Environment Act Proposal

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City of Brandon

City of Brandon Water Treatment Facility Upgrades Project
March 21, 2023

Environment Act Proposal

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Executive Summary

The City of Brandon's (City) Water Treatment Facility (Facility) has supplied water to its residents since 1893. The Facility is a conventional lime softening plant with residuals treatment and has undergone several upgrades that resulted in the current Facility. The City continues to experience higher population growth than the provincial average accompanied by an increase in demand for municipal services. This demand, combined with aging infrastructure, challenging source water quality, changing drinking water quality regulations, and elevated disinfection by-product at the edges of the distribution system led to the City developing a Water Utility Master Plan (Master Plan) to support the long-term sustainability of its potable water supply. As a result of the Master Plan and the 2015 re-assessment of the City's water system infrastructure, it was determined that the existing Facility requires upgrades.

The proposed upgrades include the provision of a new intake and raw water reservoir; the addition of a membrane treatment process and new treated water storage reservoir; the consolidation of most of the chemical systems into a centralized building; the conversion from chlorine gas to sodium hypochlorite disinfection; upgrades to the existing water treatment facility; and the implementation of corrosion control in the distribution system.

A phased approach has been applied to the upgrades, where the new chemical building will be constructed first (nearing completion), followed by the remaining upgrades. The purpose of this report is to conduct an environmental assessment of the effects of the project on soils and terrain, vegetation, water resources, groundwater, wildlife and wildlife habitat and socioeconomic elements.

For most of the elements identified that interact with the proposed upgrades to the Facility, the adverse residual environmental effects were found to be negligible to low in magnitude for construction and operations. With the application of the proposed mitigation measures for soils and terrain, vegetation, water resources, groundwater, wildlife and wildlife habitat, and socioeconomic elements including human health, the adverse effects can be avoided or reduced to low or negligible magnitude. However, for fish and fish habitat, the new intake has the potential to generate medium to high magnitude effects on fish/mussel mortality and fish/mussel habitat through the upsweep of fish larvae in the intake during operations and permanent habitat loss and alteration after the installation of the new intake and bank rip-rap. The residual effects for the new intake structure were based on preliminary design and construction plans and will need to be reassessed when the design and plans are finalized.

The Facility upgrade project will result in an improvement to the water supply, treatment, and water quality to meet current and future operational requirements of the City and meet the anticipated target design criteria for the surface water source for the Facility.

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Acronyms and Abbreviations

°C	degree(s) Celsius
ADD	average day demand
AIS	aquatic invasive species
alum	aluminium sulphate
$C_6H_8O_7$	citric acid
CCME	Canadian Council of Ministers of the Environment
CEB	chemically enhanced backwash
CIP	clean in place
City	City of Brandon
cm	centimetre
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DBP	disinfection-by-product
DFO	Fisheries and Oceans Canada
EAP	Environment Act Proposal
Facility	Water Treatment Facility
H_2SO_4	sulphuric acid
H_3PO_4	phosphoric acid
HRB	Heritage Resources Branch
IPM	integrated pest management
kg	kilogram(s)
km	kilometre(s)
km^2	square kilometre(s)
kV	kilovolt(s)
kVA	kilovolt-amp(s)
kW	kilowatt(s)
LSA	local study area
m	meter(s)
m/s	meter(s) per second
m^2	square meter(s)

m^3/s	cubic meter(s) per second
Master Plan	Water Utility Master Plan
MDD	maximum day demand
mg/L	milligram(s) per litre
ML/d	million litres per day
mm	millimetre(s)
$NaHSO_3$	sodium bisulphite
NaOCl	sodium hypochlorite
NaOH	sodium hydroxide
NF	nanofiltration
NH_3	ammonia
$(NH_4)_2H_2SO_4$	ammonium sulphate
NOM	natural organic matter
NPP	Navigation Protection Program
NTU	nephelometric turbidity unit(s)
PFD	process flow diagram
QAES	Qualified Aquatic Environment Specialist
RAP	restricted activity period
RFP	Request for Proposals
RSA	regional study area
RWI	raw water intake
RWPS	raw water pumping system
SARA	Species at Risk Act
SCU	solid contact unit
SDS	sodium dodecyl sulphate
TOC	total organic carbon
TSS	total suspended solids
UF	ultrafiltration
UV	ultraviolet
Va	approach velocity
Vs	sweeping velocity

w/w	weight to weight
WTP	water treatment plant

1. Introduction and Background

The City of Brandon's (City) Water Treatment Facility (Facility) is located on the south side of the Assiniboine River and has supplied water to its residents since 1893. The Facility is a conventional lime softening plant with residuals treatment and has undergone several upgrades that resulted in the current Facility. The current Facility draws its water from the Assiniboine River and includes a water intake system, Plant No. 1 constructed in 1946, Plant No. 2 constructed in 1958, Plant No. 3 constructed in 1976 and the Sludge Dewatering Facility constructed in 1997.

The City continues to experience higher population growth than the provincial average accompanied by an increase in demand for municipal services, as described in Table 1-1. This demand, combined with aging infrastructure, challenging source water quality, changing drinking water quality regulations, and elevated disinfection by-product (DBP) at the edges of the distribution system led to the City developing a Water Utility Master Plan (Master Plan) in 2015 to support the long-term sustainability of its potable water supply. As a result of the Master Plan (AECOM 2015) and the 2015 re-assessment of the City's water system infrastructure (CH2M HILL [now Jacobs] 2015), it was determined that the existing Facility requires upgrades. The design for the Facility upgrades has been based on a 2048 population of 60,503, and an associated average day demand of 29.5 ML/d with a corresponding maximum daily demand of 50.2 ML/d.

Table 1-1. Current and Future Water Demand for the City of Brandon Water Treatment Facility

Range of Average Current Demand[a]	Forecasted Future Demand[b]		Existing Water License Allowance[c]
	Average	Maximum	
20-40 ML/d 0.23-0.46 m3/s	29.54 ML/d 0.34 m3/s	50.21 ML/d 0.58 m3/s	101 ML/d 1.17 m3/s

Notes:

[a] City of Brandon Water Treatment Facility, range based on 2017 historical flow information (Jacobs 2018a)

[b] By year 2048. The new intake is designed to manage water demands for the next century (that is, until 2122).

[c] Government of Manitoba, Licence to Use Water for Municipal Purposes, Licence No.: 2017-057 (Government of Manitoba 2017a)

ML/d = million litre(s) per day

m^3/s = cubic metre(s) per second

The upgrades to the existing Facility are designed to increase capacity to meet increasing demand for potable water, improve operational health and safety at the existing Facility, and improve distributed/treated water quality to meet all regulatory requirements. Treated water quality improvements include reducing organics and DBP formation as well as managing corrosion in the distribution system.

The following upgrades are included in the scope of this Project:

- A new chemical storage and dosing facility including new staff facilities (Chemical Building)
- New raw water intake (RWI) system, including new RWI structure, Intake Building, raw water conveyance pipelines and raw water reservoirs
- A new dual membrane treatment process (Membrane Building or Plant 4) that includes additional clearwell storage
- New power supply and standby power generation infrastructure (generators, transformer and switchgear, substation)
- Various upgrades to the existing facility (e.g., filter underdrain upgrades)
- Ancillary features (e.g., yardwork and ring road).

Together, these upgrades comprise the Project. The province requires the City to submit an Environment Act Proposal (EAP) for the proposed Project. This EAP will identify the potential effects, mitigation measures, and provide an assessment of the residual effects of the proposed Project. Residual effects for the new RWI structure are based on preliminary design and construction plans and will need to be reassessed when the design and plans are finalized.

1.1 Previous Studies and Information Sources

The following previous studies of the existing Facility and proposed Project components have been reviewed in the preparation of this EAP:

- Water Utility Master Plan prepared by AECOM (2015). The study contains information about the existing Facility as well as surface and groundwater conditions at the Project site.
- Report on the Sand Intrusion Problem at the Water Intake Structure: City of Brandon. Prepared by Adam Stevenson and Associates (2007). A historical discussion of siltation issues at the existing water intake and recommendations for sediment management prepared for the City of Brandon's Engineering Department.
- Brandon Water Treatment Facility Upgrade - Treatability Testing Summary prepared by Jacobs (2019). This technical memorandum summarizes the results of the treatability testing and provides recommendations for the design of the expanded Facility.
- City of Brandon Assiniboine River Water Intake: Assiniboine River Mussel Survey and Relocation. Prepared by North/South Consultants Inc (2011). The study contains information about the fish and fish habitat in the Assiniboine River near the intake location.
- City of Brandon Water Treatment Plant Facility Upgrades - Development of a New Water Intake System on Assiniboine River: Hydrotechnical Design Report (2022). Prepared by SG1 Water Consulting. The report supports development of the 30% design by providing hydrological characteristics of the proposed intake location.
- Personal communications from the Manitoba Wildlife and Fisheries Branch staff about fish and freshwater mussel presence in the Assiniboine River around the proposed RWI location.
- An aquatic habitat assessment was conducted on October 7, 2020, by Jacobs. The survey included a vegetation inventory, incidental wildlife sightings and confirmation of other aquatic features.

The following information sources were reviewed in the preparation of this EAP:

- Manitoba Contaminated/Impacted Sites database
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status reports
- Department of Fisheries and Oceans fish recovery reports
- Ecozones of Canada (2021)
- Government of Canada Species at Risk Act (SARA) Public Registry
- Government of Canada Hydrometric Database
- Government of Manitoba Integrated Watershed Management Plans
- Parks or protected areas (digital layer)
- National wildlife areas and Migratory Bird Sanctuaries
- Important Bird Areas
- Western Hemisphere Shorebird Reserves
- Ramsar Wetlands
- Manitoba Conservation Data Centre species occurrence records
- General nesting periods for migratory birds
- *The Endangered Species and Ecosystems Act* of Manitoba

1.2 Summary of Alternatives

Alternatives to the Project included evaluation of several intake locations and plant design configurations. Four intake locations were considered and evaluated based on the relative level of intake hydraulic performance and reliability at a range of flows, proximity and connectivity to the Facility, long-term maintenance requirements, impacts on flood conveyance, impacts on navigation for river users and constructability (SGI 2022). Although the existing intake remains operational, sedimentation has been an ongoing issue and the new proposed location and design will allow for fewer maintenance and operational issues. The design of the water intake also considered operations and maintenance requirements and the effects of the Project on navigation, water quality and fish and fish habitat and the final design was chosen to minimize the effects on these elements.

The City issued a Request for Proposals (RFP) in 2017 for Engineering Services to upgrade the Facility. The RFP outlined that the project would include various upgrades of the existing Facility and capacity expansion by the addition of a membrane treatment plant (i.e., Plant 4). Jacobs evaluated three (3) alternative approaches (Jacobs 2018b) which included converting existing plants to membrane systems, upgrading the existing plants, and constructing a new membrane system (i.e., Plant 4). Collectively, the City and Jacobs, completed a qualitative evaluation of the different options, considering factors such as operations and maintenance, the long-term needs of the City, the feasibility of implementation, environmental impacts, and economic impacts. Ultimately the current Project components were chosen to reduce the effects of the Project on the environment whilst ensuring a safe, adequate water supply for the City.

2. Description of Proposed Development

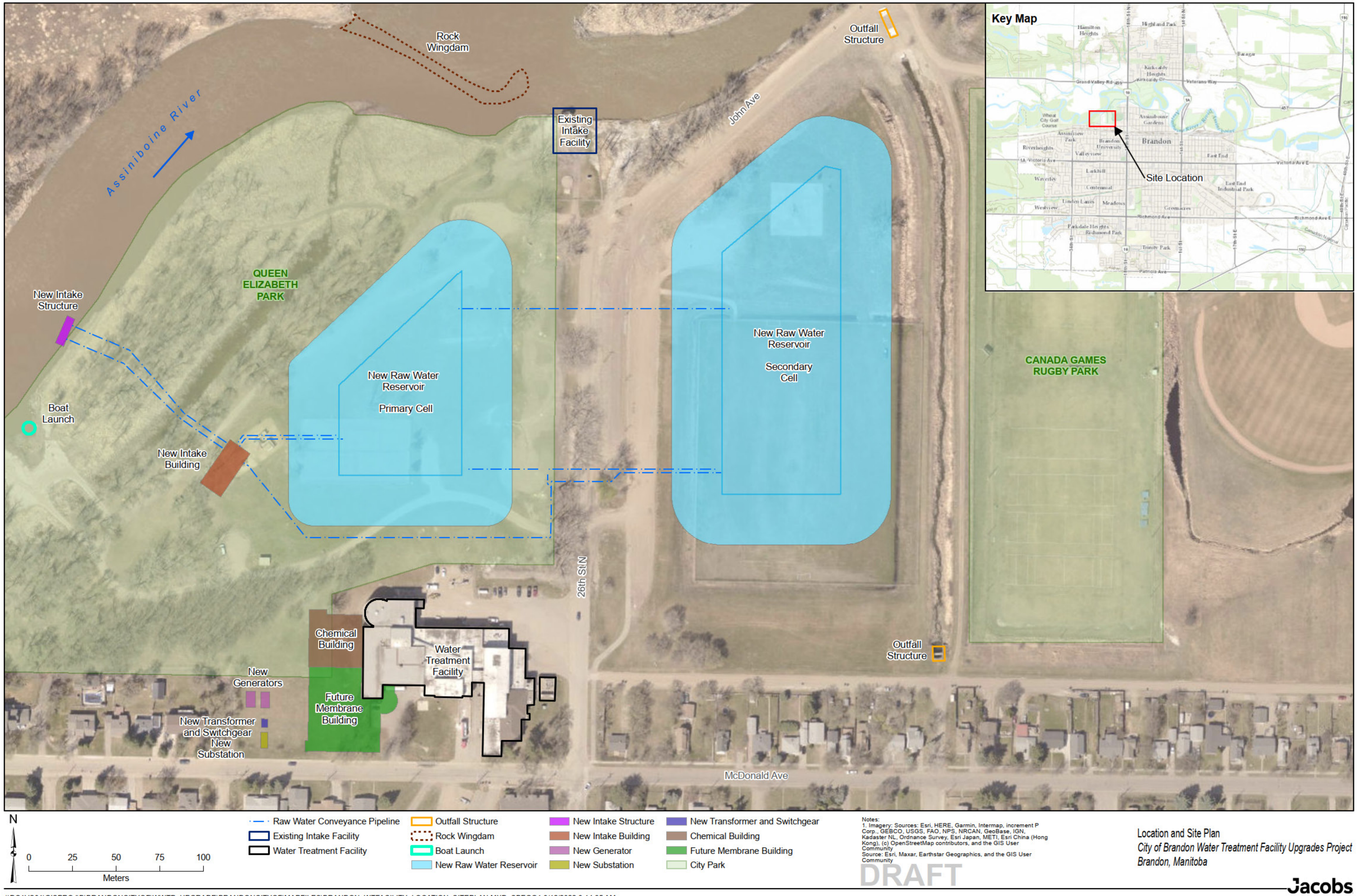
The proposed Project involves the existing Facility, additional land at Queen Elizabeth Park to the north of the existing Facility, and the soccer field area in the Canada Games Park, all located within the City boundaries as shown on Figure 2-1. The proposed Project components are located is on a parcel of land, approximately 155,000 square metres (m^2) (38 acres) in area. The site is bounded by the Assiniboine River (flows eastward) to the north, the east edge of the soccer field in Canada Games Park, McDonald Avenue to the south, and open space with nearby residential units to the west. John Avenue parallels the Assiniboine River north of the proposed secondary cell for the new water reservoir, and an existing stormwater ditch lies to the east of the new secondary cell.

2.1 Certificate of Title

The legal description of the land that the existing Facility is located on, as given on Certificate of Title 4446 is:

> *"Lots One to Ten both inclusive in Blocks On hundred and four and One hundred and five in the City of Brandon and Province of Manitoba as shown upon a plan of subdivision of part of Section Twenty-two in Township Ten and Range Nineteen West of the Principal Meridian in said Province now of record in the Brandon Land Titles Office as Plan No. 15."*

Figure 2-1. Location and Site Plan for City of Brandon Water Treatment Facility Upgrades Project



2.2 Owner of the Land

The existing Facility and proposed Project are on land owned by the City. This includes the recreational areas to the north including the soccer field to the northeast and the open space west of the Facility.

2.3 Description of Existing Land Use and Proposed Changes

The land surrounding the existing Facility has a variety of land uses. To the north of the existing Facility is Queen Elizabeth Park which contains various recreational facilities including tennis courts and a playground. To the northeast of the existing Facility there is a soccer field which is part of Canada Games Park. The Assiniboine River, including where the existing RWI is located, is to the north and west of Queen Elizabeth Park. The existing Facility is bounded to the south by McDonald Avenue and there are residential dwellings on the south side of McDonald Avenue. The existing Facility is bounded to the east by 26 Street North. To the east of 26 Street North there are residential dwellings, open space, and Andrews Field. To the west of the existing Facility is the new Chemical Building. There is also additional open space, residential dwellings and further west the Assiniboine River. There is an existing boat launch north and west of the existing Facility in Queen Elizabeth Park which is not maintained/abandoned and likely only functions as a hand launch.

The areas north and northeast of the existing Facility are within Queen Elizabeth Park, zoned as “Open Space,” and contain a baseball field, tennis courts, and washrooms. The remaining area around the Facility is zoned “Educational and Institutional.” The recreational areas to the north and the open space west of the Facility are both owned by the City and are currently accessible to the public.

As shown on Figure 2-1, with the addition of the new RWI system and the primary cell of the new raw water reservoir, the existing tennis courts and playground will be removed and there will no longer be public access to Queen Elizabeth Park. Additionally, the secondary cell of the new raw water reservoir will be located on the open land directly to the northeast of the existing Facility that is currently used as a seasonal soccer field, rendering this area also inaccessible to the public; however, this soccer field will be replaced at a new location (1st Street and Veteran’s Way). The alley to the east of 26 Street North, behind the houses along McDonald Avenue, will still be accessible. The City will engage the public regarding these changes in a future information session. Refer to Section **2.8** for additional information regarding public engagement for this project.

2.4 Overview of the Proposed Development

The Project includes several components and will be constructed using a phased approach. These include:

- New chemical storage and dosing facility including new staff facilities (Chemical Building)
- New RWI system, including new RWI structure, Intake Building, raw water conveyance pipelines and raw water reservoirs
- Addition of a new dual membrane treatment process (Membrane Plant – Plant 4) and additional clearwell storage
- New power supply and standby power generation infrastructure (generators, transformer and switchgear, substation)
- Upgrades to components of the existing facility
- Ancillary features (e.g., yardwork and ring road)

Figure 2-1 in Section 2.1 illustrates the location of the components of the proposed Project.

2.4.1 Chemical Building

A new Chemical Building has been constructed immediately adjacent to the existing Facility, sharing a west wall with the Plant 3. This Chemical Building centralizes and consolidates chemical storage and dosing equipment for the existing Facility, with room reserved for the chemical equipment for the upgraded Facility. Because the Chemical Building has already been constructed and is a part of the existing Facility, it is not considered further in this EAP.

2.4.2 New Raw Water Intake System

A new RWI system will be constructed on the southeast bank of the Assiniboine River. This new intake will transfer water to a two-celled raw water reservoir via a new Intake Building. Transfer to the raw water reservoir will occur by gravity, with the option to pump when there is a need to maintain reservoir levels that are higher than the Assiniboine River. The intake structure is sized to accommodate flow withdrawals from the Assiniboine River at the current average day demand (0.34 m^3/s), the future maximum day demand (0.58 m^3/s), and the maximum flow diversion rate as specified in the City's water license (1.17 m^3/s).

The new RWI system will consist of an intake on the riverbank, an Intake Building (valve chamber, pumps, chemical dosing, and mechanical room), primary and secondary reservoir cells with clay/synthetic liners and algal growth control systems, and reinforced concrete conductor piping conveying water to the reservoir system and sluice gates.

The location of the new RWI structure was determined based on the results of a detailed bathymetric and river morphology study of the Assiniboine River that considered four different options (SG1 Water Consulting 2022). Figure 2-1 in Section 2.1 shows the location of the proposed RWI structure for the chosen option. Factors that were considered for the chosen intake location are intake hydraulic performance/reliability, proximity to the existing Facility, navigation safety for river users, maintenance requirements, flood conveyance and constructability.

A preliminary (30%) design has been completed for the in-river RWI structure (SG1 Water Consulting 2022). The intake is a half wedge structure and composed of an upstream wingwall, an intake headwall which protrudes approximately 14 metres (m) into the river, and a downstream wingwall. Within the intake headwall are four rectangular intake ports with a total port area of approximately 15 m^2. Water will be drawn through 10 millimetre (mm) thick vertical slat fish louvers within the intake ports. The slot size between the slats for the fish louvers is 75 mm, or approximately three inches, which exceeds the design opening requirement of 2.54 mm or less in the Fisheries and Oceans Canada (DFO) *Interim code of practice: End-of-pipe fish protection screens for small water intakes in freshwater* (DFO 2020a). However, the intake sizing and approach velocity (Va) is designed to not exceed the maximum Va (0.035 metres per second [m/s]) DFO guideline for the weakest swimming fish for the forecasted maximum daily demand. Slot size and the potential risk for fish are further examined in Section 6.3.

Fish louvers are being used because, when compared to fish screens, fish louvers are less prone to sediment and frazil ice accumulation during periods of freeze up. However, the risk for frazil ice accumulation can be further reduced by avoiding operating the intake at night, or during periods where frazil ice is expected. During these periods, water can be drawn from storage ponds and replenished during more favourable conditions. The main issues associated with the existing intake (which does contain a fish screen) are sedimentation issues and sediment/frazil ice buildup on the screen. As a result, frequent maintenance is required such as annual dredging and screen cleaning. The new RWI location and design is expected to help alleviate some of these maintenance and operational issues and improve overall performance.

Fish louvers are an array of vertical slats that function by deterring fish from entering the intake by causing turbulence and fish avoidance (U.S. Department of the Interior Bureau of Reclamation 2006). Turbulence is created by placing them on a diagonal across the river flow. Therefore, fish louvers are largely a behavioural deterrent, however, the slot size (75 mm) will also exclude large-bodied fish. The intake has also been designed to have a sweeping velocity (Vs) that greatly exceeds the Va to further reduce potential entrainment of aquatic organisms.

The new RWI structure is located between the Assiniboine River and the proposed reservoir cells. River water from the new RWI system will be directed to the raw water reservoir cells via two conductor pipes each 1200 mm in diameter and approximately 115 m long. Flows from the RWI system or raw water reservoir will be connected to existing piping to enter the existing Facility. The existing intake will continue to be used until the proposed intake is operational and meeting the water withdrawal needs for the City. There are currently no plans to remove the existing intake structure.

The reservoir system will consist of two cells (a primary cell for the raw water from the Assiniboine River and a secondary cell for the storage of clarified water or pumped raw water from the Assiniboine River) as illustrated on Figure 2-1 in Section 2.1. The berms will be constructed with inner and outer slopes of 3 horizontal (H) to 1 vertical (V) to maximize storage and outer slopes of 4 horizontal (H) to 1 vertical (v) for stability and ease of maintenance. The top of the berm will be constructed a minimum of 3 m wide for vehicle access. Currently the primary cell for settling suspended solids will be about 105 m x 130 m; and the secondary cell for clarified water storage will be about 100 m x 200 m.

As noted in the Geotechnical Report prepared by Eng-Tech (Eng-Tech 2018) there is a high ground water table which will require installation of dewatering wells to facilitate groundwater drawdown and construction of the base liner. These wells will also have function post construction as they will be required to manage ground water levels during periodic cell de-sedimentation operations.

The construction of a geosynthetic membrane, 60-mil high-density polyethylene or equivalent, is proposed as an acceptable alternative to a natural clay liner for the reservoir system. The geomembrane will be under and overlain by non-woven geotextile (either 12 or 16 ounces per square yard [oz/yd^2]) and will extend over the interior side slopes of the berms. The base geotextile will serve the purpose of protecting the underside of the geomembrane from potential damage (punctures and tears) from the underlying soils, which are largely coarse-grained or contain sand or gravel. As ballast, likely sand or other fine granular material, may be required to mitigate potential uplift should an upward gradient remain after the reservoir begins filling and the pumps in the dewatering wells are turned off, the geotextile on the surface of the geomembrane will similarly act as a protective layer for the geomembrane.

