Clean Water State Revolving Fund Green Project Reserve

City of Fruitland Wastewater Project SRF Loan #WW1301

$10,000,000 (pop. 4,684)

Final Green Project Reserve Justification

Business Case GPR Documentation

1. Premium Energy Efficient Motors and VFDs (Energy Efficiency). Premium energy efficient motors and VFDs will be installed as part of the Wastewater System Upgrade project. GPR Business Case per Section 3.2-2: *Use of premium efficiency motors and VFD pumps in a new project.* ($940,400).
2. Installs SCADA for remote monitoring & control (Energy Efficiency). GPR Business Case per GPR 3.5-8: *SCADA systems can be justified based on substantial energy savings* ($175,000).
3. Installs Tertiary Filter to reduce UV disinfection energy output requirements (Energy Efficiency). Categorically GPR-eligible per Section 3.2-2: *greater than 20% reduction in energy use*; also GPR-eligible per Section 3.4-1: *cost effective as cost is recovered over the useful life of the process* ($478,525).

Categorical GPR Documentation

4. 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).
5. Lift Station & Transfer Pipe (Energy Efficiency). Categorically GPR-eligible per Section 3.2-2: *projects that achieve a 20% reduction in energy consumption* ($550,000).
6. Interceptor Sewer (Energy Efficiency). Categorically GPR-eligible per Section 3.2-2: *projects that achieve a 20% reduction in energy consumption* ($397,595).

Innovative GPR Documentation

7. Install Innovative Multi-stage Activated Biological Process For Biological Nutrient Removal (Innovative). Environmentally Innovative 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*. ($3,558,714).

State of Idaho SRF Loan Program
October 2015

1. PREMIUM EFFICIENCY MOTORS & VFDS

Summary

- The City of Fruitland upgraded and renovated their wastewater system, funded with a FY13 SRF Loan. The upgraded system includes premium pumps, premium motors, and Variable Frequency Drives (VFDs).
- Loan amount = $10,000,000[1]
- GPR-eligible = Motors/VFDs = $940,000 [Final Installed Costs]
- Green portion of loan = 9.4 %

Description

- Energy efficient practices incorporated in the design of the new Fruitland WWTP include the installation of a number of premium efficiency motors/VFDs listed below:
- Four surface aerators with 150 hp premium efficiency motors and VFDs,
- Six anaerobic mechanical floating mixers with 2 hp premium efficiency motors,
- Four anoxic mechanical floating mixers with 4 hp premium efficiency motors,
- Two sludge pumps with 25 hp premium efficient motors,
- Two high efficiency sludge blowers with 75 hp premium efficiency motors and VFDs, and
- Nine submersible (3 at clarifier effluent lift station, 4 RAS, 2 WAS) explosion proof pumps and motors with VFDs (the motor sizes range from 5 to 18 hp).

GPR Justification

VFDs:

- The Baseline Standard Practice for comparison is a standard Epact motor that is not controlled by a VFD[2].
- VFD efficiency data were calculated using the Baldor Adjustable Speed Drive Energy Savings Calculator[3] (for pump applications).
- The estimated combined annual energy savings for utilizing VFDs compared to the Baseline Standard Practice for each of the different pieces of equipment is summarized in the table below. The corresponding cost savings are estimated using an energy cost of 0.1$/kWh. An estimated incremental cost increase of $5,000 for the pumps and $30,000 for the blowers and surface aerators was used to calculate the simple payback period per VFD[4]

Equipment	Energy Savings (kWh/yr per motor/VFD system)	Cost Savings ($)	Payback period (years) per VFD
Blowers	96,065	9,607	3.1
Clarifier Effluent Lift Station Submersible Pumps	56,358	5,636	1.1
Surface Aerators	419,008	41,901	0.7
RAS Submersible Pumps	15,742	1,574	3.2
WAS Submersible Pumps	15,650	1,565	3.2

[1] FY13 SRF Loan Agreement
[2] NYS Energy Research and Development Authority, Energy Evaluation Memorandum, Village of Greenport WWTP Upgrade 8-2009
[3] http://www.baldor.com/support/software_download.asp?type=BE$T+Energy+Savings+Tool
[4] See Appendix A for further analysis of VFD comparisons.

