Volume 2, Section 16 Snake Lake Reservoir Expansion Project – Environmental Impact Assessment
Public Health

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Executive Summary

The Eastern Irrigation District (EID) is applying for approval under the *Environmental Protection and Enhancement Act* (EPEA) to construct the proposed Snake Lake Reservoir (SLR) Expansion Project (the Project). The Project, located between Bassano and Brooks in Alberta, involves the construction of a roughly 8 km long, up to 20 m high dam to increase the storage capacity of the reservoir system from 19.25 million m^3 to 87.4 million m^3. The existing SLR and proposed Project area are located within Townships 19 and 20, Ranges 16 and 17, west of the fourth meridian. The Project is proposed on private land owned by the EID, which has been used for grazing and other land uses for decades. Access into the Project area can be achieved along the partially developed Range Road 165 road allowance. Existing human infrastructure in the vicinity of the project consists of fences, access roads and trails to the existing reservoir, irrigation infrastructure (such as dams, canals, dugouts), gas industry facilities and old gravel quarry sites.

The Project is located in the Dry Mixedgrass Natural Subregion within the Grassland Natural Region of Southern Aberta. Specifically, the proposed expansion site has a combination of native grasslands and some wetlands. Parent materials include clay soils and rocky/sandy soils. The terrain in the area has low relief with flat to undulating terrain.

The closest communities to the Project are Bassano (22 km northwest), Brooks (19 km southeast), and the Lathom Hutterite Colony (6 km southwest). There are limited residences in the area, with the closest residence being 3.5 km northwest of the Project. The nearest Indigenous community is the Siksika Nation (Reserve 146), located upstream on the Bow River, 22 km away.

The objective of the Human Health Risk Assessment (HHRA) was to assess the potential health risks associated with fugitive dust emissions and combustion emissions from equipment used during the construction phase of the Project (i.e., inhalation pathway assessment). In addition, the HHRA served to characterize the health risks associated with potential changes to water quality and the subsequent uptake of mercury in sportfish in the reservoir (i.e., ingestion pathway assessment.)

The contaminants of potential concern (COPC) for the inhalation assessment were based on the anticipated Project emissions identified in the Air Quality Assessment (see Volume 2, Section 4), and were assessed over the same Local Study Area (LSA; 7.5 km from the Project centre). The Air Quality Assessment identified three key air COPC that will be emitted during the Project Construction phase:

- Nitrogen dioxide (NO_2);
- Fine particulate matter ($PM_{2.5}$); and
- Sulphur dioxide (SO_2).

The water chemistry in the expanded reservoir is not expected to change notably from current conditions (see Volume 2, Section 7: Surface Waterbodies). Existing water chemistry data indicates that water quality in the SLR meets Environmental Quality Guidelines for Alberta Surface Waters for agricultural and recreational use. Therefore, incidental exposure to water while engaged in recreational activities on the reservoir was not expected to result in adverse health effects. This is not expected to change with the expansion of the reservoir.

For the ingestion assessment, the only COPC is mercury. The creation of new reservoirs can be associated with the formation of methylmercury. Flooded soils and vegetation are sources of

mercury in various forms. Methylmercury can form when mercury is metabolized by organisms at the sediment-water interface under anoxic conditions. Due to the inundation of grassland habitat associated with the proposed expansion of the existing reservoir, it is possible that an increase in mercury concentrations will occur in the aquatic environment post-impoundment. Methylmercury can bioaccumulate in organisms within the trophic food web, particularly piscivorous fish species. As a result, methylmercury in fish was considered a COPC for the HHRA.

The Air Quality Assessment indicates that emissions associated with Project construction result in predicted concentrations that exceed the Alberta Ambient Air Quality Objectives (AAAQO) for nitrogen dioxide (NO_2; hourly and annual, at a location adjacent to the Trans-Canada Highway; TCH) and for $PM_{2.5}$ (24-hour, adjacent to the TCH in the Baseline Case and the Project construction areas in the Project Construction and Cumulative Construction Cases). The frequencies of the predicted non-compliant hourly and 24-hour concentrations are low. The concentrations of the 24-hour $PM_{2.5}$ were predicted at two sensitive receptor locations for one day out of the five years of meteorology data that were modelled.

The Air Quality Assessment adopted a conservative approach to predict the ground-level air concentrations in the LSA. Air quality dispersion models are known to overestimate the contribution of fugitive particulate matter to ambient concentrations (Watson, Chow, Wang, & Lowenthal, 2013). Because of the high level of conservatism built into the air dispersion model, the predicted 24-hour ground-level air concentrations of $PM_{2.5}$ likely overstate the actual exposures that might be received by people residing in or visiting the Local Study Area (LSA) under most circumstances. The use of dust mitigation measures is expected to have a clear effect on the reduction of $PM_{2.5}$ concentrations at all receptor locations, which emphasizes the value of a dust monitoring and mitigation strategy during all stages of construction.

The expansion of the SLR is expected to result in a temporary increase of mercury concentrations in larger predatory fish like Northern Pike (*Esox lucius*) and Walleye (*Sander vitreus*). There are significant practical limitations associated with predicting mercury concentrations in fish over time with the SLR expansion. Application of a mechanistic model for the SLR is not expected to result in accurate predictions of mercury concentrations in fish. The implementation of a fish monitoring program following the expansion of the SLR, with a focus on methylmercury concentrations in fish species of relevance to human consumption, is considered the most effective way to determine the change of mercury concentrations in sportfish in the reservoir over time.

Monitoring of mercury concentrations by the Alberta Government was recommended in Volume 2, Section 8 (Aquatic Resources). This monitoring would determine if any consumption restrictions need to be enacted to protect human health.

Table of Contents

Figures

Tables

Appendix N

Abbreviations

AAAQOs	Alberta Ambient Air Quality Objectives
AHS	Alberta Health Services
Alberta EPA	Alberta Environment and Protected Areas
asl	Above sea level
CAC	Criteria Air Contaminant
COPC	Contaminants of Potential Concern
COPD	Chronic Obstructive Pulmonary Disease
EID	Eastern Irrigation District
FEV_1	Forced expiratory volume in one second
FL	Fork length
FSL	Full Supply Level
GOA	Government of Alberta
HHRA	Human Health Risk Assessment
LSA	Local Study Area
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
$PM_{2.5}$	Fine particulate matter (Particulate matter less than 2.5 microns in diameter)
SLR	Snake Lake Reservoir
SO_2	Sulphur dioxide
SSR	South Saskatchewan Region
TCH	Trans-Canada Highway
TCHTM	Trans-Canada Highway Twinning Monument
TRV	Toxicological reference value
US EPA	United States Environmental Protection Agency

16.1 INTRODUCTION

16.1.1 Background

The Eastern Irrigation District (EID) is applying for approval under the *Environmental Protection and Enhancement Act* (EPEA; Government of Alberta [GOA], 2000) to construct the proposed Snake Lake Reservoir (SLR) Expansion Project (the Project). The Project, located in the County of Newell between Bassano and Brooks, Alberta, will be an expansion of the SLR into sections 29, 30, 31, and 32 in Township 19, Range 6, W4M, and will increase storage capacity from the current 19.25 million m^3 (15,600 ac ft) to a total storage capacity of 87.4 million m^3 (70,900 ac ft) across the SLR and expanded Project.

Water sourced from the Bow River at Bassano Dam is diverted into the reservoir from the EID's East Branch Canal via a gated inlet chute combined with an online check structure. Outflow from the reservoir is through the East Dam Low-Level Outlet, located near the north end of the East Dam. This water is used to support 20,000 ha of downstream irrigated agriculture. The Project will help address future water needs and increase water storage within the EID during low-flow conditions in the Bow River and periods of drought.

This Environmental Impact Assessment (EIA) section includes a baseline assessment, which contains details on public health resources based on requirements provided in the Final Terms of Reference (FTOR; Volume 2, Appendix A) for the Project issued by Alberta Environment and Protected Areas (Alberta EPA), and following the Guide to Preparing Environmental Impact Assessments in Alberta (GOA, 2013). This document also contains a residual impact assessment.

16.1.2 Purpose

The objective of the Human Health Risk Assessment (HHRA) is to assess the potential health risks associated with fugitive dust emissions and combustion emissions from equipment used during the construction phase of the Project. In addition, the HHRA serves to characterize the health risks associated with potential changes to water quality and the subsequent uptake of mercury in sport fish in the reservoir.

16.1.3 Project Setting

The Project is located in the Dry Mixedgrass Natural Subregion within the Grassland Natural Region of Southern Alberta. This Subregion is characterized by a semi-arid climate that experiences the warmest summers, longest growing season and lowest precipitation of any Natural Subregion of Alberta (Neville, Lancaster, Adams, & Desserud, 2014). The proposed Project area is dominated by native grasslands and also contains treed areas and wetlands. Parent materials include clay soils and rocky/sandy soils. Previously, the site was used for seasonal cattle grazing, as well as oil and gas activity. The terrain in the area has low relief with flat to undulating terrain. A detailed description of the Project setting is found in the Overview (see Volume 1, Section 2). Additional information on the vegetation, soils, and land use within the Project area can be found in those sections of the EIA (i.e., Volume 2, Section 10 [Vegetation and Wetlands], Section 9 [Soil and Terrain], and Section 13 [Land Use and Management]).

16.1.4 Regulatory Context

The HHRA followed Alberta Health's 2019 Guidance on Human Health Risk Assessment for Environmental Impact Assessment in Alberta, Version 2.0 (GOA, 2019a). As described by Alberta Health, the primary objective of that document is to "provide general guidance for the completion of an [human health risk assessment] as part of an [environmental impact assessment], with the overall goal of ensuring quality, consistency and completeness of risk assessments conducted in Alberta." Alberta Health also states that "the guidance is not intended to be a narrowly prescriptive technical protocol for the quantitative assessments of health risks" and that "proper application of the guidance requires substantial expertise and professional judgement".

Because the Project is somewhat atypical in that the potential risks to health relate exclusively to emissions from construction sources and the potential changes in water quality and fish quality with the expansion of the reservoir, professional judgment was relied upon when the HHRA required that adjustments be made to the "prescriptive technical protocol" described in the 2019 Guidance.

16.2 STUDY AREA

The Project area is located in a rural area in proximity to agricultural operations. The town of Bassano is located 22 km northwest of the Project area, and the nearest city, Brooks, is 19 km to the southeast (see Appendix N1, Figure N1-1). The nearest Indigenous community is the Siksika Nation (Reserve #146), located approximately 22 km away (see Appendix N1, Figure N1-1).

The human health study area was identified from the Air Quality Assessment (see Volume 2, Section 4). This Local Study Area (LSA) encompasses an area with a radius of 7.5 km from the approximate centre of the Project area (see Appendix N1, Figure N1-2), and includes both sensitive receptors (e.g., acreages) and existing emission sources (i.e., Oil Battery plant, highway and railway). There are limited residences within the LSA, with the closest residence being 3.5 km northwest of the Project (see Appendix N1, Figure N1-2, R2). The closest community to the Project site is the Lathom Hutterite Colony (6 km southwest; see Appendix N1, Figure N1-2, R6). Sensitive receptors are discussed further in Section 16.4.1.2. Existing human infrastructure in the vicinity of the Project consists of fences, access roads and trails to the existing reservoir, irrigation infrastructure (e.g., dams, canals, dugouts), gas industry facilities and old gravel quarry sites.

The Project area is on land privately-owned by the EID, which has been used for grazing and other land uses (e.g., oil and gas) for decades. Most of the Project area has not been accessible for Traditional Uses since the land was settled and Treaty 7 signed. Access into the Project area can be achieved along the partially developed Range Road 165 road allowance. Additional access to the SLR for fishing and other traditional or recreational uses is maintained by the EID. Hunting is not permitted at the SLR. For further information, see Land Use and Management (Volume 2, Section 13) and Traditional Ecological Knowledge and Traditional Land Use (Volume 2, Section 15).

16.3 ISSUE SCOPING

The assessment of potential human health risks is intentionally focused on people who may be present in the area on both a short-term and long-term basis during the construction and operation of the reservoir. Two main exposure pathways were assessed: inhalation (i.e., exposures from air emissions) and ingestion (i.e., consumption of fish caught in the reservoir). Potential Project effects on water quality affecting potability, or dermal exposure while swimming, were not addressed since the reservoir is not intended as a direct source of drinking water or a swimming destination.

Table 16-1 summarizes the issue scoping for this HHRA. These issues are further developed in the Problem Formulation (Section 16.4.1).

Table 16-1: Issue scoping for human health risk assessment

Project Activities and Risks	Resources	Indicators or Measures	Potential Issues	Screening[1]
Combustion emissions from workers travelling to and from the site	Human Health Effects Related to Air Quality	Comparison with Alberta Ambient Air Quality Objectives (AAAQOs) – Acute and Chronic	Increased Nitrogen Oxides (NO_x) emissions	Likely – during construction phase
Emissions from earthmoving equipment and other diesel fuel equipment on the site (e.g., lighting, space heaters, generators, etc.) and emissions from truck bringing equipment or materials to the site			Increase NO_x, sulphur dioxide (SO_2) and particulate emissions	Likely – during construction phase
Dust generated from construction activities			Increased particulate emissions	Likely – during construction phase
Dust during reservoir drawdown periods				Unlikely – since banks of existing reservoir tend to remain wet/muddy during drawdown, banks of expanded reservoir will be riprapped with rock
Construction and initial reservoir filling	Human Health Effects Related to Ingestion of/Contact with Water	Water Quality	Reduced water quality in existing SLR affecting public use of reservoir[2]	Unlikely – although some changes in water quality may take place, none are expected to affect public health or public use of the existing SLR
Reservoir drawdown during drought conditions			Reduced water quality in expanded reservoir during operations	Unlikely – although some changes in water quality may take place, none are expected to affect public health or public use of the expanded reservoir
Mercury methylation and accumulation in prey species following initial reservoir filling or during operation of reservoir	Human Health Effects Related to Fish Quality/Human Consumption of Fish	• Comparison with fish in other reservoirs/lakes • Comparison against fish consumption advisories	Increased methylmercury in sportfish	Effects Possible – inundation of new reservoirs may cause mercury methylation which may cause mercury to bioaccumulate in sportfish

[1] Determine if the issue is unlikely to occur, or if relevant data is not sufficient for assessment.

[2] The current SLR is not a direct source of drinking water and there is no evidence that people swim in the reservoir: neither are expected uses for the expanded reservoir.

16.3.1 Assessment Cases

16.3.1.1 Inhalation Pathway (Air Quality)

The air emissions from the Project would be limited to the construction phase only, as no significant air emissions will be associated with the operation of the Project over the long term. Construction of the Project is expected to take up to five years, including material shipment, dam construction, and reclamation (see the Project schedule in Volume 1, Section 2: Overview).

The Air Quality Assessment defines the following assessment cases:

- **Baseline Case:** identifies the key contaminants of concern, including criteria air contaminants (CACs) regulated by Alberta Environment and Protected Areas (Alberta EPA). Baseline air quality data was modelled for the year 2023 to capture existing conditions within the study area. The potential for soil drifting from the existing reservoir during drawdown events is captured within this case.
- **Project Construction Case**: includes the emissions during the construction period including emissions from equipment and dusts generated from construction activities in the year 2027. The modelling for the Project Construction Case assumes that no dust mitigation measures are in place.
- **Cumulative Construction Case**: includes the estimation of regional emissions during the year 2027 in addition to the estimated Project Construction Case emissions, without dust mitigation measures.
- **Project Construction Mitigation Case:** the estimated air quality impacts during Project construction, with dust mitigation measures in place (including the watering of unpaved roads more than twice a day, when required, to reduce fugitive dusts).
- **Cumulative Construction Mitigation Case:** includes the emission sources from the Cumulative Construction Case, with dust mitigation measures assumed in the Project Construction Mitigation Case being applied.

No emission of CACs is anticipated during the operational phase of the project. The Air Quality Assessment identified the Project CACs as nitrogen dioxide (NO_2), fine particulate matter (i.e., particulate matter less than 2.5 microns in diameter; $PM_{2.5}$) and sulphur dioxide (SO_2). All assessment cases, except the Project Operations case for air quality emissions, are evaluated within this HHRA.

16.3.1.2 Ingestion Pathway (Water and Fish Quality)

Water quality changes are discussed in the Surface Waterbodies Assessment (see Volume 2, Section 7). Potential effects on surface waterbodies for drinking purposes are not addressed since the reservoir is not a direct source of potable water. Methylation of mercury will be discussed here, but is also assessed in the Surface Waterbodies (see Volume 2, Section 7) and Aquatic Resources (see Volume 2, Section 8) sections. The Baseline Case was assessed based on samples collected between 2021 and 2023 from surface water, sediment, and fish tissue. No Project Operation Case is assessed based on comparison with other reservoirs and public health guidelines in southern Alberta. A regional cumulative effects assessment is also presented for Surface Waterbodies in Volume 2, Section 7, and for Aquatic Resources in Volume 2, Section 8.

16.3.2 Public and Indigenous Consultation

The EID completed a community consultation and engagement program; wherein various regional communities and stakeholders were contacted and notices were published in local media. Apart from a few individuals who attended the EID Annual General Meeting, the EID received no comments or responses from the public or Indigenous groups. This includes the closest First Nation to the Project - Siksika Nation. Alberta EPA received public comments on the proposed Terms of Reference from three organizations and one individual, none of which contained any health-related concerns, nor any comments related to air quality or mercury uptake in fish. See Volume 1, Section 12 (Public and Indigenous Engagement) for further details. To date, the EID has received no health-related concern about the Project.

16.4 METHODS

This HHRA focuses on the potential human health risks associated with emissions in the LSA and the content of mercury in fish within the reservoir and relies on a conventional risk assessment paradigm. The methods used in the HHRA are based on guidance from Alberta Health (GOA, 2019b) and Health Canada (Government of Canada [GOC], 2024).