A new building, approximately 15 m x 30 m, will be required for the mechanical and electrical equipment for the new RWI system.

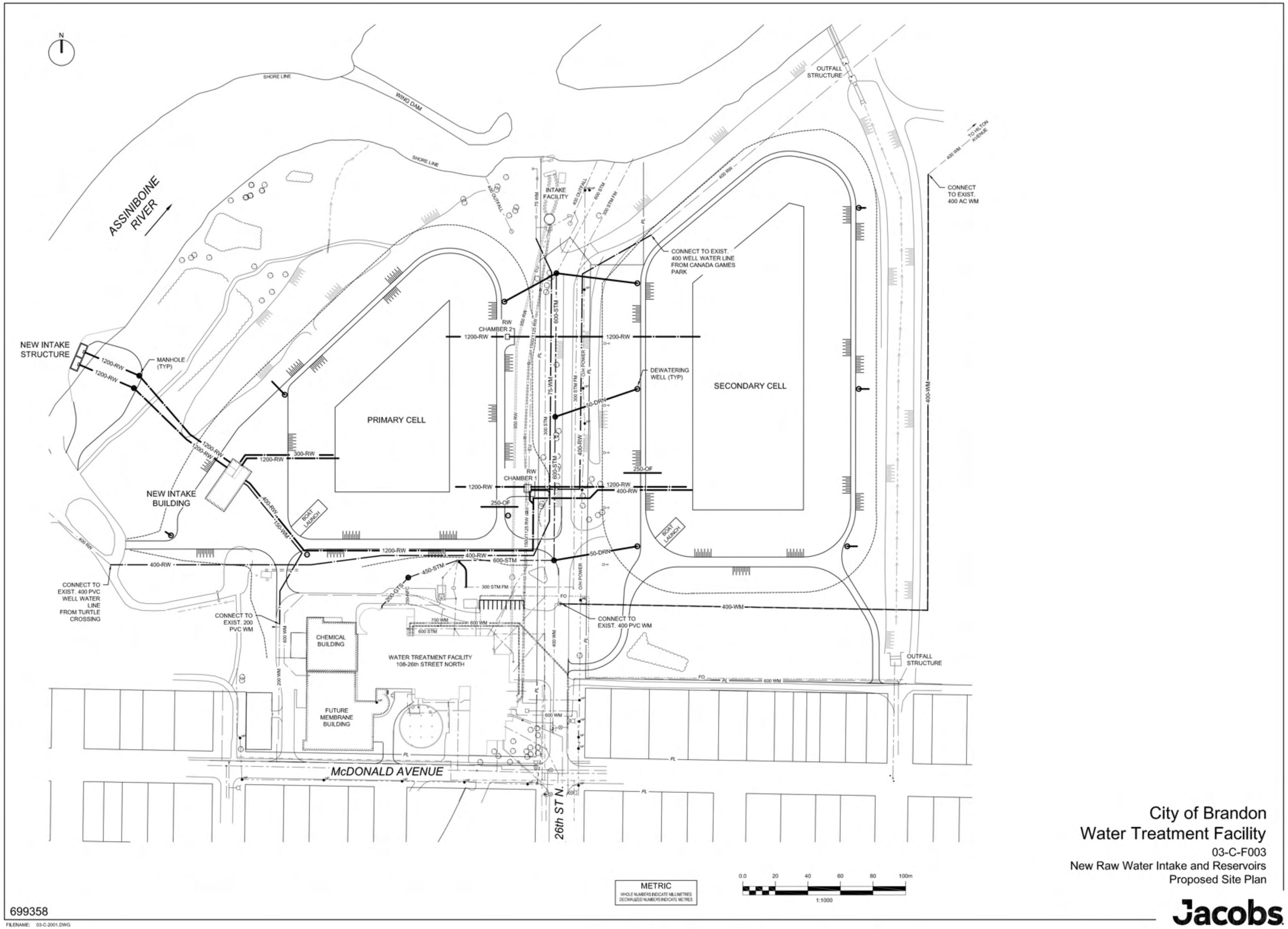
2.4.3 Raw Water Conveyance

The facilities existing raw water pumping system (RWPS) will be used to supply water to the new Membrane Plant in the medium term. The existing RWPS receives raw water flows from the Assiniboine River by gravity through a pipeline (brick-lined tunnel) from the existing intake to the raw water wet well located on the east side of Plant 1. The existing RWPS consists of four low-lift pumps (Low lift pumps 4 and 5 and pumps 9 and 10). Low-lift pump No. 9 or 10 are normally used to supply water to Plant 3 via the 600 mm raw water line. The existing RWPS has capacity to support the future Membrane Plant in the medium term while new raw water lines are constructed.

To convey raw water to the new Membrane Plant, a new 600 mm tee and transmission line from the existing 600 mm raw water line has been constructed already. The new 600 mm raw water line will tee off the existing line just north of Plant 3 and extend around the north side of the existing Facility and along the west side of the new access road that was constructed for the new Chemical Building and Membrane Plant. Figure 2-2 shows the layout and location of the new raw water main and associated pipe.

Once the 600 mm extension to the new Membrane Plant is complete and the Membrane plant operational, low-lift pumps No. 9 and 10 will be dedicated to supplying raw water via the 600 mm raw water supply line to the membrane treatment process (i.e., Plant 4), and low-lift pumps No. 4 and 5 will be dedicated to supplying the existing Facility (i.e., Plants 1, 2, 3). An existing raw water supply line will be extended inside the existing Facility to feed Plant No. 3 with raw water via pumps 4 and 5.

Figure 2-2. New Raw Water Intake and Reservoirs – Proposed Site Plan



2.4.4 Membrane Plant

The new building to house the Membrane Plant is designed as a two-storey structure with a lower level to accommodate process vessels and pumps. The Membrane Plant is adjacent to the existing Facility (which is to the east of the new Membrane Building) and directly south of the new Chemical Building.

The new Membrane Plant will house the pump trains in the south portion with a new treated water clearwell directly below grade. Flocculation tanks for Raw Water Flocculation will also be below grade in the north portion of the building. The main electrical room will be located on the ground floor. The second floor will house the secondary electrical room, mechanical room, blower room, and a control room.

In general, the membrane system will be a fully automated system that will be operated based on maintaining a blend ratio between the membrane treated water and the existing conventional lime softening plant. As much as possible, the intention of the operation is to limit the flow fluctuations within the membrane plant by allowing the treated water storage reservoir level, and distribution system storage tank levels, to fluctuate within reasonable limits.

Ancillary facilities such as a backwash system, compressed air system, chemical cleaning, storage, neutralization and transfer pump systems, control/monitoring devices will also be installed.

The overall footprint of the proposed Membrane Plant is approximately 1,700 m^2 (46.4 m x 29.5 m plus 28.9 m x 11.3 m). The layout results in the use of portions of the existing south parking lot, and the removal of the existing horizontal liquid carbon dioxide storage tank, which will be replaced with a new vertical storage tank located to the north of the existing Facility alongside the access road. The preliminary estimate for the building height from the ground level to roof is approximately 8.4 m, with a height of approximately 4 m, from the basement floor to ground level. A variance is required from the City as it is less than 3 m from the property line.

The proposed Membrane Plant (Plant 4) will include the following main processes:

- Raw water pumping (re-use of existing raw water pumps, low lift pumps No. 9 and 10)
- Pretreatment with coagulation/flocculation to bind particulate matter and reduce membrane fouling
- Dual membrane filtration (ultrafiltration [UF] and nanofiltration [NF])
- Chlorination and treated water storage
- High-lift pumping (re-use of existing high-lift pumps)
- Ultraviolet (UV) disinfection (re-use of existing UV systems), with some upgrades to the transfer pumps UV system (details provided under Upgrades to Existing Facility), and
- Residuals Treatment (re-use of the existing residuals treatment system)
- New entrance area and plant offices

2.4.4.1 Process Flow Description

The following subsections provide an overview of the components of the membrane plant (i.e., Plant 4). A process flow diagram (PFD) of Plants 1 – 4 and a PFD of the residuals treatment is presented in Appendix A. The PFDs illustrate the locations of chemical dosing, which is also summarized in Table 2-1 in Subsection 2.4.9.

2.4.4.2 Coagulation and Flocculation

Raw water will be pumped to the flocculation tanks within the Membrane Plant via a single 600 mm raw water pipeline. Chemicals (polyaluminum chloride or ferric sulphate, and sulphuric acid) will be added into the pipe, rapid mixed with a static mixer, and split into three flocculation tanks. The design capacity for flocculation was selected to match the raw water design capacity of the UF membrane system.

The raw water will enter the flocculation basins via piping with static mixers for chemical mixing. A dividing baffle wall will be included between Cell No. 1 and 2 to allow for even flow distribution and control short circuiting. Each of the cells in the flocculation basins will include two vertical, axial flow, mechanical flocculators in parallel (for a total of four per basin). A form of permanent access to the flocculation tanks (for e.g., ladders) will be provided.

2.4.4.3 Ultrafiltration

The main membrane treatment processes proposed for the project is UF followed by NF. The flocculated water will overflow from the flocculation tanks to the UF membrane feed pump wet well. Flow will then pass through the UF pre-screens (200-micron, self-cleaning screens), which will remove larger suspended solids and other particulates from the flocculated water, so they do not cause membrane integrity issues and adversely impact UF performance.

Additionally, to prevent downstream biofouling of the NF, chloramines are added to the UF feed to maintain a small chloramine residual in the NF system that prevents biological fouling. The chloramines are generated from ammonium sulphate and sodium hypochlorite in a side stream loop using NF permeate. The target dose is 1.5 – 3.0 milligrams per litre (mg/L) of chloramines (total chlorine). Following the NF, the chloramines are removed from the NF concentrate through breakpoint chlorination in the rectangular reservoir (refer to the following subsection for additional details).

The UF membrane design consists of five (5) trains (4 duty, one standby) with space for up to 200 modules per train to meet the 2048 demand. In the UF process, suspended and some colloidal solids are retained on the membrane surface and the filtered water is discharged to a break tank. The break tank acts as both a storage tank to help alleviate flow fluctuations from the UF membrane system, and to provide storage for water that will be used for backwashing the UF membranes. Normal Backwashing typically occurs every 30 – 40 minutes, and the waste from the backwash system is collected in the UF waste tank. UF waste residuals are sent to the sludge dewatering in the existing facility via the existing solid contact units (SCUs).

Because the backwashing is not 100% effective at removing particulates and foulants, additional membrane cleaning is required. The frequency of the membrane cleaning is variable. A storage tank is provided to store permeate water for the cleaning cycles. Chemically enhanced backwash (CEB) occurs with 12% sodium hypochlorite (200 mg/L), and with 93% sulphuric acid (1,825 mg/L). Additionally, in-situ clean in place (CIP) chemical cleaning occurs with 12% sodium hypochlorite (1,000 mg/L), 50% citric acid (2,000 mg/L), and 93% sulphuric acid (1,600 mg/L). The CEB and CIP cleaning cycles use heated water to approximately 40°C, using immersion heaters in the CIP tank. The spent cleaning solutions and the flush water used to remove residual chemical will be transferred to a neutralization tank. Following neutralization, the solution will be collected in the UF waste tank. Chemical cleaning cycles from the UF membrane system generate high solids and high chemical oxygen demand concentration waste. This waste is collected in a UF waste tank and is sent for treatment in the existing residuals treatment facility (Figure A-2 in Appendix A) or is sent directly to the sewer (as is the case for the citric acid waste). The backwash water will contain chloramines, so the backwash waste will be dechlorinated with sodium bisulphite as it enters the UF waste tank.

2.4.4.4 Nanofiltration

NF feed pumps will pump from the break tank through cartridge filters (which remove any particulate matter collected in the UF/NF break tank) to the NF trains. Following the cartridge filters, there is NF feedwater pre-treatment through the addition of a scale inhibitor (2.4 mg/L) to supress the precipitation of potential scalants.

The NF system is a pressure-driven membrane separation process that employs a semipermeable membrane to remove dissolved contaminants from the feed water. The NF design consists of 4 trains that will achieve the full 2048 permeate flow of 30 ML/day.

Similar to the UF system, not all of the feed water is recovered as product water; some is used to carry the rejected contaminants away from the NF membrane surface in the form of a continuous concentrate stream. The concentrate stream will not contain any appreciable amount of total suspended solids (TSS), but it is expected to be quite high in hardness, alkalinity, chlorides, total dissolved solid, total organic carbon (TOC), and various dissolved metals and salts. Initial discussions with the Manitoba Sustainable Development have suggested that there will be no issue sending this concentrate back to the Assiniboine River of the discharge compliance limits for the existing waste management facility continue to be met.

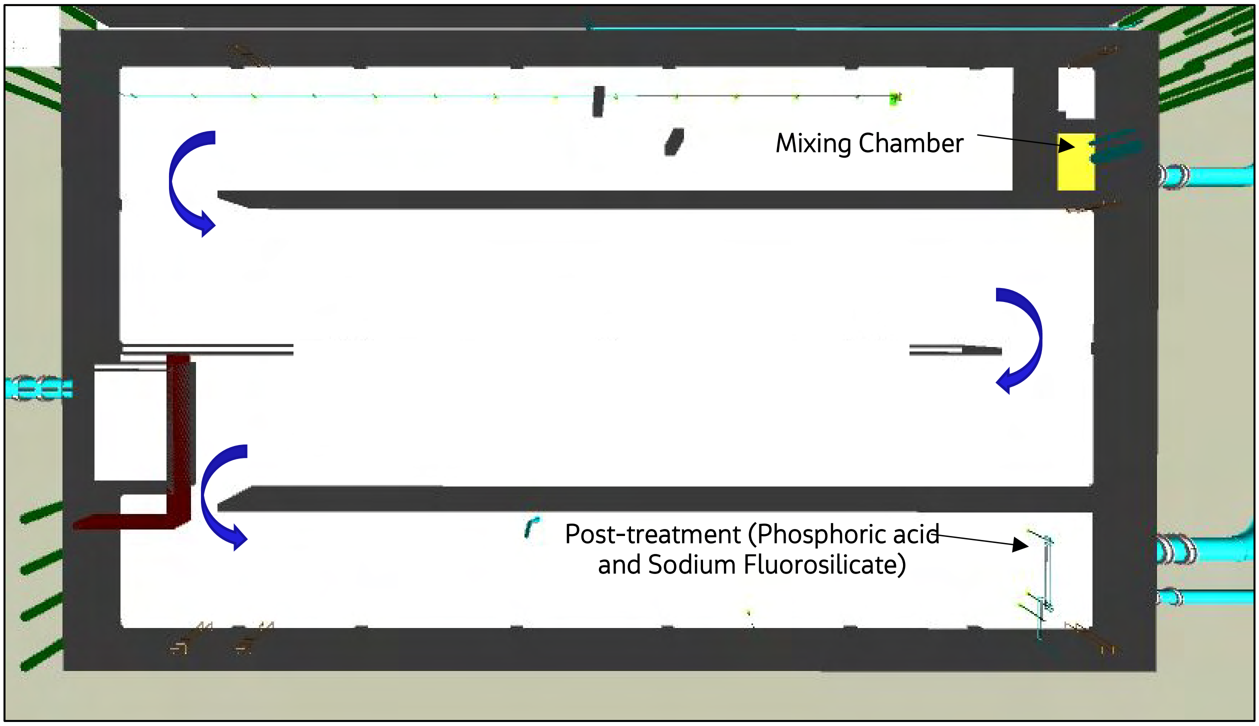
Due to the addition of chloramines and subsequent de-chloramination of the waste stream, under a worst-case scenario, there is potential to exceed the 30-day Tier II Water Quality Objective of 1.8 mg/L for ammonia (based on the average yearly raw water temperature of 9.1°C and pH of 8.2), though this is unlikely based on the poor rejection of chloramines by the NF membrane. Under typical conditions, a dosage of 1.5 mg/L chloramines will be used for biofouling control. Under this scenario, the NF waste concentration of chloramines is approximately 1.5 mg/L, resulting in an estimated amount of ammonia generated following the addition of sodium bisulphite for chloramines neutralization of 0.6 mg/L, which is below the 30-day Tier II Water Quality Objective. This assumes very little removal of chloramines with the NF membrane (approximately 10%), which is based on the data obtained during the proof pilot study. The limited literature available suggests RO membranes can remove up to 50% of chloramines, however, that does not appear to be the case for the particular tight NF membrane. This data will be discussed later on in the report.

Similar to the UF membranes, the NF membranes require chemical cleaning, however, this cleaning is completed less frequently at an interval of 3 months or greater. NF permeate is stored in a dedicated NF CIP tank for this purpose. There is a high pH clean using 50% sodium hydroxide (1,000 mg/L) and potentially sodium dodecyl sulfate (250 mg/L), as well as a low pH clean using 50% citric acid (1,000 mg/L) and 93% sulphuric acid (500 mg/L). Chlorine is not used in the cleaning process. For the high pH clean, the spent solution is pH neutralized and can be sent to the sewer or to the UF waste tank for treatment within the existing residuals treatment system. For the low pH clean, the spent solution is pH neutralized and is sent to the sewer for proper treatment.

2.4.4.5 Storage of Treated Water

A new treated water storage reservoir will be constructed below the membrane treatment skid area in the new Membrane Plant and will serve two functions: to provide the contact time required to achieve primary disinfection for virus reduction, and to provide additional storage for balancing of the flow into the distribution system. The rectangular reservoir is baffled in a serpentine configuration such that the treated water flows from the northeast corner to the southeast corner as presented on Figure 2-3. The rectangular reservoir will work in conjunction with the existing circular clearwell ahead of the existing high-lift pumps.

Figure 2-3. Membrane Building – Rectangular Clearwell



Filtered water from the existing Clearwell 3B flows by gravity into a mixing chamber located in the northeast corner of the rectangular reservoir, where it blends with the membrane permeate from the NF membrane treatment process as well as a bypass from the UF effluent. The purpose of this bypass is to maintain hardness and alkalinity and reduce the "aggressiveness" of the treated water from the membrane system and minimize the impact on the distribution system when blended with the existing softening plant effluent.

As shown on Figure A-1 of Appendix A, prior to entry to the rectangular reservoir, the NF permeate flow is dosed with sodium hydroxide to raise the pH of the treated water to reduce the corrosion potential and is dosed with sodium hypochlorite for breakpoint de-chloramination and disinfection. If the flow from existing Clearwell 3B bypasses the rectangular reservoir, there is chemical dosing of sodium hypochlorite, sodium fluorosilicate, and phosphoric acid in the existing facility. At the end of the rectangular reservoir, post-treatment chemicals including sodium fluorosilicate (fluoride) and phosphoric acid are dosed for fluoridation and corrosion control, respectively.

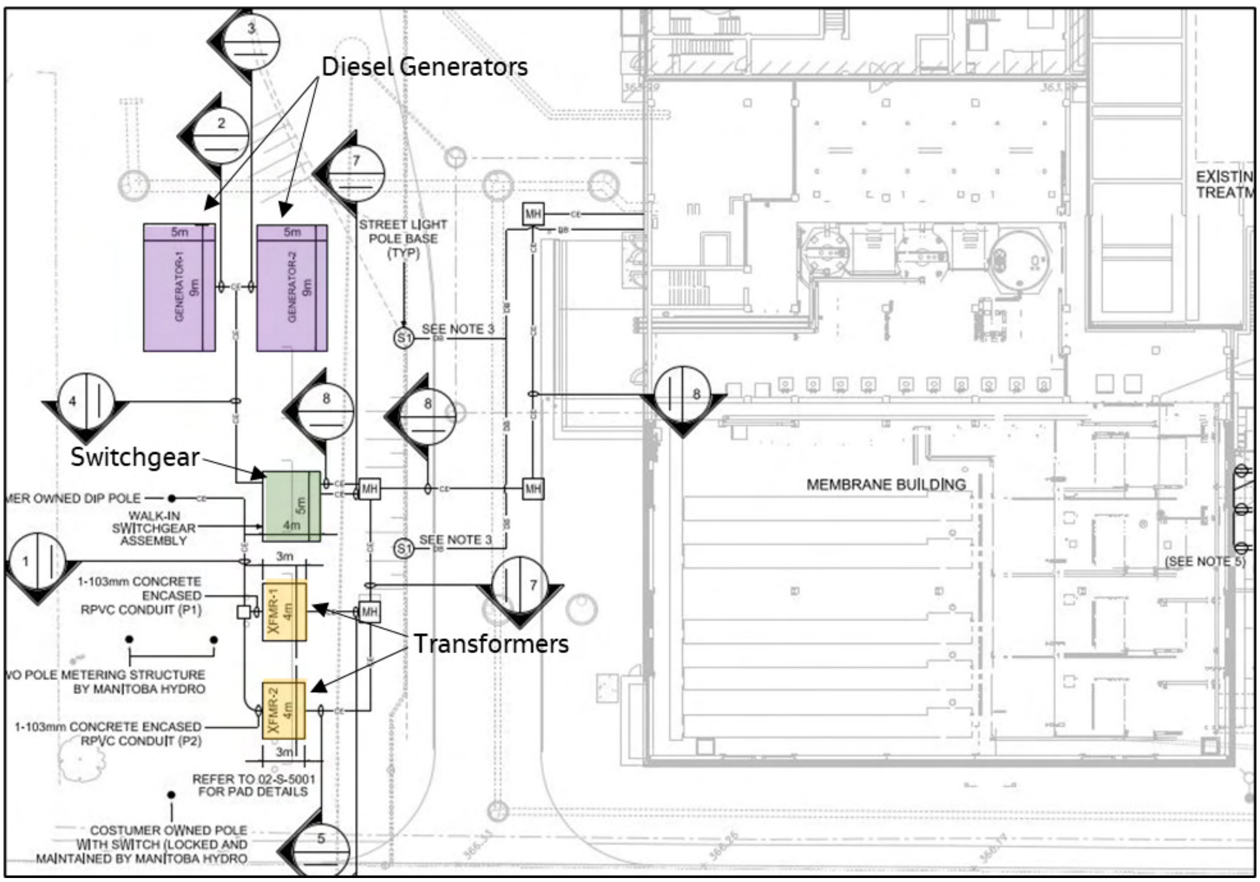
From the rectangular reservoir, the blended treated water flows by gravity into the existing circular clearwell, which is hydraulically connected to the high-lift pump well. The flow path through the existing circular clearwell will be reversed to facilitate the required tie-ins. Additionally, modification to the yard piping and the piping internal to the circular clearwell and Clearwell 3B will be completed and the construction of a new valve chamber to facilitate the tie-ins required between the reservoir and clearwells. The existing high lift pumps will continue to pump treated water from the high-lift pump well to the distribution system, once the system in operating in its final configuration.

2.4.5 New Power Supply Standby Generation Infrastructure

A new electrical substation, transformer and switchgear are required for the power demands of the proposed new components and processes and will be located on the southwest corner of the property, west of the new buildings and ring road. A new outside switchgear for the Membrane Plant will be located immediately north of the new electrical substation which is fed by the 33 kilovolt (kV) Hydro line. Two transformers will be provided for redundancy, each of size 2000 kilovolt-amp (kVA), for a total of 4000 kVA.

The existing substation on the east side of the existing Facility must remain operational to service existing plant loads. The existing 800 kilowatt (kW) generator will provide standby power to the existing substation loads. Two (2) new 1500 kW, 600 V diesel generators will be required to provide a total of 3000 kW of standby power to service critical membrane process loads during a power outage. The new generators will be contained in a weatherproof, sound attenuating enclosure, with sub-base fuel tank, and are located to the west of the membrane building and north of the new electrical substation.

