Rochester Water Reclamation Plant

# 2019 Facilities Plan

J4325

LOWER ENERGY // CLEAN DESIGN
DECREASED MAINTENANCE // INNOVATIVE PROCESSES

Brown AND Caldwell

# Rochester Water Reclamation Plant Facilities Plan

Prepared for
City of Rochester
Rochester, MN

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

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Date: June 10, 2020 License No. 17045

Brown AND Caldwell

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| | |
|---|---|
| °C | degree(s) Celsius |
| °F | degree(s) Fahrenheit |
| µm | microns |
| µm | micro-meter |
| 3D | three-dimensional |
| A/O | anaerobic/oxic |
| A2O | anaerobic/anoxic/oxic |
| AA | annual average |
| AACEI | Association for the Advancement of Cost Engineering International |
| AAS | air activated sludge |
| ABC | Aeration Basin Complex |
| ADWF | average dry weather flow |
| AGS | aerobic granular sludge |
| AHJ | authority having jurisdiction |
| AMPI | American Milk Producers, Inc. |
| ANSI | American National Standards Institute |
| ATP | adenosine triphosphate |
| Ave | average |
| AWW | average wet weather |
| AWWF | average wet weather flow |
| BACT | best available control technology |
| BC | Brown and Caldwell |
| BCE | business case evaluation |
| BFP | belt filter press |
| BNR | biological nutrient removal |
| BOD | Biochemical Oxygen Demand |
| Btu | British thermal unit(s) |
| C | Celsius |
| cap-d | capita per day |
| CBOD | Carbonaceous Biochemical Oxygen Demand |
| cBOD5 | 5-day carbonaceous biochemical oxygen demand |
| CCF | thousand cubic feet |
| ccf | 100 cubic feet |
| CCT | chlorine contact tank |
| CFD | computational fluid dynamics |
| CFH | cubic foot/feet per hour |
| cfm | cubic foot per minute |
| CH4 | methane |
| CHP | combined heat and power |
| CIP | Capital improvement plan |
| CIP | Clean in Place |
| City | City of Rochester |
| Cl2 | chlorine |
| CNG | compressed natural gas |
| CO | carbon monoxide |
| CO2 | carbon dioxide |
| COD | Chemical Oxygen Demand |
| COP | Clean Out of Place |
| CSA | Canadian Standards Association |
| cy | cubic yard |
| d | day(s) |
| DAF | dissolved air flotation |
| DG | digester gas |
| DO | dissolved oxygen |
| DSS | dispersed suspended solids |
| DT | dry tons |
| EBPR | enhanced biological phosphorus removal |
| EDI | energy-dissipating inlet |
| EPA | Environmental Protection Agency |
| EQ | equalization |
| ESS | effluent suspended solids |
| F | fraction(s) |
| FC | final clarifier |
| Fe | iron |
| FeCl3 | ferric chloride |
| FEDWA | Flocculating Energy Dissipating Well Arrangement |
| FOG | fats, oils, and grease |
| fps | foot/feet per second |
| FRP | fiberglass reinforced plastic |
| FSMA | Food Safety Management Act |
| ft | foot/feet |
| ft2 | square foot/feet |
| ft3 | cubic foot/feet |
| FTE | full-time equivalent |
| g | gram(s) |

| | |
|---|---|
| G | velocity gradient |
| gal | gallon(s) |
| GBT | gravity belt thickener |
| GGE | gasoline gallon equivalent |
| GLUMRB | Great Lakes Upper Mississippi River Board |
| gpd | gallon(s) per day |
| gpm | gallon(s) per minute |
| GT | gravity thickener |
| GTO | gravity thickener overflow |
| H2S | hydrogen sulfide |
| HDPE | high-density polyethylene |
| HEX | heat exchanger |
| HGL | hydraulic gradeline |
| HHV | higher heating value |
| HLR | hydraulic loading rate |
| hp | horsepower |
| HPO | high-purity oxygen |
| HPOAS | high-purity oxygen activated sludge |
| hr | hour(s) |
| HRT | hydraulic residence time |
| HSW | high-strength waste |
| HVAC | heating, ventilation, and air conditioning |
| HX | heat exchanger |
| IC | Intermediate Clarifier |
| IFAS | integrated fixed film activate sludge |
| in | inch(es) |
| ISS | influent suspended solids |
| k | solids settling parameter |
| K | thousand |
| KA | floc aggregation rate coefficient |
| KB | floc break-up rate coefficient |
| Kg | kilograms |
| KOH | caustic potash |
| kW | kilowatt |
| kWh | kilowatt hours |
| L | liter(s) |
| lb(s) | pound(s) |
| lb/d | Pounds Per Day |
| lbs/hr | pounds per hour |
| LF | linear foot/feet |
| LHV | lower heating value |
| LOX | liquid oxygen |
| LT | low temperature |
| m | meter(s) |
| M | million |
| MABR | membrane aerated bioreactor |
| MAC | oxygen system air compressor |
| MAD | mesophilic anaerobic digestion |
| max | maximum |
| MD | maximum day |
| MDI | Morrill Dispersion Index |
| MERC | Minnesota Energy Resources |
| MF | membrane filtration |
| mg | milligram(s) |
| MG | million gallons |
| mg/L | milligrams per liter |
| MgCl2 | magnesium chloride |
| mgd | million gallons per day |
| min | minute |
| min | minimum |
| mL | milliliter(s) |
| MLE | modified Ludzack Ettinger |
| MLR | mixed liquor recycle |
| MLSS | mixed liquor suspended solids |
| MM | maximum month |
| mm | millimeters |
| MMBtu | million British thermal unit(s) |
| MPCA | Minnesota Pollution Control Agency |
| MPN | most probable number |
| MT | medium temperature |
| MW | maximum week |
| MW | megawatt(s) |
| N | nitrogen |
| N/A | Not Applicable |
| N2 | nitrogen |
| NA | Not Applicable |
| NaHSO3 | sodium bisulfite |
| NaOH | sodium hydroxide (caustic) |
| NFPA | National Fire Protection Association |
| NG | natural gas |
| no | initial number of particles |

| | |
|---|---|
| NOx-N | nitrite plus nitrate as nitrogen |
| NPDES | National Pollutant Discharge Elimination System |
| NPV | net present value |
| nt | number of particles at time |
| O&M | operation and maintenance |
| O2 | oxygen |
| OLR | organic loading rate |
| OTR | oxygen transfer rate |
| P | phosphorus |
| PAO | phosphorus accumulating organisms |
| PC | Primary Clarifier |
| PD | positive displacement |
| PE | primary effluent |
| pH | potential hydrogen |
| PHWWF | peak hour wet weather flow |
| PIWWF | peak instantaneous wet weather flow |
| ppbv | part(s) per billion by volume |
| ppmv | part(s) per million by volume |
| PS | primary sludge |
| psi | pound(s) per square inch |
| psig | pounds per square inch -gage |
| PSRP | process to significantly reduce pathogens |
| PVC | polyvinyl chloride |
| PW | peak week |
| QAP | Quality assurance plan |
| RAS | return activated sludge |
| RFS2 | Renewable Fuel Standard 2 |
| RH | relative humidity |
| RIN | Renewable Identification Number |
| RNG | renewable natural gas |
| RO | reverse osmosis |
| rpm | revolution(s) per minute |
| s | second(s) |
| S2EBPR | sidestream enhanced biological phosphorus removal |
| SBD | sludge blanket depth |
| SCADA | supervisory control and data acquisition |
| SCF | standard cubic foot/feet |
| SCFH | standard cubic foot/feet per hour |
| scfm | standard cubic feet per minute |
| SIC Code | Standard Industrial Classification Code |
| SKU | stock keeping unit |
| SLR | solids loading rate |
| SND | simultaneous nitrification denitrification |
| SOR | surface overflow rate |
| SPA | state point analysis |
| SRT | solids retention time |
| SSV30 | 30-minute settled sludge volume |
| SVI | sludge volume index |
| SVISN | sludge volume index—2-liter settleometer unstirred |
| t | time |
| T | tons |
| TAD | thermophilic anaerobic digestion |
| TCT | theoretical contact time |
| Td | contact time |
| Title 22 | Title 22 California Code of Regulations |
| TKN | total Kjeldahl nitrogen |
| TM | technical memorandum |
| TN | total nitrogen |
| TP | total phosphorus |
| tpd | tons per day |
| TPS | thickened primary sludge |
| TS | total solids |
| TSS | total suspended solids |
| TWAS | thickened waste activated sludge |
| UF | Ultrafiltration |
| USEPA | United States Environmental Protection Agency |
| V | velocity |
| VA | volatile acids |
| VFA | volatile fatty acid |
| VFD | variable frequency drive |
| Vo | initial settling velocity |
| Vs | settling velocity |
| VS | volatile solids |
| VSA | vacuum swing adsorption |
| VSR | volatile solids reduction |
| w.c. | water column |
| WAS | waste activated sludge |
| WGB | waste gas burner |
| WRP | Water Reclamation Plant |
| WSE | water surface elevation |

| | |
|---|---|
| WWTP | wastewater treatment plant |
| X | particle concentration |
| yr | year(s) |

# Executive Summary

The Rochester Water Reclamation Plant (WRP) serves a population of approximately 120,000, discharging to the South Fork of the Zumbro River. With an average dry weather flow rating of 15.86 MGD, it was one of the first wastewater treatment plants in the state of Minnesota to receive an effluent phosphorus limit. Originally constructed in 1952, it has undergone 6 major upgrades between 1952 and 2006. The two largest plant expansions occurring within this time period were the implementation of two-stage high-purity oxygen activated sludge (HPOAS) in 1980 and implementation of parallel aeration basin complex (ABC) providing biological phosphorus removal in 2006. Whereas these up-grades have enabled the plant to consistently maintain permit compliance, the resultant process complexity, the age of existing infrastructure and pending regulatory requirements have resulted in the need for a long-range plan to maintain its ongoing level of service and environmental stewardship.

The Rochester WRP Facilities planning process was initiated to create a long-range plan to meet current and anticipated regulatory requirements with an upgraded facility that would achieve these objectives:

- Lower Energy – Reduce energy consumption while maximizing energy recovery towards a long-term goal of net-zero operation.
- Clean Design – Reduce plant complexity through elimination of parallel processes and consolidation of assets.
- Decreased Maintenance – Strive for operational simplicity and elimination of high maintenance aging infrastructure
- Innovative Processes - Implementation of best available and yet proven technologies.
- Long-Term Wholistic Approach - Provide a staging plan to achieve near term treatment goals with processes and configurations to accommodate future improvements to meet increasingly stringent regulatory requirements.

The initial planning process began by defining potential regulatory treatment levels 1, 2, 2X and 3 effluent water quality criteria identified in Table ES-1.

**Table ES-1. Rochester WRP Planning Effluent Water Quality Criteria**

| Treatment Level | Final Effluent[a] | | | General Technology Comments |
|---|---|---|---|---|
| | Monthly Ammonia, mg N/L | Annual N mg N/L | Monthly TP mg-P/L, (lb/d) | |
| Level 1 | Current Permit Limits[b] | NA | 0.8 mg-P/L (82 lb/d) 12-month rolling | |
| Level 2 | < 2 mg/L | 10 as TN | 0.4 mg-P/L (82 lb/d) 12-month rolling | Full or partial stream filtration to meet TP limit |
| Level 2X | < 2 mg/L | 10 as NOx-N | 0.4 mg-P/L (82 lb/d) 12-month rolling | Full or partial stream filtration to meet TP limit |
| Level 3 | < 2 mg/L | 4 as TN | 0.1 mg-P/L (82 lb/d) 12-month rolling | Filtration for TN and TP limit |

a. *Existing permit monthly/weekly effluent $cBOD_5$ and TSS limits of 15/25 and 30/45 apply to all options with associated mass loadings of 1352/2254 kg $cBOD_5$/d and 2705/4075 kg TSS/d.*

b. *Monthly ammonia limits for Dec-March, Apr-May, Jun-Sep, and Oct-Nov are 5,10, 3, and 13 mg N/L respectively with associated mass loadings of 451, 902, 270, and 1172 kg/d.*

# NPDES Permit

The City's current NPDES permit (MN0024619) was issued in 2010 with an original expiration date of April 30, 2015, which has been administratively continued. The continuance is allowing time for the City and MPCA to determine the best approach to several complex permitting issues including phosphorus and salt-related parameters. Current expectation is the MPCA will issue a phosphorous limit that cannot be met with the current process technology used by WRP. The draft permit would be subject to review and comment both by the City, the public and U.S. EPA Region V prior to being finalized.

# Proposed Improvements

Planned upgrades to the Rochester Water Reclamation Plant have been identified in multiple phases to address aging infrastructure, changes in flows and loads and new effluent limits. Phase 1 improvements focus on plant disinfection and outfall improvements, replacement of the waste gas burner and improvements to plant administrative and maintenance spaces. Phase 2 improvements address the need to replace the aging high purity oxygen system and are centered around a conversion to a conventional air activated sludge process and associated liquids upgrades. Phase 3 will increase solids processing capacity while providing improved operational flexibility. Phase 4 represents a staged expansion to be implemented as necessary to address future regulatory requirements.

# Phase 1 Improvements

Recommended Phase 1 improvements address immediate needs at the WRP. Figure ES-1 outlines the Phase 1 improvements, scheduled to occur between 2020 and 2023.

Following is a summary of the recommended Phase 1 improvements.

- Disinfection – Improvements to chlorination and dechlorination delivery systems as described in Section 7.1
- Effluent – Reconfiguration of the chlorine contact tanks by incorporating a Parshall flume for effluent flow metering and installation of a cascade aeration system as described in Section 7.2.
- Waste gas burner – Relocate and upgrade the waste gas burner to north side of WRP campus as described in Section 8.7.
- While outside of the scope of the work provided in this document, Phase 1 also includes a significant remodel to the WRP administration building as well as a new garage building for equipment storage.


•

| Improvement | | Benefit |
|---|---|---|
| 1 | Disinfection Improvements | Reduce energy and chemical usage while addressing aging high maintenance equipment. |
| 2 | Effluent Improvements | Improve permit required flow monitoring and add effluent cascade aeration to meet permit limits. |
| 3 | Turbine Generator | Evaluate turbine generator to produce electricity using flow of treated wastewater. |
| 4 | Remodel | Rehabilitate abandoned headworks and remodel 1952 building to meet space needs. |
| 5 | New garage | Storage for biosolids and sewer collection system equipment. |
| 6 | Waste Gas Burner | Digester gas burner relocation and safety improvements. |

**Figure ES-1. Phase 1 capital improvements and recommendations**

# Phase 2 Improvements

Phase 2 improvements focus on upgrades to the liquid treatment processes, including conversion of the HPOAS system to air activated sludge and implementing a single activated sludge system. Figure ES-2 outlines the Phase 2 improvements, scheduled to occur between 2023 and 2027.

Following is a summary of the recommended Phase 2 improvements:

- HPOAS Conversion – Decommission the existing HPO system and convert the existing HPOAS bioreactors into an air activated sludge A/O configuration with a new process aeration blower facility for nutrient removal as described in Section 6.2.
- ABC Expansion – Expand the existing ABC capacity to meet future demands as described in Section 6.2.
- Implement a single activated sludge system through the following improvements.
  - Primary Effluent Flow Structure– A new flow distribution structure to combine effluent flow from Primary Clarifiers 1 through 3 and then distribute the flow to the secondary treatment bioreactors as described in Appendix 10.
  - Return Sludge Flow Structure – Return activated sludge from Final Clarifiers 1-5 will be pumped into a common pipeline and routed to the new return sludge flow structure to be distributed to the secondary treatment bioreactors as described in Appendix 10.
  - Mixed Liquor Flow Control Structure – A new structure to route ABC mixed liquor flow in excess of Final Clarifier 5 capacity to Final Clarifiers 1-4.
- Effluent heat recovery – Implement improvements to the existing effluent heat recovery system described in Appendix 11.
- Sludge pumping – Replace existing RAS pumps servicing Final Clarifiers 1 through 4 with higher capacity units as described in Section 6.2.


| Improvement | Benefit |
|---|---|
| Wastewater Distribution | Improves plant process control and eliminates the need to construct additional primary clarifiers. |
| Biological Phosphorus Removal | Replace high purity oxygen process with conventional air to meet future phosphorus requirements and reduce energy and chemical costs. |

| | |
|---|---|
| Replace Oxygen Plant | Replace failing, unreliable, 40 year old equipment with efficient aeration system. |
| Sludge Pumping System | Addresses pumping capacity issues and eliminate the need for additional clarifiers. |
| Three Additional Bioreactors | Extension of conventional air plant to meet phosphorus requirements through 2045. |
| Wastewater Heat Recovery | Increase energy recovery from wastewater heat while reducing maintenance of system. |

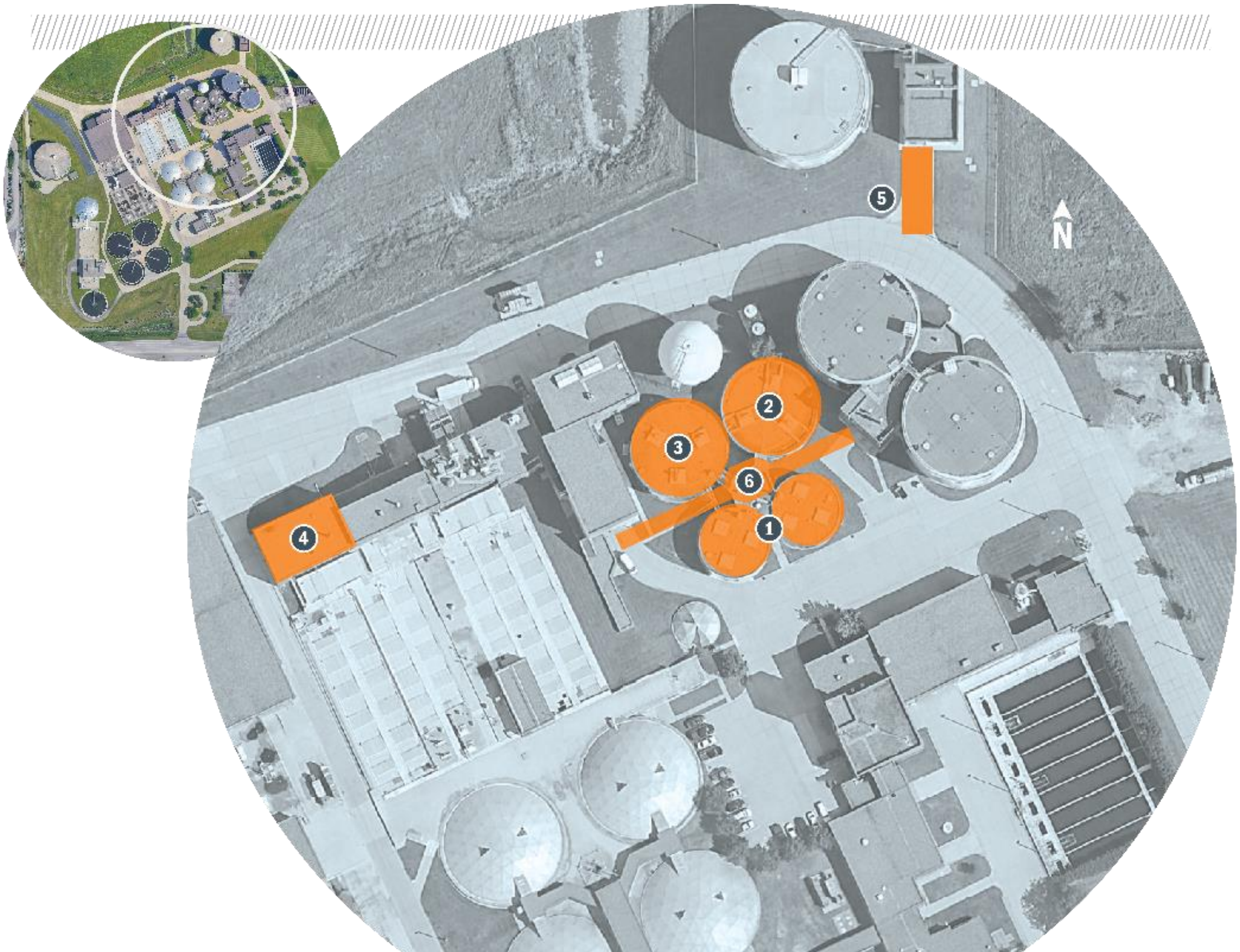
**Figure ES-2. Phase 2 capital improvements and recommendations**

# Phase 3 Improvements

Phase 3 capital improvements focus on the solids handling facilities scheduled to take place between 2027 and 2030. Delaying these improvements until after implementation of the A/O process will allow confirmation of solids loading and solids handling characteristics based on full plant implementation of the new secondary treatment processes.

Following is a summary of the recommended Phase 3 improvements and depicted in Figure ES-3.

- Gravity sludge thickening – Renovate existing Digester No. 3 as a primary sludge gravity thickener and Digester No. 4 as a primary sludge storage tank during gravity thickener outages.
- Digested solids wet well – Convert Digester No. 1 into a digested sludge storage tank or wet well prior to thickening the sludge on the gravity belt thickeners.
- Thickened digested solids storage as required – Convert Digester No. 2 to a storage tank and recuperative digester.
- Odor control – Replace antiquated odor control system with upgraded higher capacity facility.
- Sludge loadout – Provide additional sludge loadout facility to relieve truck loading congestion.
- Control building upgrades – Renovate Digester Control Building No. 1 for to meet NFPA 820 requirements.
- Replacement of one engine-generator. Second existing generator will remain for stand-by service.
- Digester gas cleaning improvements




| Improvement | Benefit |
|---|---|
| Gravity Sludge Thickener | Eliminates need for additional digesters and increases overall plant capacity. |
| Digester Wet Well | Increase operational flexibility, decrease energy usage, and decrease volume of sludge generated. |
| Sludge Storage | Increased sludge storage without building additional storage tanks. |
| Odor Control Improvements | Replace aging equipment and increase capacity to odor scrub additional solids handling facilities. |
| Sludge Loadout Improvements | Provide increase loadout flexibility and capacity. |
| Control Building Renovation | Renovate 1952 building and tunnels to current ventilation and electrical codes. |

Figure ES-3. Phase 3 capital improvements and recommendations

# Phase 4 Improvements

Phase 4 improvements focus on upgrades to the liquid treatment processes that will be required to address future effluent limit scenarios based on the treatment levels identified in Table ES-1. Figure ES-4 identifies the plant build out that will be required to achieve these progressively more stringent effluent limits as described in further detail in TM 10 – Whole Plant Evaluation. Because the specific effluent limit trajectory in terms of parameters, specific limits and scheduled implementation is unknown at this time, improvements are presented relative to potential regulatory scenarios and are not tied to a specific timeline.

