Addressing Nearshore Placement Near Lake Worth Inlet, FL

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Background – Lake Worth Inlet

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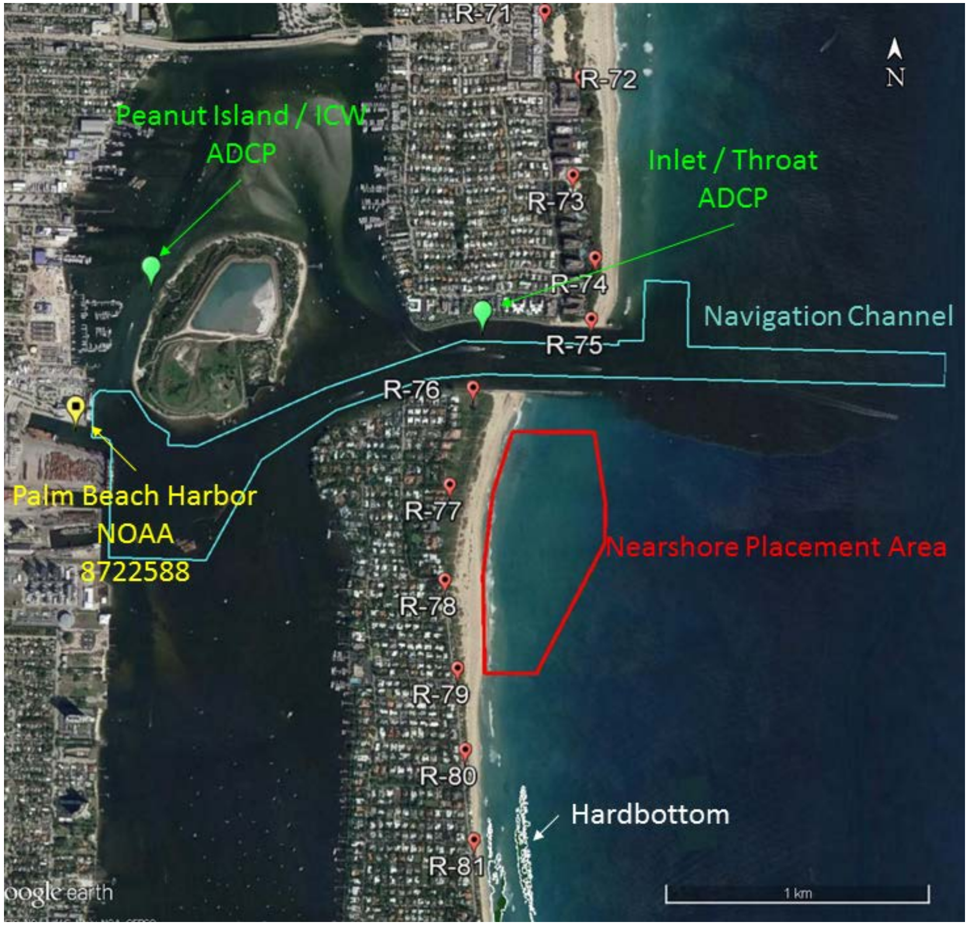
- Federally maintained inlet since 1934
  - North and south jetties, channel, turning basin, inlet revetments, and settling basin
- Final Integrated Feasibility Report and EIS (Jan 2014) report shoaling rates of approximately 117,500 cy/yr
- Beach quality material placed either on the dry beach or in the nearshore below MHW to the -17 ft MLW contour between 500 ft south of R-76 to R-79
- Where is optimal placement?



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Wave Climatology

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- To create wave regime in Nearshore: Hypercube method adopted from South Palm Beach Island Comprehensive Shoreline Stabilization Project: EIS by CB&I
  - Based on WIS data
  - Offshore dir. Bands generating 95% of the nearshore energy (5° to 155 °)
  - Six directional bins ~ equal wave energy
  - Each bin → three height classes ~ equal wave energy in shallow water
  - 18 wave cases plus calm

Wave Case	Hs (m)	Tp (sec)	Wave Dir. (°)	% Occur. In One Year	Days in Model in One Year
1	0.89	9.35	37.93	5.52	20.15
2	1.13	5.64	119.07	4.11	15.00
3	2.98	10.09	18.06	0.93	3.39
4	1.84	10.10	29.55	1.53	5.58
5	2.06	6.98	74.42	1.11	4.05
6	1.59	7.80	51.83	1.84	6.72
7	1.04	7.60	16.90	8.26	30.15
8	2.54	9.87	37.90	0.67	2.45
9	0.68	5.30	119.89	11.75	42.89
10	1.86	8.72	17.13	2.44	8.91
11	1.92	6.51	121.16	1.17	4.27
12	0.81	7.01	77.08	7.45	27.19
13	2.67	10.84	29.20	0.7	2.56
14	1.68	9.58	38.03	1.57	5.73
15	1.01	8.78	26.61	5.31	19.38
16	2.38	8.56	51.10	0.75	2.74
17	1.37	6.51	76.13	2.91	10.62
18	0.89	8.36	52.20	5.43	19.82
Calm	0.30	6.00	20.00	36.55	133.41

