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Curry Hammock Park Tidal Restoration

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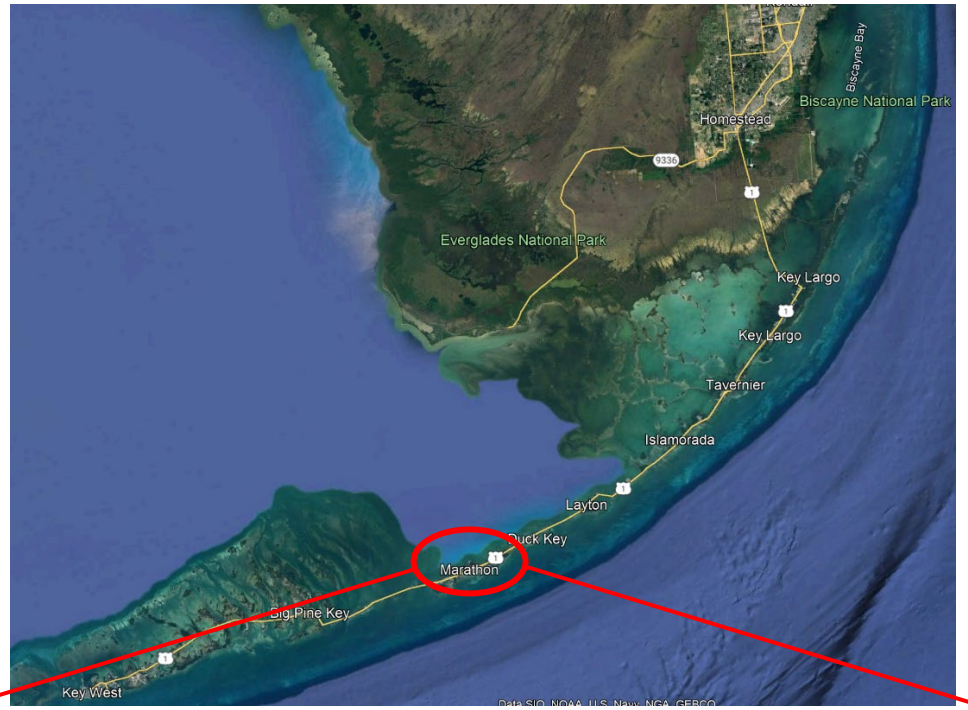
Welcome

Agenda

- Project Background and Team
- Hydrodynamic Model Development
  - Model Domain
  - Boundary Conditions and Forcing
  - Calibration
- Selection of Design Neap Period
- Tidal Improvement Scenario Results
  - Tidal Flushing Analysis
  - Sedimentation
    - Structure flushing analysis
    - Sedimentation patterns

Project Background

- Curry Hammock State Park is located along U.S. Highway 1/Overseas Highway in Marathon, FL (Monroe County).
- During the development of this area the historical tidal connections between the FL Bay and the Atlantic Ocean were filled.
- The tidal restoration aims to re-establish the surface water connection to improve circulation and flushing.