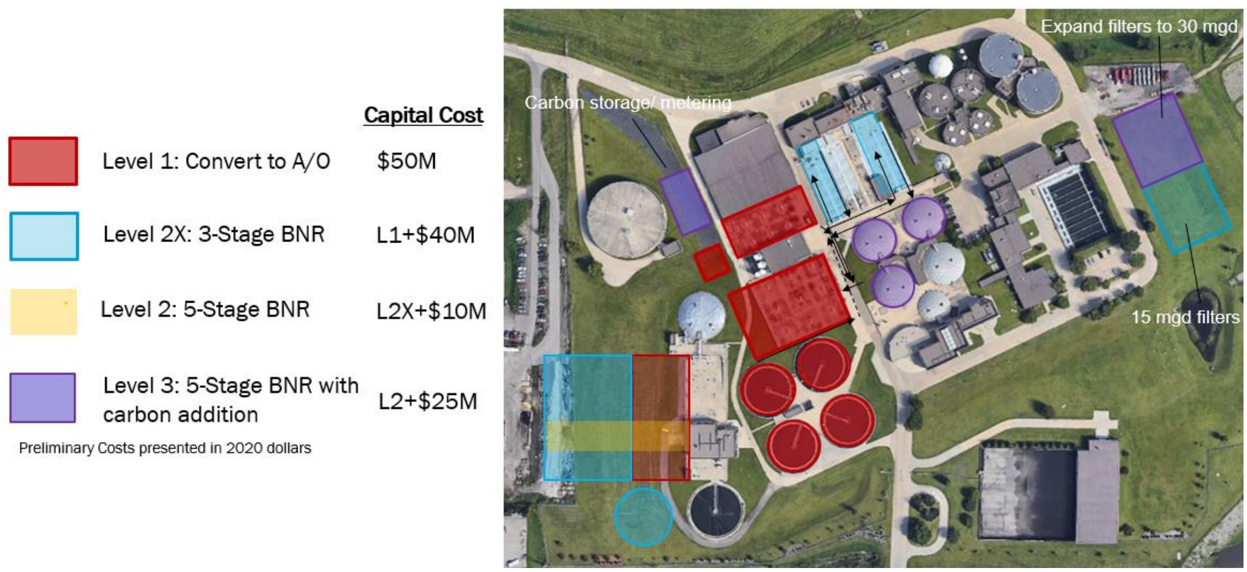



**Figure ES-4. Phase 4 capital improvements and recommendations**

# Summary and Opinion of Probable Costs

Table ES-2 summarizes the project costs for each phase. These Class 5 estimates represent a conceptual level or project viability estimate consistent with the Association for the Advancement of Cost Engineering International (AACEI). Engineering for a Class 5 estimate typically represents zero to 2 percent completeness. The accuracy of a Class 5 estimate ranges from -50 to +100 percent.

Table ES-2. Rochester WRP Phased Improvements Opinion of Probable Costs[a]

| Item | Cost | Implementation Schedule |
|---|---|---|
| Phase 1 | $10,000,000 | 2020 – 2023 |
| Phase 2 | $52,000,000 | 2023 – 2027 |
| Phase 3 | $11,000,000 | 2027 – 2030 |
| Phase 4 | $75,000,000 | Based on future effluent limits |
| Total | $148,000,000 | |

# Section 1
# Introduction

This Facility Plan presents a summary of the City of Rochester (City) Water Reclamation Plant (WRP) facility evaluations conducted by Brown and Caldwell (BC) and the City to meet current and potential future wastewater treatment requirements through the Year 2045. The planning effort focused on the liquid stream processes from primary clarification through the plant outfall, solids handling systems, heat recovery, and biogas utilization. A capital improvement plan (CIP) is included based upon the facility recommendations.

The following list summarizes the major sections and organization of the Facility Plan.

- Section 1 – Introduction
- Section 2 – Flows and Loadings
- Section 3 – Design Criteria
- Section 4 – Existing Facility Condition
- Section 5 – Process Optimization
- Section 6 – Biological Nutrient Removal
- Section 7 – Final Effluent
- Section 8 – Solids Handling
- Section 9 – Biogas Utilization
- Section 10 – Reuse and Energy Recovery
- Section 11 – Recommendations and Implementation Plan
- Section 12 - Clean Water Revolving Fund Checklists and Forms

The detailed Technical Memoranda that served as the basis for this plan are included in Appendices 1 through 13.

## 1.1 Background

The Rochester WRP has a rated dry weather flow capacity of 15.86 million gallons per day (mgd) and an average wet weather flow capacity of 23.85 mgd, currently treating approximately 13 mgd on an annual average basis. It discharges to the South Fork of the Zumbro River under National Pollutant Discharge Elimination System (NPDES) Permit MN0024619 issued on May 26, 2010.

Constructed on the existing site in 1952, the plant has undergone major renovations as shown in Table 1-1.

**Table 1-1. Plant Expansion History**

| Year | Project | Original Cost | Current Value |
|---|---|---|---|
| 1952 | Original Plant Construction | $1,900,000 | $17,000,000 |
| 1958 | Digester Addition | $267,000 | $2,000,000 |
| 1968 | Plant Expansion | $2,700,000 | $14,000,000 |
| 1980 | Plant Expansion with Conversion to High Purity Oxygen | $56,000,000 | $201,000,000 |
| 1989 | Chemical Storage and Feed Facility Addition | $900,000 | $2,000,000 |
| 1990 | Solids Handling Improvements | $14,600,000 | $38,000,000 |
| 2006 | Aeration Basin Complex Addition | $68,000,000 | $106,000,000 |

Liquid stream treatment consists of influent pumping, screening, grit removal, and flow equalization systems. Following grit removal, the flow is split into two liquid treatment trains: high purity oxygen activated sludge (HPOAS) and the aeration basin complex (ABC) which uses enhanced biological phosphorus removal (EBPR) nitrifying air activated sludge. The HPOAS system treats approximately 75 percent of the flow with the remainder going to the ABC plant.

The HPOAS train consists of two rectangular primary clarifiers followed by a two-stage HPOAS system. The first stage HPOAS operates at low solids retention time (SRT) to remove carbonaceous compounds. The second stage HPOAS operates at an SRT greater than 10 days, nitrifying ammonia to nitrate. The two stages are fed high purity oxygen (HPO) gas from a cryogenic air plant. Phosphorus removal in the HPOAS train is primarily accomplished through ferric chloride addition in the primary clarifiers with some trimming with alum prior to the HPOAS final clarifiers as necessary.

The ABC train has one circular primary clarifier followed by an EBPR nitrifying activated sludge system. The ABC plant is typically operated in an A/O configuration but does have the ability to also be operated in an anaerobic/anoxic/aerobic (A2O) or Modified Ludzack-Ettinger (MLE) configuration. Alum is added to Final 5 to help reduce effluent phosphorous when needed.

Effluent from HPOAS Final Clarifiers 1-4 and ABC Final Clarifier 5 is blended and then routed to the chlorine contact tanks for disinfection and dechlorination before being discharged to the South Fork of the Zumbro River.

Primary solids are thickened in the primary clarifiers. Waste activated sludge (WAS) from each activated sludge system is blended and thickened using gravity belt thickeners (GBT). Thickened sludges are pumped to mesophilic anaerobic digesters (MAD). Digested biosolids are fed to a sludge holding tank and then thickened using GBTs. Thickened biosolids are then pumped to sludge storage tanks for land application. Recycle streams from the GBTs are routed to the head of the plant influent.

Figures 1-1 and 1-2 present a process flow schematic and plant layout of the WRP respectively.

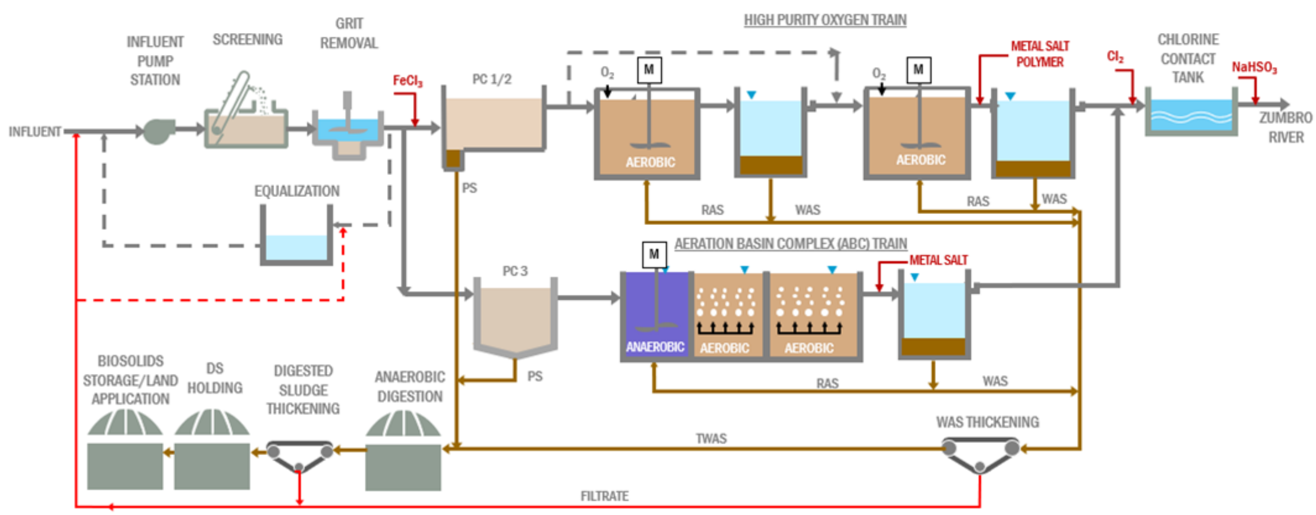
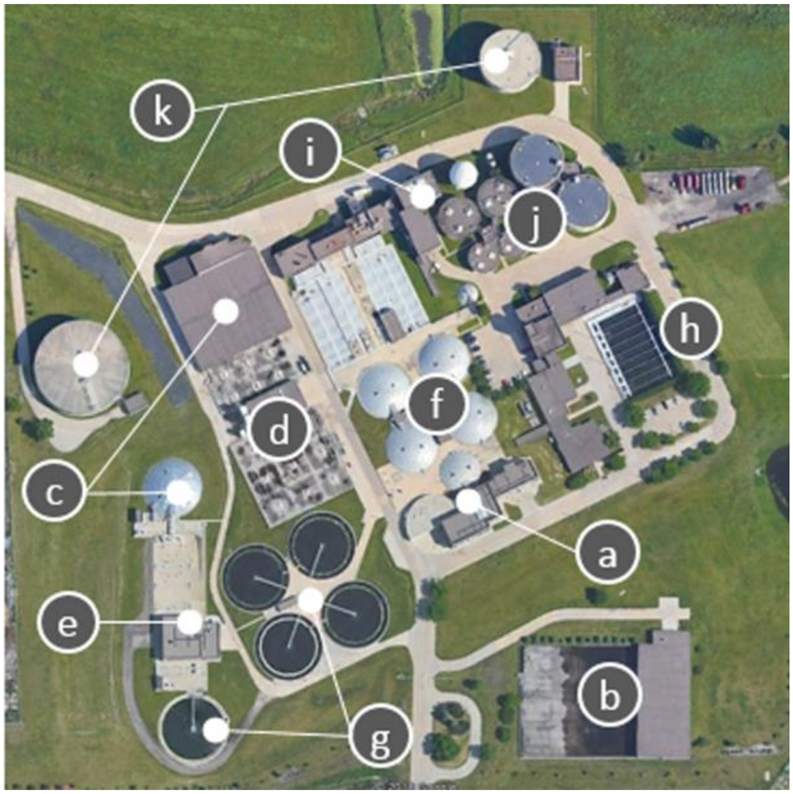



**Figure 1-1. Rochester WRP flow schematic**




a. Influent Pumping, Screening and Grit Removal
b. Influent Flow Equalization
c. Primary Clarification
d. High Purity Oxygen Activated Sludge
e. Aeration Basin Complex
f. Intermediate Clarification
g. Final Clarification
h. Disinfection
i. Thickening
j. Digestion
k. Solids Storage

**Figure 1-2. WRP site layout**

*Image: Google Earth*

## 1.2 Project Definition

The City and BC collaborated on this Facility Plan to develop a strategy to meet the projected needs at the WRP through the year 2045 providing a capital improvements plan (CIP) to meet current and anticipated future needs. The key aspects to this Facility Plan include:

- Projecting WRP influent flows and loads from current baseline conditions to Year 2045.
- Assess condition of existing WRP assets.
- Conduct detailed assessments of the existing plant treatment and hydraulic capacities. This included several full-scale data collection efforts to calibrate state-of-the-art models for predicting process performance and capacity
- Evaluate treatment process alternatives for various regulatory, capacity, and capital expenditure requirements.
- Develop recommended capital improvements plan to meet plant operating requirements through year 2035 and 2045.

# Section 2
# Flows and Loadings

This section summarizes the WRP plant influent and high strength waste flow and loading projections. Appendix 1 contains a detailed technical memorandum (TM) that presents historical plant influent flows and loadings, projected influent flows and loadings based upon historical plant data, and design influent flow and loadings projections. Appendix 13 provides information on the high strength waste flow and loads used.

## 2.1 Plant Influent Flows and Loadings

Historical plant influent flows and loadings from January 1, 2012 through December 31, 2017 were analyzed to define the existing baseline conditions. Industrial contributions to the WRP represent approximately 35 to 40 percent of the influent BOD load and 15-20 percent of the influent phosphorus loading.  An evaluation of each of the six major industries – 1) Associated Milk Producers 2) Kemps LLC North 3) Kemps LLC South 4) Pace Dairy Foods 5) Kerry Ingredients 6) Seneca Foods was conducted as a part of the planning process. This information is summarized in the Industrial Discharge Wasteloads and Practices TM in Appendix 13.

Special sampling was used to characterize influent wastewater as well as between unit processes. A follow up special sampling event was conducted to compare the pollutant parameter concentrations using the plants existing influent sampler and ISCO type sampler. The results showed the existing influent sampler chemical oxygen demand (COD), carbonaceous biochemical oxygen demand (cBOD5) and total suspended solids (TSS) concentrations were statistically lower than ISCO type sampler. As such the influent COD, cBOD5, TSS baseline conditions were increased by the following multiplication factors using comparative sampling results and supporting BioWinTM model calibration discussed in Appendix 2. The “adjusted” loadings serve as the design influent loadings.

- Design influent cBOD5 load = historically based plant influent cBOD5 load * 1.15
- Design influent TSS load = historically based plant influent COD load * 1.35
- Design influent COD load = design influent cBOD5 load * 1.87

Baseline flows and loadings were then projected through Year 2045 based upon 1.5 percent yearly com-pounded growth. Several other growth projection approaches were considered but were not consistent with the City’s growth expectations.

Table 2-1 presents the existing baseline, Year 2030, and Year 2045 design flow and loading projections. In addition, the City identified that all new facilities shall be designed to hydraulically pass a peak flow of 60 million gallons per day (mgd) based on the design of the existing headworks. This flow rate will be incorporated into the design along with the other flows listed in Table 2-1. Also, the peak hour wet weather and peak instantaneous wet weather flows were calculated using the Minnesota Pollution Control Agency guide-lines (see Appendix 1, Attachment A).i

**Table 2-1. Rochester WRP Design Influent Flow and Loading Projections**

| Item | Units | Existing Baseline | Year 2030 | Year 2045 |
|---|---|---|---|---|
| **Flows** | | | | |
| Annual Average | mgd | 12.9 | 15.9 | 19.9 |
| Average Dry Weather | mgd | 10.6 | 12.9 | 16.2 |
| Average Wet Weather | mgd | 15.7 | 19.0 | 23.8 |
| Peak Hour Wet Weather Flow | mgd | 34.0 | 40.8 | 50.8 |
| Peak Instantaneous Wet Weather Flow | mgd | 38.9 | 45.6 | 55.6[c] |
| Carbonaceous Biochemical Oxygen Demand[d] | | | | |
| Annual Average | lb/d | 44,100 | 53,600 | 67,200 |
| Maximum Month | lb/d | 53,400 | 64,900 | 81,300 |
| Maximum Week | lb/d | 62,400 | 75,800 | 94,900 |
| Maximum Day | lb/d | 66,800 | 81,200 | 101,700 |
| Chemical Oxygen Demand[a,d] | | | | |
| Annual Average | lb/d | 82,500 | 100,300 | 125,600 |
| Maximum Month | lb/d | 99,900 | 121,500 | 152,100 |
| Maximum Week | lb/d | 116,600 | 141,700 | 177,500 |
| Maximum Day | lb/d | 124,900 | 151,800 | 190,200 |
| Total Suspended Solids[d] | | | | |
| Annual Average | lb/d | 32,200 | 39,100 | 49,000 |
| Maximum Month | lb/d | 38,500 | 46,700 | 58,400 |
| Maximum Week | lb/d | 42,700 | 51,800 | 64,900 |
| Maximum Day | lb/d | 48,300 | 58,700 | 73,600 |
| Ammonia | | | | |
| Annual Average | lb-N/d | 2,600 | 3,200 | 4,000 |
| Maximum Month | lb-N/d | 3,200 | 3,900 | 4,800 |
| Maximum Week | lb-N/d | 3,400 | 4,100 | 5,100 |
| Maximum Day | lb-N/d | 4,300 | 5,200 | 6,500 |
| Total Kjeldahl Nitrogen[b] | | | | |
| Annual Average | lb/d | 4,900 | 6,000 | 7,500 |
| Maximum Month | lb/d | 6,000 | 7,300 | 9,100 |
| Maximum Week | lb/d | 6,300 | 7,700 | 9,600 |
| Maximum Day | lb/d | 8,100 | 9,800 | 12,300 |
| Total Phosphorus | | | | |
| Annual Average | lb/d | 740 | 900 | 1,130 |
| Maximum Month | lb/d | 880 | 1,070 | 1,330 |
| Maximum Week | lb/d | 1,030 | 1,250 | 1,570 |
| Maximum Day | lb/d | 1,210 | 1,470 | 1,840 |

a. *COD based on COD:cBOD5 ratio observed during wastewater characterization (August 23-31, 2017) of 1.87.*

b. *TKN based on historical ammonia:TKN ratio observed during wastewater characterization (August 23-31, 2017) of 0.53.*

c. *Peak instantaneous flow of 60 mgd to be used in planning.*

d. *Influent cBOD5, COD, and TSS include a 1.15, 1.15, and 1.35 adjustment factor, respectively, based on special sampling and BioWin™ model calibration.*

# Section 3
# Design Criteria

Design criteria used for this project include effluent water quality, solids handling requirements, and process redundancy requirements. This analysis assumes all primary clarifiers, aeration tanks, final clarifiers and tertiary filters are in service during critical maximum month flow and loadings conditions and peak wet weather flow conditions.

## 3.1 Effluent Water Quality

This planning effort considered four levels of treatment for nutrient reduction as summarized in Table 3-1. In addition, an order-of -magnitude evaluation was conducted for the plant to meet Class 2 salty water discharge river water quality standards.

**Table 3-1. Rochester WRP Planning Effluent Water Quality Criteria**

| Treatment Level | Final Effluent[a] | | | General Technology Comments |
|---|---|---|---|---|
| | Monthly Ammonia, mg N/L | Annual N mg N/L | Monthly TP mg-P/L, (lb/d) | |
| Level 1 | Current Permit Limits[b] | NA | 0.8 mg-P/L (82 lb/d) 12-month rolling | |
| Level 2 | < 2 mg/L | 10 as TN | 0.4 mg-P/L (82 lb/d) 12-month rolling | Full or partial filtration to meet TP limit |
| Level 2X | < 2 mg/L | 10 as NOx-N | 0.4 mg-P/L (82 lb/d) 12-month rolling | Full or partial filtration to meet TP limit |
| Level 3 | < 2 mg/L | 4 as TN | 0.1 mg-P/L (82 lb/d) 12-month rolling | Filtration for TN and TP limit |

a. *Existing permit monthly/weekly effluent cBOD5 and TSS limits of 15/25 and 30/45 apply to all options with associated mass loadings of 1352/2254 kg cBOD5/d and 2705/4075 kg TSS/d.*

b. *Monthly ammonia limits for Dec-March, Apr-May, Jun-Sep, and Oct-Nov are 5,10, 3, and 13 mg N/L respectively with associated mass loadings of 451, 902, 270, and 1172 kg/d.*

For evaluation purposes, process modeling targeted effluent discharges of 80 percent of less than the values identified in Table 3-1 to account for process uncertainty and factors of safety. The total phosphorus (TP) discharge effluent criteria of 82 pounds per day (lb/d) or 37 kilograms per day (kg/d is used based upon historical data from January 1, 2014 through May 8, 2017). An effluent TP loading criteria of 82 lbs/d was selected based on preliminary data provided by the governing regulatory agency regarding estimated phosphorous allocations to Lake Zumbro.

Solids handling key design features was so as to continue land applying a Class B product in accordance with all NPDES permit requirements. Further design consideration included 6 months of storage for thickened digested solids storage and a minimum digester solids retention time (SRT) of 15 days.

In addition to the key final effluent parameters listed above the NPDES permit contains several other parameters that were considered but not directly addressed in the alternatives evaluation within the scope of this Facility Plan including Disinfection requirements and pH.

# Section 4
# Existing Facility Condition

This section briefly covers the existing condition of the WRP assets.

## 4.1 Facility Condition

The City proactively tracks the condition of the WRP assets and thus BC did not conduct a condition assessment. Table 4-1 identifies the condition assessment issues identified and being tracked by the City.

