Engineering Ltd.

Report for:

English River Property Management

Grasswoods Wastewater Treatment Facility

Effluent Disposal Strategy & DUIS

Date: November 23rd, 2020
7603-002-00

English River PROPERTY MANAGEMENT

Proud of our Past… Building the Future

www.mpe.ca

Unit 122, 103 Marquis Court
Saskatoon, SK S7P 0C4
Phone: 306-668-1966
Fax: 306-668-1968

MPE Engineering Ltd.

English River Property Management
301—2555 Grasswood Road
Saskatoon, SK
S7T 0K1

November 23rd, 2020
File: 7603-002-00\R01

Attention: Jeff Balon, P. Eng., M.Eng.
Manager, Land Development

Dear Mr. Balon:

Re: English River Property Management
Grasswoods Wastewater Treatment Facility – Effluent Disposal Strategy & DUIS

We are pleased to submit three (3) copies of the above noted report. We thank you for the opportunity to be of service and to have prepared this report on your behalf. If you have any inquiries regarding our report or if clarification is required, please contact the undersigned.

Yours truly,

MPE ENGINEERING LTD.

Christopher Nameth, P.Eng.
Project Engineer

CN:mw

Enclosure

CORPORATE AUTHORIZATION

This report has been prepared by MPE Engineering Ltd. under authorization of English River Property Management. The material in this report represents the best judgment of MPE Engineering Ltd. given the available information. Any use that a third party makes of this report, or reliance on or decisions made based upon it is the responsibilities of the third party. MPE Engineering Ltd. accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions taken based upon this report.

MPE ENGINEERING LTD.

Prepared by:

PROFESSIONAL ENGINEER
C. NAMETH
MEMBER 33105
2020-11-24
YR. MN. DAY
SASKATCHEWAN

Christopher Nameth, P.Eng.
Project Engineer

Association of Professional Engineers & Geoscientists of Saskatchewan
CERTIFICATE OF AUTHORIZATION
MPE Engineering Ltd.
Number C1334
Permission to Consult held by:

Discipline	Sk. Reg. No.	Signature
CIVIL	33105	

Reviewed By:

PROFESSIONAL ENGINEER
M. J. STUSICK
MEMBER 22727
November 23 2020
YR. MN. DAY
SASKATCHEWAN

Jason Stusick, P.Eng.
Project Manager

Table of Contents

Letter of Transmittal i
Corporate Authorization ii
Table of Contents iii
1.0 Introduction 5
1.1 Study Background 5
1.2 Objectives 5
1.3 Scope 6
1.4 Study Area 6
1.4.1 Location 6
2.0 Data Review 8
2.1 Data Collection 8
2.1.1 Topographic Data 8
2.1.2 Plans, Reports, & Manuals 8
2.1.3 Design Standards & Guidelines 8
2.1.4 Effluent Flow Volumes 8
2.1.5 Wastewater Characterization 9
2.2 Regulatory 10
2.2.1 General 10
2.2.2 Regulatory Review 10
2.2.3 Treated Effluent Quality 10
2.3 Permits & Approvals 10
2.3.1 WSA – Permit to Construct 11
2.3.2 Aquatic Habitat and Protection Permit 11
2.3.3 Fisheries Act and Species at Risk Act Requirements 11
2.3.4 Navigable Waters Protection Act 11
3.0 Disposal Strategy 12
3.1 General 12
3.2 Disposal Alternatives 14
3.2.1 Alternative 1: Overland Discharge off ERPM Property 14
3.2.2 Alternative 2: Effluent Irrigation on ERPM Property 16
3.2.3 Alternative 3: Direct Discharge to the South Saskatchewan River 18
3.3 Preliminary Design Review 20
3.3.1 Proposed Underground Work 20
3.4 Construction Logistics 22
3.4.1 Schedule 22
3.5 Capital Cost Estimate 22
4.0 Downstream Use & Impact 23
4.1 Introduction 23
4.2 Methodology 23
4.3 Receiving Waterbody Characteristics 23
4.3.1 Surface Water 23
4.3.2 Flow Characteristics 24
4.3.3 Background Water Quality 24
4.3.4 Fish and Fish Habitat 28
4.4 Water Quality Assessment 28
4.4.1 General 28
4.4.2 Effluent Limit Assessment 28
4.4.3 Receiving Environment Mass Balance 28
4.4.4 Wastewater Treatment Technology 30
4.4.5 Recommended End-of-Pipe Limits 31
4.4.6 Mixing Zone Analysis 32

4.4.7 Expected Treatment System Performance 39
4.4.8 Recommended Water Quality Monitoring 40
5.0 Conclusions & Recommendations 41
5.1 Conclusions 41
5.2 General Recommendations 41
6.0 References 42
Appendix A – Cost Estimate
Appendix B – Receiving Environment Quality Analysis

List of Figures

Figure 1.4.1 – Location Plan 7
Figure 3.1 – Proposed Development Phasing 13
Figure 3.2.1 – Anticipated Overland Discharge Path 15
Figure 3.2.2 – Effluent Irrigation Disposal System 17
Figure 3.2.2 – Forcemain Alignment and Outlet Location 19
Figure 3.3.1.4 – Conceptual Plan and Profile 21
Figure 4.3.3 – Grasswood Development Sample Locations 26
Figure 4.4.6.3.1 – South Saskatchewan River Projected BOD5 Near Field Effluent Excess Concentration 33
Figure 4.4.6.3.2 – South Saskatchewan River Projected CBOD5 Effluent Plume 34
Figure 4.4.6.3.3 – South Saskatchewan River Projected Winter TAN Near Field Effluent Excess Concentration 35
Figure 4.4.6.3.4 – South Saskatchewan River Projected Summer TAN Near Field Effluent Excess Concentration 35
Figure 4.4.6.3.5 – South Saskatchewan River Projected Winter TAN Near Field Effluent Excess Concentration 36
Figure 4.4.6.3.6 – South Saskatchewan River Projected Summer TAN Near Field Effluent Excess Concentration 36
Figure 4.4.6.3.7 – South Saskatchewan River Concentration Excess vs. Downstream Distance Near Field Region 37
Figure 4.4.6.3.8 – South Saskatchewan River Concentration Excess vs. Downstream Distance Near Field Region 37
Figure 4.4.6.3.9 – South Saskatchewan River Concentration Excess vs. Downstream Distance Near Field Region 38
Figure 4.4.6.3.10 – South Saskatchewan River Concentration Excess vs. Downstream Distance Near Field Region 38

List of Tables

Table 2.1.4 – ERPM WWTF Influent Design Flows 8
Table 2.1.5 – Typical Composition of Raw Domestic Wastewater (Metcalf & Eddy) Quality Station Summary 9
Table 2.1.5.2 – Process Models 10
Table 3.1 – ERPM Grasswood Development Phases 12
Table 3.5 –Grasswood Disposal Pipeline Cost Estimate 22
Table 4.3.2.1 – Hydrometric Station Summary 24
Table 4.3.2.2 – South Saskatchewan River Flows 24
Table 4.3.3.1 – Water Quality Sampling Locations 25
Table 4.3.3.2 – Background Concentration 27
Table 4.4.3.1 – Effluent Discharge Scenarios 29
Table 4.4.3.2 – Mass Balance Analysis – Available Assimilation Capacity 30
Table 4.4.4.1 – Treated Effluent Quality Standards 30
Table 4.4.5 – Recommended End-of-Pipe Limits 31
Table 4.4.6.2 – CORMIX Input Summary 33
Table 4.4.7 – Expected Concentrations During Normal Operation 39

1.0 Introduction

1.1 Study Background

English River Property Management (ERPM) intends to upgrade its existing wastewater treatment system, currently consisting of a small mound treatment system. The intent of the upgrades is to enable the facility to service an expanded commercial and industrial development within the Grasswood Reserve, with the potential to serve as a regional wastewater treatment system in the future. Based on the *Wastewater Treatment Facility – Design Basis Memorandum; MPE Engineering; 2020*, the proposed treatment facility would consist of a Membrane Bioreactor (MBR) mechanical treatment system.

Various disposal methods have previously been considered at a high level for the treated effluent including the following:

- Connection to the City of Saskatoon (COS) sanitary collection system.
- Connection to the COS stormwater collection system.
- Disposal via effluent irrigation within ERPM property.
- Disposal via overland drainage ditches.

The purpose of the study is to review and compare potential disposal methods and provide a recommended discharge method for the treated effluent. Based on discussion with ERPM representatives, the preferred effluent disposal methods that will be considered are as follows:

- Option 1: Overland discharge off ERPM property.
- Option 2: Effluent irrigation on ERPM property.
- Option 3: Direct discharge to the South Saskatchewan River (the River).

All three (3) discharge configurations will be assessed as part of the Study. A Downstream Use & Impact Study (DUIS) section will also be included to assess the potential downstream impact of the recommended disposal method.

1.2 Objectives

The primary objective of this report is to review potential discharge alternatives and provide a recommended configuration to apply to the new WWTF. A conceptual design will be provided for the recommended disposal configuration.

Additionally, the DUIS portion of the study will assess potential downstream impacts of the treated effluent and provide recommended mitigation measures. This includes assessing the assimilation capacity of the receiving waterbody, identifying potential impacts of the treated effluent, and confirming that no adverse impacts will result with the continued discharge of treated effluent. Additionally, the report will recommend end-of-pipe limits for the regulation of the WWTF discharge.

A detailed breakdown of the objectives is as follows:

- Review historical flows for the River near Saskatoon.
- Characterize background water quality in the River.
- Determine assimilation capacity of the River.
- Review projected WWTF effluent quality.
- Determine the size and characteristics of the mixing zone at the WWTF outfall to the River.
- Review current and projected sewage effluent discharge flows based on information in the *Wastewater Treatment Facility – Design Basis Memorandum; MPE Engineering; 2020.*

- Review applicable effluent quality standards.
- Review applicable surface water quality objectives.
- Develop water quality objectives for parameters in which none currently exist.
- Assess the impact the effluent will have on the receiving water bodies.
- Provide recommendations for allowable effluent quality, discharge rates, and discharge timing.
- Review the report with the Water Security Agency (WSA) and incorporate comments into final report.
- Generate site-specific water quality objectives and recommend end-of-pipe limits for the WWTF effluent to ensure the receiving water quality is not impacted.

1.3 Scope

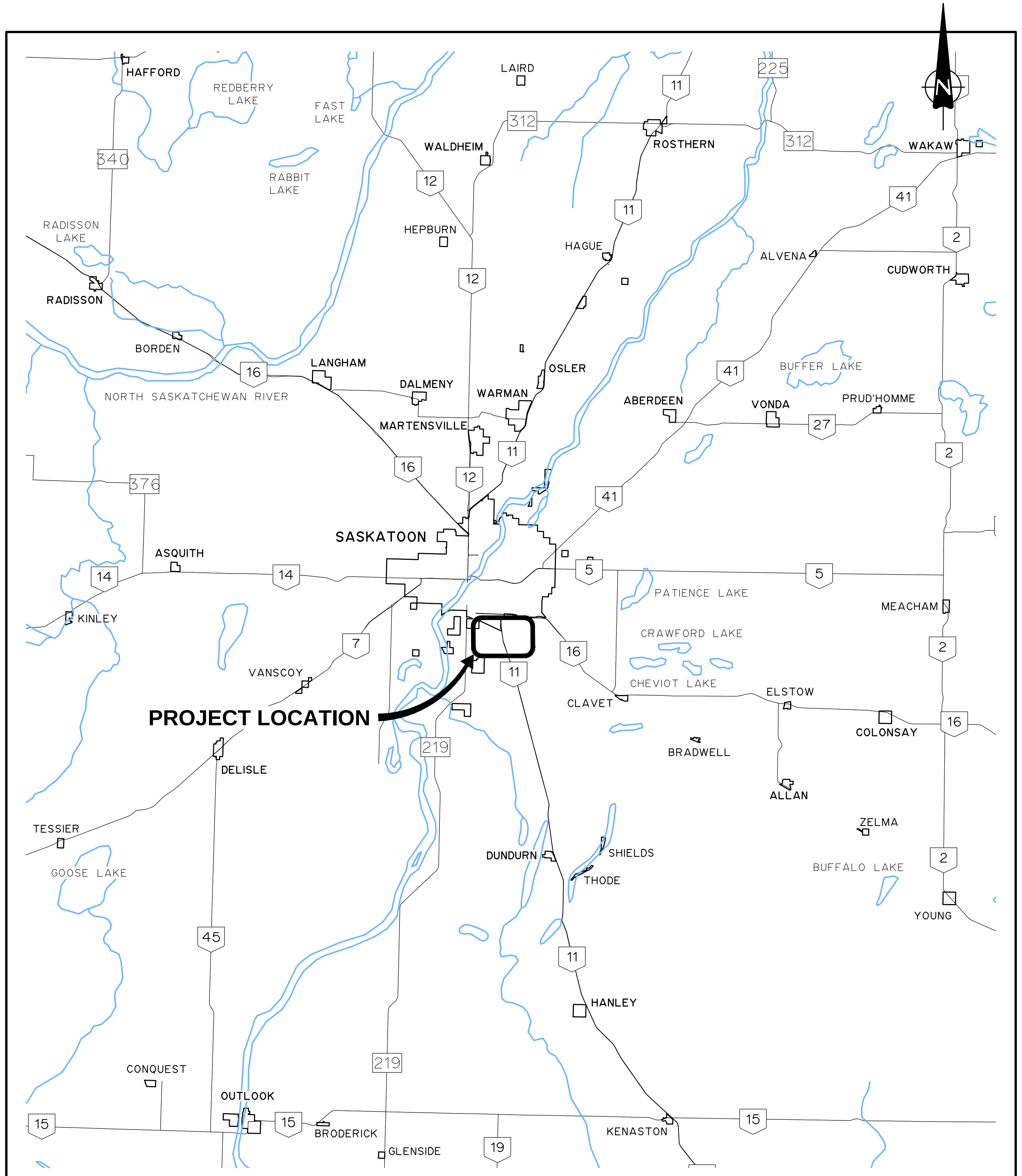
The scope of this study includes the following:

- Collect and review previous relevant studies and assessments.
- Review current and projected sewage effluent discharge flows based on information in the *Wastewater Treatment Facility – Design Basis Memorandum; MPE Engineering; 2020.*
- Review potential disposal methods for treated effluent.
- Complete the conceptual design for the recommended discharge method
- Review the federal and provincial regulatory requirements for effluent discharge and surface water quality.
- Evaluate wastewater characteristics from recorded analytical results.
- Review historical water quality in receiving waterbody.
- Undertake a receiving water quality assessment to determine the effluent requirements and recommend end-of-pipe limits and/or discharge procedures.
- Complete mixing zone modelling in the receiving waterbody to determine the special extent of treated effluent plume.

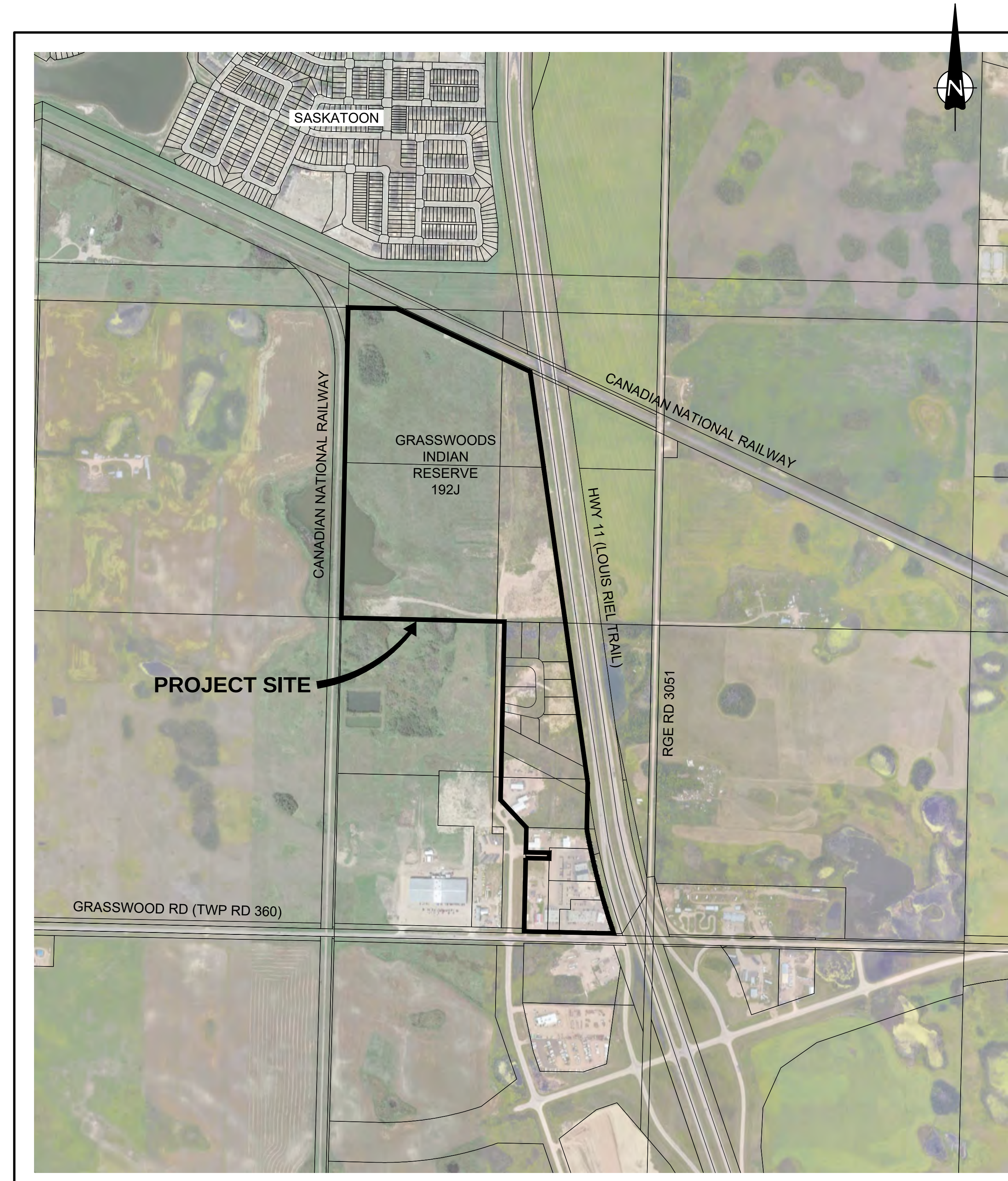
1.4 Study Area

1.4.1 Location

The ERPM commercial development is located directly adjacent to the southern COS city limit on the west side of Highway 11. The proposed wastewater treatment facility is located near the centre of the ERPM parcel. Figure 1.4.1 is a location plan of the proposed WWTF system.