Project Team

Florida Department of Environmental Protection (FDEP) – Project Sponsor

Gresham Smith
Prime, Roadway/MOT, Structural

GHD
Hydraulics

Ebbstone
Structural

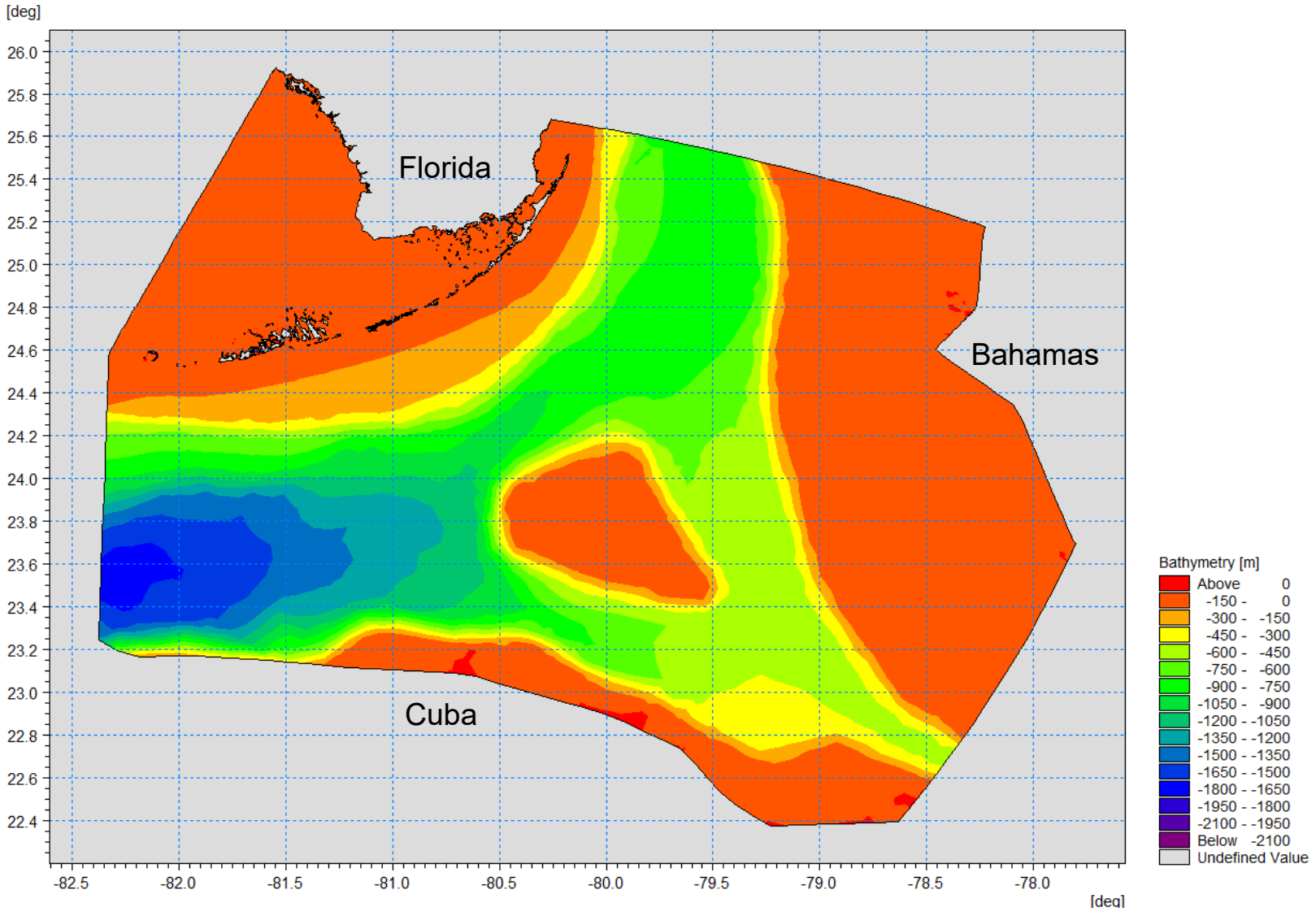
ESA
Environmental, Permitting

Terracon
Geotech

GPI
Survey

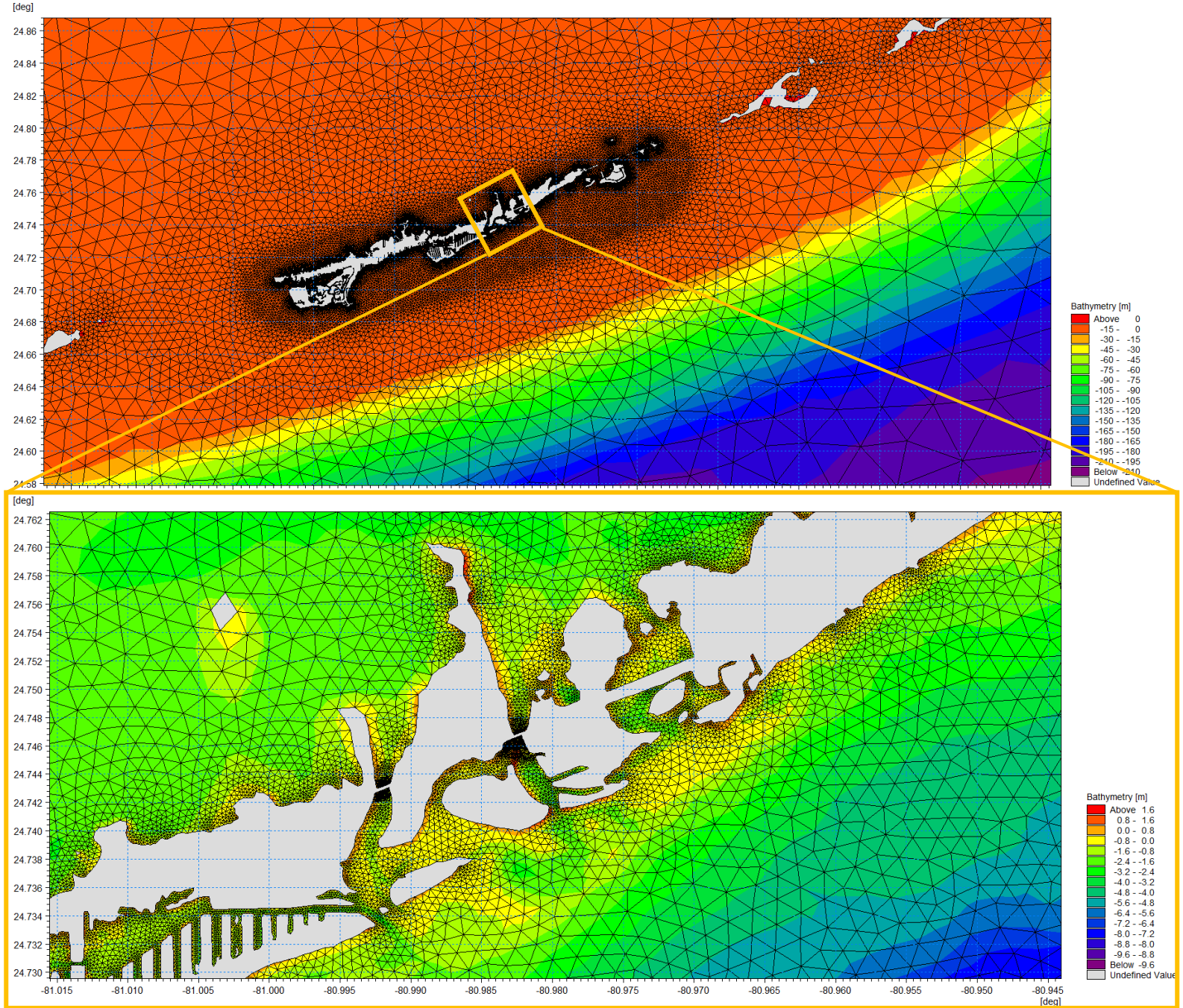
DRMP
SUE

Model Domain

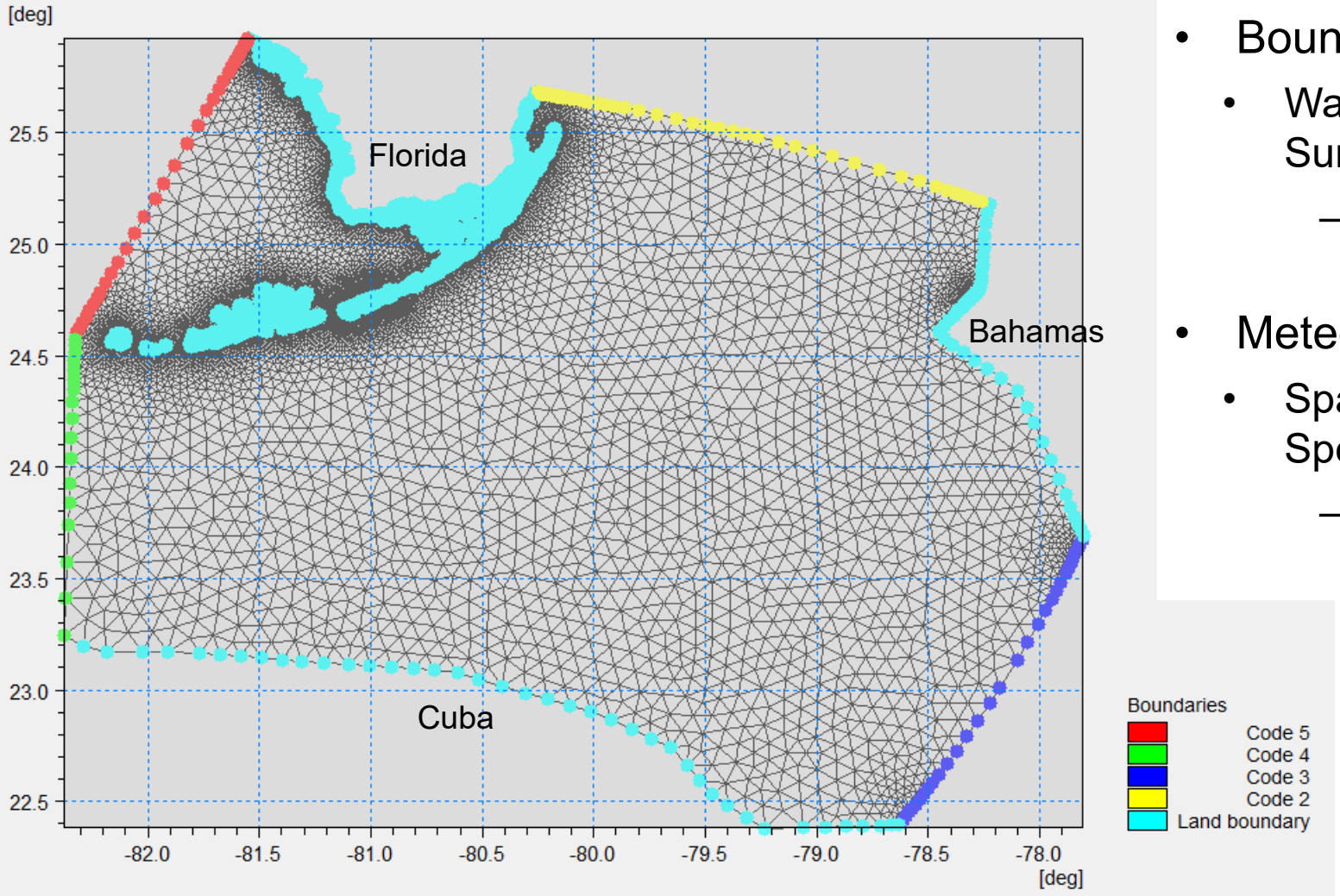


- Regional domain covering Florida-Bahamas-Cuba area
- Unstructured (triangular) mesh containing 66,850 nodes and 119,614 elements

