Rincon Bayou Salinity Monitoring Project

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RINCON BAYOU SALINITY MONITORING PROJECT 0921

Introduction:

This project was for the purpose of monitoring freshwater inflows by measuring salinities at various stations downstream of a diversion pipeline in order to calculate spatial and temporal environmental effects as well as the amount of freshwater needed to manage a healthier estuary within the Nueces River Delta located near Corpus Christi, Texas.

The City of Corpus Christi (City) is required to provide freshwater inflows into the Nueces Estuary based on the 1995 Agreed Order. Very simplistically, every month the City is required to "pass through" to the bays and estuaries an amount of water equal to the measured inflow into the Choke Canyon Reservoir / Lake Corpus Christi Reservoir System (Reservoir System), up to a target amount. The target amount varies by month and combined volume of the Reservoir System. The City may receive credits for excess flow from the previous month or from salinity relief credits based on the salinity in Nueces Bay.

Normally, a river flows through a delta area prior to making its confluence with its receiving water body. The Nueces River is different in that it flows into Nueces Bay at a point along the south shore of the bay, 2 ½ to 3 miles from the delta-bay interface, completely bypassing the delta. Only during times of severe flooding, causing over-banking of the river, or locally heavy rain, did much freshwater make it into the delta proper.

To provide even more freshwater diversions during normal flow conditions, the City has had a pipeline and pump station built to divert up to the first 3,000 Acre Feet (AF) of pass throughs from above the saltwater barrier dam directly into the upper Rincon Bayou.

The primary project objectives of this project were to monitor the freshwater inflows coming into the delta via the new pipeline by recording salinities within the water column at various stations downstream in order to calculate spatial and temporal environmental affects as well as the amount of freshwater needed to manage a healthier estuary.

Methods:

The Conrad Blucher Institute for Surveying and Science (CBI) at Texas A&M University - Corpus Christi (TAMU-CC) installed and maintained a network of salinity monitoring stations in the Nueces Delta (see Fig. 1) under contract with the Coastal Bend Bays & Estuaries Program (CBBEP). The water quality monitoring stations were installed downstream of the RBP outfall (Fig. 2). The selection of monitoring station locations were designed to capture a spatial look at the fate of the freshwater as it made its way down the Rincon Bayou to Nueces Bay. Monitoring station NUDE01 (Fig. 3) is located at 27° 53' 22" N 97° 35' 29" W. The station consists of a single piling that was jetted into the mud in the deepest part of the Rincon Bayou at that site. NUDE02 (Fig. 4) is located at 27° 53' 19" N 97° 34' 10" W and is maintained by research staff at the University of Texas Marine Science Institute (UTMSI). The last station in the network is

Figure 1. Location of Nueces Delta in relation to Texas and the Nueces Watershed.

Figure 2. Map of Stations showing locations of monitoring stations.

Figure 3. Terrence Ussery uses a radio and computer to call NUDE01 before and after exchanging the sonde to ensure the devices are measuring salinity accurately. All field data are recorded in the log book.

Figure 4. NUDE02 at the railroad crossing. The data sonde is under the railroad in the deepest part of the channel.

NUDE03 (Fig. 5), 27° 53' 1" N 97° 31' 59" W, located in the tidal reach of the Rincon Bayou. An additional station maintained by CBI, SALT08, is located at the interface of Nueces Bay and the Rincon Bayou. The station serves to give an idea of the final fate of freshwater going down the Rincon. Another station, maintained by the United State Geological Survey (USGS) is located not far downstream from the Rincon Bayou Pipeline (RBP) outfall, but upstream of NUDE01. In addition, a weather monitoring station, NUDEWX (Fig.6), was maintained and serviced as part of this project. Located in the upper delta, this station reported wind speed, wind direction, barometric pressure, rainfall, relative humidity, and solar radiation. Monthly service to the weather station included a calibration check of the rain gauge.

The salinity monitoring stations consist of either a Hydrolab® or a YSI® water quality datasonde. The sondes are interfaced with line of sight spread spectrum radios aimed back to TAMU-CC. Each station is radio polled by an automated computer program designed and implemented by the IT staff at CBI. Data are stored in the Division of Nearshore Research (DNR, a part of CBI) Environmental Database, and made available to the public in real time on the DNR webpage for the project (http://lighthouse.tamucc.edu/RinconSalinity). Also available on the project webpage is the project map showing station locations, Quality Assurance Project

Plan, Scope of Work, Data Management Documentation, Datasonde Standard Operating Procedures, Quality Assurance Quality Control Documents, datasonde calibration records, and graphs of the previous seven days data collection from all stations (Fig 6). Instruments are exchanged monthly with freshly calibrated units. All calibration and post-calibration are done at the CBI wet lab. All calibration/post-calibration sheets are kept in the laboratory record book as well as entered and stored online, and are made available upon request by interested parties.

Figure 5. NUDE03 station located in the lower delta in the Rincon Bayou.

Figure 6. Although not part of this study, the real time data collection of weather data is gathered through this station next to the USGS gauge. Larry Loyd is calibrating the rain gauge, which is helpful data when analyzing freshwater inflows into the Rincon Bayou.

