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# TECHNICAL MEMORANDUM

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| Issue Date: | October 3, 2024 | File No.: | 2021-4670-01.dp.eap.sup |
| To: | Agnes Wittmann, Director, Environmental Approvals | Previous Issue Date: | |
| From: | Associated Engineering (Sask.) Ltd. | Project No.: | 2021-4670-01 |
| Client: | RM of Springfield | | |
| Project Name: | Dugald Oakbank Water System Upgrades | | |
| Subject: | Environment Act Proposal, Process Waste Supplemental Information | | |

## 1 INTRODUCTION

The Rural Municipality (RM) of Springfield and the Manitoba Water Services Board retained Associated Engineering (Sask.) Ltd. to prepare an Environmental Act Proposal for a Class 2 development Licence under the Manitoba Environment Act for a new Water Treatment Plant (WTP), raw and treated water pipelines and ancillary services (the Project).

The Project consists of upgrades to the Dugald Oakbank Water System, including the construction of a new water treatment plant (WTP) sited on RM of Springfield property between Oakbank and Dugald. The proposed development includes construction of the following:

- Three new raw water wells south of the existing Dugald Well Field.
  - Only two of the three wells are being installed under the first phase of the project. The third would be installed as required in the future, under a separate Notice of Alteration.
- Raw water supply pipeline extension from the new well field into Dugald.
- Raw water supply pipeline extension from the Dugald WTP to the new WTP site.
- Class 2 Water Treatment Plant consisting of greensand filtration of 80% of the raw water volume and reverse osmosis for the remaining 20%. Stage 1 of construction will have a capacity of 80 L/s, with future Stage 2 having an ultimate capacity of 120 L/s.
- Connections to the existing Dugald and Oakbank WTPs through a combination of existing distribution system pipelines, as well as a new watermain into Oakbank.
- Process waste disposal infrastructure including onsite retention pond and discharge pipeline to Cooks Creek Diversion.

This Environment Act Proposal was submitted to the Environment Approvals Branch, Manitoba Environment and Climate in March 2024 and was posted on the Environmental Assessment and Licensing Public Registry. It was reviewed by the Provinces Technical Advisory Committee and open for public comment for a period of thirty days. Following this comment period, additional information and clarifications were requested by the public.

The purpose of this document is to provide supplementary information on the process waste stream that is produced by plant operations and ultimately discharged into the environment. It outlines how the waste stream integrates into the receiving bodies of the Cooks Creek Diversion, the Red River and Lake Winnipeg.

## 2 WATER QUALITY OBJECTIVES AND GUIDELINES

This Project adheres to the *Tier II Water Quality Objectives,* as written in the section on "Routine Protection of Water Uses" of the *Manitoba Water Quality Standards Objectives and Guidelines,* published by Manitoba Water Stewardship in 2011. These Objectives in conjunction with other information such as downstream water uses, existing water quality characteristics, and stream discharge volumes were used to determine allowable instream concentrations and confirm that the concentrations entering the receiving streams are compliant.

## 3 PROCESS WASTE

Process waste from the new water treatment plant is mainly comprised of greensand backwash and Reverse Osmosis (RO) concentrate.

Flushing of the greensand filters, known as backwashing, is performed using treated water from the storage reservoir. Therefore, the backwash waste stream is of potable water quality, with elevated levels of iron and manganese. Backwash volumes, which need to be returned to the environment, are estimated as 48 $dam^3$ annually for Stage 1 and 72 $dam^3$ annually for Stage 2.

The proposed RO system will have an 80% recovery rate, meaning 80% of the raw water volume will be useable and 20% will need to be returned to the environment in the form of RO concentrate. RO concentrate is simply all the minerals from the raw water supply, *concentrated* down into 20% of the liquid volume. Volumes are estimated as 66 $dam^3$ annually for Stage 1 and 99 $dam^3$ annually for Stage 2. However, recent discussions with the treatment equipment supplier have suggested system optimization could result in a recovery rate of up to 90%. The mineral loading in the waste stream would be the same but in half the liquid *volume*. Since the reduced dilution will result in higher mineral concentration in the process waste, the data for both scenarios are included in the following sections.

Process waste from the WTP will be stored in an onsite retention pond during the winter, then seasonally discharged between April 1$^{st}$ to November 15$^{th}$. Following winter storage, April discharge into the Cooks Creek Diversion will occur at a flow rate of approximately 29 L/s for three weeks. Following these three weeks, process waste will be intermittently discharged until November 15$^{th}$ at a reduced flow rate of approximately 15 L/s. Alternatively, process waste can also be stored during the summer months, when flow in the Cooks Creek Diversion may be low. If the process waste is stored during the summer, it would then require late fall discharge, prior to the November 15$^{th}$ cutoff.