Coastal Modeling System

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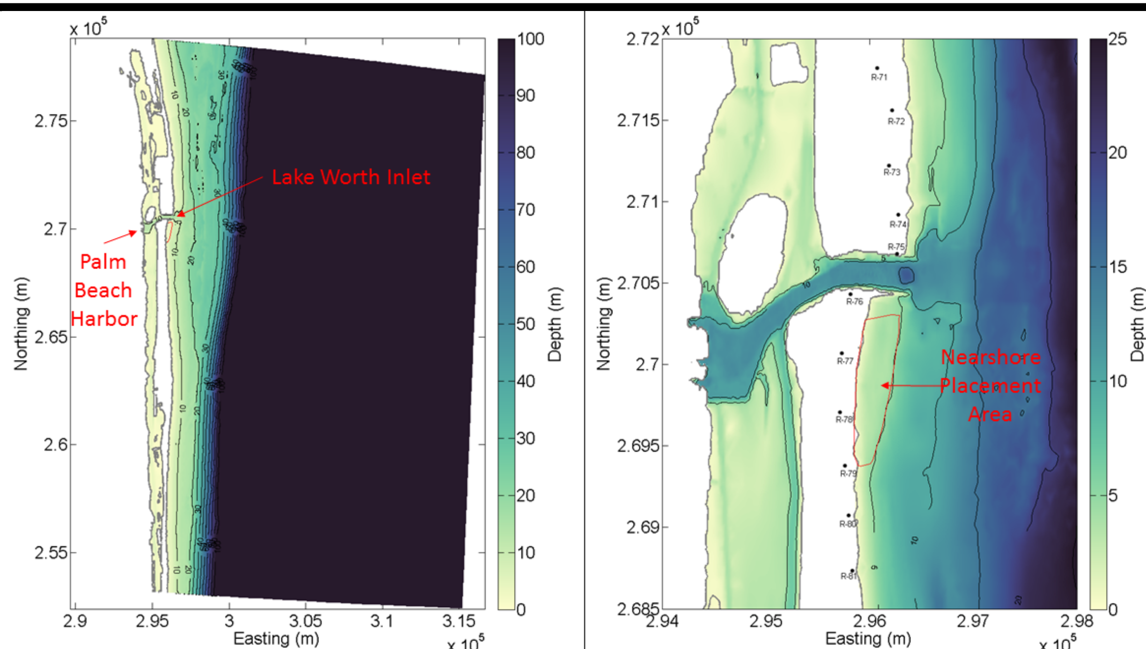

(a) (b)

Flow

- Telescoping grid
- 12.5 m to 800 m resolution
- 167,232 cells
- Tidal forcing – NOAA Lake Worth Pier Constituents

Wave

- 10 m to 200 m resolution
- 32,538 cells

Elevation

- PBH surveys
- Beach profiles
- AIWW survey
- Lidar
- NOAA Palm Beach, FL DEM
- Referenced to MSL

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Calibration / Validation

- Limited data available
  - ▶ Calibration to water levels:
    - NOAA Port of Palm Beach
  - ▶ Validation with ADCP data
    - Collected over Spring and Neap periods in 2008
- Current magnitude slightly underestimated
  - ▶ Doubled tidal amplitude to “bracket” expected conditions

Calibration / Validation

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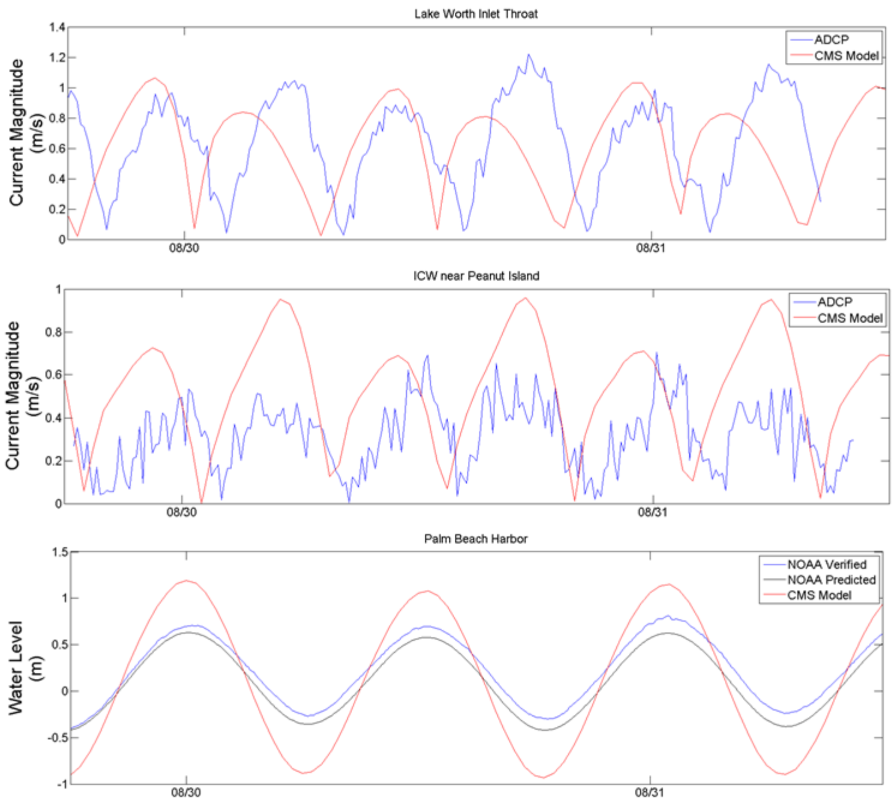
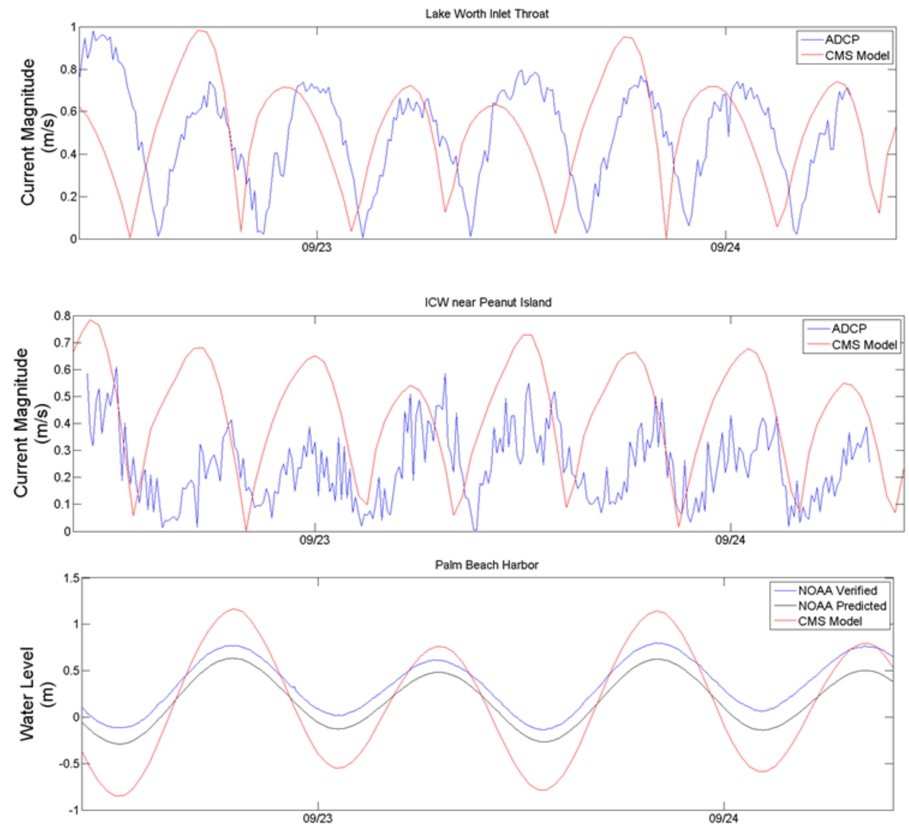
Spring Tide