PREMIUM EFFICIENCY MOTORS & VFDS (CONT'D)

Motors:
- Premium motor energy savings over the EPAct motor are summarized in the table below[5].
- An estimated incremental cost increase of $300 was used to calculate the simple payback per system.

Equipment	Energy Cost Savings	Payback Period (years) per system
Blowers	$480	0.6
Surface Aerators	$590	0.5
Anaerobic Mechanical Floating Mixers	$20	15
Anoxic Mechanical Floating Mixers	$60	5
Sludge Pumps (Rotary Lobe Pumps)	$70	4.3

Conclusion

- The use of premium energy-efficient pumps and VFDs are categorically GPR eligible as they are cost effective as shown in the two tables above.
- **GRP Costs Identified** :

○ Surface aeration system Premium Efficiency Motors/VFD's	$550,000
○ Sludge Pump Premium Efficiency Motors:	$52,000
○ High Efficiency Sludge Blowers with Premium Efficiency Motors/VFDs:	$95,000
○ High Efficiency Anaerobic Mechanical Floating Mixers	$69,000
○ High Efficiency Anoxic Mechanical Floating Mixers	$23,000
○ High Efficiency RAS Submersible Pumps and Motors/VFDs	$58,000
○ High Efficiency Clarifier Lift Station Submersible Pumps, Motors, VFDs	$66,000
○ High Efficiency WAS Submersible Pumps and Motors/VFDs:	$27,000
Total =	**$940,000**

- **GPR Justification**: The Pump/VFD system is Categorically GPR eligible (Energy Efficiency) per Section 3.2-2 page 9[6]: *Use of premium efficiency motors and VFD pumps in a new project where they are cost effective*.

[5] Productive Energy Solutions Motor Slide Calculator, energy cost @ $0.10/kWh. See Appendix A for additional motor comparison information.
[6] 2012 Clean Water State Revolving Fund Green Project Reserve: Guidance for Determining Project Eligibility

2. SCADA CONTROL TECHNOLOGY

Summary

- SCADA Control Technology is installed for on-site control of the treatment plant in order to minimize power costs and optimize treatment effectiveness.
- Estimated loan amount = $10,000,000[1]
- Energy efficiency (green) portion of loan = 1.8% ($175,000) [Final Installed Cost]
- Estimated annual energy savings $66,930 per year.

Background/ Results

- The SCADA system is part of the project at the plant.
- OXIDATION DITCHES: The aeration system is tied to the dissolved oxygen levels in the oxidation ditches and surface aerators through PLC's; these control air flow and surface aerator VFDs. Thus, SCADA monitors and controls ditch oxygen levels and speed of the surface aerators.
- TERTIARY FILTERS: The upflow tertiary filter's backwashing system is controlled through the PLC / SCADA system. A level sensor measures water level in the influent trough. Rising water is detected by the SCADA PLC, indicating that the filters need backwashing; the system then automatically initiates the air lift pumps used to backwash the sand by allowing compressed air flow through the air control panel. This saves energy by reducing the operating time of the two 15 hp air compressors and reduces the amount of reject water. The reduction of the reject water will reduce the amount pumping needed at the plant drain lift station and therefore reduce the energy consumption from the two 10 hp submersible pumps at the plant drain lift station.
- UV DISINFECTION: The SCADA system controls the UV system through flow and transmissivity PLC monitoring. A UV intensity sensor in each UV vessel monitors the transmissivity. The PLC receives inputs from the UV sensor and flow meter and automatically adjusts the received UV Dose to maintain the required levels under all operation conditions. The dose-pacing of the system installed at Fruitland has the ability to power the lamps between 50-100% of their maximum output in addition to being turn them on and off when needed.

Calculated Energy Efficiency Improvements

- OXIDATION DITCHES: Optimizing the air supplied saves significant energy: Four 150 HP surface aerators @ 20% savings = $58,630 per year.
- TERTIARY FILTERS: The SCADA ensures backwashing is based on need, not time; saving = $5,000 per year.
- UV DISINFECTION: SCADA monitoring/ control of UV light cycling and intensity = $3,300 savings per year

Conclusion

- The system results in a cost savings of $66,930 per year in energy and labor costs = payback of 2.61years.
- **GPR Costs:** SCADA = $175,000[7]
- **GPR Justificatio**n: The SCADA is GPR-eligible per Section 3.5-8[6]: *SCADA systems can be justified based on substantial energy savings*.

