CDM Smith

Memorandum

To: *City of Brockton Water Commission*

From: *Jessica Lynch, P.E. and Ian Mead, P.E., BCEE*

Date: *January 15, 2016*

Subject: *Taunton River Desalination Plant - Technical and Financial Review Summary*

Executive Summary

The City of Brockton is evaluating the potential purchase of the existing Taunton River Desalination Plant. Currently, the City pays a fixed fee for the right to buy water, and then a variable rate based on the volume of water produced, under a 20-year contract that is now in its eighth year. CDM Smith is assisting the City with preliminary due diligence to review plant and pipeline conditions, as well as financial considerations related to the purchase. This exercise did not include evaluating the current contract or consideration of compliance with the contract. The current proposed purchase price for the plant and associated assets is $88 million.

The analysis of the Taunton River Desalination Plant is being done at the request of the Brockton Water Commission. The Water Commission is responsible for deciding whether to move the proposed purchase of the plant forward. If the Water Commission decides to move the process forward, the steps established in the Letter of Intent (LOI) will continue. Under the LOI the City would also need City Council approval, as well as a home rule petition through the state legislature. In conjunction with this process, Inima (the current plant ownership) must demonstrate that the plant is capable of producing and delivering 5 million gallons per day (MGD) of water to the City. Inima is to start the expansion work as soon as the City expresses in writing its commitment to move forward with the purchase and sale process. Additionally, the pipeline must be capable of conveying flows up to 5 MGD from the Plant to Brockton and the intake structure must be altered to render the plant capable of producing 5 MGD. The City will have the right to review and approve all design and engineering plans drafted by Inima as they relate to plant, pipeline, and intake repairs and/or upgrades prior to the commencement of any and all work.

The City has indicated that the most likely operating scenario under City ownership would be a flow rate of 2 MGD. Note that this scenario is not indicative of population growth within the City, as no population projections were made; rather, it establishes a "base case", via a continuously operating condition well within the current capacity of the facility, with corresponding reductions in output from the Silver Lake and Avon water treatment facilities. All financial evaluations are developed with this baseline assumption. In evaluating operating costs, only current variable rate items were used. These include estimated costs for chemicals, electricity, sludge removal and sewer. Fixed rate items were also reviewed with the City and Aquaria, and costs that would apply to the City were calculated.

The economic analysis indicates that the cost equivalent purchase price is in the $68-$74 million range. This range is the result of a number of assumptions and variables reflected in the model, which are discussed further herein. The cost equivalent purchase price represents a comparison of the current water service agreement (WSA) with an allowance for additional capital improvements in 2028 per the WSA, versus projected fixed, variable and financing costs under a plant purchase scenario by the City. The above range assumes that there are no water sales to other water systems and does not consider the residual value of the plant after the 20 year purchase term. If instead water sales are considered, then the cost equivalent purchase price would be in the $81-87 million range assuming the discussed sales scenario herein. The residual value of the plant which is estimated at $19 to $20 million is discussed below on page 20 of the memorandum.

In addition to the analysis and model developed under this exercise, there are several other issues whose financial impact must be considered in conjunction with the purchase of the plant, and which have not been factored into the economic analysis. These are intended to be evaluated in future steps under the LOI and include the following:

- Considerations with intake sizing and associated long term Gunderboom reliability.
- Possible bridge and finished water transmission main relocation due to extension of South Coastal Railway.
- No backup power.
- Reverse Osmosis (RO membrane) elements are approaching end of anticipated useful life (replacement anticipated within the next year or two) as are the UF membranes (within the next 5 years).
- Upgrade of the plant and pipeline to 5 MGD.

These and other issues are discussed in the following sections. It is important to note that any additional funds that Inima may put into the plant to bring the capacity up to 5 MGD and updates to existing equipment would add value to the plant both at the time of purchase and in regards to residual value.

Introduction

CDM Smith visited the Taunton River Desalination Plant on Tuesday, September 16, 2014, to investigate the current condition of the existing plant and mechanical equipment, including process equipment, pumps, exposed piping, chemical systems, HVAC, electrical and instrumentation. Observations were limited to what could be readily observed on the day of the visit.

Water Treatment Plant

The water treatment plant (WTP) was commissioned in December 2008. The facility consists of a multi-level intake screening system on the Taunton River with a permeable barrier to protect aquatic life (Gunderboom), followed by a low lift pump station that supplies water to a raw water concrete tank on site. The raw water tank supplies raw water to the facility by gravity. Water is conditioned by various pretreatment chemicals (powdered activated carbon [optional], potassium permanganate, ferric sulfate, and caustic soda). The conditioned water enters the rapid mix tank followed by the flocculation phase. This conditioned water is then supplied to the Zenon 500 series ultrafiltration membranes. A vacuum pump is used to pull water through the membranes as permeate, and then chlorine is added as water enters the clearwell.

Water from the clearwell is pumped to a 350,000 gallon finished water tank, through the RO membranes, or a combination of both. Typically the RO system is used during the months of June to October when salt levels are higher in the Taunton River. Water from the clearwell can be treated with sodium bisulfite, and an antiscalant prior to being directed to the RO membrane rack system. Water from the 350,000-gallon finished water tank is then directed to the high service pumps that supply water to the City of Brockton's water distribution system via a 16-mile, 20-inch diameter ductile iron transmission main, which is located in public streets, existing active railway rights-of-way, as well as through easements across various private properties. See attached for process schematic.

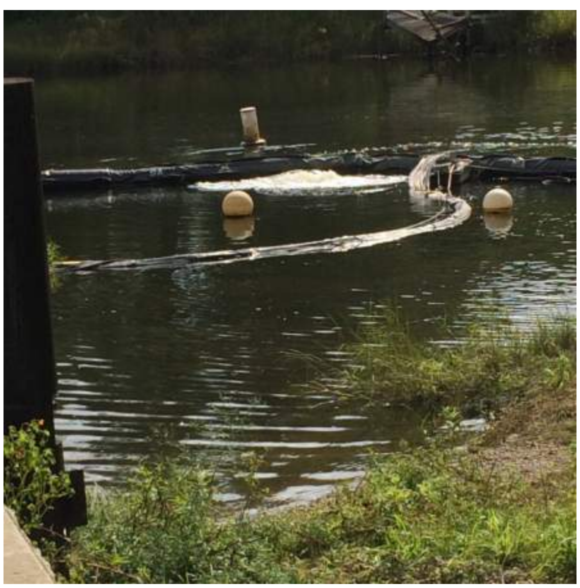
The treatment system capacity is rated as follows:

- Pipeline: 10 MGD (notwithstanding limitations further discussed below).
- Building: At build-out can accommodate a production rate of 5 MGD.
- Process as currently installed: 3.5 MGD.
- Current Finished Water pumping: 3.3 MGD with one pump in operation. Operation of both pumps is required to deliver 3.5 MGD.

