The Tampa Bay Seawater Desalination Plant

From http://www.tampabaywater.org/watersupply/tbdesaloverview.aspx

The Tampa Bay Seawater Desalination Plant provides a drought-proof, environmentally sound drinking water supply to the region. The Tampa Bay Seawater Desalination facility is an integral part of the Tampa Bay region's drinking water supply. The drought-proof, alternative water supply provides up to 25 million gallons per day of drinking water to the region.

Project Overview

Tampa Bay Water bought out the private developer and took over operations of the Tampa Bay Seawater Desalination Plant in 2002. In March 2003, the facility began using seawater to provide a sustainable, environmentally friendly, drought-proof supply of drinking water for Tampa Bay Water member governments' utility customers. It is the largest seawater desalination facility in North America. Although the plant produced some water from March 2003 to May 2005, deficiencies in the plant design required Tampa Bay Water to shut down the plant in June 2005 and select a contractor to fix the deficiencies and operate the plant long-term.

Seawater Desalination Process Trains

In November 2004, Tampa Bay Water's Board selected American Water-Pridesa to remediate the facility and operate it long-term. The plant went offline in June 2005; remediation construction began in November 2005. American Water-Pridesa completed construction in Spring 2007, after which the plant went through started up, tested and refinement of various processes. Additional work was conducted to improve sand filter and diatomaceous earth filter effectiveness and efficiency.

The remediated plant has passed an extensive acceptance test, which concluded Nov. 7. During the test, the plant ran for 14 days to prove performance at 25 million gallons per day (mgd) and at maximum capacity of 28.75 mgd.

- The Tampa Bay Seawater Desalination Plant is designed to produce up to 25 million gallons per day, and can accommodate an expansion to produce up to 35 mgd in the future.

- Plant modifications included overhauling the pretreatment process to correct inadequate screening and filtration as well as deficiencies in the reverse osmosis and post-treatment processes.

- At full capacity, the Tampa Bay Seawater Desalination Plant provides the Tampa Bay region with nearly 10 percent of its drinking water supply, making it the largest reverse osmosis (RO) seawater desalination facility in North America.

- The cost of water produced at the plant is expected to be competitive with other similar-sized plants operating around the world.

- The desalinated water is blended with water from other, less expensive water supply sources such as groundwater, making this alternative supply more affordable for member governments and consumers.

- The 30,000 square-foot seawater desalination plant is located on 8.5 acres of Tampa Electric's Big Bend power plant in Apollo Beach. The facility uses reverse osmosis to extract high-quality drinking water from the saltwater in Tampa Bay.

- The concentrated seawater left over from the desalination process will not significantly increase Tampa Bay's salinity because it is diluted in up to 1.4 billion gallons per day of power plant cooling water, a 70-to-1 dilution ratio. Monitoring during the plant's first year of operations showed no measurable changes in salinity, even when the plant was operating at maximum capacity.

- The initial cost to build the reverse osmosis plant and a nearly 15-mile pipeline was approximately $110 million. However, the plant required significant remediation throughout, which brought the total capital cost of the project to approximately $158 million, including membrane replacement.

- Under the Partnership Agreement, the Southwest Florida Water Management District will reimburse Tampa Bay Water $85 million of the plant's eligible capital costs in installments over the next 18 months. The Partnership Agreement earmarks locally collected ad valorem taxes to offset the cost of alternative water supply development.

Desalination: A Component of the Master Water Plan

Tampa Bay Water's Master Water Plan is the blueprint to meet the region's water needs. The first configuration of Master Water Plan projects was approved for construction in October 1998. This first set of projects was needed to offset major reduction in groundwater pumping from long-producing wellfields and to meet the region's growing water needs through the development of geographically diverse, alternative drinking water sources.

To date, these goals have been met. New water supply development has enabled Tampa Bay Water to reduce groundwater pumping from a permitted average of 158 million gallons a day (mgd) to 121 mgd in 2003. Further reductions to 90 mgd annual average are required be the end of 2008. The Tampa Bay Seawater Desalination Plant will help the utility meet that goal by delivering a drought-proof, environmentally sound water supply.

The desalination plant creates a new source of drinking water by removing salt from seawater. When operating at full capacity, the plant will provide 25 mgd of new drinking water and can be expanded to provide 35 mgd in the future.

