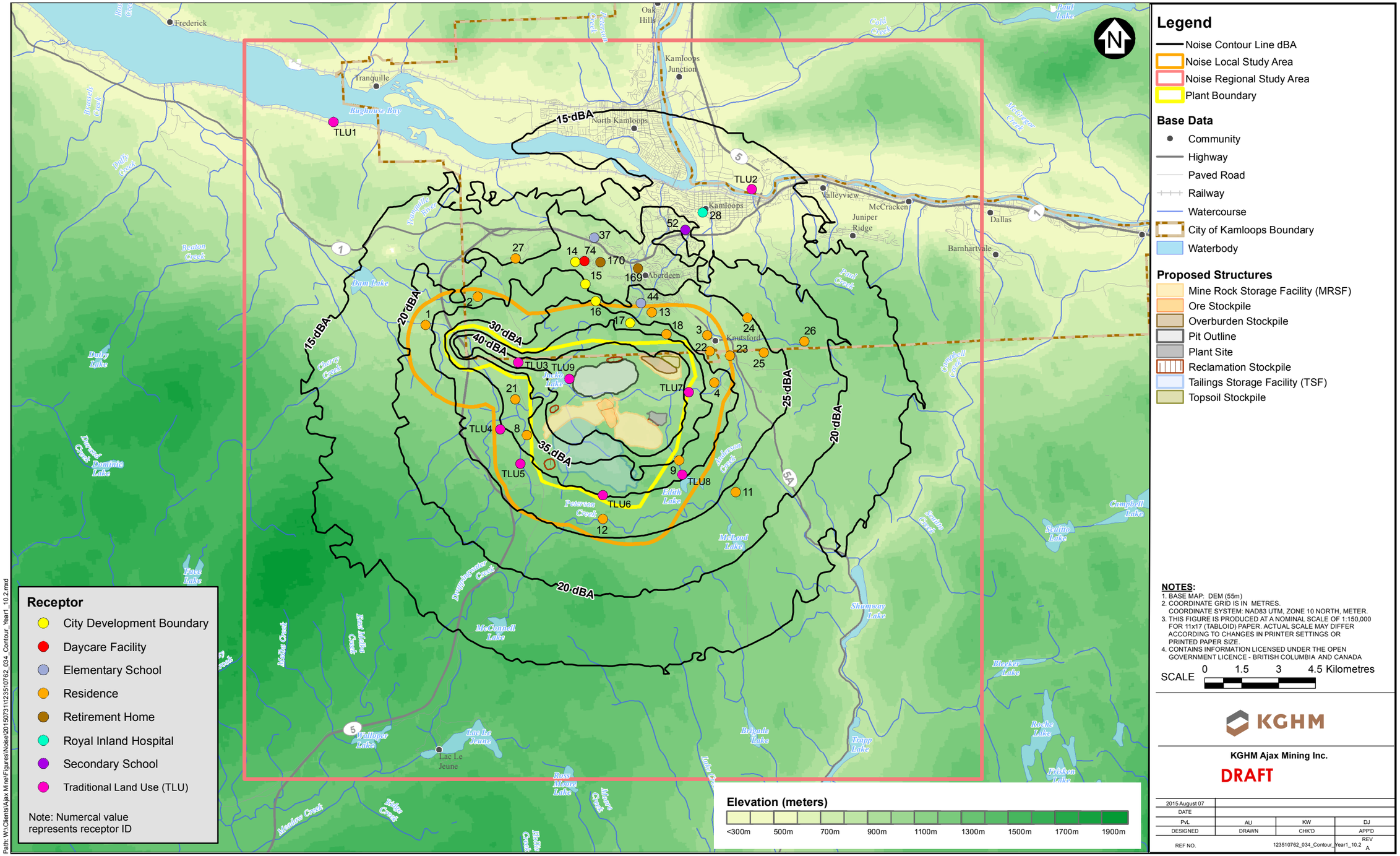
Table 10.5-5 summarizes the modelling results at the noise receptors for the Year -1 Construction phase. Figure 10.5-3 shows the predicted noise contour maps for construction activities during Year -1 within the modelling domain. The ID numbers shown in Tables 10.5-4 and 10.5-5 correspond to the numbers shown for each of the receptor locations in Figure 10.5-3.

Table 10.5-5. Construction Phase (Year -1 and Piling Activities) Noise Modelling Results

ID	Receptor Description	Year -1			Piling activities	
		L_d (dBA)	L_n (dBA)	L_{dn} (dBA)	L_d (dBA)	L_{dn} (dBA)
1	Residence	23.5	23.5	29.9	20.6	30.6
2	Residence	23.6	23.6	30.0	24.6	34.6
3	Residence	26.2	26.2	32.6	11.3	21.4
4	Residence	33.0	33.0	39.4	21.7	31.7
8	Residence	33.6	33.6	40.0	34.5	44.5
9	Residence	35.1	35.1	41.5	23.1	33.1
11	Residence	24.3	24.3	30.7	15.3	25.3
12	Residence	26.9	26.9	33.3	22.2	32.2
13	Aberdeen Development	29.0	29.0	35.4	18.7	28.7
14	CDB 1	19.4	19.4	25.8	7.3	17.6
15	CDB 2	25.7	25.7	32.1	23.9	33.9
16	CDB 3	30.2	30.2	36.6	30.9	40.9
17	CDB 4	31.4	31.4	37.8	22.8	32.8
18	CDB 5	33.3	33.3	39.7	17.4	27.4
21	Residence	32.3	32.3	38.7	42.3	52.3
22	Residence	25.6	25.6	32.0	8.3	18.5
23	Residence	28.0	28.0	34.4	18.7	28.7
24	Residence	25.1	25.1	31.5	16.4	26.4
25	Residence	25.7	25.7	32.1	15.6	25.6
26	Residence	21.6	21.6	28.0	11.6	21.7
27	Residence	20.9	20.9	27.3	21.1	31.1
28	Royal Inland Hospital	17.4	17.4	23.8	1.9	12.8
37	Dufferin Elementary	22.7	22.7	29.1	21.1	31.1
44	Pacific Way Elementary	26.9	26.9	33.3	14.8	24.8
52	Sa-Hali Secondary	20.2	20.2	26.6	7.6	17.8
74	Tots & Teddies	23.0	23.0	29.4	14.4	24.4
169	Kamloops Senior Village	21.9	21.9	28.3	13	23.0
170	Ridgepointe at Pineview Retirement Home	23.5	23.5	29.9	17.7	27.7
TLU1	Kamloops Lake Pump house	7.9	7.9	14.3	2.6	13.4
TLU2	TK'emlups te Secwepemc First Nation Reserve (Kamloops 1)	17.1	17.1	23.5	9.2	19.4
TLU3	Inks Lake	48.0	48.0	54.4	37.9	47.9
TLU4	Jacko Creek	29.6	29.6	36.0	31.4	41.4
TLU5	Upper Peterson Creek	28.8	28.8	35.2	29.3	39.3
TLU6	Goose Lake Road	30.3	30.3	36.7	25.5	35.5
TLU7	Peterson Creek Discharge	38.4	38.4	44.8	25	35.0
TLU8	Edith Lake	30.7	30.7	37.1	21.6	31.6
TLU9	Jacko Lake Prayer Tree	40.2	40.2	46.6	71.6	81.6

Figure 10.5-3
Noise Contour for Construction Activities (Year -1) during Daytime or Nighttime Period

Stantec



NOTES:
1. BASE MAP: DEM (55m)
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD83 UTM, ZONE 10 NORTH, METER.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:150,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
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SCALE 0 1.5 3 4.5 Kilometres

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In addition to the Construction phase during Year -1, the noise effect of piling at the Jacko Lake dam is presented in Table 10.5-5. Piling activities at the Jacko Lake dam are expected to occur for less than 2 months prior to the Construction phase, resulting in a noise emission that is considered highly impulsive. The impulsive sound adjustment of 12 dB was added to the L_d results in the determination of L_{dn} as presented in the table. Figure 10.5-4 shows the predicted noise contour maps for piling activities within the modelling domain.

Table 10.5-6 summarizes the modelling results at all the noise receptors for the Year 2 and Years 4 and 8 of the Operation phase. The daytime and nighttime noise levels are the same for the Operation phase. Figures 10.5-5 and 10.5-6 show the modelled daytime or nighttime noise contour maps for Year 2 and Years 4 and 8 within the modelling domain, respectively.

Table 10.5-6. Operation Phase (Year 2 and Years 4 and 8) Noise Modelling Results

		Year 2			Year 4 and 8		
ID	Receptor Description	L_d (dBA)	L_n (dBA)	L_{dn} (dBA)	L_d (dBA)	L_n (dBA)	L_{dn} (dBA)
1	Residence	26.3	26.3	32.7	26.2	26.2	32.6
2	Residence	26.7	26.7	33.1	26.8	26.8	33.2
3	Residence	28.9	28.9	35.3	28.8	28.8	35.2
4	Residence	35.3	35.3	41.7	34.5	34.5	40.9
8	Residence	37.4	37.4	43.8	36.7	36.7	43.1
9	Residence	36.1	36.1	42.5	37.7	37.7	44.1
11	Residence	27.5	27.5	33.9	27.2	27.2	33.6
12	Residence	30.0	30.0	36.4	30.0	30.0	36.4
13	Aberdeen Development	31.0	31.0	37.4	31.5	31.5	37.9
14	CDB 1	21.4	21.4	27.8	23.8	23.8	30.2
15	CDB 2	27.9	27.9	34.3	28.9	28.9	35.3
16	CDB 3	32.2	32.2	38.6	33.1	33.1	39.5
17	CDB 4	33.3	33.3	39.7	33.9	33.9	40.3
18	CDB 5	34.5	34.5	40.9	35.1	35.1	41.5
21	Residence	36.1	36.1	42.5	35.9	35.9	42.3
22	Residence	27.9	27.9	34.3	27.7	27.7	34.1
23	Residence	30.4	30.4	36.8	30.0	30.0	36.4
24	Residence	28.0	28.0	34.4	27.5	27.5	33.9
25	Residence	28.4	28.4	34.8	27.9	27.9	34.3
26	Residence	24.4	24.4	30.8	24.4	24.4	30.8
27	Residence	23.2	23.2	29.6	23.7	23.7	30.1
28	Royal Inland Hospital	19.6	19.6	26.0	20.1	20.1	26.5
37	Dufferin Elementary	25.4	25.4	31.8	25.6	25.6	32.0
44	Pacific Way Elementary	29.0	29.0	35.4	29.6	29.6	36.0
52	Sa-Hali Secondary	22.5	22.5	28.9	22.7	22.7	29.1

ID	Receptor Description	Year 2			Year 4 and 8		
		L_d (dBA)	L_n (dBA)	L_{dn} (dBA)	L_d (dBA)	L_n (dBA)	L_{dn} (dBA)
74	Tots & Teddies	25.4	25.4	31.8	26.2	26.2	32.6
169	Kamloops Senior Village	24.2	24.2	30.6	25.0	25.0	31.4
170	Ridgepointe at Pineview Retirement Home	26.2	26.2	32.6	26.9	26.9	33.3
TLU1	Kamloops Lake Pump house	10.8	10.8	17.2	11.7	11.7	18.1
TLU2	TK'emlups te Secwepemc First Nation Reserve (Kamloops 1)	20.5	20.5	26.9	20.1	20.1	26.5
TLU3	Inks Lake	50.1	50.1	56.5	50.1	50.1	56.5
TLU4	Jacko Creek	33.1	33.1	39.5	32.7	32.7	39.1
TLU5	Upper Peterson Creek	32.8	32.8	39.2	33.8	33.8	40.2
TLU6	Goose Lake Road	33.7	33.7	40.1	34.2	34.2	40.6
TLU7	Peterson Creek Discharge	40.9	40.9	47.3	39.5	39.5	45.9
TLU8	Edith Lake	33.6	33.6	40.0	33.7	33.7	40.1
TLU9	Jacko Lake Prayer Tree	46.7	46.7	53.1	49.2	49.2	55.6

Comparison to Baseline Sound Level during Construction and Operation

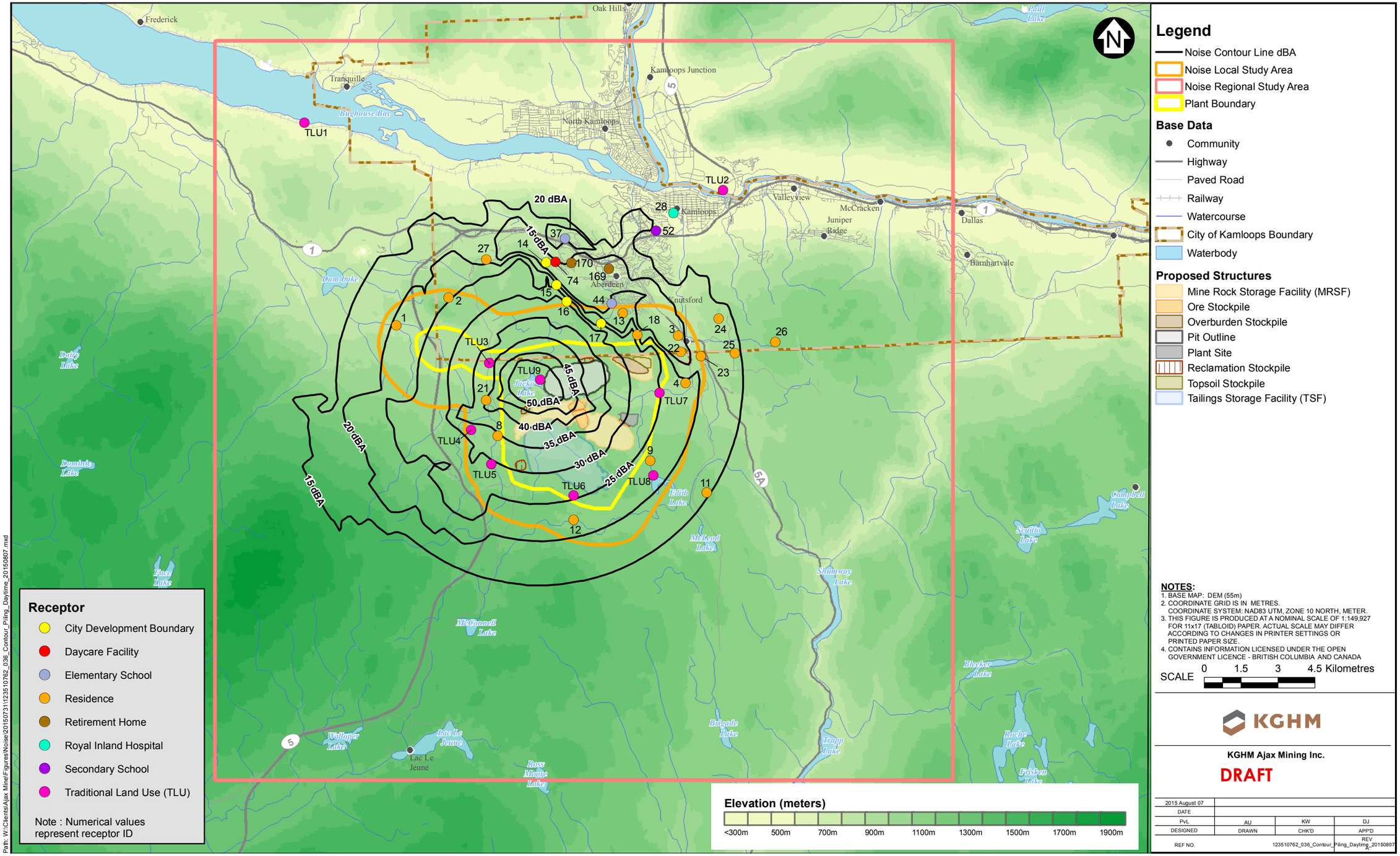
Tables 10.5-7 and 10.5-8 compare the modelling results to the baseline sound level at the noise receptors for Construction and Operation phases, respectively. The maximum level difference represents the highest arithmetic difference between the predicted and baseline level at a receptor. The noise effect is considered perceptible when the predicted noise level is the same or higher than baseline sound level (i.e., maximum level difference equals or greater than zero). A perceptible noise event does not indicate that noise guideline limits are exceeded.

During the piling activities, the predicted L_d level of 71.6 dBA is 32.6 dB above the baseline daytime sound level of 39 dBA at the Jacko Lake Prayer Tree (ID# TLU#9) traditional land use receptor location. Other traditional land use receptor locations such as Inks Lake (ID# TLU3) and Peterson Creek Discharge (ID# TLU7) will have perceptible noise effect from the piling activities. In addition, noise effect at receptors ID# 4, 8, 9, 16, 17, 18 and 21 is predicted to be perceptible.

During Operation Phase, the predicted L_n level of 50.1 dBA is 16.1 dB above the baseline nighttime sound level of 34 dBA at the Inks Lake (ID# TLU3) traditional land use receptor location. The dominate noise source is from the haul truck traffic along the access road. Other traditional land use locations such as Goose Lake Road (Id# TLU6), Peterson Creek Discharge (ID# TLU7), and Jacko Lake Prayer Tree (ID# TLU#9) are predicted to have perceptible noise effect from the operation. In addition, the noise effect at receptors ID#4, 8, 9 and 21 is predicted to be perceptible during the Operation phases.

Figure 10.5-4
Noise Contour for Piling Activities during Daytime Period

Stantec



Receptor

- City Development Boundary
- Daycare Facility
- Elementary School
- Residence
- Retirement Home
- Royal Inland Hospital
- Secondary School
- Traditional Land Use (TLU)

Note : Numerical values represent receptor ID

Elevation (meters)

<300m | 500m | 700m | 900m | 1100m | 1300m | 1500m | 1700m | 1900m

Legend

- Noise Contour Line dBA
- Noise Local Study Area
- Noise Regional Study Area
- Plant Boundary

Base Data

- Community
- Highway
- Paved Road
- Railway
- Watercourse
- City of Kamloops Boundary
- Waterbody

Proposed Structures

- Mine Rock Storage Facility (MRSF)
- Ore Stockpile
- Overburden Stockpile
- Pit Outline
- Plant Site
- Reclamation Stockpile
- Topsoil Stockpile
- Tailings Storage Facility (TSF)

NOTES:

1. BASE MAP: DEM (55m)
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD83 UTM, ZONE 10 NORTH, METER.
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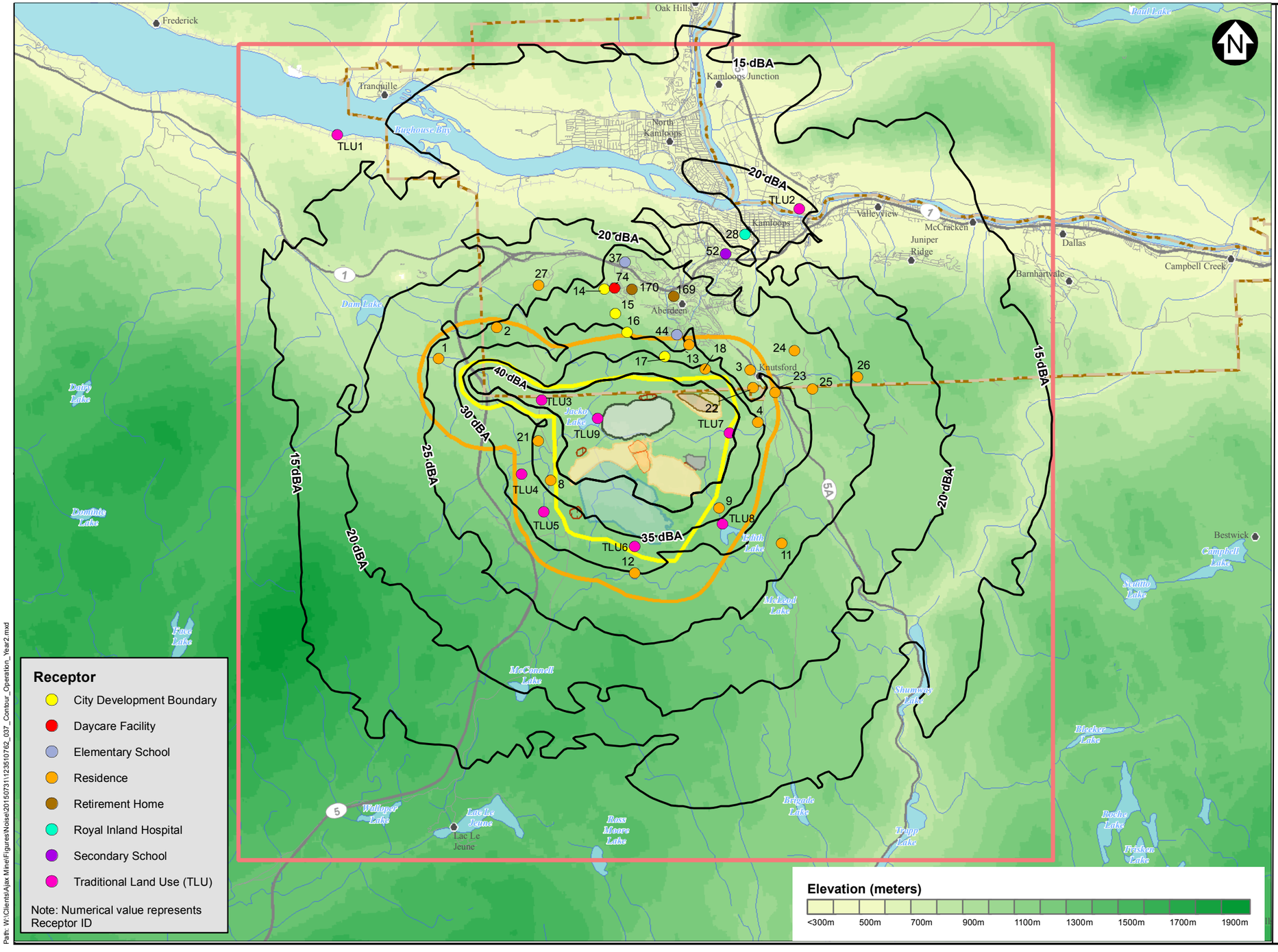
Figure 10.5-5
Noise Contour for Operation (Year 2) during Daytime or Nighttime Period

Stantec



Legend

- Noise Contour Line dBA
- Noise Local Study Area
- Noise Regional Study Area
- Plant Boundary

Base Data

- Community
- Highway
- Paved Road
- Railway
- Watercourse
- City of Kamloops Boundary
- Waterbody

Proposed Structures

- Mine Rock Storage Facility (MRSF)
- Ore Stockpile
- Overburden Stockpile
- Pit Outline
- Plant Site
- Reclamation Stockpile
- Topsoil Stockpile
- Tailings Storage Facility (TSF)

Receptor

- City Development Boundary
- Daycare Facility
- Elementary School
- Residence
- Retirement Home
- Royal Inland Hospital
- Secondary School
- Traditional Land Use (TLU)

Note: Numerical value represents Receptor ID

Elevation (meters)

<300m | 500m | 700m | 900m | 1100m | 1300m | 1500m | 1700m | 1900m

NOTES:

1. BASE MAP: DEM (55m)
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD83 UTM, ZONE 10 NORTH, METER.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:150,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
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Figure 10.5-6
Noise Contour for Operation (Years 4 and 8) during Daytime or Nighttime Period

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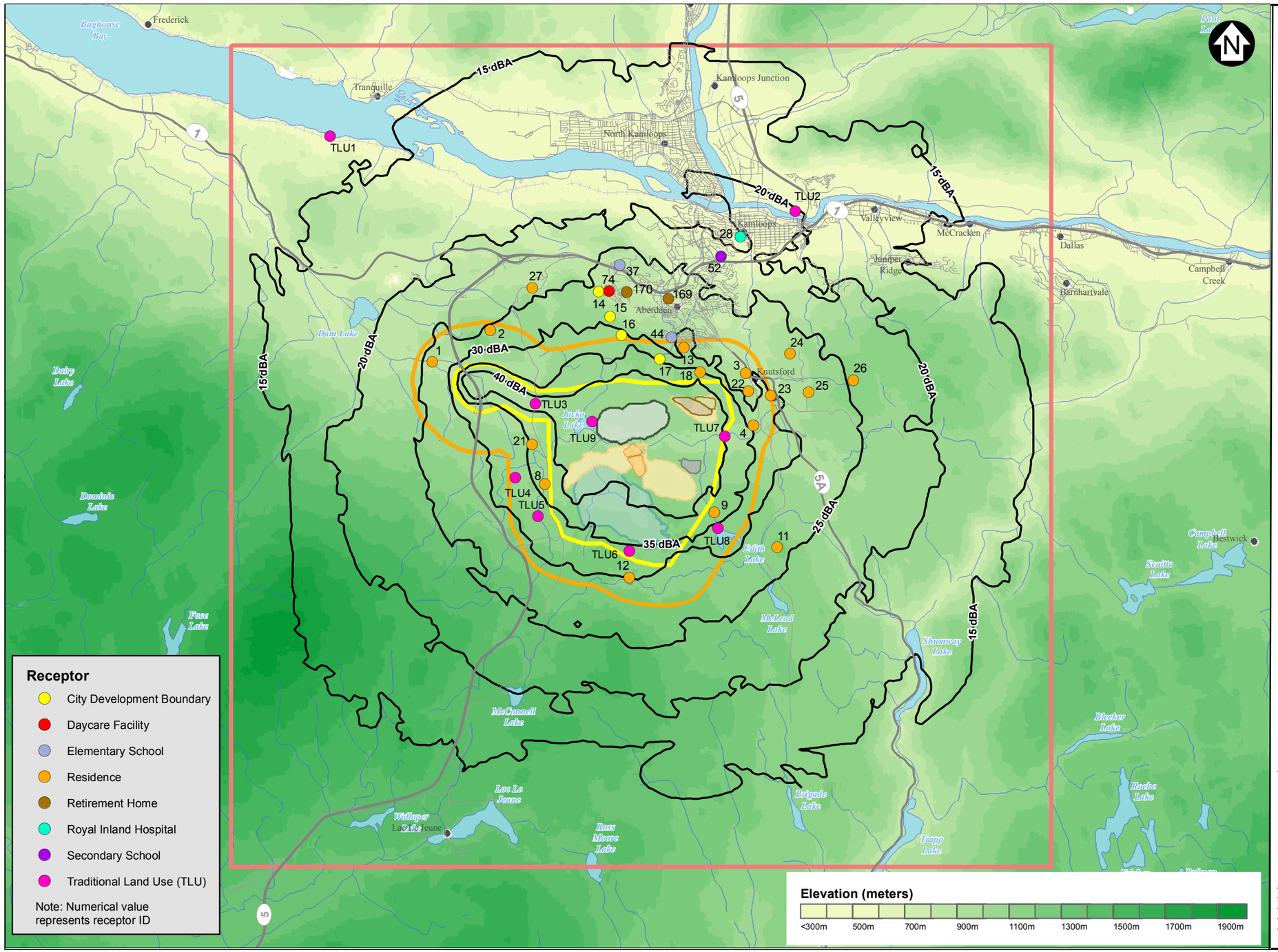

Legend

- Noise Contour Line dBA
- Noise Local Study Area
- Noise Regional Study Area
- Plant Boundary

Base Data

- Community
- Highway
- Paved Road
- Railway
- Watercourse
- City of Kamloops Boundary
- Waterbody

Proposed Structures
KGHM_AJAX_Roads_All
Layer

- Highway
- Paved Road
- Mine Rock Storage Facility (MRSF)
- Ore Stockpile
- Overburden Stockpile
- Pit Outline
- Plant Site
- Reclamation Stockpile
- Topsoil Stockpile

Receptor

- City Development Boundary
- Daycare Facility
- Elementary School
- Residence
- Retirement Home
- Royal Inland Hospital
- Secondary School
- Traditional Land Use (TLU)

Note: Numerical value represents receptor ID

Elevation (meters)

<300m | 500m | 700m | 900m | 1100m | 1300m | 1500m | 1700m | 1900m

NOTES:
1. BASE MAP: DEM (55m)
2. COORDINATE GRID IS IN METRES.
   COORDINATE SYSTEM: NAD83 UTM, ZONE 10 NORTH, METER.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:150,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
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SCALE 0 1.5 3 4.5 Kilometres

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Table 10.5-7. Comparison to Baseline Sound Level Construction Phase and Piling Activities

ID	Receptor Type	Construction Phase Year -1, L_d or L_n (dBA)	Piling Activities, L_d (dBA)	Baseline Sound Level Used in Health Canada Noise Guideline		Maximum Level Differences [1] (dB)
				L_d (dBA)	L_n (dBA)	
1	Residence	29.9	20.6	39	34	-4.1
2	Residence	30.0	24.6	39	34	-4
3	Residence	32.6	11.3	39	36	-3.4
4	Residence	39.4	21.7	39	34	5.4 *
8	Residence	40.0	34.5	39	34	6 *
9	Residence	41.5	23.1	39	34	7.5 *
11	Residence	30.7	15.3	39	34	-3.3
12	Residence	33.3	22.2	39	34	-0.7
13	Aberdeen Development	35.4	18.7	51	41	-5.6
14	CDB 1	25.8	7.3	39	36	-10.2
15	CDB 2	32.1	23.9	39	36	-3.9
16	CDB 3	36.6	30.9	39	36	1.9 *
17	CDB 4	37.8	22.8	39	36	1.8 *
18	CDB 5	39.7	17.4	39	36	3.7 *
21	Residence	38.7	42.3	39	34	13.3 *
22	Residence	32.0	8.3	39	34	-2
23	Residence	34.4	18.7	39	36	-1.6
24	Residence	31.5	16.4	39	34	-2.5
25	Residence	32.1	15.6	39	34	-1.9
26	Residence	28.0	11.6	39	34	-6
27	Residence	27.3	21.1	39	36	-7.9
28	Royal Inland Hospital	23.8	1.9	50	43	-19.2
37	Dufferin Elementary	29.1	21.1	50	43	-13.9
44	Pacific Way Elementary	33.3	14.8	50	43	-9.7
52	Sa-Hali Secondary	26.6	7.6	50	43	-16.4
74	Tots & Teddies	29.4	14.4	50	43	-13.6
169	Kamloops Senior Village	28.3	13	50	43	-14.7
170	Ridgepointe at Pineview Retirement Home	29.9	17.7	50	43	-13.1
TLU1	Kamloops Lake Pump house	14.3	2.6	39	34	-26.1
TLU2	TK'emlups te Secwepemc First Nation Reserve (Kamloops 1)	23.5	9.2	48	38	-20.9
TLU3	Inks Lake	54.4	37.9	39	34	14 *
TLU4	Jacko Creek	36.0	31.4	39	34	-4.4
TLU5	Upper Peterson Creek	35.2	29.3	39	34	-5.2

ID	Receptor Type	Construction Phase Year -1, L_d or L_n (dBA)	Piling Activities, L_d (dBA)	Baseline Sound Level Used in Health Canada Noise Guideline		Maximum Level Differences [1] (dB)
				L_d (dBA)	L_n (dBA)	
TLU6	Goose Lake Road	36.7	25.5	39	34	-3.7
TLU7	Peterson Creek Discharge	44.8	25	39	34	4.4 *
TLU8	Edith Lake	37.1	21.6	39	34	-3.3
TLU9	Jacko Lake Prayer Tree	46.6	71.6	39	36	32.6 *

Notes:
[1] The maximum arithmetic difference between the prediction results and baseline level during the nighttime period.
** Perceptible noise effect.*

Table 10.5-8. Comparison to Baseline Sound Level Operation Phase

ID	Receptor Type	Operation Year 2, L_d or L_n (dBA)	Operation Year 4 and 8, L_d or L_n (dBA)	Baseline Sound Level Used in Health Canada Noise Guideline		Maximum Level Differences[1] (dB)
				L_d (dBA)	L_n (dBA)	
1	Residence	26.3	26.2	39	34	-7.7
2	Residence	26.7	26.8	39	34	-7.2
3	Residence	28.9	28.8	39	36	-7.1
4	Residence	35.3	34.5	39	34	1.3 *
8	Residence	37.4	36.7	39	34	3.4 *
9	Residence	36.1	37.7	39	34	3.7 *
11	Residence	27.5	27.2	39	34	-6.5
12	Residence	30	30	39	34	-4
13	Aberdeen Development	31	31.5	51	41	-9.5
14	CDB 1	21.4	23.8	39	36	-12.2
15	CDB 2	27.9	28.9	39	36	-7.1
16	CDB 3	32.2	33.1	39	36	-2.9
17	CDB 4	33.3	33.9	39	36	-2.1
18	CDB 5	34.5	35.1	39	36	-0.9
21	Residence	36.1	35.9	39	34	2.1 *
22	Residence	27.9	27.7	39	34	-6.1
23	Residence	30.4	30	39	36	-5.6
24	Residence	28	27.5	39	34	-6
25	Residence	28.4	27.9	39	34	-5.6
26	Residence	24.4	24.4	39	34	-9.6
27	Residence	23.2	23.7	39	36	-12.3
28	Royal Inland Hospital	19.6	20.1	50	43	-22.9
37	Dufferin Elementary	25.4	25.6	50	43	-17.4
44	Pacific Way Elementary	29	29.6	50	43	-13.4

ID	Receptor Type	Operation Year 2, L_d or L_n (dBA)	Operation Year 4 and 8, L_d or L_n (dBA)	Baseline Sound Level Used in Health Canada Noise Guideline		Maximum Level Differences[1] (dB)
				L_d (dBA)	L_n (dBA)	
52	Sa-Hali Secondary	22.5	22.7	50	43	-20.3
74	Tots & Teddies	25.4	26.2	50	43	-16.8
169	Kamloops Senior Village	24.2	25	50	43	-18
170	Ridgepointe at Pineview Retirement Home	26.2	26.9	50	43	-16.1
TLU1	Kamloops Lake Pump house	10.8	11.7	39	34	-22.3
TLU2	TK'emlups te Secwepemc First Nation Reserve (Kamloops 1)	20.5	20.1	48	38	-17.5
TLU3	Inks Lake	50.1	50.1	39	34	16.1*
TLU4	Jacko Creek	33.1	32.7	39	34	-0.9
TLU5	Upper Peterson Creek	32.8	33.8	39	34	-0.2
TLU6	Goose Lake Road	33.7	34.2	39	34	0.2 *
TLU7	Peterson Creek Discharge	40.9	39.5	39	34	6.9 *
TLU8	Edith Lake	33.6	33.7	39	34	-0.3
TLU9	Jacko Lake Prayer Tree	46.7	49.2	39	36	13.2 *

Note:
[1] The maximum arithmetic difference between the prediction results and baseline level during the nighttime period.
** Perceptible noise effect.*

Comparison to the BC OGC Noise Guideline

Comparison with the BC OGC noise guideline Permissible Sound Level (PSL) was assessed for the Operation phase at the residential receptors. The BC OGC noise guideline does not have a noise limit on construction or decommissioning activities. Noise receptors such as schools, daycares, and traditional land use areas (with the exception of T'Kaloops Reserve) are non-residential dwellings. They are not classified as receptors as per BC OGC noise guideline. Therefore, these receptors do not have a PSL limit. The noise effects at these receptors are compared to the Health Canada noise guidance.

The cumulative sound level is compared to the PSL at the residential receptors in Table 10.5-9. The cumulative sound levels are determined by logarithmically adding the predicted sound level (Table 10.5-6) for Project operation (Year 2 and Years 4 and 8) to the baseline sound level as prescribed by BC OGC in Table 10.5-4. Details on the determination of baseline sound level, PSL, and cumulative sound level results were described in the Noise and Vibration Technical Data Report (Appendix 10.5-A).

The predicted cumulative sound levels comply with the PSL at all residential receptors for both Year 2 and Years 4 and 8 scenarios.

Table 10.5-9. Operation Phase (Year 2 and Years 4 and 8) Comparison to BC OGC PSL

ID	Receptor Description	Cumulative Sound Level Year 2		Cumulative Sound Level Years 4 and 8		Permissible Sound Level		Cumulative Sound Level below PSL Limits
		L_d (dBA)	L_n (dBA)	L_d (dBA)	L_n (dBA)	L_d (dBA)	L_n (dBA)	
1	Residence	45.1	35.5	45.1	35.5	50	40	Yes
2	Residence	45.1	35.6	45.1	35.6	50	40	Yes
3	Residence	50.0	40.3	50.0	40.3	55	45	Yes
4	Residence	45.4	38.2	45.4	37.8	50	40	Yes
8	Residence	45.7	39.4	45.6	38.9	50	40	Yes
9	Residence	45.5	38.6	45.7	39.6	50	40	Yes
11	Residence	45.1	35.7	45.1	35.7	50	40	Yes
12	Residence	45.1	36.2	45.1	36.2	50	40	Yes
13	Aberdeen Development	51.0	41.4	51.0	41.5	56	46	Yes
14	CDB 1	48.0	38.1	48.0	38.2	53	43	Yes
15	CDB 2	45.1	35.8	45.1	36.0	50	40	Yes
16	CDB 3	45.2	36.8	45.3	37.2	50	40	Yes
17	CDB 4	45.3	37.2	45.3	37.5	50	40	Yes
18	CDB 5	45.4	37.8	45.4	38.1	50	40	Yes
21	Residence	45.5	38.6	45.5	38.5	50	40	Yes
22	Residence	45.1	35.8	45.1	35.7	50	40	Yes
23	Residence	53.0	43.2	53.0	43.2	58	48	Yes
24	Residence	45.1	35.8	45.1	35.7	50	40	Yes
25	Residence	45.1	35.9	45.1	35.8	50	40	Yes
26	Residence	45.0	35.4	45.0	35.4	50	40	Yes
27	Residence	48.0	38.1	48.0	38.2	53	43	Yes
28	Royal Inland Hospital	56.0	46.0	56.0	46.0	61	51	Yes
37	Dufferin Elementary	53.0	43.1	53.0	43.1	-	-	-
44	Pacific Way Elementary	53.0	43.1	53.0	43.1	-	-	-
52	Sa-Hali Secondary	45.1	35.5	45.1	35.5	-	-	-
74	Tots & Teddies	45.1	35.6	45.1	35.6	-	-	-
169	Kamloops Senior Village	50.0	40.3	50.0	40.3	55	45	Yes
170	Ridgepointe at Pineview Retirement Home	45.4	38.2	45.4	37.8	50	40	Yes
TLU1	Kamloops Lake Pump house	45.0	35.0	45.0	35.0	-	-	-
TLU2	TK'emlups te Secwepemc First Nation Reserve	48.0	38.1	48.0	38.1	53	43	Yes
TLU3	Inks Lake	51.3	50.2	51.3	50.2	-	-	-
TLU4	Jacko Creek	45.3	37.2	45.2	37.0	-	-	-

ID	Receptor Description	Cumulative Sound Level Year 2		Cumulative Sound Level Years 4 and 8		Permissible Sound Level		Cumulative Sound Level below PSL Limits
		L_d (dBA)	L_n (dBA)	L_d (dBA)	L_n (dBA)	L_d (dBA)	L_n (dBA)	
TLU5	Upper Peterson Creek	45.3	37.0	45.3	37.5	-	-	-
TLU6	Goose Lake Road	45.3	37.4	45.3	37.6	-	-	-
TLU7	Peterson Creek Discharge	46.4	41.9	46.1	40.8	-	-	-
TLU8	Edith Lake	45.3	37.4	45.3	37.4	-	-	-
TLU9	Jacko Lake Prayer Tree	48.9	47.0	50.6	49.4	-	-	-

Note:
"-" not applicable

In addition to the PSL, low frequency noise (LFN) effects at the receptors were assessed for the Operation phase. No potential LFN issues are expected. Further details on the LFN noise effect assessment are described in the Noise and Vibration Technical Data Report (Appendix 10.5-A).

Compliance to the Health Canada Noise Guidance

For the Construction and Operation phases, change in %HA associated with the Project is compared to the threshold for change in %HA of 6.5% advised in the Health Canada noise guideline. The change in %HA is determined by the arithmetic difference between the cumulative Project plus baseline %HA and the baseline %HA.

The determination of baseline %HA at a receptor is based on the baseline L_{dn}. The baseline L_{dn} at the receptors can be estimated by two different approaches. The first approach uses the prescribed ASL in the BC OGC noise guideline. The second approach uses the baseline sound level estimated from the baseline monitoring program as presented in Section 10.5.2.3. In comparing the two approaches, the lower value baseline L_{dn} will be used to determine the baseline %HA. This is considered a more conservative (more protective) approach as a lower baseline %HA will result in a higher change in %HA when compared to the cumulative Project plus baseline %HA.

The cumulative Project/Baseline %HA at a receptor is based on the cumulative sound level of the Project and the baseline L_{dn}.

The changes in %HA during the Construction phase Year -1 and piling activities are summarized in Table 10.5-10. The changes in %HA during the Year 2 and Years 4 and 8 Operation phase for all receptors are summarized in Table 10.5-11. The changes in %HA at most of the receptors are below the 6.5% threshold for all assessed Construction and Operation scenarios. The results indicate compliance with the Health Canada guidance. The only exception is the change %HA at Jacko Lake Prayer Tree (ID# TLU9) traditional land use location during the pile activities; the value of 58.17% exceeds the recommended threshold of 6.5%.

Details on the determination of %HA were described in the Noise and Vibration Technical Data Report (Appendix 10.5-A).

