Johnson Tract Lagoon Tidal Connectivity Study

Todd DeMunda, PE (Stantec)
Matt Starr, PG (Stantec)
Taylor Kroll (FWC)

Overview

Stantec was tasked by Florida Fish & Wildlife Conservation Commission (FWC) to conduct a tidal connectivity study of their Johnson Tract property in order to increase water exchange and facilitate habitat recovery and enhancement.

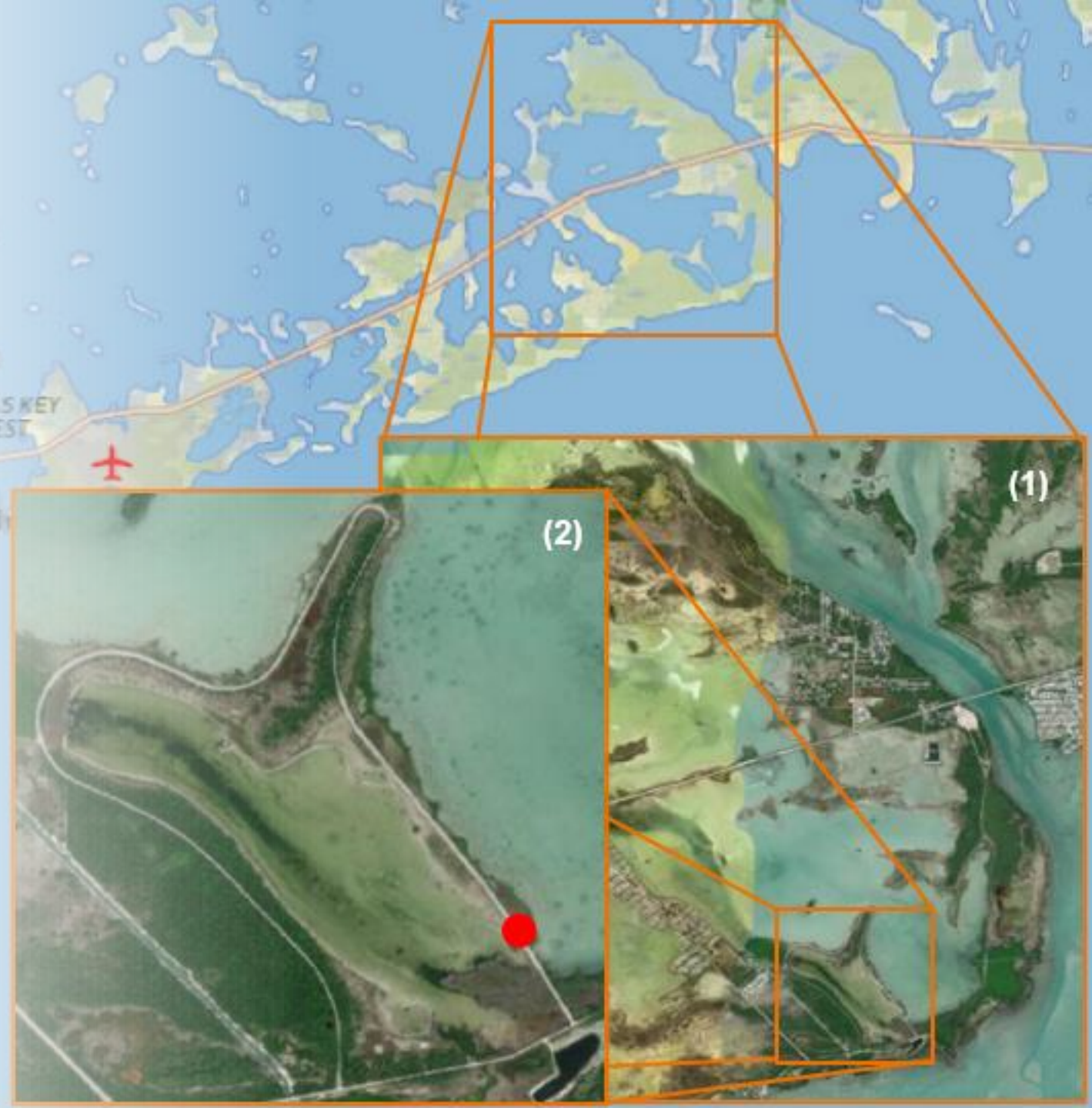
Location:

Western Florida Keys

(1) Upper Sugarloaf Sound

(2) Johnson Tract Lagoon

(existing culvert connection in red)



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Overview

Tasks

- Existing conditions assessment
- Tide data collection
- Hydrodynamic model development
- Conceptual design alternatives
- Model results and recommendations