Figure 2-4. Membrane Building – Substation and Diesel Generators



2.4.6 Upgrades to Existing Facility

There are several upgrades necessary to maintain or extend the life of the existing Facility, and allow for the construction and commissioning of the Membrane Plant. The following is a list of the intended key upgrades:

- **Solids Contactor Unit (SCU) No.2 refurbishment**: Refurbishment is required to maintain the existing design capacity and level of functionality of SCU #2 in Plant 2. The upgrade will include the replacement of SCU No. 2's internal parts and piping and the structural rehabilitation of the concrete basin.
- **Improvements to the Lime and Soda Ash Unloading System:** The existing Facility's method of transferring dry bulk chemicals from delivery trucks to silos is well-maintained but suffers from lengthy unloading times. To improve the efficiency of unloading dry bulk chemicals, system improvements are required. The associated air and dust handling equipment will also be upgraded.
- **UV Disinfection Redundancy Downstream of Transfer Pumps:** Addition of a smaller UV reactor on a bypass line around the existing UV reactor unit located downstream of the transfer pumps to allow for a limited level of redundancy when the high lift pumps are out of service and the transfer pumps are used to provide water to the distribution system.
- **Liquid Carbon Dioxide Storage Tank:** Installation of a new vertical liquid carbon dioxide storage tank on the northeast side of the existing sludge dewatering facility on a designated concrete pad located northwest of the parking lot. Decommissioning and demolition of the existing liquid carbon dioxide storage tank to facilitate the civil work associated with the new Membrane Building and tie-ins to the existing Facility.
- **Filter Underdrain upgrades for all Filters of the existing Facility:** To assist in improving the overall filtered water quality, the media filters in Plants 1, 2, and 3 of the existing Facility will be upgraded by replacing the underdrain systems and sand media. While no specific problems have been identified, the existing underdrain systems are beyond their intended useful life and use relatively outdated technology. Several alternative underdrain systems are being considered and the addition of air scour to the filters is recommended.
- **Improvements to the Gravity outfall system for the residuals stream**: At high water levels, gravity discharge of residual streams is impeded and may not be possible. This can result in back up and risk of flooding of the sludge pumping station, and potential leakage from the gravity drain manholes. To mitigate these risks, a new pumping system will be constructed.
- **Plant No.1 Roof:** The roof for Plant No. 1 will be replaced.
- **Raw Water Main Extension:** A new raw water supply line will be provided to supply raw water to the Plant No. 3 Solids Contact Unit (SCU #3) from Low Lift Pumps No. 4 and 5. The new water supply line will be routed to Plant No. 3 by extending the easing 400 mm raw water supply line that currently provides water to Plants No. 1 and 2.
- **Ultrafiltration Residuals Management:** UF backwash waste will be discharged to the offline SCU, whose blowdown connection will be used to connect to the sludge pumping station for residuals management. With the proposed future raw water feed arrangement to the existing Facility at least one plant will always be offline.
- **NF Residuals Management:** NF reject will be connected to the well water flushing line for discharge to the Assiniboine River. Additional details are provided in Subsection 2.4.4.
- **Site Drainage:** The east side of the existing Facility experiences drainage issues with stormwater backing up in this area during spring runoff and other high flow events. Improvements will be required east of the Facility to improve drainage.
- **Existing Chemical Systems:** The new chemical building contains the treatment chemicals except those applied seasonally. Once the chemical building is brought online and the new dosing system has undergone all necessary tests, meets its design intent, and is in operation, the existing dosing

infrastructure (aluminium sulphate, chlorine gas, sodium fluorosilicate and polymer (PAM A-703)) will be taken offline, rendered safe (e.g., remove power, chemicals) and dismantled.

These upgrades will occur within the existing Facility grounds.

2.4.7 Yardwork and Ring Road Addition

The civil site works described here relate to the construction of the proposed Membrane Plant, Chemical Building, and ancillary infrastructure required. The Membrane Plant will be constructed after the Chemical Building; therefore, the civil works for the Membrane Plant will build on the work completed during the new Chemical Building construction. This includes the site grading related to the Chemical Building and the roadway. Final site grading and roadway paving can only be completed once the Membrane Plant is constructed.

The main components of the civil work include:

- Sanitary building connection and lift station
- Site grading and drainage including weeping tile collection system
- Site access roadway

Prior to and during construction of the Membrane Plant, the access road south of the Chemical Building will be a gravel road. This is to prevent damage that construction activities will have on any asphalt road in the area. Following construction of the Membrane Plant, the access road will be completed.

The Chemical and Membrane buildings' wastewater service lines will flow by gravity to a sanitary lift station located along the west side of the site. The lift station connects into the existing 250 mm clay sewer located on McDonald Avenue. A new manhole is installed in-line on this sewer to connect the force main. Process waste flows and the capacity of the existing sewer will be evaluated once these are established.

In addition, a chemical containment holding tank is located immediately west of the chemical offloading station and the ring road.

2.4.8 Construction Activities

During construction of the upgrades to the existing Facility, typical construction materials will be used (e.g., rebar, concrete, gravel). All products and equipment that may come in contact with drinking water (e.g., pipes, valves) will be NSF-61 certified. Any waste materials generated from construction will be disposed of according to applicable regulations.

2.4.9 Operations – Chemical Usage and Membrane Plant Residuals

2.4.9.1 Water Treatment Process Chemicals

The Facility currently uses over a dozen chemicals for treatment. These chemicals will continue to be used following completion of the Project, however, some chemicals are now relocated to the new Chemical Building.

In addition to the chemicals required for the existing Facility, the new Chemical Building will house chemical storage and dosing systems for corrosion control (currently assumed to be 75% phosphoric acid [H_3PO_4] for ortho-phosphate addition) and post-blending pH adjustment (50% sodium hydroxide [NaOH]). The Chemical Building will also contain additional chemicals required in the future for the new membrane system.

A summary of the existing and future chemical use is summarized in Table 2-1. In Appendix A, Figure A-1 shows the chemical dosing locations. The dosing locations for the new membrane plant and rectangular reservoirs are also summarized in Table 2-1.

Table 2-1. Summary of Existing and Future Water Treatment Process Chemicals

Chemical Name	Existing or New Water Treatment Process Chemical	Located in New Chemical Building?	Applied in Membrane Plant/Rectangular Treated Water Reservoir?	Purpose of Chemical	Application Point in Membrane Plant/Rectangular Treated Water Reservoir
Potassium Permanganate	Existing	Yes	No	Pre-oxidation of raw water (intermittent use, summer typically)	N/A
Clarifier D-40	Existing	Yes	No	Settling aid (intermittent use, spring typically)	N/A
Lime (Quicklime)	Existing	No	No	Water softening	N/A
Soda Ash	Existing	No	No	Water softening	N/A
Aluminium Sulphate (Alum)	Existing	Yes	No	Coagulant	N/A
Ferric Sulphate	Existing	No	No	Coagulant (intermittent use, spring and summer typically)	N/A
PAM A (A-703)	Existing	Yes	No	Flocculation	N/A
Powdered Activated Carbon	Existing	No	No	Organics removal (intermittent use, spring to fall typically)	N/A
CTI CL2410	Existing	Yes	No	Cationic polymer used as a filtration aid (intermittent, spring typically)	N/A
PAX XL6 (polyaluminum chloride)	Existing	Yes	Yes	▪ Existing Plant: Filter aid (intermittent, spring to fall typically) ▪ Membrane Plant: Coagulant	▪ Raw water header upstream of flocculation tanks
Carbon Dioxide	Existing	No	No	pH adjustment (re-carbonation) following the solids contact units (SCUs)	N/A
Gaseous Chlorine	Existing	No	No	Disinfection	N/A

Chemical Name	Existing or New Water Treatment Process Chemical	Located in New Chemical Building?	Applied in Membrane Plant/Rectangular Treated Water Reservoir?	Purpose of Chemical	Application Point in Membrane Plant/Rectangular Treated Water Reservoir
Sodium Hypochlorite (12%) [NaOCl]	Existing	Yes	Yes	Disinfection (intermittent)	Multiple addition points: ▪ Biofouling control pumps discharge which is pumped to the UF inlet header ▪ Treated water from NF membranes before entry to rectangular reservoir ▪ UF clean in place pump discharge header ▪ UF backpulse pump discharge header
Sodium Fluorosilicate (0.2%)	Existing	Yes	Yes	Fluoridation agent	▪ End of rectangular reservoir
ZETAG 8180 (copolymer of acrylamide and quaternized cationic monomer)	Existing	No	No	Sludge Thickening Polymer: conditioning/dewatering	N/A
ZETAG 4125 (copolymer of acrylamide and acrylic acid)	Existing	No	No	Sludge Thickening Polymer: conditioning/dewatering	N/A
Phosphoric Acid (75%) [H_3PO_4]	New	Yes	Yes	Corrosion control	▪ End of rectangular reservoir
Sodium Hydroxide (50%) [NaOH]	New	Yes	Yes	pH adjustment, neutralization	Multiple addition points: ▪ NF CIP pump discharge header ▪ Neutralization tank ▪ Treated water from NF membranes before entry to rectangular reservoir

Chemical Name	Existing or New Water Treatment Process Chemical	Located in New Chemical Building?	Applied in Membrane Plant/Rectangular Treated Water Reservoir?	Purpose of Chemical	Application Point in Membrane Plant/Rectangular Treated Water Reservoir
Antiscalant (PWT Spectraguard 360)	New	Yes	Yes	Suppress the scaling potential of the concentrate water in the NF membrane and prevent scaling on the membrane	▪ NF membrane feed water
Sulphuric Acid (93%) [H_2SO_4]	New	Yes	Yes	Used in conjunction with the antiscalant to prevent scaling on the NF membrane, pH adjustment	Multiple addition points: ▪ Raw water header upstream of flocculation tanks ▪ NF CIP pump discharge header ▪ UF CIP pump discharge header ▪ UF backpulse pump discharge header
Liquid Ammonium Sulphate (38%) [$(NH_4)_2H_2SO_4$]	New	Yes	Yes	Used for the generation of chloramines for biofouling control prior to the NF membrane stage	▪ Biofouling control pumps discharge which is pumped to the UF inlet header
Sodium Bisulphite [$NaHSO_3$]	New	Yes	Yes	Used to neutralize chlorine from the cleaning process, quench chloramines	Multiple addition points: ▪ UF filtrate bypassing NF membranes ▪ Neutralization tank ▪ NF concentrate (reject) prior to discharge to the Assiniboine River ▪ UF backwash waste prior to entering the UF waste tank
Citric Acid (50%) [$C_6H_8O_7$]	New	Yes	Yes	Used to remove the inorganic foulants on the UF and NF membranes as part of the cleaning process	Multiple addition points: ▪ UF clean in place pump discharge header ▪ NF clean in place pump discharge header
Sodium Dodecyl Sulfate (SDS)	New	Yes	Yes	Potentially to be used as part of the cleaning process for the NF membranes	▪ NF clean in place pump discharge header

2.4.9.2 Process Flow

Raw water will be withdrawn from the new RWI location in the Assiniboine River. The City also has approval to draw water from two nearby wells (Turtle Crossing Well and Canada Games Park Well) that serve as both a backup and supplemental raw water source. Although blending of the Assiniboine River and the well sources has occurred when operating the existing Facility (to reduce the TOC to the Facility during the spring run-off), the intention is for the upgraded Facility to use only the Assiniboine River as a raw water source. The existing Facility is licensed to withdraw 101 megalitres per day at a maximum rate of 1.17 m^3/s from the Assiniboine River. Table 2-2 summarizes the Water Demand projection until 2048 in 5-year intervals.

Table 2-2. Water Demand Projections to 2048 at 5-Year Intervals

Year	Average Day Treated Water Production [a] (m3/d)	Maximum Day Treated Water Production [a] (m3/d)	Average Day Demand (ADD) [b] (m3/d)	Maximum Day Demand (MDD) [b] (m3/d)
2025	25, 414	43, 204	24, 448	41, 562
2030	26, 658	45, 319	25, 645	43, 597
2035	27, 822	47, 298	26, 765	45, 501
2040	28, 930	49, 182	27, 831	47, 313
2045	29, 886	50, 805	28, 750	48, 875
2048	30, 702	52, 194	29, 535	50, 210

[a] Based on an estimate of 3.8% potable water for in-plant use

[b] Treated water to distribution; does not include potable water for in-plant use

Source: Jacobs. 2018. City of Brandon Water Demand Projections

2.4.9.3 Residuals

The treatment process for the existing Facility is lime softening (SCUs), followed by recarbonation, and sand filtration. The City operates three similar process streams in Plants 1, 2, and 3. Currently lime and alum sludge from the SCUs and from the backwash from Plant 1, 2, and 3 filters combine in an underground sludge pumping station, equipped with an overflow pipe. This pipe directs excess flow to the Assiniboine River when the pumping capacity from the sludge pumping station is exceeded (typically during a filter backwash). Waste from the sludge pumping station is pumped to a gravity thickener in the Facility. Thickened solids from the gravity thickener are further dewatered in two belt presses. The dewatered sludge cake is disposed of at a landfill or is land-applied. Thickener decant and belt filter press filtrate are returned to the sludge pumping station.

The new dual-membrane facility will create two main residual streams from the ultrafiltration and the NF membrane systems. The NF reject or concentrate stream is planned to be directly discharged to the Assiniboine River. In the absence of coagulant, this stream is primary concentrated raw water, with elevated levels of raw water constituents (bi-valent ions, dissolved solid, chlorides, iron, manganese, etc.) and ammonia from the de-chloramination process mentioned earlier.

It is intended to integrate the reject stream from the UF system into the sludge handling process of the existing dewatering system through the existing SCUs, using the offline SCU as a storage basin for the UF reject. In order to allow the existing waste management system to incorporate the UF waste and to better manage the solids, the following is the proposed method of operating the residuals management system:

1. The UF backwash and neutralized cleaning waste, the SCU and filter backwash waste will all be sent to the existing sludge pumping station. The SCUs will have the ability to collect and store the UF

backwash waste, allowing the existing sludge transfer piping to re-used to convey the UF backwash wastewater to the sludge pumping station.

2. In order to limit overflow of the sludge pumping station to the filter backwash only (and limiting the filter backwash waste solids to an estimated 53 mg/L TSS), the UF waste entering the sludge pumping station will be stopped when a media filter is being backwashed.

3. The supernatant from the gravity thickener will be sent directly back to the Assiniboine River.

4. The supernatant from the belt press system will be re-cycled back to the sludge pumping station (but only when the filters are not being backwashed).

5. A cationic polymer will be added to the thickener inlet to assist with the settling of the mixed SCU and UF filter backwash wastes.

Based on operating the existing residual management system in this manner, under the Phase 1 expansion of the Facility, and typical raw water quality conditions, the following table represents the projected flow and water quality from the waste streams from the existing solids management system and the NF waste system, which are both sent back to the Assiniboine River.

Table 2-3. Estimated Solids Generation for the Waste Streams Leaving the Upgrade Facility during Phase 1 for the Average Raw Water Quality Condition

Parameter	Raw Water	Thickener Supernatant	Filter Backwash Waste	Belt Press Waste Sludge	NF Concentrate
Daily Flow (ML/d)	54.4	2.2	0.7	0.04	4.6
TSS (mg/L)	48	35	53	361.600	0.4
% Solids (w/w)	N/A	N/A	N/A	36.1%	N/A
Solids Loading (kg/day)	2610	77	37.6	14,595	1.7
Ammonia [a] (mg/L)	0.1	N/A [b]	N/A [b]	N/A	0.4

[a] Expressed as Ammonia-as-Nitrogen

[b] This is based primarily on the UF system waste, as it is mixed with the SCU waste, as the existing lime softening process will not contribute any significant amount to ammonia production.

kg = kilogram(s)

w/w = weight to weight

During the spring run-off season, the raw water characteristics can change quite dramatically regarding the TSS, with a substantial increase experienced for a few weeks. During this period, raw water turbidity can increase to up to 250 nephelometric turbidity units (NTU), resulting in TSS concentrations in excess of 350 mg/L. In this situation, the solids loading within the Facility, and subsequently the residuals management system, is briefly impacted. Using similar residual system solids removal efficiencies as the average water quality condition, projected flow and water quality from the waste streams from the existing solids management system and the NF waste system are outlined in Table 2-4.

Table 2-4. Estimated Solids Generation for the Waste Streams Leaving the Upgrade Facility during Phase 1 for the Spring Run-off Water Quality Condition

Parameter	Raw Water	Thickener Supernatant	Filter Backwash Waste	Belt Press Waste Sludge	NF Concentrate
Daily Flow (ML/d)	44.0	2.2	0.6	0.06	3.7
TSS (mg/L)	383	57	85	361.700	0.4
% Solids (w/w)	N/A	N/A	N/A	36.2%	N/A

Parameter	Raw Water	Thickener Supernatant	Filter Backwash Waste	Belt Press Waste Sludge	NF Concentrate
Solids Loading (kg/day)	16,861	124	150	23,439	1.4
Ammonia [a] (mg/L)	0.1	N/A [b]	N/A [b]	N/A	0.4

[a] Expressed as Ammonia-as-Nitrogen

[b] This is based primarily on the UF system waste, as it is mixed with the SCU waste, as the existing lime softening process will not contribute any significant amount to ammonia production.

The proposed membrane water treatment process will generate an excess UF waste stream to the sewer of 0.8 megalitres per day. This represents the flow from the UF waste stream which exceeds the maximum hydraulic load to the thickener in the existing facility. This flow will be discharged to the sewer via a lift station. Overall, Jacobs estimates the existing residual management system can process up to 62% of the UF waste flow based on the design horizon.

2.4.9.3.1 Total Suspended Solids (TSS)

As shown in Table 2-3, the solids (TSS) concentrations for the streams being returned to the River are 35 mg/L, 53 mg/L and 0.4 mg/L for the thickener supernatant, the media filter backwash, and the NF concentrate, respectively. Regarding the thickener supernatant, this solids value assumes that a solids removal efficiency of 99.5% can be achieved within the thickener. To verify if this is possible, jar testing was carried out using a representative ratio of UF backwash waste and SCU sludge (88% UF backwash waste, 18% SCU sludge). Based on maintaining the thickener overflow rate within its expected design, and the addition of approximately 4 mg/L of cationic polymer, jar testing results have shown that up to 99.7% reduction of solids can be achieved (whereas only 94.6% reduction can be achieved with no polymer addition).

During spring run-off, there is a significant increase in the suspended solids entering the Facility, resulting in an increase in the TSS within the residuals treatment system. Under this condition, the values increase to 57 mg/L for the thickener supernatant and 85 mg/L for the filter backwash waste.

2.4.9.3.2 Ammonia

Jacobs has included provisions within the design to address biofouling on the NF membrane. To prevent this, the addition of chloramines in the feedwater to the UF trains will be provided to maintain a small chloramine residual to prevent biological growth. Because the presence of chloramines in the feedwater to the NF system will translate to some level of chloramines in the concentrate stream and possibly the filtrate stream, de-chloramination of the concentrate stream will be implemented prior to discharging the concentrate to the river. As outlined earlier, based on a target chloramines dosage of 1.5 mg/L, and an approximate 10% reduction of the chloramines through the NF system (which includes an approximate 20% bypass of UF water around the NF), it would be expected that the chloramines (total chlorine) in the NF concentrate stream would be approximately 1.4 mg/L. To verify this, total chlorine measurements were taken during the proof pilot study on the treated water and concentrate streams from the NF system. When 1.5 mg/L of chloramines was consistently dosed (measured as 1.5 mg/L of total chlorine), the treated water total chlorine was very similar, if slightly less, and not statistically significantly different.

2.5 Project Schedule

The schedule for each stage of the proposed Project is outlined in Table 2-5.

Table 2-5. Proposed Schedule for Project Phases

Component	Project Phase (preliminary as per March 2023)				
	Project Definition	Design	Construction	Commissioning	Operation
Chemical Building	Dec. 2017 to Aug. 2018	Aug. 2018 to Apr. 2019	Complete	Aug. 2022	Dec. 2022
New RWI and reservoir	Dec. 2017 to Jun. 2022	Fall 2023	February 2024 to April 2025	May to June 2025	July 2025
Membrane Plant	Dec. 2017 to Jun. 2020	Complete	June 2023 to December 2026	January 2027 to Jun. 2027	July 2027
Existing Facility upgrades	Dec. 2017 to Jun. 2020	January 2025	May 2025 to Jun. 2026		November 2026

2.5.1 Decommissioning

There are currently no decommissioning plans for the Facility. If and when decommissioning occurs at some point in the future, it will consist of the removal of Facility buildings and equipment from the site and capping of the intake and discharge pipes. Decommissioning would be conducted according to regulatory requirements at the time. Decommissioning of the existing Facility is not included in the scope of the proposed Project.

The Facility upgrades are based on a 2048 design horizon, and the water intake is designed to manage water demands until 2122.

2.6 Project Funding

The Government of Canada is investing more than $78.6 million in eleven projects under the Green Infrastructure Stream of the Investing in Canada Plan. Under this plan, both the Province of Manitoba and the Government of Canada invest in flood prevention and drinking water infrastructure to strengthen the well- being of its citizens. The City has been selected to be one of the eleven recipients to receive federal and provincial funding. The City received $46,000,000 worth of federal funding, $38,329,500 of provincial funding and $30,670,500 of Recipient funding (total of $115,000,000) for the enhancement of the Facility, including the addition of a membrane treatment facility, a new intake, yard piping and settling pond.

2.7 Approvals and Permits

The relevant approvals and permits for this project are outlined as follows:

The Drinking Water Safety Act: On July 4, 2022, on behalf of the Brandon Public Water System, Jacobs submitted a permit application for the alteration of an existing water system.

The Heritage Resources Act: Jacobs will complete a Historic Resources Impact Assessment for the Project, fulfilling requirements issued by the Manitoba Historic Resources Branch. Various surveys will be conducted to identify and mitigate impacts to potential heritage resources at several site locations, including the proposed intake and water line, intake building, and new raw water cells.

Transport Canada: The Assiniboine River is a navigable waterway as defined under the Canadian Navigable Waters Act. Jacobs will be submitting an application to the Navigation Protection Program (NPP) for approval to construct the new RWI, which is categorized as a Minor Works. A public notice will be published, and the NPP will assess the requirement for parallel reviews and Indigenous peoples of Canada consultation.

DFO: The DFO's Fish and Fish Habitat Protection Program ensures that relevant provisions of the Fisheries Act and the SARA are complied with. Jacobs will submit a request for review form to the DFO, who will determine if a project authorization is required.

2.8 Public Engagement

2.8.1 Summary of Engagement Activities Undertaken

March 26, 2019: Water Treatment Plant (WTP) Upgrade Open House

This open house provided the public with the opportunity to learn more about the City's multi-year Water Treatment Facility Upgrade Project. Information was provided regarding the different project phases (i.e., chemical building, membrane plant, new river intake, upgrades to the existing facility), and the funding required for the Project. This open house was hosted by Jacobs and the City of Brandon.

Ongoing: Indigenous Consultation

The City has an obligation to consult with Indigenous Peoples as part of the Project. The City will provide to Infrastructure Canada a summary of communications, including any issues or concerns that may be raised by respective Indigenous groups and an indication of how the City has addressed or proposes to address those issues or concerns. Updates to Infrastructure Canada are provided during consultation. The City has initiated Indigenous engagement by reaching out to the Sioux Valley Dakota Nation, the Swan Lake First Nation No.7, and the Manitoba Métis Federation (Southwest Region).

2.8.2 Summary of Engagement Activities to be Undertaken in the Future

It is anticipated that there will be one or two additional open houses over the course of the multi-year Project. These open houses will provide the public with the opportunity to receive updates on the status of the Facility upgrades, as well as the opportunity to ask questions. One of these open houses will include information on the changes to the public use of Queen Elizabeth Park and the land to the northeast of the existing facility.

As introduced in Subsection 2.7, this Project requires a Transport Canada application under the NPP. As part of this application, the requirement for Indigenous peoples of Canada consultation will be assessed.

3. Scope of Assessment and Assessment Approach

The assessment evaluates the potential environmental and socioeconomic effects of the Project for all of the Project components outlined in the Project description (Section 2.4). The assessment method applied the following process:

1. Identify the environmental and socioeconomic elements to be considered.
2. Determine the spatial and temporal boundaries for the assessment.
3. Identify the potential environmental and socioeconomic effects, based on the potential interactions of the Project with each element.
4. Develop appropriate technically and economically practical site-specific mitigation to avoid or reduce residual effects.
5. Identify the predicted residual effects (i.e., those effects that remain once mitigation has been applied).

