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Abbreviations

AAAQO	Alberta ambient air quality objective
CAAQS	Canadian ambient air quality standards
CAC	criteria air contaminant
CO	carbon monoxide
COPC	chemical of potential concern
dB	decibels
ER	exposure ratio
HHRA	human health risk assessment
LAA	local assessment area
MPOI	maximum point of impingement
NO_2	nitrogen dioxide
NTU	nephelometric turbidity unit
PAH	polycyclic aromatic hydrocarbon
PDA	project development area
$PM_{2.5}$	particulate matter less than 2.5 micrometres in diameter
RAA	regional assessment area
SO_2	sulphur dioxide
TRV	toxicological reference value
VC	valued component
VOC	volatile organic compound

15.0 ASSESSMENT OF POTENTIAL EFFECTS ON PUBLIC HEALTH

The protection of public health is important to Alberta Transportation, provincial and federal regulators, Indigenous groups, stakeholders, and the public. Alberta Transportation is committed to constructing the Project in a manner that prioritizes and protects the health, safety, and the well-being of the local population.

The term "public health" in the context of this assessment refers to the physiological health of a population resulting from exposure to chemicals or other hazards in the environment.

The assessment of public health is based upon the conclusions described in the human health risk assessment (HHRA) technical data report (Volume 4, Appendix O). The HHRA characterizes the health risk to people (both Indigenous and non-Indigenous) from their exposure to chemical hazards associated with the Project. These chemical hazards include those in the air, water, and country foods.

The assessment of public health is also linked to other valued components (VC) through either the integration of information from other VCs or by providing information that supports other VCs. This assessment is linked to the following VCs:

- Air Quality and Climate (see Section 3.0)
- Surface Water Quality (see Section 7.0)
- Traditional Land and Resource Use (see Section 14.0)

15.1 SCOPE OF THE ASSESSMENT

The scope of the assessment of public health is in accordance with the information requirements indicated in the federal Environmental Impact Statement Guidelines and provincial Terms of Reference for the Project.

This assessment of public health considers the potential change in health risk to the population that may result from changes in air quality, water quality, and country foods during the construction and dry operations phases. The potential for these changes to interact with public health is assessed using HHRA methodology for assessment of exposure pathways.

Potential changes in noise levels and the characterization of public health effects based on annoyance rates are described in the Acoustic Environment VC (Volume 3A, Section 4.0), and therefore, not discussed further in this chapter.

15.1.1 Regulatory and Policy Setting

In Canada, the protection of human health from exposure to chemicals and other hazards falls under Health Canada's mandate. The Government of Canada, the Minister of the Crown in right of Canada, the Canadian Environmental Assessment Agency, federal authorities, and other responsible authorities are mandated to exercise their powers in a manner that protects the environment and human health; and applies the precautionary principle (CEAA 2012).

Provincial and federal regulatory bodies provide regulatory guidance, and environmental guidelines, objectives and standards to protect the environment and human health. Regulatory guidance and environmental guidelines, objectives and standards apply the precautionary principle in the form of conservatism, which results in the over-prediction of health risk. The following guidance is used in this assessment of public health:

- Guidance on Human Health Risk Assessment for Environmental Impact Assessment in Alberta. Alberta Health and Wellness. (Alberta Government, 2011).
- Federal Contaminated Site Risk Assessment in Canada Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (Health Canada 2010a).
- Supplemental Guidance on Human Health Risk Assessment for Country Foods ($HHRA_{FOODS}$) (Health Canada 2010b)
- Guidance for Evaluating Human Health Impacts in Environmental Assessment: Air Quality (Health Canada 2016a)
- Guidance for Evaluating Human Health Impacts in Environmental Assessment: Drinking and Recreational Water Quality (Health Canada 2016b)

15.1.2 Engagement and Key Concerns

Concerns were received following engagement with Indigenous groups, the public and regulators. Concerns were raised regarding air quality around the construction areas near residences because people could inhale emissions from vehicles and construction equipment.

TLRU information was considered during the preparation of all aspects of the EIA, including both methodology and analysis, as stipulated by the CEA Agency project guidelines. TLRU information contributed to the understanding of existing land uses, was used to identify lands that are used traditionally, and informed the assessment of potential Project effects. While this information did not directly affect the significance definition it has been incorporated into the analysis of effects on which the significance determination was based.

As of March 16, 2018, no project-specific intangible concerns, as described in Volume 3A, Section 14.1.3.3, were identified with respect to public health. Local Indigenous groups did identify concerns regarding the loss of available land, and reduced harvesting opportunities

through the changes in road access. Although this does not affect the quality of country foods, it could affect the access or availability of country foods.

These concerns were brought forward in the assessment of public health. When a pathway for the potential effect on public health is identified, the pathway is assessed. If the pathway for the potential effect is not identified, a rationale is provided to explain the absence of the potential effect in Section 15.3.

15.1.3 Potential Effects, Pathways and Measurable Parameters

Table 15-1 describes the potential environmental effect, the effect pathway and the measurable parameter applicable to the assessment of public health.

Table 15-1 Potential Effects, Effects Pathways and Measurable Parameters for Public Health

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Change to human health	• Vehicles, machinery and equipment used to construct and maintain the Project would generate airborne emissions of criteria air contaminants. People may inhale these emissions, which may affect human health. • Deposition of air emissions to soil and subsequent uptake by plants and animals may affect the quality of country foods consumed by human receptors. • Construction activities may change the quality of water consumed by human receptors	• Exposure Ratio (ER; unitless)
	• Project activities may reduce the area of public land available for country food harvesting, leading to food scarcity	• Area of land available for country food harvesting
	• Project construction may result in short-term and long-term increases in the levels of noise from construction equipment and vehicles. People may experience annoyance, stress, sleep disturbance or hearing loss. • Effects resulting from Project noise are assessed in Section 4 and are therefore not addressed further in this Section. This section summarizes the conclusions from Section 4.	• Percent of highly annoyed people

15.1.4 Boundaries

15.1.4.1 Spatial Boundaries

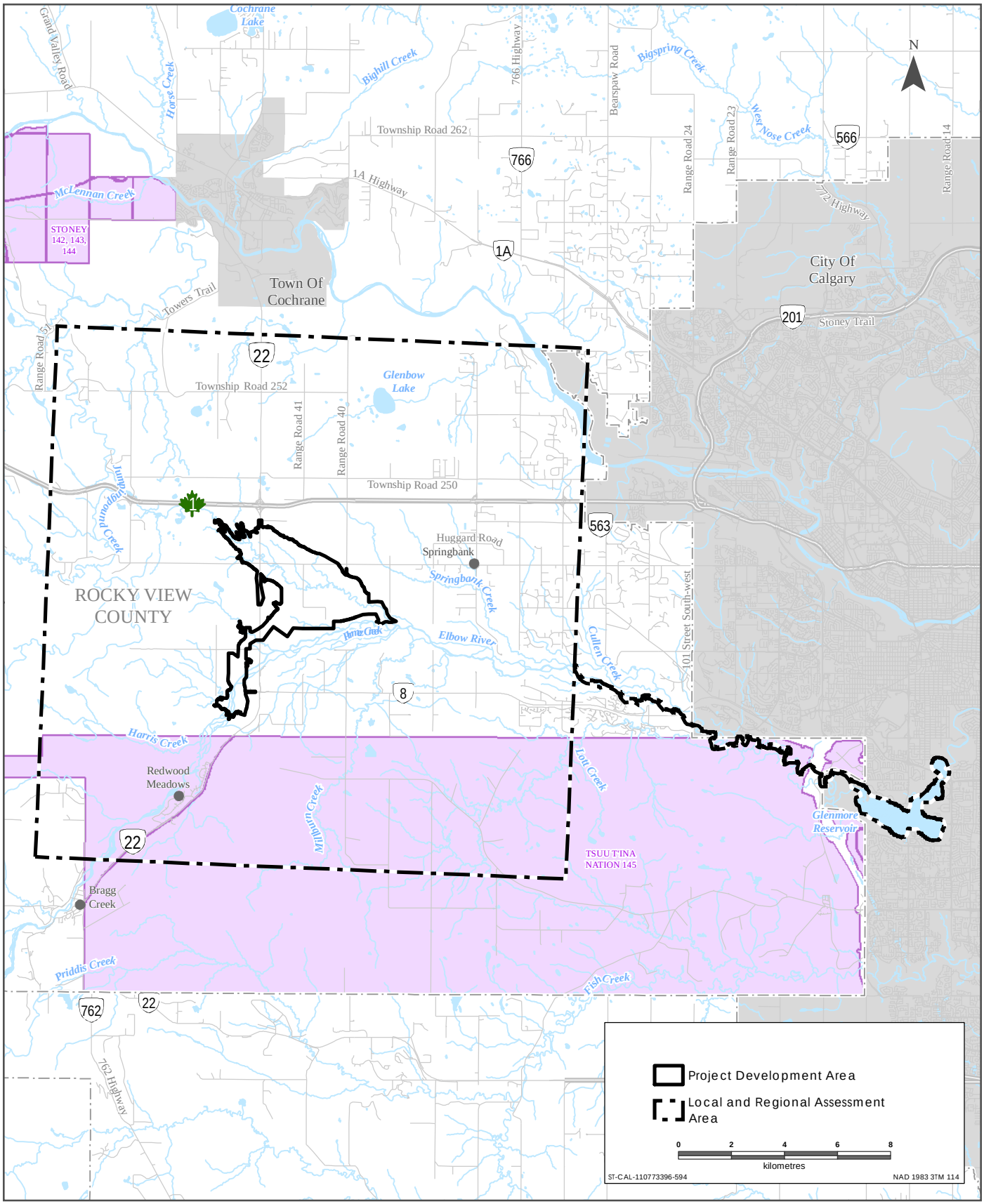
The project development area (PDA) is defined as the area for which physical ground disturbance is planned for the Project. The local assessment area (LAA) is defined as the total area for assessing public health associated with the Project. The regional assessment area (RAA) is the same as the LAA. The PDA, LAA/RAA for public health is illustrated in Figure 15-1.

The LAA/RAA for the assessment of public health is a 20 km by 20 km square centered on the PDA in addition to the waters of the Elbow River from the diversion channel to the Glenmore Reservoir. The 20 km by 20 km area is the modelling domain used in the assessment of air quality to predict air quality conditions, and it encompasses the areas used to assess other hazards associated with public health (e.g., country foods), while the waters of the Elbow River to the Glenmore Reservoir apply to water quality.

15.1.4.2 Temporal Boundaries

The temporal boundaries are the following.

Project construction would take place over a 36-month period. Assuming regulatory approval by Q4 2018, construction would commence in Q1 2019. By Q4 2020, the Project would be able to accommodate a 1:100 year flood. Construction would be fully completed by Q1 2022, at which time the Project would be able to accommodate water volumes equal to the 2013 flood, referred to as the design flood. Dry operations of the Project will occur indefinitely (i.e., permanent installation) after construction, with periods of dry operations alternating with flood and post-flood operations.



Sources: Base Data - ESRI, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Public Health Spatial Boundaries

Stantec

15.1.5 Residual Effects Characterization

Table 15-2 presents definitions for residual environmental effects on public health.

Table 15-2 Characterization of Residual Effects on Public Health

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	Positive – a residual effect that changes measurable parameters in a direction beneficial to public health relative to existing conditions. Adverse – a residual effect that changes measurable parameters in a direction detrimental to public health relative to existing conditions. Neutral – no net change in measurable parameters for public health relative to existing conditions.
Magnitude	The amount of change in the measurable parameter relative to existing conditions	If expressed quantitatively, the categories are: Negligible – No detectable or measurable change from existing conditions. Low – A measurable change from existing conditions but is below environmental and/or regulatory criteria and does not represent an unacceptable change to public health. Moderate – A measurable change from existing conditions that is above environmental and/or regulatory criteria but does not affect public health. High – A measurable change from existing conditions that is above environmental and/or regulatory criteria and represents potentially unacceptable change to public health.
Geographic Extent	The geographic area in which changes in public health occurs	PDA – residual effects are restricted to the PDA LAA/RAA – Residual effects extend into the LAA/RAA.
Frequency	Identifies how often the change in public health occurs	Single event –occurs once Multiple irregular event –occurs at no set schedule. Multiple regular event –occurs at regular intervals. Continuous –occurs continuously.

Table 15-2 Characterization of Residual Effects on Public Health

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Duration	The period of time that a change in public health is measurable.	Short-term – Residual effect continues for up to one year. Medium-term – Residual effect continues for more than one year but less than five years. Long-term – Residual effect continues for more than five years.
Reversibility	The likelihood that the residual effect to public health may be reversible if exposure to a chemical ceases, or when the project phase is complete.	Reversible – the residual effect to public health can be reversible if the hazard exposure ceases, or when the project phase is complete. Irreversible – the residual effect to public health is irreversible.
Ecological and Socio-economic Context	The level of sensitivity and resilience of the local population to changes in public health. The residual effect to the local population may be greater in areas that are already adversely affected.	Resilient – High capacity for public health to recover from perturbation, with consideration of existing levels of disturbance. Not Resilient – Low capacity for public health to recover from perturbation, with consideration of existing levels of disturbance.
Timing	Periods of time where residual effects from Project activities could affect the VC	Seasonality – residual effect is greater in one season than another (e.g., spring/summer vs. fall/winter) Time of day – residual effect is greater during daytime or nighttime Regulatory – provincial or federal restricted activity periods or timing windows (e.g., migration, breeding, spawning) related to the VC Not applicable - the residual effect of Project activities will have the same effect on the VC, regardless of timing

15.1.6 Significance Definition

The significance criteria are the limits of an acceptable change in a measurable parameter based on applicable legislation, regulatory guidance, or other management standard. The significance criteria are listed in Table 15-3.

Table 15-3 Significance Criteria for Residual Effects, Public Health

Potential Environmental Effect	Measurable Parameter	Significance Criteria
Change to human health	Exposure Ratio (ER; unitless)	A significant adverse effect to human health may occur when hazard exposures exceed the objectives established by relevant regulatory organizations (i.e., an ER greater than 1.0), and are likely to result in a substantive change in the health of an identified receptor. This conclusion is based on a consideration of the measurable parameter and relevant contextual effects attributes.
	Area of land available for country food harvesting	A significant adverse effect to human health may occur when there is a persistent and substantial decline in the area of land available for country foods harvesting, and if that land provides substantial country food resources for people.

15.2 EXISTING CONDITIONS FOR PUBLIC HEALTH

Existing environmental data can be used to characterize current environmental conditions in the study area. These data are then used in the HHRA to characterize the health risk for baseline conditions.

Existing conditions also includes a discussion of the current health status in the region. For the HHRA, the description of the current health status relies on publicly available data, and range from the large geographic area (i.e., Calgary Zone) to the local geographic area (i.e., Cochrane-Springbank).

15.2.1 Air Quality

The air quality for baseline conditions (and applicable Project phases) are based on the results of the air quality dispersion modelling. Technical details about the modelling methods (e.g., model software, model inputs and assumptions) and the modelling results are described in Volume 3A, Section 3; Volume 3B, Section 3; and Volume 4, Appendix E, Dispersion Modelling Technical Data Report.

The air dispersion model included predictions of ground-level concentrations of criteria air contaminants (CAC), volatile organic compounds (VOC), polycyclic aromatic hydrocarbons (PAH), and metals in the study area. These chemicals of potential concern (COPC) are modelled because the combustion of fuel by vehicles and equipment releases these substances into the air. Particulate matter is also modelled to address dust concerns in the post-flood operations phase, where high winds during dry periods can cause wind erosion and dust storms.

The COPC from air emissions considered in the HHRA are those associated with gasoline and diesel combustion exhaust during the construction phase (i.e., CACs, VOCs, PAHs and trace metals), and particulate matter in the air resulting from dust storms during the post-flood operation phase.

CACs include sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$) and diesel exhaust particulate (DEP). VOCs are organic compounds with a high vapour pressure at ambient temperatures that allow these substances to volatilize or evaporate into the air relatively quickly. The VOCs considered in the HHRA are those associated with emissions from fuel combustion: specifically, 1,3-butadiene, 2,2,4-trimethylpentane, acetaldehyde, acrolein, benzene, ethylbenzene, formaldehyde, propionaldehyde, toluene and xylenes.

PAHs are also byproducts of fuel combustion, but they have low vapour pressures and remain in a solid or liquid state. PAHs from fuel combustion are typically bound to particulates in the air, and do not readily exist in a gas phase at ambient temperatures. The PAHs considered in the HHRA are acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, naphthalene, phenanthrene, and pyrene. The metals associated with vehicle exhaust emissions are arsenic, chromium, manganese, mercury, and nickel.

