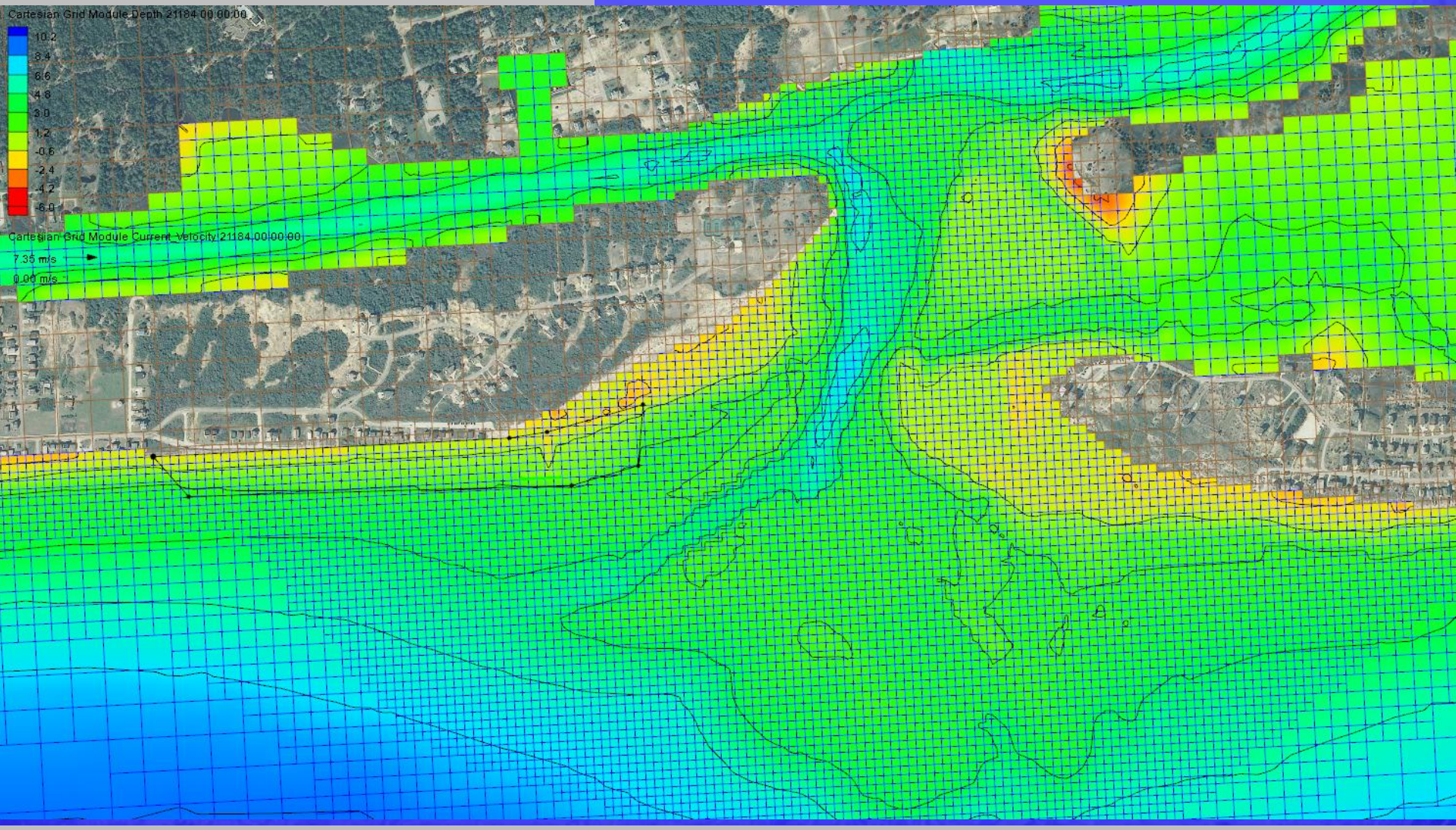
MODELING



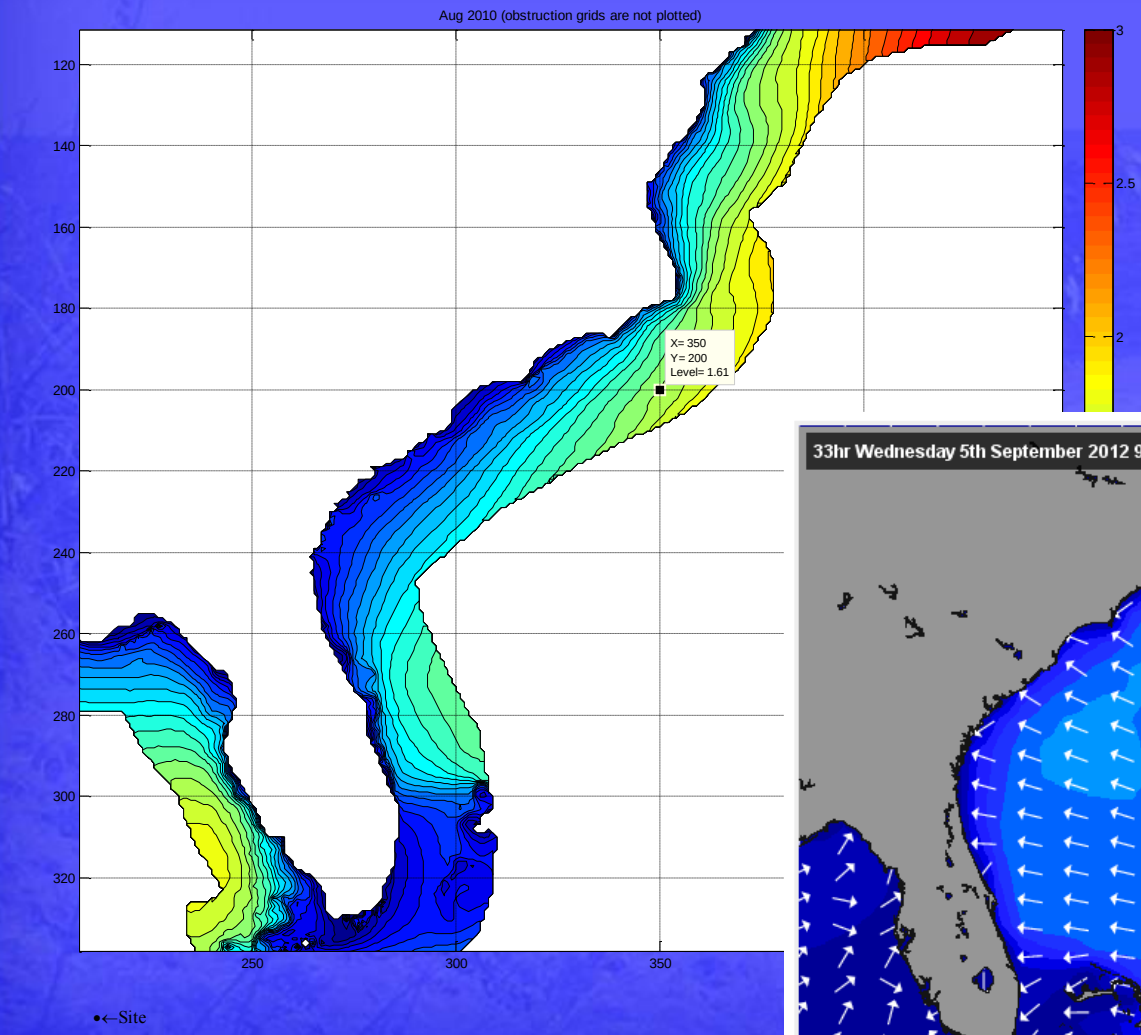
- Wave, Hydrodynamic, Sediment Transport Modeling

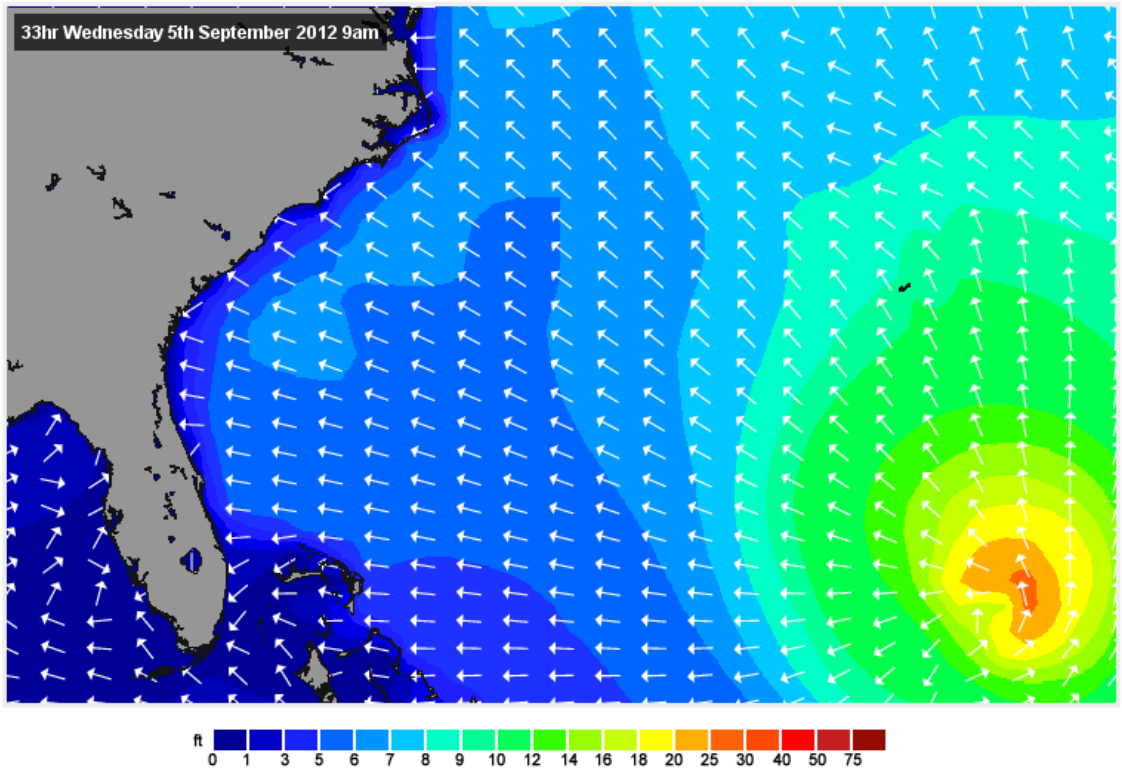
Model Application

- NOAA WAVEWATCH (1999 to 2011)
- CMS Wave
- CMS Flow and Sedimentation
- GENESIS-T

