Rook I Project

Environmental Impact Statement

TSD XX: Downstream Use and Impact Study for Proposed Treated Sewage Discharge Report

DOWNSTREAM USE AND IMPACT STUDY FOR PROPOSED TREATED SEWAGE DISCHARGE TECHNICAL SUPPORT DOCUMENT FOR THE ROOK I PROJECT

Prepared for:

NexGen Energy Ltd.

Prepared by:

Golder Associates Ltd.

March 2022

Abbreviations and Units of Measure

Abbreviation	Definition
$CBOD_5$	5-Day Carbonaceous Biological Oxygen Demand
DUIS	Downstream Use and Impact Study
EDO	effluent discharge objective (Saskatchewan Water Security Agency defined term)
EIS	Environmental Impact Statement
EQO	Environmental Quality Objective
ETP	effluent treatment plant
Hwy	highway
MDL	Method detection limit
NexGen	NexGen Energy Ltd.
pH	potential of hydrogen; measure of the acidity or alkalinity of a solution on a scale of 0 to 14
Project	Rook I Project
RMZ	regulated mixing zone
STP	sewage treatment plant
TDS	total dissolved solids
TP	total phosphorus
TSS	total suspended solids
WSA	Saskatchewan Water Security Agency

Unit	Definition
°	degree
°C	degree Celsius
%	percent
cfu/100 mL	colony-forming unit per 100 millilitres
cm	centimetre
L/s	litres per second
m	metre
m/s	metres per second
m^3	cubic metre
m^3/d	cubic metres per day
m^3/s	cubic metres per second
mg/L	milligrams per litre
mg/L as N	milligrams per litre as nitrogen

Table of Contents

TABLES

FIGURES

1 INTRODUCTION

NexGen Energy Ltd. (NexGen) is proposing to develop a new uranium mining and milling operation in northwestern Saskatchewan, called the Rook I Project (Project). The Project would be located approximately 40 km east of the Saskatchewan-Alberta border, 130 km north of the town of La Loche, and 640 km northwest of the city of Saskatoon (Figure 1-1). The Project would reside within Treaty 8 territory and the Métis Homeland. At a regional scale, the Project would be situated within the southern Athabasca Basin adjacent to Patterson Lake, along the upper Clearwater River system. Patterson Lake is at the interface of the Boreal Shield and Boreal Plain ecozones. Access to the Project would be from an existing road off Highway 955 (Figure 1-2), with on-site worker accommodation serviced by fly-in/fly-out access.

The Project would include the following key facilities to support the extraction and processing of uranium from the Arrow deposit for transportation off site (Figure 1-3):

- underground mine development;
- process plant buildings, including uranium concentrate packaging facilities;
- paste tailings distribution system;
- underground tailings management facility;
- potentially acid generating waste rock storage area;
- non-potentially acid generating waste rock storage area;
- special waste rock[1] and ore storage stockpiles;
- surface and underground water management infrastructure, including water management ponds, effluent treatment plant (ETP), and sewage treatment plant (STP);
- conventional waste management facilities and fuel storage facilities;
- ancillary infrastructure, including maintenance shop, warehouse, administration building, and camp;
- airstrip and associated infrastructure; and
- access road to Project and site roads.

This technical support document outlines the completion of the Downstream Use and Impact Study (DUIS) for the treated effluent discharge from the proposed STP for the camp and mine facilities associated with the Project. The STP would discharge to the Patterson Lake North Arm – West Basin approximately 500 m to the southwest of the proposed ETP diffuser location. It is expected that the STP would operate during Construction, Operations, and Decommissioning and Reclamation (i.e., Closure) of the Project, which is approximately 43 years.

The DUIS is a permitting requirement by the Saskatchewan Water Security Agency (WSA) for any waste water system that discharges to a fish-bearing waterbody (WSA 2012). The purpose of a DUIS is to determine the maximum allowable effluent concentrations based on the existing conditions in the Patterson Lake South Arm,

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[1] Special waste rock is mine rock that is mineralized with insufficient grade to be considered ore (i.e., greater than 0.03% of triuranium octoxide [U_3O_8] and less than 0.26% U_3O_8). All special waste would be temporarily stored in the special waste rock stockpile.

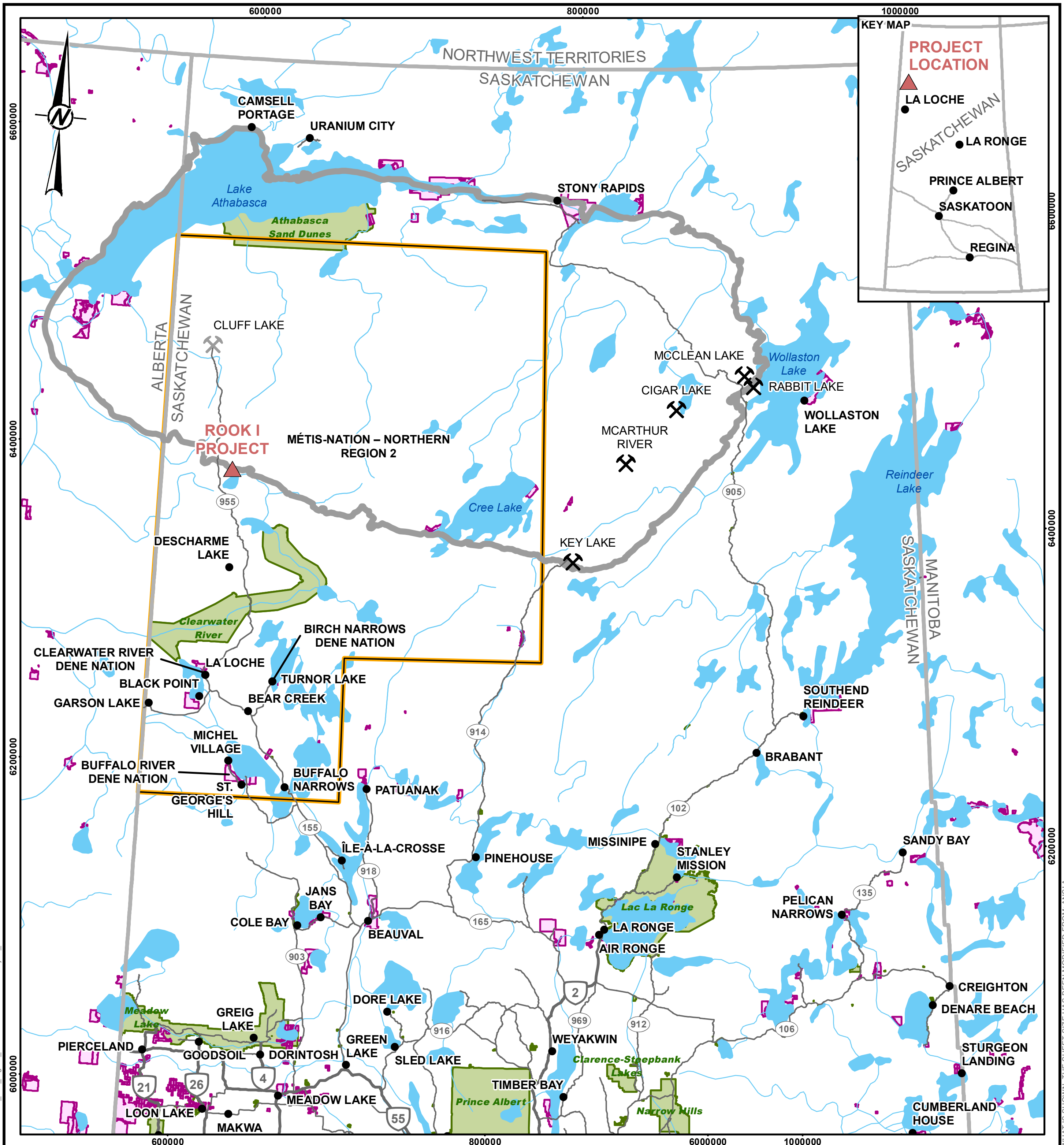
a conceptual treated sewage outfall design, and protection of the downstream environment and its users (including fresh water use by the Project). The DUIS results are then used as design criteria for the proposed STP. While this technical support document specifically mentions the proposed sewage treatment technology currently being designed for the camp, the analysis was completed independent of the selected treatment technology.

This document is specifically written to follow the requirements and terminology outlined in the DUIS guidance. In some cases, the DUIS terminology differs from those used in the Environmental Impact Statement (EIS). Specific differences in terminology include;

- In the DUIS guidance, Environmental Quality Objectives (EQOs) refer to the water quality targets not to be exceeded at the edge of the regulated mixing zone (RMZ). In the EIS, the water quality thresholds are the equivalent term.
- In the DUIS guidance, Effluent Discharge Objectives (EDO) refer to the proposed maximum allowable concentrations in the effluent. In the EIS, effluent release targets are the equivalent term.

