Nueces Delta Environmental Monitoring Project

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Final Report

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Nueces Delta Salinity Effects from Pumping Freshwater into the Rincon Bayou

INTRODUCTION

This project's focus is monitoring the hydrological effects sourced from the Rincon Bayou Pipeline (RBP) in the Nueces Delta near Corpus Christi, Texas (**Figure 1**). This report will highlight trends in salinity changes throughout pumping events and provide a detailed look at the effects seen during the 2019-2020 sampling year (September 1, 2019 to August 31, 2020). The results of this study are used for the continual adaptation of a water management plan that will help water managers make decisions on quantity, timing, and duration of pipeline inflows that are most productive and important to the ecology of the Nueces Delta.

The Nueces Delta has been a scientific research focus due to its hypersaline condition (Matthews and Mueller 1987; Whitledge and Stockwell 1995; Montagna et al. 2002; Palmer et al. 2002; Montagna et al. 2009; Hill et al. 2011; Nueces BBEST 2011; Nueces BBASC 2012; Hodges et al. 2012). Because of watershed impoundments, riverbank modifications, and increased urbanization along the Nueces River, the Nueces Delta is no longer connected to the Nueces River, except through the Nueces River overflow channel that was permanently opened in 2001. Because of these factors, the majority of freshwater flow is diverted from the river directly to the bay, bypassing the delta. The only natural means of freshwater flow through the Nueces Delta is during severe flooding events or local heavy rainfall causing the flow to over bank into the delta (BOR 2000; Pulich et al. 2002; Hill et al. 2011). Decreased inflows into the delta and prolonged Texas droughts have caused frequent hypersaline conditions in the Nueces Delta. Freshwater inundation within the Nueces Delta over the past 30 years has been insufficient in volume and distribution to maintain a healthy marsh, the lack of sediment loading in the system is leading to the delta front eroding into Nueces Bay, the marsh plants are under stress, and the connectivity of aquatic habitat is threatened (Hodges et al. 2012).

In 1990, studies found these hypersaline conditions could harm the ecological and biological processes of the marsh and degrade the overall health of the Nueces Estuary. This impact evoked the state of Texas to develop an inflow criterion for freshwater inflows (Dunton and Alexander 2000; Montagna et al. 2002; Palmer et al. 2002). The resultant 2001 Agreed Order, from the Texas Commission on Environmental Quality (TCEQ), requires the City of Corpus Christi (City) to provide no less than 151,000 acre-feet (186,255,757 m^3) per year to the Nueces Estuary (TCEQ 1995). Each month the City is required to "pass through" inflow to the Nueces Estuary equal to the measured instream flow into the Choke Canyon Reservoir/Lake Corpus Christi Reservoir System up to a target amount (TCEQ 1995). The target amount varies by month and is calculated based on the combined storage volume of the Reservoir System. The City may receive credits for excess flow from the previous month or from relief credits based on salinity measured at the SALT03 monitoring station in Nueces Bay (Montagna et al. 2009).