Model Domain - Local

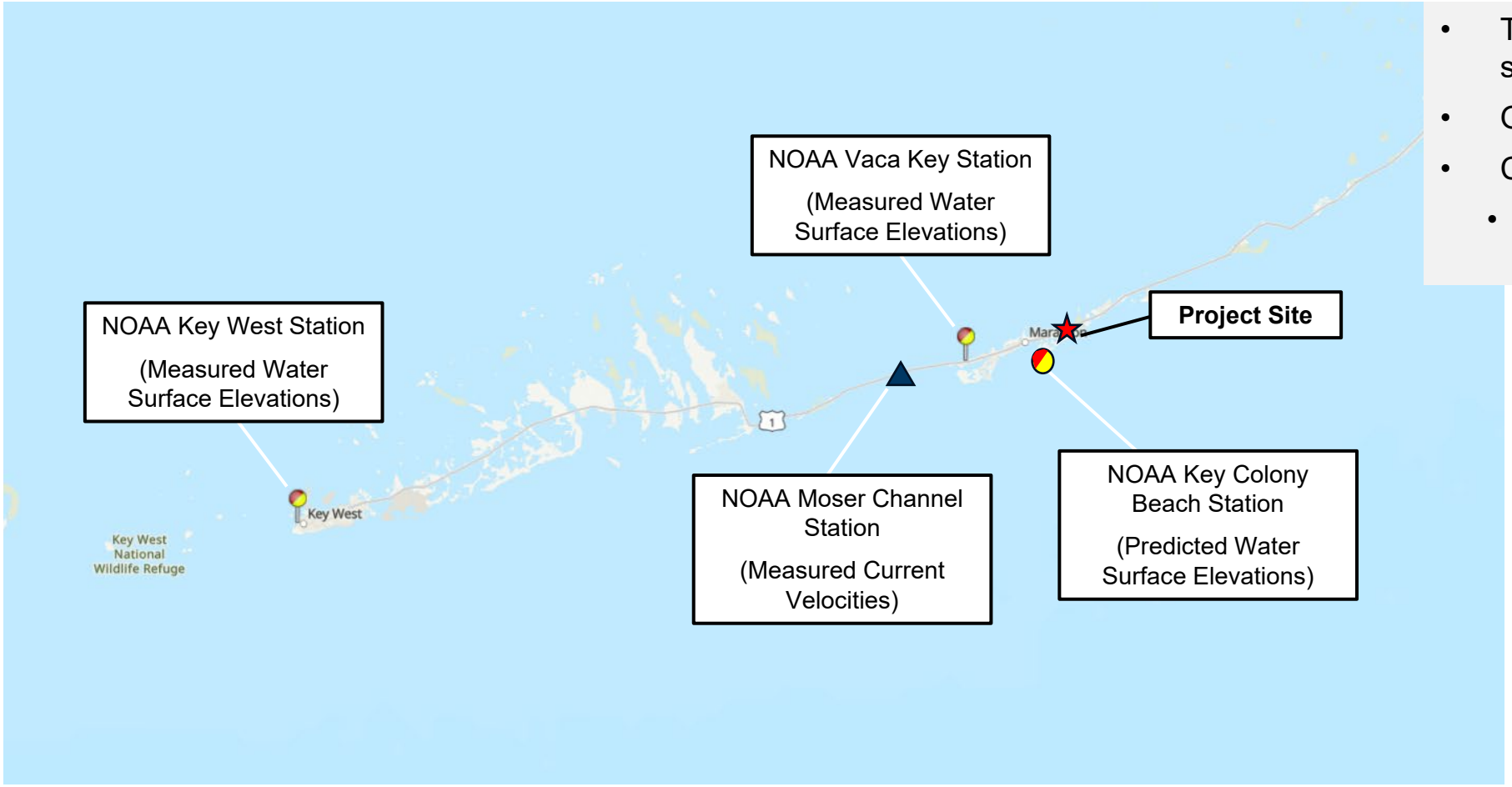


Boundary Conditions



- Boundary Conditions:
  - Water Current Velocities and Water Surface Elevations
    - Combined Global HYCOM + DHI Tidal model
- Meteorological Forcing
  - Spatially and Temporally Varying Wind Speeds
    - ERA 5 Global Wind Fields

Model Calibration



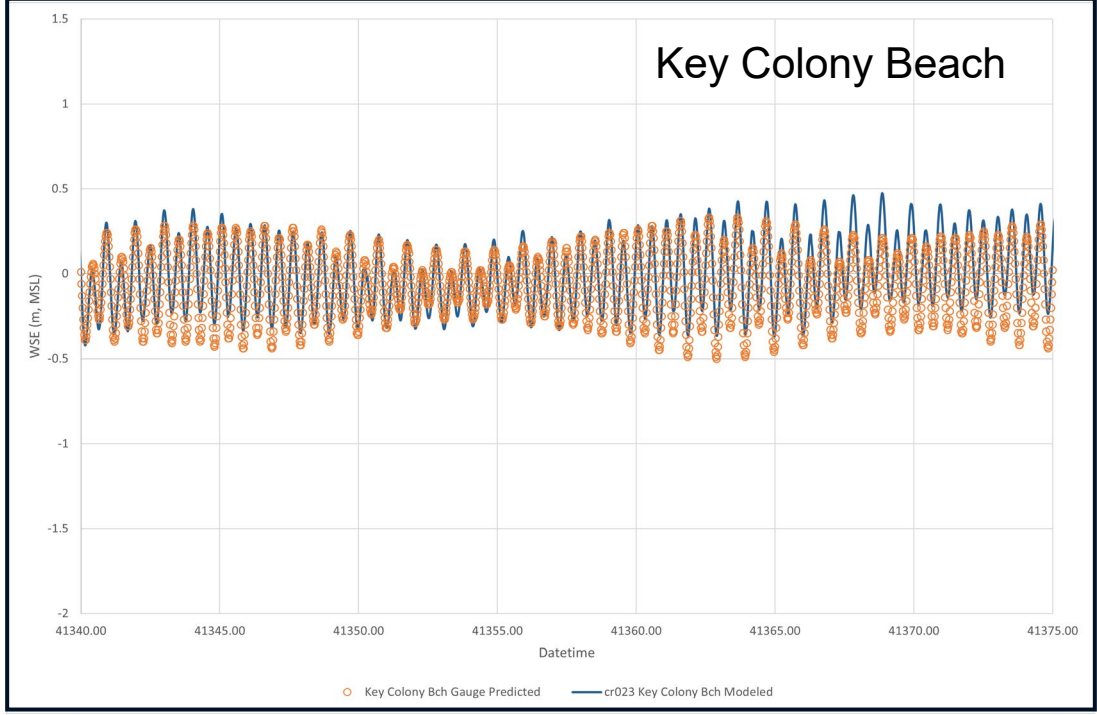
- Three (3) Water Surface Elevation (WSE) stations
- One (1) Current Velocity station
- Calibration period:
  - March/April 2013 to align with current velocity data timeframe