The primary steps of a HHRA include the following:

- **Problem Formulation** – This step is focused on the identification of the chemicals, receptors, and exposure pathways of greatest concern. Key tasks within the problem formulation include:
  - Selection of the chemicals to be examined (commonly referred to as the contaminants of potential concern or COPC).
  - Identification of the people who might be exposed to the COPC. Those people that have the greatest potential for exposure to the COPC are identified in this step of the problem formulation. Consideration is given to sensitive and vulnerable groups, such as children, seniors and individuals with pre-existing health conditions, who are most likely to spend time in the vicinity of the Project area.
  - Identification of exposure scenarios and operable exposure pathways. This step considers the exposure pathways by which each COPC could come in contact with sensitive receptors. The relevant (operable) exposure pathways are reviewed to provide a sound technical basis for the subsequent scope of the HHRA, as well as to document the rationale used to exclude specific exposure pathways from further consideration.
- **Exposure Assessment** – This step involves estimating the amount, concentration, or dose of the COPC received by people for each pathway identified in the problem formulation. The dose of a chemical depends on the concentration in various environmental media, the amount of time that a person might be in contact with these media and the physiological characteristics of that person.
- **Toxicity Assessment** – This stage of the HHRA involves the selection of toxicological reference values (TRVs; i.e., the acceptable dose that people can be exposed to without risk of adverse health effects over a lifetime). Both the type of health effect and the pathway by which a person is exposed to the contaminant (e.g., inhalation) are considered.

- **Risk Characterization** – In the risk characterization step, the results of the exposure assessment are compared with the findings of the toxicity/effects assessment to determine whether there is potential for the COPC to pose adverse human health effects.

An evaluation of the uncertainties and assumptions are important with respect to interpreting the health risks. The general risk assessment framework requires that the uncertainty be described, to the extent possible, that may surround the prediction of risks, regardless of type or source. This uncertainty can take several forms, including uncertainty due to lack of information, interindividual or interspecies variability, and experimental and measurement error. The uncertainties were evaluated to determine the level of confidence associated with the risk estimates.

16.4.1 Problem Formulation

16.4.1.1 Identification of Chemicals of Potential Concern

Inhalation Pathway Assessment

The COPC for the inhalation assessment are based on the anticipated Project emissions identified in the Air Quality Assessment (see Volume 2, Section 4). The Air Quality Assessment identified three CACs that will be emitted during the Project Construction phase:

- Nitrogen dioxide (NO_2);
- Fine particulate matter ($PM_{2.5}$); and
- Sulphur dioxide (SO_2).

Regional background air quality was determined using air quality monitoring data collected from the Brooks Airpointer Monitoring Stations and the Medicine Hat Monitoring Station from May/June 2021 to April 30, 2024. This data was then used for air quality dispersion modelling (see Volume 2, Section 4 for further details). The Baseline Case included current emission sources in the LSA (e.g., vehicular traffic, industrial emissions). The Project Case examines the predicted emissions as a result of Project construction alone. The Cumulative Construction Case includes both Project construction emissions, and other emissions predicted within the LSA in 2027. Modelling methods and assumptions associated with each Case are discussed in the Air Quality section (Volume 2, Section 4).

Ingestion Pathway Assessment

As described in Volume 2, Section 7 (Surface Waterbodies), the water chemistry in the expanded reservoir is not expected to change from current conditions. Existing water chemistry data indicates that water quality in the SLR meets Environmental Quality Guidelines for Alberta Surface Waters for agricultural and recreational use (GOA, 2014a; see Volume 2, Section 7, Appendix E2). Therefore, incidental exposure to water while engaged in recreational activities on the lake (e.g., dermal contact while fishing) is not expected to result in adverse health effects. This is not expected to change with the expansion of the reservoir. Furthermore, the current SLR is not a direct source or potable water (i.e., water requires treatment prior to drinking), nor a swimming destination.

For the ingestion pathway, the only COPC is mercury. The creation of new reservoirs can be associated with the uptake of mercury or metabolism of mercury by organisms at the sediment-water interface into its organic form, methylmercury (Ullrich, Tanton, & Abdrashitova, 2001). This process results from the large amount of inundated organic matter, decomposing in low-oxygen conditions, which are typical for a new reservoir post-inundation (Ullrich, Tanton, & Abdrashitova, 2001). Methylmercury cannot be metabolized by organisms, so accumulates within animal tissue over time, and tends to bioaccumulate in larger, piscivorous fish species, including many sportfish. New reservoirs therefore often have elevated mercury concentrations in fish tissue, especially from two to five years post-inundation (Feng, Hiltz, & Wharmby, 2011). Mercury levels will slowly decline back to background concentrations, but this process may take up to 30 years, depending on environmental conditions (Bodaly, et al., 2007; Feng, Hiltz, & Wharmby, 2011). Among many other known or likely health effects, methylmercury is an established neurotoxicant and can readily cross the blood-brain-barrier, reaching the developing fetus in mammals, including humans (Hong, Kim, & Lee, 2012). As a result, methylmercury in fish is considered a COPC for the HHRA.

16.4.1.2 Identification of Sensitive Receptors

The Air Quality Assessment (see Volume 2, Section 4) identified eight discrete locations where people may be present (Table 16-2; see Appendix N1, Figure N1-2). It is assumed that individuals may be present at the sensitive receptor locations, specifically the residences and farms (including the feedlot: sensitive receptors 1-7), on a continuous basis over a period of months to years. In addition, individuals of various life stages (infant, toddler, child, teen, adults and seniors) may be present as a result of either living, visiting or working at these locations.

Table 16-2: Sensitive receptor locations within the Local Study Area identified in air quality assessment

Sensitive Receptor ID	Description	Distance to Project area (km)	UTM Easting (m)	UTM Northing (m)
1	Residence A – Acreage	4.88	418657	5604955
2	Residence B – Acreage	3.50	410679	5614305
3	Residence C – Acreage	4.64	422200	5612468
4	Residence D – Acreage	5.44	422806	5612895
5	Antelope Creek Ranch	5.11	418529	5604712
6	Lathom Hutterite Colony	5.75	409285	5607279
7	Snake Lake Feedlot – Home Yard	4.80	408992	5613217
8	Trans-Canada Highway Twinning Monument	1.95	417159	5615320

Although sensitive receptor 8, the Trans-Canada Highway Twinning Monument (TCHTM) is not a residence or farm, it was included because it is a point of interest and rest area where visitors may be present, albeit on a short-term basis only (i.e., typically from a few minutes to one overnight stay).

The SLR is a publicly-accessible site that is suitable for different recreational activities, including fishing, boating, trail activities, and bird watching. Locals or visitors to the area may catch and eat fish from the SLR. Recreational use of the SLR may lead to incidental exposure to water, although the reservoir is not a direct source of drinking water. Public access to the existing SLR will be maintained even throughout most of the construction period, through periodic restrictions may be in place as required for safety. Once the Project is operational, both the SLR and expanded reservoir will be available to the public for recreational activities.

Consideration of Indigenous Receptors

As described in Section 16.2, the Project area is on land that is privately-owned by the EID, which has been used for grazing and other land uses for decades. The Siksika Nation Reserve (No. 146) is located 22 km northwest of the Project. Most of the Project area has not been accessible for Traditional Uses since the land was settled and Treaty 7 signed. Hunting is not permitted at the existing SLR or within the Project area. Traditional users of the area may experience reduced access to the existing SLR during construction via the installation of public access controls, however, during operation, the expanded reservoir will be publicly accessible, therefore increasing access compared to the current situation (i.e., access only permitted on the road allowance).

Members of the Siksika Nation and other Indigenous communities are not expected to be disproportionately affected by the Project when compared to the occupants of the sensitive receptor locations within the LSA (see Table 16-2). The potential health risks presented at the locations within the LSA are expected to be greater than those presented for individuals who intermittently spend time in the areas surrounding the SLR, which would include traditional use of the land. As such, risks to Indigenous Receptors are not explicitly described in the HHRA.

16.4.1.3 Identification of Relevant Exposure Pathways

People who reside in or visit the LSA during construction may be exposed to the COPC emitted from the construction emission sources via the inhalation pathway. Baseline, Project Construction and Cumulative Construction exposures are estimated based on the air quality predictions for the three COPC (i.e., NO_2, $PM_{2.5}$, and SO_2), on both a short-term and long-term basis. As none of these COPC bioaccumulate or are associated with secondary exposure pathways, the assessment of air COPC exposure via food pathways is not relevant. The only other exposure pathway that may be associated with the Project is the consumption of fish from the reservoir, which is assessed through the Baseline (i.e., conditions in the SLR) and Project Operation Cases (i.e., anticipated conditions in the expanded reservoir).

16.4.2 Exposure Assessment

The exposure assessment relied on the results of the Air Quality (Volume 2, Section 4) and Surface Waterbodies (Volume 2, Section 7) assessments.

Inhalation exposures are estimated from the modelled air quality concentrations for each COPC in the Baseline, Project Construction and Cumulative Construction cases. Ingestion exposures are discussed for the Baseline case, through a qualitative discussion regarding the existing methylmercury concentrations in fish within the SLR. Potential changes resulting from the Project represents the Project Operation case.

16.4.3 Toxicity Assessment

The assessment of the air COPC are assessed on both a short-term (acute, less than 24-hours) and long-term (chronic, weeks/years) basis. The predicted air concentrations of NO_2, $PM_{2.5}$ and SO_2 from standard air models are compared with available air quality guidelines (i.e., the Alberta Ambient Air Quality Objective [AAAQO]), presented in Table 16-3.

Table 16-3: Selected inhalation air quality guidelines for HHRA screening level

COPC	Averaging Period	Guideline (µg/m^3)	Source
NO_2	1-hour 9th	300	AAAQO (GOA, 2024a)
	Annual	45	AAAQO (GOA, 2024a)
$PM_{2.5}$	24-hour	29	AAAQO (GOA, 2024a)
	Annual	8.8	CCME[1] (2024)
SO_2	1-hour 9th	450	AAAQO (GOA, 2024a)
	Annual	20	AAAQO (GOA, 2024a)

[1] CCME: Canadian Council of Ministers of the Environment

No standard models to predict and qualitatively asses methylmercury in fish were considered applicable to the Project (see Section 16.5.3), so a qualitative discussion is instead provided for the fish ingestion pathway, with comparison to other waterbodies and provincial fish consumption advisories (GOA, 2019b).

16.4.4 Risk Characterization

For the inhalation pathway assessment, the predicted air concentrations for the COPC (i.e., NO_2, $PM_{2.5}$, SO_2) were compared with the selected toxicity limits (identified in Section 16.4.3) to determine if there is a potential risk for the air COPC to pose adverse effects on human health (Section 16.5.1).

For the ingestion assessment, baseline information regarding existing local fish populations in the SLR and measured fish tissue data from the area were reviewed and compared with data from other locations in southern Alberta (Section 16.5.2). For the assessment of the Operation Case, a qualitative evaluation of the potential changes in mercury levels in fish as a result of the expansion is provided in Section 16.5.3.

16.5 RESULTS

16.5.1 Inhalation Assessment – All Cases

The maximum predicted ground-level air concentrations for the LSA and the predicted ground-level air concentrations at the sensitive receptor locations are presented in Section 16.5.1.1 (Acute Inhalation Assessment) and Section 16.5.1.2 (Chronic Inhalation Assessment), for all assessment cases considered. Background air quality concentrations (measured, excluding the Baseline Case emission sources) are provided in the data tables in the Air Quality Assessment (Volume 2, Section 4) and are also presented in the result tables.

The Air Quality Assessment was based on conservative assumptions and modelling to present “worst-case” air emissions predictions. For instance, air emissions were modelled with the assumption that the month with the largest area being cleared best represents the period with the greatest air emissions, and the values from this worst-case month were then modelled as if they would occur throughout the entire year of 2027 (see Volume 2, Section 4.5.1.1). The construction area used for modelling (“Modelled Construction Area”) was also based on this one month, using an assumption that all applicable construction equipment would be operating in this area. Along with the conservative meteorological conditions that were assumed for the modelling exercise, these assumptions ensured that the predicted air concentrations associated with the Project were not underestimated.

16.5.1.1 Acute Inhalation Effects Assessment

Nitrogen Dioxide (NO_2)

Table 16-4 presents the 1-hour air quality concentrations for the Baseline, Project Construction and Cumulative Construction Cases for NO_2 at the various sensitive receptor locations and also provides the maximum ground-level concentration predicted for the LSA. The proposed mitigation measures incorporated into the mitigated Project and Cumulative Construction Case modelling in the air quality assessment included the watering of roads to suppress dust and will not influence NO_2 concentrations. As a result, hourly NO_2 data for the Project and Cumulative Construction Cases with dust mitigation are not presented in Table 16-4.

Table 16-4: Comparison of acute 1-hour NO_2 concentrations[1] with selected air quality criteria, all assessment cases[2]

Sensitive Receptor	Air Quality Objective (µg/m³)	Background Concentration (µg/m³)	Baseline (µg/m³)	Project Construction (µg/m³)	Cumulative Construction (µg/m³)
Maximum (LSA)	300	14.3	**1,192.2**	**485.7**	**1,153.6**
1			28.9	179.3	183.5
2			38.8	251.9	251.9
3			174.3	135.6	173.7
4			83.5	123.0	212.9
5			29.5	175.3	178.4
6			31.0	145.2	157.8
7			36.2	173.4	178.6
8			83.3	200.8	210.3

[1] **Bold** values indicate an exceedance of the guideline

[2] Concentrations for all cases include the background concentration

The predicted hourly NO_2 concentrations at all eight discrete sensitive receptors are all less than the AAAQO (or "guideline") of 300 µg/m³ in the Baseline, Project Construction and Cumulative Construction Cases, including the Sensitive Receptor 8 (the TCHTM), where visitors may be present on a temporary basis.

The predicted maximum hourly NO_2 concentrations do exceed the AAAQO of 300 µg/m³ in some areas of the LSA. Isopleths (concentration contours) of the predicted 9th-highest 1-hour NO_2 concentrations for the Baseline, Project Construction, and Cumulative Construction Cases are presented in Appendix N1, Figures N1-3, N1-4, and N1-5, respectively. For the Baseline and Cumulative Construction Cases, the predicted maximum-ground-level hourly NO_2 concentrations occur adjacent to the Trans-Canada Highway (TCH). The maximum for the Project Construction Case is predicted to occur immediately adjacent to where the removal of the existing dam structure would take place – though, this location is based on the Modelled Construction Area and will therefore vary slightly based on where in the Project area the construction activity is actually taking place at any given time. The locations of these maximum concentrations do not represent locations where people are likely to be present on a regular basis (see Appendix N1, Figure N1-4). The Air Quality Assessment (Volume 2, Sections 4.5.1.1 [Methods] and 4.5.2.1 [Results]) notes that beyond the immediate Project boundary, the hourly-average NO_2 concentrations are expected to exceed the AAAQO no more than 2.3% of the time, based on worst-case meteorological conditions. For approximately 98% of the time, the hourly NO_2 concentrations in the LSA outside the immediate Project area are anticipated to be less than the

AAAQO of 300 µg/m³. The predicted 1-hour NO_2 concentrations at locations where the possibility of exposure is greater (i.e., at the sensitive receptor locations) are all less than the AAAQO.

Consideration should be given to the degree of conservatism incorporated into the 1-hour AAAQO of 300 µg/m³ in the interpretation of the likelihood of any adverse health effects associated with short-term exposure to NO_2 in the LSA. A summary of the potential adverse health effects of short-term NO_2 exposure is presented in Table 16-5.

Table 16-5: Summary of potential acute health effects of NO_2

Air Concentration (µg/m³)	Description of Potential Acute Health Effects
<190	No documented reproducible evidence (consistent and significant) of adverse health effects among healthy individuals or susceptible individuals following short-term exposure. Study results are variable and are indiscernible from background or control groups.
190 to 560	Increased airways responsiveness, detectable via meta-analysis, among asthmatics; however, large variability in protocols and responses. At 490 µg/m³, possible allergen-induced decrements in lung function and increased allergen-induced airways inflammatory response among asthmatics. Most studies used non-specific airways challenges to assess effects.
560 to 750	Potential effects on lung function indices, including inconsistent changes FEV_1[1] and forced vital capacity among patients with COPD[2] during mild exercise.
1,900 to 3,700	Asthmatics might experience small decrements in FEV_1. Increased likelihood of inflammatory response and airway responsiveness among healthy individuals during intermittent exercise. Symptoms have not been detected by most investigators among healthy individuals.
≥3,700	Changes in lung function, such as increased airway resistance, in healthy individuals.

[1] FEV_1: Forced expiratory volume in one second – a standardized measurement of how much air a person can exhale
[2] COPD: Chronic Obstructive Pulmonary Disease

While some studies have reported mild respiratory effects in asthmatics at levels of NO_2 below 375 µg/m³, because of the absence of a clear dose–response relationship and statistical uncertainty in these studies, the findings are not considered to reflect the acute effects associated with NO_2 exposure (Forastiere, et al., 1996; WHO, 2000; California EPA, 2007). At 490 µg/m³, possible allergen-induced decrements in lung function and increased allergen-induced airway inflammatory response was reported among asthmatics (Strand, Rak, Svartengren, & Bylin, 1997; California EPA, 2007; US EPA, 2008). However, a 2009 meta-analysis of NO_2 exposure and airway hyper-responsiveness in asthmatics indicated that there is no evidence that NO_2 causes clinically relevant effects in asthmatics at concentrations up to 1,100 µg/m³ (Goodman, Chandalia, Thakali, & Seeley, 2009).