The following Table 3-1 outlines the mineral concentrations of the Process Waste streams. Process Waste concentrations are presented for both 80% and 90% recovery by the RO treatment system. Furthermore, process waste concentrations have been updated with concentration projections from the equipment supplier *Delco Water*, and therefore vary from the original proposal.

Table 3-1: Projected Process Waste Concentrations

| Parameter | Units | Process Waste: Greensand Backwash + RO Concentrate @ 80% Recovery | Process Waste: Greensand Backwash + RO Concentrate @ 90% Recovery |
|---|---|---|---|
| Alkalinity, Total (as $CaCO_3$) | mg/L | 985.09 | 1374.79 |
| Ammonia ($NH_3$) | mg/L | 1.74 | 2.97 |
| Antimony (Sb) | mg/L | 0.00033 | 0.00046 |
| Arsenic (As) | mg/L | 0.00033 | 0.00046 |
| Barium (Ba) | mg/L | 0.064 | 0.108 |
| Boron (B) | mg/L | 4.97 | 6.93 |
| Cadmium (Cd) | mg/L | 0.000031 | 0.000043 |
| Chloride (Cl) | mg/L | 336.66 | 575.19 |
| Chromium (Cr) | mg/L | 0.00033 | 0.00046 |
| Copper (Cu) | mg/L | 0.0022 | 0.0031 |
| Fluoride (F) | mg/L | 5.09 | 8.44 |
| Hardness (as CaCO3) | mg/L | 117.13 | 163.46 |
| Iron (Fe) | mg/L | 0.64 | 1.05 |
| Lead (Pb) | mg/L | 0.0086 | 0.0120 |
| Nitrate (N) | mg/L | 0.0018 | 0.0026 |
| Manganese (Mn) | mg/L | 0.017 | 0.034 |
| Selenium (Se) | mg/L | 0.00031 | 0.00043 |
| Sodium (Na) | mg/L | 719.15 | 1220.88 |
| Total Dissolved Solids | mg/L | 2462.75 | 4148.03 |
| Uranium (U) | mg/L | 0.00030 | 0.00042 |
| Zinc (Zn) | mg/L | 0.013 | 0.018 |

# 4 RECEIVING WATER BODIES

During discharge months when flows in Cooks Creek Diversion permit, the onsite retention pond will discharge Process Waste through a gravity fed pipe to Cooks Creek Diversion. If flows in the Diversion are too low or too high, the valve on the discharge pipe can be closed or throttled. When the Diversion has no flow, the next closest receiving water body is the Red River, and the Tier II Water Quality Objectives then apply for that river. Dilution calculations for both the Cooks Creek Diversion and the Red River are discussed in this Section.

## 4.1 Cooks Creek Diversion

Discharge Regulation Limits into the Cooks Creek Diversion were determined based on the *Tier II Water Quality Objectives* stated in the Manitoba Water Quality Standards, Objectives, and Guidelines. Essentially, these water quality objectives should be met after mixing of the discharge with a specific low flow in the receiving waters. For most substances, these are based on 7Q10 flow, which is the lowest average 7-day consecutive low flow in ten years One exception is Ammonia, as the worst-case scenario is based on the 30Q10 flow, which is the lowest average 30-day low flow.

The combined concentration of the receiving body and the process waste stream are calculated using Equation (1).

Equation (1):