**Table 4-1. Rochester WRP Existing Facility Condition Assessment Issues**

| Area | Asset | Issue | Comments |
|---|---|---|---|
| Equalization | Electrical equipment | Past expected life | Replaced in 2016 |
| Equalization | Odor control | Poor performance | Conduct odor analysis and scrubber performance study |
| Primary clarification | Primary sludge pumps | Capacity limitations | Rehabilitation repurposing planned for future project |
| Primary clarification | Scum beaches on Primary Clarifiers 1 and 2 | Poor condition | Replace in next few years |
| Primary clarification | Odor control for Primary Clarifiers 1 and 2 | Poor performance | Rehabilitation/repurposing planned for future project |
| High purity oxygen | First stage tanks | Leaking joints | Reseal if HPO operation in future |
| High purity oxygen | Intermediate clarifier roofs | Leaking and failed insulation | Repair dependent on future use |
| High purity oxygen | Intermediate Clarifiers 1 and 2 collector/weir | Poor condition | Replace if needed for future service |
| High purity oxygen | Intermediate clarifier sludge pumps | Poor condition | Replace if needed for future service |
| High purity oxygen | Intermediate clarifier motor control centers | Poor condition | Replace if needed for future service |
| High purity oxygen | Second stage tanks | Leaking joints | Reseal if HPO operation in future |
| High purity oxygen | Return activated sludge piping | Poor condition (rolled steel sections) | Replace as needed |
| Final clarifiers 1-4 | Return activated sludge pumps | Poor performance | Replace when HPO process switched to A/O |
| Final clarifiers 1-4 | Motor control center | Poor condition | Replace and consolidate with projects rather than modify |
| Final clarifiers 1-4 | Splitter box gates | Do not seal | Replace or refurbish as needed |
| Disinfection | Exterior equipment/piping | Past expected life | Replace with planned future project |
| Waste activated sludge holding | Tank | Poor concrete condition | Replace with planned future project |

| Table 4-1. Rochester WRP Existing Facility Condition Assessment Issues | | | |
|---|---|---|---|
| Area | Asset | Issue | Comments |
| Digested sludge holding | Tank | Poor condition | Replace with planned future project |
| Digested sludge holding | Pumps | Poor condition | Replace with planned future project |
| Digestion | Digester Nos. 1 and 2 | Roofs in poor condition and portions of interior coating failing | Repair with planned future project |
| Digestion | Digester Nos. 3 and 4 | Currently abandoned | Rehabilitation/repurposing planned for future project |
| Biogas | Low Pressure Holder | Corroded, near end of life | None |
| Biogas | Waste gas burners | Poor performance | Replace with planned future project |
| Solids handling | Odor control | Poor performance | Replace with planned future project |
| General | Concrete tanks | Interior coatings failing | None |
| General | Building roofing | Poor condition | Repair work scheduled based on annual inspections |
| General | Emergency power | Low capacity for across line starting | None |
| General | HVAC | Capacity limitations on pre-2007 equipment | Replace as needed based in future HVAC study |
| General | Field programmable logic controllers | Past expected life | None |

# Section 5
# Process Optimization

## 5.1 Existing Process Unit Capacities

In an effort to optimize existing process unit capacities, detailed evaluations of key liquid stream process units were completed. This included individual studies evaluating modifications to improve Primary Clarifiers 1 and 2 performance, Intermediate Clarifiers 1-4 capacity, and Final Clarifiers 1-5 capacity and process performance enhancement. The following discussion summarizes more detailed information found in the referenced appendices related to these key process units.

### 5.1.1 Primary Clarifiers 1 and 2

A rectangular clarifier computational fluid dynamics (CFD) model, 2Dr, was used to analyze the performance of the primary clarifiers. The effort included field and stress testing Primary Clarifier 2 to collect data to calibrate the 2Dr model. The calibrated model was subsequently used to comparatively evaluate clarifier performance under Year 2045 conditions.

The 2Dr analysis showed baffles placed in front of the inlet ports would increase TSS removal if influent flow across the tank is evenly distributed. Based on the 2Dr model findings, influent baffling and flow distribution was refined using FLUENTTM, a three-dimensional (3D) CFD model. The 3D model showed significant hydraulic improvements within the clarifiers from the addition of two baffles. The first baffle system consists of four 9-inch stub baffles in each influent channel feeding the primary clarifier to promote more even distribution between the six inlet ports. This is critical as stress testing showed uneven flow distribution and sludge blanket development and short-circuiting at higher SORs as flow was pushed to the “end” ports. Figure 5-1 shows the 3D model predicted velocity patterns at the inlet with the “stub” baffles installed.

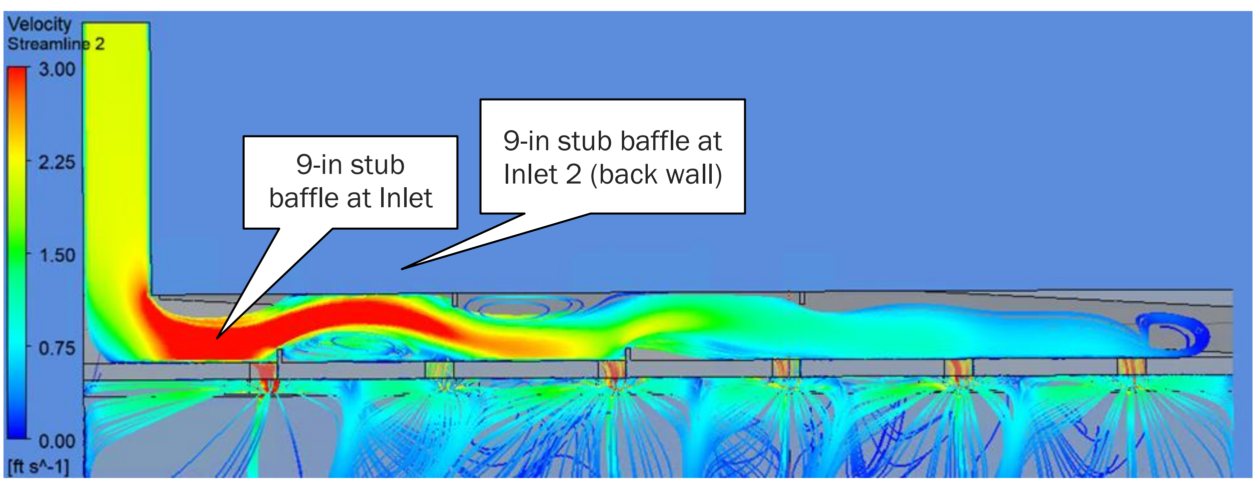



**Figure 5-1. Primary Clarifier 2 recommended inlet channel stub baffle configuration**

*(SOR = 1,660 gal/ft³-d)*

The second baffle system builds upon the inlet baffle concept shown to be beneficial by the 2Dr model. Figure 5-2 shows the recommended inlet baffle diffuser plate located directly in front of each inlet port which could increase TSS capture.

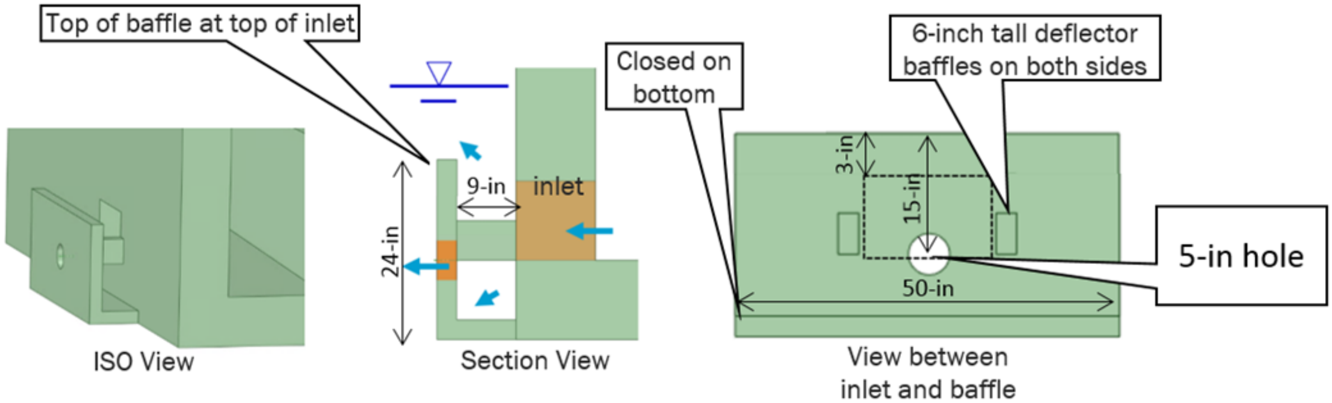



**Figure 5-2. Diffuser plate configuration**

### 5.1.2 Intermediate Clarifiers

The City performed two days of intermediate clarifier (IC) stress testing to define the maximum loading condition at which either the effluent TSS exceeded 25 mg/L or sludge blanket depth (SBD) remained stable (i.e., not rising). Table 5-1 summarizes IC capacity at the historical 90th percentile sludge volume index (SVI) value of 260 milliliters per gram (mL/g) and a potential design SVI of 150 mL/g assuming a well-settling sludge in the first-stage HPOAS system that considers both the existing return activated sludge (RAS) pumping capacity of 2.0 mgd/clarifier and increased RAS capacity of 2.5 mgd/clarifier. At MLSS concentrations of 1,200 to 1,500 mg/L, clarifier performance is assumed to be hydraulically limited at 1,200 gal/ft2-d. Further testing should be conducted to verify the peak SOR capacity.

**Table 5-1. Rochester HPOAS Intermediate Clarifier Capacity Analysis Results**

| Condition | Units | SVI[c] = 260 mL/g | | SVI[c] = 150 mL/g | |
|---|---|---|---|---|---|
| Clarifier condition | | Existing | Increased RAS | Existing | Increased RAS |
| Return sludge flow/clarifier | mgd | 2.0 | 2.5 | 2.0 | 2.5 |
| Solids loading rate | lb/ft$^2$-d | 11.5 | 13.0 | 17.0 | 20.0 |
| Flow/clarifier | | | | | |
| at MLSS = 1,200 mg/L | mgd | 5.3 | 5.7 | 7.7[a] | 7.7[a] |
| at MLSS = 1,500 mg/L | mgd | 3.8 | 4.1 | 6.7 | 7.7 |
| at MLSS = 2,000 mg/L | mgd | 2.4 | 2.5 | 4.5 | 5.2 |

a. *Assumes maximum SOR of 1,200 gal/ft2-d.*

b. *Based upon 65 percent of SPA theoretical maximum allowable SLR.*

c. *2-L non-stirred settleometer.*

### 5.1.3 Final Clarifiers

The WRP has five final clarifiers each 120-ft in diameter. Final Clarifiers 1 through 4 serve the second stage of the HPOAS system and Final Clarifier 5 serves the ABC system. Final Clarifier 2 can also serve the ABC system when Final Clarifier 5 is out of service for maintenance. BC conducted field and stress testing to calibrate a circular final clarifier CFD model, 2Dc, and analyze the capacity of the system with and without performance modifications. See Appendix 5 for more details.

Table 5-2 shows Final Clarifier 5 has a solids loading rate (SLR) capacity of 39 pounds per square foot-day (lb/ft2-d) under the current configuration and can be increased to 43 lb/ft2-d by increasing the flocculation well depth from 4.0 to 8.5 feet. Increasing the flocculation well depth also reduces effluent suspended solids concentrations compared to the existing configuration. Final Clarifiers 1 through 4 have an SLR capacity of 24 lb/ft2-d under current operations with a 2.5 mgd/clarifier RAS flow (one RAS pump in operation) and can be increased to 31 and 38 lb/ft2-d by increasing the RAS pumping rate per clarifier to 3.6 and 5.3 mgd, respectively. With conversion of HPOAS to a conventional air system with an anaerobic selector (A/O), Final Clarifiers 1–4 capacity remains the same and can be increased to 43 lb/ft2-d by increasing the RAS flow to 6 mgd/clarifier.

**Table 5-2. Rochester Final Clarifier Capacity Analysis Results**

| Condition | Unit | Final Clarifier 5 | | Final Clarifiers 1-4 | | | |
|---|---|---|---|---|---|---|---|
| Process configuration | -- | BNR with anaerobic selector | | Existing 2-stage HPOAS | | BNR with anaerobic selector | |
| Clarifier condition | -- | Existing | Deepened flocculation well | Existing | Increased RAS | Existing | Increased RAS |
| Sludge volume index[b] | mL/g | 130 | 130 | 90 | 90 | 130 | 130 |
| RAS flow/clarifier | mgd | 6.0 | 6.0 | 2.5 | 3.6/5.3 | 2.5 | 3.6/5.3/6.0 |
| Solids loading rate | lb/ft$^2$-d | 39 | 43 | 24 | 31/38 | 24 | 31/38/43 |
| Peak hour flow/clarifier[a] | | | | | | | |
| at MLSS = 3,000 mg/L | mgd | 11.5 | 12.8 | 8.3 | 10.4/12.0 | 8.3 | 10.5/12.6 |
| at MLSS = 3,500 mg/L | mgd | 9.1 | 10.3 | 6.8 | 8.4/9.5 | 6.8 | 8.5/10.0 |
| at MLSS = 4,000 mg/L | mgd | 7.2 | 8.2 | 5.6 | 6.9/7.7 | 5.6 | 7.0/8.1 |
| at MLSS = 4,500 mg/L | mgd | 5.8 | 6.7 | 4.7 | 5.7/6.2 | 4.7 | 5.8/6.6 |

*a. Assumes no hydraulic limitations.*

*b. 2-L non-stirred settleometer.*

## 5.2 Recommendations

The recommended improvements include the addition of baffles to Primary Clarifiers 1 and 2 influent channels, increasing the flocculation well depth of Final Clarifier 5, and increase RAS pumping rates of Final Clarifiers 1-4. The City has begun implementing Primary Clarifier 1 and 2 and Final Clarifier 5 improvements internally and cost estimates were not required. The increased RAS pumping rate capacity is included as part of Phase 2 Upgrades and cost estimates provided as part of meeting varying treatment standards illustrated in Section 6.

# Section 6
# Biological Nutrient Removal

This section summarizes the biological nutrient removal (BNR) alternatives screening process and recommended BNR alternative to achieve effluent water quality treatment levels presented in Section 3.1 above. The BNR alternatives include the primary clarifiers. The following TMs provide additional details on the primary and secondary system evaluations.

- Appendix 2 – Wastewater Characterization and BioWin™ Calibration
- Appendix 6 – Liquid Stream Alternative Evaluation
- Appendix 10 – Whole Plant Alternative

## 6.1 Alternative Screening

A BNR alternative screening workshop was conducted with WRP staff on April 20, 2018. The workshop focused on the review of viable liquid and sidestream technologies with respect to the City's goals listed below and proven record of operation.

- Lower energy – strive towards net-zero facility
- Clean design - streamline equipment, operation, and maintenance, limits stranded assets, reduce chemical consumption
- Decreased maintenance - includes equipment and facilities where possible
- Innovative processes –meet varying permit limits and achieve goals, proven record of operations
- Long-term holistic approach - ability to be staged to meet tighter limits, ensure treatment, operation, maintenance, and energy goals align, minimize impacts to other processes

### 6.1.1 Process Technology Screening Evaluation

The screening process identified and evaluated 19 viable liquid stream technologies which were grouped into four categories:

Conventional BNR Technologies

- Existing Configuration
- A/O
- A2O
- 5 Stage BNR
- MLE
- 4 Stage BNR

Technologies with a focus towards net zero energy

- Simultaneous Nitrification Denitrification
- Nitrite Shunt
- Membrane Aerated Bioreactor

- High Rate A/B
- Mainstream Anammox

Process Intensification Systems to Reduce Plant Footprint Requirements

- Membrane Bioreactor
- Integrate Fixed Film Activated Sludge
- BioMagTM
- Aerobic Granular Sludge (AquaNeredaTM)

Tertiary Technologies to Further Reduce TP and TN

- Denitrification Filters/Moving Bed Biofilm Reactors
- Tertiary Filters
- Dual Stage Continuous Backwash Filters
- CoMagTM

Based upon a long-term holistic approach and each technologies ability to be sequentially staged to achieve Treatment Level 2, 2X and 3 nitrogen and phosphorus discharges, three treatment pathways were developed based on the best fit of the above 19 treatment alternatives.

### 6.1.2 Treatment Process Pathway Screening

Three primary pathways were chosen to meet the increasingly more stringent effluent criteria and City goals outlined as part of this project. The three chosen pathways are shown in Figure 6-1 and summarized as follows:

- Pathway 1 maintains the existing high purity oxygen activated sludge (HPOAS) and air activated sludge system parallel treatment trains. To achieve treatment level 2, 2X, and 3, the existing second stage HPOAS is replaced with air activated sludge simultaneous nitrification denitrification (SND) and modifies the ABC facility to a 5-stage BNR process.
- Pathway 2 converts the existing facility to air activated sludge BNR. The existing HPOAS train is converted to an A/O process to meet treatment level 1, followed by 3-stage BNR for Treatment Leve 2X, and finally 5-stage BNR to meet Treatment Levels 2 and 3.
- Pathway 3 converts the existing facility to an AquaNereda aerobic granular sludge (AGS) facility. Both the existing HPOAS and ABC trains are converted into AGS to meet treatment level 2, 2X, and 3. Treatment Level 3 includes sidestream deammonification to reduce annual TN discharges below 4 mg/L. Pathway 3 did not include Treatment Level 1 as tertiary filtration is required to reduce effluent TP discharges to the target levels.

To achieve Treatment Level 2, 2X, and 3 effluent TP discharges this analysis includes deep bed continuous backwash filters.

| | Pathway 1: Parallel Systems | Pathway 2: Conversion to Air Activated Sludge BNR | Pathway 3: Conversion to Aerobic Granular Sludge |
|---|---|---|---|
| Treatment Level 1<br>Existing Permit | Alternative 1:<br>Existing Parallel System<br>Parallel ABC and HPO trains | Alternative 2<br>A/O | |
| Treatment Level 2<br>TN < 10<br>TP < 0.4 | Alternative 1A:<br>1st Stage HPOAS with 2nd Stage Air Activated Sludge SND<br>ABC: 5 stage BNR<br>Deep Bed Filters | Alternative 4:<br>5-Stage BNR with Deep Bed Filters | Alternative 15:<br>AquaNereda<br>Deep Bed Filters |
| Treatment Level 2X<br>NOx-N < 10<br>TP < 0.4 | Alternative 1X:<br>3-Stage HPOAS BNR<br>ABC: 3 stage BNR<br>Deep Bed Filters | Alternative 4X:<br>3-Stage BNR with Deep Bed Filters | Alternative 15:<br>AquaNereda<br>Deep Bed Filters |
| Treatment Level 3<br>TN < 4<br>TP < 0.1 | Alternative 1B:<br>1st Stage HPOAS with 2nd Stage Air Activated Sludge SND<br>ABC: 5 stage BNR- Carbon Addition<br>Deep Bed Filters | Alternative 4B:<br>5-Stage BNR<br>Carbon Addition<br>Deep Bed Filters | Alternative 15B:<br>AquaNereda<br>Sidestream Deammonification<br>Deep Bed Filters |

**Figure 6-1. Rochester process screening selected liquid stream treatment pathways and alternatives**

Each treatment alternative was evaluated using the calibrated BioWinTM Version 5.3 whole-plant process simulator presented in Appendix 10 and updated for the design flow and loading conditions. The BNR alternative evaluations were based upon maintaining two liquid stream system with the plants existing MAD solids processing scheme as shown in Figure 6-2 for comparison purposes. For Pathway 3, the BioWin simulator was used to develop primary effluent flows and loadings to the AGS system which were then provided to Aqua Aerobic Systems Inc. for reactor sizing and supporting requirements of an AquaNereda AGS system.

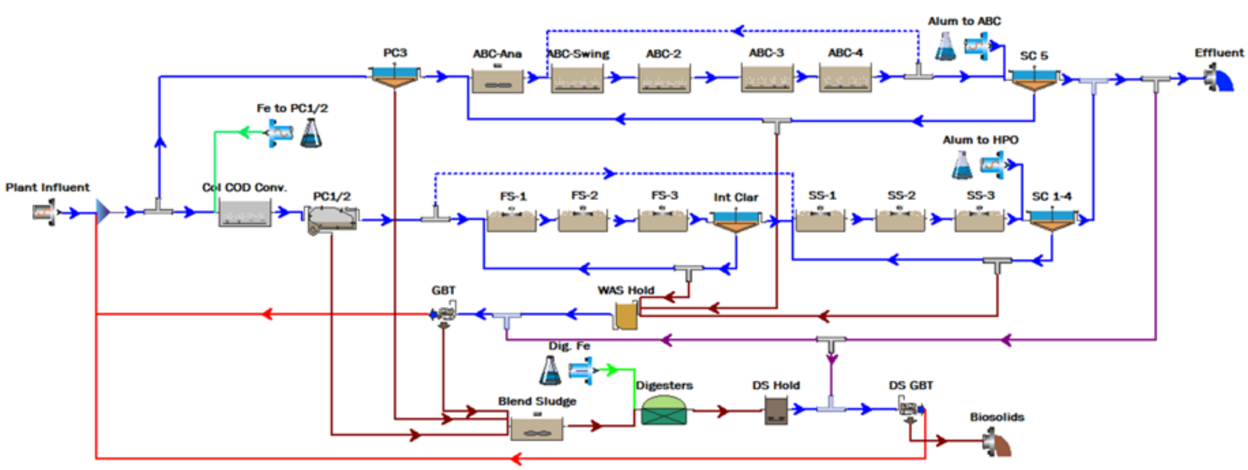



**Figure 6-2. Rochester WRP Liquid Stream BioWin™ flow schematic**

Treatment Pathway 2, Conversion to Air Activated Sludge BNR, was ultimately selected as the best fit in both regards to the facility plan goals and net present costs as detailed in Appendix 2 and 10. The following sections only present the results pertaining to Pathway 2 as it is the recommended alternative.

## 6.2 Treatment Level 1: Existing Permit with Total Phosphorus (TP) Limit of 0.8 mg/L

Figure 6-3 summarizes the key features of Alternative 2 - A/O to meet Treatment Level 1 effluent criteria through year 2045. Treatment Level 1 is the existing permit taking into account growth and replacement of end of life equipment. The ABC system continues to operate in a nitrifying activated sludge (NAS) A/O mode while the HPOAS train is converted from a two-stage HPOAS system into the same nitrifying activated sludge A/O flow scheme. The ABC complex is expanded to provide a total of five 1.4 MG trains while the existing HPOAS tanks are repurposed to provide the equivalent of three 1.4 MG trains.