The desalinated product water is blended with water from other, less expensive water supply sources, reducing costs to member governments and consumers.

Construction of the facility created approximately 447 jobs, 370 of which were in Hillsborough, Pinellas and Pasco counties. Tampa Bay Seawater Desalination Plant directly employs 19 workers. According to a Tampa Bay Regional Planning Council economic impact study, construction and operation of the facility will add $550 million

in economic activity statewide and $482 million regionally in the next 30 years. It is also expected to contribute $10 to $24 million annually to Florida's gross regional product.

Independent studies commissioned by Tampa Bay Water and Hillsborough County have found both the desalination plant's operation and discharge of concentrated seawater are safe for Tampa Bay, its marine ecology and the region's environment.

"Governance Agreements" Create Tampa Bay Water

In 1998, Tampa Bay Water became a wholesale water supply utility created to develop, store and supply water for Hillsborough, Pasco and Pinellas counties as well as the cities of New Port Richey, St. Petersburg and Tampa. They, in turn, distribute the water they purchase from Tampa Bay Water to homes, businesses and other cities. Tampa Bay Water is a wholesale government supplier. It is funded through the sale of water and has no taxing authority.

In addition to being the region's wholesale water supplier, Tampa Bay Water was also charged with reducing environmental impacts caused by concentrated water withdrawals. To accomplish this, a long-term Master Water Plan was adopted to develop diverse new water sources such as desalinated seawater, surface water and a regional reservoir to store surface water during wet times for use during dry times.

Partnership Agreement

In 1998, when Tampa Bay Water was formed, the agency and its member governments entered into a Partnership Agreement with SWFWMD. That agreement, along with the contracts creating Tampa Bay Water, call for reducing groundwater pumping from 11 long-producing regional facilities and replacing that water with a variety of alternative water supplies. To help offset the capital cost of replacement supplies, SWFWMD earmarked $183 million in ad valorem taxes for eligible non-groundwater projects, including the desalination plant, for which Tampa Bay Water will receive $85 million of the project's eligible capital costs.

Project History

In 1995, Tampa Bay Water's predecessor, the West Coast Regional Water Supply Authority, approved a Master Water Plan that included seawater desalination as one of several new sources of drinking water for the region. Deciding to take advantage of the private sector's expertise by finding a commercial developer that would design, build, own and operate a desalination facility and sell the Authority its water at a predetermined price, the Authority issued a Request for Proposals (RFP) in 1997.

The RFP, which included the possible transfer of ownership of the plant to the Authority at a later date, envisioned a desalination facility that could produce 20 to 50 mgd of drinking water. The Authority would blend the desalinated water with drinking water from other sources and supply it to the agency's member governments – Hillsborough, Pasco and Pinellas counties and the cities of New Port Richey, St. Petersburg and Tampa.

Developers who responded to the RFP were allowed to select their own plant site, facility size and operations and method of seawater desalination. Six developer teams submitted proposals and four finalists were selected with the Authority's engineering consultant, PB Water, a division of Parsons Brinckerhoff Quade and Douglas, Inc., analyzing and ranking proposals based on a number of criteria including environmental impact, ability to meet water quality requirements, economic feasibility, permittability and design.

In August 1998, as negotiations with prospective developers continued, the Authority became Tampa Bay Water. The developers' Best and Final Offers were submitted in February 1999. PB Water ranked developer teams using an evaluation criteria matrix.

In July 1999, Tampa Bay Water's board of directors awarded the final water purchase agreement for the construction and operation of a 25-mgd seawater desalination plant that could be expanded to provide 35 mgd, to S & W Water, LLC, a partnership between Stone & Webster and Poseidon Resources Corp. In June 2000, Stone & Webster declared bankruptcy, after which Poseidon acquired 100 percent of S & W Water. Poseidon replaced Stone & Webster with Covanta (formerly Ogden) in 2001 and changed the consortium's name to Tampa Bay Desal.

Facility Buy-Out

In December of 2001, Covanta Energy failed to post a required construction bond for the project. As a consequence, the sale of private bonds to fund the privately owned project was postponed. By March 2002, Tampa Bay Water determined that it was in the region's best interest to accelerate the purchase of the project from Tampa Bay Desal. On March 22, 2002, Tampa Bay Water's board of directors authorized the agency to purchase the project in order to secure long-term financing under its own name and excellent credit rating. At this point, the project was fully designed, permitted and construction was 30 percent complete. Tampa Bay Water finalized the purchase of the project from Tampa Bay Desal, a wholly owned subsidiary of Poseidon Resources, Inc. on May 15, 2002.

