Clean Water State Revolving Fund FY18 Green Project Reserve

- Interim -

Star Sewer & Water District FY18 WWTP Upgrade Project

SRF Loan #WW1805 (pop. 7,500)

$30,281,909

Interim Green Project Reserve Justification

Categorical GPR Documentation

1. INNOVATIVE ADVANCED WASTEWATER TREATMENT SYSTEM (Energy Efficiency). Categorically GPR-eligible per 4.5-2a: *projects that significantly reduce …the use of chemicals in water treatment*; and, 4.5-2b: *treatment …that significantly reduces the volume of residuals….or lowers the amount of chemicals in the residuals,* and per 3.2-2: *projects that achieve a 20% reduction in energy consumption*." ($4,203,627).
2. LOW-PRESSURE HIGH-INTENSITY UV DISINFECTION SYSTEM (Energy Efficiency). Categorically GPR-eligible per Section 3.2-2: *projects that achieve a 20% reduction in energy consumption* ($144,725).

Business Case GPR Documentation

3. INFLUENT EQUALIZATION PUMPS/VFDS (Energy Efficiency). Business Case GPR-eligible per Section 3.2-2: *projects that achieve a 20% reduction in energy consumption*. ($28,994).
4. INSTALLS SCADA CONTROL TECHNOLOGY (Energy Efficiency). Business case GPR-eligible per Section 3.4-1: *"Project must be cost-effective. An evaluation must identify energy savings and payback on capital and operation and maintenance costs that does not exceed the useful life of the asset" and Section 3.5-8: SCADA systems can be justified based on substantial energy savings".* ($221,914).

Categorical

1. Innovative Advanced Wastewater Treatment Process

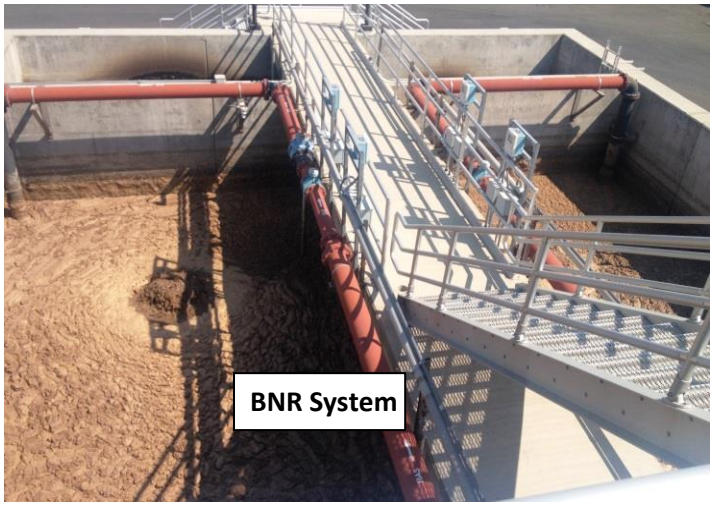
Summary

- The Star Sewer and Water District (SSWD) owns and operates a wastewater treatment plant to treat municipal wastewater generated within its boundaries. Additional treatment will be necessary to ensure compliance with new discharge limits for nutrient removal. The upgrade project includes an innovative advanced wastewater treatment process combining Biological Nutrient Removal (BNR) and Membrane Bio-Reactor (MBR) technologies.
- The new process will significantly reduce the use of chemicals and chemical residuals and eliminates the need for tertiary filtration.
- Loan amount = $30,281,909
- BNR/MBR costs = 13.9% ($4,203,627)