15.2.2 Water Quality

Through the Indigenous engagement program, Tsuut'ina Nation indicated that they depend on the groundwater in the Elbow River Alluvial Aquifer for the reserve's drinking water. Five registered water wells have been identified on the Tsuut'ina Nation reserve within the RAA. Tsuut'ina Nation also identified Elbow River as a source of drinking water and noted the importance of the river's connection to groundwater. It is understood that Tsuut'ina Nation holds a license to withdraw water from Elbow River, located upstream of the PDA. Although they do not identify sources of drinking water, Stoney Nakoda Nations noted that the waters that flow through the traditional lands have sustained the Stoney Nakoda Nations since time immemorial. No other sources of drinking water used by Indigenous groups in the area of the Project were identified through the engagement program or the literature review.

Baseline environmental data for the Glenmore Water Treatment Plant, which supplies residents of the City of Calgary with municipal tap water, is based on water samples collected from the treatment plant. Samples of treated drinking water at the plant and in the distribution system are routinely tested for quality and the results are compared to the Canadian drinking water quality guidelines (Health Canada 2017a). Table 15-4 includes a list of drinking water quality parameters, guidelines, and the range of measured results from water samples taken from the Glenmore Water Treatment Plant in 2015 and 2016 (City of Calgary 2017, personal communications for 2015 records).

The water treatment process at the Glenmore Water Treatment Plant includes water filtration and disinfection before entering the municipal water distribution system (City of Calgary 2016). First, silt, debris, and microorganisms are removed from the raw water supply using aluminum sulphate, sand, and polymer to create floc, which settles to the bottom of the tank. Next, the clarified water is treated with chlorine as sodium hypochlorite to kill microorganisms and viruses. Finally, the water is filtered through crushed coal and sand. The drinking water treatment is not designed to remove dissolved metals.

Drinking water quality from the Glenmore Water Treatment Plant is considered very good, and met the applicable health-related guidelines for the parameters tested. The water was in compliance with health-based, aesthetic and operational water quality guidelines with the exception of water temperature. The natural range of water temperature was occasionally higher than the aesthetic guideline. Higher temperatures can indirectly influence water disinfection processes and promote biofilm formation under certain conditions. However, no information was found to suggest that these potential effects occurred at the Glenmore Water Treatment Plant at the time when the water temperature was higher than the guideline.

Table 15-4 Drinking Water Quality for the Glenmore Water Treatment Plant, 2015 and 2016

Parameter	Water Quality Guideline	Measured Water Quality Range	
		2015	2016
Treated Water in from Glenmore Water Treatment Plant			
Temperature (°C)	≤15 [b]	0.8 to 20.0	5.0 to 20.2
pH	7.0 to 10.5 [c]	7.3 to 8.1	7.3 to 7.9
Turbidity (nephelometric turbidity unit)	<0.15 [c]	<0.05 to 0.14	<0.05 to 0.08
Total dissolved solids (mg/L)	≤500 [b]	152 to 300	254 to 297
Colour (True Color)	≤15 [c]	<2	<2
Nitrate as Nitrogen (mg/L as N)	10[a]	0.0023 to 0.231	<0.005 to 0.248
Nitrite as Nitrogen (mg/L as N)	1[a]	<0.003	<0.003
Sulphate (mg/L)	≤500[b]	37 to 81	70.8 to 90.2
Fluoride (mg/L)	1.5[b]	0.09 to 0.28	0.19 to 0.27
E. coli (per 100mL)	0 [a]	<1	<1
Total coliform (per 100 mL)	0 [a]	<1	<1
Aluminum (mg/L)	0.1[cd]	0.091 to 0.1	0.0528
Arsenic (mg/L)	0.01[a]	<0.0005	<0.0005
Barium (mg/L)	1[a]	0.027 to 0.079	0.0639 to 0.0877
Cadmium (mg/L)	0.005 [a]	<0.0005	<0.0005
Chromium (mg/L)	0.05 [a]	<0.0005 to 0.0023	<0.0005 to 0.0020
Copper (mg/L)	≤1.0 [b]	<0.0005 to 0.0007	<0.0005 to 0.0008
Iron (mg/L)	≤0.3 [b]	<0.05	<0.05 to 0.015
Lead (mg/L)	0.01[a]	<0.0005	<0.0005
Manganese (mg/L)	≤0.05 [b]	<0.0005 to 0.0007	<0.0005 to 0.0012
Mercury (mg/L)	0.001[a]	<0.000002	<0.000002
Sodium (mg/L)	≤200 [b]	2.5 to 10.1	5.79 to 9.30
Zinc (mg/L)	≤5.0 [b]	<0.003	<0.003
Treated Water in Municipal Distribution System			
E. coli (present/absent)	0 [a]	Absent	Absent
Total coliform (present/absent)	0 [a]	Absent	Absent

NOTES:
[a] Health guideline
[b] Aesthetic guideline
[c] Operational guideline
[d] Added to the water supply as part of the water treatment process

15.2.3 Existing Conditions for Country Foods Harvesting

Country foods are defined as those that may be produced in an agricultural (not for commercial sale) or backyard setting or harvested through self-provisioning activities such as hunting, gathering or fishing (Health Canada 2010b). Self-provisioning is a culturally embedded activity that is an important component of life for many rural households (both Indigenous and non-Indigenous) and is not based on income or employment status. In Canada, research on self-provisioning or country foods has largely focused on the activities of Indigenous populations (Health Canada 2010b), and there are indications that Indigenous populations have higher consumption rates for some country foods, as well as additional reliance on traditional foods (Alberta Health 2018). As a result, the discussion on existing conditions for country foods harvesting focuses on use by Indigenous groups.

The existing conditions for country foods harvesting includes a consideration of the types of country food harvested in the region by local Indigenous groups, a description of the area of land within the PDA that is currently available for country food harvesting, and the potential for country foods to be present within the PDA. Country foods are animals, plants, and fungi used by Indigenous groups for nutritional, medicinal, spiritual or cultural purposes that are harvested through hunting, fishing and gathering. For example, elk and moose may provide food, clothing and tools. Plants and plant parts (e.g., roots, leaves, bark, twigs) are used in traditional medicine and spiritual ceremonies.

A list of the country foods harvested by local Indigenous groups was confirmed by the groups. Understanding the level and types of country food harvesting in the region is one of the most important aspects of any human health assessment of country foods (Health Canada 2010b). Indigenous groups engaged for the Project are:

- Blood Tribe
- Ermineskin Cree Nation
- Foothills Ojibway First Nation
- Ktunaxa Nation
- Louis Bull Tribe
- Métis Nation of Alberta (Region 3)
- Métis Nation of British Columbia
- Montana First Nation
- Piikani Nation
- Samson Cree Nation
- Siksika Nation
- Stoney Nakoda Nation (Bearspaw First Nation, Chiniki First Nation and Wesley First Nation)
- Tsuut'ina Nation

Table 15-5 summarizes the traditional country foods as reported by each Indigenous group, which is described in more detail in the assessment of traditional land use (see Section 14). The list includes country foods that are harvested in the region of southern Alberta; but not necessarily within the PDA. The information is not intended to be an exhaustive list of the traditional country food that are used, nor does the absence of information imply that an Indigenous group does not use of the resource.

Table 15-5 List of Traditional Country Foods

Type of Country Food	Traditional Country Food Species	Kainai First Nation	Ermineskin Cree Nation	Foothills Ojibway First Nation	Ktunaxa First Nation	Louis Bull Tribe	Métis Nation of Alberta	Métis Nation British Columbia	Montana First Nation	Piikani First Nation	Samson Cree Nation	Siksika Nation	Stoney Nakoda Nations	Tsuut'ina Nation
Wildlife	badger									✓				
	bear (black, grizzly)		✓	✓	✓		✓	✓	✓	✓	✓		✓	
	beaver	✓	✓		✓		✓		✓	✓	✓		✓	
	bobcat, bobtail		✓				✓							
	cougar		✓				✓				✓			
	coyote	✓		✓			✓			✓				✓
	deer (mule, white-tailed)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	duck (American coot)	✓	✓		✓	✓	✓	✓		✓	✓	✓		✓
	eagle (golden, bald)	✓								✓				✓
	elk	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
	fox (red)	✓					✓			✓				✓
	fisher								✓					
	goose (Canada, white, dark)	✓	✓		✓	✓	✓	✓		✓	✓	✓		✓
	gopher									✓				
	grebe						✓							

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Wildlife (cont'd)	grouse (including prairie[1], mountain[2])		✓					✓		✓	✓	✓		
	hare, rabbit	✓	✓			✓	✓	✓		✓	✓		✓	✓
	lynx		✓				✓		✓		✓			
	marten				✓				✓					
	moose	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
	mountain goat	✓	✓					✓		✓				✓
	Mink	✓							✓		✓			
	muskrat	✓	✓		✓	✓	✓		✓		✓		✓	
	owl									✓				
	partridge (chukar)	✓						✓		✓				
	pheasant						✓	✓						
	porcupine	✓								✓				✓
	ptarmigan							✓						
	sheep (mountain, bighorn, stone, ram)	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓
	skunk										✓			
	Sprague's pipit										✓			
	squirrel	✓	✓						✓	✓	✓			✓
	swan	✓								✓	✓	✓		✓
	weasel		✓		✓						✓			
	wolverine			✓	✓		✓				✓			
	wolf	✓	✓	✓						✓	✓			✓

[1] Assumed to be sharp-tailed grouse
[2] Assumed to be spruce and ruffed grouse

Table 15-5 List of Traditional Country Foods

Type of Country Food	Traditional Country Food Species	Kainai First Nation	Ermineskin Cree Nation	Foothills Ojibway First Nation	Ktunaxa First Nation	Louis Bull Tribe	Métis Nation of Alberta	Métis Nation British Columbia	Montana First Nation	Piikani First Nation	Samson Cree Nation	Siksika Nation	Stoney Nakoda Nations	Tsuut'ina Nation
Fish	burbot		✓		✓			✓					✓	
	minnow				✓									
	pike (northern), jackfish		✓		✓	✓	✓	✓	✓		✓		✓	
	trout (bull, cutthroat, rainbow)	✓	✓		✓	✓		✓	✓		✓		✓	
	sucker		✓		✓	✓		✓	✓		✓		✓	
	whitefish (mountain)		✓		✓	✓		✓	✓		✓		✓	
Vegetation and Fungus	alsike clover		✓											
	aspen		✓											
	bearberry, *kinnikinnick*	✓	✓		✓	✓		✓	✓	✓				✓
	bear root					✓								✓
	bitter berry										✓			
	black root					✓					✓			
	blueberry (high-bush, low-bush, dwarf)		✓			✓	✓	✓	✓		✓			
	bunchberry		✓											
	camas	✓								✓				
	caribou weed							✓						
	cattail						✓	✓						
	cedar (including western red)		✓		✓	✓		✓			✓		✓	
	chokecherry	✓	✓		✓	✓	✓	✓	✓	✓	✓			
	cloudberry, dewberry						✓				✓			
	cohosh, honeysuckle						✓							
	cottonwood (black), poplar				✓			✓		✓			✓	✓
	cow parsnip				✓									

Table 15-5 List of Traditional Country Foods

Type of Country Food	Traditional Country Food Species	Kainai First Nation	Ermineskin Cree Nation	Foothills Ojibway First Nation	Ktunaxa First Nation	Louis Bull Tribe	Métis Nation of Alberta	Métis Nation British Columbia	Montana First Nation	Piikani First Nation	Samson Cree Nation	Siksika Nation	Stoney Nakoda Nations	Tsuut'ina Nation
Vegetation and Fungus (cont'd)	cranberry (low-bush), eye berry, mooseberry		✓		✓	✓	✓	✓	✓		✓			
	currant				✓									
	dandelion							✓						
	diamond willow fungus							✓	✓		✓			
	fireweed	✓						✓						
	frog plant								✓					
	fungus (tree, wood, green wood-cup)		✓				✓							✓
	goldenrod							✓						
	gooseberry (northern)		✓		✓	✓	✓		✓		✓			
	green alder		✓				✓							
	horse grass										✓			
	huckleberry		✓		✓	✓		✓			✓			
	juniper (ground, berry)	✓	✓					✓		✓	✓			✓
	king root										✓			
	Labrador tea, muskeg tea, muskeg leaves		✓			✓			✓		✓			✓
	lichen (tree)									✓				✓
	mint, peppermint, wild mint		✓			✓	✓	✓	✓		✓			
	moss (spike, sponge)	✓									✓			
	mushrooms (chanterelle, morel, pine, puff balls)						✓	✓						
	northern bedstraw						✓	✓						
	old-man's beard							✓						

Table 15-5 List of Traditional Country Foods

Type of Country Food	Traditional Country Food Species	Kainai First Nation	Ermineskin Cree Nation	Foothills Ojibway First Nation	Ktunaxa First Nation	Louis Bull Tribe	Métis Nation of Alberta	Métis Nation British Columbia	Montana First Nation	Piikani First Nation	Samson Cree Nation	Siksika Nation	Stoney Nakoda Nations	Tsuut'ina Nation
Vegetation and Fungus (cont'd)	old-man's whiskers	✓												
	onion (wild, prairie)		✓		✓		✓	✓			✓			
	pigweed (lamb's quarter, red)						✓							
	pine (lodgepole, sweet)	✓	✓						✓	✓	✓			✓
	pineapple weed						✓							
	pin cherry					✓	✓		✓					
	plantain (common, whiteman's foot)		✓				✓	✓						
	prairie clover						✓							
	prairie coneflower						✓							
	rabbit root										✓			
	raspberry (wild)		✓				✓	✓	✓		✓			✓
	red clover							✓						
	red osier dogwood, *nipiswasiskwatew*		✓		✓									
	rosehip							✓						
	sage (bush, prairie)	✓	✓			✓	✓	✓			✓			
	saskatoon berry	✓	✓			✓	✓	✓	✓	✓	✓			
	saw-grass							✓						
	silverberry, wolf willow, white sage berry	✓					✓							
	smelly root										✓			
	soapberry, hoshum							✓						
	spruce		✓					✓	✓		✓		✓	
	stinging nettle						✓	✓						

Table 15-5 List of Traditional Country Foods

Type of Country Food	Traditional Country Food Species	Kainai First Nation	Ermineskin Cree Nation	Foothills Ojibway First Nation	Ktunaxa First Nation	Louis Bull Tribe	Métis Nation of Alberta	Métis Nation British Columbia	Montana First Nation	Piikani First Nation	Samson Cree Nation	Siksika Nation	Stoney Nakoda Nations	Tsuut'ina Nation
Vegetation and Fungus (cont'd)	strawberry		✓			✓	✓	✓			✓			
	sweetgrass	✓	✓			✓					✓		✓	✓
	tiger lily								✓					
	tumbleweed										✓			
	twinberry						✓							
	western dock						✓							
	wheat		✓											
	white birch				✓			✓		✓	✓			
	wild asparagus							✓						
	wild carrot		✓											
	wild chives		✓											
	wild potato		✓		✓			✓						
	wild rice										✓			
	wild rose	✓	✓							✓				
	wild tobacco				✓					✓				
	wild turnip	✓								✓				
	willow (red)		✓			✓	✓	✓	✓	✓				✓
	yarrow	✓						✓		✓				

The PDA consists primarily private land that is used for ranching. Most of these private lands are delineated by 1 m high wire fencing, and not accessible to the public. Some Indigenous groups may have informal agreements with landowners to access private lands. The vegetation in these private lands consist mostly of common grasses and shrubs for livestock grazing. Although wildlife such as bears, elk and deer occasionally wander into these private lands, the PDA is generally not suitable habitat for large species of wildlife due to the fencing that limits movement, the limited range of available food (e.g., mostly grasses with few leaves, twigs, fruits or berries for herbivores and omnivores), and limited types of shelter and forage cover. Areas of the PDA that are currently accessible to the public include roadways (e.g., Highway 22 and Springbank Road), and the adjacent strip of grass land that runs parallel to roads. For these reasons, the PDA provides limited country food harvesting opportunities for either Indigenous or non-Indigenous peoples. There is a very low probability that the PDA can provide a range or quantity of country foods to harvesters.

15.2.4 Current Health Status

There are no specific publicly available health data for the LAA, and therefore the information presented relies on publicly available data for the Calgary Zone the local geographic area of Cochrane-Springbank. The information should not be interpreted as a definitive baseline for residents of the LAA; however, it may be useful for identifying critical receptors as well as in interpreting the HHRA in the context of population baseline, project and cumulative risks" (Alberta Government 2011).

Health Indicators

In addition to the quality of a person's natural environment (e.g., quality of air, water, food), many other factors play a role in determining a person's overall health. These determinants of health include such things as income and social status, education, employment and working conditions, physical environment (such as housing), social support networks, employment and working conditions, biology and genetics, social support networks, personal health practices, healthy child development, and access to health services (Health Canada 2004).