Table 10.5-10. Construction Phase (Year -1 and Piling Activities) Change in %HA Results

ID	Receptor Description	Baseline %HA	Year -1		Piling Activities		Change in %HA exceed 6.5%
			Cumulative Project/ Baseline %HA	Change in %HA	Cumulative Project/ Baseline %HA	Change in %HA	
1	Residence	0.73	0.76	0.03	0.76	0.03	No
2	Residence	0.73	0.76	0.03	0.81	0.08	No
3	Residence	0.88	0.92	0.04	0.88	0.00	No
4	Residence	0.73	0.96	0.23	0.77	0.04	No
8	Residence	0.73	0.99	0.26	1.35	0.62	No
9	Residence	0.73	1.08	0.35	0.79	0.06	No
11	Residence	0.73	0.76	0.03	0.74	0.01	No
12	Residence	0.73	0.79	0.06	0.78	0.05	No
13	Aberdeen Development	2.49	2.53	0.04	2.50	0.01	No
14	CDB 1	0.88	0.89	0.01	0.88	0.00	No
15	CDB 2	0.88	0.92	0.04	0.94	0.06	No
16	CDB 3	0.88	0.99	0.11	1.15	0.27	No
17	CDB 4	0.88	1.02	0.14	0.93	0.05	No
18	CDB 5	0.88	1.09	0.21	0.89	0.01	No
21	Residence	0.73	0.93	0.20	3.06	2.33	No
22	Residence	0.73	0.78	0.04	0.73	0.00	No
23	Residence	0.88	0.95	0.07	0.90	0.02	No
24	Residence	0.73	0.77	0.04	0.74	0.01	No
25	Residence	0.73	0.78	0.05	0.74	0.01	No
26	Residence	0.73	0.75	0.02	0.73	0.00	No
27	Residence	0.88	0.89	0.01	0.91	0.03	No
28	Royal Inland Hospital	2.61	2.62	0.00	2.61	0.00	No
37	Dufferin Elementary	2.61	2.62	0.01	2.63	0.01	No
44	Pacific Way Elementary	2.61	2.64	0.02	2.62	0.00	No
52	Sa-Hali Secondary	2.61	2.62	0.00	2.61	0.00	No
74	Tots & Teddies	2.61	2.62	0.01	2.62	0.00	No
169	Kamloops Senior Village	2.61	2.62	0.01	2.62	0.00	No
170	Ridgepointe at Pineview Retirement Home	2.61	2.62	0.01	2.62	0.01	No
TLU1	Kamloops Lake Pump house	0.73	0.73	0.00	0.73	0.00	No
TLU2	TK'emlups te Secwepemc First Nation Reserve (Kamloops 1)	1.69	1.69	0.00	1.69	0.00	No
TLU3	Inks Lake	0.73	3.96	3.23	1.87	1.14	No
TLU4	Jacko Creek	0.73	0.84	0.11	1.07	0.34	No

ID	Receptor Description	Baseline %HA	Year -1		Piling Activities		Change in %HA exceed 6.5%
			Cumulative Project/ Baseline %HA	Change in %HA	Cumulative Project/ Baseline %HA	Change in %HA	
TLU5	Upper Peterson Creek	0.73	0.82	0.09	0.95	0.22	No
TLU6	Goose Lake Road	0.73	0.86	0.13	0.83	0.10	No
TLU7	Peterson Creek Discharge	0.73	1.39	0.66	0.82	0.09	No
TLU8	Edith Lake	0.73	0.87	0.14	0.77	0.04	No
TLU9	Jacko Lake Prayer Tree	0.88	1.73	0.85	59.05	58.17	Yes

Table 10.5-11. Operation Phase (Year 2 and Years 4 and 8) Change in %HA Results

ID	Receptor Description	Baseline %HA	Year -1		Year 4 and 8		Change in %HA Exceed 6.5%
			Cumulative Project/ Baseline %HA	Change in %HA	Cumulative Project/ Baseline %HA	Change in %HA	
1	Residence	0.73	0.78	0.05	0.78	0.05	No
2	Residence	0.73	0.79	0.06	0.79	0.06	No
3	Residence	0.88	0.96	0.08	0.96	0.08	No
4	Residence	0.73	1.09	0.36	1.04	0.31	No
8	Residence	0.73	1.28	0.55	1.21	0.48	No
9	Residence	0.73	1.15	0.42	1.31	0.58	No
11	Residence	0.73	0.80	0.07	0.79	0.06	No
12	Residence	0.73	0.85	0.12	0.85	0.12	No
13	Aberdeen Development	2.49	2.55	0.06	2.56	0.07	No
14	CDB 1	0.88	0.89	0.02	0.90	0.03	No
15	CDB 2	0.88	0.94	0.07	0.96	0.08	No
16	CDB 3	0.88	1.05	0.17	1.08	0.21	No
17	CDB 4	0.88	1.09	0.21	1.12	0.24	No
18	CDB 5	0.88	1.16	0.28	1.19	0.31	No
21	Residence	0.73	1.15	0.42	1.14	0.41	No
22	Residence	0.73	0.81	0.08	0.80	0.07	No
23	Residence	0.88	0.99	0.11	0.98	0.11	No
24	Residence	0.73	0.81	0.08	0.80	0.07	No
25	Residence	0.73	0.81	0.08	0.81	0.08	No
26	Residence	0.73	0.76	0.03	0.76	0.03	No
27	Residence	0.88	0.90	0.02	0.90	0.03	No
28	Royal Inland Hospital	2.61	2.62	0.00	2.62	0.00	No
37	Dufferin Elementary	2.61	2.63	0.02	2.63	0.02	No
44	Pacific Way Elementary	2.61	2.65	0.04	2.66	0.04	No
52	Sa-Hali Secondary	2.61	2.62	0.01	2.62	0.01	No

ID	Receptor Description	Baseline %HA	Year -1		Year 4 and 8		Change in %HA Exceed 6.5%
			Cumulative Project/ Baseline %HA	Change in %HA	Cumulative Project/ Baseline %HA	Change in %HA	
74	Tots & Teddies	2.61	2.63	0.02	2.63	0.02	No
169	Kamloops Senior Village	2.61	2.63	0.01	2.63	0.01	No
170	Ridgepointe at Pineview Retirement Home	2.61	2.63	0.02	2.64	0.02	No
TLU1	Kamloops Lake Pump house	0.73	0.73	0.00	0.73	0.00	No
TLU2	TK'emlups te Secwepemc First Nation Reserve (Kamloops 1)	1.69	1.70	0.01	1.70	0.01	No
TLU3	Inks Lake	0.73	5.10	4.37	5.10	4.37	No
TLU4	Jacko Creek	0.73	0.96	0.23	0.94	0.21	No
TLU5	Upper Peterson Creek	0.73	0.95	0.22	1.00	0.27	No
TLU6	Goose Lake Road	0.73	0.99	0.26	1.02	0.29	No
TLU7	Peterson Creek Discharge	0.73	1.76	1.03	1.54	0.81	No
TLU8	Edith Lake	0.73	0.99	0.26	0.99	0.26	No
TLU9	Jacko Lake Prayer Tree	0.88	3.43	2.56	4.61	3.73	No

Sleep Disturbance

The sleep disturbance noise guideline of 42 dBA (outside, during nighttime) was used for this assessment based on the World Health Organization Night Guidelines for Europe (WHO 2009). The results in Tables 10.5-5 and 10.5-6 indicate that the nighttime equivalent sound level from the Project is below 42 dBA at all residential receptors for both Construction and Operation phases. No noise-related sleep disturbances of residential receptors are predicted from the Project during the nighttime period.

Vibration

Methods

The Project activities that may have key or potential moderate interaction with vibration effects are related to blasting within the mine pit. In addition, use of heavy equipment (i.e., drilling, clearing and grubbing, earthworks) and material transportation (i.e., heavy haul truck) during construction and operation phases were considered in the assessment. The vibration assessment was performed in accordance with the recommendations and requirements of the following guidelines:

- The Ontario Ministry of Environment and Climate Change – Guidelines on Information Required for the Assessment of Blasting Noise and Vibration (1985) (MOECC NPC119 1985);
- United States Bureau of Mines (USBM) RI-8485 and RI-8507; and
- Environment Canada Environmental Code of Practice for Metal Mines (2009).

These guidelines provide vibration thresholds for building structure damage. Each receptor type has been assigned a ground vibration and air blast overpressure threshold based on the location classification. The most restrictive MOECC NPC119 cautionary threshold of 10 mm/s and 120 linear decibel (dBL) is applied to all residential locations.

The guidelines above focus on structural damage threshold with no guidance on annoyance threshold for blast-related ground vibration. The following two guidelines provide guidance for annoyance threshold due to blast-related ground vibration:

- Australian Department of Environment and Conservation New South Wales (NSW) – Assessing Vibration: A Technical Guideline, 2006.
- Australian and New Zealand Environment Council (ANZECC) Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration. Australian and New Zealand Environment Council, Canberra. 1990.

Blast related ground vibration events are considered as impulsive vibration event. The NSW vibration guideline is based on guidelines contained in the British Standard (BS) 6472-1992, Evaluation of Human Exposure to Vibration in Buildings. The NSW guideline recommends an annoyance threshold of 8.6 mm/s for residences during the daytime period. The NSW vibration guideline also refers to the ANZECC guideline for blast related impulsive vibration. The ANZECC recommends a lower threshold of 5 mm/s. Based on the NSW and ANZECC guidelines, the more conservative annoyance threshold of 5 mm/s is used to assess blast-related ground vibration effect.

The USBM vibration guideline recommends the annoyance threshold of 120 dBL for air blast overpressure. The ANZECC vibration guideline recommends 115 dBL as the annoyance threshold. The more conservative annoyance threshold of 115 dBL is used to assess air blast overpressure effect.

In addition to structure damage and human receptors, the blast effect on aquatic life is compared to the 1998 vibration guideline (Wright and Hopky 1998). This guideline is considered as the best available guideline, as the Department of Fisheries and Ocean does not have any current quantitative vibration limits for aquatic life. The ground vibration threshold of 13 mm/s is applied for aquatic life at Jacko Lake. The air blast overpressure limit of 194 dBL was used at the same location.

Ground vibration effect related to other activities (drilling, heavy equipment, haul truck traffic) is based on the City of Toronto Construction Vibration Limit (ByLaw-514). The peak particle velocity vibration threshold is frequency dependant from 8 mm/s (less than 4 Hertz) to 25 mm/s (more than 10 Hertz). The lower limit of 8 mm/s will be used as the construction vibration threshold as a conservative approach.

The vibration assessment used the following approach:

- reviewed blast design information provided by KAM blast review (Appendix D of Appendix 10.5-A);
- develop blast designs to eliminate structural damage and minimize annoyance effects from blast induced ground vibrations and air blast, which could emanate into the nearby communities, residential homes, businesses, towers and other free standing structures;

- predicted the air overpressure and ground vibration effects of blasting activities at vibration receptors based on established methods, including receptor for aquatic life protection;
- predicted the ground vibration effects of heavy equipment, drilling, and piling;
- compared prediction results with vibration guidelines; and
- provided vibration mitigation and vibration management plan for blasting activities.

Commonly used and accepted equations by the industry were used to predict the blast-induced ground vibration and air blast level (Blasters' Handbook 2011). Ground vibration from other Construction and Operation phase activities was assessed for potential effects using field measurements of similar equipment for these activities. The detailed methods and input used for assessing potential effects on vibration from the Project were described in the Noise and Vibration Technical Data Report (Appendix 10.5-A).

Test blast data conducted by Orica for predicting ground vibrations and air blast was not used because the borehole diameter, maximum weight of explosives per delay, subgrade, top stemming, and the rock properties have changed in the current blast design since Orica's two test blasts.

Blast-induced Vibration Effects

During the Operation phase, the primary vibration effects are ground vibration and air blast due to blast activities in the pit. Table 10.5-12 lists the predicted ground vibration and air blast levels for the vibration receptors of interest. The blasts plan divides the pit into three progressive zones (Zone 1 – Z1, Zone 2 – Z2, and Zone 3 – Z3) based on distance from Jacko Lake. Z1 is furthest and Z3 is closest to Jacko Lake. Different blast parameters are used in different zones. Detailed discussion of blast plan and blast procedure modification to address the vibration effect at Jacko Lake is presented in the Noise and Vibration TDR (Appendix D of Appendix 10.5-A) Ajax Mine Blast Review. To be conservative in all of the predictions, the distance to each point of concern was always taken from the final pit boundary, and all blasts were assumed to be fired with 1,020 kg of explosives, except for the blasts approaching Jacko Lake (Z3).

Table 10.5-12. Predicted Ground Vibration and Air Blast Overpressure Result at Receptor Locations

ID	Receptor Description	Predicted Ground Vibration Amplitude	Predicted Air Blast (dBL)
1a	Jacko Lake Fish Habitat Area #1	12.31[1]	128[1]
1b	Jacko Lake Fish Habitat Area #2	6.96[1]	125[1]
2	Jacko Lake boat launch area	4.41	118
3	Urban Growth Boundary	2.09	113
4	Residence 1	1.70	112
5	Cell Tower 1	1.66	112
6	Cell Tower 2	1.38	111
7	Residence 2	1.21	110
8	City of Kamloops residences	1.15	110
9	Elementary Pacific Way School	1.09	109

ID	Receptor Description	Predicted Ground Vibration Amplitude	Predicted Air Blast (dBL)
10	Residence 3	1.09	109
11	Site 1	1.02	109
12	Inks Lake	0.99	109
13	Residence 3	0.95	108
14	Site 2	0.91	108
15	Residence 4	0.88	108
16	Site 3	0.88	108
17	Site 4	0.82	108
18	Python Minifile historic underground	0.76	107
19	Residence 5	0.74	107
20	Residence 6	0.74	107
21	Residence 7	0.65	106
22	Galaxy historic underground	0.63	106
23	Royal Inland Hospital	0.51	105
24	Roadcut Failure Zone (Kamloops)	0.47	104
25	Pet Boarding	0.46	104
26	Proposed bike trail (Official)	0.45	104
27	Wedding event site location	0.39	103
28	Surface storage tank 1	0.37	103
29	Iron Mask historic underground	0.34	102
20	Surface storage tank 2	0.33	102
31	Surface storage tank 3	0.30	102
TLU1	Kamloops Lake Pump house	0.07	93
TLU2	TK'emlups te Secwepemc First Nation Reserve (Kamloops 1)	0.15	97
TLU3	Inks Lake	1.17	110
TLU4	Jacko Creek	0.63	106
TLU5	Upper Peterson Creek	0.56	105
TLU6	Goose Lake Road	0.50	105
TLU7	Peterson Creek Discharge	1.36	111
TLU8	Edith Lake	0.47	104
TLU9	Jacko Lake Prayer Tree	11.96	124

[1] *Zone 3 blasting closest to Jacko Lake*

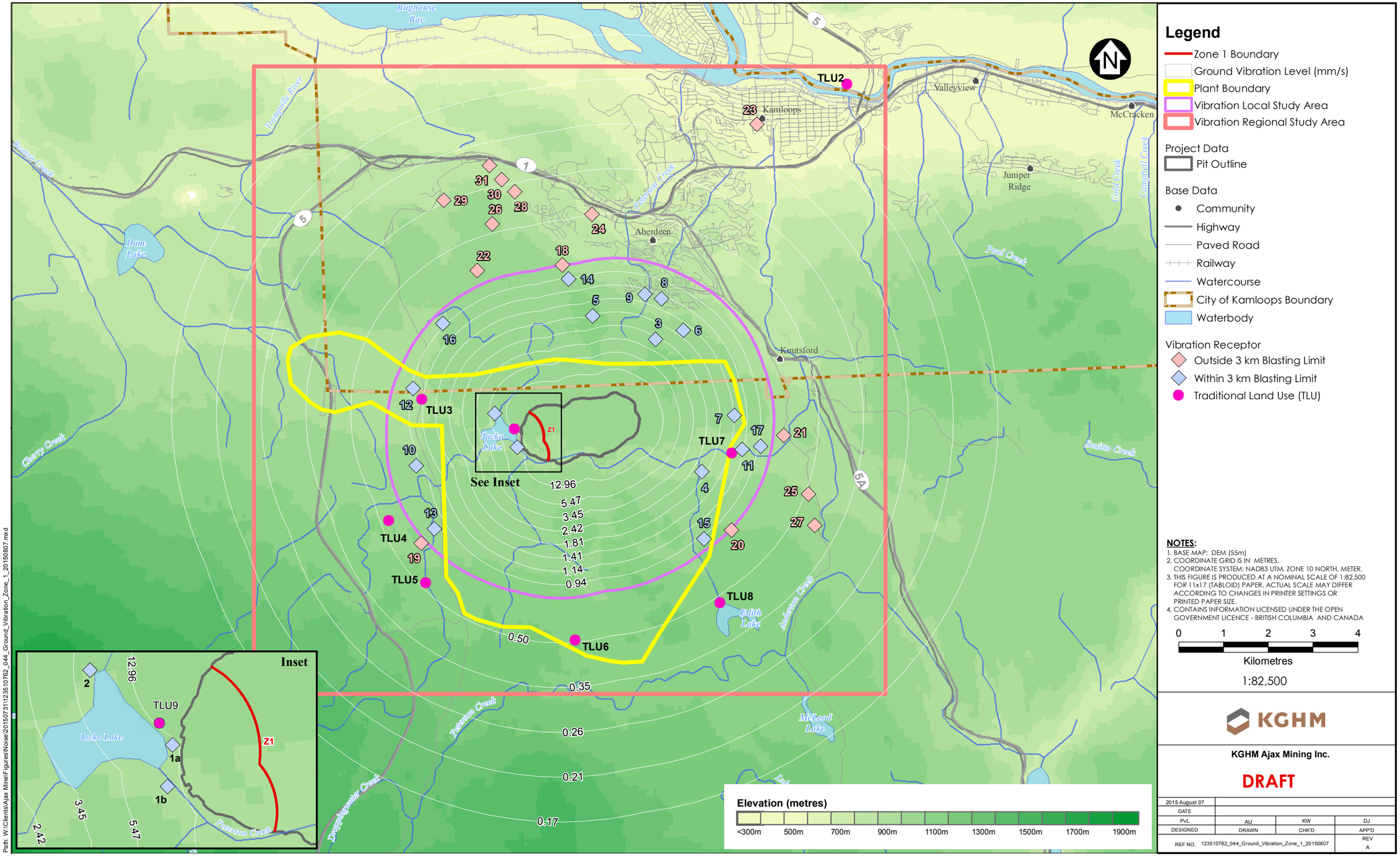
Table 10.5-13 lists the predicted ground vibration and air blast levels in increments of 100 m to 3,000 m for the Zone 1 and Zone 3 blasts, starting at 100 m from the final pit boundary. Figures 10.5-7 and 10.5-8 present the Zone 1 blasting ground vibration level and air blast overpressure, respectively. Figures 10.5-9 and 10.5-10 present the Zone 3 blasting ground vibration level and air blast overpressure, respectively. Details on the blast plan design for each zone are presented in the Noise and Vibration Technical Data Report (Appendix 10.5-A).

Table 10.5-13. Predicted Ground Vibration and Air Blast Results For Zone 1 and Zone 3 Blasts

Distance from Final Pit Boundary (m)	Zone 1		Zone 3	
	Predicted Ground Vibration Amplitude (mm/s)	Air Blast Overpressure (dBL)	Predicted Ground Vibration Amplitude (mm/s)	Air Blast Overpressure (dBL)
100	184.05	140	21.09	131
200	60.71	133	6.96	125
245 [1]	43.88	131	5.03	123
300	31.73	129	3.64	121
400	20.03	127	2.29	118
500	14.01	125	1.61	116
550 [2]	12.03	124	1.38	115
600	10.47	123	1.20	114
700	8.18	121	0.94	113
800	6.61	120	0.76	111
900	5.47	119	0.63	110
950 [3]	5.02	118	0.58	110
1,000	4.62	118	0.53	109
1,100	3.97	117	0.45	108
1,200	3.45	116	0.40	108
1,300	3.04	115	0.35	107
1,400 [4]	2.70	115	0.31	106
1,500	2.42	114	0.28	105
1,600	2.18	113	0.25	105
1,700	1.98	113	0.23	104
1,800	1.81	112	0.21	104
1,900	1.66	112	0.19	103
2,000	1.53	111	0.17	103
2,100	1.41	111	0.16	102
2,200	1.31	110	0.15	102
2,300	1.22	110	0.14	101
2,400	1.14	110	0.13	101
2,500	1.07	109	0.12	101
2,600	1.00	109	0.11	100
2,700	0.94	108	0.11	100
2,800	0.89	108	0.10	100
2,900	0.84	108	0.10	99
3,000	0.80	107	0.09	99
4,000	0.50	105	0.06	96

[1] Zone 1 blast - distance from Z1 area boundary meeting ground vibration annoyance threshold of 5 mm/s.
[2] Zone 1 blast - distance from Z1 area boundary meeting air blast overpressure annoyance threshold of 115 dBL.
[3] Zone 3 blast - distance from Z3 area boundary meeting ground vibration annoyance threshold of 5 mm/s.
[4] Zone 3 blast - distance from Z3 area boundary meeting air blast overpressure annoyance threshold of 115 dBL.

Figure 10.5-7
Ground Vibration Level for Zone 1 Blasting



NOTES:
1. BASE MAP: DEM (55m)
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD83 UTM, ZONE 10 NORTH, METER.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:82,500 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
4. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - BRITISH COLUMBIA AND CANADA

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Figure 10.5-8
Air Blast Overpressure Level for Zone 1 Blasting

Stantec

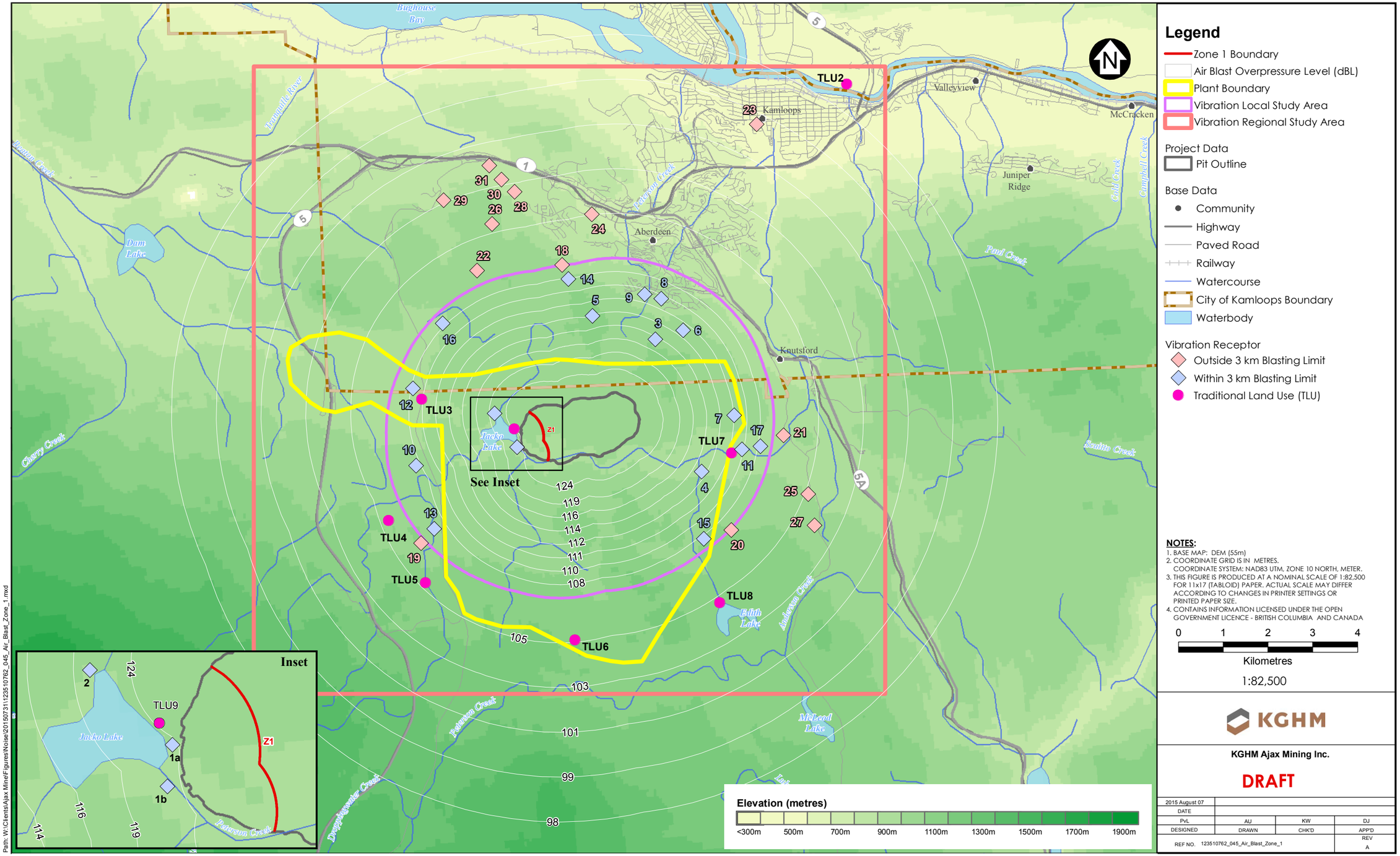


Figure 10.5-9
Ground Vibration Level for Zone 3 Blasting

Stantec

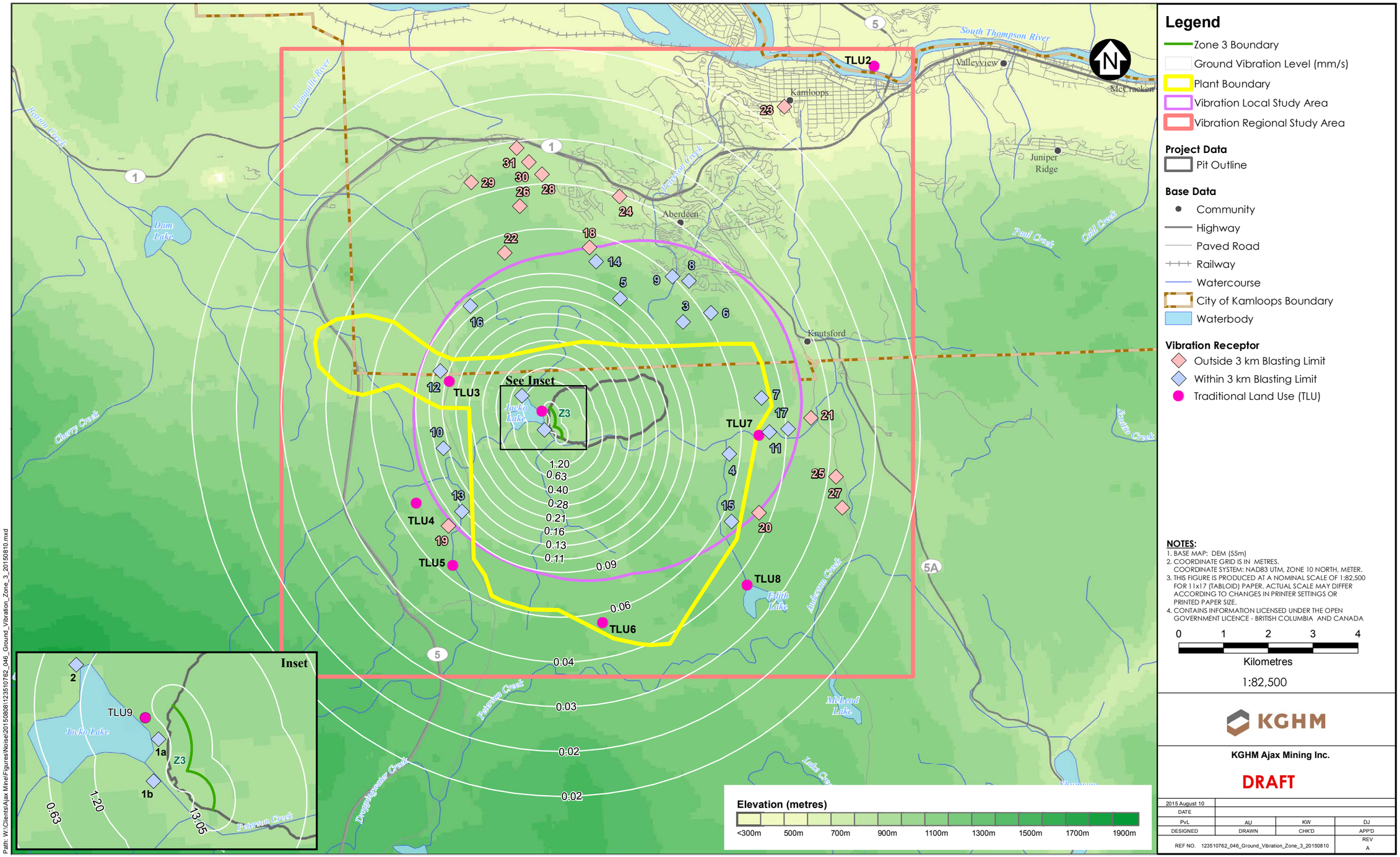
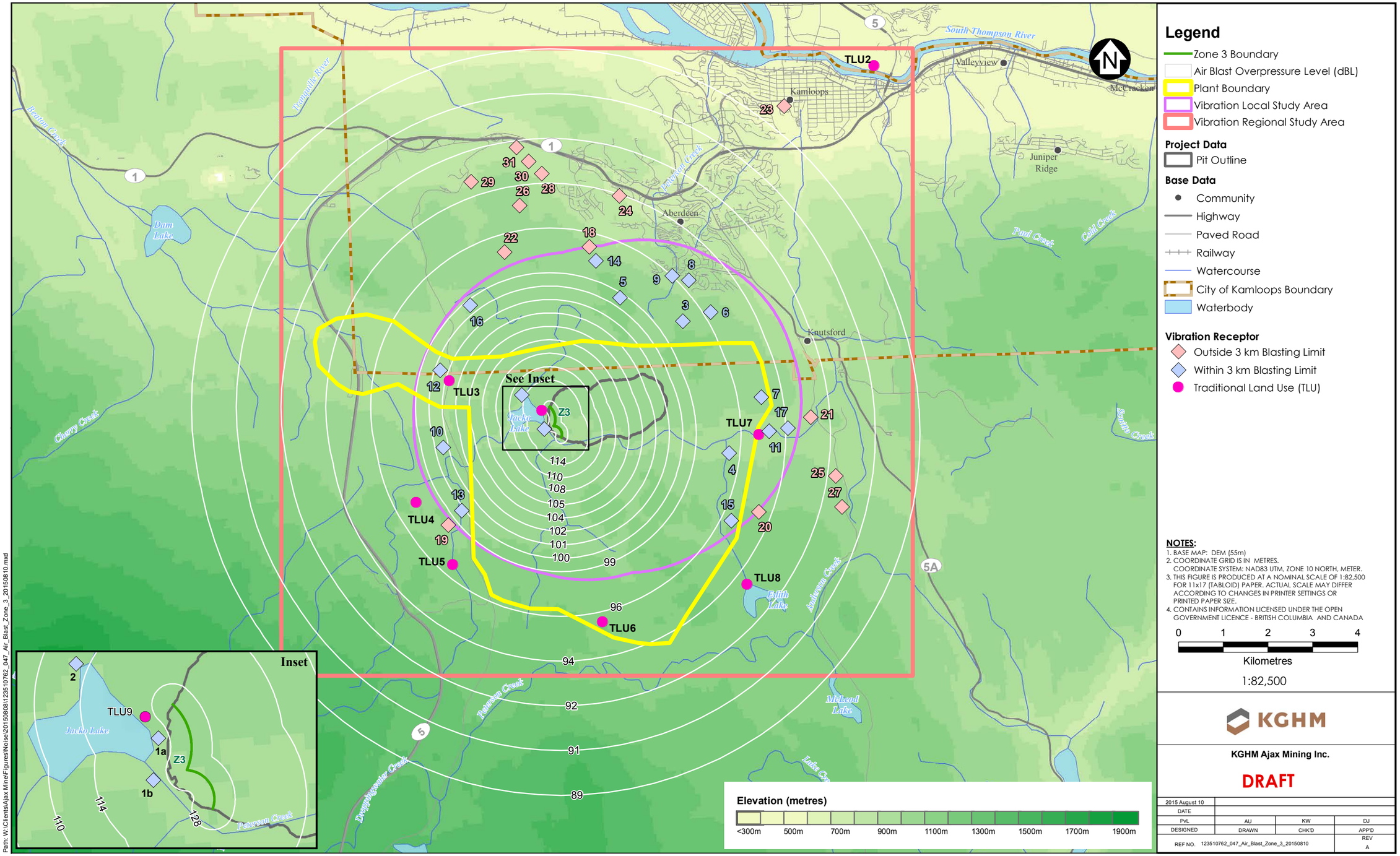


Figure 10.5-10
Air Blast Overpressure Level for Zone 3 Blasting



Vibration Effects from Other Activities

In addition to the blast-related vibration effects discussed in the previous section, the following Project construction and operation activities were considered to have key or potential moderate interaction with vibration effect:

- earthworks;
- site road construction, use and maintenance;
- piling during open pit development; and
- drilling.

As presented in the method section above, the vibration effects from different activities are compared to the City of Toronto construction vibration of 8 mm/s. These activities are expected to occur at different times and locations, vibration from multiple concurrent sources are not expected to interact cumulatively for the same receptor.

The heavy construction equipment associated with the construction (clearing and grubbing, earthworks) at the plant facilities are expected to generate ground vibration up to 1 mm/s at a distance of 25 m (FTA 1995 and ASCE 2000). The closest residences are located more than 600 m away from the plant facilities. Vibration level from the source decrease with increasing distance. Therefore, vibration levels the closest residences are expected to be below the construction vibration limit of 8 mm/s.

Typical ground vibration from site road construction equipment (i.e., grader, compactor) can generate vibration up to 2 mm/s at a distance of 25 m (Stantec 2012). Road construction along a portion of the access is expected during the construction phase. The current access road is approximately 25 m south of Inks Lake, 100 m away from the Jacko Lake Boat Launch Area, and 1,500 m away from the closest residential receptor. The vibration effect at this residential receptor from road construction equipment is expected to be well below the construction vibration limit of 8 mm/s.

Open pit development includes piling operation for the dam development near Jacko Lake east arm. Piling operations typically generate ground vibration levels up to 3 mm/s at a distance of 25 m (FTA 1995). Most of the vibration receptor (Jacko Lake Boat Launch Area) is at least 500 m from the piling operation. Vibration effect at these vibration receptors is expected to be below the construction vibration limit of 8 mm/s. The only exception is the Jacko Lake Prayer Tree (ID# TLU9) location. This location is in close proximity to the piling activities. The ground vibration level could exceed 3 mm/s in close proximity to the piling equipment; however, accessibility near the dam will be limited during the piling activities.

Drilling typically generates a ground vibration level of up to 0.4 mm/s at a distance of 25 m (FTA 1995). The nearest vibration receptor is located more than 150 m from the pit area with drilling activities. At this distance, the vibration level from drilling activities is expected to be well below the construction threshold of 8 mm/s.

Comparison to Human Annoyance Guideline

The predicted blast-related vibration results are compared to the human annoyance threshold of 5 mm/s for ground vibration and 115 dBL for air blast overpressure. The results in Table 10.5-12 indicate that at Jacko Lake Fish Habitat Area (ID# 1a and 1b) and Jacko Lake Prayer Tree (ID# TLU9) locations, the predicted levels exceed the annoyance thresholds. Results in Table 10.5-13 indicate that 1,400 m and 550 m is the minimum buffer distance from the blasting zone area boundary for annoyance threshold compliance during Zone 1 and Zone 3 blast, respectively. Prediction results at all other receptors are below the annoyance thresholds.

Comparison to Ontario Ministry of Environment and Climate Change Vibration Threshold and United State Bureau of Mining

The predicted ground vibration level at the urban growth boundary is 2.09 mm/s. At the closest residential receptor, the predicted level is 1.70 mm/s. These levels (i.e., 1 to 2 mm/s) are an order of magnitude lower than 19 mm/s, the minimum vibration level required to cause cracks in drywall (USBM); it is highly unlikely that blasting can cause structural damage to any of the free standing structures in the surrounding communities. The results indicate that blast-induced ground vibration effect is expected to be well below the MOECC NPC119 limit of 10 mm/s, Environment Canada limit of 12.5 mm/s, and USBM limit of 19 mm/s.

The predicted air blast levels for all homes, industrial structures and towers were all well below the USBM structural damage threshold (133 dBL) and MOECC cautionary limit (120 dBL). The predicted air blast level at the closest residential structure is 112 dBL. Thus, it is also highly unlikely that any air blast can cause any cosmetic or structural damage for this receptor and other similar receptors at further distance.

Compliance to Aquatic Life Projection Vibration Guideline

The DFO currently does not provide any quantitative vibration thresholds for aquatic life. In the past, the DFO referred to a guideline which prescribes quantitative vibration limits for aquatic life during blast activities. In absences of any quantitative vibration guideline for aquatic life from the DFO, the 1998 vibration guideline (Wright and Hopky 1998) is adapted as the best available guideline.

The aquatic life vibration guideline (Wright and Hopky 1998) stipulates the most restrictive threshold for vibration at 13 mm/s for protection of aquatic life in Jacko Lake. In order to comply with this threshold, the maximum weight of explosives per delay will be incrementally reduced from 1,020 kg in Zone 1 to 68 kg beyond Zone 3 through the use of explosive decks, smaller diameter 152 mm holes, or both. The vibration guideline for aquatic life at Jacko Lake dictates the blast design because the damage threshold for aquatic life is lower than the residential damage threshold of 19 mm/s and Jacko Lake is closer to the mine pit than other residential receptors. Ground vibration and air blast levels at Jacko Lake are expected to meet the aquatic life vibration guideline threshold.

Mitigation Measures for Noise and Vibration

Noise emission from stationery and mobile equipment used in Construction and Operation activities will generate noise effects. The blast activities in the mine pit have the highest potential to generate vibration effects.

There are two components to managing noise and vibration effects. The first component of mitigation measures is by Project design. The second component of mitigation measures can be accomplished during different Project phases. The following sections summarize the noise and vibration mitigation measures committed for the Project.

Mitigation by Project Design

Noise

Noise mitigation by Project design will be achieved by reducing the noise emissions to receptors by increasing buffer distance, reducing equipment usage, and the use of enclosures. The mitigation measures are presented as follows:

- conveyor from crusher to plant will be covered to reduce noise emission;
- coarse ore stockpile enclosure will provide noise attenuation for equipment activities;
- heavy equipment such as mills, crusher, compressors, pumps, and motors will be located inside buildings;
- roads are designed to minimize haul distances;
- use of large trucks for ore and mine rock transport to minimize the number of trips required between the source and destination;
- mobile equipment equipped with the manufacturer-recommended exhaust mufflers; and
- plant facilities have been located further from the City of Kamloops boundary than originally proposed.

Vibration

Vibration mitigation by Project design will be achieved by blast design. The detailed mitigation measures are presented as follows:

- blast designs were based on the threshold at the closest location (i.e., Jacko Lake) while other receptors are located much further away;
- blast designs were developed to reduce annoyance effects from blast-induced air blast overpressure;
- maximum explosives mass per time delay for the different blast zones (Z1, Z2, and Z3) decreases substantially from 1020 Kg to 68 Kg as the blasts approach Jacko Lake;
- use of lower explosives per delay in Z3 enables the blast effect to be in compliance with the aquatic life vibration guideline (Wright and Hopky 1998) at Jacko Lake;
- hole diameter sizes, number of decks, and stemming configurations are designed for different zones;
- only one hole/delay will be fired on the blast;
- minimum time delay between holes in all blasts will not be less than 8 milliseconds (ms); and
- row time delays will be incremented from the front of the blast towards the back with 100 to 300 ms.

Mitigation by Measures during all Project Phases

Noise

Noise mitigation measures include the following:

- keep all operating equipment building doors and windows closed to the extent possible;
- limit the use of vehicle horn during each shovel and haul truck loading cycle to the extent allowed by safety regulations;
- operate vehicles within the posted maximum speed limits to reduce noise emission;
- use multi-passenger vehicles to transport crews to and from job sites to reduce overall traffic noise emission;
- conduct piling activities only during the daytime period;
- select best achievable technology (technology that can achieve lower noise emissions and that has been shown to be economically feasible through commercial application) for mine fleet equipment;
- maintain vehicles in good operating condition to meet emission standards (especially with exhaust silencers/mufflers);
- reduce vehicle idling and minimize rapid starts and stops;
- develop and implement a Noise and Vibration Management Plan (Section 11.22);
- provide training and instruction for equipment operators related to the Noise and Vibration Management Plan;
- maintain records for the employee training related to Noise and Vibration Management Plan;
- regularly maintain all machinery and equipment to ensure that noise emissions are within the range set by manufacturers when available;
- implement a process in the Noise and Vibration Management Plan (Section 11.22) to address noise complaints in a timely manner.

Vibration

Vibration mitigation measures include the following:

- apply proper field, planning and engineering controls during blast activities as summarized in the Noise and Vibration Technical Data Report (Appendix D Blast Review, Conclusions and Recommendations Section 8.0. in Appendix 10.5-A);
- manage and revise the controllable blast design parameters (i.e., confinement, charge length and diameter), charge decoupling, direction of initiation, and total shot duration) on an ongoing basis as needed during the Operation phase;
- monitor ground vibrations and correlate with blast design predictions to determine if changes to blast design or procedures are necessary to reduce vibration;

- blast monitoring data will be used for predictive linear regression analysis as the blast locations move around the pit;
- test blasts or smaller blasts will be used to incrementally "scale up" to full blast until vibration effects are fully understood;
- the on-site and other existing weather stations in Kamloops will be used to monitor unfavourable atmospheric conditions (i.e., high velocity directional winds towards Kamloops, coupled with low lying inversions), blast procedures may be delayed or modified during these weather conditions;
- use electronic detonators for blasting and purchase explosives from a reputable supplier;
- develop and implement a Noise and Vibration Management Plan;
- provide training and instruction for equipment operators related to the Noise and Vibration Management Plan;
- maintain records for the employee training related to Noise and Vibration Management Plan; and
- implement a process in the Noise and Vibration Management Plan (Section 11.22) to address vibration complaints in a timely manner.

10.5.5 Residual Effects and Their Significance

10.5.5.1 Summary of Residual Effects

After the application of the various mitigation measures, noise and vibration residual effects are predicted at receptors. A summary of residual effects on noise and vibration is presented in Table 10.5-14.

10.5.5.2 Criteria for Characterization of Residual Effects

Table 10.5-15 summarizes definitions of characterization criteria for residual effects on noise and vibration.

10.5.5.3 Characterization of Residual Effects

Table 10.5-16 summarizes the characterization of residual effects for noise and vibration.

Noise – Construction Phase

During the Construction phase, the predicted results at a receptor are compared to the following guidelines to characterize the magnitude classification:

- L_d or L_n baseline sound level;
- Health Canada change in the %HA threshold of 6.5%; and
- WHO sleep disturbance threshold of 42 dBA.

Table 10.5-14. Summary of Residual Effects on Noise and Vibration

Valued Component	Project Phase (timing of effect)	Project Component/Physical Activity	Description of Cause-Effect[1]	Description of Mitigation Measure(s)	Description of Residual Effect
Noise	Construction and Operation	**Construction** • Clearing and Grubbing • Earthworks • Hazardous Wastes Transport, Storage, and Disposal • Construction Wastes Transport, Storage, and Disposal • Site Road Construction, Use and Maintenance • Site Buildings and Process Plant • Open Pit Development • Drilling and Blasting • Crushing Mine Rock • Loading, Hauling, and Deposition of Waste Rock • Tailing Storage Facility Development **Operation** • Open Pit Development • Drilling and Blasting • Hauling Mine Rock and Ore from Pit • Crushing and Conveying Ore • Stripping, Loading, Hauling, Deposition, and Contouring of Topsoil and Overburden • Process Plant Operation • Site Road Use and Maintenance (Materials, Personnel, Supplies) • Concentrate Transport and Storage • Hazardous Wastes Transport, Storage, and Disposal • General Wastes Transport, Storage, and Disposal • Water intake from Kamloops Lake	An increase of baseline sound level	• Locate noise emission inside gallery, enclosure, or buildings • Reduce haul road distance • Use large haul truck for ore and mine rock transport • Mobile equipment fitted with exhaust mufflers • Locate plant facilities further from City of Kamloops boundary • Implement the Noise and Vibration Management Plan (Section 11.22)	Change in acoustic environment, quantified by daytime (L_d), nighttime (L_n), and day-night (L_{dn}) equivalent sound level at receptors

Valued Component	Project Phase (timing of effect)	Project Component/Physical Activity	Description of Cause-Effect[1]	Description of Mitigation Measure(s)	Description of Residual Effect
Vibration	Construction and operation	**Construction** Earthworks Site Road Construction, Use and Maintenance Open Pit Development Drilling and Blasting **Operation** Drilling and Blasting	An increase in baseline vibration level	Implement blast designs that were based on the damage threshold at the closest location (i.e., Jacko Lake) Implement the Noise and Vibration Management Plan (Section 11.22)	Change in vibration environment, quantified by ground vibration and air blast level at receptors

[1] *"Cause-effect" refers to the relationship between the Project component/physical activity that is causing the change or effect in the condition of the VC.*

Table 10.5-15. Definitions of Characterization Criteria for Residual Effects on Noise and Vibration

Magnitude	Duration	Frequency	Geographic Extent (Physical/ Biophysical)	Reversibility	Resiliency	Ecological Context	Likelihood of Effects	
							Probability	Confidence Level
How severe will the effect be?	*How long will the effect last?*	*How often will the effect occur?*	*How far will the effect reach?*	*To what degree is the effect reversible?*	*How resilient is the receiving environment or population?*	*What is the current condition of the ecosystem and how commonly is it represented in the LSA?*	*How likely is the effect to occur?*	*How certain is this analysis?*
Negligible: Noise: no measureable change from baseline condition. Vibration: below human perception threshold	**Short-term:** effects are measurable for less than 1 month	**Once:** occurs once	**Local:** effects are restricted to the Project boundary	**Reversible Short-term:** recovery occurs immediately after Project closure and reclamation	**Low:** low capacity for the VC to recover from a perturbation, with consideration of the baseline level of disturbance	**Low:** occurs in a viable ecosystem and/or highly disturbed environment	**High:** high likelihood that there will be a residual effect	**High:** high level of confidence

Magnitude	Duration	Frequency	Geographic Extent (Physical/ Biophysical)	Reversibility	Resiliency	Ecological Context	Likelihood of Effects	
							Probability	Confidence Level
Minor: Noise: measureable change from baseline conditions but barely perceptible Vibration: above perceptible threshold	**Medium-term:** effects are measurable for greater than 1 month but less than 2 years	**Sporadic:** occurs at multiple irregular intervals (no set schedule)	**Landscape:** effects extend into the LSA	**Reversible Long-term:** recovery occurs long after Project closure and reclamation	**Neutral:** neutral capacity for the VC to recover from a perturbation, with consideration of the baseline level of disturbance.	**Neutral:** occurs in a stable ecosystem and/or moderately disturbed environment	**Medium:** moderate likelihood that there will be a residual effect	**Medium:** moderate level of confidence
Medium: Noise: perceptible change from baseline conditions but within guideline and guidance limits Vibration: perceptible vibration levels that exceed human annoyance threshold	**Long-term:** effects are measurable for between 2 years and the life of the Project (approximately 25 years)	**Regular:** occurs regularly and at regular intervals	**Regional:** effects extend into the RSA	**Irreversible:** no recovery, effects are permanent	**High:** high capacity for the VC to recover from a perturbation, with consideration of the baseline level of disturbance.	**High:** occurs in fragile ecosystem and/or undisturbed environment	**Low:** low likelihood that there will be a residual effect	**Low:** low level of confidence
Major: Noise: exceed noise guideline and guidance limits Vibration: exceed structural damage threshold	**Far Future:** effects are measurable for long after the end of life of the Project	**Continuous:** occurs continuously.	**Beyond Regional:** effects extend beyond the RSA					

Table 10.5-16. Characterization of Residual Effects, Significance, Likelihood and Confidence on Noise and Vibration

Residual Effect	Residual Effects Characterization Criteria							Significance of Adverse Residual Effects	Likelihood and Confidence	
	Magnitude	Duration	Frequency	Geographic Extent	Reversibility	Resiliency	Context		Probability	Confidence
Change in Acoustic Environment (construction)	Minor	Medium-term	Continuous	Regional	Reversible Short-term	Neutral	Neutral	Not Significant (minor)	High	High
Change in Acoustic Environment (operation)	Minor	Long-term	Continuous	Regional	Reversible Short-term	Neutral	Neutral	Not Significant (minor)	High	High
Change in Vibration Environment (construction)	Minor	Medium-term	Regular	Regional	Reversible Short-term	Neutral	Neutral	Not Significant (minor)	High	High
Change in Vibration Environment (operation)	Minor	Long-term	Regular	Regional	Reversible Short-term	Neutral	Neutral	Not Significant (minor)	High	High

The magnitude classification rating at a receptor is based on the following:

- Negligible - predicted level at a receptor is well below (by 10 dB or more) the baseline sound level, the magnitude classification will be negligible as there is no measureable change from baseline condition.
- Minor - predicted level at a receptor is less than 10 dB below the baseline sound level, the magnitude classification will be minor as there is barely perceptible change from baseline condition.
- Medium - predicted level at a receptor is equal to or higher than the baseline sound level, the magnitude classification will be medium as there is perceptible change from baseline condition.
- Major - predicted level at a receptor is equal to or higher than the baseline sound level, change in the %HA value at a receptor is above 6.5%, and the predicted nighttime noise level is above the WHO sleep disturbance threshold.