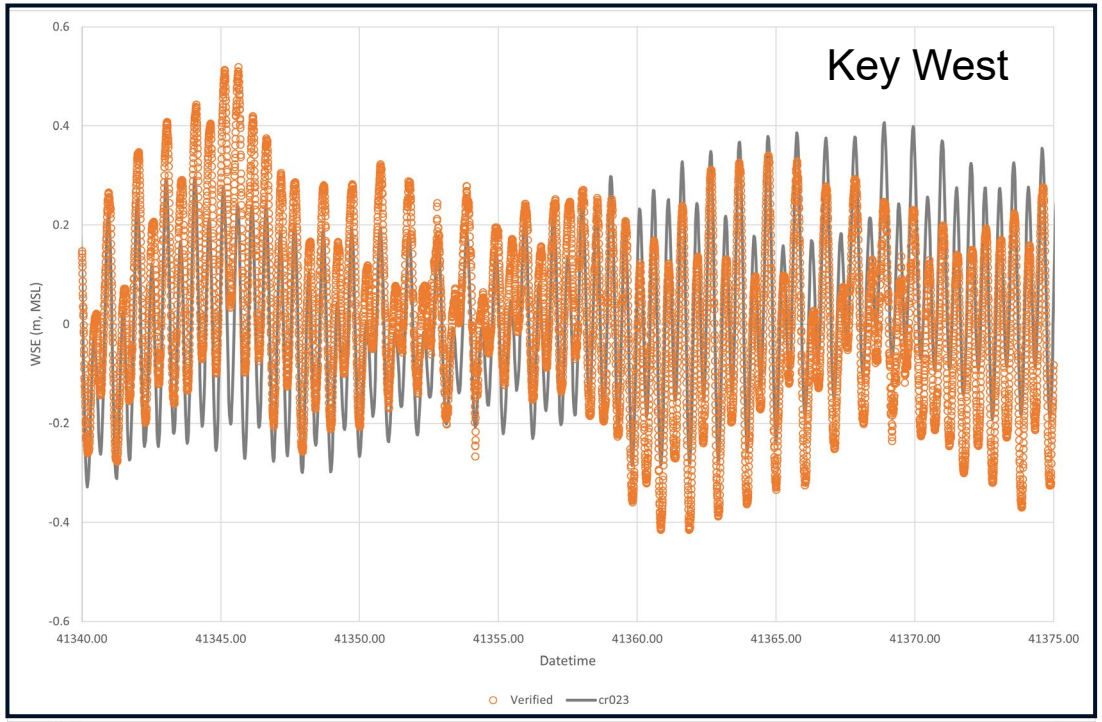
Model Calibration - WSE

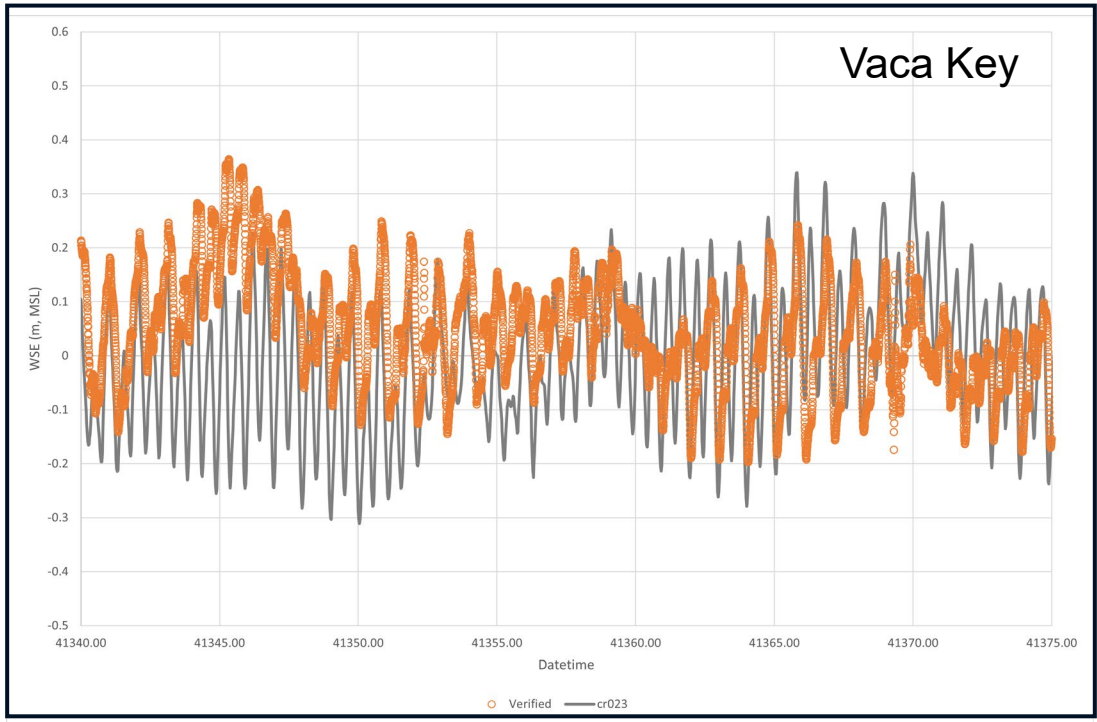
Station	MAE (m)	IOA (-)
Key Colony Beach	0.08	0.94
Key West	0.10	0.88
Vaca Key	0.12	0.50

MAE: Mean Absolute Error.

IOA: Indices of Agreement. Values >0.5 indicate good model calibration, values close to 1 represent excellent calibration per Wilmott et al. (1985)