This assessment considers the existing water quality of Patterson Lake and the predicted water quality of Patterson Lake at the end of Operations as the ETP is predicted to change the water quality in the Patterson Lake over the 43-year lifespan of the Project (EIS Section 10, Surface Water Quality and Sediment Quality).

This assessment uses an RMZ as a basis for estimating the maximum allowable effluent concentrations for the STP. An RMZ is an area where the water quality is permitted to exceed applicable chronic water quality criteria. For consistency with the surface water quality effects assessment of the EIS (Section 10), this assessment is proposing a maximum extent of 100 m for the RMZ and is consistent with WSA recommendations (WSA 2012). If water quality effects associated with the treated sewage outfall are contained within the proposed mixing zone, measurable effects to water quality are not expected to occur in other areas of Patterson Lake.



LEGEND

- POPULATED PLACE
- URANIUM MINING FACILITY (ACTIVE)
- URANIUM MINING FACILITY (DECOMMISSIONED)
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- WATERCOURSE
- ATHABASCA BASIN BOUNDARY
- INDIAN RESERVE
- PROVINCIAL PARKS
- WATERBODY
- PROJECT LOCATION
- MÉTIS NATION-SASKATCHEWAN NORTHERN REGION 2

0 100 200
1:3,500,000 KILOMETRES

REFERENCE(S)
1. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. PARKS OBTAINED FROM IHS MARKIT CANADA ULC.
PROJECTION: UTM ZONE 12 DATUM: NAD 83

PROJECT
NexGen Energy Ltd.
ROOK I PROJECT

TITLE
LOCATION OF THE ROOK I PROJECT

CONSULTANT
GOLDER MEMBER OF WSP

PROJECT		20144150	PHASE	3314 - 6
DESIGN	JMC	2022-02-28	SCALE AS SHOWN	REV. 0
GIS	NO	2022-02-28	**FIGURE 1-1**	
CHECK	JMC	2022-02-28		
REVIEW	MM	2022-02-28		

PATH: I:\CLIENTS\NexGen\20144150\Mapping\Products\General\EIS_FIGURES_SECTION1\20144150_003_Fig1-1_Location-of-the-RookI-Project_Rev0.mxd PRINTED ON: 2022-02-28 AT: 11:59:15 AM

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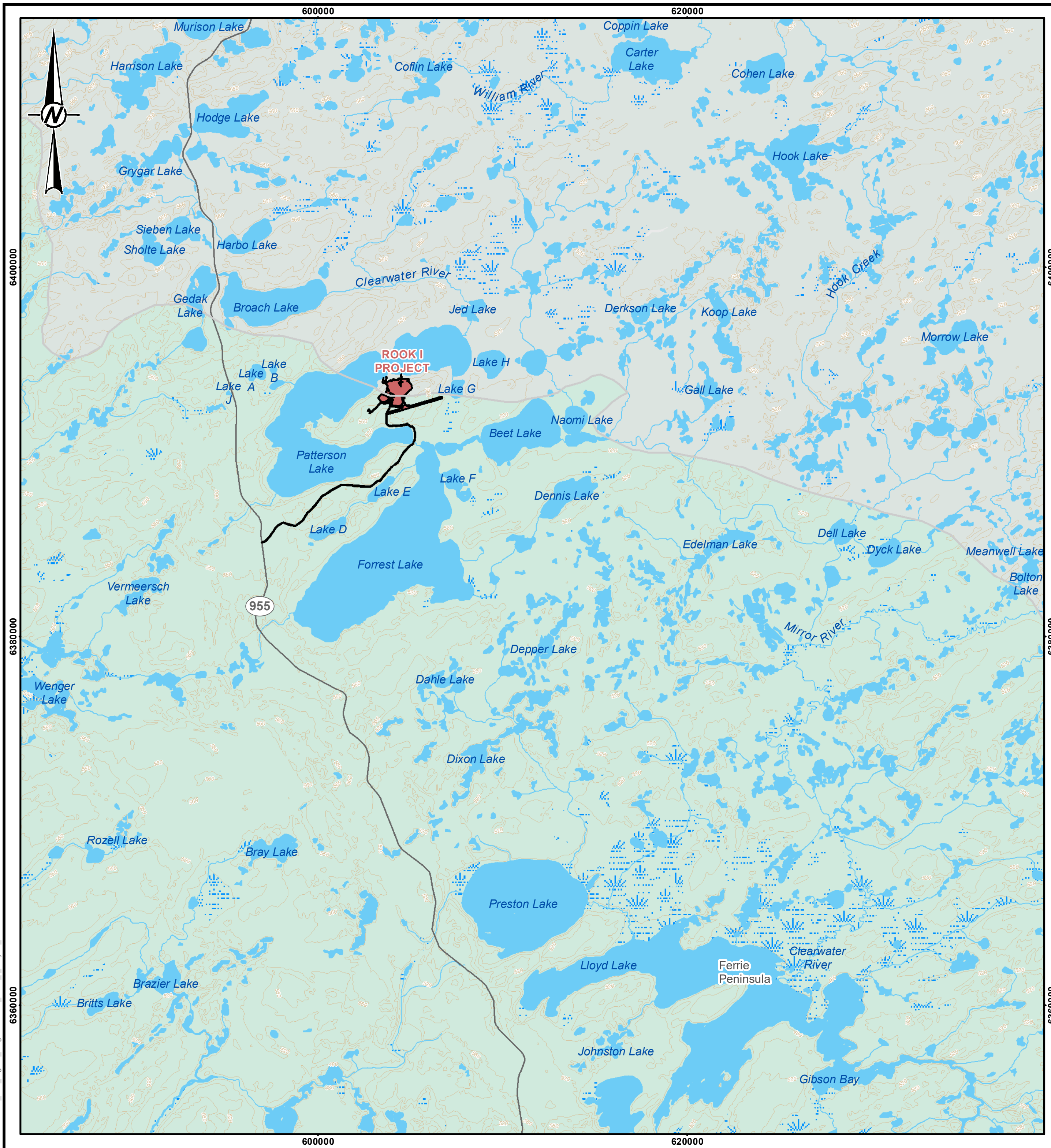
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A



LEGEND

- ELEVATION CONTOUR (20 m INTERVAL)
- SECONDARY HIGHWAY
- WATERCOURSE
- ATHABASCA BASIN
- WATERBODY
- WETLAND
- WOODED AREA
- PROPOSED PROJECT FOOTPRINT

0 5 10
1:300,000 KILOMETRES

PROJECT

NexGen Energy Ltd.

