MISSOURI DEPARTMENT OF NATURAL RESOURCES

St. Louis

Drinking Water State Revolving Fund Green Project Reserve
Business Case

State Fiscal Year 2013 Intended Use Plan

Project Number DW291280-12

Loan Date: November 13, 2013

Green Estimated Costs: $3,079,331

Water System Improvements for St. Louis, Missouri
Business Case

Summary

- The purpose of the project is to provide Chain of Rocks Water treatment plant with improvements that include: the replacement of the existing 1950's vintage, 50 million gallon per day (MGD) raw water pumping unit with a new efficient 25 mgd pumping unit; replacement of the existing 1960's vintage, 50 MGD finished water pumping unit with a new efficient 15 mgd pumping unit; and replacement of three (3) 78 inch steel pipe segments two (2) header vaults and plant service piping; Hall Street Manifold Chamber improvements including the replacement of nine (9) 48-inch valves and piping; replacement of existing software to model water quality issues; and the replacement and addition of approximately 4,550 feet of six-inch (6") water main and 2,400 feet of eight-inch (8") water main, 3,400 feet of twelve-inch (12") water main 3,000 feet of twenty-inch (20") transmission main; and all the necessary appurtenances to complete the project and have an usable system. The addition and replacement of the water mains for this project is to provide looping, to address system failures, such as the nearly 150 leaks and water main breaks costing $1,500,000 in repairs, and provide the expected capacity due to the forecasted growth.
- SRF Assistance Amount: $9,500,000.00
    - 6" to 12" pipe replacement = $1,365,153 = 14.4%
    - New 15 MGD Finished water pumping unit = $766,578 = 8.1%
    - New 25 MGD Raw water pumping unit = $947,600 = 10%

Background

- The water source for the city's water system comes from the Missouri and Mississippi Rivers.
- The distribution system consists of approximately 1,400 miles of water mains. The distribution system also includes a total system storage capacity of 145 million gallons.
- The city's drinking water system currently serves approximately 1,140 meters, with an average daily water demand of 135 million gallons per day (MGD) and a peak day demand of approximately 360 MGD. Recent history indicates that the water demand for the city has been steadily increasing. The future estimated connections to be served for the year 2030 will be approximately 1,622 with an average daily demand of approximately 202.5 MGD and 540 MGD for peak daily demand.
- Replacing the two aging 50 MGD pumping units with smaller and more efficient units will yield energy savings. The annual power consumption for the proposed pumps will reduce the cost and provide savings to the system.

- Approximately 10,350 feet of 6 to 12-inch mains are proposed for replacement. There have been nearly 150 leaks and breaks on these mains costing nearly $1,500,000 in repairs.
- The pipe replacement is estimating to account for approximately 71 million gallons per year (MGY).
- Customers pay a flat rate for their drinking water. The replacing of pipeline will reduce the amount of treated water saving on the cost of pumping and treatment.

Results

- The proposed new finished water pump will have a rated efficiency of 81%.
- The proposed new raw water pump will have a rated efficiency of 85%.

Calculated Energy Efficiency Improvements

- The power required for the new 15 MGD finished water pump to operate can be calculated based on the pump capacity of 10,410 gpm and the Total Dynamic Head (TDH) of 204 feet. The power required for the old 50 MGD finished water pump to operate can be calculated based on the pump capacity of 34,722 gpm and the TDH of 204 feet. The power required for the existing aging pump is 1336 kilowatts (kW). The power required for the proposed pump is 401 kW.
- The power required for the new 25 MGD raw water pump to operate can be calculated based on the pump capacity of 17,361 gpm and the Total Dynamic Head (TDH) of 56 feet. The power required for the old 50 MGD raw water pump to operate can be calculated based on the pump capacity of 34,722 gpm and the TDH of 56 feet. The power required for the existing aging pump is 366 kW. The power required for the proposed pump is 183 kW.
- The annual power consumption for the existing or the proposed system can be calculated from the number of hours each pump operates. For the existing 50 MGD finished water pump, the estimated annual power consumption is 5,409,636 kWh. For the proposed 15 MGD finished water pump, the estimated annual power consumption is 2,963,403 kWh.
- For the existing 50 MGD raw water pump, the estimated annual power consumption is 704,422 kWh. For the proposed raw water pump, the estimated annual power consumption is 646,411 kWh.
- As shown in the table below, the energy difference for the finished water pump = (5,409,636 kWh – 2,963,403 kWh) = 2,446,233 kWh.
- As shown in the table below, the energy difference for the raw water pump = (704,422 kWh – 646,411 kWh) = 58,011 kWh.

Energy Efficiency Calculations for Finished Water Pump

Description	No. of Units	Capacity (gpm)	TDH (feet)	Power (HP)[a]	Power (kW)[b]	Eff[c]	Runtime (hr)[d]	Annual Power Consumption (kWh)[e]
Existing System (50MGD)	1	34,722	204	1788	1336	74%	3,000[f]	5,409,636
Proposed System (15MGD)	1	10,410	204	536	401	81%	6,000	2,963,403
							Total Energy Savings	2,446,233

Table Notes:

a. Power (Hp) = flow rate (Q) * TDH / 3960
b. Power (kW) = Q * TDH * 0.746 / 3960
c. Minimum efficiency at rated design point
d. Runtime assumes 365 days per year, 12 hours per day
e. Annual consumption (kWh) = No. of Units * runtime 8 Q * TDH * 0.746 / (3960 * Eff)
f. Runtimes were estimated due to throttle time of existing pumps

Energy Efficiency Calculations for Raw Water Pump

Description	No. of Units	Capacity (gpm)	TDH (feet)	Power (HP)[a]	Power (kW)[b]	Eff[c]	Runtime (hr)[d]	Annual Power Consumption (kWh)[e]
Existing System (50MGD)	1	34,722	56	491	366	78%	1,500[f]	704,422
Proposed System (25MGD)	1	17,361	56	245	183	85%	3,000	646,411
							Total Energy Savings	58,011

Table Notes:

a. Power (Hp) = flow rate (Q) * TDH / 3960
b. Power (kW) = Q * TDH * 0.746 / 3960
c. Minimum efficiency at rated design point
d. Runtime assumes 365 days per year, 12 hours per day
e. Annual consumption (kWh) = No. of Units * runtime 8 Q * TDH * 0.746 / (3960 * Eff)
f. Runtimes were estimated due to throttle time of existing pumps

Conclusions

- By replacing the aging pumps, the utility will reduce energy by 2,504,244 kWh annually.
- At 10 cents per kWh, energy reductions from the new pumps will save up to $250,424 per year
- Assuming the cost to purchase the $1,714,178, then the simple payback = $1,714,178 / $250,424/year = 6.8 years.

- Typically a payback period of less than 5-7 years is considered reasonable for a pumping system. Life expectancy for the pumps are 15-20 years.
- By replacing the 10,350 feet of pipe, the utility anticipates conserving 71 MGY; therefore, reducing the volume of water withdrawn, treated, and pumped from the Missouri River.
- Additional benefits due to pipe replacement include reductions in unnecessary pumping and operation and maintenance expenditures, and elimination potential health hazards associated with waterborne pathogens entering the water distribution system.