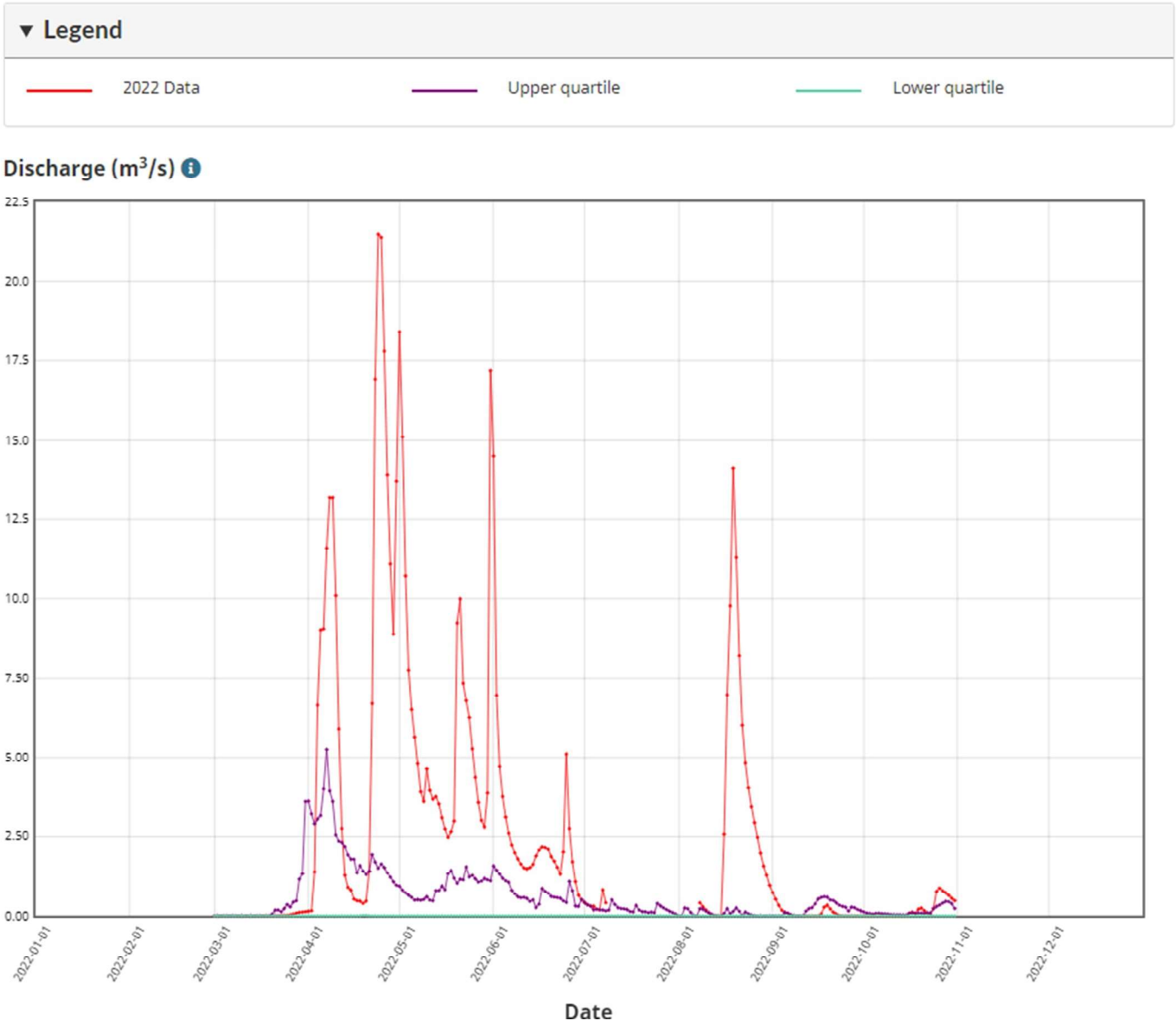
$$C_{COMB.} = (Q_{PW}C_{PW} + pQ_{CC}C_{CC})/(Q_{PW} + pQ_{CC})$$

| | | |
|---|---|---|
| Where: | $C_{COMB.}$ | Combined concentration of Process Waste and Cooks Creek near discharge location (mg/L) |
| | $Q_{PW}$ | Flow of Process Waste leaving the pond during spring discharge (L/s) |
| | $C_{PW}$ | Concentration of Process Waste leaving the pond (mg/L) |
| | $p$ | Proportion of the receiving stream flow utilized or the mixing zone. |
| | $Q_{CC}$ | Flow of Cooks Creek Diversion (L/s) |
| | $C_{CC}$ | Concentration of Cooks Creek near receiving location (mg/L) |

Flow rates used for these calculations were determined using the Historical Hydrometric Monthly Data for Station 05OJ020, Cooks Creek Diversion at Inlet. This data is collected by the Government of Canada, Water Survey of Canada, and includes comprehensive data from 1990 to 2022. For these calculations, the available monthly mean flow during the discharge period of April 1st to November 15th was considered. The minimum average of these monthly mean flows between 1990 to 2022 was used for these calculations, 438.06 L/s. This flow rate is considered a reasonable estimate of the low-end flows.

Figure 4-1 on the following page shows the monthly average flows from 1990 to 2022.

Figure 4-1: Flow in Cooks Creek Diversion at Inlet




The daily flow records and long-term statistics presented on the WSC webpage show that the lower quartile (i.e., the 25$^{th}$ percentile, or 1/4$^{th}$ of measurements) for the Cooks Creek Diversion are zero for the proposed period of discharge (i.e., April 1 to November 15). This implies that the 7Q10 and 30Q10 are zero as well and that the water body is t considered an intermittent stream. Therefore, the mixing calculations were completed for the Cooks Creek Diversion when there is flow and for Red River for periods of no flow in the Cooks Creek Diversion.

Due to the small nature of the Cooks Creek Diversion, the mixing of the discharge is expected to be relatively quick, and therefore we assumed complete mixing. For the mass balance Equation (1), this means that the proportion of flow used for mixing equals one ($p$ = 1). During low flow periods in the Diversion, process waste will not be discharged and the valve at the pond outlet will be closed. During no flow periods in the Diversion, process waste can be discharged to the channel and the Red River is considered the receiving water body. Calculations for Red River as the receiving body are described in Section 4.2.