Results and Discussion:

As of August 31, 2010, there have been three major pipeline pumping events recorded since the pump was completed in mid 2008 (Fig. 7, Table 1). A drought occurred in late 2008 and lasted until the fall of 2009 when freshwater inflows into the reservoirs were finally recorded. In 2009 the only inflow event from the pipeline was 3,030 AF over the period of late September to late October. To date (September 2010) in 2010, a total of 3,060 AF has been pumped into the upper Rincon, with a smaller pulse of ~750 AF in January and a larger one in May of ~2,300 AF. Figure 8 shows all three pumping events that took place during this study and relates the amount of freshwater being pumped through the pipeline to the overall salinities and freshwater inflow into Nueces Bay. Figure 9 demonstrates the typical Rincon Bayou water coverage during normal conditions on an aerial image of the Delta. Figure 10 shows observed freshwater coverage over the area during a pumping event. Based on temporary salinity stations deployed by the Center for Coastal Studies (CCS) freshwater is spreading out into the lower marsh of the Delta.

Salinity responded downstream after each of these events with the upper station (NUDE01) in a matter of days, with the midpoint station (NUDE02) and the lower station (NUDE03) showing salinity response roughly 8 to 14 days respectively. Variation of the time to see salinity changes due to the freshwater pulse at the stations can be attributed to external factors such and wind velocity, wind direction, and tides (Fig. 11).

Figure 7. The left image is a picture of the pipeline intake pumps along the Nueces River. The right image shows the pipeline outfall along the Rincon Bayou in the Nueces Delta.

Table 1. All three pumping events recorded during this project, acre feet pumped through the pipeline, duration of pumping, and dates pumping took place.

Pumping Event	Dates of Event	Duration (days)	Tide	Quantity of Water Pumped (Acre Feet)
1	Sept. 28 to Oct. 21, 2009	24	High	2,987
2	Jan. 6 to Jan. 14, 2010	9	Low	742
3	May 10 to May 31, 2010	21	High	2,288

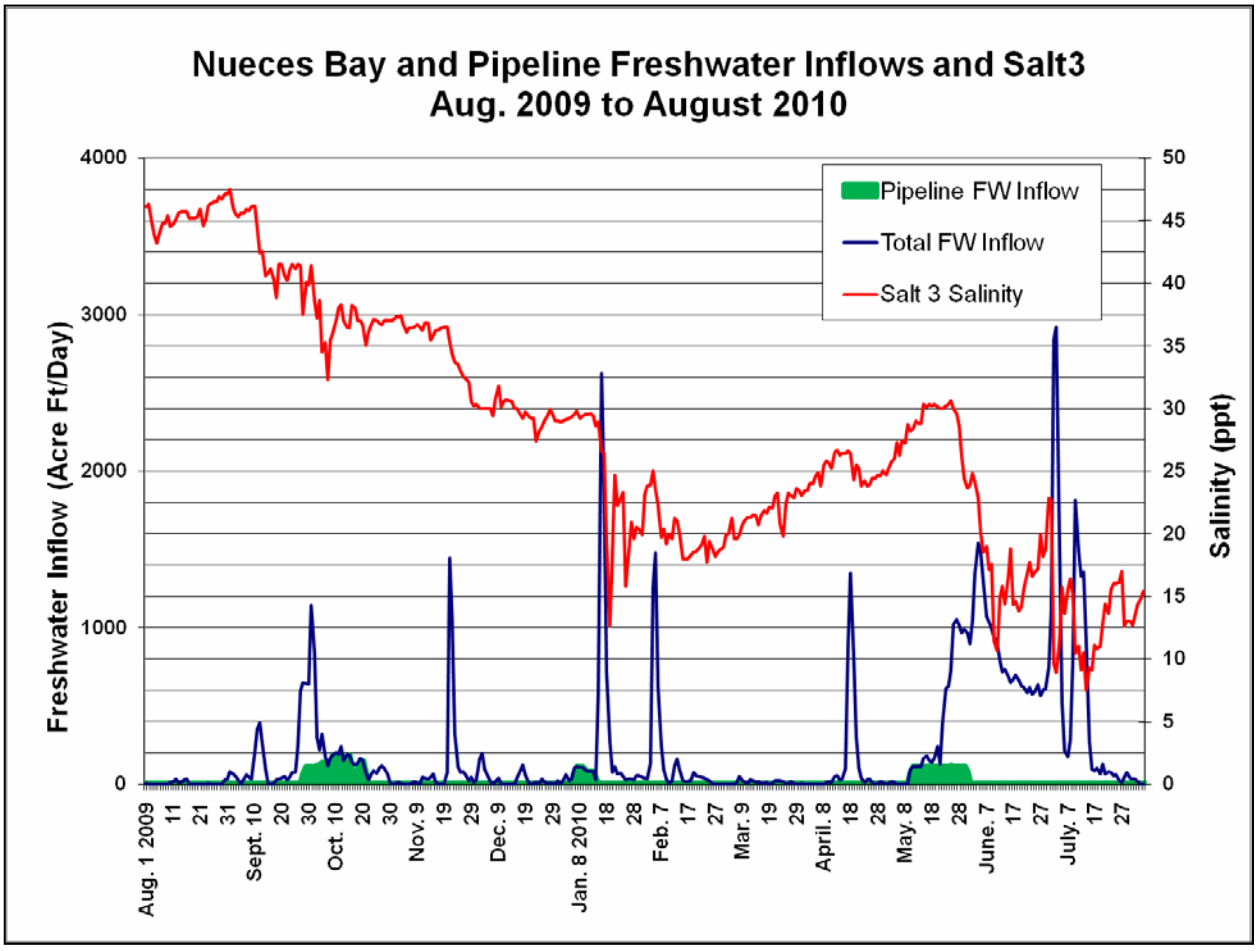

Figure 8. Freshwater inflows over the saltwater barrier dam in Calallen vs. salinity levels in Nueces Bay at Salt3. This figure also includes the 3 pipeline inflows studied during this project.