Treatment Description

Process Schematic

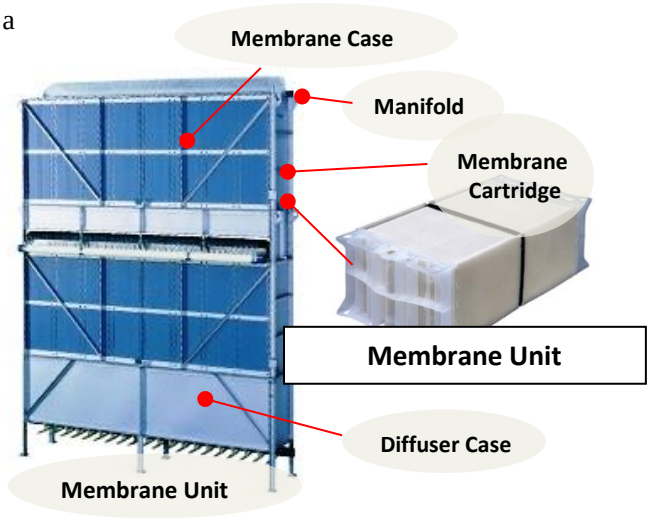
- Alternating aerobic and anoxic treatment accomplish nitrification and denitrification, respectively. The recycle ratio is varied to optimize the percent removal. At 4x the influent flow recycle ratio, an estimated 80% of the nitrogen is removed.
- The enhanced biological phosphorus removal system incorporates an anaerobic zone with internal recycle. The anaerobic zone promotes the growth of phosphorus accumulating organisms (PAO).
- Enhanced biological phosphorus removal without chemical addition will be capable of lowering the phosphorus concentration to less than 2 mg/L.



- Rare earth (RE300) is dosed into the MBR to react with the residual phosphorus. MBR technology enhances the process to achieve the ultra-low phosphorus permit limit of 0.07 mg/l without the need for a tertiary filtration process. This advanced system minimizes the use of chemicals, which decreases the amount of residuals.

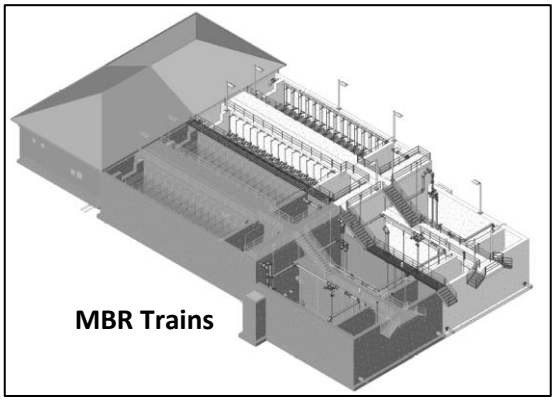
Innovative Process Justification

- The GPR-eligibility of BNR/MBR was established by comparison to a Baseline Standard Practice (BSP). The BSP was derived from an analysis of viable and relevant technologies.
- The BSP for the SSWD is conventional aerobic treatment without anaerobic or anoxic zones and with chemical addition and tertiary filtration for phosphorus removal.
- Annual chemical use for the BNR/MBR would average 3,600 gallons of liquid rare earth (RE300) per year at startup. Due to the ultra-low phosphorus removal requirement, pilot testing is necessary to estimate the alum requirement in the BSP case. Typically, 2 to 4 times more alum is needed to meet the equivalent level of phosphorus removal. However, this ratio can be even greater when ultra-low levels of phosphorus removal are required. Similarly, the residual volume can be 2 to 4 or more times larger due to the larger amount of chemical used with alum.



Conclusion

- BNR/MBR is GPR-eligible as an innovative technology when compared to the BSP, as BNR/MBR significantly reduces the need for chemical addition for nutrient removal and significantly reduces the amount of chemical sludge to be disposed.
- **GPR Costs**: Biological nutrient removal system for BNR/MBR = $4,203,627[1]
- **GPR Justification**: The process is GPR-eligible per Section 4.5-5a: *Projects that significantly reduce or eliminate the use of chemicals in wastewater treatment; 4.5-5b: …significantly reduce the volume of residuals, or lower the amount of chemicals in the residuals.*



MBR Trains

Nutrient Removal Basins

[1] Incorporates the cost of all process appurtenances e.g. premium efficiency pumps, blowers, VFDs, mixers etc.