For the Baseline and Cumulative Construction Cases, the maximum 1-hour NO_2 concentrations inside the LSA are above the air concentration (i.e., 490 µg/m³) at which possible allergen-induced decrements in lung function and increased allergen-induced airway inflammatory responses have been reported among some exercising individuals with pre-existing breathing disorders, such as asthma, bronchitis, or chronic obstructive pulmonary disease (COPD). None of the predicted NO_2

air concentrations exceed 490 μg/m^3 at the sensitive receptor locations.

Based on the above, the overall weight of evidence indicates that, despite the predicted exceedances of the 1-hour AAAQO for NO_2, the potential risk of adverse effects as a result of short-term exposure to NO_2 in the LSA is low, short term, and confined to the air emissions LSA.

Fine Particulate Matter ($PM_{2.5}$)

For fine particulates like $PM_{2.5}$ the incorporation of dust mitigation measures into the modelling is meaningful from the perspective of gaining an understanding as to how such mitigation may protect human health. The estimated 24-hour $PM_{2.5}$ concentrations for the Baseline, Project Construction (unmitigated and mitigated) and Cumulative Construction Case (unmitigated and mitigated) are presented in Table 16-6. The proposed dust mitigation includes the watering of gravel roads and the construction areas at least twice per day, when necessary.

Under the Baseline Case, a slight exceedance of the 29 μg/m^3 AAAQO (29.1 μg/m^3) is predicted at the maximum LSA location, but not at any of the sensitive receptor locations (Table 16-6). As shown in Appendix N1, Figure N1-6, the location of this maximum is adjacent to the TCH – not a location where people are likely to be present on a regular basis, other than passing through in their vehicle. The predicted Baseline Case 24-hour $PM_{2.5}$ concentrations at the sensitive receptor locations are below the AAAQO.

Without dust mitigation measures, exceedances of the AAAQO are predicted at all sensitive receptor locations on a 24-hour basis for both the Project Construction and Cumulative Construction Cases. Isopleths of the predicted 24-hour $PM_{2.5}$ air concentrations for the unmitigated Project Construction and Cumulative Construction Cases are presented in Appendix N1, Figures N1-7 and N1-8. These unmitigated cases represent worst-case conditions, as dust mitigation measures will be implemented for the Project. The mitigated 24-hour $PM_{2.5}$ air concentrations are presented in Appendix N1, Figures N1-9 and N1-10 for the Project Construction and Cumulative Construction Cases, respectively.

Section 4.5.2.3 of Air Quality (Volume 2, Section 4) indicates that with dust mitigation, exceedances of the AAAQO are predicted to occur approximately 2.2% of the time outside the boundary of the Project area, in the Project and Cumulative Construction Cases. Isopleths for the Project and Cumulative Construction Cases with dust mitigation are presented in Appendix N1, Figures N1-9 and N1-10, respectively. The maxima in both cases are located along the southern boundary of the Project working area, where the equipment-related emissions are the highest. Exceedances of the AAAQO are predicted for both the Project Construction and Cumulative Construction Cases at sensitive receptor 5 (Antelope Creek Ranch) and 8 (TCHTM). However, the Air Quality Assessment notes that the predicted frequency of exceedances at Antelope Creek Ranch and the TCHTM is about 1 day over the five-year construction period. In addition to road watering, the EID may install dust fencing around appropriate areas of the construction site to further reduce fugitive dusts, if necessary.

Table 16-6: Predicted 24-hour $PM_{2.5}$ air concentrations[1] for the baseline, project construction and cumulative scenarios (with and without mitigation)[2]

Sensitive Receptor	Air Quality Objective (µg/m³)	Background Concentration (µg/m³)	Baseline (µg/m³)	No Dust Mitigation		With Dust Mitigation	
				Project Construction (µg/m³)	Cumulative (µg/m³)	Project Construction (µg/m³)	Cumulative (µg/m³)
Maximum (LSA)	29	15.3	**29.1**	**548.7**	**548.8**	**185.6**	**185.7**
1			15.5	**56.9**	**57.0**	28.6	28.7
2			15.6	**49.8**	**49.9**	26.4	26.5
3			17.0	**35.3**	**35.4**	21.8	21.8
4			15.9	**32.9**	**33.3**	21.0	21.3
5			15.5	**64.2**	**64.3**	**30.9**	**31.0**
6			15.4	**37.0**	**37.0**	22.3	22.3
7			15.5	**44.6**	**44.7**	24.7	24.8
8			16.3	**63.1**	**63.2**	**30.6**	**30.8**

[1] **Bold** values indicate an exceedance of the guideline
[2] Concentrations for all cases include the background concentration

Exceedances of the AAAQO for $PM_{2.5}$ are predicted outside the perimeter of the Project area. However, air concentrations above the 24-hour AAAQO of 29 µg/m³ do not necessarily indicate that adverse effects will occur. Many epidemiological studies have been published that examine short-term $PM_{2.5}$ exposure and human health (e.g., Pope & Dockery, 2006). More recent methodological enhancements in the causal analysis of $PM_{2.5}$ and health outcomes have enabled researchers to further explore the shape of the particulate matter health effects concentration-response functions (or “dose-response curve”; Pope & Dockery, 2006). These estimated concentration-response functions are based on daily time-series data from multiple large urban centres that have been pooled to enhance their statistical power and generalizability. When combined, these concentration-response functions are near linear, with no obvious evidence of safe threshold levels (Pope & Dockery, 2006). For this reason, Health Canada recommends that concentrations of particulate matter be reduced in the ambient environment to the greatest extent possible (GOC, 2016).

Concentration-response functions and the associated concept of no-threshold of effect for $PM_{2.5}$ are based on large urban centres with typical populations well in excess of one million people (i.e., orders of magnitude larger than the population within the LSA). To reliably measure a small relative risk, large study populations are required to confirm adequate statistical strength. However, analysis of short-term exposure-response relationships for $PM_{2.5}$ do not always demonstrate evidence for increased mortality, indicating other factors may be responsible. Baxter et al. (2011) documented significant heterogeneity among community-specific $PM_{2.5}$ estimates of mortality effects between 27 communities in the United States. The magnitude of the effect varies depending on the nature of the particulate matter (e.g., types of emission sources, composition of particulate matter), the characteristics of the exposed population (e.g., presence of vulnerable or susceptible groups, such as individuals with pre-existing health conditions), and the extent of the exposure itself (e.g., concentrations of $PM_{2.5}$ and length of exposure). Hoek et al. (2013) identified significant heterogeneity in $PM_{2.5}$ effect estimates, likely related to differences in particle composition, infiltration of particles indoors, population characteristics and methodological differences in exposure assessment and other risk factors that can confound the results. Therefore, a certain degree of caution should be exercised when applying the findings of large urban studies to the Project LSA.

For the HHRA, reliance was placed on the results of the air dispersion modelling completed for each of the assessment cases (i.e., Baseline Case, Project Construction and Cumulative Construction Case). A considerable amount of conservatism was incorporated into these predictions (e.g., worst-case emission estimates and meteorological conditions). Additionally, emissions of $PM_{2.5}$ from the Project are associated with low-lying fugitive dust and exhaust emission sources, rather than from stacks that promote the dispersion of $PM_{2.5}$ into the atmosphere. Researchers have noted that current methods for the characterization of mechanically-generated and windblown fugitive emissions are known to provide inadequate representation of real-world, site-specific conditions, and dispersion models are known to overestimate the contribution of fugitive particulate matter to ambient concentrations (Watson, Chow, Wang, & Lowenthal, 2013). On this basis, the $PM_{2.5}$ predictions from fugitive emission sources associated with the Project are considered conservative. Due to the high level of conservatism built into the air dispersion model, the predicted 24-hour ground-level air concentrations of $PM_{2.5}$ likely overstate the actual exposures that might be received by people residing in or visiting the LSA under most circumstances.

Overall, while there will be locations where the 24-hour AAAQO of 29 μg/m^3 may be exceeded during Project Construction when the planned dust mitigation measures are in place, the potential for these events to occur is generally low, short term and confined to the LSA. The LSA maxima are located in areas where members of the public are unlikely to be (immediately adjacent to the construction area), and the frequency of exceedance events at sensitive locations is low. Furthermore, flexible dust mitigation (e.g., monitoring dust and increasing watering as appropriate) may further reduce $PM_{2.5}$ exposure risk.

Sulphur Dioxide (SO_2)

The predicted hourly SO_2 concentrations at the maximum LSA and at the sensitive receptor locations for the Baseline, Project Construction and Cumulative Construction Cases are presented in Table 16-7. The proposed mitigation measures incorporated into the air quality modelling included the watering of roads to suppress dust, which will not influence (reduce) SO_2 concentrations, and so are not included here.

Table 16-7: Comparison of acute 1-hour SO_2 concentrations with selected air quality criteria, all assessment cases[1]

Sensitive Location	Air Quality Objective (μg/m^3)	Background Concentration (μg/m^3)	Baseline (μg/m^3)	Project Construction (μg/m^3)	Cumulative (μg/m^3)
Maximum (LSA)	450	0.5	8.5	16.4	16.4
1			0.6	1.1	1.1
2			0.6	1.6	1.6
3			1.4	0.9	1.4
4			0.8	0.9	1.1
5			0.6	1.1	1.1
6			0.6	0.9	1.0
7			0.6	1.2	1.2
8			0.7	1.1	1.8

[1] Concentrations for all cases include the background concentration

All predicted hourly SO_2 concentrations, including at the LSA maximum and the sensitive receptor locations, are well below the AAAQO of 450 μg/m^3. Based on the results of the Air Quality Assessment, the likelihood of adverse health effects associated with SO_2 emissions from the Project Construction are negligible.

16.5.1.2 Chronic Inhalation Effects Assessment

The predicted annual air concentrations of NO_2, $PM_{2.5}$ and SO_2, along with the associated chronic health risks are described below.

Nitrogen Dioxide (NO_2)

The predicted annual NO_2 concentrations at the LSA maximum and the sensitive receptor locations are presented in Table 16-8. Information for the Project and Cumulative Construction Cases with mitigation measures in place are not presented, as the dust mitigation measures incorporated in the air assessment do not affect NO_2 concentrations.

The maximum annual NO_2 concentration in the LSA is predicted to exceed the AAAQO of 45 μg/m^3 at a location adjacent to the TCH both presently (i.e., in the Baseline Case; see Appendix N1, Figure N1-11) and in the Cumulative Construction Case (see Appendix N1, Figure

N1-13). The predicted concentrations for the Cumulative Construction Case are dominated by Baseline emissions, which due to the location of the maximum appear to be most influenced by traffic emissions (see Appendix N1, Figure N1-13). The location of the maximum does not represent a location where people would likely be present on a regular basis, as it is roadside to a major highway (i.e., the TCH). When considering only Project emissions, the maximum NO_2 is expected to be on the boundary of the Project Area, and to be well below the AAAQOs (see Appendix N1, Figure N1-12; Table 16-8).

Table 16-8: Annual average NO_2 air concentrations[1] at the discrete receptor locations, all assessment cases[2]

Sensitive Location	Guideline (µg/m³)	Background Concentration (µg/m³)	Baseline(µg/m³)	Project Construction (µg/m³)	Cumulative Construction (µg/m³)
Maximum (LSA)	45	5.6	**74.9**	12.3	**73.3**
1			6.1	6.0	6.5
2			6.4	5.9	6.7
3			11.5	5.9	11.7
4			8.5	5.9	8.6
5			6.1	5.9	6.5
6			5.9	5.8	6.1
7			6.1	5.8	6.3
8			10.0	6.3	10.8

[1] **Bold** values indicate an exceedance of the guideline
[2] Concentrations for all cases include the background concentration

The predicted annual NO_2 concentrations at all of the sensitive receptor locations were much lower than the AAAQO of 45 µg/m³, for all Cases (Table 16-8). The risk that residents and visitors to the area would experience adverse, long-term health impacts associated with the predicted NO_2 concentrations is negligible.

Fine Particulate Matter ($PM_{2.5}$)

Because Alberta does not have an annual AAAQO for $PM_{2.5}$, the Air Quality Assessment (see Volume 2, Section 4) does not include an assessment of annual $PM_{2.5}$ concentrations. As a result, an assessment of the potential risks to human health at the LSA maximum and sensitive receptor locations was not completed.

Sulphur Dioxide (SO_2)

The predicted annual SO_2 concentrations are presented in Table 16-9. The predicted annual SO_2 air concentrations are below the annual AAAQO of 20 µg/m³ at all locations and for all assessment cases. The risks of residents and visitors to the LSA experiencing long-term health effects associated with the Project-related SO_2 emissions are negligible.

Table 16-9: Predicted annual SO_2 air concentrations, all assessment cases[1]

Sensitive Location	Air Quality Objective (µg/m³)	Background Concentration (µg/m³)	Baseline (µg/m³)	Project Construction (µg/m³)	Cumulative Construction (µg/m³)
Maximum (LSA)	20	0.2	0.5	0.4	0.4
1			0.2	0.2	0.2
2			0.2	0.2	0.2
3			0.2	0.2	0.2
4			0.2	0.2	0.2
5			0.2	0.2	0.2
6			0.2	0.2	0.2
7			0.2	0.2	0.2
8			0.2	0.2	0.2

[1] Concentrations for all cases include the background concentration

16.5.2 Ingestion Assessment – Baseline Case

The SLR was established in 1997. The proposed Project will involve the flooding or inundation of approximately 764 ha of land, with the topsoil and vegetation removed from approximately 80% of the area to allow the exposure of deeper shale for reservoir berm construction. The inundation process will result in the decomposition and breakdown of organic material over time. These conditions are known to be favorable for increased rates of methylation of the inorganic mercury contained in the soil to its organic form – methylmercury – by sulphate-reducing bacteria (Kelly, et al., 1997; Rosenberg, et al., 1997). Methylmercury is more easily absorbed than its inorganic counterpart and accumulates in the biota at the lower trophic levels. As the lower trophic level biota are consumed by higher trophic levels, the methylmercury levels increase up the food chain such that the highest mercury levels are typically observed in the top predator species. For this reason, there can be an increased risk of exposure to methylmercury for people who eat sportfish from new or expanded reservoirs. However, removing topsoil and vegetation from much of the Project area prior to inundation will reduce this effect.

This section summarizes the types of fish found in the existing SLR during the 2021 fish inventories and methylmercury levels measured in sportfish muscle caught from the existing SLR in 2023. It goes on to compare the methylmercury levels measured in SLR sportfish to the levels reported for sportfish from other lakes and reservoirs in southern Alberta and to guideline/advisory levels established by Alberta Health for the protection of human health (GOA, 2024b).

16.5.2.1 Snake Lake Reservoir Fish Populations

Fish surveys conducted in the spring and fall of 2021 identified six species of fish in the SLR. These were: 1) Burbot (*Lota lota*); 2) Lake Whitefish (*Coregonus clupeaformis*); 3) Northern Pike (*Esox lucius*); 4) Prussian Carp (*Carassius gibbelio*); 5) Spottail Shiner (*Notropis hudsonius*); and 6) White Sucker (C*atostomus commersoni*; Volume 2, Section 8.4.2, Table 8-8). During the 2021 fish population inventories for the SLR, Lake Whitefish were the most frequently caught species (71 of 93; 76%), followed by Northern Pike (16 of 93; 17%). Of the remaining fish caught, two were White Sucker, two were Prussian Carp, one was Spottail Shiner, and one was Burbot. Lake Whitefish, Northern Pike, and Burbot represent sportfish caught from the SLR. The two Burbot caught were 25 and 50 cm in fork length (FL). As described in Volume 2, Section 8.4.2, caution should be used when interpreting the abundance of fish species in the SLR as most fish were caught in nets set offshore in deeper water which is not the preferred habitat of Northern Pike.

Instead, Northern Pike prefer shallower (<3 m deep), littoral habitats. As well, because the Bow River serves as the source of fish in the SLR and 22 species of fish have been identified upstream of the Bassano Dam on the Bow River, any of these 22 fish species could be introduced to the reservoir when the water is diverted from the Bow River via the canal.

The SLR is not stocked as part of the recreational stocking program managed by Alberta EPA (GOA, 2023). However, anglers who were fishing for Lake Whitefish and Northern Pike during both spring and fall inventories reported that the SLR provided “a good fishery” year-round (see Volume 2, Section 8.4.2).

The 2024-2025 fishing season on the SLR is open from May 8, 2024 to March 15, 2025 during which time the following possession limits are in effect (GOA, 2024c):

- 3 Northern Pike, >63 cm in total length
- 15 Yellow Perch

These limits are established annually as part of the Alberta fishing regulations and are based on “Alberta’s central goal of sustainability for fish populations and fisheries” (GOA, 2014b). No possession limits are specified for Lake Whitefish or Burbot caught from SLR (GOA, 2024c). Lake Whitefish caught from the SLR were all adults and varied from 30 to 65 cm FL, while juvenile, sub-adult and adult Northern Pike caught varied from 20 to 60 cm FL, although most were greater than 40 cm long.

16.5.2.2 Methylmercury Concentrations in Sportfish

In September 2023, two Northern Pike (>50 cm FL) were caught from the SLR and fish muscle samples were analyzed for methylmercury. The methylmercury concentrations measured in the Northern Pike muscle were 0.217 µg/g and 0.218 µg/g. The possession limit for Northern Pike in the SLR requires that the fish be at least 63 cm in total length.

Methylmercury was analyzed in fish tissue rather than total mercury (i.e., sum of all mercury) since methylmercury is much more readily absorbed into the human bloodstream and crosses both the blood-brain barrier and the placenta (GOC, 2008). The percentage of methylmercury in muscle can vary depending on the size and age of the fish, even within the same feeding guild and species, but tends to be higher in large-bodied predatory fish such as Northern Pike (Lescord, Johnston, Branfireun, & Gunn, 2018).