Neap Tide



Production Runs

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- CMS model run for year-long simulations
  - Both regular tidal constituents and double-amplitude constituents
  - 3 hour wave coupling
  - 3 different randomizations of the wave climate with yearly percent occurrence as presented
  - Total of 6 year long simulations
- Cumulative velocities analyzed to identify nodal point

Nodal Point Analysis

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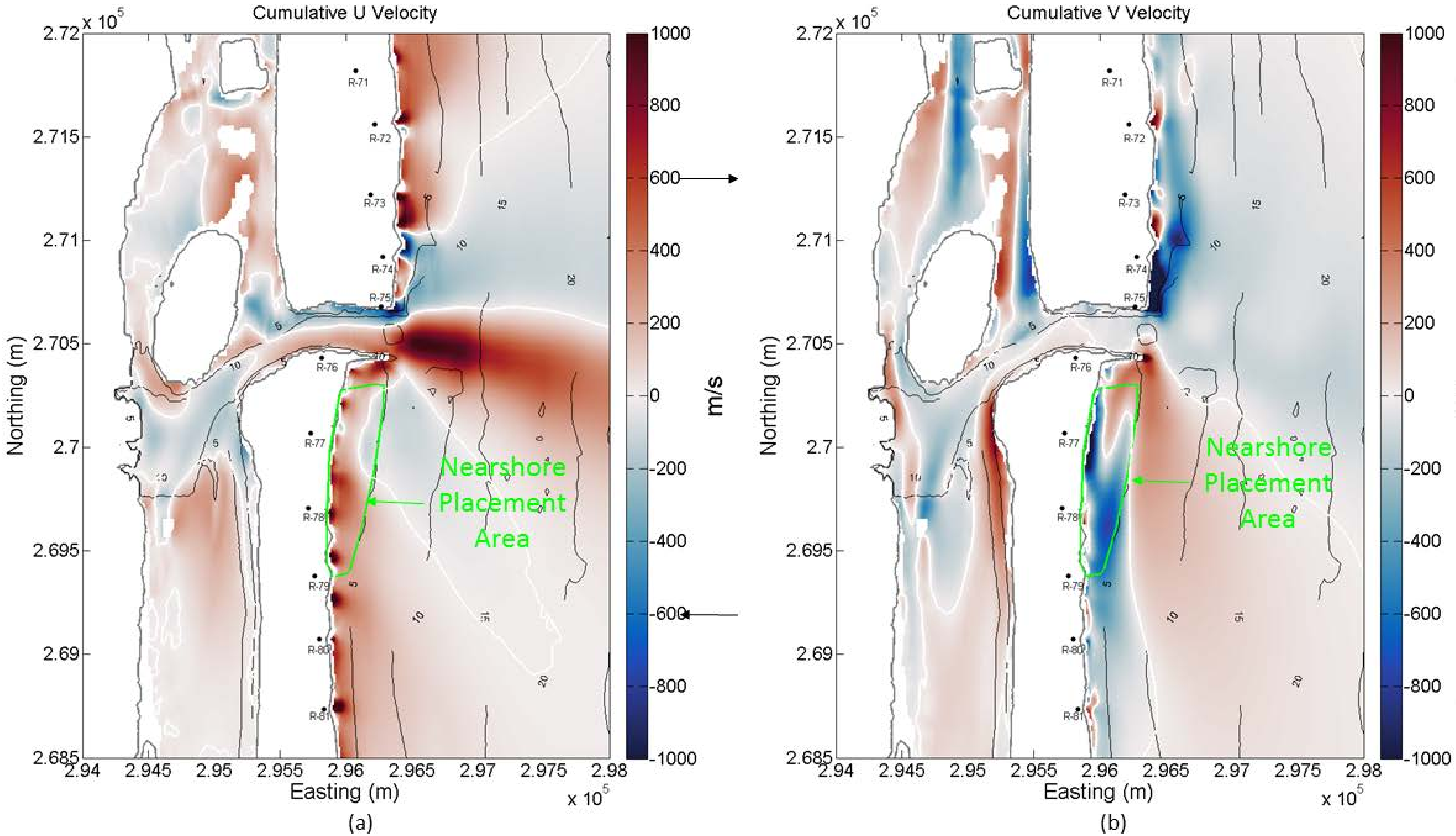