Alberta Health has developed a series of reports to provide a broad range of demographic, socio-economic, and population health statistics for various local geographic areas. The Project is located within the Cochrane-Springbank local geographic area, within the Calgary health services zones (the "Calgary Zone"). Some of the key findings of the community profile for Cochrane-Springbank (Government of Alberta 2017) were:

- The percentage of obese adults in the Calgary Zone was lower than the provincial percentage in 2014 (19.8% Calgary Zone versus 22.8% Alberta)
- The Calgary Zone reported a lower proportion of inactive people compare to the provincial proportion during the same year (39.4% Calgary Zone versus 43.1% Alberta)

- Cochrane-Springbank's population increased by 295.8% between 1996 and 2016 (compared to 62.2% increase for Alberta) and currently stands at 44,090 people
- The largest age group in Cochrane-Springbank in 2016 was 35-64 year olds, who accounted for 43.2% of the population compared to 40.4% for Alberta
- Cochrane-Springbank had a similar proportion of First Nations and Inuit people compared to Alberta (0.5% versus 2.8% Alberta)
- The percentage of female lone-parent families was lower than the provincial percentage (6.5% versus 11.1% Alberta)
- A lower proportion of families with an after-tax low-income level were reported in Cochrane-Springbank compared to Alberta (7.6% versus 10.7% Alberta)
- Cochrane-Springbank reported a higher proportion of people with university certificates, diplomas or degrees compared to Alberta (43.6% versus 30.3% Alberta)
- The mortality rate (per 100,000 population) due to all causes was lower in Cochrane-Springbank in 2013-2015, compared to the province (471.4 versus 634.7 for the Alberta) and the most frequent cause of death reported between 2006 and 2015 was neoplasms
- Acute upper respiratory infections were the most common reason for emergency visits (among select conditions) in 2014, and had a higher rate (per 100,000 population) compared to the provincial rate (4,885.9 versus 3,601.8 Alberta); emergency room visit rates for asthma (per 100,000 population) were similar to the provincial rate (501.5 versus 496.8 Alberta) but emergency room visit rates for emphysema and chronic bronchitis were higher than the provincial rate (564.2 versus 331.1 Alberta)

Cancer and Respiratory Disease

Mortality data for the most common cancers and respiratory diseases are available for the Government of Alberta's Interactive Health Data Application (IHDA) (Government of Alberta 2018). The mortality rates (per 100,000 population) for lung, colorectal, breast, and prostate cancer for both women and men in the Calgary Zone from 2003 to 2012 are presented in Table 2-4. Mortality rates for lung, colorectal breast, and prostate cancer in women and men in the Calgary zone are similar to or less than the provincial averages.

The Alberta IHDA also provides mortality data are also available for asthma and chronic obstructive pulmonary disease (COPD) (Government of Alberta 2018). The mortality rates (per 100,000 population) for asthma and COPD in the Calgary Zone are presented as from 2000 to 2015 (see Table 2-5). Mortality rates for COPD and asthma in women and men in the Calgary zone are similar to or less than the provincial averages.

Table 15-6 Mortality Cancer Rates per 100,000 Population in the Calgary Zone from 2003 to 2014 (Provincial Averages are in Parentheses)

Year	Lung		Colorectal		Breast	Prostate
	Female	Male	Female	Male	Female	Male
2003	30.4 (34.0) ↓	50.9 (53.9) ↔	14.4 (15.2) ↔	20.0 (22.0) ↔	22 (24.4) ↓	24.8 (26.8) ↔
2004	34.3 (35.3) ↔	49.8 (52.4) ↔	15.3 (16.2) ↔	25.0 (26.1) ↔	19.2 (19.4) ↔	19.3 (24.0) ↓↓
2005	32.5 (34.9) ↔	45.0 (52.1) ↓↓	12.9 (13.9) ↔	23.3 (23.7) ↔	22.7 (21.6) ↔	17.8 (23.5) ↓↓
2006	31.8 (35.0) ↓	44.4 (47.8) ↓	12.8 (14.7) ↓	19.7 (21.0) ↔	20.8 (20.1) ↔	22.3 (23.4) ↔
2007	31.9 (33.7) ↔	38.5 (49.5) ↓↓	13.0 (15.3) ↓	19.0 (22.1) ↓	18.6 (21.3) ↓	16.6 (21.8) ↓↓
2008	35.9 (35.8) ↔	39.9 (45.4) ↓	12.5 (12.6) ↔	20.5 (21.3) ↔	17.2 (18.9) ↓	18.0 (22.8) ↓↓
2009	28.4 (34.4) ↓↓	40.6 (48.4) ↓↓	11.2 (12.6) ↓	21.9 (22.8) ↔	17.6 (19.9) ↓	19.4 (23.1) ↓
2010	26.9 (33.0) ↓↓	37.3 (45.6) ↓↓	15.0 (14.8) ↔	19.7 (20.3) ↔	16.8 (18.6) ↓	22.6 (21.9) ↔
2011	30.7 (34.8) ↓	35.9 (41.5) ↓↓	9.48 (12.0) ↓↓	19.6 (21.5) ↓	16.3 (17.8) ↓	16.7 (20.1) ↓
2012	24.6 (32.3) ↓↓	33.8 (39.5) ↓↓	11.2 (12.7) ↓	18.4 (20.0) ↔	16.2 (16.6) ↔	15.8 (19.3) ↓↓

NOTES:

Statistical significance of differences between Calgary Zone and Provincial rates (based on IHDA):

- ↑↑ significantly higher than provincial average
- ↑ slightly higher than provincial average
- ↔ similar to provincial average
- ↓ slightly lower than provincial average
- ↓↓ significantly lower than provincial average

Table 15-7 Mortality Rates per 100,000 Population for COPD and Asthma in the Calgary Zone from 2000 to 2015 (Provincial Averages are in Parentheses)

Year	COPD				Asthma			
	Female		Male		Female		Male	
2000	28.3 (27.8)	↔	56.2 (57.3)	↔	0.845 (1.5)	↓	0.126 (0.44)	↓↓
2001	28.5 (27.4)	↔	47.1 (56.4)	↓	0.18 (0.76)	↓↓	0.804 (1.31)	↓
2002	27.3 (28.5)	↔	46.3 (56.6)	↓↓	0.677 (0.70)	↔	0 (0.72)	↓↓
2003	21.5 (28.5)	↓↓	45.7 (52.3)	↓	0.599 (1.28)	↓	0.294 (0.94)	↓↓
2004	27.6 (29.3)	↔	41.0 (46.4)	↓	0.696 (1.01)	↔	0.489 (1.05)	↓
2005	23.2 (28.3)	↓↓	38.5 (51.1)	↓↓	0.667 (0.87)	↔	0.615 (0.37)	↔
2006	29.5 (28.2)	↔	40.7 (52.1)	↓↓	1.039 (1.04)	↔	0.453 (0.51)	↔
2007	26.0 (29.9)	↓	41.8 (49.0)	↓	0.577 (0.71)	↔	0.388 (0.95)	↓↓
2008	30.4 (30.9)	↔	52.5 (54.5)	↔	0.761 (0.99)	↔	0.445 (0.81)	↓
2009	22.7 (28.5)	↓↓	43.0 (47.7)	↓	0.568 (0.84)	↔	0 (0.62)	↓↓
2010	25.2 (27.1)	↔	36.7 (45.3)	↓↓	0 (0.26)	↔	0.388 (0.93)	↓
2011	28.3 (31.0)	↓	41.1 (48.2)	↓	1.021 (0.79)	↔	0.138 (0.27)	↔
2012	27.0 (30.7)	↓	30.0 (43.5)	↓↓	0 (0.35)	↓	0.303 (0.59)	↔
2013	26.1 (32.5)	↓↓	39.3 (42.6)	↓	0 (0.06)	↓↓	0.793 (0.71)	↔
2014	26.7 (28.8)	↓	27.2 (41.2)	↓↓	0.589 (0.69)	↔	0.446 (0.66)	↔
2015	28.3 (29.4)	↔	37.4 (45.1)	↓↓	0.637 (0.55)	↔	0.82 (0.67)	↔

NOTES:
Statistical significance of differences between Calgary Zone and Provincial rates (based on IHDA):

- ↑↑ significantly higher than provincial average
- ↑ slightly higher than provincial average
- ↔ similar to provincial average
- ↓ slightly lower than provincial average light
- ↓↓ significantly lower than provincial average

15.3 PROJECT INTERACTIONS WITH PUBLIC HEALTH

Table 15-8 identifies the interaction between project components with public health. Health may be affected from direct (e.g., inhalation) and indirect (e.g., ingestion of country foods) exposure to chemicals emitted from Project activities and physical works. Activities that are not expected to generate any (or nominal) amounts of emissions during construction or dry operation, are not expected to interact with public health.

Table 15-8 Project-Environment Interactions with Public Health During Construction and Dry Operations

Project Components and Physical Activities	Environmental Effects for Public Health Change to Human Health
Construction	
Clearing	✓
Channel excavation	✓
Water diversion construction	✓
Dam and berm construction	✓
Low-level outlet works construction	✓
Road construction	✓
Bridge construction	✓
Lay down areas	–
Borrow extraction	–
Reclamation	–
Dry Operations	
Maintenance	–
NOTES: ✓ = Potential interaction – = No interaction	

The potential for the Project to result in a change in human health is assessed using standard HHRA methods. The HHRA (Volume 4, Appendix O) identified two types of receptors (i.e., hypothetical people of all age groups): residential receptors and Indigenous receptors. Both residential and Indigenous receptors are assumed to have the opportunity to gather, harvest and consume local foods from the LAA including garden produce, wild plants, berries, and fish from the Elbow River. Human receptors also include visitors, tourists, and recreational users. However, these people would only be in the area temporarily and they are expected to have a lower exposure to Project-related COPCs compared to residential and Indigenous receptors who also participate in recreational and traditional activities in the area.

The following provides a rationale for the absence of project interactions with human health for both residential and indigenous receptors though exposures to air via inhalation, country foods vis ingestion, and water via ingestion (for potable water or incidental exposures during recreational activities). The criteria of timing is not applicable during dry operations because effects from Project activities would be similar regardless of season or other timing characteristics.

15.3.1 Air Quality and Public Health

There is no interaction with air quality and public health related to changes in air quality during the dry operations phase. During dry operations, vehicle and equipment use would be limited to periodic inspections and routine maintenance. Although these vehicles and equipment would emit some airborne COPCs, the emissions from the limited number of vehicles would not affect the regional air quality to a degree that could affect the health of the population.

15.3.2 Country Food and Public Health

While the main exposure route for airborne COPCs is inhalation, deposition of air contaminants onto soils have the potential to be taken up by plants and stored in their tissues. Animals may also consume soil and vegetation. The absorption of contaminants in the tissues of plants and animals could change their chemical quality and increase the amount of chemicals people could be exposed to when consuming country foods. Therefore, the HHRA considered the potential for dustfall from emissions to affect country foods and interact with the health of residential and Indigenous receptors.

To identify COPC for indirect exposure pathways related to deposition (e.g., deposition of contaminant onto soil and uptake into plants and/or animals), the fate and persistence of airborne chemical emissions are assessed. The characterization of persistence and bioaccumulation is provided in the HHRA, and is consistent with provincial (Alberta Government 2011) and federal guidance (CEPA 1999, Health Canada 2010b). Based on their chemical properties, metals and some PAHs are identified as persistent or bioaccumulative.

Because changes in soil quality are caused by deposition over time, the end of the construction phase represents the point where contaminant accumulation in the soil will have reached its highest level. Therefore, the end of the three-year construction period represents the most conservative assessment of changes in country food quality. Soil concentrations for the potentially persistent or bioaccumulative COPC are predicted based on the maximum annual deposition rates. Project-related changes in soil chemistry are considered negligible since:

- maximum changes in soil chemistry are less than 5% or
- predicted concentrations are less than health-based screening levels.

The location of maximum deposition is located near the boundary of the PDA. Deposition rates (and hence potential changes in soil chemistry) at the receptor locations are lower. Given the negligible change in soil chemistry, the potential for changes in country food quality is also considered negligible.

Even without chemical uptake from soil, dustfall onto vegetation can also make vegetation unsuitable for consumption. Dust generated by earthworks during construction is essentially inert earthen material and would have a similar chemical composition as the surrounding soil in the construction area. Dust deposition to the surrounding plants would only apply during construction, when public access to the area would be limited due to safety factors. Dust on plants would be removed by precipitation and wind on a regular basis. There are no substantial dust generating activities during dry operations. Based on these considerations, there are no project interactions with public health related to changes in country food quality during construction and dry operations.

Health Canada (2010b) indicates that an important consideration when deciding whether a country foods study is merited is whether local plants and animals are being harvested. There is a low probability that the PDA can provide sufficient country foods for local harvesters to affect human health, as described in Section 15.2.2.

With regards to traditional country food access, the PDA is currently used for ranching for several types of livestock. Therefore, vegetation in the PDA is mostly tame pasture, such as grasses with sparse shrubs and trees. The types of vegetation in the PDA provide very limited harvesting opportunities. During construction and dry operations, most of the PDA would not be accessible to the public. Based on these considerations, there are no Project interactions for changes in human health to residential or Indigenous receptors from country food during construction and dry operations.

15.3.3 Water Quality and Public Health

In consideration of both residential and Indigenous receptors, there are no project interactions with public health related to changes in water quality for drinking and recreational use during construction and dry operations.

Through the Indigenous engagement program for the Project, Tsuut'ina Nation expressed concern that effects of the Project on Elbow River would affect their ability to use the river as a source of drinking water. It is understood that Tsuut'ina Nation hold a license to withdraw water from the Elbow River, located upstream of the PDA. The Tsuut'ina Nation also reported that groundwater in the Elbow River Alluvial Aquifer is a source of drinking water for the reserve. Five registered water wells have been identified on the Tsuut'ina Nation reserve within the hydrogeology RAA.

The PDA does not overlap any confirmed or suspected contaminated site and, therefore, the project would not mobilize contaminants and affect the water quality in the Elbow River or downstream at the Glenmore Reservoir.

As described in the assessment of the surface water quality (see Section 7.0), land-based construction activities such as riparian vegetation removal or grading may result in the erosion of disturbed soils along the Elbow River. This erosion may temporarily increase levels of suspended solids in the water, which could change the level of water turbidity in the Elbow River and its tributaries. Water turbidity does not directly affect human health, and therefore would not affect the health of residential and Indigenous receptors that may use the Elbow River for recreation. However, suspended particulates may harbour microorganisms, protecting them from disinfection processes during water treatment. The Canadian drinking water quality guideline for turbidity ranges from 0.1 to 1.0 nephelometric turbidity units (NTU) for post-treated water entering the water distribution system (Health Canada 2017). The applicable guideline for turbidity depends on the type of water filtration method used; however, it is recommended that water entering the distribution system have turbidity levels of 1.0 NTU or less.

Water entering the Glenmore Water Treatment Plant is subjected to a clarification and flocculation process to remove silt, debris and microorganisms, followed by a chlorination process to disinfect the water, and a final filtration process to remove residual silt, debris and microorganisms before entering the municipal water distribution system.

The seasonal average turbidity in the Bow River is 10 NTUs. However, during the 2013 Calgary flood, water turbidity in the Bow River reached 4,000 NTUs and presumably at similar levels in the Elbow River. The Bearspaw (for the Bow River) and Glenmore (for the Elbow River) Water Treatment Plants could reduce the water turbidity from at least 4,000 NTUs to produce drinking water at 0.05 NTU during this flood period (Alberta Water Portal 2013). Project activities during construction and dry operations would not increase turbidity levels to the same magnitude as

flood conditions. Therefore, fluctuations in water turbidity during construction can be mitigated with existing water treatment processes and the effectiveness of water disinfection processes would not be adversely affected.

Vegetation along the project infrastructure would be maintained and the growth of weeds and other vegetation would be managed through various vegetation control measures. The vegetation control measures may include physical/manual removal and chemical removal with the application of herbicides. If herbicides are used to control vegetation growth, they would be applied in accordance with the Alberta government's Environmental Code of Practices for Pesticides (Alberta Government 2010). The Environmental Code of Practices for Pesticides provides procedures for the safe application of pesticides to protect people and the environment, and are considered to adequately protect water in the Elbow River used by residential and Indigenous receptors for drinking and recreational purposes.

Groundwater quantity and quality are not expected to be materially affected due to the limited extent and duration of Project effects on groundwater. Therefore, it is anticipated that there will be no effects on the ability of Tsuut'ina Nation to use groundwater in the Elbow River Alluvial Aquifer or the Elbow River for drinking water; effects to functioning of the identified wells on the Tsuut'ina Nation reserve within the hydrogeology RAA are not anticipated (See Section 14.3.23).

