

Little St. James

***SWRO Plant Assessment and Operation and
Maintenance Proposal***

Prepared for:

Little St. James

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Introduction

On June 20, 2017, TSG conducted an assessment of the present condition of the 90,000 gallon per day (gpd) SWRO plant on Little St. James. This plant was designed and installed by TSG in February 2011 and has been operated by Owner's staff since that time. Previously, a 25,000 gpd plant was installed by TSG in 2007. The intake screen structure and piping were installed as a part of that original project to accommodate the needs of the larger future plant.

The following report outlines the observations and recommendations of each subsystem of the SWRO plant. We have included two options for operations and maintenance services toward the goal of ensuring reliable, cost-effective service provided by TSG.

Plant Observations and Recommendations

Intake Structure

Observations

The 8-inch diameter intake screen and check valve are located at the seaward end of the property's dock in about 10 feet of water. It is reported that the intake screen contains an abundance of marine growth. The excessive marine growth causes an increase in the suction pressure of the intake pumps, which in turn can create maintenance issues with the pump seals and makes it more difficult for the pumps to hold prime during shutdown.

Recommendations

- A new intake screen should be procured and installed.
- The old screen should be removed and cleaned with acid to remove imbedded marine growth. The old screen can then be stored and rotated into service as the new screen becomes fouled. This will allow a clean screen to be rotated into service quickly, with minimal disruptions to water production.
- The existing 8-inch check valve also needs to be cleaned with acid and reinstalled. Intake Pumps and Priming System

Intake Pumps



Figure 1: Intake Pumps

Observations

As noted previously, this system was originally installed in 2007 and expanded in 2011 for the larger plant. The expansion consisted of installing new intake pumps, additional basket strainers, a new control panel, and repairs to the priming system. The priming system is vital to insuring that the intake pumps start without cavitation, which causes damage to the impellers.

During our visit, it was noted that only two of the four intake pumps were operational, intake pumps A and D. Intake pump B had a cracked basket strainer lid, and intake C pump had a cracked flange on the suction side of the pump. Both of these pumps were started in hand and worked. The priming system was also started in hand and worked. The staff reported that the priming pump is not used in normal operation because it takes too long to prime the system and they opt to flood the system with a garden hose. The intake control panel appears to be in good condition.

Recommendations

- Replace Pump B basket strainer lid.
- Repair Pump C suction header and cracked flange.
- Provide shelf spare of priming pump and mechanical seals for intake pumps.

Pre-Filtration



Figure 2: Media Filters

Observations

The plant's pre-filtration system consists of three 48-inch diameter mixed media filter vessels that provide removal of fine particulates from the raw seawater. These filters must be monitored and backwashed manually on a regular basis – at least weekly, if the plant sees regular use. At the time of our visit, this system appeared to be well maintained and clean.

The cartridge filtration consists of one vertical vessel with twelve 40-inch long cartridge elements that further filter the raw seawater to 5 micron purity. This system appeared to be clean and well maintained. A new Eden Excel cartridge filter housing was on site but not installed. The staff reported that it was a replacement filter housing for the one installed since the installed filter has developed leaks in the past. During our visit no indications of leaking was observed on the filter housing.

Recommendations

- The media filters should be backwashed on a regular basis, once a week. This will eliminate any channeling that may occur in the filter bed.
- The cartridge filters should be changed approximately every two to four weeks or when delta pressure across them exceeds 5-8 psi.

Energy Recovery Pressure Exchangers and Boost Pump



Figure 3: Pressure Exchanger



Figure 4: Boost Pump

Observations

The energy recovery system allows the pressure energy from the reject brine to be transferred directly to a portion of the incoming raw seawater. This allows the unit to utilize a smaller high pressure pump and therefore use less energy. This system's high and low pressure flows need to be carefully balanced for correct operation of the pressure exchangers. The pressure exchangers depend on a continuous supply of water for lubrication. The grove fitting on the low pressure discharge of Pressure Exchanger A appeared to be leaking. The Boost Pump mechanical seal showed signs of salt build up indicating need of replacement. Failure of this system will result in the plant not operating.

Recommendations

- Repair leaking PX.
- Replace the mechanical seal on the boost pump.

High Pressure Pump and Motor

Observations

The high pressure pump is the “heart” of any RO plant as it raises the seawater feed pressure to approximately 850 psi to allow membrane separation to occur and convert seawater to fresh water. The system consists of a Wheatley 110Q-3L oil-filled positive displacement pump, driven by a 75 hp high efficiency motor.

A new high pressure pump was procured by LSJ and recently installed by TSG. The pump procured was not a direct replacement of the originally installed pump and the following issues should be noted.

