Drinking Water State Revolving Fund Green Project Reserve Business Case Examples

The following is a collection of hypothetical business cases designed to illustrate simple, effective approaches for water systems applying for Green Project Reserve assistance.

Example #1: Pipe Replacement

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Pipe Replacement

Summary

- Replacement of 24,000 feet of pre-1930s lead-jointed cast iron (CI) distribution pipe with new 8-inch to 16-inch ductile iron (DI) pipe to eliminatethe loss of 115 million gallons of water per year (MGY) -- 10% of production.
- Loan amount = $2,500,000
- Water saving (green) portion of loan = $250,000 (10% of total loan)
- Annual water saving = 115 million gallons (MG)

Background

- The treatment system was constructed in 1949 and upgraded in 2002. The water system includes approximately 80 miles of CI and DI distribution pipe ranging from 6 to 16 inches in diameter. The treatment plant processes an average of 3 milliong gallons per day (MGD) or 1,095 million gallons per year (MGY).
- As part of a water loss management plan, the water system evaluated trends in distribution pipeline repairs from 2000-2007 to identify potential pipeline replacement projects.
- The system determined that the pre-1930s distribution pipe incurred the most repairs.
- The pre-1930s pipe account for 17% (13.6 miles) of the 80 miles of distribution pipe. This project will replace 24,000 feet of pipe with 8-inch to 16-inch DI pipe.

Results

- The water system made 175 pipeline repairs from 2000-2007; the highest frequency of repairs was in the pre-1930s pipes and were equally distributed among all sizes.
- The system submitted documentation showing the distribution system and the schedule of pipe replacemt as well as the pipe break distribution frequency by the age of pipe.
- Avg. 8.36 leaks per mile by the length of pipe.
- Avg. leak volume is 3.1 million gallons (1,067 gpm using Greeley's formula).

To Calculate Water Loss

- 37 leaks*3.1 million gallons per leak = 115 MGY from the leaking from pipes scheduled for replacement.
- To calculate overall water loss, subtract the water billed/consumed: 1,095 MGY - 876 MGY = 219 MGY of water pumped is lost (20%).
- The estimated 115 MGY of water loss from the pre-1930s pipe is 52% of the overall water loss of the system: 115 / 219 = 52%.

Conclusion

- By replacing the 24,000 feet of pipe the system anticipates conserving 115 MGY (52% of overall water loss). The cost to pump/treat water is $1.53 per 1,000 gallons. Cost savings from reduced leaks are estimated at $175,950 (115,000 gallons * $1.53).
- Additional benefits include reductions in unnecessary pumping and operation and maintenance expenditures and eliminating potential health hazards associated with waterborne pathogens entering the water distribution system.

Existing Water Meter Replacement

Summary

- Replacement of all water meters, which are past the end of their useful lives, to eliminate 514 million gallons of water loss per year (MGY).
- Loan amount = $750,000.
- Water saving (green) portion of loan = 100% ($750,000).
- Annual water savings = 514 MG.

Background

- The water system was designed and built in the late 1940s. It serves approximately 800,000 people and has approximately 320,000 residential connections. Total annual water use is 51,388 million gallons or 141 millions gallons per day (MGD).
- Water meters were installed at all connections in 1982, and the manufacturer specified that the meters' useful life would be approximately 25 years. Based on an original installation date of 1982, the meters passed the end of their useful lives in 2007.
- Graphs provided by the system demonstrate this increased water loss, due to leaks and inaccurate readings, attributed to the old meters.

Results

- To gauge the water lost by the meters, the system estimated a 25-year-old meter to be 99% accurate and a 30-year old meter to be 82% accurate. Therefore, the annual water loss attributed to meters is estimated at 514 million gallons (1% of annual production) and will get much worse over time.
- It takes 1.50 kilowatt hours (kWh) of electricity to treat 1,000 gallons of water. At a cost of 10 cents per kWh, the water loss costs the system at least $77,000 annually from the electricity required for treatment and pumping. The system included these calculations in an attachment.
- The estimated cost of the meter replacement project is $750,000; the project will pay for itself in less than 10 years.

Other Benefits

- Replacing the old, leaking meters will increase water efficiency by decreasing the amount of water lost and by providing more accurate water-use information to customers and the system.