[7] Estimate from Custom Electric, Inc. (Electrical contractor for the City of Fruitland WWTP project)

3. Tertiary Filtration

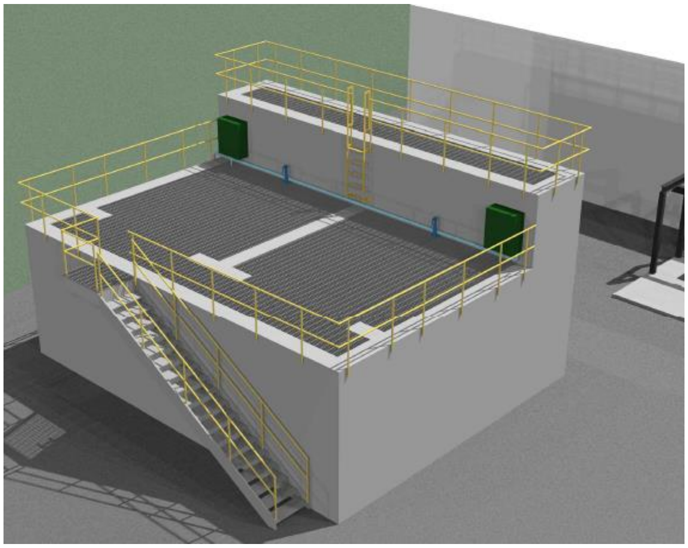
Summary

The project incorporates tertiary filtration for increased removal of suspended solids prior to UV disinfection, resulting in greater UV disinfection capacity at much lower power.

- Energy efficiency (green) portion of loan = 4.8% ($478,525) [Final Installed Cost]
- Estimated annual power savings = 16,381 kWh (30%) = $1,638 per year

Background

- The addition of the tertiary filter reduces the average TSS concentration flowing into the UV vessels from 15 mg/L to 5 mg/L or less. This allows the design UV transmissivity (or the ease at which UV light can pass through the water) to increase from 60% to 70%.
- As UVT improves, more UV light would be able to reach the disinfection target; the UV sensor would read this and adjust the lamps' output down accordingly therefore decreasing the power consumption.
- The energy savings is not completely linear, but UV disinfection suppliers indicate the increase in transmissivity would significantly reduce energy consumption.



- The Wedeco lamps for the UV disinfection are guaranteed for 14,000 hours; this accounts for 100% operation, all the time. Operating capacity does not have as large an effect on lamp life as number of on/off cycles.

Calculated Energy Efficiency Improvements[8]

- Without the tertiary filter the average power draw per UV chamber = 6.31 kW; annual power draw = 55,276 kWh = Annual Energy Costs (@$0.10/kWh) = $5,528.
- With the filter the average power draw = 4.44 kW; annual power draw = 38,894 kWh = Annual Energy Costs (@$0.10/kWh) = $3,889.
- Therefore, with the tertiary filter, the UV disinfection unit uses only 70% of the power required without the filter = 38,894 kWh /55,276 kWh = .70, resulting in an annual cost saving = $1,639.
- Thus, with the tertiary filter, the UV system is more energy-efficient resulting in an annual power savings of 16,382 kWh.

Conclusion

- At 10 cents per kW, UV energy reductions from the tertiary filter saves up to $1,639 per year.
- **GPR Costs**: Tertiary filter = $478,525
- **GPR Justification**: Categorically GPR-eligible per Section 3.2-2[6]: *greater than 20% reduction in energy use*.

[8] 12/2/13 Correspondence with Camp Fuller, Applications Engineer for Xylem Inc.-Wedeco. See Appendix B.

4. UV Disinfection System

Summary

- The Low Pressure High Intensity UV system specified for the Fruitland 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 Fruitland project is more expensive than conventional lamps and would be comparative in price to the medium pressure option.
- Total Loan amount = $10,000,000
- Categorical energy efficient (green) portion of loan = 2.4% ($242,730) [Final Installed Cost]
- Annual Energy savings = 66%

Background

- The City of Fruitland installed two 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. [9] [10]
- 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%.[11]
- The specific lamp installed at the Fruitland WWTP is the WEDECO Spektrotherm UV lamp which has a light yield to energy expenditure 3 times higher in comparison to medium pressure lamps.[12]

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 hours a day for every day of the year, the annual energy consumed by the system is 66,226 kWh/yr.