This means that the project, which began as a design-build-own-operate-transfer procurement arrangement, then became similar to a design-build-operate procurement where Tampa Bay Water, as owner, contracted with Covanta Tampa Construction to build the plant to a specified performance level and with Covanta Tampa Bay, Inc. to operate the facility.

Failed Performance Test and Covanta Tampa Construction Bankruptcy

Under the contractual agreement to design and build the plant, Covanta Tampa Construction and its principle subcontractor, Hydranautics, were obligated not only for the plant's construction, but for the plant's performance. To prove that the plant met specific contractual parameters for water quality, power use, chemical use and more, Covanta Tampa Construction was required to run a 14-day acceptance test. In May 2003, Covanta failed the required test due to a number of deficiencies. Tampa Bay Water extended Covanta's deadline for completion of the acceptance test to Sept. 30, 2003 to allow the contractor time to repair the deficiencies and achieve a successful performance test. Over the summer of 2003, Covanta addressed 14 of the 31 identified deficiencies, but failed to meet the Sept. 30, 2003 deadline. As a result, Tampa Bay Water issued a notice of default to the contractor on Oct. 1, 2003.

Tampa Bay Water was prepared to terminate its contract with Covanta on Nov. 17, 2003, due to Covanta's continued inability to remedy the plant,. However, Covanta Tampa Construction declared bankruptcy on Oct. 29, 2003, in order to prevent Tampa Bay Water from terminating its contract.

Settlement with Covanta Tampa Construction

Throughout January 2004 and facing a trial in bankruptcy court, Tampa Bay Water and Covanta Tampa Construction worked to find mutually acceptable terms to resolve Covanta's bankruptcy during a court-ordered mediation. As a result, a settlement agreement was reached and approved by Tampa Bay Water's board of directors on Feb. 9, 2004. The board approved the settlement because it protects the public's investment in the desalination facility.

With the settlement agreement, Tampa Bay Water gained full control of the facility, including the operating contract, for less than the construction contract amount of $79 million. Overall, the settlement was a win for Tampa Bay Water as Covanta spent $91 million to build the plant, and Tampa Bay Water paid them $75.5 million for the plant, including the reported settlement amount of $4.4 million from the project's $7.9 million retained reserves.

The settlement also included release of $550,000 from the project's reserves to pay outstanding subcontractor invoices whose payment was frozen due to Covanta's bankruptcy. Under the settlement, Tampa Bay Water retained its and Covanta's rights to pursue the $24 million performance bond that guarantees the plant's performance.

Plant Remediation

While the Tampa Bay Seawater Desalination Plant produced nearly 5 billion gallons of water since March 2003, it did not meet contractual design standards due to a number of deficiencies.

Modifications to the plant were necessary to ensure adequate pretreatment and prevent filters and membranes from clogging too quickly. In addition to the deficient pretreatment process, there were also significant deficiencies in plant design, the manufacture of plant components, as well as the RO and post-treatment processes.

In March 2004, two competing firms pilot tested alternative pretreatment processes. At the end of the testing period, each firm recommended possible remedies and capital costs and long-term operating costs associated with their solutions. The two teams submitted proposals in July 2004. Tampa Bay Water staff and consultants analyzed the proposals and ranked the American Water-Pridesa proposal highest. After successfully negotiating a contract with the team, Tampa Bay Water's board approved the contract in November 2004.

American Water-Pridesa Assumes Plant Operations

American Water-Pridesa operated and maintained the plant from January through June 2005, when it was taken out of service for remediation activities. Remediation construction was completed in Spring 2007, and afterward, American Water-Pridesa focused on start-up, testing and refinement of the various processes. The plant is now fully operational after passing a rigorous 14-day acceptance test.

Public/Private Partnership

Tampa Bay Water, Florida's largest wholesale water supplier, providing drinking water to its member governments - Hillsborough, Pasco and Pinellas counties and the cities of New Port Richey, St. Petersburg and Tampa - owns the project. Drinking water produced at the plant will be blended with drinking water produced by other Tampa Bay Water projects before being delivered to the agency's member governments. Member governments then provide the water to area residents and organizations through their water municipalities.