Nodal Point Analysis

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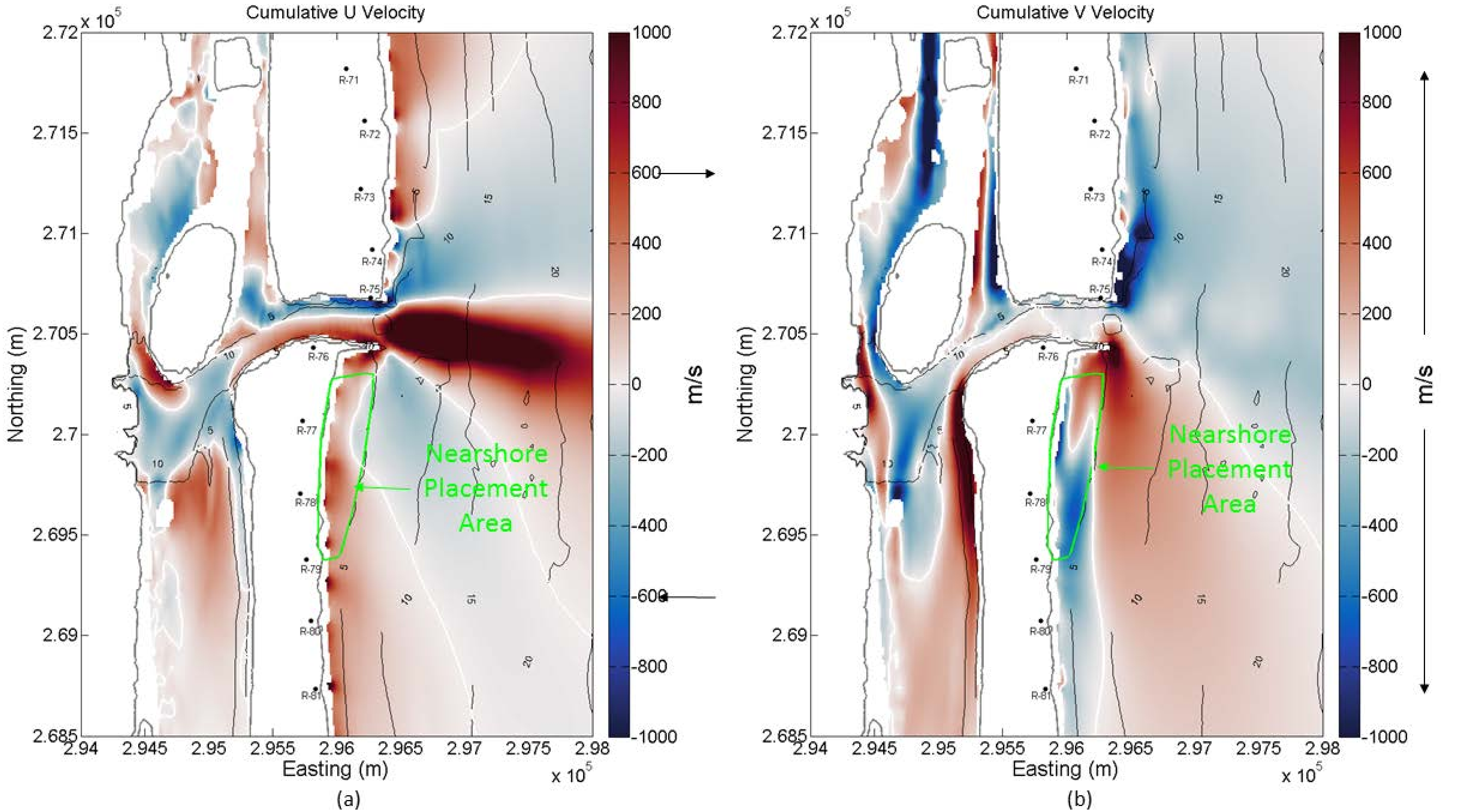