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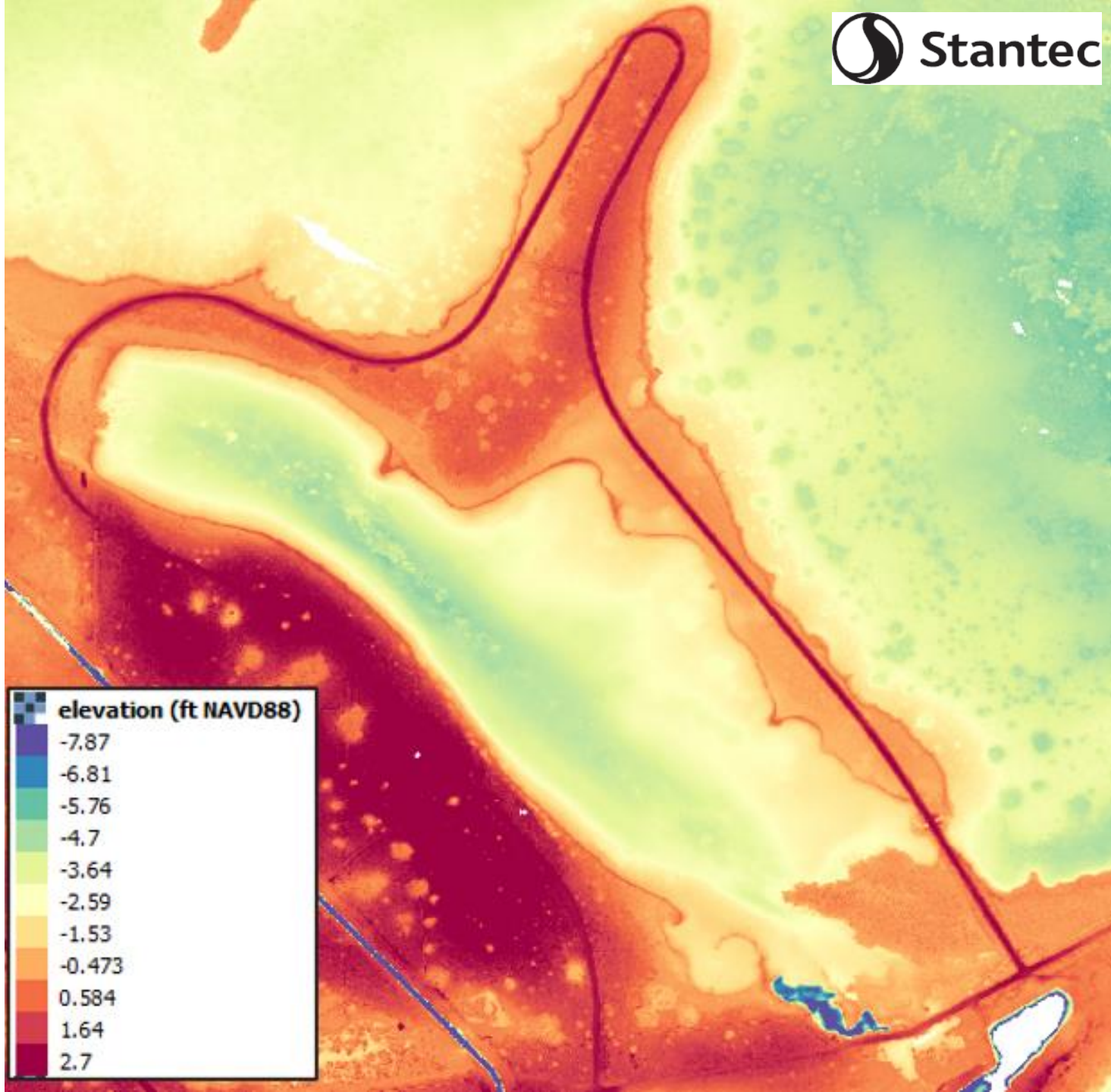
Existing Data

Bathymetry/Topography

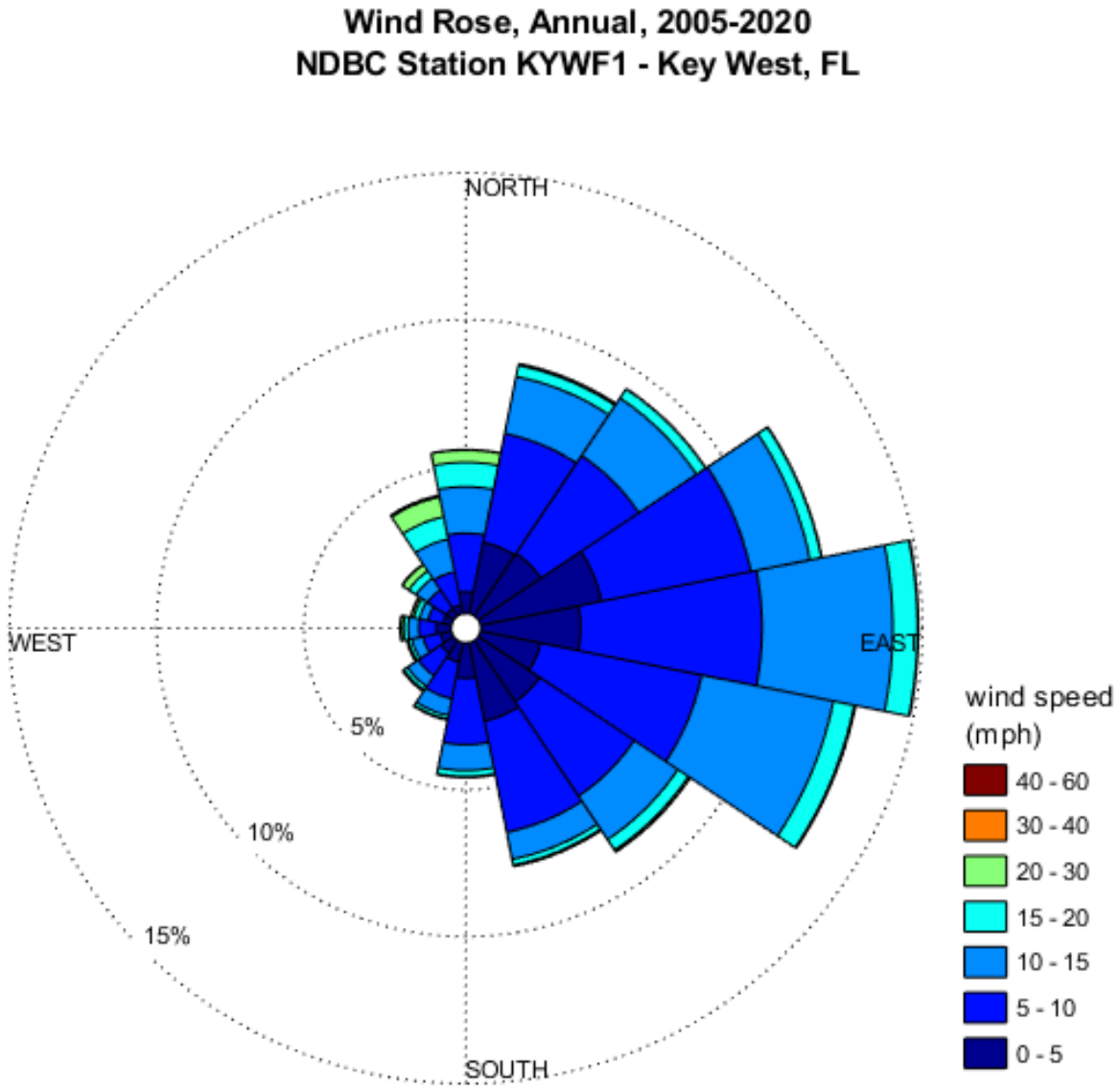
- 2018-2019 NOAA LiDAR
- 3 ft spatial resolution