Table 6-1 presents the opinion of probable construction cost, capital cost, operations costs, and net present value (NPV) to meet Treatment Level 1. The total capital cost of $52 million and annual operating cost of $2,200,000 has a NPV 12 percent less than Pathway 1's Treatment Level 1 alternative and provides staging and flexibility to meet more stringent limits in a staged process.

Appendix 6 provides a more detailed discussion on the facility requirements, design data, and economic evaluation. Appendix 10 summarizes additional facility requirements and an updated opinion of probable construction cost based upon the recommended A/O single activated sludge system concept.

- Convert HPOAS Stage 1 bioreactors into anaerobic zone
- Convert HPOAS Stage 2 bioreactors into fine pore bioreactors
- Add a fourth fine pore aerated cell to the existing Stage 2 bioreactors.
- Demolish cryogenic facility and add blower complex with three new 8,000 scfm blowers
- Add Primary Effluent and Return Sludge Flow Structures
- Add three 1.4 MG ABC bioreactors.
- Add one 7,600 scfm ABC blower
- Use influent equalization to reduce 2045 PHWWF to 48 mgd

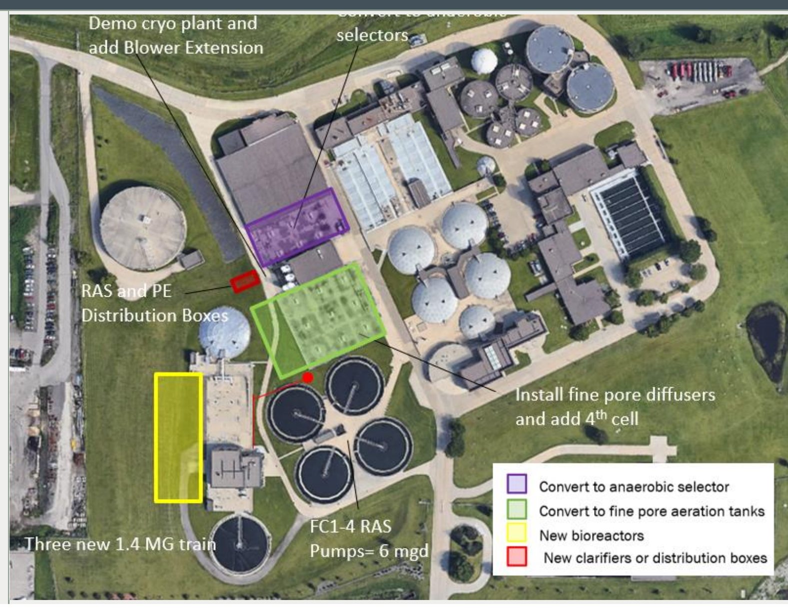



**Figure 6-3. Treatment Level 1 Anaerobic/Oxic (A/O) Key Facility Requirements and Layouts. (Year 2045)**

## 6.3 Treatment Level 2: Total Nitrogen (TN) of 10 mg/L and TP less than 0.4 mg/L

Pathway 2 converts the A/O process to a 5-stage BNR to reduce annual TN discharges below 10 mg-N/L and monthly TP discharges less than 0.4 mg/L or 82 lb/d, whichever is more stringent.

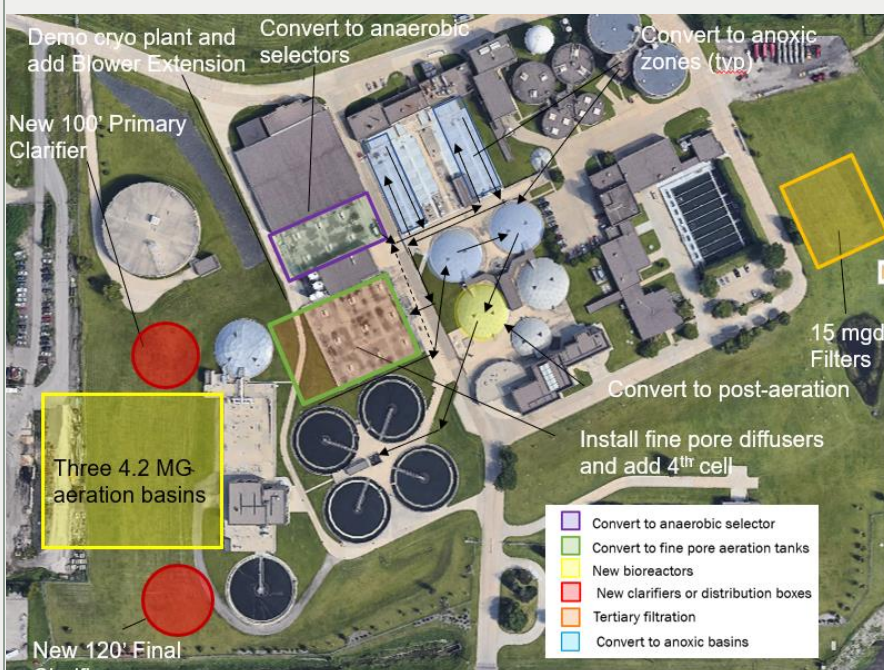
Figure 6-4 summarizes the key attributes of the 5-stage BNR process that converts both the existing HPOAS and ABC aeration trains into a 5-stage BNR basins.

The ABC complex is expanded to provide three 4.2 MG trains while the existing HPOAS tanks and old aeration basins are re-purposed to provide the equivalent of two 4.2 MG trains. A firm effluent filtration capacity of 15 mgd is required to reduce monthly effluent TP discharges below the target limits. Taking into account the plant has already been converted to the A/O system to meet Treatment Level 1, the primary additional facilities for this alternative includes the addition and modifications of aeration basins and repurpose of several older aeration basins to meet permit limits. Additional pumping stations and piping, not shown, would be added to existing tunnel systems. Operator requirements to run the facility are higher than treatment level 1.

Table 6-1 presents the capital cost, operations costs, and NPV to meet treatment level 2. The total capital cost of $114 million and annual operating cost of $2,360,000 has an NPV 12 to 17 percent less than the Pathway 1 and 3 Treatment Level 2 alternatives.

Appendix 6 provides a more detailed discussion on the facility requirements, design data, and economic evaluation.

- Convert HPOAS Stage 1 into anaerobic selectors and Stage 2 into fine pore bioreactors with an added fourth cell.
- Convert old aeration basins into 1st anoxic zones
- Convert two intermediate clarifiers into 2nd anoxic zones and one into post-aeration
- Demolish cryogenic facility and add blower complex with three new 7,500 scfm blowers
- Add one 100-ft primary clarifier*
- Provide three 4.2 MG 5-stage BNR reactors at ABC
- Add one 120-foot final clarifier
- Add one 2,600 scfm ABC blower
- Add 15 mgd tertiary filters
- Use EQ to reduce 2045 PHWWF to 49 mgd




*Final recommendation replaces the new 100-ft primary clarifier with flow control structures to implement a single activated sludge concept. Capital costs are the same for either approach.*

**Figure 6-4. Treatment Level 2 5 Stage BNR Key Facility Requirements and Layouts. (Year 2045)**

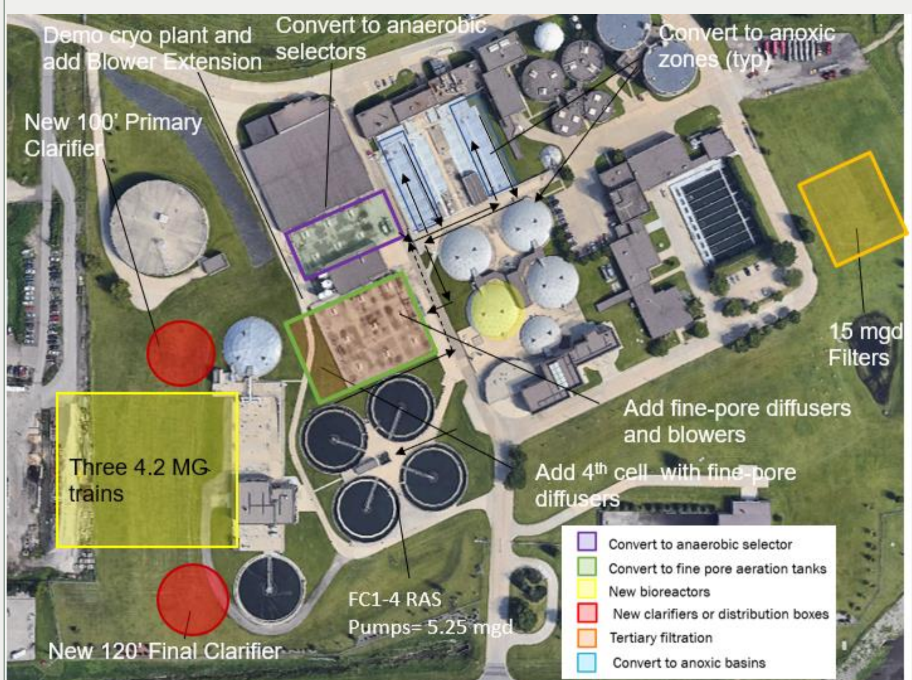
## 6.4 Treatment Level 2X: NOx-N of 10 mg/L and TP less than 0.4 mg/L

Treatment Level 2X targets reducing effluent NOx-N instead of TN primarily because TN limits are much more restrictive and pose a concern for the City. Treatment levels to reduce NOX-N discharges below 10 mg/L and monthly TP discharges less than 0.4 mg/L or 82 lb/d, whichever is more stringent. Figure 6-5 summarizes the key features of the 3-stage BNR (A2O) system needed to meet the target effluent criteria. Both the HPOAS train and ABC system are converted into 3-stage BNR (A2O) systems. This configuration is a logical progression for nitrogen reduction from the A/O configuration outlined in Treatment Level 1. To meet Treatment Level 2X requirements, similar operations and work is required to Treatment Level 2. However, conversion of the intermediate clarifiers to bioreactors is not required and overall operations are much simpler compared to the 5-stage BNR treatment system. Firm effluent filtration capacity of 15 mgd is required to reduce effluent TP discharges below the target limits

Table 6-1 presents the capital cost, operations costs, and NPV for Treatment Level 2X. The total capital cost of $104 million and annual operating cost of $2,330,000.

Appendix 6 provides a more detailed discussion on the facility requirements, design data, and economic evaluation.

- Convert HPOAS Stage 1 into anaerobic selectors
- Convert old aeration basins into anoxic zones
- Retrofit Stage 2 reactors into fine pore bioreactors with a fourth cell.
- Demolish cryogenic facility and add blower complex with three new 7,500 scfm blowers
- Add one 100-ft primary clarifier*
- Provide three 4.2 MG 3-stage BNR reactors at ABC
- Add one 3,000 scfm ABC blower
- Add 15 mgd tertiary filters
- Use EQ to reduce 2045 PHWWF to 47 mgd




**Final recommendation replaces the new 100-ft primary clarifier with flow control structures to implement a single activated sludge concept. Capital costs are the same for either approach.*

**Figure 6-5. Treatment Level 2X 3-Stage BNR Key Facility Requirements and Layouts. (Year 2045)**

## 6.5 Treatment Level 3: Total Nitrogen (TN) of 4 mg/L and TP less than 0.1 mg/L

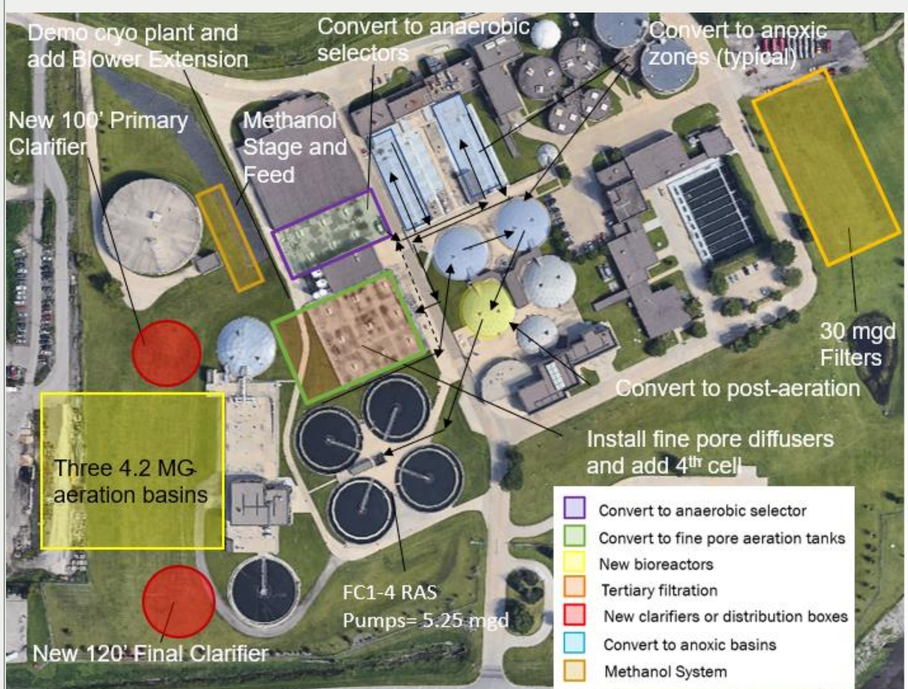
Treatment Level 3 was selected to further reduce annual TN discharges below 4 mg/L and monthly TP discharges to less than 0.1 mg/L or 82 lb/d, whichever is more stringent.

Figure 6-6 summarizes the key features of the 3-stage BNR (A2O) system needed to meet the target effluent criteria. Treatment Level 3 design is the 5 stage BNR process outlined in Treatment Level 2 with the addition of supplemental carbon addition to reduce effluent TN and expanding the tertiary filtration capacity to 30 mgd.

Table 6-1 presents the capital cost, operations costs, and NPV for Treatment Level 3. The total capital cost of $139 million and annual operating cost of $3,240,000.

Appendix 6 provides a more detailed discussion on the facility requirements, design data, and economic evaluation.

- Convert HPOAS Stage 1 into anaerobic selectors and Stage 2 into fine pore bioreactors with an added fourth cell.
- Convert old aeration basins into 1st anoxic zones
- Convert two intermediate clarifiers into 2nd anoxic zones and one into post-aeration
- Demolish cryogenic facility and add blower complex with three new 7,500 scfm blowers
- Add one 100-ft primary clarifier
- Provide three 4.2 MG 5-stage BNR reactors at ABC
- Add one 120-foot final clarifier*
- Add one 2,600 scfm ABC blower
- Add 30 mgd tertiary filters
- New methanol storage and feed system
- Use EQ to reduce 2045 PHWWF to 49 mgd




**Final recommendation replaces the new 100-ft primary clarifier with flow control structures to implement a single activated sludge concept. Capital costs are the same for either approach.*

**Figure 6-6. Treatment Level 3 5 Stage BNR Key Facility Requirements and Layouts. (Year 2045)**

## 6.6 A/O Simultaneous Nitrification Denitrification with Hydrocyclones

An emerging innovative A/O flow scheme which operates at low dissolved oxygen (DO) concentrations providing conditions for simultaneous nitrification denitrification (SND) to reduce TN discharges below 10 mg/L and TP discharges below 0.8 mg/L without filtration and 0.4 mg/L with filtration (Treatment Levels 1, 2 and 2X) should be considered for further evaluation and testing. This flow scheme builds upon the recommended A/O flow scheme by incorporating gravimetric selective wasting using hydrocyclones to significantly improve the poor sludge quality typically associated with low DO operations and advanced aeration control systems such as ammonia based aeration control. Figure 6-7 summarizes the key features of an A/O SND with Hydrocyclones system to meet Treatment Level 1, 2 and 2X effluent criteria through year 2045. Plant improvements are the same as described in Section 6.2 with the following additional systems.

- A hydrocyclone wasting station consisting of 12 hydrocyclones on 3 or 4 skids, hydrocyclone feed pumps, and waste sludge pumps for pumping hydrocyclone overflow to the gravity belt thickeners. It is assumed the hydrocyclones and feed pumps are housed in a new building with the overflow pumps in the existing plant tunnels/basement.
- One additional 1.4 MG ABC aeration basin.
- Ammonia based aeration control system.

If proven viable, this alternatives capital cost of $76 million with filters is roughly 35 and 30 percent lower than the recommended pathway alternatives for Treatment Level 2/2X respectively with annual operating costs 10 percent less under both scenarios. The annual operating cost is also 10 percent lower than the recommended A/O configuration resulting in an NPV 7 percent higher than A/O, which for planning evaluations are considered equal.

- Convert HPOAS Stage 1 bioreactors into anaerobic zone
- Convert HPOAS Stage 2 bioreactors into fine pore bioreactors
- Add a fourth fine pore aerated cell to the existing Stage 2 bioreactors.
- Demolish cryogenic facility and add blower complex with three new 8,000 scfm blowers
- Add Primary Effluent and Return Sludge Flow Structures
- Add four 1.4 MG ABC bioreactors.
- Add one 7,600 scfm ABC blower
- Use influent equalization to reduce 2045 PHWWF to 46 mgd
- Add hydrocyclone wasting station
- Add ammonia based aeration control

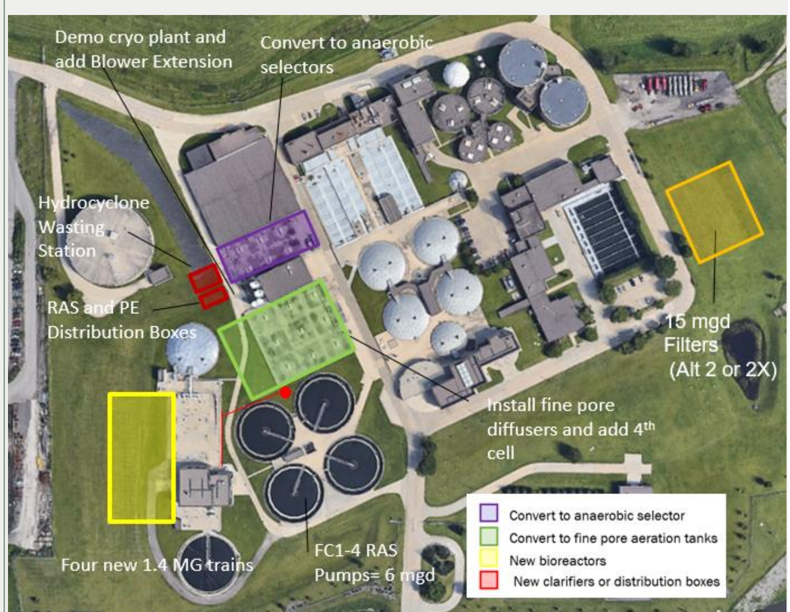



**Figure 6-7. A/O SND with Hydrocyclones Key Facility Requirements and Layouts. (Year 2045)**

To date there is limited operating data on full-scale SND systems with hydrocyclone gravimetric selective wasting. Given the potential energy saving and significant capital savings for reducing TN discharges, this alternative should continue to be monitored and be considered for full-scale demonstration testing on the existing ABC system. This alternative is consistent with the recommended plan of implementing Pathway 2's A/O single activated sludge concept above. Alternative 2SND was not evaluated to further reduce nutrient discharges to Treatment Level 3.

Appendix 6 provides a more detailed discussion on the facility requirements, design data, and economic evaluation. Appendix 10 summarizes additional facility requirements and an updated opinion of probable construction cost based upon the recommended A/O single activated sludge system concept.

## 6.7 Net Present Value Comparison

Table 6-1 provides a comparison of the net present values of the alternatives identified to achieve the respective treatment levels, listing both the capital costs and the corresponding NPV O&M costs. The A/O SND with Hydrocylones alternative listed in the last column is presented as an option that could achieve treatment levels 1, 2 or 2X.

**Table 6-1. Pathway 2 Opinion of Probable Construction Cost, Capital Cost, Annual Operating Cost, and Net Present Value**

| Treatment Level | 1 | 2 | 2X | 3 | 1, 2, or 2X |
|---|---|---|---|---|---|
| Process Configuration | A/O | 5-Stage BNR | 3-Stage BNR | 5-Stage BNR with Carbon Addition | A/O SND with Hydrocyclones |
| Item | | | | | |
| **Total Construction Cost** | $ 42,700,000 | $94,000,000 | $85,700,000 | $115,400,000 | $50,000,000 |
| Engineering and Admin. (20 percent) | $ 8,5800,000 | $19,000,000 | $17,000,000 | $23,000,000 | $10,000,000 |
| Equipment Renewal and Replacement | $750,000 | $750,000 | $750,000 | $750,000 | $750,000 |
| **Total Capital Cost (rounded)** | **$52,000,000** | **$114,000,000** | **$104,000,000** | **$139,000,000** | **$61,000,000**[c] |
| **Annual Operating Costs** | | | | | |
| ABC blower energy | $310,000 | $250,000 | $300,000 | $290,000 | $ 260,000 |
| HPOAS (Train 1) blower energy | $ 220,000 | $ 190,000 | $ 150,000 | $190,000 | $ 150,000 |
| Methanol | - | - | - | $760,000 | - |
| Ferric chloride | $ 360,000 | $ 360,000 | $ 360,000 | $380,000 | $ 360,000 |
| Mixer/pump energy | $ 90,000 | $230,000 | $200,000 | $ 230,000 | $ 110,000 |
| Raw sludge processing | $290,000 | $570,000 | $580,000 | $590,000 | $280,000 |
| Biosolids handling | $ 570,000 | $120,000 | $120,000 | $130,000 | $ 570,000 |
| Biosolids polymer | $ 120,000 | $360,000 | $340,000 | $300,000 | $ 120,000 |
| Labor O&M | $ 220,000 | $280,000 | $280,000 | $400,000 | $ 230,000 |
| **Annual operation and maintenance** | **$2,200,000** | **$ 2,360,000** | **$ 2,330,000** | **$3,240,000** | **$2,100,000** |
| Comparative Annual O&M NPV | $ 50,000,000 | $57,000,000 | $ 55,000,000 | $76,000,000 | $48,000,000 |
| **Net Present Value (rounded)** | **$103,000,000** | **$168,000,000** | **$160,000,000** | **$215,000,000** | **$110,000,000**[c] |

a. Cost presented in 2020 dollars
b. Annual operation and maintenance in first year of operation – 2023
c. Total capital cost of $76,000,000 with filters. Net present value of $125,000,000 with filters

## 6.8 Treatment Level 4: Salty Water Discharges

A high-level order-of-magnitude evaluation was conducted for the plant to meet Class 2 salty water discharge river water quality standards using membrane filtration/reverse osmosis (MF/RO). Under the Class 2 standards, the WRP effluent chlorides limits would be 405 and 454 mg/L for monthly and maximum day, respectively. Preliminary analysis based upon limited data suggests three process trains with MF capacity of 1.75 mgd/train and RO capacity of 1.5 mgd/train is needed. RO concentrate management assumed a flow scheme with evaporators followed by a crystallizer. Total capital costs for the MF/RO system are roughly $65 to $70 million with an estimated annual O&M cost of $750,000 in during the first year of operation. If total phosphorus and chlorides limits were to become more stringent than those indicated here, capital and operating costs would become even more prohibitive.

