7 Air Quality

Air quality is an important environmental factor in ensuring the conservation of local vegetation, wildlife, and human health values. KSM Project (the Project) activities will result in air emissions to the ambient environment. The change in ambient air quality needs to be assessed to ensure conservation of the environment and compliance with federal and British Columbia (BC) regulations. Air quality was also included as a valued component (VC) for assessment in the Application Information Requirements (AIR; BC EAO 2011), and Comprehensive Study Scope of Assessment (CEA Agency et al. 2010). The purpose of the assessment is to determine the potential effects of the Project on ambient air quality by:

- providing an overview of regional climate and air quality;
- summarizing relevant legislation, regulations, and guidelines;
- explaining the methods used to characterize baseline climatic and air quality conditions within a defined baseline study area;
- detailing the current meteorological and ambient air quality conditions in the Project area;
- defining a regional study area (RSA)—the same area as the baseline study area—and a temporal framework for the purposes assessing effects on air quality;
- providing a description of the selection process to identify ambient air quality as a VC;
- scoping Project-related emission sources that could cause potential air quality effects;
- reviewing potential effects and mitigation options;
- estimating the emission inventory associated with the Project;
- performing dispersion modelling in order to estimate the potential residual effect on air quality;
- predicting the change in ambient concentrations and comparing these values to applicable government air quality criteria;
- determining the significance of residual effects on air quality from the Project; and
- assessing the potential for Project-related residual effects to interact cumulatively with other human activities (i.e., past, present, and reasonably foreseeable projects).

7.1 Climate and Air Quality Setting

7.1.1 Regional Climate and Air Quality

The Project is located in a remote, mountainous region of northwestern BC. The meteorological conditions in the area are primarily influenced by the Pacific Ocean to the west and continental Arctic regions to the northeast. Hence, the Project is in a transition zone between wet coastal and dry/cold interior climate zones. The orographic influence of the mountain ranges on the Pacific and continental air masses results in precipitation and air temperatures that are widely variable over the Project area. More information on the regional climate is included in Section 7.1.3.3 and

Appendix 7-B while more information on the air quality is discussed in Section 7.4.3.4 and Appendix 7-C.

Strong winds generally occur in all seasons at high elevations above the mountains, with winds generally coming from the northeast, southeast, and southwest quadrants in the winters and from the southwest quadrant in the summers. Winds at low elevations are funnelled through valleys with a light to moderate down-valley flow of Arctic air from the northeast in the winter and a light up-valley flow of warm Pacific air from the southwest in the summer.

The regional hydroclimate reflects the interactions between incoming weather systems and local topography that produce a degree of spatial variability in snowfall and rainfall. Orographic effects result when Pacific air streams confront the west-facing slopes of the Coast Mountains and the moisture-laden air is forced up the slopes. As the air cools and rises, it is less capable of holding moisture and releases it as rain or snowfall. The mountains also slow down cyclonic storms, which can lead to prolonged and sometimes heavy rainfalls. Over the mountain summit, the air descends and warms, which disperses the cloud and potential rain through evaporation. The result is a dramatic reduction of precipitation in the rain-shadow. Within BC, the series of mountain ranges that parallel the coast produce a decrease in precipitation with increasing distance from the ocean as storms pass over the successive ranges.

The air quality in the area proposed for Project development and elsewhere in northwestern BC is predominantly not affected by anthropogenic sources, reflecting the region's remoteness and the lack of, and localized nature of, sources of anthropogenic air emissions sources.

7.1.2 Air Quality Legislation, Regulations, and Guidelines

Managing air quality is a partnership between multiple government jurisdictions and stakeholders including federal, provincial, regional, and municipal governments, along with international joint organizations. The *Canadian Environmental Protection Act* (CEPA; 1999), which came into force on March 31, 2000, is an important part of Canada's federal environmental legislation aimed at preventing pollution and protecting the environment and human health. CEPA also regulates emission sources that lie beyond provincial authorities such as motor vehicles and fuel, marine vessels, railways, and off-road engines (BC Air Quality 2013).

The *Environmental Management Act* (EMA; 2003) and Waste Discharge Regulation (WDR; BC Reg. 320/2004) are the most important pieces of legislation for air quality in BC. The EMA was enacted in July 2004, which replaced the *Waste Management Act* and the *Environment Management Act* (1996a) and brought provisions from both of these acts into one statute (BC MOE 2013b). The EMA provides a more flexible authorization framework, increases enforcement options, and uses modern environmental-management tools (BC MOE 2013b). The Waste Discharge Regulation, under the EMA, stipulates that it is applicable to mining and mining activities such as clearing and burning and incineration; this regulation also explicitly sets out enforceable fees for discharge which multiply when maximum concentrations are exceeded (WDR; BC Reg. 320/2004). Many codes of practice and regulations are also in development and review under the EMA, which include but are not limited to Hazardous Waste Regulation, the Open Burning Smoke Control Regulation, and Small Electrical Power Generating Facility Code of Practice.

Ambient air quality objectives are non-statutory limits that provincial or federal governments place on the level of contaminants in the atmosphere in order to guide decisions to protect human health and the environment. Discharges of fugitive dust and air contaminants, as well as ambient air quality objectives (in particular for Total Dustfall Particulate) may also be explicitly written into a waste discharge air permit. Typically, Criteria Air Contaminants (CACs) is a group of pollutants that include:

- sulphur dioxide (SO_2);
- nitrogen dioxide (NO_2);
- particulate matter (PM); and
- carbon monoxide (CO).

Particulate matter is often defined in terms of size fractions. Particles less than 40 µm in diameter typically remain suspended in the air and are referred to as total suspended particulate (TSP). Particles with diameter less than 10 µm and 2.5 µm are referred to as PM_{10} and $PM_{2.5}$, respectively.

The federal and provincial ambient air quality criteria are summarized in Table 7.1-1. The national ambient air quality objectives (NAAQOs) have been the benchmark against Canadian impact assessment of anthropogenic activities on air quality. The first NAAQOs developed in the mid-1970s consisted of a three-tiered approach (maximum desirable, acceptable, and tolerable levels). The subsequent new NAAQOs framework, introduced in the National Air Pollution Surveillance (NAPS) data report for the year 2000, specified two levels developed through extensive scientific assessment:

- a reference level, which is the level above which there are demonstrated effects on human health, and/or the environment; and
- an Air Quality Objective, which reflects a specific level of protection for the general population and environment and also considers aspects of technical feasibility (Environment Canada 2013).

The original objectives have not been formally revised to the new two-level system. In the interim, SO_2, NO_2, CO, and O_3 are being compared with the existing desirable and acceptable NAAQOs. The NAAQOs are set by the federal government based on recommendations from a National Advisory Committee and Working Group on Air Quality Objectives and Guidelines, and are consistent with the philosophy of the CEPA.

The province also has the authority to develop air quality standards and guidelines, regulate point and area sources, and require the preparation of airshed management plans (BC MOE 2013b). The BC air quality objectives are mostly similar to those from NAAQOs; however, some pollutants are only regulated by either the federal or the provincial government. For example, a PM_{10} objective is set for BC and is not included in the NAAQOs (Table 7.1-1). Objectives for NO_2 were also not published for BC, and the NAAQOs for NO_2 are used in most cases. The Canadian Council of Ministers of the Environment (CCME), composing Canada’s federal, provincial and territorial environment ministers, developed Canada-wide Standards (CWS) for $PM_{2.5}$ and O_3 in 2000 pursuant to the 1998 Canada-wide Accord on Environmental

Harmonization of the CCME and its Canada-wide Environmental Standards Sub-Agreement. The CWS is a step toward the long-term goal of minimizing the risk posed to human health and the environment. Since BC is a member of the CCME, a 24-hour $PM_{2.5}$ CWS of 30 µg/m^3 (based on the annual 98th percentile averaged over three consecutive years), is being implemented in BC. In 2009, new ambient air quality criteria for $PM_{2.5}$ were developed in BC. They are non-statutory limits guided by the Air Action Plan and the BC government's commitment to "… lead the world in sustainable environment management with the best air and water quality…" (BC MOE 2013a). The development of the new criteria was originally led by the BC MOE, followed by the BC Ministry of Healthy Living and Sport. The 24-hour $PM_{2.5}$ objective of 25 µg/m^3, based on an annual 98th percentile, is more stringent than the CWS for $PM_{2.5}$. BC also established an annual average objective of 8 µg/m^3 and a planning goal of 6 µg/m^3 to keep the air clean and the environment healthy.

Table 7.1-1. Federal and Provincial Ambient Air Quality Criteria

		Concentrations (µg/m^3)					
		Canada			BC Objective		
Pollutant	Averaging Time	Maximum Desirable	Maximum Acceptable	Maximum Tolerable	Level A	Level B	Level C
SO_2	1-hour	450	900	-	450	900	900-1,300
	24-hour	150	300	800	160	260	260
	Annual	30	60	-	25	50	80
NO_2	1-hour	-	400	1,000		-	
	24-hour	-	200	300		-	
	Annual	60	100	-		-	
CO	1-hour	15,000	35,000		14,300	28,000	35,000
	8-hour	6,000	15,000	20,000	5,500	11,000	14,300
TSP	24-hour	-	120	400	150	200	260
	Annual	60	70	-	60	70	75
PM_{10}	24-hour		-		-	50	-
$PM_{2.5}$	24-hour		30[a]			25[b]	
	Annual		-			8[c]	

Notes: (-) dash indicates not applicable.

a Annual 98th percentile value, averaged over three consecutive years. Canada-wide standard published by the CCME (2000b).

b Based on annual 98th percentile value.

c BC objective of 8 µg/m^3 and planning goal of 6 µg/m^3 was established in 2009.

Regional and municipal governments also develop bylaws to control emissions such as open burning and vehicle idling. In the Regional District of Kitimat-Stikine, where the Project is located, there are currently no anti-idling or open-burning bylaws; however, in the Kitimat municipality, personal communication with Grace Allen, Bylaw Enforcement Officer for the Central Kootenay Regional District, indicated, "No open air fires, except where such a fire is used in any appliance or device solely used for preparation of food, or in a National Fire Protection Associated approved incinerator." "The Fire Chief may issue a permit to allow the burning in the open air of brush, stumps, slash and like materials resulting from the cleaning of land"; and, "[t]he Fire Chief may issue a permit to allow the burning in the open air of selected combustible materials, at designated industrial sites…" (Alderson 2007).

The Pollution Control Objectives for the Mining, Smelting, and Related Industries of British Columbia (BC MOE 1979) developed dustfall objectives ranging from 1.7 to 2.9 $mg/dm^2/day$, averaged over 30 days. The aim of the objectives is to protect the quality of BC's environment for the benefit of present and future citizens of this province, intending to minimize the effect of known or potential harmful changes in receiving environments (BC MOE 1979).

Acid deposition is the end product of reactions between sulphur oxides (SO_x), nitrogen oxide (NO_x), and water in the atmosphere. Critical loads are estimates of an environment's assimilative capacity, which is the amount of acid deposition a particular region can receive without being adversely affected. Critical loads of acidity were determined for sample lakes and upland forest soil using steady-state models (Environment Canada 2004). The Environment Canada report on Canadian Acid Deposition Science in 2004 was the first major synthesis of acid deposition science in Canada since the launch of the Canada-wide Acid Rain Strategy for Post-2000 signed in 1998, and the first comprehensive examination of atmospheric and ecosystem responses to SO_2 (Environment Canada 2004). Critical loads have been determined and mapped for upland forest soils in eastern Canada following guidelines established by the New England Governors–Eastern Canadian Premiers (NEG-ECP). In western Canada, the Acid Rain Task Group (ARTG; mandated by the Air Management Committee of the CCME) has supported the determination of critical loads following the same NEG-ECP protocol. For BC, preliminary estimates of critical load have a maximum of 4,026 eq/ha/year, a median of 750 eq/ha/year, and a minimum of 174 eq/ha/year.

Other than the federal, provincial, and regional/municipal regulation and criteria on emission sources, ambient air concentrations, and deposition rates, there is also a *Guideline for Air Quality Dispersion Modelling in British Columbia* (referred as the BC Model Guideline hereafter; BC MOE 2008). The guideline is intended to provide information for practitioners and for those who use model outputs for decision-making. Details on model approach for source type, model domain and receptor spacing, and interpretation of the model output are provided in the document. The KSM Project Air Dispersion Detailed Model Plan (included in Appendix 7-A) used to predict the potential air quality effects of the Project against provincial and federal ambient air quality objectives has been prepared based on the best practices from the BC Model Guideline.

7.1.3 Baseline Climate and Air Quality – Characterization Methodology

7.1.3.1 Baseline Study Area

The baseline study area corresponds to the RSA defined for the air quality dispersion model and effects assessments (see Section 7.4.1), and is referred to as the RSA for the remainder of Chapter 7. It incorporates the area that could be potentially affected by air emission sources from the Project. This region encompasses emission sources such as truck traffic on Highway 37 and areas that could potentially be affected by the Project based on the topography and the existing airsheds.

The RSA covers a domain 100 km in an east-west direction and 60 km in a north-south direction. The centre of this area is located roughly between the proposed Project's Mine Site and the Processing and Tailing Management Area (PTMA; Figure 7.1-1).

7.1.3.2 Methods and Data Sources

Baseline climate and air quality data have been collected for the Proponent, Seabridge Gold Inc. (Seabridge), by Rescan Environmental Services Ltd., and include site-specific meteorological and dustfall stations throughout the RSA. Since the RSA is remote with few anthropogenic sources, there is little or no background information readily available in the area. In order to characterize local meteorological conditions in preparation for the dispersion modelling, hourly meteorological data collected inside the RSA were required. The BC Ministry of Forests, Lands, and Natural Resource Operations (BC MFLNRO) and BC Ministry of Transportation and Infrastructure (BC MOTI) have weather stations in the region; however, the data are only collected on a seasonal basis for forest fire forecasting and road maintenance scheduling. In addition, the BC MFLNRO and BC MOTI quality assurance and quality control program is not comparable to the Environment Canada–Meteorological Service of Canada (EC-MSC) monitoring programs. Since the BC MFLNRO and BC MOTI stations are not maintained year round and continuous meteorological data are required as inputs for dispersion modelling, another source of meteorological data is needed.

Long-term meteorological data are collected at EC-MSC meteorological stations. The closest EC-MSC stations in the area are Stewart Airport, Bob Quinn AGS, and Unuk River Eskay Creek meteorological stations. Hourly meteorological data are collected at the Stewart Airport station but only from 7:00 to 17:00. Moreover, the station is 50 km outside the RSA. Bob Quinn AGS station only provides data in daily intervals, and the station is outside the RSA. The Unuk River Eskay Creek station is inside the RSA by the recently closed Eskay Creek Mine, but only provides data on a daily basis. Due to the lack of readily available information, automated meteorological stations were installed in the RSA to record temperature, precipitation, wind speed and direction, snow depth, solar radiation, and evaporation. Although the EC-MSC stations do not record hourly data continuously, the temperature trend is expected to be similar to that inside the RSA. Parameters such as wind and precipitation are location specific and change with terrain and elevation.

Baseline or background air quality data are the ambient air concentrations prior to Project commencement due to emissions from both natural and human-caused sources (BC MOE 2008). At present, there is no background ambient monitoring station for SO_2, NO_2, and CO in northwestern BC or Alaska because the area is remote. Monitoring equipment that samples ambient concentration on an hourly basis requires power, which is a challenge in remote areas. Due to these challenges, Project-specific air quality background was not collected. Passive dustfall deposition rates were monitored at 10 locations in the RSA in the summer months. From the dustfall data, baseline dust deposition and acid deposition are analyzed. Since a network of long-term ambient monitoring stations near the Project is not available, long-term ambient monitoring at a different location that is adequately representative is used as described in the BC Model Guideline (BC MOE 2008).

Background CAC concentrations from ambient air quality monitoring stations at remote areas will be used to represent Project background. The background air concentrations are added to modelled concentrations to represent future air quality conditions after Project commencement.

PROJECT # 0868-016-06 *GIS No.* KSM-12-057 January 29, 2013

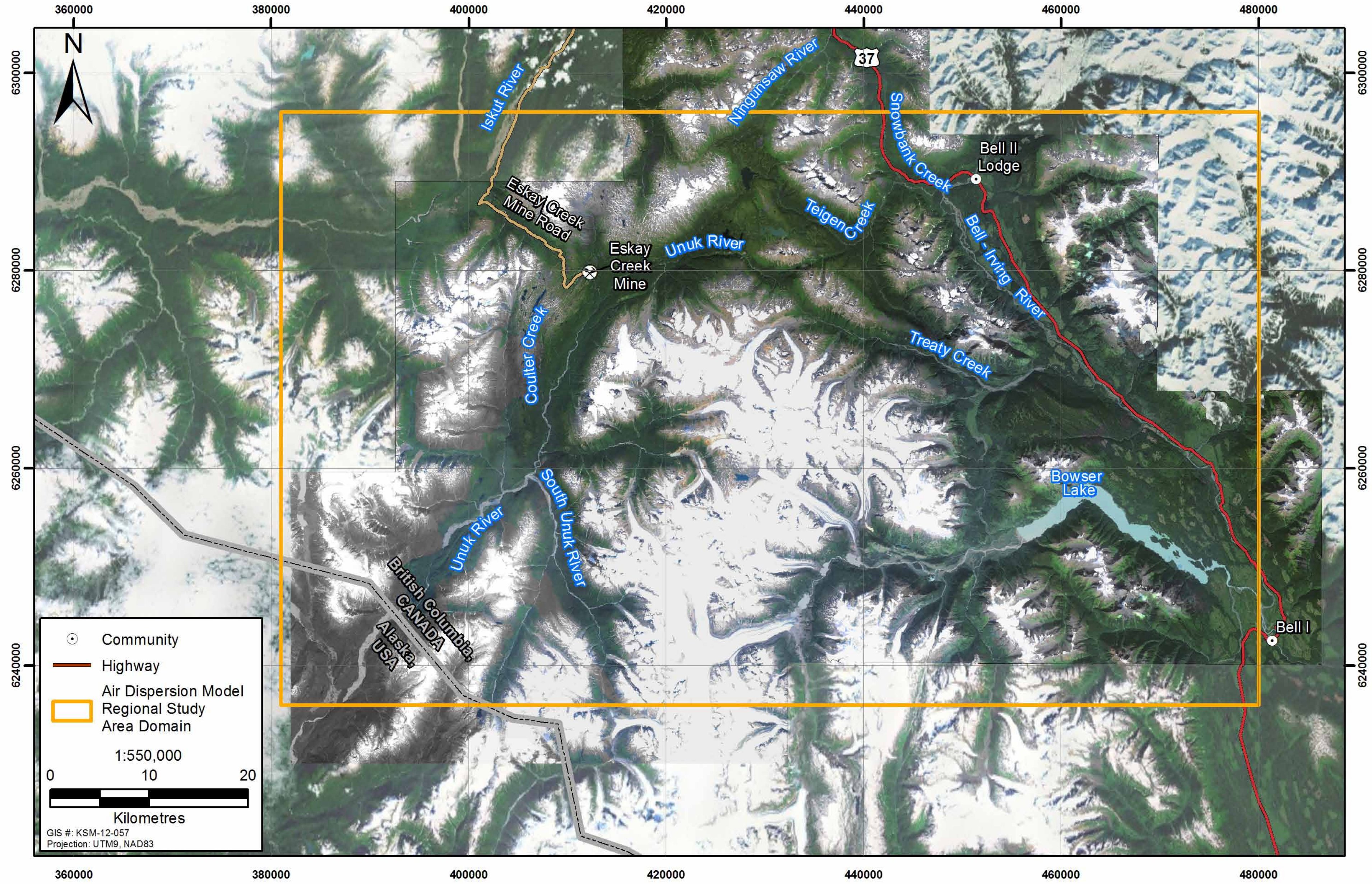

Figure 7.1-1

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KSM Project Air Dispersion Model Regional Study Area Domain

Figure 7.1-1

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7.1.3.3 Baseline Climate in the Regional Study Area

Due to the complexity of the local terrain in the RSA, a series of meteorological stations were established around the Project footprint to characterize on-site baseline climatic conditions and to form a framework for future climatic monitoring. On-site meteorological data are required not only for dispersion model setup, but also to provide information for water balance calculations and assist in the Project design. Temperature is an important indication of the type of climate in the area and is used in dispersion models. Temperature is also often used in the Project design such as cost for heating. Wind is a crucial component in air quality dispersion modelling. Precipitation is also used in the calculation and dispersion of air emissions, but also can be used in the hydrology water balance together with evaporation data. Snow depth and solar radiation can be used in the Project design while solar radiation is measured to ensure enough power is provided by the solar panel to charge the battery in order to support the meteorological measurement sensor mounted on the meteorological tower.

Meteorological data including temperature, precipitation, wind speed and direction, snow depth, solar radiation, and evaporation were collected in the RSA using a variety of automated and manual methods. Parameters other than those measured during snow surveys were collected from automated stations to provide more continuous datasets and standardized collection methods.

Since 2007, a total of five automated meteorological stations have been installed and operated as part of the meteorology baseline monitoring program (Figure 7.1-2). Sulphurets Creek station was installed in September 2007 on a ridge northwest of Sulphurets Lake in the Sulphurets Creek Valley. Teigen station (Plate 7.1-1) was installed in March 2008 in the Teigen Creek Valley, northwest of the PTMA. Unuk-Teigen station was installed in July 2008 in a saddle between the middle fork of Teigen Creek and Unuk River (Plate 7.1-2). Mitchell station (Plate 7.1-3) was installed in the area of the proposed Mitchell pit in September 2008 in order to supplement data being collected at the Sulphurets station. Eskay Creek station was installed in September 2010 on open ground at the eastern end of the Eskay Creek Mine site (Plate 7.1-4). The Eskay Creek station is located approximately 1 km east of the old Unuk River Eskay Creek meteorological station that was operated by Environment Canada from 1989 to 2010. In the following sections, baseline conditions of temperature, precipitation, wind speed and direction, snow depth, solar radiation, and evaporation are summarized. The climate is relatively consistent across the RSA and hence the environmental setting described below applies to both the Mine Site/Coulter Creek access road and the PTMA/Treaty Creek access road as the climate condition inside the RSA is assessed as one. More detailed information about the RSA climate can be found in Appendix 7-B.

7.1.3.3.1 Temperature

All Project stations follow the same temperature trend from 2008 to 2011. Generally, temperatures at the high-elevation Teigen and Unuk-Teigen stations are the lowest, while temperatures at the low-elevation Eskay Creek Mine and Mitchell stations are the highest. The summer months of July and August tend to be the warmest, while December and January are the coldest months.

PROJECT # 868-022-18 *GIS No.* KSM-12-070_T

January 24, 2013

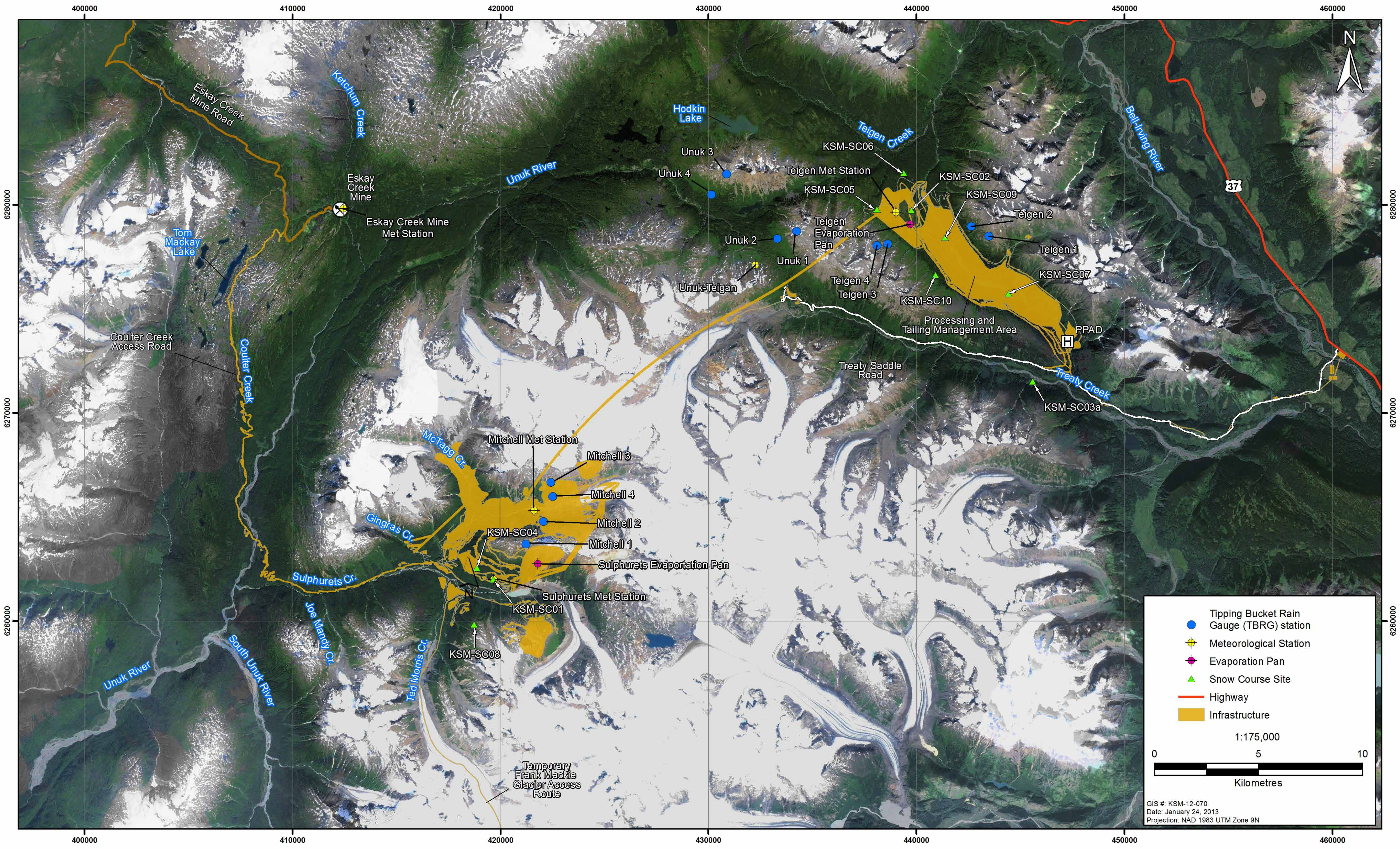

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Figure 7.1-2

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Baseline Monitoring Stations for Meteorology, Snow, Precipitation, and Evaporation

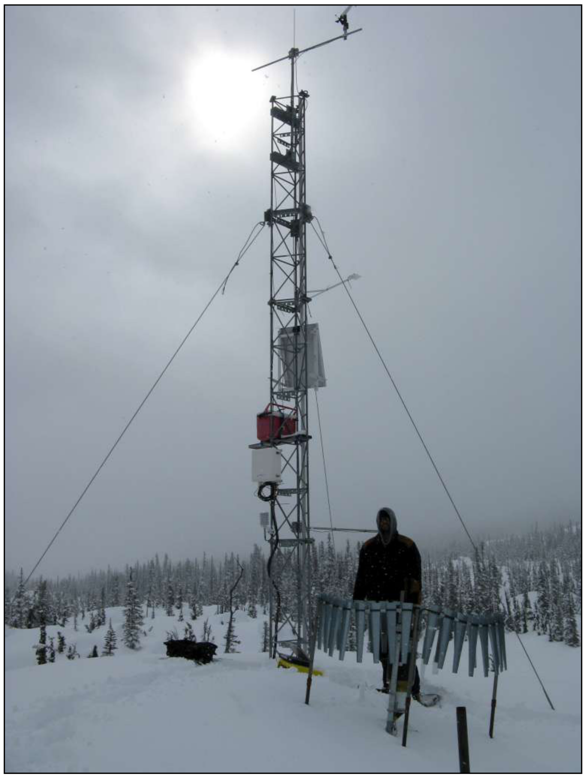


Plate 7.1-1. Teigen 10 m meteorology station (March 2011).

Plate 7.1-2. Unuk-Teigen 10 m meteorology station (June 2011).

Plate 7.1-3. Mitchell 10 m meteorology station (Left: August 2012; Right: March 2012).

Plate 7.1-4. Eskay Creek station, October 2010.

The mean monthly, mean daily maximum, and mean daily minimum air temperatures across the Project area stations ranged from 14º to -12ºC, 20º to -10ºC, and 9 to -14ºC, respectively. The highest daily maximum air temperatures collected in RSA between 2008 and 2011 were 25.3º, 27.5º, 30.2º, 29.6º, and 26.8ºC at Eskay Creek Mine, Mitchell Deposit, Sulphurets Creek, Teigen, and Unuk-Teigen stations, respectively, and the lowest daily minimum air temperatures between 2008 and 2011 were -22.1, -25.7, -31.1, -27.5, and -26.9ºC for the same respective Project stations. Comparing to data from EC-MSC stations from Stewart Airport (1974 to 2000), Bob Quinn AGS (1977 to 1994), and Unuk River Eskay Creek (1989 to 2007), the mean monthly, mean daily maximum, and mean daily minimum ranged from -8.8º to 15.1ºC, -5.8º to 20.4ºC, and -11.8º to 10.3ºC, respectively, which are similar to the air temperatures collected in the RSA.

Temperature inversions can occur due to outbreaks of Arctic air reaching the RSA as well as from radiative cooling and subsidence. During these events, higher elevations experience warmer air temperatures than lower elevations. Air pollution emitted during temperature inversions will tend to stay within valleys and may result in higher pollution concentrations as the air is not able to mix, dilute, and disperse the pollution as well as during normal temperature gradient conditions.

7.1.3.3.2 Precipitation

Precipitation spatial variation is mainly due to three factors: elevation, proximity to source of moisture, and the effect of rain shadow. Generally, precipitation increases with elevation and decreases with distance from a large source of moisture. If there is a mountain blocking the moist air masses from travelling, the air masses are forced upward. Due to this orographic lifting, water vapour condenses and precipitates, leaving the downwind side of mountain ranges drier.

Precipitation is measured at Sulphurets Creek (880 masl), Teigen (1,085 masl), and Eskay Creek Mine (770 masl) stations. Annual precipitation in 2011 was 1,914 mm at Eskay Creek Mine station. The average annual precipitation at Sulphurets Creek station was 1,243 mm (1,273 mm in 2008, 1,196 mm in 2009, 1,184 mm in 2010, and 1,319 mm in 2011), and 742 mm at Teigen station (689 mm in 2009 and 794 mm in 2010).

Maximum precipitation occurs in the fall and winter due to the influence of Pacific storms, which have greater strength and frequency in these seasons, while precipitation amounts are lowest during the summer. For the Eskay Creek Mine meteorological station, the monthly total precipitation varied from 52 mm (June) to 437 mm (September) in 2011. For Sulphurets Creek station, the monthly total precipitation varied from 42 mm (April) to 307 mm (October) in 2008, 26 mm (December) to 243 mm (January) in 2009, 36 mm (April) to 237 mm (October) in 2010 and 45 mm (June) to 275 mm (September) in 2011. For Teigen station, the monthly total precipitation varied from 20 mm (June) to 123 mm (September) in 2009 and 1 mm (May) to 156 mm (September) in 2010.

7.1.3.3.3 Wind

Figure 7.1-3 presents the September 2008 to December 2011 windroses and wind frequency distributions for Mitchell, Teigen, and Unuk-Teigen meteorological stations. Average yearly wind speeds and directions at all stations are consistent between years. The wind speeds at Mitchell and Teigen stations were generally moderate to mild, with wind speeds between 1 and 3 m/s being the most frequent (more than 50% of the time). The wind speed at Unuk-Teigen was moderate, with wind speeds between 1 and 3 m/s around 30% of the time, and wind speeds exceeding 5 m/s around 36% of the time. The highest recorded hourly average wind speeds were 17.4, 11.5, and 18.8 m/s from Mitchell, Teigen, and Unuk-Teigen stations, respectively. Winds at Mitchell and Teigen stations predominantly come from the east-southeast (27% of the time) and southeast (19% of the time), respectively. Winds at the Unuk-Teigen station predominantly come from the south-southeast and southeast 40% of the time.

Calm wind speeds less than 0.5 m/s occur 5, 3, and 4% of the time at Mitchell, Teigen and Unuk-Teigen stations, respectively. Because the wind serves to diffuse and transport air pollutants, low and calm wind speeds help prevent air pollution concentrations from decreasing, as the pollution cannot be mixed and transported away as well as times when moderate and high wind speeds are prevalent. Project air pollution transport and dilution will be reduced because of the high frequency of low and calm wind speeds in the Troposphere in different areas of the Project.

7.1.3.3.4 Snow Depth

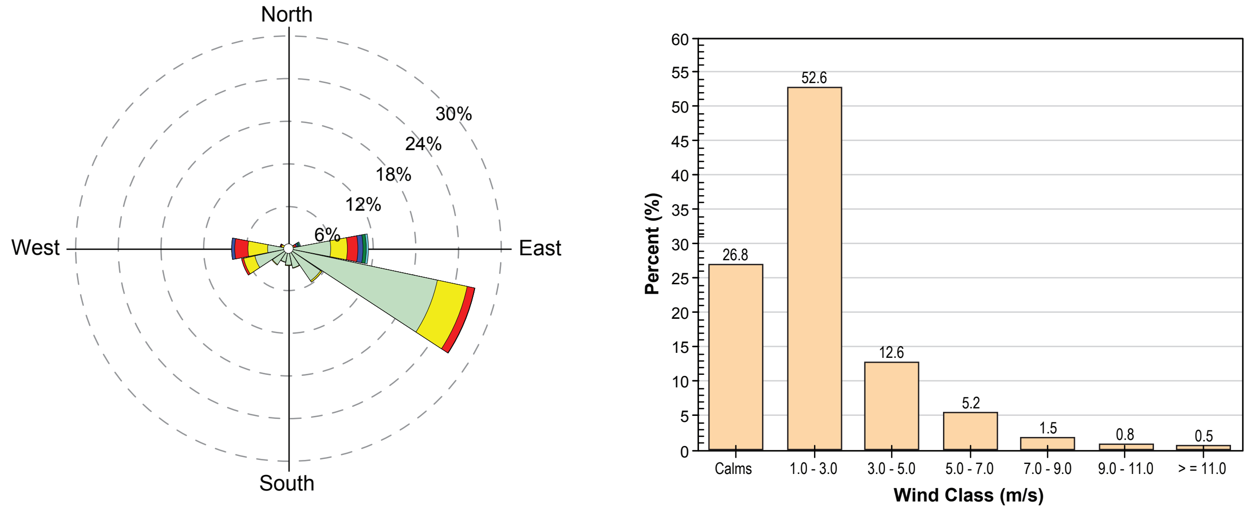
Snow depth varies greatly with elevation and surrounding topography. Wind-blown snow will also be deposited in specific patterns due to wind turbulence around local obstacles. Generally, snow accumulation starts in October when temperatures are consistently below 0ºC, and snow depth starts to decrease around late April and early May when temperatures increase to approximately 0ºC. The highest annual snow depth at Teigen station ranged from 1.8 m in 2008 to 2.1 m in 2009, and the highest annual snow depth at Eskay Creek Mine station was 2.5 m in 2011, which is the only complete year of data.

From snow course measurements within the Sulphurets Creek watershed, mean April snow depths were found to be around 1.7 m at low elevations and 2.1 m at higher elevations. Teigen Creek watershed mean April snow depths measured between 1.7 m at low elevations and 2.3 m at higher elevations. Low elevation measurements in the Treaty Creek watershed reveal mean April snow depths of 2.0 m.

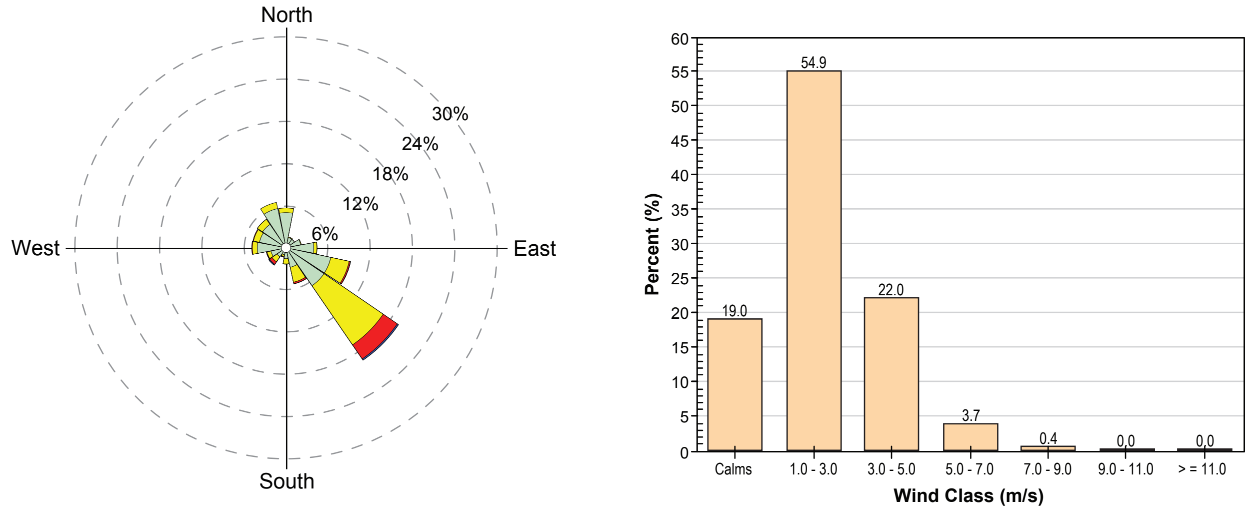
7.1.3.3.5 Solar Radiation

Solar radiation was monitored at the Sulphurets Creek and Teigen meteorological stations. At the Sulphurets Creek station, the maximum daily average solar radiation can reach approximately 380 W/m^2, while at Teigen station, it can reach 420 W/m^2. On average, solar radiation at the Teigen station is higher than at the Sulphurets Creek station owing to a higher sky exposure due to the difference in topography between the two stations.