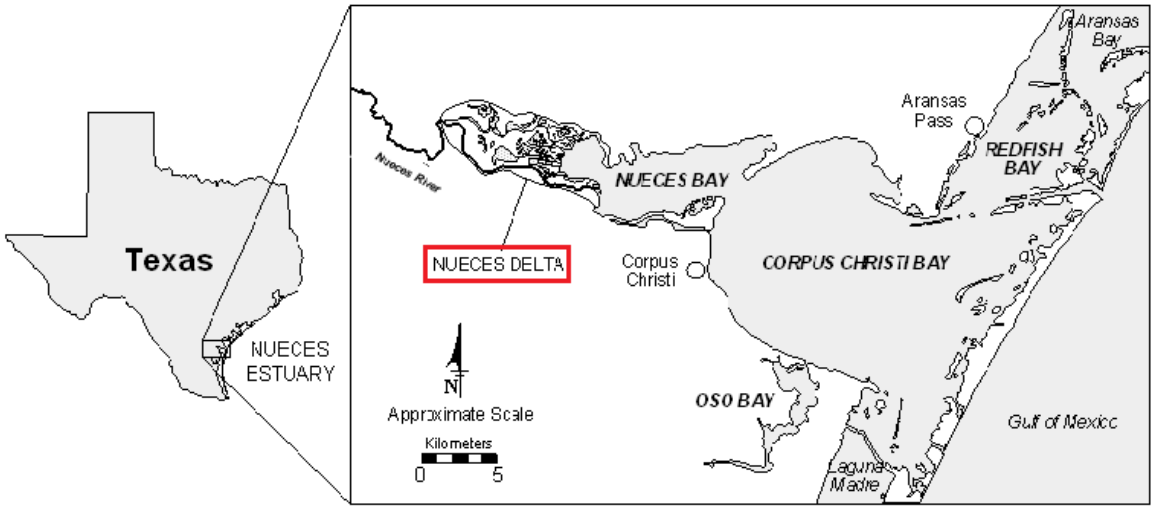


Figure 1. Location of the Nueces Delta within Texas and the Nueces Watershed.

To efficiently deliver freshwater to the Nueces Delta, the City built the Rincon Bayou pump station and pipeline (RBP) to divert up to the first 3,000 acre-feet (3,700,446 m^3) of required "pass throughs" to the upper Rincon Bayou in the Nueces Delta. The RBP became operational in November 2007. The RBP pump station includes three 350 horsepower mixed flow submersible pumps capable of moving up to 60,000 gallons per minute with all three pumps operating **(Table 1; Figure 2).** The number of days to deliver a given volume of freshwater through the RBP depends on the number of pumps used.

Table 1. Capacity of the Rincon Bayou Pipeline

	Number of Rincon Bayou Pumps in Operation		
	1	**2**	**3**
Flow, gallons/minute	28,000	46,000	60,000
Flow, cubic feet/second	62	102	134
Flow, acre-feet/day	124	203	265
Total kW	230	455	675

This project's principal objective is to monitor the RBP as it releases freshwater into the Nueces Delta system with monitoring stations to measure the salinity downstream and in adjacent areas to the main channel. The results of this study will be used in the development of a Rincon Bayou Pipeline Management Plan that will help water managers make decisions on quantity, timing, and duration of pipeline inflow events that are most productive and significant to the ecology of

A)

B)

Figure 2. View of RBP pumping facilities depicting A) the intake pumps located on the Nueces River above the Calallen Dam and B) the pipeline outfall in the Rincon Bayou. Photos taken by Jace Tunnell.

the Nueces Delta. This report will focus on the distribution of RBP freshwater inflows in the Nueces Delta and provide a descriptive analysis for the two RBP pumping events that occurred between September 1st, 2019 and August 31st, 2020. This project, initiated by John Adams, a Research Specialist with CBI, in 2009, now represents the eleventh year of continually monitoring the RBP in the Nueces Estuary.

METHODS

The Coastal Bend Bays & Estuaries Program (CBBEP) contracts this salinity-monitoring project to the Conrad Blucher Institute for Surveying and Science (CBI) at Texas A&M University - Corpus Christi (TAMU-CC). CBI installed and maintains a network of four salinity monitoring stations located downstream in the Nueces Delta and Bay recording data continuously at 30-minute intervals to capture data before, during, and after all RBP freshwater releases (**Figure 3**). Each Nueces Delta (NUDE) station is jetted