An earlier analysis considered the impact of monthly TP and maximum day chloride limits of 0.075 mg/L and 292 mg/L respectively. The estimated costs to treat to these levels were estimated to be $200,000,000 in capital cost and $22,000,000 in annual operating costs.

Because of the magnitude of these costs, the option of an alternative outfall located at the Mississippi River in Kellogg, MN was considered, based on an assumption that the effluent limits for the Mississippi would be less stringent effluent limits for the South Fork of the Zumbro River. However, the cost of a lift station and outfall pipe required for a Mississippi River discharge is equally prohibitive with an estimated capital cost of $220,000,000.

## 6.9 Sidestream Enhanced Biological Phosphorus Removal

Sidestream enhanced biological phosphorus removal (S2EBPR) is an emerging technology which incorporates a sidestream anaerobic mixed liquor or RAS hydrolysis and fermentation reactor, in lieu of, or in addition to, a traditional mainstream anaerobic selector, for purposes of EBPR. Sidestream RAS Fermentation options could be implemented by diverting a fraction of the RAS flow from the common RAS header to intermediate clarifiers retrofitted into RAS fermentation reactors. If the City wishes to pursue this EBPR approach, pilot testing is recommended to confirm the system requirements and performance. Additional discussion on consideration for a S2EBPR system are included in Appendix 10.

# Section 7
# Final Effluent

Secondary treatment is followed by disinfection, dechlorination, with final effluent discharged to the South Fork of the Zumbro River. Technical Memorandum 9 - Disinfection and Outfall Evaluation provides an analysis of recommended improvements for this area of the plant. A summary of the analysis and recommended improvements are provided as follows:

## 7.1 Disinfection

The disinfection system is composed of the three chlorine contact tanks (CCTs) and disinfection chemical feed systems. The tanks were originally commissioned as final clarifiers and later repurposed for chlorine contact, which has resulted in some performance challenges. This section describes potential improvements to the chlorine (Cl2) and sodium bisulfite (NaHSO3) chemical delivery systems and modifications to reduce short-circuiting in the CCTs.

### 7.1.1 Chlorine Addition

The WRP adds Cl2 before the CCTs via the mixing ejectors. Plant staff have indicated that Cl2 gas would continue to be used as the primary disinfectant for the foreseeable future. The City desires to reduce power consumption where possible thus BC recommends changing out the chemical mixing system with a significantly less energy intensive chlorine inductor and solution diffuser system. The chlorine inductor(s) gets installed in the chlorination building and mixes the Cl2 into a stream of final effluent acting as carrier water. The only power demand is the ejector motor final effluent pumping associated with the carrier water. The solution then travels to a submerged perforated polyvinyl chloride (PVC) pipe diffuser located at the CCT inlet.

### 7.1.2 Dechlorination

Free chlorine present after the CCTs must be removed which the WRP accomplishes through dechlorination with Sodium Bisulfite (NaHSO3) addition. The NaHSO3 is currently added approximately 10-ft upstream of the entrance to the outfall pipe. City staff report they currently use more NaHSO3 than expected based on the stoichiometric relationship would suggest which BC attributes to poor mixing. BC recommends relocating the addition point to the recommended new flow measuring flume inlet discussed in Section 7.2. A new chemical diffuser made from perforated PVC pipe will distribute the NaHSO3 evenly across the flow stream and the turbulence of the flume provides additional mixing.

## 7.2 Outfall Modifications

To improve chemical mixing, provide total effluent metering, improve dissolved oxygen concentrations, and reduce short circuiting, outfall modifications shown in Figure 7-1 are recommended. The following is a summary of the outfall modifications:

- Serpentine channels will be added to the existing chlorine basins. The serpentine flow configuration will improve chlorine contact time and reduce dead zones that exist within the current configuration.
- Plant flow is based on several flow meters located at the influent of the plant and large error occurs due to the number of flow meters required. A Parshall Flume will provide effluent

metering as a direct measurement for reliable effluent flow and load recording. A single point of flow measurement will also allow for more accurate flow based chemical dosing and decrease overall chemical costs.

- Cascade aeration will be added to improve DO levels. Forced air aeration will also likely be required to supplement cascade aeration to achieve permitted DO. The current NPDES permit requires final effluent contain 5 mg/L of DO, minimum. Switching from the existing HPO train to A/O will reduce the DO in the final effluent such that levels may drop below the regulated minimum. Cascade is an effective and low cost method to increase DO levels.
- New effluent submersible sampling pumps will replace the existing system that is inefficient due to poor hydraulic conditions. Basin reconfiguration also requires the replacement of these pumps. New effluent pump locations will increase chemical dosing efficiency and dissolved oxygen sampling accuracy.

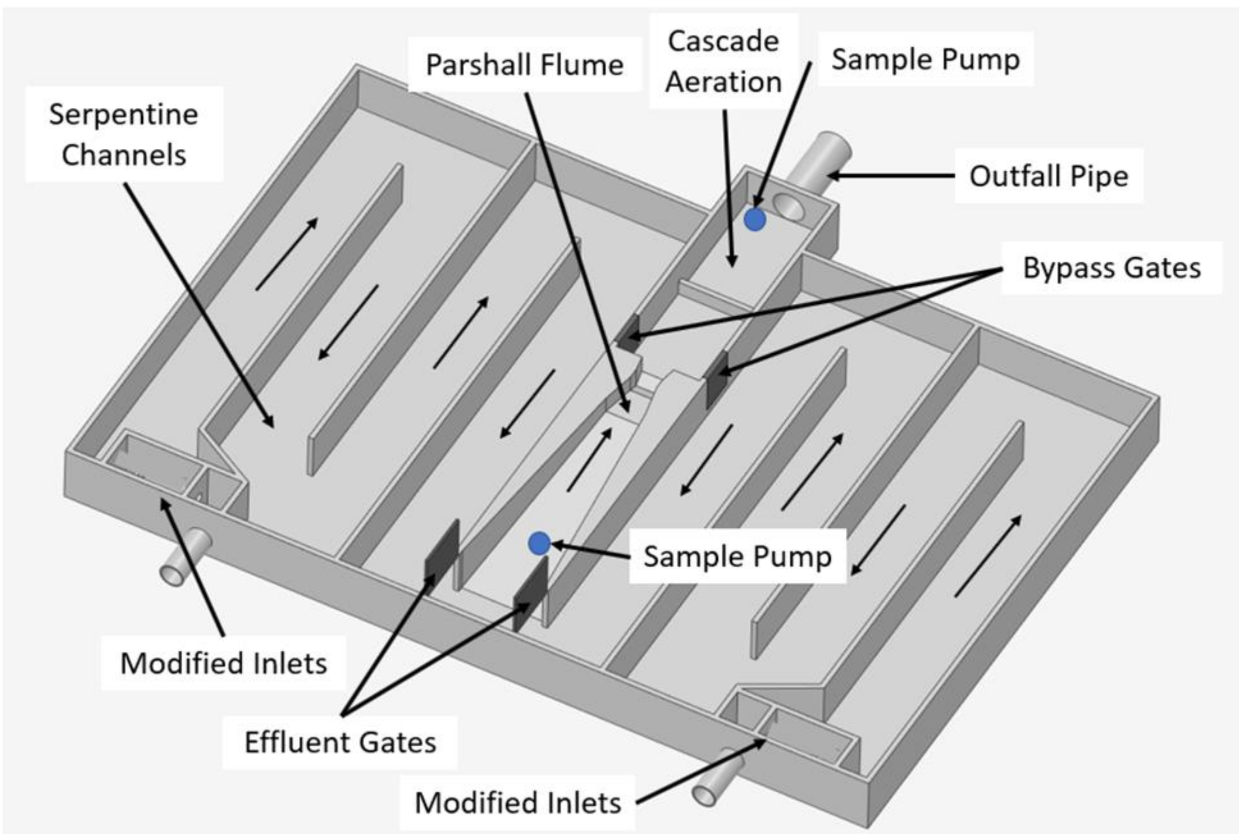



**Figure 7-1. Alternative 2: Rochester WRP serpentine CCT with center channel configuration**

## 7.3 Summary and Opinion of Probable Costs

Table 7-1 provides a summary of the preliminary estimate of construction costs associated with the projects recommended in this section. Improvements will reduce energy costs by $47,000 annually and reduce annual chemical costs by $24,000. The probable costs to implement recommended capital improvements are $1,000,000.

**Table 7-1. Disinfection and Outfall Capital Improvements Opinion of Probable Costs**

| Item | Cost |
|---|---|
| Chlorine solution equipment | $160,000 |
| Chlorine and sodium bisulfite piping and chemical diffusers | $150,000 |
| Inlet and serpentine flow revisions in existing CCTs | $230,000 |
| Temporary bypass pumping | $200,000 |
| Effluent flume | $50,000 |
| Cascade aeration | $10,000 |
| Small diffused air system | $20,000 |
| Engineering and administration (20 percent) | $160,000 |
| Total capital cost | $1,000,000 |

# Section 8
# Solids Handling

This section provides an abridged discussion of the solids handling analyses conducted in the following TMs. Refer to the TMs for more detail.

- Appendix 7 – Solids Alternatives Evaluations
- Appendix 13 – Industrial Discharge Wasteloads and Practices

## 8.1 Current Solids Production

The City provided BC with historical plant operating data from January 1, 2014, through December 31, 2017, which were used to establish the current solids loadings and peaking factors. Table 8-1 summarizes selected annual average and maximum month loading values (pounds per day [lb/d]).

**Table 8-1. Rochester WRP Current Solids Loading**

| Item | Annual Average (lb/d) | Maximum Month (lb/d) | Peaking Factor |
|---|---|---|---|
| Primary sludge | 22,400 | 28,400 | 1.3 |
| Waste activated sludge | 21,500 | 28,600 | 1.3 |
| Thickened waste activated sludge | 19,400 | 25,800 | 1.3 |
| Digester feed | 41,800 | 51,500 | 1.2 |
| Thickened digested solids | 17,200 | 22,300 | 1.3 |

## 8.2 Projected Solids Production

The projected solids in Table 8-2 are based on the BioWinTM model calibrated to WRP wastewater characteristics and operations, reflecting the recommended A/O configuration, at annual average (AA) conditions using the historical peaking factors in Table 8-1 to estimate maximum month (MM) loads.

The projected thickened digested solids quantities in Table 8-2 include high strength waste (HSW) added to the anaerobic digesters and gravity sludge thickeners for primary sludge thickening. The HSW program loadings (and digested solids quantities) are likely to vary from these projections depending on whether the HSW streams identified participate in the potential WRP program.

**Table 8-2. Rochester WRP Projected Solids Loading**

| Item | 2030 | | 2045 | |
|---|---|---|---|---|
| | Annual Average (lb/d) | Maximum Month (lb/d) | Annual Average (lb/d) | Maximum Month (lb/d) |
| Primary sludge | 23,300 | 29,500 | 29,100 | 36,900 |
| Waste activated sludge | 26,100 | 34,700 | 32,600 | 43,400 |
| Thickened primary sludge[a] | 21,000 | 27,900 | 26,200 | 34,900 |
| Thickened waste activated sludge | 23,200 | 30,900 | 29,000 | 38,700 |
| Digester feed[b] | 44,800 | 55,200 | 56,100 | 69,100 |
| High strength waste | 3,340 | 4,180 | 3,340 | 4,180 |
| Digested solids | 27,800 | -- | 34,800 | -- |
| Thickened digested solids[c] | 24,800 | 32,100 | 31,000 | 40,200 |

a. *Assumes gravity thickener installed.*

b. *High strength waste not included.*

c. *Includes high strength waste residuals.*

## 8.3 Thickening

The WRP uses multiple forms of thickening to reduce the volume of water being handled. The following discusses the existing and planned thickening improvements. Refer to Table 8-3 for a summary of capital costs associated with the proposed thickening improvements.

### 8.3.1 Primary Sludge

The WRP currently thickens primary sludge in the existing primary clarifiers. A separate primary sludge gravity thickening process will more reliably increase the percent solids of the primary sludge fed to the MAD compared to thickening in the primary clarifiers. The City decided to allocate one of the abandoned digester tanks, Digester No. 3, for primary sludge gravity thickening. This process change also requires replacement of the five existing primary sludge pumps with higher capacity units. Another abandoned digester tank, Digester No. 4, will serve as a primary sludge storage tank during gravity thickener outages in the event the anaerobic digesters cannot accept the full primary sludge load due to capacity limitations.

### 8.3.2 Waste Activated Sludge

WAS is currently thickened on one of the three existing GBTs. The two older GBTs typically support WAS thickening while a new third GBT thickens digested solids. The projected flows and loads indicate the GBTs will be hydraulically and solids overloaded by the end of the planning period during peak conditions. This requires a second GBT to operate and would leave the City without a redundant unit when the digested solids require thickening. A fourth GBT is required to provide redundancy at peak conditions. The City decided to delay the installation of a fourth GBT until the projected flows and loads show a definite increase.

### 8.3.3 Digested Solids

The digested solids thickening process requires more than one GBT by the end of the planning period from a solids loading basis at maximum day conditions. As noted before the City decided to delay installation of any additional GBTs until the solids loadings show a definite increase.

## 8.4 Mesophilic Anaerobic Digestion

The existing mesophilic anaerobic digestion system provides solids stabilization and reduction. The City considered a few alternatives to this existing process to reduce life cycle costs as described below. Refer to Table 8-3 for a summary of capital costs associated with the proposed digestion improvements.

### 8.4.1 Existing Digestion Capacity

The WRP currently relies on Digester Nos. 5 and 6 for most operations while occasionally using Digester No. 1 during outages and when cleaning of the other two digesters. With a primary sludge GT in place, capacity of the existing system does not extend through the entire planning period during maximum month conditions with Digester Nos. 1, 5, or 6 out of service. The conversion of Digester No. 2 to a thickened digested solids storage tank with secondary digester capabilities mitigates the capacity shortfall.

### 8.4.2 Digestion Alternatives

This evaluation looked at business case evaluations for three digestion alternatives to maximize capacity including thermophilic anaerobic digestion, thermophilic anaerobic digestion with primary sludge GT and mesophilic anaerobic digestion (Status Quo) with primary sludge GT.

Despite the additional volatile solids reduction (VSR) achieved in the thermophilic process the existing mesophilic anaerobic digestion with primary sludge GT resulted in the lowest NPV and lowest natural gas consumption.

This evaluation recommended continuing with the mesophilic anaerobic digestion technology and augmenting its capacity with primary sludge gravity thickening.

## 8.5 Thickened Digested Solids Storage and Pumping

The most immediate solids processing capacity constraint at the WRP is the capability to land apply thickened digested solids during the brief opportunities in the spring and fall when conditions allow. Several evaluations looked at decreasing the volume of thickened digested solids and storage alternatives.

### 8.5.1 Hauling Reduction

The existing land application method was compared to thermal and chemical hydrolysis (Lystek), low alkaline hydrolysis, dewatering to a cake solid, and drying the product to a Class A exceptional product. Because the alternate processes have significant chemical and energy costs, the current land application method had the lowest net present value. , It is recommended to stay with the existing application until volume hauled exceeds the capability of the WRP’s land application program.

### 8.5.2 Thickened Digested Solid Storage

Based on projected solids production rates, additional thickened digested solids storage capacity will be required within the planning period. Consideration was given to building new storage tanks, leasing temporary dewatering equipment and converting Digester No. 2 to storage. Conversion of Digester No. 2 to storage was selected as the recommended alternative with the lowest net present value. The storage and hauling costs for this analysis was based on 6.5 percent TS leaving the GBTs. The WRP can achieve 7.0 percent solids most of the time but at 7.5 percent solids they cannot sufficiently remove biosolids from the tanks. Efforts continue at the facility to find cost effective methods to reducing hauled solids and increasing solids concentration in storage tanks.

### 8.5.3 Digested Solids Pumping

Digested solids are currently pumped twice before thickening. This double pumping scenario has high energy costs with the increased number of pumps and high maintenance costs due to struvite buildup. Building a new transfer station or refurbishing the existing Digester No.1 with new pumps was compared against keeping the existing double pumping system. Refurbishing the 0.73 MG Digester No. 1 for digested solids storage and new transfer pumps to convey solids to the GBTs for thickening was the selected alternative to reduce pumping and increase digested solids holding capacity upstream of thickening.

## 8.6 Digester Control Building No. 1 Improvements

To keep the upper level of Digester Control Building No. 1 unclassified per National Fire Protection Association (NFPA) 820 standard physical separation is required from the lower level which contains sludge pumps and digester gas equipment. Some, electrical, HVAC and architectural modifications are required to maintain physical separation of these classified and unclassified spaces.

## 8.7 Waste Gas Burner

The existing WGB is no longer in serviceable condition and there are future capacity concerns. The new WGB will automatically light the natural gas pilot flame when the biogas system pressure rises above the relief setpoint. Because of the high safety concern and the current limited operating status of this gas burner, this cost is not included with the solids treatment improvements and is instead moved to a fast track project under construction in 2020.

## 8.8 Summary of Opinion of Probable Costs

Table 8-3 provides a summary of the preliminary estimate of construction costs associated with the projects recommended in this section and the objectives to be achieved by these improvements.

**Table 8-3. Solids Handling Improvements Opinion of Probable Costs[a]**

| Item | Cost | Objective |
|---|---|---|
| GT system including:<br>- Digester No. 3 conversion to thickener<br>- Digester No. 4 conversion to PS storage<br>- PS pump upgrades<br>- TPS pump system<br>- Elutriation water pumps system | $5,080,000 | Increase digestion HRT to 15 days when Digester No. 5 or 6 are out of service |
| Digester Control Building No. 1 NFPA 820 modifications and HVAC/electrical renovations | $830,000 | Improve tunnel safety and refurbish corroded equipment |
| Digester No. 1 conversion for wet well/digestion | $1,210,000 | Simplify operations by reducing double-pumping and provide storage during GBT outages |
| Digester No. 2 conversion for storage | $1,340,000 | Increase thickened digested sludge storage |
| Thickening odor control and filtrate drain piping[c] improvements | $1,620,000 | Replace equipment at end of useful life and remove bottleneck in GBT capacity |
| Secondary digested solids loadout | $330,000 | Provide increased loadout flexibility and capacity |
| WGB replacement[b] | $680,000 | Improve digester gas management system safety |
| Total | $11,100,000 | |

a. *Cost presented in 2020 dollars.*

b. *2020 project*

# Section 9
# Biogas Utilization

The WRP utilizes anaerobic digestion for stabilizing the solids generated during the wastewater treatment process. The stabilization, or destruction, of solids generates biogas primarily composed of methane (CH4) and carbon dioxide (CO2). The WRP utilizes this biogas to fuel either engine driven electrical generators or hot water boilers. This section summarizes the evaluation of biogas uses captured in Appendix 8.

## 9.1 Background

From January 1, 2014 to December 31, 2017 the WRP biogas production averaged 272 SCFM, or just under 400,000 standard cubic feet per day (SCFD). Growth in production may occur during the planning period from HSW or load increases but the switch from HPOAS to A/O in the mainstream liquid process will likely reduce production. For this evaluation the historical average value served as the basis.

Lab analysis from two historical gas samples taken after the moisture removal indicated the WRP biogas has relatively low contaminant levels of H2S and siloxanes.

## 9.2 Biogas Alternatives Analysis

Biogas utilization alternatives that were considered include the following:

- Engine-Generators. There are two existing 1-MW Waukesha engine generators, with one is generally operated at a time due to current gas production. The engine generator alternative's economics were based on replacement of these units at the end of their useful life, which is projected to occur by approximately 2027. New 1 MW engine generators would have an efficiency of approximately 39% compared to the approximately 29% efficiency of the existing units.
- Microturbines. The engine-generators could be replaced with microturbines, which are small combustion turbines that cogenerate heat and electricity. They are compact, modular, have lower emissions than diesel engines and require less ancillary equipment. Their output ranges from 65 kW to 330 kW per unit. They have a relatively small footprint and would be expected to fit in the existing engine building along with associated heat recovery equipment.
- Direct Pipeline Injection. There is an existing 4-inch 55 psi natural gas pipeline within 37th St. NW right of way and owned by Minnesota Energy Resources (MERC) that could provide a direct biogas injection point. This would require an approximately 50 ft x 80 ft footprint for skid mounted injection monitoring equipment that would be owned and operated by MERC. Pipeline injection would also require enhanced biogas conditioning for the removal of CO2.
- On-site Vehicle Fueling. Biogas can also be repurposed as on-site fuel source. This would require additional equipment for compression, storage and dispensing of CNG. Compressors are required to boost the pressure to approximately 4,500 psi. The footprint for a fast-fill on-site vehicle fueling station would be approximately 50 ft x 110 ft. Similar to the direct pipeline injection alternative, a vehicle fueling station would require enhanced biogas conditioning.

### 9.2.1 Emissions and Air Permitting Considerations

Olmsted County is currently considered to be in “maintenance” status from an air quality standpoint, so it is treated as being in attainment. The attainment status means that a new engine generator is unlikely to be required by the MPCA to meet Best Available Control Technology (BACT) standards, reducing the likelihood that an oxidation catalyst or selective catalytic reduction (SCR) system would be required.

## 9.3 Alternatives Comparison and Evaluation

This section presents a capital cost estimate, O&M costs, and NPV analysis for the biogas utilization alternatives.

### 9.3.1 NPV Analysis

The NPV results are based upon several assumptions and variables outlined in this section and Appendix 8. Table 9-1 shows the NPV results and summarizes the O&M costs on an annual basis for each alternative. Note that positive values reflect costs, while negative values reflect savings.