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Nodal Point Analysis

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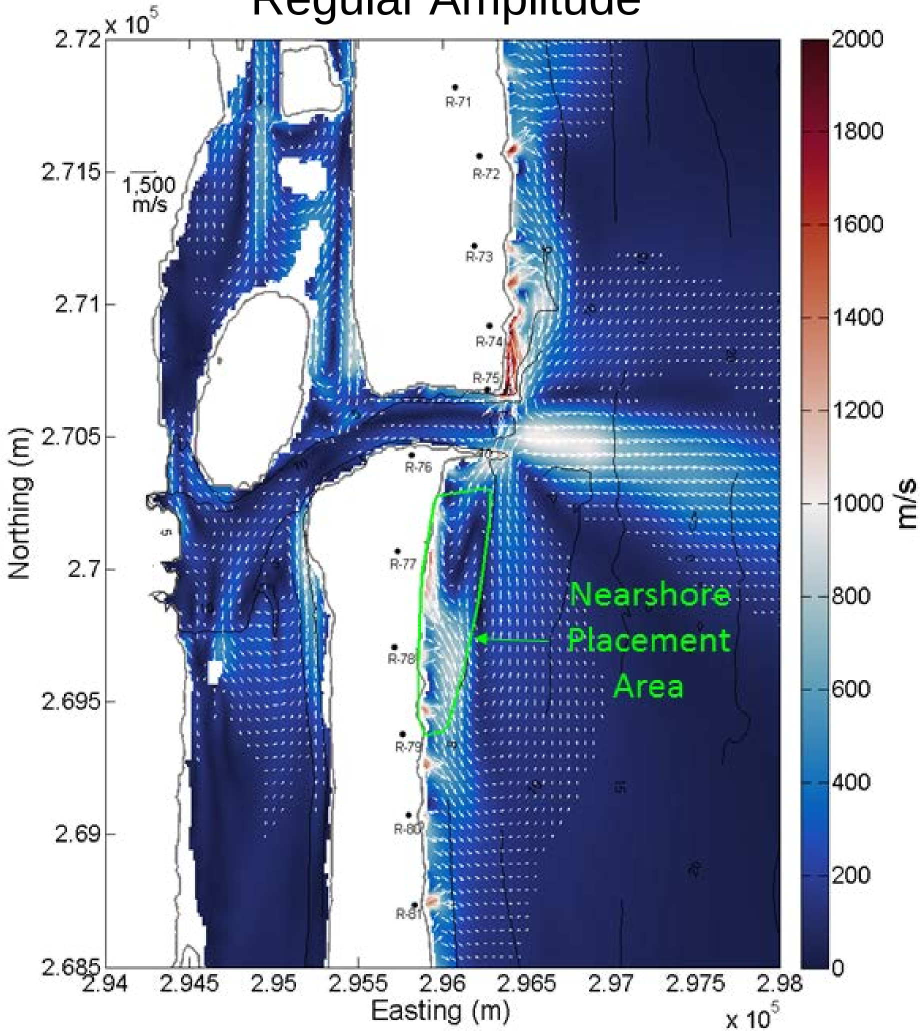
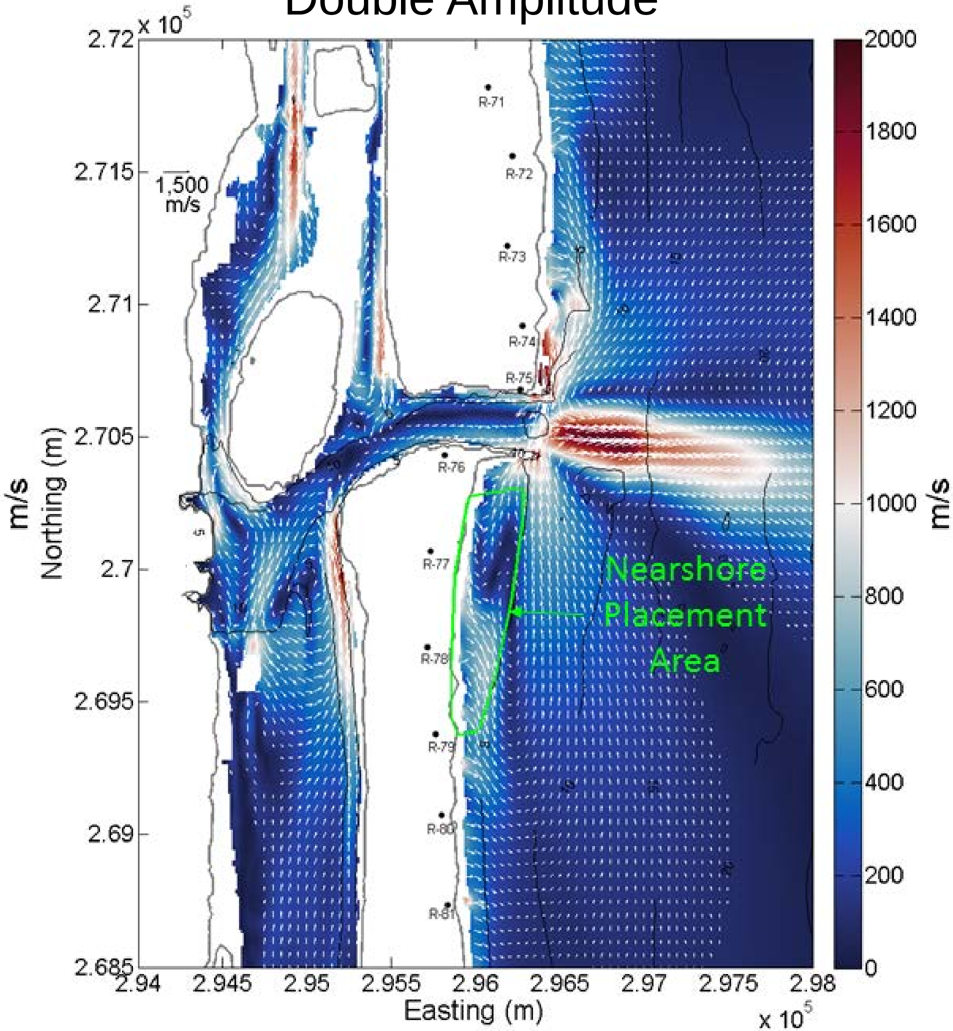
Regular Amplitude