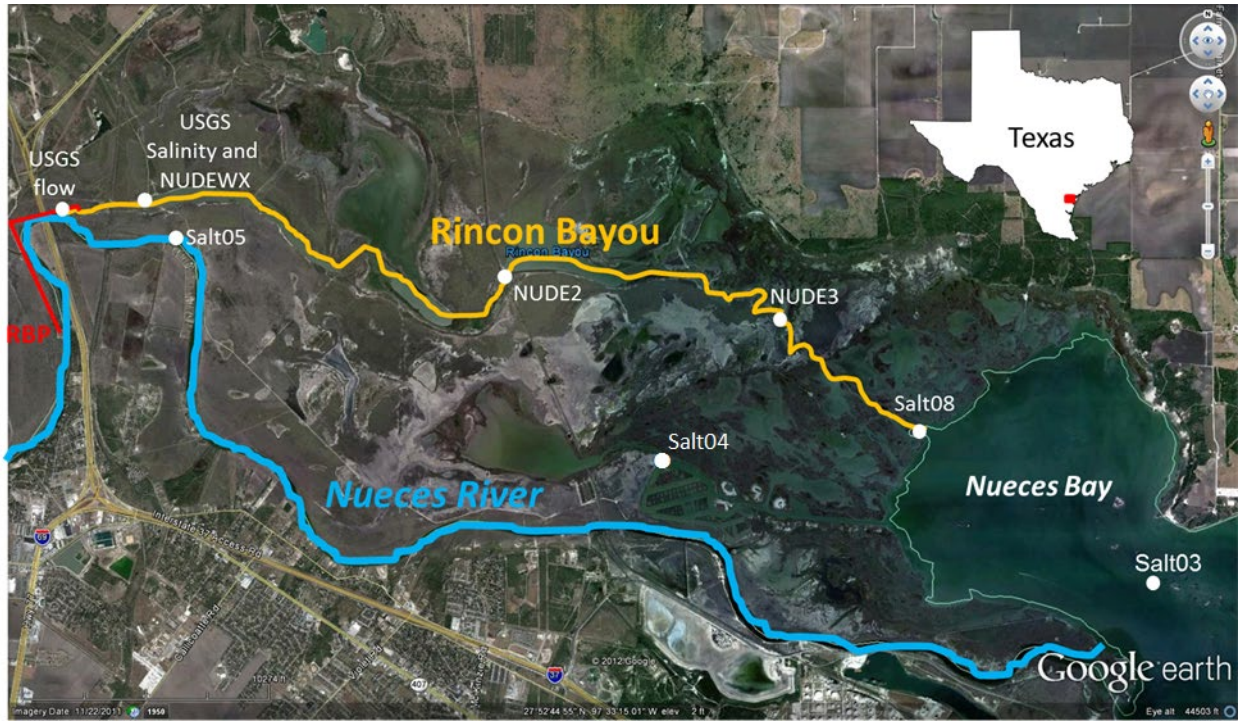


Figure 3. Map showing the RBP (Rincon Bayou Pipeline [red line]) and the four salinity monitoring stations for this project (NUDE2, NUDE3, SALT04, and SALT08).

approximately five feet into the sediment near the water's edge with a water quality datasonde extending into the deepest parts of the channel, which vary in distance at each location. NUDE2 is located in the middle reach of Rincon Bayou (27.888611°N, 97.569444°W) and NUDE3 is located in the lower tidally influenced reach of Rincon Bayou (27.883774°N, 97.533188°W). SALT08 is located in the lower Rincon Bayou at the confluence of Nueces Bay (27.870428°N, 97.517090°W). Salinity data from SALT08 provides verification RBP freshwater has reached the interface to Nueces Bay. SALT03 (27.851561°N, 97.482028°W) is located in the middle of Nueces Bay and SALT05 (27.891601°N, 97.610684°W) is located in the Nueces River; both stations are used as references in the report to compare bay and river salinity, respectively, to Rincon Bayou. The SALT04 monitoring station was reinstalled in the mitigation channel southeast of South Lake (27.867197°N, -97.549240°W). SALT04 collects baseline salinity data for comparison to a potential flow regime change that may results from future construction of a diversion channel from the Rincon Bayou to the mitigation channel.

A tide gauge (NUEBAY 185) is located in Nueces Bay (27.832149°N, -97.485056°W) and measures primary water level (m), water temperature (°C), wind speed (m/s), wind gusts (m/s), wind direction (°), and barometric pressure (mbar). A weather station, NUDEWX is located on Rincon Bayou downstream from the RBP outfall (27.897582°N, -97.616524°W). The NUDEWX measures wind speed (m/s), wind direction (°), barometric pressure (mbar), rainfall (mm), relative humidity (%), and solar radiation (cal/cm^2/min). The CBI performed monthly maintenance to NUDEWX including a rain gauge calibration check. NUEBAY 185 is serviced annually as per NOAA COOPS standards for water level monitoring stations (http://tidesandcurrents.noaa.gov/).