Existing Data

Wind

- NOAA Station KYWF1
- Measured data 2005-present
- 8.5 mph average speed
- 79 mph maximum speed



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Existing Data

Tides and Water Levels

- NOAA subordinate stations
  - Datums only
  - Based on offsets from Key West
- ADCIRC Tidal Database
  - Harmonic constituents only
  - Based on advanced numerical modeling

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Data Collection

Water Levels

- 2 gauges inside Lagoon
- 1 gauge just outside of Lagoon in Sound
- 1 gauge north of US-1
- 1-month collection period (February 2022)

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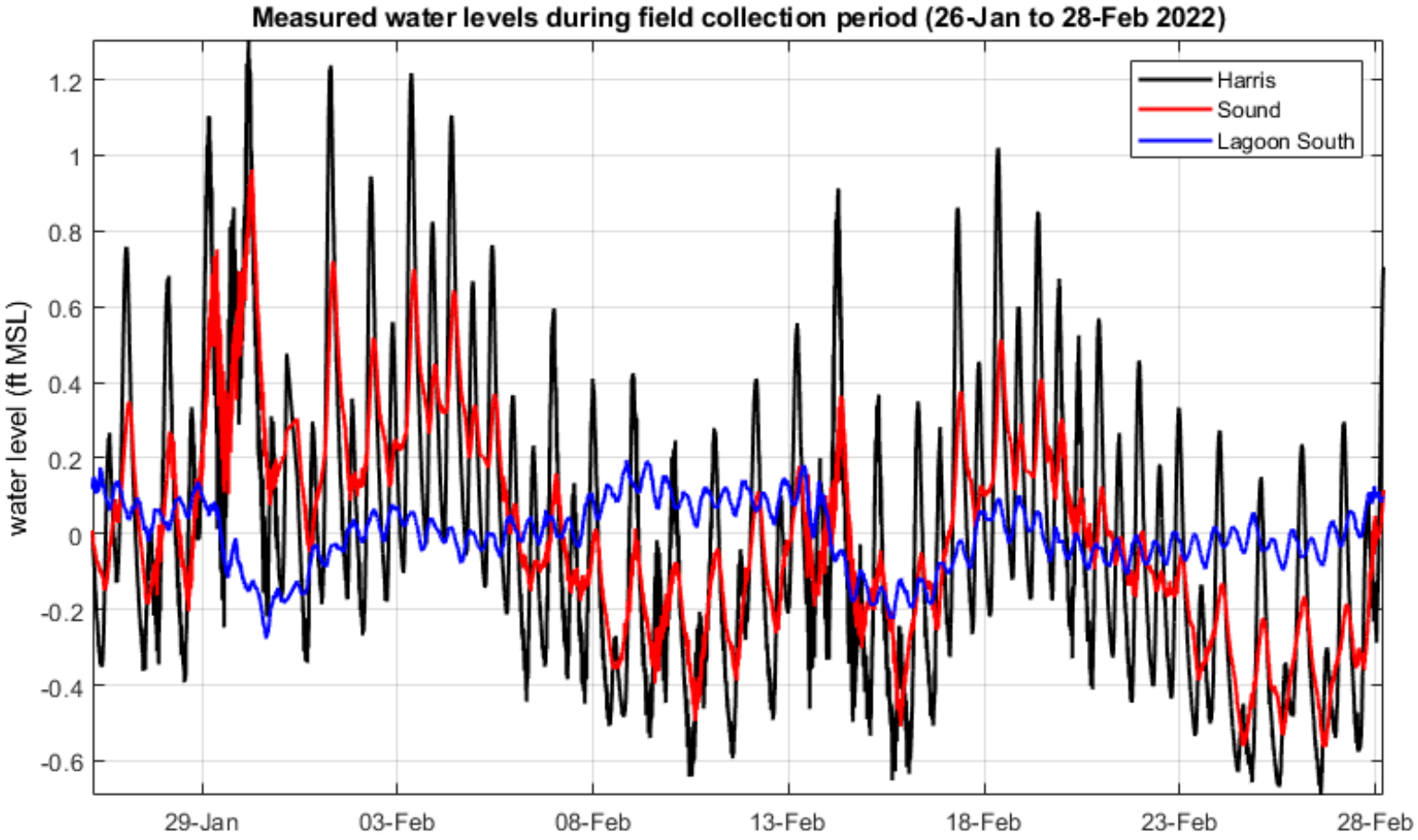
Data Collection