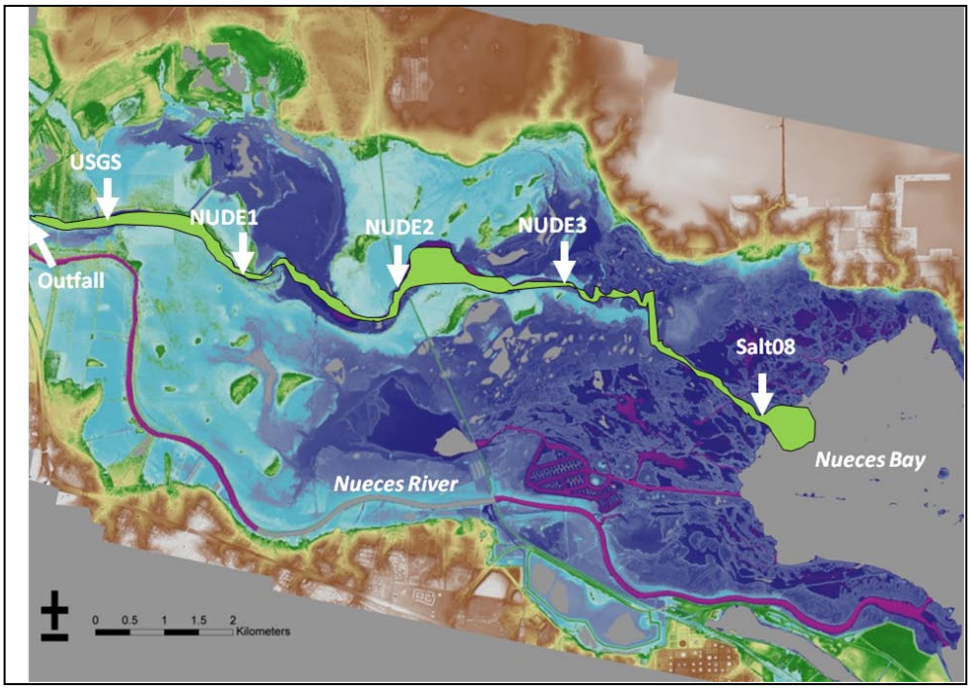

Figure 9. LiDAR image showing typical water coverage in the Rincon Bayou during normal conditions. Also shown are the salinity stations and the pipeline outfall.

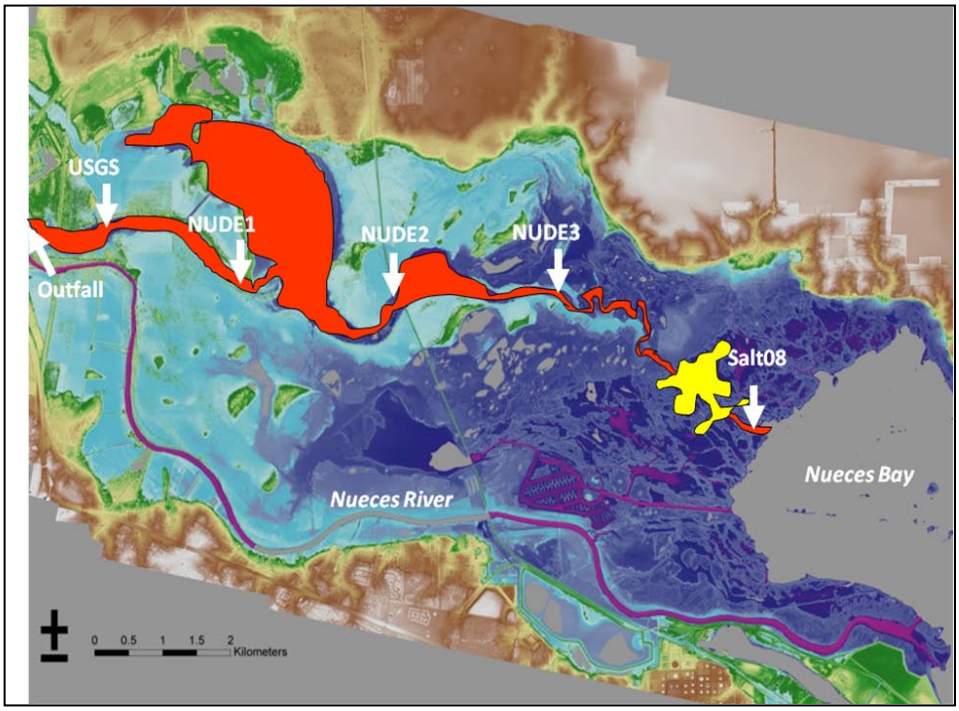

Figure 10. The red polygon is area observed to have freshwater coverage during pumping events based on aerial maps and site visits. Yellow polygon is an area where salinities have been impacted by freshwater inflows from the pipeline and are being sampled by the Center for Coastal Studies.

During the first pumping event, which started September 28, 2009 and lasted to October 21, 2009, salinities recorded over time at each station in order to see the spatial and temporal scales of salinity moving down the Rincon Bayou through the Nueces Delta (Figure 11). This was a natural seasonal high tide time period where pumped freshwater was pushing against Nueces Bay saltwater. It was soon realized that at each station the freshwater was being pushed back and forth in the Rincon depending on daily tide cycles and strong winds.