During the dry operations phase, stormwater runoff would drain into the diversion channel and the off-stream reservoir for eventual release into the Elbow River through the low-level outlet channel. As noted, concerns with runoff are primarily related to the potential for increased turbidity to affect municipal treatment. Sedimentation and erosion control measures would be implemented to mitigate the effects on water turbidity. Residual suspended solids would either settle out of the water column in the Glenmore Reservoir or be removed by water filtration processes at the Glenmore Water Treatment Plant before distribution through the municipal water distribution system. Therefore, there are no Project interactions for changes in human health from changes in water quality during dry operations.

15.4 ASSESSMENT OF RESIDUAL ENVIRONMENTAL EFFECTS ON PUBLIC HEALTH

15.4.1 Analytical Assessment Techniques

15.4.1.1 Human Health Risk Assessment Methodology

The HHRA is an evaluation process used to describe the nature and magnitude of the risk associated with the exposure of human receptors to a potential hazard (e.g., chemical emission). An HHRA combines information on potential receptors with exposure data and identified hazards (i.e., toxicity) to determine the relative level of risk resulting from an operation.

The HHRA (Volume 4, Appendix O) is composed of the following major components.

- Site Characterization: This component includes a review and compilation of existing information, such as the major Project components and related activities, as well as the findings of biophysical and land use studies completed for the Project.
- Problem Formulation: Problem formulation includes identification of the environmental hazards that may pose a health risk (i.e., COPC), potential human receptors (which for this Project, are characterized as residential receptors and Indigenous receptors), and relevant exposure pathways (e.g., inhalation of COPC in air). The problem formulation directs the HHRA at the key areas and issues of concern related to the Project emissions.
- Exposure Assessment: The exposure assessment is the qualitative or quantitative evaluation of the likelihood or degree to which the receptors will be exposed to the hazard, and considers both the quality of the environmental media (e.g., COPC concentrations in air or food), and receptor characteristics (e.g., food consumption rates).
- Toxicity Assessment: This part of the assessment includes the identification of published, scientifically reviewed toxicity reference values for each of the COPC against which the receptor exposures can be compared.
- Risk Characterization: At this stage, a qualitative or quantitative assessment of the health risk of each COPC to each receptor, based on the degree of exposure is completed. For this assessment, health risks are described using exposure ratios, as described in Section 15.4.1.2.
- Uncertainty Assessment: A review of the assumptions and data gaps associated with the risk estimation is completed.

15.4.1.2 Project-Related Air Emissions

As indicated in Section 15.3, a change to human health may occur from exposure to airborne emissions produced from project activities during construction. The Project-related COPCs in air emissions are:

- Criteria air contaminants: sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter less than 2.5 micrometres in diameter ($PM_{2.5}$), and diesel exhaust particulate (DEP)
- Volatile organic compounds: 1,3-butadiene, 2,2,4-trimethylpentane, acetaldehyde, acrolein, benzene, ethylbenzene, formaldehyde, propionaldehyde, toluene and xylenes
- Polycyclic aromatic hydrocarbons: acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, naphthalene, phenanthrene, and pyrene
- Metals (from vehicle exhaust): arsenic, chromium, mercury, manganese, nickel

15.4.1.3 Human Receptors and Receptor Locations

Human receptors are people within the study area that could be exposed to COPCs, while human receptor locations are the places where they are likely to be present. The characterization of human receptors is important because distinct groups of people (e.g., infants, elderly, people with existing health conditions, and Indigenous people) may have varying degrees of sensitivity to a COPC, or their behaviours may cause them to be exposed to COPCs in different ways. For many air contaminants, children with asthma, people with COPD, and the elderly are considered the sensitive sub-groups. Members of these sensitive sub-groups may be present at any residential location; however, their presence is more likely at institutional facilities such as schools, hospitals, retirement complexes, and assisted care homes.

Human receptors are hypothetical people of all age group (e.g., infant, toddler, child, adolescent, or adult) who could potentially be exposed to the COPC. Two types of receptors are considered for the evaluation of risks to human health: a residential receptor and an Indigenous receptor. Both residential and Indigenous receptors are assumed to have the opportunity to gather, harvest and consume local foods from the study area including garden produce, wild plants, berries, and fish from the Elbow River. Human receptors also include visitors, tourists, and recreational users. However, these people would only be in the area temporarily and they are expected to have a lower exposure to Project-related COPCs compared to residential and Indigenous receptors who also participate in recreational and traditional activities in the area.

Workers for the Project are not included as human receptors in the HHRA. Worker health and safety is addressed through compliance with applicable provincial (Work Safe Alberta) and federal legislation. Non-work related exposures of these persons (e.g., recreational activities within the study area during non-work hours) would be the same as the other human receptors already identified.

Human receptor locations are important if the exposure to a COPC is dependent on the location of the person. For example, exposure to airborne COPCs is dependent on the location of the person, since the concentration in the air will vary between locations. In total, 58 receptor locations within a 5 km radius of the PDA are considered in the HHRA. Locations in the study area that are further than 5 km from the PDA would experience less change in air quality, and there would be a lower degree of change in the health risk. The receptor locations represent the range of current and anticipated future land use in the LAA, including residential, recreational, educational, commercial, and industrial uses. Table 15-9 lists the 58 human receptor locations along with their coordinates and a description of the location. The human receptor locations are also illustrated in Figure 15-2.

Receptor locations identified in Table 15-9 as those where Indigenous receptors are likely to be present correspond to locations on the Tsuut'ina Nation reserve. Each receptor location is also characterized according to type of land use (e.g., residential, recreational, industrial, educational) and occupancy or frequency of use (e.g., permanent, seasonal, or temporary). For many air contaminants, children with asthma, people with COPD, and the elderly are considered the sensitive sub-groups and may be present at any of the residential locations. However, in recognition of the higher public concerns associated with institutional facilities where the presence of these sensitive sub-groups are more likely to be present, the locations of schools, hospitals, retirement complexes, and assisted care homes have been clearly identified as special receptors in Table 15-9. The modelled concentrations of airborne COPCs at the 58 human receptor locations are listed in the air quality and climate assessment (Volume 3A, Section 3).

Table 15-9 Human Receptor Locations for Air Quality

Receptor ID	Zone 11 UTM Coordinates		Land Use, Occupancy (Receptor Location Description)	Approximate Distance to PDA (m)	Indigenous Receptor	Special Receptor
	Easting (m)	Northing (m)				
SR1	676781	5661332	Residential, Permanent (rural residence 1,000 m from intersection of Highway 1 and Highway 22)	22	-	-
SR2	678048	5662120	Residential, Permanent (rural residence 750 m from intersection of Highway 1 and Highway 22)	457	-	-
SR3	678552	5662111	Residential, Permanent (rural residence 450 m south of Highway)	730	-	-
SR4	679819	5660801	Residential, Permanent (rural residence adjacent to Springbank Road)	44	-	-
SR5	680547	5660634	Residential, Permanent (rural residence 255 m from intersection of Springbank Road and Range Road 40)	231	-	-
SR6	681210	5661082	Residential, Permanent (rural residence adjacent to Range Road 40)	924	-	-
SR7	682145	5661010	Residential, Permanent (rural residence adjacent to Range Road 35)	1,457	-	-
SR8	683263	5660233	Residential, Permanent (rural residence adjacent to Springbank Road)	1,619	-	-

Table 15-9 Human Receptor Locations for Air Quality

Receptor ID	Zone 11 UTM Coordinates		Land Use, Occupancy (Receptor Location Description)	Approximate Distance to PDA (m)	Indigenous Receptor	Special Receptor
	Easting (m)	Northing (m)				
SR9	677002	5660074	Residential, Permanent (rural residence 520 m from intersection of Springbank Road and Highway 22)	202	-	-
SR10	676827	5659179	Residential, Permanent (rural residence adjacent to Highway 22)	616	-	-
SR11	677449	5658688	Residential, Permanent (rural residence adjacent to Highway 22)	96	-	-
SR12	680518	5660339	Residential, Permanent (rural residence 260 m from intersection of Springbank Road and Range Road 40)	19	-	-
SR13	680670	5660343	Residential, Permanent (rural residence 110 m from intersection of Springbank Road and Range Road 40)	103	-	-
SR14	680684	5660190	Residential, Permanent (rural residence 245 m from intersection of Springbank Road and Range Road 40)	62	-	-
SR15	681089	5660001	Residential, Permanent (rural residence 545 m from intersection of Springbank Road and Range Road 40)	53	-	-
SR16	682288	5658906	Residential, Permanent (rural residence adjacent to Range Road 35)	59	-	-

Table 15-9 Human Receptor Locations for Air Quality

Receptor ID	Zone 11 UTM Coordinates		Land Use, Occupancy (Receptor Location Description)	Approximate Distance to PDA (m)	Indigenous Receptor	Special Receptor
	Easting (m)	Northing (m)				
SR17	683867	5659435	Residential, Permanent (rural residence adjacent to Range Road 34)	1,589	-	-
SR18	677183	5658120	Residential, Permanent (rural residence adjacent to Highway 22)	215	-	-
SR19	677141	5657024	Residential, Permanent (rural residence adjacent to Township Road 242)	53	-	-
SR20	677303	5656696	Residential, Permanent (rural residence adjacent to Township Road 242)	35	-	-
SR21	679639	5656961	Residential, Permanent (rural residence adjacent to Elbow River)	1,008	-	-
SR22	680364	5657431	Residential, Permanent (rural residence in wooded area adjacent to Elbow River)	565	-	-
SR23	681065	5657451	Residential, Permanent (rural residence in wooded area adjacent to Elbow River)	893	-	-
SR24	682806	5658065	Residential, Permanent (rural residence in wooded area adjacent to Elbow River)	307	-	-
SR25	677400	5657051	Commercial, Permanent (commercial premises adjacent to intersection of Township Road 242 and Highway 22)	179	-	-

Table 15-9 Human Receptor Locations for Air Quality

Receptor ID	Zone 11 UTM Coordinates		Land Use, Occupancy (Receptor Location Description)	Approximate Distance to PDA (m)	Indigenous Receptor	Special Receptor
	Easting (m)	Northing (m)				
SR26	676700	5654151	Residential, Permanent (rural residence in wooded area adjacent to Elbow River)	301	-	-
SR27	677250	5653751	Residential, Permanent (rural residence in wooded area)	866	✓	-
SR28	677250	5653751	Recreational, Permanent (Entheos Conference and Retreat Centre)	845	✓	-
SR29	677500	5653751	Residential, Permanent (rural residence in wooded area)	923	✓	-
SR30	677500	5654001	Residential, Permanent (rural residence in wooded area)	755	-	-
SR31	677500	5654001	Residential, Permanent (rural residence in wooded area)	732	-	-
SR32	677750	5654251	Residential, Permanent (rural residence in wooded area)	750	-	-
SR33	678000	5654501	Residential, Permanent (rural residence in wooded area)	933	-	-
SR34	678250	5654751	Residential, Permanent (rural residence in wooded area)	1,041	-	-
SR35	678250	5654751	Residential, Permanent (rural residence in wooded area)	1,020	-	-

Table 15-9 Human Receptor Locations for Air Quality

Receptor ID	Zone 11 UTM Coordinates		Land Use, Occupancy (Receptor Location Description)	Approximate Distance to PDA (m)	Indigenous Receptor	Special Receptor
	Easting (m)	Northing (m)				
SR36	682450	5659251	Residential, Permanent (rural residence adjacent to Range Road 35)	355	-	-
SR37	681250	5657501	Residential, Permanent (rural residence in wooded area adjacent to Elbow River)	965	-	-
SR38	677800	5656551	Recreational, Temporary (Camp Gardner)	640	-	-
SR39	677350	5655701	Recreational, Temporary (Kamp Kiwanis)	200	-	-
SR40	676400	5657101	Residential, Permanent (rural residence adjacent to Township Road 242	217	-	-
SR41	676750	5657001	Residential, Permanent (rural residence adjacent to Township Road 242	69	-	-
SR42	676250	5663001	Residential, Permanent (rural residence 1,250 m from intersection of Highway 1 and Highway 22	1,105	-	-
SR43	678000	5662751	Residential, Permanent (rural residence 600 m from intersection of Highway 1 and Highway 22	944	-	-
SR44	685500	5660501	Educational, Permanent (Springbank Community High School and Springbank Park for All Seasons)	3,893	-	✓

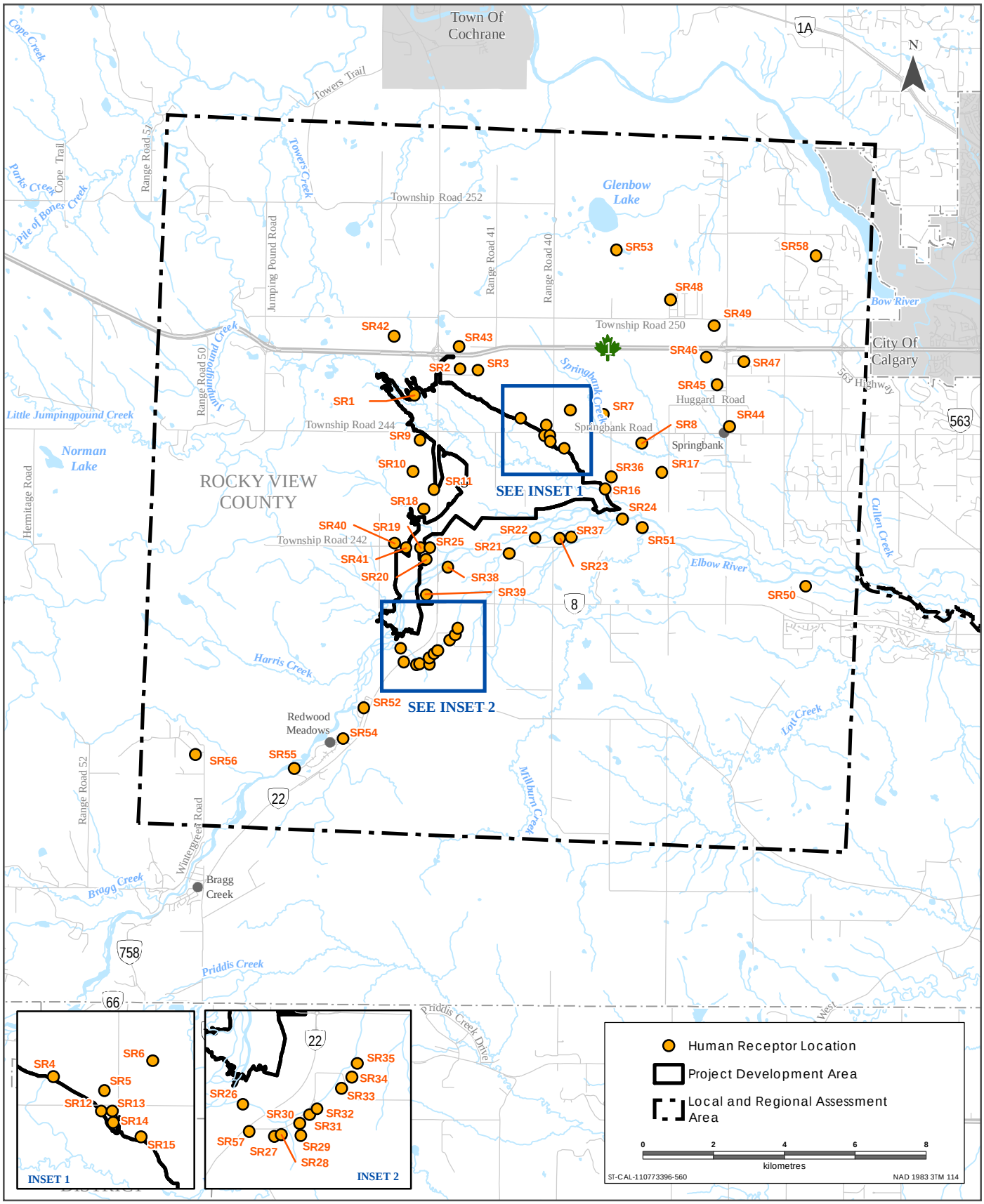
Table 15-9 Human Receptor Locations for Air Quality

Receptor ID	Zone 11 UTM Coordinates		Land Use, Occupancy (Receptor Location Description)	Approximate Distance to PDA (m)	Indigenous Receptor	Special Receptor
	Easting (m)	Northing (m)				
SR45	685000	5662001	Educational, Permanent (Springbank Middle School and Elbow Valley Elementary School)	4,318	-	✓
SR46	685000	5662501	Recreational, Seasonal (Calaway Park)	4,653	-	-
SR47	685500	5662501	Commercial, Permanent (Commercial area adjacent to Highway 1)	5,310	-	-
SR48	683500	5664001	Industrial, Permanent (Springbank Airport)	5,133	-	-
SR49	684500	5663501	Educational, Permanent (The Edge School)	5,442	-	✓
SR50	687500	5657001	Recreational, Seasonal (Glencoe Golf and Country Club)	5,713	-	-
SR51	683250	5658001	Recreational, Seasonal (River Spirit Golf Club)	845	-	-
SR52	675750	5652751	Residential, Permanent (Redwood Meadows community)	2,132	✓	-
SR53	682000	5665001	Residential, Permanent (Harmony community)	5,521	-	✓