The Southwest Florida Water Management District, the agency responsible for managing the public's water resources in 16 counties of west-central Florida, will provide $85 million in installments to Tampa Bay Water for eligible capital costs of the facility . [http://www.swfwmd.state.fl.us]

American Water-Pridesa leads remediation efforts and plant operations for Tampa Bay Water. With a history of over 100 years, American Water provides high quality water, wastewater, and other related services, serving 18 million customers in 29 US states, and three Canadian provinces. American Water is part of RWE Thames Water, and through their combined expertise, it continues the tradition of providing customers with superior quality service while gaining access to new technologies, research and development, and global experience in service, customer satisfaction and security. [http://www.amwater.com] Pridesa has designed and built over 50 desalination facilities around the world, and are currently operating over 30 plants. www.pridesa.com

Tampa Electric Company, in Tampa, is leasing an 8.5-acre site to the project and will also provide electricity and source water for the desalination plant. [http://www.tampaelectric.com]

Reverse Osmosis is used to remove the fresh water from the salt water.

Tampa Bay Seawater Desalination uses a process called reverse osmosis (RO) to produce drinking water from seawater. RO has been successfully used in nearly 200 water and wastewater treatment plants throughout Florida and produces some of the highest quality drinking water in the world.

Tampa Electric's Big Bend Power Station already withdraws and discharges up to 1.4 billion gallons a day of seawater from Tampa Bay, using it as cooling water for the power plant. The Tampa Bay Seawater Desalination plant "catches" approximately 44 million gallons (mgd) of that warm seawater a day, separates it into drinking water and concentrated seawater.

The unused concentrated seawater is returned to TECO's cooling water where it is diluted with up to 1.4 billion gallons of water before it is discharged to the bay.

Desalination Process

There are basically three main treatment elements in the desalination process: pretreatment, reverse osmosis, and post-treatment.

Pretreatment

Pretreatment must be rigorous to remove sediment, organic matter and other microscopic particles to ensure efficient reverse osmosis operations.

Seawater entering the plant is first treated with chemicals to allow eventual settling of particles. It then goes through traveling screens that filter out shells and other larger debris. The screened water then goes through settling chambers. Similar to a traditional surface water treatment process, particles in the conditioned water clump together and settle out.

The next step in pretreatment is sand filtration, where smaller particles are filtered from the water. Next, diatomaceous earth filters eliminate microscopic materials before the water passes through cartridge filters, the last barrier before the RO process.

Reverse Osmosis

Reverse osmosis is what distinguishes a desalination plant from a traditional surface water treatment plant. During RO, high pressure forces the pretreated water through semi-permeable membranes, separating saltwater from freshwater and leaving salt and other minerals behind in a salty solution.

The size of each RO membrane pore is about .001 microns, which is about 1/100,000th the diameter of a human hair.

Post-treatment

The Tampa Bay Seawater Desalination Plant produces up to 25 mgd of desalinated drinking water. Before that water is delivered to Tampa Bay Water, chemicals are added to stabilize the water. The water is then pumped to the regional facilities site, where the desalinated seawater is blended with treated drinking water from other supply sources before being delivered to Tampa Bay Water's member governments.

Concentrate Return

At full capacity, the RO process will leave about 19 mgd of twice-as-salty seawater behind which will be returned to Big Bend's cooling water stream and blended with approximately 1.4 billion gallons of cooling water, which will dilute it 70-to-1. At this point, its salinity will be only 1.0 to 1.5 percent higher, on average, than water from Tampa

Bay. Environmental scientists say this slight increase falls within Tampa Bay's normal, seasonal fluctuations in salinity.

This cooling water mixture then moves through a discharge canal, blending with more seawater, diluting the discharge even further. By the time the discharged water reaches Tampa Bay, its salinity is nearly the same as the bay's. And, the large volume of water that naturally flows in and out of Tampa Bay near Big Bend will dilute it even further, preventing any long-term build-up of salinity in the bay.

Monitoring during the plant's first year of operations showed no measurable changes in salinity, even when the plant was operating at maximum capacity.