In Tables 4-1 and 4-2 on the following pages, various concentrations are shown, based on an average day during spring discharge ($Q_{PW}$ = 29 L/s, $Q_{CC}$ = 438.06 L/s). These are upstream water quality in the Creek Diversion, estimated process waste stream quality, and calculated combined concentrations in the Creek Diversion after mixing with the process waste stream.

Cooks Creek Diversion water quality (the receiving water body) is based on water quality data provided by the Province of Manitoba, Environment and Climate, Water Science and Watershed Management Branch. The data provides a comprehensive look at the water quality in Cooks Creek. The receiving water body concentrations used in these calculations are based on the average concentrations of listed parameters during the discharge months of April 1$^{st}$ to November 15$^{th}$. Using the available data, there were eight relevant sampling events used to determine the average concentrations, gathered between 2020 and 2022.

Process Waste Discharge Concentrations are based on projections provided in part by the treatment equipment supplier. Table 4-1 is based on the RO treatment system operating at an 80% recovery rate and Table 4-2 is based on a 90% recovery rate. Both Tables are based on the ultimate WTP capacity of 120 L/s and therefore represent maximum volumes and concentrations.

Table 4-1: Estimated Downstream Concentrations During Average Flow in Cooks Creek Diversion
Compared to Tier II Water Quality Objectives
Greensand Backwash and RO Concentrate @ 80% Recovery

| Parameter | Units | Cooks Creek Diversion Water Quality | Process Waste Discharge Concentration | Discharge Regulation Limit | Final Combined Concentration |
|---|---|---|---|---|---|
| Alkalinity, Total (as CaCO3) | mg/L | 269.38 | 985.09 | - | 313.81 |
| Ammonia (NH3) | mg/L | 0.04 | 1.74 | 1.43 | 0.15 |
| Antimony (Sb) | mg/L | 0.000194 | 0.000327 | - | 0.00020 |
| Arsenic (As) | mg/L | 0.004186 | 0.000327 | 0.15 | 0.0039 |
| Barium (Ba) | mg/L | 0.047 | 0.064 | - | 0.048 |
| Boron (B) | mg/L | 0.28 | 4.97 | - | 0.57 |
| Cadmium (Cd) | mg/L | 0.0000103 | 0.0000305 | 0.0005 | 0.000012 |
| Chloride (Cl) | mg/L | 14.83 | 336.66 | - | 34.81 |
| Chromium (Cr) | mg/L | 0.000561 | 0.000330 | 0.011 | 0.00055 |
| Copper (Cu) | mg/L | 0.00163 | 0.00223 | 0.021 | 0.0017 |
| Fluoride (F) | mg/L | - | 5.09 | - | - |
| Hardness (as CaCO3) | mg/L | 244.13 | 117.13 | - | 236.24 |
| Iron (Fe) | mg/L | 0.404 | 0.637 | - | 0.42 |
| Lead (Pb) | mg/L | 0.0003 | 0.0086 | 0.0076 | 0.00080 |
| Nitrate (N) | mg/L | 0.9730 | 0.0018 | 10 | 0.91 |
| Manganese (Mn) | mg/L | 0.0393 | 0.0175 | - | 0.038 |
| Selenium (Se) | mg/L | 0.000183 | 0.000305 | - | 0.00019 |
| Sodium (Na) | mg/L | 39.76 | 719.15 | - | 81.95 |
| Total Dissolved Solids | mg/L | 336.50 | 2462.75 | 500-3500 | 468.52 |
| Uranium (U) | mg/L | 0.001319 | 0.000302 | - | 0.0013 |
| Zinc (Zn) | mg/L | 0.0038 | 0.0127 | 0.28 | 0.0044 |

Table 4-2: Estimated Downstream Concentrations During Average Flow in Cooks Creek Diversion
Compared to Tier II Water Quality Objectives
Greensand Backwash and RO Concentrate @ 90% Recovery