Table 15-9 Human Receptor Locations for Air Quality

Receptor ID	Zone 11 UTM Coordinates		Land Use, Occupancy (Receptor Location Description)	Approximate Distance to PDA (m)	Indigenous Receptor	Special Receptor
	Easting (m)	Northing (m)				
SR54	675000	5651501	Recreational, Seasonal (Curtis Field Park)	3,178	✓	-
SR55	674000	5650501	Recreational, Seasonal (Redwood Meadows Golf and Country Club)	4,639	✓	-
SR56	671500	5651001	Recreational, Seasonal (Wintergreen Golf and Country Club)	6,368	-	-
SR57	676750	5653751	Recreational, Seasonal (Bragg Creek Paintball)	689	✓	-
SR58	688500	5666001	Recreational, Seasonal (Springbank Links Golf Course)	8,850	-	-

NOTE:
Special Receptor Location - Location where sensitive sub-groups are more likely to be present, such as schools, hospitals, retirement complexes, and assisted care homes



Sources: Base Data - ESRI, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Human Receptor Locations

Stantec

15.4.1.4 Exposure Ratio and Exposure Limits

Two basic categories of contaminants are commonly recognized by regulatory agencies and applied when assessing human health risk. These are the "threshold" approach (typically used to evaluate non-carcinogens) and the "non-threshold" approach (typically used for carcinogenic compounds). In the EIA, it is common to use the concept of exposure ratio (ER) to facilitate comparison of risks associated with both classes of chemicals (Alberta Government 2011). For threshold COPC, the ER is the ratio of the estimated receptor exposure to the exposure limit (or toxicological reference value; TRV); for carcinogens, the ratio is equal to the estimated exposure concentration or dose to the risk-specific concentration or dose, respectively, where the latter are expressed in relation to the accepted target incremental lifetime cancer risk (i.e., 1 in 100,000) (Alberta Government 2011). The potential risk expressed as an ER is calculated as follows:

$$\text{Exposure Ratio (unitless)} = \frac{\text{Exposure Estimate}}{\text{Exposure Limit (or TRV)}}$$

For inhalation exposures to chemicals of potential concern (COPC), an ER that is less than 1.0 represents a low or negligible health risk. An ER that is greater than 1.0 suggests a potentially unacceptable risk to human health, and indicates that a more detailed evaluation may be required to characterize the potential health risk (Alberta Government 2011, Health Canada 2010a).

For the assessment of carcinogenic effects, the risk-specific concentrations (and the ER) are only applicable to the Project alone scenario as they are developed to address cancer risks that are above background (i.e., the ILCR). There are no regulatory benchmarks of acceptable or tolerable cancer risk for background cancers (Alberta Government 2011). Exposure ratios for carcinogens for Base and Application Cases are provided for context, but are not compared to the target of 1.0.

Exposure estimates are the predicted concentrations of airborne COPCs that are modelled as part of air quality and climate assessment (Volume 3A, Section 3.0). The exposure limits, also known as toxicological reference values, are derived using a conservative approach intended to protect human health, including sensitive members of the population such as infants, children, the elderly and women of child-bearing age. These are described in more detail in the HHRA (Volume 4, Appendix O, Section 4.2), and are summarized in Table 15-10.

The ERs for inhalation exposures are calculated for three scenarios known as the Base Case, Project Case, and Application Case, which are defined as follows:

- Base Case: ERs for the Base Case represent health risks under current, pre-Project conditions, and the contribution of future projects or activities that have been approved

- Project Case: ERs for the Project Case represent health risks of the Project in isolation (i.e., potential effects of the Project alone)
- Application Case: ERs for the Application Case represent health risks of the Project in combination with the baseline conditions (i.e., Application Case = Base Case + Project Case)

By comparing the Base, Project, and Application Case ERs, the change in health risk from the Project can be characterized.

The HHRA also qualitatively assessed the planned development case, which considered the potential risks associated with the Project in combination with other existing and approved projects as well as planned or proposed projects and other reasonably foreseeable future activities (i.e., Planned Development Case = Application Case + future projects).

The Project may also change the area of land available for country food harvesting by limiting access to areas where country foods are available and actively harvested. A reduction in the available area of land for country food harvesting could lead to food scarcity if there is a high dependency on the affected land area for food.

Table 15-10 Toxicological Reference Values

Chemical of Potential Concern	Exposure Period	Toxicological Reference Value	Critical Effect	Reference
Criteria Air Contaminants				
Nitrogen Dioxide	Acute (1-hour) [a]	114 µg/m^3	Respiratory effects	CAAQS 2017
	Chronic (Annual)	32 µg/m^3	Respiratory effects	CAAQS 2017
Sulphur Dioxide	Acute (1-hour)[a]	183 µg/m^3	Respiratory effects	CAAQS 2017
	Chronic (Annual)	13 µg/m^3	Respiratory effects	CAAQS 2017
Carbon Monoxide	Acute (1-hour)	15,000 µg/m^3	Oxygen carrying capacity of blood	Health Canada (1994)
	Acute (8-hour)	6,000 µg/m^3	Oxygen carrying capacity of blood	Health Canada (1994)

Table 15-10 Toxicological Reference Values

Chemical of Potential Concern	Exposure Period	Toxicological Reference Value	Critical Effect	Reference
$PM_{2.5}$	Acute (1-hour)	80 µg/m³	Health (not specified)	AAAQO
	Acute (24-hour) [a]	28 µg/m³	Health (not specified)	CAAQS
	Chronic (Annual) [a]	10 µg/m³	Health (not specified)	CAAQS
DEP	Acute (2-hour) [b]	10 µg/m³	Respiratory effects	Health Canada (2016b)
	Chronic (Annual)	5 µg/m³	Respiratory effects	Health Canada (2016b)
Volatile Organic Compounds				
1,3-butadiene	Acute (1-hour)	660 µg/m³	Developmental Effects	OEHHA (2013)
	Chronic (annual)	2 µg/m³	Ovarian atrophy	US EPA IRIS (2002)
	Chronic (Annual)	0.3 µg/m³	Leukemia	US EPA IRIS (2002)
2,2,4-trimethylpentane	Acute (1-hour)	19,000 µg/m³	Neurological function effects	TCEQ (2016)
	Chronic (Annual)	1,800 µg/m³	Free-standing (systemic effects)	TCEQ (2016)
Acetaldehyde	Acute (1-hour)	470 µg/m³	Respiratory effects	AAAQO
	Chronic (annual)	4.5 µg/m³	Cancer (nasal)	US EPA IRIS (1991)
Acrolein	Acute (1-hour)	4.5 µg/m³	Eye irritation	Ontario MOE (2009)
	Chronic (annual)	0.35 µg/m³	Nasal lesions	AAAQO

Table 15-10 Toxicological Reference Values

Chemical of Potential Concern	Exposure Period	Toxicological Reference Value	Critical Effect	Reference
Benzene	Acute (1-hour)	30 µg/m³	Blood toxicity (bone marrow depression)	ATSDR (2007b)
	Chronic (annual)	30 µg/m³	decreased lymphocyte count	US EPA IRIS (2003)
	Chronic (annual)	3 µg/m³	Leukemia	Health Canada (2010c), AAAQO
Ethylbenzene	Acute (1-hour)	86,000 µg/m³	Ototoxicity (hearing loss)	TCEQ (2015c)
	Chronic (annual)	1,000 µg/m³	Developmental toxicity	US EPA IRIS (1991b)
Formaldehyde	Acute (1-hour)	50 µg/m³	Eye and nose irritation	TCEQ (2008)
	Chronic (Annual)	11 µg/m³	Eye, nose, and lower airway discomfort	TCEQ (2008)
	Chronic (Annual)	2 µg/m³	Nasal squamous tumours	Health Canada (2001)
Propionaldehyde	Chronic (annual)	8 µg/m³	Atrophy of olfactory epithelium	USEPA (2008b)
Toluene	Acute (1-hour)	15,000 µg/m³	Neurological	TCEQ (2015)
	Acute (24-hour)	7,600 µg/m³	Neurological	ATSDR (2015)
	Chronic (annual)	3,800 µg/m³	Neurological	Health Canada (2010c), Alberta Government (2016)
Xylenes	Acute (1-hour)	7,400 µg/m³	Neurological and mild respiratory effects	TCEQ(2015d)
	Chronic (annual)	180 µg/m³	Developmental effects	Health Canada (2010c), Alberta Government (2016)

Table 15-10 Toxicological Reference Values

Chemical of Potential Concern	Exposure Period	Toxicological Reference Value	Critical Effect	Reference
Polycyclic Aromatic Hydrocarbons				
Benzo(a)pyrene	Annual	0.0009µg/m^3	Cancer (respiratory system)	OEHHA (2011)
Naphthalene	Chronic (annual)	3 µg/m^3	Nasal effects (hyperplasia and metaplasia in respiratory and olfactory epithelium, respectively)	US EPA IRIS (1998), ATSDR (2005), AAAQO
Metals in Air Emissions				
Arsenic	Acute (1-hour)	0.1 µg/m^3	Respiratory effects	AAAQO
	Chronic (Annual)	0.01 µg/m^3	Lung cancer	AAAQO
Chromium (VI)	Acute (1-hour)	1.3 µg/m^3	Respiratory effects	TCEQ (2014)
	Chronic (annual)	0.0043 µg/m^3	Lung cancer	TCEQ (2014)
Manganese	Acute (1-hour)	9.1 µg/m^3	Respiratory effects	TCEQ (2017a)
	Chronic (annual)	0.84 µg/m^3	Neurological effects	TCEQ (2017a)
Mercury	Acute (1-hour)	0.6 µg/m^3	Neurological effects	OEHHA (2008)
	Chronic (Annual)	0.03 µg/m^3	Neurobehavioral effects	OEHHA (2008)
Nickel	Acute (1-hour)	6.0 µg/m^3	Respiratory effects	AAAQO
	Chronic (annual)	0.05 µg/m^3	Lung cancer	AAAQO

NOTES:

[a] value is based on a statistical comparison. Please refer to details in individual contaminant write-up in the human health risk assessment report (Volume 4, Appendix O)

15.4.2 Project Pathways

During the construction phase, combustion exhaust and fugitive dust would emit COPCs, including CACs such as NO_2, SO_2, CO, $PM_{2.5}$, and DEP. COPCs also include VOCs, PAHs, and metals. These COPCs may be inhaled by residential and Indigenous receptors, and this exposure may result in an increased health risk.

Ground-level concentrations of the COPCs are modelled for construction (see Volume 3A, Section 3).

15.4.3 Mitigation

15.4.3.1 Health Risk from Inhalation

The mitigation measures described in the assessment of air quality and climate (see Section 3.4.3) during construction would reduce emissions of COPCs. Examples of mitigation measures for air quality and climate include:

- Project construction vehicles will be required to meet current emission control standards.
- Engines and exhaust systems will be properly maintained. Will not operate equipment, including construction equipment, that shows excessive emissions of exhaust gases until corrective repairs or adjustments are made.
- Dust generating construction activities will be suspended during periods of excessive winds whereby dust suppression measures are not working adequately.
- During dry periods, water will be applied to haul roads and/or disturbed areas to mitigate dust emissions. The application of water will be limited to non-freezing temperatures to prevent icing that can present a safety hazard. Watering is most effective immediately after application, and repeated watering several times a day may be required, depending on surface and meteorological conditions.
- Chemical dust suppressants will be applied to haul roads as an alternative option to watering. While chemical dust suppressants can be more effective at controlling fugitive dust than watering; they are also more expensive. Therefore, chemical dust suppression will be applied on an as-needed basis during high wind conditions or if PM concentrations are in exceedance of the Alberta Air Quality Objectives and if an increase of watering is determined ineffective or unfeasible at the time. Examples of suppressants include chlorides, petroleum products, liquid polymer emulsions, and agglomerating chemicals. These suppressants, if required, will be applied, as per the manufacturer's recommendations, to preclude unintended environmental effects.
- The construction schedule may also be adjusted to reduce the number of dust generating vehicles operating in an area during dry periods with high wind conditions.

These mitigation measures are intended to reduce the potential change in air quality (see Volume 3A, Section 3.4.4), which indirectly reduces the potential for a change to human health for both residential and Indigenous receptors.

No additional types of mitigation measures are recommended for the public health related to inhalation.

15.4.4 Characterization of Residual Effects for Change to Human Health

15.4.4.1 Health Risk from Inhalation

Criteria Air Contaminants

The characterization of residual effects to health from inhalation is based on the construction phase ERs. Table 15-11 shows the ERs for CACs at the maximum point of impingement (MPOI) location. The MPOI is the location with the maximum predicted exposure concentration in the LAA/RAA. For the Base Case (i.e., existing conditions), the MPOI location corresponds to an existing emission source (e.g., industrial facility or major roadway). For the Project Case (i.e., Project emissions only, excluding Base Case and background emissions) and Application Case (i.e., Base Case + Project Case = Application Case; which represents the conditions during the construction phase), the MPOI location corresponds to a location along the boundary of the PDA. The predicted exposure concentrations at the MPOI location are used for screening purposes, and they do not correspond to human receptor locations.

Table 15-11 Exposure Ratios at the Maximum Point of Impingement for Criteria Air Contaminants

Criteria Air Contaminant	Averaging Period	Exposure Ratio at the Maximum Point of Impingement		
		Base	Project	Application
Nitrogen Dioxide	1-hour	9.0E-01	3.1E+00	3.3E+00
	Annual	1.3E+00	6.8E-01	1.3E+00
Sulphur Dioxide	1-hour	3.5E-02	4.5E-02	7.5E-02
	Annual	2.1E-01	1.2E-02	2.1E-01
Carbon Monoxide	1-hour	6.9E-02	2.0E-01	2.3E-01
	8-hour	1.4E-01	3.4E-01	4.1E-01
Particulate Matter ($PM_{2.5}$)	1-hour	3.4E-01	3.7E+00	3.9E+00
	24-hour	6.6E-01	2.1E+00	2.6E+00
	Annual	7.2E-01	1.2E+00	1.6E+00
Diesel Emission Particulate (DEP)	1-hour	1.1E+00	1.8E+01	1.8E+01
	Annual	5.1E-01	7.2E-01	7.7E-01

NOTE:
Shaded cell indicates a ER greater than 1.0

The results indicate that the health risk from exposure to SO_2 and CO are less than 1.0 at the MPOI. This indicates that there are no unacceptable risks to human health from SO_2 and CO throughout the LAA/RAA. The ERs for NO_2 (1-hour and annual), $PM_{2.5}$ (1-hour, 24-hours, and annual), and DEP (1-hour) are greater than 1.0 at the MPOI location near the boundary of the PDA. The ERs at the 58 human receptor locations are examined in greater detail for NO_2, $PM_{2.5}$ and DEP. The ERs for NO_2, $PM_{2.5}$ and DEP at the human receptor locations are shown in Table 15-12, Table 15-13 and Table 15-14.

The ERs for annual NO_2 are less than 1.0, and indicate that there are no unacceptable health risks from chronic exposure to NO_2. The ERs for 1-hour NO_2 are greater than 1.0 at four residential receptor locations (SR01, SR 09, SR19, and SR41), which are within 100 m of the PDA. This indicates that there are potentially unacceptable acute risks from exposure to NO_2. However, given that the ERs at these locations range from 1.0 to 1.1, the overall conservative nature of the air quality model, and the uncertainty factors applied in the derivation of the TRVs, it is improbable that there would be an unacceptable risk from acute NO_2 exposure. Further mitigations can also be implemented to reduce emissions of NO_2, including operational adjustments that reduce the number of vehicles and equipment that operate in an area.

For $PM_{2.5}$, the short-term (1-hour or 24-hour), and in some locations long-term (annual), ERs are greater than 1.0 at 16 residential receptor locations (SR05, SR10, SR11, SR12, SR13, SR14, SR15, SR16, SR18, SR19, SR20, SR25, SR36, SR38, SR40 and SR41). These residential receptor locations are located near project activities associated with the construction of the diversion structure and diversion channel along Highway 22 (Cowboy Trail), and the borrow material area at the intersection of Springbank Road and Range Road 40. Thirteen of the 16 residential receptor locations are located within 100 m of the PDA, while receptor locations SR10 and SR38 are located 600 m from the PDA. These receptor locations do not include Indigenous receptor locations, or institutional facilities such as schools. The ERs are less than 1.0 at receptor locations farther than 600 m from the PDA.

