Clean Water State Revolving Fund FY18 Green Project Reserve

- Preliminary -

Star Sewer & Water District FY18 WWTP Upgrade Project

SRF Loan #WW1805 (pop. 7,500)

$30,281,909

Preliminary Green Project Reserve Justification[1]

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*." ($6,000,000).
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* ($242,730).

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*. ($231,800).
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".* ($85,905).

Prepared by the State of Idaho SRF Loan Program

August 2018

[1] All costs/analyses will be updated in the GPR Technical Memorandum submitted by the loan recipient at completion of design.

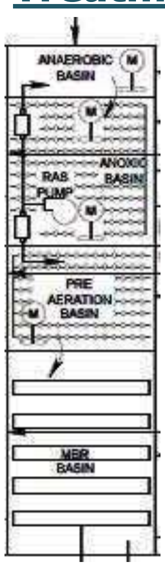
Categorical

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. To ensure compliance with strict new discharge limits for nutrient removal, tertiary treatment will be necessary. 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 = xx% ($6,000,000)

Treatment Description



Process Schematic

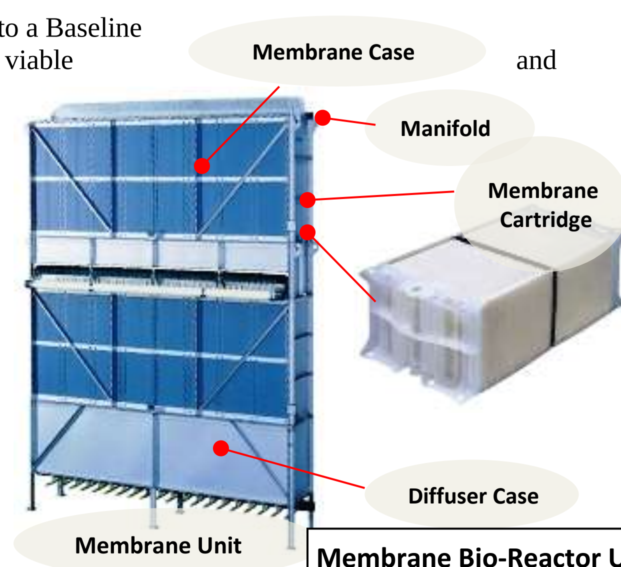
- Nitrification and denitrification is performed via extended aeration coupled with the anoxic recycle. The internal recycle ratio determines the percent removal of non-biological nitrogen.
- At 4x the influent flow recycle ratio, an estimated 80% of the nitrogen not associated with biological growth is removed.
- The biological phosphorus removal system incorporates an anaerobic zone with RAS recycle. The anaerobic zone promotes the growth of phosphorus accumulating organisms (PAO).
- It is estimated that biological phosphorus removal without chemical addition will be capable of lowering the phosphorus concentration to less than 2 mg/L.

BNR System

- The very low phosphorus permit limit of 0.07mg/l is achieved by integrating MBR technology into the process. This advanced technology minimizes the use of chemical addition, and eliminates the need for tertiary filtration by dosing directly into the MBR for removal of residual phosphorus.

Innovative Process Justification

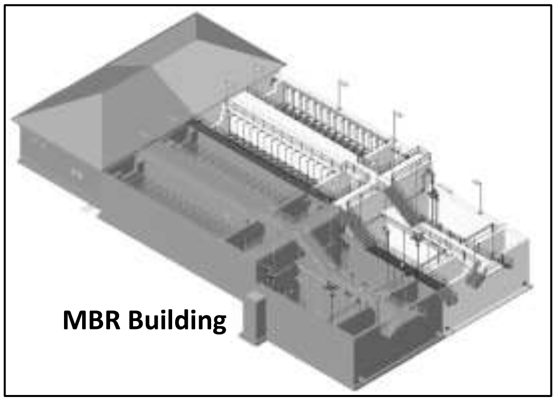
- The GPR-eligibility of BNR/MBR was established by comparison to a Baseline Standard Practice (BSP). The BSP was derived from an analysis of viable and relevant technologies.
- The BSP for the Star S&WD is conventional aerobic treatment without anaerobic or anoxic zones and with chemical addition for phosphorus removal. This conventional process is the second most efficient process considered in terms of chemical use and chemical sludge production.
- To achieve permit limits, annual chemical use for the BSP would average 165,612 gallons of liquid alum at a cost of $331,224 per year, producing 236 wet tons of additional chemical sludge to be disposed of per year at an annual cost of $4,012.
- Annual chemical use for the BNR/MBR would average xxxxx gallons of liquid alum at a cost of xxxx per year, producing xxx wet tons of chemical sludge to be disposed of per year at an annual cost of $xxxxx.



Membrane Bio-Reactor Unit

Conclusion

- BNR/MBR is GPR-eligible as an innovative technology when compared to the BSP, as BNR/MBR significantly reduces or eliminates the need for chemical addition for nutrient removal and minimizes the amount of chemical sludge to be disposed.
- **GPR Costs**: Biological nutrient removal system for oxidation ditch = $6,000,000[2]
- **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 Building

Nutrient Removal Basins

[2] 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 3X more efficient than medium pressure lamps and 5X higher UV-C output than conventional low pressure lamps. UV-C output is important when considering UV disinfection systems because the UV-C range is the germicidal portion of the UV radiation band.
- The system specified for the Star project is more expensive than conventional lamps and would be comparative in price to the medium pressure option.
- Total Loan amount = $30,281,909
- Categorical energy efficient (green) portion of loan = xx% ($xxxxx)

Background

- The SSWD proposes to install UV disinfection systems with low-pressure high-intensity lamps.
- A common alternative to low-pressure high-intensity style UV systems are medium-pressure UV systems. In comparison to medium pressure technology, low-pressure high-output technology consumes 2-4 times less power[3 4]
- 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%.[5]
- The specific lamp installed at the Star WWTP is the WEDECO Spektrotherm UV lamp which has a light yield to energy expenditure 3 times higher in comparison to medium pressure lamps.[6]

Results

- The maximum power consumption of the low-pressure high-intensity UV system (lamps and ballasts only) installed is 7.56 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 66,226 kWh/year.