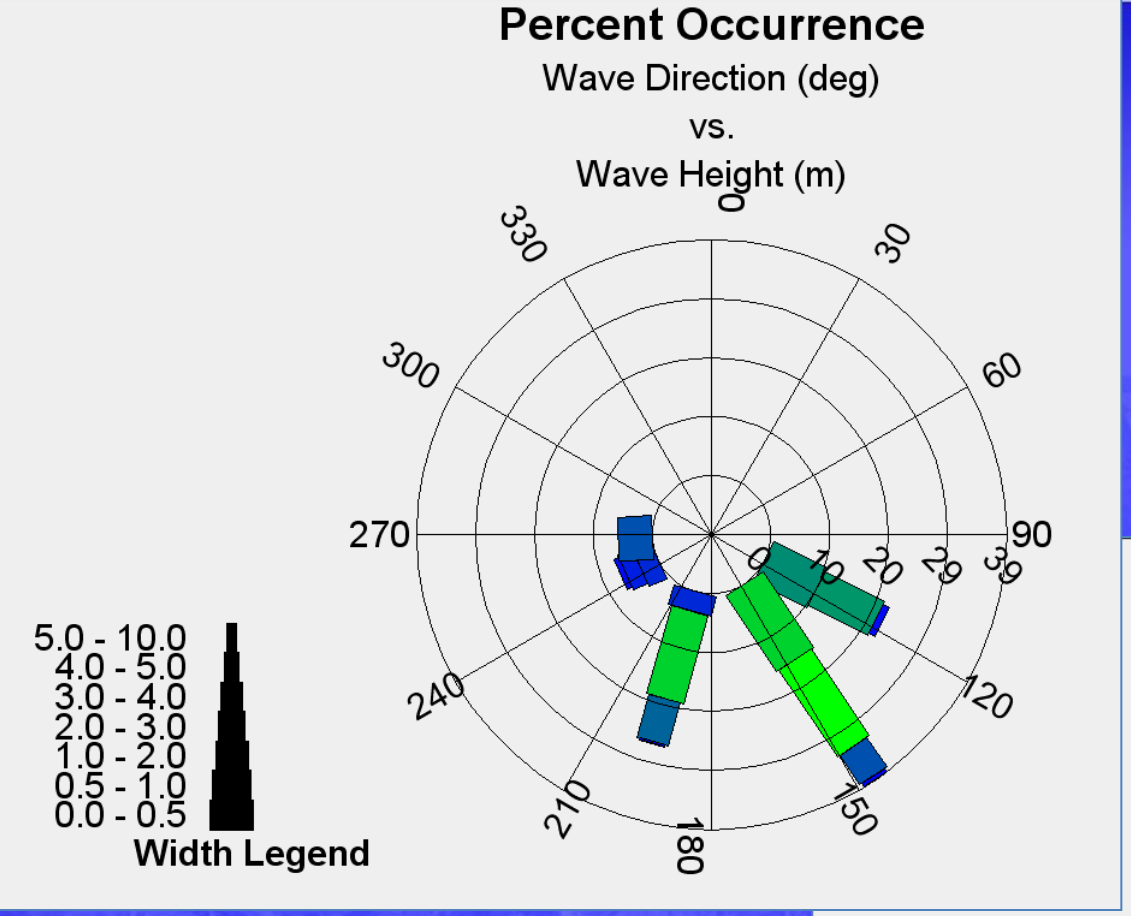
The Coastal Modeling System (CMS) is an integrated modeling system designed to simulate nearshore processes, especially with respect to navigation channel performance and sediment exchange between inlets and adjacent beaches. CMS couples flow, wave, and sediment transport models to simulate waves, current, water level, sediment transport, and morphology change.

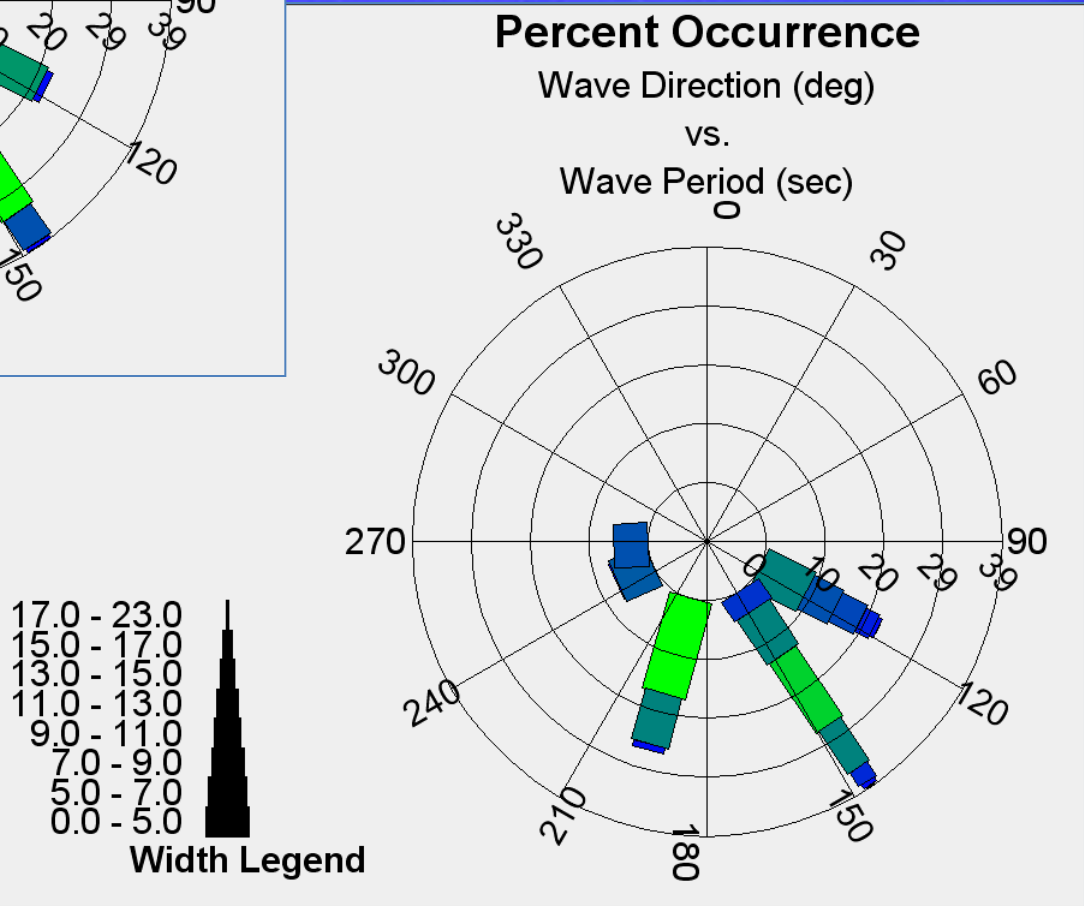
NOAA WAVEWATCH III





Hs and Pd Roses





Bathymetric and topographic data sources:

-Holden Beach annual beach and bathymetric surveys

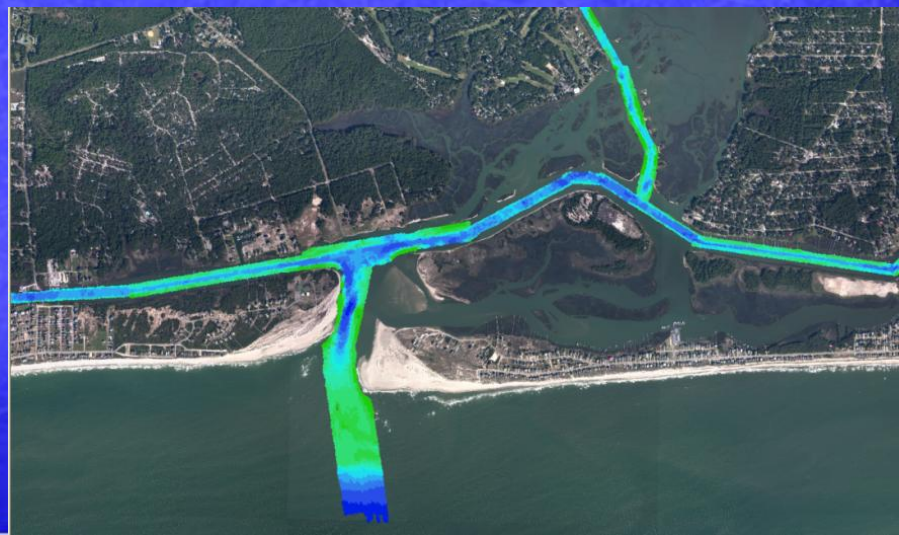
-USACE AIWW and Lockwoods Folly Inlet bathymetric surveys

-LIDAR topographic data (NOAA Digital Coast, 2004 NC Flood Mapping)

-Coastal Science and Engineering (CSE) 2008 survey (inlet/AIWW, Eastern Channel, LWF River)

-USACE LWF River survey

-NOAA Charts (inshore and offshore)



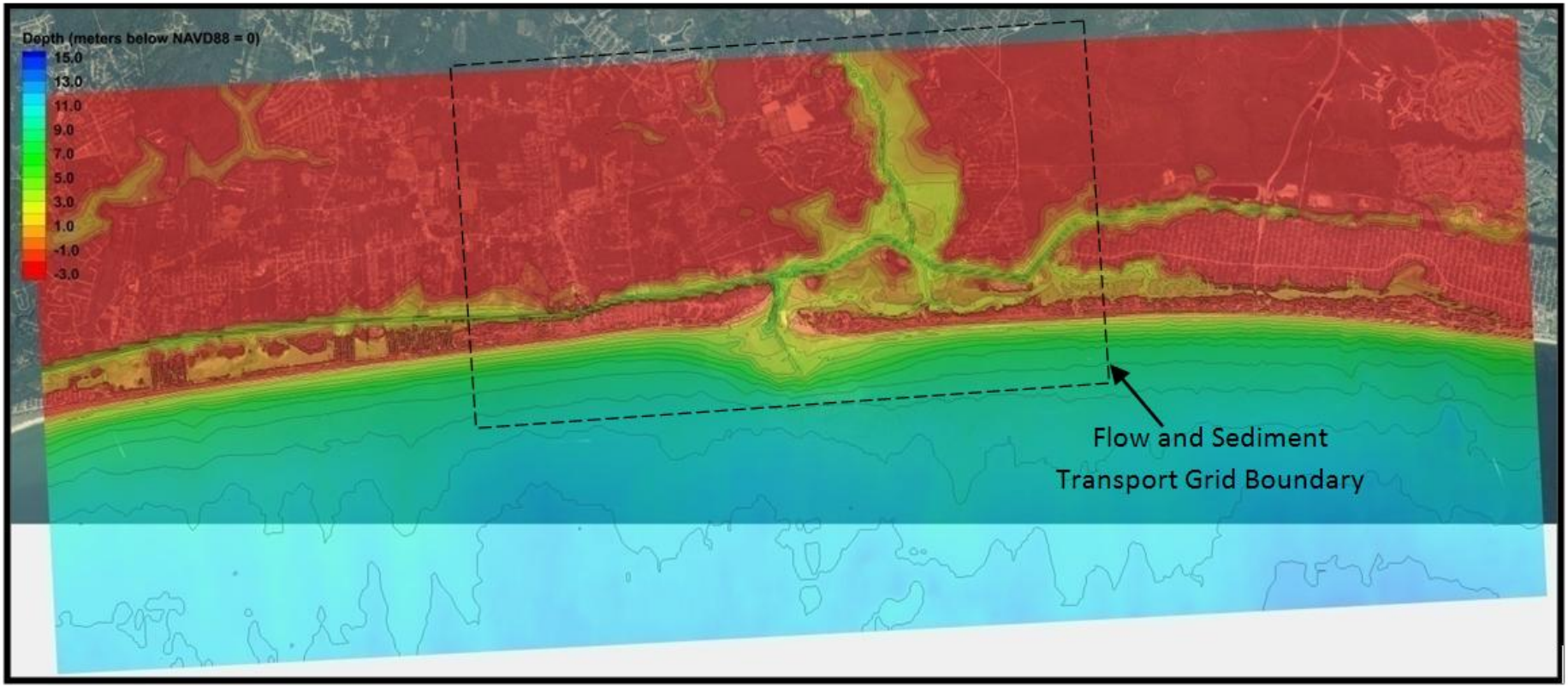
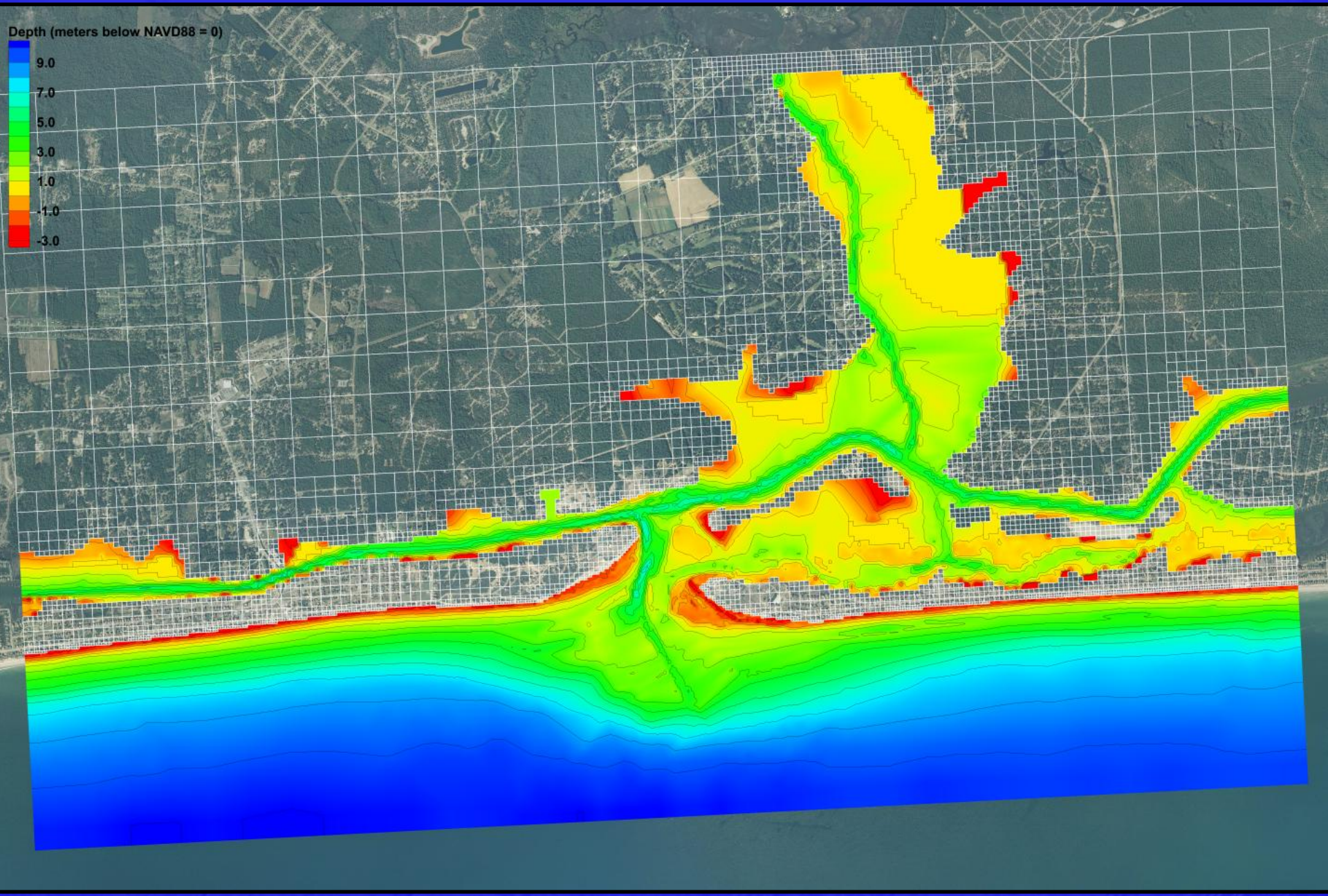