The results indicate that with partial mitigations to reduce $PM_{2.5}$ along the haul road and borrow material area, there could still be an unacceptable short-term risk to human health for residents and people adjacent to the PDA.

Concentrations of $PM_{2.5}$ are expected to be lower than the modelled predictions. More intensive dust mitigation measures can be applied during the construction phase. These mitigations include dust suppressants or water on haul roads on an as-needed basis during dry periods with high wind conditions. Real-time $PM_{2.5}$ monitors can be deployed in the areas of concern to indicate when more intensive dust mitigation measures may be needed. The construction schedule may also be adjusted to reduce the number of dust generating vehicles operating in an area during dry periods with high wind conditions.

These more intensive mitigation measures are intended to reduce the potential change in air quality, which effectively reduces the potential risk to human health. The mitigation measures are expected to be effective in reducing concentrations of $PM_{2.5}$ below the applicable TRV at human receptor locations near the PDA. Consequently, $PM_{2.5}$ can be managed to levels that do not result in an unacceptable risk to human health.

Table 15-12 Exposure Ratios for NO_2 at Human Receptor Locations (Construction)

Human Receptor Location	Exposure Ratio (unitless)					
	1-hour NO_2			Annual NO_2		
	Base	Project	Application	Base	Project	Application
SR01	3.1E-01	9.6E-01	1.1E+00	2.0E-01	2.0E-01	3.8E-01
SR02	4.9E-01	7.6E-01	8.6E-01	2.6E-01	7.9E-02	3.4E-01
SR03	4.1E-01	7.2E-01	8.1E-01	2.4E-01	8.2E-02	3.2E-01
SR04	2.1E-01	7.4E-01	8.3E-01	1.7E-01	1.6E-01	3.3E-01
SR05	2.3E-01	7.7E-01	8.6E-01	1.9E-01	1.5E-01	3.3E-01
SR06	2.2E-01	6.7E-01	7.6E-01	2.0E-01	8.2E-02	2.8E-01
SR07	2.1E-01	6.0E-01	7.2E-01	1.9E-01	6.1E-02	2.5E-01
SR08	1.9E-01	6.2E-01	7.1E-01	1.8E-01	7.2E-02	2.5E-01
SR09	3.4E-01	1.0E+00	1.1E+00	1.9E-01	1.5E-01	3.4E-01
SR10	2.8E-01	7.8E-01	8.7E-01	1.8E-01	1.3E-01	3.0E-01
SR11	6.6E-01	8.6E-01	9.7E-01	3.7E-01	1.8E-01	5.1E-01
SR12	2.1E-01	8.3E-01	9.2E-01	1.7E-01	2.1E-01	3.8E-01
SR13	2.2E-01	8.1E-01	9.0E-01	1.8E-01	2.0E-01	3.7E-01
SR14	2.1E-01	8.7E-01	9.6E-01	1.7E-01	2.5E-01	4.2E-01
SR15	2.1E-01	8.3E-01	9.2E-01	1.7E-01	2.6E-01	4.2E-01
SR16	1.5E-01	7.6E-01	8.5E-01	1.5E-01	2.1E-01	3.5E-01
SR17	1.7E-01	6.0E-01	6.9E-01	1.5E-01	9.1E-02	2.4E-01
SR18	3.9E-01	8.9E-01	9.8E-01	2.0E-01	2.2E-01	4.0E-01
SR19	3.0E-01	9.1E-01	1.0E+00	1.8E-01	5.3E-01	7.0E-01
SR20	3.7E-01	8.3E-01	9.2E-01	2.0E-01	2.8E-01	4.6E-01
SR21	1.6E-01	6.1E-01	7.1E-01	1.5E-01	1.2E-01	2.7E-01
SR22	1.4E-01	6.3E-01	7.2E-01	1.4E-01	1.2E-01	2.6E-01
SR23	1.4E-01	5.9E-01	6.8E-01	1.4E-01	1.1E-01	2.5E-01
SR24	1.4E-01	5.1E-01	6.0E-01	1.4E-01	1.1E-01	2.5E-01
SR25	4.2E-01	8.8E-01	9.8E-01	2.3E-01	3.3E-01	5.4E-01

Table 15-12 Exposure Ratios for NO_2 at Human Receptor Locations (Construction)

Human Receptor Location	Exposure Ratio (unitless)					
	1-hour NO_2			Annual NO_2		
	Base	Project	Application	Base	Project	Application
SR26	3.1E-01	7.1E-01	8.4E-01	1.8E-01	3.4E-02	2.1E-01
SR27	4.1E-01	6.2E-01	8.2E-01	2.1E-01	3.2E-02	2.3E-01
SR28	4.1E-01	6.2E-01	8.2E-01	2.1E-01	3.2E-02	2.3E-01
SR29	4.5E-01	6.2E-01	8.3E-01	2.0E-01	3.4E-02	2.3E-01
SR30	5.8E-01	6.2E-01	8.5E-01	4.3E-01	3.8E-02	4.6E-01
SR31	5.8E-01	6.2E-01	8.5E-01	4.3E-01	3.8E-02	4.6E-01
SR32	4.6E-01	6.0E-01	8.4E-01	2.9E-01	4.3E-02	3.2E-01
SR33	3.1E-01	5.9E-01	7.7E-01	2.0E-01	4.9E-02	2.4E-01
SR34	2.8E-01	6.0E-01	7.8E-01	1.8E-01	5.7E-02	2.3E-01
SR35	2.8E-01	6.0E-01	7.8E-01	1.8E-01	5.7E-02	2.3E-01
SR36	1.7E-01	7.7E-01	8.6E-01	1.5E-01	1.6E-01	3.1E-01
SR37	1.4E-01	5.8E-01	7.0E-01	1.4E-01	1.1E-01	2.5E-01
SR38	3.6E-01	7.5E-01	8.5E-01	2.4E-01	1.6E-01	3.8E-01
SR39	3.9E-01	7.4E-01	8.4E-01	2.0E-01	9.4E-02	2.8E-01
SR40	2.3E-01	8.8E-01	9.7E-01	1.5E-01	1.5E-01	3.0E-01
SR41	2.6E-01	1.0E+00	1.1E+00	1.6E-01	3.0E-01	4.5E-01
SR42	5.6E-01	6.6E-01	7.9E-01	3.1E-01	7.0E-02	3.6E-01
SR43	8.1E-01	6.4E-01	8.5E-01	6.4E-01	5.7E-02	6.6E-01
SR44	1.9E-01	3.5E-01	4.7E-01	2.0E-01	3.8E-02	2.4E-01
SR45	2.2E-01	2.6E-01	3.6E-01	1.8E-01	1.8E-02	2.0E-01
SR46	3.1E-01	2.2E-01	3.6E-01	2.2E-01	1.4E-02	2.3E-01
SR47	3.4E-01	2.4E-01	3.9E-01	2.2E-01	1.4E-02	2.4E-01
SR48	3.0E-01	1.8E-01	3.7E-01	1.9E-01	8.8E-03	2.0E-01
SR49	4.5E-01	1.6E-01	5.0E-01	2.6E-01	9.4E-03	2.7E-01
SR50	1.2E-01	1.5E-01	2.5E-01	1.3E-01	2.5E-02	1.6E-01
SR51	1.3E-01	4.2E-01	5.1E-01	1.4E-01	8.3E-02	2.2E-01
SR52	3.5E-01	4.5E-01	5.7E-01	1.6E-01	1.4E-02	1.7E-01
SR53	2.1E-01	1.7E-01	3.0E-01	1.6E-01	7.9E-03	1.6E-01
SR54	3.2E-01	2.4E-01	4.0E-01	1.5E-01	6.9E-03	1.5E-01
SR55	3.5E-01	1.6E-01	3.9E-01	1.8E-01	4.4E-03	1.9E-01

Table 15-12 Exposure Ratios for NO_2 at Human Receptor Locations (Construction)

Human Receptor Location	Exposure Ratio (unitless)					
	1-hour NO_2			Annual NO_2		
	Base	Project	Application	Base	Project	Application
SR56	1.4E-01	1.4E-01	2.4E-01	1.2E-01	3.1E-03	1.3E-01
SR57	4.5E-01	6.8E-01	8.5E-01	2.8E-01	2.9E-02	3.0E-01
SR58	1.3E-01	7.5E-02	1.8E-01	1.3E-01	4.1E-03	1.3E-01

NOTE:
Shaded cell indicates a ER greater than 1.0

Table 15-13 Exposure Ratios for PM2.5 at Human Receptor Locations (Construction)

Human Receptor Location	Exposure Ratio (unitless)								
	1-hour $PM_{2.5}$			24-hour $PM_{2.5}$			Annual $PM_{2.5}$		
	Base	Project	Application	Base	Project	Application	Base	Project	Application
SR01	1.7E-01	7.9E-01	9.6E-01	4.2E-01	4.4E-01	8.5E-01	3.7E-01	1.8E-01	5.5E-01
SR02	1.8E-01	5.0E-01	6.6E-01	4.3E-01	2.3E-01	6.4E-01	3.9E-01	9.2E-02	4.8E-01
SR03	1.8E-01	4.3E-01	5.7E-01	4.3E-01	2.2E-01	6.3E-01	3.8E-01	9.1E-02	4.7E-01
SR04	1.5E-01	8.6E-01	1.0E+00	4.1E-01	4.8E-01	8.7E-01	3.7E-01	2.1E-01	5.7E-01
SR05	1.6E-01	9.5E-01	1.1E+00	4.2E-01	4.8E-01	8.7E-01	3.7E-01	2.1E-01	5.8E-01
SR06	1.6E-01	5.5E-01	7.0E-01	4.2E-01	2.6E-01	6.6E-01	3.7E-01	1.0E-01	4.7E-01
SR07	1.6E-01	4.4E-01	5.8E-01	4.2E-01	2.1E-01	6.1E-01	3.7E-01	7.3E-02	4.5E-01
SR08	1.6E-01	5.0E-01	6.4E-01	4.2E-01	2.1E-01	6.2E-01	3.7E-01	9.1E-02	4.6E-01
SR09	1.7E-01	8.8E-01	1.0E+00	4.2E-01	4.5E-01	8.6E-01	3.7E-01	1.9E-01	5.6E-01
SR10	1.6E-01	1.1E+00	1.2E+00	4.2E-01	4.9E-01	9.0E-01	3.7E-01	2.0E-01	5.7E-01
SR11	2.1E-01	1.6E+00	1.8E+00	4.8E-01	8.1E-01	1.3E+00	4.1E-01	3.5E-01	7.6E-01
SR12	1.6E-01	1.2E+00	1.3E+00	4.1E-01	6.6E-01	1.1E+00	3.7E-01	3.2E-01	6.9E-01
SR13	1.6E-01	1.1E+00	1.3E+00	4.2E-01	6.1E-01	1.0E+00	3.7E-01	2.9E-01	6.6E-01
SR14	1.6E-01	1.3E+00	1.5E+00	4.1E-01	7.5E-01	1.1E+00	3.7E-01	3.9E-01	7.5E-01
SR15	1.6E-01	1.3E+00	1.4E+00	4.2E-01	7.8E-01	1.2E+00	3.7E-01	4.0E-01	7.6E-01
SR16	1.5E-01	1.3E+00	1.5E+00	4.1E-01	7.0E-01	1.1E+00	3.6E-01	3.8E-01	7.5E-01
SR17	1.5E-01	5.5E-01	6.9E-01	4.1E-01	2.7E-01	6.7E-01	3.6E-01	1.3E-01	4.9E-01
SR18	1.8E-01	1.9E+00	2.0E+00	4.3E-01	1.0E+00	1.4E+00	3.7E-01	4.4E-01	8.1E-01
SR19	1.7E-01	2.4E+00	2.6E+00	4.2E-01	1.3E+00	1.7E+00	3.7E-01	9.3E-01	1.3E+00

Table 15-13 Exposure Ratios for PM2.5 at Human Receptor Locations (Construction)

Human Receptor Location	Exposure Ratio (unitless)								
	1-hour $PM_{2.5}$			24-hour $PM_{2.5}$			Annual $PM_{2.5}$		
	Base	Project	Application	Base	Project	Application	Base	Project	Application
SR20	1.8E-01	1.7E+00	1.8E+00	4.3E-01	8.1E-01	1.2E+00	3.7E-01	5.1E-01	8.9E-01
SR21	1.6E-01	7.1E-01	8.5E-01	4.1E-01	3.2E-01	7.2E-01	3.6E-01	1.8E-01	5.5E-01
SR22	1.5E-01	7.1E-01	8.5E-01	4.1E-01	3.6E-01	7.5E-01	3.6E-01	1.9E-01	5.5E-01
SR23	1.5E-01	6.0E-01	7.5E-01	4.1E-01	3.1E-01	7.1E-01	3.6E-01	1.7E-01	5.3E-01
SR24	1.5E-01	4.9E-01	6.4E-01	4.1E-01	2.7E-01	6.6E-01	3.6E-01	1.8E-01	5.4E-01
SR25	1.9E-01	2.1E+00	2.2E+00	4.4E-01	9.8E-01	1.4E+00	3.8E-01	6.1E-01	9.9E-01
SR26	1.7E-01	7.0E-01	8.5E-01	4.2E-01	2.0E-01	6.1E-01	3.7E-01	5.2E-02	4.2E-01
SR27	1.8E-01	5.7E-01	7.4E-01	4.3E-01	2.0E-01	6.1E-01	3.7E-01	4.9E-02	4.2E-01
SR28	1.8E-01	5.7E-01	7.4E-01	4.3E-01	2.0E-01	6.1E-01	3.7E-01	4.9E-02	4.2E-01
SR29	1.8E-01	5.5E-01	7.2E-01	4.2E-01	2.0E-01	6.1E-01	3.7E-01	5.1E-02	4.2E-01
SR30	2.1E-01	5.9E-01	7.7E-01	4.6E-01	2.2E-01	6.5E-01	4.3E-01	5.7E-02	4.8E-01
SR31	2.1E-01	5.9E-01	7.7E-01	4.6E-01	2.2E-01	6.5E-01	4.3E-01	5.7E-02	4.8E-01
SR32	1.9E-01	5.8E-01	7.6E-01	4.4E-01	2.3E-01	6.5E-01	3.9E-01	6.4E-02	4.6E-01
SR33	1.7E-01	5.8E-01	7.4E-01	4.2E-01	2.4E-01	6.5E-01	3.7E-01	7.2E-02	4.5E-01
SR34	1.7E-01	5.9E-01	7.6E-01	4.2E-01	2.5E-01	6.6E-01	3.7E-01	8.3E-02	4.5E-01
SR35	1.7E-01	5.9E-01	7.6E-01	4.2E-01	2.5E-01	6.6E-01	3.7E-01	8.3E-02	4.5E-01
SR36	1.5E-01	1.4E+00	1.6E+00	4.1E-01	6.6E-01	1.1E+00	3.6E-01	2.9E-01	6.5E-01
SR37	1.5E-01	6.0E-01	7.5E-01	4.1E-01	3.0E-01	7.0E-01	3.6E-01	1.7E-01	5.3E-01
SR38	1.8E-01	8.7E-01	1.0E+00	4.3E-01	4.5E-01	8.6E-01	3.8E-01	2.6E-01	6.4E-01
SR39	1.9E-01	7.8E-01	9.3E-01	4.3E-01	3.8E-01	7.9E-01	3.7E-01	1.4E-01	5.2E-01
SR40	1.6E-01	1.7E+00	1.8E+00	4.1E-01	8.9E-01	1.3E+00	3.6E-01	2.9E-01	6.5E-01
SR41	1.6E-01	2.9E+00	3.1E+00	4.1E-01	1.5E+00	1.9E+00	3.6E-01	6.3E-01	9.9E-01
SR42	2.0E-01	3.4E-01	5.1E-01	4.5E-01	1.6E-01	6.1E-01	4.0E-01	6.4E-02	4.6E-01
SR43	2.6E-01	3.4E-01	5.6E-01	5.4E-01	1.7E-01	6.8E-01	4.9E-01	6.5E-02	5.6E-01
SR44	1.7E-01	2.3E-01	3.7E-01	4.3E-01	1.2E-01	5.2E-01	3.9E-01	5.0E-02	4.4E-01
SR45	1.6E-01	1.5E-01	3.0E-01	4.1E-01	6.7E-02	4.7E-01	3.7E-01	2.3E-02	3.9E-01
SR46	1.7E-01	1.3E-01	2.8E-01	4.2E-01	5.2E-02	4.6E-01	3.8E-01	1.9E-02	4.0E-01
SR47	1.8E-01	1.4E-01	2.8E-01	4.3E-01	5.6E-02	4.6E-01	3.8E-01	2.0E-02	4.0E-01
SR48	1.7E-01	9.5E-02	2.5E-01	4.2E-01	3.8E-02	4.5E-01	3.7E-01	1.2E-02	3.8E-01
SR49	1.9E-01	9.5E-02	2.7E-01	4.4E-01	3.8E-02	4.6E-01	3.9E-01	1.3E-02	4.0E-01