Double Amplitude



Wave Energy Analysis

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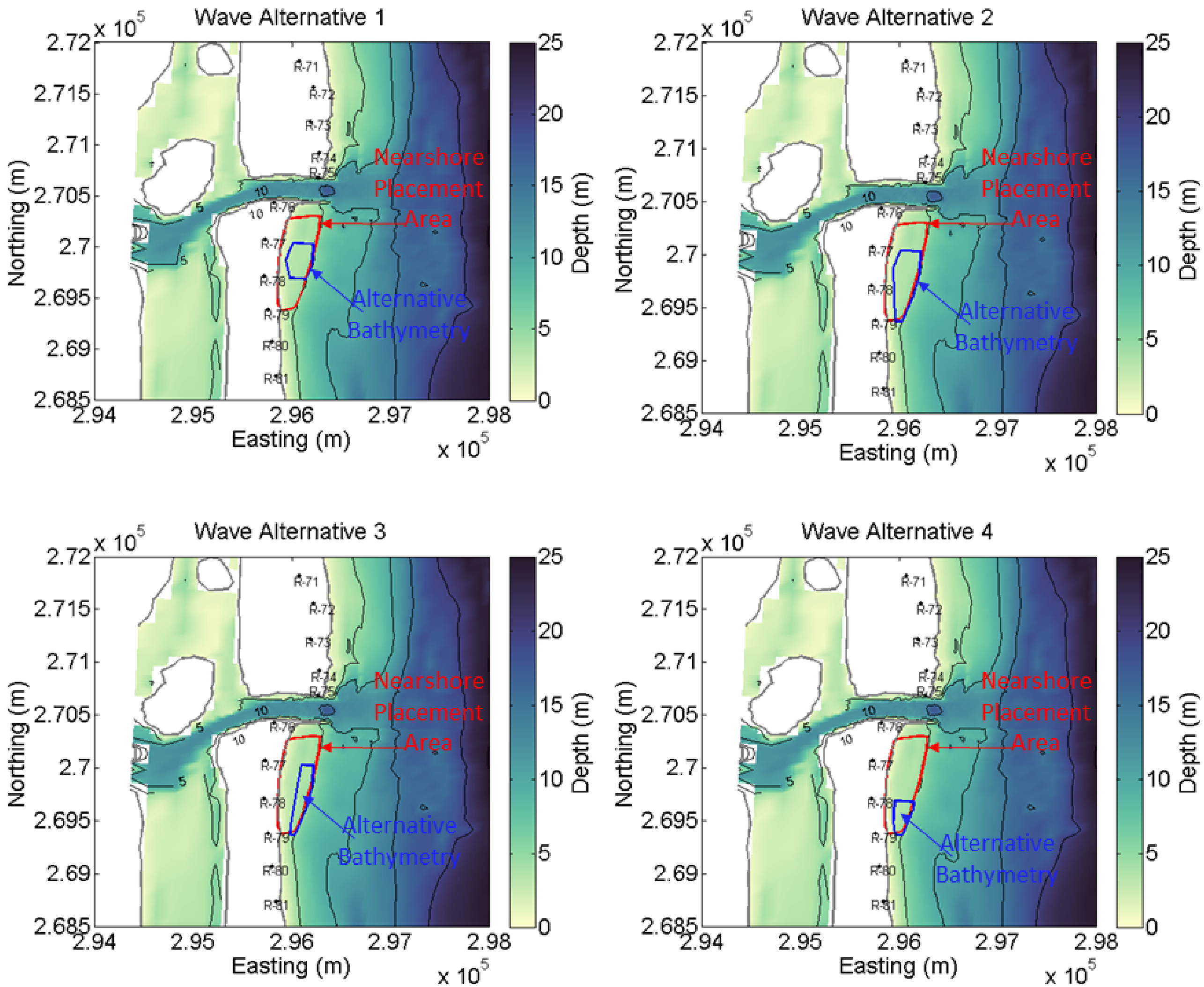
- ~ 120,000 cy/yr should be dredged from the channel and placed in the nearshore
- Four nearshore placement scenarios were developed to replicate placement of approximately 120,000 cy
  - Alternative 1: Between R-77 and R-78, 4 ft added between the -10 and -17 ft MSL contours
  - Alternative 2: Between R-77 and R-79, 2.5 ft added between the -10 and -17 ft MSL contours
  - Alternative 3: Between R-77 and R-79, 4 ft added between the -12 and -17 ft MSL contours
  - Alternative 4: Between R-78 and R-79, 6 ft added between the -8 and -17 ft MSL contours

Wave Energy Analysis



Wave Energy Analysis

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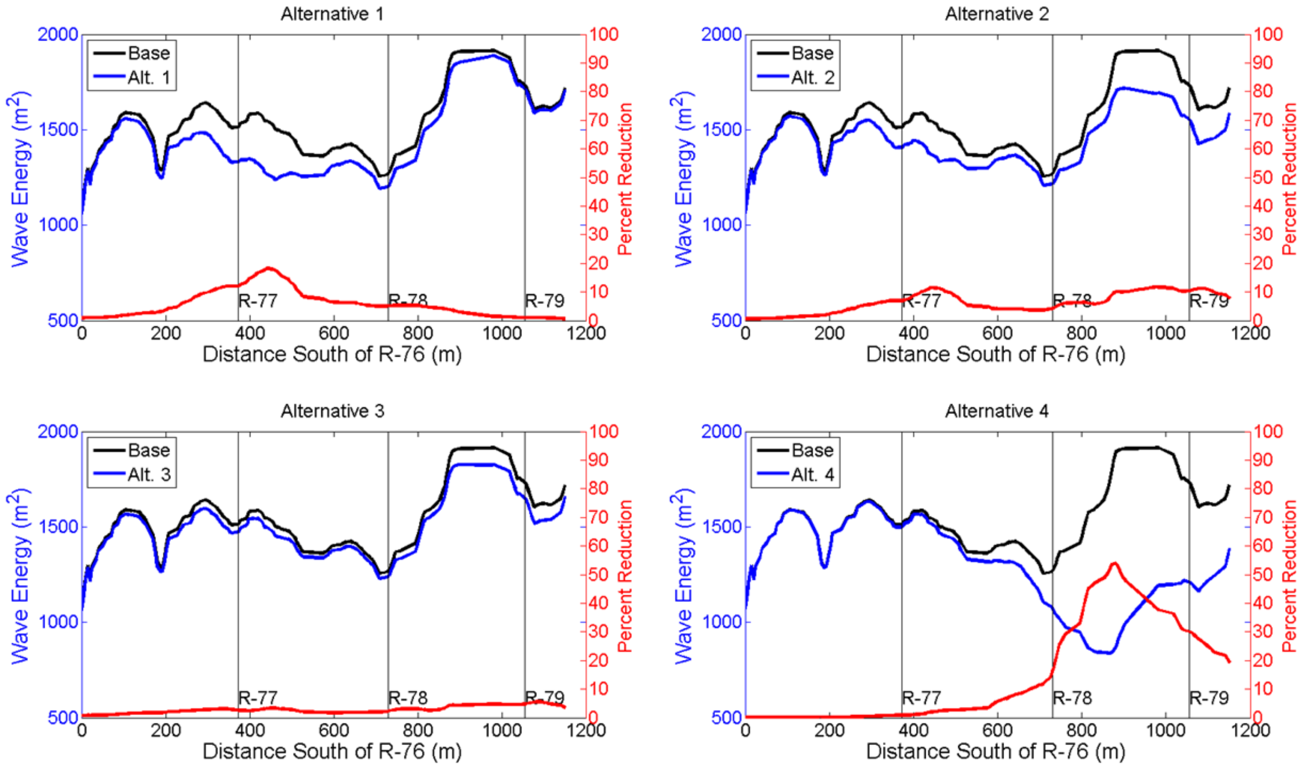
- Total cumulative wave energy was estimated as the square of the wave height
- Approximated along a north-south running profile at the -5 ft MSL water depth