16.5.2.3 Comparison Against Other Southern Alberta Waterbodies

Alberta EPA routinely collects fish from waterbodies in Alberta and submits the fish muscle to Alberta Health for mercury analysis as part of a long-term monitoring of mercury levels in a variety of fish species in Alberta waterbodies (e.g., rivers, lakes and reservoirs; GOA, 2024b). These data are used to inform fish consumption advisories throughout Alberta, which are discussed in the following section. SLR is not included in Alberta’s long-term monitoring program (GOA, 2024b).

As part of the long-term monitoring program, Alberta shares data on mercury concentrations in eight species of fish caught between 1997 and 2021 within the South Saskatchewan Region (SSR) of Alberta (GOA, 2024b). Table 16-10 summarizes mercury data collected as part of the long-term monitoring program for lakes and reservoirs located within the SSR of Alberta. Table 16-11 provides a summary of the mercury concentrations measured in Northern Pike caught from lakes and reservoirs in the SSR of Alberta.

Table 16-10: Summary of monitoring data for mercury in fish from southern Alberta waterbodies

Waterbody	Collection Year	Fish Species
Lakes		
Cowoki Lake[1,6]	2009, 2010	NRPK, WALL
Eagle Lake	2012	NRPK, WALL
Keho Lake[2]	2002, 2006, 2012	LKWH, NRPK, WALL
Lake Newell[6]	2006	LKWH, NRPK, WALL
McGregor Lake	2009	NRPK, WALL
Rolling Hills Lake[6]	2010	NRPK, WALL
Sherburne Lake	2021	NRPK, WALL
Reservoirs		
40 Mile Reservoir	2021	LKWH, NRPK, WALL
Chain Lakes Reservoir	1997	MNWH, RNTR, WHSC
Crawling Valley Reservoir[3,6]	2009, 2021	LKWH, NRPK, WALL
Lake Newell	2021	LKWH, NRPK, WALL
Little Bow Lake Reservoir (“Travers Reservoir”)	2012	NRPK
Milk River Ridge Reservoir	2006	LKWH, NRPK, WALL
Pine Coulee Reservoir[4]	2003, 2004, 2005, 2007, 2014	BURB, NRPK, WALL, WHSC
Rolling Hills Lake	2021	LKWH, NRPK, WALL
Twin Valley Reservoir[5]	2004, 2005, 2006	LNSC, NRPK, WALL

Notes: BURB = Burbot; LKWH = Lake Whitefish; LNSC = Longnose Sucker; MNWH = Mountain Whitefish; NRPK = Northern Pike; RNTR = Rainbow Trout; WALL = Walleye; WHSC = White Sucker

1. Walleye were only caught from Cowoki Lake in 2009, and Northern Pike were only caught in 2010.
2. Northern Pike and Walleye and were only caught from Keho Lake in 2006 and 2012.
3. Lake Whitefish were only caught from Crawling Valley Reservoir in 2021.
4. Burbot, Northern Pike and White Suckers were only caught from Pine Coulee Reservoir in 2007.
5. Longnose Sucker were only caught from Twin Valley Reservoir in 2005.
6. Owned and operated by the EID.

Table 16-11: Measured mercury concentrations in Northern Pike muscle from southern Alberta waterbodies

Waterbody[1]	Count	Total Length (mm)	Weight (g)	Measured Mercury Concentration (µg/g)		
				Minimum	Maximum	Average
Lakes						
Cowoki Lake	6	659-1,080	1,821-10,700	0.374	0.877	0.592
Eagle Lake	13	460-550	594-970	0.052	0.091	0.066
Keho Lake	42	482-930[2]	647-5,006[2]	0.091	0.419	0.162
Lake Newel	6	652-819	1,525-4,550	0.198	0.284	0.232
McGregor Lake	2	818, 828	3,800, 4,600	0.871	1.132	1.002
Rolling Hills Lake	6	710-924	2,435-5,100	0.849	1.230	1.044
Sherburne Lake	18	595-860	1,371-4,036	0.180	0.601	0.387
Reservoirs						
40 Mile Reservoir	17	412-1,086	402-9,290	0.166	0.906	0.406
Crawling Valley Reservoir	41	546-742	972-2,236	0.154	0.851	0.482
Lake Newell	15	311-767	180-2,602	0.096	0.486	0.272
Little Bow Lake Reservoir (“Travers Reservoir”)	9	550-707	945-1,869	0.307	0.874	0.469
Milk River Ridge Reservoir	10	557-751	993-3,255	0.183	0.225	0.205
Pine Coulee Reservoir	4	465[3]	455-640	0.112	0.276	0.169
Rolling Hills Lake	24	378-749	296-2,414	0.377	1.646	0.893
Twin Valley Reservoir	93	238-966[4]	40-6,575[4]	0.119	1.693	0.559

[1]Chain Lake Reservoir is not included because no Northern Pike were recorded.

[2]Total length and weight were not reported for two Northern Pike caught from Keho Lake.

[3] Total length was not reported for three Northern Pike caught from Pine Coulee Reservoir.

[4] Total length was not reported for 60 Northern Pike caught from Twin Valley Reservoir and weight was not reported for 30 Northern Pike.

The mercury concentrations measured in the muscle of Northern Pike caught from SLR in 2023 are shown in Figure 16-1, alongside the mercury concentrations reported for Northern Pike caught from other lakes and reservoirs in the SSR as part of the long-term monitoring program (GOA, 2024b). The box and whisker plots provide a representation of the distribution of both the SLR mercury in fish tissue data and the Alberta Government Chemical Monitoring in Local Foods – Mercury in Fish data set (GOA, 2024b). The centre line of each plot represents the median value of the data, the upper line is the upper quartile, the lower line is the lower quartile, and the "x" near the centre line represents the mean value. The upper "whisker" represents the maximum value of the data set, excluding outliers, and the lower "whisker" represents the minimum value of the data set, also excluding outliers. The dots above or below the whiskers represent the outliers.

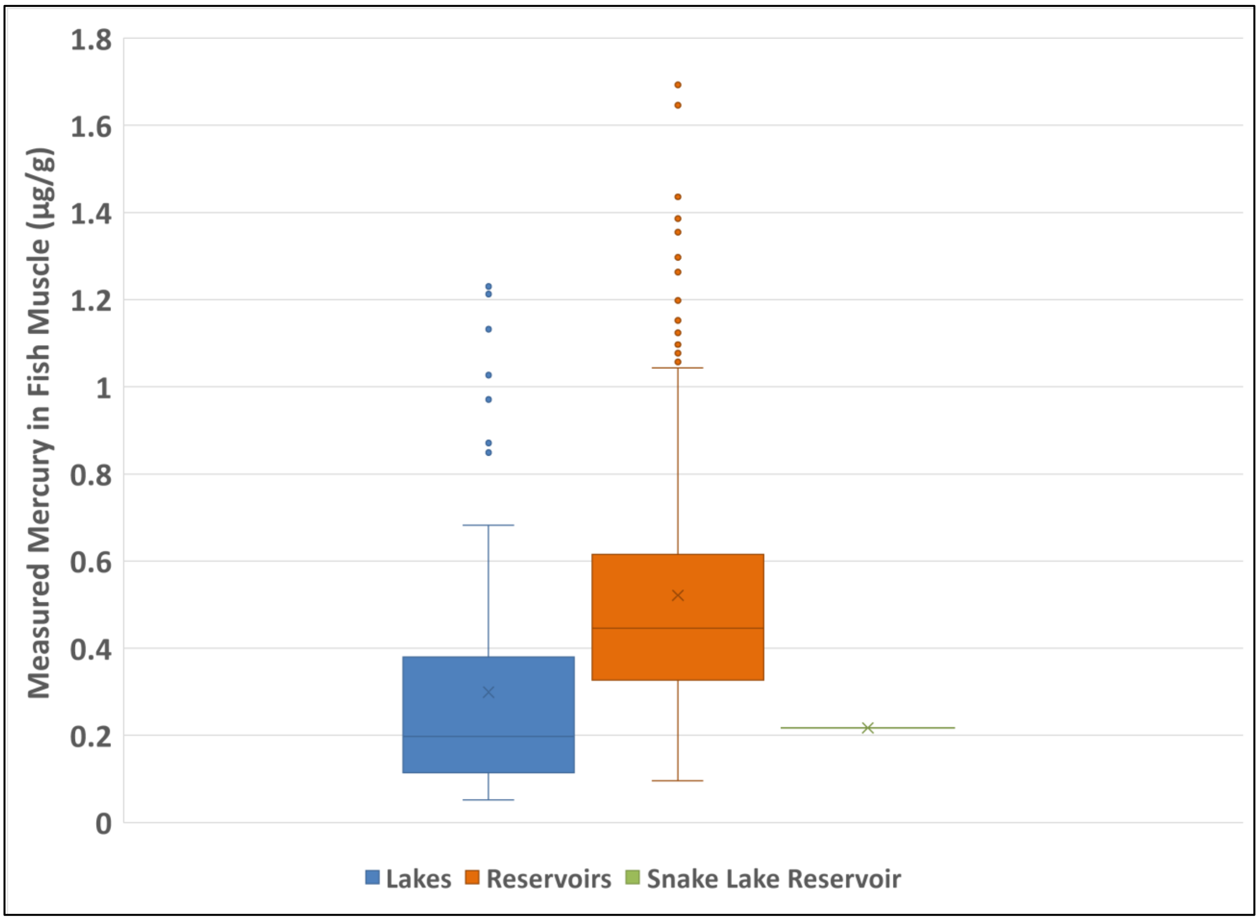

Figure 16-1: Comparison of Mercury Measured in Muscle of Northern Pike Caught from Snake Lake Reservoir and Other Waterbodies in the Southern Alberta

Source: (GOA, 2024b)

As shown in the figure, the mercury concentrations measured in the muscle of Northern Pike caught from the SLR are within the range of total mercury concentrations reported for other lakes and reservoirs in the SSR, but towards the lower end of the range reported for other reservoirs.

16.5.2.4 Comparison Against Fish Consumption Advisories

In cases of elevated fish tissue mercury concentrations, Alberta Health may issue recommended fish consumption limits for people, intended to limit consumption (number of servings per week) of the relevant fish species and size for different demographics. Alberta Health's criteria for issuing fish consumption advisories are (GOA, 2019b):

1) Mercury concentrations higher than 0.5 µg/g (commercial fishing guideline) will result in an "avoid consuming fish" recommendation for women of reproductive age and children under 12 years old;
2) Mercury concentrations between 0.2 and 0.5 µg/g (Health Canada's recommendation for subsistence consumers) will result in "consumption limit" advice;
3) Mercury concentrations less than 0.2 µg/g will not result in any consumption recommendations (i.e., no limits on consumption);
4) If the number of fish collected from a water body is less than five, fish consumption advice will not be issued (due to insufficient sample size); and,
5) If the lakes are used for commercial fishing, fish consumption advice will not be issued until consulting with the Canadian Food Inspection Agency.

When issuing its consumption advisories, Alberta Health relies on an average (mean) of the measured fish tissue concentrations. Alberta Health has not issued consumption limits for fish caught from the SLR (GOA, 2019b). The average concentration of methylmercury measured in Northern Pike muscle from SLR (i.e., 0.218 µg/g) is below the mercury concentrations that result in an "avoid consuming fish" recommendation for women of reproductive age and children under 12 years old (i.e., 0.5 µg/g), but is within the range of a "consumption limit" advisory (i.e., 0.2 – 0.5 µg/g).

Based on the 2020 fish population inventories, Whitefish and Northern Pike are the most prevalent sportfish in the SLR. In 2023, methylmercury concentrations were measured in the muscle of Northern Pike caught from the SLR (i.e., 0.217 and 0.218 µg/g). To summarize, these concentrations are:

- Comparable to the total mercury concentrations reported for Northern Pike caught from lakes in the SSR of Alberta;
- Low relative to the total mercury concentrations reported for Northern Pike caught from other reservoirs in the region; and,
- Below the total mercury concentrations that result in an "avoid consuming fish" recommendation for women of reproductive age and children under 12 years old (i.e., 0.5 µg/g), but are within the range of a "consumption limit" advisory (i.e., 0.2 – 0.5 µg/g).

16.5.3 Ingestion Assessment – Operational Case

This section provides a discussion of the challenges and limitations in predicting the potential changes in mercury levels in fish through mechanistic modelling before the expansion of the SLR. It also offers a qualitative description of the potential changes in mercury levels in fish as a result of the expansion – the Operational Case.

16.5.3.1 Mechanistic Modelling

A review of the publicly available mercury models was undertaken to determine whether any existing models could be used to predict methylmercury generation and mercury bioaccumulation with the Project. Model screening is an important part of the overall modelling process that is described in modelling best practices documents (Jakeman, Letcher, & Norton, 2006; James & Burges, 1982; National Research Council, 2007; US EPA, 2002; 2009; Vandenberg, Lauzon, Prakash, & Salzsauler, 2011; Vandenberg, Salzsauler, & Donald, 2016). These documents describe several criteria that should be considered in selecting a model to simulate environmental processes. These criteria are described in Table 16-12 below and are applied in Table 16-13, with reference to the models that were reviewed.

The criteria used to screen and select a methylmercury model are listed in Table 16-12.

Table 16-12: Model screening criteria

Screening Criteria	Description
Problem specification	Define the project objectives, the type and scope of model that is best suited to address those objectives, the data criteria, the model's domain of applicability and any programmatic constraints. The scope of model (spatial and temporal) could range from simple to very complex depending on the problem that needs to be addressed and the availability of data. For the purposes of this model selection exercise, all mercury and methylmercury models were included in the initial screening.
Ability to represent system of study	At a high level, this criterion is a given, as only mercury generation and accumulation models were included in the screening. At a more granular level, each model will simulate the components of the overall process differently. For example, some models include bioaccumulation through multiple trophic levels, whereas other models consider only one or two trophic levels (e.g., fish and benthic invertebrates). For this model selection, all models that met the high-level criterion of simulating methylmercury generation were included in the screening.
Model domain	Setting the model's domain of applicability (spatial extent within which the use of the model is scientifically defensible) requires identifying the environmental domain that needs to be modelled and specifying the processes and conditions within the domain. All models reviewed are capable of representing the whole lake, and models are already set up to transport mercury to downstream receptors, so this criterion was not necessary to select a model.
Model type	Different types of models (e.g., empirical vs. mechanistic, static vs. dynamic, deterministic vs. stochastic) are available to represent most chemical processes in a lake, including mercury cycling. The choice of model type to apply to a given problem depends on the availability of input data, the model objectives, and the similarity to calibrated conditions. In general, the model type will affect the predictive ability of the model; in particular the model type determines the degree of similarity required between the system used to calibrate the model and the system being predictively modelled.
Peer-reviewed	For an appropriate model to be selected, both by those assessing whether it would be appropriate for a given case and by those reviewing that decision, it must have adequate documentation. Documenting models for the public provides transparency to build confidence in modeling results (NRC 2007). Accordingly, in scoping a methylmercury model, preference is given to models that have been peer-reviewed.
Validated or post-audited	Model validation has been defined as the assessment of a model's predictive performance against a second set of (independent) measured data while model parameters are calibrated from a first set of data (National Research Council, 2007) or extending a calibrated model simulation with recent boundary condition (measured input) data, and comparing predictions to field data, without adjusting the calibration (Vandenberg, Salzsauler, & Donald, 2016). A validation or post-audit provides a means of testing the model predictions against reality and verifying whether the model predictions were accurate. While it has been argued that models cannot truly be "validated" (Konikow & Bredehoeft, 1992) a model validation or post audit provides one test of the model's predictive capabilities and can provide confidence that the model provides valid results under a defined set of conditions (i.e., the conditions under which it was calibrated and validated).
Open-source versus proprietary	Open-source models are preferred for regulatory applications because they can be transferred to different users and stakeholders and provide transparency to the process. A model is proprietary if any component that is a fundamental part of the model's structure or functionality is not available for free to the general public (National Research Council, 2007). Components may include source code, mathematical equations, input data, user interfaces, assumptions or computational methods). The drawback of proprietary models is that reviewers and stakeholders may not have access to the software, in which case they sometimes view it as "black box" software, which, rightly or not, can diminish the credibility of the overall project (Vandenberg, Salzsauler, & Donald, 2016).

Table 16-13: Summary of available mercury models

Model Name	Model Type	Peer-reviewed	Validated or Post-audited	Open-source or Proprietary	Model Applications	Additional Information	Reference
–	Regression	Yes	No	Open-source	Developed based on 21 lakes and reservoirs in the Churchill River diversion region of northern Manitoba. Tested using data from 18 Canadian lakes and reservoirs from Saskatchewan, Manitoba, Quebec, and Labrador	Models generally worked well with Manitoba reservoirs, but their predictive strength declined when applied to reservoirs in other regions. The largest deviations between observed and predicted values were found for reservoirs in Labrador and Quebec.	(Johnston, Bodaly, & Mathias, 1991)
–	Empirical	No	No	Open-source	LaGrande Complex reservoirs of northern Quebec	The approach worked reasonably well in a screening level capacity for the Quebec sites, but was not a good predictor in all cases	(Schetagne & Therrien, 2003)
MCM	Mechanistic	No	No	Proprietary	Lakes in Wisconsin, the Adirondacks, and the Great Lakes	–	(Harris R. , 1991)
R-MCM	Mechanistic	No	No	Proprietary	Park Lake in Michigan; Onondaga Lake in New York; lakes in Kejimkujik Park, Nova Scotia; series of lakes in Vermont and New Hampshire	The model has been applied to different lakes, and overall, the model performance was favorable when compared to available empirical data for some cases and not suitable for other cases	(Tetra Tech Inc., 1996)
D-MCM	Mechanistic	No	No	Proprietary	Devils Lake in Wisconsin	–	(Electronic Power Research Institute, 2002)
MMBM	Mechanistic	Yes	No	Proprietary	Lake Ontario	MMBM is especially sensitive to mercury concentration in food, absorption efficiency of mercury from food, elimination rate of mercury from fish, and feeding rates, indicating the importance of accurately estimating these parameters	(Trudel & Rasmussen, 2001)
OLMM	Mechanistic	Yes	No	Proprietary	Onondaga Lake	Model can simulate the concentrations of mercury species and provides a framework for understanding important processes involved in mercury cycling in Onondaga Lake.	(Henry, Dodge-Murphy, Bigham, & Klein, 1995)
MERC4	Mechanistic	No	No	Open-source	Onondaga Lake	–	(AScl Corporation, 1992)
RESMERC	Mechanistic	No	No	Proprietary (owned by Manitoba Hydro)	Notigi Reservoir, Manitoba and the Robert Bourassa Reservoir, Quebec; Site C reservoir	Model requires extensive input data for parametrization and calibration. Limited (or no) data are available from full scale reservoirs for environmental media, including fish, water, sediments, and the lower food web, to calibrate the model against for western Canada.	(Harris, Hutchinson, & Beals, 2009)

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As shown in Table 16-13, none of the reviewed models met all the desired criteria listed in Table 16-12. The inundation process (i.e., flooding of terrestrial soil and vegetation) may result in conditions that are known to be favorable for increased rates of the methylation of the inorganic mercury contained in the terrestrial soil and vegetation to its organic form – methylmercury. This could, in turn, result in increasing concentrations of methylmercury in large predatory fish in SLR. However, modelling the changing mercury concentrations in biota in a waterbody like the SLR is a complex process that requires a significant amount of data (Willacker, et al., 2016), and even with those data and the application of mechanistic model, considerable uncertainty would surround the resultant fish tissue concentrations.