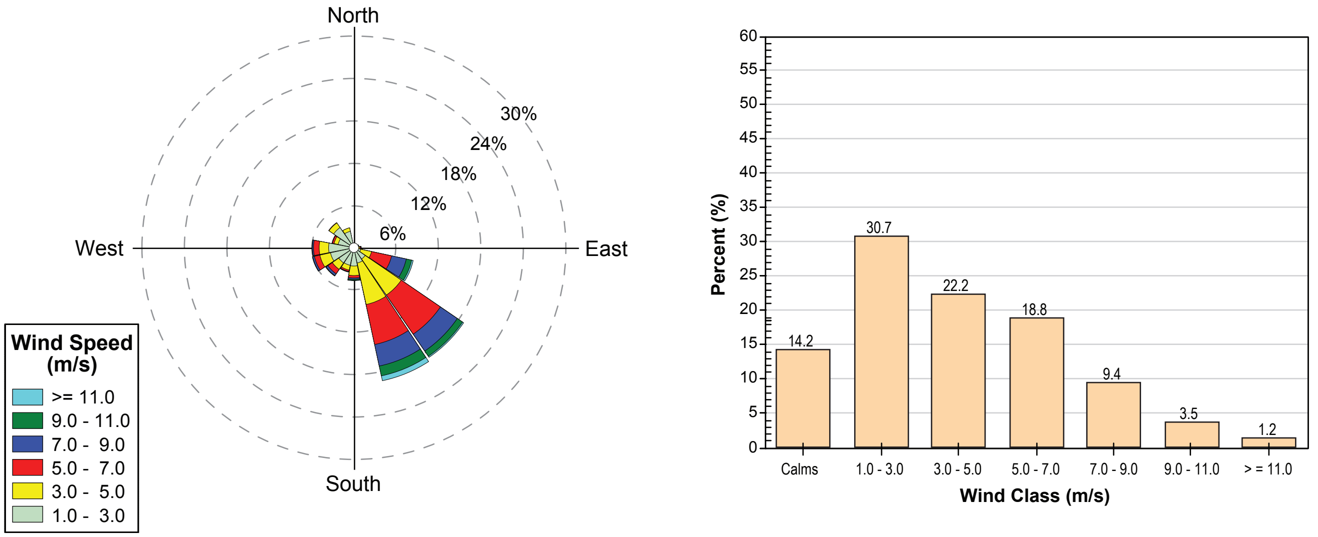
Mitchell Station (Sept 2008 to Dec 2011)



Teigen Station (Sept 2008 to Dec 2011)



Unuk-Teigen Station (Sept 2008 to Dec 2011)



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Windroses and Frequency Distributions for Project Stations

Figure 7.1-3

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7.1.3.3.6 Evaporation

Evaporation rates were monitored at the Teigen and Sulphurets stations. The average annual evaporation rates observed at these two locations ranged from 1.3 mm/day to 3.1 mm/day. Total estimated lake evaporation at the Teigen station was 121 mm from June to August 2010 and 129 mm from July to September 2011. Total estimated lake evaporation at the Sulphurets station was 189 mm from July to August 2010 and 193 mm from July to August 2012.

7.1.3.3.7 El Niño – Southern Oscillation Influence

The El Niño – Southern Oscillation has a noticeable impact on the weather in northwestern North America, including the weather within the RSA. During strong El Niño conditions, BC experiences warmer and drier winters, and during strong La Niña conditions, BC experiences cooler winters with more precipitation. The most recent strong and weak El Niño – Southern Oscillation conditions since 2008 are presented in Table 7.1-2, corresponding to the start of baseline measuring. The table indicates that baseline data match the El Niño – Southern Oscillation. During the 2009/2010 strong El Niño winter period, Project weather stations recorded warmer temperatures and lower precipitation, on average, compared to the weak La Niña winter of 2008/2009 and the strong La Niña winter of 2010/2011. This was especially noticeable in January, February, and March 2010, when monthly mean temperatures were approximately 2º to 4ºC warmer compared to the same months in 2009 and 2011. Depending on the station, lower precipitation (approximately 20 to 40% less) was recorded from September 2009 to March 2010, compared to the same monthly period in 2008/2009 and 2010/2011.

Table 7.1-2. Strong and Weak El Niño – Southern Oscillation Conditions Since 2008

Year	Winter	Spring	Summer	Fall
2008	Strong La Niña	Strong La Niña	Weak La Niña	Weak La Niña
2009	Weak La Niña	Weak La Niña	Strong El Niño	Strong El Niño
2010	Strong El Niño	Strong El Niño	Strong La Niña	Strong La Niña
2011	Strong La Niña	Strong La Niña	Weak La Niña	Strong La Niña

Source: NOAA Center for Weather and Climate Prediction (2012).
Note: The winter of a specific year includes January and February of that year, as well as December of the previous year.

7.1.3.4 Baseline Air Quality in the Regional Study Area

The 2000 British Columbia Emissions Inventory of Criteria Air Contaminants was compiled as a collaborative effort involving the ministry of Metro Vancouver (formerly GVRD, Greater Vancouver Regional District) and Environment Canada. Metro Vancouver inventoried all sources within the Canadian portion of the Lower Fraser Valley, which includes Metro Vancouver and the Fraser Valley Regional District. For the province outside the Lower Fraser Valley, the ministry of BC produced emission estimates for sources that operate under ministry authorization, as well as source that are large contributors or are best understood at provincial level. The remaining estimates were prepared by Environment Canada. The data from Metro Vancouver and Environment Canada were merged with ministry estimates to present a complete picture of a provincial emissions estimate (BC MLAP 2005). Data specific for the RSA were extracted from the 2000 British Columbia Emissions Inventory of Criteria Air Contaminant

(W. McCormic, per. comm.). Existing air quality in the area of the Project site is primarily affected by natural sources and traffic along Highway 37. Table 7.1-3 shows the CAC emissions inside the RSA. The main sources of emissions are tailpipe emissions from vehicles, non-road equipment, and road dust emissions from traffic.

Table 7.1-3. Air Emissions inside the Regional Study Area

Categories/Sectors	Emissions (tonnes/year)					
	SO_x	NO_x	CO	TSP	PM_{10}	$PM_{2.5}$
Industrial Sources						
Upstream Oil and Gas Industry	0	0	0	0	0	0
Industrial Sources Total	**0**	**0**	**0**	**0**	**0**	**0**
Area Sources						
Agriculture	0	0	0	0	0	0
Residential Wood Heating	0	0	0	0	0	0
Area Sources total	**0**	**0**	**0**	**0**	**0**	**0**
Mobile Sources						
Aircraft	0	0	0	0	0	0
Heavy-duty Diesel Vehicles	2.32	125.58	28.48	4.73	4.72	4.15
Heavy-duty Gasoline Vehicles	0.06	2.67	15.58	0.05	0.05	0.04
Light-duty Diesel Vehicles	1.01	3.69	3.07	0.51	0.51	0.45
Light-duty Gasoline Trucks	1.01	28.82	593.44	0.59	0.58	0.34
Light-duty Gasoline Vehicles	0.67	25.86	450.54	0.38	0.38	0.19
Other Mobile Sources	0	0.06	3.11	486.83	93.65	22.70
Total Mobile Sources	**5.06**	**186.69**	**1,094.22**	**493.10**	**99.90**	**27.85**
Open Sources						
Forest Fires	0	0.02	1.14	0.22	0.17	0.15
Prescribed Burning	0	0	0	0	0	0
Road Dust	0	0	0	486.23	93.20	22.28
Total Open Sources	**0**	**0.02**	**1.14**	**486.45**	**93.36**	**22.43**
Grand Total	**5.07**	**186.71**	**1,095.37**	**979.56**	**193.27**	**50.29**

Source: W. McCormic, per. comm.
Note: Due to rounding, the last digit may not add up.

As mentioned earlier, there are currently no background ambient monitoring stations for SO_2, NO_2, and CO in the area. As described in the *Guidelines for Air Quality Dispersion Modelling in British Columbia* (BC MOE 2008), other monitoring data from areas with similar sources and meteorology may be used if no representative ambient data are available for the site in question. The best available estimates of ambient background concentrations are published by the Canadian Air and Precipitation Monitoring Network (CAPMoN). CAPMoN is a non-urban air quality monitoring network, with siting criterion designed to ensure that the measurement locations are regionally representative (i.e., not affected by local sources of air pollution). Scientists examining atmospheric pollution in urban centres would consider most CAPMoN sites remote. There are currently 28 measurement sites in Canada and one in the United States (US). The closest CAPMoN site to the Project is the Saturna station, off the southern tip of Vancouver Island in the middle of the Strait of Georgia. Although the station is almost 1,000 km southeast of the RSA, it provides the best estimate of background concentration available for BC. The second closest CAPMoN monitoring station is Snare Rapids in the Northwest Territories, approximately 100 km northwest of Yellowknife, NT. This station is approximately 1,300 km from the RSA and only collects particulate matter.

Daily measurements of SO_2 concentrations are available from the Saturna monitoring station from 1996 to 2002 (1997 missing). The average annual SO_2 concentrations for that period were reported as 2.3 $\mu g/m^3$ with an average standard deviation of 2.0 $\mu g/m^3$. However, ambient NO_2 concentrations were not measured at the Saturna station and another source of background NO_2 is required. The Diavik Diamond Mine is in the Northwest Territories, located about 300 km northeast of Yellowknife. In the Diavik Diamond Mine Environmental Assessment (Cirrus Consultants 1998), ambient background concentrations were estimated based on surveys and assumptions. These background concentrations have been referenced in several other approved environmental assessments such as the Snap Lake Diamond Mine (De Beers 2001) and Galore Creek Copper-Gold-Silver Project (Rescan 2006). The background concentrations from the Diavik Diamond Mine that represented northern undisturbed remote area are deemed representative of the RSA. Background concentrations used in the assessment are summarized in Table 7.1-4.

Table 7.1-4. Project Background Ambient Air Quality Concentrations

Pollutant	Averaging Time	Concentrations ($\mu g/m^3$) NAAQOs	BC Objective	Background	Source of Background Concentrations
SO_2	1-hour	450	450	4.0	Diavik
	24-hour	150	160	4.0	Diavik
	Annual	30	25	2.0	Diavik
NO_2	1-hour	400	-	21.0	Diavik
	24-hour	200	-	21.0	Diavik
	Annual	60	-	5.0	Diavik
CO	1-hour	15,000	14,300	100	Diavik
	8-hour	6,000	5,500	100	Diavik
TSP	24-hour	120	150	10	Diavik
	Annual	60	60	10	Diavik
PM_{10}	24-hour	-	50	3.4	Galore
$PM_{2.5}$	24-hour	30[a]	25[b]	1.3	Galore
	Annual	-	8[c]	1.3	Galore

Notes: (-) dash indicates not applicable.
There are three levels of standards for Canada and three levels of objectives for BC. The most stringent level is used in this table.
a Annual 98th percentile value, averaged over three consecutive years. Canada-wide standard published by the CCME.
b Based on annual 98th percentile value.
c BC objective of 8 $\mu g/m^3$ and planning goal of 6 $\mu g/m^3$ were established in 2009.

The annual average SO_2 background concentration of 2.0 $\mu g/m^3$ assumed for Diavik Diamond Mine was generally in agreement with the 1996 to 2006 average concentrations of 2.3 $\mu g/m^3$ observed at the Saturna station, confirming the similarity of the two locations. Since all SO_2, NO_2, and CO background concentrations are available from the Diavik Diamond Mine Environmental

Assessment, these background concentrations are used to represent the RSA instead of Saturna station.

A technical document about background concentration of $PM_{2.5}$ and ozone in BC (McKendry 2006) was considered for particulate matter background concentration; however, this study does not contain TSP nor PM_{10} background. Background concentrations of PM_{10} and $PM_{2.5}$ were monitored for the Galore Creek Project. Since Galore Creek is also at a remote and mountainous location in northwestern BC, 98th percentile PM_{10} and $PM_{2.5}$ concentrations measured at Galore Creek Project (Rescan 2006) area were used to represent the RSA. Background TSP concentration was obtained from Diavik Diamond Mine Environmental Assessment (Cirrus Consultants 1998). Background ozone concentration was reported to be in the range of 40 to 80 $\mu g/m^3$ (20 to 40 ppb; McKendry 2006). For the KSM Project air dispersion modelling assessment, it is proposed that the ozone baseline concentration be 60 $\mu g/m^3$ (30 ppb).

Dustfall levels collected in the RSA from 2008 to 2011 are detailed in Appendix 7-C. The dust deposition rates exceeded the BC dustfall deposition objective twice in August 2010. One of the samples that showed exceedance had fallen over during the sampling period. Since most of the liquid remained in the canister, the sample was still analyzed; however, the sample is potentially contaminated. Sampling took place during the summer and early fall, which are typically the driest times of the year when dustfall is not mitigated by precipitation as much. The BC Model Guideline (BC MOE 2008) states that if there is more than one representative monitoring site, an acceptable approach is to take the 98th percentile of each site and then take the average of these values to be used as a background level. The 98th percentile dustfall rate of each station was calculated, and the average of the 98th percentile value was found to be 1.34 $mg/dm^2/day$.

The average of the median acid deposition from all stations from 2008 to 2011 is 125 eq/ha/yr. This would be a conservative baseline level, since it does not account for any neutralizing compounds in the dustfall and soil, which naturally exist. The actual acid loading is likely to be well below the assumed baseline acid loading. The median critical loads for BC are estimated to be 750 eq/ha/yr with minimum and maximum being 174 and 4,026 eq/ha/year, respectively (Aherne 2008).

7.2 Historical Activities

The KSM Project is approximately 30 km southeast of Barrick Gold's recently closed Eskay Creek Mine, which is also included in the RSA. The ambient air quality was previous disturbed while Eskay Creek Mine was active. The Eskay Creek Mine closed in 2008, however, and baseline ambient air quality conditions have now been restored due to natural air dispersion processes. Currently, there are only natural sources of emissions in the area; therefore, the current ambient air quality in the RSA is not significantly affected by historical cumulative effects.

7.3 Land Use and Airshed Planning Objectives

An airshed is generally described as an area where the movement of air (and therefore, air pollutants) can be hindered by local geographical features, such as mountains, and by weather conditions. In BC, there are currently 14 airsheds defined with management plans. An airshed plan provides a blueprint to help communities manage development and control air contaminant sources, and ensures that air quality goals of various levels of government are met.

The Project RSA does not fall under any of the existing airsheds at this time, and there is limited air quality monitoring in this area. The closest air quality management plan to the RSA is the Bulkley Valley–Lakes District Airshed Management *Community Action Plan for Clean Air: A Five-year Strategy* (BC MOE 2006), which targeted seven emission source categories, including road dust from paved roads.

The Project lies within the Cassiar Iskut–Stikine Land and Resource Management Plan (LRMP) boundary (BC ILMB 2000). The LRMP encompasses 5.2 million hectares in northwestern BC and extends from Ningunsaw Pass in the south to Dease Lake in the north, and from the Alaska border in the west to the Chukachida River in the east. The LRMP provides management direction, research and inventory priorities, economic strategy priorities, and implementation and monitoring of the area, but no specific goals for air quality. The Nass South Sustainable Resource Management Plan (SRMP; BC MFLNRO 2012) also does not mention or provide specific guidance on air quality; however, clean air is identified as one of its competitive advantages, so it is understood that clean air is valued in this area.

7.4 Spatial and Temporal Boundaries

7.4.1 Spatial Boundaries

A spatial boundary is defined as the area that could be potentially affected by air emission sources from the Project. This region encompasses areas such as truck traffic on Highway 37 and those that could potentially be affected by the Project based on the topography and the existing airsheds. The area defined by the spatial boundary is also the model domain to be examined in the assessment.

In this assessment, the RSA covering a domain 100 km in an east-west direction and 60 km in a north-south direction is used to model dispersion in the assessment. The same area is used for the baseline studies (Section 7.1.3). The centre of the RSA is roughly between the proposed Mine Site and the Processing and Tailing Management Area (Figure 7.1-1). Since the local study area (LSA) encompassing the Project footprint plus a 1,000 m buffer would be included in the RSA, a separate model for the LSA is not included in the assessment.

7.4.2 Temporal Boundaries

A temporal boundary is the period of time when the Project has an effect on the environment. The temporal boundaries include the following four phases:

- construction: 5 years;
- operation: 51.5 year life of mine;
- closure: 3 years, including Project decommissioning and reclamation activities; and
- post-closure: 250 years, including ongoing reclamation activities and post-closure maintenance monitoring.

The air quality effects assessment focuses on the construction and operation phases of the Project since the majority of emissions will occur during these two phases. Project reclamation activities will partially occur during the operation phase, and limited sources are expected in the post-closure phase. In this assessment, Year -1 (one year prior to Project commencement) is identified as the worst year for air emissions during the five years of construction, while Year 4 is identified as the worst year for air emissions during the 51.5 years of operation.

For the construction phase of the Project, Year -1 will be the most active in terms of total waste moved, total fuel usage (therefore highest level of diesel equipment activities), and blasting. For the operation phase, in terms of highest amount of waste rock and ore moved and amount of explosives used, Year 4 is the worst case. In terms of fuel consumption, Year 3 is the worst year, followed by Year 4. However, Year 4 has fuel consumption that is less than 1% lower than that in Year 3 and also has the highest amount of waste rock and ore moved and amount of explosives used (7% and 5% higher than that in Year 3, respectively). Therefore, Year 4 was selected to represent the worst year for air emissions during the operation phase. More information on the selection of the worst case year is provided in Appendix 7-A.

By determining the effects of the worst years during construction (Year -1) and operation (Year 4), it can be assumed that if the effects during these two years are found to be not significant, the potential effect for the entirety of the two phases should also be not significant.

7.5 Valued Components

7.5.1 Overview of Valued Component Selection

Ambient air quality is an important environmental factor in protecting ambient biota and human health. Project-related activities could result in effects on air quality, hence it was identified as a VC in the AIR (BC EAO 2011) and the Comprehensive Study Scope of Assessment (CEA Agency et al. 2010).

The scope of air quality concerns was identified based on the issues and concerns raised by Treaty and First Nations, government and others, together with professional judgment (Table 7.5-1). Nisga'a Nation raised concerns about atmospheric deposition (from air quality emissions) affecting water quality, as well as "air emissions from a carbon-regeneration process" (Chapter 29, Nisga'a Nation Interests), the latter of which has been interpreted to apply to both CAC and greenhouse gas (Chapter 6) emissions. The Tahltan Nation raised concerns on "air quality and dust control, including effects of roads dust and air quality on ice melt," and "potential for windblown dust to adversely affect the area of the Tailing Management Facility (TMF)." The Gitanyow Hereditary Chiefs' Office raised concerns on "air quality, particularly the production of atmospheric carbon, NO_x, and SO_x, and potential for acid deposition as a result of the Project," and "concern that air and water quality will be contaminated many kilometres from the site." Issues raised by First Nations and Nisga'a Nation are further detailed in Chapter 3 Information Distribution and Consultation. In general, the public, especially residents living in the area, are concerned about the change in ambient air conditions for human health reasons.

Table 7.5-1. Identification and Rationale for Selecting Air Quality as a Valued Component

Valued Component	Identified by*				Rationale for Inclusion
	F/N	G	P/S	O	
Ambient Air Quality	X	X	X		Ambient air quality is a concern in general for all human health as well as effects to the environment. Measureable parameters are selected to help define the change attribution of the Project activities to the environment.

***F/ = First Nation/Nisg̲a'a Nation; G = Government; P/S = Public/Stakeholder; O = Other.**

7.5.2 Valued Components Included in Assessment

The one air quality VC selected for the assessment is ambient air quality. Other atmospheric VCs identified in the AIR (greenhouse gases) are addressed in Chapter 6. Ambient air quality has been selected as a VC because living creatures require air quality that meets certain standards in order to survive. The VC will be assessed by estimating emissions from mining equipment and activities, followed by dispersion modelling, and then comparing the results to appropriate federal and provincial objectives/standards (BC EAO 2011).

Since ambient air quality is a broad term, it is important to select the correct measurable parameters in order to assess the potential effects of the Project on the receiving environment. The effects on air quality will be evaluated based on changes in ambient concentrations of the CACs identified in Section 7.1.2. These include SO_2, NO_2, CO, TSP, PM_{10}, and $PM_{2.5}$. Other than the increase in concentrations of the CACs, change in dust and acid deposition rates will also be assessed as measurable parameters. The measurable parameters will be compared to relevant objectives/standards.

7.5.3 Valued Components Excluded from Further Assessment

There was only one VC considered for this assessment, and it was included in the assessment; therefore, no VC was excluded. The potential for effects associated with all of the CACs listed in Section 7.1.2 are assessed.

7.6 Scoping of Potential Effects

Emissions of SO_2, NO_x, and CO are primarily produced from fuel combustion, especially at high temperature, and could potentially affect the respiratory system and cause headaches and dizziness. Suspended particles with larger particle sizes may cause a nuisance, while particles with smaller diameters can potentially cause respiratory illness and lung disease. The potential health effects from CACs are presented in the Human Health chapter, Section 25.7.2. Dust deposition occurs when dust particles settle on the surface, and acid deposition occurs when acid-forming pollutants in the air (primarily SO_2 and NO_x) deposit on the earth's surface. Deposition of foreign materials may cause changes in soil and wetland properties, as well as affecting wildlife and human health. The potential effects from airborne deposition onto soil are discussed in Chapter 8, Terrain, Surficial Geology, and Soils.

A detailed scoping table is presented in Appendix 7-D, indicating each major Project component's interaction with changes in ambient air quality during the construction and operation phases, and a simplified version is presented in Table 7.6-1. Since the construction within each area would require equipment that emits pollutants, all of the Project areas, including Mine Site, PTMA, and off-site transportation, are expected to have an interaction with changes in ambient air quality.

Table 7.6-1. Potential Effects from Project Area on Air Quality

Project Region	Project Area	Change in Ambient Air Quality
Mine Site	Camp 3: Eskay Staging Camp	X
	Camp 7: Unuk North Camp	X
	Camp 8: Unuk South Camp	X
	Coulter Creek Access Corridor (CCAC)	X
	Mitchell Operating Camp	X
	McTagg Rock Storage Facility (RSF)	X
	McTagg Twinned Diversion Tunnels (MTDT)	X
	McTagg Power Plant	X
	Mitchell Rock Storage Facility (RSF)	X
	Camp 4: Mitchell North Camp (for MTT construction)	X
	Mitchell Ore Preparation Complex (OPC)	X
	Mine Site avalanche control	X
	Iron Cap Block Cave Mine	X
	Mitchell Pit	X
	Mitchell Block Cave Mine	X
	Mitchell Diversion Tunnels (MDT)	X
	Upper Sulphurets Power Plant	X
	Mitchell Truck Shop	X
	Water Storage Facility (WSF)	X
	Camp 9: Mitchell Initial Camp	X
	Camp 10: Mitchell Secondary Camp	X
	Water Treatment and Energy Recovery Area	X
	Sludge Management Facilities	X
	Sulphurets laydown area	X
	Sulphurets-Mitchell Conveyor Tunnel	X
	Sulphurets Pit	X
	Kerr rope conveyor	X
	Kerr Pit	X

(continued)

Table 7.6-1. Potential Effects from Project Area on Air Quality (completed)

Project Region	Project Area	Change in Ambient Air Quality
Mine Site (cont'd)	Camp 2: Ted Morris Camp	X
	Explosives Manufacturing Facility	X
	Temporary Frank Mackie Glacier Access Route	X
	Camp 1: Granduc Staging Camp	X
Processing and Tailing Management Area	Mitchell-Treaty Twinned Tunnels (MTT)	X
	construction access adit	X
	Mitchell-Treaty Saddle Area	X
	Camp 6: Treaty Saddle Camp	X
	Camp 5: Treaty Plant Camp	X
	Treaty Operating Camp	X
	Treaty Ore Preparation Complex	X
	Concentrate Storage and Loadout	X
	North Cell Tailing Management Facility	X
	East Catchment Diversion	X
	Centre Cell Tailing Management Facility	X
	South Cell Tailing Management Facility	X
	Treaty Creek Access Corridor	X
	Camp 11: Treaty Marshalling Yard Camp	X
	Camp 12: Temporary Road Access Camp	X
Off-site Transportation	Highway 37 and 37A	X

X = interaction between component and effect.

Since all of the Project areas have interactions with the change in ambient air quality, the Project phases are defined further in Table 7.6-2, which presents the two worst years selected in Section 7.4.2 to represent the two assessed phases. In Table 7.6-2, the construction phase worst year is Year -1, while for the operation phase it is represented by Year 4. The specific Project components, including activities and areas that interact with the years assessed, are indicated in Table 7.6-2.

7.7 Potential Effects and Mitigation Options

Project-related air emissions sources are identified by Project component locations and activities. Project activities associated with Project components will act as sources of CAC emissions, and will have the potential to affect ambient air quality during the construction and operation phases, and there will be very little impact potential during the closure and post-closure phases. For assessment purposes, the Project footprint has been divided into three zones: the Mine Site, PTMA, and other key areas (the Mitchell-Treaty Twinned Tunnels [MTT] and Highway 37).

Section 7.6 outlined the potential Project-related sources of air emissions (see Tables 7.6-1 and 7.6-2). Section 7.7 outlines the main potential air quality effects associated with Project components and activities and proposes appropriate effects mitigation measures. The main goal of the mitigation methods listed for this Project is to avoid air quality emissions in the design stage and/or to control emissions after the Project has commenced. Below is a list of the Project's main potential air quality effects and the mitigation methods that have already been incorporated into Project planning as outlined in Chapter 26.11, the Air Quality Management Plan.

Table 7.6-2. Potential Effects from Project on Air Quality

		Change in Ambient Air Quality	
Project Region	**Project Components & Activities**	**Construction (Year -1)**	**Operation (Year 4)**
Mine Site	Camps	X	X
	Mining Equipment	X	X
	Mining Activities (i.e., Blasting and Material Handling)	X	X
	Coulter Creek Access Road	X	X
	Clearing and Debris Burning	X	X
	Ore/Overburden Stockpiles and RSF	X	X
PTMA	Camps	X	X
	Mining Equipment	X	X
	Treaty Creek Access Road	X	X
	Clearing and Debris Burning	X	
	Ore/Overburden Stockpiles and RSF	X	X
	Ore Preparation Complex		X
General Area	Mitchell-Treaty Twinned Tunnels	X	X
	Highway 37	X	X

Note: Year -1 represents the year projected to have the worst air quality during construction, and, similarly, Year 4 is the worst year for operation.

7.7.1 Mitigating Specific Effects

7.7.1.1 Unpaved Access Roads

When a vehicle travels on an unpaved road, the force of the wheels on the road surface causes pulverization of surface material, with the quantity of resultant dust emissions dependent on the fraction of silt and road surface material. Some limestone gravels can dust severely while some glacial deposits of gravel with a portion of highly plastic clay can take on a strong binding characteristic that will resist dusting remarkably well. If the road lies within a relatively wet climate then dust levels will be significantly reduced as moisture wets surface particles, binding them together by the surface tension of the water (FCM and NRC 2005). Fugitive dust emissions are assumed to be negligible if the daily precipitation is at least 0.254 mm (US EPA 2006b).

Several unpaved road mitigation controls are described in Chapter 13, Section 2 of AP-42 (US EPA 2006b): vehicle restrictions, surface improvement, and surface treatment. The vehicle restriction control method entails simply restricting the speed, weight, or number of vehicles on the road. The vehicle speed expected on the Mine Site and PTMA varies among types of vehicles but generally ranges from 5 to 30 km/hr. The design speed on the access roads is 50 km/hr. Surface improvement controls include paving or adding gravel to dirt roads. Surface treatment controls include application of water or chemical suppressant to the road surface. Of the above controls suggested by AP-42, road watering is the most effective and readily implemented method, without associated environmental effects. Watering increases the moisture content, which conglomerates particles and reduces the likelihood that they will become re-suspended. The control efficiency depends on how fast the road dries after application. Typically, watering is effective from 1 to 12 hours after treatment (FCM and NRC 2005). The current Project design envisages water trucks operating for 11.4 hours per day along the access roads, allowing a moisture ratio of 4%. The control efficiency achieved by a 4% moisture ratio is expected to be 87.5% (US EPA 2006b).

7.7.1.2 Crushers

Crushing can be a significant source of dust emission in the mining process if not mitigated. If crushing of low-moisture metallic mineral ore was not mitigated, emission rates of TSP would range from 0.2 to 1.4 kg of TSP per tonne of ore crushed. If the ore contains more than 4% of moisture by weight, the TSP emission rate could be reduced to between 0.01 and 0.03 kg/tonne of ore crushed. One typical control method used for metallic mineral processing, other than increasing the moisture content of the ore, is to install baghouses (US EPA 1982). A baghouse is an air pollution control device that removes particulates out of air or gas released from industrial processes. Most baghouses use long, cylindrical bags made of woven or felted fabric as a filter medium. Dust-laden air enters the baghouse and is drawn through the bags. A layer of dust accumulates on the filter media surface until air can no longer move through it. When a sufficient pressure drop occurs, the cleaning process begins. An example baghouse tested in the mineral processing industry reduced emissions to less than 0.05 g/dscm. Under conditions of moderate to high uncontrolled emission rates of typical dry ore facilities, this level of controlled emissions represent greater than 99% removal of TSP (US EPA 1982). For the baghouse in the Project design, the TSP emission rate is expected to be 0.0044 g/m^3, which is equivalent to more than 99.5% control efficiency.

7.7.1.3 Equipment and Vehicles

Equipment and vehicles will be maintained on a regular basis to ensure their effectiveness. Regular inspections should be conducted and all parts showing signs of wear or damage should be promptly replaced. A poorly maintained engine can use up to 50% more fuel (D. Cope Enterprises 2004). Studies indicate 1995 model-year and older vehicles produce smog up to 19 times greater than a new vehicle; however, a study conducted by Summerhill Impact (formerly Clean Air Foundation) in 2010 determined that older vehicles were in fact 39 times more smog-polluting than a new vehicle (Summerhill Impact 2012). Incomplete burning of fuel results in higher levels of CO (Cheminfo Services Inc. 2005). Leaking air directly affects the air to fuel ratio, thereby resulting in inefficient combustion and higher emissions.

7.7.1.4 Generators and Incinerators

The generators and incinerators used on-site will burn fossil fuel. When the fuel is burned, air pollution will be released in the form of exhaust gases. The Off-Road Compression-Ignition Engine Emission Regulations (SOR/2005-32) limit the amount of emissions produced; however, different generators and incinerators vary in the amount of emissions produced within the regulated limit. On November 17, 2011, Environment Canada adopted amendments to the Off-Road Compression Engine Emission Regulations (SOR/2005-32), which align Canadian emission standards with the US EPA Tier 4 standards that came into force on January 16, 2012 (Table 7.7-1).

Table 7.7-1. Tier 4 Emission Standards for Engines up to 560 kw, g/kWh (g/bhp-hr)

		Emissions g/kWh (g/bhp-hr)				
Engine Power	**Year**	**CO**	**NMHC**	**NMHC+NO$_x$**	**NO$_x$**	**TSP**
kW < 8 (hp < 11)	2008	8.0 (6.0)	-	7.5 (5.6)	-	0.4[a] (0.3)
8 ≤ kW < 19 (11 ≤ hp < 25)	2008	6.6 (4.9)	-	7.5 (5.6)	-	0.4 (0.3)
19 ≤ kW < 37 (25 ≤ hp < 50)	2008	5.5 (4.1)	-	7.5 (5.6)	-	0.3 (0.22)
	2013	5.5 (4.1)	-	4.7 (3.5)	-	0.03 (0.022)
37 ≤ kW < 56 (50 ≤ hp < 75)	2008	5.0 (3.7)	-	4.7 (3.5)	-	0.3[b] (0.22)
	2013	5.0 (3.7)	-	4.7 (3.5)	-	0.03 (0.022)
56 ≤ kW < 130 (75 ≤ hp < 175)	2012-2014[c]	5.0 (3.7)	0.19 (0.14)	-	0.40 (0.30)	0.02 (0.015)
130 ≤ kW ≤ 560 (175 ≤ hp ≤ 750)	2011-2014[d]	3.5 (2.6)	0.19 (0.14)	-	0.40 (0.30)	0.02 (0.015)

Note: NMHC = non-methane hydrocarbon.

a - hand-startable, air-cooled, DI engines may be certified to Tier 2 standards through 2009 and to an optional PM standard of 0.6 g/kWh starting in 2010.

b - 0.4 g/kWh (Tier 2) if manufacturer complies with the 0.03 g/kWh standard from 2012.

c - PM/CO: full compliance from 2012; NOx/HC: Option 1 (if banked Tier 2 credits used)—50% engines must comply in 2012-2013; Option 2 (if no Tier 2 credits claimed)—25% engines must comply in 2012-2014, with full compliance from Jan. 31, 2014.

Generators and incinerators for the Project will be in compliance with the Tier 4 standards, and models with lower emission rates will be preferred. Incinerators will also have to comply with Canada-wide standards for dioxins and furans (CCME 2009) and Canada-wide standards for mercury emissions (CCME 2000a).

7.7.1.5 Ore Stockpiles

Dust emissions may be generated by wind erosion acting upon open aggregate storage piles. Emissions from material stockpiles are highly dependent upon particle size, meteorological conditions, and the frequency and nature of disturbances (e.g., vehicle traffic, material handling). The length of time any dust particle remains airborne depends upon the particle size and weight, the wind velocity, and the duration of the wind gust (US EPA 2006a). Covering or enclosing stockpiles shelters them from the wind therefore reduces airborne dust. In the Project design, the ore stockpiles will be covered and the processed ore stockpiles will be enclosed. This will provide control efficiency of approximately 80% for handling of the material (Davis 2000).

7.7.1.6 Mitchell-Treaty Twinned Tunnels

As discussed in Section 7.7.1.2, wet scrubbers and baghouses are air pollution control devices for removing particles and/or gases from industrial exhaust streams. Wet scrubbers operate by introducing the dirty gas stream with a scrubbing liquid—typically water. Particulates are collected in the scrubbing liquid. The MTT will be used not only to transport material, but also to transport personnel and equipment between the Mine Site and PTMA. Since workers are expected to be inside the tunnels, air quality inside the MTT needs to be in compliance with the guidelines for the *Workers Compensation Act* (1996c) and the Occupational Health and Safety Regulation (BC Reg. 286/2008). Baghouses or wet scrubbers will be used in the MTT to ensure concentrations of particulate matter meet the Occupational Health and Safety standards. Fans will also be used at the portals to ensure fresh air flows through the tunnels.

7.7.2 Summary of Potential Effects and Proposed Mitigation

The above design and control mitigation methods incorporated into the Project will reduce Project air emissions; however, the potential for residual effects from a reduction in ambient air quality still exists from all Project components indicated in Table 7.7-2. The potential for residual effects, after the above mitigations, is assessed in Section 7.8 using a quantified approach.

7.8 Potential Residual Air Quality Effects

7.8.1 Approach to Residual Effects Assessment

In Section 7.8, residual Project-related (after mitigation) effects on ambient air quality in the RSA are assessed using quantitative methods. The assessment:

- estimates the Project-related emissions within the RSA originating from Project components and activities;
- predicts the dispersal of Project-related CACs through the atmosphere, using quantified dispersion modeling (as discussed and reviewed in the Air Dispersion Detailed Model Plan, Appendix 7-A;
- adds the predicted incremental concentrations/deposition rates to baseline levels to determine predicted air quality concentrations with the Project in place; and
- compares the resulting predicted concentrations and deposition rates at key locations with Canadian and BC ambient air quality criteria to determine if residual air quality effects exist. The potential for residual effects is deemed to exist if exceedances of Canadian or BC ambient air quality objectives and standards are predicted.

Table 7.7-2. Potential Residual Effects on Ambient Air Quality

VC	Timing Start	Project Area(s)	Component(s)	Description of Effect due to Component(s)	Type of Project Mitigation	Project Mitigation Description	Potential Residual Effect	Description of Residuals
Ambient Air Quality	Construction	Mine Site	Camps	Change in CAC concentrations. Change in acid deposition rate.	Management Practices and Monitoring Plan	Generators and incinerators will be selected with lower emission rates	Yes	Reduction in ambient air quality
			Mining Equipment	Change in CAC concentrations. Change in dust and acid deposition rate.		Regularly maintained equipment; watering unpaved access roads	Yes	Reduction in ambient air quality
			Mining Activities	Change in CAC concentrations. Change in dust and acid deposition rate.		Material will be dropped at lower height	Yes	Reduction in ambient air quality
			Coulter Creek Access Road	Change in CAC concentrations. Change in dust and acid deposition rate.		Watering unpaved access roads	Yes	Reduction in ambient air quality
			Clearing and Debris Burning	Change in CAC concentrations. Change in dust and acid deposition rate.		Usable debris will be taken offsite or other usage	Yes	Reduction in ambient air quality
			Ore/Overburden Stockpile and RSF	Change in dust deposition rate.		Covering or enclosing ore stockpiles	Yes	Reduction in ambient air quality
		PTMA	Camps	Change in CAC concentrations. Change in acid deposition rate.		Generators and incinerators will be selected with lower emission rates	Yes	Reduction in ambient air quality
			Mining Equipment	Change in CAC concentrations. Change in dust and acid deposition rate.		Regularly maintained equipment; watering unpaved access roads	Yes	Reduction in ambient air quality
			Treaty Creek Access Road	Change in CAC concentrations. Change in dust and acid deposition rate.		Watering unpaved access roads	Yes	Reduction in ambient air quality
			Clearing and Debris Burning	Change in CAC concentrations. Change in dust and acid deposition rate.		Usable debris will be taken offsite or other usage	Yes	Reduction in ambient air quality
			Ore/Overburden Stockpiles and RSF	Change in dust deposition rate.		Covering or enclosing ore stockpiles	Yes	Reduction in ambient air quality
		General Area	MTT	Change in CAC concentrations. Change in dust and acid deposition rate.		Wet scrubber or baghouse will be used	Yes	Reduction in ambient air quality
			Highway 37	Change in CAC concentrations. Change in dust and acid deposition rate.		-	Yes	Reduction in ambient air quality

(continued)

Table 7.7-2. Potential Residual Effects on Ambient Air Quality (completed)

VC	Timing Start	Project Area(s)	Component(s)	Description of Effect due to Component(s)	Type of Project Mitigation	Project Mitigation Description	Potential Residual Effect	Description of Residuals
Ambient Air Quality	Operation	Mine Site	Camps	Change in CAC concentrations. Change in acid deposition rate.	Management Practices and Monitoring Plan	Generators and incinerators will be selected with lower emission rates	Yes	Reduction in ambient air quality
			Mining Equipment	Change in CAC concentrations. Change in dust and acid deposition rate.		Regularly maintained equipment; watering unpaved access roads	Yes	Reduction in ambient air quality
			Mining Activities	Change in CAC concentrations. Change in dust and acid deposition rate.		Material will be dropped at lower height	Yes	Reduction in ambient air quality
			Coulter Creek Access Road	Change in CAC concentrations. Change in dust and acid deposition rate.		Watering unpaved access roads	Yes	Reduction in ambient air quality
			Clearing and Debris Burning	Change in CAC concentrations. Change in dust and acid deposition rate.		Usable debris will be taken offsite or other usage	Yes	Reduction in ambient air quality
			Ore/Overburden Stockpile and RSF	Change in dust deposition rate.		Covering or enclosing ore stockpiles	Yes	Reduction in ambient air quality
		PTMA	Camps	Change in CAC concentrations. Change in acid deposition rate.		Generators and incinerators will be selected with lower emission rates	Yes	Reduction in ambient air quality
			Mining Equipment	Change in CAC concentrations. Change in dust and acid deposition rate.		Regularly maintained equipment; watering unpaved access roads	Yes	Reduction in ambient air quality
			Treaty Creek Access Road	Change in CAC concentrations. Change in dust and acid deposition rate.		Watering unpaved access roads	Yes	Reduction in ambient air quality
			Ore/Overburden Stockpiles and RSF	Change in dust deposition rate.		Covering or enclosing ore stockpiles	Yes	Reduction in ambient air quality
			Ore Preparation Complex	Change in dust deposition rate.		Use of baghouses	Yes	Reduction in ambient air quality
		General Area	MTT	Change in CAC concentrations. Change in dust and acid deposition rate.		Wet scrubber or baghouse will be used	Yes	Reduction in ambient air quality
			Highway 37	Change in CAC concentrations. Change in dust and acid deposition rate.		-	Yes	Reduction in ambient air quality

Note: dash (-) indicates no mitigation

7.8.2 Air Emissions Inventory

An air emissions inventory was prepared for the major sources that emit CACs in the RSA. Emissions were estimated based on the best available data for the worst conditions for both the construction and operation phases. As previously mentioned, the worst conditions for these phases were determined by assessing the worst years for emissions, that is, those years with the highest activity levels (Year -1 for construction and Year 4 for operation).

