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March 22, 2012

Rebecca Poole, P.E.
Engineering Manager
DWSRF
Water Quality Division
707 N. Robinson
P.O. Box 1677
Oklahoma City, Oklahoma 73101-1677

Re: City of Pawnee Water Treatment Plant
PWSID No. OK1021209
Green Project Reserve Business Case

Dear Rebecca:

In response to your email message from March 14, 2012, the following are the responses to the request for additional information pertaining to the Green Project Reserve Business Case for the SCADA system and VFDs for the Pawnee Water Treatment Plant:

1. Please provide the individual efficiencies of the existing pump and motor. You provided the Wire-to-Water, but we would also like to see the individual efficiencies.
   - ***The existing high service pumps have a pump efficiency of 78% and a motor efficiency of 90%.***

2. Please provide an information source for the statement that SCADA will save 1-4 hours of operating time.
   - ***The assumed savings for the use of VFDs in tandem with the SCADA system for the high service pumps is based upon proceedings from the 25th World Energy Engineering Congress, which cites a 1998 report published by the American Water Works Association Research Foundation that quantified the extent of savings which SCADA system operation can achieve. The findings showed that shifting pump operation from peak demand hours to off-peak hours in addition to variable speed operation resulted in as much as 20% savings in costs and duration of operation. The quantification of 20% of a 24-hour day results in anywhere between 0-5 hours in savings.***

3. You have stated that the assumption for 3 hours of operating time savings is a conservative amount, but it appears to be at the upper end of the range stated of 1-4 hours. Please provide additional information or justification for this assumption.
   - ***The previous attempt at quantifying the use of a SCADA system and VFDs further cited a case study from Irving, Texas that showed that using pumping optimization***

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in conjunction with a SCADA system saved approximately 14% in energy and operation over a 5-year period. Given the availability of actual data similar in application to the proposed improvements in Pawnee, it was assumed to be a more accurate quantity to apply to the estimate of savings. This resulted in approximately 3 hours of savings.

4. Please provide the average run times for the pumps, PD blower and Clarifier Mixers. I noticed that you stated that there is not a lot of historical data, so please provide whatever information you have that could help verify the appropriateness of allowing a 3 hour per day reduction.
   - ***The pumps were assumed to have a savings in the range of 3 operating hours based on the discussion given above and the absence of having to operate the high service pumps at the max end of their capacity with the switch to a variable speed drive. The switch from fully on/fully off to a variable speed based on flow is not easily quantifiable but is assumed to be incorporated into the 3hours in savings.***

     The positive displacement blower will be used for filter backwash. The SCADA system will operate the blowers based on the pressure differential across the filter. The system will have a pressure loss set point, which will initiate the backwash cycle. Current operation without automation results in three backwash cycles of 30 minutes each per day, or 1.5 hours per filter. Based on automation through the SCADA system, the new process will backwash each filter once a day for 25 minutes. When applied to both filters, this should result in a savings of 2 hours 10 minutes. To be conservative, a value of 1.5 hours was used for the savings calculations.

     No data was available for the clarifier mixer mechanisms, but based on similar plant operation, without a SCADA system, the mixer drives operate at full throttle. However, with the proposed SCADA system, the mixer drive speed will be determined by the amount of a sludge blanket in the bottom of the clarifiers

If you have any questions, please feel free to contact me anytime at (405) 755-5325 or by email JeremyS@mecc.us.com.

Best Regards,

Jeremy W. Steeley, *B.S.Ch.E.*
Myers Engineering, Consulting Engineers, Inc.

cc: Tiger Feng, Project Engineer, ODEQ DWSRF
Bill Myers, P.E., Myers Engineering, Consulting Engineers, Inc.
MEC 28091 file

Summary

- DWSRF loan amount = $1,775,000
- Plant SCADA System Initial Capital Investment = $120,000
- VFDs = $10,000
- Total Cost of Improvements = $130,000
- Annual energy savings = 108,038 kWhrs
- Estimated lifetime savings = **<u>$216,076</u>**
- Install a plant-wide Supervisory Control and Data Acquisition (SCADA) System, coupled with Variable Frequency Drives (VFDs) on pumps and mechanical equipment capable of operating the Pawnee Water Treatment Facility remotely and allow automated operation based on a design capacity of 0.7 MGD.
- The SCADA control and monitoring system and VFDs will: (1) reduce energy usage by allowing selection and maintenance of optimum set points throughout the water treatment plant and process, (2) enable the remote start and stop of the finished water pump station, and (3) eliminate the need for manual pump and equipment operation, saving man hours as well as energy consumption.