Civil/Mechanical

Intake

The intake structure is used to deliver raw water for treatment to the plant and is also used to discharge brine to the Taunton River.



River Intake Location and Gunderboom

The intake provides four levels of screening to prevent fish eggs, larvae and other objects from entering the plant. Screening includes a floating Gunderboom system, bar racks, vertical wedge wire screens and cylindrical Johnson-style screens. The Gunderboom is required to protect fish eggs, allows the plant to comply with the environmental conditions of its Water Withdrawal Permit, and must be installed by divers in March and removed in November. It was reported that the installation and removal is a major effort and is expensive. It has been noted that the Gunderboom is prone to plugging and bypassing either over the top or under the bottom, and also at times is unsuccessful in preventing fish from entering the intake.
The Gunderboom was reported to have some limitations at high flow, with water levels dropping within the contained area when the plant is at full production.

The capacity and alternative equipment must be further evaluated and proven for operation at 5 MGD and the effectiveness for meeting the intended screening requirements.

Raw Water Pumping Station

The raw water pumping station (RWPS) is a metal building located above the raw water equalization clearwell; it houses raw water pumps, air compressors and other associated electrical, HVAC and instrumentation. There are currently three low-head vertical turbine pumps that can pump water from the raw water control vault to either the raw water storage tank or to the brine storage tank. The raw water control vault only contains one influent control valve.

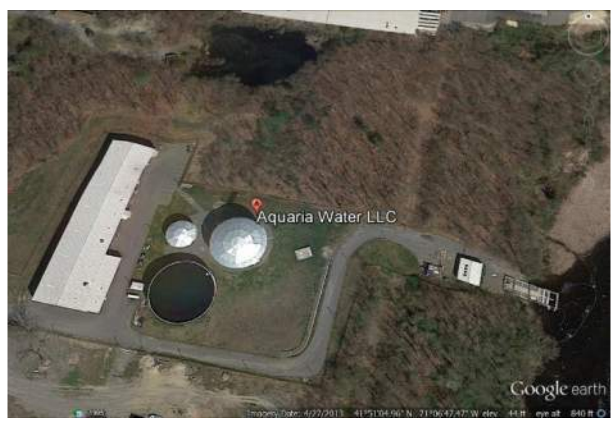
Screening and Raw Water Pump Station

Tanks

Three large tanks are located between the RWPS and the WTP including:

- 3-MG Prestressed Concrete open top brine tank.
- 2.5-MG Prestressed Concrete raw water storage tank with an aluminum cover.
- 0.35-MG Prestressed Concrete finished water storage tank with an aluminum cover.

Each tank is equipped with an ultrasonic level sensor.



Aerial View of Site Layout

Chemical Storage and Feed Facilities

Storage and feed system facilities are available for the following chemicals:

- Sodium Hypochlorite
- Potassium Permanganate
- Powdered Activated Carbon
- Caustic Soda
- Ferric Sulfate
- Sodium Bisulfite
- Sulfuric Acid
- Antiscalant

Chemical Area

- Citric Acid
- Zinc Orthophosphate
- Lime

In addition, feed pumps are installed for a future ammonia feed system that is not currently in use (in case the City chose to switch disinfection process to chloramines.) All chemical storage and feed systems appeared to be in good working condition. The chemical areas were well maintained and clean. Minor leaks were observed on the caustic soda and sodium hypochlorite systems, which are likely both related to gasket materials.

The lime system is used to increase the pH of the product water and provide additional hardness and alkalinity. Because the lime also can add turbidity to the water, it can create a challenge for operators to avoid exceeding the 0.1 Nephelometric Turbidity Unit (NTU) goal.

It should be confirmed that the blending of Membrane Filtration (MF) product water with RO product water should be sufficient for providing necessary hardness in the product water, and caustic soda may represent an alternative for finished water pH adjustment.

The caustic soda storage tank is reported to be smaller than ideal, with deliveries of caustic soda required every three days during peak summer operation. Additional storage for caustic soda is highly recommended, however, space is extremely limited. It may require elimination of other chemical feed systems to provide adequate space for expanded caustic soda storage. If the lime system was eliminated, this would provide potential space for additional storage. However, eliminating lime feed would also increase the caustic soda usage, requiring further storage capacity. Alternatively, elimination of sulfuric acid could be considered, as it is not currently used in the RO feed.

Sludge Handling

The WTP currently only has one centrifuge dewatering machine, space for one roll off sludge trailer, and one sludge decant tank. If there are issues with any one of these components, operation of the sludge handling system would be interrupted, stopping water production at the facility or requiring that liquid sludge be hauled offsite via a tanker truck.

Sludge Handling Area

High-Lift Pumps

There are currently two high-lift split case pumps that convey water to Brockton. A single pump can produce up to 3.3 MGD.

Civil/Mechanical Deficiencies and Recommendations

- Lack of redundancy within the facility could be problematic if running the plant all the time.
- Contractually the intake is required to handle 10 MGD; as installed it is unknown if this is possible; permitting for additional work may be problematic.
- The facility was not designed to remove manganese efficiently.
- The facility can produce moderate levels of disinfection byproducts (DBPs) during the summer season, particularly brominated DBPs. As such, the WTP has to rely on the RO system to remove organics rather than the ultrafiltration membranes.
- Skylights are not centered over the pumps in the raw water pump station, and removal of the pumps could be challenging in the future.
- The clearwell, as constructed, was not provided with a partition. The plant would have to be shut down for clearwell maintenance.
- The raw water control vault only contains one influent control valve; if this valve were to fail the WTP would not have an efficient way to send water to the facility in a controlled manner from the raw water tank.
- Replace leaking gaskets on hypochlorite system with alternative material.
- The caustic and potassium permanganate systems are undersized to provide the necessary chemicals for a flow of 3.5 MGD. The lime feed system only has one bulk bag unloader and one mix tank. These systems, once they reach their maximum capacity or fail, would limit or stop the production of water at the facility.
- Not all chemical tanks were provided with level monitoring elements.
- It does not appear that containment leak alarms have been provided in the design of facility.
- Several bulk tanks were not provided with chemical transfer pumps. These tanks flow by gravity to the day tank. Therefore the full capacity of bulk tanks cannot be used if the bulk tank level is low.
- The hypochlorite pumps are positive displacement pumps with degassing heads that are prone to gas binding issues.
- The sample points for chlorine are spaced too far apart. It takes on the order of 2 hours to determine the effects of a change in chlorine feed.
- Make up water for dry chemical feed systems – the lines are comprised of copper and are showing signs of corrosion.
- Sludge Handling is limited to one sludge decant tank, one centrifuge dewatering machine, and space for one roll off. If any of the systems are down sludge handling would require liquid tanker trucks. This had to be done previously and cost $10,000 as noted by the staff for that specific event.
- Neither of the two high service pumps were provided with variable frequency drives (VFDs). The pumps are controlled by a specialty valve that acts both as a check valve and flow control valve. The check valve does not always completely close and allows leakage from the transmission pipe back into the WTP.