7.8.2.1 Construction

During the construction phase, there are eight main mining activities that are sources of air emissions (a full list of mine component emission sources can be found in Appendix 7-A):

- generators (MTT construction and camps) and incinerators (camps);
- vehicular tailpipe emissions from Highway 37;
- mining equipment such as dozers, haul trucks, forklift, graders, and tractors;
- vehicular tailpipe emissions from Treaty Creek access road and Coulter Creek access road;
- fugitive dust emissions from land clearing and burning of debris;
- fugitive dust emissions from mining activities such as bulldozing, grading, material handling, drilling and blasting, and CAC emissions from explosives used in blasting;
- fugitive dust on unpaved roads from vehicles travelling in the Mine Site, PTMA, and Saddle and construction access adit areas, and on the access and spur roads; and
- fugitive dust on paved road from vehicles travelling on Highway 37.

7.8.2.1.1 Generators and Incinerators

There are four locations for construction of the MTT which require generators: the Mine Site, PTMA, Saddle, and Adit areas. Each of the construction camps requires one or more generators, depending on camp size, to provide power for the camp activities. The number of generators and generator sizes were based on the power demand required. Emission rates were determined based on a 75% load of a reference generator (CAT model 3512B) for the purpose of the assessment. Generators are only used as emergency backup during operation since electric power will be used. Emission rates of NO_x, CO, and TSP were obtained from the reference generator and the power requirements of the camps. Emissions of SO_2 were calculated using a mass balance with the assumption that sulphur content in diesel is 0.0015% (DieselNet 2012). Emissions for PM_{10} and $PM_{2.5}$ were estimated from the TSP emission rate and from using dust speciation from US EPA AP-42 Appendix B.2 (US EPA 1996a) source category 1 for stationary internal combustion engines for gasoline and diesel fuel (PM_{10} = 96% TSP; $PM_{2.5}$ = 90% TSP).

Camp incinerator emissions were estimated based on information from the Snap Lake Diamond Mine EIS (De Beers 2001), which uses camp incinerator model CA-600 from EcoWaste Solution for a camp size of 260 people. The incinerator emissions were scaled using the number of workers at each camp, as camp waste is proportional to the number of employees. Emissions from diesel generators for the MTT construction and camp activities and emissions from camp incinerators are presented in Table 7.8-1.

Table 7.8-1. Annual Emissions from Stacks during Construction

Source Description	Prime Power (kW)	Annual Emission (tonne/year)					
		SO_2[a]	NO_x	CO	TSP	PM_{10}[b]	$PM_{2.5}$[b]
MTT Construction Generator – Mine1	1825	0.05	241.60	65.13	2.85	2.73	2.56
MTT Construction Generator – Mine 2	1825	0.05	241.60	65.13	2.85	2.73	2.56
MTT Construction Generator – Adit	910	0.03	120.47	32.48	1.42	1.36	1.28
MTT Construction Generator – Saddle 1	1825	0.05	241.60	65.13	2.85	2.73	2.56
MTT Construction Generator – Saddle 2	1825	0.05	241.60	65.13	2.85	2.73	2.56
MTT Construction Generator – Treaty 1	1825	0.05	241.60	65.13	2.85	2.73	2.56
MTT Construction Generator – Treaty 2	1825	0.05	241.60	65.13	2.85	2.73	2.56
Camp 5, 700-person Treaty Plant Camp Generator 1	400	0.01	52.95	14.28	0.62	0.60	0.56
Camp 5, 700-person Treaty Plant Camp Generator 2	400	0.01	52.95	14.28	0.62	0.60	0.56
Camp 6, 120-person Treaty Saddle Camp Generator	400	0.01	52.95	14.28	0.62	0.60	0.56
Camp 10, 400-person Mitchell Secondary Camp Generator	400	0.01	52.95	14.28	0.62	0.60	0.56
Camp 5, 700-person Treaty Plant Camp incinerator	-	0.00	1.12	0.00	13.48	6.74	4.49
Camp 6, 120-person Treaty Saddle Camp incinerator	-	0.00	0.17	0.00	2.02	1.01	0.67
Camp 10, 400-person Mitchell Secondary Camp incinerator	-	0.00	0.56	0.00	6.74	3.37	2.25
Total Emission		**0.37**	**1,783**	**480**	**43**	**31**	**26**

Notes:

a. SO_2 emission rates from generators were calculated based on sulphur content in diesel (DieselNet 2012).

b. PM_{10} and $PM_{2.5}$ emission rates from generators were determined based on dust speciation from AP-42 Appendix B.2 source category 1 – Stationary Internal Combustion Engines for Gasoline and Diesel Fuel where PM_{10} = 96% TSP and $PM_{2.5}$ = 90% TSP (US EPA 1996a).

7.8.2.1.2 Mining Equipment Criteria Air Contaminant Emissions

Emissions from diesel equipment were determined based on the horsepower rating, utilization factor for each piece of equipment, and emission factors from the NONROAD2008 model. US EPA has developed the NONROAD2008 model to provide emission factors for creating accurate and reproducible non-road emission inventories. NONROAD2008 provides emissions estimates based on fuel-use in a diverse collection of vehicles and equipment. Note that the core model of NONROAD2008 calculates and outputs emissions of PM_{10}. Emissions of TSP and $PM_{2.5}$ are calculated using California Emission Inventory and Report System (CEIDARS) speciation profiles for fuel combustion of distillate[1] for all emission rates from NONROAD2008 (US EPA 2008). More detailed information on the models and lists of equipment with the corresponding emission factors can be found in Appendix 7-A. Since the goal of the air quality assessment is to capture the worst case, modelling was carried out assuming that equipment operates 365 working days in one year.

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[1] PM_{10} =0.976 TSP; $PM_{2.5}$ = 0.967 TSP.

The PTMA equipment was estimated from totals for Year -3 to Year -1. When this engineering component was designed, the Project schedule accounted for the construction of North and South dams only since the southeast dam is not raised until later in the mine life. In the current design, there are three dams being raised between Year -3 and Year -1: North dam, Saddle dam (South dam in previous design), and Splitter dam. Since there are three dams to be raised in the current design, the engineers estimated the equipment hours to be 1.5 times the hours required in the previous design. Since the equipment hours provided were for the total of hours from Year -3 to Year -1, equipment usage in Year -1 is assumed to be 34% of the total scaled equipment hours. The annual emission inventory summary from mining equipment is presented in Table 7.8-2 and the detailed equipment lists can be found in Appendix 7-A.

Table 7.8-2. Annual Emissions from Equipment Tailpipes during Construction

	Annual Emission (tonne/year)					
Source Description	**SO_2**	**NO_x**	**CO**	**TSP**	**PM_{10}[a]**	**$PM_{2.5}$[a]**
Equipment at Mine Site	1.14	640	225	32	31	31
Equipment at PTMA	0.59	240	90	12	12	11
Equipment at Saddle and Adit Area	0.11	42	18	3	3	3
Total Emission	1.84	922	333	47	46	45

Note: a. Speciation obtained from CEIDARS for fuel combustion of distillate where PM_{10} =0.976 TSP and $PM_{2.5}$ = 0.967 TSP.

7.8.2.1.3 Vehicular Emissions from Access Roads

Vehicle access to the PTMA will be by the Treaty Creek access road, which will consist of a two-lane road constructed to provide permanent access from Highway 37 to the PTMA and the east portal of the MTT. This road will leave Highway 37 approximately 19 km south of Bell II, cross the Bell-Irving River, and follow the north side of the Treaty Creek Valley for approximately 18 km. It will then turn north and follow the west side of the North Treaty Creek/Teigen Creek Valley for approximately 12 km to the PTMA and east portal of the MTT.

The Coulter Creek access road will be primarily a single-lane, radio-controlled road constructed for moving large equipment and supplies to the Mine Site. An existing road leaves Highway 37, south of Bob Quinn, and extends approximately 59 km southwest of the former Eskay Creek Mine. The new 35-km long Coulter Creek access road will commence near the former Eskay Creek Mine and follow the west side of the valley south for approximately 21 km before crossing the Unuk River. It then turns east through a series of switchbacks and follows the north side of the Sulphurets Creek valley to the Mitchell Creek valley and Mine Site.

Vehicles emit air pollutants from exhaust while travelling due to fuel combustion. Emissions from highway legal vehicles were estimated using the Motor Vehicle Emission Simulator (MOVES) developed by US EPA's Office of Transportation and Air Quality (US EPA 2012). MOVES currently estimates emissions from cars, trucks, and motorcycles that are highway legal. Specific emission factors were estimated using MOVES based on the vehicle type, fuel type, and vehicle age. For the purpose of this assessment, all of the vehicles were assumed to be new. TSP emission rates were not produced by MOVES and speciation from CEIDARS for diesel vehicular sources was used.[2] The traffic counts for the access roads were previously determined and presented in the *Highways 37 and 37A Traffic Effects Assessment* (Appendix 22-C) and also shown in Table 7.8-3. The annual emissions on each access road are presented in Table 7.8-4.

Table 7.8-3. Total Average Annual One-way Trips on Access Roads during Construction

Vehicle Type	Assumed Weight (tonne)	Cargo	Access Roads	
			Treaty Creek Access Road	Coulter Creek Access Road
48' Flat-deck	48	Infrastructure	284	111
Vans (Enclosed Trailers)	16	Infrastructure	95	36
48' Flat-deck	48	Camps & Support Facilities	485	292
Vans (Enclosed Trailers)	16	Camps & Support Facilities	162	98
48' Flat-deck	48	Mine Site	13	774
Vans (Enclosed Trailers)	16	Mine Site	5	258
48' Flat-deck	48	Plant Site	2,380	-
Vans (Enclosed Trailers)	16	Plant Site	794	-
Bus & Passenger Vehicles	12	Crew Transport	434	427
48' Flat-Deck	48	Equipment	94	158
Vans (Enclosed Trailers)	16	Equipment	32	53
48' Flat-Deck	48	Materials	263	132
Vans (Enclosed Trailers)	16	Materials	88	44
48' Flat-Deck	48	Flocculant	-	18
Bulk Tanker	60	Lime	-	279
Tanker (45,000 L)	38	Fuel	217	198
Vans (Enclosed Trailers)	16	Explosives	16	5
Grand Total (Average Annual)			5,362	2,883

Table 7.8-4. Annual Emissions from Vehicles Travelling on Access Roads during Construction

Access Road	Annual Emission (tonne/year)					
	SO_2	NO_x	CO	TSP[a]	PM_{10}	$PM_{2.5}$
Treaty Creek Access Road	0.0003	0.0196	0.2354	0.0004	0.0004	0.0004
Coulter Creek Access Road	0.0014	0.0889	1.5109	0.0018	0.0017	0.0017
Total Emission	0.0017	0.1085	1.7463	0.0022	0.0021	0.0021

Note: a. Speciation obtained from CEIDAR diesel vehicular sources where PM_{10} = 0.96 TSP.

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[2] PM_{10} = 0.96 TSP

7.8.2.1.4 *Vehicular Emissions from Highway 37*

In order to determine the effect of the entire access route, a portion of Highway 37 has been included in the Project-related emissions assessment. Emissions were also estimated using MOVES based on the vehicle type, fuel type, and vehicle age. For the purpose of this assessment, all of the vehicles were assumed to be new. Traffic counts on Highway 37 were estimated in the *Highways 37 and 37A Traffic Effects Assessment* (Appendix 22-C). The count was estimated for two routes: Eskay to Treaty and Treaty to Meziadin. Eskay to Treaty describes the section of Highway 37 from where it intersects with Treaty Creek access road north to Eskay Creek. Treaty to Meziadin describes the section of Highway 37 from where it intersects with Treaty Creek access road south to Meziadin junction. The traffic counts are presented in Table 7.8-5 and the annual emissions are presented in Table 7.8-6.

Table 7.8-5. Total Average Annual One-way Trips on Highway 37 during Construction

Vehicle Type	Assumed Weight (tonne)	Cargo	Highway 37 Eskay–Treaty	Highway 37 Treaty–Meziadin
48' Flat-Deck	48	Infrastructure	111	395
Vans (Enclosed Trailers)	16	Infrastructure	36	132
48' Flat-Deck	48	Camps & Support Facilities	292	777
Vans (Enclosed Trailers)	16	Camps & Support Facilities	98	259
48' Flat-Deck	48	Mine Site	774	786
Vans (Enclosed Trailers)	16	Mine Site	258	261
48' Flat-Deck	48	Plant Site	-	2,380
Vans (Enclosed Trailers)	16	Plant Site	-	794
Bus & Passenger Vehicles	12	Crew Transport	427	861
48' Flat-Deck	48	Equipment	158	253
Vans (Enclosed Trailers)	16	Equipment	53	84
48' Flat-Deck	48	Materials	132	394
Vans (Enclosed Trailers)	16	Materials	44	132
48' Flat-Deck	48	Flocculant	18	18
Bulk Tanker	60	Lime	279	279
Tanker (45,000 L)	38	Fuel	198	215
Vans (Enclosed Trailers)	16	Explosives	5	21
Grand Total (Average Annual)			2,883	8,041

Table 7.8-6. Annual Emissions from Vehicles Travelling on Highway 37 during Construction

Highway 37	Annual Emission (tonne/year)					
	SO_2	NO_X	CO	TSP[a]	PM_{10}	$PM_{2.5}$
Eskay to Treaty	0.001	0.034	0.412	0.001	0.001	0.001
Treaty to Meziadin	0.002	0.103	1.592	0.002	0.002	0.002
Total Emission	0.003	0.137	2.004	0.003	0.003	0.003

Note: a. Speciation obtained from CEIDAR diesel vehicular sources where PM_{10} = 0.96 TSP.

7.8.2.1.5 Emissions from Land Clearing

Clearing of the site will occur throughout the construction phase and the debris will be burned on-site. In the absence of the weight of debris burnt, emissions from a forest fire covering the same area were adopted for a conservative estimation. Emissions from a forest fire are presented in Chapter 13 of AP-42 (US EPA 1996b). Emission factors were estimated based on the region, since the types of vegetation play a role in the amounts of pollutants emitted. For this Project, the Alaska region has been selected to best describe the RSA. Emission factors for particulate matter were used for estimating TSP emission rates, and speciation of agricultural burning (Cal EPA n.d.) from CEIDARS was used to estimate PM_{10} and $PM_{2.5}$ emissions (Table 7.8-7).

Table 7.8-7. Annual Emissions from Debris Burning

Activity	Annual Emissions (tonne/year)					
	SO_2	NO_x	CO	TSP	PM_{10}[a]	$PM_{2.5}$[a]
Debris Burning	-	-	553	67	59	57

Note: a. Speciation obtained from CEIDARS for planned/unplanned forest fire where PM_{10} = 0.88 TSP and $PM_{2.5}$ = 0.85 TSP.

7.8.2.1.6 Mining Activities

Most mining activities, such as bulldozing, grading, drilling, and blasting cause fugitive dust emissions. Emission factors for open dust emissions have been presented in AP-42 Chapter 11, Section 9 (US EPA 1998). Although this section of AP-42 was written for surface coal mines, it provides a more thorough emission factor estimation methodology than other mining sectors. The emission factors for overburden from this section have often been adopted to represent mining activities. The emission factor for bulldozing has been estimated based on the hours of operation assuming the moisture content of the material is 9.3% and the silt content of the material is 7.5% (Appendix 4-C). Emissions from grading are estimated based on the distance travelled, assuming average vehicle travel speed is 7.5 km/h (approximately 5 to 10 km/h).

Drilling is required to place explosives in the ground. Fugitive TSP emissions from drilling were calculated based on emission factors from Chapter 11.9 of AP-42 (US EPA 1998), assuming that each blast requires 58 drilled holes during the construction phase. Since there are no estimated emission factors for PM_{10} and $PM_{2.5}$, speciation ratios from Source 3 in Appendix B.2 of AP-42 (US EPA 1996a) were used. Pollutants emitted from blasting depend on the type of explosives used. Blasting is a source of fugitive dust, and emission factors from AP-42 (US EPA 1998) were used assuming one blast per day, and each blast affected an area of 4,190.5 m^2. The explosive used in this Project is ammonium nitrate with fuel oil (ANFO). Since ANFO has a portion of fuel oil that combusts and causes the explosion, blasting is also as source of NO_x, SO_2, and CO. Emission factors presented in AP-42 Chapter 13.3 (US EPA 1980) were used assuming each blast requires 60,685 kg of ANFO.

Stockpiles are sources of fugitive dust emissions. When material is dumped and loaded onto a stockpile, particles are easily disaggregated and released to the atmosphere. Open stockpiles are also subject to wind erosion where particles are blown by high-speed wind. The fastest mile method is typically used to estimate emissions from open stockpiles using the magnitude of wind gusts (US EPA 2006a). Assuming threshold friction velocity of 1.02 m/s and roughness height of 0.3 cm for overburden as suggested by the US EPA, wind erosion occurs only when wind speeds exceed 19 m/s at 10 m above ground. Stockpiles at the PTMA are enclosed, while stockpiles at the Mine Site are typically open. The maximum hourly wind speed collected was 15.9 m/s at the Mitchell meteorological station in 2009. In order to trigger wind erosion, the instantaneous wind speed has to be greater than 19.2 m/s. Although hourly wind speed was used in assessing wind erosion and fast wind gusts may occur at times, given that the average hourly wind speed exceeded 10 m/s only 34 hours in 2009, the potential of wind gusts exceeding 19.2 m/s and causing an effect is very limited. Emissions from the material drop onto the stockpiles have been included, but wind erosion emissions have not.

Emissions from aggregate storage operations vary with the age of the pile, moisture content, and proportion of aggregate fines. The emissions are based on the amount of material transferred. The total emissions were calculated based on the total waste mined (54,241 kt). The estimation was done including Sulphurets RSF. The Project was redesigned to eliminate the temporary Sulphurets RSF and it has been removed from the KSM Project production schedule. Due to the elimination of Sulphurets RSF, the stockpile emissions at the mine presented in Table 7.8-8 is higher than that in the current design.

Table 7.8-8. Annual Emissions from Mining Activities during Construction

		Annual Emissions (tonne/year)					
Activity	**Activity Area**	**SO_2**	**NO_x**	**CO**	**Fugitive TSP**	**Fugitive PM_{10}**	**Fugitive $PM_{2.5}$**
Bulldozing	Mine Site	-	-	-	123	31	23
	PTMA	-	-	-	17	4	3
	Saddle and Adit	-	-	-	28	7	5
Grading	Mine Site	-	-	-	117	42	4
	PTMA	-	-	-	107	39	3
Drilling	Mine Site				12	6[a]	2[a]
Blasting	Mine Site	22	172	765	416	216	12
Stockpiles	Mine Site	-	-	-	7.36	3.48	0.53
	PTMA	-	-	-	2.21	1.05	0.16
Total Emission		22	172	765	829.57	349.53	52.69

Note: a. Speciation obtained from AP-42 Appendix B.2 Source 3 for mechanically generated dust from aggregate and unprocessed ore.

7.8.2.1.7 Unpaved Road Fugitive Dust

Other than tailpipe emissions from equipment due to fuel combustion, equipment may also create fugitive dust emissions. When vehicles travel on an unpaved surface, the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. Equipment whose main function is to transport materials at the mine and PTMA are included in the fugitive road dust estimation. Traffic counts on the unpaved access roads were used in the estimation. Fugitive unpaved road dust emissions at the mine, plant, and Saddle and Adit areas, as well as access roads, were estimated based on emission factors in AP-42 Chapter 13.2.2 (US EPA 2006b). All roads are subject to some natural mitigation, because of precipitation. The number of days in a year with at least 0.254 mm (0.1 in) of precipitation is considered in the emission estimation. The precipitation data from the Mitchell meteorological station was used for the fugitive dust emission estimation at the mine and Coulter Creek access road, while Teigen meteorological station data were used for the fugitive dust emission estimation at the PTMA and Treaty Creek access road. Moreover, the calculation was performed assuming that watering the road will achieve a 4% moisture ratio, which will reduce fugitive dust emissions by 87.5% as stated in Section 7.7.1.1 (Table 7.8-9).

Table 7.8-9. Annual Emissions of Fugitive Dust Emissions from Unpaved Roads during Construction

Source Description	Annual Emission (tonne/year)		
	Fugitive TSP	Fugitive PM_{10}	Fugitive $PM_{2.5}$
Mine Site	638	178	18
PTMA	146	41	4
Saddle and Adit Area	3.3	0.9	0.1
Treaty Creek Access Road	12	3.3	0.3
Coulter Creek Access Road	18	4.9	0.5
Total Emission	817.3	228.1	22.9

7.8.2.1.8 Paved Road Fugitive Dust

Particulate emissions also occur when vehicles travel over a paved surface such as highway. The loose material on the paved road (surface loading) gets re-suspended when a vehicle travels past it. The emission factor for PM_{10} was obtained from a study done to assess alternative technologies for evaluating paved road dust emissions. The vehicle-based mobile sampling system was assessed to be used as an alternative to traditional paved road silt sampling (Langston et al. 2006). The Testing Re-entrained Aerosol Kinetic Emissions from Roads (TRAKER) system was developed by the Nevada System of Higher Education's Desert Research Institute and testing was performed on different types of paved road. The average emission factor for freeways (0.166 g/km) was selected to represent emissions from Highway 37. Particle size multipliers for paved road emission equations from AP-42 were used to estimate TSP and $PM_{2.5}$ emissions (Table 7.8-10). Total annual emissions from the construction phase are summarized in Table 7.8-11.

Table 7.8-10. Annual Emissions of Fugitive Dust Emissions from Paved Roads during Construction

	Annual Emission (tonne/year)		
Highway 37	**Fugitive TSP**	**Fugitive PM_{10}**	**Fugitive $PM_{2.5}$**
Eskay to Treaty	22	4	1
Treaty to Meziadin	38	7	2
Total Emission	60	11	3

Table 7.8-11. Total Annual Emissions during Construction

	Annual Emission (tonne/year)								
Sources	**SO_2**	**NO_x**	**CO**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Fugitive TSP**	**Fugitive PM_{10}**	**Fugitive $PM_{2.5}$**
Generators and Incinerators	0.4	1,784	480	43	31	26	-	-	-
On-site Equipment	1.84	922	333	47	46	45	787	220	22
Access Roads	0.002	0.109	1.75	0.002	0.002	0.002	30	8	0.8
Highway	0.003	0.137	2.00	0.003	0.003	0.003	60	11	3
Land Clearing and Debris Burning	-	-	553	67	59	57	-	-	-
Mining Activities	22	172	765	-	-	-	830	350	53
Total	**24**	**2,878**	**2,135**	**157**	**136**	**128**	**1,707**	**589**	**79**

7.8.2.2 Operation

During the operation phase, there are nine main sources of emissions:

- emissions from camp incinerators;
- mining equipment such as dozers, haul trucks, forklifts, graders, and tractors;
- vehicular tailpipe emissions from the Treaty Creek access road and Coulter Creek access road;
- vehicular tailpipe emissions from Highway 37;
- emissions from MTT ventilation exhaust;
- dust emissions from baghouses in the Treaty OPC;
- fugitive dust emissions from mining activities such as bulldozing, grading and material handling drilling and blasting, and emissions from blasting;
- fugitive dust on unpaved road from vehicles travelling on access roads; and
- fugitive paved-road dust emissions from vehicles travelling on Highway 37.

The methods used to estimate emissions from the above sources are the same as the methods used to estimate emissions from construction sources (see Section 7.8.2.1). Blasting is scheduled to occur once per day with estimated affected area of 10,837.5 m^2 and 150 drilled holes required per blast.

During operation, the MTT will be used to transport material between the Mine Site and PTMA. The MTT has two separate sections of parallel tunnels separated by the construction access adits, which act as exhaust portals for the MTT. The MTT is a twin-tunnel system that is approximately 23 km in length. The transportation tunnel is 4.5 m wide by 4.3 m high to accommodate tractor and low-boy trailers. The conveyor tunnel will be 6 m wide by 4.3 m high. The exhaust portals at the construction access adits have volumetric flow rates of approximately 50 m^3/s, which is double the flow rate in the tunnels. The diameters of the exhaust were calculated based on the flow rates. The open underground/tunnel conveyor system will generate particulate at the belted transfer points. There are four conveyor drives according to the ventilation design (Mine Ventilation Services 2012); therefore, it can be assumed that there are five transfer points. It is assumed that wet scrubbers are used inside the MTT system to reduce particulate emissions at the transfer points. The flow rates at the cross-cuts between the two tunnels are expected to be low; however, it is assumed the air from the two tunnels is well mixed for more conservative emission rates. Emissions in the transportation tunnel will be required to meet standards set by BC Occupational Health and Safety, since workers are expected to be transported using the tunnel. As a result, the dust concentration limits stated by BC Occupational Health and Safety were used to calculate the emission rates at the exhaust portals. Total particulate has an eight-hour time-weighted average limit of 10 mg/m^3 and respirable particulate (assumed to represent $PM_{2.5}$) has an eight-hour time-weighted average of 3 mg/m^3. As there is no information on the inhalable particulate (assumed to represent PM_{10}), the TSP emission rate was used for PM_{10}.

Baghouses are used at several locations in the Project to reduce dust emissions from ore crushing. Dust emissions from baghouses were provided by manufacturer's specifications. Annual emissions from baghouses, generators, incinerators, and MTT exhaust portals are presented in Table 7.8-12.

Table 7.8-12. Annual Emissions from Stacks during Operation

Source Description	Prime Power (kW)	Annual Emission (tonne/year)					
		SO_2[a]	NO_x	CO	TSP	PM_{10}[b]	$PM_{2.5}$[b]
Mitchell OPC Primary Crusher baghouse	-	-	-	-	4.9	4.9	3.9
Mitchell coarse ore reclaim baghouse - before MTT	-	-	-	-	3.0	3.0	2.3
Mitchell coarse ore reclaim baghouse - after MTT	-	-	-	-	4.9	4.9	3.9
Cone Crusher Building baghouse 1	-	-	-	-	6.6	6.6	5.2
Cone Crusher Building baghouse 2	-	-	-	-	6.6	6.6	5.2
Fine ore stockpile baghouse	-	-	-	-	3.0	3.0	2.3
High Pressure Grinding Rollsbaghouse 1	-	-	-	-	3.0	3.0	2.3
Mitchell operating camp generator (350-person)	400	53.0	0.01	14.3	0.6	0.6	0.6

(continued)

Table 7.8-12. Annual Emissions from Stacks during Operation (completed)

Source Description	Prime Power (kW)	Annual Emission (tonne/year)					
		SO_2[a]	NO_x	CO	TSP	PM_{10}[b]	$PM_{2.5}$[b]
Treaty operating camp generator (250-person)	400	53.0	0.01	14.3	0.6	0.6	0.6
Mitchell operating camp incinerator (350-person)	-	0.5	0.00	0.0	5.9	2.9	2.0
Treaty operating camp incinerator (250-person)	-	0.4	0.00	0.0	4.2	2.1	1.4
Adit (Tunnel 1) exhaust	-	3.7	0.01	1.5	4.2	4.2	1.4
Adit (Tunnel 2) exhaust	-	3.7	0.01	1.5	4.2	4.2	1.4
Total Emission		114.2	0.03	31.6	51.6	46.5	32.5

Notes: a. SO_2 emission rates from generators were calculated based on sulphur content in diesel (DieselNet 2012).
b. PM_{10} and PM2.5 emission rates from generators were determined based on dust speciation from AP-42 Appendix B.2 source category 1 – Stationary Internal Combustion Engines for Gasoline and Diesel Fuel where PM_{10} = 96% TSP and $PM_{2.5}$ = 90% TSP.

The operation annual emissions are estimated using the same methods described for construction (Section 7.8.2.1). The emissions are summarized and presented in Table 7.8-13.

Table 7.8-13. Total Annual Emissions during Operation

Sources	Annual Emission (tonne/year)								
	SO_2	NO_x	CO	TSP	PM_{10}	$PM_{2.5}$	Fugitive TSP	Fugitive PM_{10}	Fugitive $PM_{2.5}$
Generators, Incinerators, and Baghouses	0.03	114	32	52	47	32	-	-	-
On-site Equipment	2.6	1,598	533	68	67	66	1,833	511	51
Access Roads	0.02	0.75	22	0.03	0.03	0.03	160	45	4
Highway 37	0.01	0.60	8	0.01	0.01	0.01	1.1	0.2	0.1
Mining Activities	71	568	2,416	-	-	-	2,146	1,032	105
Total	**74**	**2,282**	**3,011**	**120**	**113**	**98**	**4,141**	**1,588**	**161**

7.8.3 Air Emissions Dispersion Modelling

7.8.3.1 Air Quality Modelling Approach

CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model that is capable of simulating the effect of time- and space-varying meteorological conditions on pollutant transport, transformation, and removal. In order to perform dispersion modelling using CALPUFF, meteorological data were processed by CALMET, to provide meteorological data in the modelling. CALMET data were created using on-site observational data from three meteorological stations (Mitchell, Teigen, and Unuk-Teigen). MM5 prognostic data were also provided to characterize upper air conditions. Wind vector output files have been checked for quality assurance purposes (Appendix 7-A).

The dispersion modelling was performed in accordance with the *Guidelines for Air Quality Dispersion Modelling in BC* (BC MOE 2008) and as described in the Detailed Model Plan (Appendix 7-A). Building downwash effects have been included for stack sources (generators, incinerators, and baghouses where appropriate). The building layout at the Treaty OPC is shown in Figure 7.8-1. In addition to the buildings at Treaty OPC, there are also camps. The building heights used in the building downwash effect are shown in Table 7.8-14.

Table 7.8-14. Building Heights

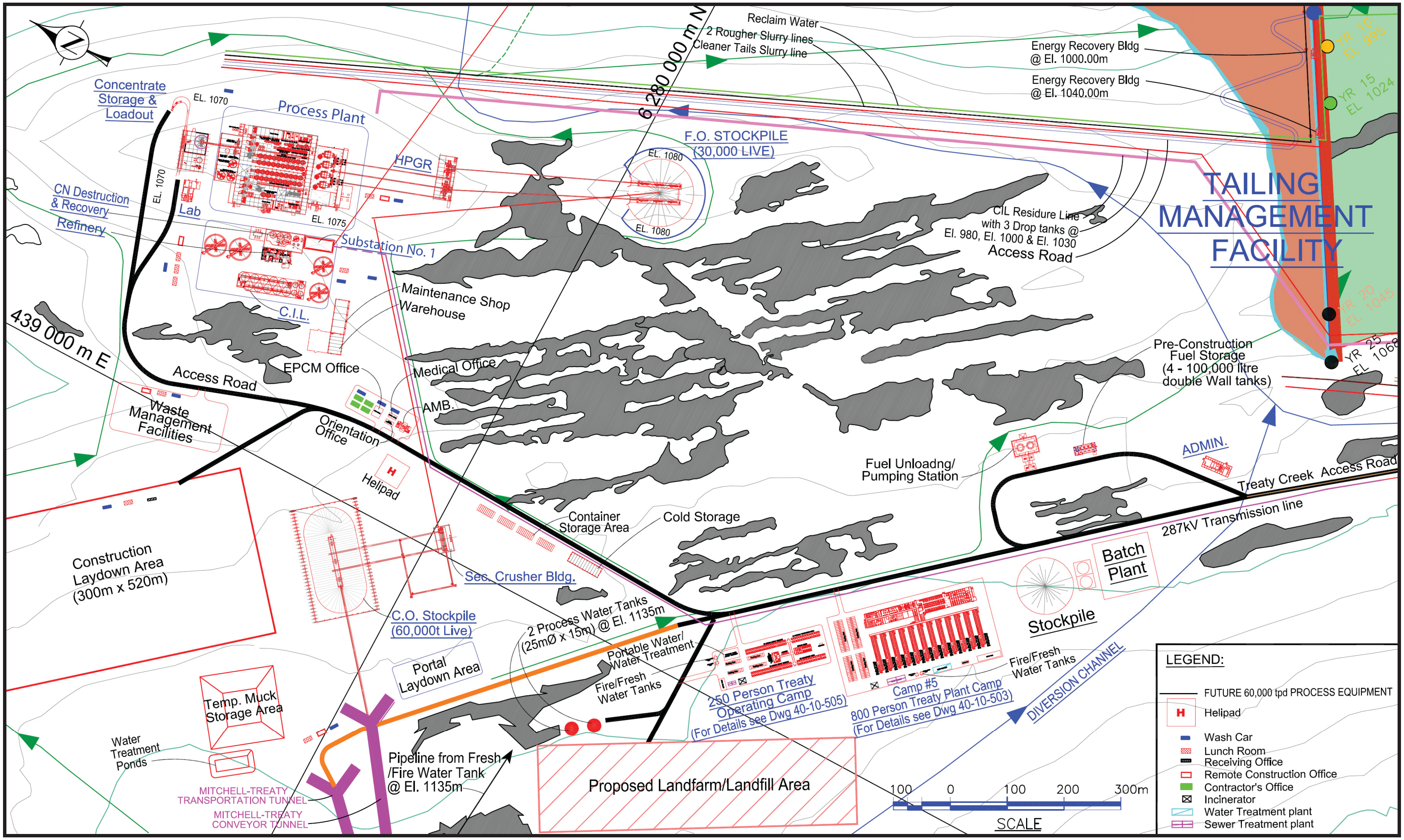
Building Description	Building Height (m)
COS Cover Building	50
Secondary Crushing Building	40
High Pressure Grinding Rolls Building	27
Grinding and Flotation Building	38
Concentrate Storage and Loadout Building	16.5
CIL Building	33
Refinery Building	19
Maintenance Shop and Warehouse Building	8.5
Administration Building	5
Cold Storage Building	8.3
EPCM Building	3
Medical Office	3
Ambulance Building	3
Treaty Operating Camp (250-person)	3
Mitchell Operating Camp (350-person)	3
Construction Camp 5 (800-person)	6
Construction Camp 6 (120-person)	3
Construction Camp 10 (400-person)	6

Source: B. Wong (pers. comm.).

As previously mentioned, NO_x primarily consists of NO and NO_2. In order to compare to the NO_2 objectives in BC, the Ozone Limiting Method (OLM) was used to convert modelled NO_x concentrations to NO_2 concentrations assuming an ozone background of 60 $\mu g/m^3$ (Appendix 7-A).

For this Project, fugitive dust is modelled separately according to the BC Modelling Guideline's procedure (BC MOE 2008). The rationale behind this is that there are large uncertainties associated with fugitive dust emissions factors. With fugitive dust emissions modelled separately, dispersion model results from non-fugitive emissions can be assessed with higher confidence when comparing with the objectives. Dust emissions from both non-fugitive and fugitive models will be compared to the provincial and federal objectives and standards.

The CALPUFF model switches used in the Project are detailed in Table 7.8-15. All of the switches were configured in accordance with the BC Model Guideline (BC MOE 2008).



Source: Tetra Tech Wardrop (2012).

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Treaty Ore Preparation Complex Layout

Figure 7.8-1

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Table 7.8-15. CALPUFF Model Switch Settings

Parameter	Default	Project	Explanation & Justification
MGAUSS	1	1	
MCTADJ	3	3	
MCTSG	0	0	
MSLUG	0	0	
MTRANS	1	1	
MBDW	2	2	
MTIP	1	1	
MSHEAR	0	0	
MSPLIT	0	0	
MCHEM	1	1	
MAQCHEM	0	0	
MWET	1	1 for non-fugitive sources; 0 for fugitive sources	Wet removal not considered for fugitive dust to provide conservative results
MDRY	1	1	
MDISP	2 or 3	3	
MTURBVW	3	3	
MDISP2	2	2	
MROUGH	0	0	
MPARTL	1	1	
MTINV	0	0	
MPDF	0 or 1	0	
MSGTIBL	0	0	
MBCON	0	0	
MFOG	0	0	
MREG	0	0	

The receptor grid spacing was configured according to the BC Model Guideline with a modification approved through regulatory consultation; the resulting nested grid of 21,477 receptors were identified as adequate to assess ambient air quality effect. Since activities on the access roads were considered sources, receptor spacing around Treaty Creek access road, Coulter Creek access road, and Highway 37 were reconfigured to accommodate this change. Sensitive receptors were determined by consulting vegetation, fish, wildlife, and human health scientists (Figure 7.8-2). The wildlife receptors include areas of moose, goat, and grizzly habitat, while the residential receptors represent the KSM mine workers' camps, existing exploration camps and trapline cabins. Bell 2 Lodge is also included as a residential receptor.

The nested receptor grids used in the model are:

- 50 m spacing along the plant boundary (fenceline);
- 100 m spacing within 500 m from the fenceline or from the roads;
- 250 m spacing within 2 km from the fenceline or the roads;
- 500 m spacing within 5 km from the fenceline; and
- 2,000 m spacing for the remainder of the RSA.