There are many advantages to locating Tampa Bay Seawater Desalination beside the Big Bend power plant in addition to large volumes of cooling water. Tampa Bay's relatively low salinity and the warm temperature of the power plant's cooling water help optimize the RO process, keeping costs down. Tampa Bay's frequent flushing also helps prevent the build-up of salinity.

Environmental protections, safeguards and monitoring ensure there are no adverse effects from the desalination plant.

Overview

During the Tampa Bay Seawater Desalination Plant's initial operations, extensive monitoring showed no changes in the salinity in Tampa Bay related to the plant's operations.

Studies conducted through the plant's first year of operations during 2003 showed the salinity outside the discharge point was the same whether or not the desalination plant was operating. Those same studies showed no measurable changes in salinity whether the plant was operating at 25 million gallons per day, a fraction of that, or completely off-line.

Permitting

Construction and operations of the Tampa Bay Seawater Desalination Plant and pipeline required 18 separate permits. The permitting process was lengthy and extensive, particularly the Florida Department of Environmental Protection's (DEP) permitting process. Over an 18-month period, DEP reviewed scientific research and public comments before permitting the facility.

The plant's permit applications were reviewed by other agencies, organizations and citizens concerned with protecting Tampa Bay, including the Agency on Bay Management, the Hillsborough County Water Team, the Audubon Society, the Tampa Baywatch and Tampa Estuary Program.

Safeguards

The plant has monitoring and alarm systems to track the salinity of the source water, desalinated drinking water and concentrated seawater discharged back into the bay. Measurements are taken in several areas before, within and after the plant.

Operators continuously monitor the blending ratio of the seawater being returned to Tampa Bay to ensure compliance with environmental permits.

The plant's comprehensive alarm system will warn plant operators to check or adjust the system. The monitoring system will also automatically shut down certain affected areas of the facility if monitored levels exceed predetermined parameters.

Monitoring

Tampa Bay Water conducts permit-required hydrobiological monitoring programs (HBMPs) for the Tampa Bay Seawater Desalination Plant as well as the Tampa Bypass Canal/Hillsborough River and the Alafia River. These comprehensive monitoring programs were developed to determine if initial predictions of environmental effects of these various water supplies are accurate and provide an early warning of potential changes.

The HBMPs monitor water quality, vegetation, benthic invertebrates, fish and other parameters in the Lower Hillsborough River, Alafia River, Palm River/Tampa Bypass Canal, McKay Bay and areas in Hillsborough Bay near Apollo Beach and the Big Bend power plant. The HBMPs are coordinated with other agency monitoring programs to maximize use of available data.

These monitoring programs use recent and historical data to develop a comprehensive baseline report against which post-operational data can be compared to identify any potential changes or trends.

Costing about $1.2 million annually, thousands of samples are collected, including continuous salinity measures every 15 minutes. The HBMP reports and related documents are provided to regulatory agencies and posted to Tampa Bay Water's web site.

Environmental Studies

Several predictive modeling studies were conducted prior to the plant being constructed, including:

- Cumulative Impact Analysis for Master Water Plan projects (including desalination at 50 mgd)
- U.S Geological Survey of the Big Bend Power Station area
- Independent studies were conducted using a pilot plant:
    - Mote Marine Laboratory
    - Danish Hydraulic Institute
    - University of South Florida (USF)
    - Savannah Laboratory/STL Precision
    - Marinco Laboratory
    - Hillsborough County

Each study was approved by the Florida Department of Environmental Protection and conducted in accordance with DEP methods by a DEP-approved laboratory. Each study concluded that the desalination plant would produce high-quality drinking water without harm to the bay's water quality or marine life.

Salinity

Although the plant's discharge is roughly twice as salty as Tampa Bay, it does not increase the bay's salinity because it is diluted in up to 1.4 billion gallons of cooling water per day from Tampa Electric's Big Bend Power Station before being discharged back into the bay. Salinity in the plant's discharge is, on average, only 1.0 to 1.5 percent higher than Tampa Bay's. This slight increase in salinity falls well within the natural, yearly salinity fluctuations of Tampa Bay, which vary from 16 to 32 parts per thousand, or by up to 100 percent, depending on the weather and the season.