The CBI salinity monitoring stations consist of Hydrolab® MS5 and H20 water quality datasondes interfaced with cellular IP modem (Figure 4). Stations are polled by an automated computer program designed and implemented by the Information Technology staff at CBI. Data is stored in the CBI project webpage that includes a 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 of data collected from each station. Each Hydrolab measures water quality parameters. Hydrolab MS5 datasondes at, SALT03, & SALT05 measure: water temperature (°C), specific conductance (µS/cm), salinity (PSU), pH, dissolved oxygen (% saturation & mg/L), and depth (m). Hydrolab H20 datasondes at SALT08, NUDE2, and NUDE3 measure: water temperature (°C), specific conductance (µS/cm), salinity (ppt). Instruments are exchanged monthly with calibrated datasondes (Figure 5). Calibration and post-calibration of datasondes are performed at the CBI wet lab with all quality control forms retained in the laboratory record book and stored online in the publically accessible CBI Environmental Database http://cbi.tamucc.edu/cbi/data/.

Figure 4. SALT08 (top image) and NUDE3 (bottom image) datasondes are being exchanged with a newly calibrated datasonde which will remain deployed for approximately 4 weeks after which the datasonde will be replaced in the same fashion.

RESULTS AND DISCUSSION

Forty-seven pumping events have occurred since the RBP became operational in late 2007. Two pumping events occurred during the 2019-2020 monitoring period totaling 12,187 acre-feet acre-feet (15,032,421 m^3) were pumped (Figures 6-7).

Table 2. 2019-2020 Rincon Bayou Pumping Events

Year	Pumping Event	Dates of Event	Duration (days)	Avg. water level (m above MSL)	Acre-Feet Pumped
	46	Sep. 05 to Sep. 27, 2019	23	0.003	3,535
2019-2020	47	May 28 to Jul. 14, 2020	46	0.003	8,652

Local rainfall varied spatially between the National Weather Service (National Weather Service 2018) at Corpus Christi International Airport (CRP) at 27°46'22.43"N, 97°30'8.47"W and at NUDEWX at 27°53'50.47"N, 97°36'58.73"W with more rainfall frequently occurring at CRP (Table 3). NUDEWX is approximately 11 miles northwest of CRP and is located directly in the Nueces Delta. Despite the regional difference in rainfall, both locations still recorded similar rainfall trends and were representative of the general meteorological conditions in the Nueces Delta watershed.

Table 3
Total rainfall per 2019-2020 sampling year for NUDEWX and CRP.

	2019-2020
NUDEWX	21.15 in
CRP	24.01 in

The 2019-2020 sampling period 24.01 in (60.99 cm) of rainfall was recorded at CPR, and 21.15 in (53.72 cm) at NUDEWX.