Water Levels

- Compared tidal harmonics from field to ADCIRC DB
- Good agreement at gauge N of US-1
- Less accurate S of US-1
- ADCIRC DB is not highly detailed in this area
- No comparison possible in Lagoon



Source	Constituent		M2	S2	N2	K1	O1
Field/UTide	amplitude	(ft)	0.30	0.10	0.03	0.15	0.18
	phase	(deg)	229.35	276.73	200.48	115.38	94.58
ADCIRC	amplitude	(ft)	0.24	0.08	0.03	0.19	0.19
	phase	(deg)	223.26	247.74	220.97	98.30	97.10

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Model Development

Boundary Conditions

- Field data collection period
- Measured water level at N boundary
- Harmonic constituents from ADCIRC DB at all other boundaries
- Spatially uniform, time-varying wind from KYWF1

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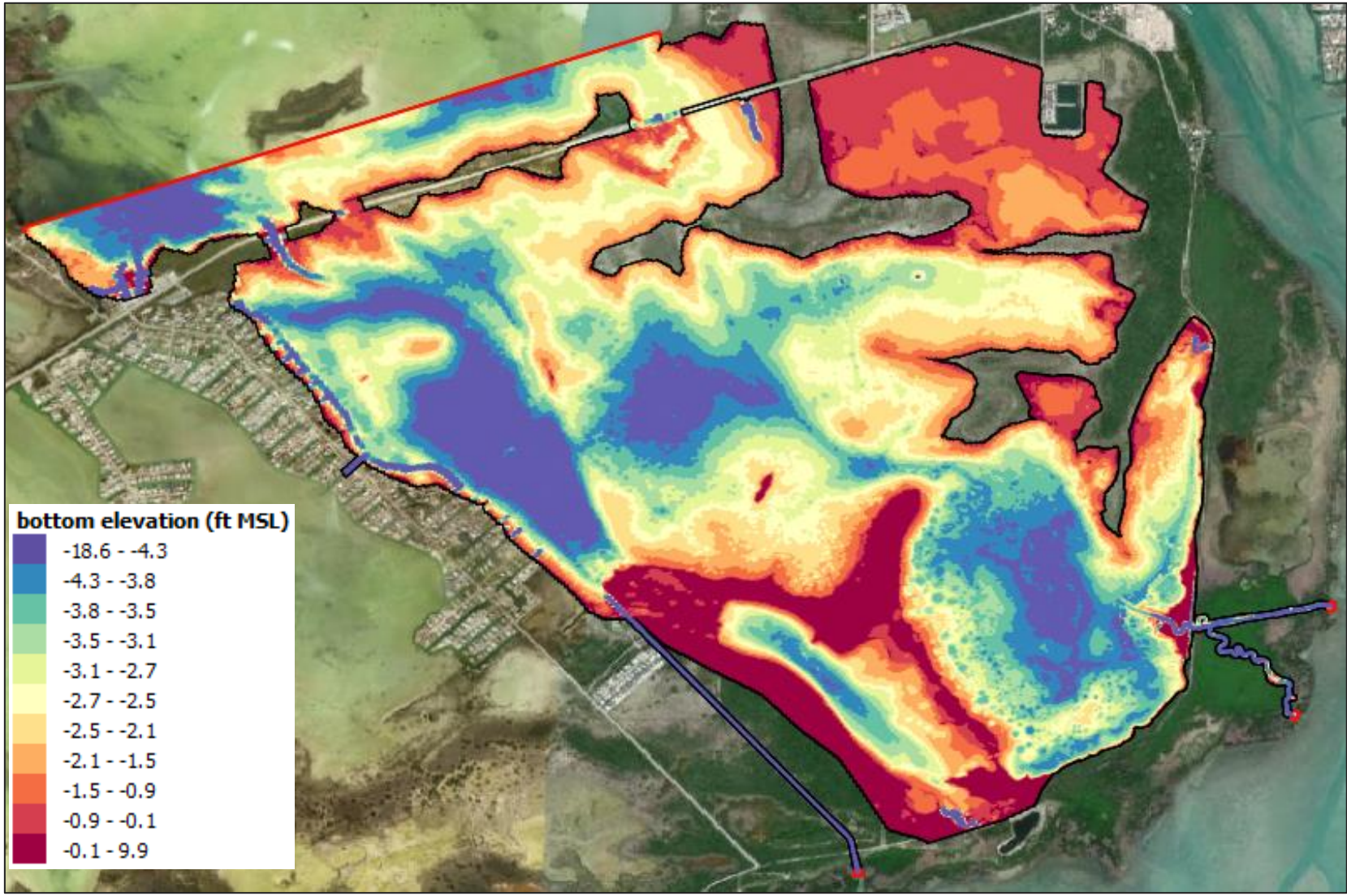
Model Development