- Additional tankage should be considered. Brine Storage/Recovery tank can be a limiting factor when salinity is high.

Membranes Ultrafiltration System

The ultrafiltration (UF) system is used for removal of suspended solids, pathogens, and turbidity from the source water. The UF system was designed with a redundant process train, allowing production up to 3.5 MGD with any two trains in operation. Potassium permanganate and caustic soda are added before the rapid mix tank. Powdered activated carbon and ferric sulfate are added directly into the tank. The injection points for sulfuric acid and sodium hypochlorite upstream of the mixing tank were reported to not be used.

UF System and Process Area

The process includes GE Zeeweed 500 submerged membranes. Over the course of the site visit, both Trains 2 and 3 were operating. A backwash on Train 3 was observed. Transmembrane pressure was 2.3 psi at a flow rate of 1,140 gpm, indicating very little fouling on the membranes. Membrane integrity tests were reported to be performed about once per day. The most recent test had been completed at 9:15 am on Friday, September 12, 2014. Results showed a 4.71 log reduction value, indicating that the membranes are intact and fiber repairs are not required at this time. Operations staff indicated that fiber repairs are done about two times per year. This is typical for the reinforced Zeeweed 500 membranes, and is in sharp contrast to many facilities utilizing other membranes that can require weekly or even daily membrane repair. The ultrafiltration system appeared to be in good shape, operating as designed and with no observable signs of membrane age, membrane damage, or fouling.

One reported challenge with the UF system was the inability to remove manganese from the source water. The current permanganate injection point is too close to the membranes for significant oxidation to occur. In general, ultra-filters do not do well at manganese removal, which can create challenges for downstream reverse osmosis membranes and for the distribution system. Manganese removal could be improved by moving the permanganate injection point to allow for oxidation time.

The RO system includes four vertical turbine transfer pumps, three centrifugal RO feed pumps with VFDs, and three RO trains. RO trains are two-stage 24x12 arrays with six element vessels. Antiscalant and sodium bisulfite are injected upstream of the RO feed pumps. The RO trains run at 75 percent recovery and do not include energy recovery devices. Overall the RO equipment appears to be in good condition. Only 1 RO unit was in operation at the time of the site visit, producing a total of 800 gpm with 159 psi feed pressure. No leaks were observed on the operating RO system; however, evidence of previous leaks was apparent at one valve on each of the two offline units and on the feed header for one unit.

The RO membranes are 6 years old and are showing evidence of permeability loss. Replacement of the RO elements would be expected to reduce feed pressures by approximately 15 percent, or 24 psi. In addition, replacing the membranes would reduce the product water Total Dissolved Solids (TDS) by approximately 25 percent, which could result in a reduction in how much water must be treated with RO. The existing design does not include energy recovery devices, which are becoming more common as energy prices continue to increase. Installation of energy recovery devices may also better balance the flow between stages, improving the product water quality and reducing the flow that needs to be treated with RO. The addition of energy recovery devices would be expected to reduce the feed pressure by an additional 11 percent and reduce the product water TDS by 10 to 15 percent. It should be noted that energy recovery devices would require significant repiping on the skids, with an associated cost that may not be fully offset by the savings in operating costs. Further evaluation of this option would be required.

RO Membranes

The production capacity of the existing 3 RO units is 3.5 MGD. Adding a fourth unit would increase the treatment capacity to 4.6 MGD. While this would not allow a full 5 MGD of RO product water, an 8 percent blend with UF product water would allow a total production of 5 MGD without exceeding the target product water conductivity of 650 uS/cm.

Membrane Cleaning System

The Ultrafiltration (UF) units share a common chemical clean-in-place (CIP) system for conducting periodic citric acid and hypochlorite cleans. Similarly, the RO units share a common CIP system for caustic soda and acid cleans. Piping modifications were reportedly made to allow cleaning of the UF systems with the backwash supply tank; however, this modified cleaning approach was not reported to have operated successfully.

Reverse Osmosis

Membrane Deficiencies and Recommendations

- While UF membranes have been in operation for 6 years, their permeability is still high and their breakage rate is low. Remaining life could be another 4 years before replacement, based on similar plants.
- Replacement of Keystone valve seats may be needed in next 2 to 3 years.
- In order to produce 5 MGD, one additional two-tank flocculation system, membrane train, and permeate pump will be required.
- Bench testing should be considered for manganese removal before determining whether relocation of the permanganate feed point is warranted.
- The RO elements are nearing the end of their projected life and should be replaced in the next 1 to 2 years. This replacement will significantly reduce operating costs.

- An evaluation of the cost-benefit of installing energy recovery devices should be considered, as these could further reduce the operating costs and improve product water quality.
- One additional RO skid and RO feed pump is recommended for expansion to 5 MGD.

HVAC

The Raw Water Pumping Station contains two electric unit heaters, an exhaust fan, two motorized dampers on one of the walls, and two motorized louvers on the opposite wall. There was no air conditioning in the Raw Water Pumping Station.

The main process area of the plant has ductwork distribution for air from the air handling units, as well as some supplemental heat from some unit heaters that are located in the lower levels of the plant. The heat source comes from two gas fired boilers in the Mechanical Room where one boiler serves as the lead boiler and the other boiler as the lag. It was noted that the temperature within the process area is maintained at 55 to 60 degrees. The air handling units are located on a mezzanine adjacent to the administration area on the second floor. Make-up air is supplied to the main process area through the ductwork system.

The offices, conference room, kitchen area, laboratory and restrooms are all located on the second floor. Each of the areas has acoustical ceilings and air conditioning. The air conditioning system is located outside the building on the ground and appears to be in excellent condition.