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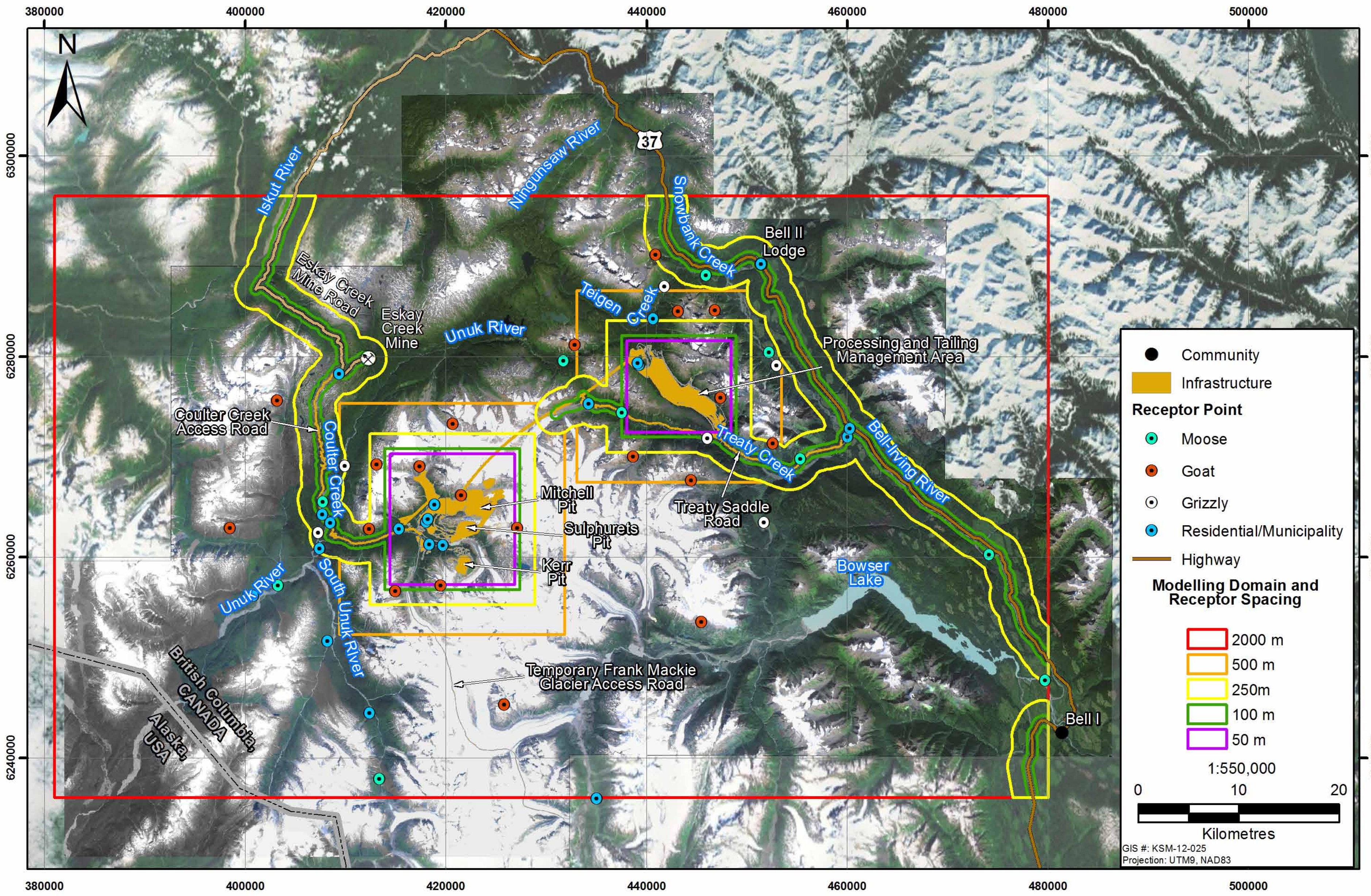

Figure 7.8-2

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KSM Air Dispersion Modelling Domain and Receptor Spacing

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The emission sources described in Section 7.8.2 were modelled as point and area sources. Stack emissions from sources such as generators, incinerators, baghouses, and the MTT exhaust portals were modelled as point sources. All other sources, such as equipment exhaust and road dust, were modelled as area sources. The stack dispersion modelling parameters are described in Table 7.8-16. Since the stacks are relatively short, stack downwash effect was included in the model.

The MTT exhaust at the adits are estimated based on the dimensions provided in the Ventilation Design (Mine Ventilation Services 2012). Since CALPUFF can only handle stacks with a circular diameter, equivalent diameters of the two portals were calculated based on the same pressure loss. Since the portals only have 10% incline and are closer to horizontal stacks, stack inputs to CALPUFF were calculated as horizontal stacks described in the BC Model Guideline (BC MOE 2008). The equivalent diameters for the portals were also used in the calculation of stack diameters as an input to the model. Since the portal is at ground level, a pseudo stack height of 0.1 m is used in the CALPUFF model input. The emissions from area sources were assumed to be evenly distributed among the corresponding activity areas. The emission sources for construction and operation are shown in Figures 7.8-3 and 7.8-4.

7.8.3.2 Air Quality Modelling Results – Construction Phase

7.8.3.2.1 Sulphur Dioxide

The dispersion model results for SO_2 outside the mining fenceline, summarized in Table 7.8-17, indicates no exceedances over the criteria for all averaging periods. The highest hourly SO_2 concentration of 33 $\mu g/m^3$ (including the background concentration of 4 $\mu g/m^3$) occurred on the fenceline on the east side of the Mine Site, and an area 2 km northeast of the Mine Site fenceline (Figure 7.8-5). The highest concentration of 33 $\mu g/m^3$ is less than 10% of the NAAQO maximum desirable and the BC level A objectives of 450 $\mu g/m^3$. The maximum one-hour concentrations predicted at sensitive receptors were lower than the above maximum.

The maximum predicted 24-hour SO_2 concentration of 11 $\mu g/m^3$, including background of 4 $\mu g/m^3$ occurred on the east side of Mine Site fenceline close to the blasting area, which is also less than 10% of the relevant criteria (Figure 7.8-6). The maximum predicted 24-hour concentrations at sensitive receptors are lower than the above maximum.

The maximum predicted annual SO_2 concentration occurred close to the fenceline on the west (Figure 7.8-7). The maximum concentration of 2.6 $\mu g/m^3$ includes background of 2 $\mu g/m^3$ and is approximately 10% of the BC level A objective, which is more stringent than the NAAQO maximum desirable objective. The highest maximum concentration predicted at sensitive receptors is 2.8 $\mu g/m^3$ including background concentration of 2 $\mu g/m^3$ and occurred at a goat receptor north of the McTagg RSF. The maximum concentration at this goat receptor is still much less than the BC objective.

Table 7.8-16. Point Sources Dispersion Modelling Parameters

Phase	Source	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exhaust Temperature (°C)	UTM (m)	
						Easting	Northing
Construction	MTT Construction Generator – Mine 1	9	0.356	58	356.7	421,080	6,265,796
	MTT Construction Generator – Mine 2	9	0.356	58	356.7	421,215	6,265,796
	MTT Construction Generator – Adit	9	0.203	77	420.5	430,928	6,274,297
	MTT Construction Generator – Saddle 1	9	0.356	58	356.7	433,761	6,276,056
	MTT Construction Generator – Saddle 2	9	0.356	58	356.7	433,751	6,276,056
	MTT Construction Generator – Treaty 1	9	0.356	58	356.7	438,590	6,280,081
	MTT Construction Generator – Treaty 2	9	0.356	58	356.7	438,580	6,280,081
	Camp 5, 700-person Treaty Plant Camp Generator 1	9	0.203	47	470.2	439,260	6,279,063
	Camp 5, 700-person Treaty Plant Camp Generator 2	9	0.203	47	470.2	439,270	6,279,063
	Camp 6, 120-person Treaty Saddle Camp Generator	9	0.203	47	470.2	434,272	6,275,342
	Camp 10, 400-person Mitchell Secondary Camp Generator	9	0.203	47	470.2	417,895	6,263,456
	Camp 5, 700-person Treaty Plant Camp incinerator	9	0.356	59	1,000	438,943	6,278,911
	Camp 6, 120-person Treaty Saddle Camp incinerator	9	0.356	59	1,000	434,367	6,275,683
	Camp 10, 400-person Mitchell Secondary Camp incinerator	9	0.356	59	1,000	417,479	6,263,423
Operation	Mitchell Primary Crusher Baghouse	9	1.500	20	Ambient	421,687	6,265,725
	Mitchell Coarse Ore Reclaim Baghouse - before MTT	9	1	27	Ambient	421,151	6,265,725
	Mitchell Coarse Ore Reclaim Baghouse - after MTT	9	1.5	20	Ambient	438,830	6,280,053
	Cone Crusher Building Baghouse 1	9	1.5	27	Ambient	439,045	6,280,004
	Cone Crusher Building Baghouse 2	9	1.5	27	Ambient	439,011	6,280,000
	Fine Ore Stockpile Baghouse	9	1	27	Ambient	439,712	6,280,000
	HPGR Baghouse 1	9	1	27	Ambient	439,614	6,280,268
	Mitchell Operating Camp Generator (350-person)	9	0.203	47	470.2	415,380	6,262,750
	Treaty Operating Camp Generator (250-person)	9	0.203	47	470.2	439,174	6,279,302
	Mitchell Operating Camp incinerator (350-person)	9	0.356	59	1,000	415,424	6,262,592
	Treaty Operating Camp incinerator (250-person)	9	0.356	59	1,000	438,943	6,278,911
	Adits (Tunnel 1) exhaust	0.1	5	2.6	Ambient	431,011	6,274,257
	Adits (Tunnel 2) exhaust	0.1	5	2.51	Ambient	431,011	6,274,247

Table 7.8-17. Maximum SO_2 Predicted Concentrations during Construction

Pollutant	Averaging Period	Concentrations ($\mu g/m^3$)					
		Criteria		Background	Maximum Predicted Concentrations from Project		
		NAAQOs	BC Objectives		Project	Project + Background	Sensitive Receptor + Background
SO_2	1-hour	450	450	4	29	33	27
	24-hour	150	160	4	7	11	10
	Annual	30	25	2	0.6	2.6	2.8

7.8.3.2.2 Nitrogen Dioxide

The dispersion model results for NO_2 for all averaging periods are shown in Table 7.8-18. The NO_2 concentrations were estimated from NO_x using the OLM with a 60 $\mu g/m^3$ ozone background concentration assumed. Note that the OLM assumes NO_x contains 10% of NO_2 and 90% of NO, which react with ozone to form NO_2. This method also assumes either NO (90% NO_x) or ozone reacts completely to NO_2. This method is conservative and not as realistic as the ambient ratio (AR) method; however, AR requires at least one year of representative ambient hourly NO and NO_2 monitoring data, which is not available in the area. As a result, only conservative OLM can be used to predict maximum NO_2 concentrations, resulting in higher than realistic concentrations. The maximum one-hour NO_2 concentration predicted outside the Project fenceline of 823 $\mu g/m^3$ occurred immediately north of the Saddle Area (Figure 7.8-8). The reasons why high concentrations were predicted in this area were that the elevation immediate north of the Saddle Area is higher, and the area is very close to the emission sources. During the construction phase, tunnel construction equipment will be operated between the Saddle and construction access adit area where portals and tunnels are being constructed. Despite the high concentration predicted, concentrations over the NAAQO maximum acceptable objective of 400 $\mu g/m^3$ are not expected beyond approximately 300 m from the Saddle Area fenceline. Moreover, the maximum concentration 823 $\mu g/m^3$ does not exceed the NAAQO maximum tolerable objective of 1,000 $\mu g/m^3$ and only exceeds the NAAQO maximum acceptable objective of 400 $\mu g/m^3$ for four hours in the modelled year, which is equivalent to 0.05% frequency in one year (Table 7.8-19).

Table 7.8-18. Maximum NO_2 Concentrations during Construction

Pollutant	Averaging Period	Concentrations ($\mu g/m^3$)					
		Criteria		Background	Maximum Predicted Concentrations from Project		
		NAAQOs	BC Objectives		Project	Project + Background	Sensitive Receptor + Background
NO_2	1-hour	400	-	21	802	823	174
	24-hour	200	-	21	130	151	92
	Annual	60	-	5	68	73	33

Note: bold indicates exceedance over criteria.
Dash (-) indicates information not applicable.

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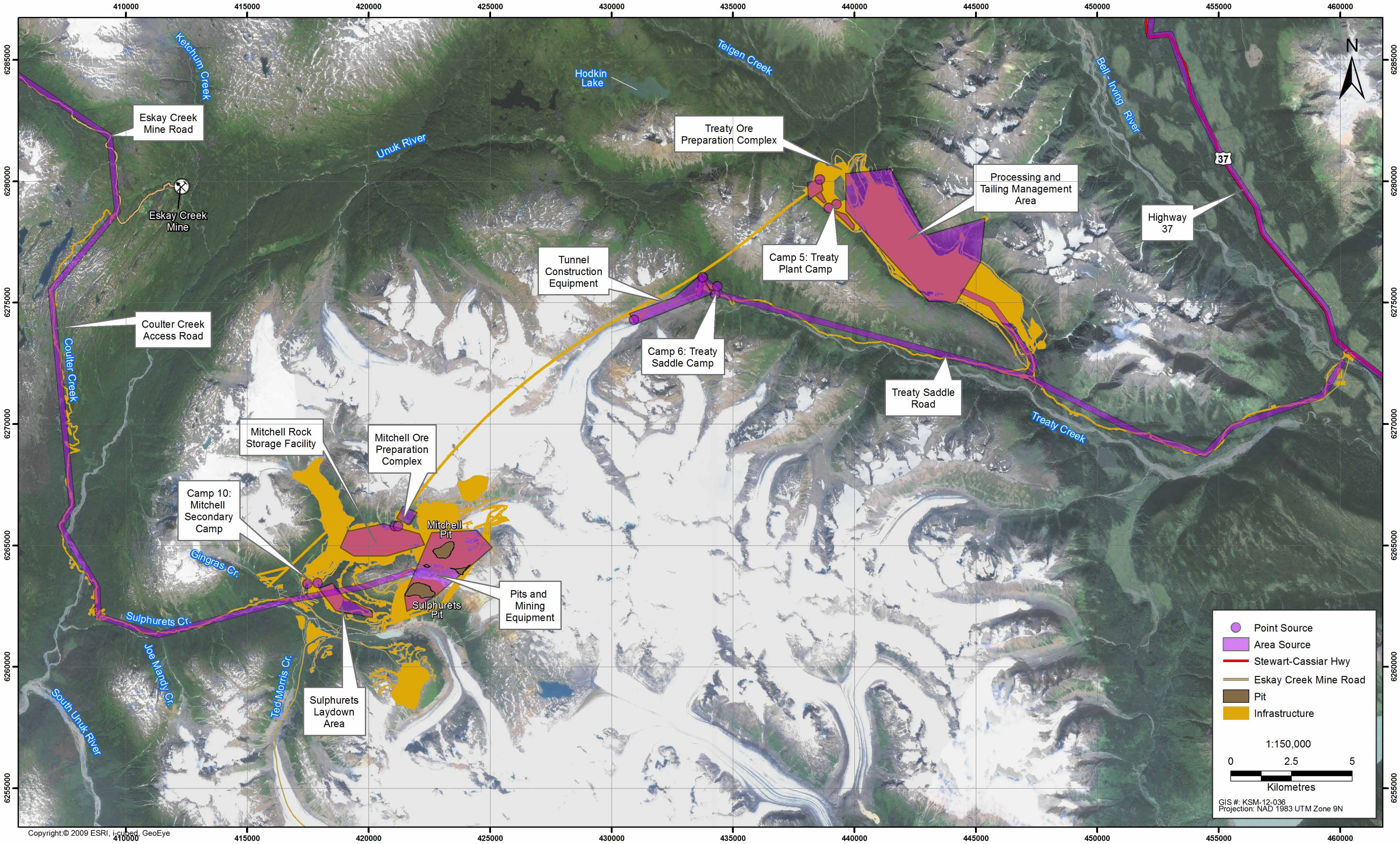

Figure 7.8-3

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KSM Project Construction Phase Air Emission Sources (Year -1)

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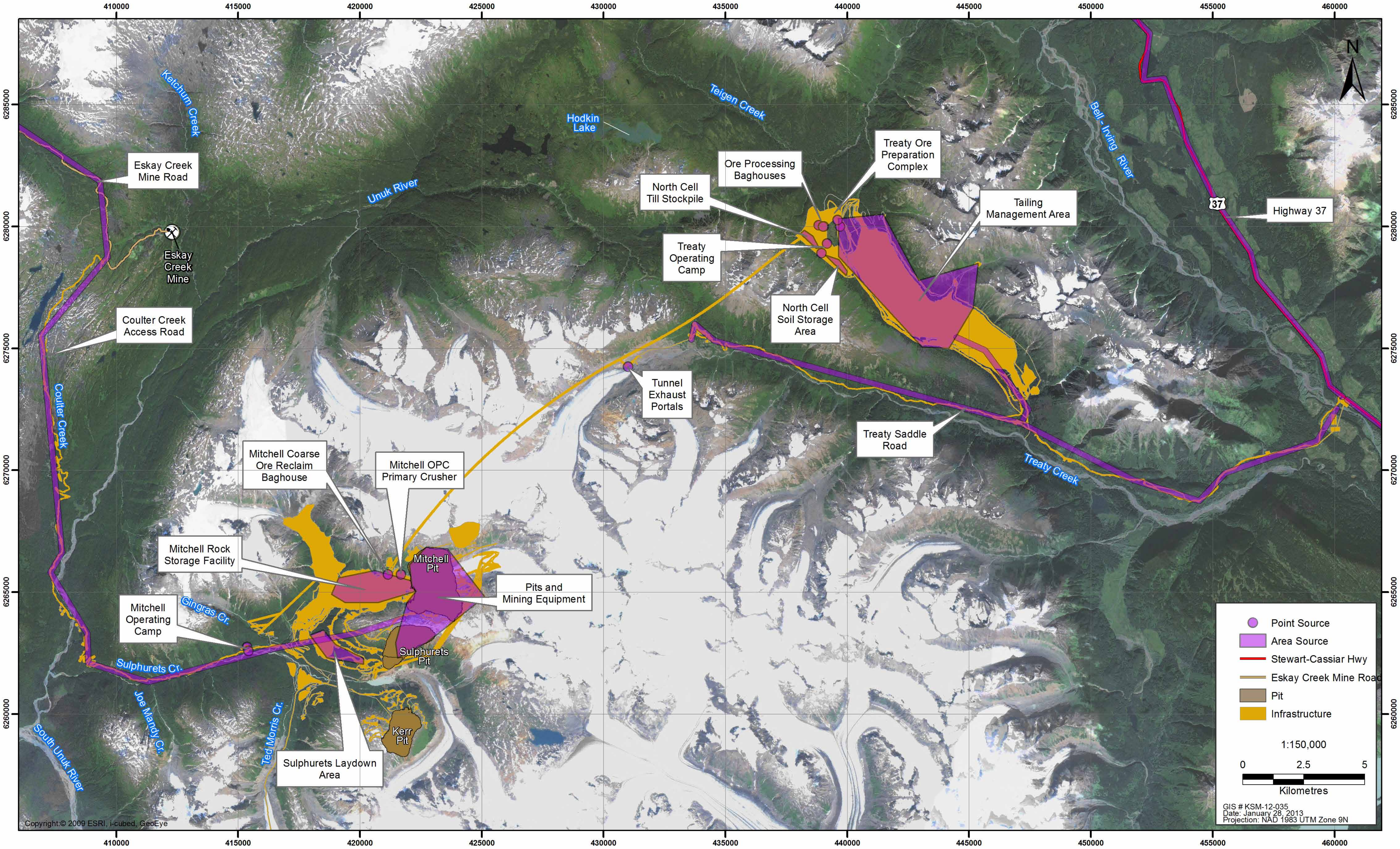

Figure 7.8-4

KSM Project Operation Phase Air Emission Sources (Year 4)

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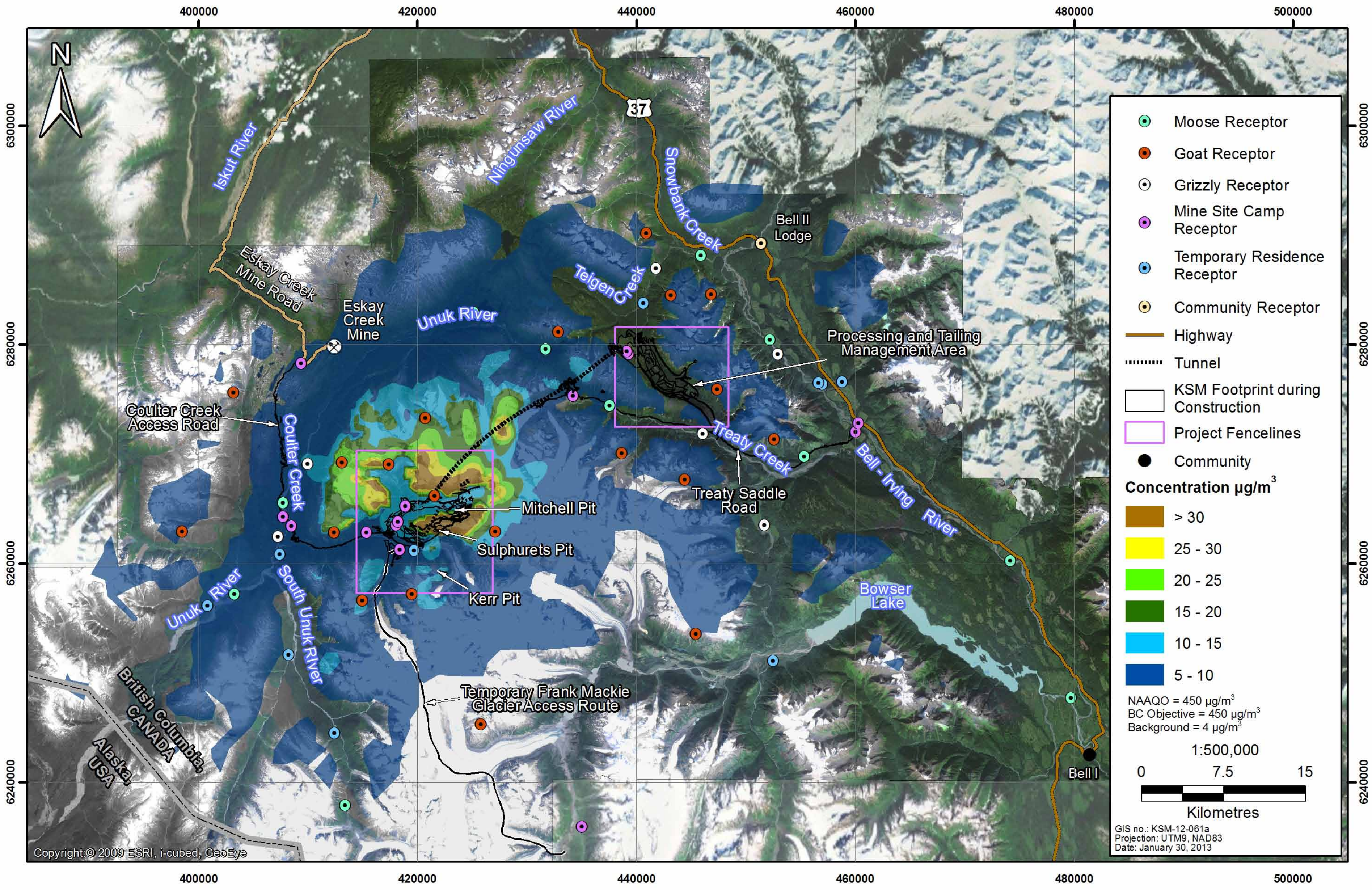

Figure 7.8-5

Maximum 1-Hour SO_2 Concentration during Construction

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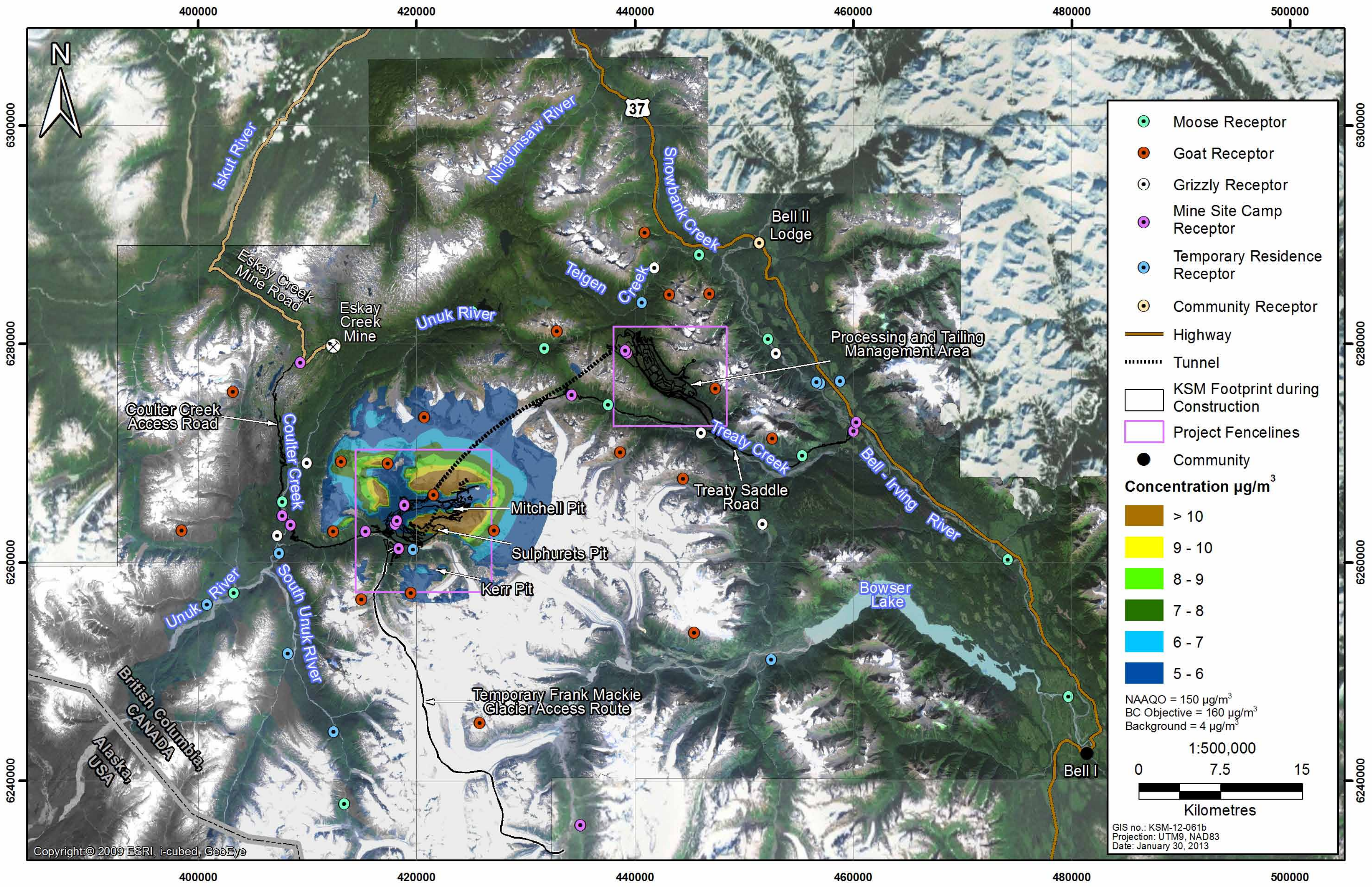

Figure 7.8-6

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Maximum 24-Hour Average SO_2 Concentration during Construction

Figure 7.8-6

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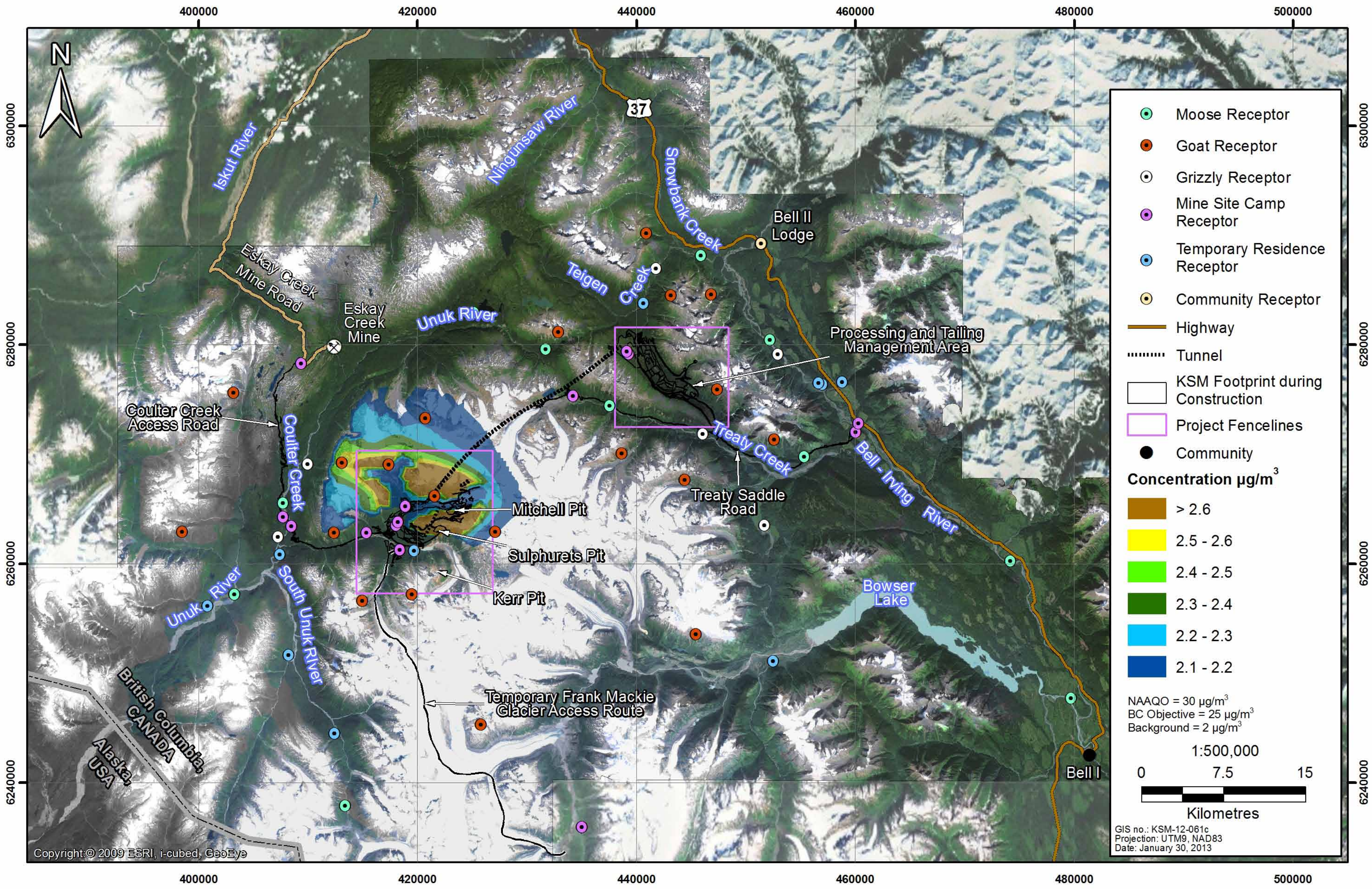

Figure 7.8-7

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Annual SO_2 Concentration during Construction

Figure 7.8-7

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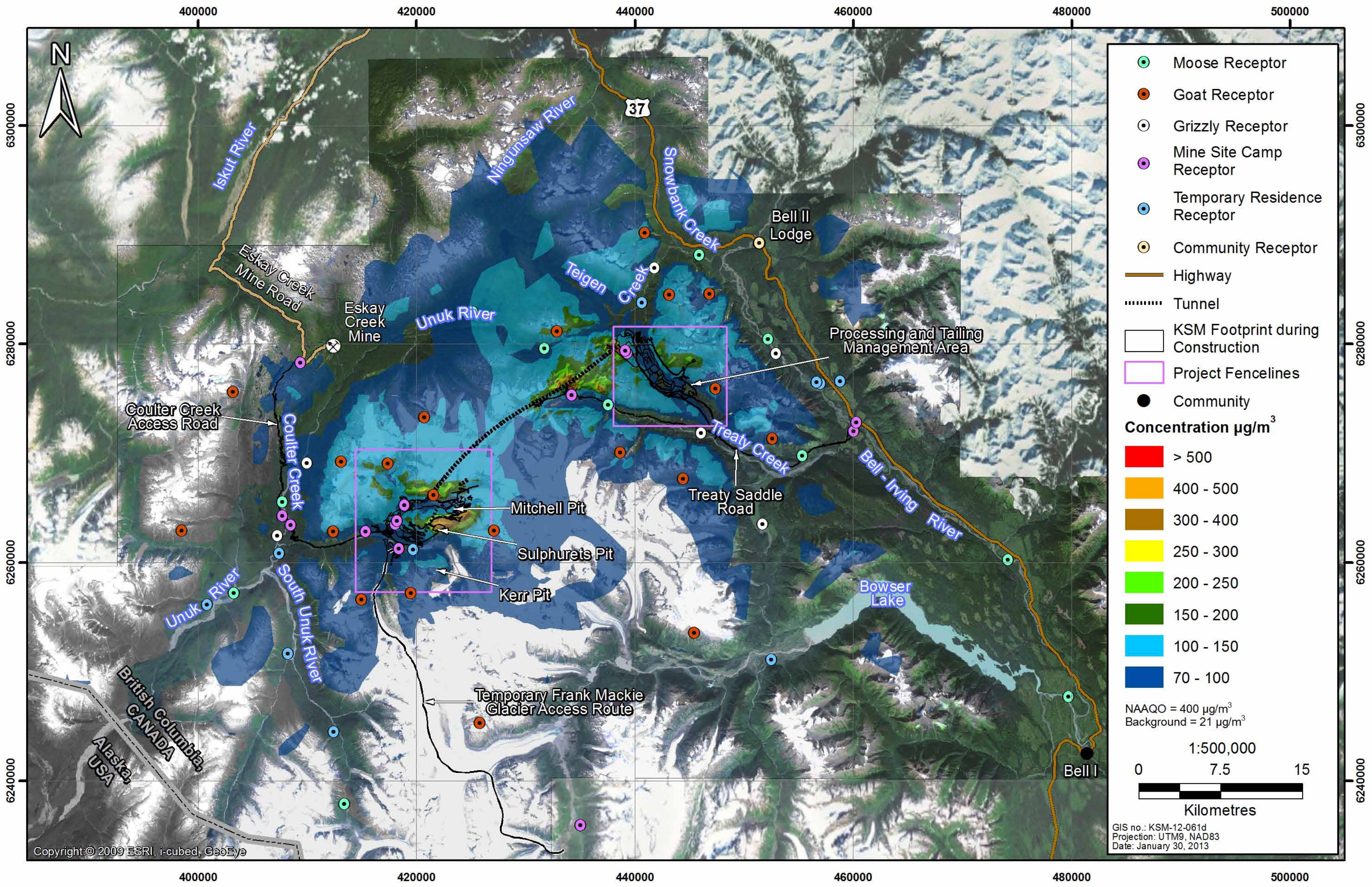

Figure 7.8-8

Maximum 1-Hour NO_2 Concentration during Construction

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Table 7.8-19. Frequency of Exceedance for NO_2 during Construction

Pollutant	Averaging Period	Number of Exceedance	Frequency of Exceedance per Year
NO_2	1-hour	4	0.05%
	24-hour	-	-
	Annual	-	-

Note: Dash (-) indicates information not applicable.

Other than for the area north of the Saddle Area, NO_2 exceedances over 400 µg/m^3 were also predicted for an area 200 m west of the PTMA fenceline. However, this area is approximately 200 m in diameter and exceeds the NAAQO of 400 µg/m^3 two hours during the model year. Other than these areas with exceedances, the 200 µg/m^3 contour, which is half of the NAAQO, is predicted to occur less than 2 km out from the PTMA fenceline or Treaty Creek access road. An area with a diameter less than 500 m west-northwest of the processing facilities is also predicted with maximum concentration over half of the objective.

The 24-hour maximum predicted NO_2 concentration of 151 µg/m^3 is approximately 75% of the NAAQO (Figure 7.8-9). The annual maximum concentration of 73 µg/m^3 exceeded the NAAQO maximum desirable objective of 60 µg/m^3 on the fenceline around the Saddle Area (Figure 7.8-10). The exceedances were not predicted to occur beyond 50 m from the Saddle Area fenceline. The Saddle Area is located in a valley. The pollutant puffs emitted from the Saddle Area during tunnel construction are blown to the northwest due to wind channelling along the Treaty Creek Valley. In the area northwest of the Saddle Area, which has a higher elevation, the pollutant reaches ground level in a short distance, not allowing a great deal of dispersion prior to reaching ground level.

7.8.3.2.3 Carbon Monoxide

The maximum predicted concentrations for one-hour and eight-hour CO are presented in Table 7.8-20. The highest maximum concentrations are lower than the BC level A objectives for both averaging periods. The highest one-hour maximum predicted CO occurred on the Saddle Area fenceline (Figure 7.8-11). The maximum one-hour 1,000 µg/m^3 contour, which is 7% of the criteria, only extends approximately 6 km out from the Mine Site fenceline.

Table 7.8-20. Maximum CO Concentrations during Construction

		Concentrations (µg/m^3)					
		Criteria			Maximum Predicted Concentrations from Project		
Pollutant	Averaging Period	NAAQOs	BC Objectives	Background	Project	Project + Background	Sensitive Receptor + background
CO	1-hour	15,000	14,300	100	2,036	2,136	2,192
	8-hour	6,000	5,500	100	604	704	1,594

The highest eight-hour maximum predicted concentration occurred on the west of the PTMA fenceline approximately 4.5 km west-northwest of the McTagg RSF (Figure 7.8-12). The highest eight-hour CO concentration for the sensitive receptors occurred on the goat receptor by the MTT entrance at the mine side.