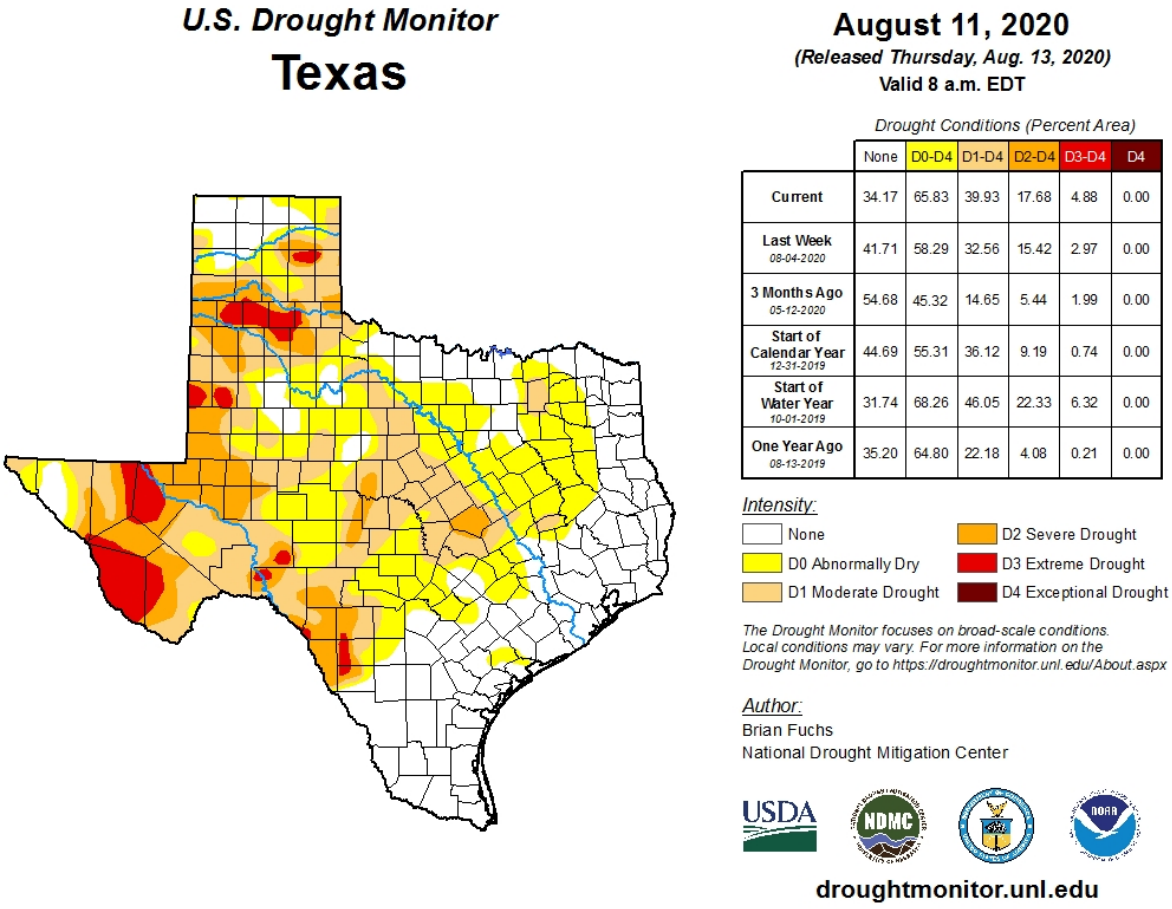


Figure 5. Drought condition figure throughout the state of Texas 2019, which will generally be representative of drought, conditions throughout the 2019-2020 sampling year.

Reservoir capacities during the 2019-2020 sampling year were similar to the 2018-2019 sampling year in that both resulted in relatively high rainfall amounts and reservoir capacities. Lake Corpus Christi reservoir levels ranged between 91.9% and 61.2% and Choke Canyon reservoir levels varied between 50.3% and 39.0% during the 2019-2020 sampling year.
Pumping events 46 & 47 resulted in a drop in salinity levels as expected at the NUDE 2 data collection location, however, the salinity levels fluctuated significantly during each daily tide cycle at NUDE 3 and SALT 08 as they are closer to the mouth of the delta and tidally influenced. Salinity levels at the NUDE 2 location generally returned to pre pumping levels after 28 days.