16.5.3.2 Other Southern Alberta Reservoirs

Many studies of fish mercury concentrations in reservoirs have been conducted in eastern Canada and the sub-arctic; however, these reservoirs are predominantly located in forested areas where both the soil and vegetation biomass represent sources of mercury storage, and the surface water flows through large wetland areas that provide ideal conditions for methylation (Paterson, Rudd, & St.Louis, 1998; St. Louis, et al., 1996; 2004). As previously described, the SSR of Alberta is located within the Dry Mixedgrass Subregion that is characterized by semi-arid grasslands with agricultural crop production and limited wetlands (Neville, Lancaster, Adams, & Desserud, 2014; see also Volume 2, Section 10 [Vegetation and Wetlands]).

As a result, the SLR area will have low vegetation biomass for mercury storage compared to the reservoirs of eastern Canada and the sub-arctic. This effect with also be further reduced since the majority of the vegetation and topsoil will be removed from the project area prior to inundation. Due to these differences, the changes in fish mercury concentrations observed in the reservoirs of eastern Canada and the sub-arctic following flooding may not be representative of the changes that might occur following the expansion of the SLR. Perspective on the changes in mercury concentration is better sought from the reservoirs of southern Alberta, particularly those included in Alberta's long-term monitoring program (e.g., see Tables 16-10 and 16-11). Of these southern Alberta reservoirs, multiple years of monitoring data are only available for three of the reservoirs. These are:

- Crawling Valley Reservoir (2009 and 2021);
- Pine Coulee Reservoir (2003, 2004, 2005, 2007 and 2014); and,
- Twin Valley Reservoir (2004, 2005 and 2006).

Results of the long-term monitoring program for these three reservoirs helps to forecast the potential changes in fish mercury concentrations that may occur in SLR upon inundation of the expansion.

Crawling Valley Reservoir is a 2,510-ha off-stream reservoir located approximately 9 km northeast from Bassano, Alberta and was filled in 1985. Crawling Valley Reservoir is about twice the size of the SLR following the expansion (920 ha). Unfortunately, mercury concentrations in fish are not available before inundation of the reservoir.

Pine Coulee is a 625-ha off-stream reservoir located west of Stavely, Alberta and was filled in 1999. Pine Coulee is about half the size of the proposed expansion of the SLR. Mercury concentrations were measured in fish before and after inundation of the new reservoir (Feng, Hiltz, & Wharmby, 2011). Mercury concentrations in piscivorous fishes in Pine Coulee were highest 4 to 6 years after impoundment and decreased 5 to 8 years after impoundment, dependent on specific fish species (Applied Aquatic Research, 2022). However, mercury concentrations increased slightly again in 2009 piscivorous fishes in Pine Coulee Reservoir, which was attributed to an artifact of sampling by the study authors.

The Twin Valley Reservoir is an 835-ha irrigation reservoir that is located 20 km northeast of Pine Coulee within the Old Man River Basin, and filled in 2003 (GOA, 2009a; 2009b). Mercury concentrations were measured in fish by Alberta Health Services (AHS) before and after inundation of the new reservoir and trophic mercury was described by Brinkmann and Rasmussen (2010). High concentrations of mercury were initially reported in benthic invertebrates in Twin Valley Reservoir and in Northern Pike that were feeding solely on these invertebrates since forage fishes were not found in the reservoir after inundation. Following inundation, mercury concentrations were higher in Northern Pike caught within and downstream from the reservoir compared to those caught upstream (GOA, 2009b). Generally, methylmercury concentrations in fish increased slightly for the initial two years following inundation and decreased in years that followed but remained within the concentrations reported for other rivers and lakes in North America (GOA, 2009b). Brinkmann and Rasmussen (2010) predicted that an increase in trophic complexity through the introduction of Lake Whitefish, an insectivore and opportunistic piscivore, would result in a reduction in mercury concentrations in the Northern Pike in Twin Valley Reservoir. This was the experience in Pine Coulee Reservoir (Applied Aquatic Research, 2022).

Advisories are in place for both Pine Coulee and Twin Valley reservoirs to limit consumption of large piscivorous fish (GOA, 2019b). Based on 2006 data on Northern Pike caught in Twin Valley Reservoir and 2014 data on Walleye caught in Pine Coulee Reservoir, children (<12 years) and women of reproductive age are encouraged to avoid eating sportfish from these reservoirs. All others are recommended to limit consumption to five, 75-gram servings per week (GOA, 2019b). The GOA also recommends avoiding eating Walleye and Northern Pike from the Bow River below the Bassano Dam (despite the absence of any mercury data) since fish from this area are anticipated to have elevated mercury levels given the geography of this reach of the river (GOA, 2019b).

16.5.3.3 Summary of Predicted Changes to Methylmercury in Fish

Based on the limitations of predicting mercury and methylmercury concentrations in the post-inundation phase of reservoir construction, and mercury measurements taken from other reservoirs in Alberta, the establishment of an environmental monitoring program after the expansion of the reservoir is expected to be the most effective way to determine the evolution of mercury concentrations in sportfish in SLR.

16.6 IMPACT ASSESSMENT

This section provides the predicted health impacts based on the baseline results and after mitigation measures have been applied. For a full description of the EIA Approach including the assessment methods and EIA criteria, see Volume 2, Section 2.

16.6.1 Residual Impact Assessment Results

Using the criteria of direction, magnitude, geographical extent, duration, confidence, and ecological/social context, Table 16-14 below characterizes the residual environmental impacts on human health resources. As described in Section 16.5 of this document, nitrogen dioxide (NO_2)

and fine particulate matter ($PM_{2.5}$) are the only indicators that are predicted to have impacts based on the acute inhalation effects assessment. Residual impacts are considered to be local and temporary.

All other indicators are determined to be negligible. In the case of the ingestion assessment, modelling and comparison of other reservoirs in Alberta were used to predict changes to methylmercury in fish. It is assumed that, similar to other reservoirs, advisories would be put in place for Snake Lake Reservoir if monitoring indicated it was necessary, which would effectively mitigate any effects of methylmercury ingestion from SLR on human health resulting in neutral effects.

Table 16-14: Residual impacts on public health resources from the Project

Impact description	Direction	Key Criteria			Modifiers		Residual Impact Rating
		Magnitude	Geographical Extent	Duration	Confidence	Ecological and Social Context	
Acute health effects from NO_2 emissions	Negative	Low	Local	Temporary	Medium	N/A	Low Negative
Acute health effects from $PM_{2.5}$	Negative	Low	Local	Temporary	Medium	N/A	Low Negative
Acute health effects from SO_2 emissions	Neutral						Neutral
Chronic health effects from NO_2 emissions	Neutral						Neutral
Chronic health effects from $PM_{2.5}$	Neutral						Neutral
Chronic health effects from SO_2 emissions	Neutral						Neutral
Health effects of ingesting fish from the Project (expansion)	Neutral						Neutral

16.7 UNCERTAINTY

The HHRA relied, in part, on the results and conclusions of the Air Quality Assessment. Air quality dispersion modelling studies, like HHRAs, are predictive exercises. Therefore, these types of assessments are inherently uncertain by nature.

In the assessment criteria for the Air Quality Assessment (Volume 2, Section 4.5.4), confidence in the residual effects rating is described as "the ability to assess if a change [will occur], given uncertainty in the data and analysis used to derive the results and conclusions." Based on that definition, confidence in the predicted ground-level air concentrations for NO_2, SO_2 and $PM_{2.5}$ was rated as "High" in the Air Quality Assessment (see Volume 2, Section 4.5.4, Table 4-30). Because the air quality predictions are based on worst-case meteorological conditions and a conservative modelling approach, the actual air concentrations are expected to be less than the predicted air concentrations that form the basis of the HHRA. To further offset any uncertainty in the risk estimates, the HHRA assumed that people would be present in the Air Quality LSA continuously throughout the construction phase of the Project (i.e., 24 hours per day, 365 days per year).

One source of uncertainty relates to the lack of predicted annual $PM_{2.5}$ air concentrations. The absence of that data prevents the HHRA from characterizing long-term health risks associated with $PM_{2.5}$. As described in Section 16.4.1, a considerable amount of conservatism was incorporated into the air quality predictions. Specifically with respect to particulate matter, emissions of $PM_{2.5}$ from the Project are associated with low-lying fugitive dust and exhaust emission sources, rather than from stacks that promote the dispersion of $PM_{2.5}$ into the atmosphere. Air Quality dispersion models are known to overestimate the contribution of fugitive particulate matter to ambient concentrations (Watson, Chow, Wang, & Lowenthal, 2013). On this basis, the 24-hour $PM_{2.5}$ predictions from fugitive emission sources associated with the Project are considered conservative.

The inundation process (i.e., flooding of terrestrial soil and vegetation) may result in conditions that are known to cause concentrations of mercury to increase in sportfish like Walleye and Northern Pike. However, it was not possible to model the changing mercury concentrations in biota in the SLR. For that reason, the potential health risks associated with increasing mercury concentrations in fish could not be quantified. The residual uncertainty associated with this exposure pathway would most effectively be addressed through a fish monitoring program.

16.8 MITIGATION AND MONITORING

Mitigation measures may be implemented to minimize the potential impacts from construction activities and their associated air emissions that could affect human health. These measures may include:

- Spraying nearby unpaved roads and the construction area at regular intervals.
- Limiting on-site vehicles to a maximum idle time of 10 minutes.
- Installing wind fencing around portions of the construction site, if necessary, to minimize fugitive dust emissions.

If monitoring is established, results could be compared with the 30-day Alberta Ambient Air Quality Guidelines (AAAQG) to see if exceedances are occurring and could end when construction is complete. However, no additional monitoring programs for public health effects are proposed.

Monitoring programs recommended for other disciplines are provided in their associated sections and summarized below:

- As described in Volume 2, Section 4.7 of the Air Quality Assessment, dust fall monitoring is recommended at the eight sensitive receptor locations. It is further recommended that this monitoring commence before the start of construction and continue throughout the duration of the construction period if complaints are received from area residents, agricultural and industrial workers, or members of the public.
- Measures to mitigate the potential effects on water quality are described in Volume 2, Section 7 (Surface Waterbodies). With respect to monitoring of the uptake of mercury in fish, it is recommended to collect water quality data (dissolved oxygen and temperature profiles, and pH) as well as sampling water and sediments for inorganic mercury and sediments for methylmercury following inundation of the reservoir expansion.
- In Volume 2, Section 8 (Aquatic Resources) monitoring for methyl-mercury in fish tissues is also proposed. It is recommended that this sampling be completed by the Alberta Government as part of the existing fish sampling program for the assessment of fish health and to set consumption limits.

16.9 CONCLUSIONS

The goal of the HHRA was to identify and understand the potential health risks that may be associated with the Project. Air COPC will be limited to the construction phase of the Project only. Construction of the Project is expected to take approximately five years.

The Air Quality Assessment indicates that emissions associated with Project construction result in predicted concentrations that exceed the Alberta Ambient Air Quality Objectives (AAAQO) for nitrogen dioxide (NO_2; hourly and annual, at a location adjacent to the Trans-Canada Highway; TCH) and for $PM_{2.5}$ (24-hour, adjacent to the TCH in the Baseline Case and the Project construction areas in the Project Construction and Cumulative Construction Cases). The frequencies of the predicted non-compliant hourly and 24-hour concentrations are low. Predicted concentrations of the 24-hour $PM_{2.5}$ were predicted at two sensitive receptor locations for one day out of the five years of meteorology data that were modelled.

The Air Quality Assessment adopted a conservative approach to predict the ground-level air concentrations in the Local Study Area. Air quality dispersion models are known to overestimate the contribution of fugitive particulate matter to ambient concentrations (Watson, Chow, Wang, & Lowenthal, 2013). Because of the high level of conservatism built into the air dispersion model, the predicted 24-hour ground-level air concentrations of $PM_{2.5}$ likely overstate the actual exposures that might be received by people residing in or visiting the LSA under most circumstances.

The use of dust mitigation measures is expected to have a clear impact on the reduction of $PM_{2.5}$ concentrations at all receptor locations, which emphasizes the value of a dust mitigation strategy during all stages of construction.

The expansion of the SLR is expected to result in a temporary increase of mercury concentrations in larger predatory fish like Northern Pike and Walleye. There are significant practical limitations associated with predicting mercury concentrations in fish over time with the SLR expansion. Application of a mechanistic model for the SLR is not expected to result in accurate predictions of mercury concentrations in fish. The implementation of a fish monitoring program following the expansion of the SLR, with a focus on methylmercury concentrations in fish species of relevance to human consumption, is considered the most effective way to determine the change of mercury concentrations in sportfish in the reservoir over time.

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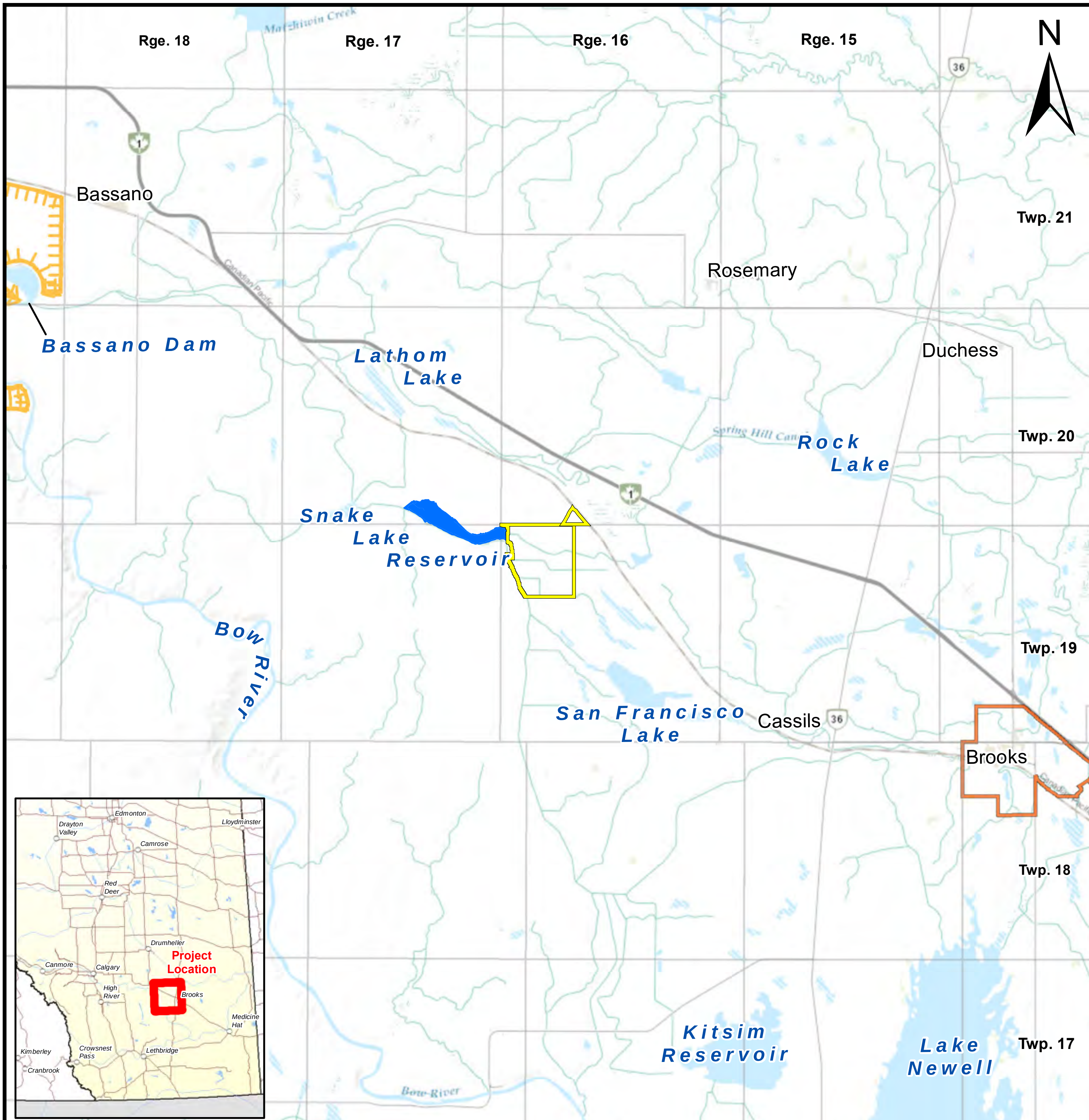
Appendix N