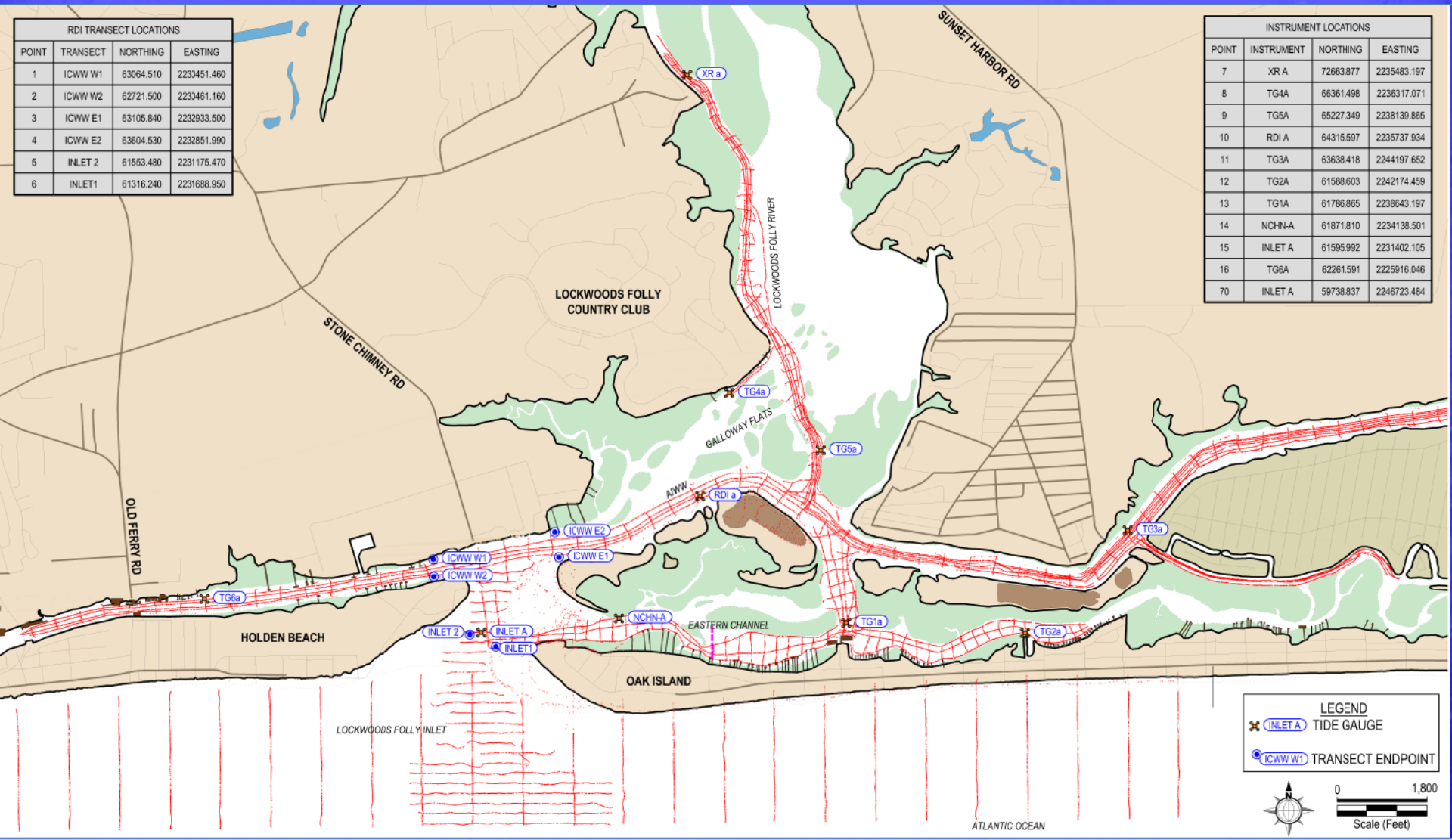
Figure 5. Wave model grid with interpolated bathymetry (2009) and aerial photograph (2008). Computational cells not shown for clarity

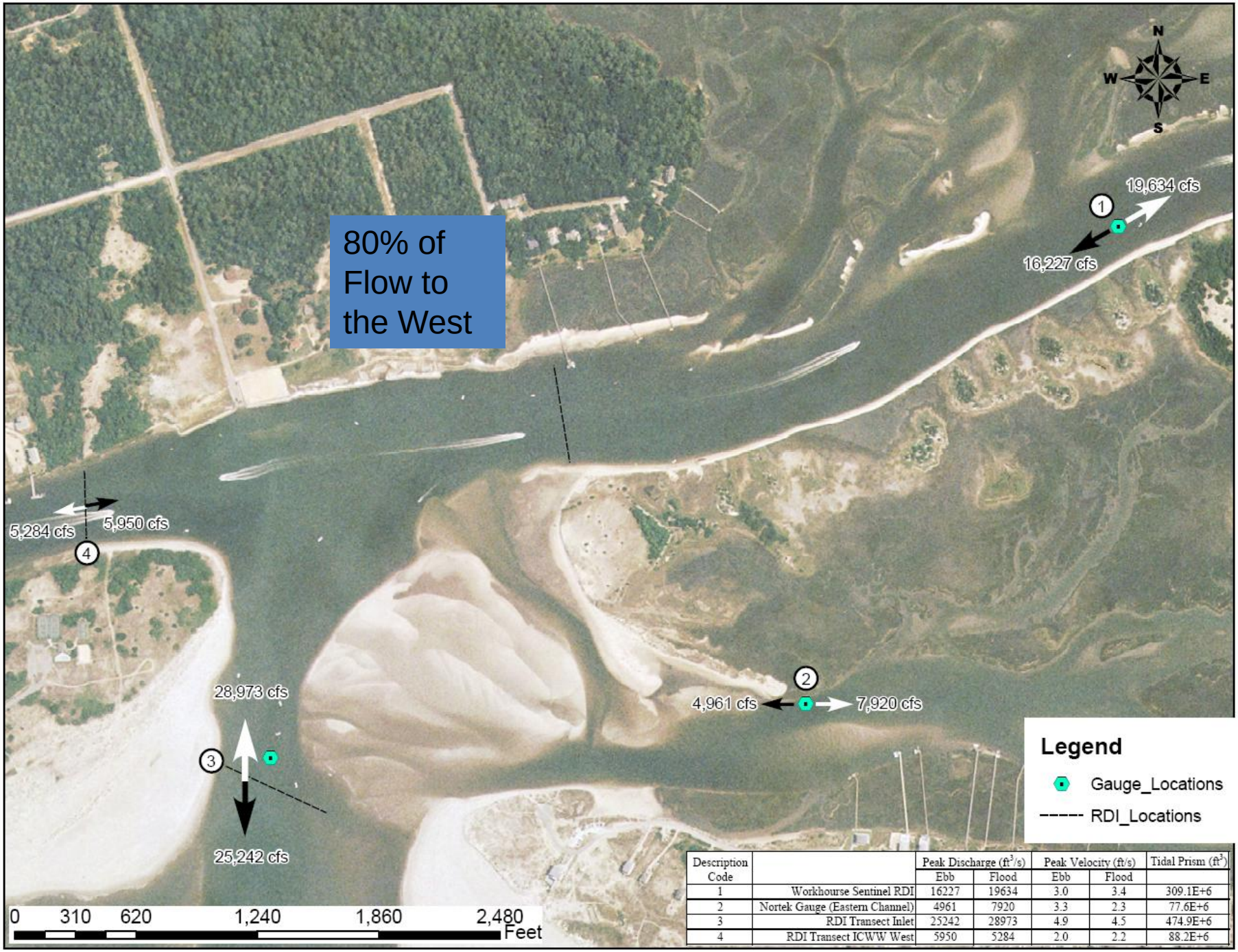

Depth (meters below NAVD88 = 0)
9.0
7.0
5.0
3.0
1.0
-1.0
-3.0

Calibration to CSE 2008 Data Collection

RDI TRANSECT LOCATIONS			
POINT	TRANSECT	NORTHING	EASTING
1	ICWW W1	63064.510	2230451.460
2	ICWW W2	62721.500	2230461.160
3	ICWW E1	63105.840	2232933.500
4	ICWW E2	63604.530	2232851.990
5	INLET 2	61553.480	2231175.470
6	INLET1	61316.240	2231688.950