| Parameter | Units | Cooks Creek Diversion Water Quality | Process Waste Discharge Concentration | Discharge Regulation Limit | Final Combined Concentration |
|---|---|---|---|---|---|
| Alkalinity, Total (as CaCO3) | mg/L | 269.38 | 1374.792 | - | 338.01 |
| Ammonia (NH3) | mg/L | 0.041 | 2.972 | 1.43 | 0.22 |
| Antimony (Sb) | mg/L | 0.00019 | 0.00046 | - | 0.00021 |
| Arsenic (As) | mg/L | 0.0042 | 0.00046 | 0.15 | 0.0040 |
| Barium (Ba) | mg/L | 0.047 | 0.108 | - | 0.051 |
| Boron (B) | mg/L | 0.28 | 6.929 | - | 0.69 |
| Cadmium (Cd) | mg/L | 0.000010 | 0.000 | 0.0005 | 0.000012 |
| Chloride (Cl) | mg/L | 14.83 | 575.191 | - | 49.62 |
| Chromium (Cr) | mg/L | 0.00056 | 0.00046 | 0.011 | 0.00056 |
| Copper (Cu) | mg/L | 0.0016 | 0.0031 | 0.021 | 0.0017 |
| Fluoride (F) | mg/L | - | 8.436 | - | - |
| Hardness (as CaCO3) | mg/L | 244.13 | 163.465 | - | 239.12 |
| Iron (Fe) | mg/L | 0.40 | 1.048 | - | 0.44 |
| Lead (Pb) | mg/L | 0.00028 | 0.012 | 0.0076 | 0.00101 |
| Nitrate (N) | mg/L | 0.973 | 0.0026 | 10 | 0.91 |
| Manganese (Mn) | mg/L | 0.039 | 0.034 | - | 0.039 |
| Selenium (Se) | mg/L | 0.00018 | 0.00043 | - | 0.00020 |
| Sodium (Na) | mg/L | 39.76 | 1220.876 | - | 113.10 |
| Total Dissolved Solids | mg/L | 336.5 | 4148.029 | 500-3500 | 573.16 |
| Uranium (U) | mg/L | 0.0013 | 0.00042 | - | 0.0013 |
| Zinc (Zn) | mg/L | 0.0038 | 0.018 | 0.28 | 0.0047 |

As demonstrated in both preceding tables, the Tier II Water Quality Objectives are met in the Cooks Creek Diversion after mixing with the process waste stream. An outlier is Total Dissolved Solids for the scenario of RO Concentrate @ 90% Recovery. The calculated value of 573 mg/L is within the 500 to 3500 mg/L range listed in the *Tier II Water Quality Objectives*.

The range is based on data published in 1987 by the Canadian Council of Resource and Environment Ministers (CCREM), for the protection of agriculture. It identified that waters with high TDS used for irrigation purposes can impact the growth rate and harvest yield of certain crops.

| TDS Guideline | Crop Type |
|---|---|
| 500 mg/L | Strawberries, raspberries, beans, and carrots. |
| 500 - 800 mg/L | Boysenberries, currants, blackberries, gooseberries, plums, grapes, apricots, peaches, pears, cherries, apples, onions, parsnips, radishes, peas, pumpkins, lettuce, peppers, muskmelons, sweet potatoes, sweet corn, potatoes, celery, cabbage, kohlrabi, cauliflower, cowpeas, broad beans, flax, sunflowers, and corn. |
| 800 - 1500 mg/L | Spinach, cantaloupe, cucumbers, tomatoes, squash, brussels, sprouts, broccoli, turnips, smooth brome, alfalfa, big trefoil, beardless wildrye, vetch, timothy, and crested wheat grass. |
| 1500 - 2500 mg/L | Beets, zucchini, rape, sorghum, oat hay, wheat hay, mountain brome, tall fescue, sweet clover, reed canary grass, birds foot trefoil, perennial ryegrass. |
| 3500 mg/L | Asparagus, soybeans, safflower, oats, rye, wheat, sugar beets, barley, barley hay, and tall wheat grass. |

As previously discussed, release of the process waste stream to the environment will not take place under low flow conditions. Low flow conditions in Cooks Creek Diversion were estimated at 10% of the average flow of 438.06 L/s, or 43.81 L/s. Tables 4-3 and 4-4 on the following pages show those results.

In both the RO Concentrate @ 80% and 90% Recovery scenarios, all of the *Tier II Water Quality Objectives* are met. The outlier is again Total Dissolved Solids which is in the specified range of 500 to 3500 mg/L.

Table 4-3: Estimated Downstream Concentrations During LOW Flow in Cooks Creek Diversion
Compared to Tier II Water Quality Objectives
Greensand Backwash and RO Concentrate @ 80% Recovery

| Parameter | Units | Cooks Creek Diversion Water Quality | Process Waste Discharge Concentration | Discharge Regulation Limit | Final Combined Concentration |
|---|---|---|---|---|---|
| Alkalinity, Total (as CaCO3) | mg/L | 269.38 | 985.09 | - | 554.46 |
| Ammonia (NH3) | mg/L | 0.04 | 1.74 | 1.43 | 0.72 |
| Antimony (Sb) | mg/L | 0.000194 | 0.000327 | - | 0.00025 |
| Arsenic (As) | mg/L | 0.004186 | 0.000327 | 0.15 | 0.0026 |
| Barium (Ba) | mg/L | 0.047 | 0.064 | - | 0.054 |
| Boron (B) | mg/L | 0.28 | 4.97 | - | 2.14 |
| Cadmium (Cd) | mg/L | 0.0000103 | 0.0000305 | 0.0005 | 0.000018 |
| Chloride (Cl) | mg/L | 14.83 | 336.66 | - | 143.02 |
| Chromium (Cr) | mg/L | 0.000561 | 0.000330 | 0.011 | 0.00047 |
| Copper (Cu) | mg/L | 0.00163 | 0.00223 | 0.021 | 0.0019 |
| Fluoride (F) | mg/L | - | 5.09 | - | - |
| Hardness (as CaCO3) | mg/L | 244.13 | 117.13 | - | 193.54 |
| Iron (Fe) | mg/L | 0.404 | 0.637 | - | 0.50 |
| Lead (Pb) | mg/L | 0.0003 | 0.0086 | 0.0076 | 0.00360 |
| Nitrate (N) | mg/L | 0.9730 | 0.0018 | 10 | 0.59 |
| Manganese (Mn) | mg/L | 0.0393 | 0.0175 | - | 0.031 |
| Selenium (Se) | mg/L | 0.000183 | 0.000305 | - | 0.00023 |
| Sodium (Na) | mg/L | 39.76 | 719.15 | - | 310.38 |
| Total Dissolved Solids | mg/L | 336.50 | 2462.75 | 500-3500 | 1183.43 |
| Uranium (U) | mg/L | 0.001319 | 0.000302 | - | 0.0009 |
| Zinc (Zn) | mg/L | 0.0038 | 0.0127 | 0.28 | 0.0074 |