2. UV Disinfection System

Summary

- The Low-Pressure High-Intensity UV system specified for the project is approximately 3X more efficient than medium pressure lamps and 5X higher UV-C output than conventional low-pressure lamps. UV-C output is crucial when considering UV disinfection systems because the UV-C range is the germicidal portion of the UV radiation band.
- The system specified for the SSWD project is more expensive than conventional lamps and would be comparative in price to the medium pressure option.
- Total Loan amount = $30,281,909
- Categorical energy efficient (green) portion of loan = 0.5% ($144,725)

Background

- SSWD proposes to install UV disinfection systems with low-pressure high-intensity lamps.
- A common alternative to low-pressure high-intensity style UV systems is medium-pressure UV systems. In comparison to medium-pressure technology, low-pressure high-output technology consumes 2-4 times less power[2] [3]
- The typical electrical to germicidal UV conversion efficiency rates of medium pressure UV systems is 10 – 20%; whereas, this efficiency for low-pressure high-intensity systems is 30 – 35%.[4]
- The specific lamp installed at the SSWD WWTP is the WEDECO Spektrotherm UV lamp, which has a light yield to energy expenditure three times higher in comparison to medium pressure lamps.[5]

Results

- The maximum power consumption of the low-pressure high-intensity UV system (lamps and ballasts only) installed is 8.6 kW per UV unit. The wastewater flow at the WWTP will be constant, meaning the disinfection system is operating at all times.
- With one unit running 24 hrs./day every day of the year, the energy consumed by the system is 75,336 kWh/year.

Energy Efficiency Improvements

- The approximate energy consumption by medium pressure UV system for this application = 75,336 kWh x 3 = 226,008 kWh. [2] [3]
- The energy reduction achieved by using a low-pressure high intensity system versus a medium-pressure high-intensity system = 1 - (75,336 kWh / 226,008 kWh) = 66%
- The annual energy cost savings associated with using a low-pressure high intensity system instead of a medium-pressure high-intensity system (@$0.10/kWh) = (226,008 – 75,336 kWh) x $0.10/kWh = $15,067 per year

Conclusion

- By selecting a low-pressure high-intensity UV disinfection system the power consumption will be 66% lower than the common alternative medium-pressure high-intensity disinfection system.
- **GPR Costs:** Low-pressure high-intensity UV disinfection system: $144,725
- **GPR Justification:** Categorically GPR-eligible (Energy Efficiency) per Section 3.2-2[9]: *projects that achieve a 20% reduction in energy consumption*.

[2] Correspondence from Katie Cook, Senior Applications Engineer for Xylem Inc.-WEDECO UV products.
[3] Metcalf and Eddy-Wastewater Engineering; Tchobanoglous, Burton, & Stensel, 2003; Table 12-25
[4] Table 2.1 from the USEPA's UV Disinfection Guidance Manual (UVDGM 2006).
[5] Wedeco LBX series UV disinfection system brochure.

3. EQUALIZATION PUMP STATION: PREMIUM PUMPS/VFDS

Summary

- The SSWD WWTP improvement project includes conversion of the lagoons to influent flow equalization basins with flow attenuation through a new influent pump station.
- Total Loan amount = $30,281,909
- Estimated Categorical energy efficient (green) portion of loan = 0.01% ($28,994)
- Estimated Average Annual Energy Savings = $424/year

Background

- SSWD will install an equalization pump station to use the existing lagoons as equalization basins.
- The pumps will have premium energy-efficient motors controlled by VFDs.

GPR Justification

The Baseline Standard Practice (BSP) for comparison is a standard Epact motor that is not controlled by a VFD[6].

VFDs:
- VFD efficiency data were calculated using the ABB Energy Save Calculator[7] (for pump applications).
- Combined annual energy savings for utilizing VFDs = 1,916 kWh per year per pump/VFD system (54% reduction in energy compared to motors without VFDs). This corresponds to a cost savings of $192 per year (at an energy cost of $0.10 per kWh) per VFD system when compared to the BSP, with a total cost savings of $384 per year (two VFD systems in operation two hours per day each).
- With an estimated incremental cost increase of $2,000 per unit, the simple payback is approximately 10 years for the system.