Background

- The lack of a SCADA system results in the need for manual operation of pumps, valves, feed systems, equipment, and related appurtenances.
- The functions to be controlled and/or monitored shall include: existing influent raw water pump, all mechanical equipment relating to the operation of the solids contact clarifiers including mixers and scrapers, influent and effluent valves, blower system for filter bed cleaning, backwash pumps, high service finished water pumps.
- The use of VFDs in tandem with the SCADA system allows the pump motors to be gradually ramped up to operating speed when the distribution system calls for the high service pumps to initiate. This reduces electrical and mechanical stress on the pump/motor components and reduces the maintenance and repair costs in addition to extending the life of the equipment. Additionally, the current finished water pumps are not on a variable frequency drive, and given the average system demand results in operation of an overdesign (operated at peak load bearing rather than operated for average demand).
- The use of VFDs offers a cost-effective method to match driver speed to load demands and presents the Pawnee Water Utility an opportunity to reduce operating costs, increase productivity and operate the pumps and system at a higher efficiency.

Results

- Through the use of the SCADA system in tandem with VFDs, the automated operation of the pumps throughout the proposed plant will reduce the run-time of each pumping component, minimize labor costs, reduce maintenance and repair costs, and extend the overall life of the pumps and motors. SCADA remote telemetry will communicate with water storage towers relaying high and low water levels to initiate the finished water pumps. Due to the lack of historical data on these particular components we conservatively estimate approximately three (3) hours of run-time per day can be saved through automated operation using a SCADA system and controlling the high service pumps with a variable frequency drive system. This is an assumed conservative value, as accepted values typically range from 1-4 hours per day of saved operating time by switching to automated operation from a manual fully on/fully off control system and load bearing operation.
- The following table details the power and energy savings that can be realized, on an annual basis, by equipping the new high service pumps with VFDs and also incorporating the pumps into the SCADA system. The annual savings were based on an assumed energy cost of $0.10 per kWhr.

Equipment Unit	Number of Pumps	TDH	Wire-to-Water Efficiency	Flowrate (gpm)	Power (kW)	Annual Power Savings (kWhrs)
High Service Pumps	2	330	0.672672	500	46.21	101197.2
					Estimated Annual Power Savings =	101197
					Estimated Annual Savings =	$10,119.72
					Estimated Lifetime Savings (20 yrs) =	**$202,394**

Table 1: Energy savings on high service pumps from VFD and SCADA operation.

The required power calculation for Table 1 was based on the equation:

Power (kW) = flow (gpm) * TDH * 0.746 / (3960 * Wire-to-Water Efficiency)

Wire-to-Water Efficiency = Pump Eff * Motor Eff

- The total pump energy savings with the VFDs and SCADA system is approximately $10,119 per year.
- In addition to the pumps, additional energy savings would be realized through automated operation of the various other mechanical appurtenances via the proposed SCADA

system. The other pieces of mechanical equipment were conservatively assumed to save an average of 1.5-hours of run time each per day. Based on a power cost of $0.10/kWhr, the estimated energy savings are given in Table 2 below.

Equipment Unit	Number of Units	Motor (hp)	Power (kW)	Annual Power Savings (kWhrs)
PD Blower	1	15	11.025	6036.2
Clarifier Mixers	2	1	0.735	804.8
Estimated Annual Power Savings =				6841
Estimated Annual Savings =				$684.10
Estimated Lifetime Savings (20 yrs) =				$13,682

Table 2: Energy savings on mechanical equipment from VFD and SCADA operation.

- The estimated annual energy savings for the SCADA automation of mechanical equipment is approximately $684 per year. This analysis is conservative and does not include all equipment to be automated and/or monitored by the proposed SCADA system and simply represent those appurtenances of which power data was available for analysis

Conclusion

- The monitoring and automation of the pumping system and the mechanical equipment by the proposed SCADA system and VFDs is estimated to provide an annual energy savings of about 108,038 kWhrs or approximately $10,803 per year based on electricity rates of $0.10/kWhr. This equates to a total of approximately $216,076 over the life of the system.
- In addition to the energy savings provided by SCADA operation, the system will reduce the amount of time spent by the operator(s) for manual monitoring of all the processes and manual operation of all pieces of equipment. The SCADA system will incorporate real-time data and information in a single interface or at the proper terminal relating to what is being monitored. The cost savings associated with automatic operation and monitoring is estimated at one man-hour per day. Assuming an hourly wage rate of $15, this equates to approximately $5,500 per annum of saved labor for a total of $110,000 over the 20 year design life of the plant.
- The simple break-even period for the proposed SCADA system with VFDs is estimated at less than 8 years ($130,000 total capital at $16,303 savings per year). This concludes

that the SCADA system and VFDs will pay for themselves well within the approximate half-life of its 20 year design life and within the first 8 years of operation.