Another interesting note is that during pumping events not all the water flows downstream. Due to little vertical elevation, freshwater tends to flow both upstream and downstream of the Rincon Bayou once water reaches the main stem of the Rincon. A USGS gage station has been in operation since 1996 just upstream of the Rincon Pipeline outfall location which allows for an accurate reading of discharge rates through the bayou. From this information a calculation of pumped freshwater back to the river can be made. During each event, approximately 10 to 30% of the water flowed back to the Nueces River instead of downstream through the Rincon Bayou and into Nueces Bay. Figure 12 shows daily totals of freshwater pumped through the pipeline and the amount of water that flowed back to the Nueces River during the first pumping event of this project in 2009.

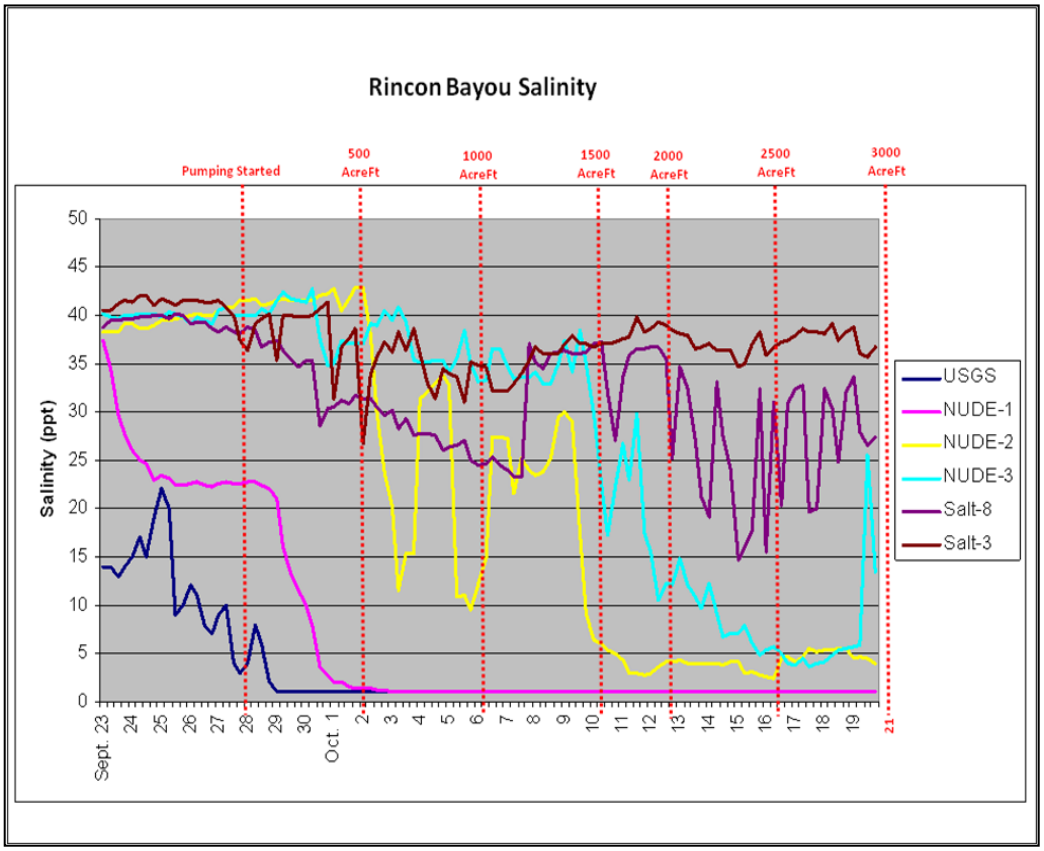

Figure 11. All stations and salinity readings between September 23, 2009 and October 21, 2009. Also included is freshwater (Acre Feet) pumped in increments of 500 AF.