ROOK I PROJECT

TITLE

REGIONAL AREA OF THE ROOK I PROJECT

CONSULTANT

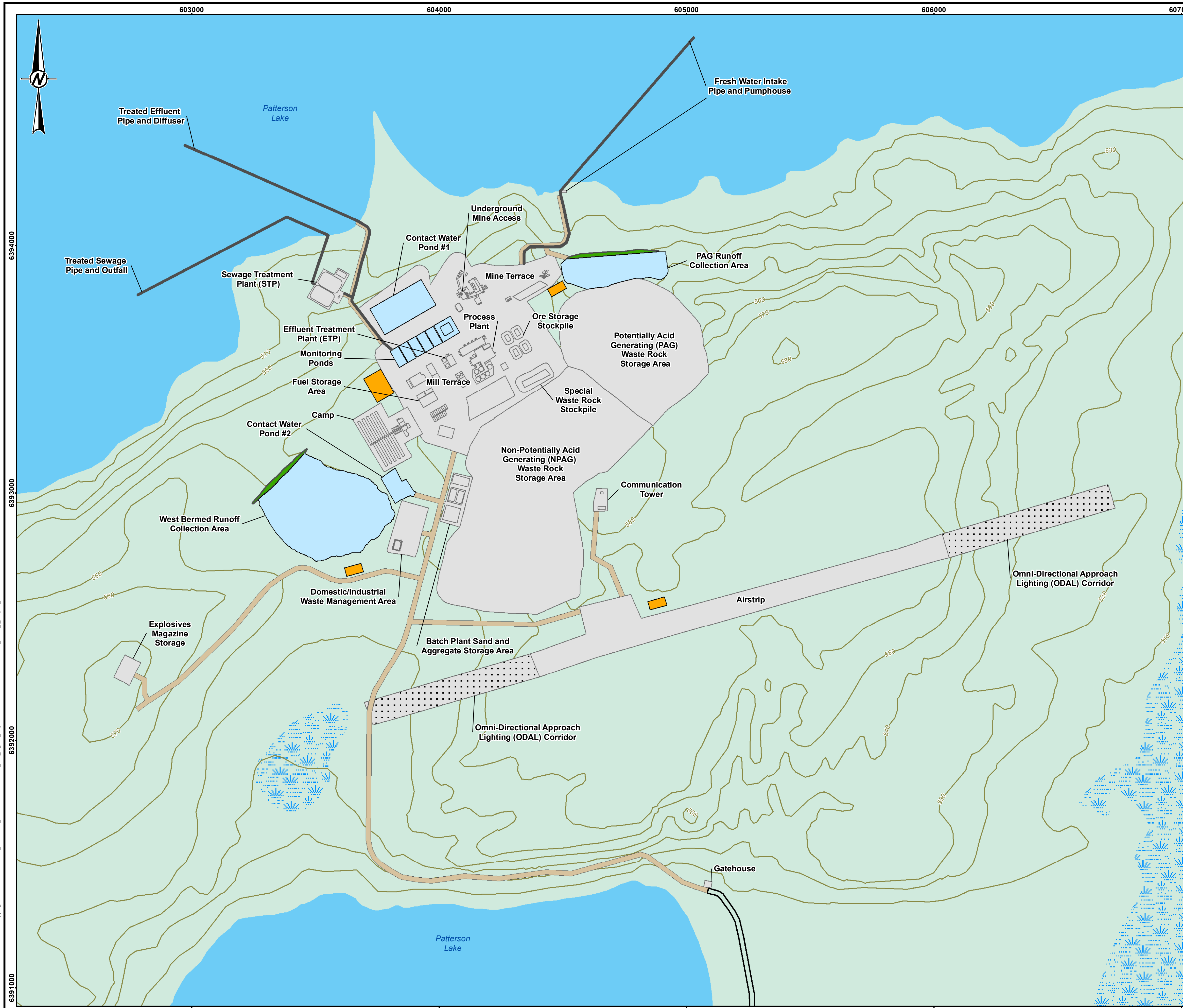
GOLDER MEMBER OF WSP

PROJECT		20144150	PHASE	3314 - 6
DESIGN	JMC	2022-02-28	SCALE AS SHOWN	REV. 0
GIS	NO	2022-02-28	**FIGURE 1-2**	
CHECK	JMC	2022-02-28		
REVIEW	MM	2022-02-28		

REFERENCE(S)

1. PROJECT FEATURES OBTAINED FROM NEXGEN, APRIL 6, 2021.
2. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

PROJECTION: UTM ZONE 12 DATUM: NAD 83



LEGEND

- ELEVATION CONTOUR (10 m INTERVAL)
- WATERBODY
- WETLAND
- WOODED AREA
- INTAKE OR DISCHARGE PIPE
- ACCESS ROAD
- CONTACT WATER CONTAINMENT BERM
- OMNI-DIRECTIONAL APPROACH LIGHTING (ODAL) CORRIDOR
- PROJECT INFRASTRUCTURE
- SITE ROAD
- TOPSOIL STORAGE AREA
- WATER MANAGEMENT POND

0 0.5 1

1:15,500 KILOMETRES

REFERENCE(S)

1. PROJECT FEATURES OBTAINED FROM NEXGEN, APRIL 6, 2021 AND UPDATED JUNE 8, 2021 .
2. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

PROJECTION: UTM ZONE 12 DATUM: NAD 83

PROJECT

NexGen Energy Ltd.

ROOK I PROJECT

TITLE

LAYOUT OF INFRASTRUCTURE AND FACILITIES FOR THE ROOK I PROJECT

CONSULTANT

GOLDER MEMBER OF WSP

PROJECT		20144150	PHASE	3314 - 6
DESIGN	JV	2020-03-13	SCALE AS SHOWN	REV. 0
GIS	NO	2022-03-18		
CHECK	JMC	2022-03-18	**FIGURE 1-3**	
REVIEW	MM	2022-03-18		

PATH: I:\CLIENTS\NexGen\20144150\Mapping\Products\General\EIS_FIGURES_SECTION1\20144150_011_Fig1-3_Layout-of-Infrastructure-and-Facilities_Rook_I_Project_Rev0.mxd PRINTED ON: 2022-03-18 AT: 10:40:38 AM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

1.1 Description of Treatment System

The STP would be located to the northwest of the mine facilities. The location of the STP is shown in Figure 2-1, along with the locations of the treated sewage outfall, ETP diffuser, and the Project fresh water intake.

Sewage would be treated through a combined use of aerated cells, chemical addition (i.e., alum), and ultraviolet disinfection. The aerated cells would aerate the incoming sewage to reduce biological oxygen demand. Settling and biological action would reduce total suspended solids (TSS) and pathogen concentrations to levels that could be further treated by alum addition and ultraviolet disinfection. Alum addition would also be required to achieve phosphorus limits. The proposed STP would discharge continuously (i.e., year-round) to Patterson Lake at an average rate of 165 m^3/d (1.9 L/s).

Conceptual Treated Sewage Outfall Design

The proposed outfall for the treated sewage effluent would be located in Patterson Lake, approximately 300 m from the shoreline and at a depth of approximately 4 m (total water depth of 4.5 m). The total depth of water (during ice-free conditions) at the outfall should be at least 4.5 m to provide sufficient water depth during ice-covered periods.

Effluent would be conveyed to the treated sewage outfall through a lake bed pipe. The outfall would be positioned 0.5 m above the lake bed to reduce the potential for sediment resuspension resulting from the operation of the STP. A single 2.9 cm (1.25 inches) port would be oriented 45° above the horizontal and in an offshore direction perpendicular to the shoreline. At the design flow of 1.9 L/s, the exit velocity would be approximately 3 m/s.

2 BACKGROUND CONDITIONS

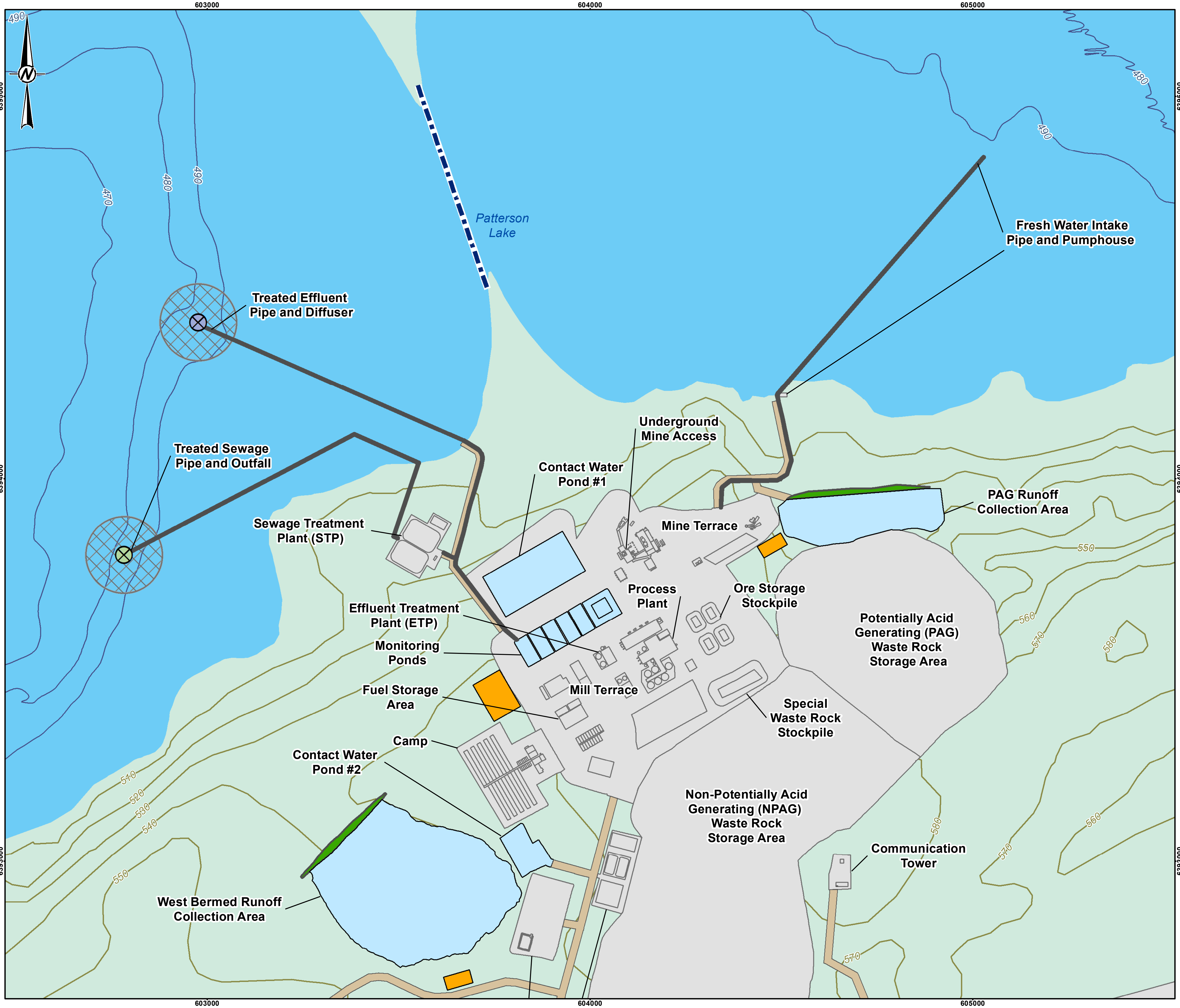
2.1 Description of Discharge Area

The proposed treated sewage outfall would be located in the Patterson Lake North Arm – West Basin (Figure 2-1). The North Arm – West Basin is approximately 7 km long and 2 km wide with a maximum depth of approximately 50 m. The lake bed in this area is primarily coarse sand with some silt and fine sand (Annex V.1, Aquatic Environment Baseline Report).