Table 10-5.17 summarizes the magnitude classification rating at different receptors during the Construction phase. The comparison of the predicted results with the baseline sound level at the receptor indicates perceptible changes in some receptors (Table 10.5-7). The change in the %HA value at most receptors is below the guidance limit of 6.5% (Table 10.5-10), with the exception of one traditional land use location at the Jacko Lake Prayer Tree (ID# TLU9).

Table 10.5-17. Magnitude Classification during the Construction Phase

ID	Receptor Type	Magnitude Classification Rating
1	Residence	Minor
2	Residence	Minor
3	Residence	Minor
4	Residence	Medium
8	Residence	Medium
9	Residence	Medium
11	Residence	Minor
12	Residence	Minor
13	Aberdeen Development	Minor
14	CDB 1	Negligible
15	CDB 2	Minor
16	CDB 3	Medium
17	CDB 4	Medium
18	CDB 5	Medium
21	Residence	Medium
22	Residence	Minor
23	Residence	Minor
24	Residence	Minor
25	Residence	Minor

ID	Receptor Type	Magnitude Classification Rating
26	Residence	Minor
27	Residence	Minor
28	Royal Inland Hospital	Negligible
37	Dufferin Elementary	Negligible
44	Pacific Way Elementary	Minor
52	Sa-Hali Secondary	Negligible
74	Tots & Teddies	Negligible
169	Kamloops Senior Village	Negligible
170	Ridgepointe at Pineview Retirement Home	Negligible
TLU1	Kamloops Lake Pump house	Negligible
TLU2	TK'emlups te Secwepemc First Nation Reserve (Kamloops 1)	Negligible
TLU3	Inks Lake	Medium
TLU4	Jacko Creek	Minor
TLU5	Upper Peterson Creek	Minor
TLU6	Goose Lake Road	Minor
TLU7	Peterson Creek Discharge	Medium
TLU8	Edith Lake	Minor
TLU9	Jacko Lake Prayer Tree	Medium to High

The predicted nighttime sound levels (Table 10.5-5) at all residential receptors are below the sleep disturbance limit of 42 dBA. The magnitude classification rating at a receptor ranges from negligible to major during the Construction Phase. Out of the 37 receptors considered, predicted noise levels for 9 receptors were rated as negligible, 18 receptors as minor, 9 receptors as medium rating, and 1 receptor as major. The receptors rated as medium includes those at the city development boundary (ID# 16, 17, 18), rural residences (ID# 4, 8, 9, 21), and traditional land use area (ID# TLU3, TLU7). Noise levels for receptors at the area near the east end of Jacko Lake such the traditional land use Prayer Tree location (ID# TLU9) are rated as major, due to its proximity to piling activities (less than two months) for the proposed dam. A "medium" rating is predicted for all other construction activities at this location. The majority of the population will have negligible to minor rating. Based on these results, a magnitude classification rating of "minor" is assigned for the noise effect during the Construction phase.

The duration of effects is medium-term, based on the 2 years of Construction phase. In the case of piling activities, the duration is short-term (less than 2 months) during the daytime period only. The frequency of noise residual effects is continuous during the Construction phase of the Project. The residual effect from the noise emission activities is reversible short-term and will cease once the activities have been completed. The geographic extent of residual effects is regional as the noise effects are not expected to interact cumulatively with the baseline environment at locations beyond the RSA.

The resiliency is neutral because the %HA results at the receptors indicate that the communities within the RSA are unlikely to have a noise annoyance effect. The ecological context is neutral because the noise effects occur in a stable ecosystem and/or moderately disturbed environment.

Noise – Operation Phase

During the Operation phase, the predicted results at a receptor are compared to the following guidelines to characterize the magnitude classification:

- baseline sound level;
- Health Canada change in %HA threshold of 6.5%;
- BC OGC PSL; and
- WHO sleep disturbance threshold of 42 dBA.

The magnitude classification rating at a receptor is based on the following:

- Negligible - predicted level at a receptor is well below (by 10 dB or more) the baseline sound level, the magnitude classification will be negligible as there is no measureable change from baseline condition.
- Minor - predicted level at a receptor is less than 10 dB below the baseline sound level, the magnitude classification will be minor as there is barely perceptible change from baseline condition
- Medium - predicted level at a receptor is equals to or higher than the baseline sound level, the magnitude classification will be medium as there is perceptible change from baseline condition.
- High - predicted level at a receptor is equals to or higher than the baseline sound level, cumulative sound level exceed PSL, change in %HA value at a receptor is above 6.5%, and the predicted nighttime noise level is above the WHO sleep disturbance threshold

Table 10-5.18 summarizes the magnitude classification rating at different receptors during the Operation phase. The comparison of the predicted results with the baseline sound level at the receptor indicates perceptible changes in some receptors (Table 10.5-8). The predicted cumulative sound level is below the PSL at all receptors (Table 10.5-9). The change in %HA values (Table 10.5-11) at all receptors are below the guidance limit of 6.5%. The predicted nighttime sound levels (Table 10.5-5) at all residential receptors are below the sleep disturbance limit of 42 dBA. The magnitude classification rating at a receptor ranges from negligible to medium during the Operation Phase. Out of the 37 receptors considered, predicted noise magnitudes at 11 receptor locations were rated as negligible, 18 receptors as minor, 8 receptors as medium, and no receptor location was rated as high. Noise levels for receptors at the rural residences (ID# 4, 8, 9, 21), and traditional land use area (ID# TLU3, TLU6, TLU7, TLU9) are rated as medium. However, the majority of the receptors will have negligible to minor rating. Based on these results, a magnitude classification rating of "minor" is assigned for the noise effect during the Operation phase.

Table 10.5-18. Magnitude Classification during the Operation Phase

ID	Receptor Type	Magnitude Classification Rating
1	Residence	Minor
2	Residence	Minor
3	Residence	Minor
4	Residence	Medium
8	Residence	Medium
9	Residence	Medium
11	Residence	Minor
12	Residence	Minor
13	Aberdeen Development	Minor
14	CDB 1	Negligible
15	CDB 2	Minor
16	CDB 3	Minor
17	CDB 4	Minor
18	CDB 5	Minor
21	Residence	Medium
22	Residence	Minor
23	Residence	Minor
24	Residence	Minor
25	Residence	Minor
26	Residence	Minor
27	Residence	Negligible
28	Royal Inland Hospital	Negligible
37	Dufferin Elementary	Negligible
44	Pacific Way Elementary	Negligible
52	Sa-Hali Secondary	Negligible
74	Tots & Teddies	Negligible
169	Kamloops Senior Village	Negligible
170	Ridgepointe at Pineview Retirement Home	Negligible
TLU1	Kamloops Lake Pump house	Negligible
TLU2	TK'emlups te Secwepemc First Nation Reserve	Negligible
TLU3	Inks Lake	Medium
TLU4	Jacko Creek	Minor
TLU5	Upper Peterson Creek	Minor
TLU6	Goose Lake Road	Medium
TLU7	Peterson Creek Discharge	Medium
TLU8	Edith Lake	Minor
TLU9	Jacko Lake Prayer Tree	Medium

The duration of effects is long-term, based on the 23 years of Operation. The frequency of noise residual effects is continuous during the Operation phase of the Project. The residual effect from the noise emission activities is reversible short-term and will cease once the activities have been completed. Predicted noise effects are well below the baseline sound level for receptors furthest away from the Project within the RSA. The geographic extent of residual effects is regional as the noise effects are well below the human hearing threshold beyond the RSA and they are not expected to interact cumulatively with the baseline environment at locations beyond the RSA.

The resiliency is neutral because the %HA results at the receptors indicate that the communities within the RSA are unlikely to have a noise annoyance effect. The ecological context is neutral because the noise effects occur in a stable ecosystem and/or moderately disturbed environment.

Vibration

The magnitude of residual vibration effects is based on criteria described in Section 10.5.4.2. During the Operation and Construction phase, the predicted results at a receptor are compared to the following guidelines to characterize the magnitude classification:

- The Ontario Ministry of Environment (MOECC NPC119 1983) ground vibration and air blast overpressure limits; and
- Aquatic life ground vibration and air blast overpressure limits guidelines (Wright and Hopky 1998);
- City of Toronto Construction Vibration Limit (ByLaw-514); and
- Human annoyance threshold for impulsive ground vibration (ANZECC 1990); and
- Human threshold of perception for ground vibration (Blasters' Handbook).

The magnitude classification rating at a receptor is based on the following:

- Negligible – predicted level at a receptor is well below the human threshold of perception (Blasters' Handbook 2011) for ground vibration;
- Minor – predicted level at a receptor is equals to or higher than the human threshold of perception for ground vibration;
- Medium – predicted level at a receptor is equals to or higher than the human annoyance threshold for ground vibration and air blast overpressure (ANZECC 1990); and
- Major – predicted level at a receptor is equals to or higher than ground vibration and air blast overpressure limits (MOECC NPC119 for blast vibration effect on human, vibration guideline for aquatic life [Wright and Hopky 1998], City of Toronto limits for construction and transportation ground vibration effect on human).

Table 10.5-19 summarizes the vibration residual effect rating at all the receptors. The magnitude of vibration residual effects at each receptor ranges from negligible to medium.

Table 10.5-19. Vibration Effects Magnitude Classification Rating during Construction and Operation Phase

ID	Receptor Description	Magnitude Classification Rating
1a	Jacko Lake Area #1	Medium
1b	Jacko Lake Area #2	Medium
2	Jacko Lake boat launch area	Medium
3	Urban Growth Boundary	Minor
4	Residence 1	Minor
5	Cell Tower 1	Minor
6	Cell Tower 2	Minor
7	Residence 2	Minor
8	City of Kamloops residences	Minor
9	Elementary Pacific Way School	Minor
10	Residence 3	Minor
11	Site 1	Minor
12	Inks Lake	Minor
13	Residence 3	Minor
14	Site 2	Minor
15	Residence 4	Minor
16	Site 3	Minor
17	Site 4	Minor
18	Python Minifile historic underground	Minor
19	Residence 5	Minor
20	Residence 6	Minor
21	Residence 7	Minor
22	Galaxy historic underground	Minor
23	Royal Inland Hospital	Minor
24	Roadcut Failure Zone (Kamloops)	Negligible
25	Pet Boarding	Negligible
26	Proposed bike trail (Official)	Negligible
27	Wedding event site location	Negligible
28	Surface storage tank 1	Negligible
29	Iron Mask historic underground	Negligible
20	Surface storage tank 2	Negligible
31	Surface storage tank 3	Negligible
TLU1	Kamloops Lake Pump house	Negligible
TLU2	TK'emlups te Secwepemc First Nation Reserve	Negligible
TLU3	Inks Lake	Minor
TLU4	Jacko Creek	Minor

ID	Receptor Description	Magnitude Classification Rating
TLU5	Upper Peterson Creek	Minor
TLU6	Goose Lake Road	Negligible
TLU7	Peterson Creek Discharge	Minor
TLU8	Edith Lake	Negligible
TLU9	Jacko Lake Prayer Tree	Medium

The vibration effects at all receptors are below the structural damage limits established by MOECC NPC119, the aquatic life vibration guideline (Wright and Hopky 1998), or the City of Toronto; therefore, there is no "major" magnitude rating for any of the vibration receptors.

Blast vibration effects during the Construction and Operation phase will be perceptible for some receptors. At locations where the vibration effects exceed the human annoyance threshold; a magnitude classification of "medium" is assigned. These receptors are located in the area east of Jacko Lake, primarily due to close proximity to the blasting or piling activities. At locations where the vibration effects is perceptible but below the human annoyance threshold; a magnitude classification of "minor" is assigned. At further distance from the Project boundary, the vibration effects are not perceptible and the magnitude classification is rated as "negligible". Most of the vibration receptors are in the "negligible" to "minor" classification. The overall magnitude classification of "minor" is assigned for both Construction and Operation phase.

The duration of effects is medium-term for the Construction phase and long-term for the Operation phase. The frequency of vibration residual effects is regular during construction and regular (i.e., up to two blasts per day) during Operation. The residual vibration effects from the Project activities are reversible short-term and will cease once the activities have been completed. The geographic extent of residual effects is regional as the vibration effects are not expected to interact cumulatively with the baseline environment at locations beyond the RSA.

The resiliency is neutral because vibration effects at all receptors are below the well-established vibration guideline and the majority of the population (i.e., City of Kamloops) within the RSA are located at least 3.5 km from the vibration source (i.e., mine pit, plant facilities). At this buffer distance, the vibration effects are unlikely to have a vibration annoyance effect. The ecological context is neutral because the noise effects occur in a stable ecosystem and/or moderately disturbed environment.

10.5.5.4 Significance of Residual Effects

Table 10.5-16 summarizes the significance of residual effects for noise and vibration.

The noise effects have minor magnitude, have regional geographic extent, are long term, and occur continuously. The noise effects may be perceptible by the population but changes in noise levels are not expected to exceed noise limits established by BC OGC, Health Canada, and WHO. The only exception is within an area near the Jacko Lake east end during the short-term (less than 2 months) piling activities at the proposed dam. Noise effects from the Project are considered to be Not Significant (Minor) for both the Construction and Operation phases.

The vibration effects have minor magnitude, have regional geographic extent, are medium to long term, and occur regularly for both Construction and Operation phases. The vibration effects are not expected to exceed the structural damage vibration limit at all receptors. The effects may be perceptible at some receptors but the level will be below the annoyance threshold for all receptor, with the exception of area near the Jacko Lake east end when blasting occurs near the western portion of the pit. Vibration effects from the Project are considered to be Not Significant (Minor) for both Construction and Operation phases.

10.5.5.5 Characterization of Likelihood and Confidence

Table 10.5-16 summarizes the characterization of likelihood and confidence of residual effects for noise and vibration. Likelihood of noise and vibration effects is high as residual effects are expected for the receptors closest to the Project. Based on scientific information, professional judgment, mitigation, and assumptions made, the prediction confidence level for both noise and vibration effects is high.

10.5.5.6 Summary of Residual Effects Assessment and Significance

Table 10.5-20 summarizes the noise and vibration residual effects, mitigation and significance. The significance of change in acoustic and vibration environment is expected to be "Not Significant (minor)".

Table 10.5-20. Summary of Residual Effects, Mitigation, and Significance on Noise and Vibration

Residual Effects	Project Phase	Mitigation Measures	Significance
Change in acoustic environment	Construction and Operation	• Locate noise emission inside gallery, enclosure, or buildings • Reduce haul road distance • Use large haul truck for ore and waste transport • Mobile equipment fitted with exhaust mufflers • Locate plant facilities further from City of Kamloops boundary • Implement the Noise and Vibration Management Plan (Section 11.22)	Not Significant (minor)
Change in vibration environment	Construction and Operation	• Implement blast designs that were based on the threshold at the closest location (i.e., Jacko Lake) • Implement the Noise and Vibration Management Plan (Section 11.22)	Not Significant (minor)

10.5.6 Cumulative Effects Assessment

10.5.6.1 Introduction

The baseline studies quantify the existing acoustic environment for receptors in the LSA and RSA. The existing acoustic environment includes the noise effect from activities other than the Project. The "other" existing noise emission sources that may have cumulative noise and vibration effects with the Project includes industrial activities, commercial and residential activities within the city of Kamloops, aboriginal activities, natural resource extraction and land use, and tourism and recreation activities.

10.5.6.2 Identification of Other Actions that May Affect Noise and Vibration

A list of projects and activities ("Other Human Actions") that were assessed for consideration in the CEA are summarized in Table 10.5-21, and the spatial locations are presented on Figure 5.3-2. The attributes of these projects and activities (location, lifespan, footprint area, etc.) are described in Section 5.3.1. This information was assessed based on the information presented in Section 5.3.2. Projects and activities were screened out of the cumulative effects assessment if there was no spatial or temporal overlap between the assumed residual effects of these other projects and activities and the residual effects of the Ajax Project on the Noise and Vibration VC.

Table 10.5-21. Screening of Other Actions for Inclusion in the CEA for Noise and Vibration

Description	Status or Likelihood	Geographic Boundaries (proximity to Project)	Temporal Boundaries	Common Resources and VCs Affected	Include in CEA (Y/N)
Industry					
New Afton Mine	Active	9 km northwest	RSA		Y
Highland Valley Copper Mine	Active	31 km southwest	RSA		N
Domtar Kamloops Pulp Mill	Active	9 km north	RSA		Y
Tolko-Hefey Creek Plywood and Veneer	Active	19 km north	RSA		N
LaFarge Cement plant	Active	14 km northeast	RSA		N
Kinder Morgan Pipeline	Active	Within mine site	LSA		N
Vidette Lake Mine	Decommissioned 1939	34 km northwest	RSA		N
City of Kamloops					
Municipal discharge	Active	9 km north	RSA		N
Domestic water supply	Active	9 km north	RSA		N
City expansion and growth	Active	3-4 km north	RSA		N
Aboriginal Activities					
Aboriginal land use (including Treaty rights, title, and other land use and resource planning)			RSA		N
Natural Resource Extraction and Land Use					
Kamloops Forest District	Active	Within 4 km	RSA		Y
Agriculture	Active	Immediately adjacent	RSA		Y
Ranching	Active	Within mine site	LSA		Y
Tourism and Commercial Recreation Activities					
Recreational Hunting, Fishing, Foraging	Active	Immediately adjacent	LSA		Y
Lac Le Jeune Resort	Active (check)	19 km south	RSA		N
Tobiano Golf Course	Active	22 km northwest	RSA		N

Description	Status or Likelihood	Geographic Boundaries (proximity to Project)	Temporal Boundaries	Common Resources and VCs Affected	Include in CEA (Y/N)
Transportation					
Kamloops airport	Active	10 km north	RSA		Y
Rail yards and lines (CP and CN)		9 km north	RSA		N
Lac le Jeune Road		3 km west	RSA		Y
Coquihalla Highway		5 km west	RSA		Y

Notes:
Y = noise effects were included in baseline study.
N = noise effects were negligible.

Actions listed in Table 10.5-21 were not explicitly included in the cumulative effects assessment because their effects were either negligible or already captured in the baseline studies, which were already considered in the assessment of Project residual effects. Non-regulated future industrial and commercial activities may have regional or local noise or vibration levels. However, it is not possible to quantify the noise and vibration effects from such actions due to a lack of public information. In addition, quantitative noise limits are not applicable to such activities. Therefore, non-regulated reasonably foreseeable future actions are not included in the cumulative assessment.

10.5.6.3 Interactions between Residual Project Effects and Other Project or Activity Effects

Table 10.5-22 summarizes the cumulative effects interactions matrix for noise and vibration. No cumulative vibration effect interaction is expected from other projects that are located outside the Project vibration RSA. For project activities located within the vibration RSA (i.e., city expansion and growth, agriculture, ranching, recreational activities, Lac le Jeune Road), the vibration effects are expected to be negligible.

Table 10.5-22. Cumulative Effects Interactions Matrix for Noise and Vibration

Other Projects/Residual Effects	Noise	Vibration
City expansion and growth	Y	-
Kamloops Forest District	Y	-
Agriculture	Y	-
Ranching	Y	-
Recreational Hunting, Fishing, Foraging	Y	-
Kamloops airport	Y	-
Lac le Jeune Road	Y	-
Coquihalla Highway	Y	-

10.5.6.4 Proposed Mitigation Measures

No additional mitigation measures are proposed for the CEA.

10.5.6.5 Evaluation of Significance of Residual Cumulative Effects

There are no cumulative noise effects from past physical works and activities because noise effects are reversible. The effects cease after the activities are completed.

The existing cumulative noise effects are characterized by a combination of residential, industrial, and commercial activities, and the natural environment. Section 10.5.2.3 provides information on the existing baseline acoustic environment in the facility RSA. The baseline noise level includes all the existing noise emission activities (i.e., residential, industrial, commercial, and natural environment) in the Project RSA. Cumulative noise effects of these existing noise emission activities are included and quantified in the baseline sound level.

Noise effects from activities located outside the Project RSA are not expected to add cumulatively to residual effects from the Project because the geographic extent for Project residual effects is mostly limited to the facility RSA; noise is expected to attenuate to levels well below the background level outside the RSA.

Table 10.5-23 summarizes the cumulative effects mitigation measures and residual effects on noise and vibration.

Table 10.5-23. Summary of Cumulative Effects Mitigation Measures and Residual Effects on Noise

Ajax Project Activity	Other Human Action	Description of Potential Cumulative Effect	Description of Mitigation Measure(s)	Description of Residual Cumulative Effect
Noise emission	• City expansion and growth • Kamloops Forest District • Agriculture • Ranching • Recreational Hunting, Fishing, Foraging • Kamloops airport • Lac le Jeune Road • Coquihalla Highway	Increase in baseline sound level Increase in baseline vibration level	No mitigation measure for the cumulative effects	Change in acoustic environment, quantified by daytime (L_d), nighttime (L_n), and day-night (L_{dn}) equivalent sound level at receptors

Table 10.5-24 summarizes the characterization of cumulative residual effects, significance, likelihood and confidence on noise. The cumulative residual noise effects are identical to the results presented in the residual noise effects (Section 10.5.5.3). The cumulative noise effects have medium magnitude; have regional geographic extent; are medium to long term; and occur continuously. The noise effects may be perceptible by the population but changes in noise levels are not expected to exceed noise limits established by BC OGC, Health Canada, and WHO. Cumulative noise effects from the Project are considered to be Not Significant (Minor) for both Construction and Operation phases.

There is no cumulative vibration effect; therefore, a significance determination is not applicable.

Table 10.5-24. Characterization of Cumulative Residual Effects, Significance, Likelihood and Confidence on Noise

Cumulative Residual Effect	Residual Effects Characterization Criteria							Significance of Adverse Residual Effects	Likelihood and Confidence	
	Magnitude	Duration	Frequency	Geographic Extent	Reversibility	Resiliency	Context		Probability	Confidence
Change in Acoustic Environment (construction)	Minor	Medium-term	Continuous	Regional	Reversible Short-term	Neutral	Neutral	Not Significant (minor)	High	High
Change in Acoustic Environment (operation)	Minor	Long-term	Continuous	Regional	Reversible Short-term	Neutral	Neutral	Not Significant (minor)	High	High

10.5.7 Conclusion

Noise baseline studies were conducted in 2012 and 2014 to quantify the baseline sound levels at selected locations within the Project RSA through field measurements. The baseline monitoring program included six locations that represented different areas. Two of the locations were in a rural area. Two locations were near the Aberdeen development boundary, representative of a transition area between rural and suburban environments. The final two locations were within the suburban residential community of Aberdeen.

Noise effects from the Construction and Operation phases of the Project are predicted to comply with the BC OGC noise guideline, WHO and Health Canada noise guidance. The only exception is in the area near the east end of Jacko Lake where noise effects from the daytime piling activities (less than two months) for the proposed dam construction is higher than the annoyance threshold recommended by Health Canada. Noise models were used to predict the magnitude of noise levels at various receptor locations to determine noise effects. Project activities during Construction and Operation will result in negligible to medium magnitudes of residual effects, with the exception of the east end of Jacko Lake mentioned above. However, it is predicted that negligible to minor noise levels will be generated for the majority of the population. These residual effects will occur continuously during the Project Construction and Operation phases but are considered reversible after the Closure and Reclamation phase is complete and Project activities cease. The significance of Project noise residual effects is expected to be "Not Significant (minor)". The cumulative noise effect assessment of other non-Project activities were captured in the baseline studies, which was considered in the assessment of Project residual effects. Therefore, the significance of change in cumulative noise residual effects is expected to be "Not Significant (minor)" during the Construction and Operation phases. The noise effects during the Closure and Reclamation phase is expected to be lower than that for the Construction phase.

The vibration effects at all receptors are below the structural damage limits established by MOECC NPC119, the aquatic life vibration guideline (Wright and Hopky 1998), and the City of Toronto Construction Vibration Bylaw; therefore, no "major"magnitude ratings were assigned for any of the vibration receptors. Blast vibration effects during the Construction and Operation phase will be perceptible for some receptors. At locations where the vibration effects exceed the human annoyance threshold; a magnitude classification of "medium" is assigned. The only area with a medium rating is located immediately east of Jacko Lake, primarily due to close proximity to the blasting activities. However, it is predicted that Project will result in negligible (not perceptible) to minor (perceptible but below annoyance thresholds) vibration effects for the majority of the population. The overall magnitude classification of "minor" is assigned for both Construction and Operation phase. These residual effects will occur regularly during the Project Construction phase and regularly during the Operation phase. Residual effects will be reversible after the Closure and Reclamation phase. The significance of the Project vibration effect is expected to be "Not Significant (minor)" during the Construction and Operation phases. No cumulative vibration effects interaction is expected from other non-Project activities. The vibration effect during the Closure and Reclamation phase is expected to be lower than that for the Construction phase.

This conclusion has been determined with a high level of confidence based on conservative assumptions used in modelling and professional judgment.

Table 10.5-25 summarizes the Project and Cumulative residual effects, mitigation and significance for noise and vibration.

Table 10.5-25. Summary of Project and Cumulative Residual Effects, Mitigation, and Significance for Noise and Vibration

Residual Effects	Project Phase	Mitigation Measures	Residual Effect Significance	Residual Cumulative Effect Significance
Noise	Construction and Operation	Locate noise emission inside gallery, enclosure, or buildings. Reduce haul road distance. Use large haul truck for ore and waste transport. Mobile equipment fitted with exhaust mufflers. Locate plant facilities further from City of Kamloops boundary. Implement the Noise and Vibration Management Plan (Section 11.22).	Not Significant (minor)	Not Significant (minor)
Vibration	Construction and Operation	Implement blast designs that were based on the damage threshold at the closest location (i.e., Jacko Lake). Implement the Noise and Vibration Management Plan (Section 11.22).	Not Significant (minor)	Not Applicable

10.6 HEALTHY LIVING AND HEALTH EDUCATION

Broadly defined, "healthy living" is the inter-related undertaken practices that support, improve, maintain, and/or enhance health. In particular, the Public Health Agency of Canada (2012b) concentrates on healthy eating, physical activity, and maintaining a healthy weight as the critical components for leading a healthy life. The assessment of effects to Healthy Living and Health Education is complementary and adjacent to a discussion of effects to community health and well-being, which includes a discussion of access to medical care and other social determinants of health. Section 10.7 of the Application/EIS discusses effects to community health and well-being. This assessment is also related to the assessment of potential effects on Outdoor Recreation (Section 8.6).

10.6.1 Rationale

This section includes a description of the scoping process used to identify Healthy Living and Health Education for inclusion in the assessment. Scoping is fundamental to focusing the Application for an Environmental Assessment Certificate/Environmental Impact Statement for a Comprehensive Study (Application/EIS) on those issues where there is the greatest potential to cause significant adverse effects. Valued components (VCs) are components of the natural and human environment that are considered to be of scientific, ecological, economic, social, cultural, or heritage importance (CEAA 2006; EAO 2013). To be included in the effects assessment, there must be a perceived likelihood that the VC will be affected by the Project. Valued components are scoped into the environmental assessment based on issues raised during consultation with Aboriginal Groups, government agencies, the public, and stakeholders. Consideration of certain VCs may also be a legislated requirement, or known to be a concern because of previous project experience. Table 10.6-1 summarizes the rationale for including Healthy Living and Health Education in the Application/EIS.

Table 10.6-1. Rationale for Including Healthy Living and Health Education as a Valued Component

Valued Component	Identified by*				Rationale for Inclusion
	AG	G	P/S	SK	
Healthy Living and Health Education	X	X	X	X	Residents of the City of Kamloops have expressed concern about Project effects on pursuing a healthy lifestyle as recreational opportunities are an important aspect of community image. In addition, assessing workplace wellness programs has been standard practice in BC.

**AG = Aboriginal Group; G = Guideline Requirement; P/S = Public/Stakeholder; SK = Scientific/Professional Knowledge.*

The City of Kamloops (Kamloops), in its vision of sustainability, sees itself as a future leader in health living initiatives. In connection with health, the air quality will be good, residents will have access to drinking water, and resident engagement in recreational activities will increase (City of Kamloops 2010). Residents perceive the "availability of green spaces and services for recreation and enjoyment" as one of the City's primary strengths (Ipsos Reid 2012) and residents would like to see additional facilities for outdoor recreation (Andersen et al., pers. comm. 2015).

The assessment of effects to Healthy Living and Health Education is largely related to Project effects assessed in other VCs, in particular to Infrastructure, Public Facilities, and Services (educational and recreational services) discussed in Section 8.1; and to Outdoor Recreation (recreational activities, including hunting and fishing) discussed in Section 8.6 (Figure 10.6-1).

10.6.2 Background

10.6.2.1 Regional Overview

The Project is located within the Thompson Nicola Regional District (TNRD), an area in the British Columbia interior that includes both urban and rural landscapes. In the TNRD, Kamloops is not only the community closest to the Project, but also the major population centre in the region. Table 10.6-2 presents the total population for Kamloops and the TNRD from 2001 to 2011. The data demonstrate that the population in Kamloops and the TNRD have been increasing consistently during this period.

Table 10.6-2. Total Population for the TNRD, 1996, 2001, 2006, 2011

	1996	2001	2006	2011	Percent Change from 2006 to 2011
Kamloops	76,394	77,281	80,376	85,678	6.6
TNRD	118,801	119,222	122,286	128,473	5.1

Source: Statistics Canada 1997, 2002, 2007, 2013.

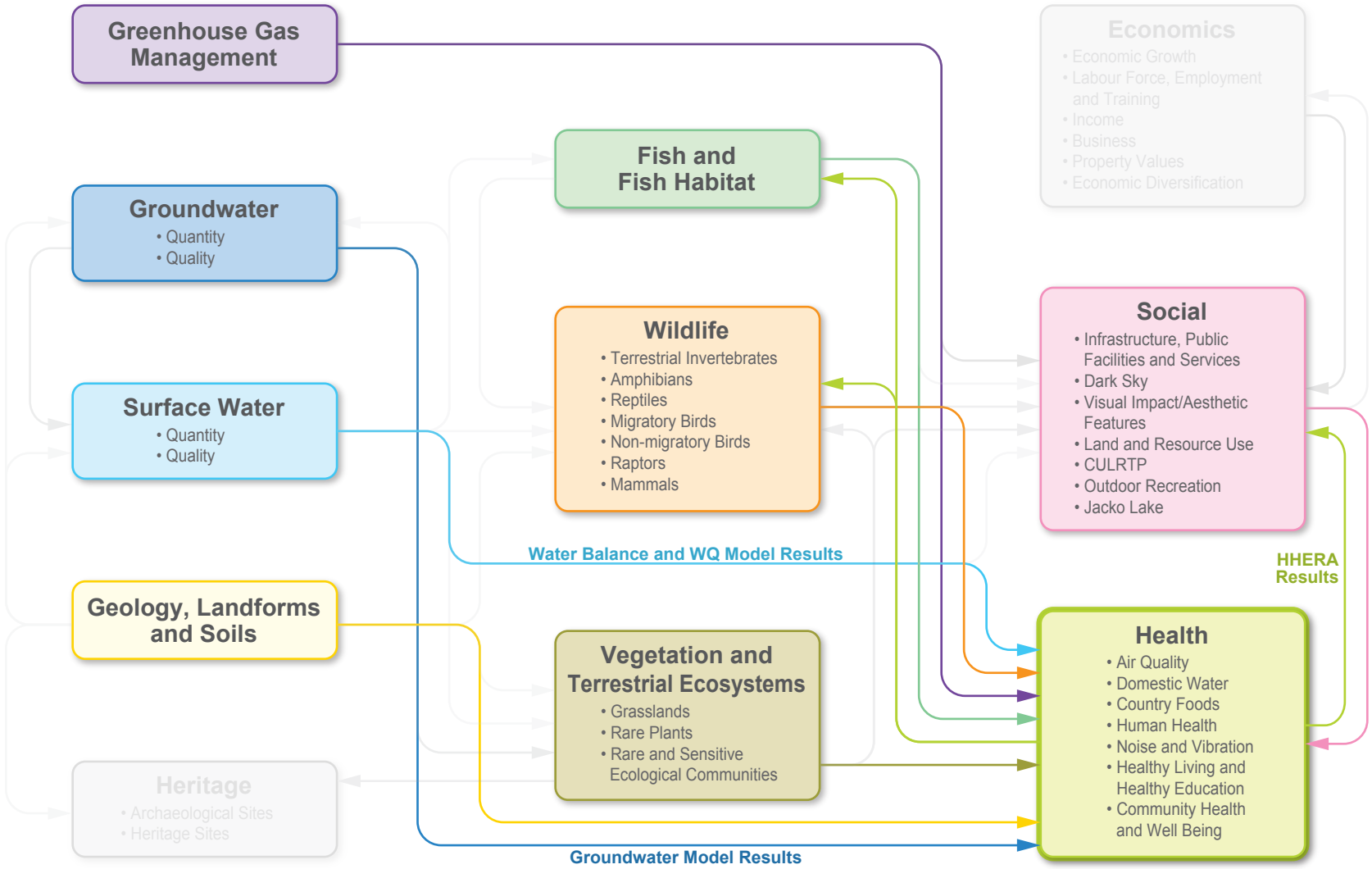
10.6.2.2 Historical Activities

The region surrounding the Project has a long history of human activity that contributes to the current baseline condition, which is defined more specifically in the following section of this assessment.

Following the completion of the transcontinental railroad in 1885 the population around the City of Kamloops grew rapidly, approaching about 500 people by the turn of the 20th century. During this time, the City was incorporated and established a public works system. Key economic drivers included the timber industry and agriculture (vegetables and orchards). The City's population grew steadily with the exception of two periods; during the Depression and after the Second World War. After this period, the City began to grow again, and much of the land that had formerly been used for agricultural purposes in the valley was used for residential development. Ranching (including cattle grazing) also developed, and is currently ongoing immediately within and adjacent to the Project. Mining activities have also served as a key economic driver since the early 1900s.

Recreational opportunities within and outside of the City have developed over time. These opportunities are important to residents of Kamloops, including those who pursue recreation in relatively close proximity to the Mine Site. The Project area and immediate surroundings are a popular area for outdoor enthusiasts including anglers, mountain bikers, hikers, birdwatchers, orienteering groups, and others. These activities take place on both Crown and private lands where permission from landowners (e.g., ranchers) may be required.

Figure 10.6-1
Inputs to Health Valued Components



The Project is located in the traditional territories of the Stk'emlupsemc te Secwépemc Nation (SSN) – comprised of the Tk'emlúps te Secwépemc (TteS) and Skeetchestn Indian Band (SIB) – and the Nlaka'pamux Nation, whose member groups include the Lower Nicola Indian Band (LNIB) and Ashcroft Indian Band (AIB). Section 12 and Section 8.5 of the Application/EIS provide a full description of these interests, as well as historical and current land uses by Aboriginal Groups. The SSN has a long history of using the area for resource harvesting activities, including hunting, fishing, and plant gathering. Jacko Lake, which is free of ice earlier in the season than many lakes in the area, played an important part in the SSN's seasonal round as it was one of the first locations where fish, an important source of protein, could be harvested. The area around Jacko Lake was traditionally an important place for gathering traditional plants. Over the past decades, as land use in the area has shifted toward agricultural activities, mining, and urbanization, SSN members have noted that their use of the lands around the Project has gradually diminished. Despite fencing and gates that have been put into place, SSN members continue to use the area. Some members note that they request permission from current landowners, including ranchers, to hunt on private property.

10.6.2.3 Baseline Studies

Baseline studies occurred from 2011 through to 2015 using the study areas described in Section 10.6.3.1. The baseline studies sought to understand local and regional health education programs and local and regional health, recreation, and fitness levels required by the Application Information Requirements/Environmental Impact Statement Guidelines (AIR/EIS Guidelines). In addition, these studies provide a baseline from which potential changes from the Project could be measured. More detailed baseline findings are contained in the Ajax Project Socio-economic Baseline (Appendix 7.1-A).

Data Sources

The baseline studies for Healthy Living and Health Education were based on a combination of primary and secondary sources. Primary sources included interviews, which were conducted between 2011 and 2015. Interviewees included representatives from the City of Kamloops and social service providers. Secondary sources include a variety of available sources, including:

- Statistics on health behaviours from Statistics Canada;
- Municipal documents, including community plans for Kamloops;
- Publicly available documents from Aboriginal Groups, including websites and annual reports; and
- The Cultural Heritage Study (Ignace 2014).

Where quantitative data were available, they were included, but data sets are not always available at the community level.

Consultation activities undertaken with the Aboriginal Groups during the Pre-Application period included capacity building and funding, TK/TLU studies, community meetings, site tours, and meetings with Aboriginal Group representatives (see Section 4.3). Multiple attempts have been made to engage each Aboriginal Group to seek the baseline data required for the Application/EIS including the circulation of baseline documentation for review and comment. The information

gathered through this engagement has been incorporated in the Application/EIS and considered in the assessments. In some cases, the requested information was not available from Aboriginal Groups at the time of writing or from secondary sources. Where appropriate, additional information made available by Aboriginal Groups will be considered in Project development plans.

Methods

The approach to understanding baseline conditions was to use a combination of literature sources, complemented by the insights and experience of residents in the Local Study Area (LSA) and Regional Study Area (RSA) with knowledge about recreational activities and community health in the LSA.

Characterization of Health Living and Health Education Baseline Conditions

Healthy Living

Healthy living as a government priority is explained in the Integrated Pan-Canadian Healthy Living Strategy, which was agreed upon by the Federal, Provincial, and Territorial governments (excluding Québec) in 2005. The strategy asserts that more than two-thirds of deaths in Canada each year are a result of four groups of chronic illnesses (cardiovascular diseases, cancer, type 2 diabetes, and respiratory diseases) that share preventable risk factors (physical inactivity, unhealthy diet, and tobacco use) and environmental, or non-medical, determinants that include income, employment, and education (The Secretariat for the Intersectoral Healthy Living Network et al. 2005).

Healthy living is affected not only by available opportunities to make healthy choices, but also an individual's willingness and ability to take advantage of those opportunities. According to the Public Health Agency of Canada (2012a), personal health practices are actions an individual uses to, among other things, prevent disease, promote self-care, and enhance health. Among the indicators listed as relevant health practices were smoking, engaging in high-risk behaviour, and diet. This section will describe indicators for dietary practices, smoking, alcohol consumption, and physical activity.

According to the First Nations Health Authority, BC Ministry of Health, and Health Canada (2012), "To live in wellness means striving to be in balance, within self (Body, Mind, Spirit, and Emotion), with others (Family and Community), with the Spirit World and with the land (nature). If there is an imbalance in any of these areas there is stress on our overall system. In time this stress causes illness and it can be physical illness, mental/emotional illness (such as depression), or spiritual illness." This idea of balance is at the core of Aboriginal worldviews and ways of life, which traditionally are embodied in ways specific to each Aboriginal Group.

Health Service Delivery

The Interior Health Authority (IHA) is responsible for administering health care services in the communities in the TNRD. Kamloops is located in the Kamloops Local Health Area (LHA), which is part of the IHA. The LSA also includes the North Thompson LHA. Both LHAs are in the Thompson Cariboo Health Service Delivery Area (HSDA). Figure 10.6-2 shows the health authority boundaries that affect health care services in Kamloops and the TNRD. In British Columbia (BC,) health services and benefits that had been administered by the federal government are now administered by the

First Nations Health Authority, which assumed responsibility in October 2013 (FHNA 2013). The Q'wemtsin Health Society (QHS) provides health care services on-reserve to TteS and SIB members.

Health Behaviour Statistics

Table 10.6-3 presents a general view of health behaviour statistics for the Thompson Cariboo Shuswap HSDA and British Columbia; data are not available for the Local Health Areas (LHAs).

Physical Activity

Engaging in physical activity during one's leisure time has increased in the Thompson Cariboo Shuswap HSDA between 2007 and 2011 from 53.8% to 64% for all residents aged 12 and older. While this rate has been increasing, the percentage of youth aged 12 to 19 engaging in moderately active or active activities in their leisure time has decreased from a high of 89.2% in 2009 to 58.6% in 2011. The downward trend differs from the general trend in British Columbia where the rate has remained relatively stable above 72% (Statistics Canada 2012b).

The BC Atlas of Wellness (Foster et al., 2011) also provides information about the physical activity levels that Thompson Cariboo Shuswap residents engaged in, in the past three months – walking, gardening, swimming, and cycling in 2007/08. Overall, residents of the HSDA had a higher percentage of its population engaging in these activities than in the Province. Additionally, the difference was greatest for doing gardening and yard work in the past 3 months; 42.76% of the population engaged in these activities in British Columbia, while 60.06% of the population in the HSDA engaged in these activities during the same period.

According to representatives from the City of Kamloops (Andersen et al. pers. comm. 2014), walking/hiking is the number one activity in the LSA. The Peterson Creek trail system is well-used, as is Coal Hill and Kenna Cartwright Park (Figure 10.6-3 and 10.6-4). Other popular recreational activities include angling at Jacko Lake, which is within the General Arrangement and a short drive away from Kamloops, and mountain biking. Kamloops has the Kamloops Bike Ranch, which is managed by the crew of the Kamloops Performance Cycling Centre, with the City providing funding (Andersen et al., pers comm. 2014; Kamloops Bike Riders Association n.d.). Usage of the bike ranch has been increasing, especially as the Kamloops Bike Riders Association has taken over stewardship and promotion of the ranch (Andersen et al., pers comm. 2014). Other activities are discussed in Section 8.6.2.3 in Outdoor Recreation and more detailed information can be found in Appendix 7.1-A.

Healthy Eating

Healthy eating as defined in Table 10.6-3 is the percentage of the population aged 12 and older who eat vegetables and fruits five or more times per day. The percentage has fluctuated between 2007 and 2014, with a high of 48.4% in 2009 and a low of 34.1% in 2011. Except for in 2009, the percentage of HSDA residents eating vegetables or fruits five or more times per day was lower than in the province as a whole. In British Columbia, the rate fluctuated between a high of 45.7% in 2009 and a low of 39.7% in 2014.

