Strategic Purpose

To evaluate potential landform and hydraulic modifications intended to **moderate the high salinities** experienced in the Nueces Delta and Nueces Bay during periods of limited freshwater inflows, with the expected benefit of **improving marsh habitat**.
Project Objectives

To evaluate specific projects designed to increase the area and duration of freshwater inundation of wetland areas within the Nueces Delta.
Project Team

- Naismith Engineering, Inc.
  - Grant Jackson, P.E.
  - James Dodson
  - Dave Sullivan
  - Mary Kay Skoruppa
  - Kara Thompson
- TAMUCC Center for Coastal Studies
  - Brien Nicolau
  - Erin Hill
- UTMSI
  - Dr. Ken Dunton
- Dr. George Ward
- Dr. Ben Hodges
The Process

The Project Team drew on the collective experience and knowledge of over thirty years’ work on the concept of diverting freshwater inflows from the Nueces River and making greater amount of freshwater available to the marsh systems within the Nueces Delta and areas within Upper Nueces Bay.

The development, analysis and final selection of the projects evaluated in this study involved an iterative process of professional judgement, modeling, evaluation of modeling results, solicitation of stakeholder input, refinement of options, additional modeling and synthesis of modeling results.
Study Area

Nueces Delta
Nueces River
Nueces Bay
Location of Existing Projects
## Original Projects Evaluated

<table>
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<tr>
<th>Project #</th>
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<td><em>Upper Rincon Bayou Diversion to high marsh/wetlands North of Rincon Bayou</em></td>
</tr>
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<td>3</td>
<td><em>East end of Upper Rincon Bayou control structure &amp; diversion to South Lake area</em></td>
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<td><em>Restoration of Allison WWTP Discharge to South Lake</em></td>
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## Projects Included in Final Modeling

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Projects Included in Final Modeling

- Odem WWTP Discharge
- Drainage & WWTP Discharge
- Elevated RR Tracks
- Tidal Flats
- North Lake
- 5-B N Lake S to Middle Lower Delta
- 4-B Middle Rincon to S Lake
- South Lake
- City of CC Diversion Pipeline
- Calallen Dam
- CBBEP Rincon Bayou Control Structure
- Existing RB-N Lake Div Channel
Hydrologic Modifications in the Nueces Delta, TX: Impacts on Porewater Salinity and Biology

Ken Dunton

University of Texas Marine Science Institute
• What is the relationship between vegetation assemblages and salinity?
Physical Setting

- Microtidal (~15 cm amplitude)
- Conspicuous semiannual “tidal” harmonic
- Irregularly flooded
Physical Setting, cont’

Typical Winter Low Water Conditions versus Inundation during Fall High Water
Continuous Monitoring (2009-2010)

- 2 sites along the Rincon Bayou
- 2 salinity loggers per site
Time Series Data

- Creekbank salinities responded strongly to inflow events
- Average creekbank salinity = $23.8 \pm 7.7$
- Average interior marsh salinity = $44.2 \pm 3.4$
- Water levels vary seasonally
Precipitation Impacts

• Sediment exposure is strongly controlled by semiannual tides

• Flushing of porewaters by precipitation limited to exposed sediments
Long Term Monitoring (1999-2011)

1. Plant abundance measured by quadrat on a percent cover basis
2. Porewater collection
3. Gauged freshwater inflows
• 3 dry periods: 1999-2001, 2005-06, 2008-09
Freshwater Inflow

Environmental Controls (CCA)

<table>
<thead>
<tr>
<th>Scores for constraining variables</th>
<th>Axis 1</th>
<th>Axis 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porewater Salinity</td>
<td>0.59</td>
<td>-0.45</td>
</tr>
<tr>
<td>Porewater Ammonium</td>
<td>-0.01</td>
<td>0.34</td>
</tr>
<tr>
<td>Soil Moisture</td>
<td>-0.94</td>
<td>0.27</td>
</tr>
<tr>
<td>Distance to Tidal Creek</td>
<td>0.40</td>
<td>0.37</td>
</tr>
<tr>
<td>Distance to Nueces Bay</td>
<td>0.59</td>
<td>0.64</td>
</tr>
<tr>
<td>% Variance Explained</td>
<td>77.93</td>
<td>14.08</td>
</tr>
</tbody>
</table>

• Soil moisture and porewater salinity have large impacts on the overall vegetation assemblage
• The delta is characterized by an estuarine gradient
Vegetation Community

Bare Area

Stress tolerant species

Dominator species
Salinity tolerance of *Spartina alterniflora*

- Porewater salinity exceeding 25 caused consistent decline in *Spartina* abundance
Salinity tolerance of *Spartina alterniflora* consistent with important faunal species
Conclusions

A target salinity of 25 meets the requirements of many estuarine dependent species.

Regular inundation by freshwater provides the most effective long-term response in the moderation of high pore water salinities (equivalent to frequent precipitation events).
Project Alternative Modeling

Criteria established to compare alternatives:

- Provided a water column depth of $\geq 1\ cm$
- Provided an inundation duration of $> 6.2\ hours$
- Provided a salinity of $< 25\ ppt, < 20\ ppt, < 15\ ppt$

*The depth and duration correspond to a typical tidal flooding period.*
Water from the Calallen Pool discharged into Upper Rincon Bayou via the City of CC’s Diversion Pipeline

- All pumping was assumed to be using only 1 pump
- Model ran for a 30-day duration in each simulation
- Volumes of 1,200 ac-ft and 3,000 ac-ft were modeled
  - 1,200 ac-ft represents drought period monthly target per the Agreed Order on FW Inflows
  - 3,000 ac-ft represents the maximum physical delivery capacity for the one pump in a 30 day period
Existing System | 1,200 ac-ft | 2,453 acres Inundated

Existing system
1200 ac-ft of freshwater with 1 pump
2453 acres inundated

Flooded Days
minimum depth of 1 cm with salinity less than 25 ppt for duration of more than 6.2 hours.