- *The new pump material is Nickel Aluminum Bronze (NAB) vs the original Duplex Stainless Steel. In our experience NAB pumps have a lower life cycle than Duplex SS. For this reason we exclusively specify stainless steel pumps in our designs.*
- *The Gland Nuts, Throat Bushing, and Packings are also constructed of other than Stainless Steel and will degrade at an accelerated rate, potentially creating problematic maintenance and pump integrity issues.*
- *The replacement pump was of right hand drive orientation whereas the installed unit was of left hand drive. The new pump required significant field modification prior to installation because of the improper drive orientation. This entailed the entire disassembly of the power end, flipping the crankshaft 180 degrees, and the reassembly of the pump to precise tolerances prior to attempting the change out.*
- *During our plant evaluation it was further discovered that the plungers that were installed on the newly procured pump were of incorrect size, 2 7/8 inch. The pump original specification called for 2 1/2 inch plungers. The larger plungers caused too much water to be produced which in turn over fluxed the membranes. The plungers from the old pump were removed, cleaned and installed into the new pump along with on the shelf spare packing assemblies.*

Recommendations

- Obtain a charging kit and nitrogen bottle for the Flow Guard high pressure discharge accumulator and maintain its pressure at 650 psi.
- Purchase and maintain critical spares for the HP pump.
 - Plungers
 - Packings
 - Oil Seals
 - Valves
 - Drive Belt
 - Accumulator Bladder
- Clean out salt buildup in pump gallery daily.
- Change oil quarterly and clean out oil/water separator as needed.

Membranes and Vessels



Figure 5: Vessel Auto-Shims



Figure 6: High Pressure Couplings

Observations

It was reported that the lead membranes were replaced earlier this year. The current water quality coming off the RO unit is acceptable. The analytical instruments need to be calibrated. There was a significant difference in the displayed conductivity values on both the HMI and controller versus a hand held grab sample.

The installed auto shims are no longer supported by the vessel manufacturer ProTec. The manufacturer highly recommends that these be replaced with “dummy” product ports. The auto shims could increase the salt passage due to corrosion and faulty seals resulting in diminished water quality.

The high pressure Victaulic couplers and hardware show signs of extensive corrosion. A failure can result in complete failure which can present a severe safety issue.

Recommendations

- Conduct regular membrane profiling and probing to detect future problems.
- Replace auto shims with dummy product ports.
- Replace corroded Victaulic style couplers and hardware.
- Clean membranes as needed using in place cleaning system.
- Calibrate analytical instruments.

Post Treatment System

Observations

The RO permeate without post treatment is highly aggressive to plumbing systems and hot water heaters. TSG installed a post treatment system that consists of a single 48-inch diameter calcium carbonate reactor and chemical injection pumps that provide hardness and alkalinity to the permeate to reduce the corrosive nature of RO water. Chlorine is also injected to provide a disinfectant. These systems were found to be acceptable but daily testing using handheld instruments and test kits are needed to establish that correct dosages are applied and that the finished water is acceptable.

Recommendations

- Calibrate analytical instruments.
- Maintain critical spares for injection pumps, rebuild kits, foot valves, and injectors

Electrical, Instrumentation and Controls

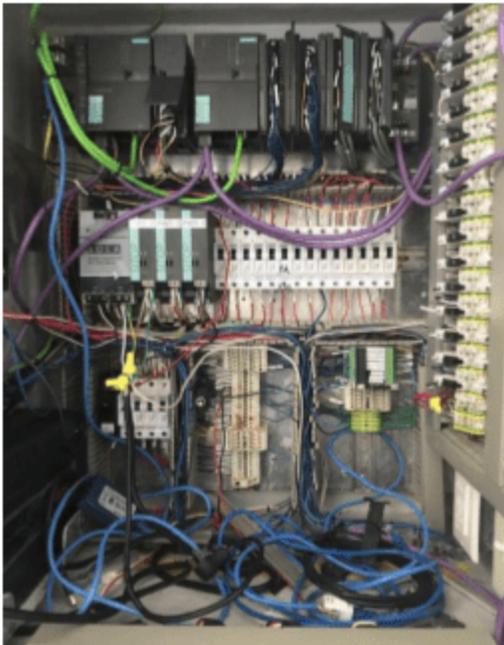


Figure 7: Control Panel



Figure 8: Surge Suppressor



Figure 9: Power Panel

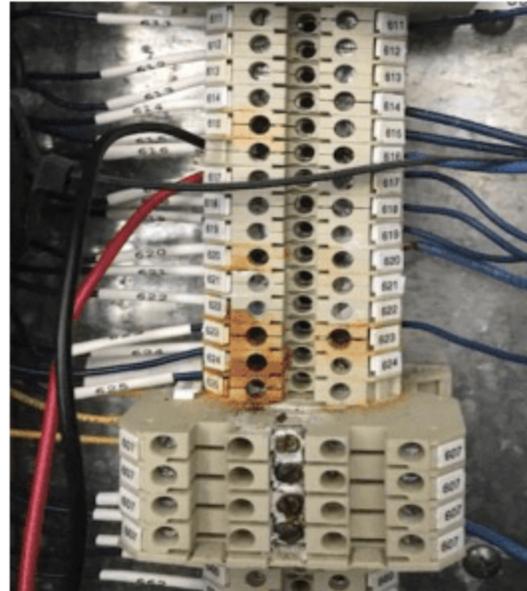


Figure 10: Terminal Blocks

Observations

There is evidence of salt water intrusion in both the main power panel and the main control panel as shown in Figures 7 through 10. Although it appears the system is operating correctly long term issues most certainly will arise. Corrosion and salt residue will wick into the individual conductors which will result in electrical issues and plant failure.