Figure 10.6-2
Health Authority Boundaries

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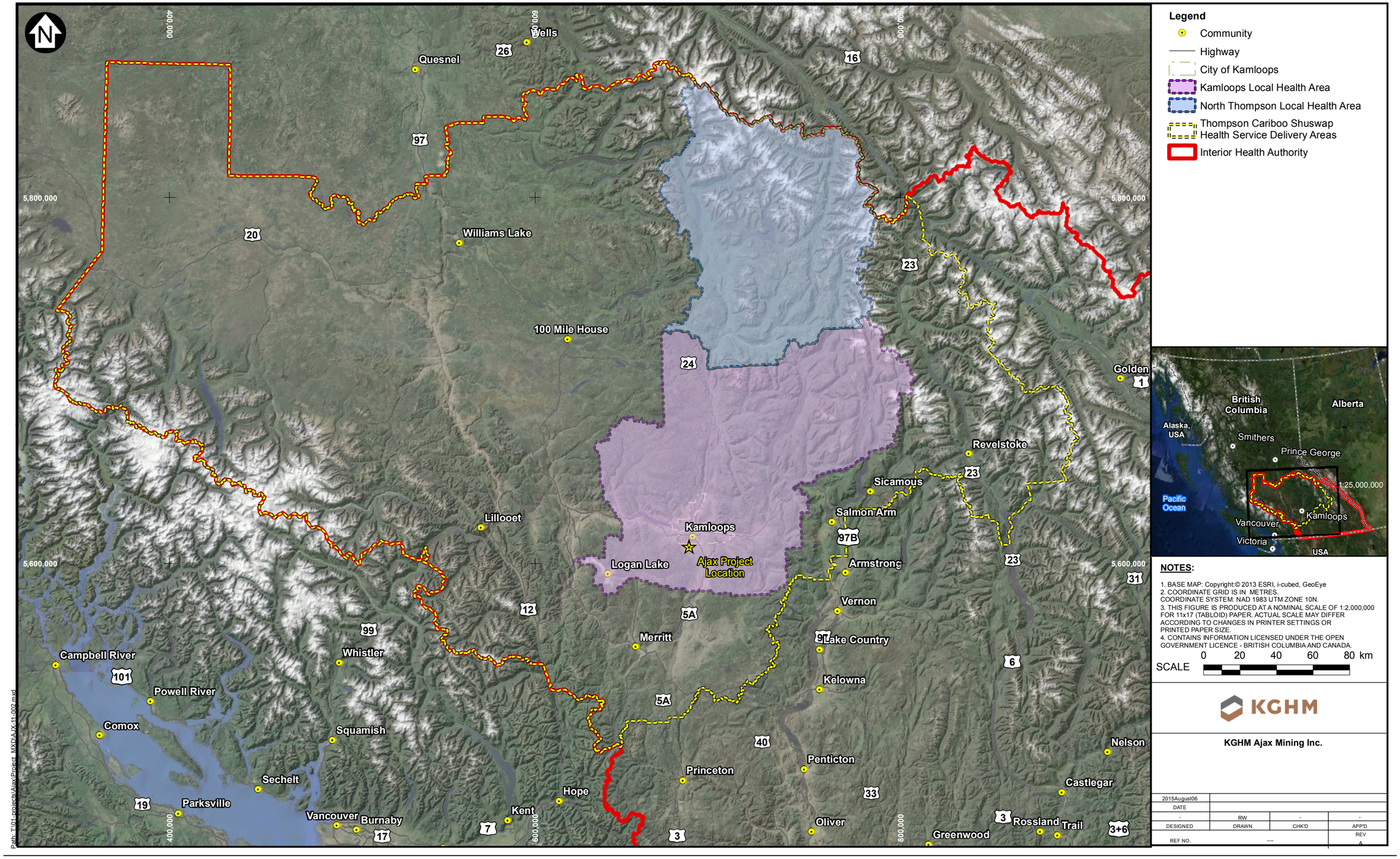

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Figure 10.6-3
Kamloops City Parks and Recreational Facilities

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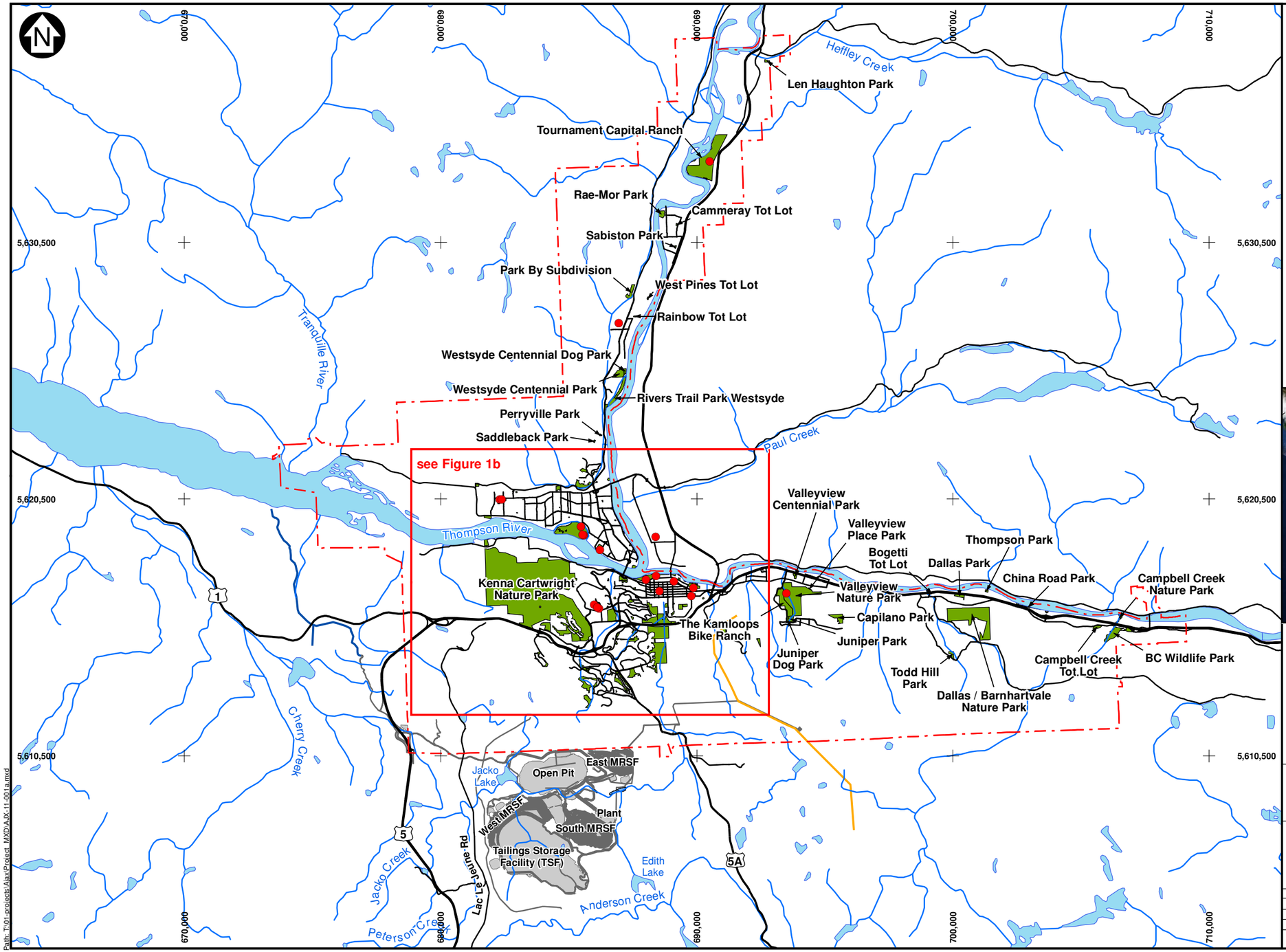

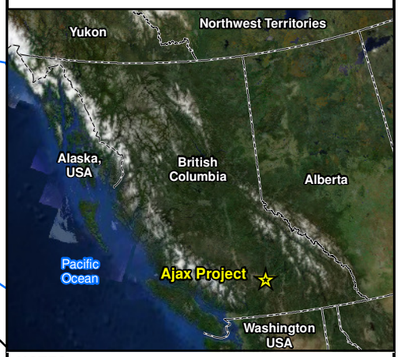

Legend

- City of Kamloops
- Highway
- Paved Road
- Existing Powerline
- Existing Waterline
- Proposed Structures
- Park / Community Garden / Cemetery
- Tournament Capital Facility

NOTES:

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Figure 10.6-4
Kamloops City Parks and Recreational Facilities (Detail)

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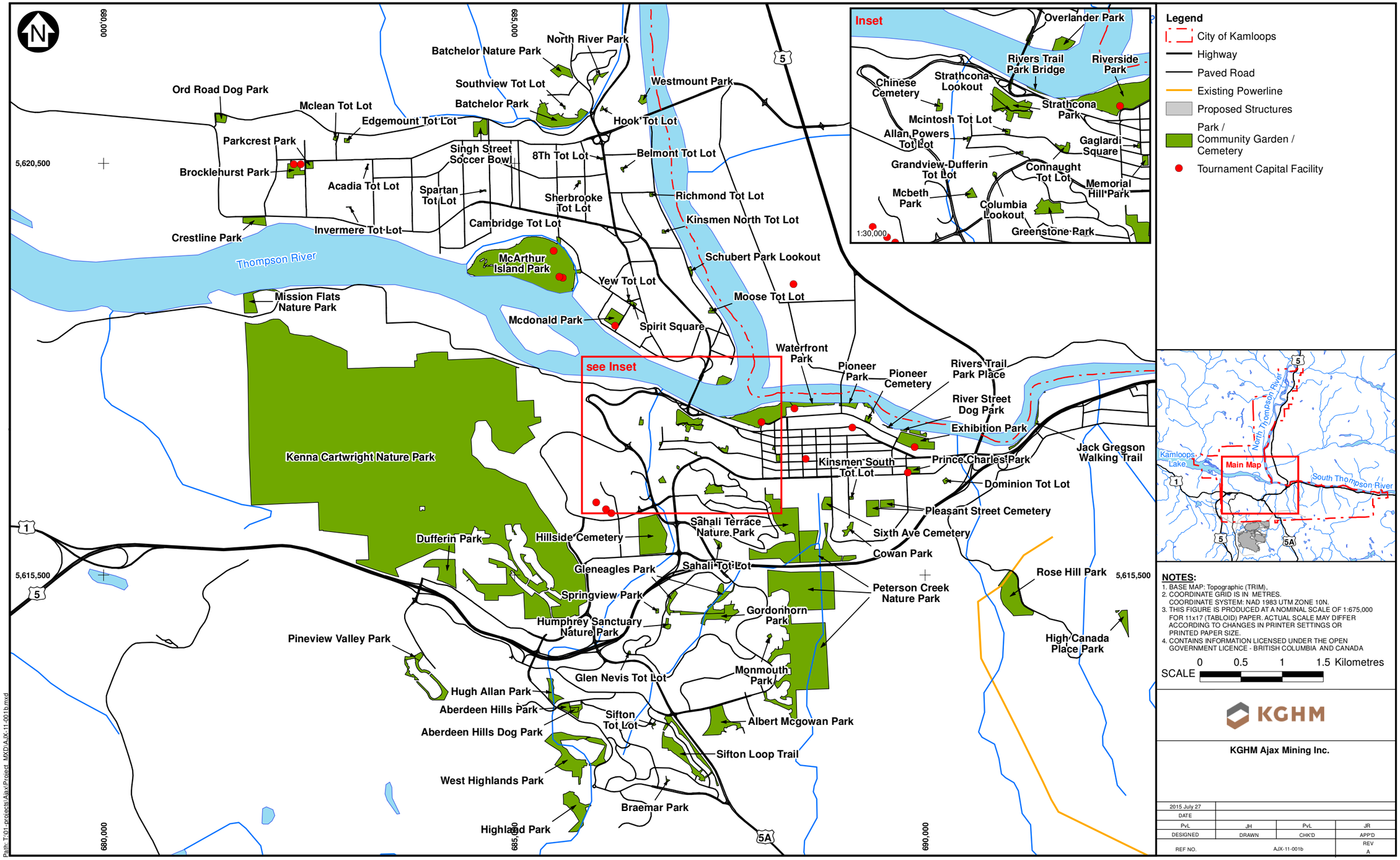

Table 10.6-3. Health Behaviour Statistics for Thompson-Cariboo-Shuswap Health Service Delivery Area and British Columbia, (2007-2014)

Year	Jurisdiction	Leisure Time Physical Activity[1]	Percentage of youth (12-19) active / moderately active	Healthy Eating[2]	Tobacco Use[3]	Overweight/ Obesity[4]	Alcohol Consumption[5]
2007	Thompson Cariboo Shuswap HSDA	53.8%	77.9%	40.9%	27.3%	51.8%	15.3%
	BC	56.7%	73.5%	44.4%	17.8%	43.9%	14.4%
2008	Thompson Cariboo Shuswap HSDA	51.2%	82.7%	37.1%	22.7%	58.5%	19.7%
	BC	58.7%	72.9%	42.4%	18.6%	45.1%	15.5%
2009	Thompson Cariboo Shuswap HSDA	65.9%	89.2%	48.4%	21.6%	52.0%	22.7%
	BC	60.3%	75.9%	45.7%	16.0%	45.1%	16.1%
2010	Thompson Cariboo Shuswap HSDA	63.2%	72.6%	37.4%	21.7%	55.2%	22.7%
	BC	58.3%	75.3%	42.3%	17.4%	44.4%	15.7%
2011	Thompson Cariboo Shuswap HSDA	64.0%	58.6%	34.1%	21.3%	56.9%	16.6%
	BC	59.6%	72.9%	40.7%	15.8%	46.6%	16.6%
2012	Thompson Cariboo Shuswap HSDA	65.1%	n/a	46.9%	25.6%	53.7%	17.9%
	BC	61.3%	n/a	42.1%	14.5%	46.5%	16.1%
2013	Thompson Cariboo Shuswap HSDA	62.1%	n/a	43.1%	22.2%	55.3%	19%
	BC	64.0%	n/a	40.7%	16.2%	46.9%	17.4%
2014	Thompson Cariboo Shuswap HSDA	65.6%	n/a	46.9%	20.8%	51.7%	18.8%
	BC	61.7%	n/a	39.7%	14.3%	48.0%	15.8%

Source: IHA 2010a, 2010b, Statistics Canada 2012b; Statistics Canada 2015.

Notes:

[1] Leisure time physical activity calculated as percentage of population 12 and over who are active or moderately active.

[2] Healthy eating is a measure of the percentage of the population 12 and over who eat vegetables and fruits 5 or more times per day.

[3] Tobacco use is a measure of the percentage of the population 12 and over who are daily or occasional smokers.

[4] Overweight/obesity is a measure of the percentage of the population 18 and over who are overweight or obese.

[5] 5 or more drinks on one occasion, at least once a month in the past year, percentage of the population 12 and over. In 2013, Statistics Canada terminated the previous question and, "A definition change was implemented in 2013 to conform with the World Health Organization (WHO) and Health Canada guidelines for Heavy drinking. Heavy drinking refers to males who reported having 5 or more drinks, or women who reported having 4 or more drinks, on one occasion, at least once a month in the past year. While this indicator remains comparable for males to the 5 or more drinks indicator published in previous years, it is no longer comparable for females."

Food security in the HSDA is considered to be good overall, based on the fact that 92.5% of households in the region were always able to afford balanced meals over the 12 months of study in 2007/08 (Foster et al. 2011). This percentage was approximately 1.5% lower than the provincial rate.

SSN members rely on traditional foods for a portion of their diet, which includes fish, game, and plants. Section 8.5 (Current Use of Lands and Resources for Traditional Purposes) describes the geographic extent of harvesting activities for the TteS and SIB, including locations outside the LSA.

Smoking

While British Columbia has the lowest tobacco smoking rates in Canada, smoking and coming into contact with second- and third-hand smoke are still key to causing chronic diseases, such as hypertension and emphysema, and premature death (Foster et al. 2011). It is also important to recognize that tobacco-related morbidity and mortality affect not only smokers themselves, but also non-smokers who come into contact with smoking by-products.

Since 2007, the percentage of smokers in the HSDA has decreased from 27.3% to 21.3% (Table 10.6-3). The decreasing rate of smokers in the HSDA is the same as the trend in the Province (Statistics Canada 2012b). While both regions have decreasing rates of smoking rates, the HSDA still has a higher percentage of its population reporting as daily and occasional smokers than in British Columbia (Statistics Canada 2012b).

The Ajax Project Socio-economic Baseline (Appendix 7.1-A) contains detailed data on morbidity and mortality rates attributable to tobacco.

Overweight/Obesity

In the Thompson Cariboo Shuswap HSDA, the rate of residents aged 18 and older reporting a body mass index that fell into the overweight or obese categories has been increasing. In 2007, the rate was 51.8% of the population. In 2011, the rate had increased by slightly more than 5 percentage points to 56.9%. During the same period of time, the rate increased by less than three percentage points from 43.9% to 46.6% in the Province.

Alcohol Consumption

Alcohol consumption levels depicted in Table 10.6-3 are considered to be for the population 12 and older who consume five or more drinks on one occasion at least once a month over the past year. Alcohol consumption in the Thompson Cariboo Shuswap HSDA has fluctuated between 2007 and 2011, increasing between 2007 and 2010 and then showing a decline by 2011. Provincial percentages show a similar pattern. Thompson Caribou Shuswap HSDA levels are consistently higher than the province except for 2011 where percentages are the same.

Health-Related Programs

One aspect of public health is educating the general populace in hopes that they adopt practices that enhance health and wellness and prevent disease. Through the municipal government, provincial government, public school system, and health authority, residents of Kamloops are exposed to a range of public health initiatives to help them improve, maintain, and/or enhance their health and well-being.

The list below provides a sample of supports and services related to healthy living that are offered through a variety of providers, including the IHA, the provincial government, and Kamloops:

- **Public Health Centres:** The IHA has public health centres throughout the health authority that offer a range of services. There are two in Kamloops – the Kamloops Downtown Health Centre and the Kamloops Public Health Services. The centres offer a range of programs and services to, among other things, promote prenatal and maternal health, support independent living for community residents, monitor air quality concerns, and foster healthy eating habits (IHA 2012).
- **Healthy Families BC:** This initiative began in 2011 to improve the health and well-being of British Columbians and their communities. It is focused on supporting proper nutrition, personal responsibility, investing in healthy lifestyles, and helping vulnerable families provide a healthy start for their children. The initiative includes a blog with daily posts about healthy living; a program to connect British Columbians that have an interest in improving their healthy lifestyles with their family doctors; a program to help residents make informed decisions when dining out; and an array of online tools (Healthy Families BC 2012).
- **Community Food Action Initiative:** Food security is an issue that has been addressed in Kamloops municipal planning documents. The IHA, the City of Kamloops, and the Kamloops Food Policy Council authored the Community Food Action Initiative in 2006 with the goal of increasing the capacity of municipal stakeholders to support food security practices and policy around the municipality. One goal of the initiative is to encourage policies and practices that promote nutrition and healthy eating. The City of Kamloops is currently also in the process of developing a food and urban agriculture plan (C. Mazzotta, pers. comm. 2015).
- **Affordable Recreation for Community Health:** The City of Kamloops supports a number of organizations and activities aimed at promoting recreation. Affordable Recreation for Community Health (ARCH) is a subsidy program for residents with limited incomes to participate in a variety of recreational activities (ARCH 2012a).

SSN members also have access to a range of programs that promote health and wellness through the Band and the First Nations Health Authority Programs include:

- The TteS have a Social Development Department, which develops, manages, and delivers health and wellness programs. These programs include cultural teaching, family support, and sports and recreation (TteS 2015a).
- The Youth, Sports, and Recreation team for the TteS provides a variety of recreational activities, including summer day camps for TteS youth and arrange for fitness classes for the community. The team seeks to increase member access to healthy activities and information (TteS 2015b).

Health-related School Curriculum

Besides public health initiatives aimed at the general populace or specific segments of the population, students from kindergarten to grade 12 receive health-related education through the

provincial curriculum. It should be noted that the provincial curriculum below applies only to provincially funded schools. Federally funded schools, which include on-reserve schools, and private schools may have different curricula, although the Sk'elep School for Excellence on the TteS reserve follows the provincial curriculum in all subject areas for grades 5 to 7 (Kamloops Indian Band Department of Education 2015).

The BC Ministry of Education's curriculum changes as students' progress, but builds on the previous years' curriculum. The discrete stages include:

- Daily Physical Activity Kindergarten to Grade 12, which requires students to engage in either 30 minutes daily or 150 minutes weekly of physical activity (British Columbia Ministry of Education 2011).
- Health and Career Education Kindergarten to 7 and Health and Career Education 8 and 9, organizes the curriculum around the following four topics:
  - *Healthy Living*, which promotes physical and emotional health and also includes course content on puberty and reproduction;
  - *Healthy Relationships*, which focuses on developing interpersonal skills and recognizing problems like bullying and discrimination;
  - *Safety and Injury Prevention*, which teaches students how to recognize and avoid unsafe situations in all areas of their lives; and
  - *Substance Misuse Prevention*, which explores the ramifications of substance abuse (BC Ministry of Education 2006).
- *Graduation Transitions,* the goal of which is to have students who can be healthy individuals by engaging in regular exercise, developing a long-term healthy living plan, and by making positive health-related choices (BC Ministry of Education 2008).

In addition to implementing provincial curriculum, School District 73 has adopted the Action Schools BC model that is associated with ActNow BC to promote comprehensive health. Among the programs included are:

- Extra-Curricular Athletics, in which 44.8% of secondary students participated during the 2010-11 school year; and
- See It, Try It, Do It Afternoons, which are aimed at higher needs schools to provide free after-school workshops that teach students skills that support healthy living. In collaboration with this program, the City of Kamloops then offers a related program at below cost at the students' home school (School District No. 73 2013).

Additionally, the school district offers health and wellness programs for staff in association with the Kamloops Thompson Teachers' Association, the Canadian Union of Public Employees, and the Kamloops/Thompson Principals and Vice Principals' Association (School District No. 73 2012).

The TteS have the Little Fawn Nursery, which provides health and nutrition programing, including dental health, hygiene, and eating well (TteS 2015c).

10.6.3 Assessment Boundaries

Assessment boundaries define the maximum limit within which the effects assessment is conducted. They encompass the areas within, and times during which, the Project is expected to interact with the VCs, as well as the constraints that may be placed on the assessment of those interactions due to political, social, and economic realities (administrative boundaries), and limitations in predicting or measuring changes (technical boundaries). The definition of these assessment boundaries is an integral part in scoping for Healthy Living and Health Education, and encompasses possible direct, indirect, and induced effects of the Project on Healthy Living and Health Education, as well as the trends in processes that may be relevant.

10.6.3.1 Spatial Boundaries

Local Study Area

The Project's interactions with the Healthy Living and Health Education VC are geographically tied to outdoor recreation in the vicinity of the Project. Residents of Kamloops have identified outdoor recreation as the primary activity that promotes healthy living through outdoor physical activity. For this reason, outdoor recreation as a source of opportunities to engage in healthy living was the focus of the assessment. Although other activities (e.g. indoor exercise, healthy eating, lifestyle habits) also contribute to healthy living, the Project is not expected to adversely affect these activities. Indoor recreational facilities such as pools, gyms, and recreational centres have the capacity to accommodate population growth (estimates of the Project's local and non-local workforce are provided in Section 7.2, Labour Force, Employment and Training). The Project may also positively influence health through health education opportunities for the workforce, based at the Mine Site.

As such, the assessment of potential effects on Healthy Living and Health Education shares its LSA with the Outdoor Recreation VC (Section 8.6). The LSA (Figure 10.6-5) is bounded by Highway 5 in the west and Highway 5A in the east to encompass sites where physical activity occurs nearest the Project (e.g., Inks Lake, Jacko Lake, Goose Lake Road, Coal Hill). The northern and southern boundaries of the LSA utilise the boundaries defined by the Visual Impacts VC (Section 8.3) as these are the distances at which someone could clearly see large Project components, which could affect the enjoyment of outdoor recreational activities. This study area also encompasses much of the LSAs for Air Quality and Noise and Vibration, each of which may also influence the Healthy Living and Health Education VCs. The Mine Site is contained within the LSA.

Regional Study Area

The RSA for the Healthy Living and Health Education VC (Figure 10.6-6) also mirrors the RSA for the Outdoor Recreation VC. Areas to the west and north include additional locations for physical activity that could be affected by the Project. These include Chuwels Mountain, Greenstone Mountain, and municipal parks in Kamloops (e.g., Kenna Cartwright Park).

10.6.3.1 Temporal Boundaries

The assessment of potential Project effects on Healthy Living and Health Education will encompass four phases of the Project as stipulated in the AIR/EIS Guidelines: Construction, Operations,

Decommissioning and Closure, and Post Closure. The duration of each phase considered in the assessment is given below:

- **Construction**: 2 years;
- **Operation**: 23 years;
- **Decommissioning and Closure**: 5 years (includes project decommissioning, abandonment and reclamation activities, as well as temporary closure, and care and maintenance); and
- **Post Closure**: 5+ years (includes ongoing reclamation activities and post-closure monitoring).

10.6.3.2 Administrative Boundaries

There are several sets of administrative boundaries affecting the assessment of potential Project effects on Healthy Living and Health Education. The administrative boundaries are the municipal boundary of the City of Kamloops (Figure 10.6-2); health service boundaries (Figure 10.6-2) as they dictate the provision of healthcare services for the LSA and RSA and are used by Statistics Canada for reporting health behaviour data (Section 10.6.3.2); and the boundaries of the populated Indian reserves (IRs) of the TteS (Kamloops IR 1) and SIB (Skeetchestn IR) as health care services for members who live on-reserve is under the jurisdiction of the First Nations Health Authority. Health care on-reserve is provided by the QHS.

10.6.3.3 Technical Boundaries

Technical boundaries did not influence the scoping of the assessment on Healthy Living and Health Education.

10.6.4 Potential Effects of the Project and Proposed Mitigation for Healthy Living and Health Education

10.6.4.1 Identifying Potential Effects on Healthy Living and Health Education

This VC, as defined by the AIR/EIS Guidelines, addresses two distinct aspects of health:

- **Healthy Living** considers how outdoor physical activities may be affected by the Project. These activities may be adversely affected by the physical presence of the Project as well as through changes to air quality, noise, visual quality (i.e. views) and other effects. Potential effects on Healthy Living are described below, and further assessed in Section 10.6.4.2.

- **Health Education** considers the information and education programs that encourage healthy living lifestyles for workers employed at the Project. This beneficial effect is described below. Since it is a benefit, effects on Health Education are not assessed further.

Figure 10.6-5
Local Study Area

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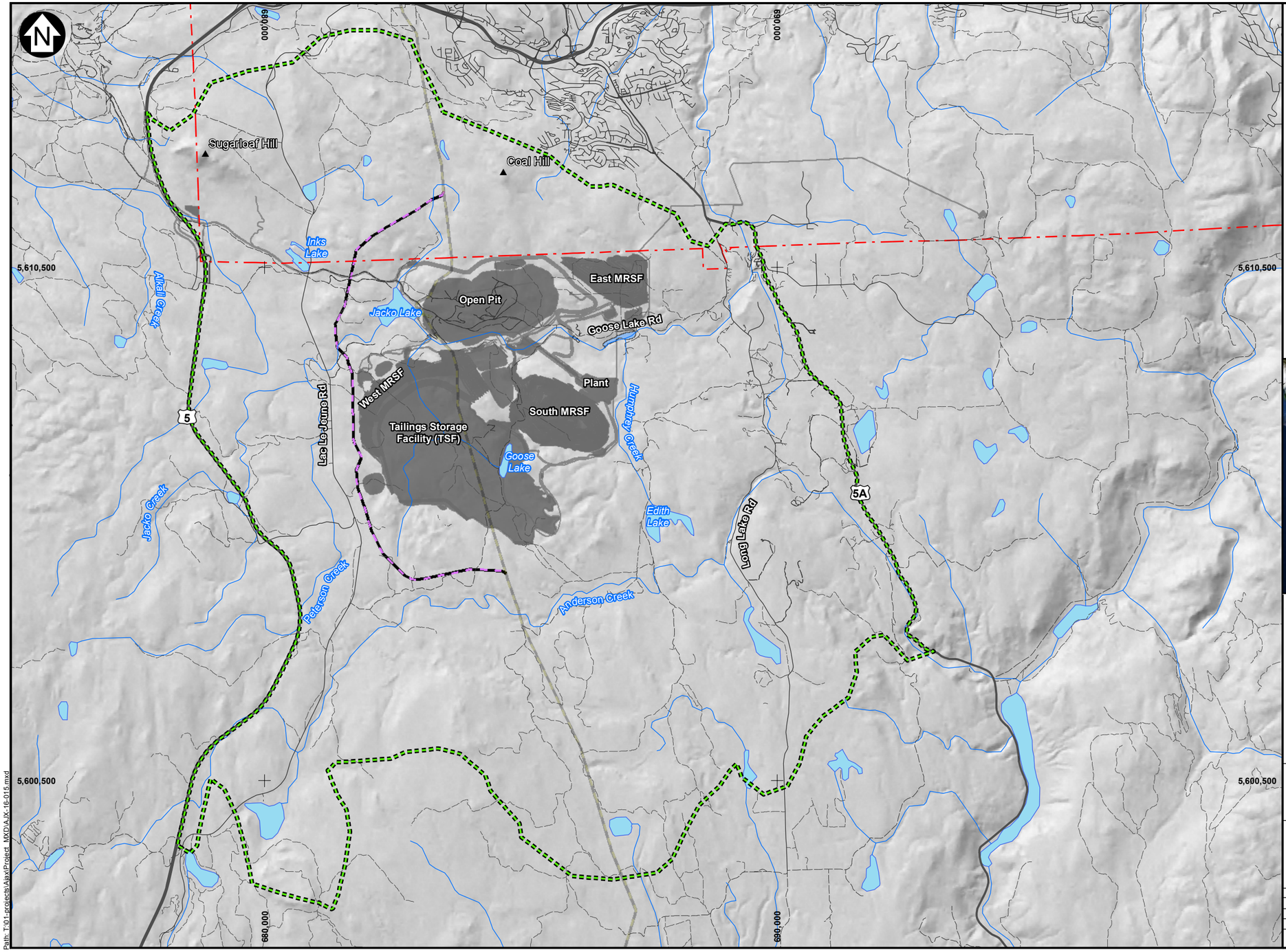

- Landmark
- Highway
- Paved Road
- Gravel Road
- Rough Road
- Recreational
- Kinder Morgan Pipeline - Current
- Kinder Morgan Pipeline - Rerouted
- Local Study Area
- Proposed Structures
- City of Kamloops

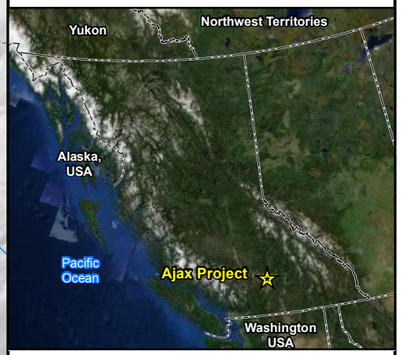

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Figure 10.6-6
Regional Study Area

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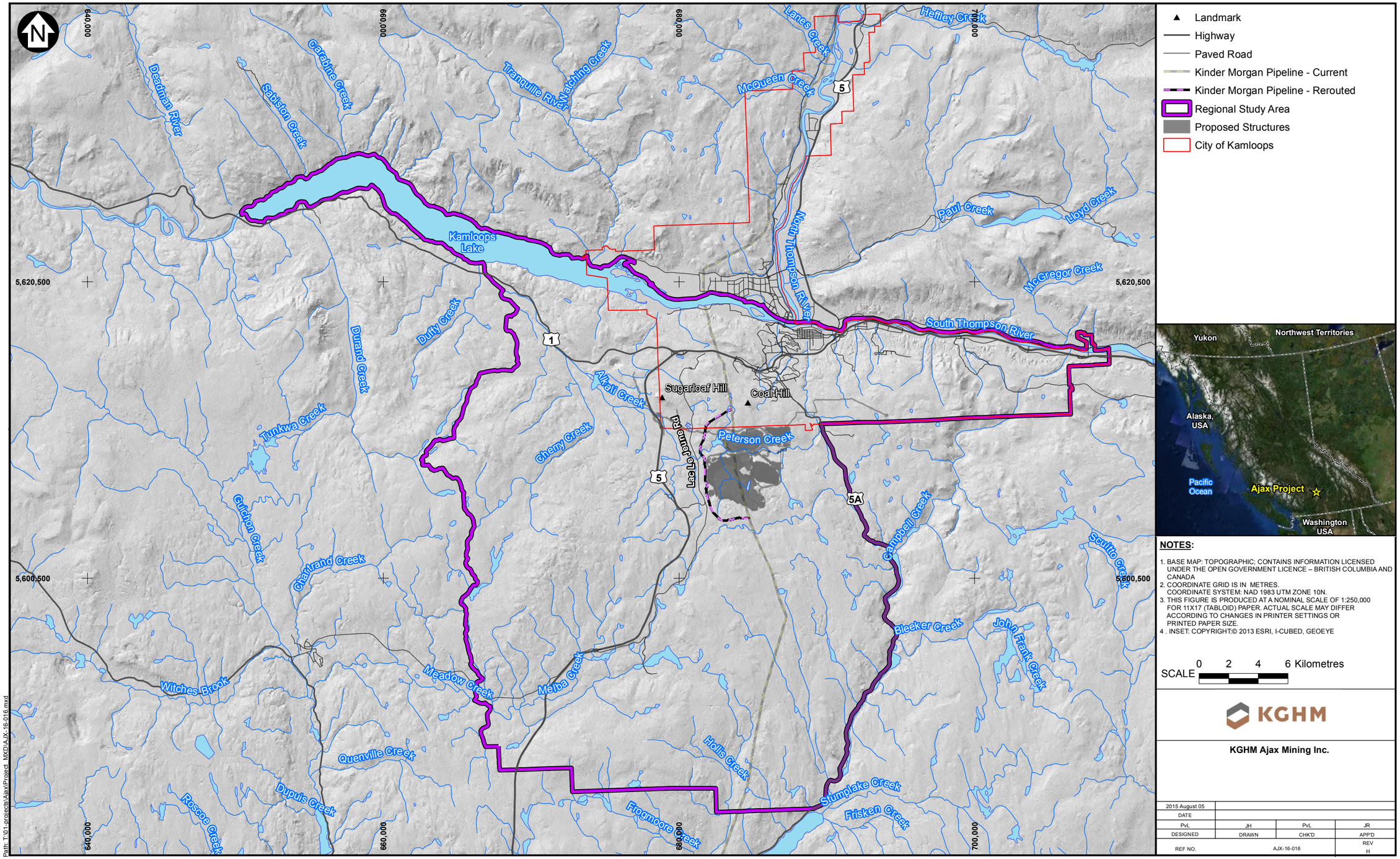

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Healthy Living

Table 10.6-4 identifies how the Project's components and activities could interact with the Healthy Living of local residents and Aboriginal Groups. These interactions may result in an adverse effect through reduced opportunities for physical activity in the vicinity of the Mine Site. The identification of interactions considered known outdoor recreational areas (as identified in Section 8.6), including those within the Mine Site (e.g., Goose Lake and Jacko Lake) or in close proximity (e.g., Coal Hill).

As noted in Section 8.1, Infrastructure, Public Facilities, and Services, the Project is not expected to result in adverse effects on municipal recreational facilities within the RSA. Therefore the discussion in Section 10.6.4.2 focuses on outdoor recreation opportunities in the LSA, and potential implications for the pursuit of physical activity in this area.

Project infrastructure and activities may also affect the ability of Aboriginal Groups to engage in traditional harvesting activities, such as fishing, plant gathering, and hunting and trapping. These activities not only provide traditional food products for consumption, but are also important in terms of cultural practices and personal enjoyment. The potential effects of the Project on traditional activities pursued by Aboriginal Groups are assessed in Section 8.5, Current Use of Land and Resources for Traditional Purposes (CULRTP).

Health Education

The information and education programs encouraging healthy living lifestyles for workers employed at the Project will have a beneficial effect in terms of promoting health education, and—by consequence—will also have a beneficial effect on healthy living for workers and their families. Since this is a beneficial effect, it is not included in Table 10.6-4 but is discussed here and in Section 2.7, Project Benefits. Effects on Healthy Living and Health Education as related to worker health and Project programming are anticipated to be positive during all phases of the Project. A summary of these positive contributions is provided below.

KGHM Ajax Mining Inc.'s (KAM) approach to healthy living and health education for its workers will strike a balance between investing in its employees and implementing appropriate systems and programs. Examples of investment by KAM to support healthy living include a Project Health and Well-Being Committee, supporting a fitness-oriented culture through sponsored events and incentives, and annual employee development programs that include education, training and skills development. On-site, KAM will reinforce a culture of safety during all Project phases with a goal of Zero Harm. This will include a commitment to continual improvements related to health and safety performance by setting objectives and monitoring performance results. Risk assessment techniques will be used to identify hazards and mitigate them so as to prevent injury and ill health. All relevant provincial and federal health and safety legislation will be continuously met or exceeded.

Table 10.6-4. Identifying Potential Project Interactions and Effects on Healthy Living and Health Education

Project Activities		Potential Effects on Healthy Living and Health Education
		Reduced Opportunities for Outdoor Physical Activity
Construction	Clearing and Grubbing	M
	Earthworks	M
	Overburden/Topsoil Stockpile	O
	Laydown Areas and Storage Yards	O
	Project Lighting	L
	Site Security and Fencing	M
	Fuel Storage and Filling Area	O
	Hazardous Wastes Transport, Storage, and Disposal	L
	Construction Wastes Transport, Storage, and Disposal	L
	Sewage Infrastructure and Disposal	L
	Public Road Realignment, Use, and Maintenance	M
	Site Road Construction, Use and Maintenance	M
	Haul Truck Road Construction, Use, and Maintenance	M
	Site Buildings and Process Plant	O
	Explosives Magazine and Storage Facilities	M
	Open Pit Development	M
	Drilling and Blasting	M
	Crushing Mine Rock	M
	Loading, Hauling, and Deposition of Mine Rock	M
	Temporary Ore Stockpile	O
	Tailing Storage Facility Development	M
	Power Transmission, Distribution	O
	Natural Gas Line	O
	Pipeline Utility Corridor (Potable Water, Sewage, and Site Water)	L
	Water Intake from Kamloops Lake	O
	Fire Suppression Infrastructure	O
	Contact Water	L
	Non-contact Water	L
	Haul Truck Road	M
	Water Management Dams	M
	Mine Staffing (Direct Employment)	O
	Contracted Employment	O
	Taxation	O
Operation	Open Pit Development	M
	Drilling and Blasting	M
	Hauling Mine Rock and Ore from Pit	M
	Crushing and Conveying Ore	M
	Temporary Ore Stockpile	O
	Development of Mine Rock Management Facilities	O
	Stripping, Loading, Hauling, Deposition, and Contouring of Topsoil	M
	Revegetation through Progressive Reclamation	L
	Process Plant Operation	M
	Deposition to Tailing Storage Facility	M
	Site Road Use and Maintenance (Materials, Personnel, Supplies)	M
	Concentrate Transport and Storage	M
	Explosives Magazine and Storage Facilities	O
	Fire Suppression Infrastructure	O
	Fuel Storage and Filling Area	O
	Hazardous Wastes Transport, Storage, and Disposal	M
	General Wastes Transport, Storage, and Disposal	M
	Sewage Infrastructure and Disposal	O

(continued)

Table 10.6-4. Identifying Potential Project Interactions and Effects on Healthy Living and Health Education (completed)

Project Activities		Potential Effects on Healthy Living and Health Education
		Reduced Opportunities for Outdoor Physical Activity
Operation (*cont'd*)	Laydown Areas and Storage Yards	O
	Power Transmission, Distribution	O
	Project Lighting	L
	Site Access, Security and Fencing	M
	Water Intake from Kamloops Lake	O
	Contact Water	L
	Non-contact Water	L
	Potable Water Treatment and Use	O
	Haul Truck Road	M
	Mine Staffing (Direct Employment)	O
	Contracted Employment	O
	Taxation	O
Decommissioning and Closure	Dismantling of Ancillary Buildings	O
	Pit Lake Planning	O
	Site Road/Bridge Decommissioning	O
	Tailing Storage Facility Decommissioning and Reclamation	O
	Mine Rock Management Facilities Reclamation	O
	Fuel Storage and Filling Area	O
	Hazardous Wastes Transport, Storage, and Disposal	L
	General Wastes Transport, Storage, and Disposal	L
	Sewage Infrastructure and Disposal	L
	Laydown Areas and Storage Yards	O
	Power Transmission, Distribution	O
	Project Lighting	L
	Site Access, Security and Fencing	L
	Contact Water	O
	Non-contact Water	O
	Potable Water Treatment and Use	O
	Haul Truck Road	L
	Road use to the Project (Materials, Personnel, Supplies)	L
	Mine Staffing (Direct Employment)	L
	Contracted Employment	O
	Taxation	O
Post-Closure	General Site Inspections and Maintenance	O
	Contact Water	O
	Non-contact Water	O
	Road use to the Project (Materials, Personnel, Supplies)	L
	Mine Staffing (Direct Employment)	O
	Contracted Employment	O

Notes:

O *No interaction anticipated.*

L *Negligible to minor interaction expected; implementation of best practices, standard mitigation and management measures; no monitoring*

M *Potential moderate interaction requiring unique active management/monitoring/mitigation; warrants further consideration.*

H *Key interaction; warrants further consideration.*

KAM will also support its workforce in its pursuit of healthy lifestyle choices through a company-wide employee wellness program. The program will provide employees with up to $500 annually to cover expenses related to health and wellness (e.g., gym memberships, health improvement programs [smoking cessation, weight loss], and athletic footwear and apparel). Additionally KAM has established a Health and Well-being Committee that provides regular communication regarding healthy living opportunities and events in the community and health and well-being education. Healthy living related education is provided to employees via guest speakers and frequent discussion of health related topics at weekly "Round-up" meetings attended by all employees.

These programs will be beneficial. As no adverse effects are identified, potential effects on Health Education are not assessed further per the assessment methodology described in Section 5.1.

10.6.4.2 Effects on Healthy Living and Health Education

Potential effects on Health Education are expected to be positive, and are described further in Section 2.7, Project Benefits.

One potential adverse effect on Healthy Living is identified:

- **Reduced opportunities for outdoor physical activity**: the Project could indirectly limit, restrict, or affect the enjoyment of, outdoor physical activities in the LSA (including fishing, walking, running, and cycling in the vicinity of the Mine Site). Reduced practice of these activities could adversely affect healthy living since physical activity is recognized by the Public Health Agency of Canada (among others) as a critical component of healthy living.

<u>Reduced Opportunities for Outdoor Physical Activity</u>

Three factors may affect the pursuit of physical activity in *LSA:*

- Altered access: the physical presence of the Project may restrict access to outdoor recreation areas surrounding the Mine Site.
- Altered experience: the Project may result in sensory disruption including increased noise and dust, changes in views, and increased traffic, all of which could affect the enjoyment of outdoor activities.
- Altered resources: outdoor activities such as fishing and hunting are dependent on natural resources (e.g. fish, wildlife). If the Project affects the distribution and quality of these resources, it could affect the ability of people to pursue (or enjoy) these activities.

Each of these factors is discussed in Section 8.6.4.2, Key Effects on Outdoor Recreation. Below, this section summarizes the overall effects of the Project on outdoor recreation based on the understanding that the loss and/or alteration of these activities correlates with reduced and/or changed opportunities to engage in outdoor physical activity.

The Project's effects on opportunities for outdoor physical activity are most likely to occur during the Construction, Operations, and Decommissioning and Closure phases. No effects are identified

during the Post Closure Phase as activities will be limited and are not expected to contribute to altered access, experience, or resources.

Altered Access

The presence of the Project will affect people's access to sites for outdoor recreational activities by either removing access or altering it. The assessment of effects on Outdoor Recreation (Section 8.6) describes the expected changes in access, and identifies Goose Lake Road and Jacko Lake as key areas where outdoor recreation may be affected by changes in access:

- Goose Lake will become part of the Mine Site and will no longer be available for recreational activities. In addition, approximately 6 km of Goose Lake Road will be closed. While Goose Lake is not known for recreation (as it is located on private land, very shallow, and does not contain fish), Goose Lake Road is currently used by hikers, mountain bikers and runners, and closure of the road will affect these users.
- Jacko Lake is a popular fishing and recreation area used by the public between April and October (road access is not maintained November through March). A portion of Jacko Lake (the northeast arm) will be permanently unavailable to public access due to the development of the Open Pit. The southeast arm of Jacko Lake will be temporarily unavailable during the Construction Phase (to accommodate the relocation of the existing dam, which will be re-constructed further downstream), but access will be restored. Overall, the total area of the lake available for public access will be reduced, but the majority of the lake will be accessible.
- Additional access restrictions for Jacko Lake will be enforced during blasting events (up until Year 13 of Operations). For public safety, a portion of the lake and surrounding area must be cleared to accommodate daily blasting activities. The blasting buffer area will be determined by blast size, geotechnical assessments, and regulatory requirements (Figure 11.21-2 provides annual progression of safety zone radius associated with blasting events). Public access to the buffer area will be restricted for an approximately two-hour window each day. These restrictions are anticipated to be in effect between Construction and up to Year 13 of Operations. After Year 13 it is anticipated that blasting events within the proposed pit will be deep enough or far enough away from Jacko Lake to remove the requirement for regularly controlled access.

