GREEN PROJECT RESERVE
BUSINESS CASE

CITY OF BROKEN ARROW
WATER SUPPLY IMPROVEMENTS PROJECT

July, 2011

The Oklahoma Water Resources Board (OWRB) requires a Business Case be made for projects or certain aspects of a project that qualify for the Green Reserve in accordance with the American Recovery and Reinvestment Act (ARRA). The City of Broken Arrow's Water Supply Improvements does include aspects that do qualify as "green" per the US Environmental Protection Agency (USEPA) definition. The following Business Case is presented to show the green elements of this project.

Modifications, retrofits, or replacement of existing water pumping systems that achieve a 20 percent increase in energy efficiency over the predetermined standard efficiency will categorically qualify for the Green Project Reserve required by the ARRA. When constructed, the new High Service and Raw Water Pump Stations for the City of Broken Arrow's Water Supply Improvements Project will achieve, at a minimum, between a **24 to 26 percent increase in energy efficiency** over the predetermined standard efficiency, which qualifies these new pump stations for the Green Project Reserve.

Project Description

The Water Supply Improvements Project is intended to provide the City of Broken Arrow (COBA) with a new 20-mgd water treatment plant facility. Part of the project is the replacement of the existing Raw Water and High Service Pump Stations (RWPS and HSPS). The new raw water intake and pump station will be located on the oxbow of the Verdigris River about ½ mile northeast of the existing Water Treatment Plant (WTP) site. The new HSPS will be located south of the existing pumping station, in a tract of land to be purchased by COBA. While the existing RWPS is seldom used currently, the existing HSPS is utilized daily to transfer water from the existing 2-MG clearwell, located within the WTP site, to several finished water storage tanks in the City of Broken Arrow (~ 15 miles west of the water plant). The two new pump stations are used in this Green Business Case.

The new Raw Water Pump Station will include the following features:

- Two intake screens, 20 mgd each;
- New wetwell and three vertical turbine, 250 hp raw water pumps, rated at 12.3 mgd each (can deliver 23 mgd with two pumps);
- Building enclosing the pump station built atop the wetwell with removable access hatches through the building roof to allow removal of the vertical turbine pumps utilizing a mobile crane;

- Associated supply and discharge piping, retaining wall, asphalt access road from WTP site to Raw Water Pump Station, raw water meter with meter vault, electrical, instrumentation, and plumbing.

The overall estimated construction cost of the RWPS is $3,700,000. The "Green" components and their estimated capital costs are as follows:

• Three Vertical Turbine Pumps and motors	$560,000
• Total Cost	**$560,000**

The remainder of the cost for the RWPS consists of piping, concrete, earthwork, valves, meters, and other electrical and instrumentation equipment.

The new High Service Pump Station will include the following features:

- New wetwell, four high service pumps, vertical turbine in cans, 900 hp each;
- Four Variable Frequency Drive (VFD) motors, 900-hp each;
- Surge control system with 33,000-gallon surge tank;
- Two 1,500-kW emergency generators located outdoors, capable of powering half of the pump station equipment during a power outage;
- Building enclosing the pump station with removable access hatches through the building roof to allow removal of the vertical turbine pumps utilizing a mobile crane;
- Associated supply and discharge piping, asphalt access road, finished water meter with meter vault, electrical, instrumentation, and plumbing.

The overall estimated construction cost of the HSPS is $5,200,000. The "Green" components and their estimated capital costs are as follows:

• Four vertical turbine pumps and motors	$1,072,000
• Four 900-hp VFDs	$860,000
• Brick Masonry and Building Insulation	$150,000
• Total Cost	**$2,082,000**

The remainder of the cost for the HSPS consists of piping, concrete, earthwork, valves, meters, and other electrical and instrumentation equipment.

The following information provides the business case that demonstrates that energy efficiency is an important goal of in this project, and is organized as follows:

- Energy Efficient Equipment
- Energy Efficient Design Practices and Considerations
- Energy Savings
- Energy Savings Justification

Energy Efficient Equipment

- The pumps, variable frequency drives (for HSPS pumps), and electrical equipment selected for the new RWPS and HSPS provide the highest efficiency practical and available on the market today.
- The minimum pump efficiencies specified for the High Service and Raw Water pumps are 86 and 85 percent, respectively. The Vertical Turbine Pump Specification (11072) is attached to this business case, and the highlighted portions of Section 2.2 show the specified efficiencies.
- Minimum motor efficiency specified for the HSPS and RWPS units is 95 percent (Premium Efficiency). The highlighted portions of Section 2.3, from specification 11072, show the specified motor efficiencies.
- The new electrical equipment for this project exceeds energy efficiency standards set forth by professional engineering and manufacturers associations.