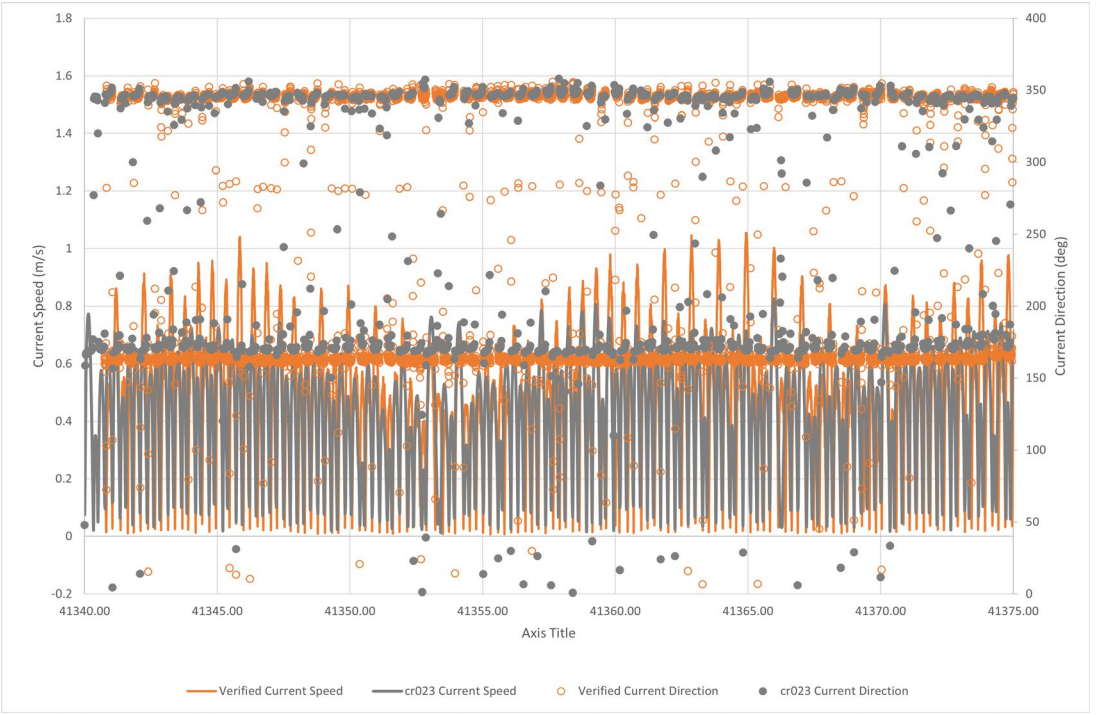


Model Calibration - Currents

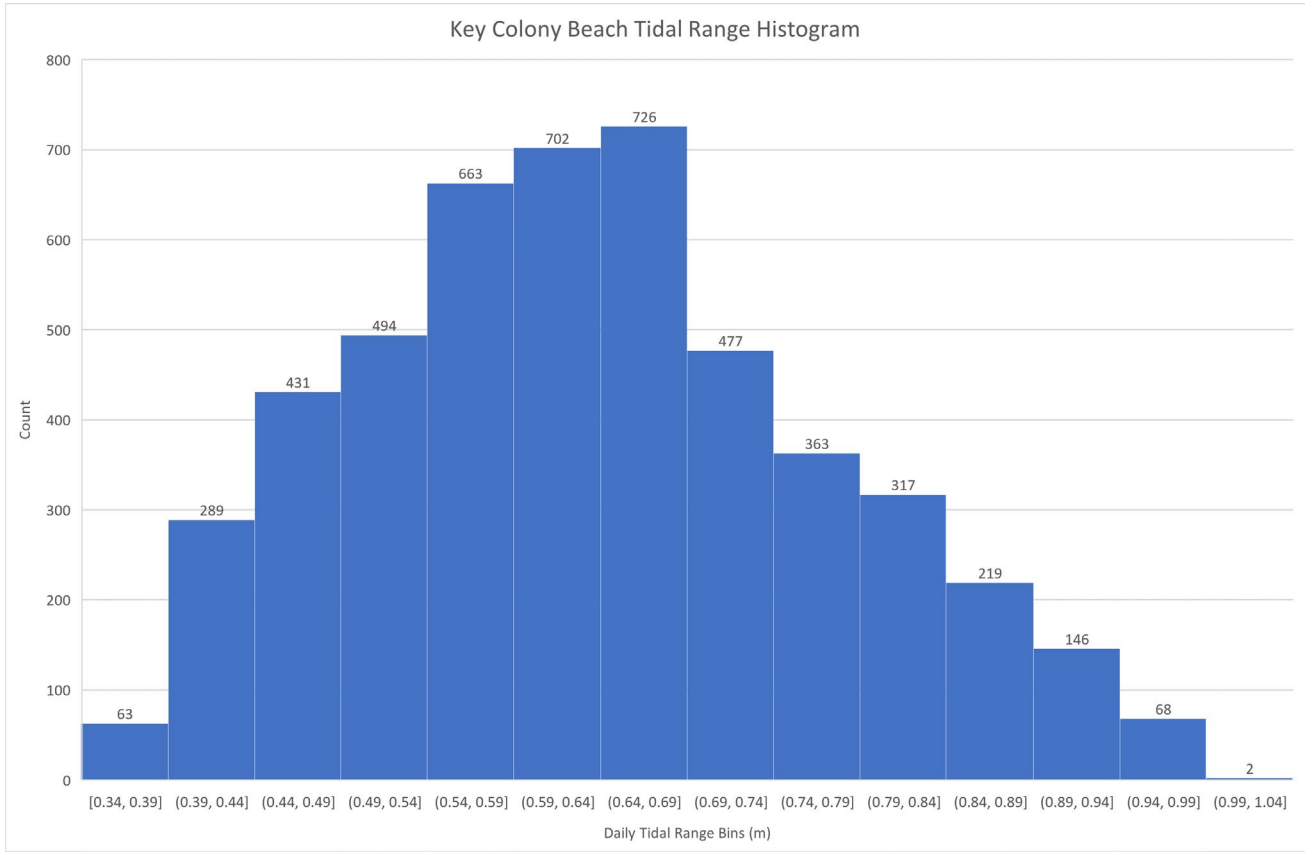
Station	MAE (m/s)	IOA (-)
Moser Channel	0.17	0.70

MAE: Mean Absolute Error.

IOA: Indices of Agreement. Values >0.5 indicate good model calibration, values close to 1 represent excellent calibration per Wilmott et al. (1985)