Overall, the removal of Goose Lake Road may displace some outdoor recreational activities such as hiking, mountain biking, and running to other nearby locations. Kamloops is home to the Kamloops Mountain Bike Ranch, which is located between Juniper Ridge and Valleyview. KAM has partnered with mountain biking groups to sponsor the Pineview Recreational Pilot Project (Kamloops Performance Cycling Centre et. al, 2014). There are numerous parks throughout the City (See Figure 10.6-3 and Figure 10.6-4), many of which have running trails that could be used instead of Goose Lake Road.

Access restrictions related to Jacko Lake may also displace outdoor activities, particularly fishing (between April and October). However, access to the lake will be maintained overall, and the lake will continue to be stocked with fish. There are also alternative lakes in the area that can be used for

fishing. Outdoor recreational activities taking place during the winter months will not be affected since access to Jacko Lake is not maintained during that time.

Altered Experience

The experience (i.e. enjoyment) of outdoor physical activities may be affected by changes in air quality, noise and vibration, visual impacts, traffic, and the number of people using the area:

- **Air Quality**: The Air Quality assessment (Section 10.1) predicts that concentrations of Criteria Air Contaminants (CACs) will slightly exceed air quality objectives during the Construction and Operation phases; however, these exceedances will be infrequent and are expected to mainly occur in the winter, when dispersion is frequently poorer than in the summer months (Stantec 2015a). The change in CAC concentrations is considered Not Significant (moderate) for Construction and Operations. Furthermore, it is assumed that recreational outdoor activities in the LSA will be diminished during winter when these air quality effects are predicted.
- **Noise**: Health Canada provides a method to predict the percentage of people in a given noise reception location that would tend to be "highly annoyed" (%HA) by a given sound level. Health Canada advises that "noise mitigation measures be considered when a change in the calculated %HA at any given receptor exceeds 6.5%" or if the day-night average sound level (Ldn) exceeds 75 dBA. The noise effects assessment (Section 10.5, Noise and Vibration) indicates that there will be an exceedance of the %HA threshold at the Jacko Lake Prayer Tree (ID# TLU#9)—located on the north side of Jacko Lake—during the Construction Phase (specifically during piling activities, which will only occur during the day and for a period of about two months). During the Operations Phase, there is no exceedance of this metric used to assess noise effects for the sites where outdoor recreational activities occur, such as Inks Lake and Goose Lake Road.
- **Vibration**: Blasting is anticipated to exceed the human annoyance threshold of 5 mm/s for ground vibration 115 linear decibel level (dBL) in a portion of Jacko Lake closest to the Open Pit and at the Jacko Lake Prayer Tree during the Construction and Operations phase. As blasting moves away from the western boundary of the Open Pit, the vibrations at Jacko Lake-related receptors will decrease.
- **Visual Impact**: Views of the natural landscape are often important for the enjoyment of activities such as hiking, biking, and fishing. Changes to viewscapes as a result of the Project are assessed in Section 8.3, Visual Impact and Aesthetic Features; this assessment considered popular sites for outdoor recreation, including Coal Hill (approximately 1.5 km north), Jacko Lake (adjacent to Open Pit), Inks Lake (2 km west), and Edith Lake (2 km southeast). Some of these sites will have a view of Project infrastructure that may affect the enjoyment of recreational activities. During the Operations Phase, Jacko Lake, the Jacko Lake boat launch, and Coal Hill are expected to experience a moderate degree of visual effect, while a viewpoint on Edith Lake Road is expected to experience a substantial degree of visual effect associated with views of soil and overburden stockpiles, the East Mine Rock Storage Facility (MRSF), and the edge of the Open Pit. Soil and overburden stockpiles and the MRSFs will be progressively reclaimed, reducing visual effect over time.

- **Traffic:** Increased traffic volumes, including heavy goods vehicles, during the first six months of the Construction Phase could affect cyclists using the Lac Le Jeune Road during the summer months. During the remainder of the Construction phase and Operations Phase, Project traffic will be restricted to the Ajax Mine Access Road, maintaining public use of Lac Le Jeune Road.
- **Over-Utilization**: The presence of the Project workforce could result in increased numbers of people engaged in outdoor recreational activities if workers choose to spend time (off-shift) fishing near the Project, which could diminish the experience of people who appreciate quiet and solitude associated with fishing on Jacko Lake. The Outdoor Recreation (Section 8.6) and Fish Populations and Fish Habitat (Section 6.7) assessments predict that, based on the size of the workforce, there could be an increase of approximately 17 additional anglers on Jacko Lake during the Construction Phase, and 10 additional anglers during the Operations Phase. Project employees will be prohibited from angling while on the job, and access to Jacko Lake from the Mine Site will be restricted.

Based on the above information, some degree of sensory change is expected during the Construction and Operations phases of the Project. There may be minor changes in air quality but these are unlikely substantially alter the outdoor recreation experiences available within the LSA. As noted in Section 10.4, these minor changes to air quality are not expected to affect the health of people engaging in outdoor recreation activities. Similarly, increased levels of noise and vibration produced by the Project are not expected to prevent people from engaging in outdoor recreation activities, although the enjoyment of activities close to the Open Pit—including at Jacko Lake—may be diminished. In terms of visual impact, there will be views of the Project from areas surrounding the Project, including Jacko Lake, Coal Hill, and Edith Lake Road. As for the other influences, people will still be able to use these areas although their enjoyment may be adversely affected by the change in the visual landscape.

Overall, it is unlikely that sensory changes attributable to the Project—including effects on air quality, noise and vibration, and visual impact—will result in lowered rates of physical activity or healthy living experiences. In practice, the decision about when and where to pursue physical activities will be highly personal. If, based on personal preference, people decide not to pursue outdoor recreational activities in the LSA, there are multiple alternative outdoor recreation areas nearby where people can engage in the same activities (e.g., fishing, hiking, mountain biking). Thus, the Project may displace some physical activity to alternative locations, but it is not expected to substantially reduce the amount of overall activity.

Altered Resources

Changes to the abundance, distribution, and quality of harvestable resources (including fish and game) may deter individuals from participating in fishing and hunting activities near the Project:

- Some fish habitat in the northeast arm of Jacko Lake will be lost with the development of the Open Pit, which will slightly reduce the surface area of the lake available for recreational fishing. However, Jacko Lake is stocked annually so there is no expected change in fish abundance in Jacko Lake. In addition, the proposed concept to offset the effects to the recreational fishery is to enhance and stock Inks Lake (currently a non-fish bearing lake) to support a recreational fishery

(Section 6.7 Fish and Fish Habitat Assessment and Appendix 6.7-C Conceptual Fish Habitat Offsetting Plan).

- Sections 6.8 to Section 6.17 provide detailed assessments of, and mitigation measures for, potential Project effects on wildlife and vegetation. For the purpose of understanding potential effects on outdoor physical activity levels, the potential effects of the Project on hunting has considered effects related to the availability and quality of game species. No significant effects on mule deer or game birds (e.g., ruffed grouse) are expected.

Based on the assessment results for other VCs, no significant effects on the availability or quality of fish or game harvests are expected. If people perceive effects on fish or game, and consequently stop hunting or fishing, their levels of physical activity may diminish. However, there are alternative areas that are nearby and easily accessible for both hunting and fishing throughout the RSA. Thus, although the Project may displace some outdoor physical activity to alternative locations, it is not expected to substantially reduce it.

Summary

Taking into account the various factors affecting the pursuit of physical activities in and close to the Project Footprint, it is possible that some people will stop engaging in physical activity near the Project. In some instances, areas currently used for outdoor recreation—i.e. Goose Lake Road and the northeast arm of Jacko Lake—will no longer be accessible, although there are alternative areas nearby that can be accessed and used for physical activities such as hiking, biking, running, and fishing. As such, the Project's changes to access for outdoor physical activities are not expected to reduce people's ability to pursue a healthy lifestyle. The Project may also affect the experience of people pursuing these activities through sensory disturbances such as changes in noise and vibration, visual quality, and traffic. The decision to no longer engage in physical activities due to these disturbances is highly personal, and may be the choice of some individuals, but it is important to note that easily accessible alternate areas are available for all physical activities pursued in the vicinity of the Project.

While participation in outdoor physical activities near the Project may be displaced to nearby areas, overall levels of physical activity for community members is not likely to decrease. Within the municipal boundaries of Kamloops, the City provides a range of sites for engaging in physical activities (indoor and outdoor). These include parks such as Kenna Cartwright Park and Peterson Creek Park; the Bike Ranch; and a public trail system. In addition, Kamloops has an abundance of green space, especially in the City's subdivisions. The green space promotes the use of these areas for walking, which is probably the most popular physical activity in which to engage (Andersen et al., pers. comm. 2014).

The only area for physical activity that may not be easily replaced is angling on Jacko Lake. The area available for fishing will be reduced; the lake will be subject to daily access restrictions up to Year 13 of Operations to safely accommodate blasting; there may be a slight increase in the number of people fishing; and people at lake will experience noise, vibration, and visual impacts from the Project. However, the lake will be continue to be stocked with trout, and the overall fish population will not be affected. There are alternative fishing sites throughout the RSA, and the implementation of the Fish and Fish Habitat Offsetting Plan (Appendix 6.7-C) will develop new fish habitat (currently planned for Inks Lake, which will add a lake stocked with trout for recreational purposes less than 2 km from Jacko Lake).

10.6.4.3 Mitigation Measures for Healthy Living and Health Education

The mitigation measures for Outdoor Recreation (Section 8.6) are applicable to Healthy Living and Health Education. These mitigation measures are designed to promote continued use of the Project area, especially in connection with Jacko Lake, to the extent that it is safe and feasible to do so. In addition to the mitigation measures for Outdoor Recreation, mitigation measures for other VCs—including Air Quality (Section 10.1), Noise and Vibration (Section 10.5), Visual Impacts and Aesthetic Features (Section 8.3)—will also help mitigate the potential for the Project to contribute to reduced opportunities for physical activities.

Mitigation measures related to the continued pursuit of physical activities are listed below according to how they relate to access to recreational areas, diminished recreational experience, or changes to resources.

Altered Access

An Access Management Plan (AMP) will be developed in order to safely manage access to the Project, including ongoing access to recreational areas such as Jacko Lake, and communication with people using the area for recreation and other activities. The AMP (described in Section 11.21) will be developed in consultation with land users (including people who fish at Jacko Lake), Aboriginal Groups, and other parties. The AMP will describe access controls and signage, safety procedures, and communications with the aim of continuing to allow access to Jacko Lake and other areas when safe and practicable.

KAM will establish a Community Liaison Group as a mechanism to work with external groups on key issues related to the Project. In addition, KAM will establish an angling/recreation working group with fishers and other interested stakeholders, with the intention of identifying initiatives and opportunities to support the development of new or improved fishing areas and other recreational resources (e.g. trails). KAM intends, through the AMP, Community Liaison Group, and the angling/recreation working group, to work with local recreational and resource land users to identify areas that can continue to be enjoyed in the Project area.

Altered Experience

Measures to mitigate potential diminished outdoor recreation experience are primarily described by those developed for air quality, noise and vibration, and visual impact and aesthetic features but also include specific measures to consult with recreational users and address concerns.

- **Air Quality:** Mitigation measures include Project design components (e.g. covered conveyors dust collectors, bag houses, etc.) and best management practices, operational and closure plans (e.g. haul road watering, tailings beach management, etc.). A detailed discussion of mitigation measures for air quality can be found in Section 10.1 (Air Quality).
- **Noise and Vibration:** Mitigation measures include Project specific and best management practices to minimize during construction (sheet pile installation) and operations (Open Pit blasting). A detailed discussion of mitigation measures for noise and vibration can be found in Section 10.5 (Noise and Vibration) and the Noise and Vibration Management Plan can be found in Section 11.22.

- **Visual Impact and Aesthetic Features:** Project design measures include implementation of good visual design principles during Project construction. For example, the design will avoid straight edges where possible and re-vegetation of Project components during construction will help hide physical alterations and straight edges. Project infrastructure will also be designed where feasible to minimize its appearance. For example, the use of non-reflective materials for buildings and using natural-coloured paint where possible will help buildings and other infrastructure blend into the landscape. In addition to designing the Project to blend into the landscape more effectively, ongoing re-vegetation is recommended to minimize the impact of larger Project components, such as the Mine Rock Storage Facilities. A detailed discussion of mitigation measures for Visual Impact and Aesthetic Features can be found in Section 8.3 (Visual Impact and Aesthetic Features).

KAM will mitigate potential traffic related effects through the implementation of the Transportation Management Plan (Section 11.20). KAM will also establish, as part of an adaptive management plan, a recreation/angling working group made up of recreational users to identify potential issues and concerns associated with access management/traffic management in accessing the recreational facilities in the area as well as providing opportunity to discuss changes in enjoyment of the area due to the construction and operations of the Project.

Altered Resources

Measures to mitigate potential changes in fish and game resources would include:

- **Fish and fish habitat:** Additional recreational fishing opportunities will be supported by the creation of new fish habitat as described in the Conceptual Fish and Fish Habitat Offsetting Plan (Appendix 6.7-C). KAM will work with fisheries regulators and other stakeholders (e.g. through the recreation/angling working group described above) to identify suitable opportunities for new or improved fishing areas. In addition, KAM will monitor potential effects on fish in Jacko Lake and solicit feedback from anglers and other recreational users to monitor effects to fishing experience. Proposed mitigation for the potential effects to fish and fish habitat is discussed in detail in Section 6.7 (Fish Populations and Fish Habitat) and Section 11.25 (Fisheries and Aquatic Life Monitoring Plan).
- **Game**: Habitat creation for game birds (e.g. ruffed grouse [Section 6.16]) and noise mitigation measures (Section 10.5) combined with other mitigation measures and best management practices to prevent direct or indirect mortality of wildlife in the LSA will mitigate potential effects of the Project on game resources.

10.6.5 Residual Effects and Their Significance

10.6.5.1 Summary of Residual Effects

The focus of the assessment on this VC is on the Construction, Operations, and Decommissioning and Closure phases of the Project as this is when potential adverse Project effects are most likely to occur. Project activities are expected to be the most intense during Construction and Operations phases. During the Decommissioning and Closure Phase, the Project is still expected to interact with physical activity as operations wind down, facilities and infrastructure are decommissioned, progressive reclamation activities continue, and the Project transitions to final closure and reclamation.

The mitigation measures and Project design features proposed in other sections—including Air Quality, Noise and Vibration, Visual Impact and Aesthetic Features, and Outdoor Recreation—are expected to effectively avoid or reduce potential effects of the Project. No residual effects to outdoor physical activity levels, and therefore the Healthy Living VC, are anticipated to occur as a result of the Project. This assessment is summarized in Table 10.6-5.

Table 10.6-5. Summary of Residual Effects on Healthy Living and Health Education

Potential Effect	Project Phase (timing of effect)	Project Component/ Physical Activity	Description of Cause-Effect[1]	Description of Mitigation Measure(s)	Description of Residual Effect
Reduced opportunities for outdoor physical activity	• Construction, • Operations, • Decommissioning and Closure	All	Presence of Project may alter access, experience, and quality of resource. These changes may cause some people to achieve lower levels of physical activity, which could adversely affect healthy living.	• Develop and implement an Access Management Plan to promote continued use of areas such as Jacko Lake for a variety of uses • Develop alternative fishing areas through fish habitat compensation and stocking • Angler/recreation working group, and potential development of new or improved fishing, biking, trails, and/or other recreation areas • Implementation of Project design and best management practices for air quality, noise and vibration, visual impacts and aesthetic features • Implementation of Project design and best management practices for fish and fish habitat and wildlife	No residual effect

[1] *"Cause-effect" refers to the relationship between the Project component/physical activity that is causing the change or effect in the condition of the VC.*

In addition, KAM is committed to supporting the development and/or enhancement of sites where physical activity can occur (e.g., the Pineview Bike Trails Pilot Project), over the life of the Project. These investments will supplement mitigation measures with the goal of enhancing opportunities to engage in outdoor physical activity.

10.6.6 Cumulative Effects Assessment

No adverse residual effects on Healthy Living and Health Education are likely to result from the Project. As a result, there are no anticipated residual effects to carry forward to consideration under cumulative effects (Table 10.6-6).

Table 10.6-6. Summary of Project and Cumulative Residual Effects, Mitigation, and Significance for Healthy Living and Health Education

Residual Effects	Project Phase	Mitigation Measures	Residual Effect Significance	Residual Cumulative Effect Significance
None	n/a	n/a	n/a	n/a

10.6.7 Conclusion

During the Construction and Operations phases of the Project, there are expected to be altered opportunities for engaging in outdoor physical activities in the LSA because of changes to access, changes to quality of experience, and changes to resources. However, the outdoor physical activities that take place in areas affected by the Project can also be pursued at nearby locations. Mitigation measures for other VCs (e.g., air quality, noise and vibration, fish and fish habitat) are expected to reduce Project effects on the sites in the LSA where outdoor physical activity occurs, including Jacko Lake.

In addition to minimizing Project effects for VCs that support the assessment on Healthy Living and Health Education, KAM commits to developing and implementing an Access Management Plan (AMP). This plan will implement safe and feasible methods for accessing the site for a variety of stakeholders (e.g., ranchers, recreationalists) as well as Aboriginal land users. Of particular interest to the Healthy Living and Health Education VC are the measures in the AMP that will affect access to Jacko Lake, including procedures surrounding safety before and during blasts. The current seasonal access to Jacko Lake is not expected to change as the lake will still be open for fishing from April through to November (i.e., when there is no ice on the lake). The AMP will be developed in consultation with stakeholder groups that are potentially affected.

KAM also commits to supporting the development and/or enhancement of alternative sites where physical activity may occur. These sites are likely to be existing outdoor recreation sites, such as Inks Lake, where fish habitat enhancement is planned as part of the Fish and Fish Habitat Offsetting Plan (Appendix 6.7-C). Efforts in connection with developing alternative sites will be developed in consultation with government representatives and representatives from recreational groups, and KAM will establish an angler/recreation working group to explore the potential development of new or improved fishing areas, trails, and other recreation resources.

Considering these mitigation measures in connection with the Healthy Living and Healthy Education VC, no residual effects are expected.

KAM not only supports opportunities for physical activity for the public at large, but also for its workforce. KAM's approach to healthy living and health education for its workers will strike a balance between investing in its employees and implementing appropriate systems and programs. On-site, KAM will reinforce a culture of safety during all Project phases with a goal of Zero Harm. KAM will also implement a Health and Well-Being Committee, support a fitness-oriented culture through sponsored events and incentives, and provide health-related education to employees via guest speakers and frequent discussion of health related topics at weekly "Round-up" meetings attended by all employees. KAM will also support its workforce in its pursuit of healthy lifestyle choices through a company-wide employee wellness program. The wellness program will provide employees with up to $500 dollars annually to cover expenses related to health and wellness (e.g., gym memberships, health improvement programs [smoking cessation, weight loss], and athletic footwear and apparel).

10.7 COMMUNITY HEALTH AND WELL-BEING

Issues of community health and well-being are standard components of socio-economic impact assessments across Canada. Given the complex array of factors that can affect community health and well-being, this VC has linkages to other VCs, including Air Quality (Section 10.1), Domestic Water Quality (Section 10.2), Country Foods (Section 10.3), Human Health (10.4), and Noise and Vibration (Section 10.5). Other VCs considered with respect to indirect effects to community health and well-being include economic VCs like Income (Section 7.3), social VCs such as Infrastructure, Public Facilities, and Services (Section 8.1), and linkages to Healthy Living and Health Education (Section 10.6). To the extent feasible, the overall quality of life for residents of Kamloops and surrounding areas is considered in this VC, as well as the desirability of the associated neighbourhoods (Aberdeen, Knutsford, and Pineview Valley). Please see Figure 10.7-1 for interactions and inputs to health VCs.

10.7.1 Rationale

Table 10.7-1 provides a summary of the rationale and justification for choosing and assessing the Community Health and Well-Being VC. Additional detail for how other VCs (e.g., Infrastructure, Public Facilities and Services and Healthy Living and Health Education) play a contributing role in the assessment is provided in relevant sub-sections below.

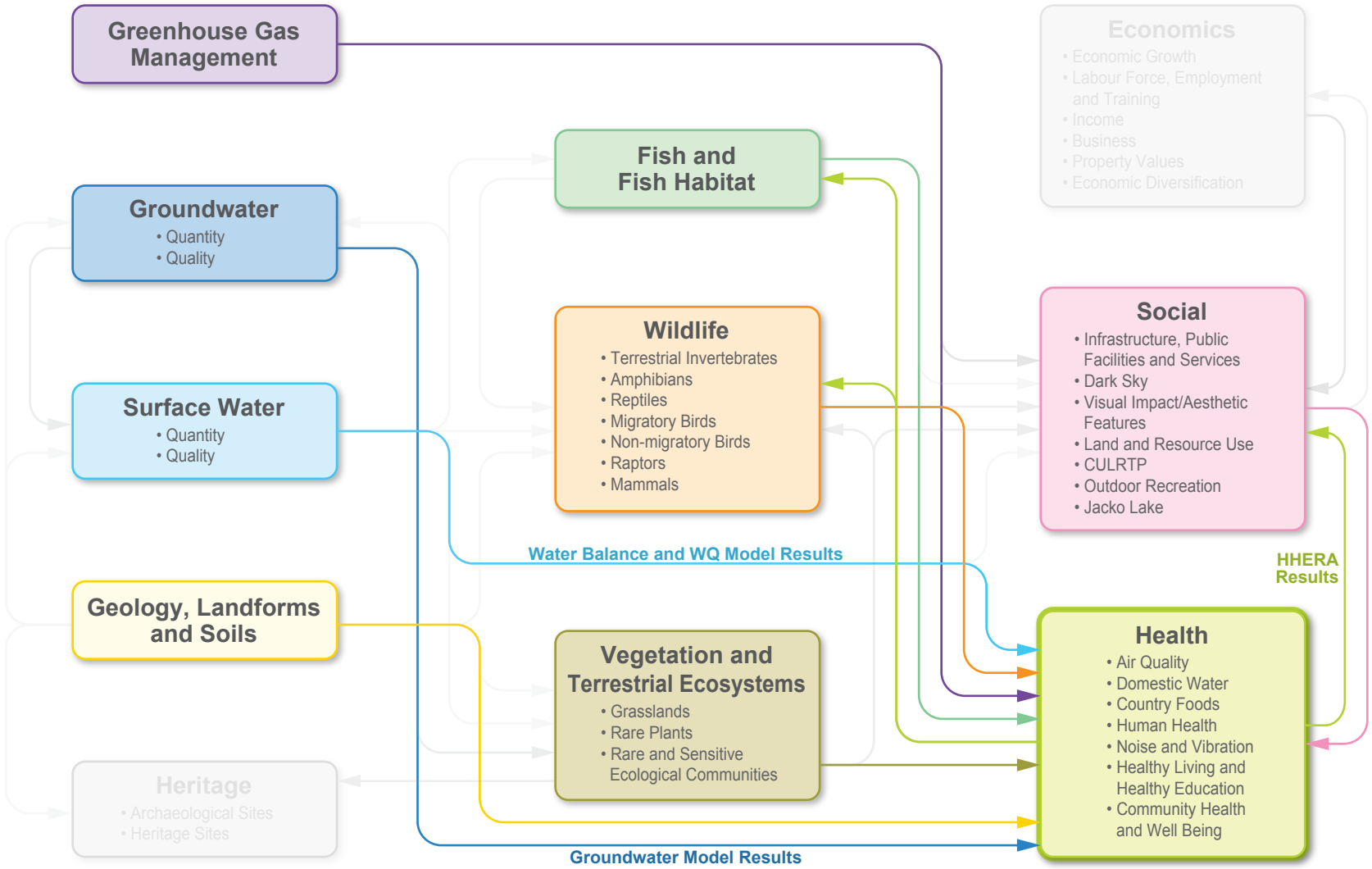
Table 10.7-1. Community Health and Well-being

Valued Components	Identified by*				Rationale for Inclusion
	AG	G	P/S	SK	
Community Health and Well-being	X	X	X	X	The Project may have an effect on community health and well-being through the pathways of changes in the biophysical environment, change in income, the presence of a temporary workforce, potential risk of reduced healthcare services, perceived changes to community image and quality of life, and Project-related traffic.

**AG = Aboriginal Group; G = Guideline Requirement; P/S = Public/Stakeholder; SK = Scientific/Professional Knowledge.*

There are many factors that may affect health, when considered broadly. Correspondingly, there are multiple potential pathways through which the Project could affect Community Health and Well-being. Changes in other VCs may affect Community Health and Well-being; Figure 10.7-1 provides an overview of inputs to Health VCs.

Figure 10.7-1
Inputs to Health Valued Components



10.7.2 Background

The health of individuals, families and communities is shaped by a variety of factors or determinants of health, which include the social and economic environment, the physical environment, and the person's individual characteristics and behaviours (WHO 2009). Examples of determinants related to the social and economic environment include income and education levels; examples of determinants related to the physical environment include distance to services or exposure to contaminants; and examples of determinants related to individual characteristics and behaviours include genetics and personal practices (e.g., diet and smoking). Since these determinants are extensive and diverse, it can be challenging to measure them. In addition, it can be difficult to draw direct correlations between indicators and the status of a community's health and well-being.

Health goes beyond the simple absence of disease. A full understanding of community health also requires consideration of a community's social, physical and economic environments as well as individual factors that contribute to overall health (i.e., a more holistic approach) (Table 10.7-2).

Table 10.7-2. Factors Contributing to Community Health and Well-being

Factor	Link to Health
Education	Improves opportunities to access employment and income Provides one with a sense of control over life's circumstances Increased understanding of information related to maintaining health
Income	Higher income is linked to improved living conditions Higher income increases ability to access resources Stressors such as job strain, financial problems, and marital problems are more common among lower income individuals
Social Networks	Social support networks act as supports when family, friends and community contribute to problem solving, dealing with adversity, and sense of control over life's circumstances Social supports act as a buffer against health problems
Physical Environment	Exposure to contaminants through air, water, soil and food can result in a variety of adverse health effects Quality of housing (including the density of dwellings, requirements for major repairs, average number of persons per room, and indoor air quality) are linked to overall health Distance to services (*e.g.*, distance to nearest hospital) Personal security (*e.g.*, incidents of personal and property crime)
Individual Characteristics	Genetic factors Personal practices/behaviours (*e.g.*, diet, exercise, smoking, use of alcohol) Coping skills

Sources: Health Canada 2003, Health Canada 2004, Health Council of Canada 2005, Hou and Chen 2003, Orpana et al. 2007, Atlas of Canada 2009, WHO 2009.

The baseline understanding of health and well-being draws from available health status indicators for the population as a whole and with respect to the health of the Aboriginal population. It examines indicators of health service provision. In addition, the baseline includes relevant socio-economic characteristics (e.g., income, community well-being) and perspectives about community image. It also

summarizes aspects of the biophysical environment that represent potential pathways of effect from the Project to people (air, water, country foods and noise and vibration). Furthermore, it characterizes road traffic, which also represents a potential pathway of effect from the Project to safety.

Baseline conditions related to the biophysical environment can be found in in the Application for an Environmental Assessment Certificate/Environmental Impact Statement for a Comprehensive Study (Application/EIS) (including Section 10.1, Air Quality and Section 10.3, Country Foods).

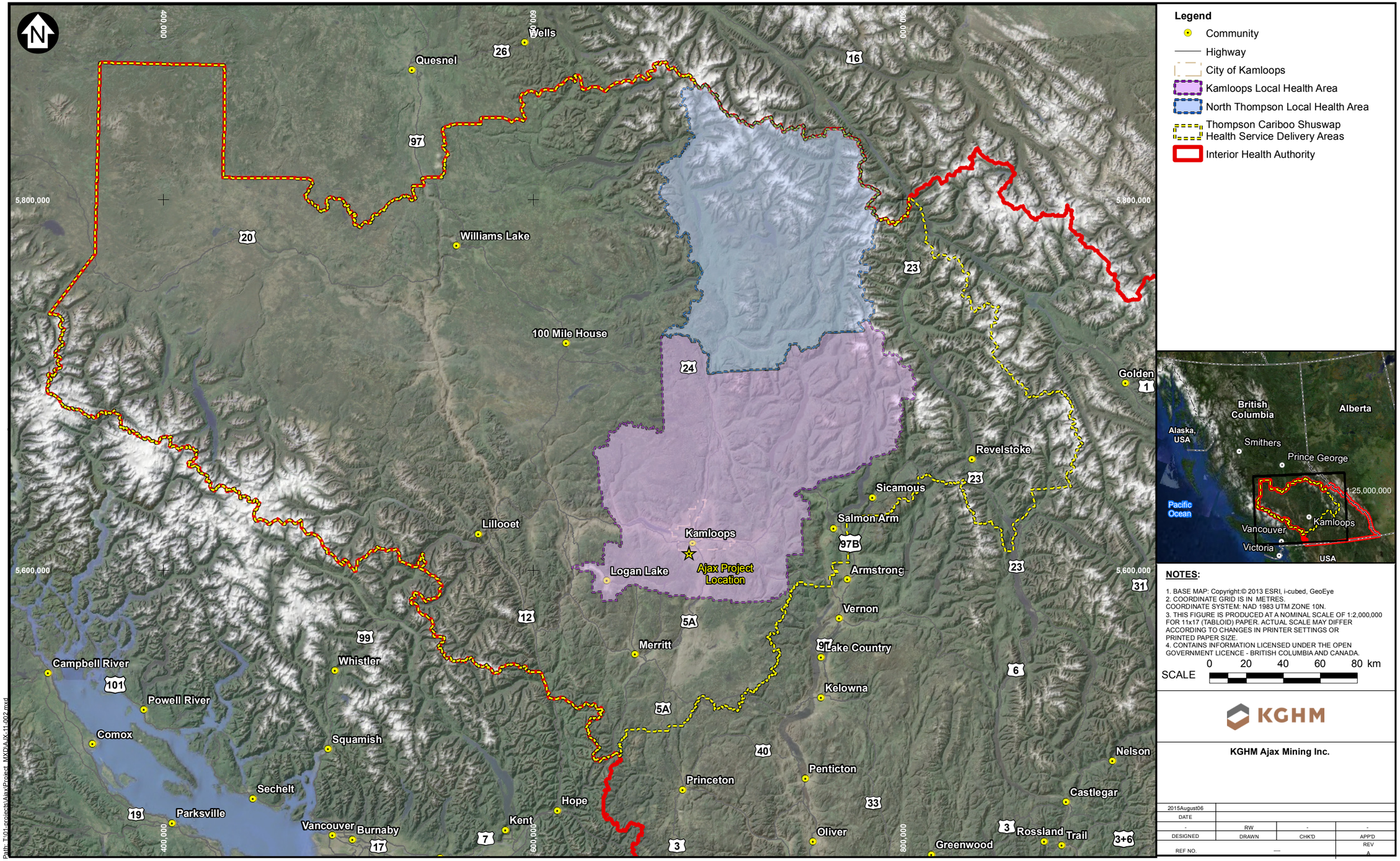
10.7.2.1 Regional Overview

Health care for the communities in the regional study area (RSA) is provided by the Interior Health Authority (IHA). The IHA provides services to four health service delivery areas (HSDAs) in the interior of BC. Each HSDA is then further divided into local health areas (LHAs). The Project, the City of Kamloops, other communities (e.g., Knutsford, Logan Lake, Savona, Chase) and several Aboriginal Groups (e.g., Skeetchestn Indian Band, Tk'emlúps te Secwepemc, Whispering Pines/Clinton, Lower Nicola Indian Band, and Ashcroft Indian Band) are located in the Kamloops LHA. The communities in the RSA are located within the Thompson-Cariboo-Shuswap HSDA (Figure 10.7-2). Healthcare services on-reserve are overseen by the First Nations Health Authority.

Some of the key health characteristics of the IHA and the Thompson Cariboo Shuswap HSDA (with comparison to BC where available) are summarized below:

- Life expectancy in the IHA and the Thompson Cariboo Shuswap HSDA is increasing, which is also true the Province as a whole, and the population is aging, resulting in increased demand for care and increased numbers of chronic diseases such as Chronic Obstructive Pulmonary Disease (COPD), diabetes, as well as mental health related issues. As the population ages, health issues rise (Ajax KPI Program 2011-2012).
- According to the 2013 Local Health Area Profile for the Kamloops LHAs, depression and anxiety, followed by asthma, COPD and diabetes were the top prevalence rates of chronic diseases. Rates were similar for the LHAs and the IHA and were only slightly higher (i.e., 2-3 percentage points) or equivalent (for diabetes) as compared to BC (IHA 2013a).
- Leading causes of death in the Kamloops and North Thompson LHAs are diseases of the circulatory system and malignant neoplasms (or cancers). Between 2007 and 2011, potential years of lost life per 1,000 population due to suicide/homicide was higher in the Kamloops and North Thompson LHAs than the rest of the Thompson Cariboo Shuswap HSDA and the IHA; however, potential years of lost life due to natural causes was similar across all jurisdictions (BC Vital Statistics 2012 h, 2012i, 2012m, 2012n).
- Obesity showed an increasing trend in the Thompson Cariboo Shuswap HSDA between 2007 and 2011, with rates approximately 15 to 20% higher than the province as a whole.
- Broadly speaking, the Aboriginal population in the IHA experiences a disproportionate rate of many diseases and injuries when compared to other segments of the population. In the IHA, access, cultural safety, and jurisdictional issues were noted as some of the issues that are creating this disparity between Aboriginal and non-Aboriginal residents (Ajax KPI Program 2011-2012).

Figure 10.7-2
Health Authority Boundaries



NOTES:

1. BASE MAP: Copyright:© 2013 ESRI, i-cubed, GeoEye
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:2,000,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
4. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - BRITISH COLUMBIA AND CANADA.

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10.7.2.2 Historical Activities

The region surrounding the Project has a long history of human activity that contributes to the current baseline condition, which is defined more specifically in the following section. Kamloops derives its name from the Secwepemc word "Tk'emlúps", which refers to the meeting of the North and South Thompson rivers. The area was first inhabited by approximately 3,000 members of the Shuswap tribe, part of the Interior Salish Nation. Archaeology indicates that the area was used by Aboriginal people for hunting and fishing.

Fur trading began in the area in the early 1800s and evolved throughout the first half of the century. The fur trade involved a number of different trading companies. The fur trading posts were located in various locations in what is now Kamloops. In the second half of the 1800s, gold exploration brought miners into the area from the United States and China. During the same period, agriculture became better established and production of livestock, vegetables, and grain increased rapidly (City of Kamloops n.d.a.). Ranching in and around Kamloops, including in the Jacko Lake area, dates back to the late 1800s.

British Columbia officially became part of Canada in 1871, and construction of the transcontinental railroad was completed in 1885, encouraging the growth of a small village on the shore of the Thompson River. The village grew rapidly and by 1893 the population had risen to approximately 500 and became incorporated as a city with public works. In the following years, there were a number of infrastructural developments, including bridges that connected villages on either side of the rivers. During this time, the timber industry was growing, and the vegetable and orchard farming industry grew, with most of the land used for this purpose located in the valley. The Canadian Northern Railway was completed in 1915, and the Kamloops airport was operational in 1939. The Trans-Canada Highway to the west of the Project area was completed in 1962, and the Yellowhead Highway in 1970. The Kamloops area grew after the First World War until development slowed during the Depression and the Second World War. After this period, the City began to grow again, and much of the land that had formerly been used for farming in the valley was used for residential development.

Throughout much of its history, Kamloops has been heavily reliant on resource extraction industries such as mining and forestry, with agriculture (primarily ranching) also being prominent. Previously (i.e., prior to the 1990s) there was a perception amongst some residents that the City was a "dirty mining town" although mining was not the only industry historically operating in the area. More recently (i.e., up to a decade ago), poor water and air quality were cited as contributors to the past negative community image (City of Kamloops and InterGroup Consultants 2012).

In recent years however, (i.e., over the past decade), the City has made a concerted effort to change its image to one of providing a clean, healthy and beautiful environment for its residents. This is reviewed in greater detail under the below noted Community Image/Vision sections.

Because of the diverse activities associated with Kamloops and the surrounding area, a discussion on the historical influences to Community Health and Well-being is difficult. The baseline conditions described in Section 10.7.2.3 provide a description of existing conditions, including the impacts of historical activities near the Project and Kamloops.

10.7.2.3 Baseline Studies

The objectives of baseline studies for community health and well-being include:

- Understanding existing conditions in the Local Study Area (LSA), including the use of primary and secondary data sources to validate the findings; and
- Characterizing the issues and concerns of residents of the LSA with respect to community health and well-being and Project activities.

Baseline information was collected to address the following potential pathways by which the Project could influence community health and well-being:

- Changes in the biophysical environment (air, water, country foods);
- Changes in noise and vibration;
- Project-related traffic;
- The presence of the Project workforce;
- Changes in income generation;
- Changes to community image and residents' perceived sense of quality of life; and
- Changes to access of recreation opportunities.

In addition to using pathways of effect to guide baseline data collection, health indicator data was used to characterize overall community health and well-being (i.e., through collection of health statistics, one can draw some general conclusions about community health). This is described in greater detail under the section on Characterization of Community Health and Well-being Baseline Conditions referenced below.

Data Sources

Community health and well-being data sources included Statistics Canada data, BC Stats data and reporting, government policies and reports, regional planning documents, journals, other publications, and online information. Of particular relevance to this section were data from the IHA and BC Vital Statistics.

Additional literature and experience from other projects was reviewed to gain an understanding of effects from resource extraction industries on communities.

Context and findings drawn from the literature and statistical data sources were confirmed and validated through a Project-specific key person interview (KPI) program. Outcomes of the public engagement process for the Project were also included.

Consultation activities undertaken with the Aboriginal groups during the Pre-Application period included capacity building and funding, Traditional Knowledge/Traditional Land Use (TK/TLU) studies, community meetings, site tours, and meetings with Aboriginal group representatives (see Section 4.3). Multiple attempts have been made to engage each Aboriginal Group to seek the

baseline data required for the Application/EIS including the circulation of baseline documentation for review and comment. The information gathered through this engagement has been incorporated in the Application and considered in the assessments. In some cases, the requested information was not available from Aboriginal groups at the time of writing or from secondary sources. Where appropriate, additional information made available by Aboriginal Groups will be considered in Project development plans.

A detailed Socio-economic baseline report was prepared and has been used to provide the background details for the Community Health and Well-being VC summary in this section. For a more in-depth understanding, please refer to the Socio-economic Baseline Report (Appendix 7.1-A).

Methods

A combination method of primary and secondary data collection was undertaken in order to triangulate from various sources of information to describe the existing baseline conditions. KPIs, stakeholder workshops, and the outcomes of public engagement activities provided the main sources of primary data. Secondary data, both qualitative and quantitative, were collected from a variety of sources including government reports, databases such as Statistics Canada and BC Stats, data from the IHA, and other literature sources (including the First Nation Health Authority). As noted above, for the purposes of the baseline, information is centered on where there is a likely linkage to Project effects, whereas broader health and well-being information is located in the detailed Socio-Economic Baseline Report (see Appendix 7.1-A).

Characterization of Community Health and Well-being Baseline Conditions

As context for the VC of Community Health and Well-being, Table 10.7-3 depicts overall census populations of the communities in the LSA and RSA. The LSA is defined as the Kamloops LHA; and the RSA is the Thompson-Cariboo-Shuswap HSDA (see Section 10.7.3 for further detail and maps). Other population characteristics, including age/sex distribution, family structure, and mobility status are included in Appendix 7.1-A.

Table 10.7-3. Population for the Kamloops LHA and Thompson Cariboo Shuswap HSDA, 2001, 2006, 2011

	2001	2006	2011
Kamloops LHA	102,480	105,450	110,639
Thompson Cariboo Shuswap HSDA	212,041	213,100	218,223

Source: BC Stats 2015.

As the table illustrates, in 2011 the Kamloops LHA made up just over 50% of the population of the Thompson Cariboo Shuswap HSDA. Within the IHA for 2011, 53,770 people have identified as Aboriginal, representing about 7.7% of the IHA's total population. The population data found in the IHA's Aboriginal Health and Wellness Strategy, 2015-2019 indicates that within the IHA, 58% of Aboriginal people live off-reserve, including members of the 15 Chartered Métis communities. The 42% of the Aboriginal population in the IHA living on-reserve fall within the territory of seven different First

Nations: Tsilhqot'in, Secwepemc, Dekelh Dene, St'st'imc, Syilx, Nlaka'pamux and Ktunaxa Nations (IHA 2015; see Appendix 7.1-A for details).

The characterization of Community Health and Well-being is focused on the following indicators and factors that support and/or describe the VC:

- Health status indicators –- a review of publicly available data as it relates to health indicators, including chronic diseases and mental health as reported by the IHA. These indicators provide overall context on community health today.
- Health status of the Aboriginal population –- a review of factors that specifically affect the status of health for Aboriginal people and provides overall context regarding the health of the Aboriginal population today.
- Summary of baseline information related to pathways of effect from the biophysical environment (air, water, country food).
- Summary of baseline information regarding noise and vibration.
- Summary of baseline information related to the pathway of effect through traffic-related incidents (i.e., an understanding of traffic volumes and incidents today).
- Health system delivery indicators –- a review of indicators related to health services delivery, which measures aspects of health care including access, efficiency and use as reported by IHA. These indicators provide overall context regarding community health today.
- Community Well-being Index—this index includes socio-economic indicators of health and well-being. Other social and economic indicators are included in the Appendix 7.1-A, Socio-economic Baseline for the Ajax Project.
- Community image – a discussion regarding how residents perceive their community, and the factors that contribute to quality of life. This discussion also contributes to context regarding community well-being today.

Health Status Indicators

For the purposes of the Application/EIS, information is presented on chronic diseases (including mental health, asthma, chronic lung disease) and potential years of life lost (PYLL). Other subject areas such as infant mortality, low birth weight, life expectancy and leading causes of death are discussed in Appendix 7.1-A.

Chronic Diseases

Chronic disease is an important measure of a community's overall health because not only does it reflect a community's demographics, it also has negative impacts on the quality of life of affected individuals, causes premature deaths, and creates adverse economic effects on families, communities, and societies (WHO 2005). According to the IHA, as the population in the health authority continues to age, the prevalence rates of chronic disease are expected to increase (Interior Health Authority 2013a, 2013b). The Ajax KPI Program also indicated a similar trend as the IHA information in that the population within the LSA is aging.

Table 10.7-4 provides an overview of the prevalence of certain chronic conditions that are of concern to the IHA. The data is presented for the Kamloops LHA (the LSA), the Thompson Cariboo Shuswap HSDA (the RSA), the IHA (which is larger than the RSA), and, for comparison purposes, BC.

Table 10.7-4. Chronic Disease Crude Prevalence Rates, 2011-2012

Chronic Disease	Kamloops LHA	Thompson Cariboo Shuswap HSDA	IHA	British Columbia
Depression/Anxiety	27%	27%	27%	25%
Asthma (5-54 years)	12%	11%	10%	10%
Chronic Obstructive Pulmonary Disease (COPD) (45+ years)	9%	8%	8%	6%
Diabetes Mellitus	8%	8%	8%	8%
Dementia (45+ years)	3%	3%	3%	3%
Heart Failure	3%	3%	3%	2%

Source: IHA 2013a, 2013b.

Table 10.7-5 describes the top three chronic diseases as they relate to the Kamloops LHA. The Socio-economic Baseline for the Ajax Project (Appendix 7.1-A) provides additional details related to these and other chronic diseases.