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. [9] [10]
- 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: $242,730
- **GPR Justification:** Categorically GPR-eligible (Energy Efficiency) per Section 3.2-2[6]: *projects that achieve a 20% reduction in energy consumption*.

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[9] Correspondence from Katie Cook, Senior Applications Engineer for Xylem Inc.-WEDECO UV products. See Appendix C.

[10] Metcalf and Eddy-Wastewater Engineering; Tchobanoglous, Burton, & Stensel, 2003; Table 12-25

[11] Table 2.1 from the USEPA's UV Disinfection Guidance Manual (UVDGM 2006).

[12] Wedeco LBX series UV disinfection system brochure. See Appendix C.

5. Snake River Lift Station

Summary

- Construction of the Snake River Lift Station allowed the entire existing Snake River Treatment Facility (SRF) to be decommissioned and abandoned. The work included the entire lift station structure, mechanical and electrical and 10" force main to gravity interceptor sewer.
- Estimated loan amount = $10,000,000
- GPR portion of loan = 5.5% ($550,000) [Final Installed Cost]

Background

- In the past, 55% of the City's 0.72 MGD of wastewater was sent to the old SRF.[13]
- To send this flow to new Fruitland WWTP on the Payette River, the Snake River Lift Station (SRLS) was constructed at the site of the SRF.

- The 30-year design flow for the SRLS is 1.23 MGD for the average day and 2.28 MGD for the peak hour. [13]
- To meet both the current flows and the future flows, the new SRLS utilizes three (3) 20 hp submersible pumps.
- The SRF was comprised of three lagoons and a headworks building. The main energy requirements at this treatment plant were 12 floating aspirating aerators with 10 hp motors, 3 floating aspirating aerators with 5 hp motors, and the step screen (1.5 hp drive). The aerators operated continuously and the step screen is estimated to have operated 3 hours per day on average.

Energy Efficiency Improvements

- Energy which would have been required to continue to operate the old SRF will be compared with the energy required to operate the new SRLS at the current flows.
- To operate the SRLS with an average flow of 0.40 MGD (55% of 0.72 MGD) would require one 20 hp pump to operate approximately 20 hours a day. The yearly energy consumption for this operation = 108,872 kWh. At $0.10/kWh the annual cost would be $10,887.
- The yearly energy consumption to continue to operate the surface aerators at the SRF = 881,865 kWh. At $0.10/kWh the annual cost would be $88,187.
- Consolidation of the two WWTP into one plant saves labor and travel costs. The distance between the two plants is 4 miles. Costs = 1 person at 8 miles per day (5 days a week) = $3,000 per year in labor costs; travel cost @ $0.51 per mile = $1060 per year. Total savings = $4,060 per year. This assumes the same amount of labor is required after the new WWTP is constructed as is currently required.

Conclusion

- By pumping the wastewater to the new Fruitland WWTP from the old SRF, the project would result 87% less power consumption at the facility than was required in the past at the old SRF.
- **GPR Costs**: The final cost for construction of the Snake River Lift Station and all of its equipment is $550,000.
- **GPR Justification**: The decommissioning of the SRF is categorically GPR-eligible per Section 3.2-2: *projects that achieve a 20% reduction in energy consumption*.

[13] Fruitland Wastewater Treatment Plant Preliminary Engineering Report by Pharmer Engineering, 11/2/2012

6. Interceptor Sewer

Summary

- The Snake River Interceptor Sewer diverts half of the sewage flow from the Snake River side of the collection system away from the Snake River Lift Station (SRLS), effectively reducing pumping requirements by nearly 35%. The GPR-eligible costs include half the cost of the interceptor sewer. The interceptor sewer is currently under contract, and thus costs are known (the final cost of the interceptor sewer project was $795,191.50).
- Total Loan amount = $10,000,000
- Categorical energy efficient (green) portion of loan = 4.0% ($397,595) [Final Installed Costs]
- Annual Energy savings = 43%

Background[14]