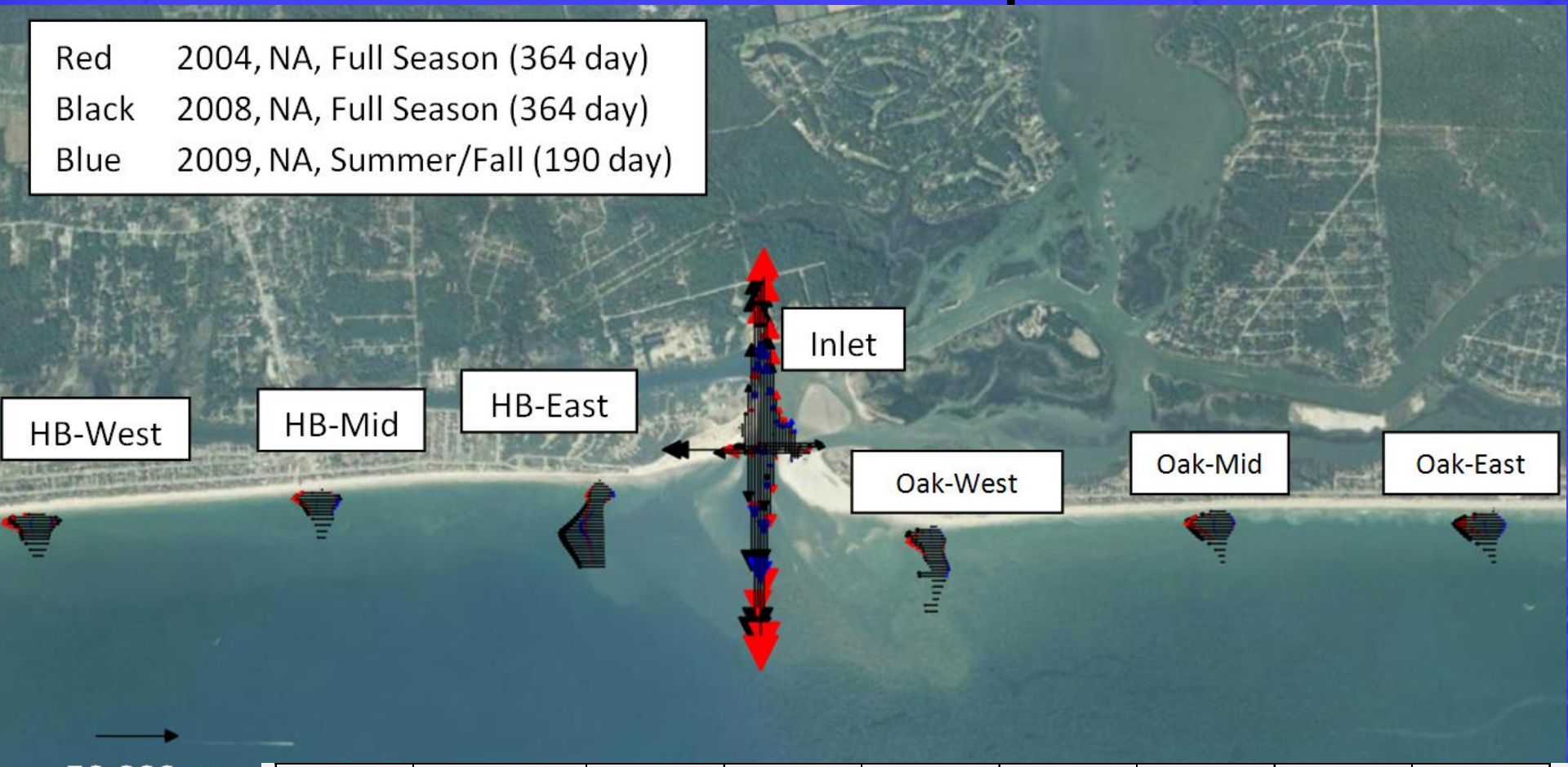
INSTRUMENT LOCATIONS			
POINT	INSTRUMENT	NORTHING	EASTING
7	XR A	72663.877	2235483.197
8	TG4A	66361.498	2236317.071
9	TG5A	65227.349	2238139.865
10	RDI A	64315.597	2235737.934
11	TG3A	63638.418	2244197.652
12	TG2A	61588.603	2242174.459
13	TG1A	61786.865	2238643.197
14	NCHN-A	61871.810	2234138.501
15	INLET A	61595.992	2231402.105
16	TG6A	62261.591	2225916.046
70	INLET A	59738.837	2246723.484





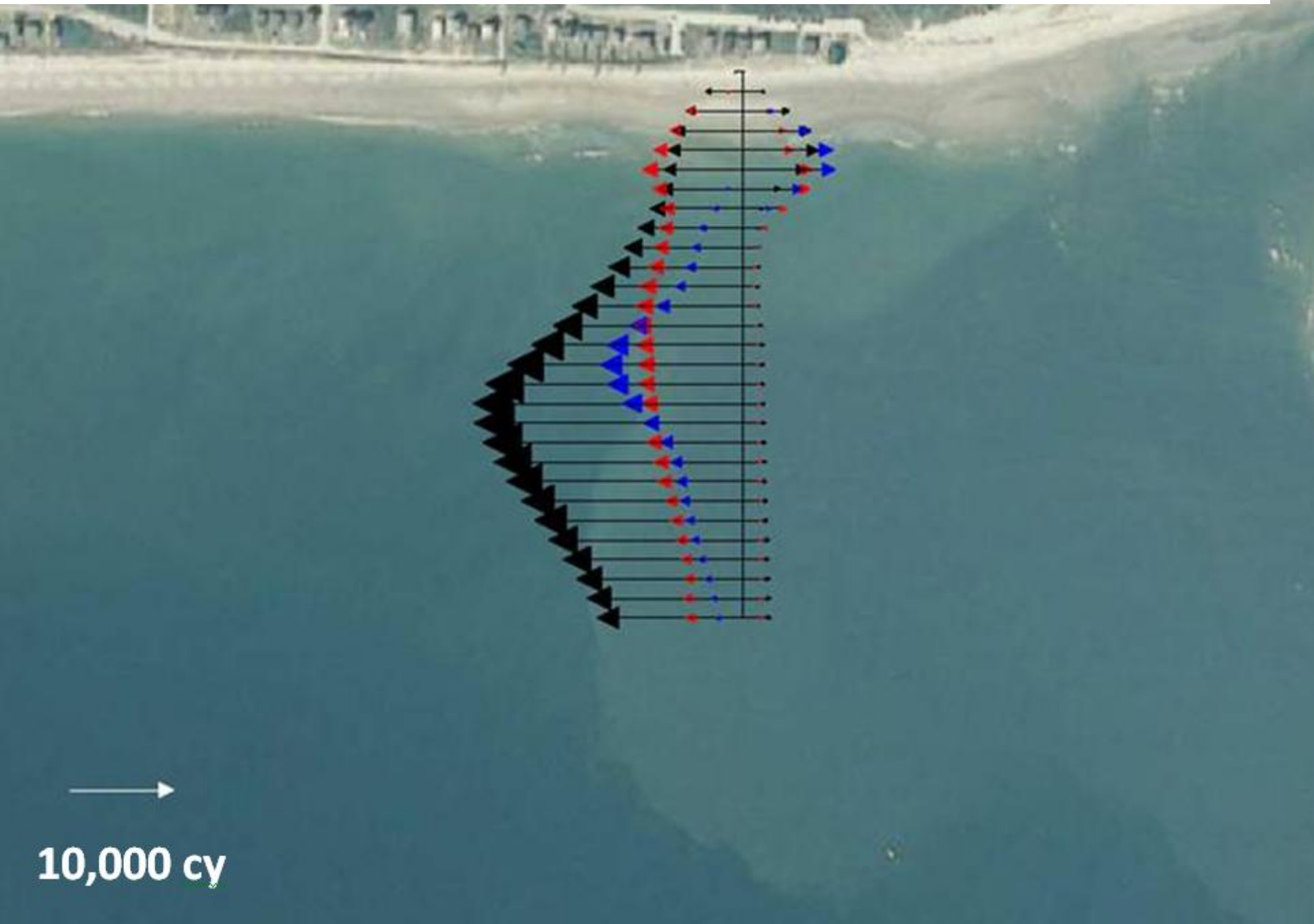
Description Code		Peak Discharge (ft^3/s)		Peak Velocity (ft/s)		Tidal Prism (ft^3)
		Ebb	Flood	Ebb	Flood	
1	Workhourse Sentinel RDI	16227	19634	3.0	3.4	309.1E+6
2	Nortek Gauge (Eastern Channel)	4961	7920	3.3	2.3	77.6E+6
3	RDI Transect Inlet	25242	28973	4.9	4.5	474.9E+6
4	RDI Transect ICWW West	5950	5284	2.0	2.2	88.2E+6

Sediment Transport



year	days	HB West	HB Mid	HB East	Inlet (Y)	Oak West	Oak Mid	Oak East
2004	364	-81,258	-49,420	-162,640	104,050	-61,675	-106,490	-97,938
2008	364	-70,708	-63,476	-370,420	31,593	-93,119	-154,810	-188,610
2009	Annualized 364	17,083	56,602	-235,776	103,834	105,901	5,608	-3,088

HB-East Transect for 2004, 2008 and 2009 runs. black=2008fullyear; red=2004fullyear; blue=2009 190day



The results of full season (~1 yr) simulations and analyses illustrate several key processes:

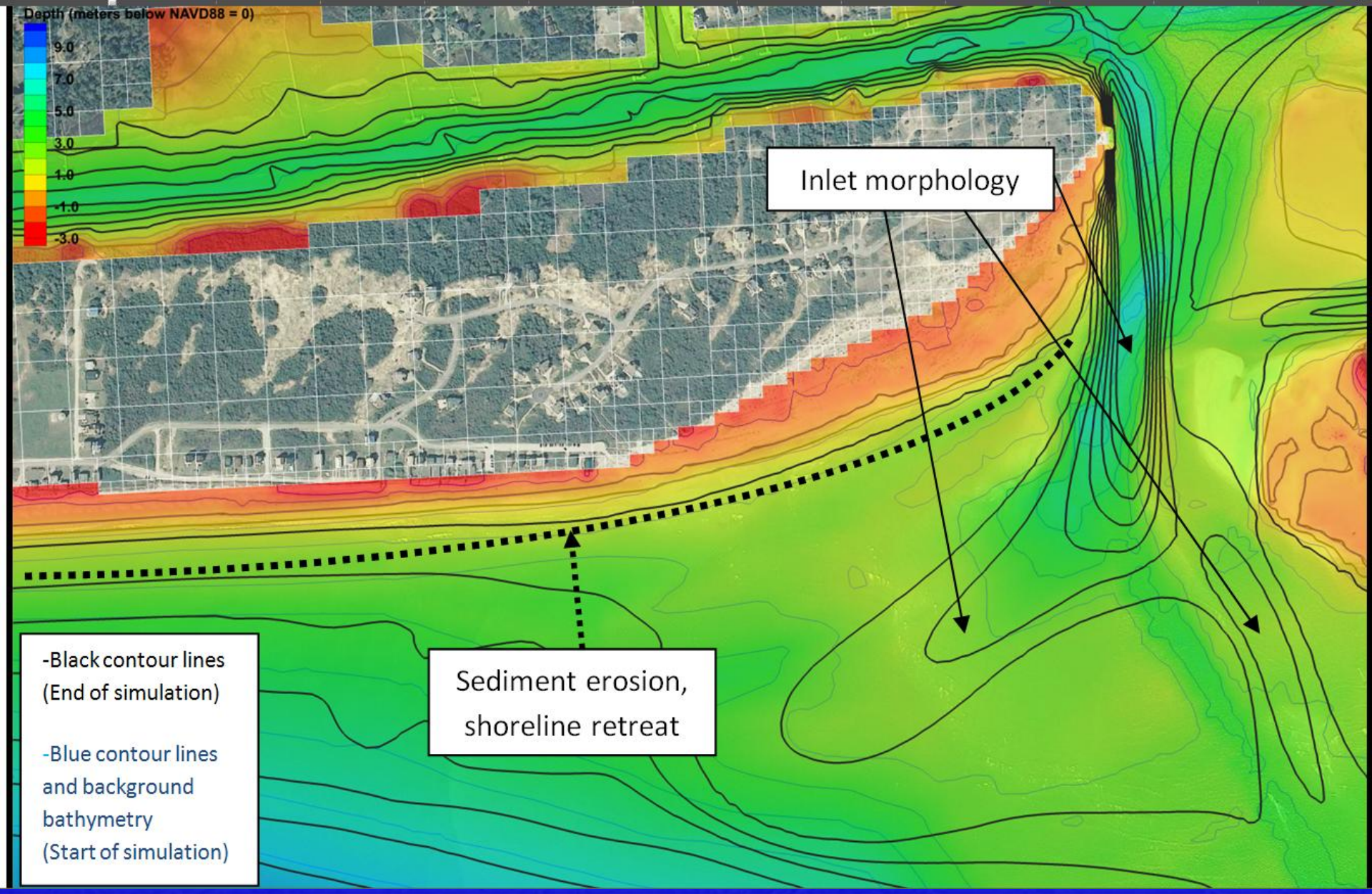
- transects bordering the inlet show sediment movement associated with inlet processes farther from shore,
- net long shore sediment transport to the West,
- increased erosion along Eastern Holden Beach relative to the surrounding areas, and
- decreased erosion along Western Oak Island relative to the surrounding areas.