3.1 Selection of Environmental and Socioeconomic Elements

The assessment team identified potential interactions using professional experience, the results of the Project-specific desktop and field studies and applicable regulatory requirements. Environmental and socioeconomic elements potentially interacting with the Project are as follows:

- Physical Environment, Soils and Terrain
- Vegetation
- Water Resources
- Groundwater Quality and Quantity
- Wildlife and Wildlife Habitat
- Socioeconomic elements including Human Health

3.2 Spatial and Temporal Boundaries

The EAP predicts the potential effects of the Project on the environmental elements within defined spatial and temporal boundaries. These boundaries will vary with the biophysical or socioeconomic elements or interactions to be considered, and will reflect:

- The biophysical and socioeconomic baseline setting within the spatial boundaries of the Project
- The area potentially affected by construction and operations activities, including the proposed physical works and physical activities
- The area in which an element occurs or functions, and within which a Project effect may be detected
- The time required for an effect to become evident
- The time required for an element to recover from an effect and return to a pre-effect condition

The spatial boundaries for the Project residual effects encompass the areas potentially affected by the Project, the areas within which a biophysical element occurs or functions, and the areas within which Project effects might occur. There are three categories of study areas:

1. **Project footprint:** the land area directly disturbed by the construction and operations activities, including associated physical works and activities.

2. **Local Study Area (LSA):** varies with the environmental element being considered. The LSA includes the Project footprint and extends beyond it to incorporate the area within which the element is most likely to be affected by the Project.

3. **Regional Study Area (RSA)**: varies with the environmental element being considered. The RSA includes the Project footprint and LSA, and the area beyond the LSA boundaries where the predicted likely residual effects from the Project may act in combination with those of existing and reasonably foreseeable developments and activities to cause cumulative effects.

The timeframes used in the assessment of the Project are defined as the temporal extent of interactions between the Project and the biophysical elements. The temporal context encompasses:

- Construction: the period of time required to complete construction activities
- Operations: the period of time that the WTP will be in operation

3.3 Mitigation

Mitigation is considered to be the elimination, reduction, or control of a project's adverse environmental effects. To verify that potential adverse environmental effects are reduced, during all phases of the Project, general and site-specific mitigation have been proposed based upon current industry accepted standards, engagement with appropriate regulatory authorities, and the professional experience of the assessment team. Mitigation measures are identified for each element in the relevant element section.

3.4 Evaluation of Residual Effects

The predicted residual effects of the Project were characterized according to a set of qualitative and quantitative criteria outlined in Table 3-1.

Table 3-1. Characterization of Residual Effects

<table>
<tr><th>Assessment Criteria</th><th colspan="2">Definition</th></tr>
<tr><td colspan="3">Direction</td></tr>
<tr><td>Positive</td><td colspan="2">Residual effect has a net benefit to the environment or human health.</td></tr>
<tr><td>Neutral</td><td colspan="2">Residual effect has no net benefit or loss to the environment or human health.</td></tr>
<tr><td>Adverse</td><td colspan="2">Residual effect has a net loss or is a detriment to the environment or human health.</td></tr>
<tr><td colspan="3">Spatial Boundary</td></tr>
<tr><td>Project Footprint</td><td colspan="2">The land area directly disturbed by the construction and operations activities including infrastructure sites and associated facilities. The Project footprint is the same for all elements included in this EAP.</td></tr>
<tr><td>LSA</td><td colspan="2">The LSA varies with the environmental element being considered. The LSA includes the Project footprint and extends beyond it to incorporate the area within which the element is most likely to be affected by the Project.</td></tr>
<tr><td>RSA</td><td colspan="2">The RSA varies with the environmental element being considered. The RSA includes the Project footprint and LSA, and an additional area beyond the LSA boundaries where the predicted likely residual effects from the Project may act in combination with those of existing and reasonably foreseeable developments and activities to cause cumulative effects.</td></tr>
<tr><td colspan="3">Temporal Context</td></tr>
<tr><td rowspan="3">Duration (period of the predicted residual effect)</td><td>Immediate</td><td>Residual effect is limited to 2 days or less.</td></tr>
<tr><td>Short-term</td><td>Residual effect is limited to the construction.</td></tr>
<tr><td>Medium-term</td><td>Residual effect extends up to 10 years post-construction, including the operations phase.</td></tr>
</table>

Assessment Criteria	Definition	
	Long-term	Residual effect extends more than 10 years post-construction, including the operations phase.
Frequency (how often the predicted residual effect would occur)	Rare	Residual effect occurs uncommonly or unpredictably (e.g., as a result of an accident or malfunction) over the assessment period.
	Isolated	Residual effect is confined to a specified phase of the assessment period.
	Occasional	Residual effect occurs intermittently and sporadically over the assessment period.
	Periodic	Residual effect occurs intermittently, but repeatedly, over the assessment period.
	Continuous	Residual effect occurs without interruption throughout the assessment period.
Reversibility	Reversible	Residual effect is reversible to pre-construction or equivalent conditions.
	Irreversible	Residual effect is permanent.
Magnitude – Residual Environmental Effects		
Negligible	Residual effects may not be detectable or are within the range of natural variability or inconsequential to the function, health, performance, or sustainability of the element.	
Low	Residual effects are detectable; however, they are well within environmental or regulatory standards, or both.	
Medium	Residual effects are detectable and may approach, but are still within, the environmental or regulatory standards, or both.	
High	Residual effects are beyond environmental or regulatory standards, or both.	

For many of the elements under evaluation, there are no specific environmental or socioeconomic standards, guidelines, thresholds, targets, or objectives. Therefore, the determination of magnitude of the residual effects often entailed consideration of previous assessments of magnitude made by regulatory authorities. In addition, determination of magnitude relied on the experience of the assessment team, informed by outcomes of previous projects with similar conditions and potential issues.

4. Assessment of Effects on Physical Environment, Soils and Terrain

Construction of the new building footprints onsite, RWI system and pipeline will result in some disturbance to soils and alteration of terrain.

4.1 Description of the Existing Conditions

4.1.1 Climate

The City has a dry continental climate, with warm summers and cold, dry winters. The following meteorological data were obtained from Environment and Climate Change Canada's meteorological station, Brandon A, between 1981 and 2010 (ECCC 2022). Daytime temperatures range from 26°C in July to -21.9°C in January (ECCC 2022). The City is relatively dry with most precipitation falling as rain between May and August, and a maximum average monthly rainfall of 80.7 mm in June. In winter precipitation is primarily snow with a maximum average monthly snowfall of 24.9 centimetres (cm) in December.

4.1.2 Soils and Terrain

The City is located in the Aspen Parkland Ecoregion in the Prairies Ecozone. The Aspen Parkland ecoregion extends in a broad arc from southwestern Manitoba, northwestward through Saskatchewan to its northern apex in central Alberta, along the Rocky Mountains. A small portion of the ecoregion extends from Manitoba into North Dakota.

This ecoregion, underlain by Cretaceous shale, is covered by undulating to kettled, calcareous, glacial till with significant areas of level lacustrine and hummocky to ridged fluvioglacial deposits. Associated with the rougher hummocky glacial till, landscapes contain numerous small lakes, ponds, and sloughs that are tree-ringed. The ecoregion is characterized by level to undulating terrain with areas of undulating to hummocky topography. Soils in the region include loamy Black Cernozemic soils and poorly drained Gleysolic soils (Smith et al. 1998).

Based on a review of the available logs from the geotechnical investigation completed for the Facility upgrade, the soil in the area consists of various thicknesses of topsoil, medium plastic clay fill, medium to highly plastic clay, silt or sand. Generally, the stratigraphy consists of topsoil above a layer of sand and clay fill underlain by silt, native clay, a second silt layer followed by clay till to the depth that was explored. For the raw water reservoir, the soil stratigraphy in the upper 4.6 m was classified as topsoil, medium plastic clay fill, medium to highly plastic clay, silt or sand.

The site elevation ranges from 366 m at McDonald Avenue to 358 m near the Assiniboine River. The northern portion of the Project footprint drains from south to north and generally east to west toward the river. The southern portion drains through a series of swales and culverts that run along the perimeter of the south and east sides of the site.

No known contaminated sites have been identified at the existing Facility site. The Facility site is listed in the Manitoba Contaminated/Impacted Sites database maintained by Manitoba Sustainable Development under file number 19101. The listing related to an underground heating fuel storage tank, formerly located north of the existing Facility. The underground storage tank was excavated and removed from the subject property in 1999. A drilling program was conducted to identify whether there were any effects on soil and no soil impacts were identified (Rospad pers. comm. 2020).

4.2 Effects on Soils and Terrain

Table 4-1 identifies the potential effect pathways of the Project on soils and terrain during construction activities.

Table 4-1. Project Activities, Effect Pathways, and Indicators for Soils and Terrain

Potential Effect	Project Activities and Effect Pathways	Effects Indicators
Change in terrain	Construction activities may result in terrain or slope instability.	▪ Slope classes and extent ▪ Slumping and erosion
	Excavations for construction may result in localized slumping and erosion.	
Change in soil productivity	Soil handling and storage may lead to a loss of topsoil or admixing during construction activities.	▪ Topsoil and subsoil composition (e.g., texture or composition) ▪ Depth of topsoil (cm) ▪ Compaction and rutting ▪ Slumping ▪ Presence of erosion ▪ Increased dust in area ▪ Presence of stones in surface horizon ▪ Number, type, and extent of areas of previously recorded contamination
	Vehicle and equipment movement and soil handling may increase soil compaction, rutting, or pulverization during construction activities.	
	Excavations for construction may result in localized slumping.	
	Following vegetation clearing, soil loss may occur as a result of water or wind erosion.	
	Topsoil and subsoil handling and stockpiling may contribute to a localized increase in dust	
	Topsoil salvage handling and grading during construction activities may increase stoniness in surface horizons.	
	Clearing of vegetation or surface gravel, topsoil salvage, and grading may disturb historically contaminated soils during construction activities.	

4.3 Mitigation Measures and Residual Effects

Potential Project effects on terrain and soils from construction will be mitigated by implementing the following measures:

- Deep foundations such as cast in place mechanically cleaned belled piles founded on the very stiff clay till, cast in place friction piles and driven pre-stressed precast concrete friction piles would limit settlement and differential movement.
- Use of clay for membrane in raw water reservoir. Should insufficient clay be identified use of a geosynthetic membrane in the raw water reservoir.
- Limiting construction equipment and vehicle movements to designated roads and pathways within and around work areas, and limit construction equipment in riparian areas, where feasible.
- Limiting clearing of vegetation and construction activities to the proposed footprint.
- Reducing disturbed and exposed areas and rehabilitating areas as soon as practical, where required.
- Stripping and stockpiling topsoil on the Project site for use in site restoration.
- Minimizing soil susceptibility to wind erosion will mitigate the risk for dust; water soil stockpiles, cover temporary stockpiles (using a tarp or geotextile), or use an annual seed mix.
- Repairing areas where equipment has compacted soils.
- Excavate soils of 5 to 6 feet below grade followed by pipeline layering. Soil layers will have 12 inches of backfill. Before the final top layer is filled and compacted, the operators will be responsible for checking the pipeline alignment to verify the safety of design and no potential sources of leakage from the pipelines that could negatively affect the soils, causing corrosion or chemical contamination to the soil layers or backfill materials.
- Revegetating disturbed soils as soon as practical.
- Re-establishing vegetation in riparian areas as soon as practical.

- Measures related to storage and handling of hazardous substances and clean-up of leaks and spills will be implemented.
- Large quantities of fuel will not be stored onsite at any given time.
- Fuel for construction equipment will be supplied by fueling trucks that are regulated under *The Storage and Handling of Petroleum Products and Allied Products Regulation*. Records of fuel volumes and an Emergency Response Plan that includes spill avoidance, notification and response will be implemented as a part of the construction specifications and enforced at the site.
- No fueling or servicing activities will be permitted within 100 m of the Assiniboine River.
- Hazardous substances stored outdoors and indoors will be situated in or on secondary containment capable of containing 1.5 times the quantity of the total stored in or on it in the event of a leak. Storage sites will be consolidated to the extent possible to reduce the number of such sites.

The operational phase of the Project is not anticipated to generate any additional adverse effects on soils and terrain. However, during operations soil contamination may occur as a result of leaks and spills or equipment malfunctions. Storage and handling of hazardous substances in the Chemical Building and clean-up processes for leaks and spills will mitigate the effects.

4.4 Summary

Potential effects on soil are considered low magnitude given the small amount of equipment and quantity of fuel, lubricants and materials that would be present at the Project site. After implementation of the mitigation measures, the residual effects on soils and terrain at the existing Facility site and the associated project components are expected to be negligible in magnitude, limited to the Project footprint, long-term in duration, isolated, reversible, and occurring within a previously disturbed area.

5. Assessment of Effects on Vegetation

Construction of the new building footprints, reservoirs, and new RWI structure will result in some disturbance to vegetation, including riparian vegetation. Therefore, vegetation is considered in this assessment.

5.1 Description of the Existing Conditions

The Project Footprint is located within the Aspen Parkland Ecoregion. The Aspen Parkland Ecoregion is situated within the Prairies ecozone and marks the transition from grassland to boreal forest. Historically the region was characterized by grasslands, woodlands and wetlands and native grasses dominated the landscape. Plains rough fescue (*Festuca hallii)*, little bluestem (*Schizachyrium scoparium)*, and multiple speargrasses (*Hesperostipa* spp.) dominate the vegetation community with scattered rose (*Rosa* spp.), creeping juniper (*Juniperus horizontalis)* western snowberry (*Symphoricarpos occidentalis*), wolf willow (*Elaeagnus commutata)*, prairie sage (*Artemesia ludoviciana)*, and fringed sage (A*rtemisia frigida)*. Open stands of trembling aspen (*Populus tremuloides),* bur oak (*Quercus macrocarpus)* with balsam poplar (*Populus balsamifera)* occur on moist sites in the absence of disturbance. The City of Brandon is situated on the western extent of the Assiniboine Delta, a transition zone where vegetation trends toward tallgrass prairie, influenced by sandy soils created by wind erosion and deposition (Thorpe 2014, Henderson and Koper 2014). Today much of the native vegetation has been converted to cropland and tame forage. Kentucky bluegrass (*Poa pratensis)*, smooth brome (*Bromus inermis)*, intermediate wheatgrass (*Thynopyrum intermedium)*, crested wheatgrass (*Agropyron cristatum)*, and shrubby encroachment of a variety of species is common with disturbance (Pyle et al. 2018).

Lands within the Project LSA and RSA have been heavily modified by human development. The existing Facility and proposed location of the Chemical Building, Membrane Plant and other associated infrastructure are on previously disturbed land used for the existing Facility. Scattered trees and shrubs remain along roadsides and buildings, and lawn is maintained around the existing Facility. The proposed reservoir sites are disturbed areas currently used as sports fields, tennis courts or other recreational purposes. The area in front of the main Facility entrance is grass-covered. Trees are also present along the west and east sides of the access to the Facility entrance, and the area immediately west of the Facility is grass-covered. In the vicinity of the proposed RWI and associated pipeline near the Assiniboine River, riparian areas are dominated by grasses and scattered immature shrubs such as willow species (*Salix* spp.). Ground cover on the north side of the river is entirely reed canary grass (*Phalaris arundinacea*), and the south side of the river is dominated by reed canary grass, sloughgrass (*Beckmannia* sp.), and scattered Noxious weeds. A dense stand of mature balsam poplars border the grass-dominated riparian boundary on both sides of the river.

Noxious weed management in Manitoba is divided into a tier system and weed designations may be applied to a geographic region, or throughout the province. The Tier 2 invasive plants must be destroyed by the landowner under the *Noxious Weeds Act* if the colonized area is less than 20 acres; areas greater than 20 acres must be controlled. Tier 3 weeds must be controlled by the landowner where the growth or spread is likely to affect the economy, environment, or the well-being of residents in proximity. The City of Brandon uses an integrated pest management (IPM) strategy to prioritize the control for regulated weeds by cultural, biological, and mechanical controls where possible (City of Brandon n.d.). Table 5-1 lists weeds that were observed on the Project footprint during the August 2021 site visit.

Table 5-1. Noxious Weeds Observed on the Project Footprint in August 2021

Common Name	Scientific Name	*Noxious Weed Act* Designation[a]	Area Where the Designation Applies
Scentless chamomile	*Matricaria perforata*	Tier 2	Whole province
Absinth	*Artemesia absinthium*	Tier 3	Whole province
Canada thistle	*Cirsium arvense*	Tier 3	Whole province

Common Name	Scientific Name	*Noxious Weed Act* Designation[a]	Area Where the Designation Applies
Yellow toadflax	*Linaria vulgaris*	Tier 3	Whole province

[a] Province of Manitoba 2022

Other unregulated, non-native vegetative species observed in August 2021 included common plantain (*Plantago major)*, and water smartweed (*Persicaria amphibia*).

Rough agalinis (*Agalinis aspera),* an Endangered SARA listed herbaceous plant, is known to occur in the Brandon area within wet meadows with full sun exposure. The species tolerates soil disturbance and is primarily found on roadsides (COSEWIC 2006).

Small white lady's-slipper (*Cypripedium candidum),* a Threatened SARA-listed plant species, has been largely extirpated in south-central Manitoba but is known to occur in the Brandon area. A subpopulation occurring on Assiniboine River was considered extirpated in 1994 (Government of Canada 2021b). Small white lady's-slipper occurs in modified landscapes, in calcareous sandy loam soils on the edge of wooded grasslands, or open sites with a southerly aspect. As the habitat requirements are similar, small white lady's-slipper is often observed with rough agalinis (COSEWIC 2014).

No rare plants or rare ecological communities were observed within the Project footprint in August 2021. Photographs of the vegetation observed during site visits and field surveys in 2021 are found in Appendix B.

5.2 Effects on Vegetation

Table 5-2. Project Activities, Effect Pathways, and Indicators for Vegetation

Potential Effect	Project Activities and Effect Pathways	Effects Indicators
Change in riparian vegetation communities	Construction activities in vegetated riparian areas (e.g., brushing) will cause a loss or alteration of vegetation	▪ Vegetation loss in riparian areas
	Construction activities (e.g., brushing) may cause a loss or alteration of rare ecological communities	
Change in vegetation species	Construction activities (e.g., brushing) may cause a direct loss or alteration of rare vegetation populations	▪ Previously observed rare plant populations are reduced in size, number, or density ▪ Weed density and distribution increase ▪ Previously unobserved weed species identified
	Transportation of equipment, workers and supplies, brushing, vegetation disposal, mowing, topsoil handling, backfilling, and clean-up activities during construction activities may indirectly alter vegetation species through the introduction or spread of invasive weed species	

5.3 Mitigation Measures and Residual Effects

Potential Project effects on vegetation from construction will be mitigated by implementing the following measures:

- Limiting construction equipment and vehicle movements to designated roads and pathways within and around work areas, and limit construction equipment in riparian areas
- Field surveys to identify potential rare plants and rare ecological communities; potential mitigation could include staking, flagging, barriers, and setbacks
- Limiting clearing of vegetation and construction activities to the proposed Project footprint
- Reducing disturbed and exposed areas and rehabilitating areas as soon as practical where required
- Pipeline installation method will avoid vegetated areas to the extent practical

- Revegetating disturbed soils as soon as practical
- Re-establishing vegetation in riparian areas as soon as practical
- Management of invasive plant species using the City of Brandon's IPM Plan prior to and following construction
- Measures related to storage and handling of hazardous substances and clean-up of leaks and spills will be implemented.

The operational phase of the Project is not anticipated to generate any additional adverse effects on vegetation.

5.4 Summary

Potential effects on vegetation are considered low magnitude given the potential for rare plants to occur on the Project Footprint. After implementation of the mitigation measures, the residual effects on vegetation at the existing Facility site and the associated new water intake system (including the raw intake reservoirs) are expected to be negligible in magnitude, limited to the Project footprint, long-term in duration, continuous, reversible, and occurring within a previously disturbed area.

6. Assessment of Effects on Water Resources

Construction and operation of the new RWI system may affect surface and groundwater resources. During operation, withdrawal of water will occur on a continual basis. The focus of this section of the report is on surface water resources, and the following section, Section 7, considers the effects on groundwater resources.

6.1 Description of the Existing Conditions

6.1.1 Water Quantity

The Assiniboine River is a major tributary of the Red River, which feeds into Lake Winnipeg. The Assiniboine River originates in southeastern Saskatchewan and becomes a reservoir, known as the Lake of the Prairies. Lake of the Prairies straddles the Saskatchewan/Manitoba provincial border and was formed by the Shellmouth Dam, located approximately 220 kilometres (km) upstream of the City. The Shellmouth Dam was completed in 1972 and was built to help control flooding, particularly downstream in the City of Winnipeg, Manitoba (Simonovic and Li 2004). The Shellmouth Dam maintains a minimum target flow of 2.8 m^3/s for the Assiniboine River through Brandon (SG1 Water Consulting 2022). There is also a floodway control structure, known as the Portage Diversion, located in the City of Portage la Prairie, Manitoba (Simonovic and Li 2004), which likely prevents fish from migrating upstream to near the Project area. The Portage Diversion diverts water from the Assiniboine River north into Lake Manitoba (Simonovic and Li 2004). The Assiniboine River joins the Red River in the City of Winnipeg. Within the City of Brandon, the Third Street Dam (which is downstream of the proposed intake) creates a backwater effect in the Assiniboine River which results in a minimum water level elevation (SG1 Water Consulting 2022).

Data for the Assiniboine River at the Brandon hydrometric station (Station Number 05MH001) is available from 1906 to 2020. However, there are interruptions in the data from 1974 to 2014, which is covered by upstream station 05MH013, located near the confluence of the Little Saskatchewan River. Hydrometric station 05MH001 is approximately 1.8 km downstream from the Project. The hydrograph for the Assiniboine River at 05MH001 hydrometric station from 2015 to 2020 displays peak flows in April (i.e., a monthly average of 164 cubic metres per second [m^3/s]), indicative of spring runoff (Table 6-1). Flows then decline over the late summer and fall. The annual mean flow over this time period was 50.34 m^3/s. More recent flood events occurred in 2011 and 2014. Seven days in May 2014 were measured over 1,000 m^3/s at station 05MH013, approximately 9 km upstream. Flows exceeded 1,000 m^3/s at the same station during four days in July, 2011 (Government of Canada 2021a).

The proposed RWI is located on the southeast bank of the Assiniboine River to the northwest of the existing Facility. The channel width at this location is approximately 71 m.

A site visit and a bathymetry survey for the proposed Project location conducted by SG1 Water Consulting Ltd. in May of 2021 determined the substrate was silty-sand interspersed with a mixture of fine to large gravel. The river discharge was found to be relatively low at 7 cubic meters per second (which is considered low for that time of year). Water depth along the proposed RWI location was 1.75 m. Bathymetry surveys in August 2002 indicated the elevation in front of the existing intake was approximately 355.5 m, and in May 2021 the elevation was approximately 357.2 m (SG1 Water Consulting 2022, Adam Stevenson and Associates 2007).

Table 6-1. 2014 to 2020 Streamflow Summary for Assiniboine River near City of Brandon (Station No. 05MH001)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean monthly discharge (m^3/s)	31.88	28.26	40.43	163.60	97.37	55.97	49.98	58.13	51.63	48.27	42.36	31.77
Maximum monthly discharge (m^3/s)	59.80	46.70	80.80	372.00	208.00	97.30	103.00	238.00	209.00	112.00	114.00	54.00
Minimum monthly discharge (m^3/s)	12.10	8.44	10.60	68.40	12.50	8.43	9.28	8.44	9.39	10.80	12.50	10.50

Note:

Monthly flow data is not available from January to July in 2014.

Source: Government of Canada 2021a

6.1.2 Water Quality

The land areas surrounding the Assiniboine River are primarily used for agricultural production (Government of Manitoba 2010a). Nutrient loading (phosphorus and nitrogen) into Lake Winnipeg is an important issue for the province (Government of Manitoba 2010a). Water quality data from Government of Canada was only available for the Assiniboine River in Saskatchewan, upstream of the Shellmouth Dam (Government of Canada 2021a) and wasn't considered relevant to include as conditions are likely too distant to be of importance to the Project in terms of watershed area and water quality inputs.