***Motors*:**
- Each pump has a premium efficiency, 7.5 HP motor (92% efficient) at an additional cost of about $500 each ($1,000 total for the pump station). Epact efficiency motors are typically 3 to 4 percent lower in price than premium efficient motors[8].
- An Epact efficiency, 7.5 HP motor has an efficiency of approximately 87%.
- Each of the pumps is designed to discharge 750 gpm. Using the average of the average day flows over the 20-year design period, it is estimated the pumps will run approximately 15% of the year.
- An energy savings of approximately 408 kWh/year will be realized, which equates to a cost savings of $40/year assuming $0.10/kWh.
- At $40/year of energy savings using a premium efficiency motor, the payback period for the cost differential between an Epact and premium efficiency motors ($500) is 12 years, which is less than the 20-year useful life of the pump/motor.

Conclusion

- The use of premium energy-efficient pumps and VFDs achieve more than a 20% reduction in energy consumption and are cost-effective.
- **GRP Costs Identified**:
  - Premium Efficiency Pumps + VFDs = **$28,994**
- **GPR Justification**: The Pump/VFD system is Categorically GPR eligible (Energy Efficiency) per Section 3.2-2 page 9[9]: *Use of premium efficiency motors and VFD pumps in a new project where they are cost-effective and achieve a 20% reduction in energy consumption*. Section 3.5-9 also states: *Variable Frequency Drives can be justified based upon substantial energy savings.*

[6] NYS Energy Research and Development Authority, Energy Evaluation Memorandum, Village of Greenport WWTP Upgrade 8-2009
[7] https://energysave.abb-drives.com/?_ga=2.107102978.1423731524.1581697042-1616770323.1581697042#/pump
[8] Page V. Energy Efficient Motor Selection Handbook, Washington State Energy Office
[9] 2012 Clean Water State Revolving Fund 10% Green Project Reserve: Guidance for Determining Project Eligibility

4. SCADA

Summary

- SCADA Control Technology (SCADA) will be installed for on-site control and monitoring of the treatment plant to minimize power usage and cost and to optimize treatment effectiveness.
- Total Loan amount = $30,281,909
- Estimated energy efficient (green) portion of loan = 0.73% ($221,914)
- Estimated annual energy savings $65,640 per year.

Description

- SCADA Control Technology is used to monitor equipment and the treatment process remotely and by computer.

GPR Justification

- The GPR-eligibility of SCADA VFDs was established by comparison to a BSP. The BSP is to operate the equipment and treatment process manually.
- BNR: The aeration system of the BNR/MBR treatment process will be tied to the dissolved oxygen levels through the PLC. The PLC controls the aeration, but the SCADA monitors and can modify the PLC set points to change the tank oxygen levels. It is estimated that optimizing the aeration system will reduce energy usage by 10%: Installed aeration = 600 HP. 10% savings = 394,000 kWh/year.
- Dewatering system: SCADA will be used to operate sludge dewatering equipment with significantly reduced operator attention. It is estimated that SCADA will reduce the amount of time an operator must be present by 6 hours/day. Dewatering: Remote SCADA control saves labor = 6 hours/day, 250 days/year = 1,500 hrs./year = $ 52,500/year in labor costs.
- Plant: Through a computer-based Graphical User Interface (GUI) program, the plant's processes will be monitored and observed remotely. The SCADA GUI will save energy through reduced travel to and from the plant.
- The estimated annual energy cost for the BSP and SCADA is summarized in the table below. The corresponding cost savings are estimated using an energy cost of $0.10/kWh. The useful life of SCADA is assumed to be greater than 10 years.

	BSP	SCADA	Savings
BNR Aeration System	3,942,000 kW-hr/yr	3,548,000 kW-hr/yr	394,000 kW-hr/yr
BNR Aeration System cost	$394,000/yr	$355,000/yr	$39,000/yr
Dewatering System	2,000-man hr/yr	500-man hrs/yr	1,500-man hrs/yr
Dewatering System cost	$70,000/yr	$17,500/yr	$52,500/yr

Conclusion

- The use of SCADA is GPR-eligible because it is cost-effective (as shown in the table above).
- **GPR Costs:** SCADA = $221,914
- **GPR Justification:** The SCADA is GPR-eligible per Section 3.5-8[10]: *SCADA systems can be justified based on substantial energy savings.*

[10] Attachment 2. April 21, 2010 EPA Guidance for Determining Project Eligibility.