Table 10.7-5. Chronic Diseases in the Kamloops LHA

Chronic Disease	Description
Mental Health (Depression and Anxiety)	Depression and anxiety can have profound impacts on individuals and communities. According to a survey conducted by the Canadian Mental Health Association, approximately 3.4 million Canadians have experienced a major bout of depression at some point in their lives. Women and those between 25-54 years of age are more likely to have experienced depression or anxiety (Canadian Mental Health Association 2002). A Statistics Canada survey reported that half a million Canadian workers experienced depression and almost 80% of them indicated that the symptoms they experienced interfered with their ability to work (Statistics Canada 2007). The high incidence and prevalence of mental illness that often goes untreated means the human and economic costs of mental illness are considerable. In the Kamloops LHA, depression/anxiety was the most prevalent chronic condition in 2011-2012 with a prevalence of 27%, the same rate as for the Thompson Cariboo Shuswap HSDA and IHA. This compares to a prevalence rate of 25% for the province of BC (IHA 2013a, 2013b).
Asthma	Asthma has been expressed as an existing concern by Kamloops residents during public consultation about the Project. The Kamloops LHA had a crude asthma prevalence rate of 12% in 2011-2012, which is one percentage point higher than in the Thompson Cariboo Shuswap HSDA. These rates were higher than both the IHA and the provincial rate of 10% (IHA 2013a, 2013b). The implications of being diagnosed with asthma are diverse. At the extreme, economic impacts include direct medical costs (e.g., pharmaceutical costs) and indirect costs such as time lost from work and premature death (WHO 2005). Individuals diagnosed with severe asthma may also have co-morbidities, which could complicate treatment, increase the cost of treatment, and contribute to missed work and rates of premature death. In the Kamloops LHA in 2008-2009, 20% of asthma suffers were diagnosed with mental health conditions (e.g. depression, anxiety, neuroses) and 15% noted suffering from another respiratory ailment (e.g., COPD, emphysema, or chronic bronchitis).

Chronic Disease	Description
Chronic Obstructive Pulmonary Disease (COPD)	Another respiratory condition, Chronic Obstructive Pulmonary Disease (COPD), was the third most prevalent chronic condition in the Kamloops LHA. The condition is characterized by shortness of breath, cough, and increased mucus production, and usually appears in individuals 55 years of age and older (Public Health Agency of Canada 2012). According to the Public Health Agency of Canada (2012), 80% to 90% of COPD cases have smoking as their principal underlying cause. Other risk factors include exposure to second-hand smoke, occupational exposure to dusts and fumes, and outdoor air pollution. In 2011-2012, COPD had a prevalence rate of 9% in the Kamloops LHA, which was slightly higher than the rate in the Thompson Cariboo Shuswap HSDA (8%) and the broader IHA (8%). All three regions had a higher prevalence rate for COPD than the rate in the province (6%) (IHA 2013a, 2013b). The IHA is in the process of rolling out a service strategy focused on COPD to minimize the need for acute care in the health authority (Ajax KPI Program 2011-2012).

Potential Years of Life Lost

Life expectancy, mortality and causes of mortality are all indicators of health status and are described in Appendix 7.1-A, the Socio-economic Baseline for the Ajax Project. Potential Years of Life Lost (PYLL) measures the impact of death occurring at younger ages –- a measure of loss that is often preventable; and would have relevance to industrial projects through possible accidents leading to death. Table 10.7-6 provides a summary of leading causes of PYLL in the Kamloops LHA, the Thompson Cariboo Shuswap HSDA, the IHA, and BC for 2007-2011. Potential Years of Life Lost information is usually grouped by cause of death for comparison with cause-specific death rates. This measure emphasizes causes of death that tend to be more common among younger persons, such as injuries/accidents and suicide.

Table 10.7-6. Average Potential Years of Life Lost per 1,000 Population, 2007-2011

Health Conditions	Kamloops LHA	Thompson Cariboo Shuswap HSDA	Interior Health Authority	British Columbia
PYLL due to suicide/homicide	4.1	5.6	4.9	4.0
PYLL due to natural causes	33.4	35.1	32.3	29.7
PYLL due to accidents	11.8	14.4	11.2	7.0

Source: BC Stats 2012a, 2012b, 2012c.
Note: Potential years of life lost is calculated by subtracting age at death from age 75 (the standard "death age") for each person who died, and then adding all of these differences for a total PYLL. The numbers in the table, and text references below refer to averages.

Compared to the provincial rate, the PYLL due to suicide or homicide was relatively high in the Thompson Cariboo Shuswap HSDA; and slightly higher in the IHA and Kamloops LHA. Potential years of life lost due to natural causes was generally higher in all areas noted in Table 10.7-6 as compared to the provincial rate. This may be attributed to the aging demographics in the health authority areas as compared to the province as a whole. Potential years of life lost due to accidents was fairly similar in both the Kamloops LHA and the IHA, with rates less than the province. PYLL due to accidents in the Thompson Cariboo Shuswap HSDA was more than twice the provincial rate.

Health Status of the Aboriginal Population

In 2006, Aboriginal people comprised 6.3% of the population in the IHA (First Nations Health Council 2011). As indicated previously, in 2011 this percentage has risen to 7.7% in the IHA (IHA 2015).

Aboriginal peoples take a much broader, holistic view of health and wellness as illustrated in the definition of health from the First Nations Health Authority: "To live in wellness means striving to be in balance, within self (Body, Mind, Spirit and Emotion), with others (Family and Community), with the Spirit World and with the land (nature). If there is an imbalance in any of these areas there is stress on our overall system. In time this stress causes illness and it can be physical illness, mental/emotional illness (such as depression), or spiritual illness" (First Nations Health Authority 2013).

Aboriginal status itself is considered by some as one of the key determinants of health in Canada (Raphael 2004). Among the determinants of health described in Table 10.7-2, Aboriginal people are more likely than other Canadians to experience inequalities that affect health. For example, the following have been noted in the literature as health issues resulting from these inequalities (Loppie Reading and Wien 2009; Health Council of Canada 2005):

- **Education:** Aboriginal youth are less likely to complete high school, and have lower levels of formal education than the non-Aboriginal population.
- **Employment:** Lower levels of education generally means that people entering the labour market have lower levels of skills and training and are therefore limited in the types of employment they can access. Across BC and Canada, unemployment rates are higher for Aboriginal people than the non-Aboriginal population.
- **Income and social status:** Relative to non-Aboriginal populations, Aboriginal populations have higher low-income bracket representation. Annual earnings are lower than other Canadians irrespective of whether they are working full-time or part-time.
- **Social support networks:** Colonialism resulted in losses of land, language, and socio-cultural resources. The residential school system furthered these losses by removing young children from their families and communities. The legacy of residential schools has been linked to continuing challenges in Aboriginal families and communities, including difficulties establishing effective family relationships.
- **Physical environments:** Aboriginal communities often face housing shortages and people are more likely to live in crowded conditions or in homes in need of major repairs. This can result in stressors such as children having little room to study or play, or adults lacking private space to relax.
- **Personal health practices and coping skills:** Among the most relevant health behaviours by Aboriginal people are the overuse or misuse of alcohol, smoking, low levels of exercise, and poor diet.
- **Healthy lifestyle choices/behaviours:** Aboriginal communities are less likely to have community facilities and infrastructure to promote health and wellness (e.g., recreation centers, playgrounds, swimming pools).

Despite making up a relatively small percentage of the total population, the Aboriginal population in the IHA experienced a disproportionate rate of many diseases and injuries when compared to other segments of the population. For example, the Status Indian population is twice as likely to be hospitalized or more likely to be hospitalized for medically preventable conditions. In the IHA specifically, Aboriginal persons (defined as First Nations, Métis and Inuit) fare worse than other

residents for dental surgery rates for all children age 14 and younger, infant mortality rates, and mortality rates from all causes (Interior Health Authority 2010c).

The Métis population of BC also experiences health issues. In the 2006 Métis Nation BC Survey, the top health issues were arthritis, lower back pain, stomach and digestive problems, and diabetes. Additionally, Métis residents of BC were concerned about affordable dental care, long-term Elder care, mental health and addiction support, affordable prescriptions assistance, and traditional healing alternatives (Métis Nation BC 2015).

The reasons underlying the disparities in health status and access to health care between Aboriginal peoples and other segments of the population are complex. The determinants potentially affecting the gap in health and wellness between Aboriginal and non-Aboriginal BC residents include a range of non-medical determinants from higher unemployment rates, lower levels of education, poorer quality of housing, and greater food insecurity due to poverty. Some of the contributing factors to health disparities stem from historical reasons, including colonization, systemic discrimination, and the residential school experience (BC Provincial Health Officer 2009). Further information about the IHA's strategies to address Aboriginal health issues are discussed in Appendix 7.1-A, the Socio-economic Baseline for the Ajax Project.

Biophysical Environment – Air, Water, and Country Foods

Potential direct pathways of effect of the Project on human health are assessed in Section 10.4 (Human Health) and are summarized in this chapter, including characterizations of existing baseline conditions relevant to those pathways of effect.

A Human Health and Ecological Risk Assessment (HHERA) was completed (Section 10.4) for the Project in 2015 (Appendix 10.4-A). The Human Health Risk Assessment portion of the study evaluated existing (i.e., baseline) levels of human exposure to metals[1] in soils, water, vegetation, and country foods,[2] as well as air quality criteria air contaminants (CACs). The Human Health Risk Assessment considered potential effects on people living in the following Kamloops communities (shown in Figure 10.4-1):

- Aberdeen;
- Brockelhurst;
- Sahali;
- North Shore; and
- West End/Downtown.

1 Metals included aluminum, antimony, arsenic, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, thallium and uranium.
2 "Country Foods" are wild flora and fauna that are harvested for human consumption, such as fish, game meat, and berries. Country foods may also include produce from backyard vegetable gardens.

In addition to the human receptor areas located within Kamloops, three additional human receptor areas were included in the assessment:

- the Kamloops Indian Reserve #1, located on the outskirts of the city to the northeast, north of the South Thompson River;
- several ranching residences in the Knutsford community; and
- the Project area, which is within the traditional territories of several Aboriginal Group.

Baseline exposures to metals and CACs were calculated for infants, toddlers, teenagers and adults. In addition, exposures were calculated for Aboriginal infants, toddlers, teenagers and adults.

The HHERA concluded that, under baseline conditions, air quality in Kamloops does not currently represent a potential concern for human health within the HHERA LSA (see Figure 10.4-4) for either Aboriginal or non-Aboriginal communities, nor does exposure to metals via country foods and drinking water, under baseline conditions, presently pose a risk to human health. For further detail, see Section 10.4 (Human Health).

Biophysical Environment – Noise and Vibration

Two baseline noise studies have been completed and the results are provided in a noise and vibration technical report (Appendix 10.5-A). Baseline noise levels were measured in the field at selected locations within the noise study area (including two sites near the Aberdeen neighbourhood, two within the community of Aberdeen and two sites within a typical rural environment). Measurements were taken in December 2012 and June 2014. Results were compared against the BC Oil and Gas Commission Noise Control Best Practice Guideline (BC OGC 2009) and the U.S. Environmental Protection Agency (US EPA 1974) Office of Noise Abatement and Control Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. Table 10.7-7 provides the summarized results of the baseline sound level results for the entire measurement period at each location as compared to applicable guidelines. There was no baseline vibration study for the Project because vibration levels are typically assessed for the event (i.e., blasting) without consideration of a baseline level. In addition, most guidelines and regulatory limits are only applicable to the event without consideration of a baseline level (Appendix 10.5-A).

Table 10.7-7. Baseline Monitoring Results – Daytime, Night time, and Day-Night Equivalent Sound Level Summary – Entire Measurement Period

			Daytime		Night-time		Day-Night Equivalent	
ID	Monitoring Location	Time Period	Measured L_d (dBA)	BC OGC L_d (dBA)	Measured L_n (dBA)	BC OGC L_n (dBA)	Measured L_{dn} (dBA)	US EPA L_{dn} (dBA)
1	Abbeyglen/Pacific Way intersection	Dec 1-5, 2012	44	51	36	41	45	48-52
2	South of the Aberdeen community	Dec 5-12, 2012	39	51	36	41	43	48-52
3	Pacific Way and Howe Road intersection	Dec 16-21, 2012	50	61	43	51	51	48-52

ID	Monitoring Location	Time Period	Daytime		Night-time		Day-Night Equivalent	
			Measured L_d (dBA)	BC OGC L_d (dBA)	Measured L_n (dBA)	BC OGC L_n (dBA)	Measured L_{dn} (dBA)	US EPA L_{dn} (dBA)
4	Jacko Lake	June 10-15, 2014	39	45	36	35	43	44
5	Straw House	June 10-15, 2014	39	45	34	35	42	44
6	Aberdeen Residence	June 10-15, 2014	53	51	45	41	54	53-57

Source: Stantec 2015.

The baseline results show the following:

- Existing noise levels at all locations except for the Aberdeen residence were below BC OGC guidelines for daytime noise levels;
- Existing noise levels for all locations except for Jacko Lake and the Aberdeen residence were below BC OGC guidelines for night-time noise levels; and
- Existing noise levels for all locations were either below or within the Day-Night equivalent US EPA ranges noted for day-night equivalent noise levels.

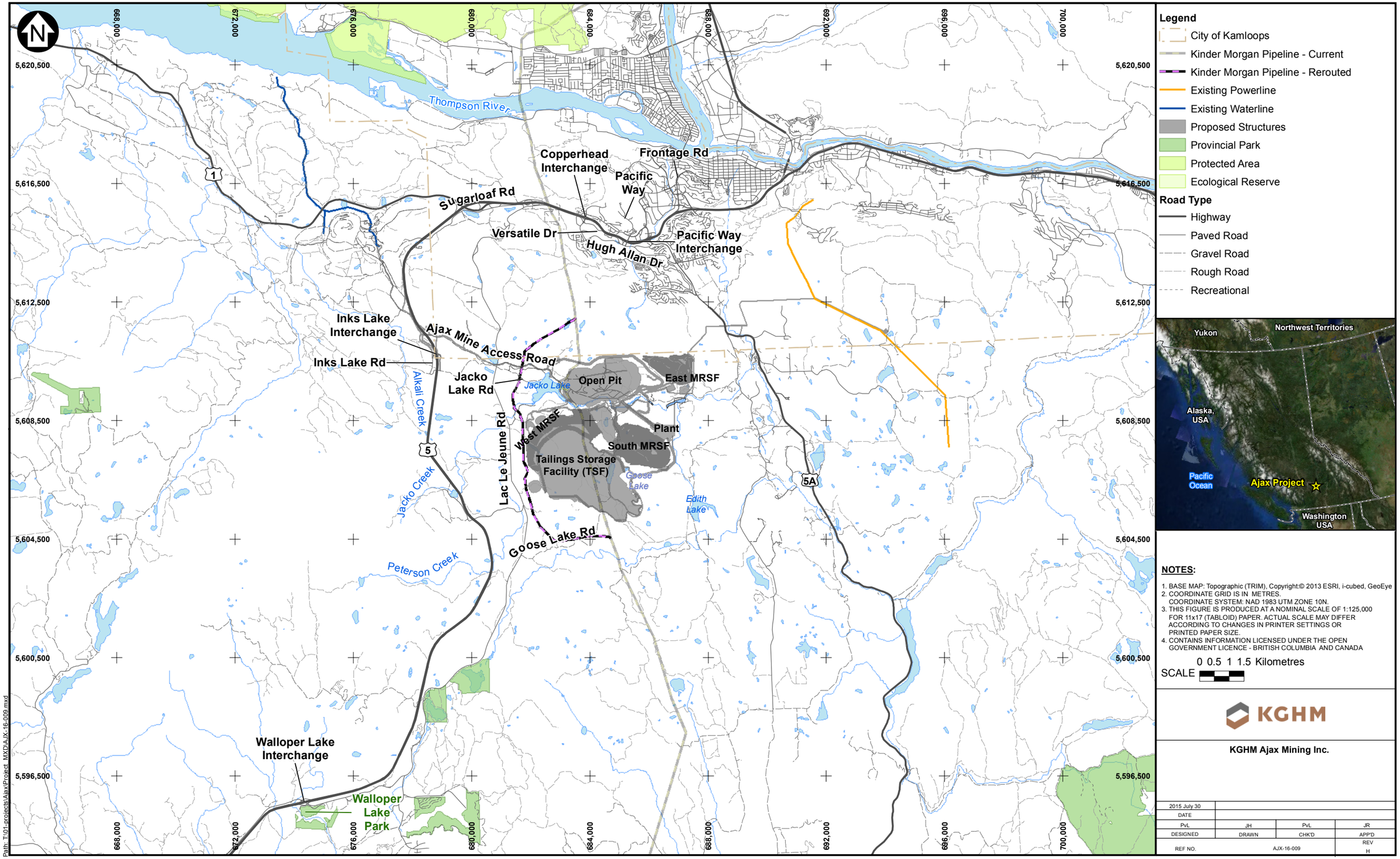
As stated in Stantec (2015), it is not uncommon to have sound values above or below the guideline levels; however, the measured values provide an indication of the average acoustic environment for each location, and provide baseline levels for which comparisons with the Project can be made. For further detail, refer to the Noise and Vibration Technical Data Report (Appendix 10.4-A).

Traffic

A Traffic Impact Assessment (TIA) was undertaken by Opus International Consultants (Canada) Limited (Opus 2015), in consultation with KGHM Ajax Mining Inc (KAM), the City of Kamloops and the Ministry of Transportation and Infrastructure (MoTI) (see Appendix 8.1-A). The TIA study area is illustrated in Figure 6 of Appendix 8.1-A. Figure 10.7-3 shows the road network near the Project. The TIA includes analysis of Project traffic impacts on the existing road network, road network operation and property access impacts resulting from changes to the road network (e.g., the closure of part of Goose Lake Road), identify potential safety issues, and develop conceptual designs for Project site access roads. More detailed discussion describing traffic volumes is contained in Section 8.1, Infrastructure, Public Facilities, and Services.

The major transportation routes through Kamloops include the Trans-Canada Hwy (No. 1) running east-west, the provincial Yellowhead Hwy/Coquihalla Hwy (No. 5) running north-south, and the Princeton-Kamloops Hwy (No. 5a) running south of Kamloops to Princeton. Provincial Hwy 5 is known as the Coquihalla south of Kamloops and connects with Hwy 97C in Merritt. The Coquihalla is the primary highway route connecting Kamloops with the Lower Mainland of BC. It is part of the National Highway System and part of the principal trans-provincial route, carrying approximately 10,000 vehicles per day (vpd) in the rural sections and up to 46,000 vpd within Kamloops. The on-ramp at the Inks Lake Interchange does not meet current Transportation Association of Canada (TAC) geometric design requirements for ramps (Opus 2015).

Figure 10.7-3
Road Network near the Project



NOTES:

1. BASE MAP: Topographic (TRIM), Copyright© 2013 ESRI, i-cubed, GeoEye
2. COORDINATE GRID IS IN METRES.
   COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:125,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
4. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - BRITISH COLUMBIA AND CANADA

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KGHM Ajax Mining Inc.

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There are several secondary and rural roads to the south of Kamloops that are in the vicinity of the proposed Project. These include Lac Le Jeune Road, a paved two-lane arterial public road that is approximately 23 km long. It has marked centerline and no shoulder lines. LLJR is used primarily by passenger vehicles, with commercial vehicles generally restricted to the north of the road, near the existing industrial development. Average Daily Traffic (ADT) in the vicinity of Inks Lake Road is about 825 vehicles per day and the mean speed of traffic consistently exceeds the 80 kilometre per hour speed limit in both directions. Lac Le Jeune Road becomes Frontage Road to the north and intersects Copperhead Drive in Kamloops, where there is an interchange with Hwy 5. To the south, Lac Le Jeune Road becomes Meadow Creek Road at the location where the road connects to Hwy 5 at the Walloper Lake interchange, Exit 336 from Hwy 5. Lac Le Jeune Road provides access to a small industrial park near Kamloops, Iron Mask Trailer Park, private agricultural land, recreational land, and three provincial parks (Figure 8.1-2). Currently, the existing LLJR is operating below the Level of Service design standards established by both the BC Ministry of Transportation and Infrastructure (MoTI) and the City of Kamloops and has been identified as needing improvement (Opus International 2015).

The Ajax Mine Access Road (AMAR) is an existing private road that connects an existing decommissioned open pit formerly operated by the Afton Operation Corporation with the New Afton Mine site on the west side of Highway 5. It is approximately 2.5 km in length from Highway 5 to the Lac Le Jeune Road (Opus 2015).

For details on other roads and interchanges in the traffic study area (e.g., Sugarloaf Road, Goose Lake Road, Inks Lake Road, Jacko Lake Road, Copperhead Interchange and Pacific Way Interchange), please see Appendix 8.1-A.

Under base conditions, the TIA indicates that all intersections included in the traffic study area and associated movements perform within the desired thresholds with some exceptions.[3] Recommendations on improvements are noted in the TIA (see Appendix 8.1-A)

The TIA compiled base traffic volumes using traffic data from MoTI for various locations and intersections in the traffic study area, as well as installed traffic counters to collect data at two locations on Lac Le Jeune road in the summer of 2012. The resulting traffic count data were analysed, and growth rates were used to estimate the projected traffic volumes for various intersections and interchanges for future horizon years (2016, 2018, 2024 and 2039); these projected

[3] Intersections requiring improvement include Pacific Way/Hugh Allan Drive and Highway 1/5 Westbound Ramps and Versatile Drive/Hugh Allan Drive south-bound lane roundabout under 2016 and 2018 base conditions; further decline is noted under 2024 and 2039 base conditions requiring additional improvements to storage lengths for turning movements and for the southbound lane entering the roundabout.

traffic volumes provide the anticipated base volume (i.e., without the Project) traffic volumes for these future years (Table 10.7-8).[4]

Table 10.7-8. Base Traffic Volumes

Road	Segment	Direction	# Lanes	Base Volume (AADT)			
				2016	2018	2024	2039
HWY 5	Ironmask I/C to Copper-head I/C	EB	3	7,658	7,843	8,425	10,076
		WB	3	7,658	7,843	8,425	10,076
	Inks Lake I/C to Ironmask I/C	NB	2	4,946	5,065	5,441	6,507
		SB	2	4,946	5,065	5,441	6,507
	Walloper I/C to Inks Lake I/C	NB	2	4,946	5,065	5,441	6,507
		SB	2	4,946	5,065	5,441	6,507
LLIR	Sugarloaf Rd to AMAR	NB	1	535	771	828	991
		SB	1	270	390	419	501
	AMAR to Goose Lake Rd	NB	1	535	771	10	13
		SB	1	270	390	10	13
AMAR (new road)	LLIR to Project Site	EB	1	0	9	10	13
		WB	1	0	9	10	13
	Highway 5 to LLJR	EB	1	0	9	10	13
		WB	1	0	9	10	13

Source: Opus 2015

The TIA also analysed collision statistics data from the Insurance Corporation of British Columbia (ICBC) and police records, between 2007 and 2011, for road sections near the Project including Lac Le Jeune Road, Highway 5 and Goose Lake Road. Table 10.7-9 provides a summary of this data.

Table 10.7-9. Summary of Traffic: Collision Data, 2007-2011

Road	ICBC		Police	
	Total Collisions	Severity Split	Total Collisions	Severity Split
Lac Le Jeune Road[1]	12	25% casualty 73% property damage	6	33% casualty 67% property damage
Highway 5	25	32% casualty 68% property damage	75	39% casualty 61% property damage
Goose Lake Road	3	100% property damage	0	

Source: Opus 2015
Note: according to the TIA, none of the collisions occurred near the Ajax Mine Access Road overpass.

[4] Estimates of future traffic volumes have incorporated estimates for traffic related to the Gateway Casino development, on the assumption that the casino development is completed by 2016. Further, as requested by the City and MoTI, planned road network improvements were also included in the assumptions.

The TIA also reported on the timing of the Lac Le Jeune Road and Highway 5 collision data, noting the following trends:

- For Lac Le Jeune Road, 50% of both ICBC and police records had collisions during the winter months of January and February, as well as clusters around both peak AM and PM hours when traffic volumes are highest.
- For Highway 5, collisions increased in the winter months, showing increased rates during the weekdays and spike during the PM peak rush hours. This is most evident in the police record data.

According to the ICBC statistics, the majority (i.e., 76%) of Highway 5 collisions were at the Highway 1 interchange; whereas 58% of Lac Le Jeune collisions were at the Sugarloaf Road intersection.

Health System Delivery Indicators

The IHA is responsible for administering health care services in the communities in the LSA and RSA. Facilities range from Community Health Centres, which offer a variety of services from basic laboratory and radiology to long-term residential care, to hospitals in Ashcroft, Clearwater, and Kamloops. Royal Inland Hospital (RIH), which is located in Kamloops, is the primary medical facility in the Thompson-Nicola Regional District (TNRD). Kamloops is located in the Kamloops LHA, which is part of the Interior Health Authority (IHA). The RSA is the Thompson Cariboo Shuswap HSDA (see Figure 10.7-2 for a map of the relevant health authority boundaries). Healthcare services in Kamloops are currently facing challenges in two areas: a chronic shortage of family doctors and capacity at the RIH.

In 2009-10, which is the last year for which statistics at the LHA level were publicly available through the IHA for the LHAs, in the Kamloops LHA, there were 1.1 general practitioners per 1,000 population (IHA 2010). These rates were comparable for the Thompson-Cariboo Health Service Delivery Area (RSA), which had 1.1 general practitioners per 1,000 population and the larger IHA, which had 1.3 general practitioners per 1,000 population (IHA 2010). These rates are lower than ratios reported by Statistics Canada (2012) for British Columbia, which had a rate of 1.34 per 1,000. More recent statistics from the Canadian Institute for Health Information are available for the Thompson/Cariboo Health Region. According to the Canadian Institute for Health Information (2014), there were 1.2 physicians per 1,000 population in 2013. The shortage of family doctors in the LHA is not unique to the area as the provincial and national rates were 1.2 family medicine physicians per 1,000 population and 1.1 per 1,000 population, respectively. To counter the current shortage, there has been a concerted recruitment effort involving the Thompson Region Division of Family Practice and Venture Kamloops, along with a recently established program through the RIH to recruit family physician residents. The recruitment efforts will bring six new family physicians to Kamloops and the RIH residency program has brought in six residents (Venture Kamloops 2014).

The RIH in Kamloops operates above its capacity (IHA 2013c) as occupancy for inpatient beds has increased every year (Ajax KPI Program 2011-2012, 2014-2015; IHA 2013c). There have been a small number of inpatient beds added and strategies are in place to lower the number of alternate level care days, which would free up beds. Additionally, a new clinical services building for out-patient

diagnostics is currently under construction. The facility is expected to open in May 2016. It will free up space in the RIH but how the space will be used is currently being discussed (Ajax KPI Program 2011-2012, 2014-2015).

The emergency department at the RIH is also an area of concern in connection with capacity. Unscheduled visits to the emergency department have increased by close to 5,000 visits from 49,748 visits in 2009-10 to 56,695 visits in 2012-13 (IHA 2012, 2013c). The reasons for the increase in visits include a lack of family physicians in general and the lack of care alternatives available on weekends (Ajax KPI Program 2011-2012). To help alleviate some of the pressure on the emergency department, the RIH is working on a number of initiatives to improve access and flow, including stronger relations with community partners to smoothly transition patients out of hospital care, and planning to use out-patient clinics more effectively to increase access to hospital beds (Ajax KPI Program 2011-2012, 2014-2015).

Indicators of health services delivery measure various aspects of health care including access, efficiency and utilization. From 2010-2011 to 2012-2013, acute care statistics indicate that the Kamloops LHA had roughly equivalent rates of inpatient cases, acute/rehab days, and emergency department visits as the Thompson Cariboo Shuswap HSDA (see Appendix 7.1-A, Socio-economic Baseline for the Ajax Project, for details on acute care statistics). The similarities between rates may reflect the fact that the Kamloops LHA makes up the highest proportion of population in the HSDA.

Community Care Services fall under the IHA's Community Integrated Services, which include initiatives that strengthen primary care services. In the Kamloops LHA there were about 74 home support clients for every 1,000 people over the age of 75. The number of clients per 1,000 population age 75 and older has been increasing. The aging population in Kamloops may exacerbate this situation and affect the quality of care for older individuals. A new residential care facility opened in the fall of 2013, housing 125 publicly funded beds and 5 private-pay beds. The facility will offer programs for physically frail seniors and seniors in mild-to-moderate stages of dementia (Ministry of Health and Interior Health 2013).

The Q'wemtsin Health Society (QHS) provides health care services on-reserve to TteS and SIB members. On-reserve healthcare is under the jurisdiction of the First Nations Health Authority. The TteS health centre is currently without a doctor and the Nurse Practitioner, who is in the community two days a week, cannot always meet demand. Similar to the situation in Kamloops, there is a long list of TteS members who are in need of a family doctor. The clinic on the Skeetchestn IR is attended by a variety of staff throughout each week and month (Q'wemtsin Health Society, pers. comm. 2015).

Community Well-Being Index

The Community Well-Being (CWB) Index uses data from Statistics Canada about education, labour force, income, and housing to provide "…a relatively quick and convenient measure of well-being, focusing on the socio-economic dimensions" (Murphy 2010). A community's CWB index score is a single number that can range from 0 to 100. Lower numbers indicate poorer levels of community well-being. The component scores consider the following:

- **Income**, which is based on income per capita;

- **Education**, which factors in the proportion of a community's population, 20 years and older, that has at least a high school certificate and the proportion of a community's population, 25 years and older that has at least a bachelor's level degree;
- **Housing**, which comprises indicators on housing quantity and quality; and
- **Labour Force Activity**, which quantifies the labour force participation and employment rate in the community (INAC 2010).

Of the three component scores, education, income, and housing are generally acknowledged as key non-medical determinants of health. Detailed information about the communities on all these topics and on labour force activity can be found in Appendix 7.1-A (Section 2.1 presents information on detailed educational attainment rates; Section 2.2 discusses personal income, family income, household income, and income composition; Section 2.2 discusses household characteristics; and Section 2.1 discusses labour force activity, including labour force participation rates and employment rates).

As of 2011, the City of Kamloops had a Community Well-Being (CWB) Index score of 84 (Table 10.7-10). The component scores for Kamloops range from 64 for education to 96 for housing. Its component scores for income and labour force activity were both in the high 80s. Kamloops IR 1 (a TteS Indian Reserve adjacent to the city) had a CWB Index score of 82 in 2011 (Table 10.7-10). Kamloops IR 1 had scores of 94 for both Income and Housing, 60 for Education and 81 for Labour Force Activity. The Skeetchestn IR had scores ranging from a low of 44 for Education, to a high of 86 for Housing; with an overall CWB Score of 69.

Table 10.7-10. Community Well-being Index, 2011

Census Subdivision (CSD) Name	2011 Income Score [3]	2011 Education Score [4]	2011 Housing Score[5]	2011 Labour Force Activity Score [6]	2011 CWB Score	2011 Population
Kamloops	89	64	96	86	84	83,730
Kamloops IR 1[1]	94	60	94	81	82	2,540
Skeetchestn[2]	70	44	86	78	69	250

Source: AANDC 2015
Notes:
The T'kemlups Indian Band is listed as Kamloops 1 by Statistics Canada and is for on-reserve population only. Scores such as the Income score, are likely influenced by the predominantly non-Aboriginal Sun Rivers development that exists on reserve.
Skeetchestn First Nation is listed as Skeetchestn by Statistics Canada and is for on-reserve population only.
Composed of data on income per capita.
Relates to 1) the proportion of a community's population, 20 years and over, that has obtained at least a high school certificate and; 2) the proportion of a community's population, 25 years and over, that has obtained a university degree at the bachelor's level or higher.
Composed of indicators relating to housing quantity and quality.
Relates to labour force participation and employment rate.

Kamloops had higher component scores for Education, Housing and Labour Force Activity as compared to either Kamloops IR 1 and Skeetchestn; however, Kamloops IR 1 scored higher for Income as compared to the other two. Skeetchestn had lower component and aggregate scores than both Kamloops and Kamloops IR 1 (AANDC 2015).

Community Image

There are many ways that a community's image can be described. In public consultation to date, some residents of Kamloops have expressed concern with respect to the Project and how it may influence the overall image of the community. Consideration is given below to citizen perspectives about what contributes to quality of life in Kamloops, followed by a description of the official vision and community plan for the city.

Quality of Life

The most recent publicly available survey related to quality of life was undertaken by Ipsos Reid in 2012. This study found that "weather/climate" was the top feature that contributed to quality of life in the city of Kamloops (identified by 40% of citizens), followed by "recreational/sports activities and facilities" (22%), "friendly/nice people" (19%), "location/proximity to other places" (16%), "scenery/landscape" (15%), "size of the community" (13%), and "outdoor activities (walking, hiking, biking, skiing" (12%).

In 2012, the vast majority of citizens (98%) found that the quality of life in Kamloops was positive, with 43% indicating that qualify of life was "good" and 55% indicating it was "very good." The majority of citizens (62%) found that the quality of life in Kamloops has stayed the same over the previous three years, while 28% thought it had improved and 8% thought it had worsened. The results were consistent with what was reported in 2009. In comparison, residents of other British Columbian municipalities generally think their quality of life has stayed the same over the past few years. Reasons why quality of life had improved included "economic growth (more businesses/more industry)" noted by 16% of citizens, with 8% of respondents indicating there were more "jobs/employment opportunities". Other contributors to improved quality of life included "growth/development" (14%), "better shopping/more retailers" (12%), "improved infrastructure" (10%), "more services/amenities (unspecified)" (10%), among other things. The 2012 results were different from what was reported in 2009, when the number one reason for feeling the quality of life had improved was "more/improved recreational facilities" (Ipsos Reid 2012).

For those citizens who thought the quality of life in Kamloops had worsened, factors included "high unemployment/no job opportunities" (20%), "economic downturn" (11%), and "higher cost of living" (10%), which suggests that the benefits of economic growth had not been experienced by all citizens. Other factors contributing to a decline in quality of life included "crime issues/high crime rate" (17%), and "local government/City Council" (11%), among other items (Ipsos Reid 2012).

The Ipsos Reid survey (2012) asked citizens what they thought were the most important issues facing the community. The top items cited in survey responses included:

- Mines/the Ajax mine (31%);
- Transportation (20%);
- Taxation/Municipal Government Spending (10%); and
- Social issues (10%).

The 2012 survey noted that comparisons to previous surveys showed substantial changes in what was on the public issue agenda over the past few years. For example, the main 2012 issue (mining) was not even mentioned in 2009. Transportation-related topics increased 7 points in 2012; while social concerns, which were the leading issue in 2009, dropped 8 points. When comparing these results to other BC municipalities, Kamloops showed several differences. For example, mines/mining are not top of mind in other BC municipalities – the key issue for others is primarily focused on transportation-related issues (24%). The second most common items for other municipalities are social-related topics; followed by growth (Ipsos Reid 2012).

Community Vision

The desired image of the City of Kamloops has been framed by the Community Vision outlined in the Official Community Plan or KAMPLAN (City of Kamloops 2004). Key tenets of this Vision include:

- Building strong and diverse neighbourhoods;
- Providing a variety of housing types;
- Encouraging healthy and active lifestyles;
- Supporting cultural and athletic pursuits;
- Diversifying economic and educational opportunities; and
- Maintaining sustainable environmental stewardship.

The current iteration of the KAMPLAN has served as a basis for community development since 2004. All other planning processes and documents tie back to this document and the Vision above. Taken as a whole, this helps to frame how the city of Kamloops envisions itself – its community image. This image has changed over the last several decades, as described below.

Much of the evolution of Kamloops' image stems from the development of its economic base. Through much of its history, Kamloops was heavily reliant on resource extraction industries like mining and forestry, although agriculture (primarily ranching) was also very prominent; this is reflected in the opinion of some residents that Kamloops was "an industry town.".

Within the past decade however, there has been a notable shift in the community's image. This image is one that largely reflects the Vision points as outlined in the KAMPLAN. A surge in community pride has led to a perception of the community as one that is clean, healthy, beautiful and can facilitate exceptional quality of life. Key contributors to this include:

- **Adoption of the Tournament Capital brand:** This branding first developed in the early 1990s when Kamloops hosted the Canada Summer Games. In 2003, city residents agreed to fund the required sports and related infrastructure through municipal taxes. The campaign enjoys wide support from the public (with good levels of volunteerism) and leadership (City of Kamloops and InterGroup Consultants 2012). Kamloops has hosted major events such as the 2006 IHF World Junior Hockey Championships, the 2010 National Gymnastics Championships, and the 2011 Western Canada Summer Games (City of Kamloops 2015).

- **Economic diversification:** There is a view from some residents of Kamloops that the city has become much more diversified from an economic point of view; less heavily reliant on resource extraction and more diversified in the areas of health, education and public administration.
- **Focus on sustainable development:** Kamloops has given attention to sustainability for decades. The Sustainable Kamloops Plan outlines the vision for a sustainable Kamloops and sets out principles to move forward (City of Kamloops 2010).
- **Participation in the Communities in Bloom program:** Communities in Bloom originally began in Canada as part of an international challenge in which communities are judged on eight criteria: tidiness, environmental action, heritage conservation, urban forestry, landscape, turf and groundcovers, floral displays, and community involvement (Communities in Bloom 2012). Kamloops was a winner in 2004 and 2009 as a National Community in Bloom; and in 2006 was an International Communities in Bloom winner. It was hoped that participating in the program would help beautify the community (City of Kamloops and Intergroup Consultants 2012). Based on the 2009 Citizen Survey, it appears that the program is working; 95% of residents had a positive opinion of the City's appearance (Ipsos Reid 2009). In addition to beautifying Kamloops, the program hopes to cultivate civic pride, environmental responsibility and encourage residents to be more involved in their community (City of Kamloops n.d.b.). In the City of Kamloops, the Communities in Bloom Committee serves in an advisory role to the Mayor, City Council and appropriate City departments (e.g., Parks, Recreation and Culture) (City of Kamloops 2012a).
- **Improvements in municipal water quality:** Kamloops' water treatment systems have undergone a period of renewal and improvement since February 2005, beginning with a new water treatment centre and ending with a water main flushing program in 2008 (Net Resources International 2012).
- **Improvements in air quality:** The development of Kamloops' Airshed Management Plan took place from 2010 through July 2012. Key strategies outlined to improve and maintain air quality include limiting contaminant emissions from industrial and other sources and expanding the role of local government to act on concerns (City of Kamloops 2012b).

The resulting civic pride and engagement can be measured through a variety of indicators, including voting, volunteering, and participating in civic events (CIRCLE n.d.). Voter turnout rates are a well-accepted measure of civic engagement (Uppal and LaRochelle-Côté 2012). Higher voter turnout rates mean that residents have greater confidence in government institutions and administration (Organisation for Economic Co-operation and Development n.d.). During the November 2011 municipal elections in BC, the voter turnout rate in Kamloops was 29.76%, which was consistent with provincial turnout rates of 29.55% (Civic Info BC 2011).

Volunteer rates are also believed to correlate with civic pride. As residents feel better about their community, they want to participate in community activities. This important theme was raised during discussions with the City of Kamloops: community residents currently take great pride in Kamloops and are concerned about anything that may jeopardize that (City of Kamloops and InterGroup Consultants 2012). One of the selling points for the Tournament Capital of Canada brand

is the pool of volunteers available to help out at events. The City also has a non-profit organization, Volunteer Kamloops, which helps fill volunteer opportunities throughout the community (City of Kamloops 2012c). During the 2011 Western Canada Summer Games, over 2,300 residents of Kamloops volunteered (City of Kamloops 2012d).

10.7.3 Assessment Boundaries

10.7.3.1 Spatial Boundaries

Spatial boundaries for baseline studies for Community Health and Well-being focused on two of the LHAs (Kamloops and North Thompson) within the Thompson Cariboo Shuswap HSDA, with a particular focus on the community of Kamloops as the closest community and service centre to the Project (see Figure 10.7-2 provided previously). Baseline studies (as noted in Section 10.7.2.3) collected data to address the following potential pathways by which the Project could influence community health and well-being: changes in the biophysical environment (air, water quality, country foods), changes in noise and vibration, increased income, the presence of a temporary workforce (during construction), changes (or perceived changes) to the delivery of healthcare services, community image and sense of quality of life, and Project-related traffic.

For the purposes of the effects assessment, the spatial boundaries consider the extent to which Project effects may accrue from other related VCs (i.e., air quality, water quality, noise and vibration, and HHERA), in addition to the other pathways to health and well-being. This includes consideration of direct and indirect effects on Community Health and Well-being.

Local Study Area

The LSA for Community Health and Well-being coincides with the Kamloops LHA. The LHA includes: the City of Kamloops, the communities of Knutsford, Savona, Logan Lake, and Chase; the Indian Reserves (IRs) for SSN (Kamloops IR 1 [TteS] and Skeetchestn IR [SIB]), IRs for the Whispering Pines/Clinton Indian Band and IRs for the Lower Nicola Indian Band (see Figure 10.7-4). Particular focus, however, is paid to those areas in closest proximity to the Project, including residents of areas in proximity to the Project Footprint (such as Aberdeen and Pineview Valley neighbourhoods and Kamloops IR 1 (TteS reserve land north of the Thompson River and adjacent to the city), and the City of Kamloops. This is due to the fact that certain pathways of effect to Community Health and Well-being are unlikely to extend beyond areas in close proximity to the Project (such as noise and vibration), while others (such as those associated with income) may have a broader reach but not have the same magnitude.

Regional Study Area

The Thompson Cariboo Shuswap HSDA was chosen as the RSA as it is the next largest division in the health authority structure and Statistics Canada provides data and reporting at that level. The Thompson Cariboo Shuswap HSDA includes the Kamloops LHA and is a subset of the much broader Interior Health Authority (see Figure 10.7-5).

10.7.3.2 Temporal Boundaries

The temporal phases of the Project are as follows:

- **Construction Phase**: 2 years;
- **Operation Phase**: 23 years;
- **Decommissioning and Closure Phase**: 5 years (includes project decommissioning, abandonment and reclamation activities, as well as temporary closure, and care and maintenance); and
- **Post-Closure Phase**: 5+ years (includes ongoing reclamation activities and post-closure monitoring).

10.7.3.3 Administrative Boundaries

Administrative boundaries influenced the characterization of baseline information and the selection of the LSA and RSA boundaries. Health indicator data were available for administrative health areas such as the Kamloops LHA, the Thompson Cariboo Shuswap HSDA, and the IHA. Information regarding community image and associated quality of life relied on secondary data (e.g., published reports, the KAMPLAN), which was confirmed through workshops with key stakeholders along with public engagement outcomes. Baseline information regarding Aboriginal health was limited to secondary data sources, and often limited to specific Indian Reserve boundaries.

Although the information presented in this section is considered an accurate representation of Community Health and Well-being, it may not reflect the perspectives of all residents in the LSA and RSA. Many aspects of community well-being—including quality of life and community image—are subjective and will vary based on the interests, priorities, and socio-economic circumstances of respondents.