Table 4-4: Estimated Downstream Concentrations During LOW Flow in Cooks Creek Diversion Compared to Tier II Water Quality Objectives
Greensand Backwash and RO Concentrate @ 90% Recovery

| Parameter | Units | Cooks Creek Diversion Water Quality | Process Waste Discharge Concentration | Discharge Regulation Limit | Final Combined Concentration |
|---|---|---|---|---|---|
| Alkalinity, Total (as CaCO3) | mg/L | 269.38 | 1374.792 | - | 709.68 |
| Ammonia (NH3) | mg/L | 0.041 | 2.972 | 1.43 | 1.21 |
| Antimony (Sb) | mg/L | 0.00019 | 0.00046 | - | 0.00030 |
| Arsenic (As) | mg/L | 0.0042 | 0.00046 | 0.15 | 0.0027 |
| Barium (Ba) | mg/L | 0.047 | 0.108 | - | 0.072 |
| Boron (B) | mg/L | 0.28 | 6.929 | - | 2.93 |
| Cadmium (Cd) | mg/L | 0.000010 | 0.000 | 0.0005 | 0.000023 |
| Chloride (Cl) | mg/L | 14.83 | 575.191 | - | 238.03 |
| Chromium (Cr) | mg/L | 0.00056 | 0.00046 | 0.011 | 0.00052 |
| Copper (Cu) | mg/L | 0.0016 | 0.0031 | 0.021 | 0.0022 |
| Fluoride (F) | mg/L | - | 8.436 | - | - |
| Hardness (as CaCO3) | mg/L | 244.13 | 163.465 | - | 212.00 |
| Iron (Fe) | mg/L | 0.40 | 1.048 | - | 0.66 |
| Lead (Pb) | mg/L | 0.00028 | 0.012 | 0.0076 | 0.00496 |
| Nitrate (N) | mg/L | 0.973 | 0.0026 | 10 | 0.59 |
| Manganese (Mn) | mg/L | 0.039 | 0.034 | - | 0.037 |
| Selenium (Se) | mg/L | 0.00018 | 0.00043 | - | 0.00028 |
| Sodium (Na) | mg/L | 39.76 | 1220.876 | - | 510.22 |
| Total Dissolved Solids | mg/L | 336.5 | 4148.029 | 500-3500 | 1854.70 |
| Uranium (U) | mg/L | 0.0013 | 0.00042 | - | 0.0010 |
| Zinc (Zn) | mg/L | 0.0038 | 0.018 | 0.28 | 0.0094 |

## 4.2 Red River

The Cooks Creek Diversion flows to the Red River Floodway and then the Red River. There is currently no comprehensive flow data set available for the Red River Floodway; therefore, receiving water flows and parameter concentrations are based on the Red River. For the dilution calculations, a 7Q10 flow of the Red River was calculated based on Station 05OJ005 and determined to be 33,980 L/s. This station is located downstream of where the Red River Floodway discharges back into the Red River at Selkirk, MB.

As previously described, when there is no flow in the Cooks Creek Diversion, dilution calculations are based on the downstream receiving body, the Red River. As per *Manitoba Water Quality Standards, Objectives and Guidelines*, a mixing zone of 25% of the receiving stream flow for Rivers is utilized for dilution calculations. For Equation (1), the portion of flow used for mixing was set at 0.25.

The following Tables 4-5 and 4-6 demonstrate the resultant concentrations in the Red River after mixing of 25% of the river flow with the process waste discharge. Table 4-5 is based on the RO treatment system operating at an 80% recovery rate and Table 4-6 is based on a 90% recovery rate. Again, both tables are based on the ultimate WTP capacity of 120 L/s and therefore represent maximum volumes and concentrations for the future.