The Assiniboine River in its raw form is characterized by high natural organic matter (NOM). High NOMs can increase total suspended sediment (TSS) and turbidity values, which are two of the parameters identified by the Canadian Water Quality Guidelines for the Protection of Aquatic Life. The Guidelines provide data related to anthropogenic impacts and physical parameters that provide a national benchmark for protection of aquatic life (Canadian Council of Ministers of the Environment [CCME] 2021). Table 6-2 provides water quality values of raw river water measured in May 2018 (considered a high flow time of year) (Jacobs 2019).

Table 6-2. The Canadian Water Quality Guidelines for the Protection of Aquatic Life Compared to a Raw Water Sample Taken from Assiniboine River

	Canadian Water Quality Guidelines for the Protection of Aquatic Life [a]	Assiniboine River Raw Water Sample (May 2018) [b]
pH	6.5 – 9	7.8
Temperature (°C)	Refer to note c	12.2
Turbidity (NTU)	▪ Clear flow - Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g., a 24 hour period). Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g., 30 day period). ▪ High flow or turbid waters - Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs. Should not increase more than 10% of background levels when background is > 80 NTUs.	157
TSS (mg/L)	▪ Clear flow - Maximum increase of 25 $mg{\cdot}L^{-1}$ from background levels for any short-term exposure (e.g., a 24 hour period). Maximum average increase of 5 $mg{\cdot}L^{-1}$ from background levels for longer term exposures (e.g., inputs lasting between 24 hours and 30 days). ▪ High flow - Maximum increase of 25 $mg{\cdot}L^{-1}$ from background levels at any time when background levels are between 25 and 250 mg·L-1. Should not increase more than 10% of background levels when background is >250 $mg{\cdot}L^{-1}$.	280
Nitrate (NO_3 - mg/L)	▪ Long-term exposure - 13 ▪ Short-term exposure - 550	3.5

	Canadian Water Quality Guidelines for the Protection of Aquatic Life [a]	Assiniboine River Raw Water Sample (May 2018) [b]
Ammonia (NH_3 – mg/L)	▪ Long-term exposure - In the range of 0.1 – 7.3 (varies on pH and temperature)[d, e] ▪ Short-term exposure - No data	Not Detected

Notes:

[a] CCME 2021

[b] Jacobs 2019

[c] Temperature does not have a general guideline value as it is species-specific. Temperature is not likely to be limiting for the fish species present in the Assiniboine River.

[d] Water quality guidelines for total ammonia for the protection of aquatic life (mg/L NH3), CCME 2001

[e] Range determined from Assiniboine River raw water temperature and pH data

Phosphorus and dissolved oxygen levels at six water quality monitoring stations throughout the Central Assiniboine River watershed, including a station on 18th Street in Brandon, were found to consistently exceed the CCME guidelines based on sampling from 1990 to 2008 as part of a long-term monitoring initiative (Government of Manitoba 2010a).

Turbidity testing is routinely conducted by the City of Brandon. Results from January 2009 to December 2014 show NTU range from approximately 4-405, with an average of 42 NTUs over this period. High turbidity coincides with months which have the highest mean flow (April and May).

6.1.3 Fish, Fish Habitat and Freshwater Mussels

The Assiniboine River includes a diverse assemblage of coolwater and warmwater fish species (Table 6-3) and includes primarily spring and summer spawners, with the exception of burbot which spawn in the winter. Further discussion of species of management concern is included in the text that follows.

The restricted activity period (RAP) for the Assiniboine River, in the section where the proposed RWI is located, is April 1 to June 30 for spring and summer spawners (DFO 2013). The RAP is intended to help to prevent instream disturbance during sensitive periods for fish and the organisms upon which they feed.

During September 2020, a site visit was completed by Jacobs at a previously considered intake option located approximately 170 m downstream of the currently proposed intake. The previously considered intake location was closer to the wingdam. What was believed to be Common carp (*Cyprinus carpio*) were observed at this location. Photographs taken of the Project Footprint in 2021 are found in Appendix B. The banks were vegetated and the riparian areas were dominated by Reed canary grass (*Phalaris arundinacea),* deciduous trees further back, and several Noxious weed species in low density. The riparian vegetation observed near the proposed intake location is consistent on both banks throughout the Project area. The habitat reach in the Project area was noted to be a relatively homogenous run, with a water depth of 1.75 m measured near the proposed intake location (SG1 Water Consulting 2022). Existing habitat disturbance includes clearing of riparian vegetation, an access trail to an old boat launch with riprap armoring, bank sloughing downstream of the boat launch, the existing intake, and the wing dam.

The existing rock wing dam approximately 200 m downstream of the proposed intake location was originally constructed using wood pilings in 1893 and later reinforced with rip-rap in 1963-1964 to deflect low flows toward the existing intake (Adam Stevenson and Associates 2007). The wingdam crosses roughly 85% of the channel, causing a navigation hazard in periods of low flow. Submerged timber piles have caused scour in the riverbed and banks upstream and downstream on the north side of the river, while depositing sandy materials in the south bend of the wingdam, in front of the existing intake (SG1 Water Consulting 2022, Adam Stevenson and Associates 2007). Adam Stevenson and Associates note that the scour and deposition patterns influenced by the instream structures cause variability in sediment deposition in front of the existing intake, but the bottom of the intake screens can be buried by sediment at a depth of up to 45 cm below the river bottom.

This portion of the Assiniboine River is unlikely to be of particular importance for spawning fish as the habitat type is common and homogenous (run/flat habitat). Cover is limited and consists of some trace amounts of woody debris along the banks that may provide rearing or holding habitat. Fish may also use the existing rip-rap from an old boat launch as cover. Due to the lack of coarse substrates in the area, spawning potential is expected to be poor for species such as Lake Sturgeon and walleye (Stewart and Watkinson 2004). Spawning habitat may be present for species that can spawn on mud, sand/silt such as bullheads and burbot (Stewart and Watkinson 2004). Downstream of the proposed RWI, deep scour pools are present which may provide overwintering or thermal refugia in the summer.

Potential habitat is present for Mapleleaf (*Quadrula quadrula*) due to the species general substrate preference for mud, sand or gravels, however, habitat is not limiting at this location. The location is notable as a likely migration corridor for Lake Sturgeon (*Acipenser fulvescens*), based on monitoring of tagged fish by the province of Manitoba (Jeff Long, personal communication, September 23, 2021). Other options proposed for the intake were located downstream of the proposed location and closer to deeper potential overwintering/ thermal refugia habitat, or areas with more heterogeneity due to scour from the wing dam.

Table 6-3. Fish Species Previously Documented within the Assiniboine River

Common Name	Scientific Name	Spawning Season	COSEWIC Listing	*SARA* Listing
Sportfish				
Lake sturgeon (Saskatchewan-Nelson River population)	*Acipenser fulvescens*	Summer	Endangered	--
Rock bass	*Ambloplites rupestris*	Spring to summer	--	--
Black bullhead	*Ameiurus melas*	Spring to summer	--	--
Brown bullhead	*Ameiurus nebulosis*	Spring to summer	--	--
Freshwater drum	*Aplodinotus grunniens*	Spring to summer	--	--
Northern pike	*Esox lucius*	Spring	--	--
Goldeye	*Hiodon alosoides*	Spring	--	--
Mooneye	*Hiodon tergisus*	Spring	--	--
Channel catfish	*Ictalurus punctatus*	Spring	--	--
Bigmouth buffalo (Saskatchewan-Nelson River population)	*Ictiobus cyprinellus*	Spring to summer	Special concern	Special concern
Burbot	*Lota lota*	Winter	--	--
Yellow perch	*Perca flavescens*	Spring	--	--
Black crappie	*Pomoxis nigromaculatus*	Spring to summer	--	--
Sauger	*Sander canadensis*	Spring	--	--
Walleye	*Sander vitreus*	Spring	--	--

Common Name	Scientific Name	Spawning Season	COSEWIC Listing	*SARA* Listing
Non-Sportfish				
Quillback	*Carpiodes cyprinus*	Spring	--	--
White sucker	*Catostomus commersonii*	Spring	--	--
Finescale dace	*Chrosomus neogaeus*	Spring	--	--
Brook stickleback	*Culaea inconstans*	Spring to summer	--	--
Spotfin shiner	*Cyprinella spiloptera*	Spring to summer	--	--
Common carp	*Cyprinus carpio*	Spring	--	--
Iowa darter	*Etheostoma exile*	Spring-summer	--	--
Johnny darter	*Etheostoma nigrum*	Spring-summer	--	--
Chestnut lamprey (Saskatchewan-Nelson River population)	*Ichthyomyzon castaneus*	Spring to summer	Data deficient	--
Common shiner	*Luxilus cornutus*	Spring to summer	--	--
Silver chub	*Macrhybopsis storeriana*	Spring to summer	Not at risk	--
Pearl dace	*Margariscus margarita*	Spring	--	--
Silver redhorse	*Moxostoma anisurum*	Spring	--	--
Golden redhorse	*Moxostoma erythrurum*	Spring	Not at risk	--
Shorthead redhorse	*Moxostoma macrolepidotum*	Spring	--	--
Golden shiner	*Notemigonus crysoleucas*	Spring to summer	--	--
Emerald shiner	*Notropis atherinoides*	Summer	--	--
River shiner	*Notropis blennius*	Spring to summer	--	--
Bigmouth shiner	*Notropis dorsalis*	Spring to summer	Not at risk	--
Blackchin shiner	*Notropis heterodon*	Spring to summer	Not at risk	--
Blacknose shiner	*Notropis heterolepis*	Spring to summer	--	--
Spottail shiner	*Notropis hudsonius*	Spring to summer	--	--
Sand shiner	*Notropis stramineus*	Spring to summer	--	--
Mimic shiner	*Notropis volucellus*	Spring to summer	--	--
Stonecat	*Noturus flavus*	Summer	--	--
Tadpole madtom	*Noturus gyrinus*	Summer	--	--
Logperch	*Percina caprodes*	Spring to summer	--	--

Common Name	Scientific Name	Spawning Season	COSEWIC Listing	*SARA* Listing
Blacksided darter	*Percina maculata*	Spring to summer	--	--
River darter	*Percina shumardi*	Spring to summer	Not at risk	--
Trout-perch	*Percopsis omiscomaycus*	Spring to summer	--	--
Fathead minnow	*Pimephales promelas*	Spring to summer	--	--
Flathead chub	*Platygobio gracilis*	Spring	--	--
Ninespine stickleback	*Pungitius pungitius*	Spring-summer	--	--
Western blacknose dace	*Rhinichthys obtusus*	Spring to summer	--	--
Longnose dace	*Rhinichthys cataractae*	Spring to summer	--	--
Creek chub	*Semotilus atromaculatus*	Spring	--	--
Central mudminnow	*Umbra limi*	Spring to summer	--	--

Sources

List based on information from Laureen Janusz, personal communication, February 26, 2021

Retrieved October 2021 from the Integrated Taxonomic Information System (ITIS) on-line database

Holm et al. 2009, Stewart and Watkinson 2004, McCulloch and Franzin 1996, RL&L 1998

Government of Canada 2021c

6.1.3.1 Species of Management Concern

Two aquatic species at risk under the SARA have the potential to occur within the Project location: Bigmouth buffalo (*Ictiobus cyprinellus*) of the Saskatchewan-Nelson Rivers population, is listed as Special Concern, and Mapleleaf, which is a freshwater mussel species, of the Saskatchewan-Nelson Rivers population, is listed as Threatened (Government of Canada 2021b). No aquatic species critical habitat is identified in the Assiniboine River. Critical habitat is not yet established for Mapleleaf and a recovery strategy is not yet formed for the Saskatchewan-Nelson Rivers population. Lake sturgeon of the Saskatchewan-Nelson Rivers population, which are listed as Endangered under COSWIC are an additional species of conservation concern, although not listed under *SARA* at this time (Government of Canada 2021b).

Bigmouth buffalo are not known to occur in the section of the Assiniboine River where the proposed intake is located (Jeff Long, personal communication, September 23, 2021), and electrofishing by boat yielded no individuals from the Assiniboine River above Portage la Prairie Dam, where the proposed intake is located (Nelson 2003). Therefore, the Portage la Prairie Dam may be a barrier to passage for the species. Spawning, inferred by an assessment of spawning condition, has been documented to take place from mid-May to late-August in shallow, flooded lakeshores and river banks over vegetation (Johnson 1963, Hlasny 2003, Stewart and Watkinson 2004).

The original Assiniboine River lake sturgeon population (designatable unit 4) has essentially become extirpated (COSEWIC 2017). Historical stocking efforts have been made in the City to attempt to recover the species, with the most recent being 2015 (Jeff Long, personal communication, September 23, 2021). It is suggested, by tagging movements, that Lake sturgeon populations in the river have been persisting following stocking efforts, and the fish are found to migrate from the Third Street Dam in Brandon to at least the confluence of the Little Saskatchewan River, approximately 13 km upstream (Jeff Long, personal communication, September 23, 2021). This movement is notable as it passes by the location of the proposed intake (Figure 6-1). Figure 6-1 shows the documented movement. Lake sturgeon spawn from early May to late June after spring break up, when water temperatures approach 11°C (Stewart and Watkinson 2004, DFO 2010a,b). Spawning typically occurs in areas of fast-flowing waters below waterfalls or rapids over clay, sand, gravel and boulders (COSEWIC 2017).

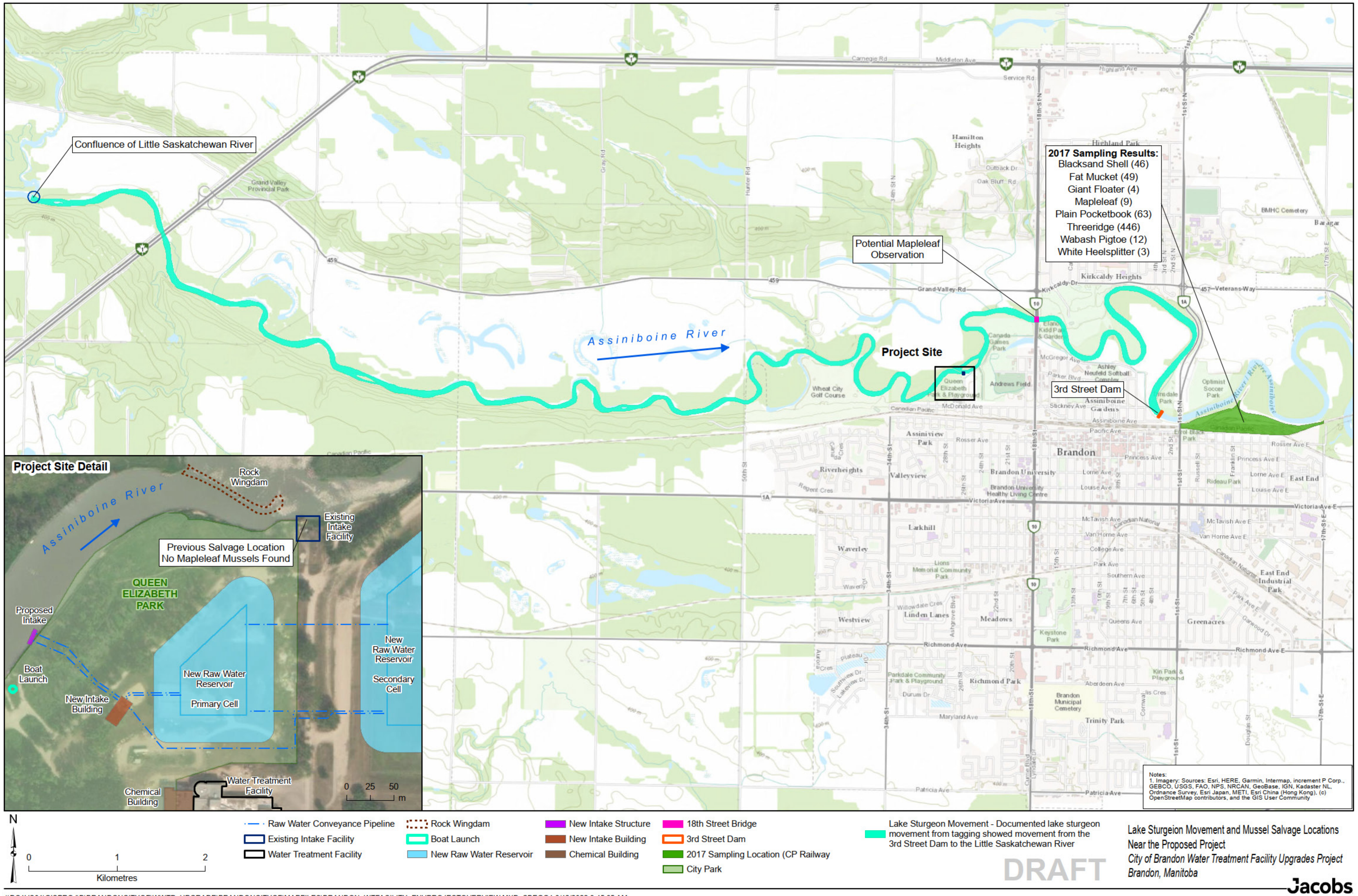
Mapleleaf are known to occur in the Assiniboine River and are found on a wide variety of substrate types including mud, sand and fine gravel (Committee on the Status of Endangered Wildlife in Canada [COSEWIC] 2016). Like other freshwater mussels in the family Unionida, Mapleleaf have a complicated life cycle and are an obligate parasite on fish during the larval stage (COSEWIC 2016). Female Mapleleaf release packets of glochidia (larva) called conglutinates, which may resemble fish prey and attract fish. Channel catfish are known to be a host (COSEWIC 2016). Females are considered short term brooders and the brooding season may range from late spring to early summer in Canada based on data from other locations (COSEWIC 2016). Mapleleaf habitat preferences are fairly general, as they are found in medium to large rivers on firmly packed coarse gravel, sand and clay/mud (COSEWIC 2016).

Locations of known nearby mussel sampling are shown on Figure 6-1. During a mussel salvage conducted for routine maintenance on the existing intake (which is located approximately 250 meters downstream of the proposed intake location) by North/South Consultants Inc. in 2011, no Mapleleaf were found. During this maintenance activity, Plain pocketbook (*Lampsilis cardium*), Fatmucket (*Lampsilis siliquoidea*), Threeridge (*Amblema plicata*), Giant floater (*Pyganodon grandis*), and Wabash pigtoe (*Fusconaia flava*) were found and relocated (North/South Consultants Inc. 2011). North/South Consultants Inc. (2011) also note that Mapleleaf have been documented at the 18th Street bridge which is located approximately 2 km downstream of the proposed intake, however details on this record are unknown.

A 2017 mussel salvage was conducted in the CN rail yard approximately 8 km downstream of the Project site which found the following number of individuals: 46 Blacksand shell (*Ligumia recta*), 49 Fatmucket, 4 Giant floater, 9 Mapleleaf, 63 Plain pocketbook, 446 Threeridge, 12 Wabash pigtoe, 3 White heelsplitter (*Lasmigona complanata*) (Janusz pers. comm. 2021).

Aquatic invasive species are a potential concern in the Assiniboine River, most notably, zebra mussel (*Dreissena polymorpha*). Zebra mussel have not been detected in the Assiniboine River at the time of writing (Government of Manitoba 2022a). However, zebra mussel is known to occur in the Red River and there is a potential risk of spread into other waterbodies.

Figure 6-1. Lake Sturgeon Movement and Mussel Salvage Locations Near the Proposed Project



6.2 Effects on Water Resources

Table 6-4. Project Activities, Effect Pathways, and Indicators for Aquatic Resources

Potential Effect	Project Activities and Effect Pathways	Effects Indicators
Change in surface water quality and quantity	Water withdrawal from the Assiniboine River may cause a reduction in water level.	Surface water quantity (discharge)
	Increased erosion on the Project footprint and instream work for intake installation and maintenance may increase sediment and contaminant concentrations and transport in surface water.	Transport of contaminants Surface water quality parameters (e.g., total suspended solids)
	Compared to the raw water from the Assiniboine River, the NF waste discharge is expected to contain concentrated raw water parameters, higher ammonia, and significantly lower TSS concentrations. Refer to Subsection 2.4.9.3 for more details.	Surface water quality parameters (e.g., total suspended solids)
Change in fish/mussel habitat	Brushing/clearing for access and terrestrial project components will lead to alteration of riparian habitat from within the Project footprint.	Area of riparian habitat disturbance
	Construction activities, and runoff and erosion can introduce fine sediment and contaminants to watercourses. Fine sediment can cause downstream sediment deposition and may alters substrate composition and modifies the availability and suitability of habitat for spawning, overwintering and rearing.	Surface water quality parameters (e.g., total suspended solids)
	Fish/mussel habitat alteration/destruction in the Assiniboine River from the intake structure.	Total instream footprint including permanent intake and armoring area and temporary coffer dam area.
Change in fish/mussel mortality risk	Instream work during the installation and maintenance of the intake.	Fish/freshwater mussel injury or mortality from instream construction.
	Water withdrawal during operations of the intake.	Entrainment or impingement risk during construction and operations
	Suspended sediment released at trenched crossings during instream activities could cause adverse effects on fish	Surface water quality parameters (e.g., total suspended solids)
	Noise generated from pile driving has the potential to harm fish causing injury and mortality.	Noise levels during construction of the intake.
Increase in aquatic invasive species	Water withdrawal or instream construction may cause inter-basin transfer of invasive aquatic organisms.	Transport of invasive aquatic organisms to other waterbodies

6.3 Mitigation measures and residual effects

Jacobs has reviewed the preliminary intake design and construction plans to identify some consideration, however, after the design and plans are finalized, the intake will be reassessed for additional mitigation measures and residual effects. Additional consultation with regulators (i.e., DFO and Manitoba Environment and Climate) may be required. The following DFO guidance tools and documents have been incorporated into the intake mitigation measures:

- *Measures to protect fish and fish habitat (DFO 2019)*
- *Interim code of practice: End-of-pipe fish protection screens for small water intakes in freshwater (DFO 2020a)*

- *End-of-Pipe Screen Size Tool (Di Rocco, R. and R. Gervais 2021)*
- *Interim code of practice: Temporary cofferdams and diversion channels (DFO 2020b)*
- *Fish Screening Guide for Water Intakes (Katopodis 1992)*

The *Interim code of practice: End-of-pipe fish protection screens for small water intakes in freshwater* (DFO 2020a) is intended for small water intakes (where the water intake flow rate is up to 0.150 m^3/s, or 150 litres per second). The guidance from that code of practice was reviewed regardless and incorporated into the mitigation measures as it has relevant general mitigation measures for intakes.

The recommended screen size of 2.54 mm from the *DFO Interim code of practice: End-of-pipe fish protection screens for small water intakes in freshwater* (DFO 2020a) will not be met with the intake design. The limitations to the existing water intake experienced over decades by the City of Brandon would be repeated using a design with slot sizes that meet the Code of Practice values. Previous experience has determined that the sedimentation load that characterizes Assiniboine River cannot be mitigated by adding a secondary screen, and there is need for a design which does not require annual dredging and cleaning to remove sediment buildup and reduce the frazil ice buildup.

The proposed intake will use a fish repellent louver design which creates turbulence to deter fish from traveling close to the intake screen. Louver systems rely on fish sensing pressure fluctuations that guide them around obstacles (U.S. Department of the Interior Bureau of Reclamation 2006). In addition to creating turbulence, which is a behavioural deterrent for fish, the louvers collect debris (including trash) and discourage the collection of frazzle ice. While larger fish are excluded by design of the spacing, smaller fish may enter an area where risk of impingement or entrainment may occur, located immediately in front of the intake slots. Fish louvers to avoid fish mortality have had varying degrees of success and depend on the fish species present, life stage, slot size, and Vs (U.S. Department of the Interior Bureau of Reclamation 2006, Goodman et al 2017). Locations where fish louvers are shown to not deter fish as effectively may have much higher intake approach velocities and span the length of the river channel (such as for hydropower).