**Table 9-1. Biogas Utilization Alternatives 20-year NPV Results ($, millions)**

| Cost Component | Status Quo Engines[a] (2 at 1 MW) | Status Quo Engines[a] (1 at 1 MW) | Microturbines with Gas Conditioning (5 at 200 kW) | Pipeline Injection D3[c] RIN No HSW | Pipeline Injection D5[c] RIN With HSW | On-site Vehicle Fueling D3 RIN No HSW | On-site Vehicle Fueling D5 RIN With HSW |
|---|---|---|---|---|---|---|---|
| 20-year NPV | $1.3 | ($2.2) | $5.5 | ($4.1) | $15.8 | ($15.9) | $2.7 |

a. *Costs are presented in 2020 dollars.*

b. *Future mechanical component replacements at 15 years.*

c. *Assumed D3 RIN $1.60 and D5 RIN $0.45*

In comparing alternatives, the most favorable calculated NPV is where all biogas is used for on-site RNG fueling. Sending all biogas to produce a renewable vehicle fuel offers an economic benefit because the D3 RIN value and commodity value of fuel are both recoverable. However, there are hurdles in implementing this alternative, including the need to identify a fleet fueling partner. The pipeline injection alternative has smaller implementation barriers and net 20-year anticipated savings over $4 million, assuming D3 RIN revenue at $1.60 and no high strength waste addition that would disqualify the WRP from cellulosic RINs under current EPA policy. If RIN values trend lower, vehicle fueling and pipeline injection revenue will decrease proportionately. As of completing this report, D5 RIN values have remained fairly constant but D3 RIN values have dropped to around $1.00, which effects NPV’s significantly for D3 alternatives. The local pipeline operator, MERC, has indicated an unwillingness to pursue pipeline injection at the WRP at this time, but this technology is growing rapidly and as industry standards for injection become more common MERC’s interest should increase. Of the cogeneration alternatives, engines appear to have a favorable NPV in comparison to microturbines due to the higher electrical and thermal efficiencies of the technology.

### 9.3.2 Recommendation

Replacing one existing engine generator with a single new engine generator and new gas cleaning system is the recommended alternative for biogas utilization with a 20 year NPV of $2.2 million in savings. The remaining Waukesha engine generator would be maintained for stand-by service.

Although vehicle fuel alternatives had higher projected savings in the NPV analysis, the volatile market of D3 and D5 RIN credits, uncertainty of natural gas prices, and hurdles of working with local utilities to transport compressed methane gas make the on-site fueling and pipeline injection alternatives less favorable than the engine generator approach.

# Section 10
# Reuse and Energy Recovery

This section provides an abridged discussion of the resource and energy recovery systems conducted in Appendix 11 – Heat Recovery Loop Alternative Evaluations

## 10.1 Existing Systems

The WRP currently operates four heat recover loops serving different areas of the plant:

- Low Temperature (LT) Loop – High-purity oxygen (HPO) system, air compressors, digester gas cooling
- Medium Temperature (MT) Loop – Oxygen Compressor Intercooler
- ABC Low Temperature Loop– Aeration Basin Complex (ABC) and headworks
- Primary Clarifier (PC) 3 – Heat recovery and heat pump for make-up air heating

In the winter, these systems recover heat from wastewater and process equipment and use the heat in air handling unit preheating coils, reducing the energy required for boiler operation. In the summer, the equipment heat is rejected to the wastewater via heat exchange with water from the final clarifiers.

In tandem with the thermal reuse systems, the WRP operates three major effluent reuse systems:

- Spray Water – Headworks and chemical feed water uses (this flow is also the thermal source for ABC low temperature loop and PC3 heat exchangers listed above)
- GBT Washwater – Belt washing
- Flush Water – Basin flushing prior to personnel entering for headworks and ABC plant

The following sections describe these systems and their current maintenance concerns.

### 10.1.1 Heat Recovery: Low and Medium Temperature Loop

The LT loop uses wastewater withdrawn from FC1 and FC2 to reject excess process equipment heat that is not recovered for space heating. Heat recovery in the LT HVAC systems is currently limited by HVAC equipment and control system components that are not functioning as intended. The MT loop is used for heat recovery of the MAC intercooler system on the cryogenic air plant and then transfers heat to the LT loop. The anticipated shift from HPO to anaerobic/oxic (A/O) operations will remove the oxygen turbo expander, aftercooler, and compressor intercooler from this system and thus eliminate the need for the MT loop. . New blowers with oil cooling will be installed with the A/O conversion, and the oil-cooling system for these blowers can be connected to the LT loop. During winter months, the low temperature loop distributes roughly 1,300,000 btu/hr from equipment and distributes that to hvac preheat coils. During summer months, the low temperature loop dumps the collected heat from equipment into the wastewater through heat exchangers.

### 10.1.2 Water Reuse: Spray Water System

The spray water pumping system currently serves:

- Heat exchangers serving the ABC low temperature water loop

- Spray water usage, primarily in the headworks area
- PC3's make-up air heating

Water is withdrawn from FC3 and FC4. To improve water quality, chlorine solution can be added to the system and a motorized strainer is located downstream of the pumping system. Continuous use of the spray water system demands approximately 150 gpm while peak demand requires 660 gpm, most of which is for the primary clarifier 3 heating system later discussed. Non-potable water can supplement the spray water system if needed for peak flow conditions.

### 10.1.3 Heat Recovery: ABC Low Temperature Loop

ABC low temperature loop serves the newer ABC and headworks portions of the plant. The ABC low temperature water loop temperature is 5°F to 10°F lower than the effluent and thus recovers more heat from the effluent under winter conditions than the low temperature loop. The effluent water in this system is also used as a heat source for the heat pump serving PC3. During winter months, the ABC low temperature loop distributes 40,000 btu/hr from aeration blower equipment and 1,600,000 btu/hr from wastewater and distributes that to HVAC preheat coils. During summer months, the ABC low temperature loop dumps 40,000 btu/hr from equipment heat into the wastewater through heat exchangers.

### 10.1.4 Heat Recovery: Primary Clarifier 3 Heating

The PC3 heating system was added in 2011 to minimize fogging and improve personnel safety under the ABC primary clarifier dome. The PC3 system uses effluent water (wasted from the spray water system) in two modes:

- Closed loop preheating of the make-up air
- Effluent-source heat pump (Spray water)

The preheat system provides roughly a third of the winter heating at current loop temperatures with the remainder being provided by the heat pump. Heat recovered from the spray water system is approximately 600,000 Btu/hr during winter months and approximately 400,000 Btu/hr during the fall and spring months.

### 10.1.5 Water Reuse: Gravity Belt Thickener Washwater

Gravity belt thickener (GBT) washwater is withdrawn from Chlorine Basin 1 via a 20-inch pipe connection to the 1950's wet well. This piping reduces down to 3" before it passes through automatic strainers to the pumping system. Three pumps (replaced in 2004 up-grade) serve 3-inch and 4-inch parallel headers to the three GBT units. The manufacturer requires a minimum of 120 psi washwater at the GBT units at a flow rate of approximately 50 gpm per unit.

### 10.1.6 Flushing Water

Flushing water system draws wastewater from the same piping as the spray water system and is designed to flush out basins prior to personnel entering. The system works great however, the flushing water system starves the spray water pumping system of flow which has caused premature failure of pumps several times over just 13 years.

## 10.2 Recommendations

The recommended modified heat recovery loop configuration is shown in Figure 10-1. The addition of a final clarifier effluent vault water intake was chosen as a water source for both the heat recovery system and reuse water systems. The addition of the vault removes wastewater intakes from the clarifiers which testing has shown will increase clarifier performance. In addition, the quality of treated wastewater will be higher and provide for better use as a spray water and flushing water throughout the plant as well as reduce maintenance caused by fouling on the wastewater heat exchangers. Figure 10-1 also shows the elimination of the medium temperature loop and combining of the low temperature loops to reduce pumping energy costs and maintenance costs.

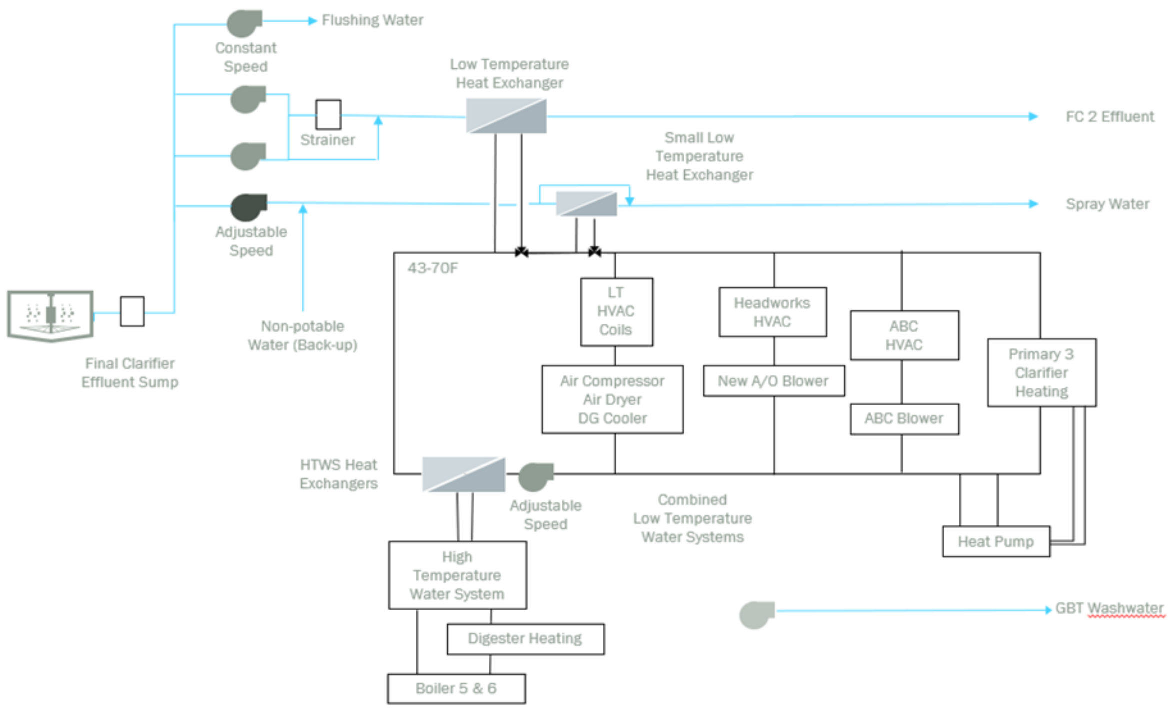



**Figure 10-1. Proposed heat recover and water reuse system**

*Note: Following conversion to A/O*

## 10.3 Summary of Opinion of Probable Costs

Current heat recovery and water reuse system operating costs were estimated to be roughly $125,000 per year. The modified effluent water intake, merged water loops, and spray water modifications are estimated to save approximately $35,000 per year in pumping energy and $20,000 per year in reduced pump and heat exchanger maintenance, reducing the estimated future annual operating cost to $70,000.

Table 10-1 summarizes the recommended capital improvements.

**Table 10-1. Immediate Capital Improvements Opinion of Probable Costs[a]**

| Item | Cost [a, b] | Objective |
|---|---|---|
| Effluent water intake vault and suction piping near final clarifiers | $138,000 | Reduce maintenance and pumping energy |
| Merged LT water loops | $50,000[c] | Reduce pump maintenance |
| Reuse spray water pumping and piping revisions | $115,000[e] | Reduce pumping energy |
| PC3 HVAC heat source revisions | $180,000 | Reduce pumping energy |
| Strainer upgrades | $100,000 | Minimize maintenance of equipment served by spray water and GBT washwater systems |
| Demolish MT cooling loop | --[d] | Loop no longer required following conversion of secondary treatment to A/O |
| Total | $590,000 | |

a. *Refer to Appendix 11 for accuracy, contingency, mark ups, and engineering and administration assumptions*

b. *AACEI Class 5 estimate*

c. *Rough estimate without developed scope of improvements*

d. *Cost included in liquid treatment estimate*

e. *Spray water pump replacement and connection to new effluent water intake vault*

# Section 11

# Recommendations and Implementation Plan

The Rochester WRP Facilities planning process was initiated to create a long-range plan to meet current and anticipated regulatory requirements with an upgraded facility that would achieve these objectives:

- Lower Energy – Reduce energy consumption while maximizing energy recovery towards a long-term goal of net-zero operation.
- Clean Design – Reduce plant complexity through elimination of parallel processes and consolidation of assets.
- Decreased Maintenance – Strive for operational simplicity and elimination of high maintenance aging infrastructure
- Innovative Processes - Implementation of best available and yet proven technologies.
- Long-Term Wholistic Approach - Provide a staging plan to achieve near term treatment goals with processes and configurations to accommodate future improvements to meet increasingly stringent regulatory requirements.

The City considered the recommended improvements from the previous sections and in collaboration with BC came up with a three-phased implementation plan based upon facility needs.

## 11.1 Phase 1 Improvements

Phase 1 improvements shown in Figure ES-1 are programmed to occur between 2020 and 2023 and will address immediate needs at the WRP including the following:

- Disinfection

  Disinfection improvements will include replacement of the chlorine injection equipment and replacement of the dechlorination feed system to reduce energy consumption, reduce chemical consumption and replace aging equipment. The chlorine contact basins will also be reconfigured to minimize short-circuiting and to increase chlorine contact time

- Outfall Improvements

  Reconfiguration of the chlorine contact basins will include installation of a Parshall flume to provide plant effluent metering and installation of a cascade aeration system to improve effluent dissolved oxygen going to the river.

- Waste Gas Burner Replacement

  The existing waste gas burner will be replaced with an upgraded unit installed on the north side of the WRP, improving safety and reliability.

- Space Modifications

  While evaluated as a separate project outside the scope of his document, Phase 1 also includes a significant remodel to the WRP administration building and a new garage building for equipment storage.

## 11.2 Phase 2 Improvements

Phase 2 improvements shown in Figure ES-2 are programmed to occur between 2023 and 2027 and will focus on upgrades to the liquid treatment processes, including conversion of the HPOAS system to an air activated sludge system. These improvements will include the following:

- Primary Effluent Distribution

  A new flow-distribution structure will combine effluent flow from Primary Clarifiers 1 through 3 and then distribute the flow to the secondary treatment bioreactors improving process control and maximizing primary clarifier capacity.

- Biological Phosphorus Removal

  The existing HPOAS system will be decommissioned and converted to a nitrifying enhanced biological phosphorus removal system. The new single stage activated sludge system will include a new process aeration blower facility. These upgrades will allow the decommissioning of the aging cryogenic facility reducing maintenance costs and reducing energy consumption.

- Sludge Pumping Improvements

  Sludge withdrawn from Final Clarifiers 1-5 will be pumped into a common RAS pipeline and routed to a new return sludge flow structure and will then be distributed to the secondary treatment bioreactors.

  A new flow control structure will be constructed to route excess ABC mixed liquor flow to Final Clarifiers 1-4.

  The existing RAS pumps servicing Final Clarifiers 1 through 4 will also be replaced with higher capacity units.

- Additional Aeration Capacity

  The ABC plant will be expanded through the construction of three additional aeration basins to meet future demands.

- Effluent Heat Recovery

  Effluent heat recovery will be improved through the addition of a final clarifier effluent vault water intake as a source for the heat recovery system and the reuse water system. The medium temperature loop will be eliminated and the low temperature loops will be combined, reducing energy costs, reducing maintenance costs and providing a higher quality water,

## 11.3 Phase 3 Improvements

Phase 3 improvements shown in Figure ES-3 are programmed to occur between 2027 and 2030 and will focus on the solids handling facilities. Deferring these improvements until after implementation of the A/O process will allow confirmation of solids loading and solids handling characteristics based on full plant implementation of the new secondary treatment processes.

Following is a summary of the recommended Phase 3 improvements:

- Gravity sludge thickening

  Digester No. 3 will be renovated and converted to a primary sludge gravity thickener and Digester No. 4 will be upgraded as a primary sludge storage tank providing storage capacity during gravity thickener outages. This will avoid the need to provide additional digester capacity

- Digested solids wet well

  Digester No. 1 will be converted to a digested sludge storage tank and will be used as a wet well prior to thickening the sludge on the gravity belt thickeners, improving overall operational flexibility.

- Thickened digested solids storage

  Digester No. 2 will be refurbished as recuperative digester and sludge storage tank.

- Odor control

  The odor control system for the new solids handling facilities will be upgraded, replacing antiquated equipment and providing increased capacity.

- Sludge loadout

  The sludge loadout facility will be upgraded with increased capacity to relieve truck loading congestion and improve the efficiency of the land application program.

- Control building upgrades

  Digester Control Building No. 1 will be upgraded to bring it into compliance with NFPA 820 requirements.

# Phase 4 Improvements

Phase 4 improvements shown in Figure ES-4 focus on upgrades to the liquid treatment processes required to address future effluent limits based on the treatment levels identified in Table ES-1. Each level represents increasingly stringent effluent limits with corresponding upgrades necessary to achieve those limits.

- Level 2X

  Level 2X improvements are based on monthly ammonia limits less than 2 mg/L, an annual nitrate + nitrite nitrogen limit of 10 mg N/L and a monthly total phosphorus limit of 0.4 mg/L. Under this scenario an upgrade to a 3-stage BNR process would be required and the addition of effluent filters at a rated capacity of 15 mgd.

- Level 2

  Level 2 improvements are based on monthly ammonia limits less than 2 mg/L, an annual total nitrogen limit of 10 mg N/L and a monthly total phosphorus limit of 0.4 mg/L. The selected treatment alternative for these effluent limits consists of migration to a 5-stage BNR process and effluent filters at a rated capacity of 15 mgd.

- Level 3

  Level 3 improvements are based on monthly ammonia limits less than 2 mg/L, an annual total nitrogen limit of 4 mg N/L and a monthly total phosphorus limit of 0.1 mg/L. Level 3 regulatory requirements would require 5-stage BNR with carbon addition and effluent filter capacity of 30 mgd.

## 11.4 Summary and Opinion of Probable Costs

Table 11-1 summarizes the project costs for each phase. The phase 4 cost is based on the cumulative cost of treatment levels 2, 2X and 3.

| Table11-1. Rochester WRP Phased Improvements Opinion of Probable Costs[a] | | |
|---|---|---|
| Item | Cost | Implementation Schedule |
| Phase 1 | $10,000,000 | 2020 – 2023 |
| Phase 2 | $52,000,000 | 2023 – 2027 |
| Phase 3 | $11,000,000 | 2027 – 2030 |
| Phase 4 | $75,000,000 | Based on future effluent limits |
| Total | $148,000,000 | |

# Section 12

# Clean Water Revolving Fund Checklists and Forms

At that point in time when specific projects are identified for implementation, several steps will be required for participation in the Clean Water Revolving Fund (CWRF) Program as administered by the MN Pollution Control Agency. These steps are outlined in the following MN PCA Checklists and Forms as summarized below:

1. CRWF Facilities Plan Submittal Checklist

   This checklist provides a summary list of steps to be taken and documentation required for facilities plan submittals.

2. CWRF Cost and Effectiveness Checklist

   This checklist provides a summary of the cost and effectiveness analysis as documented in the facilities plan.

3. CWRF B3 SB 2030 Exemption Form.

   This form documents exemption from the Building, Benchmarks and Beyond (B3) provisions of the Sustainable Building (SB) 2030 guidelines as applicable.

4. CWRF Cost and Effectiveness Certification Form

   This form documents compliance with the cost and effectiveness review requirements of the project.

5. Minnesota Clean Water Revolving Fund Cost and Effectiveness Guidance

   This document provides guidance for completing the cost and effectiveness checklist.

6. Environmental Information Worksheet (EIS) Form

   This form summarizes the environmental review process that must be completed in conjunction with submittal of the Facilities Plan to the MN Pollution Control Agency.

These checklists and forms are included as attachments at the end of this section

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# CWRF facilities plan submittal checklist

**Clean Water Revolving Fund (CWRF) Program**

Submissions Required for a Complete Facilities Plan

Minn. R. 7077.0272

**Instructions:** The Facilities Plan may be submitted via email at ppl.submittals.pca@state.mn.us (and one hard copy submitted to the assigned Minnesota Pollution Control Agency [MPCA] Review Engineer).

## Facility information

Project name: ______________________________

Proposed dates for construction: ______________________________

City's authorized representative: ______________________________

Title: ______________________________ Telephone: ______________

Mailing address: ______________________________

City: ____________________ State: __________ Zip code: __________

Technical agent or consulting engineer: ______________________________

Name of firm/organization: ______________________________ Telephone: ______________

## Check yes or no for the following questions

Is the Facilities Plan signed by an engineer registered in the State of Minnesota? ☐ Yes ☐ No

Has the municipality in which the facility will be located held at least one public hearing to discuss the proposed project?

☐ Yes ☐ No If yes, what was the date the hearing was held: ______________

## Check the boxes below if you have included the following items

If all of the following items are not included with the Facilities Plan, the Facilities Plan is incomplete and may be returned or filed until a complete submittal is received. Facilities Plan review will not begin until a complete submittal is received. Please see Minn. R. 7077.0272 for more information about the content of facilities plan.

**The following forms can be found on the MPCA website at https://www.pca.state.mn.us/water/wastewater-financial-assistance.**

- ☐ A completed *CWRF cost and effectiveness certification checklist* **provided by the MPCA**.
- ☐ A completed *CWRF B3 2030 exemption form* **provided by the MPCA**.
- ☐ A completed CWRF cost and effectiveness certification form **provided by the MPCA**.
- ☐ A summary of the public hearing documenting that the following items were discussed:
  - ☐ The various treatment alternatives considered
  - ☐ The location of the project site
  - ☐ The reasons for choosing the selected treatment method
  - ☐ The estimated sewer service charges
- ☐ A summary of the comments received at the public hearing and the action taken to address those comments.
- ☐ A complete list of addresses used for public notice purposes on a form **provided by the MPCA.**
- ☐ A copy of the resolution of the municipality's governing body adopting the facilities plan.
- ☐ A list of ordinances or intermunicipal agreements required for the implementation and administration of the project.
- ☐ A signed treatment agreement with each significant industrial user.
- ☐ For surface water dischargers only, a copy of the Preliminary Effluent Limits review letter **provided by the MPCA.**
  - Contact the MPCA to determine if a formal request for Preliminary Effluent Limits needs to be made for the project.
  - The alternatives analysis should address antidegradation requirements if the project is proposing an increase in flow or loading.
- ☐ A completed *Environmental Information Worksheet* **provided by the MPCA.**
- ☐ For individual sewage treatment systems that serve more than one structure, an assurance from the municipality stating that all property owners who will be served by the proposed system agree to be part of the system, to participate in the construction project, and to finance future operation, maintenance, and replacement of the system.
- ☐ Copies of all notifications, certifications, and comments received.