Water levels in Patterson Lake ranged from 498.545 metres above sea level to 498.645 metres above sea level between 4 August and 2 October 2018. The average water level over that period was 498.589 metres above sea level (EIS Section 10, Appendix 10A, Surface Water Quality Modelling Report).

The overall direction of flow of water in Patterson Lake is from the North Arm – East Basin through the North Arm – West Basin into the South Arm toward the outlet to the Clearwater River. Currents in the vicinity of the proposed treated sewage outfall vary in direction and speed due to varying wind conditions over the entire lake, as described in Section 2.1.1, Currents.

The total volume of the Patterson Lake North Arm – West Basin has been estimated to be 230 million cubic metres and represents approximately 40% of the total volume of Patterson Lake. The average retention time of the Patterson Lake South Arm is estimated to be 7.3 years based on an annual average outflow of approximately 1 m^3/s (EIS Appendix 9B, Hydraulic and Sediment Transport Modelling Summary Report).



LEGEND

- BATHYMETRY CONTOUR ELEVATION (10 m INTERVAL)
- ELEVATION CONTOUR (10 m INTERVAL)
- WATERBODY
- WOODED AREA
- INTAKE OR DISCHARGE PIPE
- ACCESS ROAD
- CONTACT WATER CONTAINMENT BERM
- OMNI-DIRECTIONAL APPROACH LIGHTING (ODAL) CORRIDOR
- PROJECT INFRASTRUCTURE
- SITE ROAD
- TOPSOIL STORAGE AREA
- WATER MANAGEMENT POND
- EFFLUENT TREATED PIPE DIFFUSER
- SEWAGE TREATED PIPE OUTFALL
- LAKE BASIN DIVISION
- PROPOSED REGULATED MIXING ZONE

0 0.3 0.6

1:10,000 KILOMETRES

REFERENCE(S)

1. PROJECT FEATURES OBTAINED FROM NEXGEN, APRIL 6, 2021 AND UPDATED JUNE 8, 2021 .
2. BASE DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
3. BATHYMETRY CONTOURS DERIVED FROM DATA COLLECTED BY NEXGEN, 2016.

PROJECTION: UTM ZONE 12 DATUM: NAD 83

PROJECT

NexGen Energy Ltd.

ROOK I PROJECT

TITLE

MINE HYDRAULIC INFRASTRUCTURE AND ASSOCIATED MIXING ZONE

CONSULTANT

GOLDER MEMBER OF WSP

PROJECT		20144150	PHASE	3314 - 6
DESIGN	GVA	2020-03-13	SCALE AS SHOWN	REV. 0
GIS	NO	2022-03-02		
CHECK	GVA	2022-03-02	**FIGURE 2-1**	
REVIEW	JF	2022-03-02		

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

2.1.1 Currents

Information on lake currents in Patterson Lake is required to predict the mixing of the effluent near the outfall. Current speed and direction were measured near the proposed STP outfall location from 9 July to 23 September 2020 using an acoustic doppler current profiler (Annex IV.4, Patterson Lake Currents Assessment Report). While the acoustic doppler current profiler provided current data at 1 m intervals, the data collected at mid-depth (i.e., 5 m) were used as the typical current speed at the outfall location. A complete analysis of the current speeds and directions can be found in Annex IV.4.

The current speed scenarios used in this assessment and in the EIS are summarized in the following points and provided in Table 2.1-1:

- High current speeds were represented by the 95th percentile of the measured current speeds (0.079 m/s) and were assumed to only occur during open-water conditions.
- Typical current speeds were represented by the average measured current speed (0.042 m/s) and were assumed to only occur during open-water conditions.
- Calm conditions were assumed to have a current speed of 0.001 m/s, which is the lowest value that can be entered in CORMIX (the near-field mixing model used for this assessment). Calm conditions were assumed to occur in both open-water and ice-covered conditions.

Table 2.1-1: Assumed Current Speeds and Direction Near the Sewage Treatment Plant Outfall

Current Speed Scenario	Speed (m/s)	Lake Conditions
High current speeds	95th percentile mid-depth = 0.079	Open-water
Typical current speeds	Average mid-depth = 0.042	Open-water
Calm conditions	0.001	Open-water and ice-covered

2.1.2 Water Temperature and pH

The surface water temperature in Patterson Lake varies between 0°C and 20°C. Seasonal water column profiles in Patterson Lake suggest that thermal stratification occurs in the lake between late spring and early fall, with the lake exhibiting bi-annual (i.e., spring and fall) turnover events (EIS Section 10). Depending on the time of year, the thermocline depth varies between 4 m to 18 m. As the water depth at the STP outfall is 4 m, stratified conditions were not modelled for the STP outfall.

Water temperatures in Patterson Lake were collected at 20-minute intervals at the inlet and outlet between 7 August 2018 and 23 September 2020 as part of a hydrological baseline field program (Annex IV.2, Hydrometric Monitoring Characterization Report). The monthly average and 75th percentile water temperatures are summarized in Table 2.1-2. Table 2.1-2 also includes the average 75th percentile water temperature that was used to conservatively estimate the fraction of ammonia that is un-ionized.

Table 2.1-2: Assumed Current Speeds and Direction Near the Sewage Treatment Plant Outfall

Month	Season	Monthly Average Water Temperature		Monthly 75th Percentile Water Temperature		Seasonal pH		
		Inlet (ºC)	Outlet (ºC)	Inlet (ºC)	Outlet (ºC)	Average (ºC)	Average	75th Percentile
Jan	Winter	-0.2	0.1	-0.2	0.2	0.0	6.8	7.0
Feb		-0.1	0.1	-0.1	0.2	0.0		
Mar	Spring	0.4	0.3	0.7	0.4	0.6	6.5	7.1
Apr		2.6	2.1	3.9	3.4	3.7		
May		7.8	5.9	12.0	7.9	10.0		
Jun	Summer	14.8	11.0	17.4	13.6	15.5	6.7	7.5
July		18.3	17.4	20.1	18.6	19.4		
Aug		16.2	16.4	17.3	17.8	17.5		
Sep	Fall	10.8	10.5	13.1	12.9	13.0	6.9	7.3
Oct		2.7	3.2	3.1	3.4	3.2		
Nov		0.4	0.3	0.5	0.3	0.4		
Dec	Winter	-0.1	0.2	0.0	0.3	0.1	6.8	7.0

2.1.3 Ice Thickness

While measured ice thicknesses in Patterson Lake ranged from 0.62 m to 0.80 m (Annex V.1), an ice thickness of 1 m was used to represent ice-covered periods. As a result, the total water depth at the outfall was reduced by 1 m during ice-covered periods. Ice thicknesses are rarely known with certainty, and this assumption is conservative because it assumes a shallower water depth under ice compared to measured conditions which leads to lower predicted dilution.

2.1.4 Patterson Lake Water Quality

The background water quality was based on 19 samples collected in the Patterson Lake North Arm – West Basin between 10 November 2015 and 24 September 2020 (EIS Appendix 10A, Attachment 10A-1, Background Surface Water Quality Characterization) and is summarized in Table 2.1-3. For purposes of this assessment, the presentation of results for the water quality is limited to nutrients, suspended solids, 5-day Carbonaceous Biological Oxygen Demand ($CBOD_5$), and coliforms as these are typically associated with discharge quality from sewage treatment systems. Under baseline conditions, it is noted that most of the samples for these constituents (e.g., ranging from 60% to 90% depending on parameter) were reported as less than the method detection limit (MDL).

Patterson Lake is considered to be oligotrophic, which is characterized by low concentrations of nutrients and low rates of primary productivity (EIS Section 10.2.8.3.3, Productivity Status Thresholds).