Recommendations

- Clean as much salt residue and corrosion as possible with contact cleaner
- Replace Sola Surge Suppressor immediately and closely monitor other components for possible failure.
- Maintain critical spares of individual components.
- Install a Tosibox system which will allow for remote monitoring of the plant and provide a gateway if any programming changes need to be made by offsite programmers.



Figure 11: HP Tubing Connector



Figure 12: Pressure Transmitter

Observations

It is imperative that accurate flow and pressure information is monitored, analyzed, and recorded daily. This is the primary indication of the overall operation of the plant. All of the analytical pressure transmitters and gauges were displaying faulty readings and the tubing connectors all showed signs of degradation, corrosion, and leaks. This is causing the displayed values on both the dial gauges and touchscreen to be inaccurate.

The local display on the flowmeters corresponded to those on the touchscreen with the exception of the boost pump flowmeter which displayed a 5 gallon per minute disparity. This disparity can be attributed to the meter's scaling and settings.

The conductivity indications on the controllers and HMI did not correspond and were totally different than when tested against a handheld conductivity meter. There was no conductivity calibration solution to test the accuracy of the handheld meter.

Recommendations

- Replace all high and low pressure connectors and tubing.
- Adjust flowmeter settings to bring both the local and remote displays closer together
- Calibrate all analytical instrumentation with the proper calibration standards
- Verify scaling of all instruments on touchscreen

Summary

The Little St. James SWRO Plant is now approaching six years old. It is evident that the plant is kept in a clean and orderly state however the items discussed here are of critical nature and can potentially result in catastrophic failure causing significant down time, poor plant performance and water quality issues.

The high pressure couplers and high pressure tubing connectors are a major safety concern and should be addressed immediately.

Many of these reported items are easily overlooked by untrained operators who have the best intentions but lack the training, experience and resources.

Additionally, having expert knowledge of the system and its operation would alleviate issues such as the procurement of the improper high pressure pump, which in the long run resulted in a much higher cost and shorter life cycle.

LSJ has made a significant investment in their reverse osmosis system. To protect this investment and ensure the longest life cycle and long term performance, we highly recommend that the plant be operated and maintained on a regular basis by RO water treatment professionals that have the training and experience to address the issues that may not be observed by an untrained eye.

The subsequent sections outline the two service options that we have tailored specifically for Little St. James.

Operation and Maintenance

Full Responsibility

TSG proposes to accept full responsibility for the operation and maintenance of the plant for the long term, including all consumables, replacements and repairs, with the exception of the replacement costs of the control panels and/or components and membranes.

TSG has a stringent routine and preventive maintenance schedule that ensures reliability and extends the service life of equipment. We guaranty a 90% water production factor for desalination plants. We also guarantee water quality during the term of the agreement.

TSG's contracts typically provide for a monthly fixed fee and a production fee. The fixed fee is paid to cover all TSG's fixed costs, such as labor, general and administrative expenses, insurance, tools, testing equipment and vehicles. The production fee compensates TSG for those items whose costs vary with the operation of the plant, primarily consumables and parts. Under this arrangement, TSG maintains on site and at its cost a complement of spare parts that are necessary to keep the plants on line.

Component	Fixed Cost	Water Variable Cost - \$US/1,000 gal
Labor	\$9,143	
Consumables-Water Treatment		\$1.36
Cartridge Filters		\$0.06
Preventive Maintenance/Repair and Replacement		\$1.23
General Expenses and Outside Support	\$2,611	
Totals	\$11,754	\$2.65
Unit cost at 90% on line factor- US\$/1,000 gals	\$7.42	

NOTES:

1. Shipping for all parts, equipment, chemicals and consumables is FOB to a port of Owner's choice in FL.
2. RO membranes are not included.
3. Underwater or underground piping is not included, includes 1 yearly intake screen cleaning.
4. Costs do not include power.

Weekly Professional Services

The services being proposed consist of TSG providing weekly professional services to supplement your own operations staff. Since this is more of a supervisory and consulting role, the actual day to day maintenance of the plant is done by the owners own staff.

The weekly assessment visits will consist of a one day visit on site to inspect and assess the plant's operation and condition, review operating data as well as the status of the inventory. For this type of service to be successful, it is imperative that the owner's staff perform the recommended maintenance protocols prior to the next weekly visit.

TSG cannot be held responsible for maintenance items that were not performed. Since TSG has limited control of the daily operation of the plant, these services do not include or guarantee any online factor, water quality, parts, consumables, or additional labor required for maintenance.

<i>Item</i>	<i>Description</i>	<i>Price (US\$)</i>
1	<i>Weekly Professional Services</i>	<i>\$5,200/month</i>

If additional services are required, the prices for additional services requested by Owner will be as follows:

<i>Item</i>	<i>Description</i>	<i>Price (US\$)</i>
1	<i>Visits that are scheduled more than a week in advance</i>	<i>\$1,500/day</i>
2	<i>Visits that are not scheduled or less than 48 hours' notice</i>	<i>\$2,000/day</i>