LOCATION PLAN
1:750 000



SITE PLAN
1:15 000

MPE Engineering Ltd.	ENGLISH RIVER PROPERTY MANAGEMENT
	WWTF - EFFLUENT DISPOSAL STUDY LOCATION PLAN

SCALE: AS SHOWN	DATE: NOVEMBER 2020	JOB: 7603-003-00	FIGURE: 1.4.1

2.0 Data Review

2.1 Data Collection

2.1.1 Topographic Data

Existing cadastral, air photo, and topographical mapping were obtained and used for delineation purposes.

2.1.2 Plans, Reports, & Manuals

The following data, plans, reports, and manuals were compiled and reviewed to complete this report:

- English River Property Management – Wastewater Treatment Facility; Design Basis Memorandum; MPE Engineering; 2020
- Grasswood Development – Wastewater Treatment and Disposal Feasibility; Urban Systems; 2019
- Grasswood Reserve Development Project – Conceptual Servicing Plan; Urban systems; 2019

2.1.3 Design Standards & Guidelines

MPE has prepared this report in accordance to the following standards and guidelines as a minimum:

- Water Security Agency, The Waterworks and Sewage Works Regulations, 2015
- Water Security Agency, The Environmental Management and Protection Act, 2010
- Water Security Agency, Sewage Works Design Standard (EPB 503), 2015
- Water Security Agency, Surface Water Quality Objectives (EPB 356); 2015
- Environment Canada, Wastewater Systems Effluent Regulations SOR/2012-139
- Canadian Council of Ministers of the Environment; Canadian Environmental Quality Guidelines; 2007
- Canada Wide Strategy for the Management of Municipal Wastewater Effluent; Canadian Council of Ministers of the Environment; 2009
- Water Quality Based Effluent Limits Procedures Manual; Alberta Environmental Protection; 1995
- Guidance for Deriving Site-Specific Water Quality Objectives for Alberta Rivers; Alberta Environment and Water; 2012
- Environmental Quality Guidelines for Alberta Surface Waters; Alberta Environment and Sustainable Resource Development; 2018
- Guidance Manual for Developing Nutrient Guidelines for Rivers and Streams; Canadian Council of Ministers of the Environment; 2016
- Quality Criteria for Water (Gold Book); EPA; 1986
- Mixing Zone and Dilution Implementation Procedures; EPA Department of Environment and Natural Resources; 1998

2.1.4 Effluent Flow Volumes

Current and projected effluent flow volumes were generated and summarized in the *ERPM Wastewater Treatment Facility – Design Basis Memorandum; MPE Engineering; 2020*. Discharge flows are summarized in Table 2.1.4.

Table 2.1.4 - ERPM WWTF Influent Design Flows

Paramenter	Avg Dry Weather Flow	Infiltration / Inflow	Avg Wet Weather Flow	Avg Day Flow	Max Month Flow	Max Day Flow	Peak Dry Weather Flow (PDWF)	Peak Hour Flow
	m^3/d	m^3/d	m^3/d	m^3/d	m^3/d	m^3/d	m^3/d	m^3/d
Peaking Factor	-	-	ADWF + I/I	(ADWF + AWWF)/2	1.5 x ADF	2.0 x ADF	5.0 x ADWF	PDWF + I/I
Initial/Current	154	68	222	188	282	376	769	837
Future MBR Expansion	240	96	336	288	432	576	1199	1295

2.1.5 Wastewater Characterization

The mixture of wastewater coming into the proposed MBR will be expected to be of high strength. Table 2.1.5.1 presents the typical documented raw wastewater ranges retrieved from Metcalf and Eddy.

Table 2.1.5.1 - Typical Composition of Raw Domestic Wastewater (Metcalf & Eddy)				
Constituent	**Unit**	**Concentration**		
		Low	**Medium**	**High**
Total Solids (TS)	mg/L	537	806	1612
Total Disolved Solids (TDS)	mg/L	374	560	1121
Total Suspended Solids (TSS)	mg/L	130	195	389
Biological Oxygen Demand (BOD5)	mg/L	133	200	400
Total Organic Carbo (TOC)	mg/L	109	164	328
Chemical Oxygen Demand	mg/L	339	508	1016
Total Nitrogen (TN)	mg/L	23	35	69
Organic	mg/L	10	14	29
Free Ammonia	mg/L	14	20	41
Total Phosphorus (TP)	mg/L	3.7	5.6	11
Potassium	mg/L	11	16	32
Chlorides	mg/L	39	59	118
Sulfate	mg/L	24	36	72
Oil and Grease	mg/L	51	76	153
Volatile Organic Compounds (VOCs)	µg/L	< 100	100-400	>400
Total Coliform	mg/L	10^6-10^8	10^7-10^9	10^7-10^{10}
Fecal Coliform	mg/L	10^3-10^5	10^4-10^6	10^5-10^8

The medium and high concentrations presented in Table 2.1.5 shall be utilized as the basis for designing the MBR treatment system.

Other parameters that are unknown shall be assumed as follows:

- Temperature: typical design temperatures used are the lowest temperatures expected during the winter months. A temperature of 9° Celsius shall be used.
- Alkalinity: Alkalinity is important for biological nitrification processes and shall be assumed at 200 mg/L for this project. This value is typical for domestic wastewater and will be a good starting point. Provisions for alkalinity addition shall be included in the design.
- pH: pH for industrial and commercial wastewater can vary.
- Volatile Suspended Solids (VSS): the ratio of VSS/TSS is critical to the biological design process and shall be assumed to be 0.75, which is typical for wastewater.

The following influent wastewater flow and effluent have been assumed and are presented in Table 2.1.5.2.

Table 2.1.5.2: Process Models

Scenario	Flow		Influent Parameters							Operating Parameters	Effluent Parameters					
			BOD	TSS	TKN	NH_3-N	COD	TP	Temp	MLSS	BOD	TSS	F/T Coliform	NH_3-N	NO_3	E. Coli
	m^3/d	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	C	mg/L	mg/L	mg/L	MPN/100 mL	mg/L	mg/L	MPN/100 mL
Stage 1 (Phase 1, 3 & 4 Industrial Development)																
ADF	188	2.2	350	350	70	41	1016	11	9	8000	≤ 5	≤ 5	≤ 200	≤ 1	≤ 10	≤ 1
MMF	282	3.3	250	250	34	20	508	5.6	9	8000	≤ 5	≤ 5	≤ 200	≤ 1	≤ 10	≤ 1
MDF	376	4.3	200	200	34	20	508	5.6	9	8000	≤ 5	≤ 5	≤ 200	≤ 1	≤ 10	≤ 1
PHF	837	9.7														
Stage 2 (Phase 2 Industrial Development)																
ADF	288	3.3	350	350	70	41	1016	11	9	10000	≤ 5	≤ 5	≤ 200	≤ 1	≤ 10	≤ 1
MMF	432	5.0	250	250	34	20	508	5.6	9	10000	≤ 5	≤ 5	≤ 200	≤ 1	≤ 10	≤ 1
MDF	576	6.7	200	200	34	20	508	5.6	9	10000	≤ 5	≤ 5	≤ 200	≤ 1	≤ 10	≤ 1
PHF	1295	15.0														

The parameters of concern for which end-of-pipe limits will be generated are as follows:

- Biochemical Oxygen Demand (BOD_5).
- Total Phosphorus.
- TSS.
- Total Ammonia – N.
- Fecal Coliform.

2.2 Regulatory

2.2.1 General

The performance requirements of the proposed WWTF will be determined by the regulatory requirements of the provincial and federal governments. Regulatory performance requirements were determined and established in the conceptual design and technology review phase of the project. Results of the assessment will be used to establish end-of-pipe limits for the proposed WWTF. The following section reviews, confirms, and builds upon the regulatory requirements established during the conceptual design phase.

2.2.2 Regulatory Review

The wastewater treatment system for the Grasswood development will be regulated by the Water Security Agency (WSA) through the application of two separate pieces of legislation, *The Environmental Management and Protection Act, 2010*, and *The Waterworks and Sewage Works Regulations, 2015*. In addition, the *EPB 356 Surface Water Quality Guidelines; WSA; 2015,* should be consulted when designing a wastewater treatment system. When applied to municipal wastewater systems, *The Environmental Management and Protection Act, 2010,* and *The Waterworks and Sewage Works Regulations, 2015,* are concerned primarily with final effluent quality performance and facility operation. The requirements for facility performance and operation are dictated by the *Permit to Operate a Sewage Works*.

2.2.3 Treated Effluent Quality

Federal wastewater effluent quality standards were enforced on January 1st, 2015, under the *Department of Fisheries and Oceans, Fisheries Act, Wastewater System Effluent Regulations (WSER).* These regulations are a combination of discussions by Canadian Council of Ministers of the Environment (CCME) since 2009 and put in place stringent limits on carbonaceous biological oxygen demand (CBOD), TSS, and un-ionized ammonia-nitrogen (NH3-N) released by both intermittent and continuous discharging wastewater treatment systems.

2.3 Permits & Approvals

The following summarizes all necessary permits and approvals required to successfully complete this project:

2.3.1 WSA – Permit to Construct

The WSA requires all work to existing or proposed water and wastewater systems to obtain a Permit to Construct. This will be obtained prior to proceeding to the tendering phase of the project.

2.3.2 Aquatic Habitat and Protection Permit

Under the *Environmental Management and Protection Act* (EMPA) and *The Water Regulations*, the WSA is responsible for the *Aquatic Habitat Protection Permit* (AHPP). The AHPP reviews aquatic habitat alterations and is concerned for the protection of aquatic ecosystems. This includes the protection of aquatic habitats, aquatic organisms, water cycles, and shoreline stability.

2.3.3 Fisheries Act and Species at Risk Act Requirements

Under the Department of Fisheries & Oceans' (DFO's) *Fish Habitat Management Program*, a project proposal is to be submitted to the DFO for review in order to perform work in any Canadian fisheries waters. The project proposal will be reviewed under the *Fisheries Act and Species at Risk Act* to determine whether the work will have impacts to fish and fish habitats.

2.3.4 Navigable Waters Protection Act

Transit Canada is responsible for the administration of the Navigable Waters Protection Act (NWPA) through the Navigable Waters Protection Program. NWPA applies to any intrusion that is in, on, over, under, though or across any Canadian navigable body of water. A navigable water is defined as any body of water that you can travel on by any type of floating vessel for transportation, recreation or commerce.

An Approval is required under NWPA for anyone that plans on constructing or modifying a work in, on, over, under, through or across any navigable waterway. This includes:

- Any man-made structure, device or thing (temporary or permanent)
- Any dumping of fill in navigable water, and
- Any excavation of materials from the bed of any navigable water.

ERPM would require an Approval under NWPA in order to construct an outfall to the South Saskatchewan River.

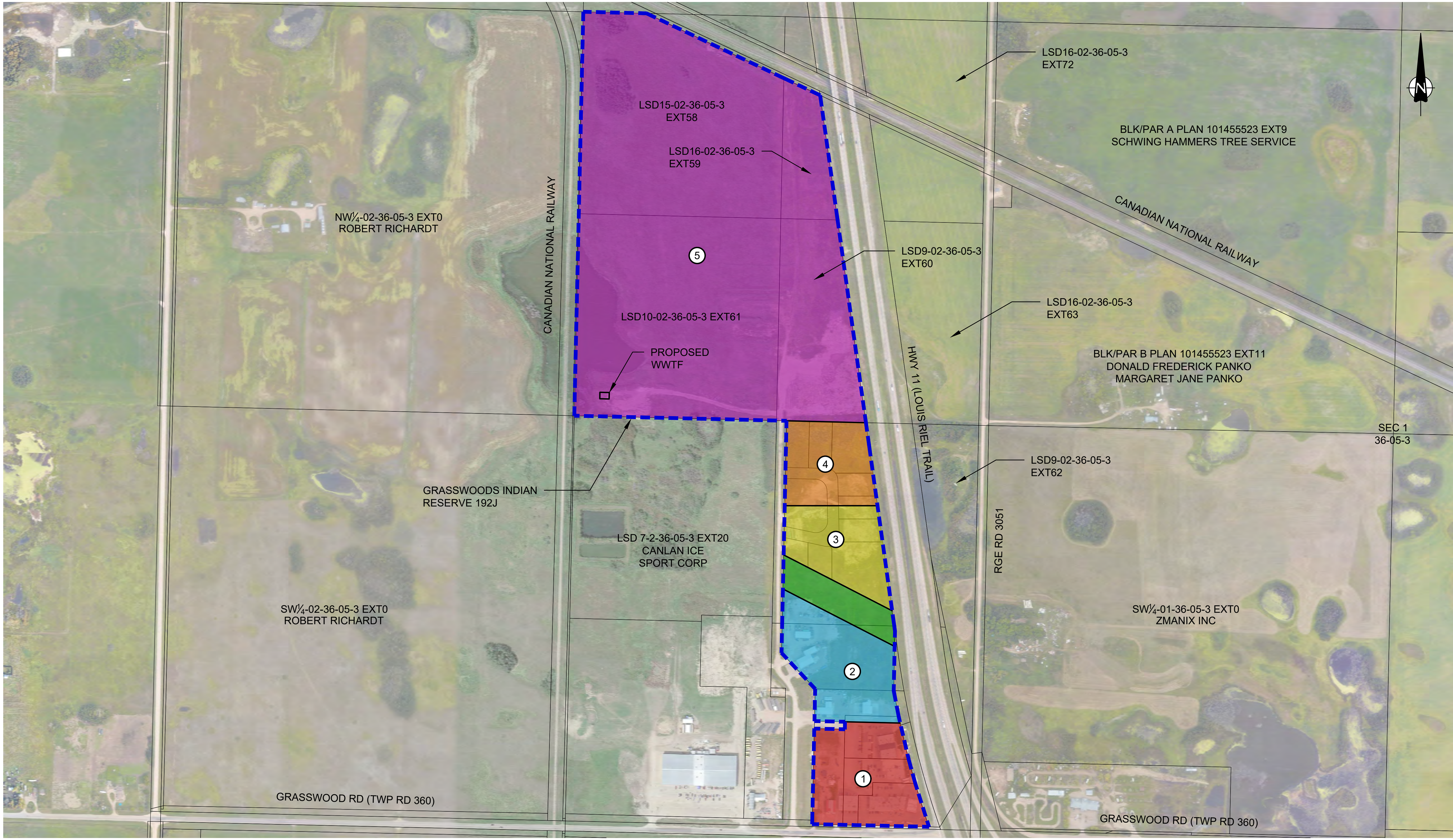
3.0 Disposal Strategy

3.1 General

The proposed Grasswood development is divided into five (5) phases. The proposed WWTF will be used to service Phases 1-4, with Phase 5 being serviced via septic tanks due to the low, spread out sanitary loading. The proposed developments are summarized in Table 3.1.

Table 3.1 - ERPM Grasswood Development Phases			
Phase	Development Area		Developments
	(ha)	(ac)	
1	4.02	9.9	1,860 m^2 office
			3,716 m^2 office
			279 m^2 quick service restaurant
2	4.02	9.9	418 m^2 sit-down restaurant
			100 room hotel
			4-sheet ice arena
3	2.98	7.4	Small lot industrial development
4	2.90	7.2	Small lot industrial development
5	31.95	79	Large lot "Dry Industrial"

Figure 3.1 illustrates the proposed development phasing as well as location of the proposed WWTF.



LEGEND:

PHASING AREA 1:	4.02ha
PHASING AREA 2:	4.03ha
PHASING AREA 3:	3.01ha
PHASING AREA 4:	2.87ha
PHASING AREA 5:	39.04ha

MPE Engineering Ltd.