The intake slot sizes will be a maximum opening of 75 mm, which is greater than DFO guidelines for screening. The proposed intake velocity and screen size requirements, as indicated by the *End-of-Pipe Screen Size Tool,* are met for anguilliform swimmers (weakest swimmers) such as burbot and lamprey species in which the guideline is a maximum of 0.035 m/s for forecasted daily maximum intake.

A ratio of 2:1 of Vs to Va is recommended (Katopodis 1992) to enable fish to outswim the area approaching an intake. As Vs is greater than Va with the intake design, a counter-acting Vs is likely to push fish along the intake structure rather than pulling fish into the area of risk. This aspect of the design is expected to reduce the risk of potential fish impingement, in addition to the behavioural deterrent. Aquatic life that are passive (such as, larvae and eggs) will be most susceptible to entrainment in the area of risk. Maintenance of the fish louver system may be completed using divers, or using a wire brush and camera extended into the water from the top of the intake. Frequent monitoring of debris build up will be required by the City for several years prior to establishing a maintenance schedule.

Similar intake designs are located on the North Saskatchewan River in Edmonton, Alberta, and on the Red Deer River in Red Deer, Alberta and have been accepted by DFO. A 2.54 mm screen may be added to the pipes leading into the treatment facility, to exclude potential fish larvae which may end up in the reservoirs.

As the intake velocity requirement is met, no fish-return system is being proposed.

Construction of the intake structure will occur in isolation of river flow. Construction may take up to a year or more, and the RAP of April 1 to June 30 cannot be completely avoided. The placement and removal of the cofferdam and riprap will avoid the RAP and construction work in the RAP will occur in the dry within the cofferdam. Riparian clearing is expected to be minimal with minor brushing/clearing or select tree felling where needed for access. Corrugated sheet piling or similar non erodible materials will be used as a cofferdam to isolate the instream work area, and construction for the intake can be completed in the dry along the bank. Only a relatively small portion of the river will need to be isolated. Riprap armoring will also be placed instream to support banks adjacent to the intake, which is anticipated to help alleviate existing local bank sloughing. In addition, instream work related to maintenance activities such as dredging will aim to avoid the RAP.

Details are not yet available to evaluate the noise levels expected. Construction and design inputs required may include geotechnical information of the proposed intake area, pile diameter, pile material and pile driving technique. Once the intake design is more advanced (such as, 90% design), the noise levels expected should be evaluated.

The following mitigation measures will be implemented to avoid or reduce the potential Project effects on water resources:

- **Pre-Construction**
  - Adhere to all conditions in any approvals or avoid and mitigate letters from DFO for the Fisheries Act and SARA and approvals from Manitoba provincial regulators.
  - Develop a response plan inclusive of terrestrial and aquatic spills to be implemented immediately in the event of a sediment release or spill of a deleterious substance and keep an emergency spill kit onsite at all times. The kit should contain (at a minimum) emergency contact numbers, a plan to contain and remediate any substance release that causes or may cause an adverse effect on aquatic environments, readily accessible materials and supplies for containment (for all times and conditions), and access to approved disposal sites for contaminated materials.
  - Develop and implement an Erosion and Sediment Control Plan for the site that minimizes risk of sedimentation of the watercourse during all phases of the removal.
  - A Live Fish Handling Permit from the Manitoba government is required for fish/mussel salvage activities and must be applied for at least 10 working days prior to instream work.
  - A SARA Permit from DFO may be required for salvage activities due to the presence of Mapleleaf.
- **Construction**
  - The intake slots will be coated in a non-stick finish to deter mussel attachment
  - Time work in water work for cofferdam placement and removal, riprap armoring placement and scheduled maintenance that requires instream work to respect timing windows to protect fish, including their eggs, juveniles, spawning adults, or the organisms upon which they feed. All construction “in the wet” should comply with the RAP of April 1 to June 30.
  - If, due to unforeseen delays, in water work will be required within the RAP, then work will not proceed unless a Qualified Aquatic Environment Specialist (QAES) is consulted and approval is obtained from DFO and Manitoba provincial regulators.
  - Design and construct all temporary workspace, stand down locations, and storage locations so that they are set back from the watercourse as much as feasible, and minimize loss or disturbance to riparian vegetation.
  - Schedule work to avoid wet, windy, and rainy periods that may increase erosion and sedimentation, and postpone instream works if excessive flows or flood conditions are present or anticipated.
  - To reduce elevated sediment levels, isolate the intake construction area (such as with coffer dams composed of non-erodible material) to avoid working directly in flowing water. Ensure sufficient working space within the cofferdams to accommodate construction activities.
  - Do not use an earthen cofferdam to isolate the intake construction area.
  - Fish passage must be maintained during the construction of the intake, due not constrict more of the channel then is necessary.

- A water quality monitoring plan should be developed and implemented by a QAES during construction. If monitoring reveals construction activities are causing potentially harmful sediment events, additional mitigation will be required or removal activities will be halted until suspended sediment levels return to background.
- Minimize the removal of natural woody debris, rocks, sand or other materials from the banks, the shoreline or the bed of the watercourse below the high water mark. If material is removed from the watercourse, set it aside and return it to the original or similar location once construction activities are completed.
- Evaluate the noise levels that may be generated from pile driving for the intake temporary cofferdams and wingwalls. Implement mitigate, as appropriate, such as bubble curtains and acoustic monitoring.
- Whenever possible, operate machinery from land above the high water mark in a manner that minimizes disturbance to the banks and bed of the waterbody.
- Place swamp mats, rig mats or similar materials over the staging areas, access paths and working pads to protect riparian vegetation, river bed and prevent erosion and limit sediment mobilization from equipment operation during construction and maintenance.
- Clearing of riparian vegetation should be kept to a minimum. Use existing trails and roads wherever possible to avoid disturbance to the riparian vegetation; and prevent soil compaction.
- Site preparations will occur above the high water mark as much as possible to minimize duration of instream activity.
- Ensure that machinery arrives onsite in a clean condition and is maintained free of fluid leaks, invasive species, and noxious weeds.
- Bulk hazardous materials will be stored in temporary construction yards or other designated areas except for quantities required for the daily construction activities. Wastes will be stored in temporary construction yards or other designated areas and removed during final clean-up. Fuel, oil, generators, or hazardous materials required to be stored onsite will be stored within secondary containment that is to be located greater than 100 m from the watercourse.
- Report environmental accidents as per the City of Brandon and provincial protocols. Environmental accidents which may or is likely to create a hazard to human life or health, to other living organisms, or to the physical environment must be reported to the provincial Environmental Emergency Response Program (Government of Manitoba 2022b)
- Use non-toxic, biodegradable hydraulic fluids in all equipment that will work in or around the watercourse during construction.
- Ensure sediment and erosion control materials are on site and ready to be installed where needed.
- Install erosion and sediment control measures (e.g., silt fence) according to the Erosion and Sediment Control Plan, environmental inspectors or the onsite QAES.
- For rock reinforcement/armouring confirm that appropriately-sized, clean rock is used; and that rock is installed at a similar slope to maintain a uniform bank/shoreline and natural stream/shoreline alignment.
- Operate machinery from land for riprap installation. Install rocks individually or a few at a time in a controlled manner such as by using a machine equipped with a hydraulic thumb.
- Do not wash equipment or machinery in any water body. Control wastewater from construction activities, such as equipment washing or concrete mixing, to avoid discharge directly into any water body.
- Grey water pumped out from the isolated area should not cause erosion, scouring, or introduce sediment into the channel.

- Suspend construction activities to allow for fish/mussel salvage to occur within the isolated area prior to and during dewatering. If any river sediment is removed from the river, the dredged material should also be searched for mussels.
- Conduct a fish scare and mussel salvage within the area of riprap installation.
- Follow the mussel detection, handling and relocation guidelines from the Protocol For The Detection And Relocation Of Freshwater Mussel Species At Risk In Ontario-Great Lakes Area (OGLA) (Mackie et al. 2008)
- Verify that pump intakes for grey water management during construction do not disturb the streambed and are screened with a maximum mesh size of 2.54 mm and maximum Va of 0.038 m/s for the fish species present (Di Rocco, R. and R. Gervais 2021).
- Grey water from the isolated areas should be pumped onto overland surfaces, within the Project extents, and allowed to infiltrate or settle. Pumping should be done in an area that limits disturbance to riparian areas, erosion and elevated levels of suspended sediment in the watercourse.
- Turn off intake pump and any small intakes used for grey water management prior to the removal of the screens for cleaning and/ or maintenance.
- Follow the relevant measures from the Manitoba Aquatic Invasive Species (AIS) checklists for any watercraft, sampling gear and in-water equipment to avoid the spread of AIS such as zebra mussels (Government of Manitoba 2020)
- If zebra mussels are observed in the Project area, note the location, take photographs and immediately report the observation to the Manitoba government's AIS Unit (1-877-867-2470 and AIS@gov.mb.ca)
- Immediately stabilize shoreline or banks disturbed by any activity associated with the Project to prevent erosion or sedimentation, preferably through revegetation with native species suitable for the site.
- Remove all construction materials from the site upon Project completion.

▪ **Reclamation**

  - Return the bed and banks of the watercourse to its pre-construction contours.
  - Revegetate banks and approach slopes with native seed mix representative of the area or erosion control mix at the discretion of the environmental inspector, Contractor or City of Brandon.

▪ **Operations and Maintenance**

  - Treat raw water with chlorine to prevent invasive mussel establishment within the treatment facility
  - Follow a City standard sampling protocol including measures in response to combined sewer and dry weather overflow, and to monitor water quality. This could include monitoring the discharge points upstream or downstream
  - Follow standard operations procedures for the alarm system at the sewer discharge locations and wastewater lift stations to monitor likelihood of an overflow
  - Continue to collect samples of untreated wastewater when discharge is confirmed. Sample from the outfall pipe, station wet well, or a nearby sewer manhole to ensure a representative sample. Analyse the samples at an accredited laboratory located at the North End Water Pollution Control Centre for testing.
  - Analyse the samples for the following parameters: biological oxygen demand ammonia, total nitrogen, total phosphorus, TSS, pH, and *Escherichia coli.* Test results will be provided to appropriate authorities within 30 days of a discharge.

- Do not use fertilizer or herbicide in the immediate vicinity of a watercourse.

6.3.1 Residual Effects

The potential effect of an increase in aquatic invasive species is expected to be avoided with the successful implementation of mitigation, therefore no residual effect is anticipated and as a result a characterization has not been included. Residual effects related to the other potential effects identified in Table 6-4 are described in the following subsections.

6.3.1.1 Change in Surface Water Quality and Quantity

A temporary increase in suspended sediment is expected from instream work. This increase in suspended sediment may result from increased bank erosion, material placement in the river (coffer dam materials and riprap), dewatering of the work area, dredging during construction of the intake headwall, and during maintenance of the intake. Suspended sediment would move downstream through the zone of influence (expected to be potentially over 1 km downstream). Instream disturbance can be reduced to a small area of the river by using a cofferdam. A minor sediment release is expected during installation and removal of isolation structures. It is anticipated that with the successful implementation of the proposed mitigation measures, the average TSS levels during instream construction will be below the CCME guideline for short-term (24 hour) exposure of 25 mg/L above baseline levels (CCME 1999), given construction of the intake will be isolated from the river flow.

The forecasted future water demand from the Assiniboine River is approximately 30 to 50 ML/d, which converts to 0.34-0.58 m^3/s. Compared to the average flow rate of the Assiniboine River, the maximum forecasted withdrawal rate is 1.15% of the river on average. Comparing to the existing maximum withdrawal the difference is 0.12 m^3/s, or a 20% increase in current demand, and is still within the City's Water Rights Act Licence maximum withdrawal rate of 1.17 m^3/s. It is not expected that this decrease in river water quantity will impact fish/mussels on a population level overall. The relative volume of water withdrawn will vary between seasons and years. The withdrawal rates would also be subject to Manitoba provincial approval conditions which may be variable based on the discharge of the river.

Dredging will be required, however in a much less frequent basis than which is required for the existing intake. Dredging and cleaning of the screens may result in elevated turbidity downstream of the proposed intake, but turbidity levels are not suspected to contribute a significant risk to fish or fish habitat. Dredging activities can be expected every few years, rather than each year, and cleaning can be done manually from land, using divers, or by using a vac truck to clean the interior of the intake.

For a summary of the pertinent parameters associated with the discharge from the updated treatment facility, please refer to section 2.4.9.3. A significant change in water temperature is not anticipated for the WTP residuals discharge.

6.3.1.2 Change in Fish and Mussel Habitat

The Project including the intake and terrestrial WTP components are located on already disturbed land within the City of Brandon, and it is expected that additional riparian disturbance will be minimal. An existing access road to an abandoned boat launch can be used to facilitate construction access to the river, reducing the amount of clearing required to brushing and select tree felling to access the intake location (SG1 Water Consulting 2022).

The introduction of fine sediment during construction may cause downstream sediment deposition that alters substrate composition and modifies the availability and suitability of fish habitat for spawning, overwintering and rearing (Anderson, 1996; Newcombe and MacDonald, 1991). Additionally, the deposition of sediment can alter invertebrate communities and thus, alter fish food supply (Harrison et al. 2007). As discussed for surface water quality and quantity, increased suspended solids concentrations during instream construction are likely to be within CCME guidelines, with the successful implementation of mitigation. The potential deposition of sediment resulting from instream construction is expected to be reversed by the redistribution of sediment following typical annual spring freshets (Anderson et al. 1998; Reid and Anderson 1999).

There is a permanent loss to fish/mussel habitat for the intake structure footprint, which will be approximately 410 m^2. Habitat was not noted to be limiting at the location for fish or mussels, which was relatively homogeneous run/flat and primarily fine substrate along the bank. Potential habitat exists for Mapleleaf at the proposed intake location; however the habitat type was common.

Grading of the riparian area for construction access is not anticipated to cause sediment or erosion issues with appropriate bank stabilization and erosion control materials.

The abandoned boat launch is contributing to the erosion in the vicinity of the proposed RWI location; rip-rap below the boat launch has been displaced, promoting lateral erosion of the unprotected bank. Regrading of the bank slope to restore the banks to a comparable adjacent terrain and revegetation/ regeneration efforts followed by rip-rap armouring of the bank on either side of the proposed RWI location will contribute to a maximum of 1,500 m^2 permanent habitat alteration, but will likely preserve the sloughing bank, which has eroded over 15 m in the last 63 years (SG1 Water Consulting 2022).

6.3.1.3 Change in Fish and Mussel Mortality Risk

Some construction activities may lead to an increase in the risk of fish/mussel mortality or injury to adults, fry/larva, and eggs. Fish and mussel mortality from construction will be minimized by conducting a salvage including capturing and relocation within the isolated area. Qualified personal will be assigned to complete fish and mussel savages to reduce potential mortality, injury, and stress. Completing construction and scheduled maintenance for the intake outside of the RAP is expected to mitigate potential effects on eggs and larval stages.

The introduction of fine sediment may also have adverse effects on fish and mussels (Anderson, 1996; Newcombe and MacDonald, 1991; Wilber and Clarke, 2001; Tuttle-Raycraft et al. 2017). However, increases in suspended sediment are likely to be within guidelines and short term (i.e., less than 24-hours).

Water withdrawal increases the risk of entrainment (occurs when a fish is drawn into a water intake and cannot escape) or impingement (occurs when an entrapped fish is held in contact with the intake screen or louvers and is unable to free itself.). Mussels are located in the substrate and are not expected to be at risk of entrainment or impingement. Mussel glochidia (larva) are microscopic, however based on the life cycle of freshwater mussels including Mapleleaf, glochidia must attach to fish hosts shortly after being released by the adult after the brooding period or they die (COSEWIC 2016). Therefore, the period of time glochidia are in suspension and still viable is expected to be minimal and any potential glochidia taken into the proposed intake inconsequential.

The guidance for intake Va for anguilliform swimmers such as burbot and lamprey (0.035 m/s) is met for the forecasted maximum daily demand. Meeting the intake velocity DFO guideline is expected to avoid fish involuntarily being entrained or impinged, however the 75 mm slot size would not exclude smaller fish that may travel into the intake despite the behavioural deterrent from the fish louvers. Aquatic life that are passive (such as, larvae and eggs) will be most susceptible to entrainment. However, the expected counteracting sweeping velocities that are incorporated into the design are expected to reduce the risk of potential fish entrainment even for eggs and larva. The proposed RWI location is also not expected to be where high concentration of fish are present, or high potential for spawning habitat. Any fish including eggs or larva which are entrained would end up in the reservoir and a fish screen (2.54 mm) could be considered to avoid entraining aquatic life into the treatment facility.

Design detailed is not yet available to evaluate the noise levels expected and the potential effects or residual effects (if any) on fish/mussels. The high intensity sound waves generated from construction activities such as pile driving have the potential to cause stress and injure or cause death to fish. One type of injury resulting from noise is damage to the swim bladder or surrounding organs (Halvorsen et al, 2012). Effects are expected to be species-specific based on the morphology of the swim bladder (Halvorsen et al, 2012).

6.3.1.4 Offsetting

Potential offsetting requirements for fish and fish habitat are determined by DFO in the *Fisheries Act* review process, and there are currently no offsetting needs prescribed. However, potential offsetting opportunities have been discussed with Manitoba Fisheries, and could include removal of the abandoned boat launch (followed by restoration planting, which is already a part of the construction plan), or removal of the wingdam.

6.3.1.5 Summary

After implementation of the mitigation measures, the residual effects on Water Resources at the WTP site and the associated water intake pipeline during the construction phase are expected to be low in magnitude, limited to the Project Footprint or LSA, short-term to medium-term in duration, isolated to occasional, and reversible. The operations and maintenance phase of the Project includes longer duration residual effects which are be low to medium in magnitude, limited to the Project Footprint or LSA, short-term to long-term in duration, isolated to continuous, and reversible. The Project is occurring within a disturbed ecological context.

Table 6-5. Project Residual Effects on Water Resources

Predicted Residual Effects	Direction	Spatial Boundary	Temporal Context			Magnitude
			Duration	Frequency	Reversibility	
Construction						
Change in surface water quality and quantity	Adverse	LSA	Immediate to short term	Isolated to occasional	Reversible	Low
Change in fish/mussel habitat	Adverse	LSA	Short-term to medium-term	Isolated to occasional	Reversible	Low
Change in fish/mussel mortality risk	Adverse	Project Footprint	Short-term to medium-term	Isolated to occasional	Reversible	Low
Operations and Maintenance						
Change in surface water quality and quantity	Adverse	LSA	Immediate to long-term	Isolated to continuous	Reversible	Low
Change in fish/mussel habitat	Adverse	LSA	Immediate to long-term	Isolated to continuous	Irreversible	Medium to high Subject to DFO review
Change in fish/mussel mortality risk	Adverse	Project Footprint	Immediate to long-term	Isolated to periodic	Irreversible	Medium to high Subject to DFO review

7. Assessment of Effects on Groundwater Quality and Quantity

During construction activities, effects on groundwater in terms of quality, flows or levels are limited to building foundations at the Project site, and reservoir construction.

7.1 Description of Existing Conditions

Groundwater seepage was encountered in ten test holes from the silt, sand, silty sand, and gravel layers during drilling. The static groundwater level in the wells was measured to be between 1.84 and 5.73 m below existing grades (elev. 356.42 m to 358.85 m) at the time of the investigation (i.e., January 2018).

The Assiniboine River Valley Aquifer underlies that Project footprint and serves as a back up water supply in spring when the water quality in the Assiniboine River is turbid and high in organic carbon and hardness. Groundwater in the Assiniboine River Valley Aquifer is not under the direct influence of surface water (CH2M HILL 2015). Groundwater from the two wells used to supplement water supply ranges in quality, and has at times reported exceedances on several Canadian Drinking Water Quality Guidelines (Earth Tech Canada Inc 2008). Going forward, the intention is for the upgraded Facility to only use the Assiniboine River as the raw water source.

Changes to the surrounding area will result in alterations to drainage patterns. The southern wall of the membrane building will be within a few metres of the property line on the north side of McDonald Avenue. Due to the building location, it is recommended that all culverts on the north side of McDonald Avenue be removed and the site be graded towards the north gutter on McDonald Avenue.

7.2 Effects on Groundwater Quality and Quantity

A drainage ditch will be constructed between the west side of the new access road and the east side of the back lane that is located immediately west of the Facility. Final drainage design will use land drainage software to determine anticipated water volumes and appropriate pipe and ditch sizing. Proposed drainage changes are shown on Figure 2-1. Potential effects and effect pathways for the Project in relation to groundwater quality and quantity are provided in Table 7-1.

Table 7-1. Project Activities, Effect Pathways, and Indicators for Groundwater Quality and Quantity

Potential Effect	Project Activities and Effect Pathways	Effects Indicators
Change in groundwater quality	Disturbance to physical hydraulic properties of soil and parent material above or below the water table due to grading and backfilling and particle transport may cause changes in ground water quality.	Presence of contaminants in groundwater
Change in groundwater quantity	Compaction of soils due to vehicle and equipment crossings could reduce permeability of materials along the groundwater flow path and may result in a rise in the groundwater table to the extent that ground to surface flooding occurs.	Groundwater flowing to the surface
Groundwater contamination	Chemical leakage during chemical transport to the plants can contaminate groundwater and make it non drinkable	Presence of contaminants in groundwater

7.3 Mitigation Measures and Residual Effects

To reduce risks associated with groundwater quality and quantity, a detailed geotechnical investigation will be conducted prior to construction. The following mitigation measures intended to minimize the project effects are proposed:

- Using professional and licensed drillers during foundation installation
- Limiting construction equipment and vehicle movements to designated roads and pathways within and around work areas, and limit construction equipment in riparian areas, where feasible
- Repairing areas where equipment has compacted soils
- Having an emergency response plan to report chemical leakage and have pumping and sealing protocols in place
- Monitoring water table level in the process of drilling
- Proper containment and storage of chemical to avoid leakage
- Installing clay based or geosynthetic liner under neath the reservoirs to prevent particle transport
- Silt or sand removed from the raw water reservoir locations should not be used in areas adjacent to proposed structures
- Surface drainage should be controlled by ensuring a minimum grading away from any proposed foundations, and runoff from the roofs should also be directed away from the perimeter of the foundations to reduce the potential of excessive moisture near the buildings. In addition, a perimeter sub-drainage system (weeping tiles) around the below grade areas (basements) of the proposed upgrades will be required to aid in the removal of excess moisture. The weeping tiles will need to be directed to a sump pit(s) and the water discharged as far as possible from the proposed upgrades.
- Temporary dewatering wells will be required during the construction of the new raw water reservoir to maintain appropriate groundwater levels
- Revise piping at the catch basin located at the southwest corner of the McDonald Avenue and 27 Street North intersection to connect to the LDS pipe running along McDonald Avenue
- Adhere to proper regulatory maintenance guidelines in regard to the reservoir and do routine checkups to verify the soil liners are functioning properly

7.3.1 Residual Effects on Groundwater

With the implementation of the previously identified mitigation measures, the residual effects on groundwater are assumed to be low magnitude. Although, it is still possible for chemical permeation through soil layers, following the successful implementation of mitigation measures, any contaminants will be of low toxicity and are not anticipated to cause groundwater to be non-drinkable.

8. Assessment of Effects on Wildlife and Wildlife Habitat

Construction and operation of the new building footprints, reservoirs, and water intake facility will result in some disturbance to wildlife and wildlife habitat. Therefore, wildlife and wildlife habitat are considered in this assessment.

8.1 Description of Existing Conditions

The Project has the potential to alter wildlife habitat or increase wildlife mortality risk; therefore, Wildlife and Wildlife Habitat has been selected as a biophysical element. The Wildlife and Wildlife Habitat element includes wildlife, wildlife species at risk, and potentially suitable habitat. The assessment team conducted a desktop review to establish the existing conditions (that is, baseline setting) for Wildlife and Wildlife Habitat from which the potential effects of the Project can be determined. The existing conditions description is based on a review of existing literature, internet searches, consultation and engagement, field surveys, and expert opinion.