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# CWRF cost and effectiveness checklist

**Clean Water Revolving Fund (CWRF) Program**

**Instructions:** This checklist must be used with the Minnesota Pollution Control Agency (MPCA) *Minnesota Clean Water Revolving Fund (CWRF) cost and effectiveness guidance* document dated March 2018. The guidance document assists the consulting engineer in completing the cost and effectiveness analysis required by the Federal Water Pollution Control Act (FWPCA) Section 602(b)(13). The cost and effectiveness analysis for a project must be further documented in the project Facilities Plan. This checklist is also an attachment to the MPCA *Facilities Plan submittal checklist.*

## Project information

Project name: ______________________________ Date submitted (mm/dd/yyyy): ______________

City: ____________________________________________

City's authorized representative: ______________________________

Consulting engineer: ______________________________

## Cost analysis items

Cost analysis items to be completed for all CWRF wastewater projects.

| Section | | Yes | No |
|---|---|---|---|
| II. | Does the project owner have an Asset Management system in place?<br>Where is the Asset Management system documented in the Facilities Plan: | ☐ | ☐ |
| IVA. | Did the Facilities Plan address Energy Conservation Opportunities?<br>Where is the Energy Conservation discussion documented in the Facilities Plan: | ☐ | ☐ |
| IVB. | Did the Facilities Plan address Renewable Energy Opportunities?<br>Where is the Renewable Energy discussion documented in the Facilities Plan: | ☐ | ☐ |
| IV.C.i. | Has the Facilities Plan analyzed Water Reuse options?<br>Where is the Water Reuse options analysis documented in the Facilities Plan: | ☐ | ☐ |
| IV.C.ii. | Has the Facilities Plan analyzed installation of Water Efficient Devices?<br>Where is the use of Water Efficient Devices analysis documented in the Facilities Plan: | ☐ | ☐ |
| IV.C.iii. | Has the Facilities Plan analyzed installation of new Water Meters or replacement of existing Water Meters?<br>Where is the installation of new or replacement Water Meters analysis documented in the Facilities Plan: | ☐ | ☐ |
| IV.C.iv. | Has the Facilities Plan considered or completed Water Audits and/or Conservation Plan?<br>Where is the discussion of Water Audits and/or Conservation Plan documented in the Facilities Plan: | ☐ | ☐ |
| IV.D. | Did the Facilities Plan for the project complete a Buildings, Benchmark, and Beyond (B3) Sustainable Building (SB) Wastewater Treatment Plant (WWTP) or B3 SB 2030 *WWTP exemption form*?<br>Where is the B3 SB 2030 *WWTP exemption form* documented in the Facilities Plan: | ☐ | ☐ |

## Nonmonetary analysis items **Applicable**: Yes ☐ No ☐

Nonmonetary analysis items to be completed for all new wastewater treatment facilities with design average wet weather (AWW) flow of greater than 100,000 gallons per day, or significant upgrades meaning work on three or more major treatment units for any wastewater treatment facilities with a design AWW flow of greater than 1 million gallons per day.

| Section | | Yes | No |
|---|---|---|---|
| V.A.i. | Does the Facilities Plan analyze the project sustainability and climate resilience?<br>Where is the discussion on project sustainability and climate resilience documented in the Facilities Plan: | ☐ | ☐ |
| V.A.ii. | Does the Facilities Plan analyze how a project addresses Water Quality objectives?<br>Where is the discussion on how the project addresses Water Quality objectives documented in the Facilities Plan: | ☐ | ☐ |
| V.A.iii. | During the project planning process, did the owner consider project alternatives, such as consolidation or regionalization with another or other service area?<br>Where is the discussion on how the project addresses possible consolidation or regionalization documented in the Facilities Plan: | ☐ | ☐ |
| V.B.i. | Is the project location and physical aspects discussed in the Facilities Plan?<br>Where is the discussion on the project location and physical aspects located in the Facilities Plan: | ☐ | ☐ |
| V.B.ii. | Is the project reliability discussed in the Facilities Plan?<br>Where is the discussion on the project reliability located in the Facilities Plan: | ☐ | ☐ |
| V.B.iii. | Is the project feasibility and operability discussed in the Facilities Plan?<br>Where is the discussion on the project feasibility and operability located in the Facilities Plan: | ☐ | ☐ |
| V.C.i. | Are possible water conservation practices, water reuse and/or water recapture opportunities discussed in the Facilities Plan?<br>Where is the discussion on the project water conservation practices, water reuse, and/or water recapture opportunities located in the Facilities Plan: | ☐ | ☐ |
| V.C.ii. | Are possible energy conservation practices discussed in the Facilities Plan?<br>Where are the possible energy conservation practices discussed in the Facilities Plan: | ☐ | ☐ |
| V.C.iii. | Are possible opportunities to recover and recycle or reuse other resources discussed in the Facilities Plan?<br>Where are possible opportunities to recover and recycle or reuse other resources options discussed in the Facilities Plan: | ☐ | ☐ |
| V.C.iv. | Are possible opportunities to use green infrastructure components within the project discussed in the Facilities Plan?<br>Where are possible opportunities to use green infrastructure components within the project discussed in the Facilities Plan: | ☐ | ☐ |
| V.C.v. | Are possible other environmental impacts of the project discussed in the Facilities Plan?<br>Where are the possible other environmental impacts of the project discussed in the Facilities Plan: | ☐ | ☐ |

| Section | | Yes | No |
|---|---|---|---|
| | | | |
| V.D.i. | Are possible considerations which may be part of a local trend or demographics affecting the need or demand for a project discussed in the Facilities Plan?<br>Where are the possible considerations which may be part of a local trend or demographics affecting the need or demand for a project discussed in the Facilities Plan: | ☐ | ☐ |
| V.D.ii. | Are possible considerations which may be part of a local trend or demographics affecting the need or demand for a project discussed in the Facilities Plan?<br>Where are the possible considerations which may be part of a local trend or demographics affecting the need or demand for a project discussed in the Facilities Plan: | ☐ | ☐ |
| V.D.iii. | Are there possible environmental justice issues which may be considered for the project discussed in the Facilities Plan?<br>Where are the possible environmental justice issues which may be considered for the project discussed in the Facilities Plan: | ☐ | ☐ |
| V.D.iv. | Are there possible acceptability or affordability issues which may be considered for the project discussed in the Facilities Plan?<br>Where are the possible acceptability or affordability issues which may be considered for the project discussed in the Facilities Plan: | ☐ | ☐ |

## Integrating cost and effectiveness analysis **Applicable: Yes ☐ No ☐**

Integrating cost and effectiveness analysis to be completed for all new wastewater treatment facilities with design AWW flow of greater than 100,000 gallons per day, or significant upgrades meaning work on three or more major treatment units for any wastewater treatment facilities with a design AWW flow of greater than 1 million gallons per day.

| Section | | Yes | No |
|---|---|---|---|
| VI. | Has an integrated cost and effectiveness analysis of the cost factors and the other/nonmonetary factors for a project been completed in the Facilities Plan?<br>Where is the integrated cost and effectiveness analysis of the cost factors and the other/nonmonetary factors for a project discussed/located in the Facilities Plan? | ☐ | ☐ |

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# CWRF B3 SB 2030 exemption form

**Clean Water Revolving Fund (CWRF) Program**
**Wastewater Projects**
(Minn. Stat. § 216B.241, sub. 1-10 and 16B, sub. 1-4)

**Instructions:** If at least one of the "**Yes**" statements is checked, the project is considered to have completed these requirements and is not required to submit additional information to meet the Building, Benchmarks, and Beyond (B3) provisions of the Sustainable Building (SB) 2030 Guidelines (B3 SB 2030). Sign and send the completed form to the Minnesota Pollution Control Agency (MPCA) project engineer.

If the answer to **all of the statements is** "**No**", the project will submit a preliminarily approved Facilities Plan [Minn. R. 7077.0272] to B3 SB 2030 Wastewater Treatment Plant Review. Sign and send the completed form to the MPCA project engineer.

## Project information

Project name: ______________________________

MPCA review engineer: ______________________ MPCA project number: ______________

## Exempt criteria

| | Yes | No |
|---|---|---|
| 1. The project is limited to environmental study. | ☐ | ☐ |
| 2. The project is limited to planning and design. | ☐ | ☐ |
| 3. The project is for emergency/disaster relief and/or protection. | ☐ | ☐ |
| 4. The project is limited to minor modifications to an existing treatment facility. | ☐ | ☐ |
| 5. The project is limited to modifications within a new or an existing building less than 10,000 square feet. | ☐ | ☐ |
| 6. The project is limited to a new or existing collection system including lift stations. | ☐ | ☐ |
| 7. The project is limited to pond system. | ☐ | ☐ |
| 8. The project is limited to installation of a backup power generator. | ☐ | ☐ |
| 9. The project is limited to a stormwater project | ☐ | ☐ |

**If "Yes" to any of 1- 9 above, please provide a brief written description of the project and complete the Certification Statement below.**

## Certification statement

I certify that the information provided on this form is complete and accurate and that this project:

☐ Meets the exempt criteria established by the Minnesota Pollution Control Agency.

☐ Does not meet the exempt criteria and a preliminary approved Facilities Plan will be sent to the B3 SB 2030 Wastewater Treatment Plant Review

### Project Representative or Professional Engineer

Print name: ______________________

Organization: ______________________

Signature: ______________________

Date (mm/dd/yyyy): ______________________

MINNESOTA POLLUTION CONTROL AGENCY
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# CWRF cost and effectiveness certification form

**Clean Water Revolving Fund (CWRF) Program**

Federal Water Pollution Control Act Section 602(b)(13)
and Minn. R. 7077.0272, subp. 2.D. or 7077.0277, subp. 2.C.

**Instructions:** The project representative must check boxes 1), 2), and either Z) or ZZ) below, and the form must be signed by both the Project Representative and the Professional Engineer for the project.

☐ 1) The municipality has studied and evaluated the cost and effectiveness of the processes, materials, techniques, and technologies for carrying out the proposed project or activity for which the assistance is sought under the Clean Water Revolving Fund (Minn. Stat. § 446.07); and

☐ 2) The municipality has selected, to the maximum extent practicable, a project or activity that maximizes the potential for efficient water use, reuse, recapture, conservation, and energy conservation[Z&ZZ], taking into account:

a) The cost of constructing the project or activity.
b) The cost of operating and maintaining the project or activity over the life of the project or activity.
c) The cost of replacing the project or activity.

☐ Z) If this project exempt from Building, Benchmarks, and Beyond (B3) provisions of the Sustainable Building (SB) 2030 Guidelines (B3 SB 2030) Wastewater Treatment Plants (WWTP) Review (attach a completed *B3 SB 2030 exemption form*).

☐ ZZ) If this project not exempt from B3 SB 2030 WWTP Review.

## Project information

Municipality name: ______________________________

Project number: ______________________________

## Certification

We certify that the project has completed requirements (1 and 2, and either Z or ZZ) as checked above.

**Project Representative**

Print name: ______________________________

Signature: ______________________________

Date (mm/dd/yyyy): ______________________________

**Professional Engineer**

Print name: ______________________________

Signature: ______________________________

Date (mm/dd/yyyy): ______________________________

**Footnote:** If ZZ) is checked, the Professional Engineer has submitted a Facilities Plan to the B3 SB 2030 WWTP Review and will consider the Review water and energy conservation recommendations.

# Minnesota Clean Water Revolving Fund

## Cost and Effectiveness Guidance



# I. Introduction

The Federal Water Pollution Control Act (FWPCA) was amended on June 10, 2014, to include a requirement under Section 602 (b)(13) that any recipient of Clean Water Revolving Fund (CWRF) assistance must complete a **Cost and Effectiveness Analysis** for any project with signed loan agreements after October 1, 2015.

> (13) beginning in fiscal year 2016, the State will require as a condition of providing assistance to a municipality or inter-municipal, interstate, or State Agency that the recipient of such assistance certify, in a manner determined by the Governor of the State, that the recipient –
>
> > (A) has studied and evaluated the cost and effectiveness of the processes, materials, techniques, and technologies for carrying out the proposed project or activity for which assistance is sought under this title; and
> >
> > (B) has selected to the maximum extent practicable, a project or activity that maximizes the potential for efficient water use, reuse, recapture, and conservation and energy conservation, taking into account -
> >
> > (i) the cost of constructing the project or activity;
> > (ii) the cost of operating and maintaining the project or activity over the life of
> > (iii) the life of the project or activity; and
> > (iv) the cost of replacing the project or activity

The U.S. Environmental Protection Agency (EPA) has provided State CWRF program staff with interpretive guidance documents to assist with implementing this requirement. On January 6, 2015, the EPA published a memorandum[i] with additional supplemental information on section 602(b)(13). This document identified the State has discretion to decide how an assistance recipient will certify that it has completed the required cost and effectiveness analysis and that it has selected to the maximum extent practicable, a project or activity that maximizes the potential for water and energy conservation, as appropriate.

To address this section 602(b)(13) requirement, the Minnesota Pollution Control Agency (MPCA) first created a certification form dated January 28, 2015, to state the section language directly[ii]. The current practice with this MPCA certification form has allowed the project recipient's consulting professional engineer to use their best professional judgement when making the statement or signing the certification form. This MPCA guidance document will further assist the consulting professional engineer with completing the cost and effectiveness analysis during the project Facilities Plan process, prior to signing off on the MPCA certification form.

# II. Asset Management related to Facilities Plan discussion

Asset Management is a tool that can help inform the project Facilities Plan process. For a project owner, an Asset Management system can help inform project needs identification by showing the age of the individual system asset and the current condition or status of an asset. Asset Management systems or inventories can assist the project owner in determining which system components and equipment have remaining life that can be retained as a part of a project, which components and equipment need replacement, and may assist the owner with describing possible salvage values of components.

If a project owner has an existing Asset Management document or tool, a copy or summary of it should be located in the Facilities Plan. If the Asset Management tool is an electronic management system, a sample page of the Asset Management electronic system should be attached and referenced in the Facilities Plan and identified as a sample of the owner's Asset Management system.

The Minnesota Public Facilities Authority and the MPCA strongly encourage municipalities to have an Asset Management system. Some costs related to the development of an Asset Management system may be fundable as a part of a CWRF construction loan.

For project owners currently without an Asset Management system, there are resources available to help develop such a system.

The Minnesota Rural Water Association recently published Asset Management information on their website. Two documents are available: (1) Asset Management Introduction and (2) Asset Management for Wastewater (Stabilization Ponds) Systems {in an Excel template}. Links to those two documents are located at: http://mrwa.com/assetmgmt.html.

The EPA has an Asset Management guidance document for Small Water Systems that may be a useful reference for developing a small wastewater facilities Asset Management system. The current webpage location for this document is: http://tinyurl.com/zwhsdbg.

The EPA also has an Asset Management tool available to download called Check Up Program for Small Systems at: https://www.epa.gov/dwcapacity/information-check-program-small-systems-cupss-asset-management-tool.

# III. Cost and Effectiveness Analysis

A cost effectiveness comparison of alternatives has been a requirement of the Minnesota CWRF program for many years, as part of the Facilities Plan for Wastewater Treatment Systems process for a project. The wastewater Facilities Plan must include information on the initial analysis of a project owner's identified needs, and the alternatives explored for meeting the objectives set out by that owner within any given goals and constraints while maximizing the federal, state, and local objectives for potential for water and energy efficiencies. The Facilities Plan must also identify the chosen project alternative selected by the owner and give the supporting reasons for selecting that alternative.

For CWRF wastewater collection and treatment projects, Minnesota Rule (Minn. R.) 7077.0272, subp. 2 describes the required contents of a Facilities Plan and includes subp. 2.D. "an analysis of all feasible treatment alternatives that are capable of meeting the applicable effluent, water quality and public health requirements for 20 years". Minn. R. 7077.0272, subp. 2(1) goes on to require a cost effectiveness comparison of the alternatives considered, and is narratively described as a present worth analysis of all capital costs, annual operation and maintenance costs, equipment replacement costs, and salvage values.

Another way to depict this common engineering analysis calculation was shown in an EPA interpretive guidance memorandum dated April 17, 2015[iii]. This EPA guidance document cited an Oregon state program reference[iv] which shows an equation that will be adopted and modified slightly here using the Minnesota Rule cost effective language:

> The present worth (PW) for each technically feasible alternative is calculated as the sum of the capital cost (C) plus the present worth uniform series of annual operation and maintenance costs (USPW {O & M}) plus equipment replacement costs (ER) minus the single payment present worth of the salvage values (SPPW {S}) or shown as:
>
> PW = C + (USPW {O & M}) + ER – (SPPW {S})

The change required by the FWPCA Section 602 (b)(13) adds the word **"and"** to the analysis, calling it a cost **"and"** effectiveness. What does this mean for Minnesota projects?

In short, it means added detail to the required cost **"and"** effectiveness analysis will need to be included in a project Facilities Plan.

# IV. Cost Analysis

A Cost Analysis is to be completed for all wastewater projects and should include consideration of these items.

## A. Energy conservation opportunities

Energy assessments for the electrical use components of a project should be completed at least preliminarily during the Facilities Plan process. This may be done for separate project types and/or portions of a project. Collection system projects should consider the electrical use at lift stations and pump types given the overall system design. This should be for both lift stations within the collection system as well as the main pumping station transporting the wastewater to the treatment facility.

Treatment facilities should assess energy usage throughout the plant complex. This could include mechanical facilities aeration energy use, mixing energy, solids handling energy use (transfer, mixing, aeration), and possible energy capture and reuse from solids processing.

For any existing electrical equipment that is proposed to be reused in a project or remain in service, energy audits should be considered to identify opportunities for possible energy savings. Similar to the energy assessments, components should be reviewed for their purpose and need, and determinations should be made if more efficient electrical components could be used to improve energy efficiency at the facility.

The state of Minnesota's Buildings, Benchmarks & Beyond (B3) suite of tools has a wastewater treatment energy evaluation process within B3 Sustainable Buildings (SB) 2030 called B3 SB 2030 Wastewater Treatment Plant (WWTP) Review, including WWTP energy performance metrics in B3 Benchmarking.

The B3 Benchmarking tool provides an on line platform to track energy performance and help determine efficiency at existing WWTPs.

Learn more about B3 Benchmarking: https://mn.b3benchmarking.com/

Learn more about B3 Benchmarking & WWTPs: http://mn.b3benchmarking.com/WastewaterTreatmentPlants.

Access the B3 Benchmarking tool: https://mn.b3benchmarking.com/Request-Access.

The B3 SB 2030 WWTP Review is an energy review process and set of minimum energy conservation measures (ECM) that should be considered for WWTP designs. B3 SB 2030 WWTP Review may apply to certain wastewater projects. An MPCA SB 2030 exemption form is available to determine if the B3 SB 2030 WWTP Review applies. For more information, see Section III.D. or to learn more about the B3 SB 2030 WWTP Review go to: http://www.b3mn.org/.

Energy audits conducted by the local gas provider, electric utility, professional engineer, or the Minnesota Technical Assistance Program (MnTAP) may be able to help with efforts to optimize energy use. Other possible resources or references for energy conservation information are available from the Water Environment Federation[v] and on the MNTAP webpage at: http://www.mntap.umn.edu/POTW/energy.html.

## B. Renewable energy opportunities

The Cost Analysis should also consider renewable energy opportunities such as solar, wind, biogas, combined heat and power, etc. as a means of reducing the energy profile and providing a more reliable energy source in times of power outages. There may be rebate offers by public utilities to help finance the installation of renewable energy systems.

## C. Water conservation opportunities

The Cost Analysis should also consider water conservation opportunities. Using less water within a project area can have an impact on the wastewater facilities in that project area. The Cost and Effectiveness Analysis should consider water conservation opportunities, including:

i. Water reuse options. This option would be most appropriate in facilities planning for wastewater treatment facilities projects, as the treatment facility eventual design would be impacted by the type of treatment required for the possible water reuse opportunities. For example, are there industries, recreational locations (golf courses, parks, fields etc.), agricultural producers, or landscaping locations in the project area or near the project service area that may be interested in partnering on a water reuse project?

   A Water Reuse Analysis section should be in the Facilities Plan clearly so it is very easy to document the option has been considered by the project.

   If water reuse is not analyzed as an alternative, the project Facilities Plan should include a brief statement on the justification for this decision. These would typically be sewer pipe or forcemain replacement projects that do not include work not related to the wastewater treatment process, which typically must be addressed to facilitate water reuse. However, sewer extension projects may be candidates for possible water reuse projects, especially extensions to new industrial park growth areas where water reuse may be a possible industrial plant water source or where landscape watering or irrigation may be considered.

ii. Water efficient devices. This is an option that may reduce overall water use within a project service area, and thereby reduce the wastewater flow volume that must be treated. This water conservation opportunity should be considered for both collection system and wastewater treatment projects as installing water efficient devices in residential homes, commercial businesses or industries can have the potential positive impact of reducing flows in the sewer pipes and reducing flows needed to be treated at the wastewater treatment facility.

iii. Use of or replacement of water meters. Similar to using water efficient devices, addressing water meters in the project service area may reduce overall water use within a project service area simply by raising the user's awareness of the volume and cost, and thereby reduce the wastewater flow that must be treated. This water conservation opportunity should be considered for both collection system and wastewater treatment projects as installing or replacing water meters at residential homes, commercial businesses, or industries can have the potential positive impact of reducing flows in the sewer pipes and reducing flows needed to be treated at the wastewater treatment facility. Costs related to installation or replacement of water meters may be fundable as a part of a CWRF construction loan.

iv. Water audits and conservation plans. Water audits, particularly with large water system users in the distribution system may locate flows of water that become wastewater that may be mitigated or reduced that can have positive impacts on the wastewater collection system and the treatment facilities. Similarly, implementing a water conservation plan (this may tie in with a Water Reuse option, for example) may have a positive impact on the wastewater collection system and the treatment facilities. For ideas to consider with this option, an information resource available in Minnesota is through the University of Minnesota at MNTAP: http://www.mntap.umn.edu/ and the specific water conservation webpage link is at: http://www.mntap.umn.edu/POTW/water.html.