10.7.3.4 Technical Boundaries

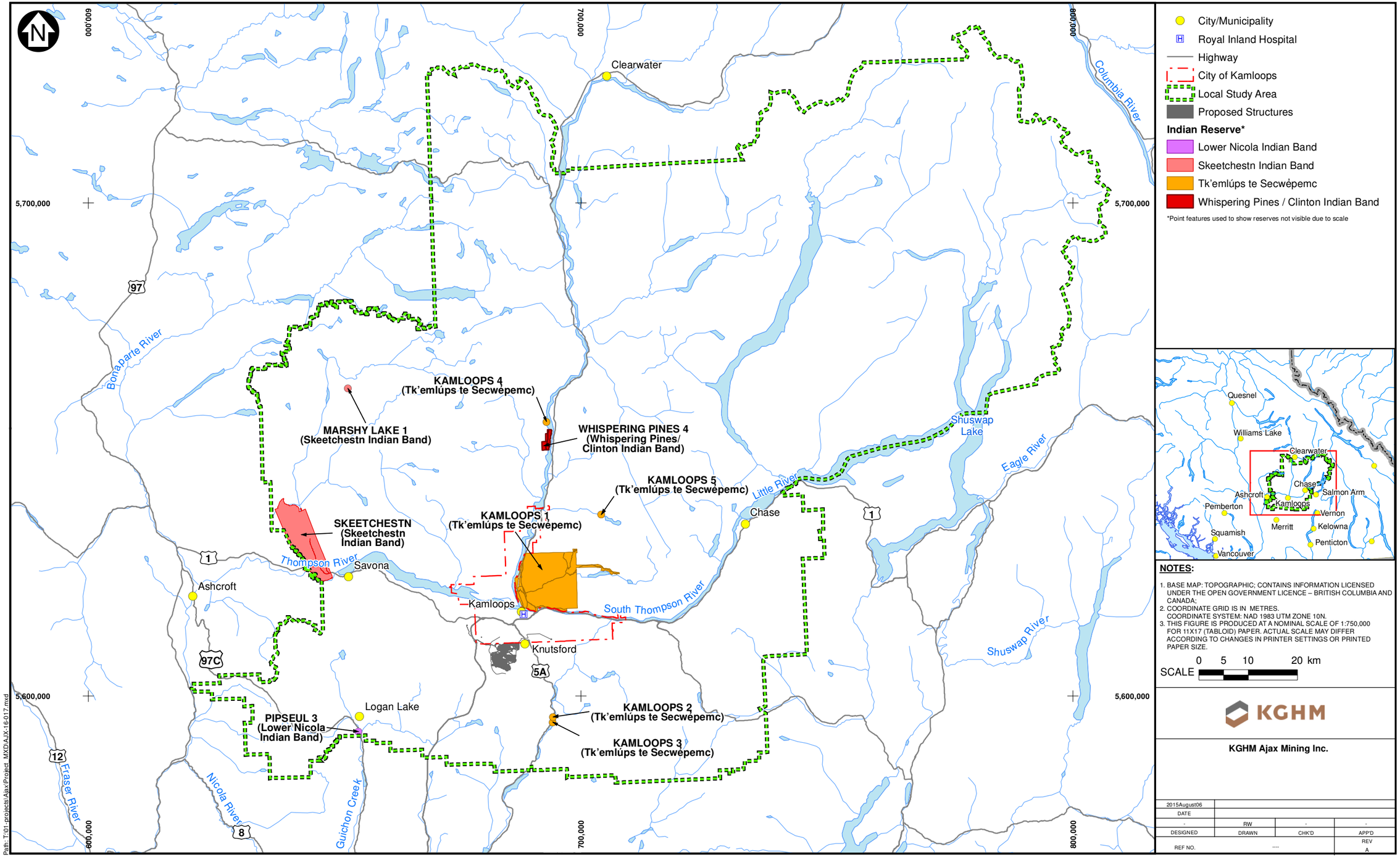
Sources of uncertainty associated with the assessment of effects to Community Health and Well-being include:

- Health determinants are affected by many factors beyond those which may be connected to the Project, thus it is very difficult to isolate the specific effects of Project changes;
- Some influences may be positive and others negative; in fact, the same source of change can have both positive and negative consequences in some cases (i.e., income); and
- There are uncertainties associated with some predictions made in the assessment (e.g., degree to which an effect may be experienced by an individual, a neighbourhood, or a community as a whole).

For these reasons, the assessment of effects to Community Health and Well-being is focused on areas where effects are most likely to occur, with the aim of identifying appropriate strategies to avoid adverse effects or address them as they arise, either through mitigation or adaptive management.

Figure 10.7-4
Local Study Area

InterGroup CONSULTANTS



NOTES:

1. BASE MAP: TOPOGRAPHIC; CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE – BRITISH COLUMBIA AND CANADA;
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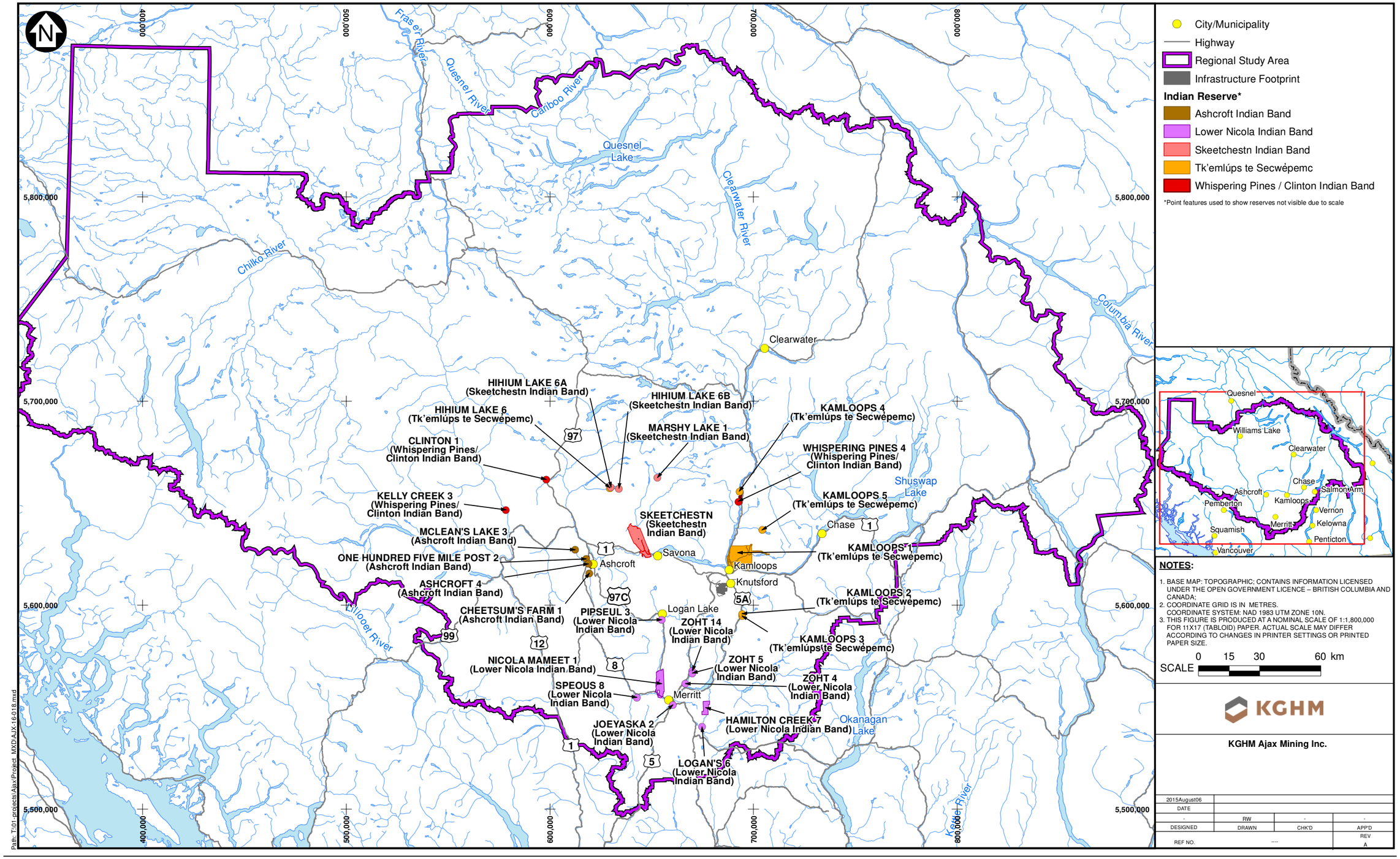
Figure 10.7-5
Regional Study Area

InterGroup CONSULTANTS



NOTES:

1. BASE MAP: TOPOGRAPHIC; CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE – BRITISH COLUMBIA AND CANADA;
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:1,800,000 FOR 11X17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

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KGHM Ajax Mining Inc.

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10.7.4 Potential Effects of the Project and Proposed Mitigation for Community Health and Well-being

10.7.4.1 Identifying Potential Effects on Community Health and Well-being

Previously in this chapter, it was noted that there are many factors that may affect health, when considered broadly. Correspondingly, there are multiple potential pathways through which the Project could affect Community Health and Well-being. Changes in other VCs may affect Community Health and Well-being.

Table 10.7-11 presents potential effects of the Project on Community Health and Well-being by phase, and the potential that Project activities and components may cause or contribute to these effects. Potential effects include:

- Changes to the biophysical environment may affect community health and well-being;
- Increased noise and vibration may affect overall community health and well-being;
- Project-related traffic could result in increased collision and accident incidence on public roads;
- Project workforce may stress the provision of community health services;
- Change in income generation may affect community health and well-being; and
- Project proximity to the City of Kamloops may affect community image and residents' perceived quality of life.

The Project may also affect outdoor recreation activities. Section 8.6 (Outdoor Recreation) assesses the potential effects of the Project on outdoor recreation activities during all Project phases. The assessment considers potential effects related to reduced access, changes to natural resources (e.g. fish and game), and the overall quality of outdoor recreation (including the influences of noise, air quality, and other effects). Various outdoor recreation activities were considered including fishing, biking, walking, and other pursuits. With appropriate mitigation, Section 8.6 concludes that no significant adverse effects on outdoor recreation will result from the Project. Therefore, no potential effects to community health and well-being are identified.

Three of the potential effects identified in Table 10.7-11 are considered to have minor, negligible, or no interactions with the Project:

- Changes to the biophysical environment may affect community health and well-being;
- Increased noise and vibration may affect overall community health and well-being; and
- Change in income generation may affect community health and well-being.

Table 10.7-11. Identifying Potential Project Interactions and Effects on Community Health and Well-being

Project Activities		Potential Effects on Community Health and Well-being					
		Changes to the Biophysical Environment May Affect Community Health and Well-being	Increased Noise and Vibration May Affect Community Health and Well-being	Project-related Traffic Could Result in Increased Collision and Accident Incidence on Public Roads	Project Workforce May Stress the Provision of Community Services	Change in Income Generation May Affect Community Health and Well-being	Project Proximity to the City of Kamloops May Affect Community Image and Residents' Perceived Quality of Life
Construction	Clearing and Grubbing	L	L	M	M	O	M
	Earthworks	L	L	M	M	O	M
	Overburden/Topsoil Stockpile	L	O	M	M	O	M
	Laydown Areas and Storage Yards	L	O	M	M	O	M
	Project Lighting	L	O	M	M	O	M
	Site Security and Fencing	L	O	M	M	O	M
	Fuel Storage and Filling Area	L	O	M	M	O	M
	Hazardous Wastes Transport, Storage, and Disposal	L	L	M	M	O	M
	Construction Wastes Transport, Storage, and Disposal	L	L	M	M	O	M
	Sewage Infrastructure and Disposal	L	O	M	M	O	M
	Public Road Realignment, Use, and Maintenance	L	O	M	M	O	M
	Site Road Construction, Use and Maintenance	L	L	M	M	O	M
	Mine Haul Road Construction, Use, and Maintenance	L	L	M	M	O	M
	Site Buildings and Process Plant	L	L	M	M	O	M
	Explosives Magazine and Storage Facilities	L	O	M	M	O	M
	Open Pit Development	L	L	M	M	O	M
	Drilling and Blasting	L	L	M	M	O	M
	Crushing mine Rock	L	L	M	M	O	M
	Loading, Hauling, and Deposition of Mine Rock	L	L	M	M	O	M
	Temporary Ore Stockpile	L	O	M	M	O	M
	Tailing Storage Facility Development	L	L	M	M	O	M

Project Activities		Potential Effects on Community Health and Well-being					
		Changes to the Biophysical Environment May Affect Community Health and Well-being	Increased Noise and Vibration May Affect Community Health and Well-being	Project-related Traffic Could Result in Increased Collision and Accident Incidence on Public Roads	Project Workforce May Stress the Provision of Community Services	Change in Income Generation May Affect Community Health and Well-being	Project Proximity to the City of Kamloops May Affect Community Image and Residents' Perceived Quality of Life
Construction (*cont'd*)	Power Transmission, Distribution	L	L	M	M	O	M
	Natural Gas Line	L	O	M	M	O	M
	Pipeline Utility Corridor (Potable Water, Sewage, and Site Water)	L	O	M	M	O	M
	Water Intake from Kamloops Lake	L	O	M	M	O	M
	Fire Suppression Infrastructure	L	O	M	M	O	M
	Contact Water	L	O	M	M	O	M
	Non-contact Water	L	O	M	M	O	M
	Mine Haul Road	L	O	M	M	O	M
	Water Management Dams	L	O	M	M	O	M
	Mine Staffing (Direct Employment)	L	O	M	M	M	M
	Contracted Employment	L	O	M	M	M	M
	Taxation	O	O	O	O	O	O
Operation	Open Pit Development	L	L	M	M	O	M
	Drilling and Blasting	L	L	M	M	O	M
	Hauling Mine Rock and Ore from Pit	L	L	M	M	O	M
	Crushing and Conveying Ore	L	L	M	M	O	M
	Temporary Ore Stockpile	L	O	M	M	O	M
	Development of Mine Rock Management Facilities	L	O	M	M	O	M
	Stripping, Loading, Hauling, Deposition, and Contouring of Topsoil and Overburden	L	L	M	M	O	M
	Revegetation through Progressive Reclamation	L	O	M	M	O	M
	Process Plant Operation	L	L	M	M	O	M
	Deposition to Tailing Storage Facility	L	O	M	M	O	M
	Site Road Use and Maintenance (Materials, Personnel, Supplies)	L	L	M	M	O	M

Project Activities		Potential Effects on Community Health and Well-being					
		Changes to the Biophysical Environment May Affect Community Health and Well-being	Increased Noise and Vibration May Affect Community Health and Well-being	Project-related Traffic Could Result in Increased Collision and Accident Incidence on Public Roads	Project Workforce May Stress the Provision of Community Services	Change in Income Generation May Affect Community Health and Well-being	Project Proximity to the City of Kamloops May Affect Community Image and Residents' Perceived Quality of Life
Operation (*cont'd*)	Concentrate Transport and Storage	L	L	M	M	O	M
	Explosives Magazine and Storage Facilities	L	O	M	M	O	M
	Fire Suppression Infrastructure	L	O	M	M	O	M
	Fuel Storage and Filling Area	L	O	M	M	O	M
	Hazardous Wastes Transport, Storage, and Disposal	L	L	M	M	O	M
	General Wastes Transport, Storage, and Disposal	L	L	M	M	O	M
	Sewage Infrastructure and Disposal	L	O	M	M	O	M
	Laydown Areas and Storage Yards	L	O	M	M	O	M
	Power Transmission, Distribution	L	O	M	M	O	M
	Project Lighting	L	L	M	M	O	M
	Site Access, Security and Fencing	L	O	M	M	O	M
	Water Intake from Kamloops Lake	L	L	M	M	O	M
	Contact Water	L	O	M	M	O	M
	Non-contact Water	L	O	M	M	O	M
	Potable Water Treatment and Use	L	O	M	M	O	M
	Mine Haul Road	L	O	M	M	O	M
	Mine Staffing (Direct Employment)	L	O	M	M	M	M
	Contracted Employment	L	O	M	M	M	M
	Taxation	O	O	O	O	O	O
Decommissioning and Closure	Dismantling of Ancillary Buildings	L	L	L	O	L	L
	Pit Lake Planning	L	O	L	O	L	L
	Site Road/Bridge Decommissioning	L	O	L	O	L	L
	Tailing Storage Facility Decommissioning and Reclamation	L	L	L	O	L	L
	mine Rock Management Facilities Reclamation	L	L	L	O	L	L
	Fuel Storage and Filling Area	L	O	L	O	L	L
	Hazardous Wastes Transport, Storage, and Disposal	L	L	L	O	L	L

Project Activities		Potential Effects on Community Health and Well-being					
		Changes to the Biophysical Environment May Affect Community Health and Well-being	Increased Noise and Vibration May Affect Community Health and Well-being	Project-related Traffic Could Result in Increased Collision and Accident Incidence on Public Roads	Project Workforce May Stress the Provision of Community Services	Change in Income Generation May Affect Community Health and Well-being	Project Proximity to the City of Kamloops May Affect Community Image and Residents' Perceived Quality of Life
Decommissioning and Closure (*cont'd*)	General Wastes Transport, Storage, and Disposal	L	L	L	O	L	L
	Sewage Infrastructure and Disposal	L	O	L	O	L	L
	Laydown Areas and Storage Yards	L	O	L	O	L	L
	Power Transmission, Distribution	L	O	L	O	L	L
	Project Lighting	L	O	L	O	L	L
	Site Access, Security and Fencing	L	O	L	O	L	L
	Contact Water	L	O	L	O	L	L
	Non-contact Water	L	O	L	O	L	L
	Potable Water Treatment and Use	L	O	L	O	L	L
	Mine Haul Road	L	O	L	O	L	L
	Road use to the Project (Materials, Personnel, Supplies)	L	L	L	O	L	L
	Mine Staffing (Direct Employment)	L	O	L	O	L	L
	Contracted Employment	L	O	L	O	L	L
	Taxation	O	O	O	O	O	O
Post Closure	General Site Inspections and Maintenance	L	O	L	O	O	L
	Contact Water	L	O	L	O	O	L
	Non-contact Water	L	O	L	O	O	L
	Road use to the Project (Materials, Personnel, Supplies)	L	O	L	O	O	L
	Mine Staffing (Direct Employment)	L	O	L	O	O	L
	Contracted Employment	L	O	L	O	O	L

Notes:

O — *No interaction anticipated.*

L — *Negligible to minor interaction expected; implementation of best practices, standard mitigation and management measures; no monitoring required; no further consideration warranted.*

M — *Potential moderate interaction requiring unique active management/monitoring/mitigation; warrants further consideration.*

H — *Key interaction; warrants further consideration.*

Changes to the Biophysical Environment May Affect Community Health and Well-Being

Health effects of changes in the biophysical environment as a result of the Project were assessed as part of the Human Health and Ecological Risk Assessment (HHERA) for the Project (Appendix 10.4-A) and in the assessment of the Human Health VC (Section 10.4). The analysis concluded that inhalation exposure resulting from the Project would result in a negligible change in human health risk to those living in the vicinity of the Project. Similarly, the analysis concluded that Project-related changes in water and country food consumed by people in the LSA would result in negligible change in risk to human health. For further detail, see Section 10.4. As risks to human health are assessed to be negligible, effects on broader community health and well-being resulting from biophysical changes are not assessed further.

Increased Noise and Vibration May Affect Overall Community Health and Well-Being

Effects of noise and vibration associated with the Project during the Construction and Operation phases were assessed and are summarised in a technical data report (Appendix 10.5-A). The Decommissioning and Closure Phase was not assessed because the noise effect is expected to be less than during the Construction Phase.

The noise assessment identified 28 noise receptors, including residences, daycares, hospitals and potential city development areas; many of these locations were chosen through consultation with the City of Kamloops. International Organization of Standardization (ISO) methods were used to predict noise levels expected to be generated by the Project. Predicted values were then compared against provincial, federal, and international thresholds, including Health Canada's guidance for noise annoyance (percent highly annoyed [%HA]). For details on methodology and analysis refer to the Noise and Vibration Technical Data Report (Appendix 10.5-A). The noise assessment concluded that predicted noise levels during both Construction and Operation meet the BG OGC noise guideline, World Health Organization, and Health Canada noise guidance at all residential receptor locations (see Section 10.5).

The vibration assessment focused on the potential for blast-induced ground vibration and air blast effects on human health and structures (Appendix 10.5-A). The following activities were assessed for the Construction and Operation phases (noted by activity) at 31 potential vibration receptors including residences, commercial structures, potential city development areas, Jacko Lake, and recreation areas (See Section 5.2 of the Noise and Vibration Technical Data Report [Appendix 10.5-A]):

- Blasting (Operation Phase);
- Earthworks (Construction Phase);
- Site road construction, use, and maintenance equipment (Construction Phase);
- Piling during open pit development (Construction Phases); and
- Drilling (Construction Phase).

The vibration assessment resulted in the following conclusions (see Section 10.5):

- Blast-related vibration effects at all receptors are below the structural damage limits;

- Blast-related vibration effects at residential receptors are below the human annoyance thresholds; and
- Vibration effects from other activities (heavy construction equipment associated with earthworks, road construction activities, piling operations at Jacko Lake, and drilling operations) are predicted to be below the construction vibration guideline.

Predicted air blast levels for all homes, industrial structures and towers are well below structural damage (133 dBL) and annoyance levels (120 dBL).

KAM has committed to developing and implementing a Noise and Vibration Management Plan (Section 11.22) that will include noise and vibration monitoring during the Construction, Operation, and Decommissioning and Closure phases. The plan will also include a process to address public concerns or complaints in a timely manner. As predicted Project effects are well within noise and vibration guidelines, no residual adverse effects are anticipated. As a result, changes in noise and vibration are not expected to adversely affect community health and well-being and this effect is not considered further.

Changes in Income Generation may affect Community Health and Well-being

During the Construction and Operation phases, the Project is expected to generate substantial employment and income opportunities within the LSA and RSA. Employment and income have the potential to affect Community Health and Well-being in various ways. Employment opportunities, for example, may provide opportunities for individuals to gain new skills and experience, which may contribute to an individual's self-esteem. Increased income allows people to purchase higher quality foods, to pay for advanced education opportunities, or to make other health-related choices that may not be accessible with less income.

On the other hand, higher levels of disposable income have been linked to "intense drinking and drug use" in other resource projects in Canada (Goldenberg et al. 2010). Increased disposable income may lead to inappropriate spending on alcohol and drugs and associated effects on health, well-being and public safety. New income and the "boom and bust" cycle that a major construction project creates will result in relatively short-term periods of increased (high paying) opportunities. Past experience with resource development projects across North America indicates that increases in disposable income can result in increased spending on activities that are deleterious to the health, well-being, and the safety of individuals, families, and communities. However, it should also be noted that these effects are more prevalent in remote northern communities inexperienced in dealing with resource development and with limited local opportunities for entertainment and recreation. Residents of Kamloops and the LSA, have experienced past developments that have come and gone; they are likely more resilient to this type of change, and the city offers a variety of options for entertainment and recreation that are not found in smaller communities.

It is difficult to predict precisely how an individual or family will react to the outcomes of employment income as this will be dependent on individual choices and preferences. During the Operation Phase, average incomes for Project employment are estimated to be $117,000 per full-time equivalent job; average earnings for indirect and induced employment are estimated to be $56,000 (see Section 7.3). Typically, operational staff (as well as the indirect and induced employment) will

be members of the local community, with associated ties to that community. Tendencies to socially irresponsible behaviours are less prevalent in such a situation.

Most research shows a positive relationship between a higher income and improved health outcomes for people who sustain higher incomes over longer periods of time. This is related to "higher socio-economic status," which does not necessarily result for those who experience sudden increases in income for limited periods of time (Scott and Lessard 2002). Research suggests that, after one or two years, communities can adjust to increased income levels through an increase in social stability and improved services (NAHO 2008). This suggests that while construction employment may represent an opportunity for misspending, operations employment income is more likely to contribute to overall improvements to individual health and well-being.

During the Decommissioning and Closure and Post-Closure phases, employment levels (direct, indirect, and induced) are anticipated to decrease. Recommended mitigation measures include communication efforts and transition programming for employees affected (see sections 7.2 and 7.3). Transition programming will assist employees who will be laid off after the Operation Phase find alternative employment prior to the conclusion of their tenure; this can alleviate adverse health effects such as stress and anxiety. No additional mitigation related to effects on Community Health and Well-being is deemed necessary.

As Project effects relating to income generation are likely to contribute to improved community health and well-being, no adverse effects are anticipated and this effect is not considered further.

10.7.4.2 Potential Effects on Community Health and Well-being

Table 10.7-11 shows that the following potential effects may have a moderate ("M") interaction with one or more Project components or activities:

- Project-related traffic could result in increased collision and accident incidence on public roads;
- Project workforce may stress the provision of community services; and
- Project proximity to the City of Kamloops may affect community image and residents' perceived quality of life.

These potential effects are described further below, with reference to the existing characteristics of the community, concerns of local residents and other stakeholders, and the potential ways in which the Project may cause or contribute to these effects. Mitigation measures to avoid or minimize these effects are discussed in Section 10.7.4.3.

<u>Project-Related Traffic Could Result in Increased Collision and Accident Incidence on Public Roads</u>

During the Construction and Operation phases, increases in traffic volumes over the life of the Project could affect road and traffic conditions and potentially the safety of road users. KAM commissioned a traffic impact assessment (TIA; Appendix 8.1-A) to assess the potential effects of the Project on the existing road network, analyze potential safety issues, and identify mitigation

measures to address any effects (Opus International 2015). The study was designed in consultation with the City of Kamloops and the Ministry of Transportation and Infrastructure (MoTI). This section focuses on the safety of road users. Effects on traffic volumes and road capacity are discussed in Section 8.1, Infrastructure, Public Facilities, and Services.

During the Construction Phase, the TIA indicates that potential effects on road travel will stem from increased vehicular traffic associated with the simultaneous construction of the Inks Lake Interchange, and delivery of materials, equipment and personnel in the LSA for early Project Construction works; this temporary impact will be negated upon the completion of the Inks Lake Interchange and upgrades to the Ajax Mine Access Road and Lac Le Jeune Intersection. During the Operation Phase, the effects on road travel will also include a small increase to heavy goods vehicle traffic for transporting concentrate to Port Metro Vancouver, through the RSA via Highway 5; however, an increase in collisions is not expected and no effect on community health and well-being is identified during the Operation Phase. The Decommissioning and Closure, and Post Closure, phases were not included in the TIA as traffic during these phases will be minimal.

Prior to the application of mitigation measures, Project-generated traffic could have an evident impact on the road network during peak construction (i.e., in 2018). The most pronounced effects are anticipated at the new Inks Lake Interchange where all site traffic converges to travel along the Mine Access Road, and at the intersection of Lac le Jeune Road and the Ajax Mine Access Road. The Versatile Drive/Hugh Allan Drive roundabout and Pacific Way/Hugh Allan Drive intersection are also expected to perform poorly during this period (see Section 8.1, Infrastructure, Public Facilities, and Services for details). Potential adverse effects related to community health and well-being include increased collision and accident incidence resulting in negative effects to people's health (either through injury or death).

Mitigation measures presented in the TIA including bus staging, increased carpooling and shift staggering, and increased signage, are expected to reduce adverse effects on traffic, thereby minimizing the potential effects on community health and well-being. For details on predicted effects on traffic volumes, see Appendix 8.1-A.

Project Workforce May Stress the Provision of Community Health Services

The potential for a temporary and non-local construction workforce to have adverse interactions with local communities during resource-related developments has been documented in Canada. This effect is often exacerbated by the availability of disposable income, which can lead to socially irresponsible or reckless behaviours and thereby increase demands on health, social and policing services. Several factors are considered in the assessment of effects related to the temporary construction workforce, including the number, timing, and location of workers, in addition to the services/amenities available to workers during down-time. The assessment of potential effects to community health and well-being (in this section) focuses on potential stresses to healthcare services. Potential effects on other community services, such as police services, are discussed in Section 8.1, Infrastructure, Public Facilities, and Services.

Residents of the LSA have expressed concern that incoming, non-local construction workers are likely to be predominantly male, with relatively high levels of disposable income and limited ties to

the Kamloops community. This could lead to health issues such as alcohol and drug use and sexually transmitted infections. Given the proximity of the Project to the City of Kamloops, there is potential for interaction between the construction workforce and local residents.

During the Construction Phase, the total number of workers required will fluctuate over the course of each year. Table 10.7-12 provides the estimated range of non-local workers that may be present in the LSA to support construction. At the peak of construction (Year 2), the number of non-local workers is estimated between 648 and 950 (see Section 7.2). The estimate's high of 950 is well within the average annual mobility rates for the city of Kamloops (as of 2011), with 4,035 (4.8%) of people reporting being "movers" from another census division or beyond in a one-year timeframe (Statistics Canada 2013). The extent to which interaction with the construction workforce could result in additional community health issues cannot be estimated in quantitative terms, but awareness that potential health issues may be generated by the construction workforce will help to prepare and adapt appropriate mitigation.

Table 10.7-12. Estimated Non-Local Workforce at Peak for Construction[1]

	Year 1	Year 2	Year 3
Peak workforce (local and non-local)	1,175	1,800	898
Estimated non-local workforce[1]	231 to 425	648 to 950	305 to 465

Source: Derived from workforce estimate data provided by KGHM Ajax 2014.
Notes:
[1] The Project construction phase is defined as a two-year period for the purposes of the environmental assessment; however, the total period between the start of construction activities and plant commissioning is approximately three years (see Section 2.2.4). The Construction and Operation phases overlap. Since the magnitude of construction activities in the third year is much smaller than in the previous two years, the overlap does not influence the conclusions of many of the effects assessments. For the effects assessments on the Economic Growth; Labour Force, Employment, and Training; Income; Business; and Economic Diversification VCs the three-year construction phase is more relevant as these assessments are particularly influenced by Project construction workforce and expenditures. Therefore, these VCs will refer to the three-year construction phase instead of to the two-year phase. Since workforce estimates are based on the analysis completed for Labour Force, Employment, and Training, this table reflects the three-year Construction Phase.

In addition to potential socially irresponsible behaviours, the Project workforce could increase demand for healthcare services in the LSA, especially in Kamloops, in other ways. As noted in the Section 10.7.2, healthcare in the LSA currently faces two issues regarding capacity: increasing pressures on the emergency room at the RIH and a shortage of family physicians.

- During the Construction Phase, the non-local workforce (Table 10.7-12) may place additional pressure on the emergency room at Royal Inland Hospital (RIH) as they may use the emergency facility at RIH for basic medical attention.
- During the Operation Phase, population growth associated with workers and their families (for direct, indirect, and induced employment) will also place pressure on healthcare in the LSA. Non-local workers hired during the Operation Phase are anticipated to settle permanently in the LSA and will therefore likely seek out family physicians. The estimated in-migration during the Operation Phase is anticipated to be between 447 and 1,111 people total (See Section 8.1 for a detailed discussion of Project-related in-migration). Since the LSA already faces a shortage of family physicians, an additional influx of residents could

exacerbate the situation. Concerted government recruitment efforts are underway and have been successful to date; such undertakings may help alleviate this issue.

Some residents of Kamloops have expressed concern that the Project will contribute to the out-migration of physicians, as the image of Kamloops may be negatively altered by the Project and general perceptions about mining and 'mining towns.' As of 2009-2010, in the Kamloops LHA there were 1.1 general practitioners per 1,000 population (IHA 2010). Although it is not uncommon to have lower physician-to-patient ratios outside of the main urban areas of the province, local residents report that it is difficult to access a general practitioner in Kamloops (Ajax KPI Program 2011-2012). Various entities in the Kamloops LHA have made concerted recruitment efforts targeting family physicians and family physician residents. Recent recruitment efforts will bring in six new family physicians and six medical residents (Venture Kamloops 2014).

A survey conducted in 2012 by three Kamloops physicians likely helped to raise general levels of awareness of this concern in the community. The survey asked three questions of physicians in Kamloops:

1. If you were a physician searching for a community in which to practise, and the Ajax mine as proposed was in place, would you eliminate Kamloops as an option? (Definitely, probably, not likely, no).
2. If the Ajax mine is approved and built in Kamloops, would you move your practice to another community? (Definitely, probably, not likely, no).
3. Are you concerned about the potential health impacts of the Ajax mine on the people of Kamloops? (Yes, no).

Of the 152 physicians who responded to the survey (of a possible 207), 105 (69%) said they would "probably" or "definitely" reconsider Kamloops if they were looking for a place to practice. If the Project was approved, 54 (36%) indicated they would "probably" or "definitely" move to another community to practice. A total of 128 (84%) indicated that they were concerned about how the Project might affect the health of Kamloops residents (Young 2012).

While these results suggest that Project effects related to physician out-migration could be quantified, the survey design and the nature of a decision to move to and/or from a community create uncertainty around quantification. In connection with survey design, the following points should be considered. First, the survey was conducted before the Project was redesigned to move infrastructure further away from Kamloops and has not been conducted again. Information about the new General Arrangement, which is intended to reduce potential Project effects for a range of VCs (e.g., Noise and Vibration), could have altered some responses. Second, details about the survey design, including how respondents were chosen, are unknown and therefore the results cannot be accurately evaluated. The choice of questions and responses, and phrasing, can also influence survey results.

Finally, there are many factors influencing an individual's decision to move between locations, which cannot be easily captured in multiple choice and dichotomous questions (e.g., "yes" or "no" questions). Multiple choice and dichotomous survey questions are not very effective for gaining an

understanding of complex and personal decisions. Decisions to move to and/or from a community are influenced by a range of factors and at least some of these factors will vary from one individual to the next (and at different times). Factors include the availability of employment elsewhere, potential for higher wages, and the liveability of alternative locations. These factors and others will also interact with each other during the decision-making process and be ranked differently by different people.

Similar concerns were not expressed—and outcomes did not occur—for other mining projects such as Teck's Highland Valley Copper or New Gold's New Afton mine; however, both of these projects have different characteristics than the Ajax Project. Although Highland Valley Copper is also an open pit mine, it is located farther from any community than the Project. The New Gold project is in close proximity to Kamloops, but as an underground operation it does not present the same issues and concerns as expressed by the community relative to the Project.

Representatives of the IHA have indicated that active recruitment of physicians, with or without the Project, will continue to be a priority and the challenges to be faced will be similar to other parts of the province facing similar shortages (Ajax KPI Program 2011-2012).

Project Proximity to the City of Kamloops May Affect Community Image and Residents' Perceived Quality of Life

In consultation to date, Kamloops residents have expressed concern that the presence of the Project could adversely affect the image of the city. As noted in Section 10.7.2.3, the vast majority of citizens in Kamloops (98%) in 2012 felt that their quality of life was positive. Much of residents' image of the city rests on the development of its economic base, which has shifted from being resource-extraction intensive, to a more diversified economy focused on sustainable development, including recreation, education (and the Thompson Rivers University) and other sectors.

Residents have different opinions as to the factors that contribute to and detract from the quality of life in the area, and also have differing opinions about how the Project may affect the overall image of Kamloops. Mining activities are often met with differing views, in Kamloops and elsewhere across Canada and internationally. As noted in connection with social tensions surrounding Voisey's Bay nickel deposits in Labrador, "There can be differences of opinion within a community about a whole range of issues. While some may welcome a new mine, others may oppose it…while some are reluctant to countenance any change, others will eagerly embrace new business opportunities" (MMSD 2002). This appears to be the case for residents of the LSA.

Some residents have expressed concerns about the future ability of the LSA to maintain its image and association with the Tournament Capital brand, although municipal representatives have noted that attracting events is primarily related to the organizational and infrastructure capacity to host an event (e.g., does the venue meet required standards, are there sufficient accommodations for participants). The Project is not expected to affect the capacity of Kamloops to successfully host events (City of Kamloops and InterGroup Consultants 2012). Some residents feel that the Project is in conflict with the overall community vision and plan, and that its development will impede efforts associated with sustainability. Nuisance factors (such as noise, blasting, dust), factors affecting

environmental health (such as air quality and water quality) are of particular concern, in part because of the community's recent efforts towards improvements in these areas.

Other residents express optimism that the economic growth associated with the Project will have a net benefit to the overall community. Although there is acknowledgement that development should not focus on a single sector (e.g., mining), the Project could positively contribute to the city by attracting more skilled and professional businesses to the area, resulting in a more educated workforce.

Although there are examples in Canada of how mining projects can affect community life (including consideration of overall well-being, quality of life, and effects to sub-populations), many of these have a very different context than the Project LSA, primarily involving small, remote, often predominantly Aboriginal communities (e.g., Bradshaw and Maksimowski 2013; Gison and Klinck 2007; NAHO 2008; Czyzewski et al. 2014). Other studies have focused on the boom-bust effects on communities, with focus on the closure phase of resource-extraction-dependent communities (e.g., McDonagh 2010; Shandro et al. 2011), when the benefits of employment, procurement, and income come to an end.

The Voisey's Bay Mine in Newfoundland and Labrador provides an example where during the environmental assessment process, the community was clearly divided in its perceptions of the project. The Joint Federal Provincial Panel (1999) in its review of the project noted that it was difficult to predict how individuals would respond to such an initiative, and that these perceptions could change over time. The Panel (1999) also noted that effects of the project on community life were "inherently difficult to distinguish from larger ongoing social, economic and demographic changes occurring independently."

Although other mining examples in Canada can provide insight into how the overall community image and quality of life might be affected, there are limited examples of open pit mine sites in immediate proximity to a city to be drawn upon. One example can be found in the Kennecott Mine near Salt Lake City and the City of South Jordan, Utah. Although this mine differs from the Ajax Project insofar as the site has been in operation over 100 years with considerable legacy issues and associated need for remediation, in addition to clear technical, size and scope elements, it does provide an example of a large open pit copper mining and milling operation in close proximity to municipalities and residential properties.

Despite differences (i.e., environmental clean-up that is not scalable to the proposed Project; issues caused by decades-old operating methods), the Kennecott Mine and the proposed Ajax Project do share some common characteristics. In both instances, these are open pit copper mining operations set within historic mining jurisdictions; both are located in close proximity to communities; and both regions are set for population growth. As such, the Kennecott Mine offers some valuable lessons:

- Industrial sites and communities can co-exist in close proximity;
- Cooperation among industry, regulators, and community leadership engenders good will (EPA 2006); and

- Open and transparent processes enable trust to be developed among stakeholders (EPA 2006).

The Kennecott Mine example also reinforces the notion that interactions between local stakeholders and project proponents work towards allowing "communities [to] develop in ways that are consistent with their own vision" (MMSD 2002). The City of Kamloops is currently in the process of revising its official community plan (i.e., the KAMPLAN), which provides the opportunity for the Project to be considered within the next phase of community planning.

10.7.4.3 Mitigation Measures for Community Health and Well-being

Project-Related Traffic Could Result in Increased Collision and Accident Incidence on Public Roads

The Traffic Impact Assessment and Traffic Management Plan prepared by Opus International (2015) propose a variety of mitigation measures to reduce the potential effects of Project-related traffic during the Construction and Operation phases. For a complete list, please see Appendix 8.1-A and Section 11.20, Transportation Management Plan. Key mitigation measures include:

- Implementing carpooling incentives during Construction and Operation to increase the car-pooling rate from 7% (average for the city) to 15% (targeted rate for the Project workforce).
- During Construction, providing workforce personnel shuttles from key locations within the City to the Project Site to reduce personal vehicle traffic.
- Staggering shifts during the Construction Phase and to a lesser extent during the Operation Phase, to reduce traffic during AM and PM peak traffic periods.

KAM will also ensure best management and safety practices related to traffic control while intersections are constructed and/or upgraded, including the Inks Lake Interchange and at the intersection of Lac le Jeune Road and Ajax Mine Access Road.

In terms of road safety and the potential for vehicle collisions (contributing factors to community health and well-being), the TIA identified Lac Le Jeune Road as a road segment of concern; this road will be used for site access during the early Construction Phase prior to the completion of the Inks Lake interchange. Mitigation measures presented in the TIA include the incorporation of appropriate road signage to warn vehicles of limited sight distance issues; undertaking proportionate road improvements to address temporary safety and traffic related impacts; and the effective implementation of the Project's Traffic Management Plan. As the site access configuration is temporary, the proposed mitigations are expected to address potential project effects.

KAM will also implement a Transportation Management and Control Plan (TMCP) and Transportation Management Plan (TMP; Section 11.20) for the Project as part of the Environmental Management System for the Project. The TMP summarizes the mitigation and traffic management strategies, and is seen as a bridge between the TIA and the TMCP. The TMP provides overall guidelines and procedures for implementing the traffic mitigation measures recommended in the TIA to minimize commuter traffic volume and its impacts on the street networks surrounding the

mine development. It also provides recommendations for monitoring, and responding to, the effectiveness of the planned mitigation procedures.

Accidents and injuries have an adverse effect on community health and well-being. KAM is committed to a safety culture for the Project. Safe driving behaviour will be required by all Project staff, and specific requirements will be identified and managed through the TMP. The mitigation measures outlined in the TMP are expected to sufficiently address traffic safety impacts of the Project.

Project Workforce May Stress the Provision of Community Health Services

The potential effect of interaction between construction workers, residents, and healthcare facilities and services is difficult to predict, and ongoing communication and monitoring will be important. Mitigation measures intended to help reduce potential effects include:

- Establishing a Community Liaison Group comprising representatives from the City, the TNRD, health and social service providers, and other relevant organizations to discuss potential issues and solutions in relation to effects associated with strains on services (see Socio-Economic Management Plan 11.29);
- The Socio-Economic Monitoring Plan (Section 11.29) will include a monitoring program for Community Health and Well-being. The approach to and content of this monitoring program will be defined in collaboration with the Community Liaison Group including relevant service providers and healthcare specialists. While the program will be designed to monitor topics of concern (to be determined but may include grievances related to workforce behaviours; hospital/emergency services usage statistics, specific health indicators etc.), the approach will ultimately depend on availability of data. An initial step will be to identify existing data collection efforts by service providers, government, and other organizations, and determine whether this data is accessible for monitoring purposes. Available and accessible quantitative data will likely also be supplemented by qualitative data collected through interviews with service providers and municipal representatives; Ongoing dialogue with service organizations (e.g., RCMP) to inform them of workforce requirements or changes; and
- During the Construction Phase, KAM will require the Engineering, Procurement, and Construction contractor to secure a dedicated general practitioner to provide basic healthcare services for the workforce, including non-local construction workers.

With respect to the potential out-migration of medical professionals, no specific mitigation measures are anticipated beyond the current recruitment efforts by Interior Health, Venture Kamloops and others.

Project Proximity to the City of Kamloops May Affect Community Image and Residents' Perceived Quality of Life

To address residents' concerns about community image (i.e., projecting an image as a resource-based industrial city with environmental quality issues, contrary to the vision of a city with sound environmental quality to support other economic activities (e.g., tournament capital), the following mitigation measures will be undertaken:

- Offer of active participation by KAM in planning for the future of the City of Kamloops; the next update to KAMPLAN will include consideration of the Project.
- KAM will implement a Community Investment Program to support the image of the community. For example, KAM has partnered with community/recreation advocacy groups, private business, and the Provincial government provide seasonal access to a network of upgraded and expanded mountain bike/recreational trails in Pineview; these trails are largely located on private and ranch lands.
- Monitoring of environmental effects of the Project and transparent communication of monitoring results in a timely way to residents of the LSA, in order that they are aware of the continuing quality of their environment. A Community Liaison Group will be established as a vehicle for ongoing dialogue about monitoring results and environmental quality.

10.7.5 Residual Effects and Their Significance

10.7.5.1 Summary of Residual Effects

Residual effects are those Project effects that remain after mitigation is applied. This section describes in greater detail the residual effects for the Community Health and Well-being VC, considering the mitigation measures described in Section 10.7.4.3. Residual effects are summarized in Table 10.7-13.

<u>During Peak Construction, Increased Traffic Could Result in Increased Incidence of Road Collisions at Four Intersections</u>

Increases in traffic volumes over the life of the Project, during the Construction and Operation phases, could affect road and traffic conditions and the safety of road users. The mitigation measures put in place for the Project, such as safe driving behaviours, bus staging, shift staggering, and road safety improvements, as described in the TMP, are expected to reduce the Project's contribution to traffic congestion, and associated accidents and injury. The potential residual effect is therefore focused on four specific intersections, which may have a reduced level of service (e.g. increased congestion) during the peak of construction:

- Inks Lake Interchanges (while under construction);
- intersection of Lac le Jeune Road and Ajax Mine Access Road (while under construction);
- roundabout at intersection of Versatile Drive and Hugh Allan Drive; and
- intersection of Pacific Way and Hugh Allan Drive.

Although KAM will ensure that construction of intersections is managed in accordance with industry best practices, and will also employ other incentives to reduce the number of vehicles using public roads during construction (including carpooling incentives and workforce shuttles), a residual effect may remain. Some level of residual effect, therefore, is expected during the Construction Phase of the Project (Table 10.7-13).