ENGLISH RIVER PROPERTY MANAGEMENT

WWTF - EFFLUENT DISPOSAL STUDY
GRASSWOODS DEVELOPMENT
CONCEPTUAL PHASING PLAN

SCALE: 1:7500	DATE: NOVEMBER 2020	JOB: 7603-003-00	FIGURE: 3.1

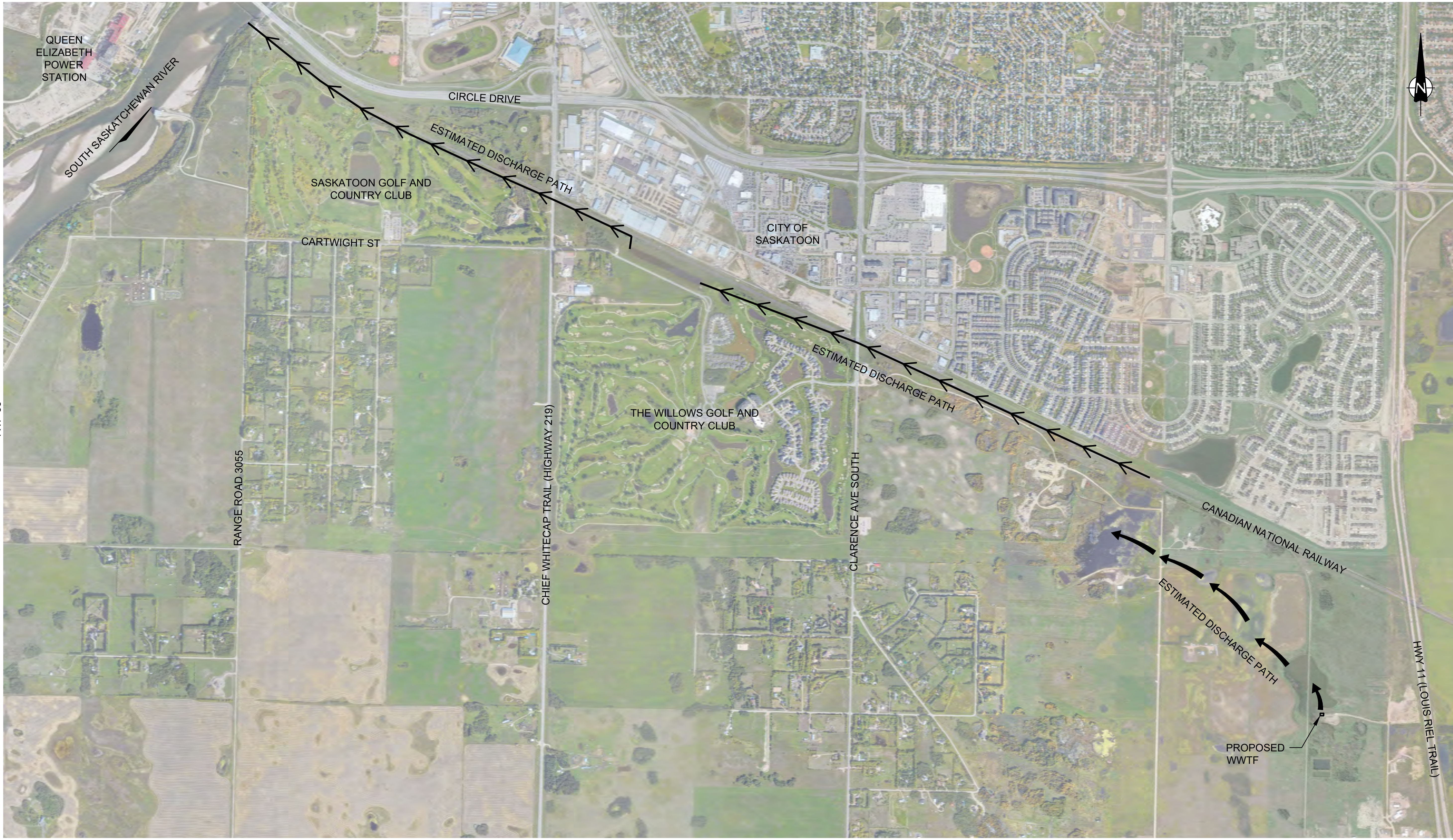
3.2 Disposal Alternatives

The proposed WWTF consists of an MBR system that would continuously discharge treated effluent to a holding cell located adjacent to the facility. The holding cell would be used for equalization storage during periods of time when a discharge is unable to occur. Three (3) preferred disposal alternatives were generated and have been reviewed to determine the most feasible long-term solution for disposal of the treated MBR effluent. Previous studies considered disposing treated effluent to the stormwater collection system or sanitary collection system owned and operated by COS. These alternatives consisted of pumped forcemains over 10 km in length which would have significant capital and operation costs, as well as uncertainty of gaining approvals from COS. For these reasons, only the following alternatives were considered:

1. Overland Discharge off ERPM Property.
2. Effluent Irrigation on ERPM Property.
3. Direct Discharge to the South Saskatchewan River.

3.2.1 Alternative 1: Overland Discharge off ERPM Property

Alternative 1 consists of the intermittent release of treated effluent from the proposed holding cell. The holding cell would discharge continuously via overflow during the summer months and retain effluent during the winter months. Effluent would be directed to the northwest and follow the natural drainage route. The discharge path would need to be confirmed with survey data; however, it is anticipated that the effluent would proceed in a westward direction. Several sloughs are located downstream of the Grasswood development; these sloughs would likely fill significantly unless additional drainage works are constructed. Furthermore, several acreage developments, as well as The Willows Golf & Country Club, are located between the Grasswood development and the River, potentially making it difficult to secure approvals and land control for a discharge path. Figure 3.2.1 illustrates the anticipated overland discharge path.



MPE Engineering Ltd.

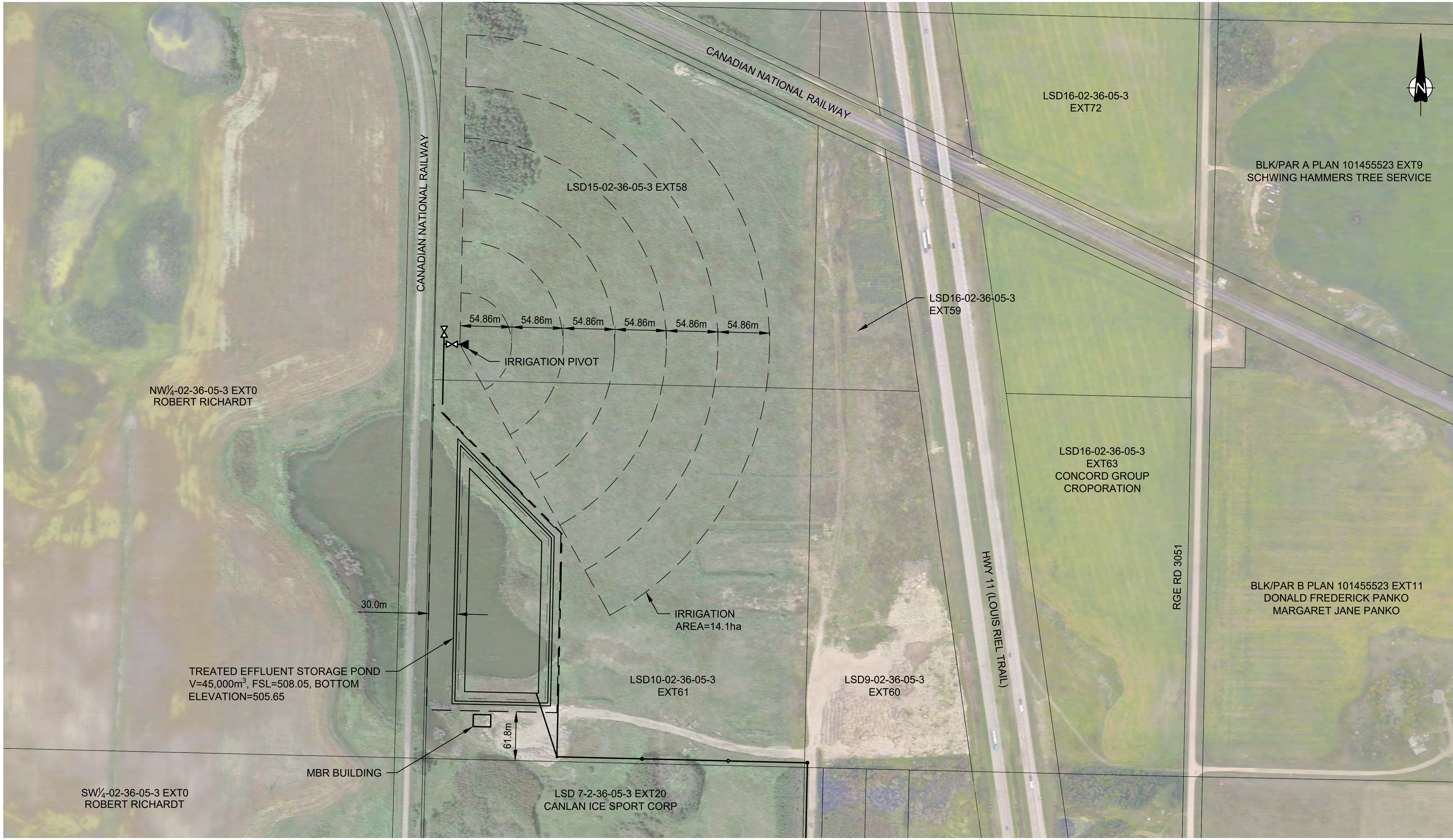
ENGLISH RIVER PROPERTY MANAGEMENT

WWTF - EFFLUENT DISPOSAL STUDY
ALTERNATIVE 1 - OVERLAND DISCHARGE

SCALE: 1:20 000	DATE: NOVEMBER 2020	JOB: 7603-003-00	FIGURE: 3.2.1

3.2.2 Alternative 2: Effluent Irrigation on ERPM Property

Alternative 2 consist of the disposal of treated effluent over the land parcel currently designated for Phase 5 of the development. Under this scenario, the future Phase 5 stormwater pond would be utilized as treated effluent storage for a pivot installed on the phase 5 land parcel. The effluent irrigation would be designed to service the Phase 1, 3, and 4 developments, with discharge to the River to be investigated prior to developing Phase 5. This alternative would serve as a temporary discharge method until all phases of the development have been completed. Additionally, it would require capital investment into effluent irrigation infrastructure that would serve a limited time period. Based on discussions with ERPM, there is significant interest in developing Phase 5 sooner than originally anticipated, which would require the ultimate river disposal plan to be expedited. Figure 3.2.2 illustrates the effluent irrigation disposal system.



MPE Engineering Ltd.		ENGLISH RIVER PROPERTY MANAGEMENT
		WWTF - EFFLUENT DISPOSAL STUDY ALTERNATIVE 2 - EFFLUENT IRRIGATION
SCALE: 1:4000	DATE: NOVEMBER 2020	JOB: 7603-003-00 / FIGURE: 3.2.2

3.2.3 Alternative 3: Direct Discharge to the South Saskatchewan River

The third discharge alternative involves constructing a forcemain and pumping system to convey treated effluent from the proposed MBR treatment system to the River. It is expected that a pump station would be constructed with the proposed stormwater pond used as an emergency overflow. The forcemain alignment could be constructed along the existing road allowances between the Grasswood development and River. Figure 3.2.3 illustrates the forcemain alignment and outlet location.

This alternative would avoid the potential issues of overland disposal across private land and would also eventually be required with the second alternative, effluent irrigation. However, a DUIS would be required and several permits obtained to have the outlet construction and disposal location approved by WSA. Based on the proposed development timeline and feasibility, it is recommended that this disposal alternative be adopted for the Grasswood development WWTF. It is recommended that a geotechnical investigation be completed along the alignment to confirm the feasibility of the proposed alignment and installation methods based on the sub surface conditions.

MPE Engineering Ltd.

ENGLISH RIVER PROPERTY MANAGEMENT

WWTF - EFFLUENT DISPOSAL STUDY
ALTERNATIVE 3 - DISCHARGE TO SOUTH SASKATCHEWAN RIVER

SCALE: 1:25 000	DATE: NOVEMBER 2020	JOB: 7603-003-00	FIGURE: 3.2.3

3.3 Preliminary Design Review

For the purpose of this report, an effluent pump station is expected to be constructed as part of the WWTF. The following upgrades will be required for the effluent disposal project.

3.3.1 Proposed Underground Work

In addition to construction of the effluent pumping system, the following additional underground work is recommended:

- Construction of a 6,300 m HDPE forcemain, 250 mm in diameter, between the pumping station and an intermediate manhole.
- Construction of a transition manhole between the forcemain and gravity discharge line.
- Construction of a 2,400 m HDPE gravity discharge line, 300 mm in diameter, between the transition manhole and the proposed outlet along the River.

3.3.1.1 Effluent Forcemain

A 6,300 m long 250 mm HDPE DR 11 forcemain is required to connect the effluent pumping system to the transition manhole. The proposed alignment extends east, then south in the ditch to Grasswood road approximately 500 m, then proceeds east approximately 6,800 m, and discharges into the intermediate manhole. The intent would be to have the 250 mm forcemain installed via directional drilling, or narrow trench ploughed.

3.3.1.2 Transition Manhole

The new 1800 mm concrete manhole is recommended to be installed along at the end of the proposed forcemain, upstream of the proposed gravity line. The purpose of the manhole is to transition between the pressurized forcemain and gravity line downstream. The manhole will be fitted with venting piping to vent the downstream gravity line to avoid creation of a vacuum and/or slug flow in the gravity pipeline. The manhole invert will be set even with both the forcemain outlet and gravity line inlet.

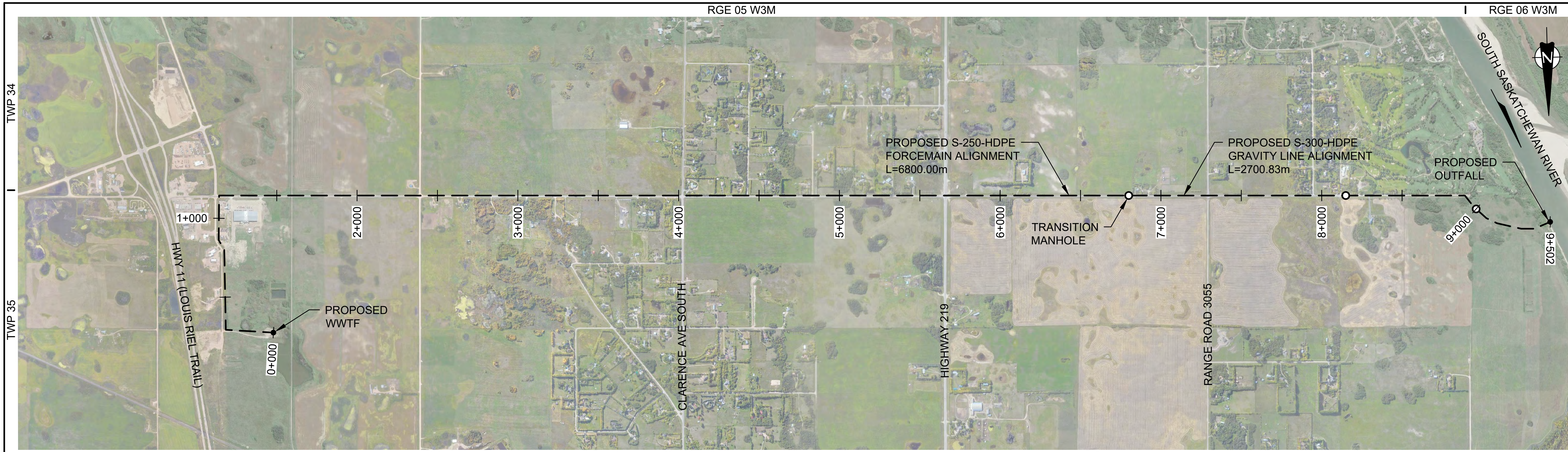
3.3.1.3 Effluent Gravity Line

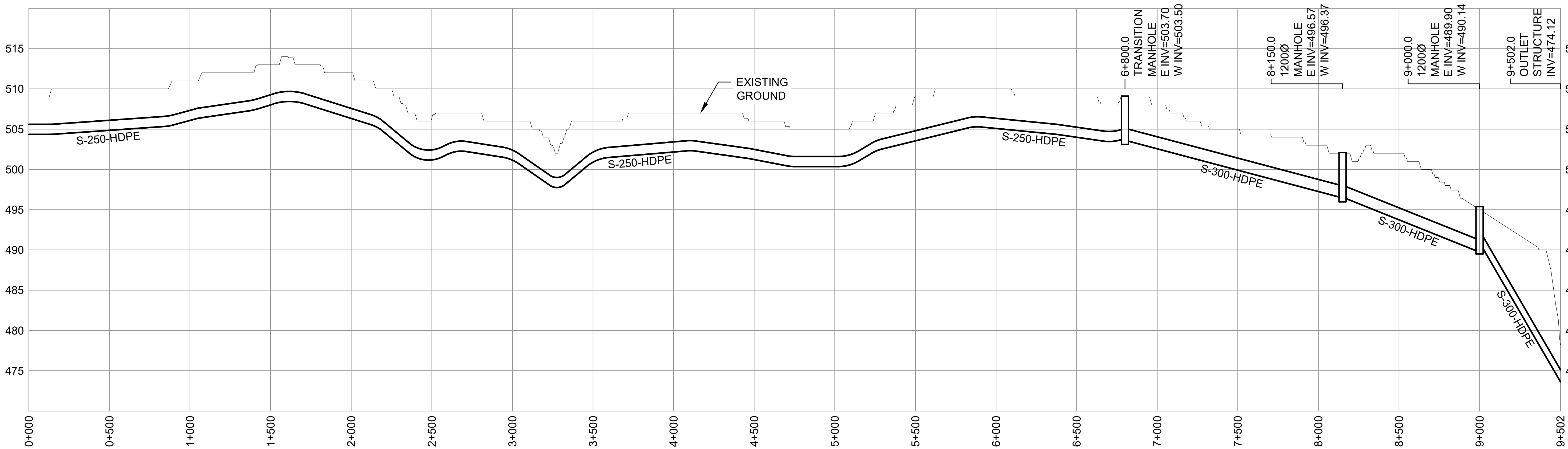
The topography between the transition manhole and the outfall declines consistently and is suitable to flow via gravity. It is recommended that a 300 mm HDPE DR11 gravity line 1,400 m in length be constructed via directional drilling between the transition manhole and outfall. Two (2) additional manholes are recommended to be installed along the alignment at grade change locations.

3.3.1.4 Outfall

A concrete outfall structure is proposed to be installed at the discharge location to the River. The proposed outfall would consist of a precast concrete headwall fitted with an energy dissipation baffle to reduce erosion due to effluent discharge.

Figure 3.3.1.4 depicts the conceptual plan/profile and illustrates all major work to be completed.





MPE Engineering Ltd.

ENGLISH RIVER PROPERTY MANAGEMENT

WWTF - EFFLUENT DISPOSAL STUDY
CONCEPTUAL DISCHARGE PIPING

SCALE: H 1:25000 V 1:100	DATE: NOVEMBER 2020	JOB: 7603-003-00	FIGURE: 3.3.1.4

3.4 Construction Logistics

Construction of the piping and outfall should not have an impact on the construction of the proposed WWTF and construction can proceed in conjunction with the facility. Connections will need to be coordinated during construction.

3.4.1 Schedule

Pipeline work can likely begin at any time during the construction season. It is expected that the forcemain between the WWTF and transition manhole would be installed via directional drilling. It is also anticipated that the gravity line between the transition manhole and outfall would also be installed via directional drilling. Excavations would be required for the transition manhole as well as the additional two (2) manholes along the gravity line and outlet structure. Installation of the outlet structure would need to occur within the regulatory window determined by WSA, which is typically after July 1. Late summer or fall installations would also be favorable due to low river flows.