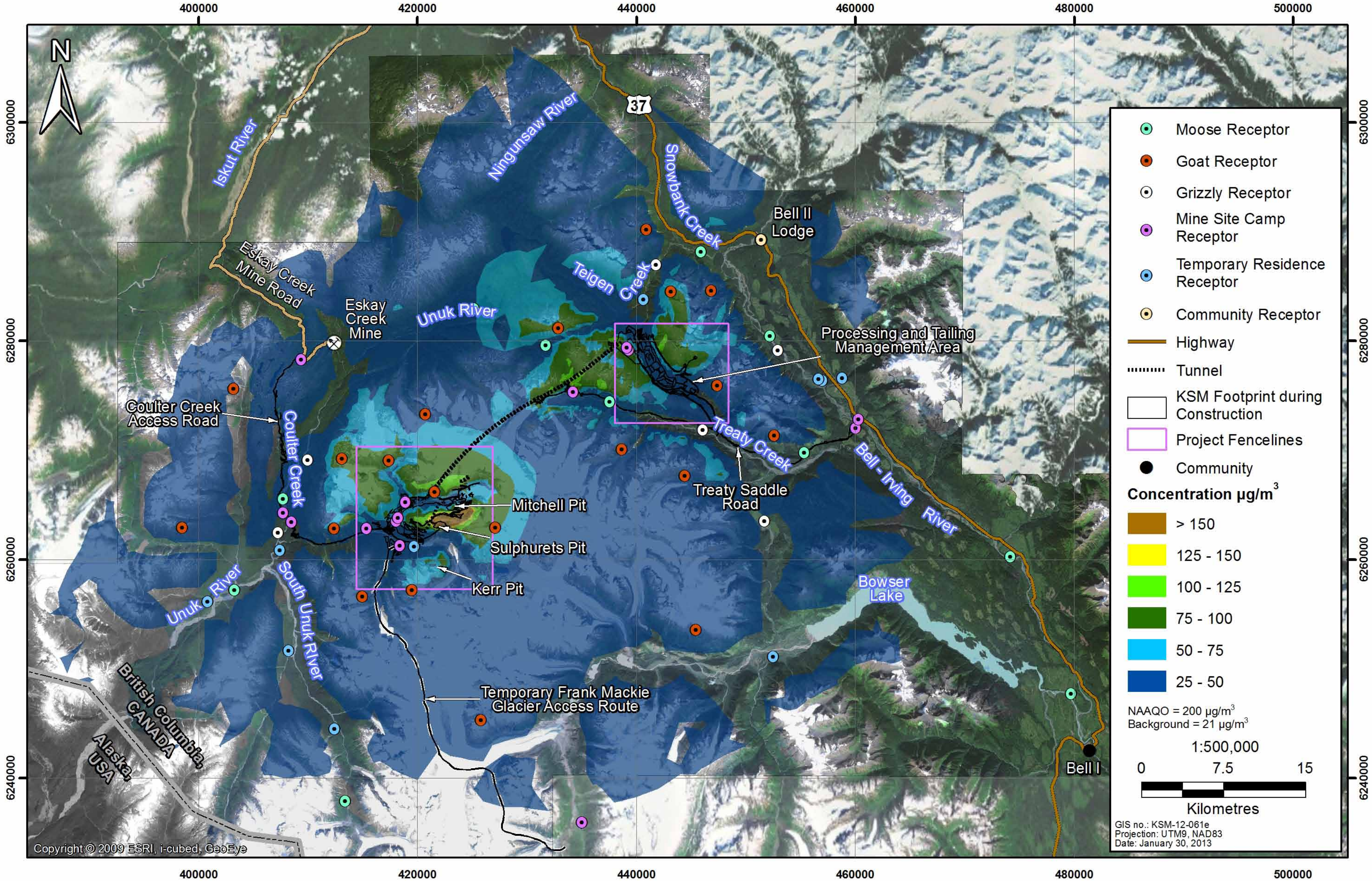

Figure 7.8-9

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Maximum 24-Hour NO_2 Concentration during Construction

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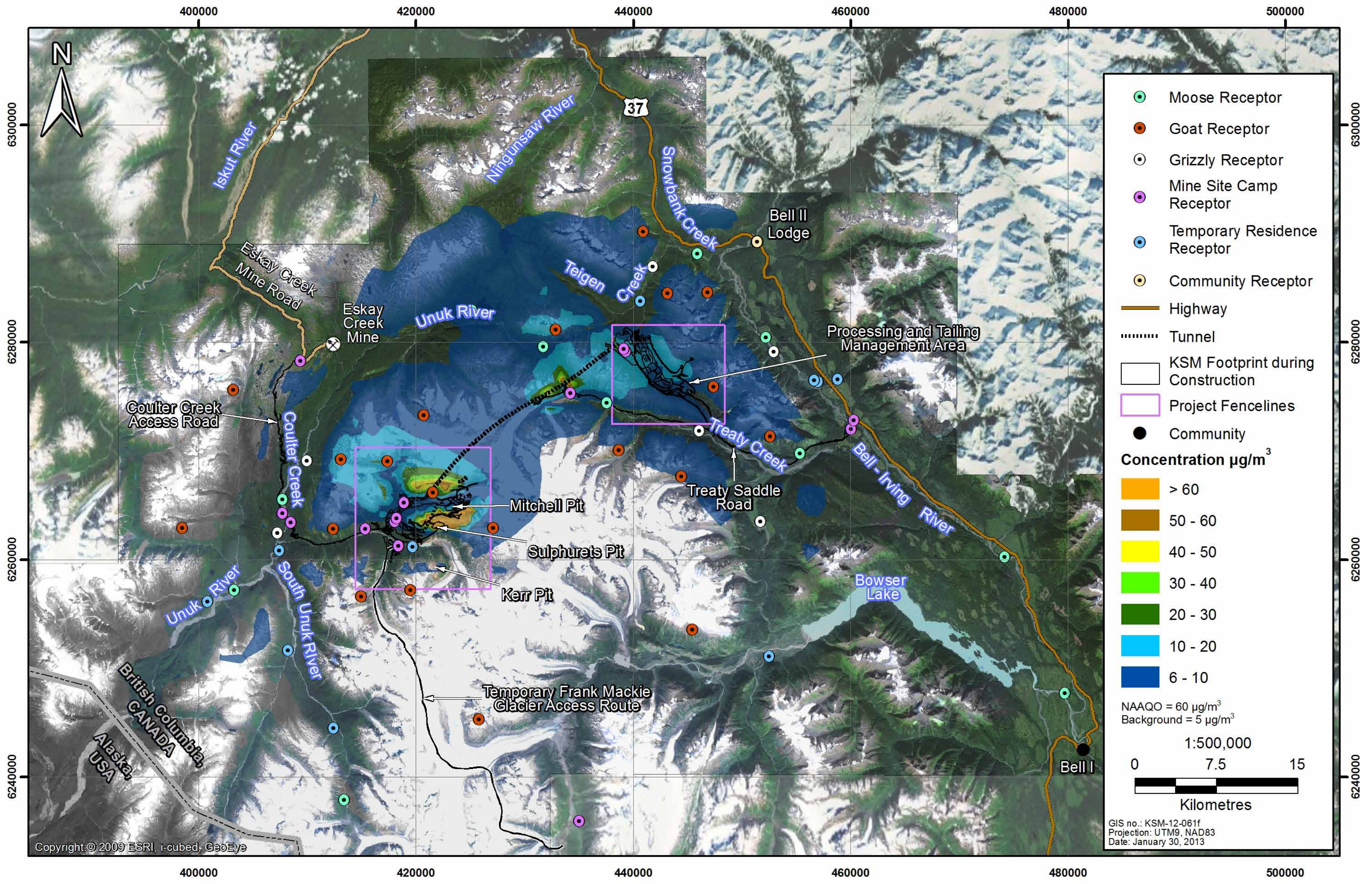

Figure 7.8-10

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Annual NO_2 Concentration during Construction

Figure 7.8-10

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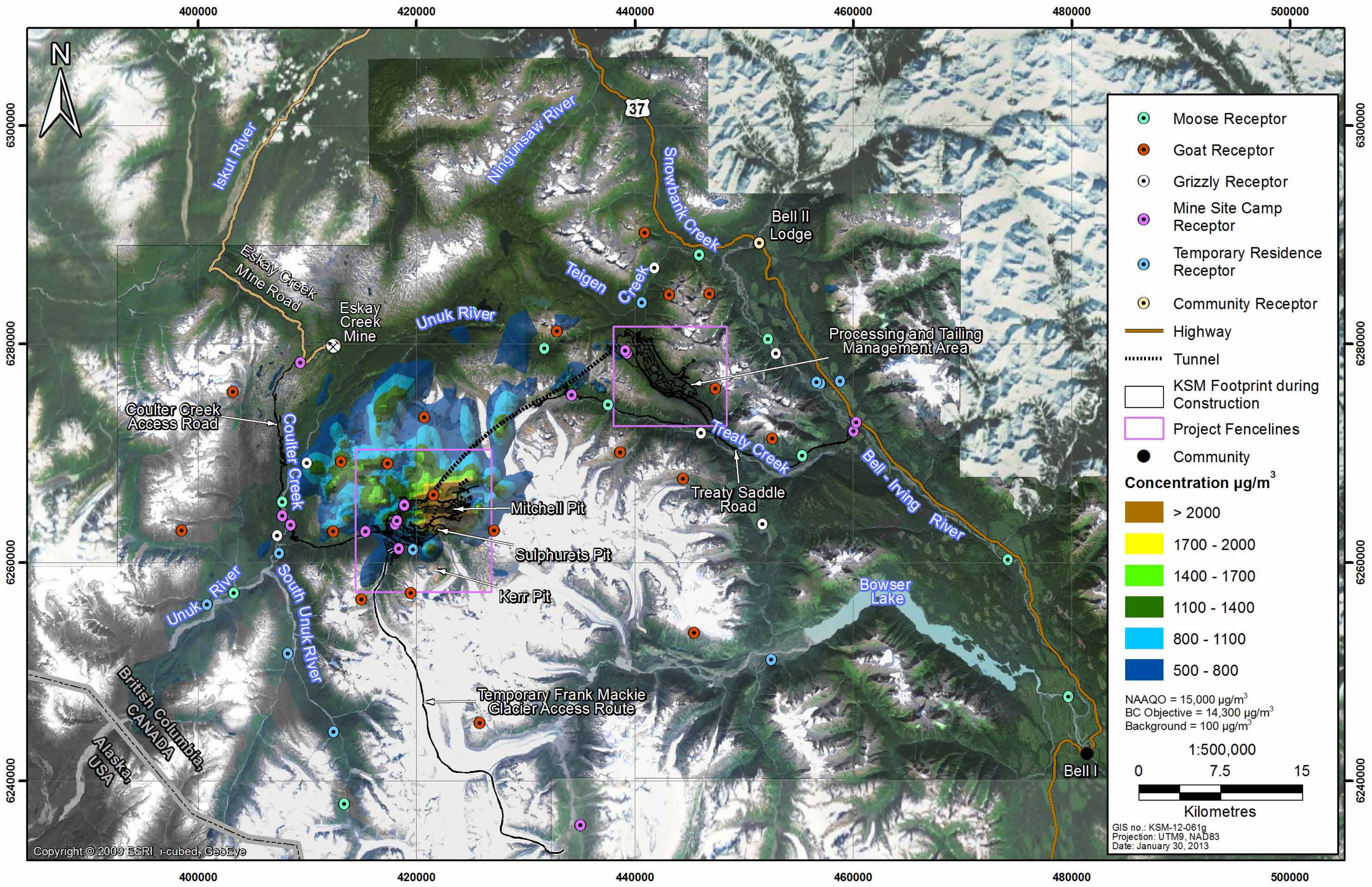

Figure 7.8-11

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Maximum 1-Hour CO Concentration during Construction

Figure 7.8-11

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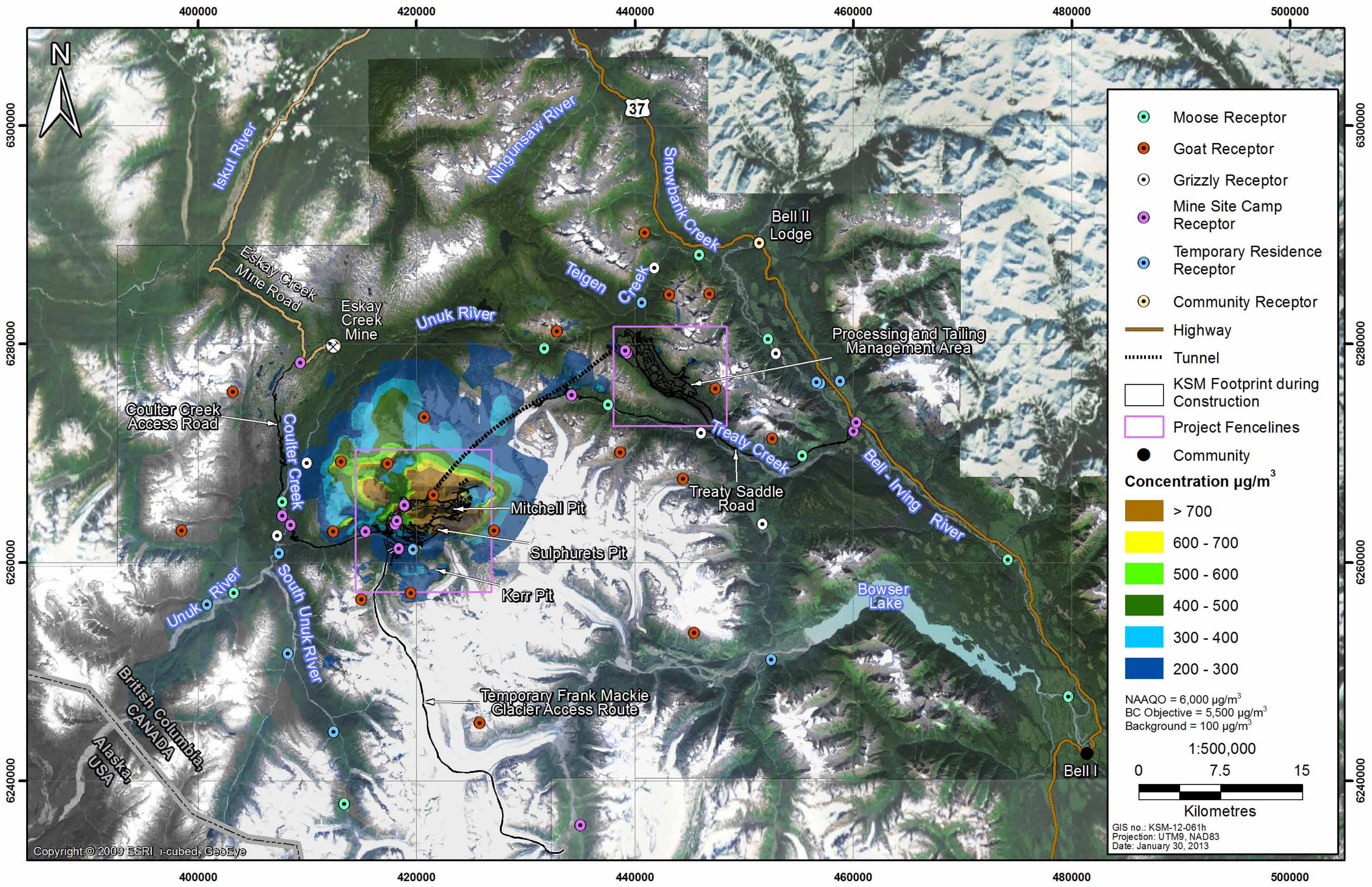

Figure 7.8-12

Maximum 8-Hour CO Concentration during Construction

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7.8.3.2.4 Total Suspended Particulate

The dust from fuel combustion and fugitive dust from movement of material was modelled separately. This allows the results to be shown separately, as fugitive dust emission factors have a lower confidence level. The TSP results from non-fugitive sources, fugitive sources, and total, which is the two types combined, are shown in Table 7.8-21.

The highest maximum 24-hour total TSP concentration is 180 μg/m^3 including background. This value is higher than the BC objective of 150 μg/m^3 and NAAQO of 120 μg/m^3. The highest 24-hour total TSP occurred on the east of the PTMA fenceline, but only exceeded once in the year. The area north of the Saddle Area exceeded the NAAQO six times. (Figure 7.8-13). This is equivalent to approximately 1.6% of the time that this area exceeded the criteria shown in Table 7.8-22; however, the BC objective was only exceeded twice in a year which is 0.5% of the time. The results showed that the majority of the dust is from fugitive sources, which has higher uncertainty in the emission estimation and is less of a health concern. The area that was predicted to exceed the criteria is only 750 m in diameter and is immediately north of the Saddle Area. An area that extends to 1 km out from the PTMA fenceline also predicted exceedances over the NAAQO, but even less frequently than the area by the Saddle. No sensitive receptor was predicted to have exceedances over the Canadian objective. The concentrations reach 50% of the NAAQO of 120 μg/m^3 at a distance of approximately 10 km from the sources or 3.4 km from the Project fenceline.

The highest annual total TSP for the Project was predicted to be 41 μg/m^3, which is approximately 70% of the criteria (Figure 7.8-14). The annual total TSP contour reaches 15 μg/m^3, which is 25% of the national and BC objective, approximately 3 km outside the fenceline.

7.8.3.2.5 PM_{10}

Fugitive PM_{10} was also modelled separately from non-fugitive sources since fugitive sources have much higher uncertainties. The highest maximum 24-hour PM_{10} concentration for non-fugitive sources was 25 μg/m^3, while the highest for fugitive PM_{10} was 56 μg/m^3. For both non-fugitive and fugitive sources, the highest value for a sensitive receptor occurred at the goat receptor by the MTT on the mine side. This is expected due to the proximity of this receptor to the sources (Table 7.8-23). The highest total PM_{10} 24-hour maximum was predicted to be 64 μg/m^3, including background of 3.4 μg/m^3 and exceeded the BC objective of 50 μg/m^3. The area of exceedance is immediately north of the Saddle Area with a radius of less than 300 m, and an area that is 700 m beyond the east edge of the PTMA fenceline. The exceedance was predicted to occur twice in one year, which is equivalent to 0.5% of the time (Table 7.8-24). The total PM_{10}, the majority of which consists of fugitive dust, reaches half of the BC objective of 50 μg/m^3 at distances of approximately 12 and 3 km from the Project fenceline (Figure 7.8-15).

7.8.3.2.6 $PM_{2.5}$

The highest maximum 24-hour $PM_{2.5}$ concentration for non-fugitive sources was predicted to be 14 μg/m^3, while the highest value predicted for fugitive sources was 16 μg/m^3. The highest total $PM_{2.5}$ predicted was 27 μg/m^3, which is higher than the BC objective of 25 μg/m^3, but lower than the Canada-wide standard of 30 μg/m^3 (Table 7.8-25). The highest 24-hour total $PM_{2.5}$ was predicted on the fenceline by the Saddle Area and does not go beyond the fenceline (Figure 7.8-16). The BC objective of 25 μg/m^3 was predicted to be exceeded nine times in one year, which is 2.5% of the time (Table 7.8-26); however, no exceedances over the Canada-wide standard of 30 μg/m^3 were predicted.

Table 7.8-21. Maximum TSP Concentrations during Construction

		Concentrations (µg/m^3)											
					Maximum Predicted Concentrations from KSM Project								
		Criteria			Non-fugitive			Fugitive			Total (Non-fugitive + Fugitive)		
Pollutant	Averaging Period	NAAQOs	BC Objectives	Background	Project	Project + Background	Sensitive Receptor + Background	Project	Project + Background	Sensitive Receptor + Background	Project	Project + Background	Sensitive Receptor + Background
TSP	24-hour	120	150	10	21	31	81	161	171	112	170	180	119
	Annual	60	60	10	4	14	22	27	37	24	31	41	27

Note: bold indicates exceedance over criteria.

Table 7.8-22. Frequency of Exceedance for Total TSP during Construction

Pollutant	Averaging Period	Number of Exceedances	Frequency of Exceedances per Year
Total TSP	24-hour	6	1.6%
	Annual	-	-

Note: Dash (-) indicates information not applicable.

Table 7.8-23. Maximum PM$_{10}$ Concentrations during Construction

		Concentrations (µg/m^3)											
		Criteria			Maximum Predicted Concentrations from Project								
					Non-fugitive			Fugitive			Total (Non-fugitive + Fugitive)		
Pollutant	Averaging Period	NAAQO	BC Objective	Background	Project	Project + Background	Sensitive Receptor + Background	Project	Project + Background	Sensitive Receptor + Background	Project	Project + Background	Sensitive Receptor + Background
PM$_{10}$	24-hour	-	50	3.4	21	25	66	52	56	39	61	64	69

Note: bold indicates exceedance over criteria.

Table 7.8-24. Frequency of Exceedance for Total PM$_{10}$ during Construction

Pollutant	Averaging Period	Number of Exceedances	Frequency of Exceedances per Year
Total PM$_{10}$	24-hour	2	0.5%

Note: Dash (-) indicates information not applicable.

Table 7.8-25. Maximum PM$_{2.5}$ Concentrations during Construction

		Concentrations (µg/m^3)											
		Criteria			Maximum Predicted Concentrations from Project								
					Non-fugitive			Fugitive			Total (Non-fugitive + Fugitive)		
Pollutant	Averaging Period	Canada-wide Standard	BC Objectives	Background	Project	Project + Background	Sensitive Receptor + Background	Project	Project + Background	Sensitive Receptor + Background	Project	Project + Background	Sensitive Receptor + Background
PM$_{2.5}$	24-hour	30a	25b	1.3	13	14	46	14	16	4	26	27	46
	Annual	-	8c	1.3	3.9	5.2	11	4.4	5.7	1.9	8.3	9.6	11.5

Note: bold indicates exceedance over criteria.
a Annual 98th percentile value, averaged over three consecutive years. Canada Wide Standard published by CCME.
b Based on annual 98th percentile value.
c BC objective of 8 µg/m^3 and planning goal of 6 µg/m^3 were established in 2009.

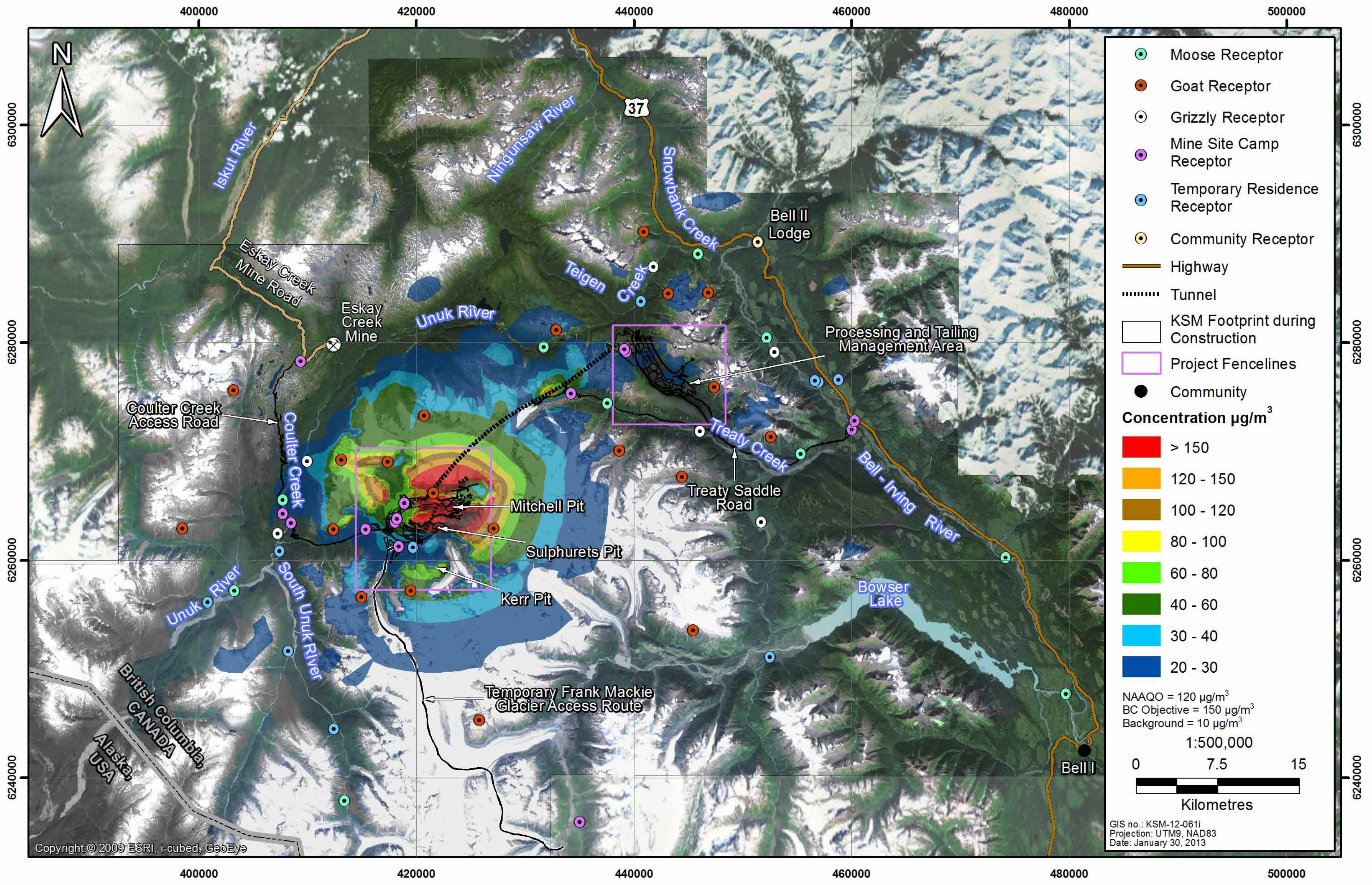

Figure 7.8-13

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Maximum 24-Hour Total TSP Concentration during Construction

Figure 7.8-13

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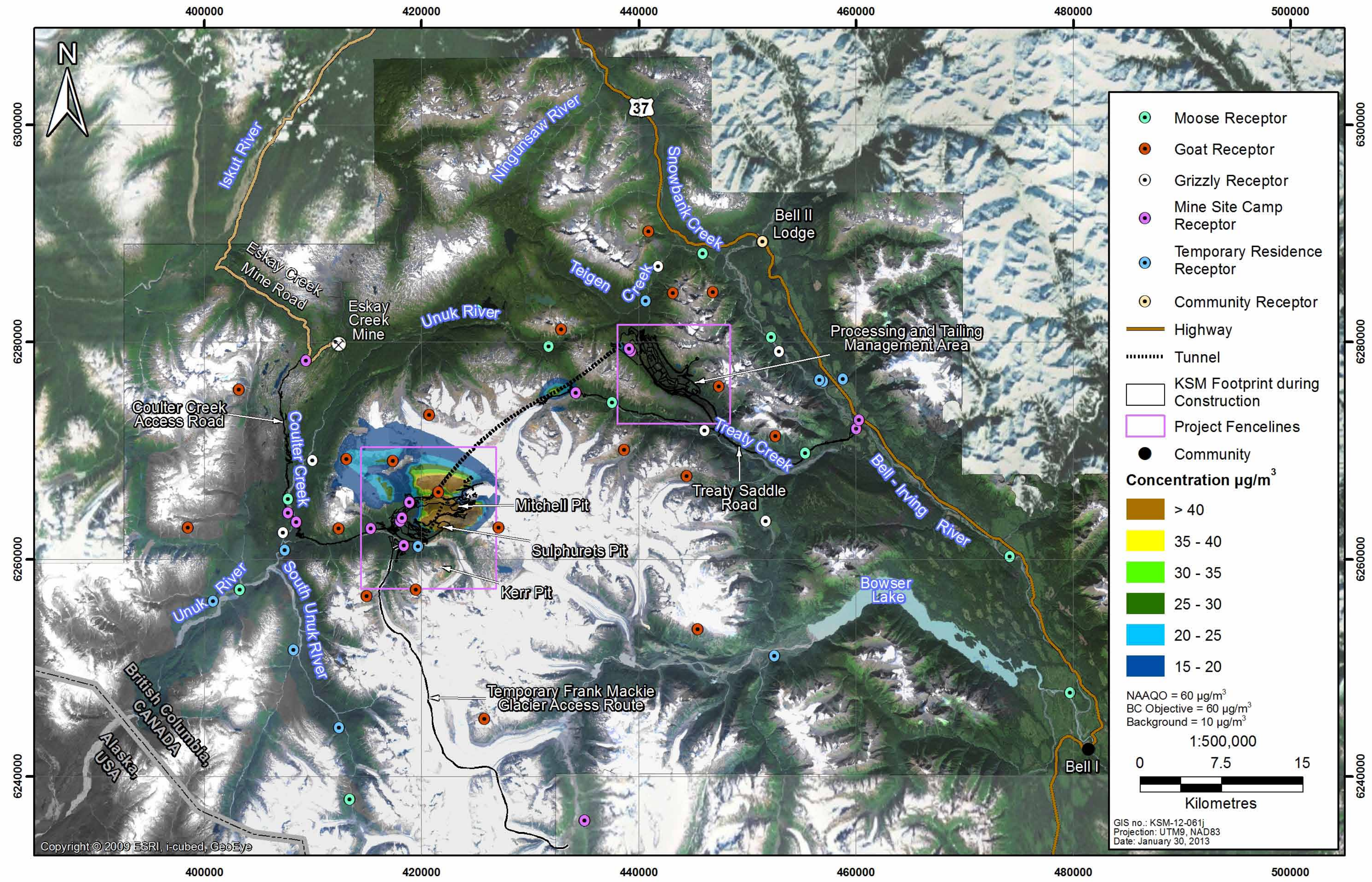

Figure 7.8-14

SEABRIDGE GOLD
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Annual Total TSP Concentration during Construction

Figure 7.8-14

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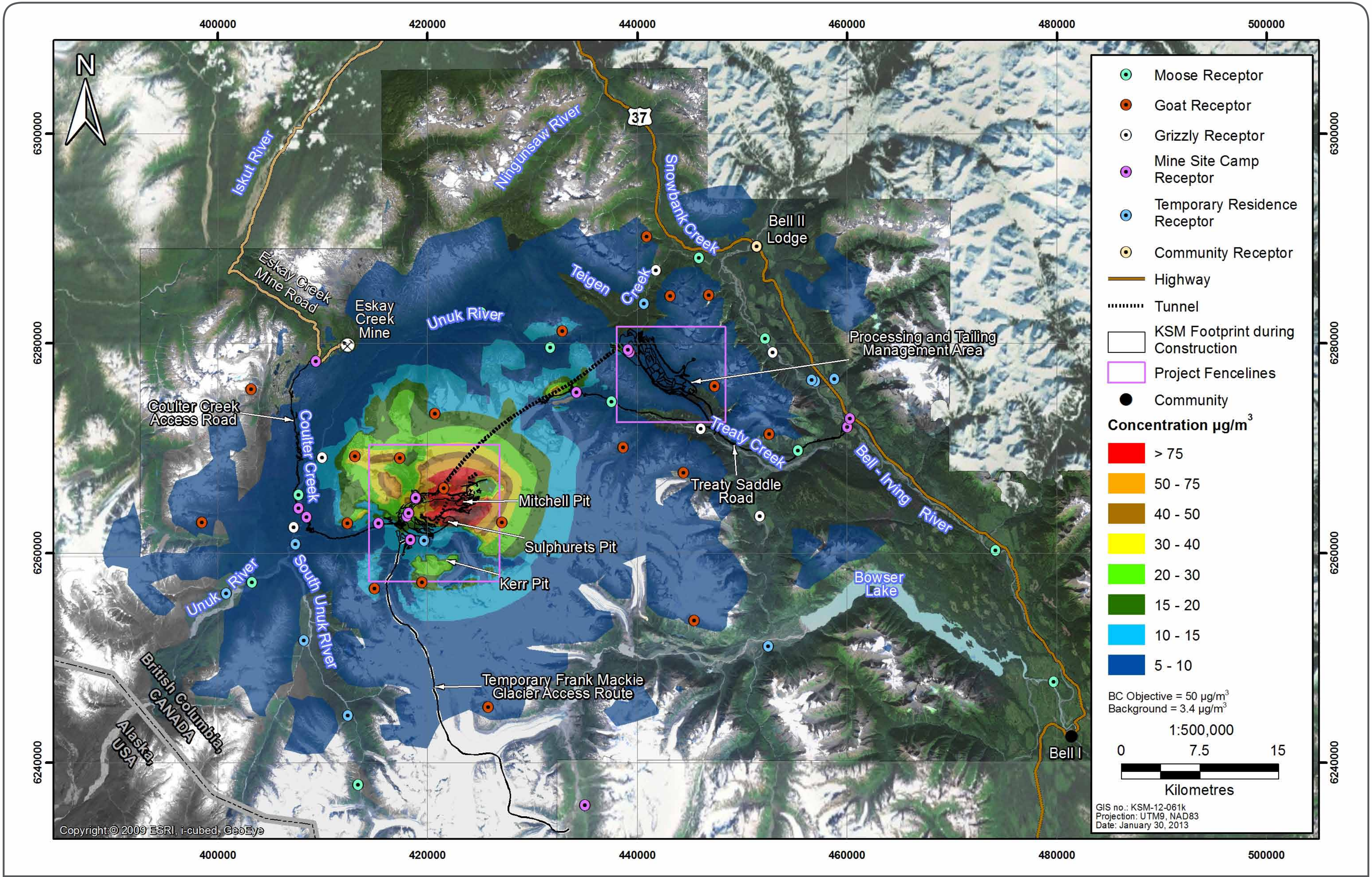

Figure 7.8-15

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Maximum 24-Hour Total PM_{10} Concentration during Construction

Figure 7.8-15

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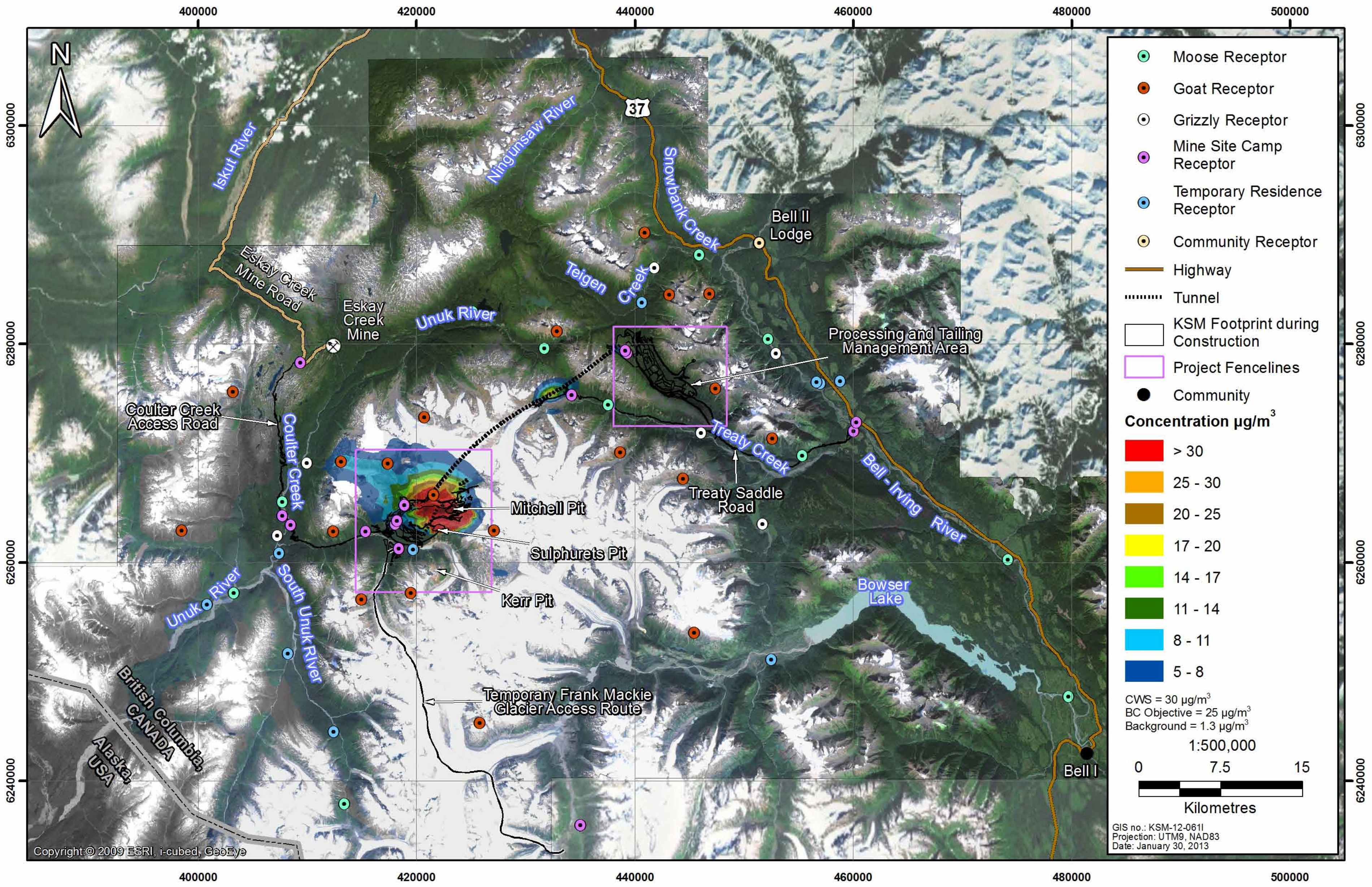

Figure 7.8-16

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Maximum 24-Hour Total $PM_{2.5}$ Concentration during Construction

Figure 7.8-16

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Table 7.8-26. Frequency of Exceedance for Total $PM_{2.5}$ during Construction

Pollutant	Averaging Period	Number of Exceedances	Frequency of Exceedances per Year
Total $PM_{2.5}$	24-hour	9	2.5%
	Annual	-	-

Note: Dash (-) indicates information not applicable.

The annual $PM_{2.5}$ concentration from non-fugitive sources was predicted to be 5.2 µg/m^3, while the annual $PM_{2.5}$ concentration from fugitive sources was predicted to be 5.7 µg/m^3. The highest annual total $PM_{2.5}$ concentration was predicted to be 9.6 µg/m^3, which is higher than the BC objective of 8 µg/m^3; however, the exceedance was only predicted in an area by the Saddle where MTT construction will take place, and the area extends less than 450 m out from the Saddle Area. The concentration decreases rapidly as distance increases from the Saddle Area. The concentration reaches 4 µg/m^3, which is half of the BC objective, at a distance of 600 m from the Saddle Area fenceline (Figure 7.8-17).

7.8.3.2.7 Dust Deposition

Dust deposition was modelled from fugitive dust sources, and the deposition results are shown in Table 7.8-27. The Project's highest 30-day dust deposition was predicted to be 1.3423 mg/dm^2/day with background of 1.34 mg/dm^2/day. This is lower than the more stringent BC objective of 1.7 mg/dm^2/day, which is often interpreted as the objective for residential areas. The dust deposition rate was predicted to be the highest in the area by the Saddle Area due to the close proximity to the MTT construction (Figure 7.8-18). This area is at a higher elevation than the Mine Site. With the dominant wind from the southeast, the dust from the mining activities tends to be blown away and deposited at the higher elevation area northwest of the mine. However, the Project's contribution of dust deposition is minimal compared to the provincial objective or baseline levels.