Mote Marine Laboratory and the Danish Hydraulic Institute performed salinity studies using a pilot desalination plant, 1/1000th the size of the Tampa Bay Seawater Desalination facility. Scientists collected data during the 2000-2001 drought, where very little freshwater entered Tampa Bay. They combined this with a worst-case power plant operations scenario (only two of four of the power plant's condensers working) and operational data from the pilot plant to determine potential long-term salinity changes in the bay. Based on Mote Marine Laboratory's research, the Danish Hydraulic Institute reported that under these extreme conditions, a 2.5 percent increase in salinity is predicted in the area closest to the power plant and desalination plant and this would quickly dissipate.

The U.S. Geological Survey of the Big Bend Power Station area determined that salinity will not build up in Tampa Bay because it flushes often. "Water Transport in Lower Hillsborough Bay, Florida, 1995-1996," found that each time the tide changes, more than 200 times as much water enters or leaves the bay as circulates through the power plant. The report also found that enough water flows in and out of the bay system near Big Bend to properly dilute and flush the plant's discharges, further preventing any long-term salinity build-up.

Biological

Marinco Laboratory of Sarasota tested the toxicity levels of saline-sensitive animals such as mysid shrimp and Gulf silverside fish using concentrated seawater from the pilot desalination plant at a dilution ratio of 1:1 (one part seawater concentrate to one part "normal" seawater). Researchers found no long or short-term increase in mortality at the 1:1 dilution level, leading them to conclude the plant would not harm saline-sensitive marine life. Under normal operating conditions, the dilution for the seawater concentrate will be 70:1, and at least 18:1 or 36:1 even with two or three of Big Bend's cooling units out of service.

Chemical

Savannah Laboratory/STL Precision of Miramar, Florida, conducted tests to determine if undesirable chemicals already in Tampa Bay, which could harm water quality or marine life at higher levels, would be concentrated in the desalination process and discharged back into the bay. Researchers tested the discharge from the pilot plant for 200 compounds, none of which exceeded the Florida Department of Environmental Protection's water quality standards for Tampa Bay.

Circulation and Dispersion in Tampa Bay

The University of South Florida (USF), with Dr. Mark Luther as the principal investigator, studied the bay's circulation to determine if desalination-related changes in salinity could change the currents in Tampa Bay. (Saltwater is heavier than freshwater so changes in salinity could affect the bay's currents and the time it takes to flush the bay.)

Focusing on the farfield (areas away from the power plant and desalination facility), USF researchers found that desalination plant-related changes in the bay's salinity were so slight, that even if all of Tampa Bay Water's current water projects were to be implemented simultaneously, changes in circulation were not significant, and "There is no reason to suggest that the flushing time of the bay would be altered in a significant way."

In other words, because the salinity of the bay normally varies widely – from 16 to 32 parts per thousand – depending on the weather and season, any change in its salinity linked to the desalination plant, even if all of Tampa Bay Water's current Master Water Plan projects were implemented simultaneously, would fall well within this range of salinity and, therefore, have no effect on the currents, circulation or flushing of the bay.

Hillsborough County's Independent Study

Hillsborough County 's own, independent study into the potential environmental impact of the desalination plant concluded that, "The marine ecology of the areas of major biological concern will not be affected by the desalination facility operations."

Did you know...

- Tampa Bay Seawater Desalination's 25-million-gallon per day (mgd) rated production capacity makes it the largest seawater desalination plant in North America.
- The total surface area of the 10,032 Reverse Osmosis (RO) membranes in the plant is 85.2 acres or 64.5 football fields. The facility sits on land one-tenth that size.
- If the plant's RO membranes were unrolled and connected, they would stretch the 223 miles from Tampa to Tallahassee.
- The size of each RO membrane pore is about 0.001 microns or 1/100,000th the size of one human hair.
- The 1.4 billion gallons of warm water that typically flow through the Big Bend power plant's cooling system daily could provide every New York City resident with three hot showers.
- The plant's high pressure RO feed pumps push source water through RO membranes at up to 1,000 pounds per square inch (psi). That's the same pressure high quality pressure washers use to clean concrete driveways.
- All the plant's high pressure RO feed pumps have energy recovery units which help cut the plant's energy costs and boost pump horse power as much as 40 percent.
- The transmission main connecting the desalination facility with Tampa Bay Water's facility site crosses the Alafia River. This crossing spans more than one-half mile and is the longest horizontal directional drill involving a 36-inch fiberglass pipe in the country.