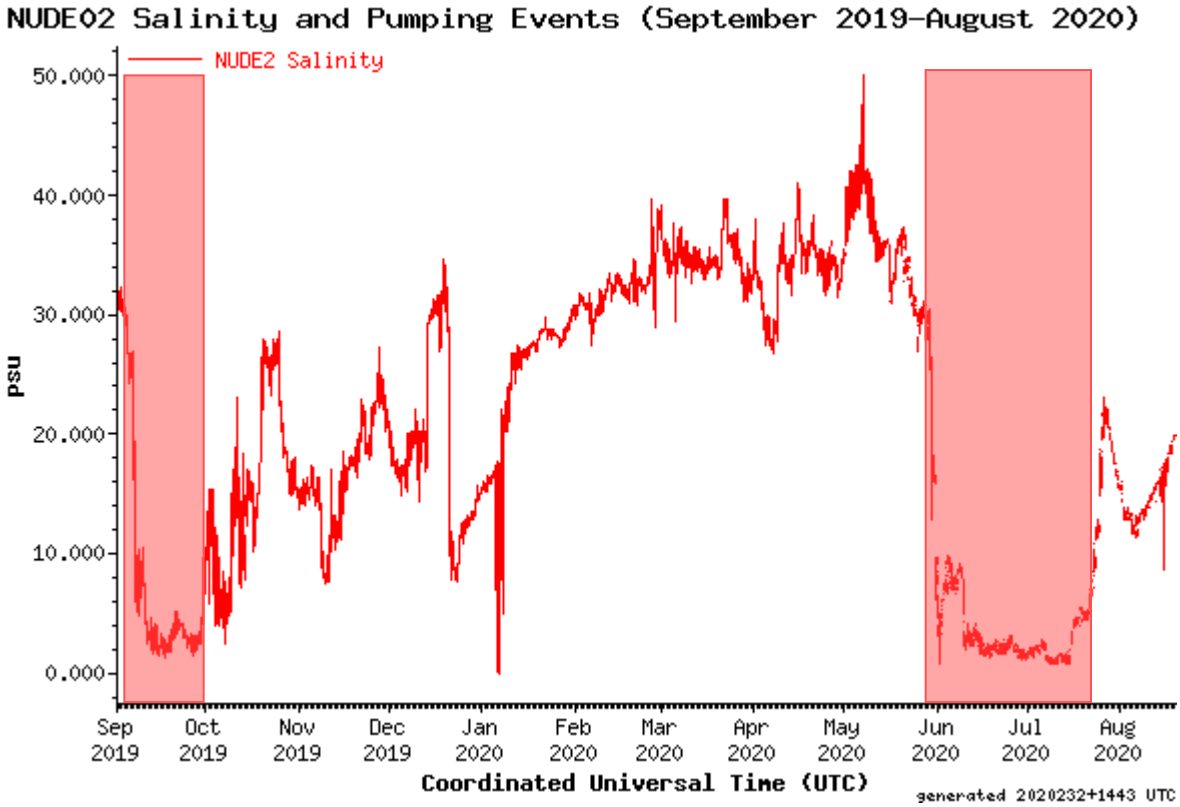
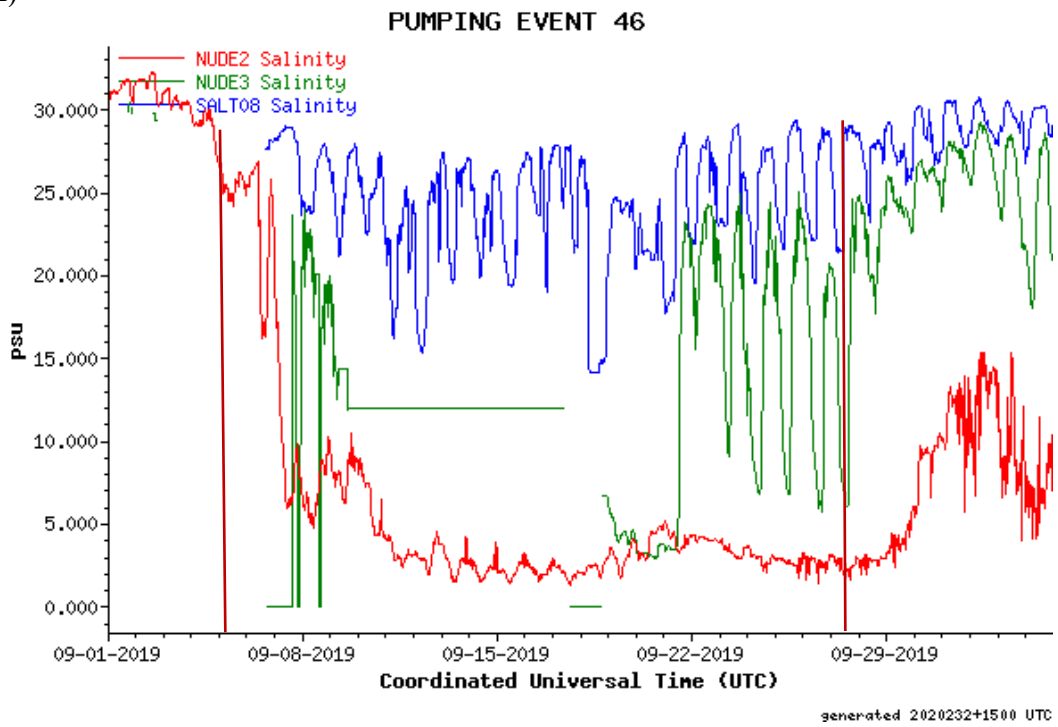


Figure 6. NUDE2 salinity during the 2019-2020 pumping events. Shaded areas denote the ----- pumping event, thickness of each shaded area represents duration (days) of pumping events.