HVAC Deficiencies

- The freeze stat trips and causes the HVAC system to shut down and the system has to be re-started, which causes fluctuations in temperature within the building during the cold winter months.

Architectural

The Raw Water Pumping Station is a Butler building structure with an approximately square footprint, with a Pre-Engineered Metal Building system, with steel columns and steel girts framing the walls, with steel beams and steel purlins framing the roof. The wall and roof systems are completed with fiberglass insulation blankets and vapor retarders, and with exterior cladding ribbed metal panels for both walls and roof. Metal gutters and downspouts are part of the entire building system.

The WTP is a large two-story high facility with a long rectangular footprint. It is also a Butler building structure, with a Pre-Engineered Metal Building system, with steel columns and steel girts framing the walls, with steel beams and steel purlins framing the roof. The wall and roof systems are completed with fiberglass insulation blankets and vapor retarders, and with exterior cladding ribbed metal panels for both walls and roof. Metal gutters and downspouts are part of the entire building system.

Water Treatment Plant

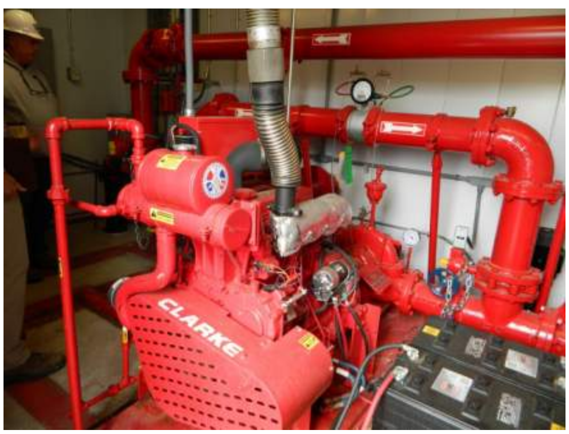
Architectural Deficiencies and Recommendations

- Egress paths within the treatment plant were not always obvious or delineated
- Recommend installing an emergency shower and eyewash station within the Sodium Hypochlorite containment area
- Recommend to install auxiliary steps, to step up, over and down containment curbs higher than 24 inches

Plumbing/Fire Protection

The Raw Water Pumping Station did not have any plumbing or fire protection present in the building. The fire protection is done with smoke and heat detectors since there was no water supply to the building. There is no floor drainage in the building.

A fire pump house was installed on the site with a diesel driven fire pump. The building is a pre-engineered building designed by Gorman Rupp Patterson and has a fire pump, jockey pump, 280 gallon indoor fuel tank, fire pump controller, jockey pump controller and various electrical panels. The building and its components are in excellent condition; the fire pump is tested on a monthly basis by the plant staff and checked yearly by the insurance carrier.



Fire Pump

The main process area has some floor drains but everything is piped or conveyed into the tanks and is re-cycled to the head of the plant. The pipe labeling within the plant is very well done and all of the pipes are clearly labelled, which made it easy to follow the various piping systems. The entire building is protected with a wet sprinkler fire protection system. The water feed for the fire protection system comes from the Town of Dighton. The offices, conference room, kitchen area, laboratory and restrooms all have acoustical ceilings and recessed sprinkler heads.
The various chemical areas have some issues including the location of the emergency equipment such as emergency showers and eyewash units. Occupational Safety and Health Administration (OSHA) and American National Standards Institute (ANSI) stipulate that you cannot go through a door to access a piece of emergency equipment.

You can also not go up or down a set of stairs or go over a containment wall to access a piece of emergency equipment. If the wall is higher than 24 inches stairs may need to be provided for access into the containment area.

The incoming water service is properly protected by a backflow preventer. The potable water entering the facility is from the Town of Dighton and it only serves the bathrooms, kitchen area and emergency showers and eyewash units. The service water for the wash hose stations and chemical areas is provided as a by-product of the water from the WTP and is separate from the potable water system.

Automation/I&C

Existing Supervisory Control and Data Acquisition (SCADA) System

- The existing SCADA system consists of Allen-Bradley ControlLogix Programmable Logic Controller (PLC) hardware and Rockwell FactoryTalk 5.0 Human Machine Interface (HMI) software.
- The locations for viewing the entire control system are from two monitors in the control room (desktop monitor and large screen TV) and an industrial flat panel mounted on a PLC panel on the main process floor.
- There are several Allen-Bradley PanelViews of various sizes located around the plant. These are for monitoring and control of specific processes only and cannot access other equipment throughout the plant.
- Several vendor PLC systems are also connected to the SCADA system. The Centrisys Centrifuge PLC is an Allen-Bradley SLC 5/05 PLC; this is obsolete and if there is a failure, this PLC will need to be upgraded. Other PLC systems contain Allen-Bradley MicroLogix 1200 controllers.
- Other software in SCADA system: XLReporter to generate reports, WIN911 software calls out critical alarms, remote access software for remote monitoring.
- Carbonite cloud back-up service is used for SCADA data.
- Computerized Maintenance Management System (CMMS) data is backed-up to local NetGear external hard drive.
- CMMS server is located in the Electrical room and SCADA server is located in the control room.
- There is no PLC redundancy, and SCADA redundancy is in the process of being implemented.
- Brockton communicates to the plant over a leased telephone line in order to obtain meter vault information. A leased telephone line connects the meter vault and raw water pump station to the plant's SCADA system.
- Fiber optics connects the plant to the RWPS on-site. SCADA data is passed over the fiber optic connection, but the fire alarm system communicates over a copper line to the plant that has been problematic due to electrical surges.
- Back-up power is through local small Uninterruptible Power Supply (UPS) systems that are between 500VA and 1KVA.
- The Plant Manager indicated that the plant is not fully programmed for automatic operations (i.e., blend valve limitation) but this is not impeding operations.
- The HVAC control system is a separate system from Huntington Controls.
- GE has the ability to access their membrane system over a Verizon broadband connection.
- The plant pays for a Rockwell maintenance agreement for free software upgrades to FactoryTalk HMI software and technical support.

Existing Instrumentation (major components only)

- Endress and Hauser Promag 50 - Magnetic Flow Meters
- Endress and Hauser Prosonic FMU 860 & Liquisys M - Ultrasonic Level Measurement
- Chemtrac PC2400 - Particle Counters
- Endress and Hauser PMC41 - Pressure Transmitters

- Rodi EZ-1 SDI Monitor – Silt Density Monitor
- Hach SC100 controllers with various probes – pH, ORP, etc.