The following points outline the selected background concentrations (including rationale) used as the basis for assessment:

- The reported concentrations of total phosphorus (TP) were consistently below the MDL of 0.01 mg/L. The TP concentration was conservatively assumed to be equal to the MDL (i.e., 0.010 mg/L).
- Total ammonia concentrations were frequently (61% of the samples) reported as less than 0.01 mg/L as nitrogen (mg/L as N) and occasionally (28% of the samples) reported as 0.02 mg/L as N. Two samples (11%) had reported values higher than 0.02 mg/L as N. A total ammonia concentration of 0.02 mg/L as N was assumed to be approximately equal to the 75th percentile of the measured concentrations.
- Un-ionized ammonia concentrations were estimated based on field-measured total ammonia, pH, and water temperature. The un-ionized ammonia concentrations ranged from 0.0000028 to 0.00034 mg/L as nitrogen (mg/L as N), with a 75th percentile of 0.000044 mg/L as N.
- Nitrate concentrations were generally below the MDL of 0.01 mg/L with only 2 of 15 (13%) samples reporting values above the MDL. A nitrate concentration of 0.01 mg/L as N was assumed to be approximately equal to the 75th percentile of the measured concentrations.
- Patterson Lake has high water clarity as TSS concentrations ranged from less than 1 mg/L to 6 mg/L, with 84% of the samples being reported as less than the MDL. The reported MDL ranged from 1 mg/L to 6 mg/L. A TSS concentration of 2 mg/L was assumed to be approximately equal to the 75th percentile of the measured concentrations.
- Water quality results were not available for $CBOD_5$ or coliforms. However, given the low nutrient levels, low suspended solids, high water clarity, and extremely limited development in the area, it expected that the existing concentrations of $CBOD_5$ and coliforms are low. For this assessment, concentrations of 1 mg/L and 1 colony-forming unit per 100 millilitres (cfu/100 mL) for $CBOD_5$ and total coliforms, respectively, were assumed to be representative of background conditions. These were assumed in the absence of site-specific data.
- Total dissolved solids (TDS) in Patterson Lake North Arm – West Basin was estimated to be approximately 24 mg/L using the available average specific conductivity measurements. Specific conductivity measurements were converted to TDS (in mg/L) using a calculated TDS/specific conductivity coefficient of 0.64 as recommended for natural waters by Maidment (1994), which lies within the range of the TDS-/-specific conductivity coefficients between 0.55 and 0.7 recommended by the American Public Health Association (APHA 2012).
- The seasonal 75th percentile of pH ranges from 7.0 to 7.5 as shown in Table 2.1-2. Monthly values could not be estimated as the water quality sampling was completed on a quarterly basis. As such, seasonal values were assumed and assigned to months as follows:
  - winter: December, January, and February;
  - spring: March, April, and May;
  - summer: June, July, and August; and
  - fall: September, October, and November.

The STP discharge is not expected to measurably affect the lake-wide water quality in Patterson Lake as the design discharge rate of the STP (i.e., 0.019 m^3/s) is small in comparison to the average annual outflow of Patterson Lake, which is approximately 1 m^3/s (EIS Appendix 9A). Similarly, the maximum annual discharge volume of approximately 0.060. million cubic metres would be negligible compared to the total volume of Patterson Lake North Arm – West Basin of 230 Mm^3.

Surface water quality modelling for the EIS, Section 10, predicts that the concentrations of total ammonia, nitrate, and TP would increase as a result of the discharge of effluent from the STP and ETP. The maximum monthly averages predicted for these constituents are provided in Table 2.1-3. For the remaining constituents (i.e., $CBOD_5$, TDS, TSS, and total coliforms), the STP discharge concentrations are expected to be small or negligible. As such, the lake-wide concentrations of $CBOD_5$, TDS, TSS, and total coliforms at the end of the proposed Project (i.e., at the end of Operations) are assumed to be the same as at the beginning of the Project (i.e., pre-Construction).

Table 2.1-3 also includes values for the expected effluent quality and the EQOs which are discussed in further detail in Sections 2.4 and 3.1 respectively.

Table 2.1-3: Summary of Background (Ambient) Water Quality, Lake Water Quality at End of Operations, and Expected Effluent Quality

Parameter	Measured Ambient Water Quality (Start of Operation)		Predicted Water Quality at End of Operations[c]	Expected Effluent Quality[d]	EQO[e]
	Measured[a]	Assumed[b]			
$CBOD_5$ (mg/L)	n/a	1	1[f]	<25	none[g]
TDS (mg/L)	<1 to 6	2	2[f]	<25	5 mg/L above background
Total ammonia (mg/L as N)	<0.01 to 0.02	0.02	0.35	45 mg/L	Based on unionized ammonia
Un-ionized ammonia as (mg/L as N)	0.0000028 to 0.00034	calculated[h]	calculated[h]	calculated[h]	0.0156
Total nitrate as (mg/L as N)	<0.01 to 0.07	0.01	0.33	n/a[i]	3
Total phosphorus (mg/L)	<0.010	0.010	0.009	1.2	<4 ultra-oligotrophic lakes 4 to 10 oligotrophic lakes 10 to 20 mesotrophic
Total coliforms (cfu/100 mL)	n/a	1	1[f]	2,000 to 200,000	100
TDS (mg/L)	24[j]	24	24	n/a	none

a) For samples collected in Patterson Lake North Arm – West Basin.
b) Values assumed for DUIS at start of Operations.
c) Predicted maximum monthly concentrations predicted in EIS (EIS Appendix 10A, Section 10A6.4.1.3 Patterson Lake) for total ammonia, nitrate, and TP during Project Operations.
d) Expected effluent quality provided by Stantec (Stantec 2021).
e) Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME 1999).
f) Values carried over from start of Operations. Concentrations of $CBOD_5$, TSS, and total coliforms in Patterson Lake were not modelled in the EIS (EIS Appendix 10A) and are not expected to change as a result of the Project.
g) No applicable water quality criteria or guidelines for $CBOD_5$ – discharge criteria are related to dissolved oxygen consumption in receiving water.
h) Un-ionized ammonia concentration estimated based on total ammonia, average pH, and average water temperature.
i) Numeric value not provided.
j) TDS (in mg/L) calculated from specific conductivity using a TDS/specific conductivity coefficient of 0.64 as recommended for natural waters by Maidment (1994).

EQO = Environmental Quality Objective; < = less than; cfu/100 mL = colony-forming unit per 100 millilitres; n/a = analysis not available; $CBOD_5$ = 5-Day Carbonaceous Biological Oxygen Demand; DUIS = Downstream Use and Impact Study; TSS = total suspended solids; EIS = Environmental Impact Statement; TDS = total dissolved solids; TP = total phosphorus.

2.2 Aquatic Habitat

Fish species captured during baseline sampling in Patterson Lake in 2018 and 2019 included Arctic grayling (*Thymallus arcticus*), lake trout (*Salvelinus namaycush*), lake whitefish (*Coregonus clupeaformis*), cisco (*Coregonus artedi*), burbot (*Lota lota*), walleye (*Sander vitreus*), northern pike (*Esox lucius*), yellow perch (*Perca flavescens*), white sucker (*Catostomus commersonii*), longnose sucker (*Catostomus catostomus*), johnny darter (*Etheostoma nigrum*), spottail shiner (*Notropis hudsonius*), trout-perch (*Percopsis omiscomaycus*), lake chub (*Couesius plumbeus*), ninespine stickleback (*Pungitius pungitius*), and slimy sculpin (*Cottus cognatus*). Focused fish and fish habitat sampling was conducted in Patterson Lake near the proposed Project camp area, approximately 100 m east of the proposed outfall location. The most abundant species found near the camp area were trout-perch, spottail shiner, and yellow perch (Annex V.1).

A fish habitat assessment of the Patterson Lake shoreline near the Project camp area (i.e., in the vicinity of the ETP and STP outfall locations) was conducted in June 2018 (Annex V.1) and focused on the shoreline, littoral, and riparian zone habitats. The riparian zone comprised shrubs and trees over stable, gentle to moderate slopes. The dominant substrate in the littoral zone consisted of sand in approximately half of the habitat sections. Other habitat sections featured a combination of rocky substrates (i.e., gravel, cobble, and boulder) or a mixture of sand and gravel, cobble, and boulder. Rocky substrates were generally covered in a thin layer of silt.

Cover for fish in the vicinity of the ETP diffuser and STP outfall locations was generally present in sparse quantities. Sparse amounts of large woody debris were found in some sections, while moderate to dense amounts of rock cover and sparse overhanging vegetation occurred in approximately half of the habitat sections. While the littoral zone generally featured gentle slopes, some areas had steeper slopes. Most littoral areas were between 0.2 m and 0.5 m deep at a distance of 5 m from shore.