4.0 Downstream Use & Impact

4.1 Introduction

The proposed method of disposal from the Grasswood development is direct discharge to the River. Since the River is fish bearing and is a major source of water in Western Canada, a Downstream Use & Impact Study (DUIS) is required by WSA. The following sections fulfill the requirements of a DUIS. The DUIS will be completed following WSA regulations as well as Alberta Environment and Parks (AEP) regulations as required.

4.2 Methodology

The River has been designated as the receiving waterbody and will be used as the basis for determining the potential effects of the effluent constituents. To determine assimilation capacity, the following was completed:

- Determine River flow scenarios, including average and 7Q10 for winter and summer seasons.
- Using the existing background quality of the River, determine resultant constituent concentration based on regulated and expected effluent quality.
- Complete mass balance of inflows to determine estimated effluent constituent concentrations once fully mixed.
- Compare allowable effluent concentrations with AEP *Best Practicable Technology Standards* and utilize the more stringent value for the WWTF end-of-pipe limits.
- Complete the mixing zone model to determine the extent of the plume prior to complete mixing in the River.
- Utilize this model to confirm appropriate end-of-pipe limits.

4.3 Receiving Waterbody Characteristics

The River has been designated as the receiving watercourse for the treated effluent. The River begins at the confluence of the Red Deer River, Bow River, and Oldman River systems near the Alberta/Saskatchewan border. The River flows in a northeastern direction and eventually combines with the North Saskatchewan River to form the Saskatchewan River near Prince Albert, SK.

Based on the *South Saskatchewan River Watershed – Source Water Protection Plan; Sept 2007,* 2% of the flow through the Saskatchewan River is supplied from local runoff in Saskatchewan, half of which is supplied upstream from Swift current creek. Flow through the River is continuous throughout the year and is regulated at Gardiner Dam. Currently, WSA is required to allow a minimum flow of 42.5 m^3/sec through Gardiner Dam; although, seasonal fluctuations still exist during high flow periods.

4.3.1 Surface Water

Currently, the main downstream surface water user in the vicinity of the proposed outfall is the COS Water Treatment Plant (WTP) intake, located approximately 4.5 km downstream of the proposed outfall location on the opposite bank. The WTP is currently used to supply potable water to the COS as well as surrounding municipalities.

Potential surface water uses for the River are as follows:

- Municipal.
- Recreation.
- Irrigation.
- Aquatic Life.
- Livestock Watering.

4.3.2 Flow Characteristics

Several Water Survey of Canada (WSC) streamflow gauging stations exist or have existed along the Saskatchewan River system. Stations selected for analysis met the following criteria:

- Located along the South Saskatchewan River.
- Had continuous long term (greater than 30 years) streamflow records, including annual maximum instantaneous discharges and annual maximum daily discharges.
- Had continuous flow data after the construction of Gardiner Dam.

One (1) WSC station was deemed to have met all the criteria and will be used for the analysis. A summary of the selected WSC station is provided in Table 4.3.2.1.

Table 4.3.2.1 - Hydrometric Station Summary

Station	Station Name	Operation Span	Recorded Years	Drainage Area (km^2)	
				Gross	Effective
05HG001	South Saskatchewan River at Saskatoon	1911 - Present	109	141,000	88,100

This station was used to estimate annual unit discharge rates and flow characteristics for the River. Only years following construction of Gardiner Dam were used for the assessment.

The historical flow data was used to develop daily and 7-day average 10 year minimum (7Q10) and average flow values. Flows for the months spanning May to October were used to develop the flows for summer discharge scenarios and months spanning November to April were used for winter discharge scenarios. A summary of the generated river flows is presented in Table 4.3.2.2

Table 4.3.2.2 - South Saskatchewan River Flows

Flow Scenario	Summer (m^3/sec)	Winter (m^3/sec)
Daily		
1:100 Flow	3,052.4	-
1:25 Flow	1,713.8	-
1:10 Flow	1,134.1	-
1:5 Flow	805.7	-
1:2 Flow	470.3	-
Median Flow	142.0	237
Regulated Minimum Flow	42.5	42.5
7-Day Average Flows		
Median Flow	142.0	237.0
1:10 Year Minimum Flow	59.4	57.6

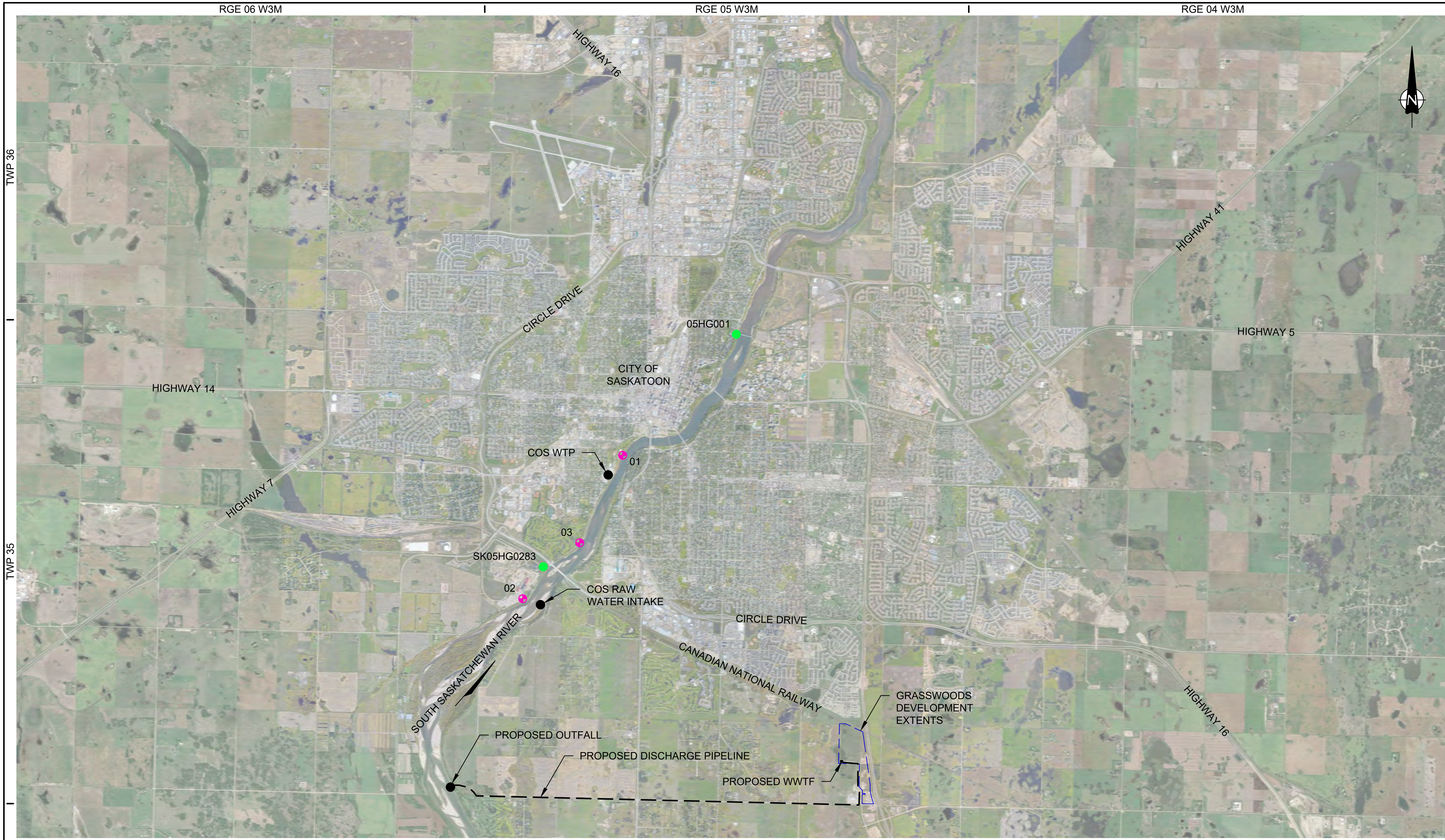
4.3.3 Background Water Quality

Historical water quality was available from a primary water quality station near Saskatoon, SK. To gain additional insight on the background chemical parameters of the watercourses, nine (9) field samples were taken at various locations along the River. Information on the stations is presented in Table 4.3.3.

Table 4.3.3.1 - Water Quality Sampling Locations

Station ID	Station Name	Proximity to Outfall	Parameter	No. of Historical Samples (2010-2020)	No. of Recent Samples (2019-2020)
SK05HG0283	South Saskatchewan River South of Saskatoon	Downstream	Water Quality	44	-
1	South Saskatchewan River @ Canoe Club	Downstream	Water Quality	-	3
2	South Saskatchewan River near QE Power Station	Downstream	Water Quality	-	3
3	South Saskatchewan River near Holiday Park	Downstream	Water Quality	-	3

Figure 4.3.3 shows the location of the sample locations in relation to the Grasswood development.



LEGEND

- WATER QUALITY SAMPLE LOCATION
- ENVIRONMENT CANADA HYDROMETRIC STATION
- DIRECTION OF FLOW

MPE Engineering Ltd.

ENGLISH RIVER PROPERTY MANAGEMENT		
WWTF - EFFLUENT DISPOSAL STUDY OVERALL SITE PLAN		
SCALE: 1:75 000	DATE: NOVEMBER 2020	JOB: 7603-003-00
FIGURE: 4.3.3		

The River and other various lakes located downstream are classified as fish bearing, recreational, and agricultural waterbodies. Sampling data for the receiving watercourses was used to determine the average background concentrations of the parameters of concern. The quality at each of the sampling locations generally had consistent quality parameters. Table 4.3.3.2 summarizes background concentrations in the River as compared to the instream guidelines as per WSA, CCME and the Prairie Provinces Water Board.

Table 4.3.3.2 - Background Concentrations

Parameter	Unit	South Saskatchewan River				Instream Guidelines								Reference 90%ile Objective	
						WSA		AEP				CCME	Best Industry Practices	Prairie Provinces Water Board: South Saskatchewan River - Highway #41 to Confluence with Red Deer River	
		Minimum	Maximum	Background Average	Background Median			Aquatic Life		Agriculture				Open Water	Ice Cover
						Irrigation	Livestock	Acute	Chronic	Irrigation	Livestock	Chronic			
Aluminum	ug/L	0.027	0.12	0.06	0.06	5000	5000	100	50	5	5				
Ammonia Total	mg/L	0.01	0.48	0.04	0.01				[2] 0.581/0.385			[2] 0.689/0.457			
Ammonia - Un-ionized	mg/L								0.016			0.019		0.019	0.019
Antimony	ug/L	0.00	0.00	<0.0002	<0.0002										
Arsenic Total	ug/L	0.05	5.2	0.97	0.90	0.1	0.025		0.005	0.16	0.025	0.005		0.005	0.005
Barium	ug/L	0.087	0.1	0.09	0.10									1000	1000
Beryllium	ug/L	<0.0001	<0.0001	<0.0001	<0.0001	100	100			100	100			100	100
Bicarbonate	mg/L	187	221	202.11	202.00										
Biochemical Oxygen Demand	mg/L	<3	<3	<3	<3								[1] 5		
Boron	ug/L	0.02	0.03	0.02	0.02	500-6000	5000	29000	1500	500	5000	29000		500	500
Cadmium	ug/L	0.00001	0.00003	0.00	0.00	5	80	0.37	7.7	8.2	80				
Calcium Dissolved	mg/L	45	52	47.56	47.00						1000				
Carbonate	mg/L	2	2	2.00	2.00										
Chloride Dissolved	mg/L	5.1	16	10.50	10.50	100-700		640	120	100-700		120		100	100
Chlorophyll A	mg/m3	0.66	19.14	4.48	3.46										
Chromium	ug/L	0	0	<0.0005	<0.0005	8	50		8.9			8.9		50	50
Cobalt	ug/L	0.0001	0.0006	0.00	0.00	50	1000		2.5	50	1000			50	50
Copper	ug/L	0.0011	0.0016	0.00	0.00	200-1000	500-5000	62		200	500	62			
Dissolved Oxygen	mg/L	7.25	12.59	9.79	9.63			> 5	> 6.5 - 9.5 [5]					5	3
Electrical Conductivity	µS/cm	0	0												
Escherichia Coli	MPN/100mL	1	1076	83.88	10.00	100				100				200	200
Fecal Coliforms	MPN/100 mL	1	46	17.00	14.00	100				100		100		100	100
Fluoride Dissolved	mg/L	0.07	0.17	0.14	0.15	1	1.5			1	1	0.12		0.19	0.19
Hardness	mg/L	178	208	189.44	187.00										
Hydroxide	mg/L	0	0	<1	<1										
Iron	mg/L	0.068	2.17	0.37	0.12	5	0		0.3	5		0.3		0.3	0.3
Nitrogen Total Kjeldahl	mg/L	0.1	1.4	0.28	0.21										
Lead	ug/L	0.0001	0.0004	0.00	0.00	200	100		7	200	100	7			
Lithium	ug/L	0	0			2500				2500				2500	2500
Magnesium Dissolved	mg/L	16	35	18.58	18.00										
Manganese	mg/L	0.013	0.089	0.03	0.03	0.20				0.2				0.05	0.05
Mercury	mg/L	0	0					0.0000013	0.000005		3			0.000026	0.000026
Molybdenum	ug/L	0.001	0.0016	0.00	0.00	10-50	500.00		73	10	500	73		10	10
Nickel	ug/L	0.0017	0.0026	0.00	0.00	200	1000	1520	170	200	1000	170			
Nitrate - N	mg/L	0.98	1.2	1.09	1.10			124	3					3	3
Nitrate and Nitrite - N	mg/L	0	0				0.1				100				
Nitrite - N	mg/L	0	0					0.6	0.2	10	10	0.06			
Nitrogen Total	mg/L	0.3	1.4	0.50	0.50									1.073	1.638
Organic Carbon	mg/L	0	0						100						
Orthophosphate-P	mg/L	0	0												
P-Alkalinity	mg/L	2	2	2.00	2.00										
pH (Lab)	pH units	7.6	8.6	8.36	8.40				6.5 - 9.0			6.5 - 9.0		6.5-9.0	6.5-9.0
pH (Field)	mg/L	0	0						6.5 - 9.0					6.5-9.0	6.5-9.0
Phosphorus Total	mg/L	0.005	0.23	0.02	0.01									0.159	0.054
Potassium Dissolved	mg/L	2	25	3.67	3.00										
Selenium	ug/L	0.0004	0.0005	0.00	0.00	20-50	50		1	20	50	1		1	1
Silicon	mg/L	0	0												
Silver	mg/L	0	0	<0.00005	<0.00005				0.1			0.25		0.0001	0.0001
Sodium	mg/L	23	29	26.11	26.00										
Sodium, Dissolved	mg/L	12	41	27.58	27.00									200	200
Solids, Total Suspended	mg/L	4	42	16.78	10.00				< Increase of 5					5.6-339.8	
Specific Conductance (Lab)	USIE/cm	401	697	487.63	480.50										
Strontium	mg/L	0.27	0.32	0.29	0.29										
Sulfate	mg/L	62	80	71.33	71.00		1				1000			250	250
Total Alkalinity	mg/L	157	181	166.67	166.00										
Temperature (Field)	°C	0.7	29.1	14.97	16.10										
Thallium	mg/L	0	0	<0.0002	<0.0002				0.8			0.8		0.0008	0.0008
Tin	mg/L	0	0	<0.0001	<0.0001										
Titanium	mg/L	0.0009	0.0042	0.00	0.00										
Total Coliforms	MPN/100 mL	62	3800	1122.00	475.00	1000									
Total Dissolved Solids	mg/L	252	594	367.36	375.27	.5-3.5	3			500 to 3500	3000			500	500
Turbidity	NTU	1.1	9	3.04	2.50				< Increase of 2						
Uranium	mg/L	1.1	1.4	1.24	1.20	0.01	0.2	33	15			15		0.01	0.01
Vanadium	mg/L	0.0002	0.0042	0.00	0.00	0.1	0.1							0.1	0.1
Zinc	ug/L	0.0007	0.0017	0.00	0.00	1000-5000	50000		30			30		30	30

As per the table above, there were no median parameter concentrations in the River found to exceed the instream guidelines.

4.3.3.1 Parameter Stratigraphy

The sampling program included sample locations at various distances downstream of the existing wastewater treatment system. The sample results from all locations showed very similar water quality, with no significant variation between sampled locations for the parameters of concern.

4.3.4 Fish and Fish Habitat

The River and corresponding downstream lakes are considered fish bearing waterbodies. Acute and chronic wastewater parameters for fish and other aquatic organisms will be considered within the mixing zone as well as in the resultant river quality.

4.4 Water Quality Assessment

4.4.1 General

The impact treated effluent will have on the River is governed by the flows present in the River, background quality of the receiving watercourse, quality of the sewage effluent, flow rate of the treated effluent, timing of the discharge. The assessment has been completed for the proposed MBR WWTF construction. The assessment was completed to ensure the proposed limits will not result in degradation of the receiving environment or have an adverse effect on the downstream water users.

4.4.2 Effluent Limit Assessment

Three (3) methods of assessment were utilized to generate effluent limits for the WWTF that will not result in further degradation of the receiving environment. They are as follows:

- Receiving System Mass Balance:
    - Used to assess available assimilation capacity of the receiving environment.
- Comparison to AEP Best Practicable Technology Standards & Advanced Technology Performance:
    - Used to compare receiving environment concentration levels to effluent guidelines.
- Mixing Zone Analysis:
    - Used to assess the disbursement of effluent within the receiving waterbody and determine the spatial extent of the plume, as well as to understand the overall effect on the receiving environment.