year	days	**HB West**	**HB Mid**	**HB East**	**Inlet (Y)**	**Oak West**	**Oak Mid**	**Oak East**
2004	364	-81,258	-49,420	-162,640	104,050	-61,675	-106,490	-97,938
2008	364	-70,708	-63,476	-370,420	31,593	-93,119	-154,810	-188,610
2009	Annualized 364	17,083	56,602	-235,776	103,834	105,901	5,608	-3,088

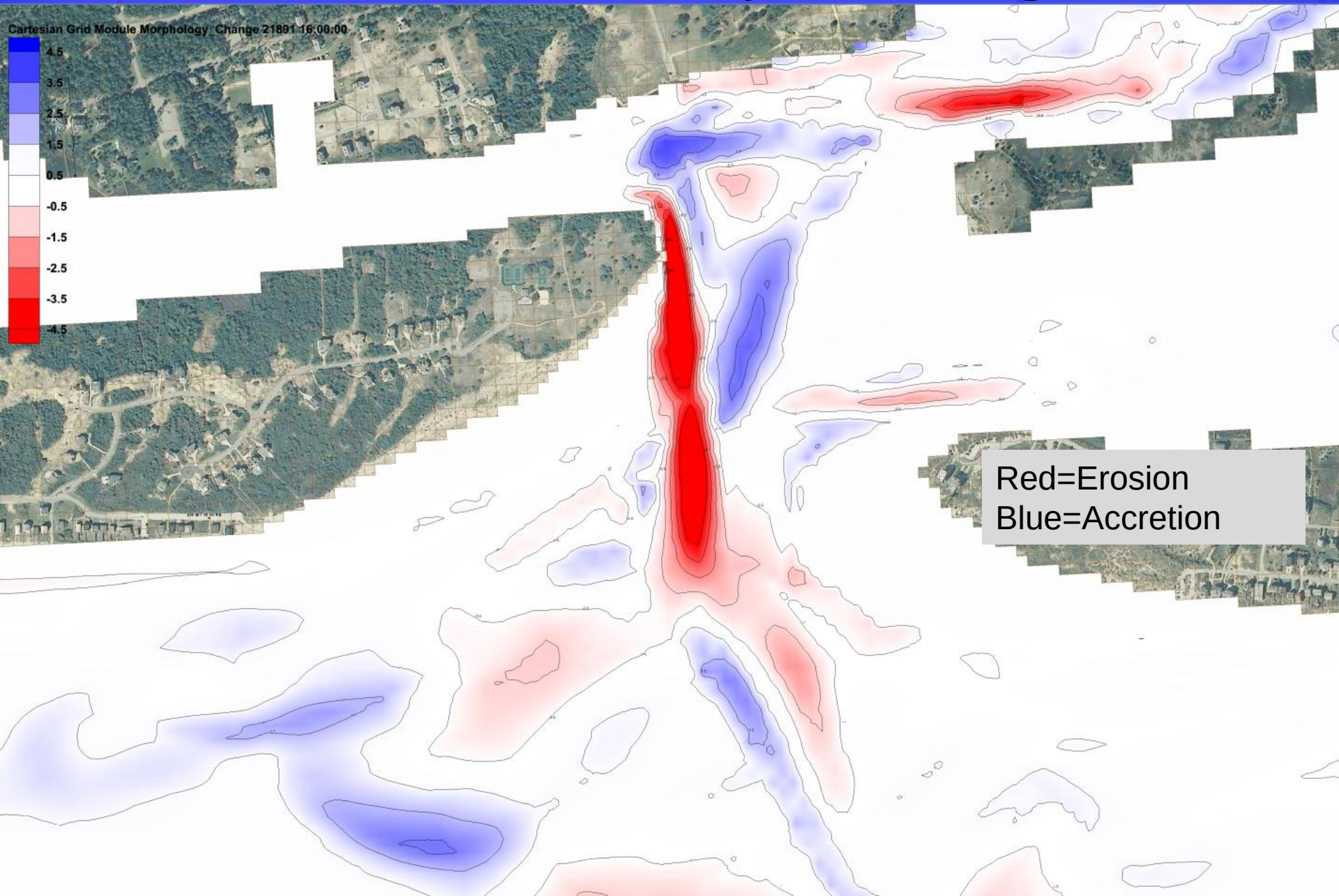
CMS ALTERNATIVES MODELING

1. Baseline “no action” case
2. “Short” groin and 60,000 cy nourishment
3. Long groin and 90,000 cy nourishment
4. 60,000 cy nourishment
5. 90,000 cy nourishment
6. “short” groin only case
7. “long” groin only case
8. 1,310,000 cy Central Reach nourishment
9. Outer channel re-location
10. “Short” groin, 60,000 cy nourishment, and outer channel relocation

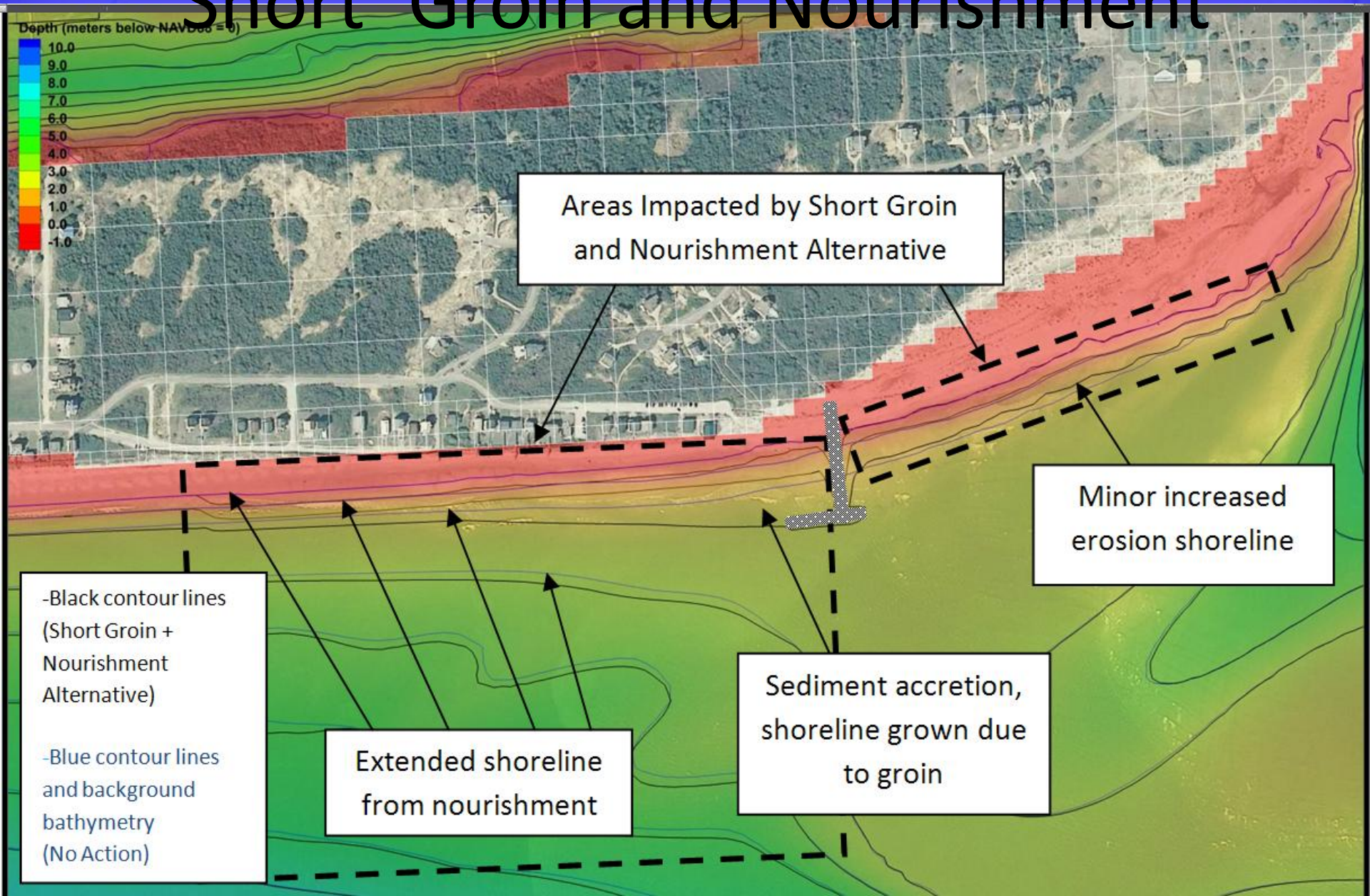
Base Case


Depth (meters below NAVD88 = 0)
9.0
7.0
5.0
3.0
1.0
-1.0
-3.0
Inlet morphology
Sediment erosion, shoreline retreat
-Black contour lines (End of simulation)
-Blue contour lines and background bathymetry (Start of simulation)