Table 4-5: Estimated Downstream Concentrations in the Red River
Compared to Tier II Water Quality Objectives
Greensand Backwash and RO Concentrate @ 80% Recovery

| Parameter | Units | Red River Water Quality | Process Waste Discharge Concentration | Discharge Regulation Limit | Final Combined Concentration |
|---|---|---|---|---|---|
| Alkalinity, Total (as CaCO3) | mg/L | 222.19 | 985.09 | - | 224.78 |
| Ammonia ($NH_3$) | mg/L | 0.83 | 1.74 | 1.68 | 0.83 |
| Antimony (Sb) | mg/L | 0.000365 | 0.00033 | - | 0.00036 |
| Arsenic (As) | mg/L | 0.0059125 | 0.00033 | 0.150 | 0.0059 |
| Barium (Ba) | mg/L | 0.0749825 | 0.064 | - | 0.075 |
| Boron (B) | mg/L | 0.1073125 | 4.97 | - | 0.12 |
| Cadmium (Cd) | mg/L | 0.000068 | 0.000031 | 0.000580 | 0.000068 |
| Chloride (Cl) | mg/L | 44.035 | 336.66 | - | 45.03 |
| Chromium (Cr) | mg/L | 0.0021875 | 0.00033 | 0.0110 | 0.0022 |
| Copper (Cu) | mg/L | 0.004195 | 0.0022 | 0.0288 | 0.0042 |
| Fluoride (F) | mg/L | - | 5.09 | - | - |
| Hardness (as $CaCO_3$) | mg/L | 345.44 | 117.13 | - | 344.66 |
| Iron (Fe) | mg/L | 16.039 | 0.64 | - | 15.987 |
| Lead (Pb) | mg/L | 0.001155 | 0.0086 | 0.0094 | 0.0012 |
| Nitrate (N) | mg/L | 0.675 | 0.0018 | 10.00 | 0.67 |
| Manganese (Mn) | mg/L | 0.17722 | 0.017 | - | 0.18 |
| Selenium (Se) | mg/L | 0.0007635 | 0.00031 | - | 0.00076 |
| Sodium (Na) | mg/L | 54.6 | 719.15 | - | 56.86 |
| Total Dissolved Solids | mg/L | 535.565 | 2462.75 | 500-3500 | 542.12 |
| Uranium (U) | mg/L | 0.0037 | 0.00030 | - | 0.0037 |
| Zinc (Zn) | mg/L | 0.01109 | 0.013 | 0.335 | 0.011 |

Table 4-6: Estimated Downstream Concentrations in the Red River
Compared to Tier II Water Quality Objectives
Greensand Backwash and RO Concentrate @ 90% Recovery