4.4.3 Receiving Environment Mass Balance

An iterative mass balance model was completed for the parameters of interest between the estimated stream flow, treated effluent, and existing background water quality to determine the available assimilation capacity of the waterbody. The investigation utilizes the background constituent concentrations, effluent concentration, and flow through the receiving waterbody to determine the final concentration downstream of the mixing zone. The final water quality was compared to the CCME *Surface Water Quality Objectives*, objectives outlined by the Prairie Provinces Water Board, as well as additional generic objectives. This will be used to recommend end-of-pipe concentrations and discharge procedures. Assumptions in the assessment are as follows:

- Flow scenarios are reflective of available data from Station 05HG001.
- Treated effluent is discharged continuously year-round.
- Historical average background concentrations are reflective of water quality in the River.
- Further reduction of constituents after discharge has been neglected in the assessment but is likely to

occur.

- 10% of the flow in the River is used to assimilate the treated effluent

4.4.3.1 Discharge Scenarios

Four (4) scenarios were generated as part of the assessment to reflect various effluent and river flow rates. The scenarios assessed are presented in Table 4.4.3.1

Table 4.4.3.1 - Effluent Discharge Scenarios

Scenario	Discharge Timing	Effluent Flow (Description)	Effluent Flow (m^3/sec)	River Flow (Description)	River Flow (m^3/sec)
South Saskatchewan River					
1.1	Summer (May-Oct)	Continuous Discharge: MDF	0.015	Minimum Flow	42.5
1.2				Median 7-Day Flow	142
2.1	Winter (Nov-Apr)	Continuous Discharge: MDF	0.015	Minimum Flow	42.5
2.2				Average 7-Day Flow	237

Note: 7Q10 denotes the 1:10 year 7 day low flow

The MDF effluent flows and minimum regulated river flows are used to assess the receiving stream under a worst-case flow scenario. The following sections present the results of a mass balance assessment of the River under the generated scenarios.

The maximum daily flow (MDF) effluent flows and minimum regulated river flows are used to assess the receiving waterbody under a worst-case flow scenario. Based on the *Design Basis Memorandum; MPE Engineering; 2020*, the MDF flows are expected to occur during the summer months of high precipitation. In the case of the River, it would be more conservative to utilize the minimum regulated flow as opposed to the calculated 7Q10 flows. The *Surface Water Quality Objectives; Water Security Agency; 2015* recommends that treated effluent not utilize more than 30% of assimilation capacity with a diffused outfall, or 10% of assimilation capacity with a point source outfall. This may not be required if it can be demonstrated that the effluent discharge does not have a detrimental impact on the receiving environment. The following sections present the results of a mass balance assessment of the River under the generated scenarios.

4.4.3.2 Available Assimilation Capacity

The River was assessed during continuous discharge after full build out (Phase 5) of the development has been completed. The results of the mass balance analysis portray the maximum concentration of constituents that 10% of the River flow capable of assimilating before the resultant water quality would exceed the instream water quality guidelines. Instances in which the River does not have sufficient capacity to assimilate effluent of a concentration at the WSA or WSER generic limits have been highlighted. This shows constituents in which stricter limits may be required. The dilution ratios of River flow to effluent flow have also been calculated. Commonly a 10:1 dilution ratio is required for ***continuous discharges*** unless it can be demonstrated otherwise that no adverse effect will be had on the environment. This has also been shown for perspective.

Table 4.4.3.2: Mass Balance Analysis - Available Assimilation Capacity

Description	Discharge Scenario	Effluent Discharge Flow (m^3/sec)	Receiving Stream Flow (m^3/sec)	10% of Receiving Stream Flow (m^3/sec)	Dilution Ratio (XX:1)	Concentration: BOD (mg/L)	TSS (mg/L)	Un-Ionized Ammonia (mg/L)	Total Ammonia-N (mg/L)	Total - P (mg/L)	Fecal Coliform (CFU/100ml)
Surface Water Quality Guidelines											
AEP						-	15	0.016	0.238/0.643	-	100
CCME						-	-	0.019	0.283/0.764	-	100
Prairie Provinces Water Board						-	5.6 - 339.8	0.019	0.283/0.764	0.159/0.054	100
Best Industry Practices						5	-	-	-	-	-
Treated Effluent Discharge Limits											
WSER/ WSA						30	25	1.25	50.29/18.65	-	-
AEP - Best Practicable Technology Standards						20	20	1.25		1.0	200
Existing Water Quality											
South Saskatchewan River						1.5	10.0	-	0.010	0.010	14
South Saskatchewan River - Allowable Effluent Concentration											
1.1 Summer Discharge, Minimum Flow	MDF Discharge: Phase 5	0.015	42.500	4.25	283.3	997	1432	-	77.6	42.38	24,467
1.2 Summer Discharge, Median Flow			142.000	14.20	946.7	3318	4748	-	258.7	141.21	81,513
2.1 Winter Discharge, Minimum Flow		0.015	42.500	4.25	283.3	997	1432	-	214.4	12.52	24,467
2.2 Winter Discharge, Median Flow			237.000	23.70	1,580.0	5535	7915	-	1192.1	69.57	135,980

The assimilation capacity mass balance analysis indicates that the River has a significant level of assimilation capacity. This is to be expected as the minimum regulated River flows are approximately 2,833 times greater that the MDF from the proposed WWTF.

The above values were used as a benchmark in the mixing zone model for further assessment and *do not account* for further reduction within the receiving waterbody itself.

4.4.4 Wastewater Treatment Technology

4.4.4.1 AEP Best Practicable Technology Standards

Although not specifically applicable to projects in Saskatchewan, AEP has significantly more detailed and stringent guidelines for tertiary and advanced treatment facilities than WSA. This is largely due to a greater population base and a greater amount of mechanical treatment facilities. For review of the proposed system for the Grasswood development, the AEP standards and guidelines have been considered. AEP requires treated wastewater effluent quality to be based on the more stringent of the receiving environmental capacity or the AEP *BPT Standards*. It is important to compare the assimilation capacity to the BPT standards prior to establishing recommended end-of-pipe limits for the facility. A summary of the AEP BPT Standards is presented in Table 4.4.4.1.

Table 4.4.4.1 - Treated Effluent Quality Standards

Parameter	AEP Best Practicable Technology Standards: Secondary Treatment	Tertiary Treatment	Aerated Lagoons	WSER Regulations
CBOD	25 mg/L	20 mg/L	20 mg/L	25 mg/L
TSS	25 mg/L	20 mg/L	25 mg/L	25 mg/L
NH_3-N	-	[a]-	[a]-	[b]1.25 mg/L
Total-Phosphorus	-	1 mg/L	1 mg/L	-
Total Coliform	-	1000 CFU/100 mL	1000 CFU/100 mL	-
Fecal Coliform	-	200 CFU/100 mL	200 CFU/100 mL	-

CBOD: 5-Day Carbonaceous Biochemical Oxygen Demand
TSS: Total Suspended
NH_3-N: Ammonia Nitrogen
a. Assessed on a site-specific basis
b. Un-Ionized ammonia

The AEP *BPT Standards* recommend that regulated levels of Ammonia – N be determined on a site-specific basis as unionized ammonia is correlated with Ammonia – N concentrations, pH, and temperature. Wastewater treatment facilities with nitrification processes are commonly regulated at concentrations of 10.0 mg/L and 5.0 mg/L of Total Ammonia – N for winter and summer, respectively. However, they are sometimes regulated more stringently depending on the sensitivity of the receiving waterbody and/or proximity to downstream uses. All of these concentrations are lower than the theoretically allowable treated effluent concentration of 50.29 and 18.65 mg/L of Total Ammonia – N for summer and winder discharges respectively based on the WSER effluent limit of 1.25 mg/L of unionized ammonia.

4.4.4.2 Advanced Technology Review

Several methods and processes of treatment have been proposed and reviewed in the years leading up to implementation of the project. As a product of the previous reviews and studies, a Membrane Bioreactor (MBR) system was selected as the preferred treatment process. The MBR system is one of the most advanced wastewater treatment technologies and is capable of producing high quality effluent.

The preferred process presented in the *Design Basis Memorandum; MPE Engineering; 2020* was the MBR system. MBR systems provide high quality treated effluent and typically do not exceed the following effluent parameter concentrations:

- CBOD: < 5 mg/L.
- TSS: < 5 mg/L.
- Total Ammonia – N: < 1.0 mg/L.
- Total Phosphorus: < 0.5 mg/L.
- Fecal Coliform: < 1 CFU/100 ml (with UV disinfection).

All parameters are significantly lower than the available assimilation capacity of the River.

The expected performance of an optimized wastewater treatment facility should be considered. In the case of an MBR, treated effluent is expected to be of significantly higher quality than that required by the available assimilation capacity and/or the AEP BPT guidelines, and therefore should have more stringent limits applied to ensure system performance, and corresponding environmental protection is maximized.

4.4.5 Recommended End-of-Pipe Limits

To establish end-of-pipe design criteria for the WWTF, it is recommended that the WWTF be capable of providing a high-quality effluent within the receiving waterbody guidelines where feasibly attainable. These guidelines are set by considering the*, Department of Fisheries and Oceans, Fisheries Act, WSER Regulations, 2012*, and *Canadian Water Quality Guidelines for the Protection of Aquatic Life; CCME; 2004*. End-of-pipe limits have been recommended based on assessment of the receiving environment. The assimilation capacity of the River using 10% of the minimum regulated flows under a worst-case scenario and the required concentrations can be achieved using advanced technology. Recommended limits to be applied to the WWTF have been recommended based on the capabilities of the technology as they will be significantly more stringent than the available assimilation capacity. Table 4.4.5 summarizes the recommended end-of-pipe limits for the WWTF.

Table 4.4.5 - Recommended End-of-Pipe Limits

Parameter	Unit	Generic Instream Objectives					Regulated Maximum Effluent Limits		Available Assimilation Capacity	Recommended Limits
		WSA	AEP	CCME	Prairie Provinces Water Board	Best Industry Practices	AEP[1]	WSA/WSER		
BOD	(mg/L)	-	-	-	-	5	20	25	997	**10**
TSS	(mg/L)	-	15	-	5.6-339.8	-	20	25	1,432	**10**
Total Ammonia - N (Summer/Winter)	(mg/L)	0.283/0.764	0.238/0.643	0.283/0.764	-	-	50.29/18.65	50.29/18.65	77.6/214.4	**1.0/5.0**
Unionized Ammonia	(mg/L)	0.019	0.016	0.019	-	-	1.25	1.25	-	**1.25**
Total - P	(mg/L)	-	-	-	0.159/0.054	-	1.0	-	42.4/12.5	**1.0**
Fecal Coliform	(CFU/100 ml)	100	100	100	100	-	200	-	24,467	**100**
pH		-	6.5 - 9.0	6.5 - 9.0	-	-	-	-	6.5 - 9.0	**6.5 - 9.0**

[1]Based on the Best Practicable Technology Standards

[2]Based on the background pH, temperature resulting in 1.25

The recommended end-of-pipe limits are based on the guidelines established by the generic instream guidelines and mass balance model. A mixing zone model has been completed to assess the potential spatial mixing zone under the recommended limits.

4.4.6 Mixing Zone Analysis

4.4.6.1 Introduction

The mixing zone is defined as the point where the effluent is assimilated into the receiving waterbody prior to becoming completely mixed. A mixing zone may be established in which the instream water quality guidelines are exceeded, where necessary. The mixing zone should be constrained to a size so as not to affect other beneficial uses of the waterbody. In this specific case, the primary concern is to ensure that the effects of the discharge do not extend so as to have an effect on the City of Saskatoon WTP intake. The mixing zone is established to protect the waterbody as a whole and to limit the acute toxicity to organisms passing through the plume. Near the outer edge of the mixing zone the water quality should be similar to the receiving water quality.

The size of the mixing zone is typically governed by the difference in quality between the effluent and the receiving waterbody as well as ambient flow and environmental conditions. General restrictions to reduce the effect of mixing zones on the receiving environment are as follows:

- Protection from acute lethality is afforded to passing organisms.
- The chronic, or sublethal, zone is limited to the extent that the waterbody as a whole is protected.
- Fish spawning grounds are avoided.
- Drinking water intakes are not impinged upon.
- Acute mixing zones do not overlap.
- Existing water uses are not interfered with.
- Mixing zones are not used as an alternative to reasonable and practical treatment.
- Mixing zone allowance is not extended to bio accumulative substances of hazardous substances for which instream guidelines – provincially, nationally, or internationally – do not exist, unless it can be specifically demonstrated that they will not cause an adverse impact.
- Mixing zone allowance is not extended where it attracts organisms, resulting in prolonged exposure.
- Mixing zone allowance is not extended where it creates a barrier to the migration of aquatic life.
- Recommended mixing zone spatial restrictions are summarized below.
- Acute guidelines met by end-of-pipe. If justified, can be extended to 30 m from outfall.
- Chronic guidelines met preferably before 10 times stream width downstream and met by half the stream width laterally.

4.4.6.2 Modelling

An analysis of the mixing zone at the two potential outlet locations was completed using CORMIX v11.0GT computer modeling software. Scenarios were developed for several constituents under the projected continuous effluent discharge. The purpose of the model analysis is to determine the magnitude and extent of the mixing zone within the receiving water bodies to verify and assess the recommended effluent end-of-pipe limits. The model was completed under a worst-case scenario in which each parameter was at the proposed maximum regulated concentration, effluent was discharging at the projected MDF, and the River was flowing at the minimum regulated flow of 42.5 m^3/sec. Table 4.4.6.2 summarizes the model inputs including concentrations for each of the parameters modelled.

Table 4.4.6.2 - CORMIX Input Summary							
Worksheet	Parameter	Phase 5 Development - Minimum Regulated Flows					
		Total Ammonia - N Summer	Total Ammonia - N Winter	TSS	BOD_5	Total Phosphorus	Fecal Coliform
Effluent	Conservative/Non-Conservative	Conservative	Conservative	Conservative	Conservative	Conservative	Conservative
	Decay Coefficient	N/A	N/A	N/A	N/A	N/A	N/A
	Discharge Concentration (Excess)	0.99	4.99	5.0	8.5	0.99	86
	Effluent Flow Rate (m/sec)	0.015	0.015	0.015	0.015	0.015	0.015
	Effluent Density - Temperature	15	15	15	15	15	15
Ambient	Average Depth	1.3	1.3	1.3	1.3	1.3	1.3
	Depth at Discharge	1	1	1	1	1	1
	Wind Speed	2	2	2	2	2	2
	Bounded/Unbounded Water Body	Bounded	Bounded	Bounded	Bounded	Bounded	Bounded
	river Flow Flow (m^3/sec)	42.5	42.5	42.5	42.5	42.5	42.5
	Roughness - Manning's n	0.035	0.035	0.035	0.035	0.035	0.035
	Ambient Density - Temperature	15	4	15	15	15	15
Discharge (CORMIX 1)	Discharge Location	Left	Left	Left	Right	Left	Left
	Discharge Configuration	Single Port	Single Port	Single Port	Single Port	Single Port	Single Port
	Horizonal Angle	305	305	305	305	305	305
	Height Above Channel Bottom	0.3	0.3	0.3	0.3	0.3	0.3

4.4.6.3 Model Results

The discharge plume shape and classification were predicted in the CORMIX model for various concentrations of Total Ammonia – N (TAN), BOD_5, TSS, Total Phosphorus (TP), and Fecal Coliforms. The model analysis does not account for natural reduction of these parameters over time and is considered conservative.

Based on the characteristics of the existing outfall, the discharge plume is classified as “H2A2” in which strong initial mixing occurs in the near field region. When the flow enters the River, it is initially dominated by strong cross flow which may lead to attachment to the bottom of the River and a recirculating eddy around the outlet structure. The effluent spreads near the bottom and proceeds with ambient mixing as it proceeds downstream.

<u>BOD_5</u>

The recommended maximum concentration for BOD_5 of 10.0 mg/L was assessed in the mixing zone model. This is below the WSER, WSA, and AEP recommended concentrations, but greater than the average background concentration of <3.0 mg/L. Figure 4.4.6.3.1 is a plot illustrating the excess concentration above background levels along the centerline distance away from the outfall in the River. Figure 4.4.6.3.2 illustrates the estimated plume extent near the point of discharge.

