Regulatory Considerations in the Permitting of Seawater Desalting Facilities

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The Tampa Bay Desalination Facility is located on Hillsborough Bay, in the southeastern portion of Tampa Bay on the Gulf Coast of Florida. This facility is part of Tampa Bay Water's interconnected system of groundwater, surface water, and desalination supply sources developed to meet drinking water demand for 2.4 million people in the region and to help reduce regional reliance on groundwater. In 2008, production contributed an average of 20.1 million gallons per day (mgd) or approximately 11 percent of regional supply.

The desalting facility uses reverse osmosis, a process that forces seawater through semipermeable membranes under high pressure, separating freshwater from saltwater. Salt and other minerals are left behind in a concentrated seawater solution.

The facility is co-located with Tampa Electric's Big Bend Power Plant and is designed to withdraw up to 44 mgd from the "used" power plant cooling water to produce 25 mgd of potable water. At maximum capacity, approximately 19 mgd of concentrate is discharged back into the TECO power plant cooling water conduits (see Figure 1). The withdrawal used for potable production is a small fraction of the 1.4 billion gallons of cooling water used by the power plant; the concentrate is an even smaller portion of the cooling water discharge (diluted about 70 to 1), so the salinity of the combined cooling water and concentrate is about the same as water typically found in Tampa Bay.

Permitting of the facility included extensive modeling and assessment of potential impacts to water quality as well as biological components of the Tampa Bay ecosystem (e.g., fish, benthos, and sea grasses). This article offers a brief overview and summary of permitting monitoring that one could expect to encounter with seawater desalting plants as related to salinity and discusses some information collected from additional environmental monitoring (PBS&J and Janicki Environmental, 2009).

Monitoring Methods

The Tampa Bay Water desalting monitoring program has been ongoing since at least 2002 in the immediate vicinity of the facility and adjacent areas of Tampa Bay. Overall objectives for the monitoring program are to detect and evaluate effects of discharge through comparison to a control area and time periods defined by facility operation (pre-operational, operational, and off-line periods).

The monitoring design was developed by special conditions of the National Pollutant Discharge Elimination System (NPDES) Industrial Wastewater Discharge Permit issued by the Florida Department of Environmental Protection (FDEP). Permit-required and supplemental sampling is performed as part of Tampa Bay Water's hydrobiological monitoring program.

Water quality and benthic invertebrate monitoring includes fixed and random sites, and is focused in areas most likely affected by the discharge, including the power plant discharge canal and areas of Hillsborough Bay and middle Tampa Bay near the mouth of the canal; a small embayment adjacent to the discharge canal is also monitored.

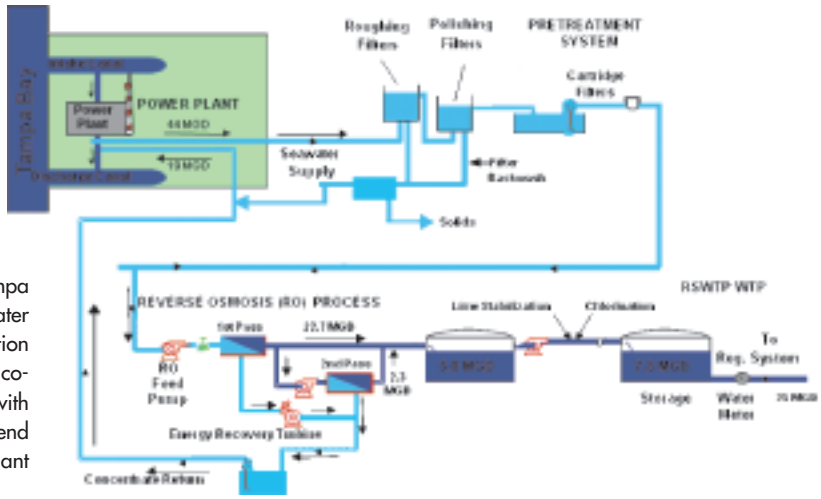

Figure 1: Tampa Bay Water Desalination Facility co-located with TECO Big Bend Power Plant

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Water Quality

The water quality monitoring program is designed to detect the potential impact on water quality that may occur in Hillsborough Bay as a result of the desalination facility discharge. Sampling is focused in three areas near the facility: the TECO power plant intake and discharge canals and the North Apollo embayment.

Permit-required monitoring includes four components: (1) continuous specific conductivity, salinity, and temperature; (2) bimonthly, 72-hour, continuous dissolved oxygen monitoring; (3) concurrent, instantaneous water column profiles across a tide cycle; and (4) chloride and pH grab samples on a single tide stage during the 72-hour monitoring period. These data are coordinated with water quality data collected in Hillsborough Bay by another monitoring agency, the Environmental Protection Commission of Hillsborough County (Grabe, et. al., 2003).

"Continuous" recorder monitoring consists of permanently deployed surface and bottom pairs of YSI water quality sensor-recorders (sondes) at the three fixed stations in stilling wells attached to pilings or positioned on buoy arrays anchored in the canals. These sondes record specific conductance, temperature, and salinity at 15-minute intervals.

The bi-monthly monitoring events consist of deploying a pair (near-surface and near-bottom) of water quality sondes at each of the three fixed stations for a minimum 72-hour period to record specific conductance, salinity, temperature, and dissolved oxygen at 15-minute intervals.

Instantaneous water quality monitoring consists of water column profile monitoring across tidal cycles, coupled with grab sampling of chloride and pH. These events occur in conjunction with the 72-hour dissolved oxygen deployments and at the same locations.