The spawning habitat in the vicinity of the ETP and STP outfall locations can be summarized as:

- Lacking high-quality northern pike spawning habitat. Sand and rocky substrate and sparse amounts of emergent vegetation provided marginal spawning habitat for northern pike in some areas.
- Moderately to highly suitable for spawning by yellow perch in some areas, while other areas were rated as marginally suitable.
- Moderately to highly suitable spawning habitat for walleye, lake whitefish, lake trout, and two sucker species in approximately half of the area due to a combination of rocky substrates.

2.3 Identified Downstream Users

Patterson Lake is used for recreational fishing and back country travel to trapping, hunting, and fishing areas.

There are no existing or proposed fresh water intakes in Patterson Lake downstream of the treated sewage outfall location. The proposed fresh water intake for the Project is expected to be located upstream in Patterson Lake North Arm – East Basin (i.e., 3 km to the east of the proposed treated sewage outfall) as shown in Figure 2-1. There is a potential for a water intake to be proposed by the Fission Patterson Lake Project, but none has been proposed at the time of this study.

2.4 Expected Effluent Quality

A preliminary design of the STP has been completed by Stantec; preliminary estimates of the expected effluent quality are available. The expected effluent quality provided by Stantec (2021) is presented in Table 2.1-3 for all constituents except nitrate, temperature, and TDS.

A nitrate concentration of 2 mg/L was conservatively assumed, which is approximately double the reported nitrate concentration in aerated lagoons located in cooler climates (USEPA 2011).

For this study, the TDS in the effluent was estimated from the measured conductivity at a similar facility in Cold Lake (AECOM 2011). Specific conductivity measurements were converted to TDS (in mg/L) using a calculated TDS/specific conductivity coefficient of 0.64 as recommended for natural waters by Maidment (1994), which lies within the range of the TDS / specific conductivity coefficients between 0.55 and 0.7 recommended by the American Public Health Association (APHA 2012).

For consistency with the conceptual diffuser design study for the ETP diffuser (TSD XIX, Conceptual Diffuser Design Report), three effluent temperatures were considered in the modelling as described in Section 3.2.2, Required Effluent Dilution:

- 4°C, represented a lower bound for effluent water temperature as this would be the temperature at which water density is the highest;
- 8.5°C, represented an average effluent temperature based on measured average at Rabbit Lake (NexGen 2019); and
- 20°C, represented the maximum effluent water temperature expected based on:
  - Recorded water temperatures during July and August in small lakes near the Project (Lakes D, G, H, and J) that ranged from 19°C to 23°C, with an average of 21ºC (Annex V.1).
  - Reported effluent water temperatures at the Rabbit Lake Mine in 2015 and 2018 (Cameco 2019) that ranged from 10°C to 18°C, with an average of 16°C.

It is expected that the STP would use ultraviolet disinfection to reduce the total coliforms concentration in the effluent. As such, residual chlorine is not considered in this study.

3 DEVELOPMENT OF EFFLUENT DISCHARGE OBJECTIVES

The EDOs represent the maximum allowable effluent concentrations that are estimated such that the water quality at the edge of the RMZ do not exceed the selected EQOs under a variety of conditions.

3.1 Environmental Water Quality Objectives

The EQOs for receiving water quality used in this study are provided in Table 2.1-3 and are based on the Canadian Council of Ministers of the Environment guidelines (CCME 1999) with the following comments and exceptions:

- Because there is no guideline for $CBOD_5$, a criterion of 5 mg/L was selected to limit the potential for oxygen depletion in Patterson Lake at the edge of the RMZ to 5 mg/L of oxygen over a 5-day period.

- Seasonal guidelines for total ammonia were based on the CCME criteria for un-ionized ammonia (i.e., 0.0156 mg/L as N), monthly water temperatures, and seasonal pH for Patterson Lake (Table 2.1-2).
- As phosphorus is a nutrient and contributes to the growth of algae and macrophytes, the TP guideline is intended to be applied as a lake-wide value over the growing season. Short term (e.g., a week or less) exceedances within the mixing zone are not expected to result in any changes to the overall trophic level of Patterson Lake provided there are no measurable increased to the lake-wide TP concentration. As there are no Saskatchewan provincial objectives for TP, the Ontario provincial water quality objective for TP is an interim objective, being an average TP concentration of 0.02 mg/L for the ice-free period to avoid nuisance concentrations of algae in the waterbodies (MOEE 1994).

In addition to the EQOs for the receiving water, which apply at the edge of the RMZ and beyond, the following limits on the end-of-pipe effluent concentration (*The Waterworks and Sewage Works Regulations*) were used in this study:

- a maximum $CBOD_5$ concentration of 25 mg/L;
- a maximum TSS concentration of 25 mg/L; and
- a maximum un-ionized ammonia concentration of 1.24 mg/L at 15°C.

3.2 Mixing Zone Allocation

3.2.1 Proposed Mixing Zone Allocation

Based on the WSA (2015) guidelines, the RMZ was chosen as a 100 m radius from the centre of both the ETP diffuser and STP outfall locations as shown in Figure 2-1. The ETP diffuser and STP outfall would be 500 m apart; therefore, the closest distance between the RMZs for the two outfalls is 300 m. Thus, the two mixing zones do not intersect.

Additionally, neither the STP outfall nor the ETP diffuser are expected to affect the fresh water intake for the Project as this intake pipe is located upstream of both discharge locations in the North Arm – East Basin.

Based on the modelling in the previous subsection, the minimum predicted dilution factor in Table 3.2-2 (210:1) will be used to conservatively estimate the EDOs (Section 3.3.1, Estimated Maximum Effluent Discharge Objectives).

3.2.2 Required Effluent Dilution

The effluent dilutions required at the end of mixing zone to meet EQOs are provided in Table 3.2-1 for each parameter. These dilution factors are based solely on concentrations, are independent of the size of the mixing zone, and are used to identify the most restrictive parameter and aid in the development of the conceptual design for the outfall. The dilution factor is a measure of the amount the effluent is mixed with ambient water as follows:

$$S = \frac{Q_E + Q_A}{Q_E} \qquad \text{Equation 1}$$

Where: S dilution factor
Q_E effluent flow rate (L/s)
Q_A ambient (background) flow rate (L/s)

The required dilution factor (S) was found by combining a simple mass balance (equation 2) with equation 1 and then solving for the required dilution (equation 3):

$$(Q_E + Q_A)C_T = Q_E C_E + Q_A C_A \qquad \text{Equation 2}$$

$$S = \frac{C_E - C_A}{C_T - C_A} \qquad \text{Equation 3}$$

Where: C_T selected water quality threshold (mg/L)
C_E effluent concentration (mg/L)
C_A ambient (background) concentration (mg/L)

As shown in Table 3.2-1, the required dilution is not required for total nitrate as the assumed effluent concentration is below the water quality objective of 3 mg/L as N. Table 3.2-1 also shows that total coliforms would likely require the highest dilution of all constituents (i.e., 2,000:1) to meet EQOs when the highest effluent concentration (i.e., 200,000 cfu/100 mL) is assumed. However, if effluent disinfection (i.e., using ultraviolet treatment before release) is implemented, then the effluent concentration of total coliforms can be expected to be less than the lowest effluent concentration (2,000 cfu/100 mL) and the required dilution for total coliforms is predicted to be 20:1 or less. Under this assumption, the highest predicted dilution required would be for TP (120:1). However, since most (i.e., greater than 90%) of the water quality samples collected in Patterson Lake reported TP concentrations as less than the method MDL of 0.01 mg/L the required dilution for TP was estimated using an assumed background concentration of 0.010 mg/L (i.e., equal to the MDL). As a result, the actual required dilution factor for TP is likely lower than the estimated value of 120:1. Additional water quality data with a lower MDL are required to better quantify the existing TP concentration and eliminate this uncertainty.

The subsequent analysis in this report assumes that effluent disinfection is implemented, and that TP is the limiting water quality parameter.

Table 3.2-1: Required Dilution at End of Mixing Zone to Meet Water Quality Objectives

Parameter	Month	Units	EQO[a]	Patterson Lake[a]	Expected Effluent[b]	Required Dilution[c]
$CBOD_5$	All	mg/L	5.0	1.0	25	6.0:1
TSS	All	mg/L	7.0	2.0	25	4.6:1
Un-ionized ammonia[d]	Jan	mg/L as N	0.0156	0.000016	0.036	2.3:1
	Feb			0.000016	0.036	2.3:1
	Mar			0.000022	0.049	3.1:1
	Apr			0.000028	0.063	4.1:1
	May			0.000047	0.105	6.7:1
	Jun			0.000184	0.413	27:1
	Jul			0.000245	0.550	36:1
	Aug			0.000214	0.480	31:1
	Sep			0.000093	0.210	14:1
	Oct			0.000043	0.097	6.2:1
	Nov			0.000034	0.076	4.9:1
	Dec			0.000016	0.036	2.3:1
Total nitrate	All	mg/L as N	3.0	0.020	2[e]	Not required[f]
Total phosphorus	All	mg/L	0.020	0.010	1.2	120:1
Total coliforms	All	cfu/100 mL	100	1	2,000[g]	20:1
Total coliforms	All	cfu/100 mL	100	1	200,000[g]	2,000:1

a) Table 2.1-3 and Section 3.1, Environmental Water Quality Objectives, for details.
b) Expected effluent quality provided by Stantec (2021).
c) Required dilution values rounded off to two significant figures.
d) Un-ionized ammonia concentrations estimated from total ammonia concentrations in Patterson Lake (0.02 mg/L) and effluent (45 mg/L) using monthly ambient water temperatures and seasonal pH from Table 2.1-2.
e) As nitrate concentration in the effluent is expected to be low (Stantec 2021), a concentration of 2 mg/L was assumed, which is approximately double the reported nitrate concentration in aerated lagoons located in cooler climates (USEPA 2011).
f) Expected effluent concentration is below water quality objective.
g) Range of expected coliform concentration provided by Stantec (2021).