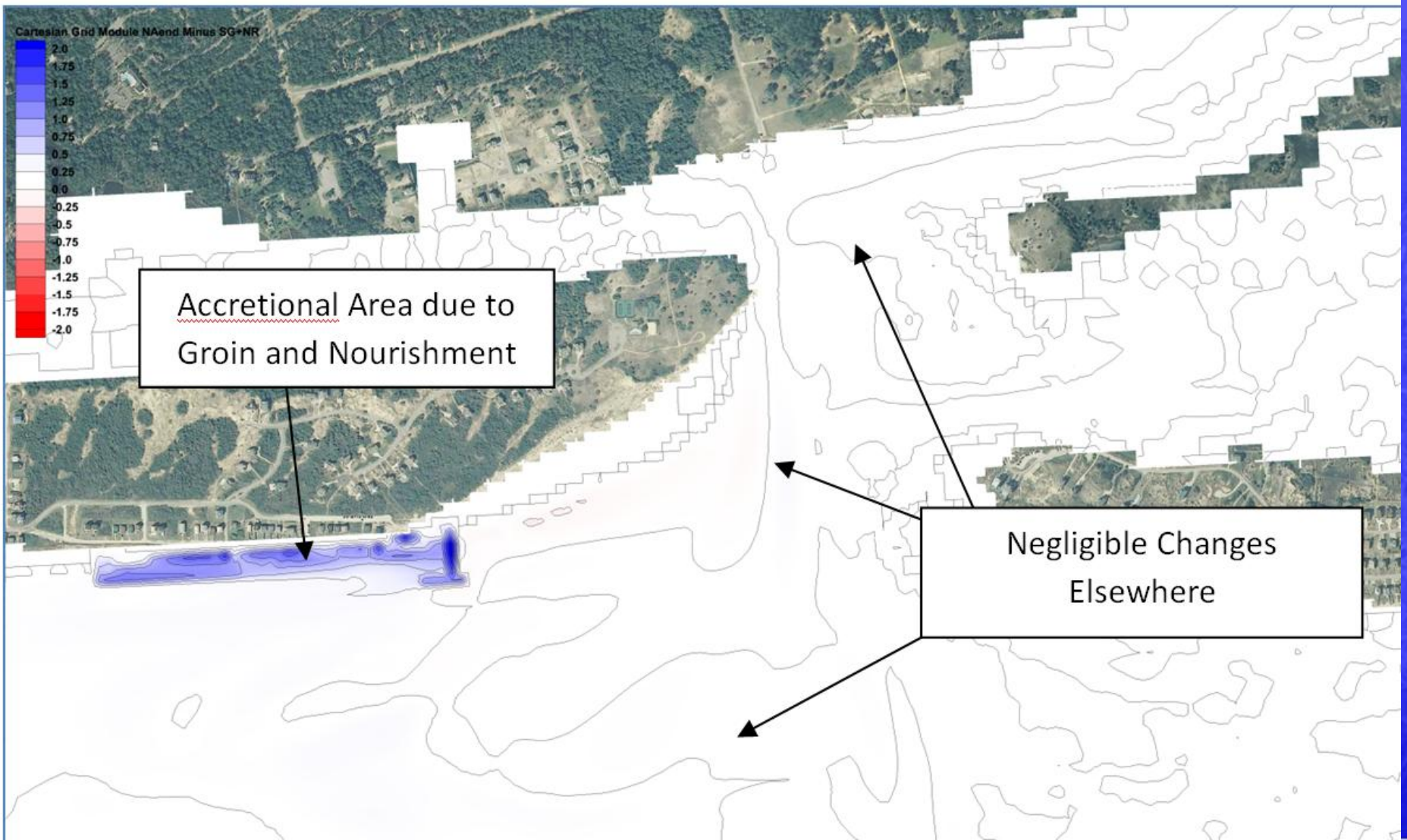
Base Case Morph Change



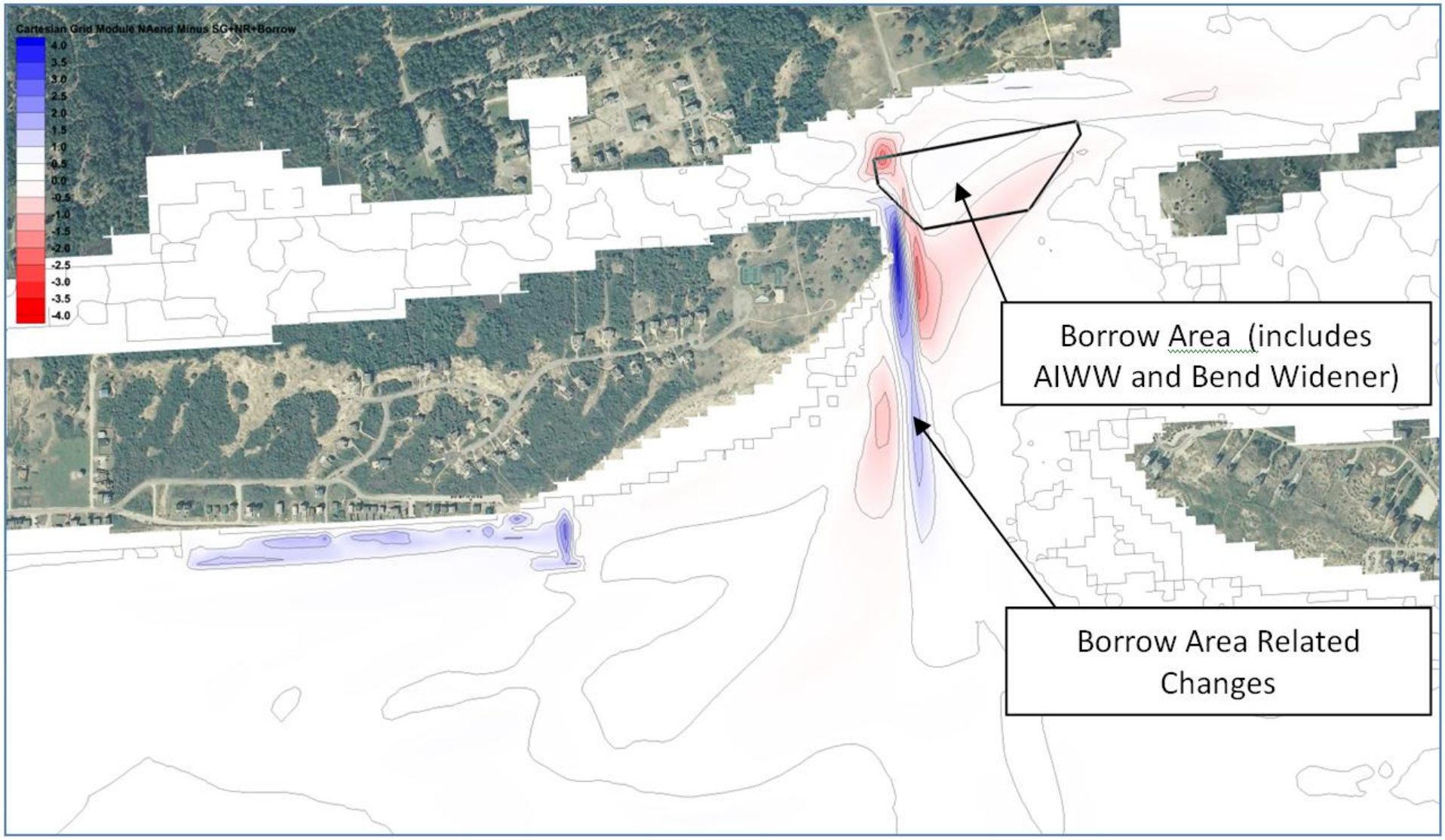
‘Short’ Groin and Nourishment



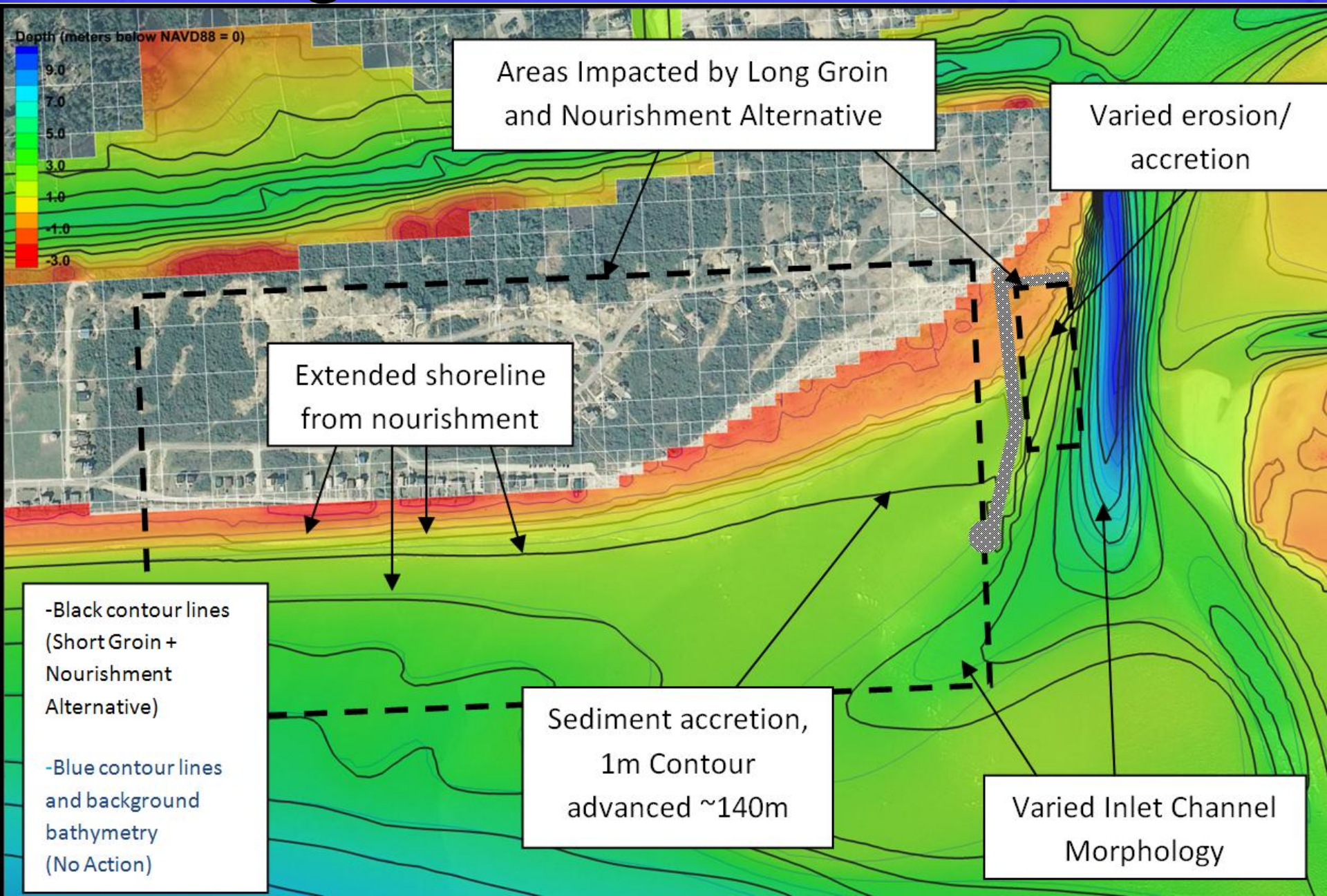
Morphology Change



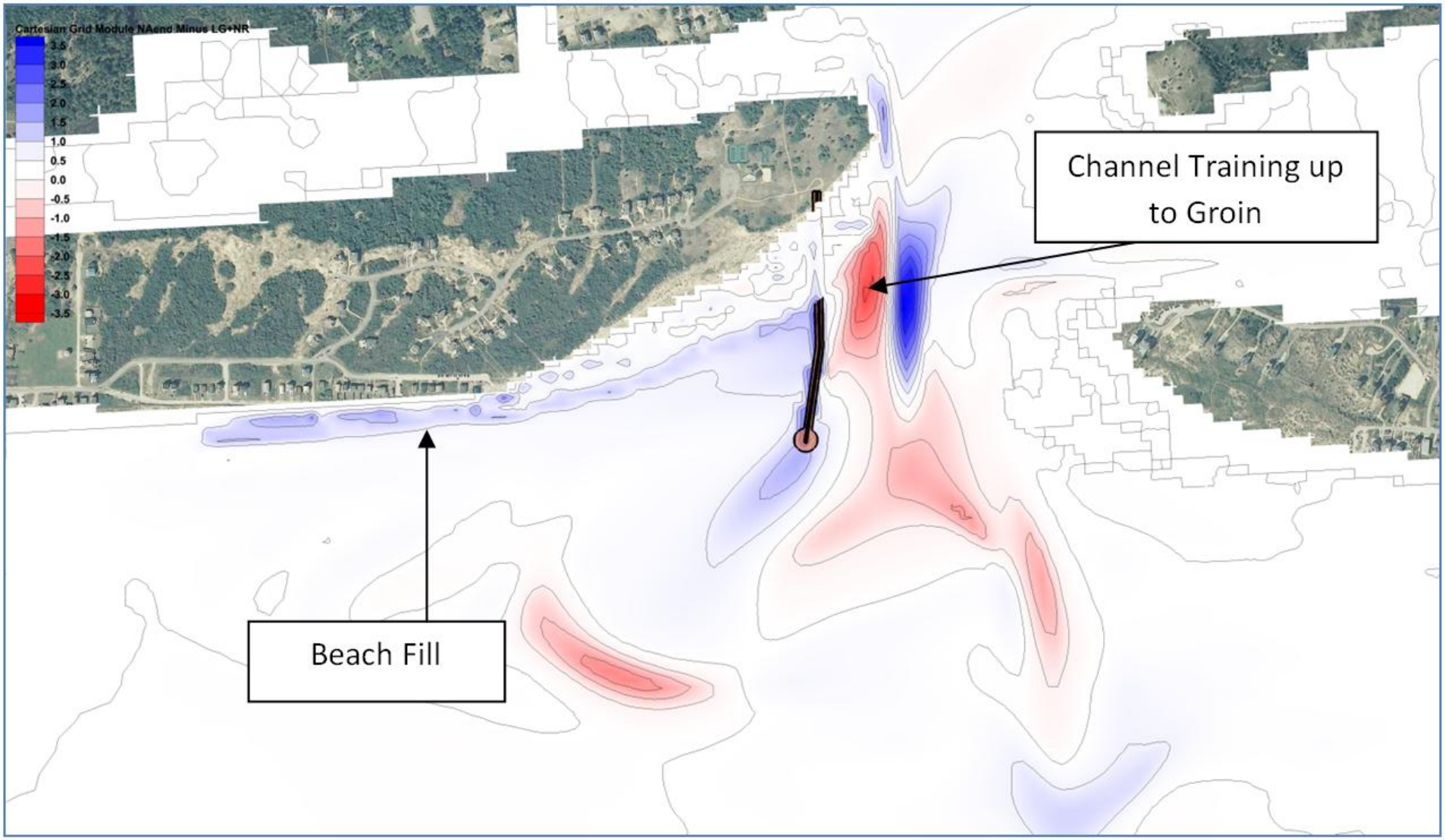