Table 15-13 Exposure Ratios for PM2.5 at Human Receptor Locations (Construction)

Human Receptor Location	Exposure Ratio (unitless)								
	1-hour $PM_{2.5}$			24-hour $PM_{2.5}$			Annual $PM_{2.5}$		
	Base	Project	Application	Base	Project	Application	Base	Project	Application
SR50	1.5E-01	1.1E-01	2.5E-01	4.0E-01	5.9E-02	4.5E-01	3.6E-01	3.7E-02	3.9E-01
SR51	1.5E-01	3.2E-01	4.6E-01	4.0E-01	1.9E-01	5.8E-01	3.6E-01	1.2E-01	4.8E-01
SR52	1.7E-01	3.3E-01	4.8E-01	4.1E-01	1.0E-01	5.0E-01	3.6E-01	2.1E-02	3.8E-01
SR53	1.6E-01	9.3E-02	2.4E-01	4.1E-01	3.3E-02	4.4E-01	3.6E-01	1.1E-02	3.7E-01
SR54	1.7E-01	2.0E-01	3.4E-01	4.1E-01	5.4E-02	4.5E-01	3.6E-01	1.2E-02	3.7E-01
SR55	1.7E-01	1.3E-01	2.9E-01	4.2E-01	3.5E-02	4.4E-01	3.7E-01	7.7E-03	3.7E-01
SR56	1.5E-01	9.5E-02	2.4E-01	4.0E-01	2.5E-02	4.2E-01	3.5E-01	5.5E-03	3.6E-01
SR57	1.9E-01	6.2E-01	7.8E-01	4.4E-01	1.7E-01	5.9E-01	3.9E-01	4.4E-02	4.3E-01
SR58	1.5E-01	5.0E-02	1.9E-01	4.0E-01	1.8E-02	4.1E-01	3.5E-01	5.9E-03	3.6E-01

NOTE:
Shaded cell indicates a ER greater than 1.0

Short-term exposures to DEP are assessed by comparing 1-hour concentrations to the acute (2-hour) DEP exposure limit. The ERs at multiple residential receptor locations are higher than the benchmark of 1.0; the ERs at Indigenous receptor locations and schools are less than 1.0. Also provided in Table 15-14 are the frequency of exceedances for each of the receptor locations. As indicated, maximum frequency of exceedances is less than 5%. Based on multiple studies on test subjects, Health Canada (2016b) concluded that at concentrations above the DEP exposure limit, healthy and/or mildly asthmatic participants may experience increased measures of airway resistance and/or respiratory inflammation. Large-scale epidemiological studies examining the acute effects of diesel exhaust in the general population would likely provide a better understanding of the exposure–response relationships and characterization of population health risks associated with short-term diesel exposure (Health Canada 2016b).

Table 15-14 Exposure Ratios and Frequency of Exceedance for DEP at Human Receptor Locations

Human Receptor Location	Exposure Ratios			Frequency of Exceedances (%)		
	1-hour DEP			1-hour DEP		
	Base	Project	Application	Base	Project	Application
SR01	1.4E-01	3.3E+00	3.4E+00	0.0%	2.6%	2.7%
SR02	2.5E-01	2.0E+00	2.1E+00	0.0%	0.5%	0.6%
SR03	2.0E-01	1.4E+00	1.5E+00	0.0%	0.2%	0.2%
SR04	8.2E-02	1.0E+00	1.1E+00	0.0%	0.0%	0.1%
SR05	1.0E-01	1.3E+00	1.3E+00	0.0%	0.3%	0.4%
SR06	9.2E-02	6.9E-01	7.4E-01	0.0%	0.0%	0.0%
SR07	9.0E-02	5.7E-01	6.0E-01	0.0%	0.0%	0.0%
SR08	8.8E-02	5.5E-01	5.9E-01	0.0%	0.0%	0.0%
SR09	1.7E-01	3.6E+00	3.7E+00	0.0%	0.7%	0.8%
SR10	1.3E-01	1.6E+00	1.7E+00	0.0%	0.3%	0.4%
SR11	3.8E-01	1.9E+00	2.1E+00	0.0%	1.4%	2.1%
SR12	8.4E-02	1.9E+00	1.9E+00	0.0%	1.4%	1.5%
SR13	1.0E-01	1.8E+00	1.8E+00	0.0%	1.0%	1.1%
SR14	9.2E-02	2.5E+00	2.5E+00	0.0%	1.8%	1.8%
SR15	8.9E-02	1.9E+00	2.0E+00	0.0%	1.8%	1.8%
SR16	5.0E-02	1.5E+00	1.5E+00	0.0%	0.5%	0.5%
SR17	6.4E-02	5.8E-01	5.8E-01	0.0%	0.0%	0.0%
SR18	2.0E-01	2.1E+00	2.2E+00	0.0%	1.9%	2.2%
SR19	1.5E-01	2.6E+00	2.7E+00	0.0%	3.7%	3.8%
SR20	1.9E-01	1.8E+00	1.9E+00	0.0%	1.0%	1.2%
SR21	5.5E-02	7.2E-01	7.4E-01	0.0%	0.0%	0.0%
SR22	4.1E-02	7.5E-01	7.7E-01	0.0%	0.0%	0.0%
SR23	3.8E-02	6.3E-01	6.6E-01	0.0%	0.0%	0.0%
SR24	3.7E-02	5.0E-01	5.1E-01	0.0%	0.0%	0.0%
SR25	2.3E-01	2.3E+00	2.5E+00	0.0%	1.9%	2.1%
SR26	1.7E-01	8.7E-01	9.0E-01	0.0%	0.0%	0.0%
SR27	2.2E-01	7.0E-01	8.1E-01	0.0%	0.0%	0.0%
SR28	2.2E-01	7.0E-01	8.1E-01	0.0%	0.0%	0.0%
SR29	2.3E-01	7.5E-01	9.5E-01	0.0%	0.0%	0.0%
SR30	3.7E-01	7.9E-01	1.1E+00	0.0%	0.0%	0.0%

Table 15-14 Exposure Ratios and Frequency of Exceedance for DEP at Human Receptor Locations

Human Receptor Location	Exposure Ratios			Frequency of Exceedances (%)		
	1-hour DEP			1-hour DEP		
	Base	Project	Application	Base	Project	Application
SR31	3.7E-01	7.9E-01	1.1E+00	0.0%	0.0%	0.0%
SR32	2.4E-01	7.2E-01	9.0E-01	0.0%	0.0%	0.0%
SR33	1.6E-01	7.0E-01	7.9E-01	0.0%	0.0%	0.0%
SR34	1.3E-01	6.8E-01	7.8E-01	0.0%	0.0%	0.0%
SR35	1.3E-01	6.8E-01	7.8E-01	0.0%	0.0%	0.0%
SR36	6.0E-02	1.5E+00	1.5E+00	0.0%	0.5%	0.6%
SR37	3.8E-02	6.4E-01	6.6E-01	0.0%	0.0%	0.0%
SR38	1.9E-01	1.0E+00	1.1E+00	0.0%	0.0%	0.1%
SR39	2.1E-01	9.0E-01	1.0E+00	0.0%	0.0%	0.0%
SR40	9.6E-02	2.0E+00	2.0E+00	0.0%	1.0%	1.1%
SR41	1.1E-01	3.3E+00	3.4E+00	0.0%	3.1%	3.2%
SR42	3.2E-01	1.1E+00	1.2E+00	0.0%	0.0%	0.2%
SR43	6.4E-01	1.3E+00	1.8E+00	0.0%	0.1%	0.5%
SR44	1.0E-01	2.7E-01	3.2E-01	0.0%	0.0%	0.0%
SR45	1.1E-01	1.9E-01	2.1E-01	0.0%	0.0%	0.0%
SR46	1.6E-01	1.7E-01	2.3E-01	0.0%	0.0%	0.0%
SR47	1.9E-01	1.7E-01	2.3E-01	0.0%	0.0%	0.0%
SR48	1.5E-01	1.3E-01	2.1E-01	0.0%	0.0%	0.0%
SR49	2.6E-01	1.3E-01	3.1E-01	0.0%	0.0%	0.0%
SR50	2.9E-02	1.1E-01	1.2E-01	0.0%	0.0%	0.0%
SR51	3.5E-02	3.2E-01	3.4E-01	0.0%	0.0%	0.0%
SR52	1.9E-01	3.7E-01	4.4E-01	0.0%	0.0%	0.0%
SR53	9.1E-02	1.3E-01	1.7E-01	0.0%	0.0%	0.0%
SR54	1.5E-01	2.2E-01	2.7E-01	0.0%	0.0%	0.0%
SR55	1.7E-01	1.4E-01	2.4E-01	0.0%	0.0%	0.0%
SR56	3.9E-02	1.2E-01	1.3E-01	0.0%	0.0%	0.0%
SR57	2.4E-01	7.7E-01	9.1E-01	0.0%	0.0%	0.0%
SR58	3.6E-02	6.6E-02	8.3E-02	0.0%	0.0%	0.0%

NOTE:
Shaded cell indicates a ER greater than 1.0

Volatile Organic Compounds

Table 15-15 shows the ERs at the MPOI for each VOC. The ERs for 1,3-butadiene, 2,2,4-trimethylpentane, acetaldehyde, acrolein (annual), benzene, ethylbenzene, propionaldehyde, toluene, and xylenes are less than 1.0, indicating that there are no unacceptable risks to human health from these COPCs. The ERs for acrolein (1-hour) and formaldehyde (1-hour) are greater than 1.0 at the MPOI location. The ERs at the 58 human receptor locations are examined in greater detail for acrolein and formaldehyde.

Table 15-15 Exposure Ratios at the Maximum Point of Impingement for Volatile Organic Compounds (Construction)

Volatile Organic Compound	Averaging Period	Exposure Ratio at the MPOI		
		Base	Project	Application
1,3-butadiene	1-hour	1.2E-03	6.7E-04	1.8E-03
	Annual	1.5E-02	4.6E-03	1.5E-02
	Annual*	9.9E-02	3.0E-02	1.0E-01
2,2,4-trimethylpentane	1-hour	1.0E-03	1.0E-04	1.1E-03
	Annual	1.8E-04	2.2E-05	1.8E-04
Acetaldehyde	1-hour	7.8E-03	4.6E-02	5.3E-02
	Annual*	7.6E-02	9.8E-02	1.6E-01
Acrolein	1-hour	7.6E-02	1.2E+00	1.2E+00
	Annual	1.1E-01	3.0E-01	3.8E-01
Benzene	1-hour	5.1E-02	2.8E-01	3.1E-01
	Annual	1.6E-02	5.7E-03	1.7E-02
	Annual*	1.6E-01	5.7E-02	1.7E-01
Ethylbenzene	1-hour	7.7E-06	1.7E-05	2.1E-05
	Annual	1.8E-04	3.0E-05	1.8E-04
Formaldehyde	1-hour	2.1E-01	1.2E+00	1.4E+00
	Annual*	1.4E+00	6.3E-01	1.9E+00
	Annual	2.5E-01	1.1E-01	3.5E-01
Propionaldehyde	Annual	2.9E-02	1.4E-02	4.2E-02
Toluene	1-hour	2.7E-04	4.3E-04	5.4E-04
	24-hour	4.1E-04	2.9E-04	4.6E-04
	Annual	3.1E-04	3.5E-05	3.1E-04

Table 15-15 Exposure Ratios at the Maximum Point of Impingement for Volatile Organic Compounds (Construction)

Volatile Organic Compound	Averaging Period	Exposure Ratio at the MPOI		
		Base	Project	Application
Xylenes	1-hour	2.7E-04	6.0E-04	6.9E-04
	Annual	2.7E-03	5.1E-04	2.7E-03

NOTES:
* ERs are based on non-threshold effects (i.e., cancer risk)
Shaded cell indicates a ER greater than 1.0

The ERs for acrolein and formaldehyde at the human receptor locations are shown in Table 15-16**Error! Reference source not found.**. The ERs for acrolein (1-hour) and formaldehyde (1-hour) are less than 1.0, and indicate that there are no unacceptable health risks from acute exposure to these COPCs

Table 15-16 Exposure Ratios for Acrolein and Formaldehyde at Human Receptor Locations (Construction)

Human Receptor Location	Exposure Ratio (unitless)					
	1-hour Acrolein			1-hour Formaldehyde		
	Base	Project	Application	Base	Project	Application
SR01	6.6E-02	2.2E-01	2.8E-01	2.0E-01	2.3E-01	4.3E-01
SR02	6.7E-02	1.3E-01	2.0E-01	2.0E-01	1.4E-01	3.4E-01
SR03	6.7E-02	9.4E-02	1.6E-01	2.0E-01	9.9E-02	3.0E-01
SR04	6.5E-02	7.1E-02	1.4E-01	2.0E-01	7.5E-02	2.7E-01
SR05	6.6E-02	8.7E-02	1.5E-01	2.0E-01	9.2E-02	2.9E-01
SR06	6.6E-02	4.7E-02	1.1E-01	2.0E-01	5.0E-02	2.5E-01
SR07	6.6E-02	3.9E-02	1.0E-01	2.0E-01	4.1E-02	2.4E-01
SR08	6.6E-02	3.7E-02	1.0E-01	2.0E-01	3.9E-02	2.4E-01
SR09	6.6E-02	2.4E-01	3.0E-01	2.0E-01	2.5E-01	4.5E-01
SR10	6.6E-02	1.1E-01	1.7E-01	2.0E-01	1.1E-01	3.1E-01
SR11	6.9E-02	1.3E-01	2.0E-01	2.0E-01	1.4E-01	3.4E-01
SR12	6.5E-02	1.3E-01	2.0E-01	2.0E-01	1.4E-01	3.4E-01
SR13	6.6E-02	1.2E-01	1.9E-01	2.0E-01	1.3E-01	3.3E-01
SR14	6.6E-02	1.7E-01	2.3E-01	2.0E-01	1.7E-01	3.7E-01

Table 15-16 Exposure Ratios for Acrolein and Formaldehyde at Human Receptor Locations (Construction)

Human Receptor Location	Exposure Ratio (unitless)					
	1-hour Acrolein			1-hour Formaldehyde		
	Base	Project	Application	Base	Project	Application
SR15	6.6E-02	1.3E-01	2.0E-01	2.0E-01	1.4E-01	3.4E-01
SR16	6.5E-02	9.8E-02	1.6E-01	2.0E-01	1.0E-01	3.0E-01
SR17	6.5E-02	3.9E-02	1.0E-01	2.0E-01	4.1E-02	2.4E-01
SR18	6.7E-02	1.5E-01	2.2E-01	2.0E-01	1.6E-01	3.6E-01
SR19	6.6E-02	1.8E-01	2.5E-01	2.0E-01	1.9E-01	3.9E-01
SR20	6.7E-02	1.3E-01	2.0E-01	2.0E-01	1.4E-01	3.4E-01
SR21	6.5E-02	4.9E-02	1.1E-01	2.0E-01	5.2E-02	2.5E-01
SR22	6.5E-02	5.1E-02	1.2E-01	2.0E-01	5.4E-02	2.5E-01
SR23	6.5E-02	4.4E-02	1.1E-01	2.0E-01	4.6E-02	2.4E-01
SR24	6.5E-02	3.4E-02	9.8E-02	2.0E-01	3.6E-02	2.3E-01
SR25	6.7E-02	1.7E-01	2.4E-01	2.0E-01	1.8E-01	3.8E-01
SR26	6.6E-02	6.0E-02	1.3E-01	2.0E-01	6.4E-02	2.6E-01
SR27	6.7E-02	4.9E-02	1.1E-01	2.0E-01	5.1E-02	2.5E-01
SR28	6.7E-02	4.9E-02	1.1E-01	2.0E-01	5.1E-02	2.5E-01
SR29	6.7E-02	5.1E-02	1.2E-01	2.0E-01	5.4E-02	2.5E-01
SR30	6.9E-02	5.6E-02	1.2E-01	2.0E-01	5.9E-02	2.6E-01
SR31	6.9E-02	5.6E-02	1.2E-01	2.0E-01	5.9E-02	2.6E-01
SR32	6.7E-02	5.2E-02	1.2E-01	2.0E-01	5.5E-02	2.6E-01
SR33	6.6E-02	5.0E-02	1.1E-01	2.0E-01	5.3E-02	2.5E-01
SR34	6.6E-02	5.0E-02	1.2E-01	2.0E-01	5.3E-02	2.5E-01
SR35	6.6E-02	5.0E-02	1.2E-01	2.0E-01	5.3E-02	2.5E-01
SR36	6.5E-02	9.8E-02	1.6E-01	2.0E-01	1.0E-01	3.0E-01
SR37	6.5E-02	4.4E-02	1.1E-01	2.0E-01	4.7E-02	2.5E-01
SR38	6.7E-02	7.0E-02	1.4E-01	2.0E-01	7.4E-02	2.7E-01
SR39	6.7E-02	6.8E-02	1.3E-01	2.0E-01	7.2E-02	2.7E-01
SR40	6.6E-02	1.4E-01	2.0E-01	2.0E-01	1.5E-01	3.4E-01
SR41	6.6E-02	2.3E-01	3.0E-01	2.0E-01	2.5E-01	4.4E-01
SR42	6.8E-02	7.1E-02	1.4E-01	2.0E-01	7.5E-02	2.7E-01