Deficiencies and Recommendations for SCADA and Instrumentation

- Add PLC ControlLogix controller redundancy. HMI redundancy is currently in the progress of being implemented. The plant is vulnerable with only one PLC controlling the balance of plant.
- Upgrade Centrisys PLC, as SLC 5/05 is an obsolete model and spare parts will be difficult to obtain in the future.
- Centrally locate the SCADA server, CMMS server, external hard drives and other network components in a communications rack, as opposed to spreading them out between the Electrical Room and Control Room.
- Upgrade the fire alarm system at the RWPS to communicate over existing fiber optics to the plant.
- Since there is no generator, the small UPS systems provide limited back-up time for the control system. If no generator is added in the future, we suggest at a minimum increasing the size of the UPS systems for the control room SCADA equipment to allow more time to ensure orderly shutdown of the computer systems. A plant-wide standard for UPS systems is also recommended.
- Revisit remote communications with recent advances in cellular communications, as leased lines are becoming obsolete. The existing Verizon broadband connection could also be used for remote site communications.
- Upgrade HMI graphics to support widescreen monitors. Current graphics are "stretched" and slightly distorted to fit these screens.
- Implement remainder of automatic control logic (i.e., blend valve). More detailed discussions with the Plant Manager are required to determine what other logic is missing.
- General clean-up of some of the panels related to UPS mounting arrangements and fiber optic terminations.
- Update the control system architecture to match what is at the plant.
- Hach SC100 and Endress and Hauser FMU860 units are obsolete and will need to be upgraded to newer models in the future.
- Consistent tagging of all instrumentation to correlate with MP2 system (O&M/maintenance software).
- Add leak detectors in chemical areas.
- Evaluate surge protection around the plant at power sources and on signal lines to protect equipment.

Electrical

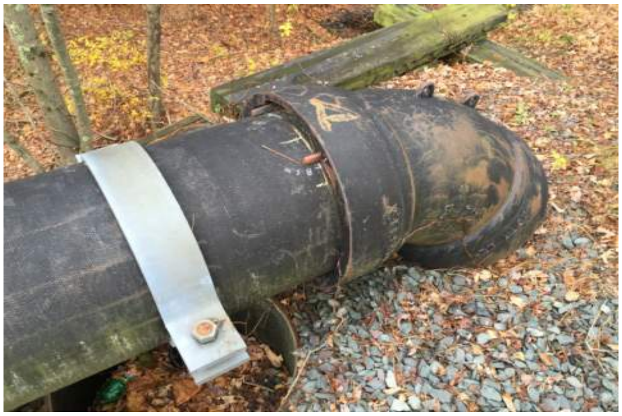
National Grid is the electric utility for the plant and service comes from Somerset Avenue via primary metering. There is a 13.8kV exterior pad mounted switch across from the main building entrance, which is used for power distribution to the facility. Adjacent to the switch are two pad mounted transformers, which operate in parallel and are used to step down the voltage to 480/277V 3-Phase, 4 wire. In addition, there is a transformer located down near the RWPS, which is used solely for that intake building with three 250Hp pumps and additional miscellaneous equipment. The transformer sizes at the main building were not known at the time of the inspection since as-built one-line drawings were not available, but each transformer feeds a 3000A main distribution switchgear breaker in the main building's electrical room. The transformer size at the RWPS is also not known, but it feeds the 1600A MCC-1 breaker in the building.

The existing main electrical room houses the main 480V, 3000A Square-D Switchgear. This switchgear distributes power to MCC-11, MCC-21, MCC-22 and numerous 480V process motors. MCC-21 and MCC-11 are located in the main electrical room, along with panel boards, 120/208V 75kVA transformer, soft starters and VFDs for process equipment (MCC-22 is located in the process corridor and MCC-23 is located in the Maintenance room). Within the electrical room there is some space for future equipment, but further coordination and investigation would be needed to determine if the space is adequately sized for the build out to 5 MGD capacity. This may include additional electrical equipment for power distribution, along with recommended redundancy and the addition of back-up power source. If a standby generator is added to the facility, there appears to be adequate room outside to locate this.

A Simplex fire alarm system consisting of horn/strobes and manual pull stations was installed at the main building and Raw Water Pumping Station. At the Raw Water Pumping Station, smoke detectors are used for fire detection. At the main building, a fire pump and fire suppression system was installed per the insurance provider's requirements; the fire pump was located outside in a walk-in enclosure and is backed up by diesel fuel.

Electrical Deficiencies and Recommendations

- No emergency generator at the plant for stand-by power.
- Modifications to the power distribution system are recommended so there is a main-tie-main power distribution scheme.
- Electrical equipment should be tested by a National Electrical Testing Association (NETA) accredited testing firm, since testing is currently out of date.
- A power system study should be performed on the electrical system in accordance with OSHA and National Fire Protection Association (NFPA) 70E, so that arc flash labels can be applied to the electrical equipment.
- The open process area is not adequately illuminated; this may have been due to some lights being burnt out or not turned on at the time of inspection.
- Consideration should be given to replacing outdoor HID fixtures with LED.
- Plant personnel mentioned that often when there is a lightning event nearby, the Fire Alarm system goes into alarm at the plant and the surge protection module gets "fried". This could be related to the copper cable running between the Raw Water Fire Alarm Control Panel (FACP) and the Main Building FACP. Replacing this copper cable with fiber could prevent this, but further investigation should be performed.
- We recommend an intrusion detection system, consisting of door/hatch contacts, motion sensors, glass break sensors and 24/7 monitoring, be installed, as a typical best practice.