Table 10.7-13. Summary of Residual Effects on Community Health and Well-being

Project Effect	Project Phase (timing of effect)	Project Component/ Physical Activity	Description of Cause-Effect	Description of Mitigation Measure(s)	Description of Residual Effect
Project-related traffic could result in increased collision and accident incidence on public roads	Construction	Project-related traffic	Project-related traffic will result in increased traffic volumes and the potential for increased injuries and accidents	• Shuttles, shift staggering, and carpooling incentives to reduce traffic volumes • Improved road signage • Improvements to Lac le Jeune Rd and Inks Lake Interchange • Transportation Management Plan • Transportation Management and Control Plan	During peak construction, increased traffic could result in increased incidence of road collisions at four intersections
Project workforce may stress the provision of community health services	Construction, Operation	Presence of the Project; Construction and Operation workforce	Population growth (including non-local construction workers, and in-migration of operation workers) could increase demand for healthcare; Potential for reduced health care capacity due to out-migration of physicians	• Develop a monitoring program for community health and wellbeing within the Socio-economic Monitoring Plan; • Contract dedicated general practitioner for construction workforce • Processes to monitor and address issues if they arise and to communicate Project information to service providers. • Community Liaison Group • Thompson Region Division of Family Practice, IHA, Venture Kamloops, and others will continue to recruit physicians for Kamloops	Increased demand for physicians and emergency room could affect availability of community health services
Project proximity to the City of Kamloops may affect community image and residents' perceived quality of life	All phases	Presence of the Project	Concern that the mine will perpetuate an image of Kamloops as an industrial city, which is not consistent with a new vision of sound environmental quality to support other economic activities (e.g., tournament capital and attracting retiring population)	• KAM offer of participation in next round of community planning • Community Investment Program to support community vision • Monitoring of environmental changes; transparent and timely communication of monitoring results to residents of the LSA; and discussion of monitoring results within the Community Liaison Group.	Project could affect community image and quality of life perceptions for some residents

Increased Demand for Physicians and Emergency Room Could Affect Availability of Community Health Services

The Project may contribute to pressure on local healthcare services during Construction and Operation phases. During construction, non-local workers temporarily residing in Kamloops may increase demand for healthcare services to address their needs (e.g. illness, injury), and in the absence of personal physicians many construction workers may use local clinics and/or the emergency room at RIH to attend to non-emergency health concerns. If workers partake in high-risk behaviours, there could be increased need for healthcare related to drinking, violence, STIs and other issues. These issues are further discussed in Section 8.1 (Infrastructure, Public Facilities and Services), and will be monitored through the socio-economic monitoring plan (Section 11.29).

To mitigate this effect, KAM will require the construction contractor to provide the dedicated services of a general practitioner for the workforce, including non-local construction workers. Workers are likely to choose the dedicated doctor because access will be easier and more timely as opposed to using a walk-in clinic or the emergency department at the RIH. However, considering the shortage of physicians and existing pressures on the RIH emergency room, a residual effect is conservatively predicted.

KAM will also facilitate ongoing dialogue with service providers through the Community Liaison Group, which will include participation from the City, TNRD, health and social service providers and other relevant organizations. The Community Liaison Group will provide a venue to discuss concerns and effects associated with strains on service and to develop solutions if challenges arise, and will also have input into the socio-economic monitoring plan.

During the Operation Phase, healthcare concerns are related to potential population growth as a result of the Project, and the possibility that existing physicians may choose to leave the community if the Project is developed. The existing shortage of family physicians is acknowledged for both these effects, and there may be a residual effect in terms of reduced access to healthcare services as a result of increased demand and possibly a decreased number of physicians (noting that recruiting efforts by Interior Health Authority and other agencies are currently underway and will continue with or without the Project).

Project Could Affect Community Image and Quality of Life Perceptions for Some Residents

Some residents have raised concerns about the effect of the Project on the image of Kamloops, i.e., projecting an image as a resource-based industrial city with environmental quality issues, contrary to the vision of a city with sound environmental quality to support other economic activities (e.g., Tournament Capital) and a positive quality of life. Concern or dissatisfaction regarding the community image could adversely affect the perceived well-being of some residents. To mitigate these concerns, KAM will offer its participation and support for the next stage of community planning for the future of Kamloops (that would include the Project in that future). KAM will look for ways to support the future vision of the City through its Community Investment Program. The company has already shown its willingness to partner in such work, with the development of a series of recreational trails in Pineview and various other community investment initiatives undertaken in partnership with public, private and not for profit stakeholders.

KAM will also manage concerns about environmental quality through careful monitoring of environmental effects of the Project and transparent communication of those monitoring results in a timely way to residents of the LSA. A Community Liaison Group is proposed as a vehicle for ongoing dialogue about monitoring results and environmental quality.

Concerns about community image and quality of life will be highly personal and subject to variation between individuals. A residual effect may occur.

10.7.5.2 Criteria for Characterization of Residual Effects

Residual effects are characterized using the following standard criteria: magnitude, duration, frequency, geographic extent, reversibility, resiliency, and social value. Table 10.7-14 provides a description of the characterization of residual effects, significance, likelihood and confidence in Community Health and Well-being. Each effect is further characterized below.

10.7.5.3 Characterization of Residual Effects

Characterization of residual effects is based primarily on information collected from key person interview and workshop settings, as well as professional judgment. For traffic, reliance on the TIA was the primary source (Appendix 8.1-A).

Table 10.7-15 provides the characterization of residual effects, including significance rating, likelihood and confidence level for the rankings for Community Health and Well-being.

<u>During Peak Construction, Increased Traffic Could Result in Increased Incidence of Road Collisions at Four Intersections</u>

The residual effect of increased Project-related traffic on roads and highways leading to the Project site (particularly at the peak of the Construction Phase) is the potential for an increase in collision and accident incidence rates on public roads (specifically at four intersections), thus contributing to an effect on Community Health and Well-being. A suite of mitigation measures will be put in place to reduce the volume of traffic and the probability of traffic accidents. Monitoring of road safety and road condition inspections is outlined in the TMP to identify possible areas that may require further mitigation. With these measures in place, the magnitude of traffic accidents is expected to be minor. The effect may occur over the duration of the Construction Phase of the Project (short-term) and will occur sporadically. Although there may be a general increase in traffic on public roads, the results of the TIA show that effects on traffic flow and congestion are primarily localized to four intersections. The effect is reversible in the short-term, with accidents reduced by additional measures that may be warranted with monitoring. To the extent that they occur, traffic accidents have some ability to affect the well-being of people in the community (neutral).

<u>Increased Demand for Physicians and Emergency Room Could Affect Availability of Community Health Services</u>

Increased demand for physicians and emergency room services may occur during the Construction Phase in regard to incoming non-local construction workers. To ensure that construction workers have access to reliable medical care, KAM will ensure that a general physician is available at the

mine site and dedicated to the needs of the workforce. This will reduce the workforce use of local clinics and/or use of the emergency room for non-urgent care.

As there is currently reported to be limited availability of family physicians in Kamloops, KAM will work with the Community Liaison Group to develop a health monitoring program within the context of the Socio-economic Monitoring Plan with participation from the City, the TNRD, health and social service providers and other relevant organizations to discuss and respond to effects associated with strains on service and to discuss with service organizations workforce requirements or changes.

Permanent in-migration of workers (and families) may occur during the Operation Phase, and community members have also expressed concern that physicians will choose to leave Kamloops as a result of the presence of the Project. The degree to which physicians may choose to leave the community is difficult to predict given the wide array of factors that would enter such decisions for each individual. Recruitment efforts in the LSA have successfully recruited physicians to the city, and will continue. While a survey pertaining to an earlier iteration of the Ajax Project indicated that substantive numbers of physicians would leave, the actual number of physicians who would leave is uncertain, as is the effectiveness of recruitment efforts to replace the number of physicians who choose leave.

With mitigation measures in place—including contracting a physician for the construction workforce and processes to work with service providers to respond to health issues—residual effects are expected to be minor and sporadic. Effects are primarily associated with the Construction Phase and—with respect to the influence of in-migrating workers (and families) during operations, and potential departures of existing physicians—in the early years of the Operation Phase; therefore the duration is medium-term. They are likely to occur in the LSA (local) and to be reversible in the short-term. The City of Kamloops is expected to be able to accommodate a construction workforce of this scale and their potential health issues (neutral resiliency), and the social value of the effect is neutral.

Project Could Affect Community Image and Quality of Life Perceptions for Some Residents

Residents have raised concerns about the effect of the Project on the image of Kamloops, i.e., projecting an image as a resource-based industrial city with environmental quality issues, contrary to the vision of a city with sound environmental quality to support other economic activities (e.g., tournament capital) and a positive quality of life. To mitigate these concerns and their associated stresses, KAM intends to offer its participation and support for the next stage of community planning for the future of Kamloops (that would include the Project in the KAMPLAN). KAM will also look for ways to support the future vision of the city through its Community Investment Program. KAM also intends to allay residents' concerns about environmental quality through careful monitoring of environmental effects of the Project and transparent communication of those monitoring results in a timely way to residents of the LSA. A Community Liaison Group is proposed as a vehicle for ongoing dialogue about monitoring results and environmental quality.

Table 10.7-14. Definitions of Characterization Criteria for Residual Effects on Community Health and Well-being

Magnitude	Duration	Frequency	Geographic Extent (Physical/Biophysical)	Reversibility	Resiliency	Social Value	Likelihood of Effects	
							Probability	Confidence Level
How severe will the effect be?	*How long will the effect last?*	*How often will the effect occur?*	*How far will the effect reach?*	*To what degree is the effect reversible?*	*How resilient is the receiving environment or population?*	*How influential is the effect on the broader socio-economic environment?*	*How likely is the effect to occur?*	*How certain is this analysis?*
Negligible: No or very little detectable change from baseline conditions.	**Short-term:** Effect lasts 1 to 5 years.	**Once:** Effect is confined to one discrete period in time during the life of the Project.	**Site-specific:** Effect extends less than 500 m from infrastructure or activity.	**Reversible Short-term:** Effect can be reversed relatively quickly.	**Low:** The receiving environment or population has a low resilience to imposed stresses, and will not easily adapt to the effect.	**Low:** The effect has limited ability to alter the economic base, social structure, community stability or the well-being of people in the study area.	**High:** It is highly likely that this effect will occur.	**High:** > 80% confidence. There is a good understanding of the cause-effect relationship and all necessary data are available for the Project area. There is a low degree of uncertainty and variation from the predicted effect is expected to be low.
Minor: Differs from the average value for baseline conditions to a small degree.	**Medium-term:** Effect lasts 6 to 25 years.	**Sporadic:** Effect an effect that occurs at sporadic or intermittent intervals during any phase of the Project.	**Local:** Effect is limited to the LSA.	**Reversible Long-term:** Effect can be reversed within 20 years of Post Closure.	**Neutral:** The receiving environment or population has a neutral resilience to imposed stresses and may be able to respond and adapt to the effect.	**Neutral:** The effect has some ability to alter the economic base, social structure, community stability or the well-being of people in the study area.	**Medium:** This effect is likely, but may not occur.	**Medium:** 50 to 80% confidence. The cause-effect relationships are not fully understood, there are a number of unknown external variables, or data for the Project area are incomplete. There is a moderate degree of uncertainty; while results may vary, predictions are relatively confident.
Medium: Differs substantially from the average value for baseline conditions and approaches the limits of natural variation.	**Long-term:** Effect lasts between 26 and 50 years.	**Regular:** Effect occurs on a regular basis during the life span of the Project.	**Regional:** Effect extends across the broader region (RSA).	**Irreversible:** Effect cannot be reversed (i.e., is permanent).	**High:** The receiving environment or population has a high natural resilience to imposed stresses, and can respond and adapt to the effect.	**High:** The effect has moderate ability to alter the economic base, social structure, community stability or the well-being of people in the study area.	**Low:** This effect is unlikely but could occur.	**Low:** < 50% confidence. The cause-effect relationships are poorly understood, there are a number of unknown external variables, and data for the Project area are incomplete. High degree of uncertainty and final results may vary considerably.
Major: Differs substantially from baseline conditions, resulting in a detectable change beyond the range of natural variation.	**Far Future:** Effect lasts more than 50 years.	**Continuous:** Effect occurs constantly during the life of the Project.	**Beyond Regional:** Effect extends beyond the regional scale, and may extend across or beyond the province.					

Table 10.7-15. Characterization of Residual Effects, Significance, Likelihood and Confidence on Community Health and Well-being

Residual Effect	Residual Effects Characterization Criteria							Significance of Adverse Residual Effects	Likelihood and Confidence	
	Magnitude	Duration	Frequency	Geographic Extent	Reversibility	Resiliency	Value		Probability	Confidence
During peak construction, increased traffic could result in increased incidence of road collisions at four intersections	Minor	Short-term	Sporadic	Local	Reversible Short-term	High	Neutral	Not Significant (minor)	Medium	Medium
Increased demand for physicians and emergency room could affect availability of community health services	Minor	Medium-term	Sporadic	Local	Reversible Short-term	Neutral	Neutral	Not Significant (moderate)	Medium	Medium
Project could affect community image and quality of life perceptions for some residents	Minor	Medium-term	Regular	Local	Reversible Long-term	Neutral	Neutral	Not Significant (moderate)	Medium	Low

With mitigation measures in place, it is anticipated that the residual effect among residents about the image of the community and quality of life will be reduced to a minor magnitude, and most likely to occur during the Construction and Operation phases (medium-term) and on a regular basis (regular frequency). The effect is likely to extend to those living in proximity to the Project where concern about environmental quality would be greatest (local). Residual stress may be reversible in the long term (i.e., within 20 years of post-closure). It is anticipated that Kamloops has neutral resilience and may be able to adapt to the presence of the mine. The residual effect has some ability to alter the well-being of people (neutral).

10.7.5.4 Significance of Residual Effects

<u>During Peak Construction, Increased Traffic Could Result in Increased Incidence of Road Collisions at Four Intersections</u>

The residual effect of increased Project-related traffic on roads and highways leading to the Project site during the Construction Phase is the potential for increased road collisions. A suite of mitigation measures will be put in place to reduce the volume of traffic and the probability of traffic accidents. Monitoring of road safety and road condition inspections is outlined in the TMP to identify possible areas that may require further mitigation.

Due to duration, frequency, geographic extent, reversibility, and resiliency the residual effect is expected to be Not Significant (Minor).

<u>Increased Demand for Physicians and Emergency Room Could Affect Availability of Community Health Services</u>

Increased demand for physicians and emergency room services may occur during the Construction Phase in regard to incoming non-local construction workers. Permanent in-migration of workers (and families) may occur during the Operation Phase, and community members have also expressed concern that physicians will choose to leave Kamloops as a result of the presence of the Project.

Overall, due to duration, frequency, geographic extent, reversibility, resiliency, and social value the residual effect is expected to be Not Significant (Moderate).

<u>Project Could Affect Community Image and Quality of Life Perceptions for Some Residents</u>

Residents have raised concerns about the effect of the Project on the image of Kamloops as a city with sound environmental quality to support other economic activities (e.g., tournament capital) and a positive quality of life, as opposed to an image as an 'industrial' community. Changes in the image of the community could also affect residents' perception of their overall well-being, particularly if the change in image does not align with their values for the community.

Due to duration, frequency, geographic extent, reversibility, resiliency, and social value the residual effect is expected to be Not Significant (Moderate).

10.7.5.5 Characterization of Likelihood and Confidence

During Peak Construction, Increased Traffic Could Result in Increased Incidence of Road Collisions at Four Intersections

With all of the mitigation measures in place and ongoing monitoring to determine if additional measures are required, the effect may not occur, but some accidents are likely (medium probability). The traffic analysis provides a quantitative foundation for the conclusion, but not all variables can be estimated (e.g., individual driving behaviours); therefore, the conclusion is considered to have medium certainty. It is difficult to predict the level of increased injuries and accidents as there are a wide range of variables that could influence whether or not the residual effect occurs. For example, personal driving habits, timing of traffic volumes and weather/road conditions are considered to be key factors contributing to increased collisions. However, after mitigation, there is still the potential for increased collisions and accidents to occur, thus affecting the Community Health and Well-being VC. The effect is likely but not certain hence the probability of the residual effect occurring is medium and the confidence level is medium.

Increased Demand for Physicians and Emergency Room Could Affect Availability of Community Health Services

Overall, the residual effect on health services (as a result of non-local construction workers, population growth, and/or out-migration of physicians) is expected to be Not Significant (Moderate). In terms demand created by non-local construction workers, there is a medium probability and confidence (given experience elsewhere) but these effects may not occur if the mitigation measures (i.e., providing a doctor at the mine site; engagement processes with service providers) are effective in preventing them and in addressing issues as they arise. The effects are not unknown in other large-scale construction settings but past accounts are often anecdotal and often related to smaller, more remote communities. Likewise, the potential demand created by population growth during the Operation Phase is also considered to be of medium probability and confidence, and will depend on the success of physician recruitment efforts.

In regard to potential changes in availability of health services if physicians leave the community, there is a high level of uncertainty of the Project's effect due to the variables involved, such as the success of ongoing physician recruitment efforts, and the highly personal decisions of local physicians to stay or leave the community, both of which are subject to the influence of numerous external factors. Therefore, there is low confidence regarding the degree to which this could influence the availability of health services. However, overall, the probability and confidence level for this effect has been ranked medium. Considering the expected success of mitigation during the Construction Phase, the influence of in-migration of workers and their families during the Operation Phase is more likely to place strain on health services in the community.

Project Could Affect Community Image and Quality of Life Perceptions for Some Residents

Changes in the image of the community could also affect residents' perception of their overall well-being, particularly if the change in image does not align with their values for the community. Although this effect will vary with the individual, based on results of KPIs and community workshops, some residents will likely feel that the presence of the Project affects their community

image and quality of life. However, with effective mitigation measures intended to engage KAM in the future of Kamloops and to illustrate to residents the continued quality of their environment, these concerns may be allayed. As a result, there is a medium probability of occurrence of this residual effect. The range of variables affecting residents' views, however, means that the confidence in this estimate is low.

10.7.5.6 Summary of Residual Effects Assessment and Significance

Table 10.7-16 provides an overall summary of the residual effects and significance of the Project on Community Health and Well-being. All residual effects are carried forward to the Cumulative Effects Assessment.

Table 10.7-16. Summary of Residual Effects, Mitigation, and Significance on Community Health and Well-being

Residual Effects	Project Phase	Mitigation Measures	Significance
During peak construction, increased traffic could result in increased incidence of road collisions at four intersections	Construction	• Shuttles, shift staggering, and carpooling incentives to reduce traffic volumes • Improved road signage • Improvements to Lac le Jeune Road, Inks Lake Interchange • Transportation Management Plan • Transportation Management and Control Plan	Not Significant (minor)
Increased demand for physicians and emergency room could affect availability of community health services	Construction, Operation	• Develop a monitoring program for community health and well-being within the Socio-economic Monitoring Plan; • Contract dedicated general practitioner for construction workforce; • Processes to monitor and address issues if they arise and to communicate Project information to service providers. • Community Liaison Group • Thompson Region Division of Family Practice, IHA, Venture Kamloops, and others will continue to recruit physicians for Kamloops	Not Significant (moderate)
Project could affect community image and quality of life perceptions for some residents	Construction, Operation	• KAM participation in community planning and positive measures for community image. • Community Investment Program • Monitoring of environmental changes; transparent and timely communication of monitoring results to residents of the LSA; and discussion of monitoring results within the Community Liaison Group.	Not Significant (moderate)

10.7.6 Cumulative Effects Assessment

10.7.6.1 Introduction

This section describes the potential incremental effects likely to result from the Project on the environment when the effects are combined with those from other past, present or future projects and activities. The intent is to determine whether the residual effects of the Project could interact with the residual effects of other projects or activities thereby causing a greater impact on the Community Health and Well-being VC.

10.7.6.2 Identification of Other Actions that May Affect Community Health and Well-being

Chapter 5 (Assessment Methodology) describes the past, present, and reasonably foreseeable projects and activities that could interact with the effects of the Project. These projects are screened against the residual effects of the Project. For the Community health and Well-being VC, the key concern from a cumulative effects perspective is whether these projects or activities will also increase the potential for road collisions in similar areas of the road network, increase demand for healthcare services, and/or adversely affect the image of the community within a similar time frame as the Project.

10.7.6.3 Interactions between Residual Project Effects and Other Project or Activity Effects

Table 10.7-17 screens the other projects and activities that could interact with the Project's effects on community health and well-being. Only potential interactions ranked "M" or "H" are subject to further assessment as potential cumulative effects. The influence of past projects that are no longer active (e.g., Vidette Lake Mine and Iron Mask Mine) are included in the baseline and therefore no cumulative interactions are identified. Active projects and other existing activities that could interact with Project effects on Community Health and Well-being are also generally not considered further as they have been captured in the baseline.

Table 10.7-17. Ranking Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Community Health and Well-being

Residual Effect	Industrial Projects/Activities													Natural Resources and Land Use			Tourism and Commercial Recreation Activities					Community Infrastructure			Transportation					
	Vidette Lake Mine	Afton Mine (Historical)	Iron Mask Mine	Bonaparte Mine	New Afton Mine (New Gold)	Highland Valley Copper Mine (Teck)	Domtar Kamloops Pulp Mill	Tolko-Hefley Creek Plywood and Veneer	LaFarge Cement Plant	Trans Mountain Pipeline System (Kinder Morgan)	Trans Mountain Pipeline System - Expansion (Kinder Morgan)	Harper Creek	Highland Valley Copper – Bethlehem Expansion	Kamloops Forest District	Agriculture	Ranching	Tranquille on the Lake	Lac Le Jeune Resort	Tobiano Golf Course	Recreational Hunting, Fishing, Foraging	Recreational Trails	City of Kamloops Wastewater Management	Water Treatment Centre	City Expansion and Growth	Lac le Jeune Road	Highway 1	Highway 5A	Highway 5 (Coquihalla Highway)	Kamloops Airport	Rail Yards and Lines (CP and CN)
During peak construction, increased traffic could result in increased incidence of road collisions at four intersections	O	O	O	O	O	O	O	O	O	O	M	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Increased demand for physicians and emergency room could affect availability of community health services	O	O	O	O	O	O	O	O	O	O	M	L	L	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Project could affect community image and quality of life perceptions for some residents	O	O	O	O	O	O	O	O	O	O	L	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

Notes:

(-)	*No spatial or temporal overlap.*
O	*Spatial or temporal overlap, but no interaction anticipated OR No change from current condition anticipated, and already captured as part of baseline characterization; no further consideration warranted.*
L	*Negligible to minor interaction expected; implementation of best practices, standard mitigation and management measures; no monitoring required; no further consideration warranted.*
M	*Potential moderate interaction requiring unique active management/monitoring/mitigation; warrants further consideration.*
H	*Key interaction; warrants further consideration.*

Therefore, as shown in Table 10.7-18, the following projects and activities are evaluated in terms of their potential to interact with the residual effects of the Project:

- **TransMountain Pipeline System Expansion (Kinder Morgan):** Trans Mountain filed a comprehensive application with the National Energy Board (NEB) on December 16, 2013, initiating a regulatory review of the proposed expansion facilities. The proposed expansion, if approved, would create a twinned pipeline that would increase the nominal capacity of the system from 300,000 barrels per day, to 890,000 barrels per day. The project involves approximately 994 km of new pipeline, reactivation of 193 km of pipeline, 12 new pump stations to be built, 20 new tanks to be added to existing storage terminals in Burnaby (14), Sumas (1) and Edmonton (5), Westridge Marine Terminal in Burnaby to be expanded with three new berths. The project's lifespan is expected to include 20 years of operation and involves twinning of existing pipeline corridor. The expanded pipeline corridor may be located immediately adjacent to the Ajax mine site. If the regulatory application process is successful, construction of the new pipeline could begin as early as 2015/2016. The expanded pipeline would be operational in late 2017. This project has the potential to interact with all residual effects for the Community Health and Well-being VC. If the construction phases overlap, the effects of traffic and non-local workforce could result in moderate ("M") interactions, while the potential effect on community image is considered to be negligible to low ("L") as the pipeline will be buried and therefore less likely to influence concerns about the community image.
- **Highland Valley Copper - Bethlehem Expansion:** The HVC mine is located near Logan Lake and is approximately 50 km by highway from Kamloops. In 2014, HVC was the third largest employer in the LSA with over 1,300 employees. In the past five years, the number of employees has risen from 800 to approximately 1,380. About half of the HVC workforce lives in Kamloops. The remainder of the workforce commutes from other nearby communities in the RSA, including Logan Lake and Ashcroft (Ajax KPI Program 2011-2012; Dechert pers. comm. 2014). The mine is currently expected to operate until 2027 based on a new operations plan (Teck 2015). If the Bethlehem Expansion proceeds, the mine is anticipated to operate until 2029; however, the rate of production is not expected to change (see Section 5.3.1.3). Since production rates will remain the same, it is not anticipated that staffing levels will increase. Therefore, the effects of the HVC labour force residing in Kamloops is captured in the current description of baseline conditions. The potential interaction is considered to be negligible to low ("L") and is not assessed further.
- **Harper Creek Mine Project (proposed):** Located 150 km from the City of Kamloops, this project (if approved) would have a mine life of about 28 years (BC EAO and CEA Agency 2015). The mine is expected to have approximately 600 positions during construction and peak operation employment of 466 positions (ERM Consultants Canada Ltd. 2015). Construction is not expected to start until earliest 2016 which would indicate mine operations would continue until approximately 2046. This project has the potential to interact with the residual effect component of potential for reduced health care capacity due to out-migration of physicians. While the Harper Creek Mine Project could overlap with the Project in time it is too far away to have any spatial overlap with the Project and is not

expected to generate any change to the availability of healthcare services in Kamloops ("L") or other residual effects.

Table 10.7-18. Summary of Cumulative Effects Mitigation Measures and Residual Effects on Community Health and Well-being

Ajax Project Activity	Other Human Action Activity	Description of Potential Cumulative Effect	Description of Mitigation Measure(s)	Description of Residual Cumulative Effect
During peak construction, increased traffic could result in increased incidence of road collisions at four intersections	TransMountain Pipeline System Expansion (Kinder Morgan)	Potential for increased traffic accidents as a result of construction traffic for both the Ajax Project and the TMPL Expansion	• Engagement with Kinder Morgan to identify and address potential cumulative effects on traffic and road safety. • Initiatives to reduce traffic volumes (e.g. shuttles) • Traffic management plans	Although best management practices will be used to control intersections and traffic activities, the increased volumes of construction traffic could increase the potential for traffic accidents during the Construction Phase.
Increased demand for physicians and emergency room could affect availability of community health services	TransMountain Pipeline System Expansion (Kinder Morgan)	Additional increase in demand for healthcare services if construction workforces overlap	• Engagement with Kinder Morgan to identify and address potential cumulative effects on local health services • Community Liaison Group • Socio-Economic Monitoring Plan • Ongoing dialogue with service providers	Although best efforts will be made to address the health needs of the workforce, the cumulative effect of overlapping construction workforce could increase demand and strain the capacity of local health services.

Natural resources and land use projects and activities (Kamloops Forest District, agriculture and ranching) are already considered as part of the baseline of the LSA. Traffic generated by these activities are part of the baseline considered in effects of traffic. These activities generate no additional construction workforce that would be accommodated in the LSA. The activities do not appear to generate concern for healthcare services or community image. Therefore, no cumulative interaction with the Project on Community Health and Well-being is anticipated.

Tourism and recreation activities (changes in recreational hunting, fishing and foraging; and use of recreational trails) may generate minor levels of traffic in the vicinity of the Project but are captured in the baseline conditions. All other activities in this category are also considered in the baseline and would generate no additional effects on Community Health and Well-being.

Considering community infrastructure, expanded traffic generated by city expansion and growth could overlap with Project-related traffic; however, population growth was considered in the base traffic volumes in the TIA (Appendix 8.1-A) so no additional interaction is identified. City expansion is not expected to generate construction workforces that would overlap with the Project construction workforce. City expansion and growth have not been raised as concerns that could generate

additional pressures on health services or stress regarding community image. The City of Kamloops wastewater management facility and water treatment centre are expected to generate no effects that have not already been considered in the baseline.

In the category of transportation, traffic on Lac Le Jeune Road, Highway 1 and Highway 5 are in the vicinity of the Project but current and projected traffic levels are incorporated in the TIA. Similarly, they would not generate incremental construction workforces or create concerns that would lead to out-migration of physicians or concerns about community image. Similarly, the highway infrastructure is not expected to generate additional effects that would combine with Project-related effects on Community Health and Well-being.

Of the projects or activities listed above (Table 10.7-17), only those that ranked with a potential moderate adverse interaction ("M") are considered for the cumulative effects assessment (as indicated in Section 5.2 (Effects Assessment Methodology). As such, the TransMountain Pipeline System Expansion (TMPL Expansion) interacts with the Project as follows:

- Construction of the TMPL Expansion would generate traffic, which could overlap with the Ajax Project traffic, potentially increasing the potential for road collisions; and
- The TMPL Expansion project would create a construction workforce which, if accommodated in and around Kamloops, could overlap with the Project construction workforce and increase the level of demand on local healthcare services.

Consultation with Kamloops residents to date has not indicated a concern that physicians and other healthcare professionals may choose to leave the community as a result of the TMPL Expansion. This project would be most visible during its construction; following construction, the pipeline will be buried and is unlikely to influence the community image or the decisions of healthcare professionals to reside in the community.

10.7.6.4 Proposed Mitigation Measures

Mitigation measures identified for potential increased traffic incidences included signage, infrastructure and network improvements, and the implementation of the TMP. These mitigation measures are sufficient from the Project's perspective to address cumulative effects of the Project with the TransMountain Pipeline Expansion. Regarding road infrastructure, TMPL proposes to transport workers by shuttle where feasible to worksites and promoting carpooling where shuttles are not feasible. TMPL is also committed to developing a Traffic and Access Control Management Plan and Traffic Control Plans for specific contracts.

It is not within the operational control of the Project to minimize the effect of another project on local roads and traffic; however, KAM will maintain an ongoing dialogue with TMPL during Project construction as the TMPL Expansion involves a reroute of the pipeline around the Mine Site to avoid Project infrastructure. As such, KAM will engage Kinder Morgan to discuss potential cumulative effects on road use and traffic and to identify the need for coordinated or additional mitigation measures.

Similarly, KAM will engage Kinder Morgan to discuss potential cumulative effects and concerns related to the presence of overlapping non-local construction workforces in the community. The

Community Liaison Group will also provide a venue for identifying and managing cumulative effects, and changes will be monitored through the Socio-Economic Monitoring Plan. KAM plans to maintain regular ongoing dialogue with the City, the TNRD, and service organizations to inform them of workforce requirements.

10.7.6.5 Evaluation of Significance of Residual Cumulative Effects

The residual cumulative effect is limited to potential interaction between the Project and the TransMountain Pipeline System Expansion project (see Table 10.7-18), in relation to potential effects related to road use and the capacity of local healthcare services.

Table 10.7-19 characterizes the cumulative effects of the Ajax Project and the TMPL Expansion project. In each case, the cumulative residual effects are not considered large enough to change the characterization of the residual effect of the Ajax Project alone.

The residual cumulative effect on traffic is expected to remain Not Significant (Minor). The effect is expected to be sporadic but is temporally constrained to the short-term as only the construction phases are expected to interact. The geographic extent is characterized as local because although the TMPL Expansion project may use a wider range of public roads to access various points along the pipeline route, the Project's effects are expected to be concentrated to four intersections (Inks Lake Interchange; Lac le Jeune Road at Ajax Mine Access Road; the roundabout at Versatile Drive and Hugh Allan Drive; and the intersection of Pacific Way and Hugh Allan Drive) and therefore the cumulative effects will be localized. Communication between KAM and Kinder Morgan is expected to be an effective mitigation measure to manage effects on traffic and road safety.

In regard to demand for health services, the cumulative effect is also anticipated to be Not Significant (Moderate). Communication between proponents and KAM's plan to implement an advisory committee are expected to help mitigate this residual effect. The cumulative residual effect will occur during the construction phases of both projects and is therefore short-term in duration. Considering the availability of a dedicated physician at the Project site, the potential increased demand on community health services is expected to be sporadic, and the effect will be reversible in the short-term.

10.7.7 Conclusion

The topic of Community Health and Well-Being was raised during the Project consultation with government agencies, the public, stakeholders, and the BC EAO. The health of individuals, families, and communities is shaped by a variety of factors or determinants of health, which include the social and economic environment, the physical environment, and an individual's characteristics and behaviours (WHO 2009).

Table 10.7-19. Characterization of Cumulative Residual Effects, Significance, Likelihood and Confidence on Community Health and Well-being

Cumulative Residual Effect	Residual Effects Characterization Criteria							Significance of Adverse Residual Effects	Likelihood and Confidence	
	Magnitude	Duration	Frequency	Geographic Extent	Reversibility	Resiliency	Context		Probability	Confidence
During peak construction, increased traffic could result in increased incidence of road collisions at four intersections	Minor	Short-term	Sporadic	Local	Reversible Short-term	High	Neutral	Not Significant (minor)	Medium	Medium
Increased demand for physicians and emergency room could affect availability of community health services	Minor	Short-term	Sporadic	Local	Reversible Short-term	Neutral	Neutral	Not Significant (moderate)	Medium	Medium

An array of potential Project effects on Community Health and Well-being were examined, including inputs from other VCs. Considering the various ways in which the Project could affect health and well-being, the results of other VCs were examined and a number of effects were consequently eliminated (including changes to human health as a result of biophysical changes in the environment, as assessed in Section 10.4; effects of noise and vibration, as assessed in Section 10.5; effects related to outdoor recreation, as assessed in section 8.6 and 10.6; and beneficial effects related to income). Following this analysis, three key effects on Community Health and Well-being were identified and assessed:

- Project-related traffic could result in increased collision and accident incidence on public roads;
- Project workforce may stress the provision of community services; and
- Project proximity to the City of Kamloops may affect community image and residents' perceived quality of life.

Project-Related Traffic Could Result in Increased Collision and Accident Incidence on Public Roads

Increases in traffic volume over the life of the Project, during the Construction and Operation Phases, could affect road and traffic conditions and the safety of road users. The mitigation measures put in place for the Project, such as safe driving behaviours, bus staging, shift staggering, road safety improvements, as described in the TMP, and network and infrastructure investments are expected to reduce the potential for accidents and injury as a result of Project-related traffic. However, based on the results of the TIA, a potential residual effect was identified for four intersections (Inks Lake Interchange; Lac le Jeune Road at Ajax Mine Access Road; the roundabout at Versatile Drive and Hugh Allan Drive; and the intersection of Pacific Way and Hugh Allan Drive) during the Construction Phase. The TMPL Expansion project could also interact with this residual effect to create a cumulative effect as a result of increased construction traffic. In addition to the mitigation measures identified for each project (including traffic management plans and workforce shuttles), KAM will Kinder Morgan to identify and address potential cumulative effects on traffic and road safety.

The residual effect of the Project is considered to be Not Significant (Minor). When considered along with the TransMountain Pipeline Expansion Project, the cumulative effect on Community Health and Well-being is also considered to be Not Significant (Minor).

Project Workforce May Stress the Provision of Community Services

Increased demand for physicians and emergency room services may occur during the Construction Phase in regard to incoming non-local construction workers. The capacity of local health services are noted to be currently constrained, with a limited number of family physicians and existing stress on hospital and emergency room resources. To ensure that construction workers have access to reliable medical care, KAM will ensure that a general physician is available at the mine site and dedicated to the needs of the workforce. This will reduce the workforce use of local clinics and/or use of the emergency room for non-urgent care.

Permanent in-migration of workers (and families) may also increase demand on health services during the Operation Phase, and community members have also expressed concern that physicians will choose to leave Kamloops as a result of the presence of the Project, although it is noted that this decision would be highly personal and subject to various influences other than the Project. In addition to the provision of medical services for construction workers, other key mitigation measures include developing a monitoring program for community health and well-being with input from service providers and the Community Advisory Group. The Interior Health Authority and other agencies are also actively recruiting for additional physicians to join the Kamloops community.

The demand for community health services may be exacerbated if the Project's construction phase overlaps with the presence of the TMPL Expansion project's construction workforce in Kamloops. In addition to the Project's mitigation measure, KAM will engage with Kinder Morgan to identify and manage potential cumulative effects on local health services. As mentioned above, the socio-economic monitoring plan will also include monitoring of changes in community health and well-being; monitoring approach and indicators will be defined in collaboration with service providers and the Community Advisory Group.

Overall, the Project's effect of increased demand for physicians and emergency room services is considered to be Not Significant (Moderate). When considered along with the TransMountain Pipeline Expansion Project, the cumulative effect on Community Health and Well-being is also considered to be Not Significant (Moderate).

Project Proximity to the City of Kamloops May Affect Community Image and Residents' Perceived Quality of Life

Residents have raised concerns about the effect of the Project on the image of Kamloops, and that it may project an image as a resource-based industrial city with environmental quality issues, contrary to the vision of a city with sound environmental quality to support other economic activities and a positive quality of life.

To mitigate these concerns and their associated stresses, KAM will offer to participate and support the next stage of community planning for the future of Kamloops. KAM will also look for ways to support the future vision of the city through its Community Investment Program; to date, the company has partnered in community investment with the development of a series of recreational trails in the Pineview neighbourhood and various other community investment initiatives undertaken in partnership with public, private and not for profit stakeholders. KAM will also manage residents' concerns about environmental quality through careful monitoring of environmental effects of the Project and transparent communication of those monitoring results in a timely way to residents of the LSA. Further, the Community Liaison Group will provide a forum for ongoing dialogue about monitoring results and environmental quality.

With mitigation in place, the effect of the Project on community image and well-being is considered to be Not Significant (Moderate). No cumulative effects with other projects were identified.

Summary

Table 10.7-20 summarizes the residual effects of the Project considered alone and as cumulative effects with other projects and activities. The table also reviews mitigation and significance of residual effects considered alone and as cumulative effects.

Table 10.7-20. Summary of Project and Cumulative Residual Effects, Mitigation, and Significance for Community Health and Well-being

Residual Effects	Project Phase	Mitigation Measures	Residual Effect Significance	Residual Cumulative Effect Significance
During peak construction, increased traffic could result in increased incidence of road collisions at four intersections	Construction	• Shuttles, shift staggering, and carpooling incentives to reduce traffic volumes • Improved road signage. • Improvements to Lac le Jeune Road, Inks Lake Interchange. • Transportation Management Plan. • Transportation Management and Control Plan. • Engagement with Kinder Morgan to identify and address potential cumulative effects on traffic and road safety	Not Significant (minor)	Not Significant (minor)
Increased demand for physicians and emergency room could affect availability of community health services	Construction, Operation	• Community Liaison Group • Socio-Economic Monitoring Plan including monitoring program for community health and well-being, to be developed in collaboration with Community Liaison Group and relevant service providers. • Processes to monitor and address issues if they arise and to communicate Project information to service providers. • Construction contractor will secure a dedicated general practitioner to provide healthcare services to workers. • Thompson Region Division of Family Practice, IHA, Venture Kamloops, and others will continue to recruit physicians for Kamloops • Engagement with Kinder Morgan to identify and manage potential cumulative effects on local health services	Not Significant (moderate)	Not Significant (moderate)
Project could affect community image and quality of life perceptions for some residents	Construction, Operation	• KAM participation in community planning and positive measures for community image. • Community Investment Program • Monitoring of environmental changes; transparent and timely communication of monitoring results to residents of the LSA; and discussion of monitoring results within the Community Liaison Group.	Not Significant (moderate)	No residual effect

10.8 SUMMARY OF ASSESSMENT OF POTENTIAL HEALTH EFFECTS

Table 10.8-1 summarizes all residual Project and cumulative effects, significance determinations, and mitigation measures for the assessment of health Valued Components. Additional summary information is also provided in Chapter 18.

Table 10.8-1. Summary of Residual Project and Cumulative Effects and Mitigation Measures: Health

Residual Effect	Project Phase	Mitigation	Significance of Project Residual Effect	Significance of Cumulative Residual Effect
VC: Air Quality (Section 10.1)				
Change in CAC concentrations.	Construction	• Minimize material drop heights, • Watering road surfaces prone to generating fugitive dust, • proper road maintenance, • wheel cleaning, where necessary, to prevent "track-out", • minimize area of exposed rock and soil, reduce vehicle idling and rapid starts and stops, • use multi-passenger vehicles to transport crews, • operate vehicles within posted maximum speed limits, • maintain vehicles in good operating condition.	Not Significant (moderate)	Not Significant (moderate)
Change in CAC concentrations.	Operation	• In addition to those listed above, • Arch cover over conveyor from crusher to plant, • Cover over the coarse ore and fine ore stockpiles, • Partially enclose the primary crusher, • use covered and well sealed concentrate transport trucks, • Use large trucks for ore and mine rock transport to minimize the number of trips, Select best achievable technology for the mine fleet, • Adhere to all permits, authorizations and approvals related to air quality.	Not Significant (moderate)	Not Significant (moderate)

Residual Effect	Project Phase	Mitigation	Significance of Project Residual Effect	Significance of Cumulative Residual Effect
VC: Domestic Water (Section 10.2)				
Change in Knutsford groundwater quality.	Operation	• Mitigations from Surface Water Quality and Groundwater Quality, • Water Management Plan, • TSF Design which includes an underdrain system in the embankment foundation, Liner system on the upstream face of the embankment overlying a low permeability glacial till basin liner, • SMRSF Pond – manage seepage and runoff from the southern extent of the SMRSF, • Reclamation of MRSFs in Decommissioning and Closure with a low permeability till layer overlain with topsoil to reduce infiltration and maximize evapotranspiration and runoff, • Dry cover on TSF to reduce infiltration into the underlying tailings solids and increase non-contact runoff, • Air Quality Management Plan to reduce dust.	Residual effects assessed in Human Health VC (Section 10.4)	No residual cumulative effect
VC: Country Foods (Section 10.3)				
Change in country foods quality.	All phases	• Mitigations applied in the assessment of air quality, surface water quality and groundwater quality also apply to the country foods VC.	Residual effects assessed in Human Health VC (Section 10.4)	No residual cumulative effect
VC: Human Health (Section 10.4)				
Change in air quality that could result in a change in human health risk associated with inhalation exposures to CACs and particulate-bound metals.	Construction, Operation, Decommissioning and Closure	• Mitigation measures specific to human health have not been recommended, • Mitigation measures to control air and dust emissions outlined in the Air Quality and the Dust Control Plan will reduce Project emissions to levels that are protective of human health.	Not Significant (minor)	No residual cumulative effect

Residual Effect	Project Phase	Mitigation	Significance of Project Residual Effect	Significance of Cumulative Residual Effect
• **VC: Human Health (Section 10.4)** *(cont'd)*				
Changes in soil, surface water, groundwater, and country food quality could result in a change in human health risk associated with direct contact and ingestion exposures to metals.	Post Closure	• Mitigation measures specific to human health have not been recommended, • Mitigation measures to control air and dust emissions outlined in the Air Quality and Dust Control Plan will reduce Project emissions to levels that are protective of human health, • Mitigation measures to control surface water discharges outlined in the Water Management Plan will reduce Project emissions to levels that are protective of human health.	Not Significant (minor)	No residual cumulative effect
VC : Noise (Section 10.5)				
Change in acoustic environment.	Construction, Operation	• Locate noise emission inside gallery, enclosure, or buildings, • Reduce haul road distance, • Use large haul truck for ore and mine rock transport, • Mobile equipment fitted with exhaust mufflers, • Locate plant facilities further from City of Kamloops boundary, • Implement the Noise and Vibration Management Plan.	Not Significant (minor)	Not Significant (minor)
Change in vibration environment.	Construction, Operation	• Implement blast designs that were based on the damage threshold at the closest location (i.e. Jacko Lake), • Implement the Noise and Vibration Management Plan.	Not Significant (minor)	No residual cumulative effect
VC: Healthy Living and Health Education (Section 10.6)				
No residual effect				

Residual Effect	Project Phase	Mitigation	Significance of Project Residual Effect	Significance of Cumulative Residual Effect
VC: Community Health and Well-Being (Section 10.7)				
During peak construction, increased traffic could result in increased incidence of road collisions at four intersections	Construction	• Shuttles, shift staggering, and carpooling incentives to reduce traffic volumes, • Improved road signage, • Improvements to Lac le Jeune Road, Inks Lake Interchange, • Transportation Management Plan, • Transportation Management and Control Plan, • Engagement with Kinder Morgan to identify and address potential cumulative effects on traffic and road safety.	Not Significant (minor)	Not Significant (minor)
Increased demand for physicians and emergency room could affect availability of community health services	Construction, Operation	• Community Liaison Group, • Socio-Economic Monitoring Plan including monitoring program for community health and well-being, to be developed in collaboration with Community Liaison Group and relevant service providers, • Processes to monitor and address issues if they arise and to communicate Project information to service providers, • Construction contractor will secure a dedicated general practitioner to provide healthcare services to workers, • Thompson Region Division of Family Practice, IHA, Venture Kamloops, and others will continue to recruit physicians for Kamloops, • Engagement with Kinder Morgan to identify and manage potential cumulative effects on local health services.	Not Significant (moderate)	Not Significant (moderate)

Residual Effect	Project Phase	Mitigation	Significance of Project Residual Effect	Significance of Cumulative Residual Effect
Project could affect community image and quality of life perceptions for some residents	Construction, Operation	• KAM participation in community planning and positive measures for community image, • Community Investment Program, • Monitoring of environmental changes; transparent and timely communication of monitoring results to residents of the LSA; and discussion of monitoring results within the Community Liaison Group.	Not Significant (moderate)	No residual effect

10.9 REFERENCES

Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

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