- The new Fruitland WWTP and the SRLS were designed to be capable of handling the estimated flows and loads in 30 years. For this reason the 30 year design flows will be used in this analysis.
- With the interceptor sewer in place, the 30 year design peak hour flow to the SRLS is estimated to be 1,130 gpm. The head required by the lift station at this flow is 70.5 feet. To meet this design flow and head three 20 hp submersible pumps (one standby) are required at the SRLS (assuming pump efficiency = 55%).
- Without the interceptor sewer in place, the 30 year design peak hour flow to the SRLS is estimated to be 1,707 gpm. The head required by the lift station at this flow is 83.1 feet. To meet this design flow and head three 35 hp submersible pumps (one standby) will be required at the SRLS (assuming pump efficiency = 55%).
- The interceptor sewer will reduce the cost to the City because the smaller pumps at the SRLS will have a lower capital cost and the pumping requirements will be significantly reduced.

Results

- Assuming that pumping operations at the SRLS will occur 20 hours per day and two pumps are required to operate in parallel, the energy required by the SRLS with and without the interceptor sewer at the different design flows is shown in the table below:

	Flow (gpm)	**Annual Energy Consumption (kWh)**	**Annual Energy Cost (@ $0.10/kWh)**
With Interceptor Sewer	1,130	108,574	$10,857
Without Interceptor Sewer	1,707	190,000	$19,000

Energy Efficiency Improvements

- The resulting reduction in energy requirements with the new system = 1 – (108,574 ÷ 190,000) = .43 = 43%

Conclusion

- By diverting over 30% of the flow that would have gone to the SRLS into a gravity sewer line instead the City reduced the energy requirements by 43% at the SRLS.
- **GPR Costs:** Interceptor Sewer: $795,191/2 = $397,595
- **GPR Justification:** Categorically GPR-eligible (Energy Efficiency) per Section 3.2-2[6]: *projects that achieve a 20% reduction in energy consumption.*

[14] 11/1/13 Correspondence with Russell Brooks, P.E., and Jordi Figueras, P.E., Pharmer Engineering

7. POTW Unit Process: Biological Nutrient Reduction

Summary

- An innovative biological nutrient removal (BNR) system has been incorporated into the treatment process which results in phosphorus removal without chemical addition.
- Total Loan amount = $10,000,000
- Categorical energy efficient (green) portion of loan = 35.6% ($3,558,714) [Final Installed Cost]

Background[15]

- The City's NPDES permit has both nitrogen and total phosphorus effluent limits.
- The secondary treatment system was configured to provide biological removal of nitrogen and phosphorus.
- BNR is a proven innovative technology that can significantly reduce nitrogen and phosphorus levels in WWTP effluent.
- The oxidation ditch system incorporates biological nitrogen and phosphorus removal via anoxic and anaerobic zones, respectively.

Treatment Description[15]

- Nitrification and denitrification is performed via extended aeration coupled with anoxic recycle. The internal recycle ratio determines the percent removal of non-biological nitrogen. A 4x the influent flow recycle ratio removes an estimated 80% of the nitrogen not associated with biological growth.
- The biological phosphorus removal system incorporates an anaerobic zone with RAS recycle from the secondary clarifiers. 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.
- Efficient solids separation is necessary to maintain the low phosphorus concentration, which is provided via modern clarifiers, and backed up via tertiary filtration.

Innovative Process Justification[16]

- The GPR-eligibility of BNR was established by comparison to a Baseline Standard Practice (BSP). The BSP was derived from an analysis of viable and relevant treatment technologies measured against a broad set of weighted criteria.
- The BSP for the City of Fruitland is conventional aerobic treatment without anaerobic or anoxic zones and with chemical addition for phosphorus removal which scored closest to the chosen technology and was the second most efficient process considered in terms of chemical use and chemical sludge production, and the second in overall scoring.
- Annual chemical use for the BSP averages 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.

Conclusion

- BNR is GPR eligible as, compared to the BSP, BNR 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 = $3,558,714[17]
- **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*.

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[15] Fruitland Wastewater Treatment Plant Preliminary Engineering Report by Pharmer Engineering, 11/2/2012

[16] See calculations included in Appendix D.

[17] The cost of premium efficiency motors and VFDs has already been used toward the energy efficient portion of the loan as part of item 1