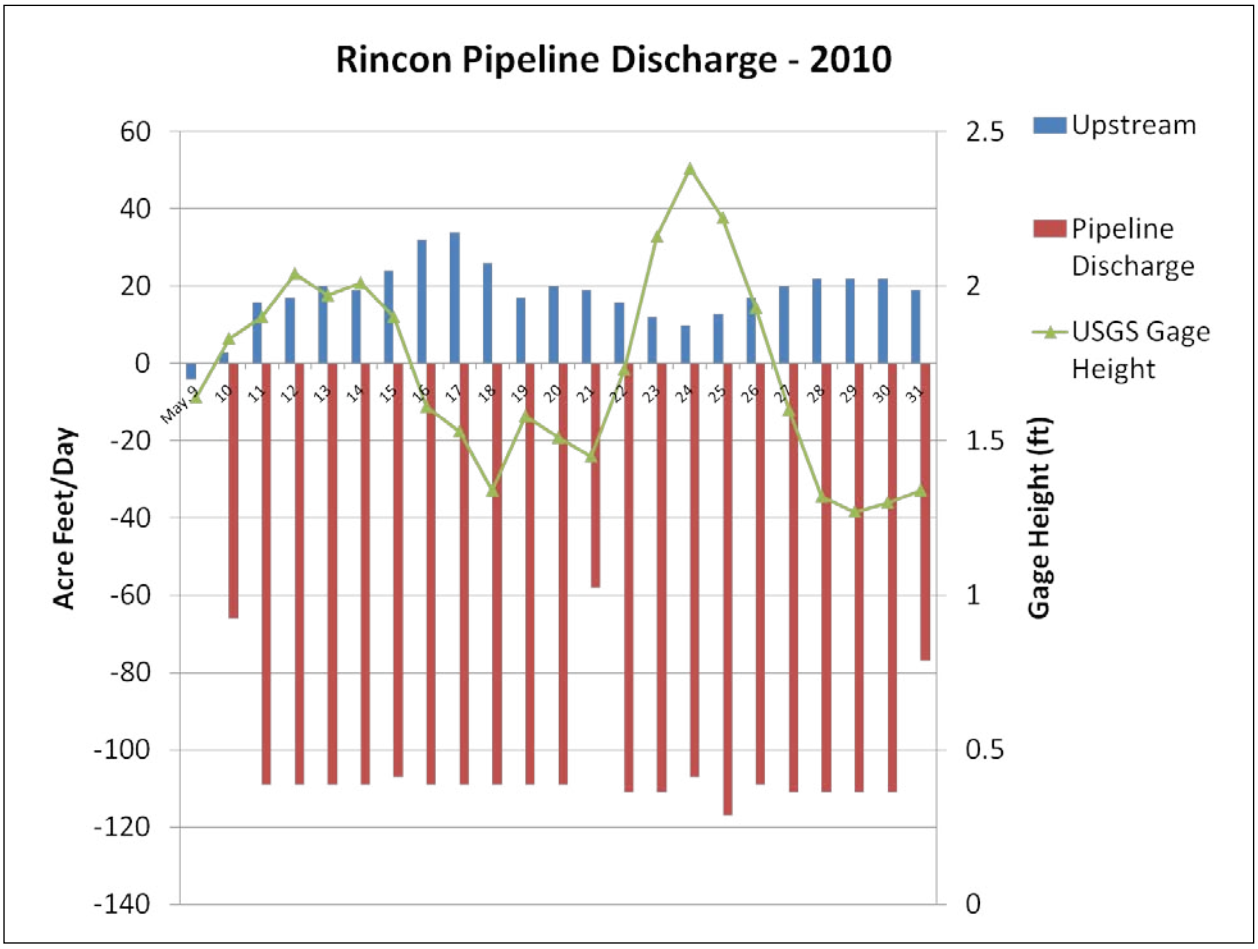

Figure 12. Discharge rates (in Acre Feet) of freshwater through the Rincon Bayou from the USGS gauge located upstream of the pipeline outfall on the Rincon Bayou. This shows the amount of water pumped through the pipeline and the amount that goes back upstream and back to the Nueces River. Water height is also shown from the pumping period of May 10 to May 31, 2010.

In an attempt to analyze all data that might be useful in determining freshwater movement through the Delta during pumping events, various types of data were collected and evaluated. Figure 13 depicts a chart of different types of data that were looked at during the beginning of the study in order to determine which data sources would be the most useful in determining freshwater flow through the Rincon Bayou. For this study it was determined that salinity, tide cycles, number of pumps used to pump freshwater through the pipeline, and duration of the pumping event were the best indicators to use in comparing pumping events to each other.