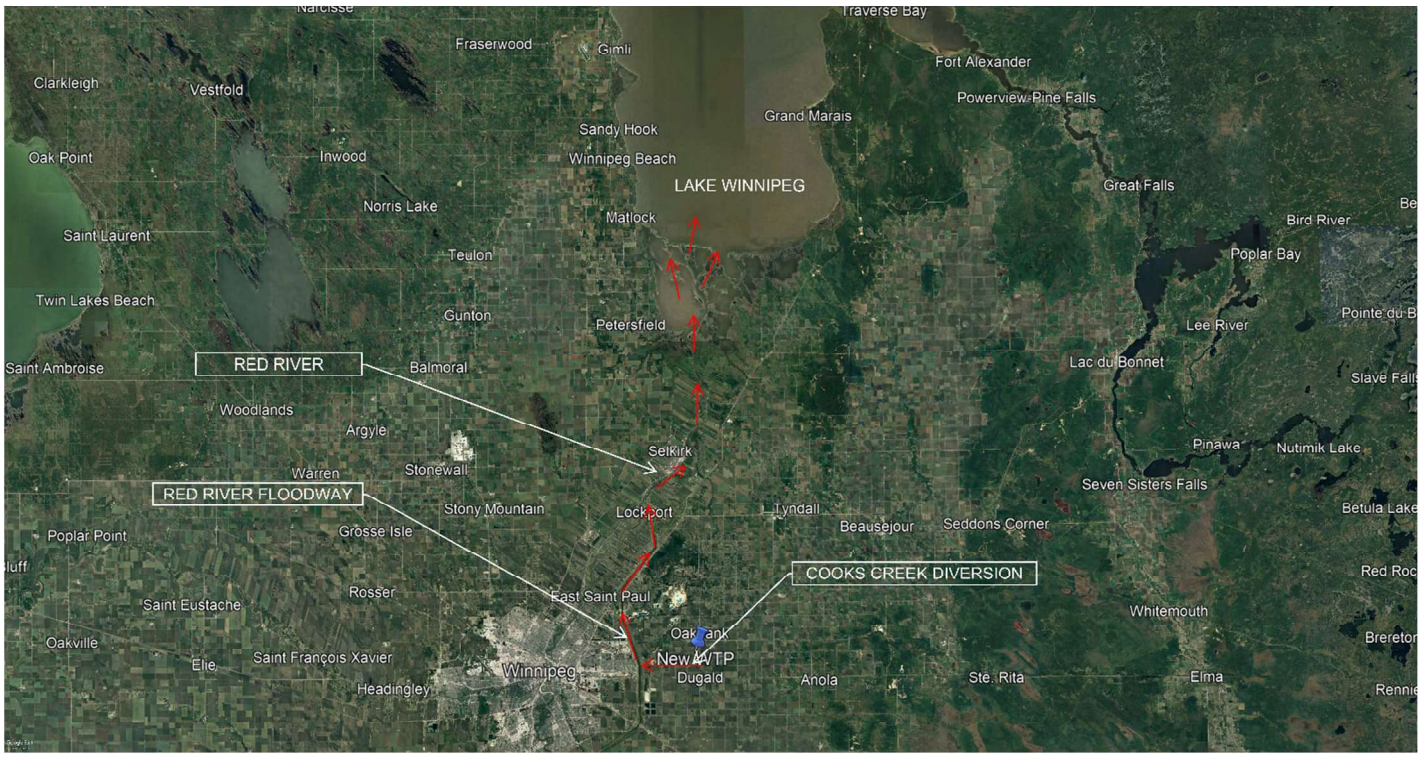
| Parameter | Units | Red River Quality | Process Waste Concentration | Discharge Regulation Limit | Final Combined Concentration |
|---|---|---|---|---|---|
| Alkalinity, Total (as CaCO3) | mg/L | 222.19 | 1374.79 | - | 226.11 |
| Ammonia ($NH_3$) | mg/L | 0.83 | 2.97 | 1.68 | 0.84 |
| Antimony (Sb) | mg/L | 0.000365 | 0.00046 | - | 0.00037 |
| Arsenic (As) | mg/L | 0.0059125 | 0.00046 | 0.150 | 0.0059 |
| Barium (Ba) | mg/L | 0.0749825 | 0.108 | - | 0.075 |
| Boron (B) | mg/L | 0.1073125 | 6.93 | - | 0.13 |
| Cadmium (Cd) | mg/L | 0.000068 | 0.000043 | 0.000580 | 0.000068 |
| Chloride (Cl) | mg/L | 44.035 | 575.19 | - | 45.84 |
| Chromium (Cr) | mg/L | 0.0021875 | 0.00046 | 0.0110 | 0.0022 |
| Copper (Cu) | mg/L | 0.004195 | 0.0031 | 0.0288 | 0.0042 |
| Fluoride (F) | mg/L | 0 | 8.44 | - | 0.03 |
| Hardness (as $CaCO_3$) | mg/L | 345.44 | 163.46 | - | 344.82 |
| Iron (Fe) | mg/L | 16.039 | 1.05 | - | 15.988 |
| Lead (Pb) | mg/L | 0.001155 | 0.0120 | 0.0094 | 0.0012 |
| Nitrate (N) | mg/L | 0.675 | 0.0026 | 10.00 | 0.67 |
| Manganese (Mn) | mg/L | 0.17722 | 0.034 | - | 0.18 |
| Selenium (Se) | mg/L | 0.0007635 | 0.00043 | - | 0.00076 |
| Sodium (Na) | mg/L | 54.6 | 1220.88 | - | 58.57 |
| Total Dissolved Solids | mg/L | 535.565 | 4148.03 | 500-3500 | 547.86 |
| Uranium (U) | mg/L | 0.0037 | 0.00042 | - | 0.0037 |
| Zinc (Zn) | mg/L | 0.01109 | 0.018 | 0.335 | 0.011 |

The Water Quality Objectives are met in the Red River after mixing with the waste streams from the proposed Project for both discharge scenarios. As with the previous estimates, TDS remains an outlier. Although at the low end of the guideline range, so to are the natural waters of the Red River.

## 4.3 Lake Winnipeg

The Cooks Creek Diversion drains into the Red River Floodway, reconnecting with the Red River and ultimately reaching Lake Winnipeg. Figure 4-2 below shows the approximate drainage path.

Figure 4-2: Drainage Path of WTP Waste Stream Discharge




The volume of Lake Winnipeg is approximately 295 $km^3$ or 295,000,000 $dam^3$. At the ultimate WTP capacity, the total annual volume of process waste that may reach Lake Winnipeg is estimated at 171 $dam^3$. Therefore, the dilution ratio of the Process Waste volume into Lake Winnipeg is over 1:1.7 million. The influence of the proposed WTP discharge on Lake Winnipeg is therefore negligible.

## 5 CLOSURE

This Technical Memorandum was prepared by Associated Engineering (Sask.) Ltd. to provide supplementary information for the Environment Act Proposal submitted to the Environment Approvals Branch, Manitoba Environment and Climate in March 2024.

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