- Furthermore, repair and maintenance costs will be greatly reduced, as minimal operational duration would be achieved during low-demand times with a SCADA controlled system. Additionally, VFDs will greatly reduce mechanical and electrical stresses on the pumping motor systems. These savings were not quantified in this analysis; however, these benefits would be realized by implementing the proposed project.
- The SCADA system, VFDs, and labor saved through automated operation, yield an estimated total savings of approximately $326,000 over the 20-year design life of the plant and conservatively, more than $240,000 over a fifteen year period (time elapsed since last upgrade), not accounting for inflation.

Oklahoma Drinking Water State Revolving Fund
Green Project Reserve Checklist

Applicant: City of Pawnee/Pawnee Public Works Authority
Project Number: P40-1021209-01
Date: 03/07/2012

The Green Project Reserve (GPR) includes four types of projects: Green Infrastructure, Water Efficiency, Energy Efficiency and Environmentally Innovative. All GPR projects must meet DWSRF eligibility requirements. Please check all green components or activities that are applicable to your project. Additional information concerning categorically green and business cases is available in the Oklahoma DWSRF Green Project Reserve Guidance Document (DW-621). Please submit this checklist and all applicable attachments (business case, cost estimate with each green component highlighted, etc.) to your DWSRF Project Engineer.

Green Infrastructure

Green stormwater infrastructure includes a wide array of practices at multiple scales that manage wet weather and that maintains and restores natural hydrology by infiltrating, evapotranspiring and harvesting and using stormwater. On a regional scale, green infrastructure is the preservation and restoration of natural landscape features, such as forests, floodplains and wetlands, coupled with policies such as infill and redevelopment that reduce overall imperviousness in a watershed. On the local scale, green infrastructure consists of site- and neighborhood-specific practices, such as bioretention, trees, green roofs, permeable pavements and cisterns.

☐	Pervious or porous pavement	Categorically Green
☐	Biorentention	Categorically Green
☐	Green roofs	Categorically Green
☐	Rainwater harvesting/cisterns	Categorically Green
☐	Gray water use	Categorically Green
☐	Xeriscape	Categorically Green
☐	Landscape conversion programs	Categorically Green
☐	Retrofitting or replacing existing irrigation systems with moisture and rain sensing equipment	Categorically Green
☐	Other green infrastructure	Business Case Required

Water Efficiency

EPA's WaterSense program defines water efficiency as the use of improved technologies and practices to deliver equal or better services with less water. Water efficiency encompasses conservation and reuse efforts, as well as water loss reduction and prevention, to protect water resources for the future.

☐	Installing or retrofitting water efficient devices such as plumbing fixtures and appliances	Categorically Green
☐	Installing any type of water meter in previously unmetered areas, if rate structures are based on metered use	Categorically Green
☐	Replacing existing broken/malfunctioning water meters with Advanced Meter Reading systems (AMR)	Categorically Green
☐	Retrofitting/adding AMR capabilities or leak equipment to existing meters (not replacing the meter itself).	Categorically Green
☐	Recycling and water reuse projects that replace potable sources with non-potable sources,	Categorically Green
☐	Retrofit or replacement of existing landscape irrigation systems to more efficient landscape irrigation systems, including moisture and rain sensing controllers	Categorically Green
☐	Projects that result from a water efficiency related assessments (such as water audits, leak detection studies, conservation plans, etc) as long as the assessments adhered to the standard industry practices referenced above	Categorically Green
☐	Distribution system leak detection equipment, portable or permanent.	Categorically Green
☐	Automatic flushing systems (portable or permanent).	Categorically Green
☐	Pressure reducing valves (PRVs).	Categorically Green
☐	Internal plant water reuse (such as backwash water recycling).	Categorically Green
☐	Water meter replacement with traditional water meters	Business Case Required
☐	Distribution pipe replacement or rehabilitation to reduce water loss and prevent water main breaks	Business Case Required
☐	Storage tank replacement/rehabilitation to reduce water loss	Business Case Required
☐	New water efficient landscape irrigation system (where there is currently not one)	Business Case Required

Energy Efficiency

Energy efficiency is the use of improved technologies and practices to reduce the energy consumption of water quality projects, use energy in a more efficient way, and/or produce/utilize renewable energy.