The scope of the assessment of the effects on Wildlife and Wildlife Habitat includes the range of wildlife species and habitats that are expected to occur in and around the Project and considers species at risk and species with special conservation status that have the potential to interact with the Project. Species at risk are those species listed federally on Schedule 1 of *SARA* or by COSEWIC. Species of special conservation status include those with provincial conservation designations, including species designated as Endangered or Threatened under the Manitoba *Endangered Species and Ecosystems Act*.

Areas within the Project LSA and RSA have been heavily modified by human development and support infrastructure including industrial development, residential development in the City of Brandon, roads and sports and recreational facilities. The existing Facility and proposed location of the Chemical Building, Membrane Plant, and other associated infrastructure are on previously disturbed land used for the existing Facility and have been cleared of vegetation. The proposed raw water reservoir sites are located on disturbed areas currently used as sports fields, tennis court, other recreational purposes, and associated parking lots and roadways. Areas not currently developed include riparian habitat along the south bank of the Assiniboine River that is dominated by reed canary grass with areas containing common plantain, water smartweed, cattail, and willow.

The Project occurs in the Aspen Parkland Ecoregion and is located within generally level terrain and includes riparian habitat dominated by grasses along the Assiniboine River as well as previously disturbed land (recreational park, sports fields, existing facility) within the City of Brandon.

The project footprint does not encounter any designated parks or protected areas (Government of Manitoba 2017b), national wildlife areas (Government of Canada 2021b), Migratory Bird Sanctuaries (Government of Canada 2021d), Important Bird Areas (Bird Studies Canada 2015), Western Hemisphere Shorebird Reserves (WHSRN 2020), or Ramsar Wetlands (The Secretariat of the Convention on Wetlands 2021). The Project is located within migratory bird nesting zone B4 (Government of Canada 2018). The primary nesting period, when the majority (approximately 90%) of migratory bird species are expected to be nesting, is April 26 to August 14.

Species at risk (that is, species that are federally listed on Schedule 1 of *SARA* [Government of Canada 2021b] or COSEWIC [2021]) that have the potential to interact with the Project, were identified based on a desktop review of available information from the area, species ranges, habitat requirements, and professional judgment. A summary of species at risk that have the potential to interact with the Project include:

- Barn swallow (listed as Threatened on Schedule 1 of *SARA* and by COSEWIC)
- Common nighthawk (listed as Threatened on Schedule 1 *SARA* and Special Concern by COSEWIC)
- Northern leopard frog (listed as Special Concern on Schedule 1 of *SARA* and by COSEWIC)

Field studies at the Project site were conducted in September 2020 and focused on a watercourse assessment for previously considered intake option located approximately 170 m downstream of the currently proposed intake. Detailed field notes were recorded throughout the site and included observations of the terrestrial and riparian aquatic and wildlife habitat and incidental wildlife observations. The riparian habitat along the south bank of the Assiniboine River is dominated by reed canary grass with some shrubs, snags, and downed woody debris present. Incidental wildlife observations included ring-billed gull, black-billed magpie, Lincoln's sparrow, raccoon (tracks), and northern leopard frog. No wildlife habitat features were observed during the field visit.

8.2 Effects on Wildlife and Wildlife Habitat

During construction and operation, the Project will interact with two effect pathways for wildlife: alteration of wildlife habitat and increased wildlife mortality risk, as outlined in detail in Table 8-1.

Table 8-1. Project Activities, Effect Pathways and Indicators for Wildlife and Wildlife Habitat

Potential Effect	Project Activities and Effect Pathways	Effects Indicators
Alteration of wildlife habitat	Brushing of vegetation and ground disturbance during construction and operation activities may cause direct habitat loss or alteration.	Direct habitat disturbance Alteration in habitat quality or effectiveness Disturbance of wildlife habitat features that may be occupied during construction, and are identified in the Project footprint or within recommended buffer distances Increased waterbird presence Increased amphibian presence
	Increased sensory disturbance caused by noise and activity during construction activities may reduce habitat effectiveness, causing indirect habitat loss or alteration.	
	The removal of recreation areas and addition of two open water reservoirs may create wildlife habitat (waterbird and amphibian stopover) and reduce the sensory disturbance associated with the existing recreational facilities.	
Increased wildlife mortality risk	Traffic from transportation of Project personnel and equipment, and movement of equipment and machinery on the Project footprint during construction activities may increase the risk of wildlife collisions.	The overlap of activities with sensitive periods for wildlife Disturbance to wildlife habitat features that may be occupied during construction
	Human-wildlife conflict, such as attraction of wildlife to work sites during construction activities may result in the need for removal or destruction of the animal.	
	Vegetation brushing and ground disturbance scheduled during sensitive periods for wildlife may increase the risk of wildlife mortality through disturbance of occupied habitats during construction and operations.	
	Changes in soil contours at excavation areas required for construction activities may create artificial ponding of water following the completion of backfilling which may create breeding areas that become population sinks for some amphibians (e.g., ponded areas dry out before larvae completely develop).	Creation of ponded water during excavation and observation of amphibian breeding
	Raw water ponds constructed using pond liners may increase the risk of wildlife mortality by attracting amphibians and small and medium mammals to a fresh water source with limited egress options at various water levels.	Wildlife becoming trapped in the raw water ponds

8.3 Mitigation Measures and Residual Effects

The assessment team has reviewed relevant regulatory guidance to establish the effectiveness of the proposed mitigation to reduce potential effects on Wildlife and Wildlife Habitat. It was determined that the mitigation measures and construction practices for wildlife that have been established are effective in reducing residual effects on Wildlife and Wildlife Habitat and will be implemented during Project activities to avoid or reduce environmental effects. Potential Project effects on wildlife from construction will be mitigated by implementing the following measures:

- Avoid clearing during the Nesting Period for Migratory Birds (Nesting Zone B4 – April 26 to August 14 [ECCC 2018]) where possible.
- If activities are scheduled during the nesting period, conduct a nonintrusive area search for evidence of nesting within seven days of activities that are scheduled to occur and establishing protective setbacks from active nests.
- Confirm the accuracy of all setbacks and ensure protective marking is maintained during construction.
- Ensure that noise abatement equipment on machinery is in good working order and reduce idling of equipment, where possible.
- Install impermeable pond liner to prevent vegetation growth and limit waterbird nesting habitat and potential amphibian overwintering habitat within the raw water reservoirs.
- Install access egress devices (such as, strips of high friction material) at regular intervals around the raw water ponds to allow wildlife to climb out during low water levels.
- Construction workers should report sightings of species of interest including amphibians. Specific protection measures may be implemented and the sighting will be recorded.
- Project personnel are prohibited from harassing, feeding, collecting, or possessing wildlife species from the construction footprint.
- The Contractor will monitor the open excavations for trapped wildlife. Report any incidences of wildlife discovered in the open excavations, or in association with any other activity or facility.
- Cover or fence open excavations when construction is paused or delayed, to minimize hazards to wildlife.
- Implement a wildlife management strategy during operations for wildlife that may enter the raw water reservoirs (such as, install egress, regular visual searches for wildlife, developing a plan for trapped wildlife).

8.3.1.1 Residual Effects

In some cases, a residual effect on Wildlife and Wildlife Habitat may remain after the implementation of mitigation measures. The predicted residual effects are:

- Localized alteration of wildlife habitat during construction of the Project through vegetation removal during the nesting period for migratory birds and the amphibian activity period, and through the addition of the raw water reservoirs and reduced public access in the area during operations.
- Increased wildlife mortality risk within the raw water reservoirs.

8.3.1.2 Localized Alteration of Wildlife Habitat

The Project will alter wildlife habitat and the new disturbance is limited mainly to areas of existing disturbance where vegetation is patchy or manicured. Habitat alteration during construction can cause the displacement of wildlife, and potentially result in use of less suitable habitat, reduced foraging ability (Bird et al. 2004), increased energy expenditure (Jalkotzy et al. 1997), and lower reproductive success (Habib et al. 2007). The Project will require removal of small areas of grass, sparse low-growing shrubs, and willow trees within the footprints for the raw water reservoirs. The remaining vegetation to be impacted is primarily areas of landscaped grass as part of the existing facility and existing recreational fields. The current value of this existing habitat for wildlife is limited given the vegetation community composition, lack of structural diversity, and existing noise from surrounding facility and recreational areas. Following expansion during the operations phase, the Facility buildings will remain largely unsuitable for wildlife and there will be low potential for wildlife to be using any habitat within the building footprint; however there may be resilient species that use the site, such as barn swallows or killdeer. Regenerating grass and shrub in previously manicured areas is expected to regenerate relatively quickly following construction (medium-term) if allowed and may create wildlife habitat where it was limited previously. However, the habitat quality would be dependent on the vegetation composition and maintenance plans throughout and adjacent to the Facility infrastructure.

During operations, ponded water in the raw water reservoirs could attract wildlife, mainly waterbirds and amphibians, however presence is expected to be temporary during foraging and migratory stopover and movement events, and not expected to support breeding or overwintering. Northern leopard frogs require emergent vegetation for breeding and cobble-mud substrate for overwintering (Environment Canada 2013). The lined raw water reservoirs may act as a temporary aquatic site for frogs moving through the area but are not thought to support leopard frogs as part of their life cycle. Similarly, water birds (shorebirds, wading birds, and waterfowl) may use the reservoirs as summer foraging and resting sites or stopover locations during migration, but the reservoirs are not expected to support nesting due to lack of nesting substrate, cover vegetation, and the occurrence of water level fluctuations. The ponded fresh water may also attract wildlife as a drinking source. Fish eggs or larvae may enter through the water intake supplying a food source for foraging diving ducks, mergansers, and herons.

Considering the spatial scope and limited value of the existing vegetated area, and with mitigation, during construction, to detect and protect active migratory bird nests and implement contingency measures for discovered wildlife and wildlife features, the residual effect from habitat alteration due to vegetation removal and ground disturbance during construction is predicted to be short term in duration and negligible to low in magnitude. The residual effect is reversible upon decommissioning and reclamation of the facilities. During the operations phase, the residual effect from habitat alteration due to the addition of the ponded water reservoirs is predicted to have a neutral benefit on wildlife and be long-term in duration and low in magnitude. The raw water ponds may create habitat for wildlife; however, the habitat is not natural, lacks vegetation, and experiences water fluctuations, therefore the habitat would not be considered high quality or provide consistent benefits to wildlife.

Indirect habitat effects occur when the quality or effectiveness of available habitat is altered such that wildlife avoid or reduce their use of the habitat or are attracted to the habitat and increase their use of it. Habitat effectiveness may be affected by the changing noise, light, and human and industrial activity levels associated with Project construction and operations. Increased sensory effects on wildlife can cause avoidance, increased energy expenditure, changes in normal behaviours, and impaired communication between individuals. However, different species and even individuals of a given species are expected to respond differently to sensory disturbances. Wildlife that are present in the area are anticipated to have some level of tolerance to human activities given the level of existing anthropogenic disturbance in the local and surrounding areas.

While the expansion of the treatment plant is expected to incrementally increase the Facility created noise and light disturbance in the area, the removal of the recreational fields and reduced public access in the area will reduce the overall human presence, including vehicles, recreational noise, trail users, and dogs. This may increase the presence of wildlife residing in and moving through the area for travel and foraging. The Project is located along the Assiniboine River and is likely part of a naturally occurring wildlife movement corridor.

Habitat effectiveness as a result of altered sensory disturbance will be incremental in nature and may have a neutral benefit impact on wildlife compared with the existing public access and recreational facilities (for example, roadways, parking lots, sports fields, and recreational pathways) in the area. The residual effect of noise and light affecting wildlife habitat effectiveness will be localized to the Facility footprint and adjacent areas. The residual effect from habitat alteration due to sensory disturbance is expected to be long term (extending for the life of the Project), but reversible, and predicted to be low magnitude.

8.3.1.3 Increased Wildlife Mortality Risk

The construction and operation of the Project has the potential to increase wildlife mortality risk if occupied habitats are directly or indirectly disturbed during Project activities. Some activities during construction and operations may occur during seasons when wildlife may be migrating, breeding, rearing or denning in habitats within or adjacent to the Project. Mitigation measures to reduce mortality risk include conducting pre-disturbance surveys for evidence of occupied habitat and implementing protective buffers until habitat features are no longer active or other mitigation. The residual effect from disturbing occupied habitats is continuous and low-magnitude with the implementation of mitigation measures during construction and operations.

The raw water reservoirs also have potential to increase mortality risk for wildlife, mainly amphibians, and small mammals that may be attracted to the potential drinking water source. Ponds with liners can trap wildlife that are unable to climb out once inside depending on the slope of the sides, water levels, and material of the pond liner. Installation of egress devices (such as, ropes, or textured ramps) may reduce wildlife mortality by allowing wildlife to climb out on their own if they are trapped.

8.4 Summary

Some residual effects will carry forward into the operations phase. Effects on habitat suitability (alteration of sensory disturbance at the Project site, and ongoing vegetation maintenance), will be continuous in duration. While the effects will extend over the life of the Facility, sensory disturbance will cease and vegetation will regenerate on the construction footprint following Project decommissioning. Residual effects on wildlife mortality risk are possible, even after the implementation of mitigation measures during vegetation removal and maintenance and at the raw water ponds. Overall, the effects of the Project on Wildlife and Wildlife Habitat are anticipated to be negligible to low in magnitude given that the Project is located in an urban environment.

9. Assessment of Effects on Socioeconomic Elements including Human Health

9.1 Existing Conditions

9.1.1 Population

The City of Brandon has a population of approximately 51,313 people (Statistics Canada 2021). The population grew by 2,430 people (5%) between 2016 and 2021 (Statistics Canada 2021). Of the total 22,526 private dwellings recorded in 2021, 21,203 dwellings were occupied. The total land area for the City of Brandon is 79.04 square kilometres (km^2). with a population density of 649.2 persons per km^2. (Statistics Canada 2021). It is anticipated that the population will continue to grow.

9.1.2 Indigenous Communities

The closest First Nation community to the Project is the Sioux Valley Dakota Nation located on the banks of the Assiniboine River, approximately 34 km west (and upstream) of the existing WTP. Sioux Valley Dakota Nation has three reserves: Fishing Station 62A, Sioux Valley Dakota Nation and Sioux Valley Indian Reserve No 58A (CIRNAC 2021). The population of Sioux Valley Dakota Nation consists of 2,682 members with approximately 1,466 residents living on-reserve. In July 2014 Sioux Valley Dakota Nation signed a self-government agreement with both the Government of Canada and the Government of Manitoba (Sioux Valley Dakota Nation 2021).

As introduced in Section 2.8.1, in addition to the Sioux Valley Dakota Nation, Indigenous Engagement involves outreach to the Swan Lake First Nation No. 7, and the Manitoba Métis Federation (Southwest Region).

9.1.3 Infrastructure and Services

The existing Facility is near the intersection of McDonald Avenue and 26 Street North in Brandon, Manitoba. The City of Brandon is located on the Trans Canada Highway and railway service is provided by Canadian Pacific Rail. There is an abundance of affordable and reliable electricity in the City of Brandon generated by the publicly owned utility, Manitoba Hydro. The Brandon Municipal Airport provides an air link between the City of Brandon and other Canadian cities.

Municipal services in the City of Brandon consist of a WTP and distribution, wastewater treatment plant, garbage and recycling collection, and operation of the waste disposal facility (City of Brandon 2022). The City of Brandon does not have a hospital, but the Brandon Regional Health Centre provides a suite of health services to residents. Other emergency services include ambulance, fire and police services.

9.1.4 Land and Resource Use

The City of Brandon is located 201 km west of the City of Winnipeg. Brandon has a varied economic base with agri-food products and related services and the manufacture of metals, chemicals and pharmaceuticals accounting for the bulk of industrial jobs. Oil drilling and production is also present in the area, and the city is surrounded by privately owned agricultural land.

The existing Facility is located on land owned and administered by the City of Brandon. Land use surrounding the existing Facility includes residential areas to the east, west and south and to the north is a recreational area (Queen Elizabeth Park). To the northeast of the existing Facility there are soccer fields which are part of Canada Games Park. The Assiniboine River is to the west and north of the existing Facility and Queen Elizabeth Park. Uses of the Assiniboine River include fishing, and recreational activities.

Water is withdrawn from the Assiniboine River for the existing Facility. The City's water license for the existing intake facility allows for withdrawal of up to 1.17 m^3/s or 101 ML/d from the Assiniboine River. The current raw water demand varies between 20 and 40 MLD on an average daily basis, whereas future design flows are expected to reach an average day demand of 29.54 MLD (0.34 m^3/s) and a maximum day demand of 50.21 MLD (0.58 m^3/s) by the year 2048. It is understood that the new RWI facility must be designed to handle the City's forecasted water demands for the next century (circa 2122).

9.1.5 Heritage Resources

The Project is located on the lower terrace of the Assiniboine River valley and as such archaeological potential is high. "*The Assiniboine, and the tributaries that form its watershed, have a number of known archaeological sites along and near the margins, including large Precontact Indigenous campsites, Bison Kill sites, Fur Trade Posts, and Precontact and Historic burial locations. These factors, to name a few, suggest that any planned development within the area has the potential to impact heritage resources, therefore, the Historic Resources Branch has concerns with the project at this time*" (Heritage Resources Branch [HRB] File # AAS-21-17984). A Heritage Resources Impact Assessment (HRIA) was completed for the Project from September 20 to 23, 2022. The assessment consisted of a pedestrian survey and subsurface testing program based on requirements outlined in HRB File #AAS-21-17984. A total of 44 shovel tests and nine deep sediment probes (auger holes) were excavated throughout the project area. One new archaeological site was recorded, overlapping the water intake pipeline footprint along the Assiniboine River. The site (Borden number TBD) consists of two pieces of chert debitage (waste from making stone tools) with low interpretive potential. The DlLx-17 site area (1893 Water Treatment facility) was also revisited. Observations suggest that the recorded location is inaccurate, and the actual location is likely near the southwest corner of the existing Intake Facility fence line. Two shovel tests excavated in this area contained brick and mortar fragments in a disturbed, hard packed gravel. The findings support previous observations that the building is likely predominately destroyed, but monitoring of any activities planned in this area may be warranted to see if anything remains intact. Results from the HRIA have been submitted to the Historic Resources Branch.

9.1.6 Human Health

The Project is located within Prairie Mountain Health Region jurisdiction. Overall, general health conditions in the Prairie Mountain Health Region are better than the provincial average. As this is an urban area there are several residential buildings near the Project footprint. Noise effects from construction equipment and vehicles are anticipated at residences near the Project footprint.

9.2 Effects on Socioeconomic Elements including Human Health

The Project is expected to have negligible effects on human health. The operation of the new membrane WTP and associated water intake infrastructure are expected to improve the drinking water supply in the City of Brandon. The Project is expected to contribute only nominally to greenhouse gas emissions during the construction period.

There is some potential for noise effects in the immediate area from the operation of construction equipment and vehicles. Noise effects from construction and operation of the WTP will be limited to the Project Footprint and may carry at low levels to residences in the immediate area. Contractors engaged in the construction phase of the proposed Project will be subject to site specific health and safety plans and worker protection standards and procedures under the provincial Workplace Safety and Health Act. Operational worker health and safety programs and policies will be implemented for the Project.

There will be a temporary increase in traffic in the immediate vicinity of the Project on McDonald Avenue and 26 Street North. During operations no increased demand on traffic infrastructure and services is expected as a result of the Project. The Project also has the potential to disrupt users of the Assiniboine River during construction.

9.3 Mitigation Measures and Residual Effects

The proposed Project will be an improvement over the existing Facility. The greater volume and improved quality of treated water will benefit residents of the City of Brandon. Effects of noise during construction will be mitigated by scheduling of construction activities during day-time hours to avoid sleep disturbance and disruption of evening residential activities, equipping vehicles with appropriate mufflers and maintaining vehicles in good working order. The City of Brandon's Nuisance Bylaw requires that construction activities take place between 7:00 AM and 10:00 PM unless otherwise permitted (City of Brandon, 2007). During operations, workers will be provided with hearing protection and clear signage will be posted for those areas where hearing protection is required. Warning signs will be installed along the banks both upstream and downstream of the Project site during construction to caution users of a navigational hazard, where appropriate.

The City is committed to health and safety for the Project. Improvements to health and safety are one of the drivers for the Project. Construction teams will be required to prepare and submit a site Health and Safety Plan that meets the requirements of *The Workplace Safety and Health Act* and other applicable legislation and by-laws. The Construction team will also be required to submit copies of reports or directions issued by the Province, copies of incident and accident reports, and Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets as required. Appropriate fire protection equipment and measures will be maintained onsite during the performance of site work, as required by local municipal codes, regulations and by-laws.

Once the Project is constructed and commissioned a site health and safety program will be developed and implemented by the City that will include chemical handling procedures, and worker health and safety requirements.

With implementation of the mitigation measures previously identified, the potential adverse residual effect to socioeconomics is anticipated to be negligible in magnitude, limited to the Project footprint, short- term and reversible, and occurring within a disturbed socioeconomic context. No further operational effects on human health and safety are expected once the construction phase of the Project has been completed. As such, residual effects are considered not significant

10. Follow-up Plans including Monitoring and Reporting

The Facility will be operated by certified operators. Specific training for the proposed plant operation and maintenance will be provided during start-up and commissioning. This includes facility monitoring, and laboratory techniques to monitor day-to-day treatment operations for meeting the water quality and treatment requirements. Follow-up plans including monitoring and reporting will be prepared for the following:

- Following commissioning and initial testing monitoring will occur to ensure that potable water produced meets the water quality requirements
- Monitoring the input of UF waste to the SCU units which are not used for treated water production (new piping and instrumentation)
- Quality monitoring of gravity thickener overflow and belt filter press filtrate
- Sampling of all required water quality parameters done in accordance with the Drinking Water License for the updated facility and requirements per regulations
- During commissioning, sampling and monitoring will be conducted at a frequency to optimize the Facility operations

Follow-up plans including monitoring and reporting for the effects of the Project on environmental elements include:

- DFO requirements for intake construction

11. Conclusions

Jacobs prepared this EAP application on behalf of the City of Brandon for the proposed updates to the Brandon WTP.

For most of the elements identified that interact with the proposed upgrades to the City of Brandon WTP, the adverse residual environmental effects were found to be negligible to low in magnitude for construction and operations. With the application of the proposed mitigation measures for soils and terrain, vegetation, water resources, groundwater, wildlife and wildlife habitat, and socioeconomic elements including human health the adverse effects can be avoided or reduced to low or negligible magnitude. For fish and fish habitat however, the new intake has the potential to generate high magnitude effects on fish mortality through upsweep of fish larvae in the intake during operations.

The Water Treatment Facility Upgrade Project will result in an improvement to the water supply, treatment, and water quality to meet current and future operational requirements of the City of Brandon and meet the anticipated target design criteria for the surface water source for the Facility.

12. References

12.1 Personal Communications

Rospad, personal communication, 2020.

Jeff Long, personal communication, September 23, 2021.

Laureen Janusz, personal communication, February 26, 2021.

12.2 Literature Cited

Adam Stevenson and Associates. 2007. *Report on the Sand Intrusion Problem at the Water Intake Structure: City of Brandon*. Prepared for the City of Brandon Engineering Department. + 18 pp.

AECOM. 2015. *City of Brandon Water Utility Master Plan*. https://brandon.ca/images/pdf/engineering/Water-Utility-Master-Plan.pdf.

Anderson, P.G. 1996. Sediment Generation from Forestry Operations and Associated Effects on Aquatic Ecosystems. Proceedings of the Forest-Fish Conference: Land Management Practices Affecting Aquatic Ecosystems, Canadian Forest Service, Edmonton, Alberta.

Anderson, P.G., Fraikin, C.G.J., and Chandler, T.J. 1998. Natural Gas Pipeline Crossing of a Coldwater Stream: Impacts and Recovery. Proceedings of the International Pipeline Conference – 1998, Calgary, Alberta.

Bayne, E.M., Habib, L., Boutin, S. 2008. Impacts of Chronic Anthropogenic Noise from Energy-Sector Activity on Abundance of Songbirds in the Boreal Forest. Integrated Landscape Management Group, Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada. Vol. 22, No. 5. pp. 1186-1193.