Figure 4.4.6.3.1: South Saskatchewan River Projected BOD_5 Near Field Effluent Excess Concentration

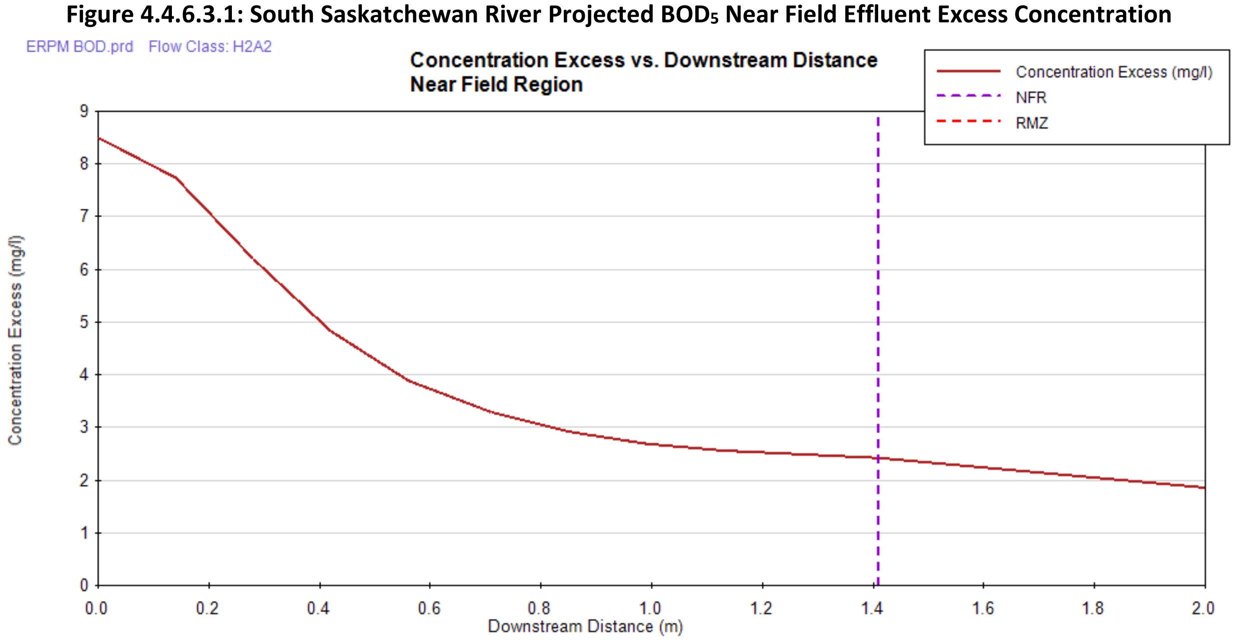
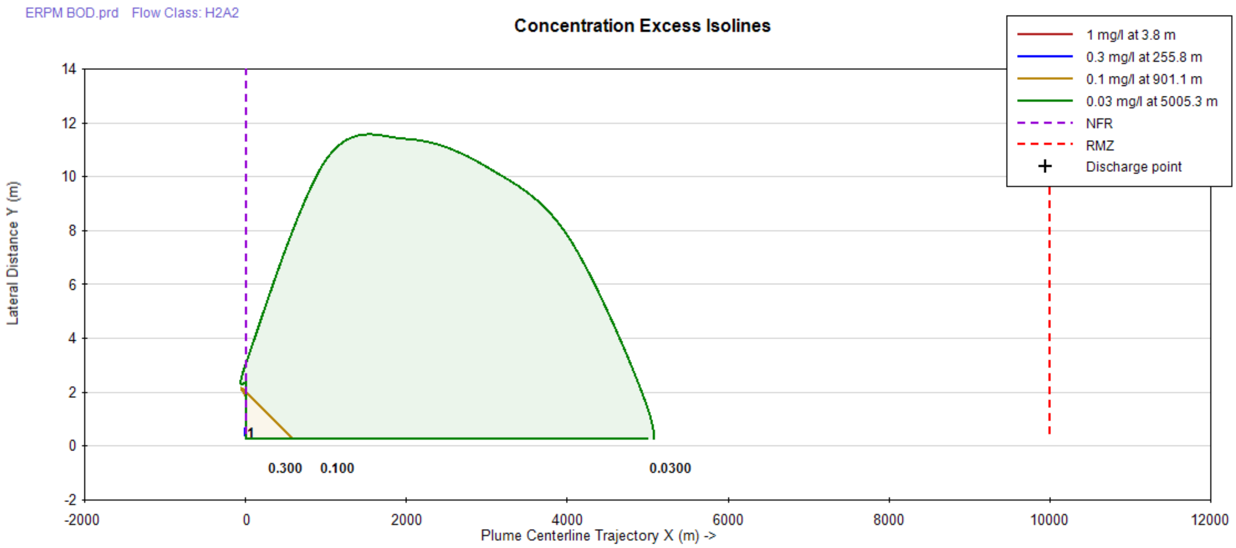


Figure 4.4.6.3.2: South Saskatchewan River Projected $CBOD_5$ Effluent Plume



The effluent mixes quickly as it progresses downstream. Under the modelled worst-case scenario, the BOD_5 excess concentration is reduced by dilution by approximately 70% within 1.5 m of the outfall. The plume is expected to exceed the background concentrations by 0.03 approximately 4,500 m downstream before becoming undetectable. The actual effluent will be significantly lower than the modelled limit the majority of the time. The BOD_5 concentration will also be further reduced from natural processes as it progresses downstream.

<u>Total Suspended Solids (TSS)</u>

A mixing zone analysis was not completed for Total Suspended Solids. The existing average background quality in the River is approximately 10 mg/L. If the recommended end-of-pipe limit of 10 mg/L is adopted, the effluent concentration will be equal to the measured background concentration. Therefore, treated effluent will match the existing background concentration and not result in an increase or decrease of Total Suspended Solids.

<u>Total Ammonia – N</u>

The recommended maximum concentration for TAN of 5.0 mg/L and 1.0 mg/L for winter and summer discharge periods respectively were assessed in the mixing zone model. This is below the WSER, WSA, and AEP recommended concentrations, but greater than the average background concentration of 0.01 mg/L. The un-ionized portion of Total Ammonia is typically regulated and was the basis for assessing Total Ammonia – N. The mixing zone model was used to assess the extent of the mixing zone and predict the plume in which the levels are above the background concentration. Figures 4.5 and 4.6 are plots of the near field region for 5 mg/L effluent limits showing the excess concentration above background levels along the centerline distance away from the outfall. Figures 4.4.6.3.3 to 4.4.6.3.6 illustrate the concentrations for TAN in various scenarios.

Figure 4.4.6.3.3: South Saskatchewan River Projected Winter TAN Near Field Effluent Excess Concentration

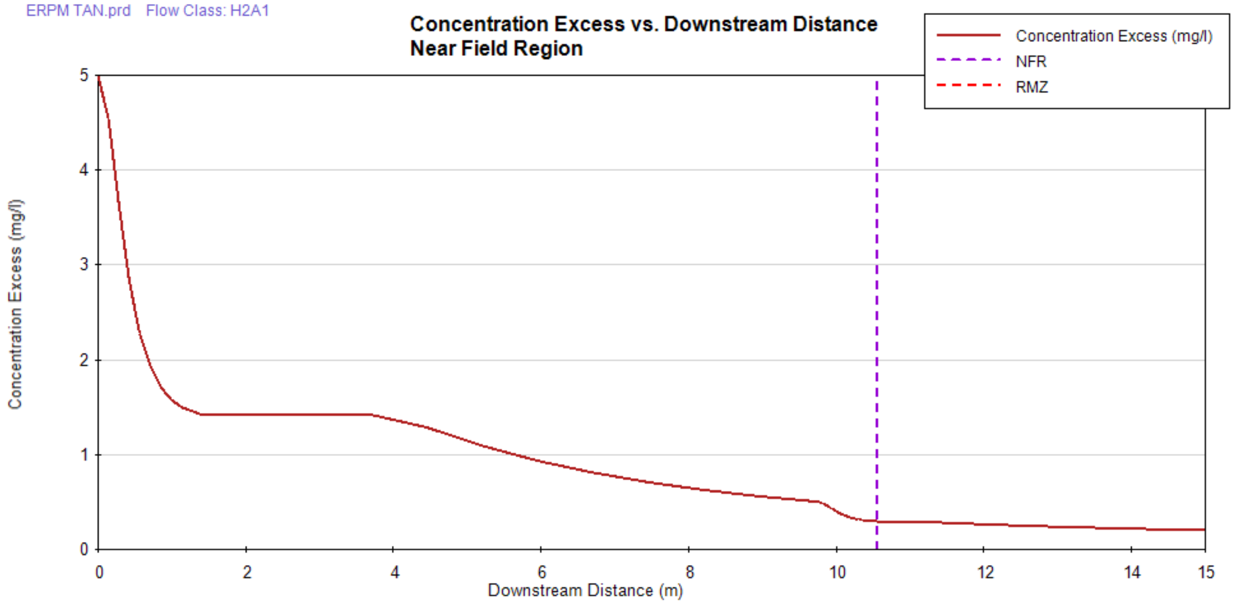


Figure 4.4.6.3.4: South Saskatchewan River Projected Summer TAN Near Field Effluent Excess Concentration

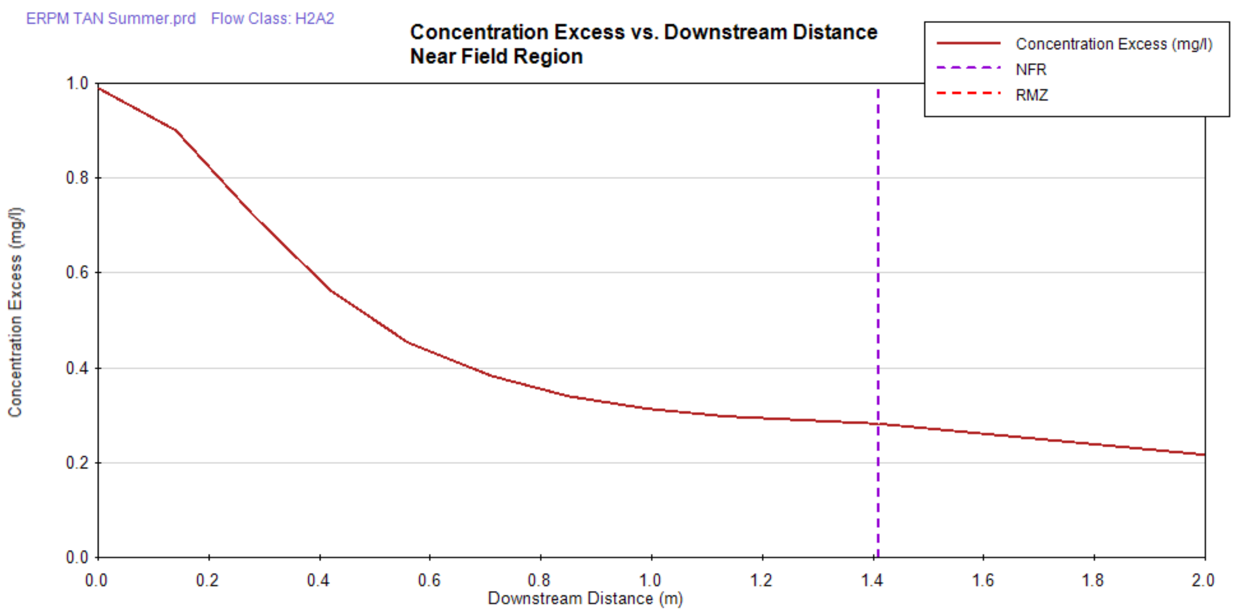


Figure 4.4.6.3.5: South Saskatchewan River Projected Winter TAN Effluent Plume

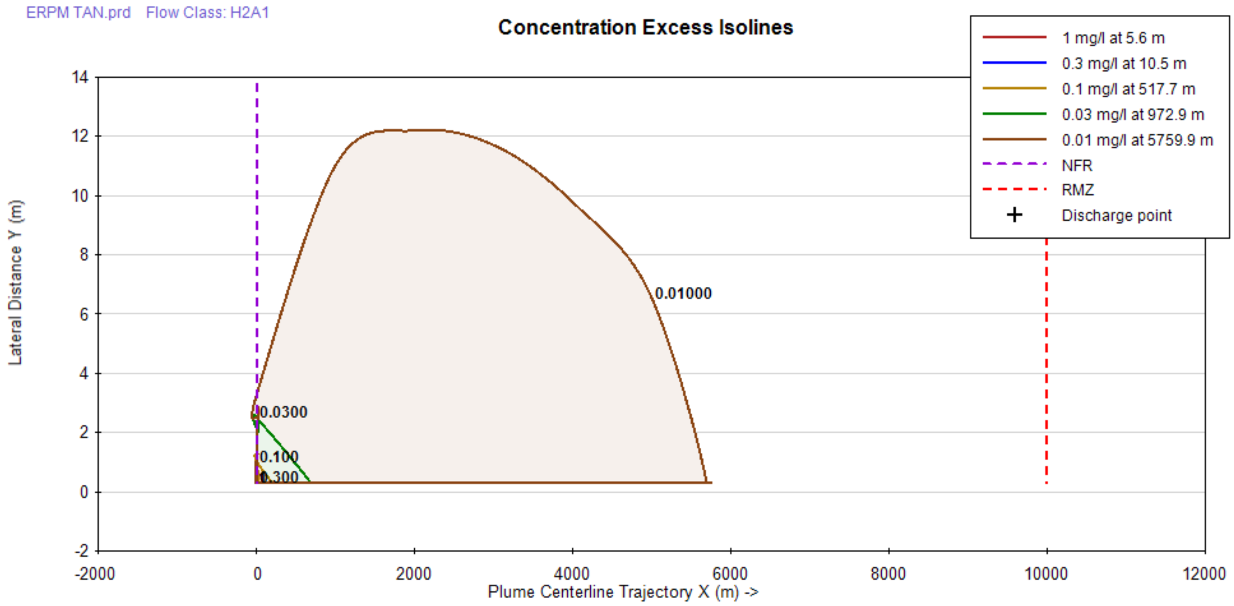
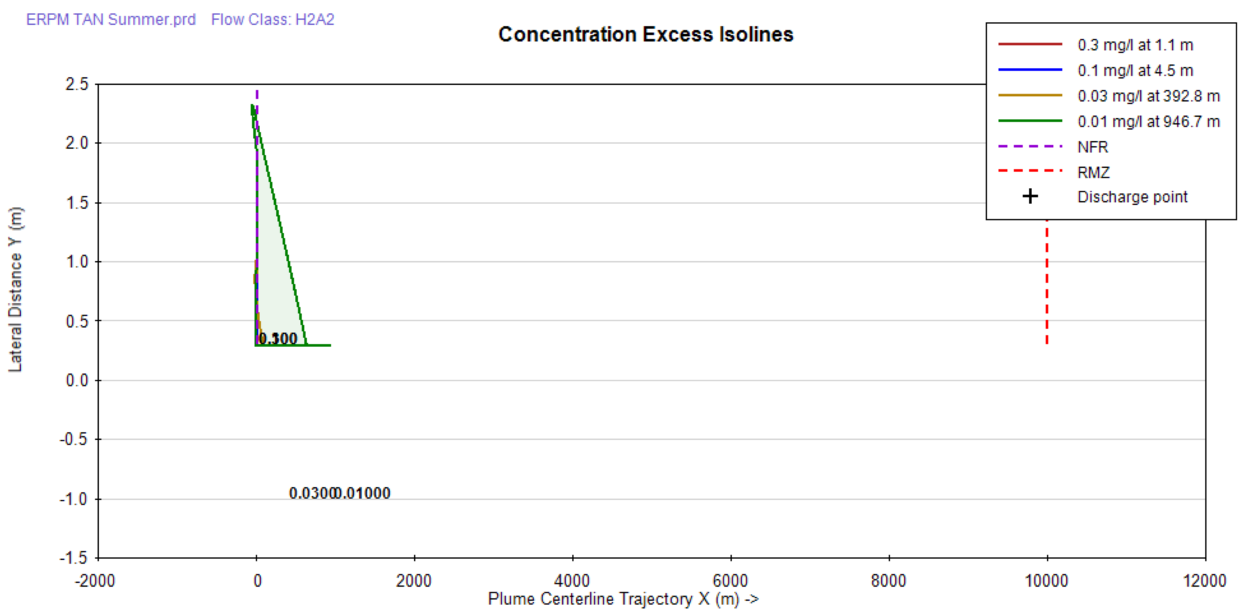


Figure 4.4.6.3.6: South Saskatchewan River Projected Summer TAN Effluent Plume



The effluent stratifies as it progresses downstream. Under the modelled worst-case scenario for winter and summer discharge, the excess TAN concentration is reduced by approximately 94% and 28% within 1.5 m of the outfall for winter and summer discharges respectively. The levels of TAN will never be above acute levels within the mixing zone. The plume is expected to exceed the background concentrations by 0.01 approximately 6,000 m and 800 m downstream before becoming undetectable for winter and summer discharge periods respectively. The actual effluent will be significantly lower than the modelled limit the majority of the time. The TAN concentration will also be further reduced from natural processes as it progresses downstream.

Total Phosphorus

The recommended maximum concentration for Total Phosphorus of 1.0 mg/L was assessed in the mixing zone model. This is consistent with the typical AEP recommended concentrations and greater than the concentration that the WWTF is expected to operate under normal conditions. However, this concentration is also greater than the background concentration of 0.01 mg/L in the River. Figure 4.7 is a plot illustrating the excess concentration above background levels along the centerline distance downstream of the outfall. Figure 4.4.6.3.7 and 4.4.6.3.8 illustrate the total phosphorus concentration excess vs. downstream distance in various scenarios.

Figure 4.4.6.3.7: South Saskatchewan River Projected Total Phosphorus Near Field Effluent Excess Concentration

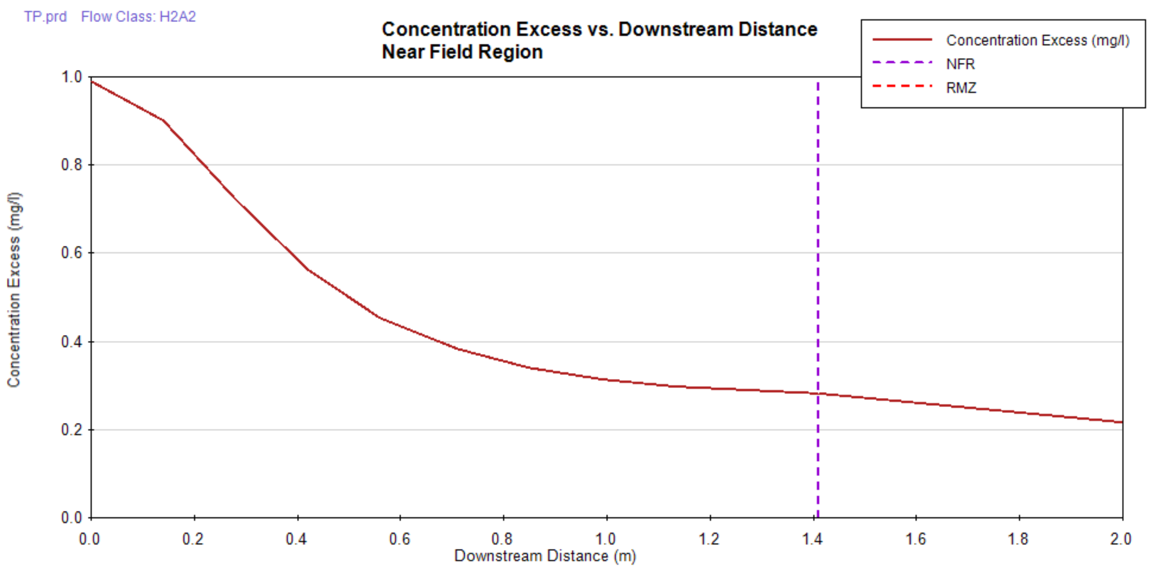
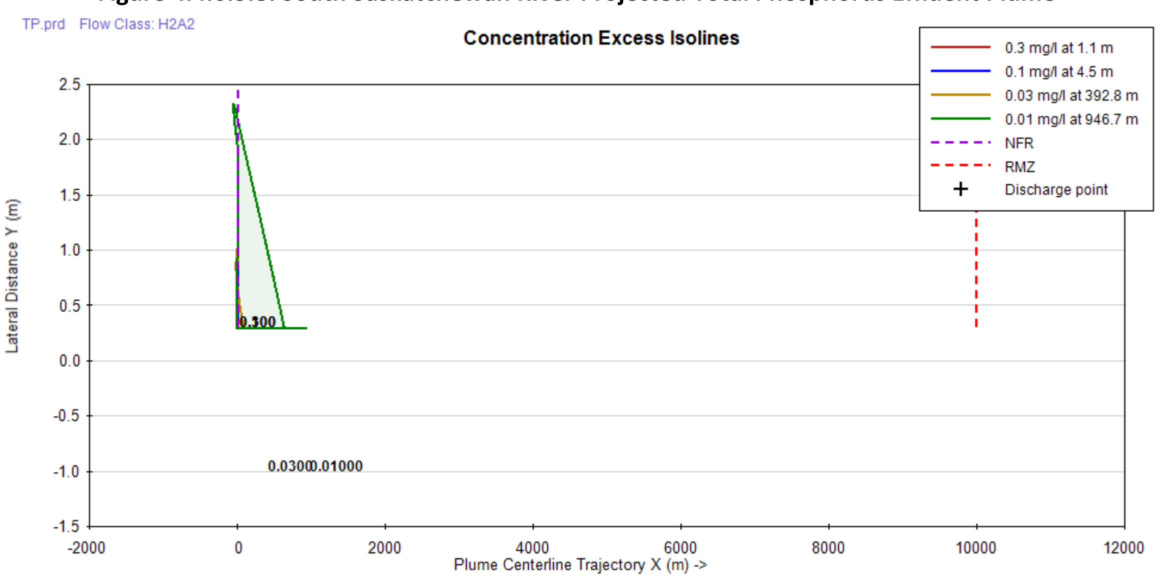


Figure 4.4.6.3.8: South Saskatchewan River Projected Total Phosphorus Effluent Plume



The effluent mixes quickly as it progresses downstream. Under the modelled worst-case scenario, the TP excess concentration is reduced by dilution by approximately 72% within 1.5 m of the outfall. The plume is expected to exceed the background concentrations by 0.03 approximately 800 m downstream before becoming undetectable. The actual effluent will be significantly lower than the modelled limit the majority of the time. The TP concentration will also be further reduced from natural processes as it progresses downstream.