With AIWW Borrow Area



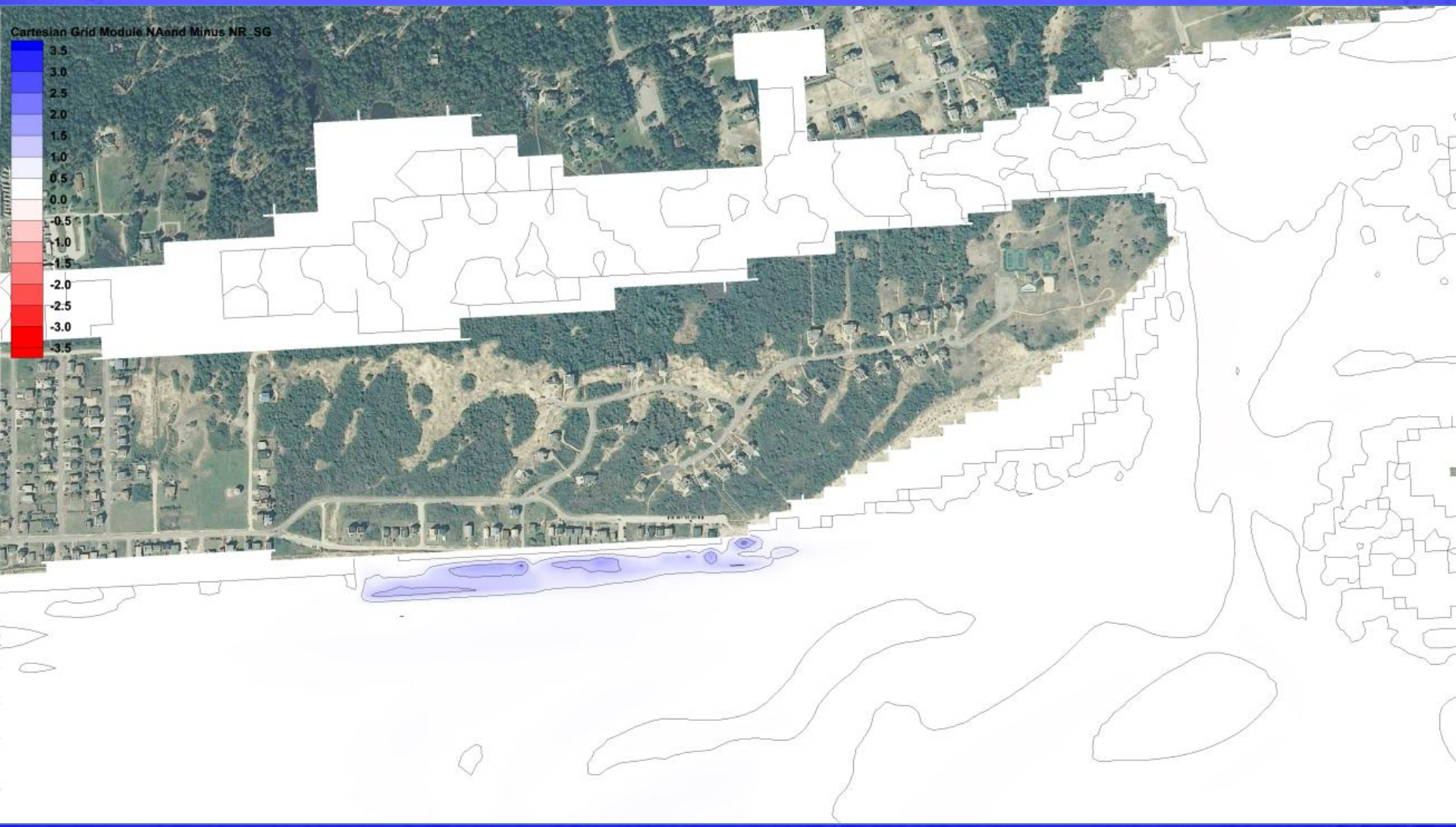
‘Long’ Groin and Nourishment



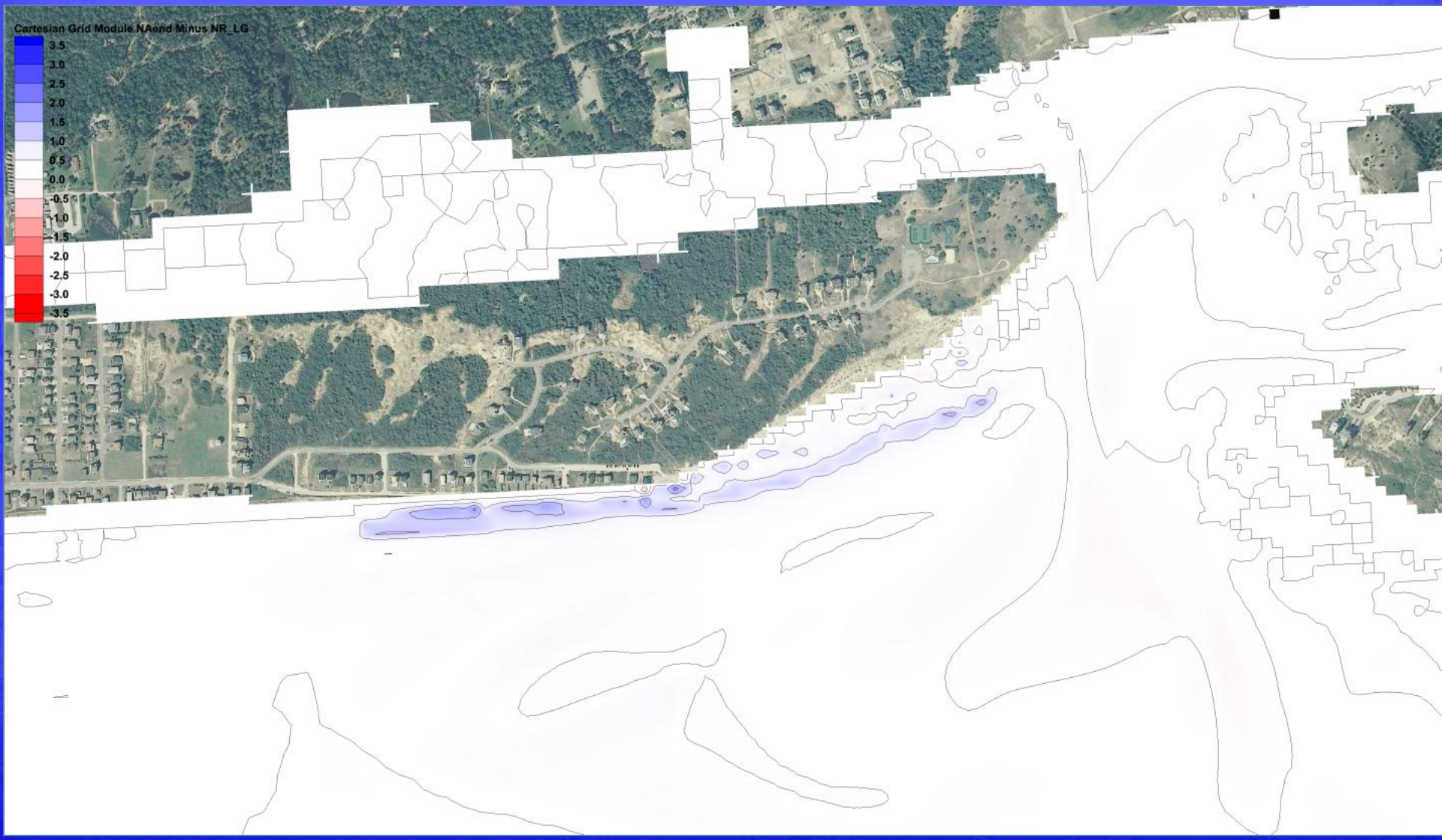
Long Groin & Nourishment



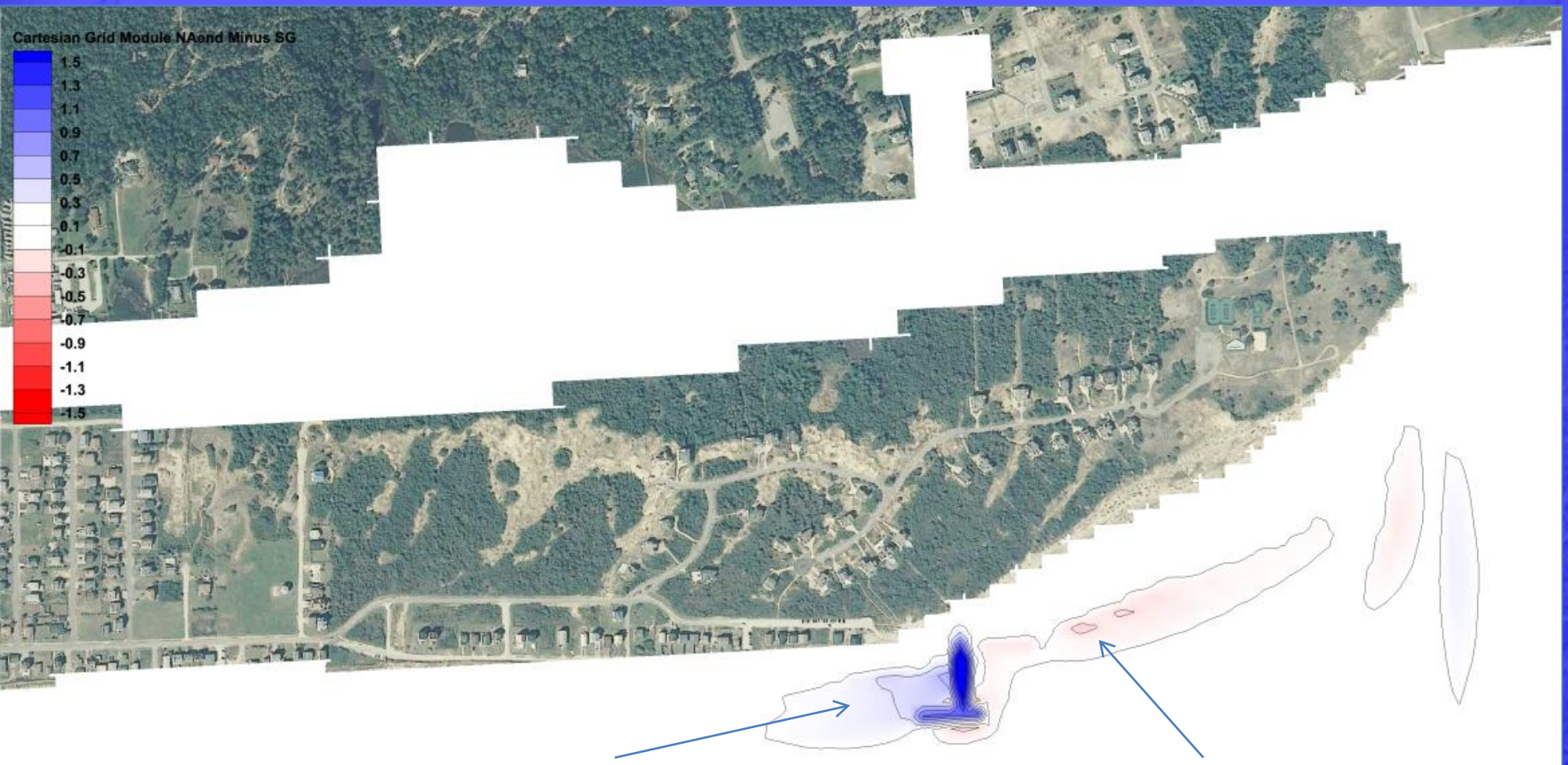
60,000 cy Nourishment



90,000 cy Nourishment