50 acres
Modified System (Projects 4 & 5) | 1,200 ac-ft | 2,823 acres inundated

Two channels added
1200 ac-ft of freshwater with 1 pump
2823 acres inundated

Flooded Days
minimum depth of 1 cm with salinity less than 25 ppt for duration of more than 6.2 hours.

50 acres
Existing System | 3,000 ac-ft | 4,511 acres Inundated

Existing system
3000 ac-ft of freshwater with 1 pump
4511 acres inundated

Flooded Days
minimum depth of 1 cm with salinity less than 25 ppt for duration of more than 6.2 hours.

50 acres
Two channels added
3000 ac-ft of freshwater with 1 pump
5120 acres inundated

Flooded Days
minimum depth of 1 cm with salinity less than 25 ppt for duration of more than 6.2 hours.

50 acres
### Inundation Comparison
1200 ac-ft of freshwater with 1 pump

<table>
<thead>
<tr>
<th>Description</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>New acres:</td>
<td>720 ac</td>
</tr>
<tr>
<td>Lost acres:</td>
<td>350 ac</td>
</tr>
<tr>
<td>Acres in common with Existing System:</td>
<td>2,103 ac</td>
</tr>
<tr>
<td>Net Addition:</td>
<td>370 ac</td>
</tr>
</tbody>
</table>

Minimum depth of 1 cm with salinity less than 25 ppt for duration of more than 6.2 hours.
**Modified System (Project 4 & 5)**

- **3,000 ac-ft**
- **Saltness < 25 ppt**

### Inundation Comparison

- **3000 ac-ft of freshwater with 1 pump**

#### Minimum depth of 1 cm with salinity less than 25 ppt for duration of more than 6.2 hours.

<table>
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<tr>
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<tr>
<td>New acres:</td>
<td>889 ac</td>
</tr>
<tr>
<td>Lost acres:</td>
<td>279 ac</td>
</tr>
<tr>
<td>Acres in common with existing system:</td>
<td>4,323 ac</td>
</tr>
<tr>
<td>Net Addition:</td>
<td>610 ac</td>
</tr>
</tbody>
</table>
Modified System (Project 4 & 5) | 1,200 ac-ft | salinity < 20 ppt

- New acres: 398 ac
- Lost acres: 548 ac
- Acres in common with Existing System: 1,595 ac
- Net Addition: -150 ac

Inundation Comparison
1,200 ac-ft of freshwater with 1 pump

Minimum depth of 1 cm with salinity less than 20 ppt for duration of more than 6.2 hours.
Inundation Comparison
3000 ac-ft of freshwater with 1 pump

Minimum depth of 1 cm with salinity less than 20 ppt for duration of more than 6.2 hours.

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
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<tr>
<td>New acres:</td>
<td>1,034 ac</td>
</tr>
<tr>
<td>Lost acres:</td>
<td>752 ac</td>
</tr>
<tr>
<td>Acres in common with Existing System:</td>
<td>3,167 ac</td>
</tr>
<tr>
<td>Net Addition:</td>
<td>282 ac</td>
</tr>
</tbody>
</table>
New acres: 212 ac
Lost acres: 436 ac
Acres in common with Existing System: 1,314 ac
Net Addition: -224 ac
New acres: 882 ac

Lost acres: 1,017 ac

Acres in common with Existing System: 2,237 ac

Net Addition: -135 ac

Inundation Comparison
3000 ac-ft of freshwater with 1 pump

Minimum depth of 1 cm with salinity less than 15 ppt for duration of more than 6.2 hours.
Modified System (Project 4 & 5)
Summary of Results for Varying Salinity Criteria and Volumes Pumped

<table>
<thead>
<tr>
<th>Salinity Criteria:</th>
<th>&lt; 25 ppt</th>
<th>&lt; 20 ppt</th>
<th>&lt; 15 ppt</th>
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<tr>
<td>Ac-ft pumped:</td>
<td>1,200</td>
<td>3,000</td>
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<td>720</td>
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<td>-150</td>
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The overall picture is that the simple inclusion of the channels is effective in increasing the area flooded with 20-25 ppt salinity, but at the expense of reducing some of the areas that would otherwise see salinities below 15 ppt.
Modeled impacts of the Q of Odem WWTP discharge, over the 30-day modeling period are negligible, but long-term benefits of moving more freshwater into tidal flats area, as measured on an annual basis, is probable.
Conclusions

• Evaluation of several potential landform and hydraulic modifications in the Nueces Delta/Upper Nueces Bay revealed that two new channels diverting water from Rincon Bayou would inundate and lower salinities in areas to the south of the main channel, as compared to existing conditions, although, in some cases, at the expense of some areas which were inundated before the new channels were included in the model.

• The recently developed hydraulic model of the Nueces Delta proved to be extremely useful in the preliminary evaluation of project alternatives and the quantification of impacts associated with selected configurations of hydraulic modifications.

• Further modeling should be undertaken to design and evaluate a “system operations” concept for the pumping of required Pass-Thru flows into Rincon Bayou and the operation of water control structures which would be associated with the two proposed diversion channels.