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One pair of grab samples (one at surface, one at bottom) is collected at each station per 72-hour event. These samples are collected during a single tide stage and analyzed for chloride and pH. Four water column profile measurements (one per each of four tide stages) are performed at each station during these events.

Water column profiles were also collected on each of the four tide stages at the north and south sides of the intake canal and the middle and south sides of the discharge canal in order to characterize the entire canal cross section. These cross section profiles are not specified in the permit, but are performed at the request of FDEP staff. These data are used in conjunction with the continuous recorder measurements to better understand water quality conditions throughout the canal.

In addition, supplemental water column profile monitoring was performed in four other areas. Background data were also collected in the North Apollo embayment.

As a first-cut evaluation of possible water quality changes that could be related to operation of the desalination facility, salinities in the intake and discharge canals were compared for different operational conditions ranging from no production to full capacity. Monitoring data are available from the pre-operational period, the period of initial operations (2003 to 2005), the off-line period (2005-2007), and with the remediated facility back on line (2007-2008).

Continuous surface and bottom salinity measurements were averaged and weighted to determine water column salinities and were adjusted to account for travel time through the desalination and power facilities to allow comparison of intake and discharge canal salinities. When the desalination facility was operating, the difference in salinity from the intake canal to the discharge canal averaged 0.48 parts per thousand (ppt), as shown in Figure 2. When the facility was not operating, the average difference in salinity from the intake to discharge canals was 0.75 ppt (see Figure 3).

Given the practical instrument detection limits, these measurements suggest that there are little if no differences in salinity whether the desalination facility is operating or not. As a result, differences observed fall within the range of values which can be attributed to equipment accuracy.

The greatest potential effects from the facility are expected when the ratio of concentrate discharge from the desalination facility to the TECO power plant cooling water flow is highest (i.e., lowest cooling water flow and maximum potable water production). Figure 4 shows that as desalination production increases, no trend in discharge salinity is observed. A comparison of average intake and discharge salinities at increasing production rates during the initial operation period showed little difference in salinities over the range of production.

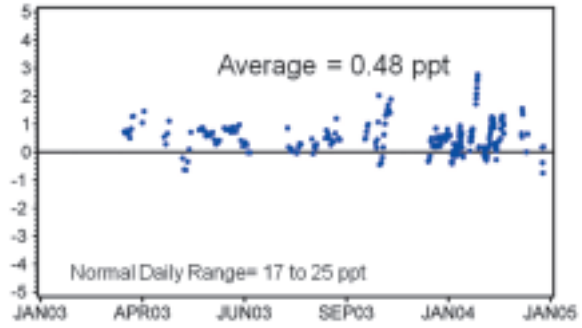

Figure 2: Salinity Differences between Intake and Discharge Canals During Periods with Desalination Production

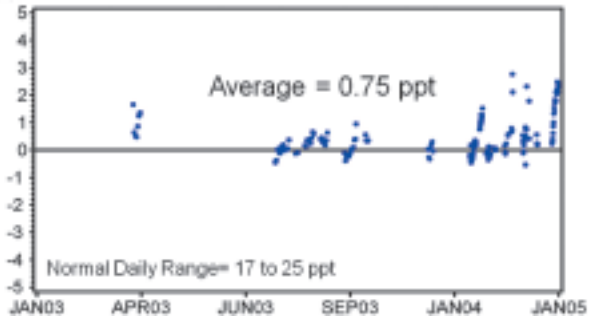

Figure 3: Salinity Differences between Intake and Discharge Canals During Periods with NO Desalination Production.

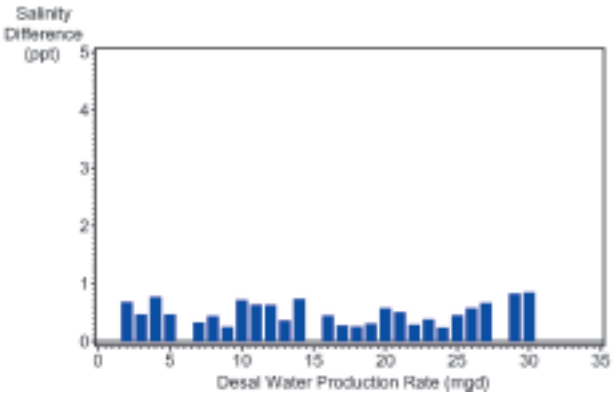

Figure 4: Desalination Production and Salinity Differences Observed in Monitoring Locations in Tampa Bay.

In addition, if discharges from the facility were elevating salinities in the adjacent bay waters, one would expect to see a trend among the four biological monitoring areas near the mouth of the discharge canal. Differences in surface, middle, and bottom salinities in these biological monitoring areas during any given month were very small, did not follow a trend, and were not consistently higher or lower in any of the areas.

For relative comparison, it is important to note that waters in the bay near the facility experience daily, seasonal, and annual changes in salinities ranging from 4 to 14 ppt. For example, higher salinities were observed from March 2007 to June 2008 and represent the impact of lower rainfall and decreased freshwater inflow to Tampa Bay during this period.

Monitoring Summary

Evaluation of monitoring data from 2002-2008 showed that even during periods of maximum water production, changes in salinity were within or below expected values (less than the increase over background) that were predicted by the University of South Florida hydrodynamic model developed during design and permitting of the facility (Vincent et al., 2000). To date, there has been no indication that the desalination facility has had an adverse impact on Tampa Bay.

References

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