Bathymetry and Grid

- 26 ft (8 m) spatial resolution
- Parameterized culverts



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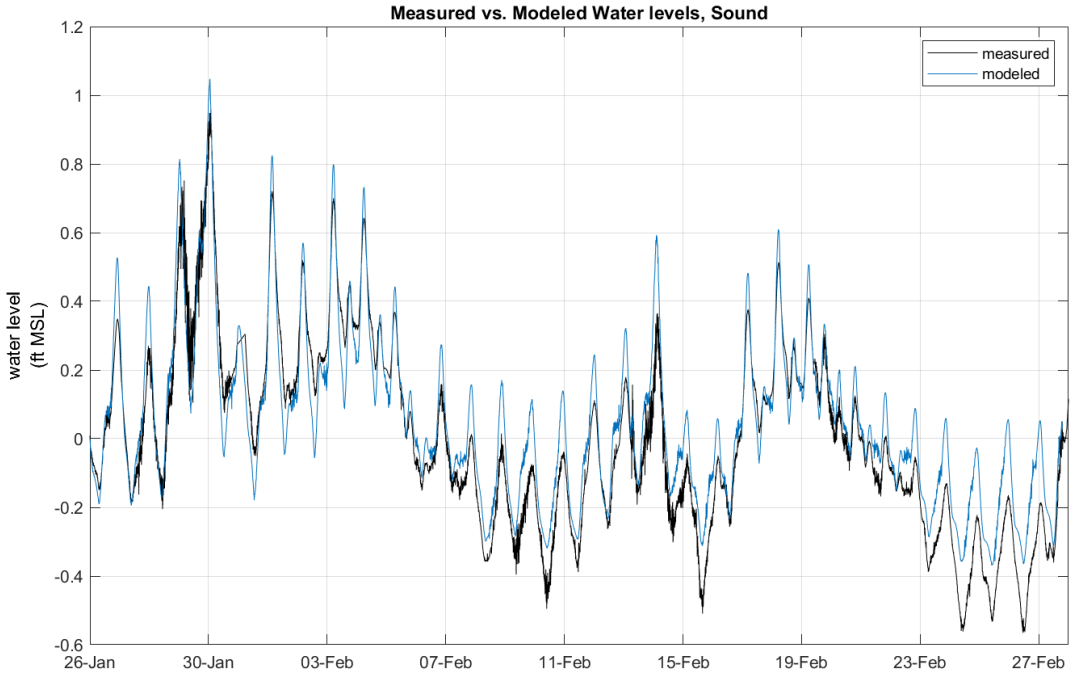
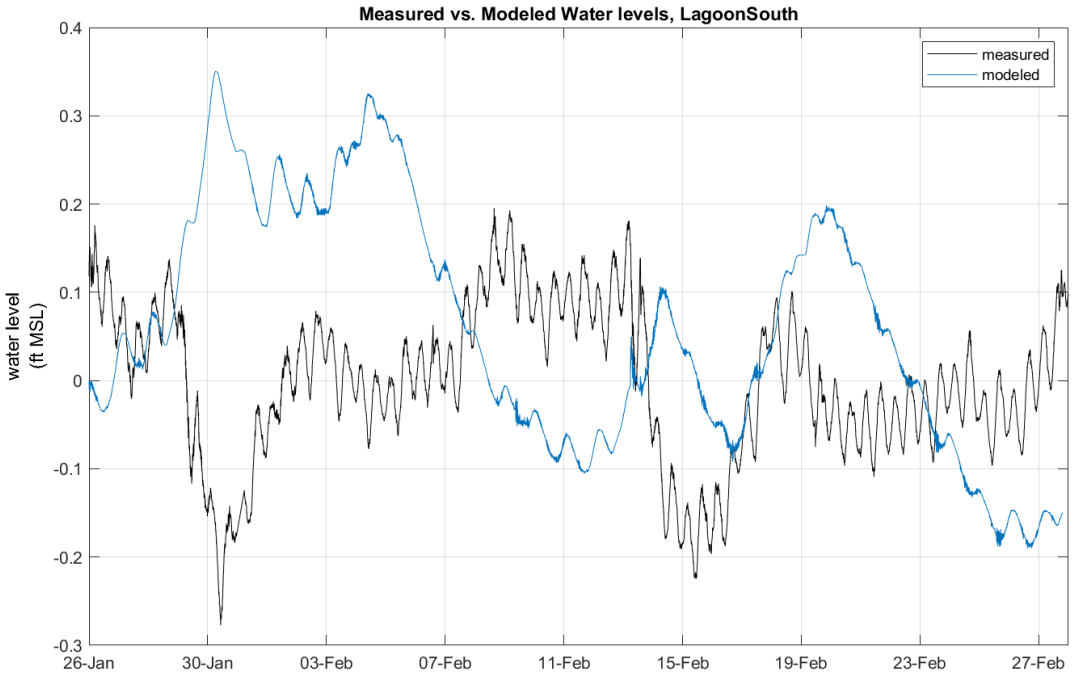
Model Results

Water Levels

- Sound gauge (top) replicated reasonably well
- Lagoon gauge (bottom) encountered difficulties
  - Parameterization of culverts
  - Very small (0.5 ft) range
  - Potential unknown groundwater and seepage effects