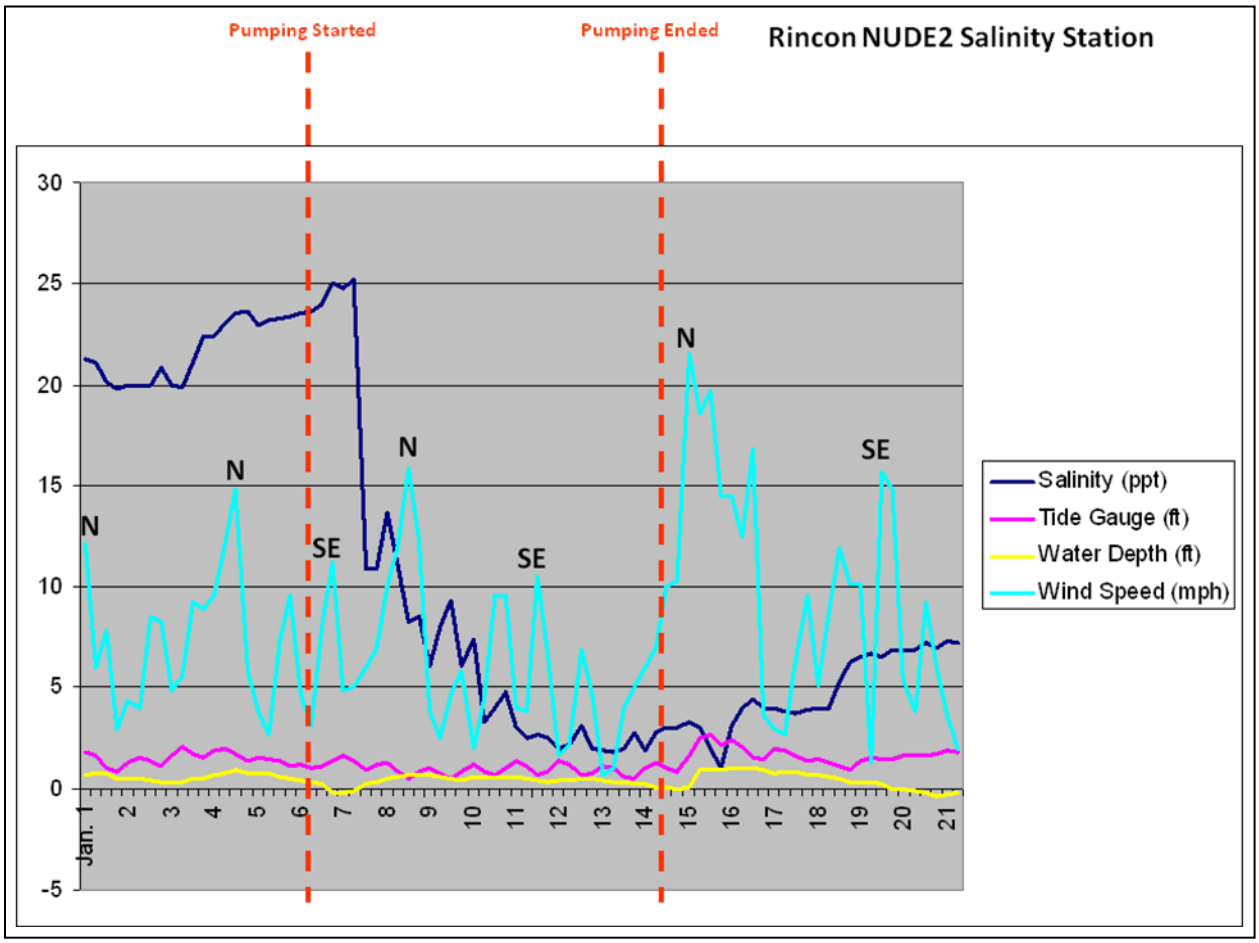

Figure 13. Various data collected to figure out the best methodology for looking at freshwater inflows and what might impact these flows. Salinity, tides, water depth, wind speed, and wind direction were all looked at during each pumping event. These data for this figure were collected during January 2010.

It was also decided that NUDE02 seemed to be the most consistent salinity monitor to use for comparing the different types of data since it was centrally located in the Delta. NUDE02, under the railroad trestle, is the midpoint of Nueces Bay pulsing saltwater with tide cycles and the freshwater flowing down the Rincon Bayou. The idea being that if freshwater reached NUDE02 for an extended period of time then much of the freshwater pumped beyond that time frame would be pushed out into the lower delta and possibly into Nueces Bay. Figure 14 shows NUDE02 salinity levels throughout the project period and shows the dates when pumping occurred. From the figure there is distinct drop in salinity at NUDE02 when freshwater pumping begins and a slow increase in salinities after the pumping has stopped. Salinity upper and lower bounds have been added to this chart for reference of what might be considered healthy throughout the various seasons. These salinity bounds (ranges) were taken from what already exist for Nueces Bay in looking at salinity relief credits for the City of Corpus Christi in terms of meeting the City's passthrough requirement.

When analyzing all pumping events over the project period there was a clear distinction between low and high tide events in terms of how long it took for freshwater being pumped to reach the NUDE02 station (Fig. 15). When each pumping event was zeroed out to the day pumping began and compared to each other, the low tide pumping event showed a quicker drop in salinities at NUDE02 than did the other two events. Field observations were also performed during each of these pumping events and water was spread over much of the same area during both low and high tide events, indicating that during low tide there is still good freshwater coverage over a large area and a better chance of lower delta marsh infiltration than in high tide events. This is thought to be due to less resistance of pumped freshwater pushing against Nueces Bay water.

The same concept of zeroing out the days of freshwater pumping was used for looking at what happens to salinities at NUDE02 after the pumps have been turned off (Fig. 16). On all low and high tide events it took salinities about 20 days to reach within 5 ppt of Nueces Bay salinities.