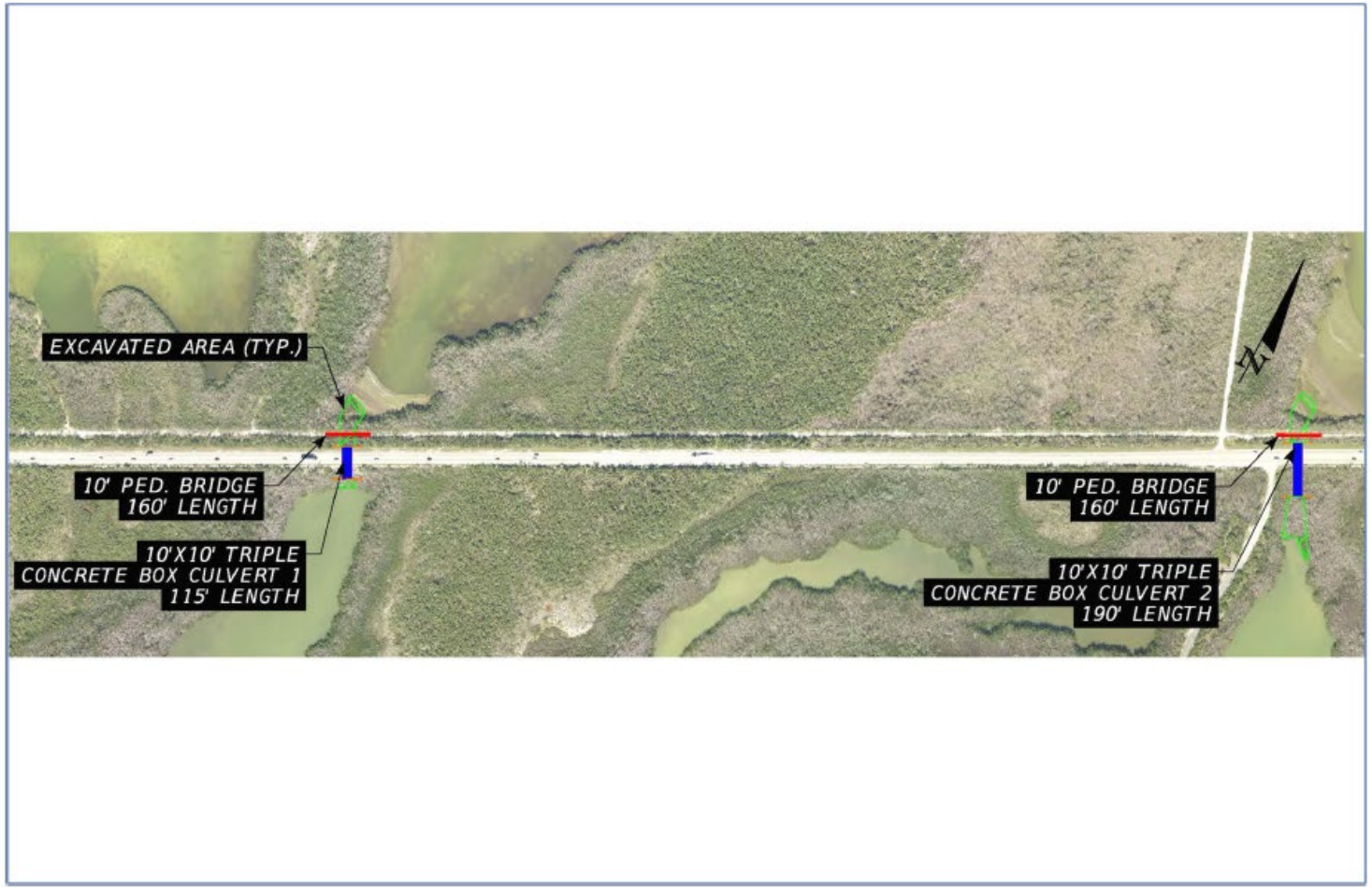
Selection of Design Neap Period



Rank	Date	Tidal Range (m)
1	11/15/10	0.34
2	1/3/20	0.346
3	5/7/10	0.349
4	12/5/19	0.351
5	5/8/10	0.353
6	12/13/10	0.357
7	11/16/14	0.358
8	5/8/14	0.359
9	5/29/23	0.359
10	5/28/23	0.36