Finished Water Transmission Main

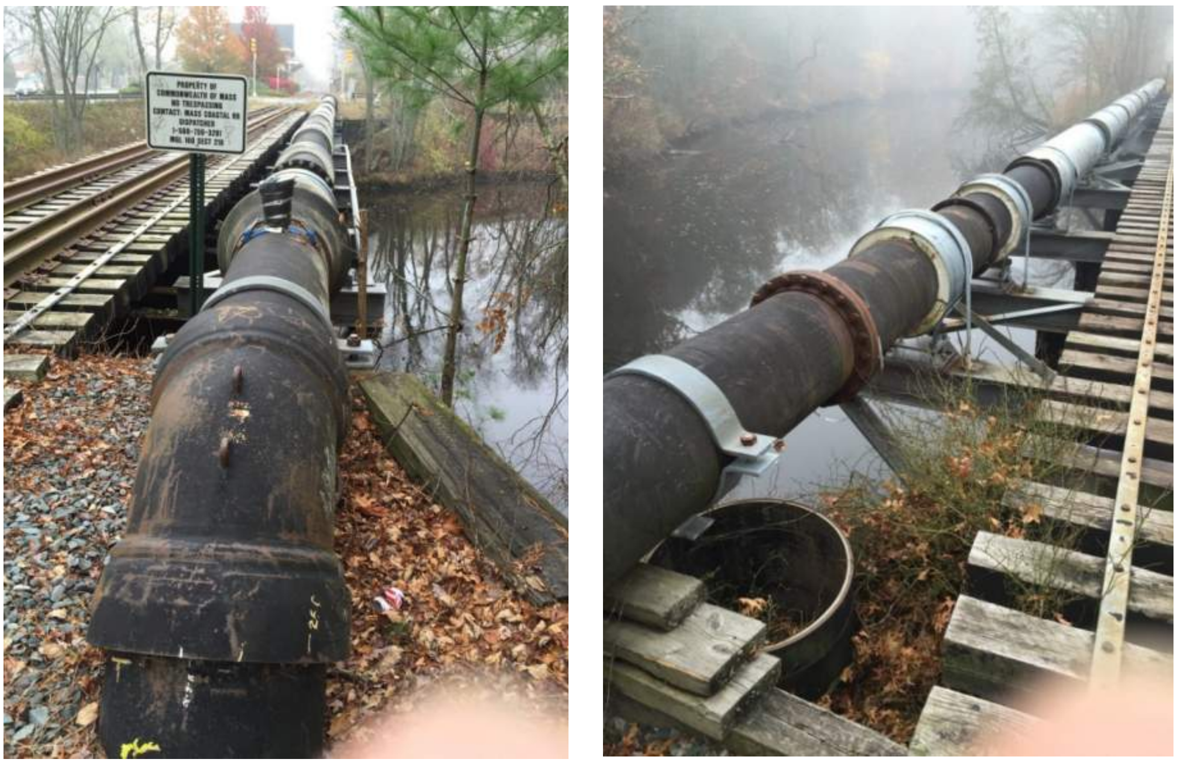
Finished Water Transmission Main

Finished water is delivered to the City of Brockton by a 16-mile, 20-in ductile iron (DI) water main. The pipe is rated for 250 psi and there is no booster station. The transmission main crosses four railroad bridges prior to entering Brockton in the southwest corner of the City, in addition to several public streets and easements across private properties along its length.

Transmission Main Deficiencies and Recommendations (10 MGD Capacity)

- The joints on the transmission main located on the river crossings were not expanded correctly during construction, and joint separation could occur during high flows/high pressure. The pipe configurations at these crossings need to be improved to allow the transmission main to safely operate at demands above 3.5 MGD.
- There are currently no hydrants along the pipeline, which can make flushing at a velocity of at least 3.0 ft/s problematic. Hydrants or other provisions should be considered along the pipeline to allow adequate flushing.
- Air valve manholes along the pipeline are problematic as they are not well constructed and tend to fill with water, which creates a potential sanitary hazard to the drinking water. The manholes are currently pumped out annually.
- 2 miles of pipeline along the CSX easement will most likely need to be relocated if the South Coast Rail Extension occurs. The feasibility of permitting is a major unknown and could be of great concern. Costs for relocation are unknown at this time, but given the unique nature of the pipe route they are expected to be above industry average for water main construction. Further investigation is required and is intended to be done under subsequent steps in the LOI process. High service pump capacity and hydraulics should also be considered if the pipeline location moves.
- Access to easements is limited (due to wetlands and overgrown conditions) for leak detection, repairs, maintenance, and/or replacement.

- Areas within railway easements and on railway bridges create access issues. Massachusetts Coastal Railroad requires Roadway Worker Protection class for all individuals working on or within 4 feet of the tracks. Employees in Charge (from Mass Coastal) are required to provide on-track protection from trains or other equipment.



Finished Water Transmission Main at Railroad Bridge Crossings

Financial Considerations

Electrical Analysis

As indicated previously, the basis of the current analysis is that the plant, if purchased by the City, would operate continuously at 2 MGD. Historically the plant has not operated continuously in this mode, and therefore the historical power usage cannot not simply be extrapolated to accurately predict future electric power costs under the hypothetical "base load" operating mode. Although the plant generally operates daily to produce enough water to maintain water quality within the pipeline during periods when the City is not calling for supply, the quantity of water is small as compared with the proposed 5 MGD future capacity. During low water production periods the base electric load for items such as HVAC, instrumentation, compressed air, lighting, security, etc. is disproportionately high as compared with the variable amount of electricity billable to the actual treatment process (i.e., the additional electricity to produce various quantities of water.) As a result, the projected future electric cost cannot be accurately projected by simple evaluation of the historical monthly production (millions of gallons) compared with the corresponding total monthly electric consumption (Kwh), as this would provide an unrealistically high unit rate for the proposed operating scenario.

To better estimate future electrical costs under City ownership, the historical electric data as filed with the DTE for the years 2011, 2012, and 2013, plus the daily water production data as provided to the City by Aquaria, were used to establish the major components of the plant power requirements:

- Base Plant Electric Load
- Incremental Electric Load to produce water in the Ultrafiltration (UF) only operating mode
- Incremental Electric Load to produce water in the UF/Reverse Osmosis (RO) operating mode

To estimate the power requirements of the various seasonal operating modes, the historical operating data was separated into two periods, 1) when only the UF cycle should be operating and, 2) when both the UF and RO systems would be needed. Typically during the winter and spring months the "salt wedge", which occurs on the incoming tide and causes the streamflow to reverse direction at the location of the plant intake, does not reach far enough upstream to impact plant operations, and only the UF system is needed. When normal streamflow in the river is reduced during the summer and fall months the salt wedge can extend up the river to the intake for short periods during the tidal cycle and the RO system must operate in series with the UF system. Based upon this premise, an analysis was performed using the incremental changes in monthly water production as compared with the incremental change in monthly power consumption. By using this approach only the power needed for water production will be quantified.

1) For periods when only the UF system would be operating, from the 2011 DTE filing, approximately 21,600,000 gallons more water was produced in March compared to May and required an additional 93,000 kWh of energy. This results in a variable electric value for the UF only operation of 4.31 kwh/1,000 gallons. Likewise a similar comparison was made for June vs. May 2014 and resulted in a value of 5.21 kwh/1,000 gallons.