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Conceptual Alternatives

Culvert Additions

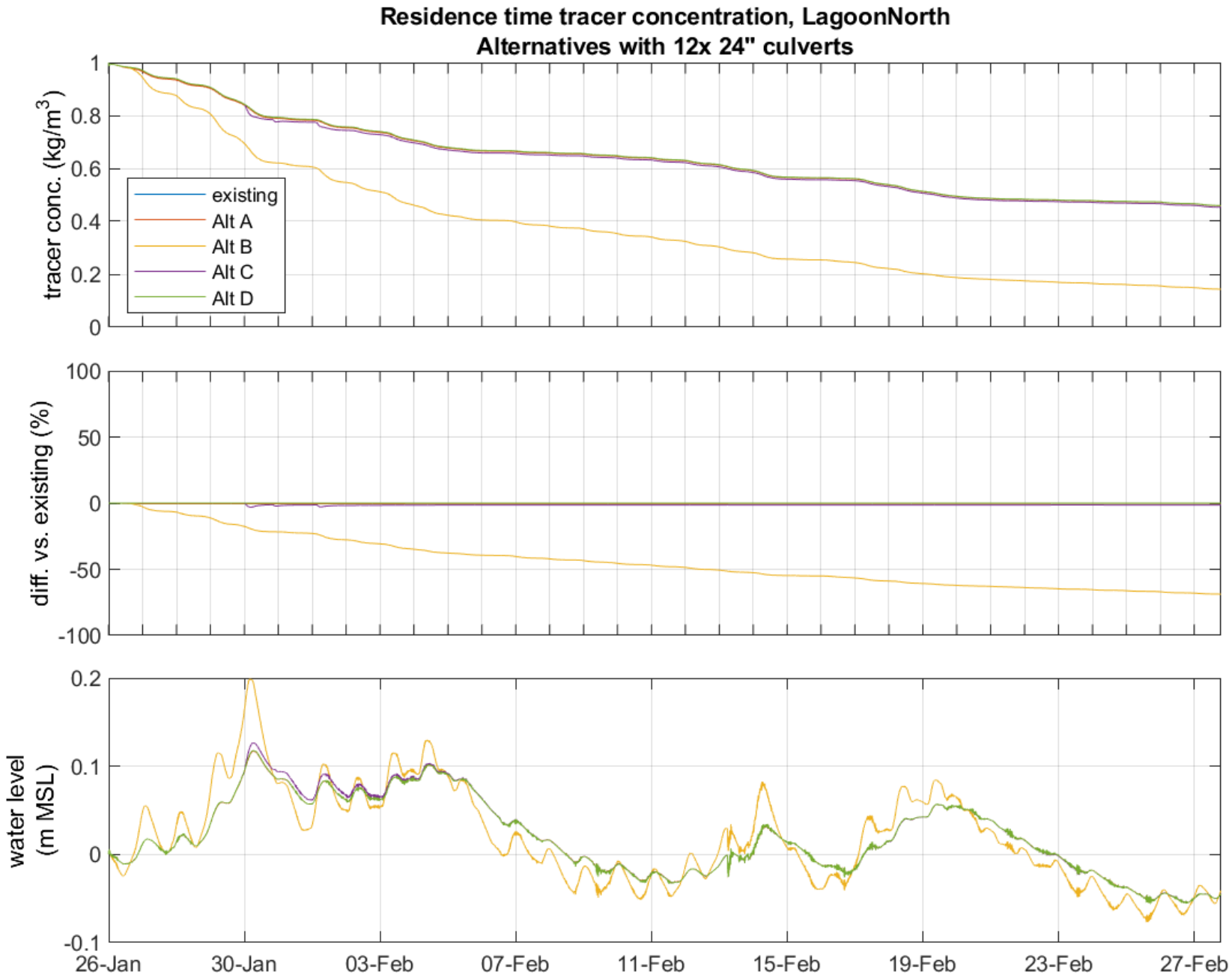
- 4 alternative locations
- 6-18 24" culverts at/close to bottom grade
- Massless, conservative tracer initialized in Lagoon (blue) at model start

Parameter	Alternative A Access Road	Alternative B Narrow Loop Road	Alternative C NW Mangroves	Alternative D Loop/Access Tee
Culvert section width (ft)	60	80	120	50
Culvert length (ft)	90	150	150	90
Number of 24" culverts	6/12/18	6/12/18	6/12/18	6/12
Invert elevation, inside (ft NAVD88)	-1.5	-1.5	-0.5	-0.5
Roadway elevation (ft NAVD88)	2.0	2.7	2.5	2.5
Invert elevation, outside (ft NAVD88)	-1.5	-1.5	-0.5	-0.5

Model Results

Tracer Residence Time

- Only Alt B has appreciable effect
- Not enough available flow at other locations