Tidal Improvement Scenarios

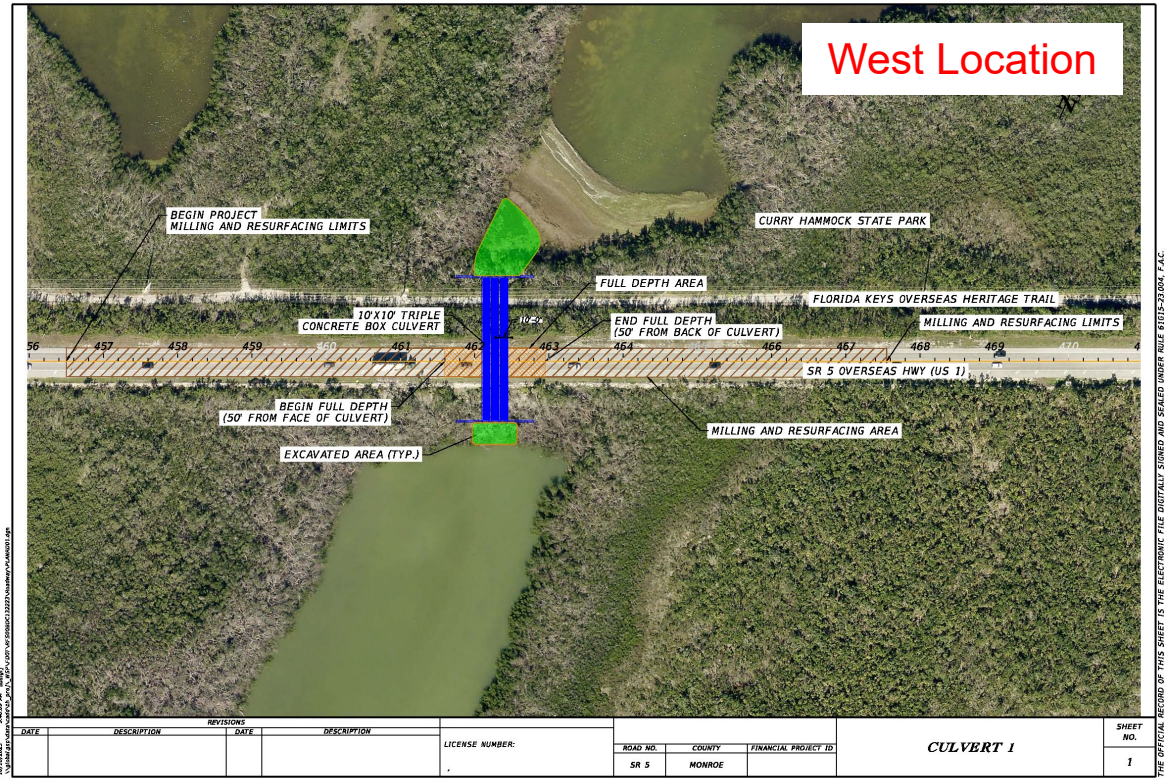
Figure 2 – Proposed Culvert Locations

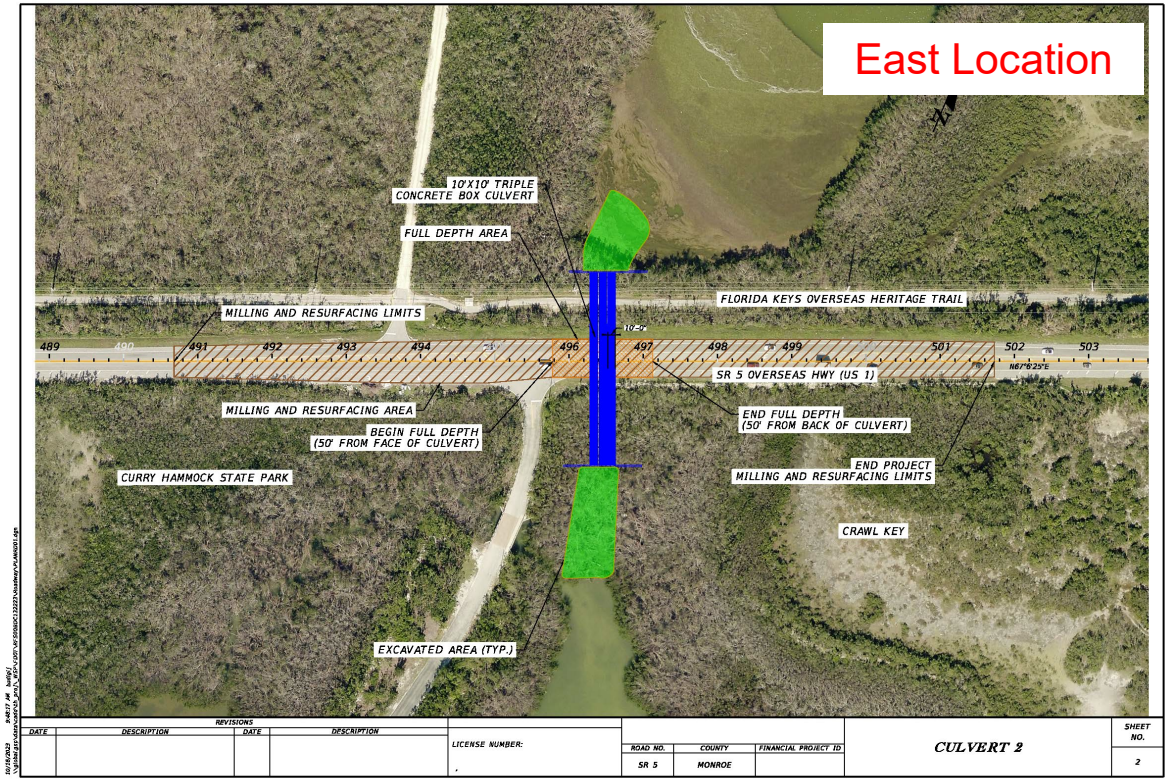


Scenario 1: 10’ x 10’ **Triple** Box Culvert at Both East & West Locations

Scenario 2: 10’ x 10’ **Double** Box Culvert at Both East & West Locations

Tidal Improvement Scenarios





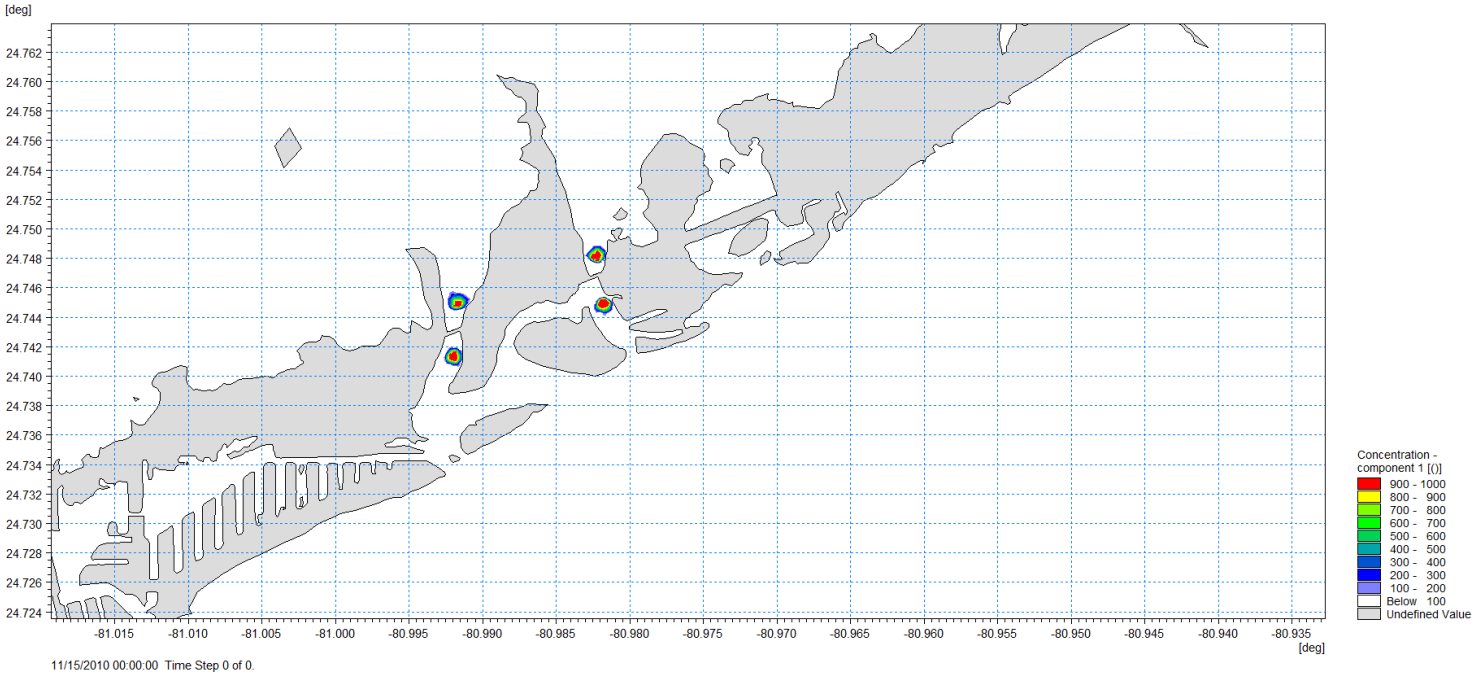
Scenario 3: 10’ x 10’ **Triple** Box Culvert at West Location & 10’ x 10’ **Double** Box Culvert at East Location

Scenario 4: 10’ x 8’ **Triple** Box Culvert at West Location & 10’ x 8’ **Double** Box Culvert at East Location

Scenario 5: 10’ x 6’ **Triple** Box Culvert at West Location & 10’ x 6’ **Double** Box Culvert at East Location

Tidal Improvement Scenarios

Flushing Analysis



- Initial concentrations of 1000 (non-dimensional units) specific in each waterbody
- 96-hour (4 day) simulation around maximum neap tide conditions
- Time required to diminish concentration by 90% quantified

Tidal Improvement

Flushing Analysis Results

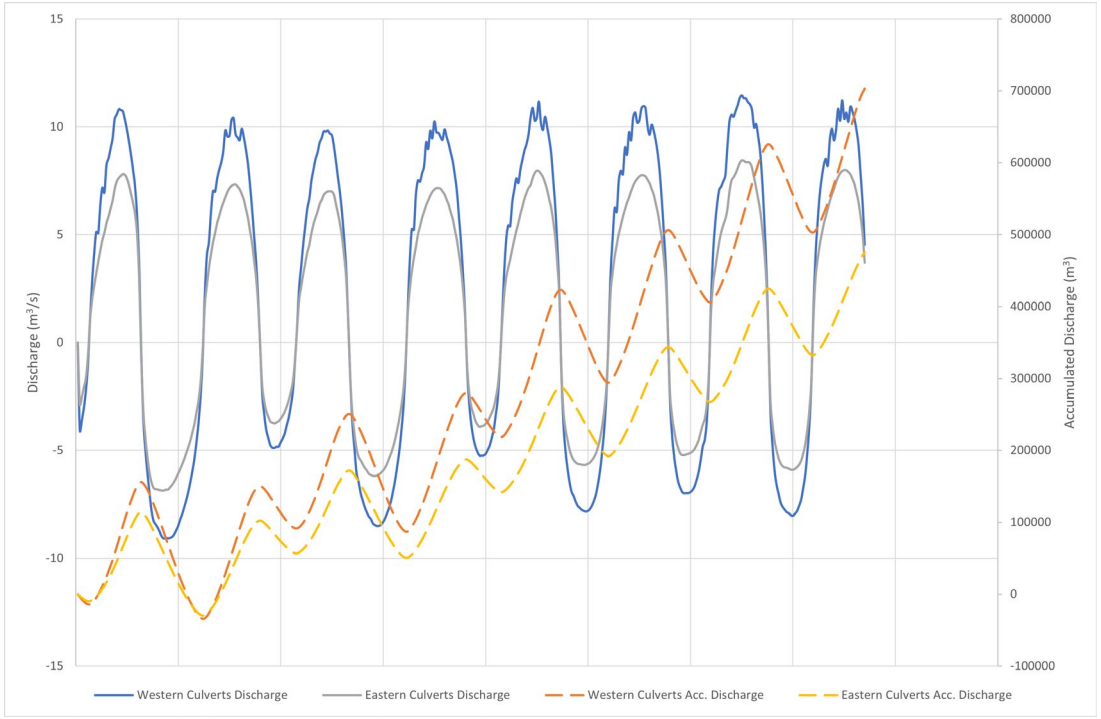
Scenario 1: Triple 10’ x 10’ box culverts