2) For periods when both the UF and RO systems are in operation, August 2012 was compared with September 2012 and resulted in a variable electric value of 7.59 kWh/1,000 gallons. July 2013 was also compared with August 2013 and resulted in a variable electric value of 7.21 kWh/1,000 gallons. The increase in power requirement is due to the additional pumping power for the RO system plus the need to increase the total amount of raw water treated to compensate for the 75% recovery rate of the RO system.

These unit values were then used to determine the variable electric cost of the total monthly kWh values as reported to the DTE. Further, by subtracting the calculated variable portion from the total electric power, the average annual fixed electric cost was determined to be approximately $68,000/year, which was used in the analysis as one of the Fixed Cost Components.

In establishing a basis for operation of UF only and UF/RO, although the seasonal salt impacts would indicate approximately 5 months per year on UF only and 7 months per year on UF/RO, the analysis has assumed that additional time on UF/RO operation may be required to supplement the treatment process provided by the UF system during "non-salt" periods. During periods of high upstream (agricultural) surface water runoff or other upstream permitted discharge upsets, there can be abnormal increases in the level of contaminants in the intake water. Contaminants are removed in the treatment process first by mechanical filtration through the Ultra Filtration system followed by chemical injection of sodium hypochlorite to kill the remaining contaminants. Organic and inorganic materials in the water will react with the sodium hypochlorite which in turn results in the formation of disinfection by-products (DBP's). The amount of DBP's in the treated water is regulated by the Primary Drinking Water Standards. If the organic/inorganic levels of the raw water are excessively high additional chemical must be used to treat the water, and in turn will create high DBP's which may need to be removed prior to distribution. At the Aquaria facility the removal can be accomplished by further processing the water through the Reverse Osmosis portion of the cycle, which is highly effective in removing DBP's. Thus, this additional RO operation can occur during any period of the year, regardless of salinity levels, if contaminant levels in the raw water are determined to be higher than normal. Recognizing this type of operation is a possibility, the analysis has assumed that the plant will operate with 3 months UF only, and 9 months UF/RO.

The current average Brockton electric rate is $0.13/kWh and was used in the analysis. Using the above derived low range and high range unit kWh/1000 gallon rates, yields a variable electric cost range at 2 MGD of $615,418/yr. to $664,103/yr.

To validate the assumptions and calculations related to the variable electrical cost above, costs were compared to a recent one-month period during which the City received 1 MGD of water consistently over the majority of the month. The electric usage was taken from that month and extrapolated to a yearly electrical usage. The electrical usage and costs were found to be within the variable cost range detailed above.

In comparing the current Water Service Agreement (WSA) operations vs. proposed ownership/ operation by the City, it is important to note that although the initial 3 years of plant operation allowed for "pass-through" of electric rate increases, after that time the electric cost increases experienced by Aquaria are fixed. This would not be the case under the ownership scenario; the risk of electric cost increases would shift entirely to Brockton, and based on the operating scenario are estimated to be on the order of $50,000/year for each $0.01 increase in electric rate. Further, if rates rise by 30% as has been forecast in the industry, the City could expect to incur an additional cost of approximately $185,000 per year.

Chemical Analysis

Aquaria provided chemical data for operating parameters when RO & UF are running and when only UF is running. Below is a summary of the information provided as well as a resulting projected total yearly cost for chemicals assuming an anticipated 2 MGD production rate.

	UF	RO & UF
Total Chemical Cost	$26,495.15	$33,429.00
Finished water produced	83,140,756	66,179,048
Chemical cost per/1000 gal	$0.32	$0.51
Information below is projected based on above provided data from 2014		
Daily chemical cost at 2 MGD	$638.00	$1,010
Total project annual chemical cost **Assuming UF operating 3 months and RO & UF operating at 9 months*	**$334,705***	

Aquaria also provided further breakdown of the chemical costs within the 2013 DPU filing and 2014 DPU filing; this included a chemical cost of $60,233.13 and $160,663.94 respectively (under line item 605-2). The amount of metered water produced in 2013 was 71,286,200 gallons and 190,846,544 gallons in 2014. Unmetered flushing water was estimated and added to this total, which impacted the overall chemical cost. The 2013 numbers result in a chemical cost of $0.845/1000 gallons and the 2014 numbers result in a chemical cost of $0.842; these numbers are higher than noted in the table above, and should be considered. It is important to note that chemical costs taken from the DPU filing are based on intermittent operation of the plant. It is likely that chemical costs would be lower under continuous operation of the plant because chemicals could be purchased in bulk. Purchasing chemicals in bulk is typically cheaper per gallon than buying in smaller quantities.

If the 2013 numbers are used, the City of Brockton could see a chemical cost as high as $616,850 per year. Assuming average flushing rates of 200,000 GPD for a total of 6 days per year, the total water produced would be approximately 72,500,000 gallons, resulting in a chemical cost of $0.83/1000 gallons, or a total annual chemical cost of $605,900.

Variable Cost Summary

In addition to electrical and chemical expenses, the City would be responsible for sewer and sludge disposal costs. Sewer costs are approximately $15,000 per year, and it is expected that those costs will remain consistent. Current sludge disposal costs have been projected in proportion to the proposed production rate. The City can expect to spend approximately $50,000/year on sludge disposal.

The cost analyses for electrical, chemical, sewer and sludge disposal can be summarized to determine an approximate total variable cost per year. A portion of the electrical cost is considered as a fixed cost as noted above, and is not included in the variable cost analysis. Total variable costs were calculated

Total Variable Cost Assuming 2 MGD	low range	high range
Electrical (not including $68,000 fixed electrical cost)	$615,400	$664,100
Chemical	$335,000	$605,000
Sludge	$50,000	
Sewer	$15,000	
Total variable cost	**$1,015,400**	**$1,334,103**
Total variable cost per 1000 gallons	**$1.39**	**$1.83**

assuming a 2 MGD production rate; low and high ranges were considered based on assumptions made in the applicable section above.

Fixed Cost Summary

The City also must consider costs for maintenance, repair and/or replacement of equipment. To determine an approximate cost for equipment maintenance/repair/replacement each year, the average maintenance costs from the DTE filings for 2011-2014 were applied. The purification supplies and expenses item (DTE line 605-2 as noted below) includes lab costs as well as sewer/sludge disposal costs and an expansion allocation; however, only the lab costs are being considered as City costs under the purification supplies and expenses item. Also any expansion allocations carried under the DTE filings would not apply to the City, therefore those costs were ignored.

Additional fixed cost considerations include: insurance, current and future staffing, office supplies, site equipment and a vehicle.