Appendices

Figures

Appendix N1: Figures



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Approved:	VL	Revision:	0
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CAD Survey		Revision:	0

Data Sources:
ESRI World Topographic Map
ATS Grid: AltaLIS 2007.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the topographic map is from 2010 (NRCAN) and although we have no reason to doubt the accuracy and completeness of it, users should be aware discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Existing Snake Lake Reservoir at Full Supply
- City Boundary
- Siksika First Nation

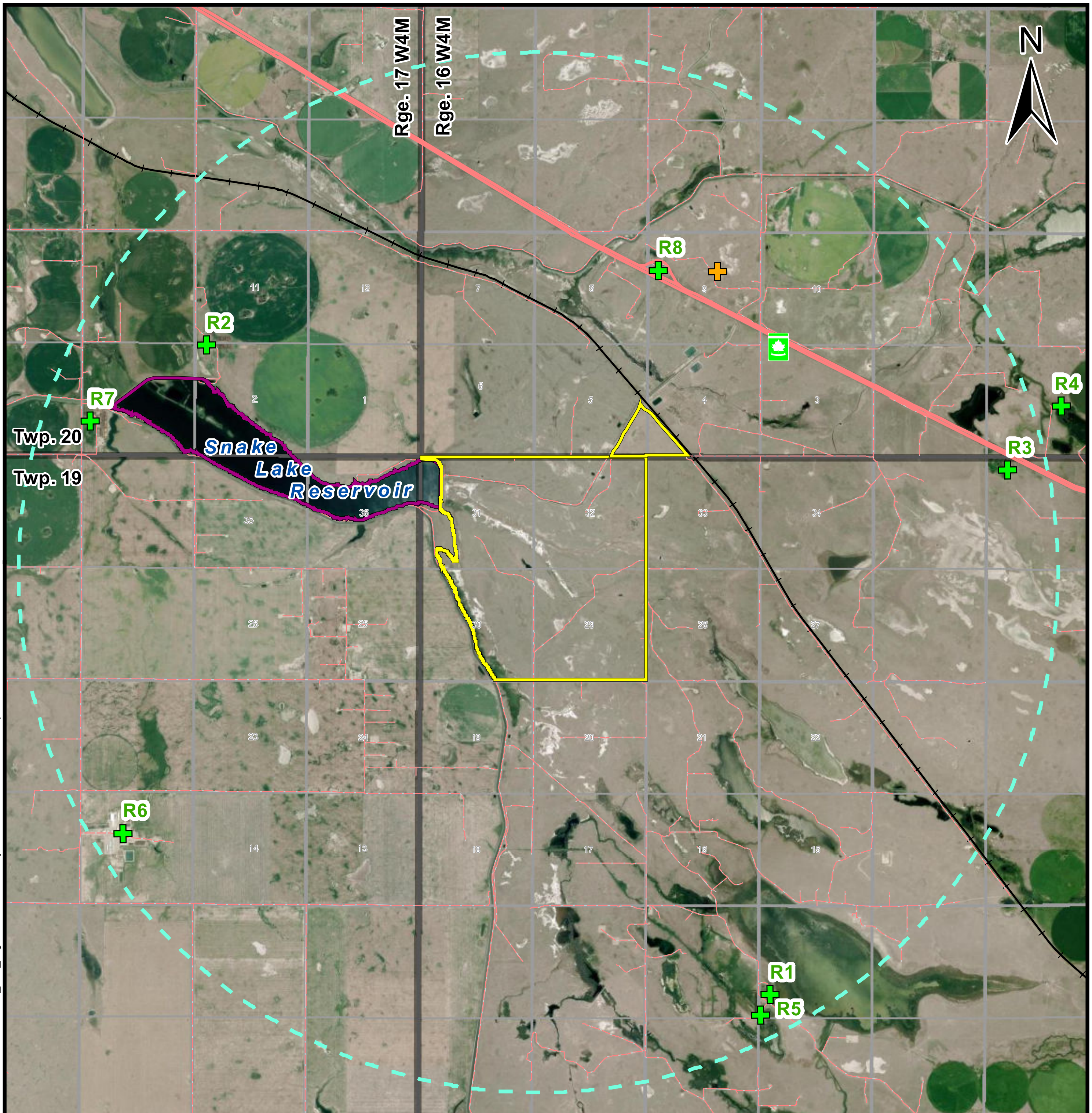
EID

Snake Lake Reservoir Expansion Project Location

January 2025

REF.: AARES21-127 (PublicHealth)

Figure N1-1



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Data Sources:
Imagery Reference: ESRI 2021/07/10
ATS Grid: AltaLIS 2007.
Calvin Consulting Group Ltd.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware that discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Local Study Area
- Existing Snake Lake Reservoir
- Sensitive Receptors
- Countess Oil Battery Source
- Highway
- Gravel Road
- Railway

EID

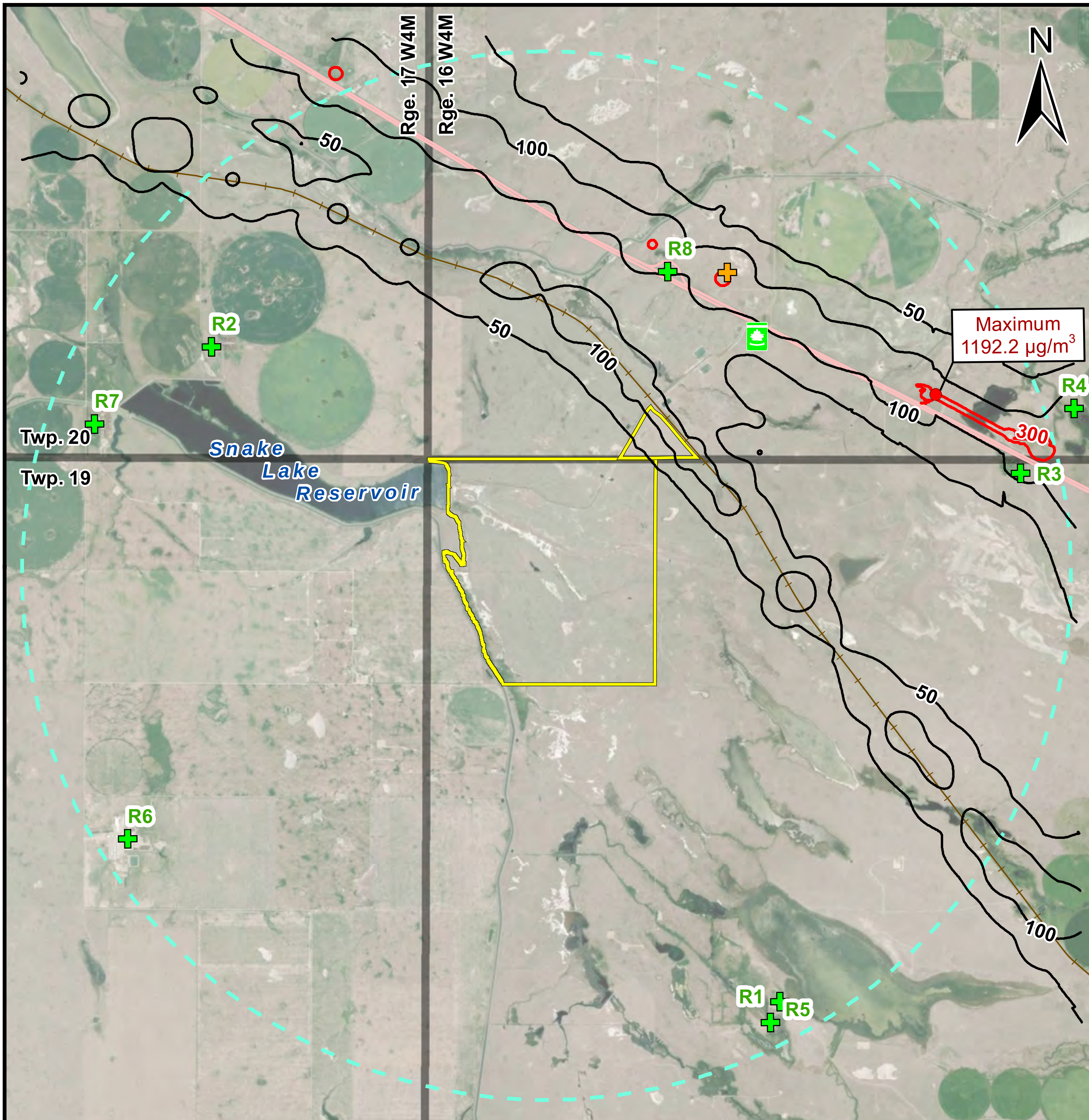
Public Health Local Study Area and Sensitive Receptors

February 2025

REF.: AARES21-127 (PublicHealth)

Figure N1-2

Map Location: Y:\01_GISProject\AARES_21\AARES21_127 (5653)\Public Health\AARES21_127_Fig N1-2 Local Study Area and Sensitive Receptors.mxd



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Surfer Shp		Revision:	0

Data Sources:
Imagery: ESRI. Date: 2021/07/10
ATS Grid: AltaLIS 2007.
Calvin Consulting Group Ltd.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware that discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Local Study Area
- Maximum Location
- Sensitive Receptors
- Countess Oil Battery Source
- Predicted Exceedance Contour (µg/m^3)
- Predicted Concentration Contour (µg/m^3)
- Highway
- Railway

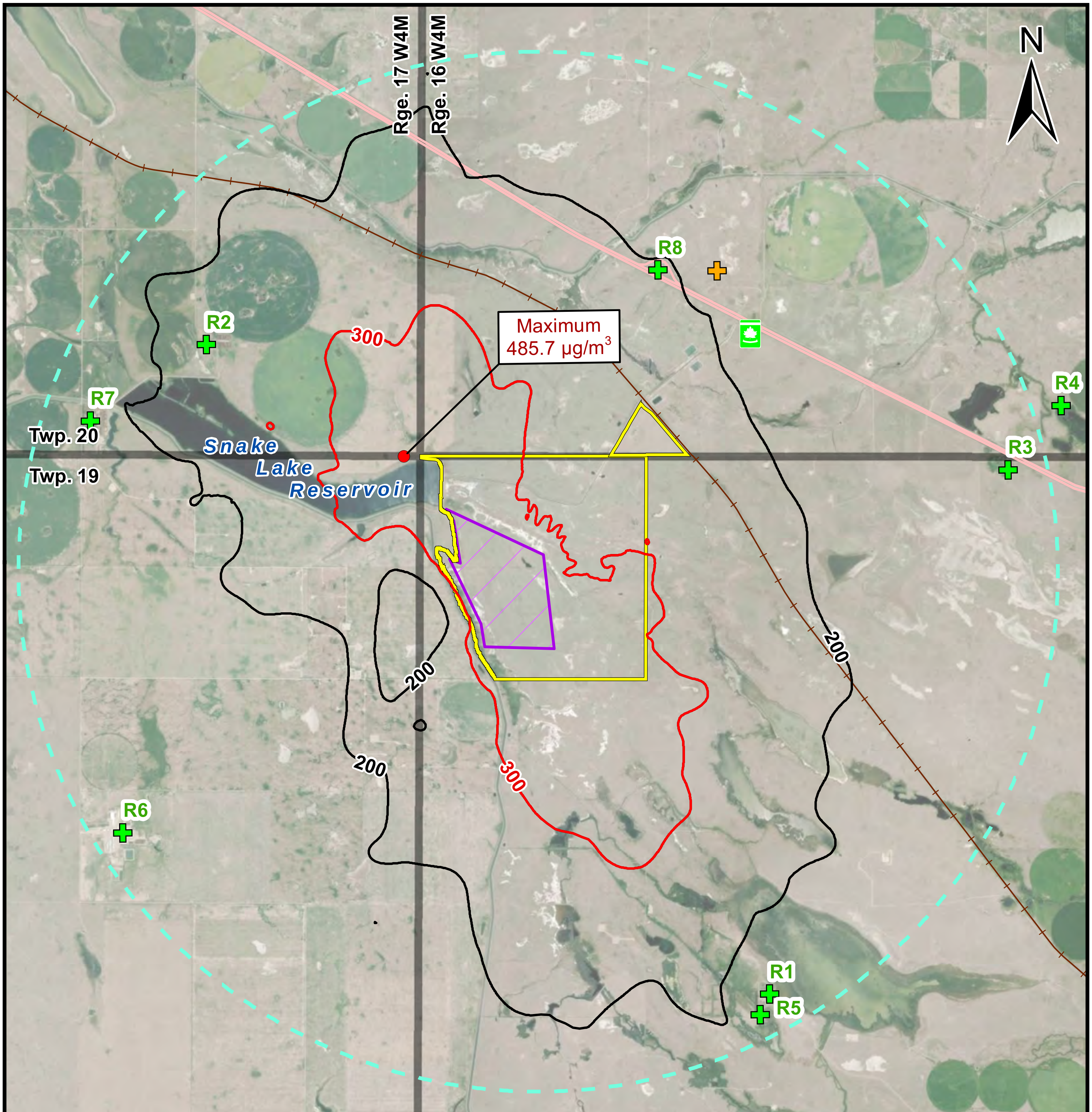
EID

9th Highest Predicted 1-h Average NO_2 Concentrations Baseline Case

March 2025

REF.: AARES21-127 (PublicHealth)

Figure N1-3



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Approved: VL	Revision: 0		
Route Source:	Date: Jan 7, 2025		
Surfer shp	Revision: 0		

Data Sources:
Imagery: ESRI. Date: 2021/07/10
ATS Grid: AltaLIS 2007.
Calvin Consulting Group Ltd.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware that discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Modelled Construction Area
- Local Study Area
- Maximum Location
- Sensitive Receptors
- Countess Oil Battery Source
- Predicted Exceedance Contour (µg/m³)
- Predicted Concentration Contour (µg/m³)
- Highway
- Railway

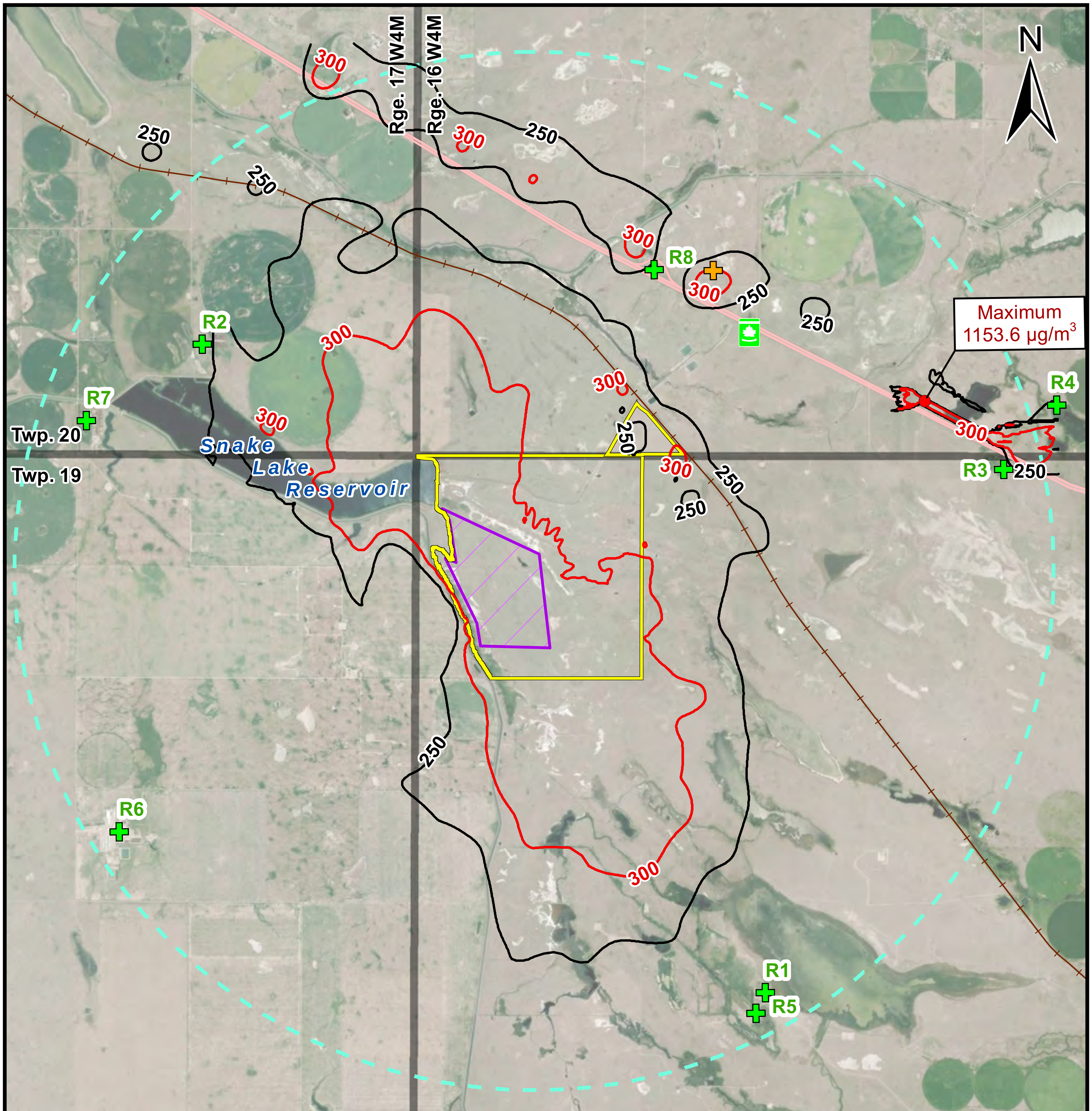
EID

9th Highest Predicted 1-h Average NO_2 Concentrations Project Construction Case

March 2025

REF.: AARES21-127 (PublicHealth)