Alternatives

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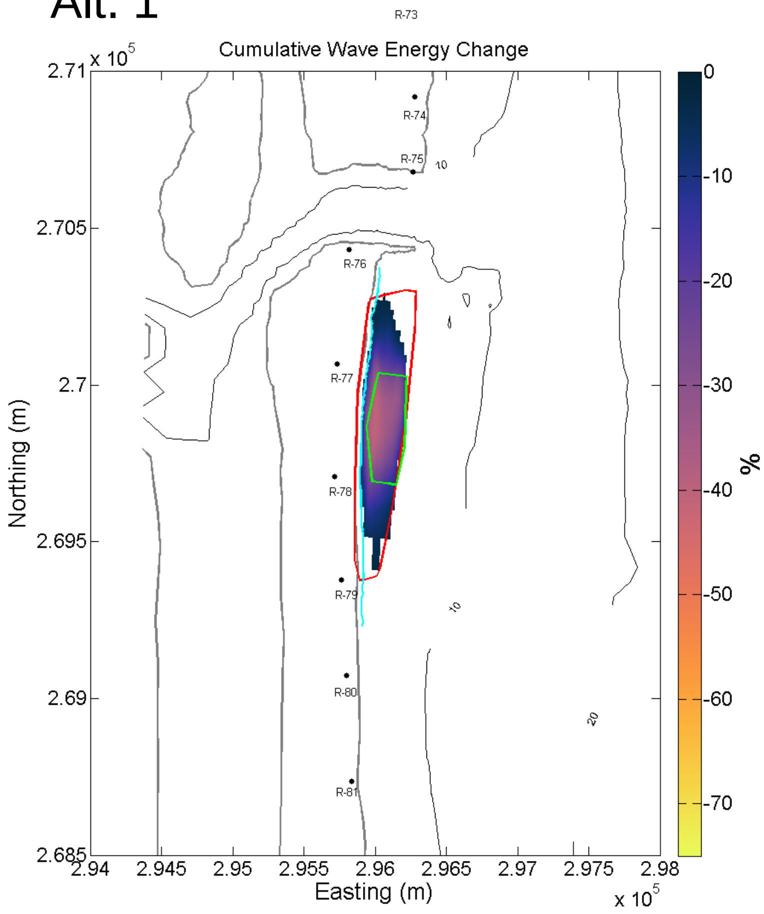
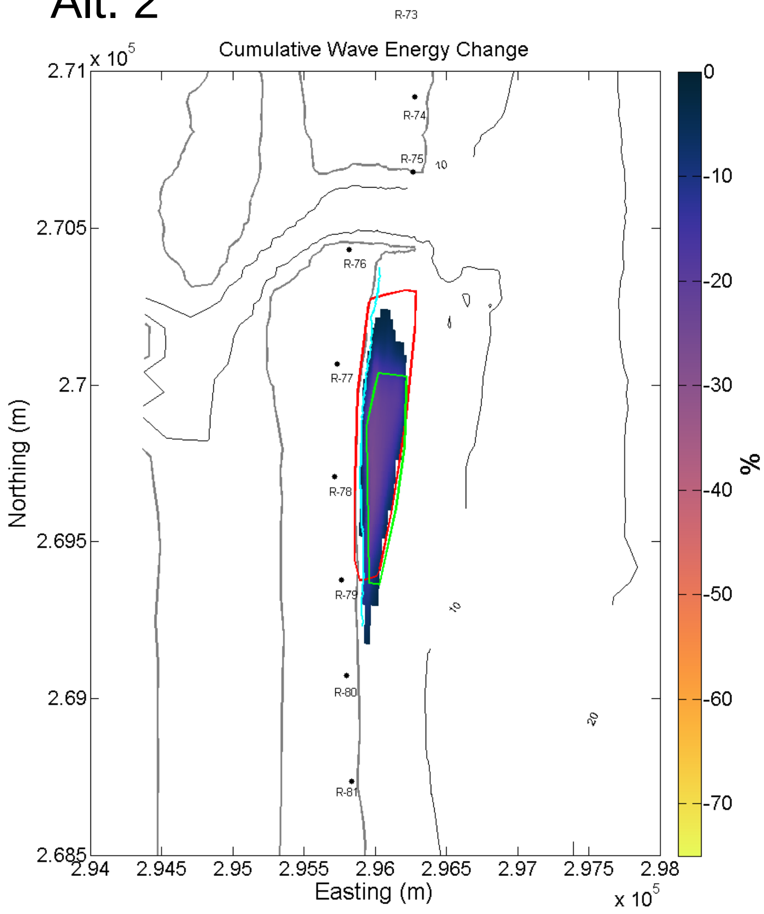
Alt. 1