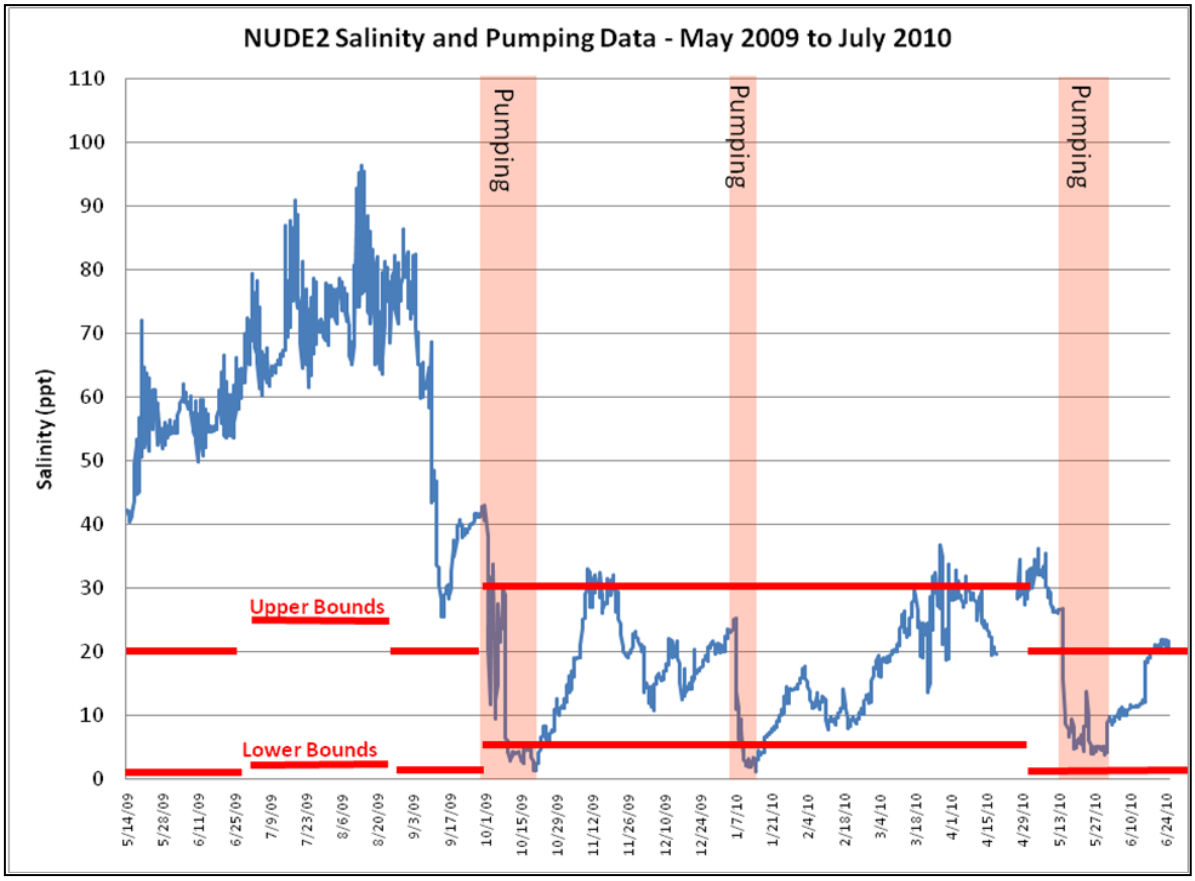

Figure 14. NUDE02 station and all 3 pumping events. Also included in this chart are the salinity upper and lower bounds for Nueces Bay as a reference to what might be considered a healthy environment for most estuarine aquatic life in this area.

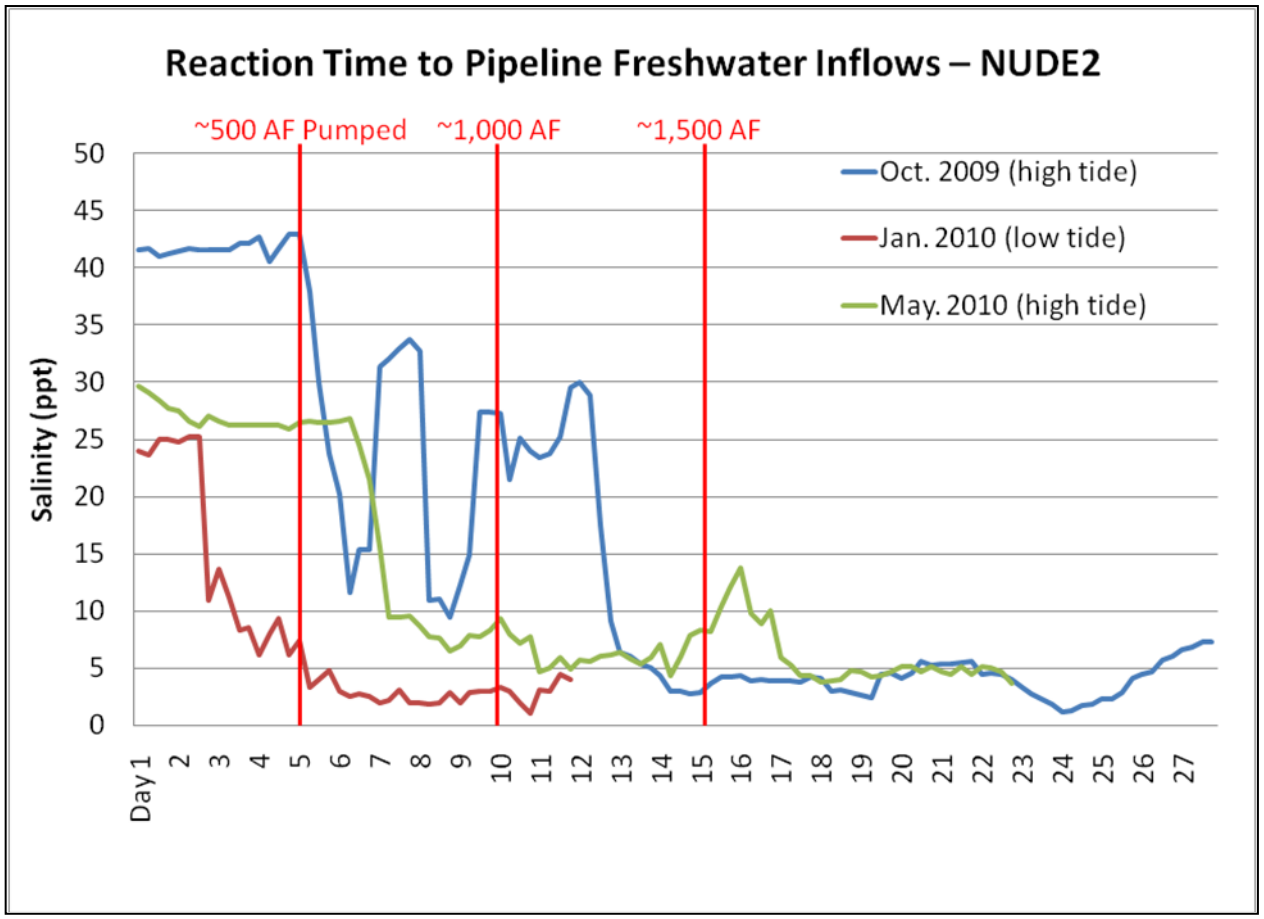

Figure 15. All three pumping events were placed on the chart based on the day pumping started in order to see how many days freshwater inflows impacted salinity at the NUDE02 station. Acre Feet of freshwater pumped were estimated, and tides were also included in this chart.