Table 7.8-27. Maximum 30-day Dust Deposition during Construction

		Deposition Rate (mg/dm^2/day)					
		Criteria			Maximum Predicted Deposition Rate from Project		
Pollutant	Averaging Period	NAAQO	BC Objective	Background	Project	Project + Background	Sensitive Receptor + Background
Dust Deposition	30-day	-	1.7 to 2.9	1.34	0.0023	1.3423	1.3414

7.8.3.2.8 Acid Deposition

The acid deposition baseline levels were calculated from sulphate and nitrate concentrations based on their acidity equivalencies (Environment Canada 2004). The Project's highest modelled acid deposition rate was 125.18 eq/ha/year, which includes a background of 125 eq/ha/year (Table 7.8-28). The highest annual acid deposition at sensitive receptors, occurred on the goat receptor by the MTT on the mine side, where diesel equipment is expected to be operating (Figure 7.8-19). The Project contribution of acid deposition is considered minimal compared to the baseline or the BC median critical load.

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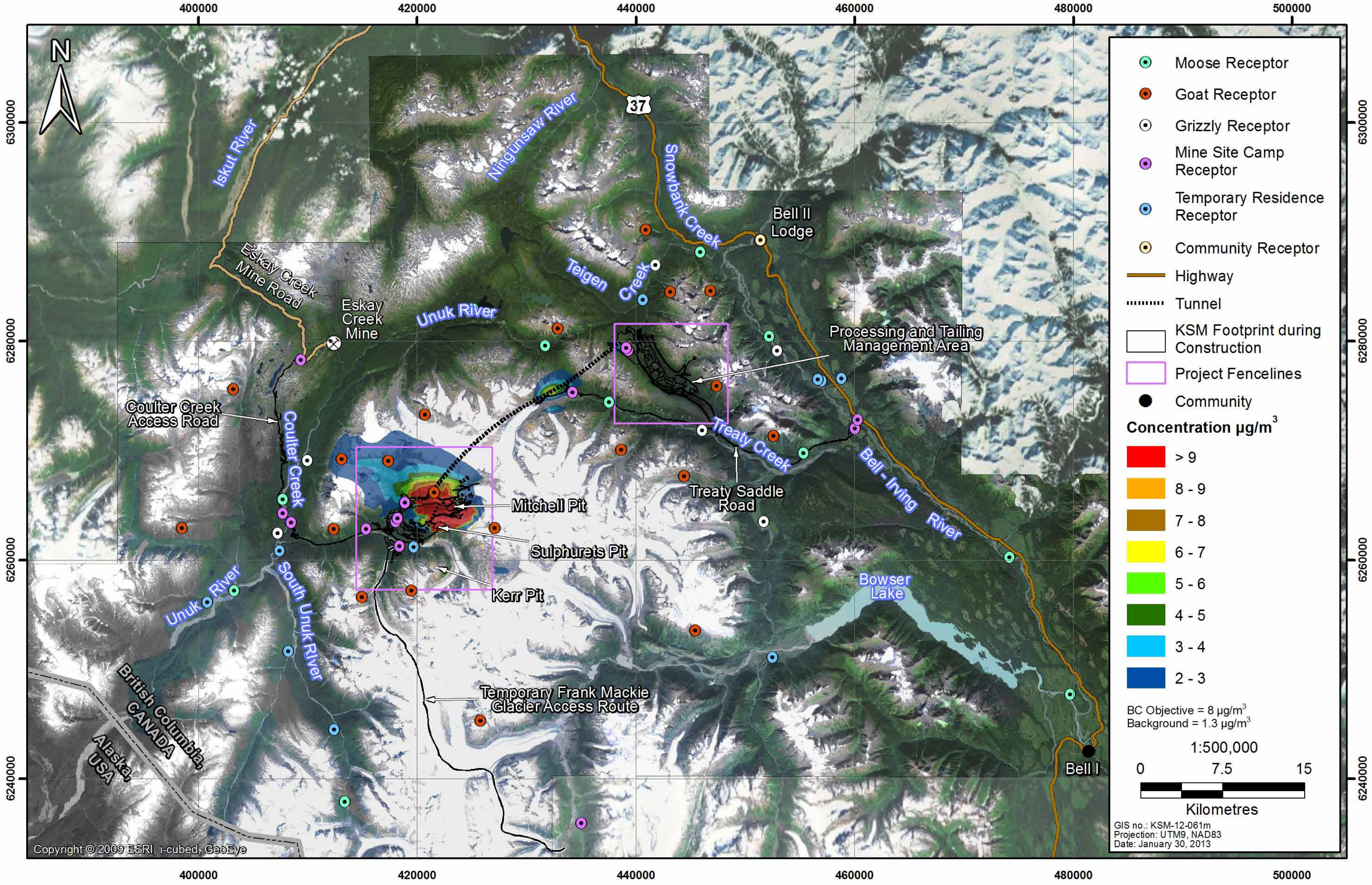

Figure 7.8-17

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Annual Total $PM_{2.5}$ Concentration during Construction

Figure 7.8-17

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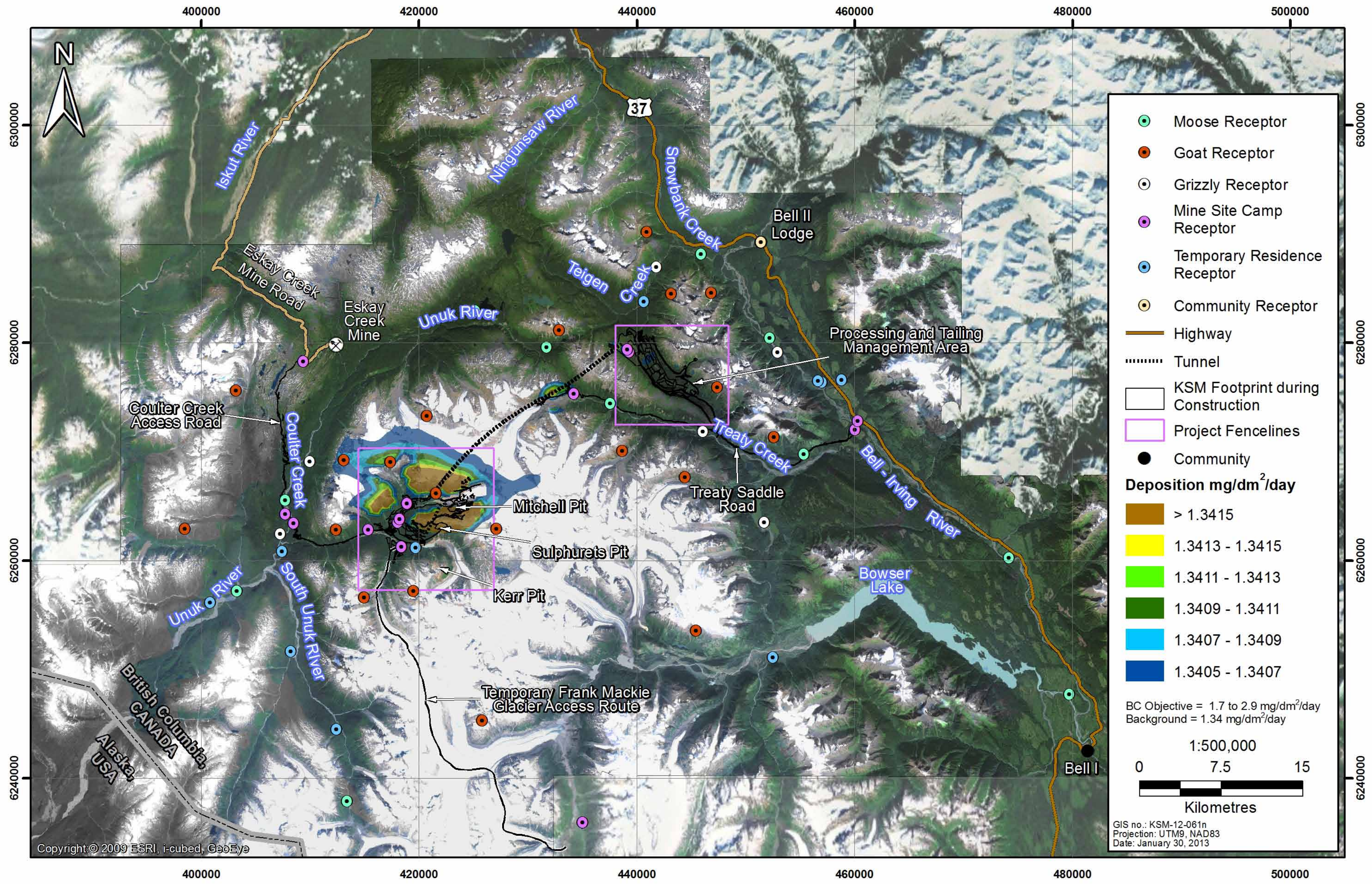

Figure 7.8-18

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Maximum 30-day Dust Deposition during Construction

Figure 7.8-18

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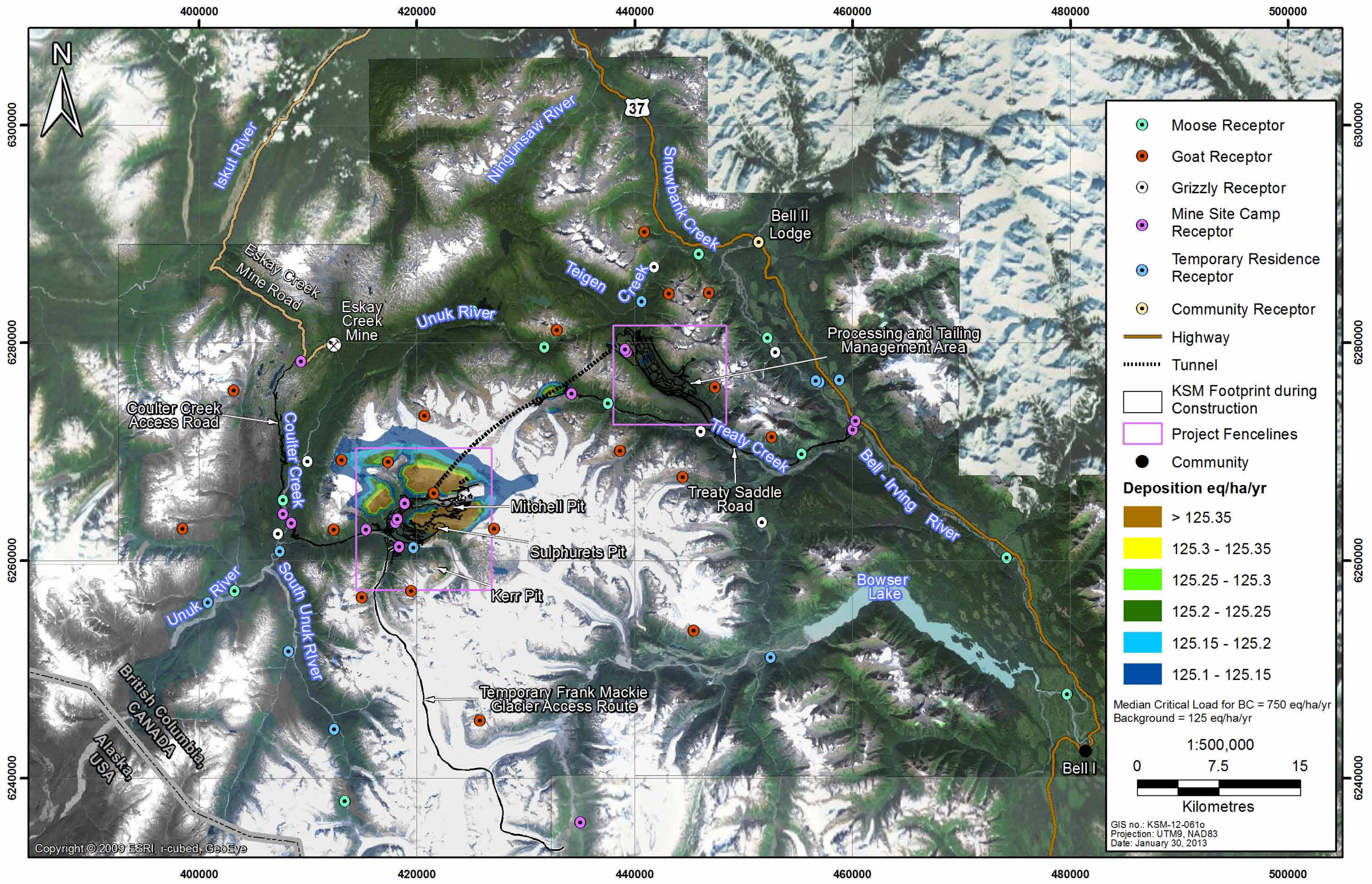

Figure 7.8-19

SEABRIDGE GOLD
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Annual Acid Deposition during Construction

Figure 7.8-19

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Table 7.8-28. Annual Acid Deposition during Construction

		Acid Deposition (eq/ha/year)				
				Maximum Predicted Deposition Rate from KSM Project		
Pollutant	**Averaging Period**	**Median Critical Load for BC**	**Background**	**Project**	**Project + Background**	**Sensitive Receptor + Background**
Acid Deposition	Annual	750	125	0.18	125.18	125.32

7.8.3.2.9 Summary for Construction Phase

The air quality dispersion model results for the construction phase are summarized in Table 7.8-29, with the relevant federal and provincial criteria.

7.8.3.3 Air Quality Modelling Results – Operation

7.8.3.3.1 Sulphur Dioxide

The dispersion model results for SO_2 during the operation phase are summarized in Table 7.8-30. The highest one-hour maximum SO_2 concentration is 39 µg/m^3, which includes a background of 4 µg/m^3 and is less than 10% of the NAAQO and BC objective. Concentration of 10 µg/m^3, which is approximately 2% of the criteria, extends 8 km out from the Mine Site fenceline (Figure 7.8-20).

The highest 24-hour SO_2 concentration of 12 µg/m^3 is 8% of the Canadian standard. The 10 µg/m^3 concentration, which is approximately 7% of the Canadian standard, does not extend beyond 5 km from the Mine Site fenceline, while the 5 µg/m^3 concentration, which is approximately 3% of the NAAQO, does not extend beyond 10 km from the Mine Site fenceline (Figure 7.8-21).

The highest annual SO_2 concentration is predicted to be 2.8 µg/m^3 outside the Project fenceline and 3 µg/m^3 at a goat receptor north of the McTagg RSF. The 2.5 µg/m^3 concentration contour is within 2.5 km from the Mine Site fenceline (Figure 7.8-22).

7.8.3.3.2 Nitrogen Dioxide

The maximum concentrations for NO_2 are summarized in Table 7.8-31. The highest one-hour maximum concentration outside the Project fenceline was predicted to be 160 µg/m^3 and the highest one-hour maximum concentration predicted at sensitive receptors is 170 µg/m^3, which occurred on a goat receptor by the MTT on the mine side (Figure 7.8-23). The highest predicted one-hour concentrations are less than half of the NAAQO maximum acceptable standard of 400 µg/m^3.

The highest 24-hour maximum concentration of 92 µg/m^3 occurred outside the fenceline (Figure 7.8-24). The 75 µg/m^3 concentration contour, which is 25% of the NAAQO, extends approximately 5.5 km north from the Mine Site fenceline. The highest 24-hour NO_2 concentration at sensitive receptors was predicted to be 102 µg/m^3, and occurred at the goat receptor by the MTT on the mine side.

Table 7.8-29. Summary of Construction Results

Pollutant	Averaging Period	Concentrations ($\mu g/m^3$), Dust Deposition Rate ($mg/dm^2/day$), and Acid Deposition Rate (eq/ha/year)						
		Criteria		Background	Maximum Predicted Concentrations or Deposition Rate from Project			
		Federal	Provincial		Project	Project + Background	Number of Exceedances	Percent of Exceedances
SO_2	1-hour	450	450	4	29	33	-	-
	24-hour	150	160	4	7	11	-	-
	Annual	30	25	2	0.6	2.6	-	-
NO_2	1-hour	400	-	21	802	823	4	0.05%
	24-hour	200	-	21	130	151	-	-
	Annual	60	-	5	68	73	-	-
CO	1-hour	15,000	14,300	100	2036	2136	-	-
	8-hour	6,000	5,500	100	604	704	-	-
Total TSP	24-hour	120	150	10	170	180	6	1.6%
	Annual	60	60	10	31	41	-	-
Total PM_{10}	24-hour	-	50	3.4	61	64	2	0.5%
Total $PM_{2.5}$	24-hour	30a	25b	1.3	26	27	9	2.5%
	Annual	-	8c	1.3	8.3	9.6	-	-
Dust Deposition	30-day	-	1.7 to 2.9	1.34	0.0023	1.3423	-	-
Acid Deposition	Annual	-	250	125	0.18	125.18	-	-

Note: boldface indicates exceedances.

Dash (-) indicates information not applicable.

a Annual 98th percentile value, averaged over three consecutive years. Canada Wide Standard published by CCME.

b Based on annual 98th percentile value.

c BC objective of 8 $\mu g/m^3$ and planning goal of 6 $\mu g/m^3$ were established in 2009.

Table 7.8-30. Maximum SO_2 Predicted Concentrations for Operation

		Concentrations (µg/m^3)					
		Criteria			Maximum Predicted Concentrations from Project		
Pollutant	Averaging Period	NAAQOs	BC Objectives	Background	Project	Project + Background	Sensitive Receptor + Background
SO_2	1-hour	450	450	4	35	39	32
	24-hour	150	160	4	8	12	12
	Annual	30	25	2	1	2.8	3

Table 7.8-31. Maximum NO_2 Concentrations for Operation

		Concentrations (µg/m^3)					
		Criteria			Maximum Predicted Concentrations from Project		
Pollutant	Averaging Period	NAAQOs	BC Objectives	Background	Project	Project + Background	Sensitive Receptor + Background
NO_2	1-hour	400	-	21	139	160	170
	24-hour	200	-	21	71	92	102
	Annual	60	-	5	11	16	52

The highest annual NO_2 concentration of 16 µg/m^3 outside the Project fenceline, which is approximately 27% of the NAAQO maximum desirable standard, was predicted on the Mine Site fenceline immediately west of the McTagg RSF area (Figure 7.8-25). A higher maximum concentration was predicted at a goat receptor by the MTT on the Mine Site with a concentration of 52 µg/m^3.

7.8.3.3.3 Carbon Monoxide

The CO dispersion model results, shown in Table 7.8-32, are lower than the NAAQO and BC objectives for both averaging periods. The maximum one-hour CO concentration predicted outside the Project fenceline is 1,499 µg/m^3, and occurred at an area northeast of the Mine fenceline (Figure 7.8-26). The 500 µg/m^3 contour, which is approximately 3.5% of the criteria, does not extend beyond approximately 15 km from the sources or 11 km from the fenceline.

Table 7.8-32. Maximum CO Concentrations for Operation

		Concentrations (µg/m^3)					
		Criteria			Maximum Predicted Concentrations from Project		
Pollutant	Averaging Period	NAAQOs	BC Objectives	Background	Project	Project + Background	Sensitive Receptor + Background
CO	1-hour	15,000	14,300	100	1,399	1,499	1,223
	8-hour	6,000	5,500	100	679	779	601

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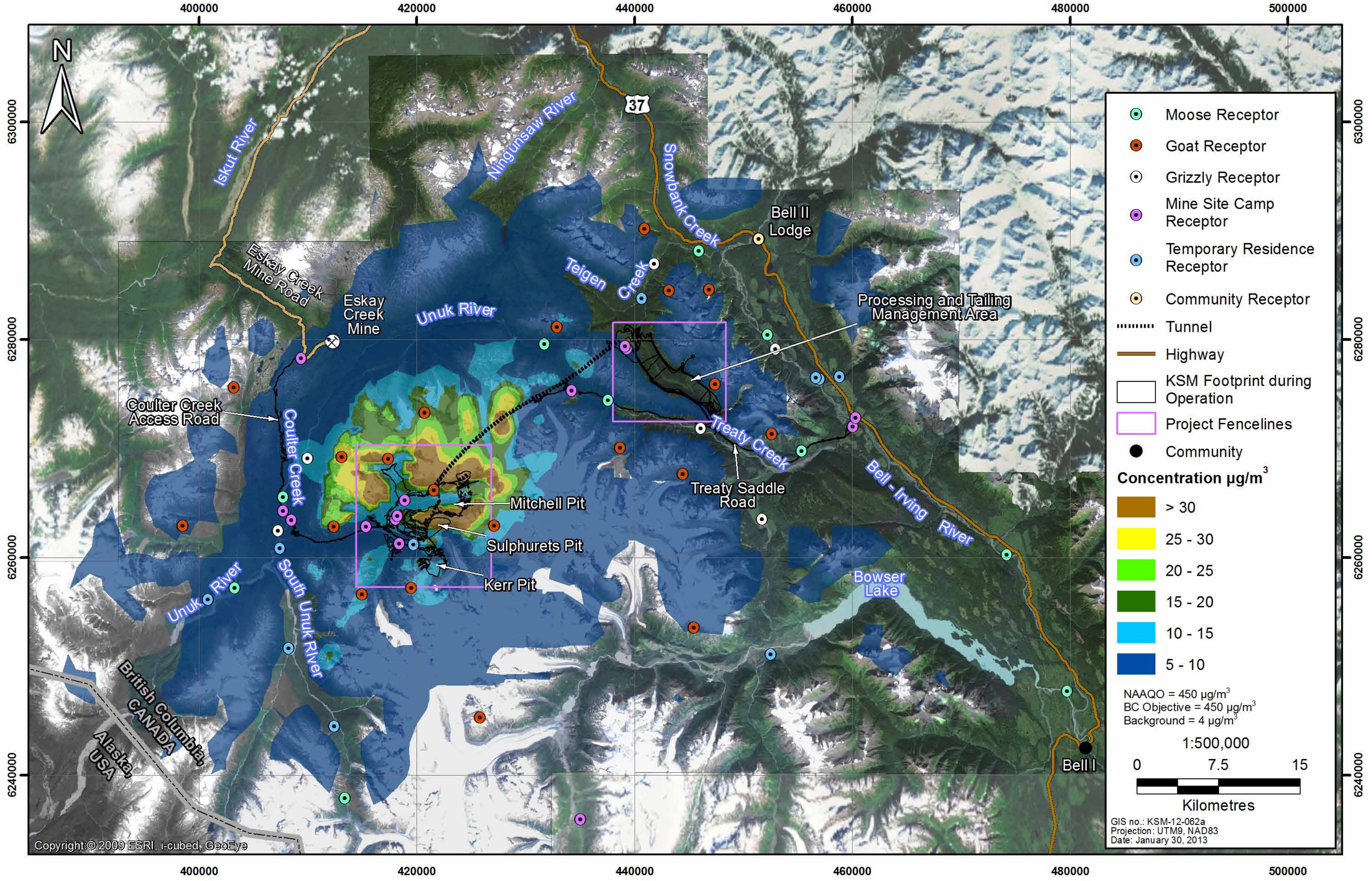

Figure 7.8-20

Maximum 1-Hour SO_2 Concentration during Operation

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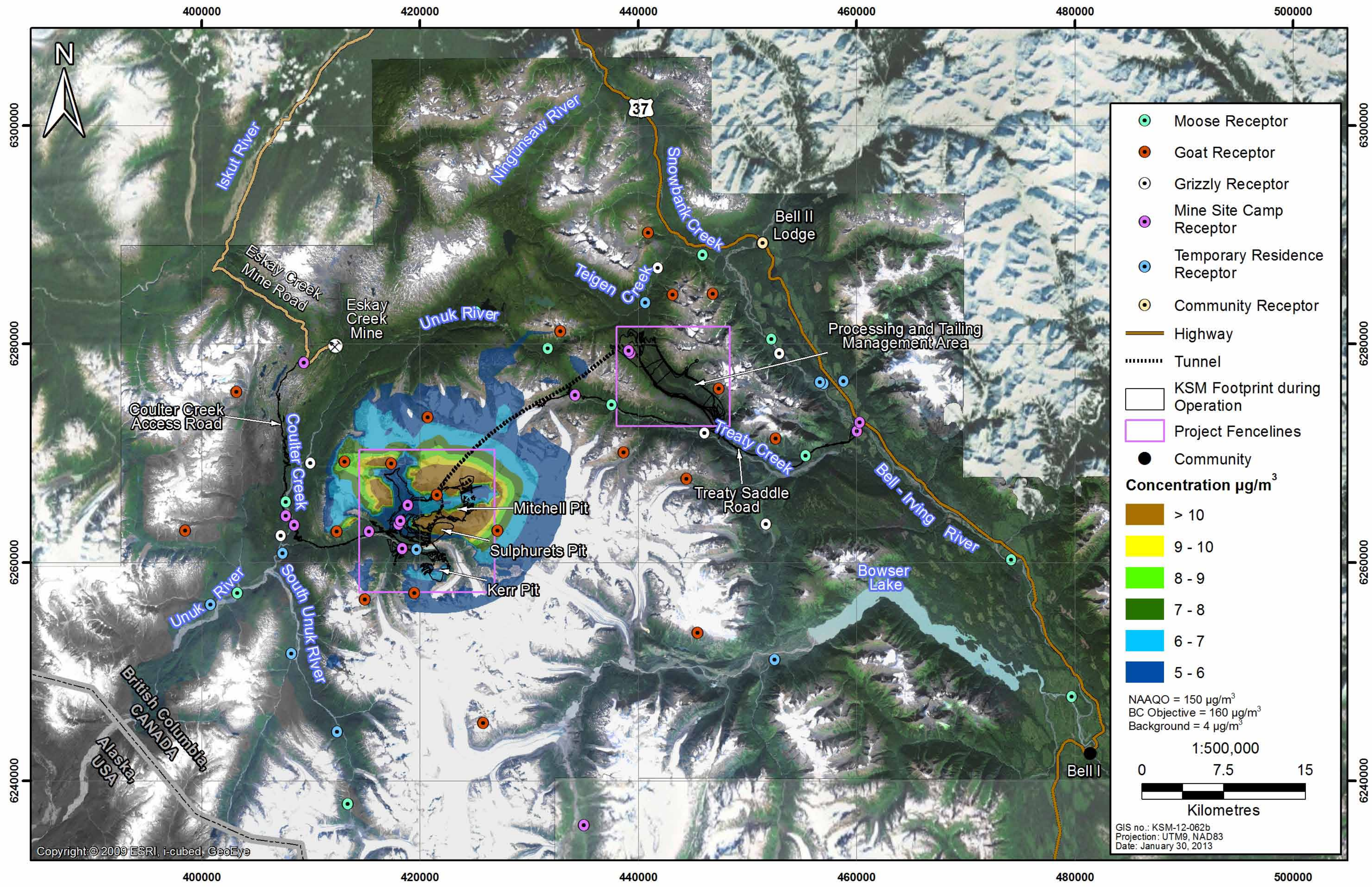

Figure 7.8-21

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Maximum 24-Hour SO_2 Concentration during Operation

Figure 7.8-21

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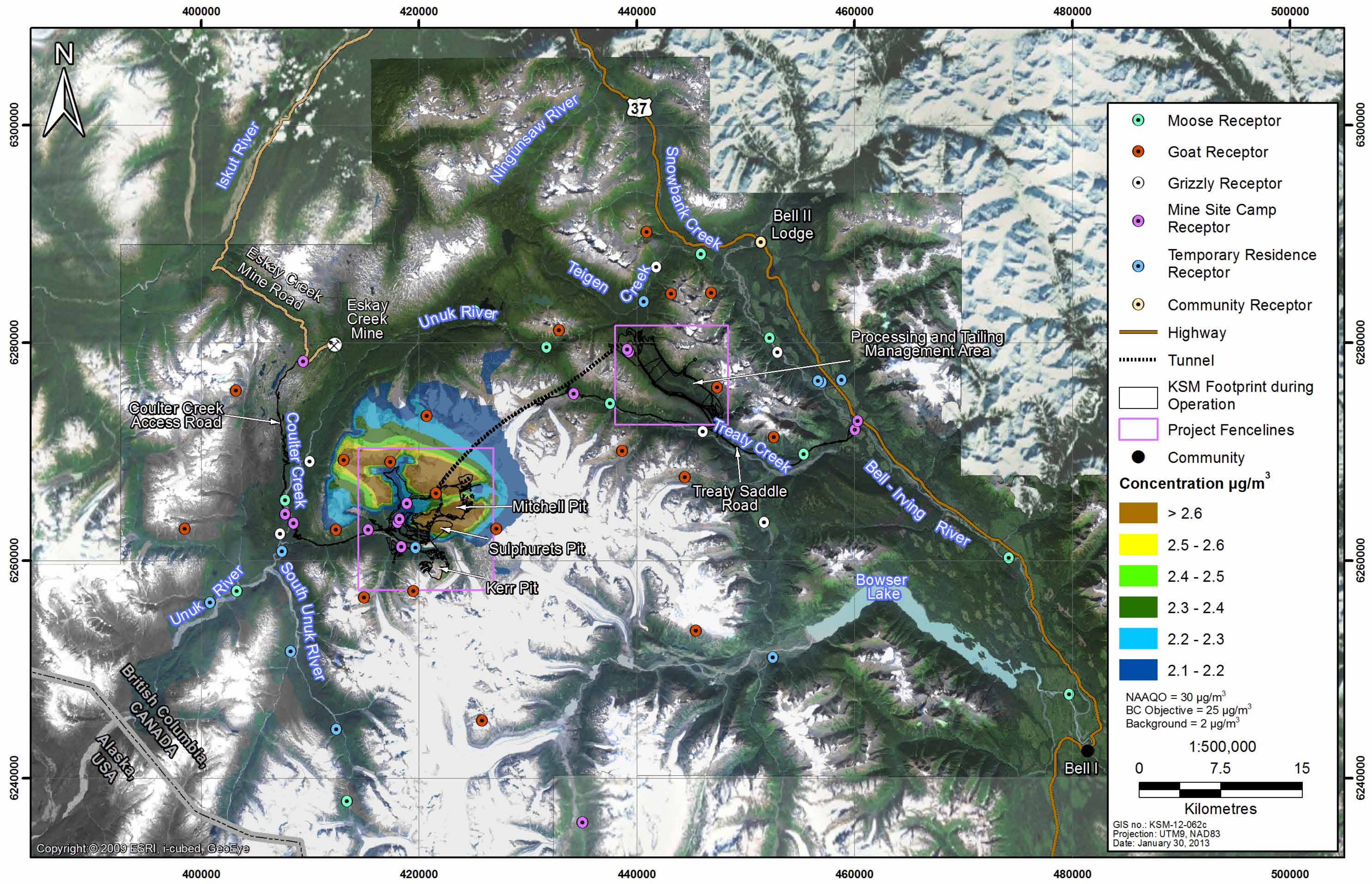

Figure 7.8-22

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Annual Average SO_2 Concentration during Operation

Figure 7.8-22

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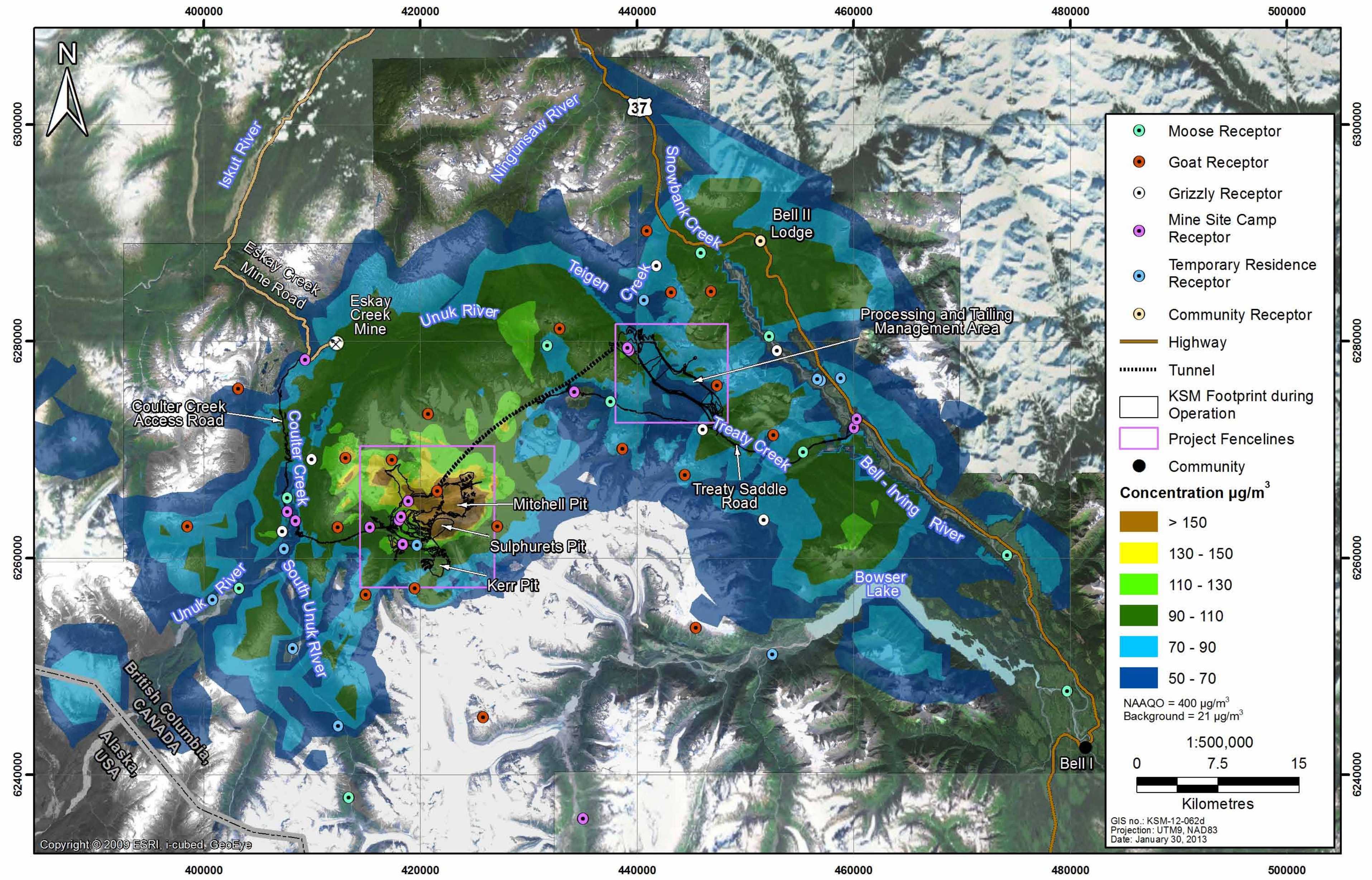

Figure 7.8-23

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Maximum 1-Hour NO_2 Concentration during Operation

Figure 7.8-23

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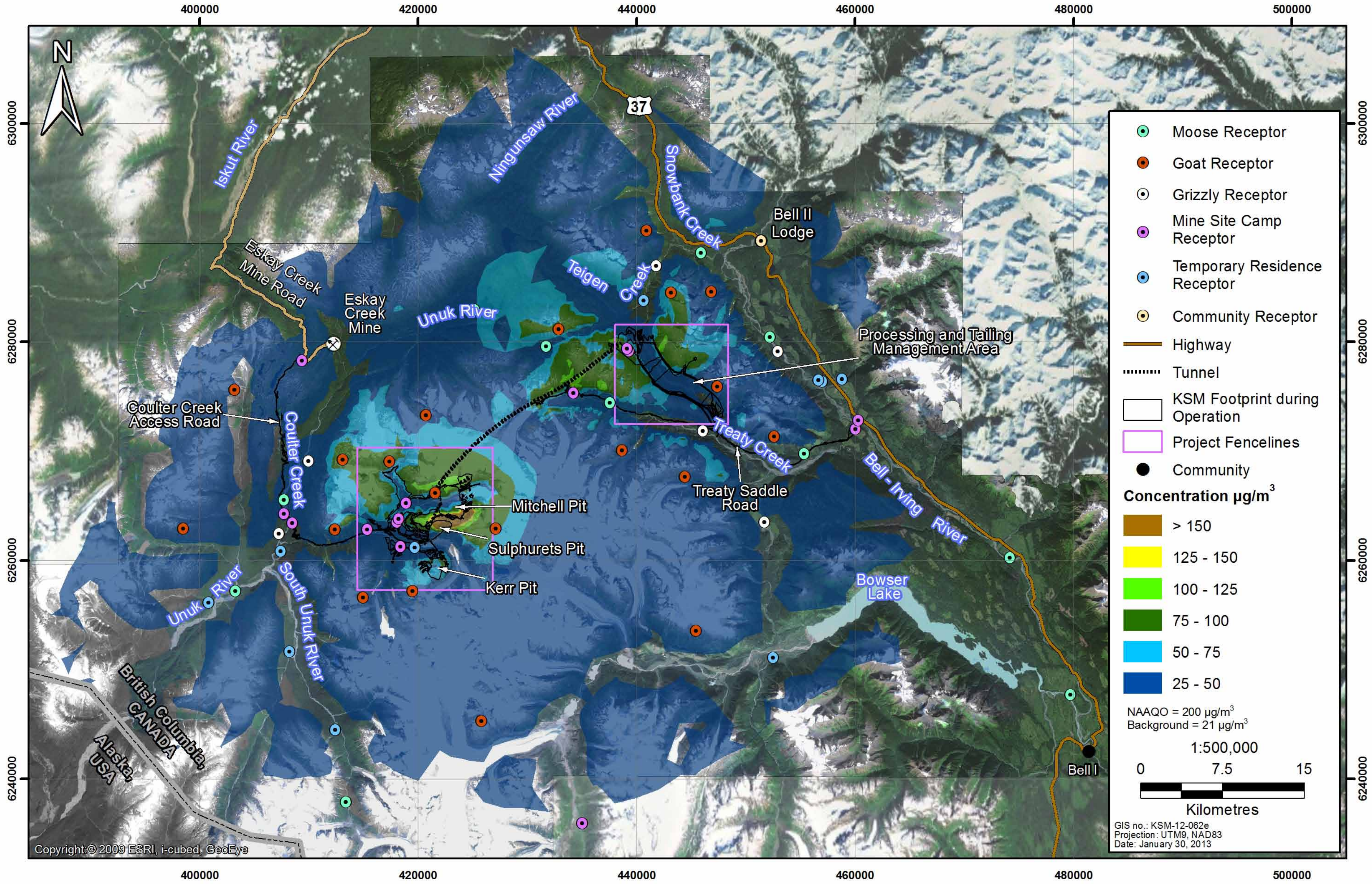

Figure 7.8-24

Figure 7.8-24

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Maximum 24-Hour NO_2 Concentration during Operation