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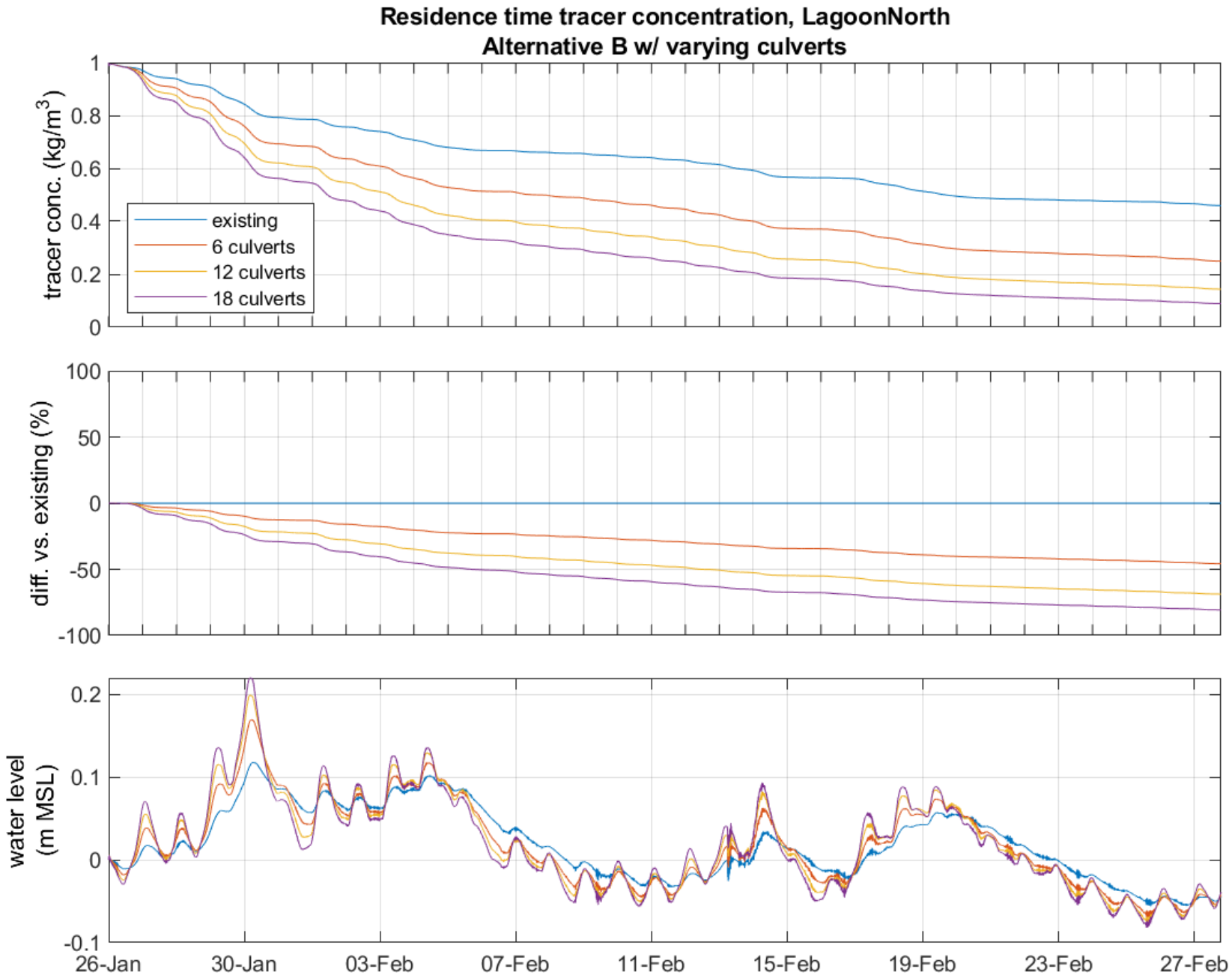
Model Results

Alternative B

- More culverts results in more exchange (with diminishing returns)



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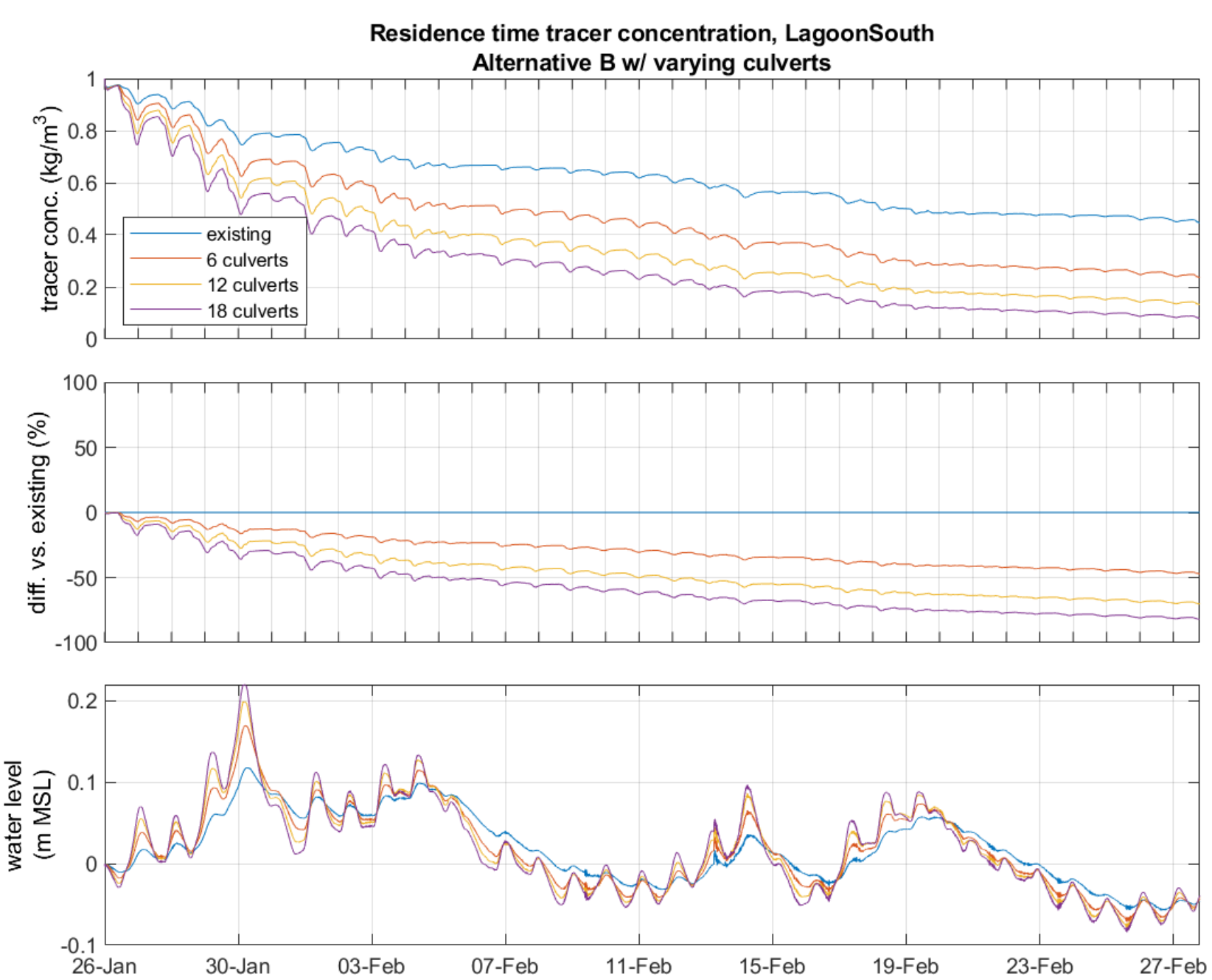
Model Results