Alt. 2



Alternatives

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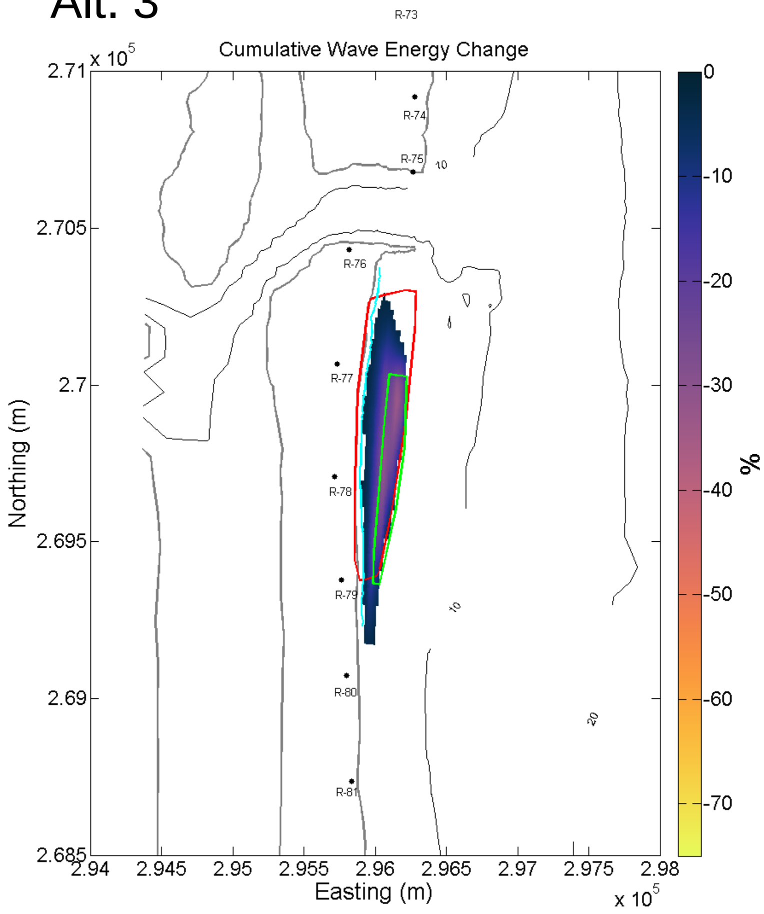
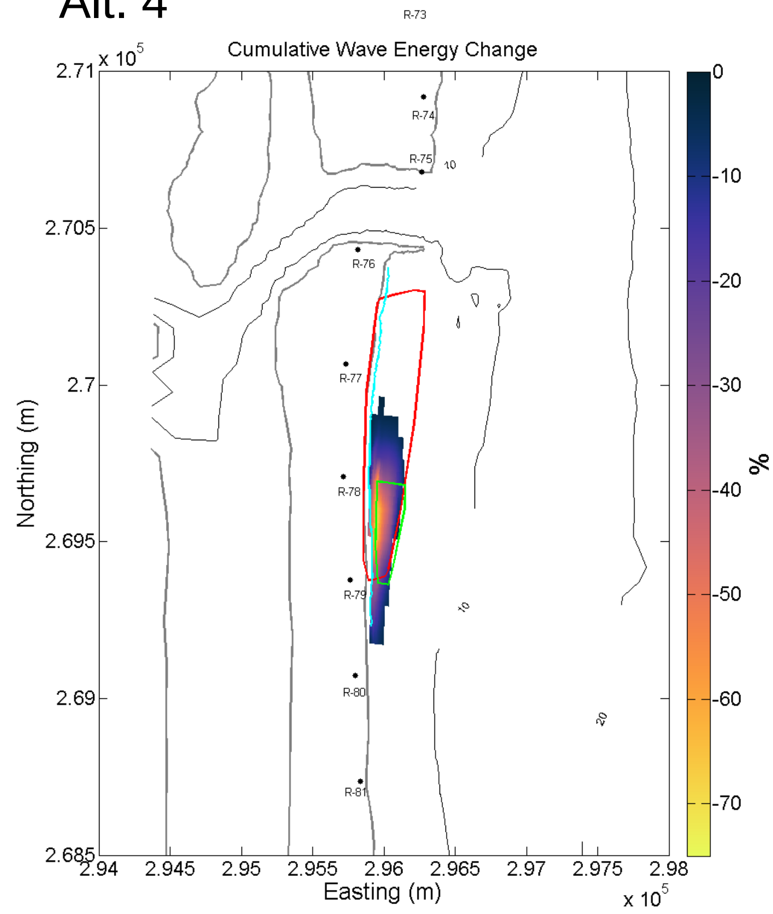
Alt. 3



Alt. 4



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Mobilization of Sediment

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- Sediment Mobility Tool applied at 7 different cross-shore depths assuming median grain size, d_{50}, of 0.14 mm

	Linear Wave Theory		Stream Function Wave Theory	
Depth (m)	Freq. of Sediment Mobility	Mean Mobility Score <M>	Freq. of Sediment Mobility	Mean Mobility Score $\langle M_u \rangle$
3.04	**99.9%**	**3.61**	**100%**	**4.69**
4.57	**99.9%**	**2.15**	**99.9%**	**3.53**
6.10	93.6%	1.45	99.9%	2.84
7.62	93.6%	1.01	99.9%	2.29
9.14	93.5%	0.67	93.6%	1.87
10.67	82.0%	0.43	93.6%	1.53
12.19	41.3%	0.25	93.6%	1.26

- Dean number used to predict cross-shore sediment migration

d_{50} (mm)	Predicted Sediment Migration
0.1	72% Erosive, Offshore Migration
0.14	**84% Accretion, Onshore Migration**
0.2	97% Accretion, Onshore Migration
0.3	100% Accretion, Onshore Migration
0.4	100% Accretion, Onshore Migration
0.5	100% Accretion, Onshore Migration

Conclusion

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- North – South velocity nodal point located around R-77
  - Material placed north of this will likely end up in the inlet
  - Nearshore placement should be confined between R-77 and R-79
- Reduction of wave energy varies by placement layout, between 5 and 75%
  - Smaller the negative freeboard, the greater the energy reduction
- Sediment is likely to mobilize and move onshore
  - SMT predicts mobilization is highly probable
  - Dean number predicts that when mobilized sediment will migrate onshore
- Wave climate randomizations all produced similar average and cumulative current results

Questions

- Thank you!

References

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