EQO = Environmental Quality Objective; cfu/100 mL = colony-forming unit per 100 millilitres; $CBOD_5$ = 5-Day Carbonaceous Biological Oxygen Demand; TSS = total suspended solids.

3.2.3 Treated Sewage Outfall Mixing Potential

The mixing and dispersion of the effluent near the treated sewage outfall were predicted for 26 scenarios using CORMIX (Version 11.0GTS). The scenarios represented combinations of assumed current speeds, effluent temperatures, ambient temperatures, and ice conditions; scenarios are summarized with their predicted dilution factors at the edge of the RMZ (i.e., 100 m) in Table 3.2-2. In all seasons except winter (i.e., December, January, and February), the water depth was assumed to be 4 m. In winter, the assumed water depth was decreased to 3 m to reflect conservative ice thickness assumptions.

Table 3.2-2: Summary of CORMIX Model Simulations for the Sewage Treatment Plant Outfall

Conditions	Scenario	Effluent Temperature (°C)	Ambient Conditions		Estimated Dilution[(a)] at Edge of RMZ (100 m)
			Current Speed (m/s)	Lake Water Temperature (°C)	
Ice-covered	STP-1	8.5	0.001	0	350
	STP-2	4.0			350
Open-water	STP-3	20	0.001	5	410
	STP-4			10	400
	STP-5			15	360
	STP-6			20	400
	STP-7		0.042	5	210
	STP-8			10	220
	STP-9			15	220
	STP-10			20	590
	STP-11		0.079	5	650
	STP-12			10	670
	STP-13			15	740
	STP-14			20	1,800
	STP-15	8.5	0.001	5	280
	STP-16			10	400
	STP-17			15	400
	STP-18			20	370
	STP-19		0.042	5	340
	STP-20			10	700
	STP-21			15	300
	STP-22			20	300
	STP-23		0.079	5	1,500
	STP-24			10	1,600
	STP-25			15	1,200
	STP-26			20	870

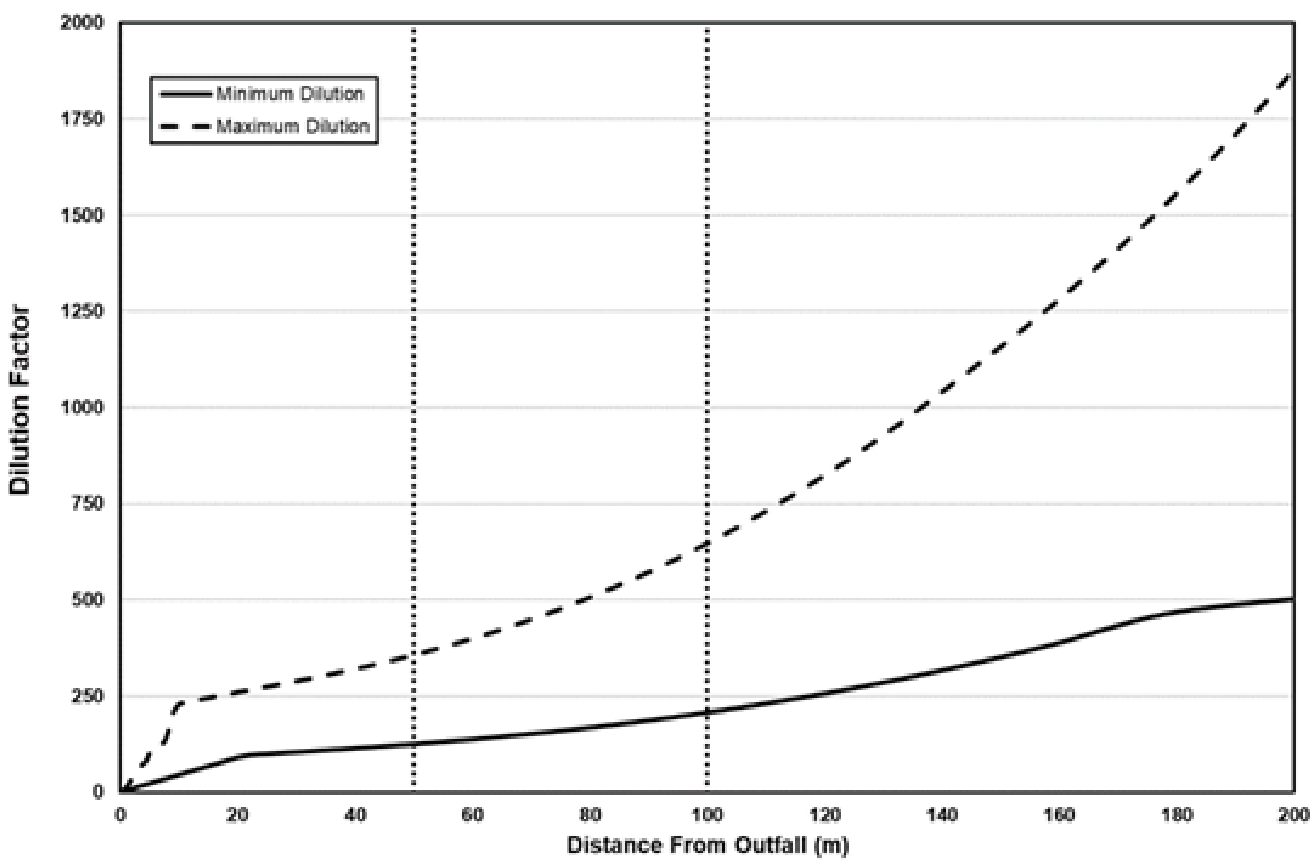
a) Distances measured from centre of outfall.
RMZ = regulated mixing zone; STP = sewage treatment plant.

The predicted effluent dilution factors at the edge of the RMZ (i.e., 100 m) ranged from 210:1 to over 1,800:1 with an average of 518:1. The minimum and maximum dilution factors with distance from the outfall are provided in Figure 3-1. Based on the results, the following conclusions were drawn:

- While rapid initial mixing is expected to occur in the immediate area of the outfall (e.g., predicted dilution factors at a distance of 25 m ranged from 100:1 to 275:1), the predicted dilution factor continues to increase with distance from the outfall.

- The lowest predicted dilution factor at the edge of the RMZ occurs when the density difference between the effluent and lake water is the greatest.
- At the edge of the RMZ, the dilution factor is predicted to increase with an increase in ambient current speed.
- During ice-covered periods, the predicted dilution factor at the edge of the RMZ is similar to open-water periods.
- The estimated dilution factor at the edge of the RMZ is greater than the required dilution factor for TP (120:1) for all the conditions modelled and parameters.
- As the critical dilution factor (i.e., the highest required dilution) is based on measured TP concentrations in Patterson Lake that are consistently reported as less than the MDL (0.01 mg/L), additional water quality sampling utilizing a lower MDL (i.e., 0.001 mg/L or less) is required to confirm the minimum required dilution factor at the edge of the RMZ prior to permitting and construction of the STP outfall.

Figure 3-1: Minimum and Maximum Dilution Factors with Distance from the Sewage Treatment Plant Outfall



3.3 Effluent Discharge Objectives

3.3.1 Estimated Maximum Effluent Discharge Objectives

The maximum allowable effluent discharge concentrations were estimated using a dilution factor (210:1) such that water quality objectives are consistently met at the edge of the RMZ (100 m) for all the constituents, conditions, and months. The maximum allowable EDOs represent the maximum allowable effluent concentrations that the receiving environment can accept and are estimated independent of any end-of-pipe restrictions that may be applicable. The results of this analysis are discussed in the following points and are presented in Table 3.3-1:

- Except for total coliforms, the estimated maximum allowable effluent concentrations for all constituents are orders of magnitude higher than their corresponding concentrations for the expected treated effluent.
- The maximum allowable effluent concentration for total coliforms is approximately 21,000 cfu/100 mL, which is within the range provided by Stantec and is likely to be met with disinfection.