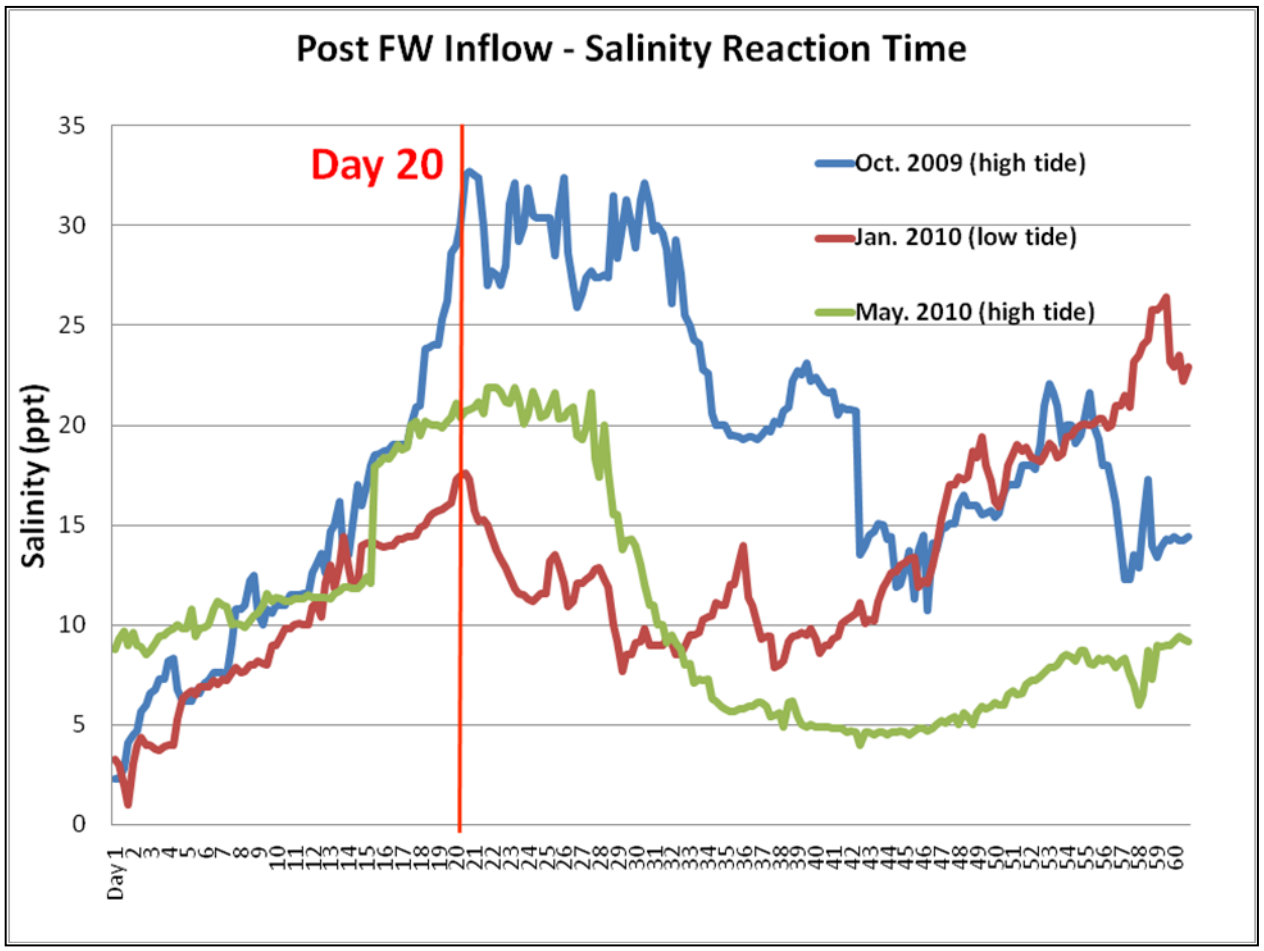

Fig. 16. All three pumping events were placed on the chart based on the day pumping stopped (day 1 = 1st day pumps were turned off) in order to see how long salinities take to get back up close (within 5 ppt) to Nueces Bay salinities. This information gives an idea of freshwater impacts on salinities in the Nueces Delta after the pumps have been turned off. In all 3 events it took approximately 20 days for salinities to reach within 5 ppt of Nueces Bay salinities.

Conclusions:

Various weather events occurred during each of these freshwater pumping events so more scenarios need to be completed before a full assessment can be made on how to run the pumps and how freshwater inflows will impact the Nueces Delta.

There are several key items that have been learned throughout this project:

- Salinity station NUDE02 seems to be in a good location for monitoring freshwater inflows from pumping because of its mid-point position between freshwater coming down the Rincon Bayou and saltwater seasonal and daily tide cycles up into the lower marsh. **Based on data collected during this study it is recommended that NUDE02 be considered the controlling monitoring station for future pumping decisions.**

- Low tide gets more pumped freshwater downstream of the Rincon Bayou faster than high tide with around the same amount of spatial coverage. **It is recommended to pump larger volumes of freshwater during seasonal high tide times vs. low tide times of the year if spatial coverage into the lower marsh areas of the Delta is desired.**

- Approximately 20% of the total water pumped through the pipeline goes back towards the Nueces River rather than downstream of the Rincon Bayou. **Efforts to build an effective back-flow preventer structure should be considered.**

- It takes around 1,500 acre feet of pumped freshwater to get NUDE02 below 5 ppt under low or high tide conditions.

- It takes about 27 days to pump 3,000 acre feet of freshwater into the delta using a single pump.

- Rincon Bayou salinities at station NUDE02 will take about 20 days to reach within 5 ppt of Nueces Bay salinities after the pumps have been turned off.