Energy Efficiency Improvements

- The approximate energy consumption by medium pressure UV system for this application = 66,226 kW-hr x 3 = 198,677 kW-hr. [3 4]
- The energy reduction achieved by using a low-pressure high intensity system versus a medium-pressure high-intensity system = 1 - (66,226 kW-hr / 198,677 kW-hr) = 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) = (198,677 – 66,226)kWh x $0.10/kWh = $13,245 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: $xxxxxx
- **GPR Justification:** Categorically GPR-eligible (Energy Efficiency) per Section 3.2-2[10]: *projects that achieve a 20% reduction in energy consumption*.

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

3. Equalization Pump Station: Premium Pumps/VFDs

Summary

- Star Sewer & Water District wastewater plant improvement project includes conversion of 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 = xx% ($231,800)
- Estimated Average Annual Energy Savings = $xxxxx/year

Background

- The Star Sewer and Water District (SSWD) will install an influent 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[7].

VFDs:

- VFD efficiency data were calculated using the Baldor Adjustable Speed Drive Energy Savings Calculator[8] (for pump applications).
- Combined annual energy savings for utilizing VFDs = xxxxx kWh per year per pump/VFD system (xx% reduction in energy compared to motors without VFDs). This corresponds to a cost savings of $xxx per year (at an energy cost of $xxx per kWh) per VFD system when compared to the BSP, with a total cost savings of $xxxxx per year (xx VFD systems in operation continuously).
- With an estimated incremental cost increase of $xxxxx per unit, the simple payback is approximately xx years for the system.

***Motors*:**

- Each pump has a premium efficiency 20HP motor (93.0% efficient) at an additional cost of about $xxx each ($xxxx total for the pump station). Epact efficiency motors are typically 3 to 4 percent lower in cost than premium efficient motors[9].
- An Epact efficiency 20HP motor has an efficiency of approximately 90%.
- Each of the pumps are designed to discharge 1500gpm. Using the average of the average day flows over the 20-year design period, it is estimated that the pumps will run approximately xx% of the year.
- An energy savings of approximately xxxkWh/year will be realized, which equates to a cost savings of $xx/year assuming $0.08/kWh.

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[7] NYS Energy Research and Development Authority, Energy Evaluation Memorandum, Village of Greenport WWTP Upgrade 8-2009
[8] http://www.baldor.com/support/software_download.asp?type=BE$T+Energy+Savings+Tool
[9] Page V. Energy Efficient Motor Selection Handbook, Washington State Energy Office

(CONT'D) EQUALIZATION PREMIUM PUMPS/VFDS

- At $xx/year of energy savings using a premium efficiency motor, the payback period for the cost differential between a Epact and premium efficiency motors ($xxx) is xx 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 = **$281,300**
- **GPR Justification**: The Pump/VFD system is Categorically GPR eligible (Energy Efficiency) per Section 3.2-2 page 9[10]: *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*[11].

[10] 2012 Clean Water State Revolving Fund 10% Green Project Reserve: Guidance for Determining Project Eligibility
[11] Attachment 2. April 2012 EPA 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 in order to minimize power usage and cost and to optimize treatment effectiveness.
- Total Loan amount = $30,281,909
- Estimated energy efficient (green) portion of loan = x% ($85,905)
- Estimated annual energy savings $74,575 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 Baseline Standard Practice (BSP). The BSP is to operate the equipment and treatment process manually.
- BNR: the aeration system of the activated sludge treatment process will be tied to the dissolved oxygen levels through the PLCs. The PLC's control the speed of the aerators; thus, SCADA monitors and controls tank oxygen levels and aerator speed. Activate Sludge: It is estimated that optimizing the aeration system will reduce energy usage by xx%: Installed aeration = xxx HP. xx% savings = xxxxxx kW-hr/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 man hours/day. Dewatering: Remote SCADA control saves labor = 6 man hours/day, 250 days/year = 1,500 hrs/yr = $ 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 0.06$/kWh. The useful life of SCADA is assumed to be greater than 10 years.

	BSP	SCADA	Savings
Anaerobic basins mixers	xxx kW-hr/yr	yyy kW-hr/yr	zzz kW-hr/yr
Anaerobic basins operating cost			
Anoxic basins mixers	xxx kW-hr/yr	yyy kW-hr/yr	zzz kW-hr/yr
Anoxic basins operating cost			
Oxidation ditches aeration energy usage	xxxx kW-hr/yr	yyy kW-hr/yr	zzzzz kW-hr/yr
Oxidation ditch operating cost	$xxxx/yr	$ yyyy/yr	$ yyyyy/yr

Conclusion

- The use of SCADA is GPR-eligible because it is cost effective (as shown in the table above).
- **GPR Costs:** SCADA = $85,905
- **GPR Justification:** The SCADA is GPR-eligible per Section 3.5-8[12]: *SCADA systems can be justified based on substantial energy savings.*

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