Scenario	Area	Time to Dissipate 90% of Concentration (hrs.)	Description
Baseline	Western	11 hrs.	Existing Conditions (**No Culverts**)
	Eastern	27 hrs.	
Scenario 1	Western	7.75 hrs. (30% Reduction in Flush Time)	**Triple** 10’ x 10’ box culverts
	Eastern	13.25 hrs. (51% Reduction in Flush Time)	
Scenario 2	Western	9.5 hrs. (14% Reduction in Flush Time)	**Double** 10’ x 10’ box culverts
	Eastern	15.75 hrs. (42% Reduction in Flush Time)	
Scenario 3	Western	7.75 hrs. (30% Reduction in Flush Time)	**Triple** 10’ x 10’ box culverts
	Eastern	16.25 hrs. (40% Reduction in Flush Time)	**Double** 10’ x 10’ box culverts
Scenario 4	Western	7.5 hrs. (32% Reduction in Flush Time)	**Triple** 10’ x 8’ box culverts
	Eastern	16.25 hrs. (40% Reduction in Flush Time)	**Double** 10’ x 8’ box culverts
Scenario 5	Western	8.0 hrs. (27% Reduction in Flush Time)	**Triple** 10’ x 6’ box culverts
	Eastern	16.25 hrs. (40% Reduction in Flush Time)	**Double** 10’ x 6’ box culverts

Tidal Improvement

Structure Self-Flushing Hydraulics

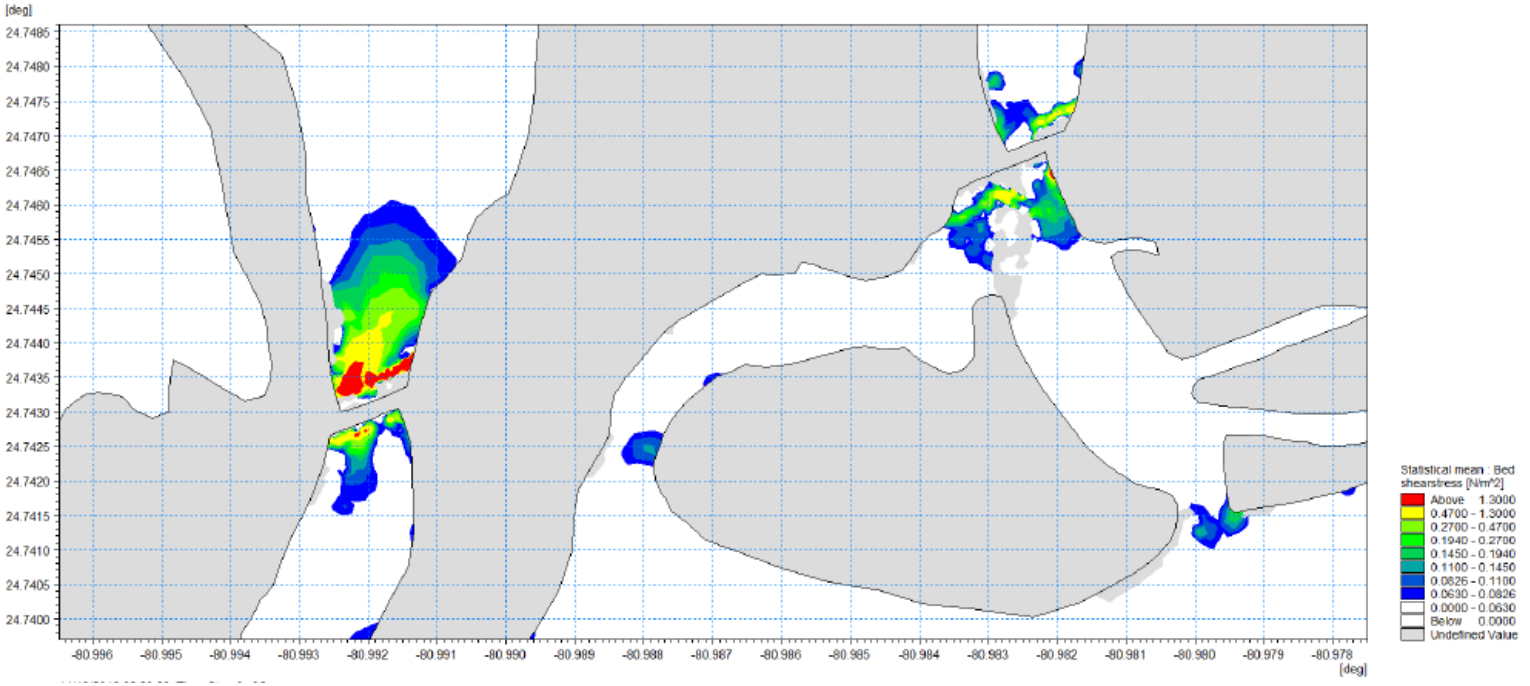
- Impoundment of sediment and other materials can decrease hydraulic performance and lead to increased maintenance costs.
- Shear stress trough structures is calculated and compared to recommended values from the literature to evaluate self-flushing capability.
- Shear stress values between 3-4 N/m^2 are generally sufficient to clear storm sewers per (Yao, 1974).



Scenario	Western Culvert Shear Stress Percentiles (N/m^2)			Eastern Culvert Shear Stress Percentiles (N/m^2)		
	25th	50th	95th	25th	50th	95th
1	3.91	9.62	24.10	2.17	4.94	11.31
2	5.09	11.90	25.60	2.66	5.73	12.24
3	4.96	11.43	35.09	2.94	6.22	12.59
4	5.01	12.12	35.03	2.94	6.22	12.59
5	4.96	11.39	35.09	2.94	6.23	12.61

Tidal Improvement

Sedimentation Patterns



- Shear stresses induced by each alternative were developed.
- Shear stresses were related to sediment classifications based on critical bed shear stress values (see USGS Scientific Investigations Report 2008-5093 for more details).

Particle Classification Name	Ranges of Particle Diameters (mm)	Shields Parameter (-)	Critical Bed Shear Stress (τ_c) (N/m^2)
Very Coarse Sand	1.0 – 2.0	0.029 – 0.039	0.47 – 1.30
Coarse Sand	0.5 – 1.0	0.033 – 0.029	0.27 – 0.47
Medium Sand	0.25 – 0.50	0.048 – 0.033	0.194 – 0.27
Fine Sand	0.125 – 0.25	0.072 – 0.048	0.145 – 0.194
Very Fine Sand	0.0625 – 0.125	0.109 – 0.072	0.110 – 0.145
Coarse Silt	0.0310 – 0.0625	0.165 – 0.109	0.0826 – 0.110
Medium Silt	0.0156 – 0.0310	0.25 – 0.165	0.0630 – 0.0826
Fine Silt	0.0078 – 0.0156	0.3 – 0.25	0.0378 – 0.0630

Conclusion and Path Forward

- Scenario 4 is recommended as the most advantageous alternative and should be progresses through the design phase. This alternative is summarized below:

Scenario #	Number of Culvert Structures		Length of Culvert Structures (ft)		Structure Dimensions (Width x Height)		Inverts (ft, NAVD88)	
	East	West	East	West	East	West	East	West
4	2	3	260	200	10’x8’	10’x8’	-3.4	-4.2

- Anticipated Project Schedule/Milestones:
  - 30% Design – Submitted 01/31/2023
  - 60% Design – 06/30/2024
  - Permitting % Final Design – 02/28/2025
  - Construction – Dependent on acquiring funding.

Thank You

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