Bird Studies Canada. 2015. Important Bird Areas of Canada Database. http://www.ibacanada.org.

Bird, B.L., L.C. Branch, and D.L. Miller. 2004. "Effects of Coastal Lighting on Foraging Behaviour of Beach Mice." *Conservation Biology*. Vol. 18, No. 5. pp. 1435-1439.Canadian Council of Ministers of the Environment. 2021. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Total Particulate Matter. Accessed March 2022. [https://ccme.ca/en/resources].

Bureau of Reclamation (Reclamation). 2006. Fish Protection at Water Diversions: A Guide for Planning and Designing Fish Exclusion Facilities. Water Resources Technical Publication. Denver, Colorado. Accessed March 2022. https://www.usbr.gov/tsc/techreferences/mands/mands-pdfs/FishProtectionAtWaterDiversions_April2006.pdf.

CH2M Hill. 2015. Water Supply System Re-Assessment Report. Final. Prepared for the City of Brandon.

City of Brandon. 2007. Continuing Consolidation Nuisance By-Law No. 5806/81/90.

City of Brandon. 2021. City of Brandon. Accessed March 2022. https://www.brandon.ca.

City of Brandon. n.d. Integrated Pest Management (IPM) Plan. First draft. https://www.brandon.ca/images/pdf/pestControl/pestControl.pdf.

COSEWIC. 2006. COSEWIC assessment and status report on the rough agalinis *Agalinis aspera* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Vi + 22 pp. Accessed March 2022. https://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_rough_agalinis_e.pdf.

COSEWIC. 2014. COSEWIC assessment and status report on the Small White Lady's-slipper *Cypripedium candidum* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii + 48 pp. Accessed March 2022. https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/cosewic/sr_Small%20White%20Lady%27s-slipper_2014_e.pdf.

COSEWIC. 2016. COSEWIC assessment and status report on the Mapleleaf Quadrula quadrula, Great Lakes - Upper St. Lawrence population and Saskatchewan - Nelson Rivers population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 86 pp. (http://www.registrelepsararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1).

COSEWIC. 2017. COSEWIC assessment and status report on the Lake Sturgeon Acipenser fulvescens, Western Hudson Bay populations, Saskatchewan-Nelson River populations, Southern Hudson Bay James Bay populations and Great Lakes-Upper St. Lawrence populations in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxx + 153 pp. (http://www.registrelepsararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1).

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2021. COSEWIC Wildlife Species Assessment. https://www.cosewic.ca/index.php/en-ca/assessment-process.html.

Crown Indigenous Relations and Northern Affairs Canada (CIRNAC). 2021. GeoViewer. Accessed XXXXX. https://geo.aadnc-aandc.gc.ca/geoviewer-geovisualiseur/index-eng.html.

Crown Indigenous Relations and Northern Affairs Canada (CIRNAC). 2021. First Nation Profile for Sioux Valley Dakota Nation. Accessed December 2021 https://fnp-ppn.aadnc-aandc.gc.ca/fnp/Main/Search/FNMain.aspx?BAND_NUMBER=290&lang=eng.

Department of Fisheries and Oceans. 2010a. Recovery Potential Assessment of Lake Sturgeon: Saskatchewan River Populations (Designatable Unit 2). Science Advisory Report 2010/049. DFO Canada Science Advisory Secretariat. Winnipeg, MB. 24 pp.

Department of Fisheries and Oceans. 2010b. Recovery Potential Assessment of Lake Sturgeon: Red-Assiniboine Rivers-Lake Winnipeg Populations (Designatable Unit 4). Science Advisory Report 2010/051. DFO Canada Science Advisory Secretariat. Winnipeg, MB. 27 pp.

Di Rocco, R. and R. Gervais. 2021. *SPOT: Swim Performance Online Tools*. Accessed March 2022. http://www.fishprotectiontools.ca.

Eng-Tech Consulting Ltd. 2018. Geotechnical Investigation Water Treatment Facility Upgrade. Prepared for CH2M Hill Canada Ltd.

Environment Canada. 2013. Management Plan for the Northern Leopard Frog (Lithobates pipiens), Western Boreal/Prairie Populations, in Canada. Species at Risk Act Management Plan Series. Environment Canada, Ottawa. iii + 28 pp.

Environment and Climate Change (ECCC). 2018. Nesting periods. Accessed March 2022. https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods/nesting-periods.html.

Environment and Climate Change Canada (ECCC). 2022. Canadian Climate Normals 1981-2010 Station Data. Brandon A. Available: https://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?searchType=stnProv&lstProvince=MB&txtCentralLatMin=0&txtCentralLatSec=0&txtCentralLongMin=0&txtCentralLongSec=0&stnID=3471&dispBack=0.

Fisheries and Oceans Canada (DFO). 2019. Projects near Water. Measures to protect fish and fish habitat. Accessed March 2022. https://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures-eng.html.

Fisheries and Oceans Canada (DFO). 2020a. Interim code of practice: End-of-pipe fish protection screens for small water intakes in freshwater. Accessed March 2022. https://www.dfo-mpo.gc.ca/pnw-ppe/codes/screen-ecran-eng.html.

Fisheries and Oceans Canada (DFO). 2020b. Interim code of practice: Temporary cofferdams and diversion channels. Accessed March 2022. https://www.dfo-mpo.gc.ca/pnw-ppe/codes/cofferdams-batardeaux-eng.html.

Ecozones of Canada. 2021. Ecological Framework of Canada. http://ecozones.ca/english/region/156.html.

Goodman, D.H., Reid, S.B., Reyes, R.C., Wu, B.J., and Bridges, B.B. 2017. Screen Efficiency and Implications for Losses of Lamprey Macrophthalmia at California's Largest Water Diversions. North America Journal of Fisheries Management. Vol 37. pp. 30-40. Accessed March 2022. https://kbifrm.psmfc.org/wp-content/uploads/2017/06/Goodman-et-al_2017_0338_Screening-efficiencies-and-implications-for-lamprey-survival.pdf.

Government of Canada. 2018. *General nesting periods of migratory birds*. https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods.html.

Government of Canada. 2021a. "Historical Hydrometric Data Search." Accessed March 2022. https://open.canada.ca/data/en/dataset/02dc5c3d-da90-465a-8d87-4acf881ad4ba.

Government of Canada. 2021b. "Species at Risk Public Registry." Accessed October 2021. https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html.

Government of Canada. 2021c. *National wildlife areas*. https://www.canada.ca/en/environment-climate-change/services/national-wildlife-areas.html.

Government of Canada. 2021d. *Migratory bird sanctuaries across Canada*. https://www.canada.ca/en/environment-climate-change/services/migratory-bird-sanctuaries/locations.html.

Government of Manitoba. 2010a. The Central Assiniboine and Lower Souris River Integrated Watershed Management Plan. + 136 pp. Accessed March 2022. https://gov.mb.ca/water/watershed/iwmp/central_assiniboine/central_assiniboine.html

Government of Manitoba. 2010b. Central Assiniboine Watershed Integrated Watershed Management Plan - Water Quality Report. + 33 pp.

Government of Manitoba. 2017a. License to Use Water for Municipal Purposes. License No. 2017-057.

Government of Manitoba. 2017b. *Conservation and Water Stewardship*. https://mli2.gov.mb.ca/adminbnd/index.html.

Government of Manitoba. 2020. Aquatic Invasive Species Open-water Season Checklist. Accessed March 2022. https://www.gov.mb.ca/asset_library/en/ais/ais_summer_checklist.pdf.

Government of Manitoba. 2021. *The Endangered Species and Ecosystems Act*. https://www.manitoba.ca/fish-wildlife/wildlife/ecosystems/index.html#:~:text=Endangered%3A%201%20Baird%27s%20Sparrow%20%28%20Ammodramus%20bairdii%29%202,9%20Least%20Bittern%20%28Ixobrychus%20exilis%29%20More%20items...%20.

Government of Manitoba. 2022a. Aquatic Invasive Species. Zebra Mussels in Manitoba. Accessed March 2022. https://www.gov.mb.ca/stopais/zebra-mussels.html.

Government of Manitoba. 2022b. Environment, Climate and Parks. Environmental Emergency Response Program. Accessed March 2022. https://www.gov.mb.ca/sd/environment_and_biodiversity/petroleum_storage/emergency_response.html#:~:text=Environmental%20Emergency%20Response%20Program&text=Manitoba%20Conservation%20maintains%20a%2024,and%20provincial%20spill%20reporting%20regulations.

Habib, L., E.M. Bayne, and S. Boutin. 2007. "Chronic Industrial Noise Affects Pairing Success and Age Structure of Ovenbirds Seiurus aurcapilla." *Journal of Applied Ecology*. Vol. 44. pp. 176-184.

Halvorsen, M.B., B.M. Casper, F. Matthews, T.J. Carlson and A.N. Popper. 2012. Effects of exposure to pile-driving sounds on the lake sturgeon, Nile tilapia and hogchoker. Proceedings of the Royal Society B: Biological Sciences 279: 4705-4714.

Harrison, E.T., R.H. Norris, and S.N. Wilkinson. 2007. The Impact of Fine Sediment Accumulation on Benthic Macroinvertebrates: Implications for River Management. Proceedings of the 5th Australian Stream Management Conference. Australian rivers: making a difference. Charles Sturt University, Thurgoona, New South Wales. 6pp.

Henderson, D.C. and Koper, N. 2014. Historic distribution and ecology of tall-grass prairie in Western Canada. Proceedings of the North American Prairie Conference 23:40-49.

Hlasny, R.E. 2003. Assessment of the Bigmouth Buffalo Population of Pasqua Lake. Report to the Fish and Wildlife Branch of Saskatchewan Environment. Regina SK. 22 pp.

Jacobs. 2018a. City of Brandon Water Demand Projections. Prepared for the City of Brandon

Jacobs. 2018b. Water Treatment Facility Upgrade Approach. Prepared for the City of Brandon

Jacobs. 2019. Brandon Water Treatment Facility Upgrade - Treatability Testing Summary. Prepared for City of Brandon. Memorandum. + 98 pp.

Jacobs. 2022. Civil Site Plan. Prepared for the City of Brandon.

Jalkotzy, M.G., P.I. Ross, and M.D. Nasserden. 1997. The Effects of Linear Developments on Wildlife: A Review of Selected Scientific Literature. Prep. for Canadian Association of Petroleum Producers. Arc Wildlife Services Ltd., Calgary. 115pp.

Johnson, R.P. 1963. Studies on the life history and ecology of the bigmouth buffalo, Ictiobus cyprinellus (Valenciennes). Journal of the Fisheries Research Board of Canada 20(6):1397-1429.

Katopodis, C. 1992. Fish Screening Guide for Water Intakes. Freshwater Institute, Central and Arctic Region, Department of Fisheries and Oceans. Winnipeg, Manitoba. + 4 pp.

Mackie, G., Morris, T.J., Ming, D. 2008. Protocol for the detection and relocation of freshwater mussel species at risk in Ontario-Great Lakes Area (OGLA). Can. Manuscr. Rep. Fish. Aquat. Sci. 2790: vi + 50 pp.

McPherson N, Williams C, McTavish P, Allen A, Gaber M, Ostash A, Tregunna N, Allan J. 2019. Prairie Mountain Health Community Health Assessment 2019, December 2019. https://prairiemountainhealth.ca/images/2019CHAFeb102020.pdfMcCulloch, B.R., and Franzin, W.G. 1996. Fishes of the Canadian portion of the Assiniboine River drainage. Can. Tech. Rep. Fish. Aquat. Sci 2087: v + 62 p

Nelson, P. 2003. Bigmouth Buffalo status summary. Report to Manitoba's Endangered Species Advisory Committee. Draft. 8 pp.

Newcombe, C.P., and D.D. MacDonald. 1991. "Effects of suspended sediments on aquatic ecosystems." North American Journal of Fisheries Management 11:72-82.

North/South Consultants Inc. 2011. City of Brandon Assiniboine River Water Intake: Assiniboine River Mussel Survey and Relocation. Prepared for KGS Group.

Province of Manitoba. 2022. Declaration of Noxious Weeds in Manitoba. Accessed March 2022. https://www.gov.mb.ca/agriculture/crops/weeds/declaration-of-noxious-weeds-in-mb.html

Pyle, L., Elsinger M., and LaForge K. 2018. Manitoba's Rangeland Plan Communities of the Aspen Parkland and Assiniboine Delta Rangeland Ecoregions. A First Approximation. Prepared for Manitoba Forage and Grassland association. Accessed March 2022. https://static1.squarespace.com/static/5c6d9be4797f740e645a4310/t/5c8461c3eb393173c6df5930/1552179673863/MB+Plant+Community+Guide+-+AspenParkland+%26+AssiniboineDelta+%28May2018%29.pdf.

Thorpe, J. 2014. Rangeland classification for Agri-Manitoba. Prepared for Manitoba Forage and Grassland Association. Saskatchewan Research Council Pub. No. 12870-1E14.

Tuttle-Raycraft S., Morris T.J., and Ackerman J.D. 2017.Suspended solid concentration reduces feeding in freshwater mussels. Science of The Total Environment. Vol. 598. pp 1160-1168. Accessed March 2022. https://doi.org/10.1016/j.scitotenv.2017.04.127

Reid, S.M., and P.G. Anderson. 1999. Effects of Sediment Released During Open cut Pipeline Water Crossings. Canadian Water Resources Journal. Vol. 24, No. 3. pp. 235-251.

RL&L. 1998. Fisheries Assessment for the IPL Terrace Phase I Expansion Program. Prepared for TERA Environmental Consultants. 164 pp.

SG1 Water Consulting. 2022. City of Brandon Water Treatment Plan Facility Upgrades Development of New Water Intake System on Assiniboine River: Hydrotechnical Design Report. Prepared for Jacobs Engineering Group. Manuscript in preparation.

Simonovic, S.P. and L. Li. 2004. Sensitivity of the Red River Basin flood protection system to climate variability and change. Water Resources Management 18(2):89-110.

Sioux Valley Dakota Nation. 2021. Sioux Valley Dakota Sioux Website. https://svdngovernance.com/.

Smith, R.E., Velduis H., Mills G.F., Eilers R.G., Fraser W.R., and Lelyk G.W. 1998. Terrestrial Ecozones, Ecoregions, and Ecodistricts: An Ecological Stratification of Manitoba's Landscapes. Technical Bulletin 98-9E. Land Resource Unit, Brandon Research Centre, Research Branch, Agriculture and Agri-Food Canada, Winnipeg, Manitoba.

Statistics Canada. 2021. Census of Population: Brandon. Accessed March 2022. https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/Page.cfm?Lang=E&SearchText=brandon&DGUIDlist=2021A00054607062&GENDERlist=1&STATISTIClist=1&HEADERlist=0.

Stewart, K.W. and D.A. Watkinson. 2004. The Freshwater Fishes of Manitoba. University of Manitoba Press. Winnipeg, MB. 276 pp.

The Secretariat of the Convention on Wetlands. 2021. *Ramsar List - The List of Wetlands of International Importance*. Gland, Switzerland. 56 pp.

Western Hemisphere Shorebird Reserve Network (WHSRN). 2020. *WHSRN Sites*. https://whsrn.org/whsrn-sites/map-of-sites/.

Wilber, D.H. and D. G. Clarke. 2001. Biological Effects of Suspended Sediments: A Review of Suspended Sediment Impacts on Fish and Shellfish with Relation to Dredging Activities in Estuaries. North American Journal of Fisheries Management, 21:4, 855-875.

Appendix A
Process Flow Diagrams

Figure A-1. Existing plants (1-3), new membrane plant (4), and treated water storage

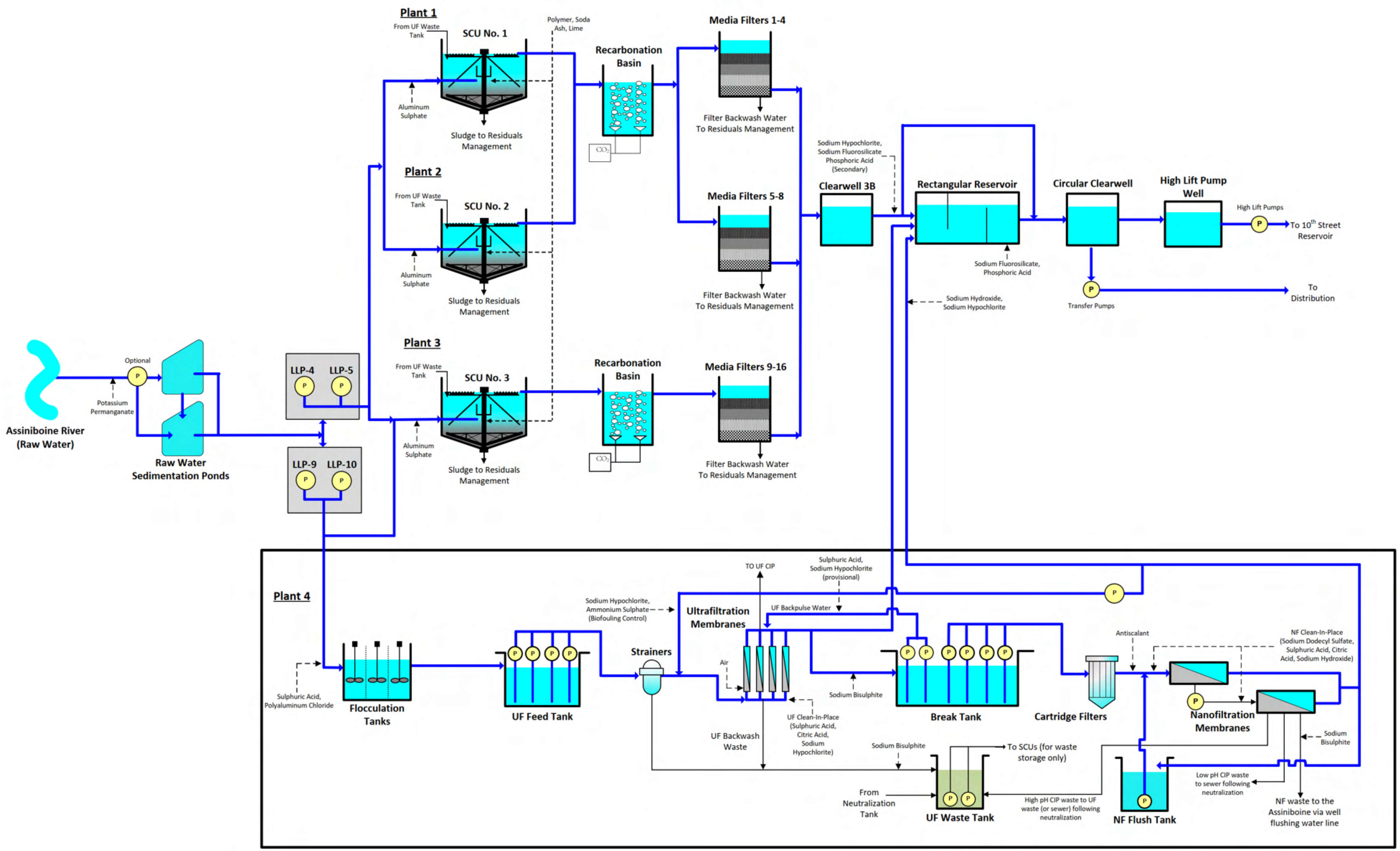
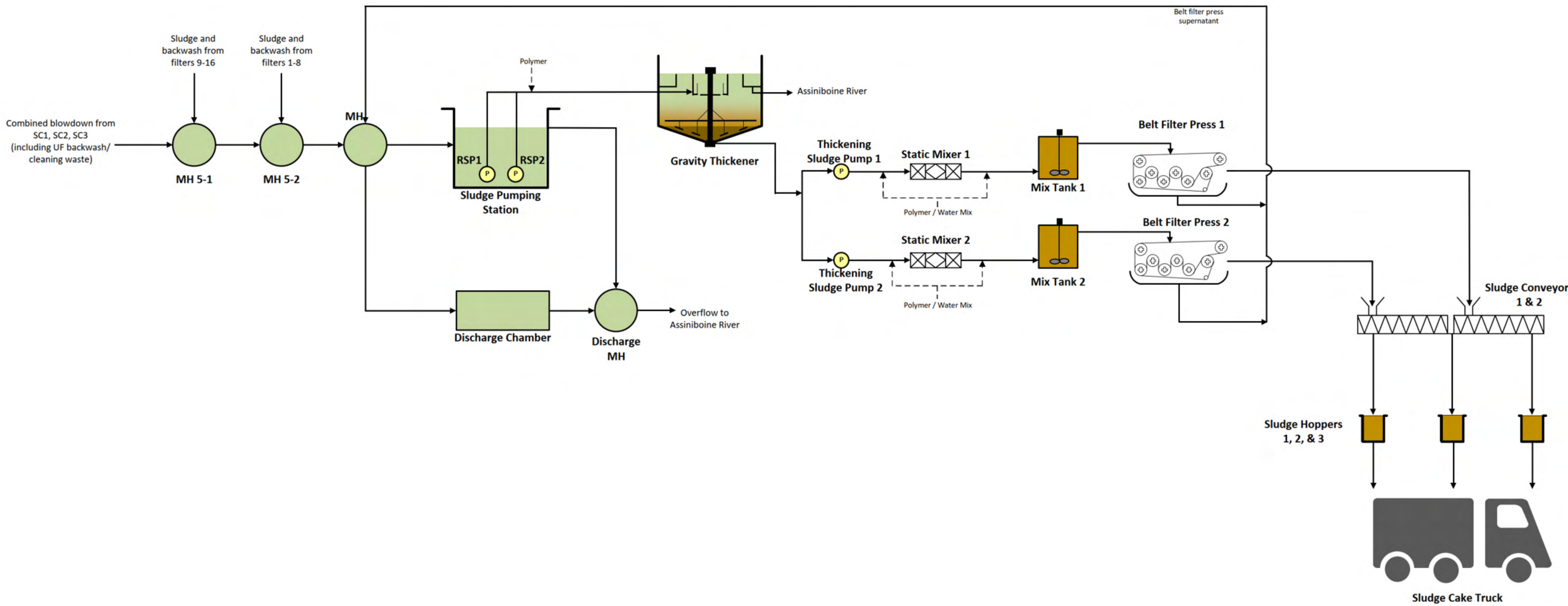


Figure A-2. Residuals Treatment



MH = manhole

Appendix B
Photographs

Plate 1. Aerial photograph looking downstream at southeast bank in the vicinity of the proposed intake location (May 19, 2021, SG1 Water Consulting Ltd.).

Plate 2. Photograph looking downstream at southeast bank in the vicinity of the proposed intake location (May 19, 2021, SG1 Water Consulting Ltd.).

Plate 3. Aerial photograph facing the southeast bank in the vicinity of the proposed intake location (May 19, 2021, SG1 Water Consulting Ltd.).

Plate 4 .Aerial photograph looking upstream at southeast bank in the vicinity of the proposed intake location (May 19, 2021, SG1 Water Consulting Ltd.).

Plate 5. Aerial photograph of the southeast bank, downstream of the proposed intake location (May 19, 2021, SG1 Water Consulting Ltd.).

Plate 6. Aerial photograph looking downstream at southeast bank showing existing access (an abandoned boat launch) from the south, near the proposed intake location (May 19, 2021, SG1 Water Consulting Ltd.).

Plate 7. Photograph looking northeast at the rock wingdam, located downstream of the proposed intake (August 23, 2021, Jacobs).

Plate 8. Photograph looking east at the rock wingdam and existing intake, located downstream of the proposed intake (August 23, 2021, Jacobs).

Plate 9. Photograph looking upstream at southeast bank showing the abandoned boat launch, near the proposed intake location (August 23, 2021, Jacobs).

Plate 10. Photograph of the substrate observed in the Assiniboine River (September 6, 2021, Jacobs).

Plate 11. Photograph of the substrate observed in the Assiniboine River (September 6, 2021, Jacobs).

Plate 12. Photograph of a fish taken downstream of the proposed intake location, suspected to be a common carp (September 6, 2021, Jacobs).