A)



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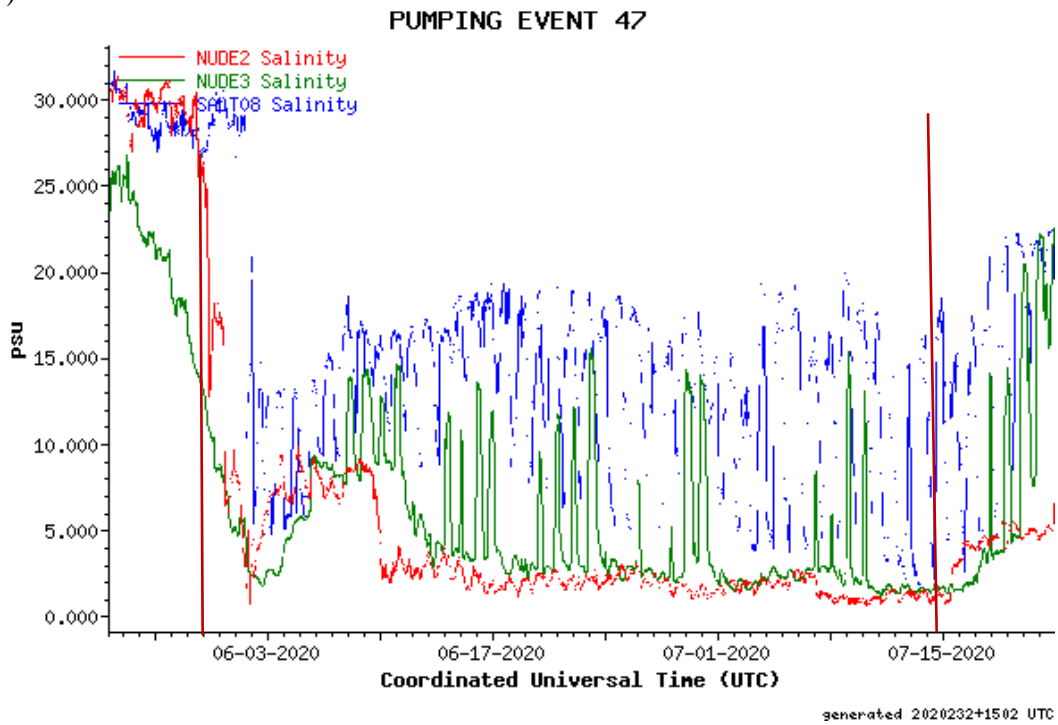

Figure 7. Individual pumping events during the 2019-2020 year. Vertical lines represent the start (left line) and end (right line) of pumping events. Each graph represents 4 days before pumping start and 7 days after pumping end for A) event 46 and B) event 47.

In addition to freshwater inflows, the salinities in the Nueces Delta are also influenced by tidal variations which will cause movements of fresh and saltwater separated by a halocline (Adams and Tunnell 2010). As the tide rises, saltwater nearer to the bay is forced further back into the delta, and as the tide lowers, freshwater located further away from the bay is pulled closer to the bay. This is evident at SALT08, which will undergo rapid increases and decreases in salinity after a pumping event in correlation with rising and lowering tides (Figure 9).

At least some tidal influence on salinity levels at SALT08 appeared to be present during periods of all pumping events during the 2019-2020 sampling year. Diurnal tidal variation appeared to have little to no effect on salinities at NUDE2 during pumping events. Wind direction, wind velocity, evaporation and rainfall during pumping events have all had an effect on hydrodynamics in the Nueces Delta (Adams and Tunnell 2010).

Pumping events did not seem to have a significant effect on salinity levels at the new SALT04 monitoring station. This is as expected as the mitigation channel currently has no direct connection to the Rincon Bayou. Salinity values at SALT04 ranged from 9.3 to 42.9 PSU with an average of 29.1 PSU during the sampling year. SALT04 will continue to monitor salinity values for the potential construction of a diversion channel that will connect the Rincon Bayou to the mitigation channel.