☐	Renewable energy projects, which are part of a public health project, such as wind, solar, geothermal, and micro-hydroelectric that provide power to a utility (http://www.epa.gov/cleanenergy). Micro-hydroelectric projects involve capturing the energy from pipe flow.	Categorically Green
☐	National Electric Manufacturers Association (NEMA) Premium energy efficiency motors	Categorically Green
☒	Energy efficient retrofits, upgrades, or new pumping systems and treatment processes (including variable frequency drives (VFDs)).	Business Case Required
☐	Pump refurbishment to optimize pump efficiency (such as replacing or trimming impellers if pumps have too much capacity, replacing damaged or worn wearing rings/seals/bearings, etc.).	Business Case Required
☐	Projects that result from an energy efficiency related assessments (such as energy audits, energy assessment studies, etc), that are not otherwise designated as categorical.	Business Case Required
☐	Projects that cost effectively eliminate pumps or pumping stations.	Business Case Required
☐	Projects that achieve the remaining increments of energy efficiency in a system that is already very efficient.	Business Case Required
☐	Upgrade of lighting to energy efficient sources (such as metal halide pulse start technologies, compact fluorescent, light emitting diode, etc).	Business Case Required
☒	Automated and remote control systems (SCADA) that achieve substantial energy savings	Business Case Required

Environmentally Innovative

Environmentally innovative projects include those that demonstrate new and/or innovative approaches to delivering services or managing water resources in a more sustainable way.

☐	Utility Sustainability Plan consistent with EPAs SRF sustainability policy	Categorically Green
☐	Greenhouse gas (GHG) inventory or mitigation plan and submission of a GHG inventory to a registry (such as Climate Leaders or Climate Registry), as long as it is being done for a facility which is eligible for DWSRF assistance.	Categorically Green
☐	Source Water Protection Implementation Projects	Categorically Green
☐	Construction of US Building Council LEED certified buildings, or renovation of an existing building, owned by the utility, which is part of an eligible DWSRF project.	Categorically Green
☐	Projects, or components of projects, that result from total/integrated water resources management planning (including climate change) consistent with the Decision Criteria for environmentally innovative projects and that are DWSRF eligible.	Business Case Required
☐	Application of innovative treatment technologies or systems that improve environmental conditions and are consistent with the Decision Criteria for environmentally innovative projects, such as projects that significantly reduce or eliminate the use of chemicals in water treatment; or treatment technologies or approaches that significantly reduce the volume of residuals, minimize the generation of residuals or lower the amount of chemicals in residuals; or trenchless or low impact construction technology; or use of recycled materials	Business Case Required
☐	Educational activities and demonstration projects for water or energy efficiency (such as rain gardens).	Business Case Required
☐	Projects that achieve the goals/objectives of utility asset management plans	Business Case Required

Form completed by:

JEREMY STEELEY
Typed or Printed Name

EI
Title

405-755-5325
Phone Number

JeremyS@mecc.us.com
E-mail Address

Attachments:

☒ Business Case(s)
☒ Project Cost Estimate with Green Components marked or highlighted
☐ Other ______________________

Pawnee Public Works Authority

Drinking Water SRF Note, Series 2012
Water Treatment Plant Improvements

Based on Bids 02-15-2012

Component	Low Bid Amount	Engineering Grant	Pawnee Funding Contingency	I H S Funds	DWSRF Loan Amount
Construction	1,879,000.00			355,000.00	1,524,000.00
Contingency	93,831.18		71,125.00		22,706.18
Engineering	157,943.10	68,875.00			89,068.10
Construction Staking	36,155.72				36,155.72
ODEQ Permit Fee	2,910.00				2,910.00
Inspection	40,000.00				40,000.00
Testing	7,500.00				7,500.00
Financial Advisor Fee w/ Expenses	17,000.00				17,000.00
Bond Counsel Fee w/ Expenses	17,000.00				17,000.00
Local Counsel Fee	15,000.00				15,000.00
ODEQ Permit Fee	2,910.00				2,910.00
Trustee Bank Fee	750.00				750.00
Total Loan Amount	**2,270,000.00**	**68,875.00**	**71,125.00**	**355,000.00**	**1,775,000.00**