Modeling Potential Circulation Improvements in Old Tampa Bay
Tampa, FL

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Project Location

Old Tampa Bay
Tampa, FL
Project Location

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[Map showing the project location with an area of interest highlighted]
Background

• Florida Department of Transportation (FDOT) anticipating significant costs with upcoming local construction and associated runoff treatment
• Department of Environmental Protection encouraging alternatives to wet detention ponds for treatment
• Area of concern in Old Tampa Bay north of the Courtney Campbell Causeway (SR60)
• Location of healthy seagrass beds in the 1930s prior to causeway construction
Background

- Phase I of this study determined that a modification of the Causeway (adding a bridge section to increase flow exchange) would likely bring about an ecological response greater than that achieved by additional runoff treatment.
- Phase II involved the development and application of a hydrodynamic model to quantify the changes in circulation and residence time achieved by adding bridge segment.
Methodology

• Field data collection (water levels, currents) during August-September 2015
• Bathymetric survey in area of interest
• Delft3D hydrodynamic model
  – Tidal and wind forcing
  – Coarse and nested regional and local model grids
  – Conservative constituent dispersion
  – Quantify changes in residence time with modification to the Causeway
Model Development

Delft3D-FLOW hydrodynamic model

• Regional domain encompassing Tampa Bay to the Gulf of Mexico
  – Based on NOAA’s Tampa Bay Operational Forecast System model
• Nested domain in area of interest driven by regional model
  – Uniform 10 m spatial resolution
Model Development

Delft3D-FLOW hydrodynamic model

- Spatially-varying tidal forcing at Gulf of Mexico
  - Constituents from Oregon State University Tidal Model Driver (TMD)
- Uniform wind forcing from measured data at NOAA Station 8726607
- Daily precipitation from Tampa International Airport (KTPA)
  - (over model domain only; no stormwater runoff into domain)
- Model run concurrent with field data collection period
Regional Grid
Regional Grid
Nested Grid
Proposed Bridge Location

- 60 m (200 ft) opening
- Flap-gate culverts
# Modeled Scenarios

<table>
<thead>
<tr>
<th>Name</th>
<th>Proposed Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing conditions</td>
<td>None (no change)</td>
</tr>
<tr>
<td>Alternative 1</td>
<td>60 m (200 ft) width</td>
</tr>
<tr>
<td></td>
<td>-2.3 m (-7.6 ft) NAVD88 bottom</td>
</tr>
</tbody>
</table>
Simulating Residence Time

- Conservative, neutrally-buoyant, generic tracer in model
- Start with uniform 1 kg/m$^3$ in area of interest
- Run model for 1 week, compare initial & final concentrations in area of interest between the 2 alternatives
Results – Existing Conditions
Results – 60 m Opening

Western area of interest: concentrations drop below 50% of initial level 2 days faster

Eastern area of interest: concentrations drop below 50% of initial level 1.5 days faster
Reduction in Residence Time

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>80%</td>
</tr>
<tr>
<td>B</td>
<td>82%</td>
</tr>
<tr>
<td>C</td>
<td>50%</td>
</tr>
</tbody>
</table>
Conclusions

• Relief bridge effective in increasing exchange between area of interest and greater Tampa Bay
• Allows for freshwater runoff to be more readily dispersed, increasing salinity in the area
• Help return hydrodynamic conditions to pre-causeway historical conditions
• Gradually restore seagrass population to historical healthy condition
Conclusions

• Construction currently underway, completion Summer 2019
Further Work in Tampa Bay: Cooper’s Bayou
Overview

• Previous work inspired new investigations elsewhere
• Build upon 2017 study focused on stormwater runoff
• Increase circulation in historic seagrass areas in western OTB
• Use same methodology as before (generic tracers) to track water originating in Cooper’s Bayou and surrounding waters
Model Domain

- Based on work from a 2017 study
- Three grids (coarse, medium, fine) using Delft3D’s domain decomposition
Model setup

- Grid encompassing Old Tampa Bay, with increasing spatial detail within Cooper’s Bayou
- Bathymetry from previous model
- Tidal boundary at Gandy Bridge
- Five model scenarios
- Residence time defined as the time to reach 10% of initial concentration of tracer (i.e. a 90% reduction)
Model scenario 1: Base conditions

- Existing conditions, plus:
  - bayou dredging to 4 ft below MSL
  - Improved mangrove channel (option 2 in previous study)
  - channel enlargement at Damascus Rd. (current project)
Model scenario 2: Eastern cut

- Base conditions, plus:
  - ~180 ft channel through the narrowest section of mangroves on the eastern side of the Bayou (circled in red)
Model scenarios 3-5: Eastern cut + SR60 opening

• Base conditions, plus:
  • ~180 ft channel through the narrowest section of mangroves on the eastern side of the Bayou (circled in red)
  • channel through SR60 east of Damascus Rd (circled in red) (800, 400, 200 ft widths tested)
Residence time, Bayou tracer, Base vs. Scenario 2

Scenario 1

Scenario 2
Residence time, Bayou tracer, Base vs. Scenario 3
Change in Residence time (%), Bayou tracer, vs. Base

Scenario 2

Scenario 3
## Results

<table>
<thead>
<tr>
<th>Location</th>
<th>Scenario</th>
<th>Residence time (days)</th>
<th>Change vs. Base (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>south bayou</td>
<td>Base</td>
<td>3.17</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Eastern cut</td>
<td>2.75</td>
<td>-13</td>
</tr>
<tr>
<td></td>
<td>Eastern cut + SR60 opening 800 ft</td>
<td>2.67</td>
<td>-16</td>
</tr>
<tr>
<td></td>
<td>Eastern cut + SR60 opening 400 ft</td>
<td>2.75</td>
<td>-13</td>
</tr>
<tr>
<td></td>
<td>Eastern cut + SR60 opening 200 ft</td>
<td>2.75</td>
<td>-13</td>
</tr>
<tr>
<td>middle bayou</td>
<td>Base</td>
<td>2.75</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Eastern cut</td>
<td>2.67</td>
<td>-3</td>
</tr>
<tr>
<td></td>
<td>Eastern cut + SR60 opening 800 ft</td>
<td>2.17</td>
<td>-21</td>
</tr>
<tr>
<td></td>
<td>Eastern cut + SR60 opening 400 ft</td>
<td>2.08</td>
<td>-24</td>
</tr>
<tr>
<td></td>
<td>Eastern cut + SR60 opening 200 ft</td>
<td>2.67</td>
<td>-3</td>
</tr>
<tr>
<td>north bayou</td>
<td>Base</td>
<td>2.67</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Eastern cut</td>
<td>1.67</td>
<td>-37</td>
</tr>
<tr>
<td></td>
<td>Eastern cut + SR60 opening 800 ft</td>
<td>1.67</td>
<td>-37</td>
</tr>
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</tr>
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<td>Eastern cut + SR60 opening 200 ft</td>
<td>1.67</td>
<td>-37</td>
</tr>
</tbody>
</table>
Summary

• Two of a number of projects in Tampa Bay seeking to enhance / restore historical flow pathways
Thank you!

Questions?