3.3.2 Determination of Final Proposed Effluent Discharge Objectives

The WSA has specific end-of-pipe effluent criteria for $CBOD_5$, TSS, and un-ionized ammonia that cannot be exceeded regardless of the effluent concentrations that can be accommodated by a mixing zone. The determination of the final proposed EDOs for these three constituents was based on the minimum value of either the maximum allowable effluent concentration or the applicable WSA requirement (Government of Saskatchewan 2015) as shown in Table 3.3-1. In all cases, the WSA requirement was lower than the respective estimated maximum allowable effluent concentration.

As effluent objectives for ammonia are typically expressed as total ammonia, the monthly un-ionized ammonia objectives were converted to total ammonia as shown in Table 3.3-2. The final proposed EDO for total ammonia (i.e., 100 mg/L) will be based on the minimum monthly concentration of 102 mg/L (i.e., July).

The maximum allowable EDO for nitrate of 210 mg/L is two orders of magnitude higher than the assumed effluent quality of 2 mg/L. The proposed EQO for nitrate is rounded off to 200 mg/L.

The proposed EDO for TP was rounded off to 2.1 mg/L which is higher than the estimated effluent concentration of 1.2 mg/L. Lake-wide water quality completed for the EIS (EIS Appendix 10A) that an STP discharge using an effluent TP concentration of 1.2 mg/ is not expected to change the trophic status of Patterson Lake even when the contribution of the ETP discharge is included.

As the maximum allowable effluent concentration for total coliforms is approximately 21,000 cfu/100 mL, which is within the range provided by Stantec and is likely to be met with disinfection. The proposed EDO for total coliforms is rounded off to 20,000 cfu/100 mL.

Table 3.3-1: Estimated Maximum Allowable Effluent Concentrations and Proposed Effluent Discharge Objectives

Constituents	Month	Units	Criteria or Guideline[(a)]	Patterson Lake[(a)]	Expected Effluent[(b)]	Estimated Maximum Allowable Effluent Concentration	WSA Effluent Limits[(c)]	Proposed EDO[(d)]
$CBOD_5$	All	mg/L	5.0	1.0	25	841	25	25
TSS	All	mg/L	7.0	2.0	25	1,052	25	25
Un-ionized ammonia[(e)]	Jan	mg/L as N	0.0156	0.000016	0.036	3.27	1.24	1.24
	Feb			0.000016	0.036	3.27		
	Mar			0.000022	0.049	3.27		
	Apr			0.000028	0.063	3.27		
	May			0.000047	0.0105	3.26		
	Jun			0.000184	0.413	3.23		
	Jul			0.000245	0.550	3.22		
	Aug			0.000214	0.480	3.23		
	Sep			0.000093	0.210	3.25		
	Oct			0.000043	0.097	3.26		
	Nov			0.000034	0.076	3.27		
	Dec			0.000016	0.036	3.27		
Total nitrate	All	mg/L as N	3.0	0.020	2[(f)]	212.0	not specified[(g)]	200
Total phosphorus	All	mg/L	0.020	0.010	1.2	2.11	not specified[(g)]	2.1
Total coliforms	All	cfu/100 mL	100	1	2,000 to 200,000[(h)]	20,791	not specified[(g)]	20,000

a) Table 2.1-3 and Section 3.1 for details.
b) Expected effluent quality provided by Stantec (2021).
c) As specified in *The Waterworks and Sewage Works Regulations*.
d) Minimum value of either maximum allowable concentration or those specified in *The Waterworks and Sewage Works Regulations*.
e) Un-ionized ammonia concentrations estimated from total ammonia concentrations in Patterson Lake (0.02 mg/L) and effluent (45 mg/L) using monthly ambient water temperatures and seasonal pH from Table 2.1-2.
f) As nitrate concentration in the effluent is expected to be low (Stantec 2021), a concentration of 2 mg/L was assumed, which is approximately double the reported nitrate concentration in aerated lagoons located in cooler climates (USEPA 2011).
g) Effluent limits for total nitrate, TP, and total coliforms not specified by WSA.
h) Range of expected coliform concentration provided by Stantec (2021).

EDO = effluent discharge objective; cfu/100 mL = colony-forming unit per 100 millilitres; WSA = Saskatchewan Water Security Agency; $CBOD_5$ = 5-Day Carbonaceous Biological Oxygen Demand; TSS = total suspended solids; TP = total phosphorus.

Table 3.3-2: Proposed Effluent Discharge Objectives for Total Ammonia

Month	Assumed Water Temperature (ºC)[a]	Assumed pH[b]	Fraction Un-ionized Ammonia©	Proposed EDO	
				Un-ionized Ammonia (mg/L as N)	Total Ammonia (mg/L as N)
Jan	0.0	7.0	0.08%	1.24	1,557
Feb	0.0		0.08%		1,557
Mar	0.6	7.1	0.11%		1,151
Apr	3.7		0.14%		890
May	10.0		0.23%		537
Jun	15.5	7.5	0.92%		136
Jul	19.4		1.22%		102
Aug	17.5		1.07%		117
Sep	13.0	7.3	0.47%		268
Oct	3.2		0.21%		582
Nov	0.4		0.17%		736
Dec	0.1	7.0	0.08%		1,544

a) Average of 75th percentile water temperatures measured and the inlet and outlet of Patterson Lake.
b) Seasonal 75th percentile of pH measured in Patterson Lake.
c) Fraction of total ammonia that is un-ionized, estimated using equations provided by CCME (1999).
EDO = effluent discharge objective.

3.3.3 Monitoring and Follow-Up

Additional baseline data are planned to be gathered for phosphorus using lower MDLs that will allow for more precise EQO for phosphorus. As the limiting nutrient, TP concentrations are typically managed on a mass-loading, lake-wide basis rather than as a mixing zone parameter. Total phosphorus concentrations in Patterson Lake have been assessed for potential effects on trophic status as part of the EIS (EIS Section 11, Fish and Fish Habitat), which concluded that, even under the conservative assumption of baseline concentrations of 0.010 mg/L, total concentrations would reach 0.009 mg/L and not affect trophic status or fish in Patterson Lake. Additional data are also being collected for coliforms and $CBOD_5$ to confirm that the low values assumed in this study are representative of baseline conditions.

In addition to the ongoing baseline data collection, discharge and receiving environment conditions would be monitored as per licensed conditions if the STP becomes operational to confirm that EQOs are met and that the receiving environment is protected.

4 SUMMARY AND PROPOSED EFFLUENT LIMITS

The proposed STP would discharge to an undeveloped portion of Patterson Lake that has water quality typical of oligotrophic lakes in northern Saskatchewan (e.g., low nutrients, high water clarity). While the existing water quality in Patterson Lake provides adequate capacity to receive effluent from the proposed STP, these existing conditions also require that suitable EDOs be developed to prevent the degradation of the water quality and maintain the protection of aquatic habitat. The analysis suggests that TP is the water quality parameter that would require the greatest dispersion to meet the EQO, and that this required dispersion will be met under a range of plausible conditions. The proposed mixing zone of 100 m is not expected to interact with the ETP mixing zone or the proposed fresh water intake for the Project located in Patterson Lake North Arm – East Basin. As such, the proposed treated sewage discharge is not expected to have any adverse effects on the Project's fresh water supply or on the aquatic life in Patterson Lake.

Based on the analysis presented in this memorandum, the final proposed EDOs are provided in Table 4-1.

Table 4-1: Final Proposed Effluent Discharge Objectives

Parameter	Proposed EDO
$CBOD_5$ (mg/L)	25
TSS (mg/L)	25
Total ammonia (mg/L as N)	100
Un-ionized ammonia (mg/L as N)	1.24
Total nitrate (mg/L as N)	200
Total phosphorus (mg/L)	2.1
Total coliforms (cfu/100 mL)	20,000

cfu/100 mL = colony-forming unit per 100 millilitres; $CBOD_5$ = 5-Day Carbonaceous Biological Oxygen Demand; TSS = total suspended solids; EDO = effluent discharge objective.

CLOSING

Golder is pleased to submit this report to NexGen in support of the environmental assessment for the Rook I Project. For details on the limitations and use of information presented in this report, please refer to the Study Limitations section following this page. If you have any questions or require additional details related to this study, please contact the undersigned.

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GVA/JF/rd

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REFERENCES

Acts and Regulations

Government of Saskatchewan. 2015. The Waterworks and Sewage Works Regulations. RRS c E-10.22 Reg 3 under *The Water Security Agency Act*. Effective June 1, 2015. Available at https://www.canlii.org/en/sk/laws/regu/rrs-c-e-10.22-reg-3/latest/rrs-c-e-10.22-reg-3.html

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