Fecal Coliforms

The recommended maximum concentration for Fecal Coliforms of 100 CFU/100 ml was assessed in the mixing zone model. This is consistent with the WSA, PPWB, and CCME surface water quality guidelines, and is approximately 86 CFU/100 ml greater than the background concentration of 14 CFU/100 ml in the River. Figure 4.4.6.3.9 and 4.4.6.3.10 illustrate the excess concentration above background levels along the centerline distance downstream of the outfall.

Figure 4.4.6.3.9: South Saskatchewan River Projected Fecal Coliform Near Field Effluent Excess Concentration

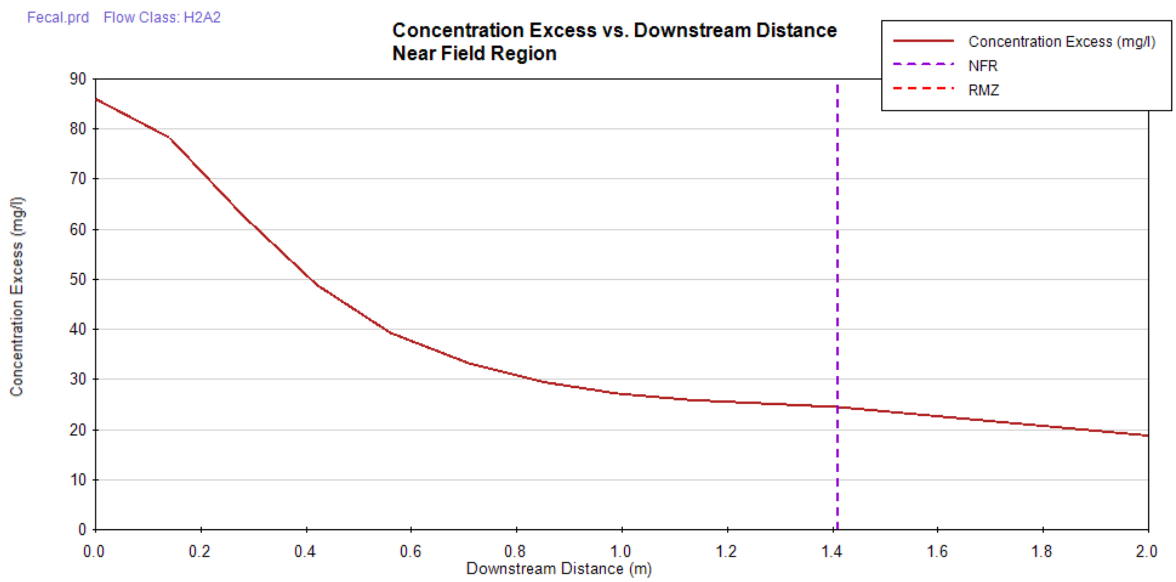
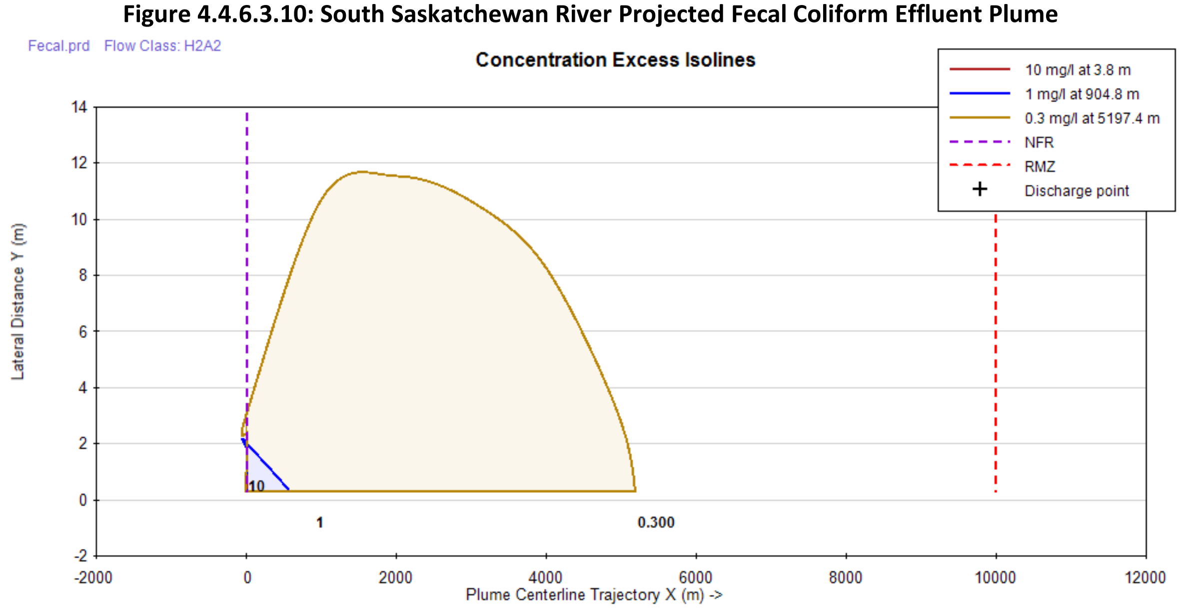


Figure 4.4.6.3.10: South Saskatchewan River Projected Fecal Coliform Effluent Plume



The effluent mixes quickly as it progresses downstream. Under the modelled worst-case scenario, the TP excess concentration is reduced by dilution by approximately 70% within 1.5 m of the outfall. The plume is expected to exceed the background concentrations by 0.3 approximately 5,000 m downstream before becoming undetectable. The majority of the time, the actual effluent will be significantly lower than the modelled limit. The fecal coliform concentration will also be further reduced from natural processes as it progresses downstream.

It should be noted that all parameters of concern will be further reduced over time with settlement, biological activity, and exposure to UV rays within the River. None of these parameters would result in bioaccumulation in the River. The discharge plume estimate is based on discharge into the River during minimum regulated flow conditions. The exact location of the plume may also vary depending on daily environmental factors such as runoff as well as wind speed and direction.

4.4.7 Expected Treatment System Performance

As outlined in the *Design Basis Memorandum; MPE Engineering; 2020*, the proposed treatment system is expected to have concentrations significantly lower than the proposed end-of-pipe limits the majority of the time. The expected effluent concentrations are as follows:

- BOD_5: 5.0 mg/L.
- TSS: 5.0 mg/L.
- Total Ammonia – N: 0.3 mg/L.
- Total Phosphorus: 0.3 mg/L.
- Fecal Coliforms: 5 CFU/100 ml.

A mass balance has been completed to illustrate the likely effects on the receiving environment, assuming the proposed treatment process is operating as intended. The analysis determines the final theoretical concentration of each parameter of concern once completely mixed. Similarly, the mass balance does not consider reduction of constituents over time due to natural processes. The results are presented in Table 4.4.7.

Table 4.4.7: Expected Concentrations During Normal Operation

Description	Discharge Scenario	Effluent Discharge Flow	Receiving Stream Flow	Dilution Ratio	Parameter											
					BOD		TSS		Un-Ionized Ammonia		Total Ammonia-N		Total - P		Fecal Coliform	
		(m^3/sec)	(m^3/sec)	(XX:1)	Concentration (mg/L)	% Change (%)	Concentration (mg/L)	% Change (%)	Concentration (mg/L)	% Change (%)	Concentration (mg/L)	% Change (%)	Concentration (mg/L)	% Change (%)	Concentration (CFU/100ml)	% Change (%)
Generic Surface Water Quality Objectives																
AEP					-	-	15	-	0.016	-	0.238/0.643	-	-	-	100	-
CCME					-	-	-	-	0.019	-	0.283/0.764	-	-	-	100	-
Prairie Provinces Water Board					-	-	5.6 - 339.8	-	0.019	-	0.283/0.764	-	0.159/0.054	-	100	-
Best Industry Practices					5	-	-	-	-	-	-	-	-	-	-	-
Treated Effluent Discharge Limits																
WSER/ WSA					30	-	25	-	1.25	-	50.29/18.65	-	-	-	-	-
AEP - Best Practicable Technology Standards					20	-	20	-	1.25	-		-	1.0	-	200	-
Existing Water Quality																
South Saskatchewan River					1.5	-	10.0	-	-	-	0.01	-	0.01	-	14	-
Effluent Concentration																
Expected WWTF Effluent Concentration					5.0	-	5.0	-	-	-	0.30	-	0.30	-	5	-
South Saskatchewan River - Resultant Concentration																
1.1 Summer Discharge, Minimum Flow	Copntinuous Discharge: Phase 5	0.015	42.500	2,833.3	1.5	0.08%	10.0	-0.02%	-	-	0.01	1.02%	0.01	1.02%	14	-0.02%
1.2 Summer Discharge, Median Flow			142.000	9,466.7	1.5	0.02%	10.0	-0.01%	-	-	0.01	0.31%	0.01	0.31%	14	-0.01%
2.1 Winter Discharge, Minimum Flow			42.500	2,833.3	1.5	0.08%	10.0	-0.02%	-	-	0.01	1.02%	0.01	1.02%	14	-0.02%
2.2 Winter Discharge, Median Flow			237.000	15,800.0	1.5	0.01%	10.0	0.00%	-	-	0.01	0.18%	0.01	0.18%	14	0.00%

Based on the results presented in Table 4.1.6, concentrations would not exceed the instream objectives for any parameters and would result in maximum increases of approximately 1 % during MDF effluent flow scenarios coupled with minimum regulated River flows. Based on the results expected during normal operation, the ERPM Grasswood development WWTF would have a negligible impact on the River. These results do not include further reduction of parameters of concern within the effluent storage cells and receiving stream.

4.4.8 Recommended Water Quality Monitoring

With continuous discharge to the South Saskatchewan River, it is recommended (and required by WSA) that a water quality monitoring plan be established upon completion of the project. It is recommended that three (3) monitoring stations be established with details as follows:

Water Quality Monitoring Recommendations:

- Sample Parameters:
  - BOD_5
  - $CBOD_5$
  - Total suspended Solids
  - Total Ammonia - N
  - Unionized Ammonia
  - E. coli
  - Total Coliforms
  - Fecal Coliforms
  - Total Phosphorus
  - Total Nitrogen
  - Metals
- Sample Locations:
  - 50 m upstream (minimum)
  - 50 m downstream (minimum)
  - Near COS raw water intake
- Sample Frequency:
  - Quarterly

5.0 Conclusions & Recommendations

5.1 Conclusions

The major findings from this report include:

Disposal Strategy

- Several disposal alternatives have previously been reviewed including connection to COS infrastructure, overland discharge, effluent irrigation, and direct disposal to the River.
- Direct disposal to the River is the recommended method.
- Recommended work is as follows:
  - Construction of effluent pumping system as part of the WWTF project.
  - Construction of a 6,800 m, 250 mm HDPE forcemain.
  - Installation of a precast concrete transition manhole.
  - Construction of a 1,400 m, 250 mm HDPE gravity line with corresponding manholes.
  - Construction of an outlet structure to the River.

Downstream Use & Impact

- The South Saskatchewan River is a major waterbody in Western Canada with municipal, agricultural, and aquatic habitat uses. The River experiences consistent flow throughout the year and is largely regulated by outflows through Gardiner Dam.
- Significant assimilation capacity is available in the receiving waterbody.
- Proposed WWTF effluent is expected to be of extremely high quality and exceed all applicable guidelines and regulations.
- Mixing zone will not contain acute concentrations of any parameter.
- Effluent plume will facilitate the majority of the mixing within 1.5 m, plume will be undetectable prior to reaching the COS WTP intake.
- The ERPM Grasswood Development will have a negligible impact on the River quality during worst-case flow scenarios.

5.2 General Recommendations

- Adopt this report and its recommendations to meet wastewater and surface water quality guidelines as outlined in this report.
- Forward a copy of this report to the Water Security Agency for their review and comment.

References

(1) Water Supply and Pollution Control, 8th Ed. W. Viessmen, Jr., M. Hammer, E. Perez, and P. Chadik. Prentice Hall, 2009.

(2) Alberta Environment, "Standard and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems", Drinking Water Branch, Environmental Policy Branch, Environmental Assurance Division, Edmonton, Alberta, March 2013.

(3) Ministry of Justice, "Wastewater Systems Effluent Regulations", http://laws-lois.justicr.gc.ca

(4) Wastewater Systems Standards for Performance and Design; Alberta Environment and Parks; 2013.

(5) Department of Fisheries and Oceans, Fisheries Act, Wastewater Systems Effluent Regulations SOR/2012-139, 2012.

(6) Canadian Council of Ministers of the Environment, Canadian Environmental Quality Guidelines, 2007.

(7) Environmental Quality Guidelines for Alberta Surface Waters; Alberta Environment and Sustainable Resource Development; 2014.

Appendix B – Receiving Environment Quality Analysis

SASKATCHEWAN RESEARCH COUNCIL
Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2
T: 306-933-6932 F: 306-933-7922
Toll-free: 1-800-240-8808
E: analytical@src.sk.ca
www.src.sk.ca/analytical

SRC Group # 2019-17753

Dec 23, 2019

MPE Engineering Ltd.
122, 103 Marquis Court
Saskatoon, SK S7P 0C4
Attn: Christopher Nameth

Date Samples Received: Dec-13-2019 Client P.O.:

All results have been reviewed and approved by a Qualified Person in accordance with the Saskatchewan Environmental Code, Corrective Action Plan Chapter, for the purposes of certifying a laboratory analysis

Results from Lab Section 1, Lab Section 2 authorized by Keith Gipman, Supervisor

---

* Test methods and data are validated by the laboratory's Quality Assurance Program.

* Routine methods follow recognized procedures from sources such as
  * Standard Methods for the Examination of Water and Wastewater APHA AWWA WEF
  * Environment Canada
  * US EPA
  * CANMET

* The results reported relate only to the test samples as provided by the client.

* Samples will be kept for 30 days after the final report is sent. Please contact the lab if you have any special requirements.

* Additional information is available upon request.

* Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

This is a final report.

Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2
T: 306-933-6932 F: 306-933-7922
Toll-free: 1-800-240-8808
E: analytical@src.sk.ca
www.src.sk.ca/analytical

SRC Group # 2019-17753

Dec 23, 2019

MPE Engineering Ltd.
122, 103 Marquis Court
Saskatoon, SK S7P 0C4
Attn: Christopher Nameth

Date Samples Received: Dec-13-2019 Client P.O.:

73025 **12/13/2019 1 *WATER***
73026 **12/13/2019 2 *WATER***
73027 **12/13/2019 3 *WATER***

Analyte	Units	73025	73026	73027
Lab Section 1				
Bicarbonate	mg/L	221	204	202
Carbonate	mg/L	<1	<1	<1
Chloride	mg/L	16	15	15
Hydroxide	mg/L	<1	<1	<1
P. alkalinity	mg/L	<1	<1	<1
pH	pH units	8.16	8.18	8.22
Specific conductivity	uS/cm	520	504	499
Sum of ions	mg/L	423	396	392
Total alkalinity	mg/L	181	167	166
Total hardness	mg/L	208	196	194
Ammonia as nitrogen	mg/L	0.14	0.05	0.04
Nitrate	mg/L	1.1	1.0	0.98
Total Kjeldahl nitrogen	mg/L	1.0	0.34	0.38
Total nitrogen	mg/L	1.2	0.56	0.60
Biochemical oxygen demand	mg/L	<3	<3	<3
Fluoride	mg/L	0.15	0.16	0.17
Total dissolved solids	mg/L	328	321	314
Total suspended solids	mg/L	4	6	7
Lab Section 2				
Calcium	mg/L	52	49	48
Magnesium	mg/L	19	18	18
Potassium	mg/L	4.7	4.1	4.1
Sodium	mg/L	29	28	28
Sulfate	mg/L	80	77	76
Aluminum	mg/L	0.038	0.035	0.027
Antimony	mg/L	<0.0002	<0.0002	<0.0002
Arsenic	ug/L	1.1	1.0	1.0
Barium	mg/L	0.10	0.097	0.096
Beryllium	mg/L	<0.0001	<0.0001	<0.0001
Boron	mg/L	0.03	0.03	0.02
Cadmium	mg/L	0.00001	0.00001	0.00001

SASKATCHEWAN RESEARCH COUNCIL

Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2
T: 306-933-6932 F: 306-933-7922
Toll-free: 1-800-240-8808
E: analytical@src.sk.ca
www.src.sk.ca/analytical

SRC Group # 2019-17753

Dec 23, 2019

MPE Engineering Ltd.