## D. B3 Sustainable Building (SB) 2030 Wastewater Treatment Plant Review

The B3 SB 2030 WWTP Review is an energy review process and set of minimum energy conservation measures (ECM) that should be considered for wastewater treatment plant designs using tools established under Minn. Stat. § 216B.241.

Learn more about B3 SB 2030 WWTP Review: https://www.b3mn.org/

An MPCA SB 2030 exemption form is available to determine if the B3 SB 2030 WWTP Review applies. All nonexempt wastewater treatment plants will need to participate in the SB 2030 WWTP Review.

# V. Other Factors/Nonmonetary Analysis

(To be completed for all new wastewater treatment facilities with design average wet weather {AWW} flow of greater than 100,000 gallons per day and significant upgrades meaning work on three or more major treatment units for any wastewater treatment facilities with a design AWW flow of greater than 1 million gallons per day).

In addition to cost analysis factors, there are also nonmonetary or non-cost factors that may be considered during project facilities planning. These factors can most certainly change depending on the type of wastewater facilities project the owner is proposing. Some nonmonetary factors may also have monetary or costs associated with them. This portion of the project analysis should be limited to considering the nonmonetary discussion or consideration of those factors or items. Some of these factors are listed below and the project consulting engineer and owner have flexibility in determining if these or other items should be considered for an individual project.

## A. National, regional, state, and local priorities

i. The CWRF is available to assist sustainable and climate resilient infrastructure projects, for example safeguarding water infrastructure from risks of climate change and extreme weather events. The Facilities Plan should address the extent to which sustainability and climate resilience have been considered. For information on these subjects, EPA has information on their webpage at:

   https://www.epa.gov/sustainability/learn-about-sustainability#what
   https://www.epa.gov/sustainable-water-infrastructure/effective-utility-management-practices
   https://www.epa.gov/crwu/build-climate-resilience-your-utility

ii. The Facilities Plan should address the water quality objectives of the project. For collection system projects, this may be insuring that the sewer system is capable of transporting all the wastewater in the service area to the treatment plant for final treatment that meets the effluent limits in the owners permit, or maybe addressing past bypass issues during wet weather events as examples. For treatment facilities, it may be how the project is addressing current or new effluent limits.

iii. Consolidation/regionalization. Are there opportunities to consider collaborating in a consolidation or regionalization project for treatment facilities with other nearby communities or housing areas? In some cases, this alternative may involve nonmonetary considerations, such as benefiting the local technical and managerial capacity to operate the system, obtaining more favorable discharge locations or facilitating a water reuse option. If the owner already is a “regional” facility, this should be identified in the Facilities Plan.

## B. Technical factors

i. The project location and project physical aspects may raise some nonmonetary considerations. Examples could include minimizing impacts on residents of the community or reducing the amount of land needed for the wastewater treatment facility site.

ii. Project reliability may raise some nonmonetary considerations for a project alternative. This may be particularly true for small communities. In Minnesota, an example of this would be that a large number of small communities use stabilization pond systems for their treatment technology because that type of treatment process has been shown to be very reliable. The treatment alternatives considered for a particular location should consider this issue. This should not be confused with MPCA treatment plant component reliability requirements.

iii. Project feasibility and operability may also raise some nonmonetary issues to consider when analyzing alternatives. For example, can the project owner reasonably expect to find qualified candidates for operations and maintenance staff in the local area or reasonably expect to contract for operation and maintenance services for the planned project? Is it a specialized technology that may take more operator time and take time away from other expected job responsibilities? Is the technology flexible and adaptable to future conditions, like changes in influent wastewater quality or quantity from a new or expanded industrial user?

## C. Environmental factors

i. The potential opportunity for a project to implement or enhance possible water conservation practices, water reuse, and/ or water recapture may have nonmonetary related consideration or aspects for a project alternative. Discuss this in the Facilities Plan as appropriate for a project.

ii. Potential implementation of energy conservation practices, including the use of alternative energy sources may have nonmonetary related issues to consider for a project. Discuss this in the Facilities Plan as appropriate for the project.

iii. Opportunities to recover and recycle or reuse other resources may have non-cost related considerations to identify for a project alternative. Good examples of this may include nutrient recapture from the wastewater stream for possible reuse. The most common practice is land applying biosolids in cooperation with landowners to use the nitrogen and phosphorus in crop uptake to assist with growing agricultural crops. More recent practices include struvite (phosphorus) harvesting or nitrogen harvesting for fertilizers have been put in to practice in some parts of the United States. Discuss this in the Facilities Plan as appropriate for the project.

iv. The use of green infrastructure components within a project proposal may have nonmonetary considerations. Discuss this in the Facilities Plan as appropriate for the project.

v. There may be other environmental impacts of a project that may have nonmonetary considerations. Examples may be land use impacts, impact to wildlife and/or habitat, impacts to wetlands or other critical water bodies, or impacts on air/water quality. Discuss this in the Facilities Plan as appropriate for the project.

## D. Socioeconomic factors

i. There may be nonmonetary related considerations for certain industries using or served by public infrastructure by the type of project. Discuss this in the Facilities Plan as appropriate for a project.

ii. Nonmonetary considerations may be a part of local trend or demographics affecting the need or demand for a project. Discuss this in the Facilities Plan as appropriate for a project.

iii. Environmental justice issues may have nonmonetary related issues or considerations for a project. Discuss this in the Facilities Plan as appropriate for a project.

iv. Project acceptability or affordability may have nonmonetary types of considerations for a project. Discuss this in the Facilities Plan as appropriate for a project.

# VI. Integrating Cost and Effectiveness Analysis

(To be completed for all new wastewater treatment facilities with design AWW flow of greater than 100,000 gallons per day and significant upgrades meaning work on three or more major treatment units for any wastewater treatment facilities with a design AWW flow of greater than 1 million gallons per day).

This is the recommended method or series of steps to integrate the Cost and Effectiveness Analysis into projects including the Cost Analysis and Other Factors/Nonmonetary Analysis portions of the review of alternatives.

A. Display a summary table of the results of the present worth cost analysis of each of the alternatives studied during the Facilities Plan process that are capable of meeting the needs identified.

B. Describe narratively or summarize in a table the Other Factors/Nonmonetary Analysis for each alternative studied.

C. Assign a numeric weighting factor to both the Present Worth Cost Analysis and the Other Factors/Nonmonetary Analysis for each of the project alternatives.

D. Summarize the weighting factors of both the Present Worth Cost Analysis and the Other Factors/Nonmonetary Analysis in one single table and identify how the weighting factors will be used to assist in making a decision on selecting a project alternative.

E. Choose a selected project alternative. The Facilities Plan narrative should describe how both the Present Worth Cost Analysis and the Other Factors Analysis each shaped the reasoning behind selecting the implementation of this alternative. It is very important to note that Minn. R. 7077.0272 subp. 2.F. does not require selecting the lowest cost alternative for the project. The project owner is given latitude to select a project alternative that meets their identified needs and addresses the analysis of each of factors identified in this guidance document as appropriate for the individual project.

A reference to consider when integrating a Cost and Effectiveness Analysis is available from the Natural Resource Defense Council at: https://www.nrdc.org/sites/default/files/wat_16012504a.pdf.


References:

[i] EPA, Interpretive Guidance for Certain Amendments in the Water Resources Reform and Development Act to Titles I, II, V, and VI of the Federal Water Pollution Control Act, January 6, 2015, https://www.epa.gov/sites/production/files/2015-04/documents/water_resources_reform_and_development_act_guidance.pdf

[ii] MPCA Cost and Effectiveness Certification Form: https://www.pca.state.mn.us/sites/default/files/wq-wwtp2-46.doc

[iii] EPA, Supplemental Information of Implementing Section 602(b)(13), April 17, 2015

[iv] Preparing Wastewater Planning Documents and Environmental Reports for Public Utilities Financed by Oregon Infrastructure Finance Authority, Oregon Department of Environmental Quality, Rural Community Assistance Corporation, United States Department of Agriculture, May 21 and 22, 2013, http://www.deq.state.or.us/wq/loans/docs/FacilitiesPlansGuidelines.pdf

[v] Water Environment Federation, Energy Conservation in Water and Wastewater Facilities, Manual of Practice No. 32, 2009

MINNESOTA POLLUTION CONTROL AGENCY
520 Lafayette Road North
St. Paul, MN 55155-4194

# Environmental Information Worksheet (EIW) form

## Clean Water State Revolving Fund Program

Minnesota Rule Chapter 7077.0272, subp. 2.a.F.
Minnesota Rule Chapter 7077.0277, subp. 3.E.

*Doc Type: Wastewater Point Source*

Eligible applicants seeking funds for clean water (stormwater and wastewater) projects through the Clean Water State Revolving Fund (commonly referred to as the CWSRF Program) are required by Minn. R. ch. 7077.0272, subp. 2.a. F. and Minn. R. ch. 7077.0277, subp. 3.E., to complete an Environmental Information Worksheet (EIW). This information will be used to assess environmental impacts, if any, caused by the project.

**Questions:** Contact Review Engineer or Bill Dunn at 651-757-2324 or bill.dunn@state.mn.us.

1. **Project title:** ____________________

2. **Proposer:** ____________________

   **Contact person:** ____________________

   **Title:** ____________________

   **Address:** ____________________

   ____________________

   **Phone:** ____________________

   **Fax:** ____________________

3. **Project location:** County: ____________ City/Twp: ____________

   ________ 1/4 ________ 1/4 Section: ________ Township: ________ Range: ________

*Tables, Figures, and Appendices attached to the EIW:*

- County map showing the general location of the project;
- United States Geological Survey 7.5 minute, 1:24,000 scale map indicating project boundaries (photocopy acceptable);
- Site plan showing all significant project and natural features.

4. **Description:**

a. Provide a project summary of 50 words or less.

b. Give a complete description of the proposed project and related new construction. Attach additional sheets as necessary. Emphasize construction, operation methods and features that will cause physical manipulation of the environment or will produce wastes. Include modifications to existing equipment or industrial processes and significant demolition, removal or remodeling of existing structures. Indicate the timing and duration of construction activities.

c. Explain the project purpose; if the project will be carried out by a governmental unit, explain the need for the project and identify its beneficiaries.

d. Are future stages of this development including development on any outlots planned or likely to happen? ☐ Yes ☐ No
If yes, briefly describe future stages, relationship to present project, timeline and plans for environmental review.

e. Is this project a subsequent stage of an earlier project? ☐ Yes ☐ No
If yes, briefly describe the past development, timeline and any past environmental review.

**5. Project magnitude data**

Total Project Area (acres) ____________ or Length (miles) ____________
Number of Residential Units: Unattached ________ Attached ________ maximum units per building ________
Commercial/Industrial/Institutional Building Area (gross floor space): total square feet ____________
Indicate area of specific uses (in square feet): ____________

Office ____________ Manufacturing ____________
Retail ____________ Other Industrial ____________
Warehouse ____________ Institutional ____________
Light Industrial ____________ Agricultural ____________
Other Commercial (specify) ____________
Building height ____________ If over 2 stories, compare to heights of nearby buildings ____________

**6. Permits and approvals required.** List all known local, state and federal permits, approvals and financial assistance for the project. Include modifications of any existing permits, governmental review of plans, and all direct and indirect forms of public financial assistance including bond guarantees, Tax Increment Financing and infrastructure.

| Unit of government | Type of application | Status |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

**7. Land use.** Describe current and recent past land use and development on the site and on adjacent lands. Discuss project compatibility with adjacent and nearby land uses. Indicate whether any potential conflicts involve environmental matters. Identify any potential environmental hazards due to past site uses, such as soil contamination or abandoned storage tanks, or proximity to nearby hazardous liquid or gas pipelines.

**8. Cover types.** Estimate the acreage of the site with each of the following cover types before and after development:

| | Before | After | | Before | After |
|---|---|---|---|---|---|
| Types 1-8 wetlands | | | Lawn/landscaping | | |
| Wooded/forest | | | Impervious Surfaces | | |
| Brush/grassland | | | Other (describe) | | |
| Cropland | | | | | |
| | | | **Total** | | |

9. **Fish, wildlife, and ecologically sensitive resources.**

a. Identify fish and wildlife resources and habitats on or near the site and describe how they would be affected by the project. Describe any measures to be taken to minimize or avoid impacts.

b. Are any state (endangered or threatened) species, rare plant communities or other sensitive ecological resources such as native prairie habitat, colonial waterbird nesting colonies or regionally rare plant communities on or near the site?
☐ Yes ☐ No
If yes, describe the resource and how it would be affected by the project. Indicate if a site survey of the resources has been conducted and describe the results. If the Minnesota Department of Natural Resources (DNR) Natural Heritage and Nongame Research program has been contacted give the correspondence reference number: ______________________
Describe measures to minimize or avoid adverse impacts.

10. **Physical impacts on water resources.** Will the project involve the physical or hydrologic alteration (dredging, filling, stream diversion, outfall structure, diking, and impoundment) of any surface waters such as a lake, pond, wetland, stream or drainage ditch? ☐ Yes ☐ No
If yes, identify water resource affected. Describe alternatives considered and proposed mitigation measures to minimize impacts. Give the DNR Protected Waters Inventory (PWI) number(s) if the water resources affected are on the PWI.

11. **Water use.** Will the project involve installation or abandonment of any water wells, connection to or changes in any public water supply or appropriation of any ground or surface water (including dewatering)? ☐ Yes ☐ No
If yes, as applicable, give location and purpose of any new wells; public supply affected, changes to be made, and water quantities to be used; the source, duration, quantity and purpose of any appropriations; and unique well numbers and DNR appropriation permit numbers, if known. Identify any existing and new wells on the site map. If there are no wells known on site, explain methodology used to determine.

12. **Water-related land use management districts.** Does any part of the project involve a shoreland zoning district, a delineated 100-year flood plain, or a state or federally designated wild or scenic river land use district? ☐ Yes ☐ No
If yes, identify the district and discuss project compatibility with district land use restrictions.

13. **Water surface use.** Will the project change the number or type of watercraft on any water body? ☐ Yes ☐ No
If yes, indicate the current and projected watercraft usage and discuss any potential overcrowding or conflicts with other uses.

14. **Erosion and sedimentation.** Give the acreage to be graded or excavated and the cubic yards of soil to be moved: _____________ Acres: ________ cubic yards. Describe any steep slopes or highly erodible soils and identify them on the site map. Describe any erosion and sedimentation control measures to be used during and after project construction.

15. **Water quality – surface-water runoff.**

a. Compare the quantity and quality of site runoff before and after the project. Describe permanent controls to manage or treat runoff. Describe any storm water pollution prevention plans.

b. Identify routes and receiving water bodies for runoff from the site; include major downstream water bodies as well as the immediate receiving waters. Estimate impact runoff on the quality of receiving waters.

**16. Water quality – wastewater.**

a. Describe sources, composition and quantities of all sanitary, municipal and industrial wastewater produced or treated at the site.

b. Describe waste treatment methods or pollution prevention efforts and give estimates of composition after treatment. Identify receiving waters, including major downstream water bodies, and estimate the discharge impact on the quality of receiving waters. If the project involves on-site sewage systems, discuss the suitability of site conditions for such systems.

c. If wastes will be discharged into a publicly owned treatment facility, identify the facility, describe any pretreatment provisions and discuss the facility's ability to handle the volume and composition of wastes, identifying any improvements necessary.

d. If the project requires disposal of liquid animal manure, describe disposal technique and location and discuss capacity to handle the volume and composition of manure. Identify any improvements necessary. Describe any required setbacks for land disposal systems.

**17. Geologic hazards and soil conditions.**

a. Approximate depth (in feet) to

| | | | | | |
|---|---|---|---|---|---|
| Groundwater | ______________ | minimum; | ______________ | average. |
| Bedrock: | ______________ | minimum; | ______________ | average. |

Describe any of the following geologic site hazards to groundwater and also identify them on the site map: sinkholes, shallow limestone formations or karst conditions. Describe measures to avoid or minimize environmental problems due to any of these hazards.

b. Describe the soils on the site, giving U.S. Soil Conservation Service (SCS) classifications, if known. Discuss soil granularity and potential for groundwater contamination from wastes or chemicals spread or spilled onto the soils. Discuss any mitigation measures to prevent such contamination.

**18. Solid wastes, hazardous wastes, storage tanks.**

a. Describe types, amounts and compositions of solid or hazardous wastes, including solid animal manure, sludge and ash, produced during construction and operation. Identify method and location of disposal. For projects generating municipal solid waste, indicate if there is a source separation plan; describe how the project will be modified for recycling. If hazardous waste is generated, indicate if there is a hazardous waste minimization plan and routine hazardous waste reduction assessments.

b. Identify any toxic or hazardous materials to be used or present at the site and identify measures to be used to prevent them from contaminating groundwater. If the use of toxic or hazardous materials will lead to a regulated waste, discharge or emission, discuss any alternatives considered to minimize or eliminate the waste, discharge or emission.

c. Indicate the number, location, size and use of any above or below ground tanks to store petroleum products or other materials, except water. Describe any emergency response containment plans.

**19.** **Traffic.** Parking spaces added: ______________ Existing spaces (if project involves expansion): ______________________ Estimated total average daily traffic generated: __________________ Estimated maximum peak hour traffic generated (if known) and its timing: ____________________ Provide an estimate of the impact on traffic congestion affected roads and describe any traffic improvements necessary. If the project is within the Twin Cities metropolitan area, discuss its impact on the regional transportation system.

**20.** **Vehicle-related air emissions.** Estimate the effect of the project's traffic generation on air quality, including carbon monoxide levels. Discuss the effect of traffic improvements or other mitigation measures on air quality impacts. Note: If the project involves 500 or more parking spaces, consult *Environmental Assessment Worksheet (EAW) Guidelines* about whether a detailed air quality analysis is needed.

**21.** **Stationary source air emissions.** Describe the type, sources, quantities and compositions of any emissions from stationary sources of air emissions such as boilers, exhaust stacks or fugitive dust sources. Include any hazardous air pollutants (consult *EAW Guidelines* for a listing), any greenhouse gases (such as carbon dioxide, methane, and nitrous oxides), and ozone-depleting chemicals (chlorofluorocarbons, hydrofluorocarbons, perfluorocarbons or sulfur hexafluoride). Also describe any proposed pollution prevention techniques and proposed air pollution control devices. Describe the impacts on air quality.

**22.** **Odors, noise, and dust.** Will the project generate odors, noise or dust during construction or during operation? ☐ Yes ☐ No

If yes, describe sources, characteristics, duration, quantities or intensity and any proposed measures to mitigate adverse impacts. Also identify locations of nearby sensitive receptors and estimate impacts on them. Discuss potential impacts on human health or quality of life. (Note: fugitive dust generated by operations may be discussed at item 23 instead of here.)

**23a.** **Nearby resources.** Are any of the following resources on or in proximity to the site? Projects should search the Minnesota State Historic Preservation Office's (SHPO) National Register of Historic Places database.

***Note:** Project proposers must contact the SHPO at datarequestshpo@mnhs.org to request a database review to obtain information on any known historical or archaeological sites in the project area.
Include a copy of correspondence with SHPO with the submittal of this EIW form.

a. Archaeological, historical, or architectural resources? ☐ Yes ☐ No
b. Prime or unique farmlands or land within an agricultural preserve? ☐ Yes ☐ No
c. Designated parks, recreation areas, or trails? ☐ Yes ☐ No
d. Scenic views and vistas? ☐ Yes ☐ No
e. Other unique resources? ☐ Yes ☐ No

If yes, describe the resource and identify any project-related impacts on the resources. Describe any measures to minimize or avoid adverse impacts.

**23b.** **Section 106 Review** (36 CFR 800) is required for all CWRF projects. The following forms can be found on the MPCA Wastewater and Stormwater Financial Assistance website at https://www.pca.state.mn.us/ppl. Select Clean Water Revolving Fund tab; then scroll to Facilities Plan and Facilities Plan Supplement for Wastewater Treatment Systems heading.

a. Project is exempt from review (attach completed *Exemption Checklist*) ☐ Yes ☐ No
b. Project is required to complete further Section 106 Review: ☐ Yes ☐ No
    a. SHPO
    b. Tribal consultation
    c. Other Consulting parties

**24.** **Visual impacts**. Will the project create adverse visual impacts during construction or operation? Such as glare from intense lights, lights visible in wilderness areas and large visible plumes from cooling towers or exhaust stacks? ☐ Yes ☐ No

If yes, explain.

25. **Compatibility with plans and land use regulations.** Is the project subject to an adopted local comprehensive plan, land use plan or regulation, or other applicable land use, water, or resource management plan of a local, regional, state or federal agency? ☐ Yes ☐ No

If yes, describe the plan, discuss its compatibility with the project and explain how any conflicts will be resolved. If no, explain.

26. **Impact on infrastructure and public services.** Will new or expanded utilities, roads, other infrastructure or public services be required to serve the project? ☐ Yes ☐ No

If yes, describe the new or additional infrastructure or services needed. (Note: any infrastructure that is a connected action with respect to the project must be assessed in the EAW; see *EAW Guidelines* for details.)

27. **Cumulative impacts.** Minn. R. 4410.1700, subp. 7, item B requires that the RGU consider the "cumulative potential effects of related or anticipated future projects" when determining the need for an environmental impact statement. Identify any past, present or reasonably foreseeable future projects that may interact with the project described in this EAW in such a way as to cause cumulative impacts. Describe the nature of the cumulative impacts and summarize any other available information relevant to determining whether there is potential for significant environmental effects due to cumulative impacts (or discuss each cumulative impact under appropriate item(s) elsewhere on this form).

28. **Other potential environmental impacts.** If the project may cause any adverse environmental impacts not addressed by items 1 to 28, identify and discuss them here, along with any proposed mitigation.

29. **Summary of issues.** List any impacts and issues identified above that may require further investigation before the project is begun. Discuss any alternatives or mitigative measures that have been or may be considered for these impacts and issues, including those that have been or may be ordered as permit conditions.

# Section 13
# Limitations

This document was prepared solely for City of Rochester in accordance with professional standards at the time the services were performed and in accordance with the contract between City of Rochester and Brown and Caldwell dated May 17, 2017. This document is governed by the specific scope of work authorized by City of Rochester; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City of Rochester and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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# References

Chow, V. T., Open-Channel Hydraulics, McGraw-Hill, 1959, page 72.

City of Rochester, MN, Sustainability, https://www.rochestermn.gov/departments/community-development/sustainability.

# Appendices

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LOWER ENERGY // CLEAN DESIGN

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