The following table provides further breakdown of annual maintenance costs:

Annual Maintenance Costs	*2011*	*2012*	*2013*	*2014*	*Projected City Costs*
601-2 Maintenance of Surface Source Supply Facility	$89,067	$532,128	$503,978	$371,107	$375,000
603-2 Gas	$48,569	$31,998	$50,656	$49,559	$50,000
603-5 Misc. Pump Station Supplies and Expenses	$5,214	$317	$2,123	$1,422	$2,269
604-1 Maintenance of Power Pumping Buildings and Fixtures	$1,227	$3,315	$1,679	$10,463	$4,171
604-2 Maintenance of Pumping Equipment	$15,591	$3,668	$10,460	$21,191	$12,727
605-2 Purification Supplies and Expenses	$412,652	$147,384	$195,486	$352,473	$60,000
606-1 Maintenance of Purification Buildings and Fixtures	$25,031	$44,637	$33,049	$35,209	$34,482
606-2 Maintenance of Purification Equipment	$176,818	$80,541	$39,178	$72,610	$92,287
608 Misc. Transmission Distribution Supplies and Expenses	$19	$0	$2,381	$5,643	$2,011
609-1 Maintenance of Transmission and Distribution Buildings and Fixtures	$1,080	$200	$3,128	$73	$1,120
609-2 Maintenance of Transmission and Distribution Mains	$26,711	$1,675	$4,933	$8,041	$10,340
609-3 Maintenance of Storage Tanks	$0	$96,319	$9,406	$0	$26,431
Total Cost per year	**$801,979**	**$942,182**	**$856,457**	**$927,791**	
Total Projected City Costs					**$670,838**

Historically, when the plant was periodically running 24/7, Aquaria brought in extra staff to cover additional shifts. The City will likely need additional staff to run the plant at 2 MGD consistently.

The total annual fixed costs table provides a breakdown of fixed costs that would apply to the City.

Total Annual Fixed Costs	
Equipment Maintenance Cost	$670,838
Insurance	$80,405
Current Staffing	$361,976
Additional Staffing	$200,000
Office Supplies	$15,000
Site Vehicle	$5,000
Fixed Electrical Cost	$68,000
	$1,401,219

Future Outside Water Sales

The City may also consider potential revenue from future water sales in their decision to purchase the desalination plant. A potential sales scenario that has been considered is the City selling 0.25 MGD in outside sales to adjacent communities beginning 5 years after the plant purchase, and then growing at 0.25 MGD every 3 years over the 20 year analysis period, up to a maximum volume of 1.25 MGD in outside water sales. A conservative sale price of $4.50/1000 gallons has been used as a base purchase price, but the purchase price would be negotiated by the City with surrounding communities and could potentially be higher.

Residual Asset Value

The evaluation of the residual value of the plant is an accumulated depreciation assessment (not reflecting facility condition or income generation) and should be considered an “order of magnitude estimate” given the lack of specific relevant data. However, it is estimated that the residual value of the Plant in 2027 (20 years from the start of operations) will be approximately $39.4 million. If the depreciation schedule is extended to 2035, the residual value of all assets will be approximately $32.0 million. This evaluation is based on the limited data available in Annual Reports filed with the Massachusetts Public Utility Commission (now the Massachusetts Department of Telecommunications and Energy—DTE).

The following is an explanation of the evaluation:

- Based on the Annual Reports, the Original Cost of the Plant was approximately $89.1 million and was placed into service in 2008.
- Included in that Book Value, are intangible assets (Organization and Intangible) with an original book value of $21.1 million.
- Annual Depreciation reported in the Annual Report is approximately $2.5 million.
- In estimating residual value, we are assuming that the existing plant equipment, although past its depreciable life, will continue to operate.
- Since the Annual Report does not provide detail on depreciation by asset group, we have estimated this by applying typical depreciation periods for utility asset classes to the original cost by asset class. The biggest uncertainty with this is what the depreciation period for the

intangible assets is. We have assumed a relatively long period (50 years) and that assumption has a significant impact on the remaining residual value.

Converting the residual value of all assets to present worth at a 2.5% discount rate results in a present value of $19.6 million. Although this figure is not directly included in either fixed or variable costs, it should be considered in the context of the potential purchase.

Summary and Conclusions

The financial analysis considered fixed costs to the City, variable rates based on operation at 2 MGD, an interest rate of 2.5% and a 20 year term. Annual costs to the City under the existing WSA and proposed purchase price of the asset were compared. Considering the variable and fixed rates outlined above, and the outlined sales scenarios results in the summary of cost equivalent purchase prices, within the assumed high and low range of variable costs:

Cost Equivalent Purchase Price Ranges		
	variable rate = 1.39	variable rate=1.83
No Sales	$74,000,000	$68,000,000
Outlined Sales	$87,000,000	$81,000,000
Present Worth Residual Value	$19,600,000	$19,600,000

The City has indicated that it intends to operate the plant at a flow of 2 MGD but would likely consider operating the plant within the 1 to 5 MGD range. The variable rates determined above are based on the assumption of operating the plant at 2 MGD. Variable rates are estimated to be approximately the same for each production rate and are assumed as such. The impact to the ranges of cost equivalent purchase prices is reflected in the following table.

	Cost Equivalent Purchase Prices - no sales				
Plant Production Rate	1 MGD	2 MGD	3 MGD	4 MGD	5 MGD
Variable Rate - 1.39	$75,000,000	$74,000,000	$73,000,000	$72,000,000	$71,000,000
Variable Rate - 1.83	$72,500,000	$68,000,000	$64,000,000	$60,000,000	$55,500,000
Present Worth Residual Value	$19,600,000	$19,600,000	$19,600,000	$19,600,000	$19,600,000

	Cost Equivalent Purchase Prices – sales*			
Plant Production Rate	2 MGD	3 MGD	4 MGD	5 MGD
Variable Rate - 1.39	$87,000,000	$86,000,000	$85,000,000	$84,000,000
Variable Rate - 1.83	$81,000,000	$76,500,000	$72,500,000	$68,500,000
Present worth Residual Value	$19,600,000	$19,600,000	$19,600,000	$19,600,000

*Water sales scenario assumes that up to 1.25 MGD of water produced is being sold

The cost equivalent purchase price does not include deficiencies that are identified herein and that would need to be implemented/corrected prior to purchase of the plant. These deficiencies are intended to be addressed under the next step of the LOI process. This would add additional value to the asset which is not quantified in this analysis.

Process Schematic – Taunton River Desalination Project