73025 **12/13/2019 1 *WATER***
73026 **12/13/2019 2 *WATER***
73027 **12/13/2019 3 *WATER***

Analyte	Units	73025	73026	73027
Lab Section 2				
Chromium	mg/L	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	0.0002	0.0002	0.0001
Copper	mg/L	0.0014	0.0012	0.0014
Iron	mg/L	0.068	0.076	0.18
Lead	mg/L	0.0001	0.0001	<0.0001
Manganese	mg/L	0.017	0.016	0.013
Molybdenum	mg/L	0.0016	0.0015	0.0015
Nickel	mg/L	0.0022	0.0021	0.0021
Selenium	mg/L	0.0004	0.0004	0.0004
Silver	mg/L	<0.00005	<0.00005	<0.00005
Strontium	mg/L	0.32	0.30	0.30
Thallium	mg/L	<0.0002	<0.0002	<0.0002
Tin	mg/L	<0.0001	<0.0001	<0.0001
Titanium	mg/L	0.0012	0.0012	0.0009
Uranium	ug/L	1.4	1.4	1.4
Vanadium	mg/L	0.0004	0.0004	0.0006
Zinc	mg/L	0.0012	0.0008	0.0014
Phosphorus	mg/L	0.03	0.01	<0.01

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.

The temperature of the cooler was 6.8 °C upon receipt.

SRC SASKATCHEWAN RESEARCH COUNCIL

Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2

T: 306-933-6932 **F:** 306-933-7922
Toll-free: 1-800-240-8808
E: analytical@src.sk.ca

www.src.sk.ca/analytical

SRC Group # 2020-4993

May 20, 2020

MPE Engineering Ltd.
122, 103 Marquis Court
Saskatoon, SK S7P 0C4
Attn: Christopher Nameth

Date Samples Received: May-11-2020 Client P.O.:

All results have been reviewed and approved by a Qualified Person in accordance with the Saskatchewan Environmental Code, Corrective Action Plan Chapter, for the purposes of certifying a laboratory analysis

Results from Lab Section 1, Lab Section 2 authorized by Keith Gipman, Supervisor
Results from Lab Section 8 authorized by Hongda Yuan, Supervisor

---

* Test methods and data are validated by the laboratory's Quality Assurance Program.

* Routine methods follow recognized procedures from sources such as
    * Standard Methods for the Examination of Water and Wastewater APHA AWWA WEF
    * Environment Canada
    * US EPA
    * CANMET

* The results reported relate only to the test samples as provided by the client.

* Samples will be kept for 30 days after the final report is sent. Please contact the lab if you have any special requirements.

* Additional information is available upon request.

* Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

This is a final report.

SASKATCHEWAN RESEARCH COUNCIL

Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2
T: 306-933-6932 F: 306-933-7922
Toll-free: 1-800-240-8808
E: analytical@src.sk.ca
www.src.sk.ca/analytical

SRC Group # 2020-4993

May 20, 2020

MPE Engineering Ltd.

122, 103 Marquis Court
Saskatoon, SK S7P 0C4
Attn: Christopher Nameth

Date Samples Received: May-11-2020

Client P.O.:

24617 **05/11/2020 1 *WATER***
24618 **05/11/2020 2 *WATER***
24619 **05/11/2020 3 *WATER***

Analyte	Units	24617	24618	24619
Lab Section 1				
Bicarbonate	mg/L	201	202	212
Carbonate	mg/L	<1	<1	<1
Chloride	mg/L	14	14	16
Hydroxide	mg/L	<1	<1	<1
P. alkalinity	mg/L	<1	<1	<1
pH	pH units	8.20	8.24	8.23
Specific conductivity	uS/cm	481	480	491
Sum of ions	mg/L	381	380	398
Total alkalinity	mg/L	165	166	174
Total hardness	mg/L	187	187	190
Ammonia as nitrogen	mg/L	0.09	0.12	0.11
Nitrate	mg/L	1.2	1.1	1.1
Total Kjeldahl nitrogen	mg/L	0.30	0.27	0.31
Total nitrogen	mg/L	0.57	0.52	0.56
Biochemical oxygen demand	mg/L	<3	<3	<3
Fluoride	mg/L	0.16	0.15	0.15
Total dissolved solids	mg/L	252	260	266
Total suspended solids	mg/L	42	23	16
Lab Section 2				
Calcium	mg/L	47	47	48
Magnesium	mg/L	17	17	17
Potassium	mg/L	3.3	3.2	3.3
Sodium	mg/L	26	26	27
Sulfate	mg/L	71	70	73
Aluminum	mg/L	0.097	0.061	0.044
Antimony	mg/L	<0.0002	<0.0002	<0.0002
Arsenic	ug/L	1.1	0.9	0.9
Barium	mg/L	0.10	0.095	0.092
Beryllium	mg/L	<0.0001	<0.0001	<0.0001
Boron	mg/L	0.02	0.02	0.02
Cadmium	mg/L	0.00002	0.00002	0.00002

SASKATCHEWAN RESEARCH COUNCIL

Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2

T: 306-933-6932 F: 306-933-7922
Toll-free: 1-800-240-8808
E: analytical@src.sk.ca

www.src.sk.ca/analytical

SRC Group # 2020-4993

May 20, 2020

MPE Engineering Ltd.

24617 **05/11/2020 1 *WATER***
24618 **05/11/2020 2 *WATER***
24619 **05/11/2020 3 *WATER***

Analyte	Units	24617	24618	24619
Lab Section 2				
Chromium	mg/L	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	0.0006	0.0002	0.0002
Copper	mg/L	0.0015	0.0011	0.0011
Iron	mg/L	2.17	0.13	0.096
Lead	mg/L	0.0003	0.0002	0.0002
Manganese	mg/L	0.089	0.029	0.025
Molybdenum	mg/L	0.0010	0.0010	0.0010
Nickel	mg/L	0.0026	0.0019	0.0018
Selenium	mg/L	0.0004	0.0004	0.0004
Silver	mg/L	<0.00005	<0.00005	<0.00005
Strontium	mg/L	0.30	0.29	0.29
Thallium	mg/L	<0.0002	<0.0002	<0.0002
Tin	mg/L	<0.0001	<0.0001	<0.0001
Titanium	mg/L	0.0042	0.0014	0.0011
Uranium	ug/L	1.2	1.1	1.1
Vanadium	mg/L	0.0042	0.0003	0.0002
Zinc	mg/L	0.0015	0.0007	0.0009
Phosphorus	mg/L	0.02	0.01	0.01
Lab Section 8				
E. coli	MPN/100mL	16	1	23
Fecal coliform	MPN/100mL	5	1	12
Total coliform	MPN/100mL	130	62	120

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.
Most Probable Number (MPN) is equivalent to counts (CTS).

The temperature of the cooler was 11.6 °C upon receipt.

SRC Group # 2020-4993

May 20, 2020

MPE Engineering Ltd.

Analyte Methods

Name	Units	Method
P. alkalinity	mg/L	Chm-211
Biochemical oxygen demand	mg/L	Chm-400
Chloride	mg/L	Chm-115
Carbonate	mg/L	Chm-211
Fluoride	mg/L	Chm-211
Bicarbonate	mg/L	Chm-211
Ammonia as nitrogen	mg/L	Chm-123
Total nitrogen	mg/L	Calculation
Total Kjeldahl nitrogen	mg/L	Chm-128
Nitrate	mg/L	Chm-124
Hydroxide	mg/L	Chm-211
pH	pH units	Chm-211
Total dissolved solids	mg/L	Chm-203
Total suspended solids	mg/L	Chm-206
Specific conductivity	uS/cm	Chm-211
Sum of ions	mg/L	Calculation
Total hardness	mg/L	Calculation
Total alkalinity	mg/L	Chm-211
Silver	mg/L	Chm-522
Aluminum	mg/L	Chm-522
Arsenic	ug/L	Chm-522
Boron	mg/L	Chm-522
Barium	mg/L	Chm-522
Beryllium	mg/L	Chm-522
Calcium	mg/L	Chm-508
Cadmium	mg/L	Chm-522
Cobalt	mg/L	Chm-522
Chromium	mg/L	Chm-522
Copper	mg/L	Chm-522
Iron	mg/L	Chm-522
Potassium	mg/L	Chm-508
Magnesium	mg/L	Chm-508
Manganese	mg/L	Chm-522
Molybdenum	mg/L	Chm-522
Sodium	mg/L	Chm-508
Nickel	mg/L	Chm-522
Phosphorus	mg/L	Chm-522
Lead	mg/L	Chm-522

MPE Engineering Ltd.

Name	Units	Method
Antimony	mg/L	Chm-522
Selenium	mg/L	Chm-522
Tin	mg/L	Chm-522
Sulfate	mg/L	Chm-508
Strontium	mg/L	Chm-522
Titanium	mg/L	Chm-522
Thallium	mg/L	Chm-522
Uranium	ug/L	Chm-522
Vanadium	mg/L	Chm-522
Zinc	mg/L	Chm-522
Fecal coliform	MPN/100mL	Chm-407
Total coliform	MPN/100mL	Chm-410
E. coli	MPN/100mL	Chm-410

SASKATCHEWAN RESEARCH COUNCIL

Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2

T: 306-933-6932 F: 306-933-7922
Toll-free: 1-800-240-8808
E: analytical@src.sk.ca

www.src.sk.ca/analytical

SRC Group # 2020-8442

Aug 10, 2020

MPE Engineering Ltd.
122, 103 Marquis Court
Saskatoon, SK S7P 0C4
Attn: Christopher Nameth

Date Samples Received: Jul-24-2020 Client P.O.:

All results have been reviewed and approved by a Qualified Person in accordance with the Saskatchewan Environmental Code, Corrective Action Plan Chapter, for the purposes of certifying a laboratory analysis

Results from Lab Section 1, Lab Section 2 authorized by Keith Gipman, Supervisor
Results from Lab Section 8 authorized by Hongda Yuan, Supervisor

---

* Test methods and data are validated by the laboratory's Quality Assurance Program.

* Routine methods follow recognized procedures from sources such as
    * Standard Methods for the Examination of Water and Wastewater APHA AWWA WEF
    * Environment Canada
    * US EPA
    * CANMET

* The results reported relate only to the test samples as provided by the client.

* Samples will be kept for 30 days after the final report is sent. Please contact the lab if you have any special requirements.

* Additional information is available upon request.

* Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

This is a final report.

SRC SASKATCHEWAN RESEARCH COUNCIL

Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2
T: 306-933-6932 F: 306-933-7922
Toll-free: 1-800-240-8808
E: analytical@src.sk.ca
www.src.sk.ca/analytical

SRC Group # 2020-8442
Aug 10, 2020

MPE Engineering Ltd.
122, 103 Marquis Court
Saskatoon, SK S7P 0C4
Attn: Christopher Nameth

Date Samples Received: Jul-24-2020 Client P.O.:

35788 **07/23/2020 1 *WATER***
35789 **07/23/2020 2 *WATER***
35790 **07/23/2020 3 *WATER***

Analyte	Units	35788	35789	35790
Lab Section 1				
Bicarbonate	mg/L	200	187	190
Carbonate	mg/L	<1	2	2
Chloride	mg/L	13	12	14
Hydroxide	mg/L	<1	<1	<1
P. alkalinity	mg/L	<1	2	2
pH	pH units	8.23	8.39	8.38
Specific conductivity	uS/cm	454	448	472
Sum of ions	mg/L	367	352	368
Total alkalinity	mg/L	164	157	160
Total hardness	mg/L	178	178	187
Ammonia as nitrogen	mg/L	0.02	<0.01	0.02
Nitrate	mg/L	1.1	1.0	1.2
Total Kjeldahl nitrogen	mg/L	0.45	0.40	0.38
Total nitrogen	mg/L	0.70	0.62	0.65
Biochemical oxygen demand	mg/L	<3	<3	<3
Fluoride	mg/L	0.16	0.15	0.15
Total dissolved solids	mg/L	276	273	283
Total suspended solids	mg/L	34	9	10
Lab Section 2				
Calcium	mg/L	45	45	47
Magnesium	mg/L	16	16	17
Potassium	mg/L	3.7	3.6	3.7
Sodium	mg/L	24	23	24
Sulfate	mg/L	64	62	69
Aluminum	mg/L	0.12	0.059	0.071
Antimony	mg/L	<0.0002	<0.0002	<0.0002
Arsenic	ug/L	0.9	0.8	0.8
Barium	mg/L	0.095	0.087	0.090
Beryllium	mg/L	<0.0001	<0.0001	<0.0001
Boron	mg/L	0.02	0.02	0.02
Cadmium	mg/L	0.00003	0.00002	0.00002

SASKATCHEWAN RESEARCH COUNCIL

Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2

T: 306-933-6932 F: 306-933-7922
Toll-free: 1-800-240-8808
E: analytical@src.sk.ca

www.src.sk.ca/analytical

SRC Group # 2020-8442
Aug 10, 2020

MPE Engineering Ltd.

35788	**07/23/2020 1**	***WATER***
35789	**07/23/2020 2**	***WATER***
35790	**07/23/2020 3**	***WATER***

Analyte	Units	35788	35789	35790
Lab Section 2				
Chromium	mg/L	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	0.0003	0.0002	0.0002
Copper	mg/L	0.0016	0.0015	0.0013
Iron	mg/L	0.42	0.090	0.12
Lead	mg/L	0.0004	0.0001	0.0002
Manganese	mg/L	0.042	0.015	0.026
Molybdenum	mg/L	0.0010	0.0012	0.0011
Nickel	mg/L	0.0022	0.0017	0.0018
Selenium	mg/L	0.0004	0.0004	0.0005
Silver	mg/L	<0.00005	<0.00005	<0.00005
Strontium	mg/L	0.27	0.27	0.28
Thallium	mg/L	<0.0002	<0.0002	<0.0002
Tin	mg/L	<0.0001	<0.0001	<0.0001
Titanium	mg/L	0.0029	0.0014	0.0023
Uranium	ug/L	1.2	1.1	1.3
Vanadium	mg/L	0.0012	0.0003	0.0004
Zinc	mg/L	0.0017	0.0011	0.0011
Phosphorus	mg/L	0.02	0.01	0.01
Lab Section 8				
E. coli	MPN/100mL	48	9	58
Fecal coliform	MPN/100mL	22	16	46
Total coliform	MPN/100mL	1800	820	3800

Symbol of "<" means "less than". This indicates that it was not detected at level stated above.
Most Probable Number (MPN) is equivalent to counts (CTS).

The temperature of the cooler was 24.3 °C upon receipt.

SASKATCHEWAN RESEARCH COUNCIL

Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2

T: 306-933-6932 **F:** 306-933-7922
Toll-free: 1-800-240-8808
E: analytical@src.sk.ca

www.src.sk.ca/analytical

SRC Group # 2020-8442

Aug 10, 2020

MPE Engineering Ltd.

Analyte Methods

Name	Units	Method
P. alkalinity	mg/L	Chm-211
Biochemical oxygen demand	mg/L	Chm-400
Chloride	mg/L	Chm-115
Carbonate	mg/L	Chm-211
Fluoride	mg/L	Chm-211
Bicarbonate	mg/L	Chm-211
Ammonia as nitrogen	mg/L	Chm-123
Total nitrogen	mg/L	Calculation
Total Kjeldahl nitrogen	mg/L	Chm-128
Nitrate	mg/L	Chm-124
Hydroxide	mg/L	Chm-211
pH	pH units	Chm-211
Total dissolved solids	mg/L	Chm-203
Total suspended solids	mg/L	Chm-206
Specific conductivity	uS/cm	Chm-211
Sum of ions	mg/L	Calculation
Total hardness	mg/L	Calculation
Total alkalinity	mg/L	Chm-211
Silver	mg/L	Chm-522
Aluminum	mg/L	Chm-522
Arsenic	ug/L	Chm-522
Boron	mg/L	Chm-522
Barium	mg/L	Chm-522
Beryllium	mg/L	Chm-522
Calcium	mg/L	Chm-508
Cadmium	mg/L	Chm-522
Cobalt	mg/L	Chm-522
Chromium	mg/L	Chm-522
Copper	mg/L	Chm-522
Iron	mg/L	Chm-522
Potassium	mg/L	Chm-508
Magnesium	mg/L	Chm-508
Manganese	mg/L	Chm-522
Molybdenum	mg/L	Chm-522
Sodium	mg/L	Chm-508
Nickel	mg/L	Chm-522
Phosphorus	mg/L	Chm-522
Lead	mg/L	Chm-522

Environmental Analytical Laboratories
143-111 Research Drive, Saskatoon, SK Canada S7N 3R2
T: 306-933-6932 F: 306-933-7922
Toll-free: 1-800-240-8808
E: analytical@src.sk.ca
www.src.sk.ca/analytical

SRC Group # 2020-8442

Aug 10, 2020

MPE Engineering Ltd.

Name	Units	Method
Antimony	mg/L	Chm-522
Selenium	mg/L	Chm-522
Tin	mg/L	Chm-522
Sulfate	mg/L	Chm-508
Strontium	mg/L	Chm-522
Titanium	mg/L	Chm-522
Thallium	mg/L	Chm-522
Uranium	ug/L	Chm-522
Vanadium	mg/L	Chm-522
Zinc	mg/L	Chm-522
Fecal coliform	MPN/100mL	Chm-407
Total coliform	MPN/100mL	Chm-410
E. coli	MPN/100mL	Chm-410