Table 15-16 Exposure Ratios for Acrolein and Formaldehyde at Human Receptor Locations (Construction)

Human Receptor Location	Exposure Ratio (unitless)					
	1-hour Acrolein			1-hour Formaldehyde		
	Base	Project	Application	Base	Project	Application
SR43	7.1E-02	8.5E-02	1.5E-01	2.1E-01	9.0E-02	2.9E-01
SR44	6.6E-02	1.8E-02	8.3E-02	2.0E-01	1.9E-02	2.2E-01
SR45	6.6E-02	1.3E-02	7.7E-02	2.0E-01	1.4E-02	2.1E-01
SR46	6.7E-02	1.1E-02	7.6E-02	2.0E-01	1.2E-02	2.1E-01
SR47	6.7E-02	1.2E-02	7.7E-02	2.0E-01	1.3E-02	2.1E-01
SR48	6.6E-02	8.7E-03	7.4E-02	2.0E-01	9.2E-03	2.1E-01
SR49	6.8E-02	8.5E-03	7.4E-02	2.0E-01	9.0E-03	2.1E-01
SR50	6.5E-02	7.8E-03	7.2E-02	2.0E-01	8.2E-03	2.1E-01
SR51	6.5E-02	2.2E-02	8.7E-02	2.0E-01	2.3E-02	2.2E-01
SR52	6.7E-02	2.7E-02	9.3E-02	2.0E-01	2.9E-02	2.3E-01
SR53	6.6E-02	8.8E-03	7.4E-02	2.0E-01	9.3E-03	2.1E-01
SR54	6.6E-02	1.6E-02	8.1E-02	2.0E-01	1.7E-02	2.2E-01
SR55	6.6E-02	1.1E-02	7.6E-02	2.0E-01	1.2E-02	2.1E-01
SR56	6.5E-02	8.7E-03	7.3E-02	2.0E-01	9.2E-03	2.1E-01
SR57	6.7E-02	5.3E-02	1.2E-01	2.0E-01	5.6E-02	2.6E-01
SR58	6.5E-02	4.4E-03	6.9E-02	2.0E-01	4.7E-03	2.0E-01

NOTE:
Shaded cell indicates an ER > 1.0

Polycyclic Aromatic Hydrocarbons

Table 15-17 shows the ERs at the MPOI for carcinogenic PAH (expressed as benzo(a)pyrene) and naphthalene. The chronic ERs for benzo(a)pyrene and naphthalene are less than 1.0 at the MPOI, indicating that the ER must be less than 1.0 throughout the entire LAA/RAA. The difference between the Base Case and Application Case ERs are negligible, indicating that the Project is not a substantial contributor to the risk associated with these substances in the LAA/RAA. Based on this information, there are no unacceptable risks to human health from benzo(a)pyrene and naphthalene, and these substances are not assessed further.

Table 15-17 Exposure Ratios at the Maximum Point of Impingement for Polycyclic Aromatic Hydrocarbons (Construction)

Polycyclic Aromatic Hydrocarbon	Averaging Period	Exposure Ratio at the MPOI		
		Base	Project	Application
Benzo(a)pyrene	Annual *	6.9E-01	3.1E-02	6.9E-01
Naphthalene	Annual	2.4E-02	7.8E-03	2.6E-02

NOTES:
* ERs are based on non-threshold effects (i.e., cancer risk) and therefore only Project case values are compared to a threshold target of 1.0
Shaded cell indicates an ER > 1.0

Metals in Air Emissions

Table 15-18 shows the ERs at the MPOI for metals in the air. The ERs for arsenic, chromium (1-hour), manganese, mercury and nickel are less than 1.0, indicating that there are no unacceptable risks to human health from these COPCs. The Project Case ER for chromium is greater than 1.0, and a more detailed characterization this risk is provided. The Base and Application ER values for chromium(VI) (annual) are provided for context, and are not compared to the threshold target of 1.0 since chromium(VI) is a carcinogen.

Table 15-18 Exposure Ratios at the Maximum Point of Impingement for Metals in the Air (Construction)

Metals in Air Emissions	Averaging Period	Exposure Ratio at the MPOI		
		Base	Project	Application
Arsenic	1-hour	2.2E-02	4.0E-01	4.0E-01
	Annual*	5.6E-02	2.2E-01	2.3E-01
Chromium (VI)	1-hour	3.9E-03	1.2E-01	1.2E-01
	Annual*	3.2E-01	1.9E+00	2.0E+00
Manganese	1-hour	5.3E-04	9.5E-05	6.0E-04
	Annual	2.5E-03	2.1E-05	2.5E-03
Mercury	1-hour	4.6E-05	2.9E-04	2.9E-04
	Annual	2.2E-04	3.1E-04	3.3E-04
Nickel	1-hour	8.2E-04	2.3E-02	2.4E-02
	Annual	2.6E-02	1.5E-01	1.6E-01

NOTES:
* ERs are based on non-threshold effects (i.e., cancer risk) and therefore only Project case values are compared to a threshold target of 1.0
Shaded cell indicates a ER greater than 1.0

The ERs for annual chromium at the human receptor locations are shown Table 15-19. The ERs for annual chromium are less than 1.0 for the Project Case, with the exception of receptor location SR19 (rural residence adjacent to Township Road 242). This indicates that there may be an unacceptable risk to human health for long-term cancer risk.

To characterize the risk more accurately, the conservative assumptions applied in the HHRA are examined to determine the effect of these assumptions on the quantified ER. Firstly, the air quality model is generally conservative. For example, the air quality is modelled over three years, and the year with the poorest air quality is applied as the Project Case. Another assumption in the air quality model is that all chromium emissions are hexavalent chromium. However, contributions from soil are unlikely to contain hexavalent chromium, and the USEPA reports that an analysis of emissions from on-road vehicles show that only 18% of the total chromium is composed of hexavalent chromium (USEPA 2016). The remaining 82% of chromium is composed of the less toxic forms of chromium (e.g., Cr^{-2}, Cr^{0}, and Cr^{+3}), that are also not carcinogenic (USEPA 2016). If this is factored into the air quality model, the Project Case ER at receptor location SR19 would be reduced from 1.3 to 0.23.

The air quality model also only applied partial mitigations to reduce vehicle emissions, since the construction schedule and use of vehicles is flexible. During the construction phase, further operational mitigations can be applied that reduce the number of vehicles and equipment operating in an area with nearby human receptors. This would effectively reduce vehicle emissions, but the degree of effect on chromium emissions cannot be quantified without a more detailed construction schedule.

Another factor affecting the characterization of cancer risk is the duration of the construction phase. The Project's contribution to chromium in the air only lasts for 36 months during construction. After this time, the cancer risk from hexavalent chromium will likely return to Base Case levels. Given that cancer risk is amortized over a lifetime exposure (80 years), Health Canada (2010a) recommends adjusting cancer risk from inhalation for the fraction of time exposed (i.e., 3 years/80 years). The effect of this adjustment would reduce the Base Case ER at SR 19 from 0.23 to 0.0087 for non-threshold cancer risk.

Based on these factors, there is no unacceptable cancer risk to human receptors from chromium during the construction phase.

Table 15-19 Exposure Ratios for Chromium at Human Receptor Locations (Construction)

Human Receptor Location	Exposure Ratio (unitless)		
	Annual Chromium (VI)*		
	Base	Project	Application
SR01	8.4E-02	9.6E-02	1.8E-01
SR02	9.5E-02	5.9E-02	1.5E-01
SR03	9.1E-02	6.5E-02	1.6E-01
SR04	8.1E-02	2.2E-01	3.0E-01
SR05	8.6E-02	2.4E-01	3.3E-01
SR06	8.9E-02	1.0E-01	1.9E-01
SR07	8.6E-02	6.7E-02	1.5E-01
SR08	9.1E-02	1.0E-01	1.9E-01
SR09	8.2E-02	1.4E-01	2.2E-01
SR10	7.9E-02	1.7E-01	2.5E-01
SR11	1.1E-01	3.6E-01	4.7E-01
SR12	8.2E-02	4.1E-01	4.9E-01
SR13	8.3E-02	3.6E-01	4.5E-01
SR14	8.1E-02	5.2E-01	6.0E-01
SR15	8.1E-02	5.4E-01	6.2E-01
SR16	7.8E-02	5.4E-01	6.2E-01
SR17	8.0E-02	1.4E-01	2.2E-01
SR18	8.1E-02	4.7E-01	5.5E-01
SR19	7.9E-02	1.3E+00	1.4E+00
SR20	8.1E-02	7.0E-01	7.8E-01
SR21	7.8E-02	2.1E-01	2.9E-01
SR22	7.7E-02	2.6E-01	3.4E-01
SR23	7.7E-02	2.2E-01	3.0E-01
SR24	7.7E-02	2.3E-01	3.1E-01
SR25	8.4E-02	7.6E-01	8.4E-01
SR26	7.9E-02	3.3E-02	1.1E-01
SR27	8.2E-02	2.9E-02	1.1E-01
SR28	8.2E-02	2.9E-02	1.1E-01
SR29	8.1E-02	3.1E-02	1.1E-01
SR30	1.1E-01	3.6E-02	1.5E-01
SR31	1.1E-01	3.6E-02	1.5E-01

Table 15-19 Exposure Ratios for Chromium at Human Receptor Locations (Construction)

Human Receptor Location	Exposure Ratio (unitless)		
	Annual Chromium (VI)*		
	Base	Project	Application
SR32	9.4E-02	4.3E-02	1.4E-01
SR33	8.1E-02	5.1E-02	1.3E-01
SR34	7.9E-02	6.0E-02	1.4E-01
SR35	7.9E-02	6.0E-02	1.4E-01
SR36	7.9E-02	3.7E-01	4.5E-01
SR37	7.7E-02	2.1E-01	2.9E-01
SR38	8.6E-02	3.1E-01	4.0E-01
SR39	8.2E-02	1.5E-01	2.4E-01
SR40	7.7E-02	2.9E-01	3.7E-01
SR41	7.7E-02	8.3E-01	9.0E-01
SR42	1.0E-01	3.6E-02	1.4E-01
SR43	1.7E-01	4.4E-02	2.1E-01
SR44	1.0E-01	4.8E-02	1.5E-01
SR45	8.0E-02	1.7E-02	9.6E-02
SR46	8.2E-02	1.2E-02	9.4E-02
SR47	8.1E-02	1.3E-02	9.4E-02
SR48	7.9E-02	6.7E-03	8.5E-02
SR49	8.5E-02	7.4E-03	9.2E-02
SR50	7.7E-02	4.0E-02	1.2E-01
SR51	7.7E-02	1.7E-01	2.5E-01
SR52	7.8E-02	1.0E-02	8.9E-02
SR53	7.7E-02	6.5E-03	8.3E-02
SR54	7.7E-02	4.8E-03	8.2E-02
SR55	8.3E-02	2.9E-03	8.6E-02
SR56	7.5E-02	2.0E-03	7.7E-02
SR57	9.3E-02	2.6E-02	1.2E-01
SR58	7.5E-02	3.7E-03	7.9E-02

NOTE:
* ERs are based on non-threshold effects (i.e., cancer risk) and therefore only Project case values are compared to a threshold target of 1.0
Shaded cell indicates a ER greater than 1.0

Planned Development Case

Based on air model predictions, the HHRA results for the Base, Project Alone, and Application Case indicate that with only partial mitigations, there could still be an unacceptable short-term risk to human health for residents and people adjacent to the PDA. To address these concerns, an ambient air monitoring program is planned during construction (i.e., an adaptive management plan). In addition, more intensive mitigation measures have been planned to reduce the potential change in air quality, which effectively reduces the potential risk to human health.

With respect to the Planned Development Case for construction, several future projects are identified that could potentially overlap with the Project-related emissions during construction. As per the HHRA (Volume 4, Appendix O), emissions from these other projects are not expected to materially change the predicted Project-related exposures, or affect the need for an air quality monitoring program and adaptive management plan.

15.4.5 Summary of Project Residual Effects

Table 15-20 summarizes the residual environmental effects on public health during the construction phase.

Table 15-20 Project Residual Effects on Public Health During Construction

Residual Effect	Residual Effects Characterization								
	Project Phase	Timing	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change to Human Health	C	S	A	H	LAA	MT	IR	R	R

KEY

See Section 15.1.5 for detailed definitions

Project Phase

C: Construction

DO: Dry Operation

Timing Consideration

T: Time of day

S: Seasonality

R: Regulatory

Direction:

P: Positive

A: Adverse

N: Neutral

Magnitude:

N: Negligible

L: Low

M: Moderate

H: High

Geographic Extent:

PDA: Project Development Area

LAA: Local Assessment Area

RAA: Regional Assessment Area

Duration:

ST: Short-term;

MT: Medium-term

LT: Long-term

N/A: Not applicable

Frequency:

S: Single event

IR: Irregular event

R: Regular event

C: Continuous

Reversibility:

R: Reversible

I: Irreversible

Ecological/Socio-Economic Context:

R: Resilient

NR: Not Resilient

15.5 DETERMINATION OF SIGNIFICANCE

A significant adverse effect to public health may occur when hazard exposures exceed the objectives established by relevant regulatory organizations (e.g., an ER greater than 1.0), and are likely to result in a substantive change in the health of a receptor. For a change to human health from inhalation, the ERs for SO_2, CO, VOCs (except acrolein and formaldehyde), PAHs, arsenic, manganese, mercury and nickel are below 1.0 for short-term and long-term exposures throughout the LAA/RAA, including the 58 residential and Indigenous receptor locations within 5 km the PDA.

The ERs for NO_2 (1-hour), $PM_{2.5}$ (24-hour and annual) and DEP (1-hour) are greater than 1.0 at some residential receptor locations within 200 m of the PDA. There are no predicted exceedances at the locations where Indigenous receptor presence is expected, nor at any of the schools. These results indicate that, based in the air dispersion modeling, levels of $PM_{2.5}$ and DEP may be greater at residential locations near the PDA than the objectives established by regulatory organizations.

The ERs for acrolein and formaldehyde at each of the 58 receptor locations within 5 km of the PDA are less than 1. Although the ER for hexavalent chromium is greater than 1.0 at one receptor location, an adjusted exposure that reflects the 3-year construction period would be less than 1.0. These findings suggest that health risks at the residential and Indigenous receptor locations are negligible.

The predicted air concentrations overstate the potential exposure because of the conservative assumptions that are used in the air quality model. During construction, the location and duration of individual construction activities within the PDA is not uniform, and once construction activities are completed in one area of the PDA, construction activities continue at a different location. Consequently, construction activities near human receptor locations would be occurring for only a portion of the entire 36-month construction period.

Since emissions of NO_2, $PM_{2.5}$, and DEP are dependent on the construction execution plan and the types of vehicle and equipment used, adaptive management may be used to mitigate exposures to people in residences nearest the PDA. Additional mitigation measures for a change to human health from inhalation may be achieved by reducing the spatial and temporal overlap of construction activities in an area (i.e., have fewer vehicles and machinery operating simultaneously near a residence).

The mitigation measures are effective at reducing exposures to COPCs, and the residual effects to public health from inhalation are not significant.

15.6 PREDICTION CONFIDENCE

For the assessment of human health from inhalation, the prediction confidence is high. The high level of prediction confidence is because air quality modelling was conducted using industry standards that adhered to applicable provincial and federal guidelines. Emissions from vehicles and machinery are based on either manufacturer specifications or standard emission rates for vehicle and equipment types. The health risk associated with the predicted concentrations of CACs, VOCs, PAHs and metals also carries a high level of confidence. Health risk is quantified using guidance provided by Health Canada, and similar methods are used by international regulatory agencies such as the United States Environmental Protection Agency.

15.7 CONCLUSIONS

The assessment of public health shows that the effects from air quality, water quality and country foods are not significant for the construction and dry operations phases. There are no interactions between public health with water quality and country foods.

15.8 REFERENCES

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