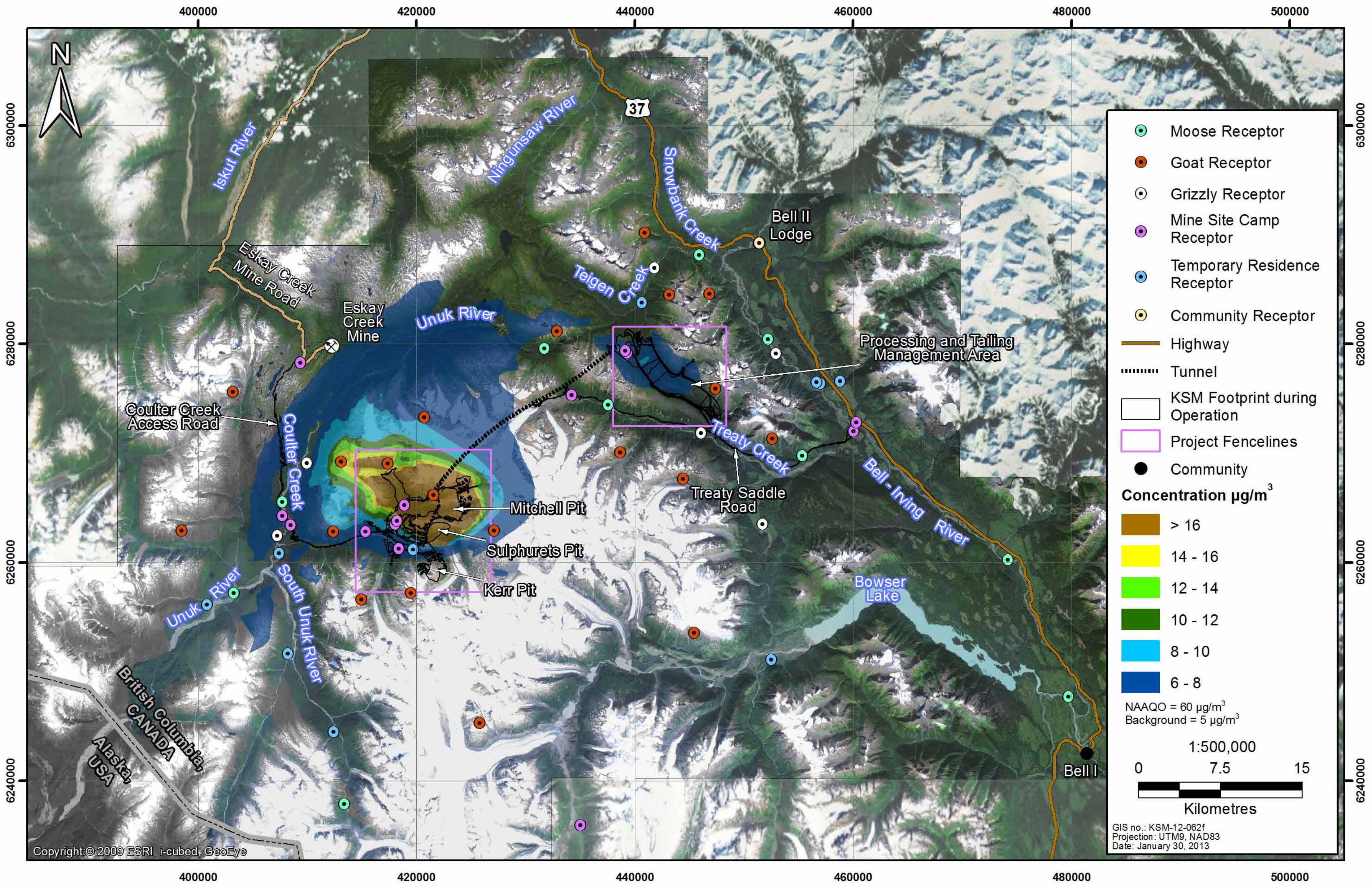

Figure 7.8-25

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Annual Average NO_2 Concentration during Operation

Figure 7.8-25

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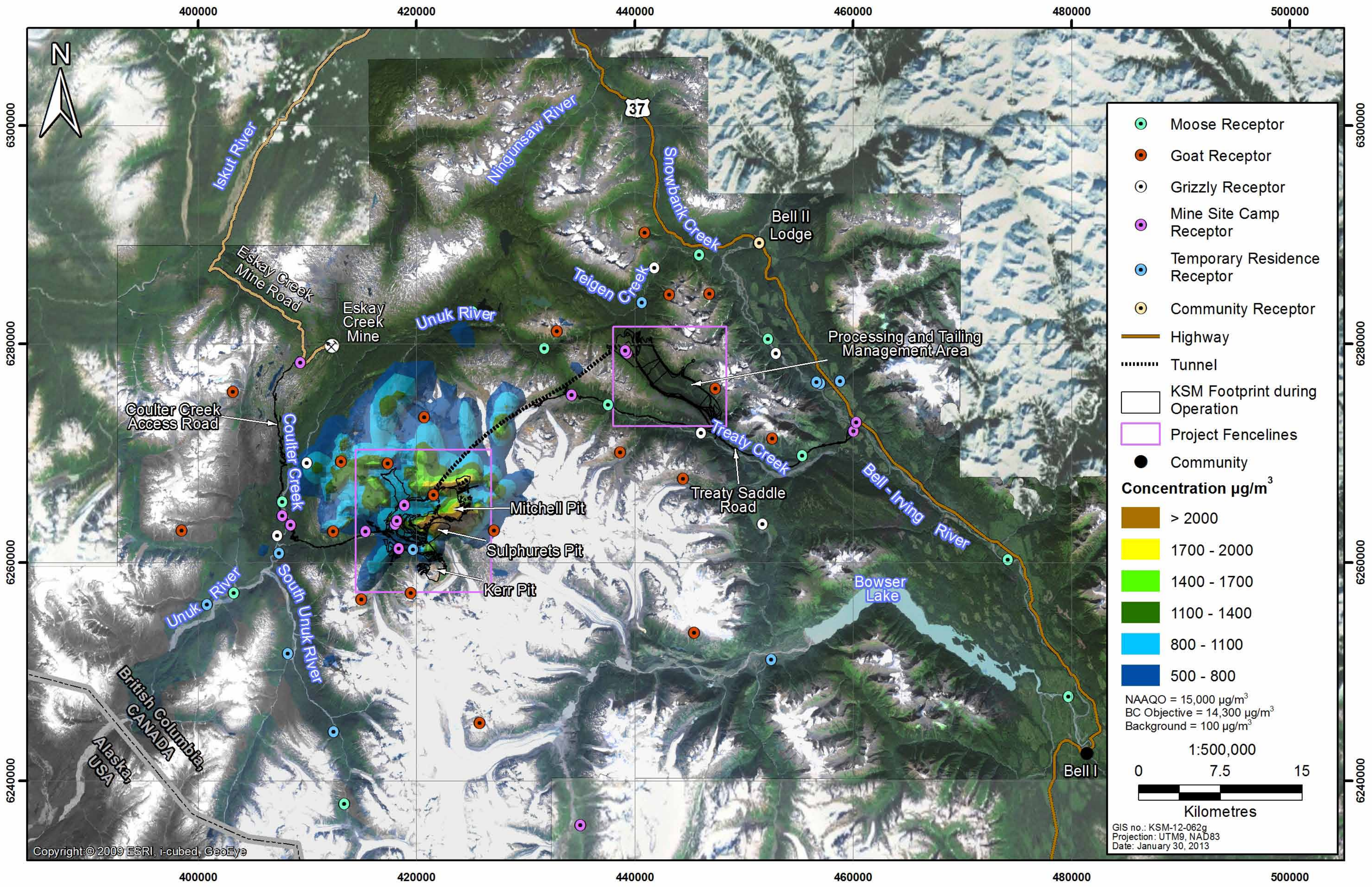

Figure 7.8-26

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Maximum 1-Hour CO Concentration during Operation

Figure 7.8-26

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The highest eight-hour CO concentration of 779 $\mu g/m^3$ occurred on the west side of the PTMA fenceline (Figure 7.8-27). The highest eight-hour CO concentration is only 14% of the criteria. The 200 $\mu g/m^3$ concentration contour, which is less than 4% of the criteria, extends to less than 15 km from the sources or 9.5 km beyond the Project fenceline.

7.8.3.3.4 Total Suspended Particulate

The particulate sources were modelled separately in two different runs based on source type. As mentioned earlier, this allows the distinction between the fugitive and non-fugitive sources since there are higher uncertainties associated with fugitive sources. The maximum 24-hour non-fugitive TSP concentration was predicted to be 26 $\mu g/m^3$, while the maximum for fugitive dust was predicted to be 289 $\mu g/m^3$, which exceeds both the Canadian standard of 120 $\mu g/m^3$ and BC objective of 150 $\mu g/m^3$. The total TSP, which is the sum of the two sources, indicates the highest value was predicted to be 295 $\mu g/m^3$, including background of 10 $\mu g/m^3$ (Table 7.8-33). Exceedances can be found in areas north and west of the McTagg RSF where the elevation is higher. The area of exceedances extends less than 4 km (Figure 7.8-28). Exceedances are also predicted in areas east of the PTMA fenceline where elevation is also higher than that of the sources. Although the highest 24-hour total TSP is higher than the federal and provincial criteria, the more stringent NAAQO of 120 $\mu g/m^3$ was only exceeded three times in the modelled year, which is less than 1% of the time (Table 7.8-34). The 40 $\mu g/m^3$ concentration contour, which is 33% of the NAAQO, does not extend beyond approximately 10 km from the Project fencelines.

The highest annual non-fugitive concentration was predicted to be 11 $\mu g/m^3$, while the highest concentrations for fugitive dust were predicted to be 30 $\mu g/m^3$, both including background of 10 $\mu g/m^3$. The highest annual total TSP was predicted to be 31 $\mu g/m^3$ on the west of the Mine fenceline (Figure 7.8-29). The highest annual total TSP at sensitive receptors occurred at the same goat receptor by MTT on the mine side, where mining activities will take place.

7.8.3.3.5 PM_{10}

The highest 24-hour PM_{10} concentration for non-fugitives was predicted to be 13 $\mu g/m^3$, while for fugitives it was predicted to be 104 $\mu g/m^3$ (Table 7.8-35). The total PM_{10} concentration with the non-fugitive and fugitive sources combined was predicted to be 110 $\mu g/m^3$, which is higher than the BC objective of 50 $\mu g/m^3$. However, the objective was only exceeded twice in one year, which is equivalent to 0.5% of the time (Table 7.8-36). Exceedances were predicted north and west of the McTagg RSF and west and east of the PTMA fenceline extending approximately 2 km out from the fenceline (Figure 7.8-30). The 15 $\mu g/m^3$ concentration contour, which is 30% of the BC objective, does not extend beyond 15 km from the sources or 6 km from the Project fencelines.

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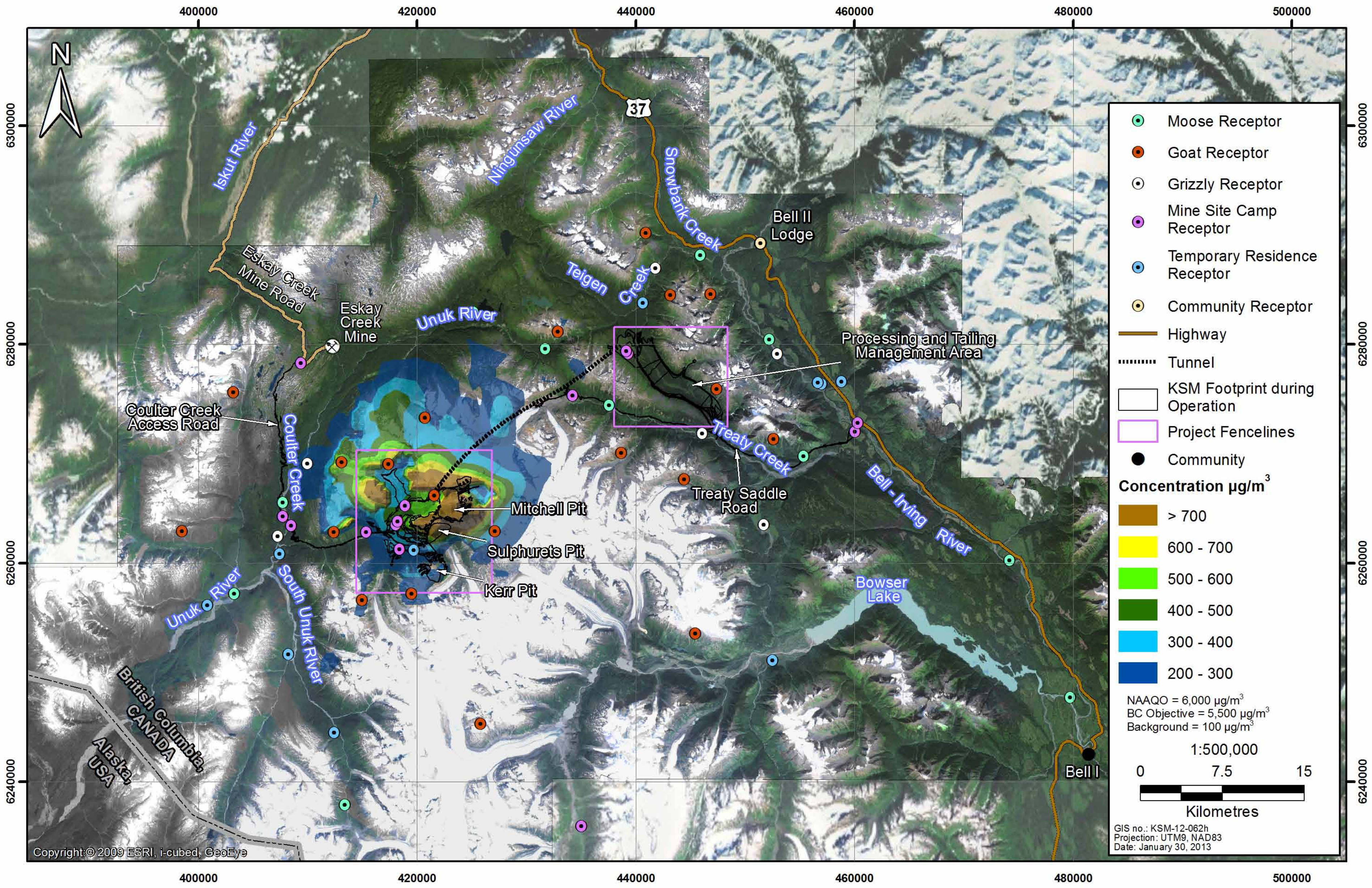

Figure 7.8-27

SEABRIDGE GOLD
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Maximum 8-Hour CO Concentration during Operation

Figure 7.8-27

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Table 7.8-33. Maximum TSP Concentrations during Operation

		Concentrations (µg/m³)											
		Criteria			Maximum Predicted Concentrations from Project								
					Non-fugitive			Fugitive			Total (Non-fugitive + Fugitive)		
Pollutant	Averaging Period	NAAQOs	BC Objectives	Background	Project	Project + Background	Sensitive Receptor + Background	Project	Project + Background	Sensitive Receptor + Background	Project	Project + Background	Sensitive Receptor + Background
TSP	24-hour	120	150	10	10	20	26	279	289	197	285	295	201
	Annual	60	60	10	1	11	13	20	30	35	21	31	36

Note: bold Tablesindicates exceedance over criteria.

Table 7.8-34. Frequency of Exceedance for Total TSP during Operation

Pollutant	Averaging Period	Number of Exceedances	Frequency of Exceedances per Year
Total TSP	24-hour	3	0.8%
	Annual	-	-

Note: Dash (-) indicates information not applicable.

Table 7.8-35. Maximum PM_{10} Concentrations during Operation

		Concentrations (µg/m³)											
		Criteria			Maximum Predicted Concentrations from Project								
					Non-fugitive			Fugitive			Total (Non-fugitive + Fugitive)		
Pollutant	Averaging Period	NAAQO	BC Objective	Background	Project	Project + Background	Sensitive Receptor + Background	Project	Project + Background	Sensitive Receptor + Background	Project	Project + Background	Sensitive Receptor + Background
PM_{10}	24-hour	-	50	3.4	10	13	19	101	104	77	107	110	81

Note: bold indicates exceedance over criteria.

Table 7.8-36. Frequency of Exceedance for Total PM_{10} during Operation

Pollutant	Averaging Period	Number of Exceedances	Frequency of Exceedances per Year
Total PM_{10}	24-hour	2	0.5%

Note: Dash (-) indicates information not applicable.

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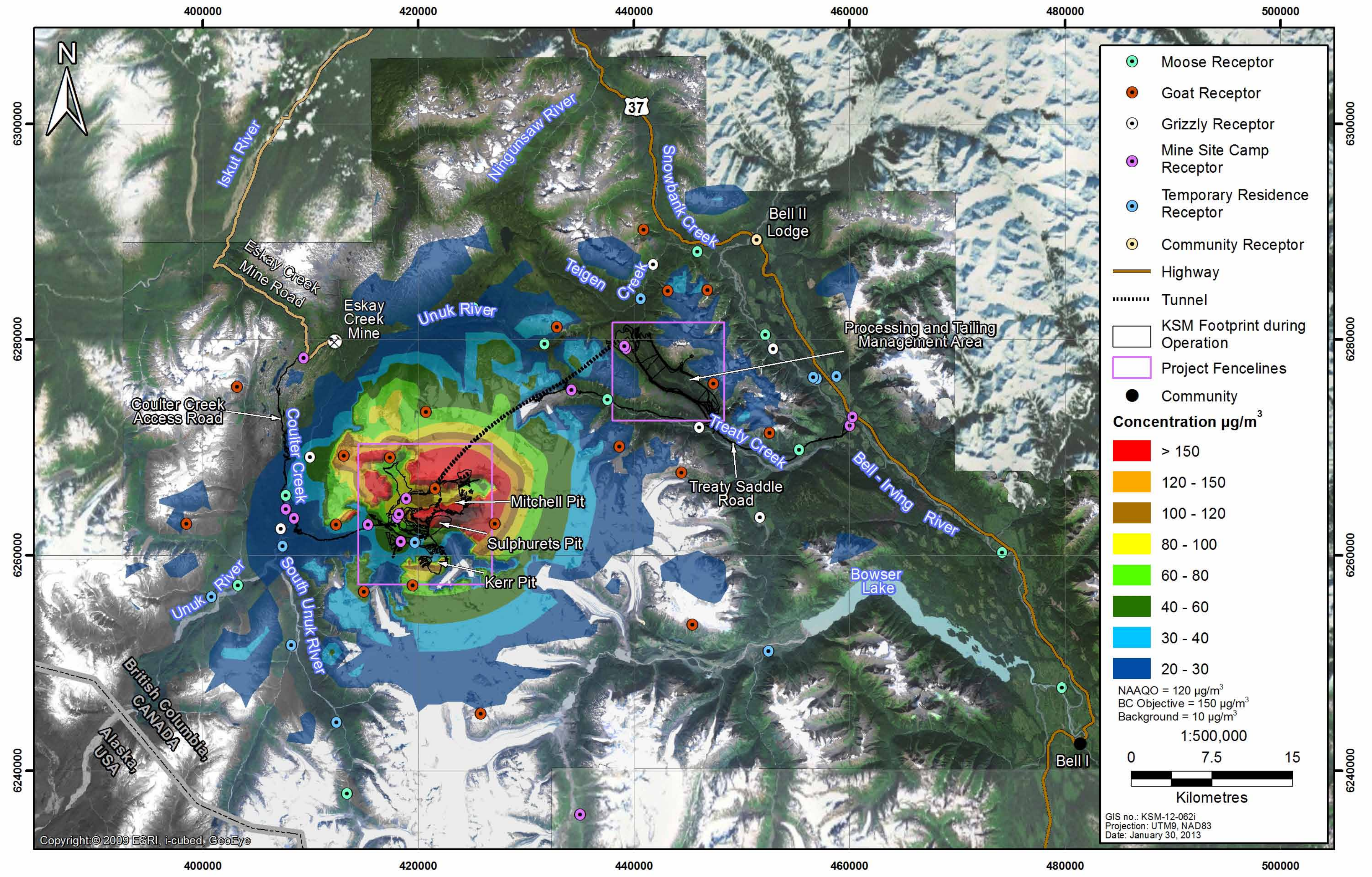

Figure 7.8-28

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Maximum 24-Hour Total TSP Concentration during Operation

Figure 7.8-28

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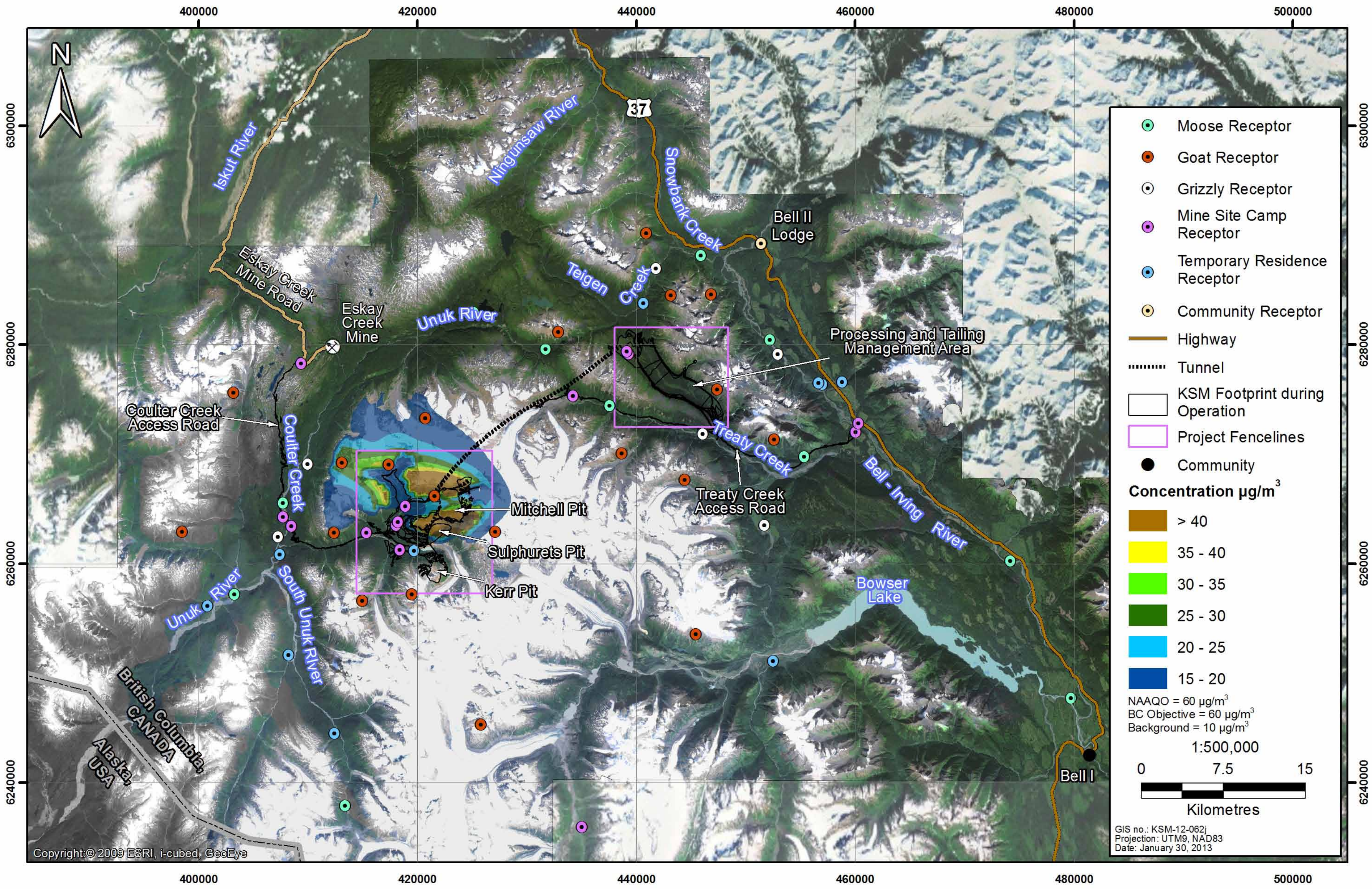

Figure 7.8-29

SEABRIDGE GOLD
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Annual Total TSP Concentration during Operation

Figure 7.8-29

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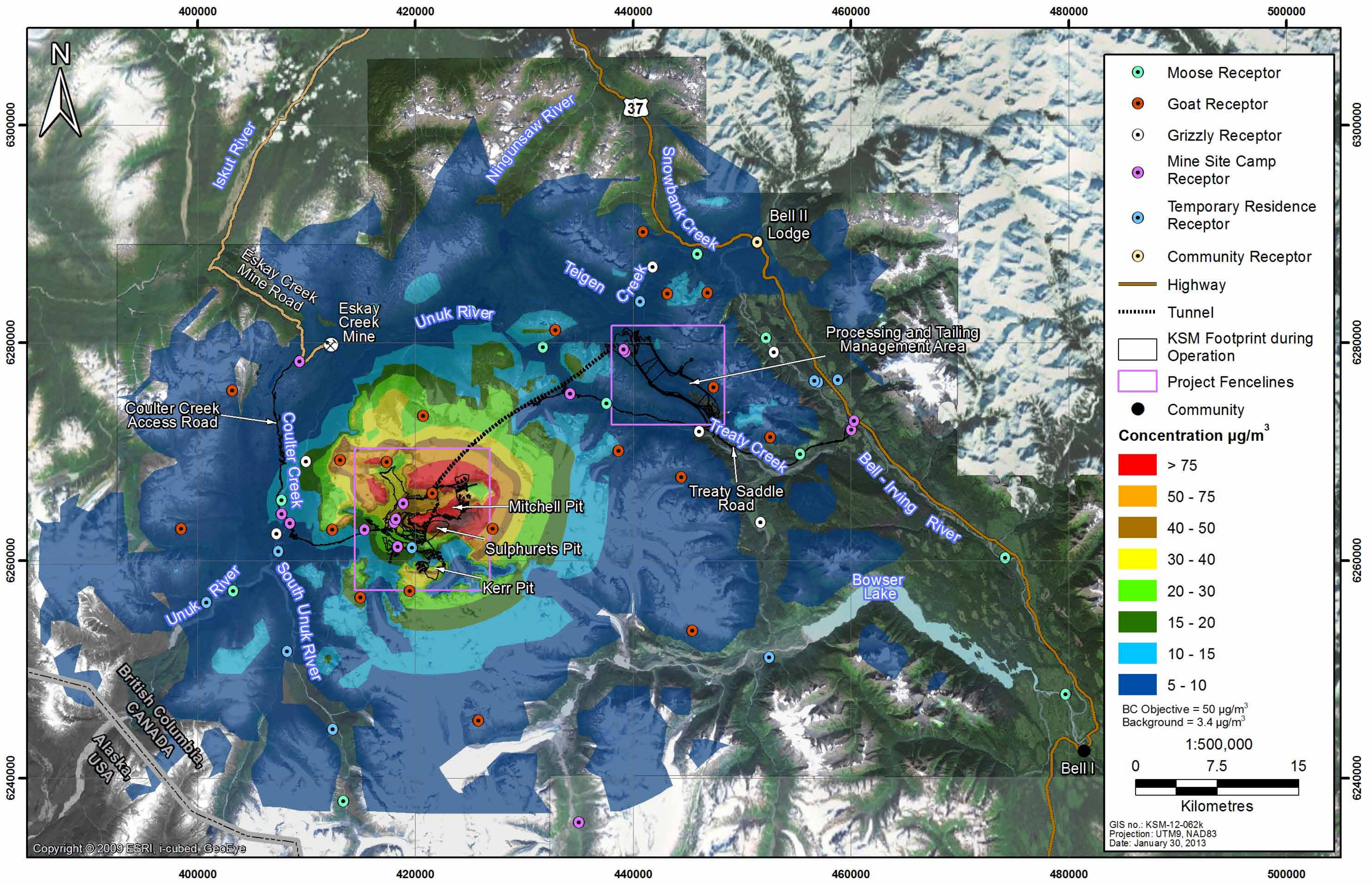

Figure 7.8-30

SEABRIDGE GOLD
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Maximum 24-Hour Total PM_{10} Concentration during Operation

Figure 7.8-30

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7.8.3.3.6 $PM_{2.5}$

The highest non-fugitive 24-hour $PM_{2.5}$ concentration was predicted to be 3 μg/m^3, while the highest for fugitive concentration was predicted to be 5 μg/m^3 (Table 7.8-37). The total combined $PM_{2.5}$ concentration was predicted to be 7 μg/m^3, which is less than 30% of the BC objective of 25 μg/m^3 (Figure 7.8-31). The highest value predicted at sensitive receptors was 13 μg/m^3 at the goat receptor by the MTT on the mine side. The maximum is about half of the BC objective. The 5 μg/m^3 concentration contour, which is 20% of the BC objective, does not extend beyond 10 km from the sources or 2.5 km from the Project fencelines.

The highest annual total $PM_{2.5}$ concentration was predicted to be 2.5 μg/m^3 including background of 1.3 μg/m^3. The highest value is 31% of the BC objective of 8 μg/m^3. Comparing to the BC's planning goal of 6 μg/m^3, the highest annual $PM_{2.5}$ is less than half of the planning goal. The concentration decreases to about 25% of the BC objective at about 10 km from the MTT, which is approximately 2.5 km from the PTMA fenceline (Figure 7.8-32).

7.8.3.3.7 Dust Deposition

The highest 30-day dust deposition rate of 1.3416 mg/dm^2/day (Table 7.8-38) occurred on the east fenceline of the PTMA (Figure 7.8-33). Aside from the fenceline, the highest dust deposition rate was predicted in areas west of the McTagg RSF due to the southeast dominant wind direction and the terrain of the area.

7.8.3.3.8 Acid Deposition

The baseline acid deposition was calculated from sulphate and nitrate concentrations based on their acidity equivalencies (Environment Canada 2004). The Project's highest acid modelled deposition rate of 125.48 eq/ha/year occurred north of the PTMA fenceline and included a background of 125 eq/ha/year (Table 7.8-39). The highest annual acid deposition at sensitive receptors occurred at the goat receptor by the MTT on the mine side where diesel equipment is expected to be operating (Figure 7.8-34). Comparing to the background of 125 eq/ha/year and the critical load median of 750 eq/ha/year, the Project's contribution is minimal.

7.8.3.3.9 Summary for Operation Phase

The dispersion model results during the operation phase are summarized in Table 7.8-40 with the relevant federal and provincial criteria.

7.9 Significance of Residual Air Quality Effects

7.9.1 Approach to Significance Determination

The significance of the residual effects of the Project are described in terms of magnitude, geographic extent, duration, frequency, reversibility, context, probability, and confidence. These terms are referred to as the effects assessment descriptors (Table 7.9-1) and these terms are used here to assess the significance of residual effects on air quality. The significance of the residual effects for air quality will be determined using the definition and logic in Table 7.9-1; however, professional judgment will also be used in determining the significance of the effect.

Table 7.8-37. Maximum $PM_{2.5}$ Concentrations during Operation

		Concentrations (µg/m^3)											
		Criteria			Maximum Predicted Concentrations from Project								
					Non-fugitive			Fugitive			Total (Non-fugitive + Fugitive)		
Pollutant	Averaging Period	Canada-wide Standard	BC Objectives	Background	Project	Project + Background	Sensitive Receptor + Background	Project	Project + Background	Sensitive Receptor + Background	Project	Project + Background	Sensitive Receptor + Background
$PM_{2.5}$	24-hour	30[a]	25[b]	1.3	2	3	11	4	5	6	6	7	13
	Annual	-	8[c]	1.3	0.4	1.7	4.2	0.8	2.1	2.3	1.2	2.5	4.6

Note: bold indicates exceedance over criteria.

[a] Annual 98th percentile value, averaged over three consecutive years. Canada-wide standard published by CCME.

[b] Based on annual 98th percentile value.

[c] BC objective of 8 µg/m^3 and planning goal of 6 µg/m^3 were established in 2009.

Table 7.8-38. Maximum 30-day Dust Deposition during Operation

		Deposition Rate (mg/dm^2/day)					
		Criteria			Maximum Predicted Deposition Rate from Project		
Pollutant	Averaging Period	NAAQO	BC Objective	Background	Project	Project + Background	Sensitive Receptor + Background
Dust Deposition	30-day	-	1.7 to 2.9	1.34	0.0016	1.3416	1.3425

Table 7.8-39. Annual Acid Deposition during Operation

		Acid Deposition (eq/ha/year)				
				Maximum Predicted Deposition Rate from Project		
Pollutant	Averaging Period	BC Critical Load	Background	Project	Project + Background	Sensitive Receptor + Background
Acid Deposition	Annual	750	125	0.48	125.48	125.69

Table 7.8-40. Summary of Operation Results

		Concentrations (μg/m^3), Dust Deposition Rate (mg/dm^2/day) and Acid Deposition Rate (eq/ha/year)						
		Criteria			Maximum Predicted Concentrations or Deposition Rate from Project			
Pollutant	**Averaging Period**	**Federal**	**Provincial**	**Background**	**Project**	**Project + Background**	**Number of Exceedances**	**Percent of Exceedances**
SO_2	1-hour	450	450	4	35	39	-	-
	24-hour	150	160	4	8	12	-	-
	Annual	30	25	2	1	2.8	-	-
NO_2	1-hour	400	-	21	139	160	-	-
	24-hour	200	-	21	71	92	-	-
	Annual	60	-	5	11	16	-	-
CO	1-hour	15,000	14,300	100	1,399	1,499	-	-
	8-hour	6,000	5,500	100	679	779	-	-
Total TSP	24-hour	120	150	10	285	295	3	0.8%
	Annual	60	60	10	21	31	-	-
Total PM_{10}	24-hour	-	50	3.4	107	110	2	0.5%
Total $PM_{2.5}$	24-hour	30a	25b	1.3	6.0	7.3	-	-
	Annual	-	8c	1.3	1.2	2.5	-	-
Dust Deposition	30-day	-	1.7 to 2.9	1.34	0.0016	1.3416	-	-
Acid Deposition	Annual	-	750	125	0.48	125.48	-	-

Note: boldface indicates exceedances.
Dash (-) indicates information not applicable.
a Annual 98th percentile value, averaged over three consecutive years. Canada Wide Standard published by CCME.
b Based on annual 98th percentile value.
c BC objective of 8 μg/m^3 and planning goal of 6 μg/m^3 were established in 2009.