Conclusion

- The water system will realize $77,000 in savings in annual electricity costs as a result of reducing water lost from malfunctioning meters by 514 MG.
- Accurate metering of water consumption is an important water conservation measure because inaccurate metering provides customers with misleading information regarding water consumption. Providing more accurate water bills will send a stronger price signal to customers and will result in more efficient water use by customers.
- Billing inaccuracies (unbilled water consumption) result in lost revenue for the water system.
- Water leakage and inaccuracy increases with water meter age; therefore, an investment in water meters today will lead to additional water and dollar savings over time. Also, meter replacement will extend the life of the water supply and delay capital expansion projects.

Storage Tank Replacement

Summary

- Replacement of the Valley Shoulder water storage tank will improve water efficiency of the system by eliminating 7.2 million gallons of annual water loss and result in additional water storage capacity and significantly more efficient use of water resources by eliminating current waste.
- Loan Amount = $510,000
- Water Savings (Green) Portion of Loan = $225,000
- Annual Water Savings = 7,200,000 gallons

Background

- The Valley Shoulder potable water distribution tank is located at a 150 feet lower elevation than the North tank. This configuration effectively stops water from flowing out of the Valley Shoulder tank when the North tank is at normal operating levels (pressure difference of 65 psi).
- As a result of the current configuration, the water within the Valley Shoulder tank stagnates, and loses its residual chlorine. The water tank must then be emptied and refilled weekly to ensure that potable water is available.
- Currently, approximately 600,000 gallons of water (5.9% of current monthly use) is drained on a monthly basis from the 150,000 gallon Valley Shoulder tank.

Results

- The system provided a copy of a design incorperating proposed upgrades.
- By replacing the Valley Shoulder tank with a larger storage tank that matches the North tank elevation, both storage tanks will drop and fill at similar levels thus reducing the amount of stagnant water that must be discarded (7,200,000 gallons annually).
- The annual water savings are calculated at $55,000 and the annual fuel costs for the pumps moving 150,000 gallons of capacity upslope is $225,000; the simple payback period on this investment is 4.1 years.
- The system analysed the costs and benefits of a new storage tank.

Conclusion

- Construction of a new water storage tank is the most cost-effective and sustainable solution. The new storage tank will save 7,200,000 gallons of water annually and reduce the systems treatment costs.
- With a capacity of 340,000 gallons, the new tank will improve service pressure, decrease water waste, and increase infrastructural reliability as well as well as increase the overall capacity to match recent population growth.
- Implementing the project instead of maintain status quo will delay the need for plant expansions and there will be less water taken from the source water body (Sawgaha River), which is important for maintaining its habitat quality, especially during drought conditions.

Treatment Process Selection

Summary

- Water system will use an innovative approach of blending groundwater with treated surface water to reduce disinfection byproducts (DBP) concentrations, reduce system costs, and conserve water resources.
- Loan amount = $4.2 million
- Water savings (green) portion of loan = 100%
- Annual water savings = 620 million gallons per year (MGY) (3.2% of water used)

Background

- The system withdraws19.1 BGY from the only surface water source in the area: a river in an arid region of the Southwest, which contains significant levels of organic matter. Total organic carbon (TOC) in the surface water is 10 parts per million (ppm).
- The surface water is treated using conventional treatment and chlorine disinfection. DBPs are created during the treatment process and their resultant annual average concentration exceeds EPA's new regulatory standards. The system submitted supporting DBP water quality data.
- The water system has rights to groundwater that contains less than 0.1 ppm TOC.

Proposal

- The treated surface water will be diluted at the storage tank with the groundwater (i.e. 23% groundwater to 77% treated water blend) to lower the DBP concentrations in the finished water. Based on modeling, during a peak day, 37 million gallons of treated surface water would be mixed with 11 million gallons of groundwater withdrawn from the aquifer to provide 48 million gallons of water that meets all water quality standards.
- The system provided a diagram of the system with proposed treatment.
- Prior to blending, 23% of the treated surface water in the storage tank will be diverted to injection wells to recharge the aquifer and replace the groundwater withdrawn.
- The vadose zone of the aquifer is a desirable mixture of sand and unconsolidated clay that will naturally filter out much of the TOC and DBPs in the treated surface (recharge) water.
- Groundwater wells will be located at least 1 kilometer from the injection wells to maintain steady-state aquifer level change of about 17 feet from the high point where the treated surface water is injected to the low point where it is recovered. Because the aquifer is normally at saturated depth of 130 feet, the injections and withdrawals should not be a significantly disturb the aquifer.
- The blending technique was chosen over a granulated activated carbon (GAC) filter becaise the GAC system was determined not feasible due to the size of the filter required, the life-cycle costs of the system, its additional energy consumption, and backwash water waste. A GAC system would increase water use by an estimated 620 MGY.