Energy Efficient Design Practices and Considerations

1. High Service Pump Station:
    - During design, it was determined that adding variable frequency drives (VFDs) would increase overall pump station efficiency and give the City of Broken Arrow more flexibility to meet fluctuating demands without having multiple pump stops and starts.
    - The pumps selected for this project are designed to operate at or near their best efficiency point (BEP).
    - The pump columns and discharge piping have been appropriately sized to provide the optimal velocities and low friction head losses.
    - Because VFDs must be operated properly in order to achieve “green” savings, the specifications require training for the operations and requires the integration of current limiting and auto restart features into the VFDs to ensure the controls will be intuitive.

2. Raw Water Pump Station:
    - The pumps selected for this project are designed to operate at or near their best efficiency point (BEP).
    - The pump columns and discharge piping have been appropriately sized to provide the optimal velocities and low friction head losses.

Energy Savings

Comparing the energy requirements of the proposed system with standard efficiency pumps and motors and the energy requirements of the proposed new system with high efficiency pumps and motors yields a substantial increase in overall efficiency. The estimated average daily flow for the High Service Pump

Station is 12.6 mgd. Consequently, the Raw Water Pump Station will deliver an average daily flow of 12.6 mgd as well.

Comparing the specified pump and motor efficiencies to the "standard" efficiency that has been predetermined by EPA Region 6 yields the following:

- "Standard" Efficiency is:
  - Pumps = 72.5% Efficiency
  - Motors = 89% Efficiency
  - Overall Pump & Motor Efficiency = 72.5% x 89% = 65%
- New Specified High Service Pump and Motor Efficiency is:
  - Pumps = 86% Efficiency
  - Motors = 95% Efficiency
  - Overall Pump & Motor Efficiency = 86% x 95% = 82%
- New Specified Raw Water Pump and Motor Efficiency is:
  - Pumps = 85% Efficiency
  - Motors = 95% Efficiency
  - Overall Pump & Motor Efficiency = 85% x 95% = 81%

EPA Region 6 is looking for the new pumps/motors to have a combined efficiency that is at least 20% greater than the standard or 77% minimum efficiency. Both the High Service Pumps and Raw Water Pumps for the new pump stations exceed this minimum criterion.

Based on historical data and the calculated efficiencies, the annual kilowatt hours per year used for equipment at standard efficiency versus the equipment at high efficiency are as follows:

- kWh/year used with equipment at standard efficiency is **12,614,400 kWh/year** (10,371,840 for HSPS + 2,242,560 for RWPS). These values are calculated based on the yearly average flows for both pump stations (12.6 mgd) and a design total dynamic head (TDH) of 461 ft for the high service pumps and 100 ft TDH for the raw water pumps.
- The overall increase in energy efficiencies are **26.2 %** (82/65) for the HSPS and **24.6%** (81/65) for the RWPS
- kWh/year used with equipment at high efficiency **10,021,116 kWh/year** (8,221,581 for HSPS + 1,799,585 for RWPS)

Therefore:

- **Kilowatt hours saved per year** **2,593,234 kWh/year**
- **Cost Savings at Broken Arrow's $0.07 /kWh Rate** **$181,526 per year**

Energy Saving Justification

- Throughout the design of the new HSPS and RWPS, energy efficiency improvements have been at the forefront and all practical opportunities to improve energy efficiency have been employed into the design. Any further improvement in efficiency would provide only very small, if not, immeasurable increases in efficiency.
- Because VFDs must be operated properly in order to achieve "green" savings, the specifications require training for the operations staff and also require the integration of current limiting and auto restart features into the VFDs to ensure the controls will be intuitive.
- The calculated increase in efficiency and the kilowatt hours saved per year do not take into account the VFDs, which will decrease the number of pump starts. Therefore, the efficiency increases and kilowatt hours saved with the new facilities will likely be higher than those reported in this business case.