Figure N1-4



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Surfer Shp		Revision:	0

Data Sources:
Imagery: ESRI. Date: 2021/07/10
ATS Grid: AltaLIS 2007.
Calvin Consulting Group Ltd.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware that discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Modelled Construction Area
- Local Study Area
- Maximum Location
- Sensitive Receptors
- Countess Oil Battery Source
- Predicted Exceedance Contour (µg/m³)
- Predicted Concentration Contour (µg/m³)
- Highway
- Railway

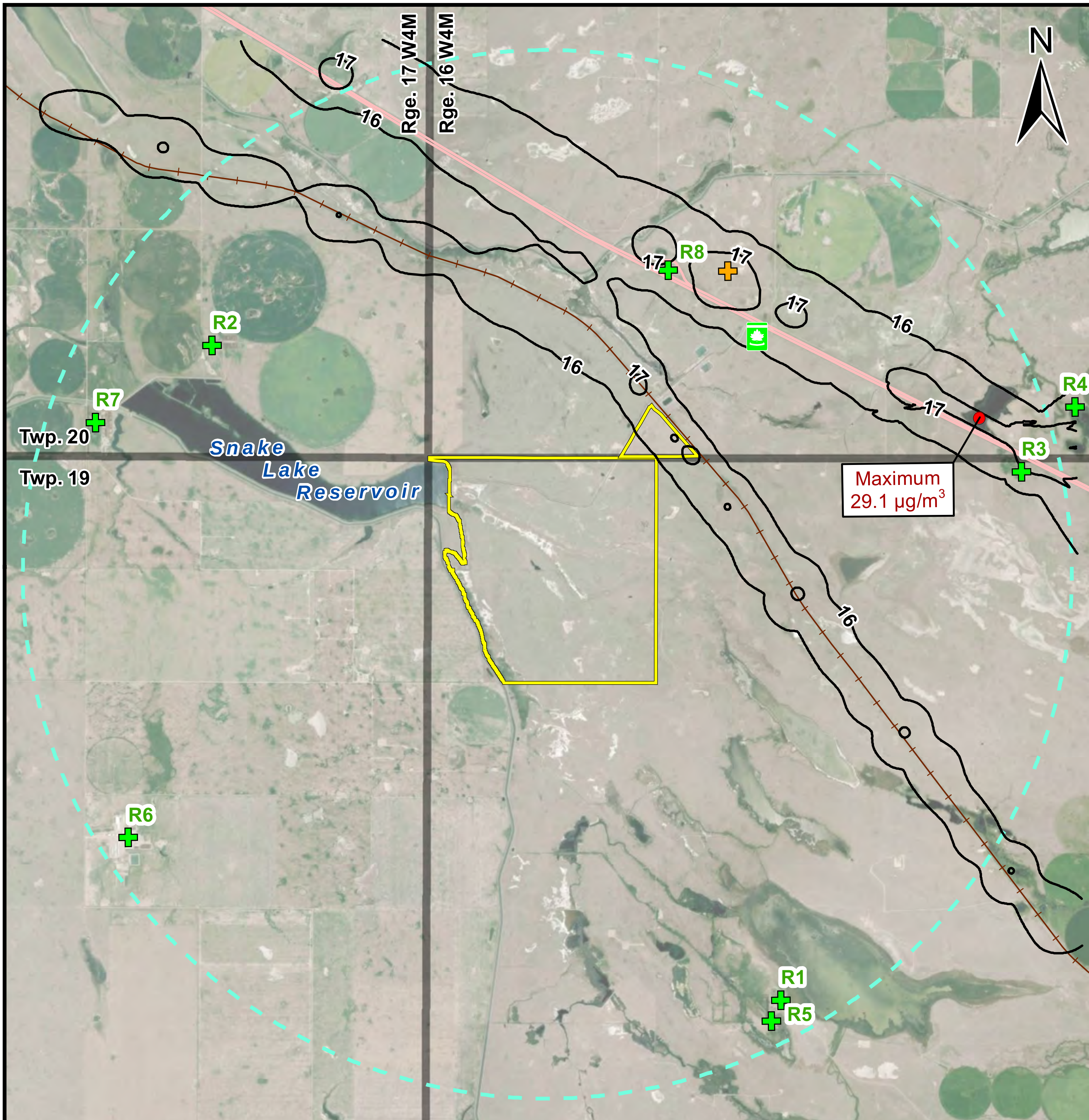
EID

9th Highest Predicted 1-h Average NO_2 Concentrations Cumulative Construction Case

March 2025

REF.: AARES21-127 (PublicHealth)

Figure N1-5



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Surfer shp		Revision:	0

Data Sources:
Imagery: ESRI. Date: 2021/07/10
ATS Grid: AltaLIS 2007.
Calvin Consulting Group Ltd.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware that discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Local Study Area
- Maximum Location
- Sensitive Receptors
- Countess Oil Battery Source
- Predicted Concentration Contour (µg/m^3)
- Highway
- Railway

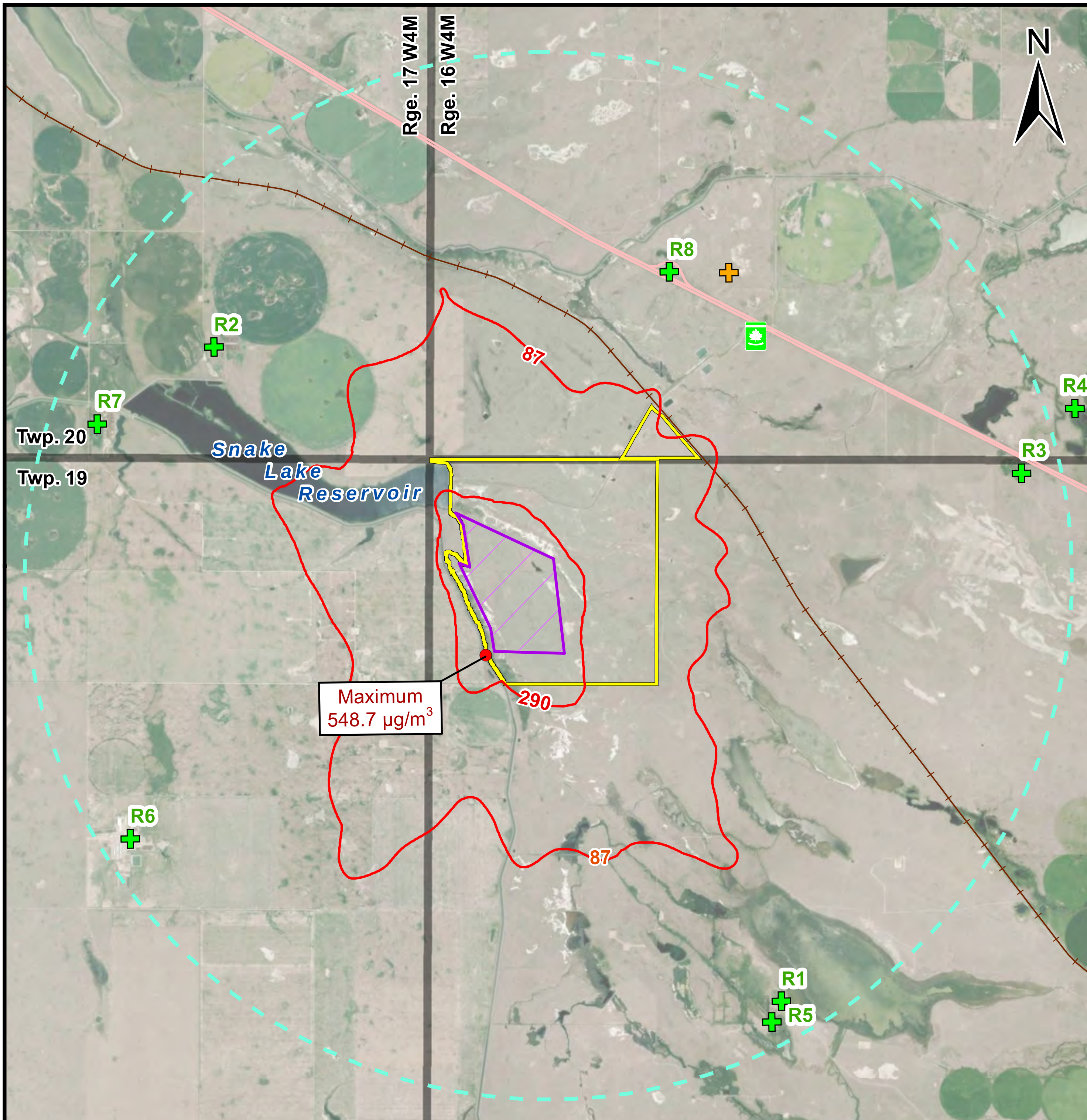
EID

Maximum Predicted 24-h Average $PM_{2.5}$ Baseline Case

March 2025

REF.: AARES21-127 (PublicHealth)

Figure N1-6



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Data Sources:
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ATS Grid: AltaLIS 2007.
Calvin Consulting Group Ltd.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware that discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Modelled Construction Area
- Local Study Area
- Maximum Location
- Sensitive Receptors
- Countess Oil Battery Source
- Predicted Exceedance Contour (µg/m³)
- Highway
- Railway

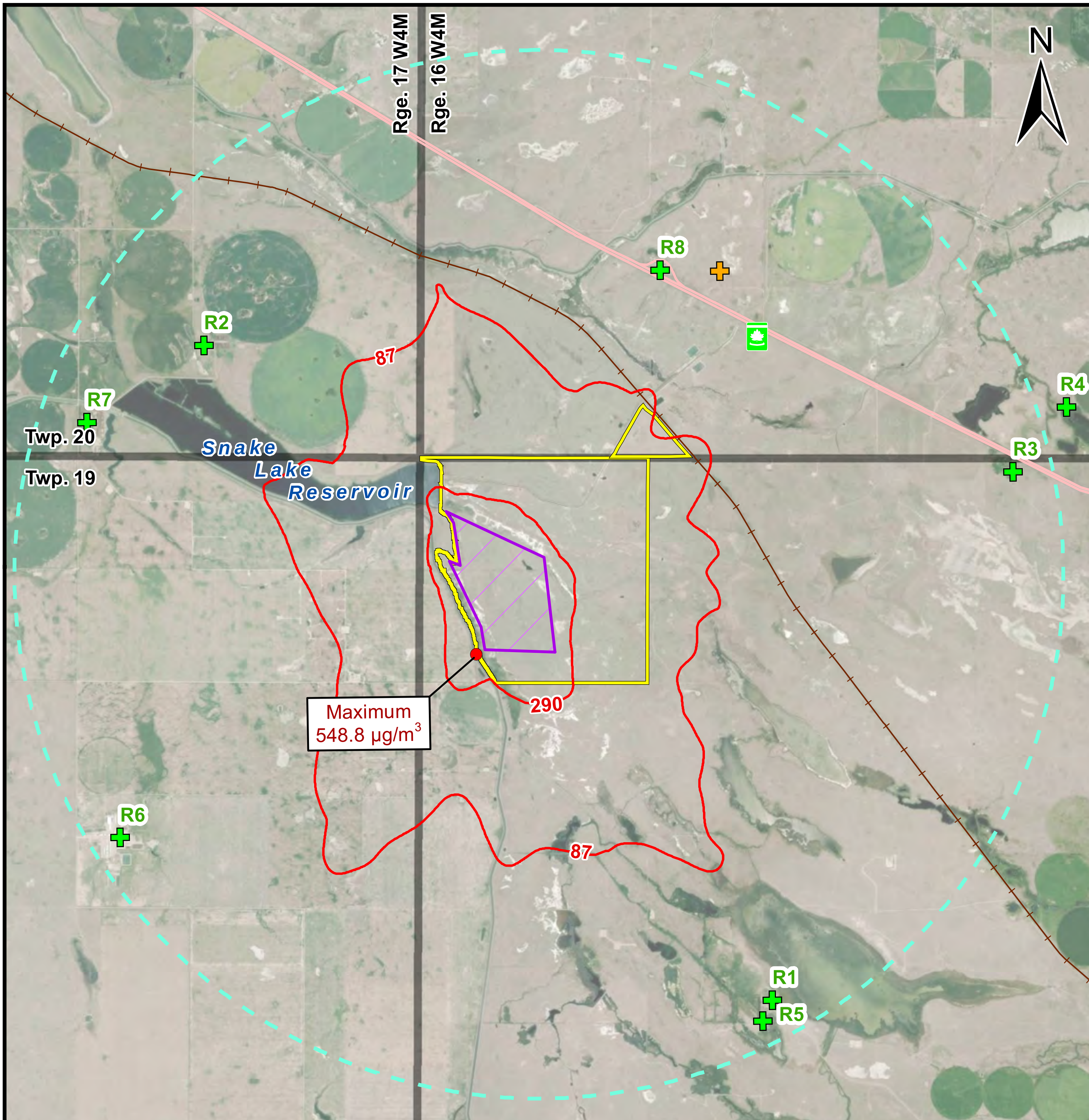
EID

Maximum Predicted 24-h Average $PM_{2.5}$ Assuming No Mitigation Project Construction Case

March 2025

REF.: AARES21-127 (PublicHealth)

Figure N1-7



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Data Sources:
Imagery: ESRI. Date: 2021/07/10
ATS Grid: AltaLIS 2007.
Calvin Consulting Group Ltd.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware that discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Modelled Construction Area
- Local Study Area
- Maximum Location
- Sensitive Receptors
- Countess Oil Battery Source
- Predicted Exceedance Contour (µg/m^3)
- Highway
- Railway

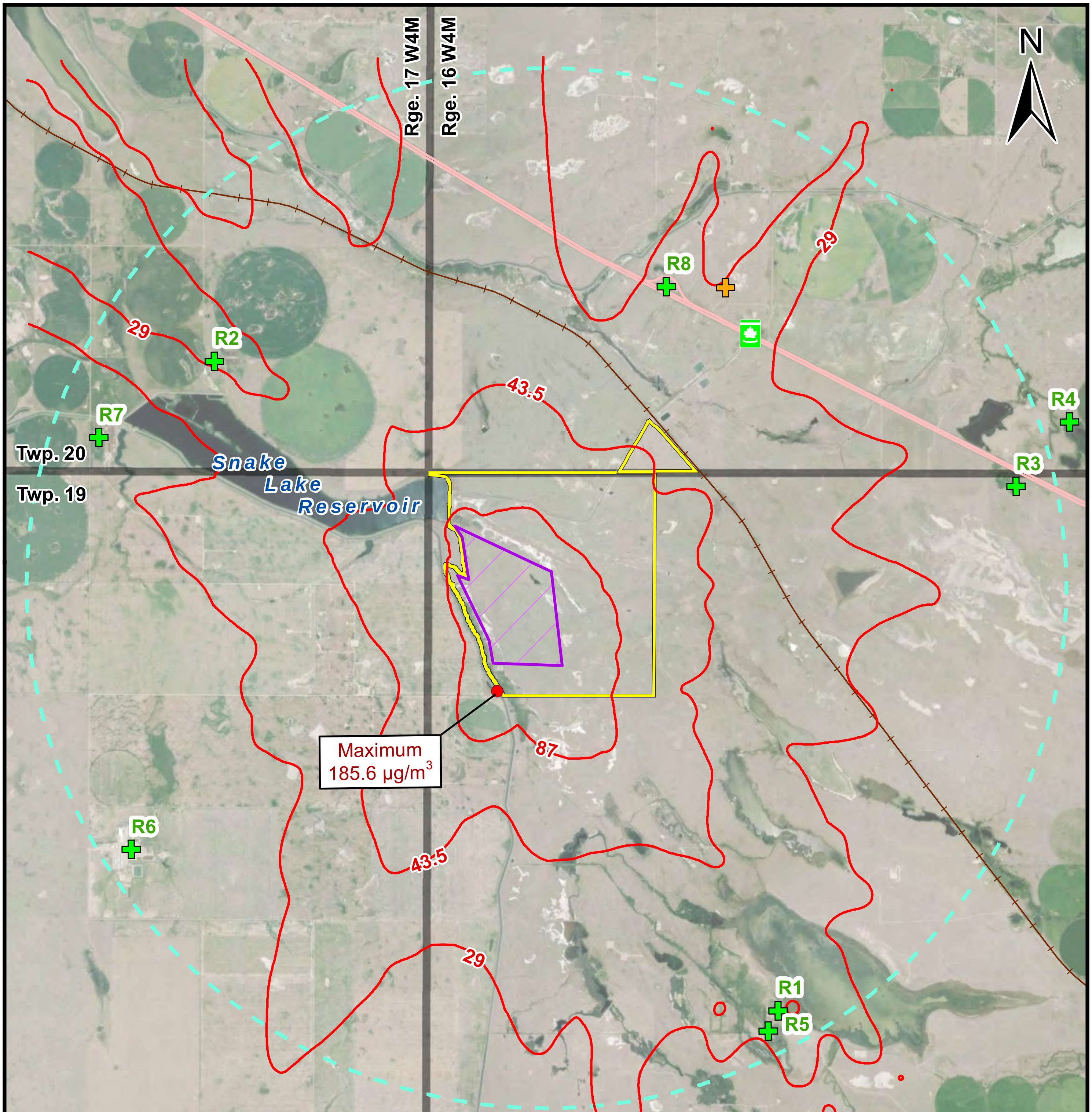
EID

Maximum Predicted 24-h Average $PM_{2.5}$ Assuming No Mitigation Cumulative Construction Case

March 2025

REF.: AARES21-127 (PublicHealth)

Figure N1-8



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Approved:	VL	Revision:	0
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Data Sources:
Imagery: ESRI. Date: 2021/07/10
ATS Grid: AltaLIS 2007.
Calvin Consulting Group Ltd.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware that discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Modelled Construction Area
- Local Study Area
- Maximum Location
- Sensitive Receptors
- Countess Oil Battery Source
- Predicted Exceedance Contour (μg/m^3)
- Highway
- Railway