Conclusion

- Blending groundwater blending instead of using a GAC system will avoid the withdrawal of 620 million gallons each year from the surface source and will help maintain the riparian habitat of endangered wildlife.
- Groundwater blending will save energy, conserve water, and avoid the purchase of GAC equipment and its associated operation and maintenance costs.
- Incorporating groundwater into the potable water supply may improve its taste.

High-Service Pump and Motor Replacement

Summary

- Large-scale pipe replacement project includes replacement of high-service pump station with two large pumps and motors.
- Estimated loan amount = $2.8 million
- Estimated energy efficiency (green) portion of loan = $200,000
- Estimated annual energy savings range from 22.9% to 24%.

Background

- The high-service pump station was constructed 100 years ago. The existing pump system is about 30 years old. The existing pumps are rated at 200 gpm at 154 feet with a manufacturer-rated efficiency of 77%. Existing motors were rated at 85%. The actual operating efficiency probably is lower because of the age of the pump system.
- The replacement of the high-service pump station will also include installation of variable frequency drives.

Results

- The proposed new pumps will have a rated efficiency of 89%.
- The proposed new motors will have a rated efficiency of 93.5%.

To Calculate Energy Efficiency Improvements

- Standard pumps have efficiency ratings of 72.5%.
- Standard motors have efficiency ratings of 89%.
- Total efficiency (wire-to-water) for pumps and motors is the product of pump efficiency times motor efficiency.
- Therefore, the efficiency of standard pumps and motors =

$$72.5\% * 89\% = 64.5\%$$

- The efficiency of proposed pumps and motors =

$$89\% * 93.5\% = 83.2\%$$

- To compare the efficiency of proposed pumps and motors with standard pumps and motors, divide the total efficiency of the proposed components by the efficiency of the standard components:

$$83.2\% / 64.5\% = 1.29$$

- Thus, the increased wire to water efficiency is 29%. This level of efficiency exceeds the minimum required for pumps and motors to be included in the Green Project Reserve.

Conclusion

- By replacing the pumps and motors in the high-service pump station, and by adding variable frequency drives to the pump systems, the system will reduce energy use by 22.9% (for maximum day operation) to 24.0% (for average day operation).

Intake Pump and Motor Replacement

Summary

- Replacement of two raw water intake pumps and motors with high-efficiency models fitted with variable frequency drives (VFDs) to improve energy efficiency. Replacement is associated with a 1 million gallons per day (MGD) surface water treatment plant expansion.
- Loan amount = $1.8 million
- Energy saving (green) portion of loan = $140,000
- Annual energy saving = 81,265.84 kWh

Background

- The current surface water treatment plant was built in the 1970s and is composed of older infrastructure, including older constant speed pumps.
- The plant is operating at capacity of 1 MGD, and the associated project includes a 1 MGD expansion (storage and pump station).
- The system underwent an energy audit as part of the design of the treatment plant expansion and concluded that replacement of the intake pump systems was the most cost-effective option for energy efficiency.

Results

- Two existing constant speed raw water pumps will be replaced with 2 high efficiency vertical turbine deep shaft raw water pumps fitted with VFDs.
- The new pumps are rated at 84% efficiency and the motors are rated at 93% efficiency.

To Calculate Energy Efficiency Improvements

- Standard pumps have efficiency ratings of 72.5%.
- Standard motors have efficiency ratings of 89%.
- Therefore, the total efficiency of standard pumps and motors =

$$72.5\% * 89\% = 64.5\%$$

- The total efficiency of the proposed new pumps and motors =

$$84\% * 94\% = 78.1\%$$

- To compare the efficiency of proposed pumps and motors with standard pumps and motors, divide the total efficiency of the proposed components by the total efficiency of the standard components:

$$78.1\% / 64.5\% = 1.21$$

- The increase in efficiency is 21%. This value exceeds the minimum required for pumps and motors to be eligible for assistance under the Green Project Reserve.
- The existing raw water pumps consume: 251,858 kWh per year; the new pump systems will consume an estimated to be 170,592 kWh per year.
- Improved energy efficiency: 251,8578 – 170,592 = 81,266 kWh per year.
- At $0.096 per kWh, annual savings are 81,266 kWh * $0.096 = $7,802 per year.

Conclusion

- Pump and motor replacement will have a noticeable impact on energy consumption, and the use of VFDs will allow more control over the on/off cycling of the pumps.
- These changes will result in an estimated energy savings of almost $7,802 per year.