Alternative B

- Time to 50% of initial concentration
- Concentration after 1 month
- Both metrics exhibit similar reduction numbers
- 6 culverts: 48% increase in exchange
- 12 culverts: 69%
- 18 culverts: 78%



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Model Results

Inundation Extents

- Slight increase in E/S mudflat areas
- Little to no difference on vegetated shorelines

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Model Results

Inundation Extents

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- Little to no difference on vegetated shorelines

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Next Steps

Full Design

- Awaiting FWC budget
- Anticipating FY2024

Permitting and Construction

- Following design phase

Post-Construction Monitoring

- How well did the model do in predicting exchange increase?

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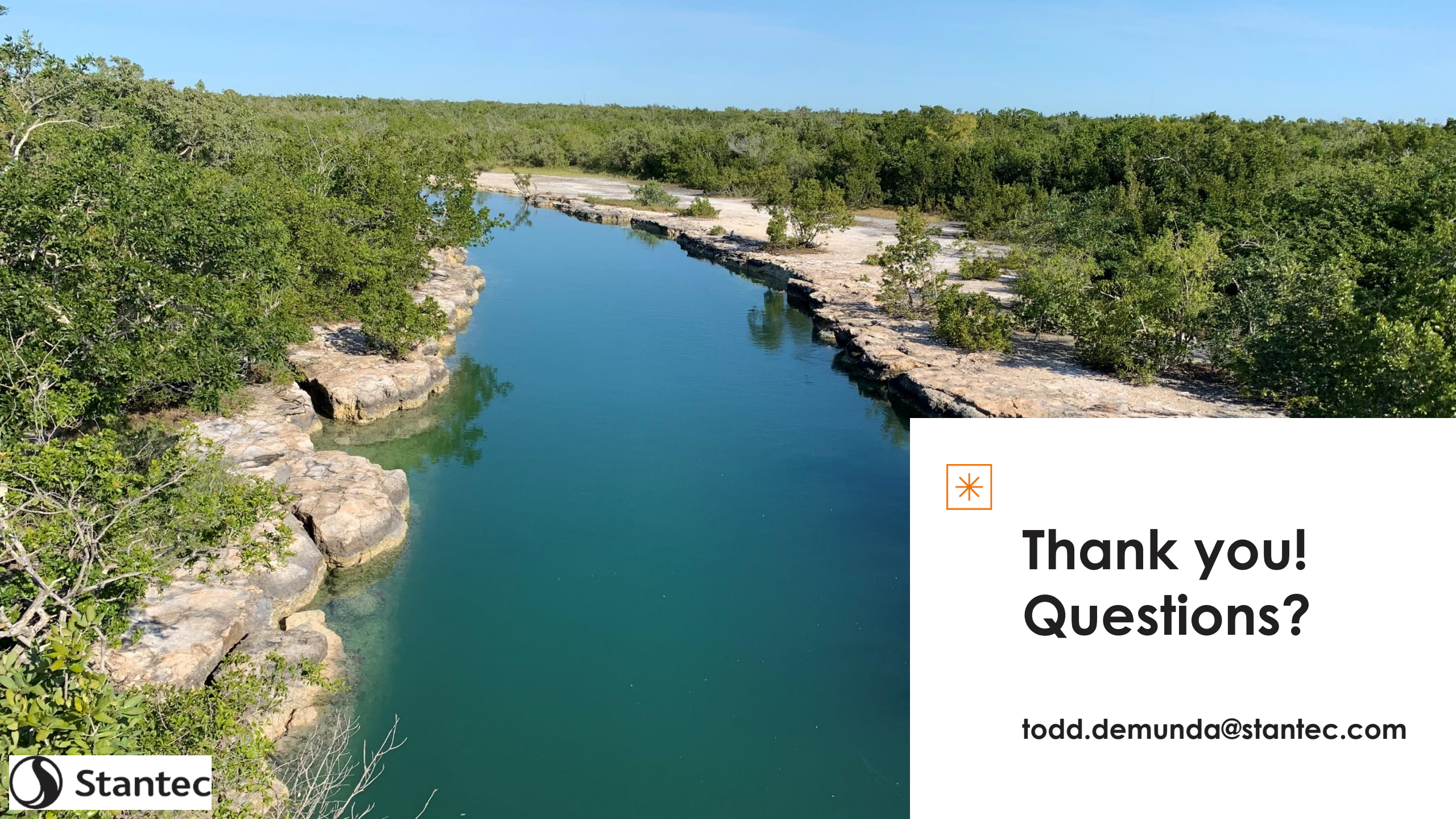

Thank you!
Questions?

todd.demunda@stantec.com

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