PROJECT # 868-016-06 *GIS No.* KSM-12-062l January 30, 2013

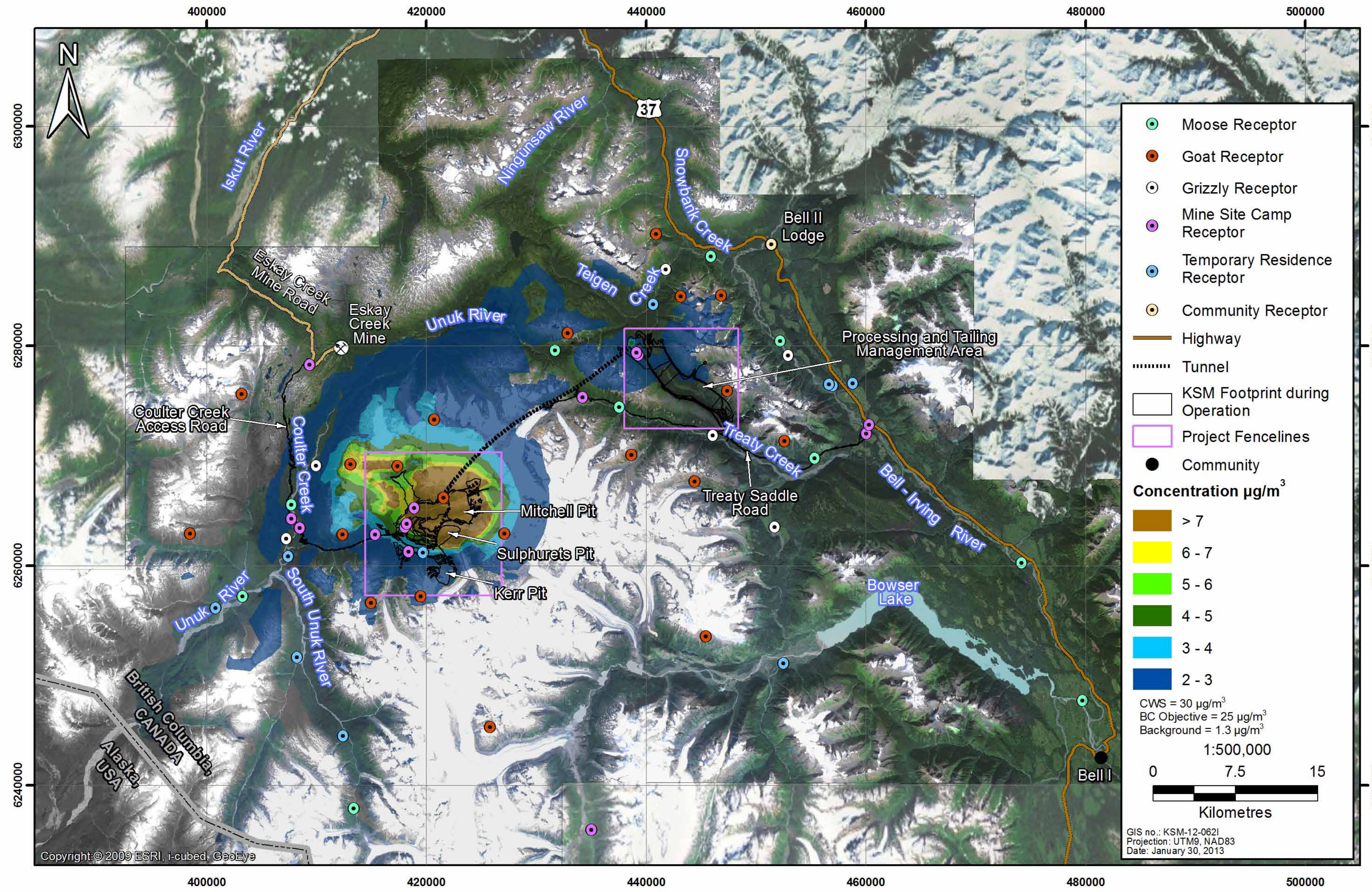

Figure 7.8-31

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Maximum 24-Hour Total $PM_{2.5}$ Concentration during Operation

Figure 7.8-31

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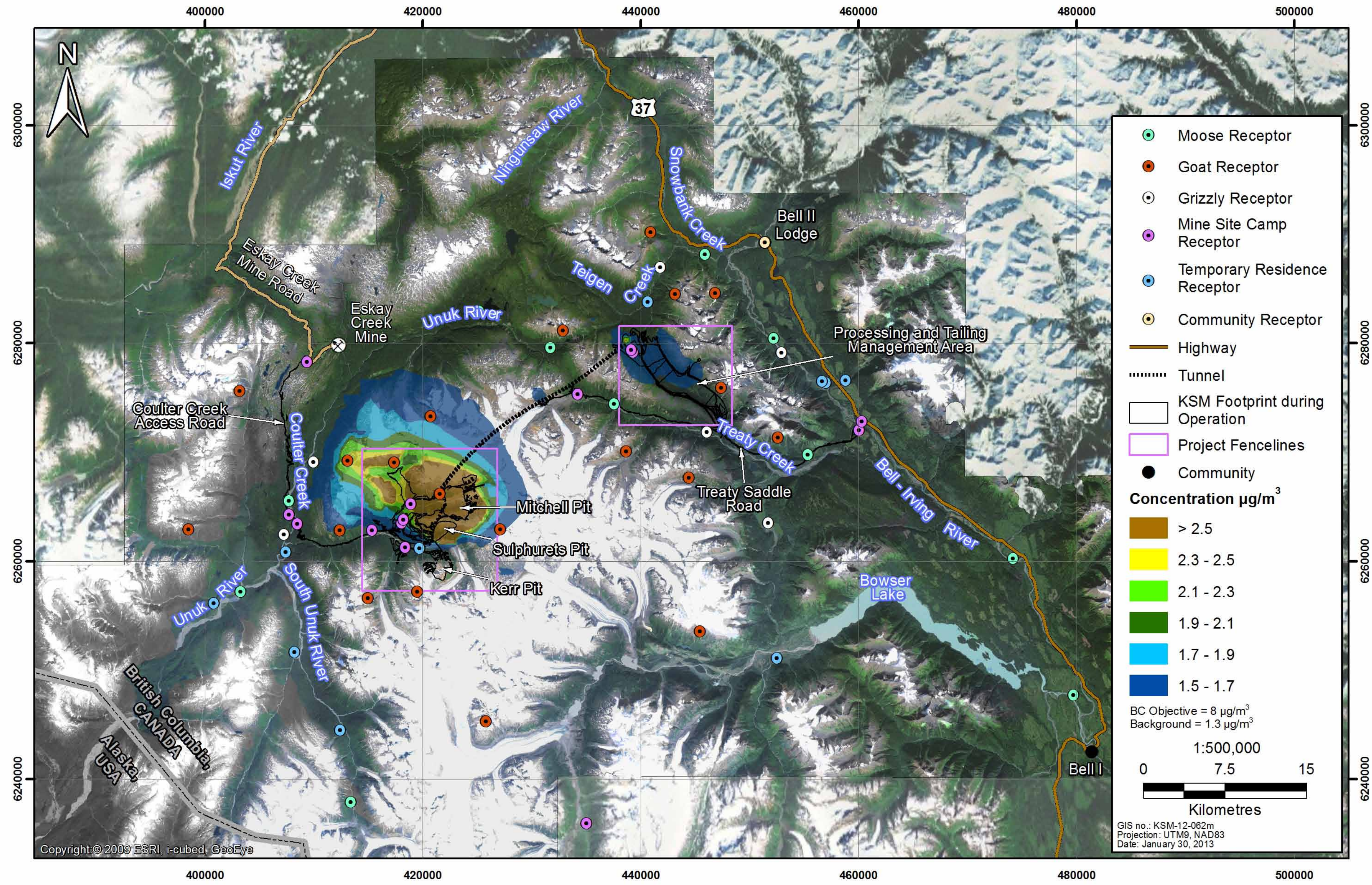

Figure 7.8-32

SEABRIDGE GOLD
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Annual Total $PM_{2.5}$ Concentration during Operation

Figure 7.8-32

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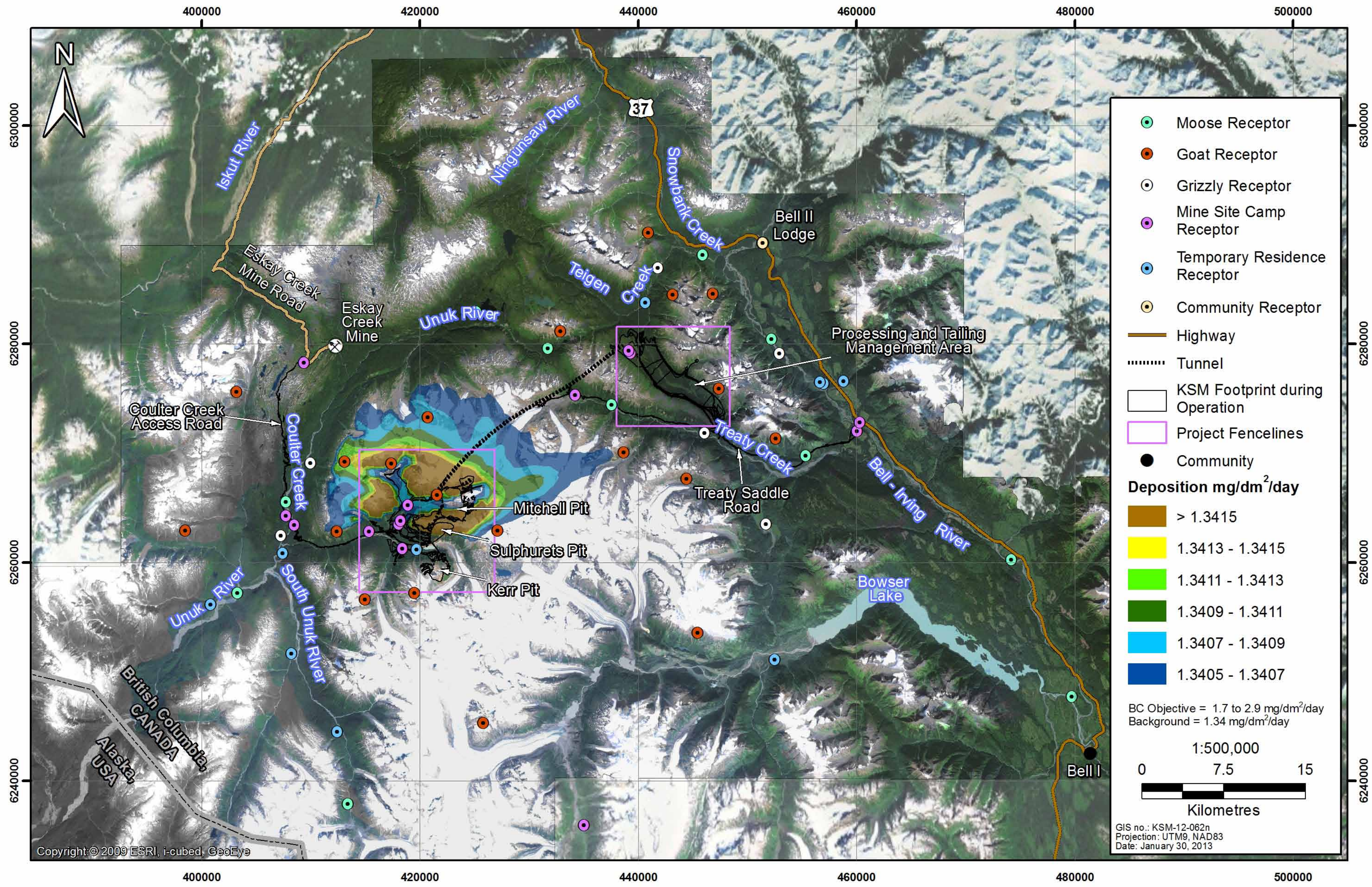

Figure 7.8-33

SEABRIDGE GOLD
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Maximum 30-day Dust Deposition during Operation

Figure 7.8-33

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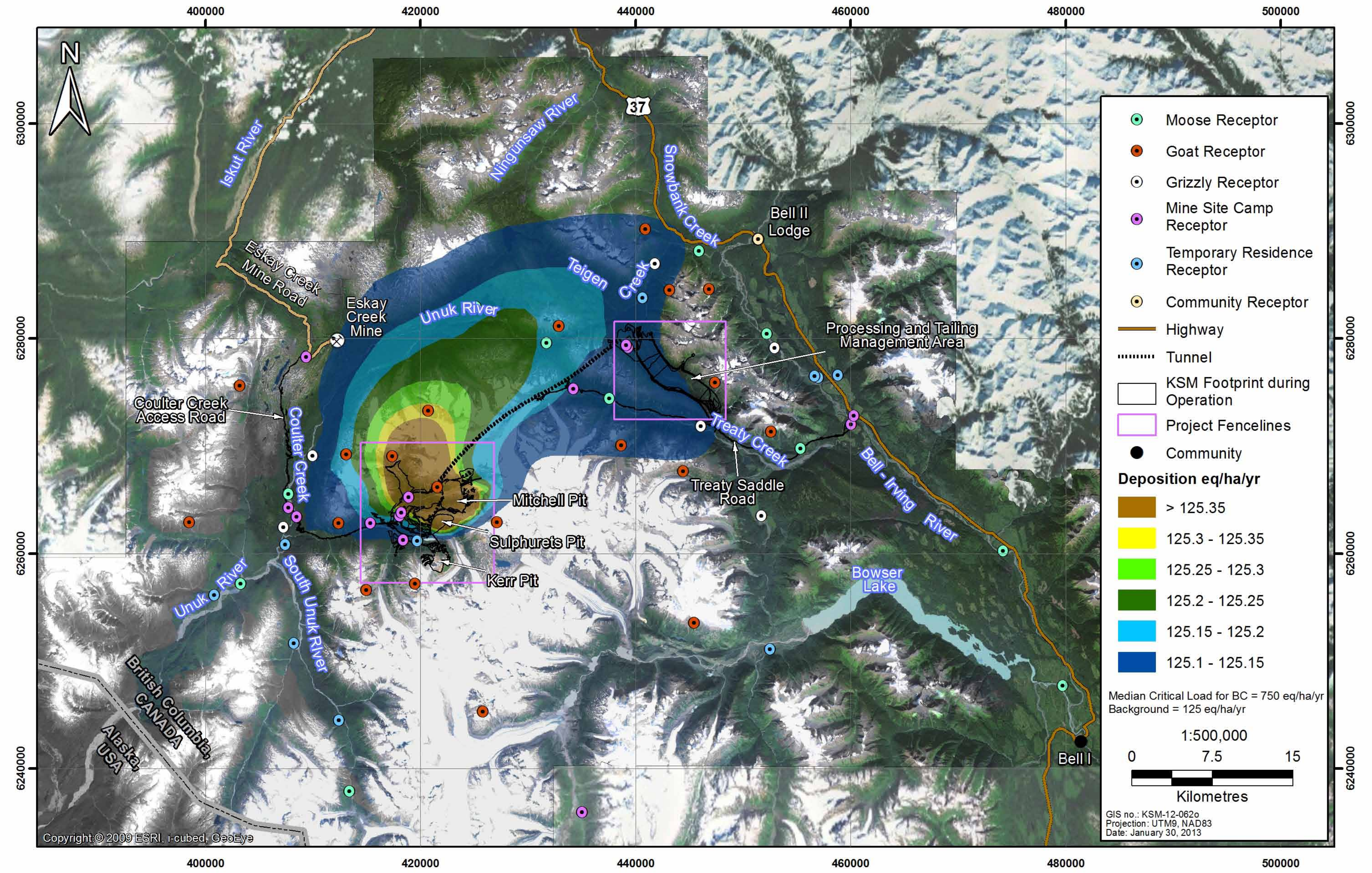

Figure 7.8-34

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Annual Acid Deposition during Operation

Figure 7.8-34

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Table 7.9-1. Definitions of Significance Criteria for Air Quality Residual Effects

							Likelihood of Effects			Follow-Up Monitoring
Timing	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Probability	Confidence Level	Significance	
When will the effect begin?	*How severe will the effect be?*	*How far will the effect reach?*	*How long will the effect last?*	*How often will the effect occur?*	*To what degree is the effect reversible?*	*How resilient is the receiving environment or population? Will it be able to adapt to or absorb the change?*	*How likely is the effect to occur?*	*How certain is this analysis? Consider potential for error, confidence intervals, unknown variables, etc.*	**Not Significant (minor).** Residual effects have no or low magnitude, local geographical extent, short or medium-term duration, and occur intermittently, if at all. There is a high level of confidence in the conclusions. The effects on the VC (at a population or species level) are indistinguishable from background conditions (i.e., occur within the range of natural variation as influenced by physical, chemical, and biological processes). Land use management objectives will be met. Follow-up monitoring is optional.	**Required**
Construction Phase	**Negligible:** Change in Project related ambient concentration or depositionis not measurable from baseline conditions.	**Local:** Non-negligible effect is limited to the immediate Project footprint (e.g. within a 100 m buffer).	**Short-term:** effect lasts less than 1 year.	**Once:** effect is confined to one discrete period in time during the life of the Project (i.e., less than 1% of the Project lifetime)	**Reversible Short-term:** Effect can be reversed relatively quickly after activities cease.	**Low**. The change in air quality is considered to have little to no unique attributes and/or there is high resilience to imposed stresses.	**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.	**Not Significant (moderate).** Residual effects have medium magnitude, local, landscape or regional geographic extent, are short-term to chronic (i.e., may persist into the far future), and occur at all frequencies. Residual effects on VCs are distinguishable at the population, community, and/or ecosystem level. Ability of meeting land use management objectives may be impaired. Confidence in the conclusions is medium or low. The probability of the effect occurring is low or medium. Follow-up monitoring of these effects may be required.	**Not Required**
Operations Phase	**Low:** Change in Project related ambient concentrations or deposition levels are measurable but less than the relevant criteria.	**Landscape**: Non-negligible effect confined within 1 km from the Project footprint.	**Medium term.** The effect lasts from 1 – 11 years.	**Sporadic:** effect occurs less than 10% of the Project life.	**Reversible Long-term:** Effect can be reversed over many years after activities cease.	**Neutral.** The change in air quality is considered to have some unique attributes, and/or there is neutral (moderate) resilience to imposed stresses.	**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.	**Significant (Major).** Residual effects have high magnitude, regional or beyond regional geographic extent, are chronic (i.e., persist into the far future), and occur at all frequencies. Residual effects on VCs are consequential (i.e., structural and functional changes in populations, communities and ecosystems are predicted). Ability to meet land use management objectives is impaired. Probability of the effect occurring is medium or high. Confidence in the conclusions can be high, medium, or low. Follow-up monitoring is required.	
Closure Phase	**Medium:** Change in Project related ambient concentrations or deposition may exceed relavent criteria but not more than 5% of the time.	**Regional:** Non-negligible effect is confined within the RSA (Figure 7.1-1).	**Long term.** The effect lasts between 12 and 70 years.	**Regular:** effect occurs on a regular basis (i.e., between 10% to 80% of the Project life).	**Irreversible:** effect cannot be reversed.	**High.** The change in air quality is considered to be unique, and/or there is low resilience to imposed stresses.	**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.		
Post Closure Phase	**High**: Change in Project related concentrations or deposition is greater than the relevant criteria for an extensive amount of time.	**Beyond regional:** Non-negligible effect extends beyond the RSA.	**Far Future: The** effect lasts more than 70 years.	**Continuous:** effect occurs constantly (i.e., more than 80% of the time).						

7.9.2 Construction Phase

Based on results from the dispersion modelling for the construction phase (Table 7.8-29), 1-hour and annual NO_2, 24-hour total TSP, 24-hour total PM_{10}, and 24-hour total $PM_{2.5}$ exceeded the ambient air quality standards, while the other pollutant-averaging period combinations were below the air quality standards. The frequencies of exceedance are low (a maximum of 2.5% of the time) and the areas of exceedance are also small for the pollutants with exceedances. Therefore, magnitude is considered low to medium (Table 7.9-2). The change in ambient concentrations for all pollutants is expected to be confined to an area inside the RSA so the extent is considered landscape to regional. The construction phase is five years and the pollutants are expected to be emitted only while equipment is in use. The duration is therefore medium, while the frequency is regular. Once the equipment and engines are shut off, the emissions will stop and the ambient concentration in the area is expected to decrease. The reversibility is then rated reversible in the short term. The area is considered previously disturbed by the other prior mining projects, so the context is neutral. The probability of the change in ambient air quality is high. The confidence level for non-fugitive results is high; however, the confidence level for fugitive particulate matter results is intermediate since the emission factors associated with the emission inventory calculation were rated with lower confidence by US EPA. The overall confidence for both non-fugitive and fugitive sources is medium to high. Given that the magnitude is low to medium and the extent does not go beyond the RSA, effects are reversible and short-term; while the context is neutral, the overall significance for the construction phase is **not significant (moderate)**.

7.9.3 Operation Phase

From the results for the operation phase (Table 7.8-40), the Project's maximum concentrations or deposition rates are all below the relevant criteria except 24-hour total TSP and total PM_{10}. Although the highest maximum 24-hour concentrations exceeded the relevant criteria, they are only exceeded two to three times in one year, which is less than 1% of the time. All of the other pollutant-averaging period combinations are below the relevant government criteria; therefore, the magnitude is rated low to medium. The change in ambient air quality was predicted to be confined to the RSA, so the extent is regional. The operation phase is 51.5 years (long in duration) and the change in air quality is regular (frequency).

As stated for the construction phase, the change in air quality will stop once all engines and disturbances cease; therefore, the effect is reversible in the short term. Since the area has been previously disturbed by other mining activities, and the construction of the Project, the context is neutral. The probability of change in air quality occurring during operation is high. Since confidence levels for fugitive sources are lower due to the lower confidence level of emission factors, the overall confidence level is intermediate to high. With the low to medium magnitude with only two pollutants exceeding less than 1% of the time, and regional extent, short-term reversible effects and neutral context, the overall significance for the operation phase is considered **not significant (minor)**.

Table 7.9-2. Summary of Residual Effects on Air Quality

Description of Residual Effect	Project Component(s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Change in Ambient Air Quality	All	Construction	Low to Medium	Landscape to Regional	Medium	Regular	Reversible Short Term	Neutral	High	Medium to High	Not Significant (Moderate)	Not Required
		Operation	Low to Medium	Landscape to Regional	Long	Regular	Reversible Short Term	Neutral	High	Medium to High	Not Significant (Minor)	Not Required
Overall Residual Effect	All	All	Low to Medium	Landscape to Regional	Long	Regular	Reversible Short Term	Neutral	High	Medium to High	Not Significant (Minor)	Not Required

7.9.4 Overall Project

The overall magnitude of the Project's residual effect is low to medium, with regional extent, long duration, regular frequency, and reversible short-term effects. Since the area was previously disturbed, context is neutral. The probability of the effect occurring is high, and the confidence level of the residual effect is medium to high. Since the operation phase is 51.5 years while the construction phase is 5 years, the overall significance of the air quality effect is considered not significant (minor). An air quality monitoring program will take place once construction starts and follow-up monitoring is not required. Dustfall stations will be installed at various locations throughout the Project area to ensure compliance.

7.10 Potential Cumulative Air Quality Effects

7.10.1 Scoping of Cumulative Air Quality Effects Assessment

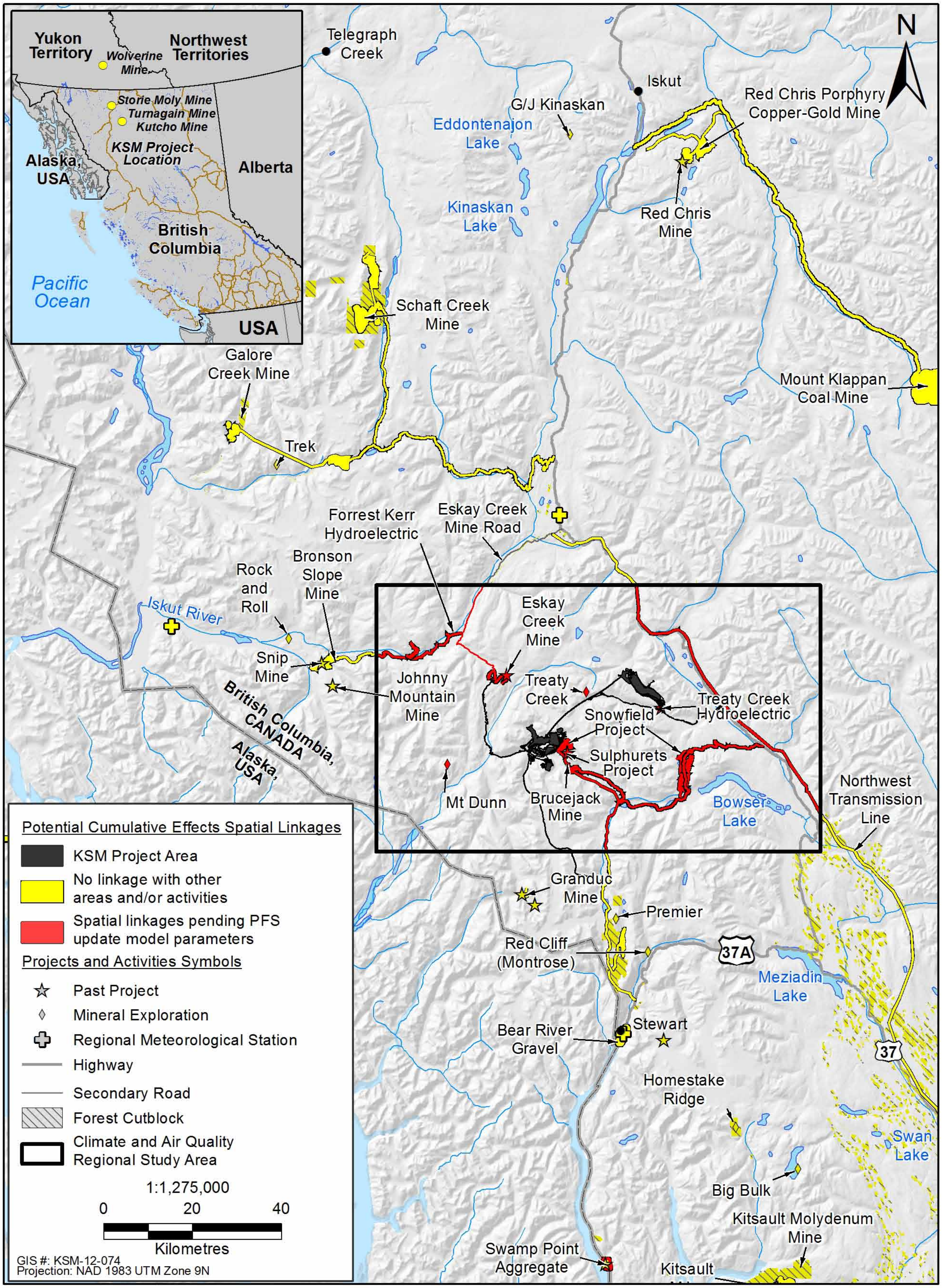
7.10.1.1 Spatial Linkages with Other Projects and Human Actions

A list of past, present, and reasonably foreseeable future projects that the KSM Project has the potential to interact with related to air quality is presented below. Projects and human activities with a spatial overlap inside the RSA are summarized in Table 7.10-1 and shown in Figure 7.10-1. Activities include:

- Eskay Creek Mine;
- Treaty Creek Hydroelectric;
- Forrest Kerr Hydroelectric;
- the Northwest Transmission Line (NTL);
- the Snowfield Project;
- the Brucejack Gold Mine Project;
- Mineral, oil, and gas exploration; and
- Road access and traffic.

Since the Eskay Creek Mine ceased operation in 2008, there is no temporal linkage except for maintenance vehicles that still access the site and ongoing monitoring activities associated with post-closure. However, the activity level is expected to be negligible compared to the level of activities during the KSM Project construction and operation phases. A cumulative effect between Eskay Creek Mine and the KSM Project is not expected.

PROJECT # 868-022-018 GIS No. KSM-12-074 January 30, 2013



KSM Project Air Quality Cumulative Effects Scoping: Projects and Activities with Potential Spatial Interaction

Figure 7.10-1

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Table 7.10-1. Summary of Potential Linkages between KSM Project and other Human Activities

Action/Project		Past	Present	Future
Past Projects	Eskay Creek Mine	NL	X	X
	Granduc Mine	NL	NL	NL
	Johnny Mountain Mine	NL	NL	NL
	Kitsault Mine (Closed)	NL	NL	NL
	Snip Mine	NL	NL	NL
	Sulphurets Project	NL	NL	NL
	Swamp Point Aggregate Mine	NL	NL	NL
Present Projects	Forrest Kerr Hydroelectric	NL	X	X
	Long Lake Hydroelectric	NL	NL	NL
	NTL (Northwest Transmission Line)	NL	X	X
	Red Chris Mine	NL	NL	NL
	Wolverine Mine	NL	NL	NL
Reasonably Foreseeable Future Projects	Arctos Anthracite Coal Mine	NL	NL	NL
	Bear River Gravel	NL	NL	NL
	Bronson Slope Mine	NL	NL	NL
	Brucejack Mine	NL	NL	X
	Galore Creek Mine	NL	NL	NL
	Granduc Copper Mine	NL	NL	NL
	Kitsault Mine	NL	NL	NL
	Kutcho Mine	NL	NL	NL
	McLymont Creek Hydroelectric	NL	NL	NL
	Schaft Creek Mine	NL	NL	NL
	Snowfield Project	NL	NL	X
	Storie Moly Mine	NL	NL	NL
	Turnagain Mine	NL	NL	NL
	Treaty Creek Hydroelectric	NL	NL	X
Land Use Activities	Agricultural Resources	NL	NL	NL
	Fishing	NL	NL	NL
	Guide Outfitting	NL	NL	NL
	Resident and Aboriginal Harvest	NL	NL	NL
	Mineral and Energy Resource Exploration	NL	NL	X
	Recreation and Tourism	NL	NL	NL
	Timber Harvesting	NL	NL	NL
	Traffic and Roads	NL	X	X

NL = No Linkage (no spatial and temporal overlap, or potential effects do not act in combination)

X = Potential spatial and temporal linkage with project or action

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The Treaty Creek Hydroelectric Project, mineral explorations (Mt. Dunn and Treaty Creek Exploration projects), and oil and gas activities are considered to have low activity levels compared to the KSM Project, with spatially restricted effects and minimal air emissions; therefore, the interaction between the Treaty Creek Hydroelectric Project and the KSM Project is considered negligible. Road traffic associated with other mining activities *is* expected to have an effect, although minor. The isopleth figures for the construction and operation phases of the KSM Project (Figures 7.8-5 to 7.8-34) indicate very low concentrations, occurring rarely near background along provincial highways. The interaction between the modelled air quality effects from the KSM Project, and highway traffic associated with other activities is expected to be negligible to minor. As a result, Forest Kerr Hydroelectric Power Project, NTL, Snowfield Project and Brucejack Gold Mine Project are carried forward in the assessment.

7.10.1.2 Temporal Linkages with Other Projects and Human Activities

Past, present, and reasonably foreseeable future projects and human activities with a temporal overlap with the KSM Project (construction is forecasted to start in 2014) include the:

- construction of the Forrest Kerr Hydroelectric Project and a portion of the NTL that may overlap temporally with the KSM Project. These projects will use Highway 37 and the Eskay Creek Mine road mainly during their construction periods, which may overlap with the KSM Project's construction phase.
- construction phase of the Snowfield Project which is scheduled to start in 2027.
- construction phase of the Brucejack Gold Mine Project, which has a similar construction schedule to KSM. The operation phase of the Brucejack Gold Mine Project will start following two years of construction; the operation phase of the Brucejack Project will overlap with the construction and operation phases of the KSM Project.

The construction and operation phases for the projects mentioned above, together with the proposed KSM Project timeline, are presented in Figure 7.10-2.

7.10.2 Cumulative Effect of Change in Ambient Air Quality

Each of the projects contributing to a potential cumulative effect with the Project-related air quality effects from the KSM Project are discussed below.

7.10.2.1 Forrest Kerr Hydroelectric

The Forrest Kerr Hydroelectric Project is a run-of-river hydroelectric power facility currently under construction until mid-2014. After mid-2014, the Forrest Kerr Hydroelectric Project is expected to be in operation. The construction phase of the Forrest Kerr Hydroelectric Project is not anticipated to spatially or temporally overlap with the KSM Project since Forrest Kerr begins construction prior to the KSM construction phase. During operations, physical activities associated with the Forrest Kerr Hydroelectric Project include some road traffic for inspection or maintenance purposes, and employee vehicle travel along highway 37 and the Eskay Creek Mine road. Although information related to predicted traffic levels is not readily available, provided that the activity level for the Forrest Kerr Hydroelectric Project is low during operations (and because of atmospheric mixing that disperses contaminants quickly such that only short-term transient effects on air quality are experienced along roads), any interaction between the Forrest Kerr Project and the KSM Project is considered to be negligible, with no residual effect.

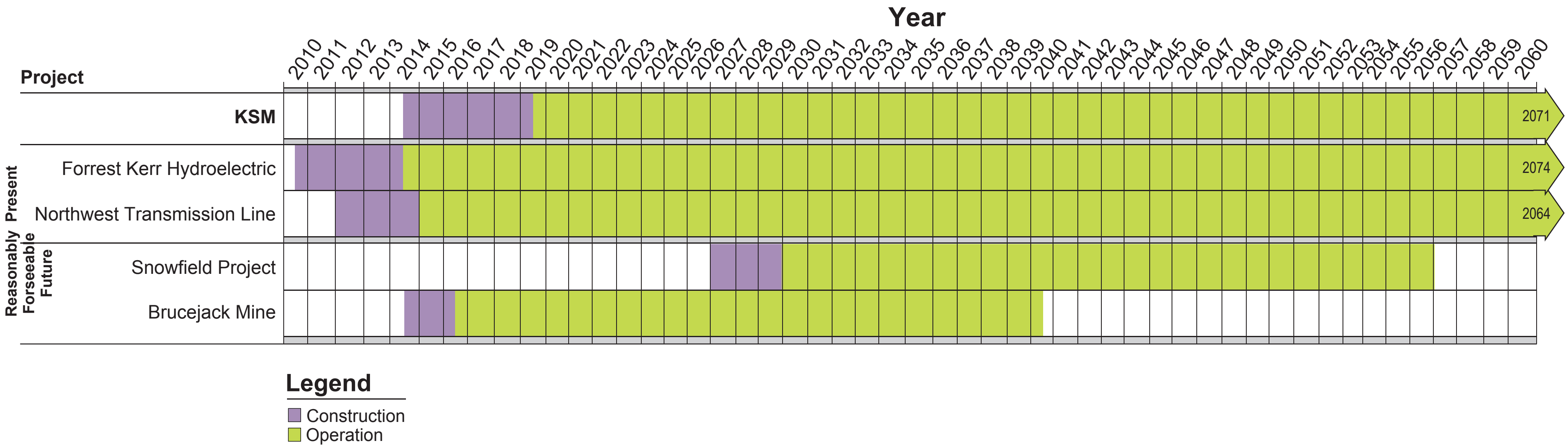

Figure 7.10-2

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Estimated Timeline for Present and Future Projects with Potential Cumulative Effects for Air Quality

Figure 7.10-2

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7.10.2.2 Northwest Transmission Line

The NTL, an approximately 344-km electricity transmission line, is currently under construction (since 2012), and is expected to be operational in 2014. When the NTL is in operation, no regular activities will be required other than periodic inspection or maintenance. Since the KSM Project construction phase is not expected to commence until 2014, there is *no* temporal linkage between the KSM Project, and hence, no potential for residual effects.

7.10.2.3 Snowfield Project

The Snowfield property, located within the Sulphurets District immediately adjacent to the KSM Project, is partially inside the KSM Project modelling fenceline. The Snowfield Project is currently in a dormant exploration stage with no immediate plans to initiate the Project. No interaction between the Snowfield Project and the KSM Project is expected.

7.10.2.4 Brucejack Gold Mine Project

The Brucejack Gold Mine Project is located 65 km north-northwest of Stewart, 21 km south-southeast of the closed Eskay Creek Mine, and approximately 5.5 km east-southeast of the Sulphurets Deposit of the KSM Project. Temporal and spatial linkages between the Brucejack Project and the KSM Project exist with the potential for cumulative effects on air quality. The Brucejack Project has recently entered the BC *Environmental Assessment Act* (1996b) and *Canadian Environmental Assessment Act, 2012* (2012) EA processes. The Brucejack Project is a proposed underground gold and silver mining operation with primary crushing of ROM ore underground before transport to surface facilities. Since Brucejack is an underground mine, threshold limit values in the *Health, Safety and Reclamation Code for Mines in British Columbia* (BC MEMPR 2008) are expected to be met. Since the air quality in the underground mine will meet the threshold limit values, the emissions from the Brucejack underground mining operation are expected to be low and controlled. The primary crushed ore will be hauled to the mill, which consists of crushing, grinding, gravity concentration, and flotation processes. The ore stockpile, surface crusher, flotation plant, backfill paste plant, and concentration stockpile will be housed within a single building (Rescan 2012); this design reduces fugitive dust emissions from material handling and eliminates the potential of wind erosion of the stockpiles. With a proposed processing rate of up to 2,700 tpd for Brucejack (much less than the average ore production rate of 130,000 tpd for KSM), the effect on air quality from Brucejack that has the potential to interact at a regional scale with the KSM Project is expected to be minor. Although an interaction between the Brucejack Project and the KSM Project exist, the magnitude of increase of the cumulative residual effect is expected to be minor.

7.10.3 Significance Determination of Residual Cumulative Effects for Air Quality

The only project that may potentially interact with the KSM Project in the foreseeable future is the Brucejack Project. As discussed in Section 7.10.2.6, the residual effect on air quality from the Brucejack Project is expected to be much lower than that from the KSM Project. Adjusted for the cumulative contribution of the two projects, the magnitude of the cumulative residual effect is expected to be low to medium. The extent of a residual cumulative effect on air quality is landscape to regional during both the construction and operation phases, while the duration of the cumulative residual effect for construction is considered medium, and long for operation. The frequency of the cumulative residual effect is regular for both phases. The nature of air quality and the resilience of the area will not change due to the cumulative effect and the cumulative effect is reversible in the short-term, with a neutral context. The close proximity of the Brucejack Project to the KSM Project indicates the probability of a cumulative effect occurring is high. Since quantitative data are not available for the Brucejack Project, the adjusted confidence level for the cumulative residual effect is considered low to medium. Given the rating of a moderate magnitude and landscape to regional geographic extent, the significance of the overall cumulative effect is considered **not significant (minor)**. A follow-up program is not required (Table 7.10-2).

7.11 Summary of Assessment of Potential Air Quality Effects

The change in ambient air quality due to the KSM Project was evaluated after mitigation measures were incorporated. The assessed effect on air quality for the construction phase of the Project was considered **not significant (moderate)** and during the operation phase **not significant (minor)** as summarized in Table 7.11-1.

7.12 Air Quality Conclusions

Air quality has intrinsic value in terms of human health, wildlife, vegetation, odour, and visibility. Air quality has been identified as a VC in this assessment. The assessment of the change in ambient air quality required:

- an understanding of the current baseline conditions;
- an inventory of the emission sources;
- the selection of the worst-case year for the construction and operation phases;
- quantification of the emissions inventory in the worst years for the construction and operation phases;
- dispersion modelling of the sources, which included consideration of the terrain and meteorological conditions for one year;
- comparison of the dispersion modelling results to relevant federal and provincial ambient air quality standards; and
- a determination of the significance of the Project-related and cumulative residual effects on air quality.

Exceedances of federal one-hour and annual NO_2 air quality objectives were predicted. However, the exceedance of the one-hour objective is predicted to occur only four hours per year, approximately 0.05% of the time. The exceedance of the annual NO_2 objective was predicted on the Project fenceline by the Saddle Area, extending 50 m from the Saddle Area fenceline. For both the construction and operation phases, exceedances of ambient air quality guidelines for total particulate of different diameters were predicted. These total particulate concentrations are the combination of particulate matter from non-fugitive sources (assessed with a higher level of confidence) and fugitive sources (assessed with a lower confidence level). Fugitive dust sources are the main source for TSP and PM_{10}, while the contribution for non-fugitive and fugitive sources are about the same for. Although exceedances were predicted of the annual average for $PM_{2.5}$, the frequency is not expected to occur more than 2.5% of the time. Moreover, the area with predicted exceedances outside the Project fencelines does not feature any sensitive receptors. The effect on air quality for the KSM Project is expected to be confined inside the RSA. As a result of the assessment, the overall significance on air quality is considered **not significant (minor)**.

Several projects have spatial linkages or temporal linkages with the KSM Project. The only project that is expected to have a cumulative residual effect with the KSM Project is the Brucejack Project. Because of the underground mining operations of the Brucejack Project, effects on air quality from Brucejack are expected to be much lower than the KSM Project. Cumulative effects were estimated using the readily available information and best professional judgement. The cumulative residual effect on air quality is expected to be **not significant (minor).**

The air quality effects assessment was based on an assessment of the point and fugitive air emissions associated with the construction and operation phases of the KSM Project. Air emissions were assessed based on the predicted “worst” (i.e., maximum expected) emissions (this year was identified as the year with the highest level of mining activity). Given the not significant results based on the modelling associated with the construction and operation phases, Year -1 and Year 4 respectively, it is reasonable to assume that, if the effects during these two years are confirmed as not significant, the potential effect for the entirety of the two phases should also be **not significant**.

Table 7.10-2. Cumulative Effect on Air Quality

Description of Residual Effect	Other Project(s)/ Activity(ies)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects				Significance Determination	Significance Determination Adjusted for CE	Follow-up Monitoring	Follow-up Monitoring Adjusted for CE
															Probability	Probability Adjusted for CE	Confidence Level	Conf. Level Adjusted for CE				
Change in Ambient Air Quality	Brucejack Mine	Construction	Low to medium	Low to medium	Landscape to regional	Landscape to regional	Medium	Medium	Regular	Regular	Reversible short-term	Reversible short-term	Neutral	Neutral	High	High	High	Low to medium	Not Significant (Moderate)	Not Significant (Moderate)	Not Required	Not Required
	Brucejack Mine	Operation	Low to medium	Low to medium	Landscape to regional	Landscape to regional	Long	Long	Regular	Regular	Reversible short-term	Reversible short-term	Neutral	Neutral	High	High	High	Low to medium	Not Significant (minor)	Not Significant (minor)	Not Required	Not Required
Overall Effect	All	Construction and operation	Low to medium	Low to medium	Landscape to regional	Landscape to regional	Long	Long	Regular	Regular	Reversible short-term	Reversible short-term	Neutral	Neutral	High	High	High	Low to medium	Not Significant (minor)	Not Significant (minor)	Not Required	Not Required

Table 7.11-1. Summary of Assessment of Potential Environmental Effects: Air Quality

Valued Component	Phase of Project	Potential Effect	Key Mitigation Measures	Significance Analysis of Project Residual Effects	Significance Analysis of Cumulative Residual Effects
Air Quality	Construction and Operation	Change in Ambient Air Quality	Unpaved access roads will be watered; crushers will be equipped with baghouses, equipment will be regularly maintained; emission rate will be considered when selecting equipment; ore stockpiles will be covered and processed ore stockpiles will be enclosed; and wet scrubber or baghouses will be used in the MTT.	Not Significant (Minor)	Not Significant (Minor)

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