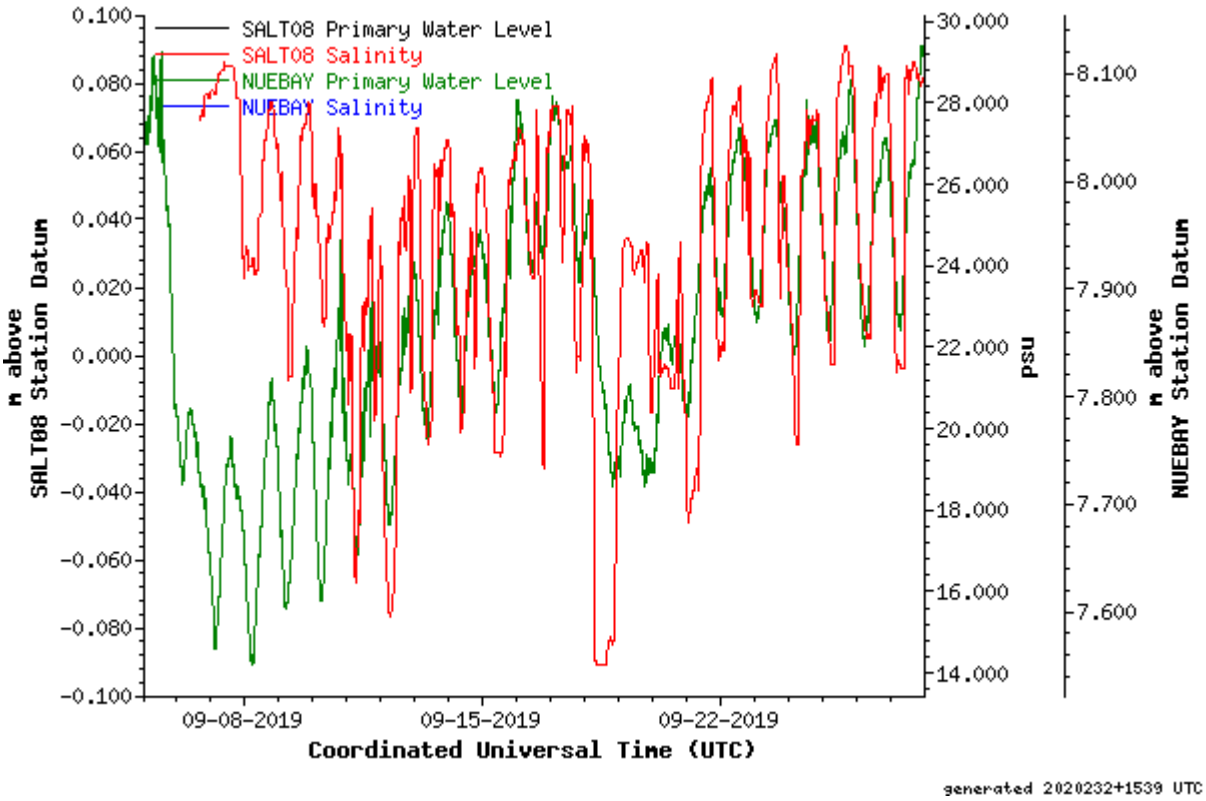

Figure 8. SALT08 salinity (red line) and NUEBAY water level (green line) during pumping event 46.

CONCLUSIONS

During the 2019-2020 sampling year 12,187 acre-feet of water was released utilizing the RBP. All the pumping events during the 2019-2020 sampling year were relatively large in terms of amount of water pumped with the minimum amount pumped at 3,535 acre-feet during event 46.

Both pumping events during the 2019-2020 sampling year were typical causing salinity levels to drop below 5 PSU at NUDE 2. Salinity levels at the Salt 8 station, located at the mouth of the Delta, only dropped below 5 psu during Event 47 and then only for a short duration during low tide.

A review of the RBP events appears to indicate that the pipeline is an effective tool for managing salinities within the Rincon Bayou. The combined effects of precipitation, wind direction and velocity, tidal variations and evaporation has a significant effect on salinity levels in the Nueces Delta, and the data gathered from this project will be incorporated into the overall water management strategy for reestablishing the connectivity and salinity gradient back in the Nueces Delta.

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