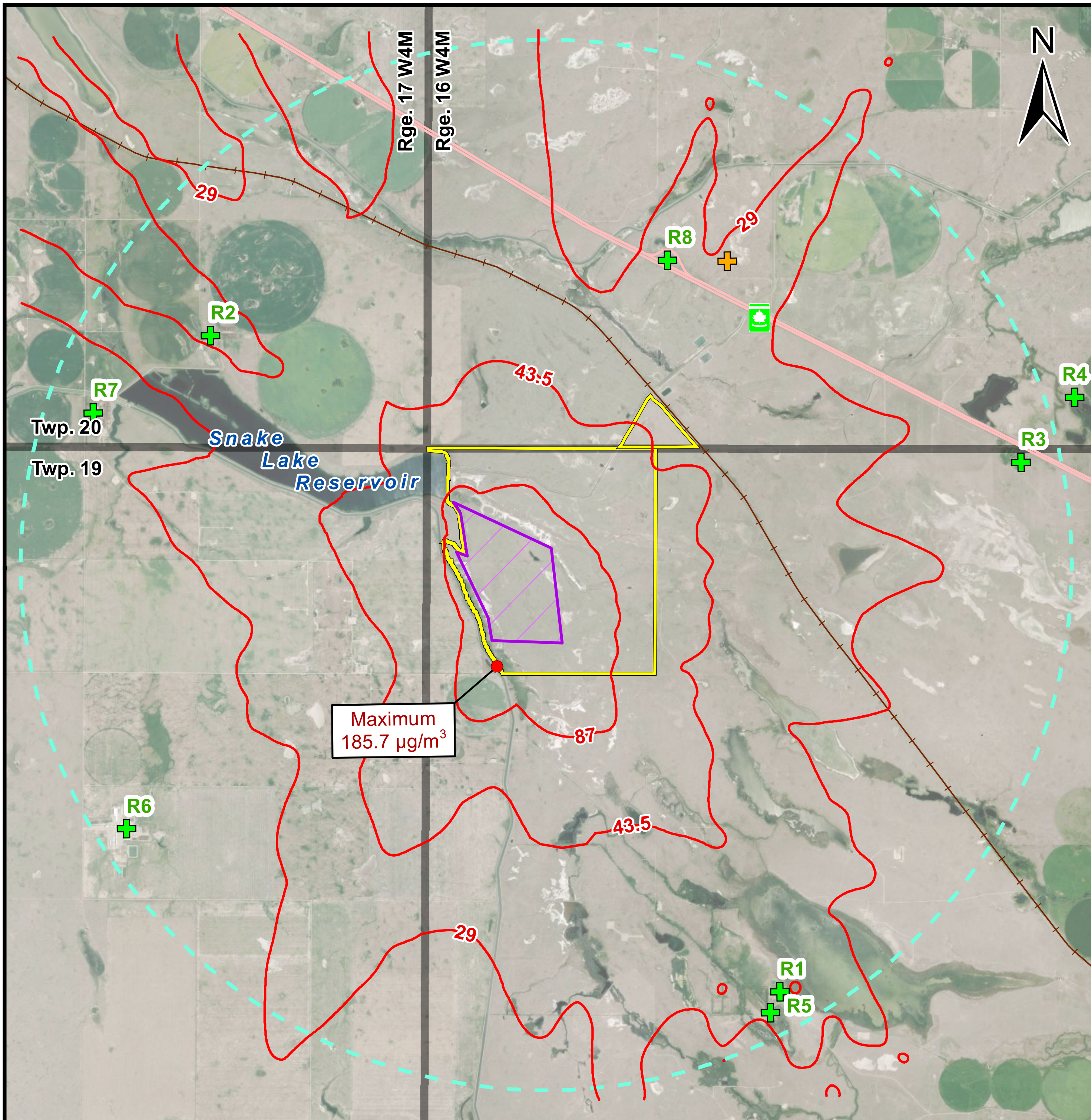
EID

Maximum Predicted 24-h Average $PM_{2.5}$ Assuming Watering Project Construction Case

March 2025

REF.: AARES21-127 (Public Health)

Figure N1-9



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Data Sources:
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ATS Grid: AltaLIS 2007.
Calvin Consulting Group Ltd.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware that discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Modelled Construction Area
- Local Study Area
- Maximum Location
- Sensitive Receptors
- Countess Oil Battery Source
- Predicted Exceedance Contour (μg/m³)
- Highway
- Railway

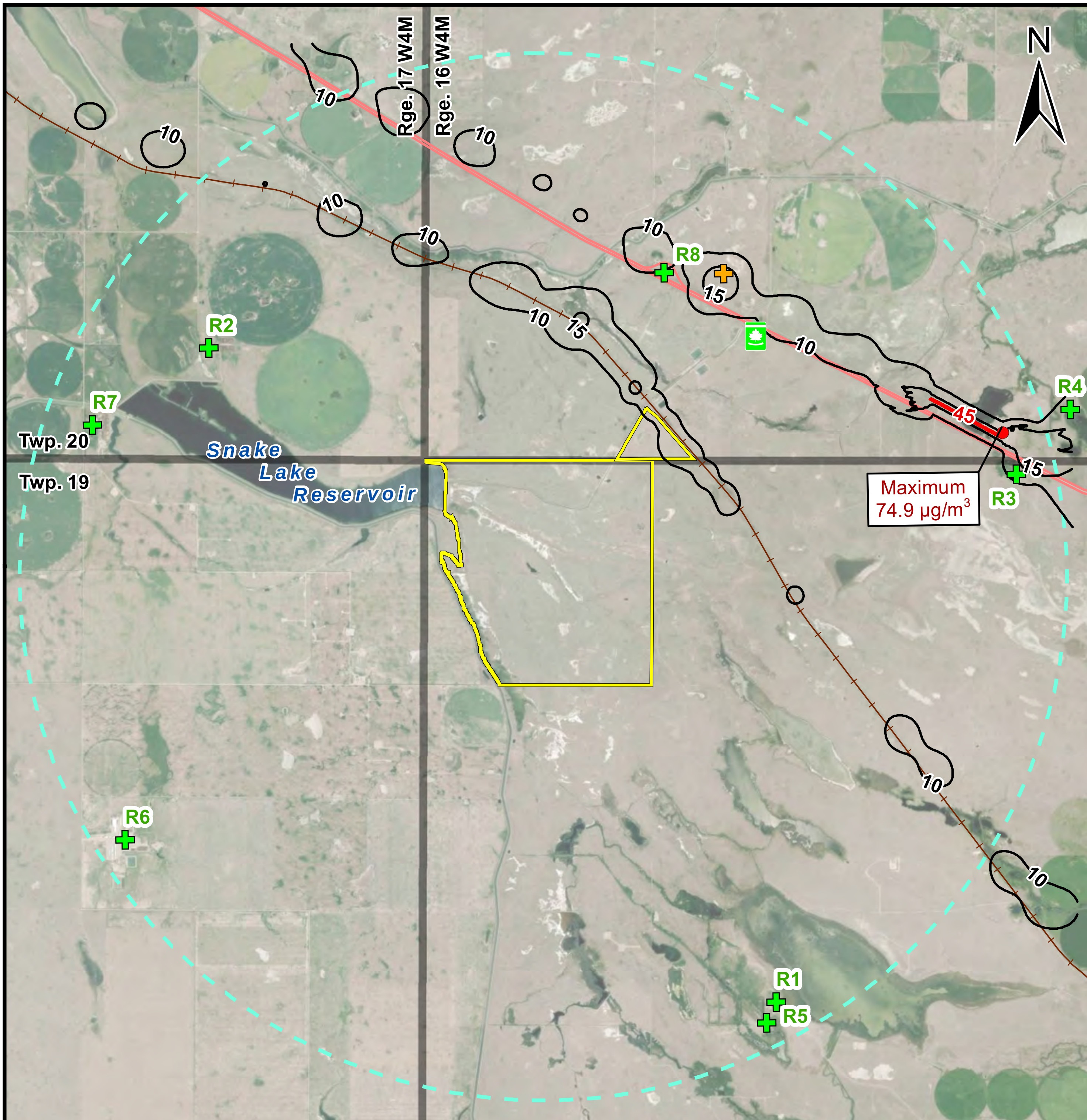
EID

Maximum Predicted 24-h Average $PM_{2.5}$ Assuming Watering Cumulative Construction Case

March 2025

REF.: AARES21-127 (PublicHealth)

Figure N1-10



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Calvin Consulting Group Ltd.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware that discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Local Study Area
- Maximum Location
- Sensitive Receptors
- Countess Oil Battery Source
- Predicted Exceedance Contour (µg/m³)
- Predicted Concentration Contour (µg/m³)
- Highway
- Railway

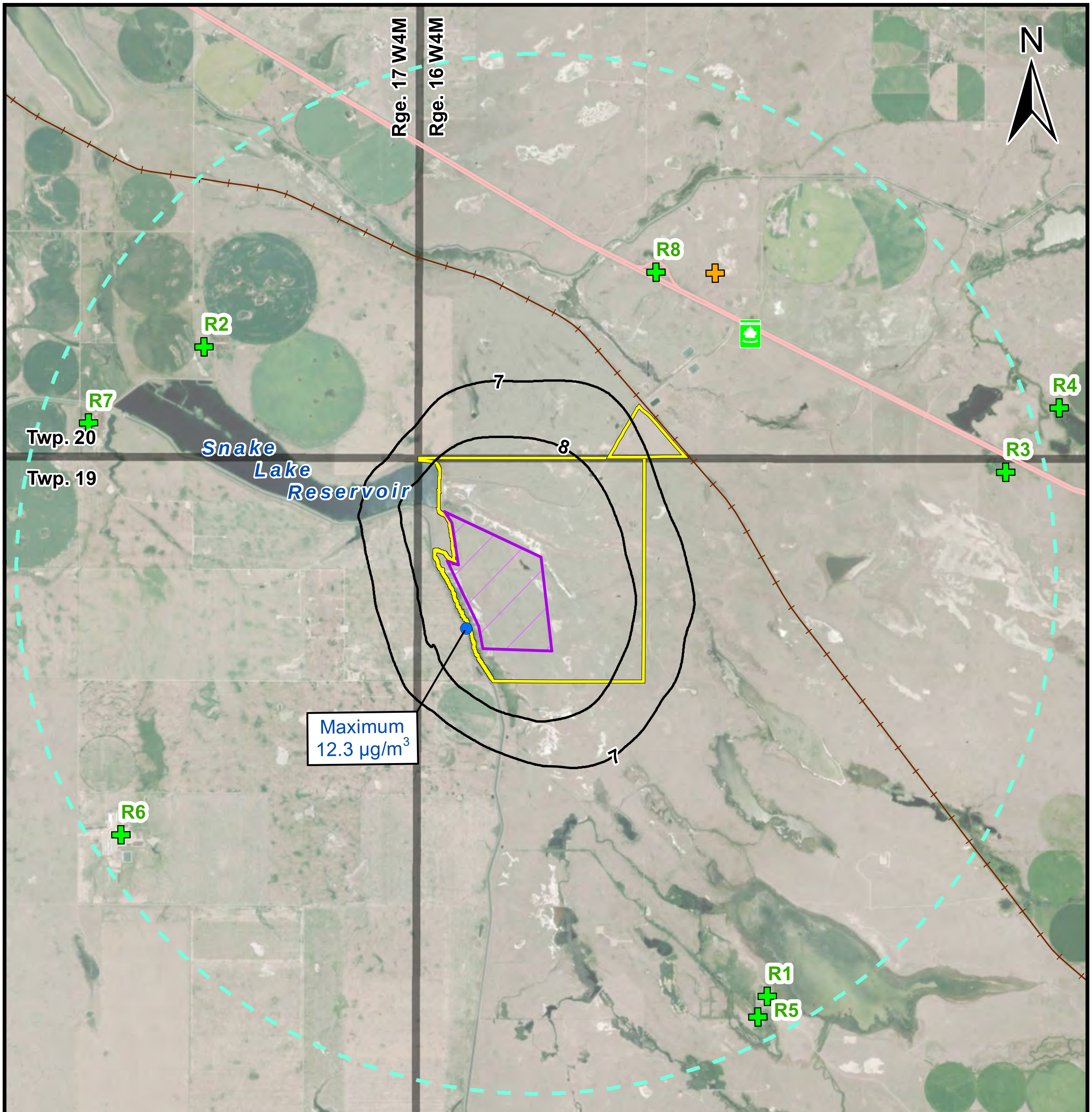
EID

Maximum Predicted Annual NO_2 Concentration Baseline Case

March 2025

REF.: AARES21-127 (PublicHealth)

Figure N1-11



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Data Sources:
Imagery: ESRI. Date: 2021/07/10
ATS Grid: AltaLIS 2007.
Calvin Consulting Group Ltd.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware that discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Modelled Construction Area
- Local Study Area
- Maximum Location
- Sensitive Receptors
- Countess Oil Battery Source
- Predicted Concentration Contour (µg/m^3)
- Highway
- Railway

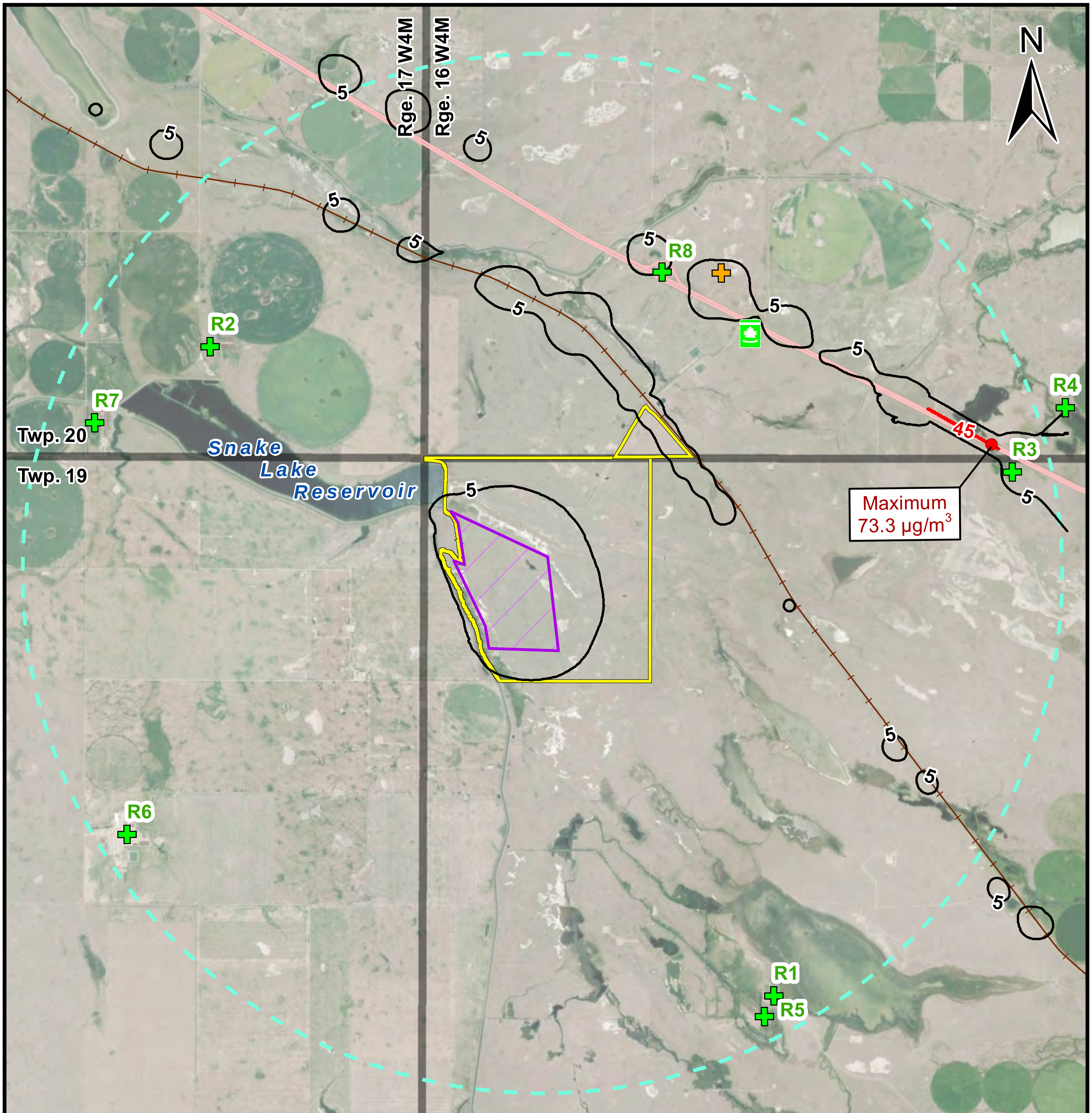
EID

Maximum Predicted Annual NO_2 Concentration Project Construction Case

March 2025

REF.: AARES21-127 (PublicHealth)

Figure N1-12



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Surfer shp		Revision:	0

Data Sources:
Imagery: ESRI. Date: 2021/07/10
ATS Grid: AltaLIS 2007.
Calvin Consulting Group Ltd.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware that discrepancies may be present.

Legend

- Snake Lake Reservoir Expansion Project Area
- Modelled Construction Area
- Local Study Area
- Maximum Location
- Sensitive Receptors
- Countess Oil Battery Source
- Predicted Exceedance Contour (µg/m^3)
- Predicted Concentration Contour (µg/m^3)
- Highway
- Railway

EID

Maximum Predicted Annual NO_2 Concentration Cumulative Construction Case

March 2025

REF.: AARES21-127 (PublicHealth)

Figure N1-13