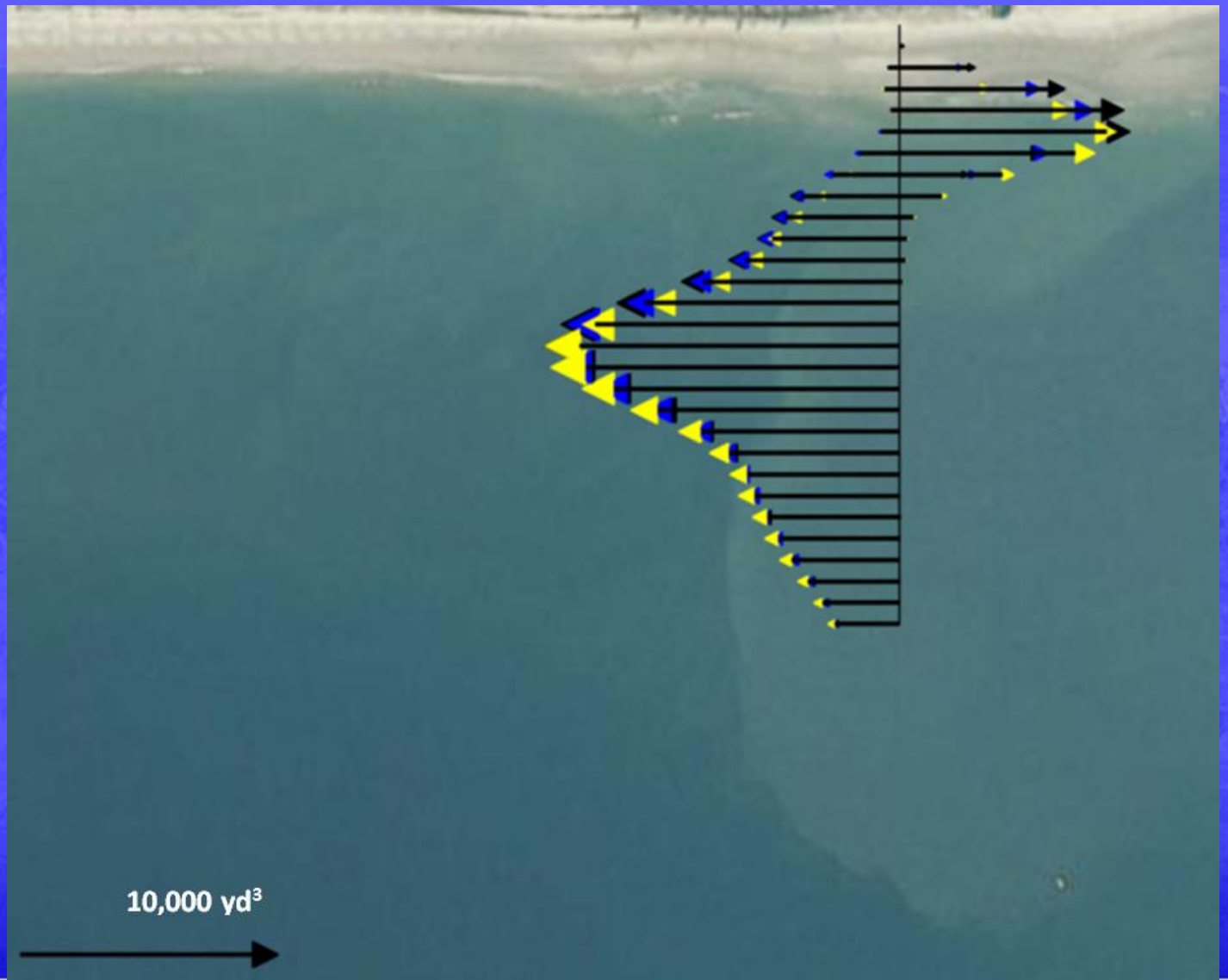
‘Short’ Groin Only (No Nourishment)



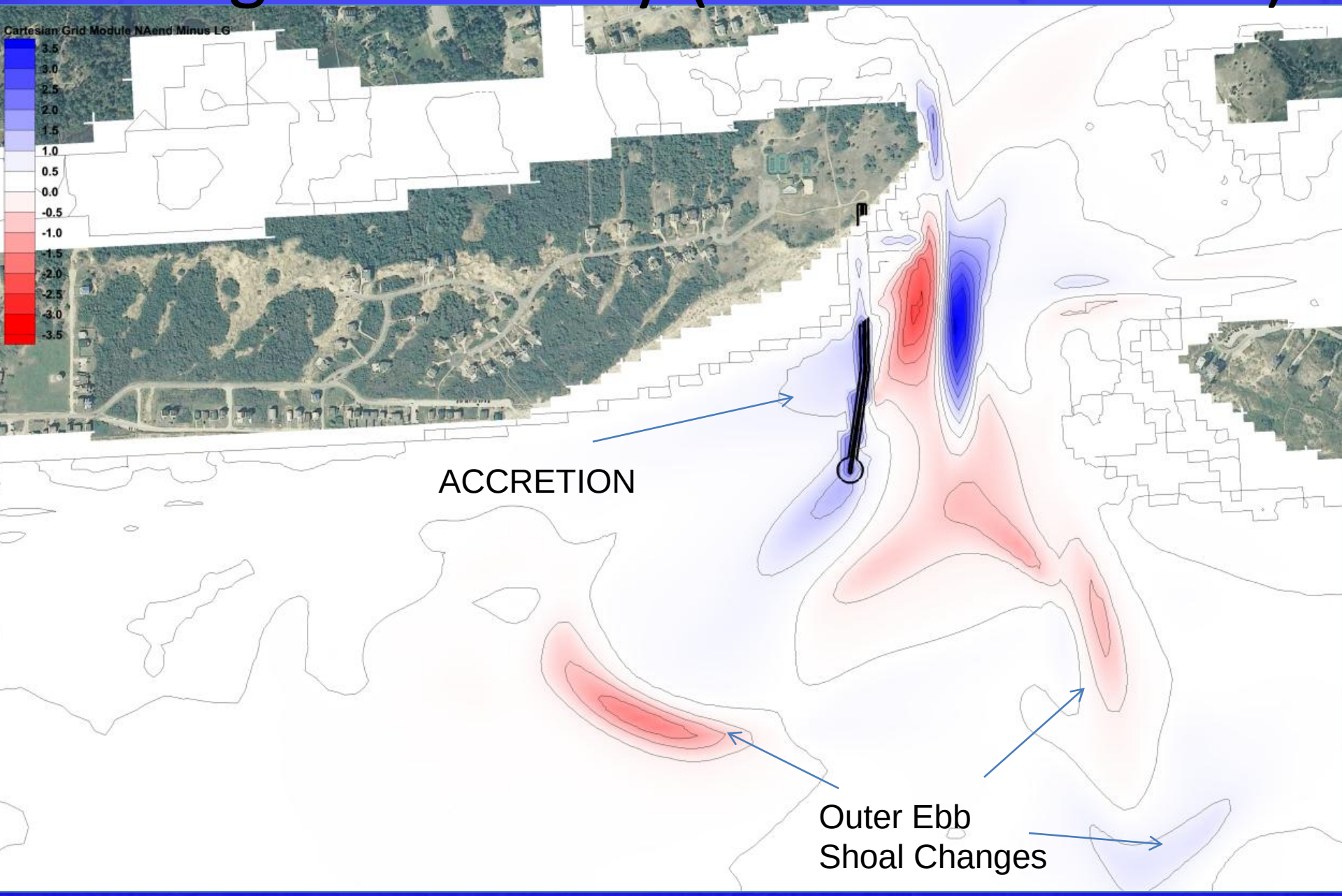
ACCRETION

EROSION

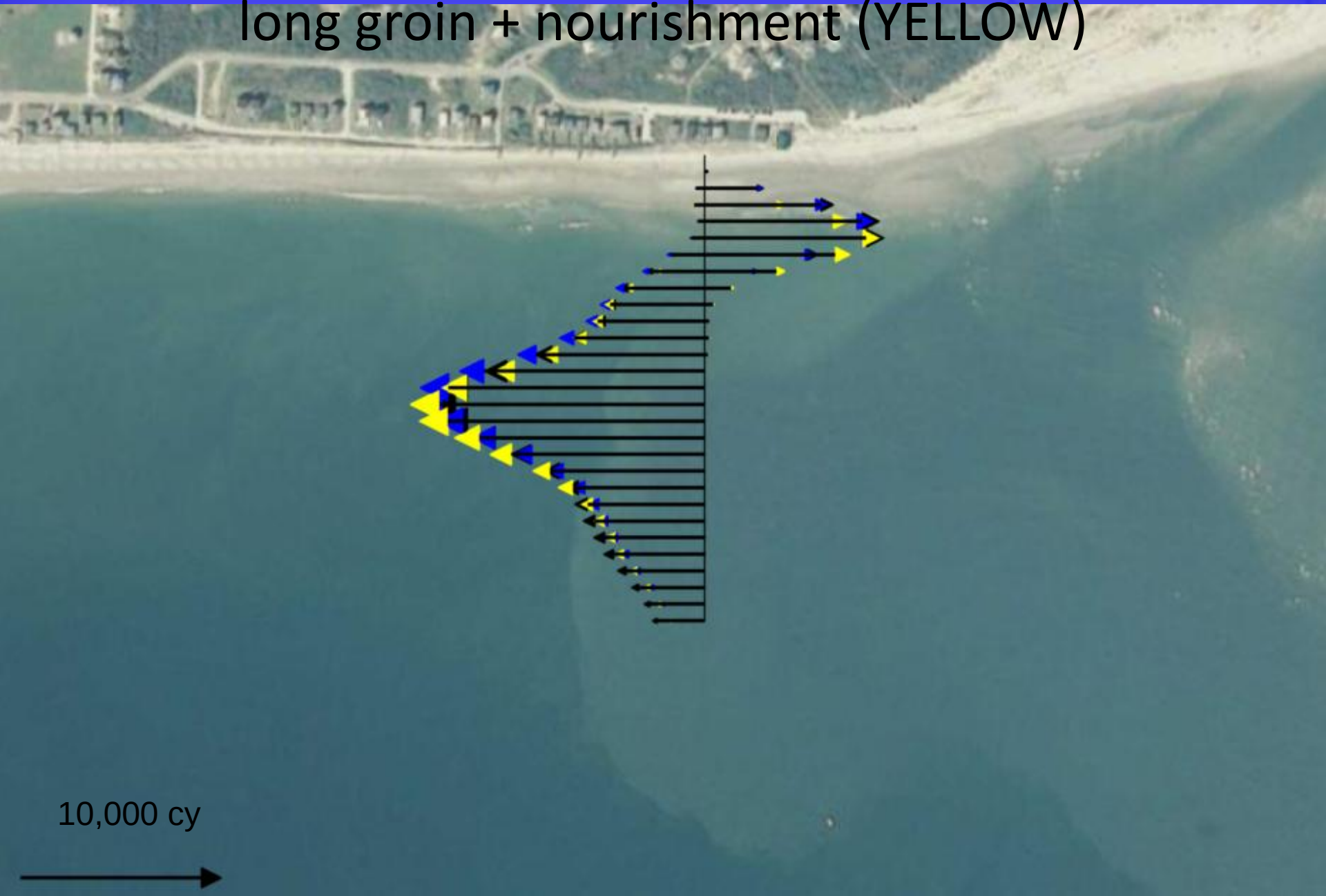
no action (BLACK), short groin only (BLUE), short groin and nourishment (YELLOW)



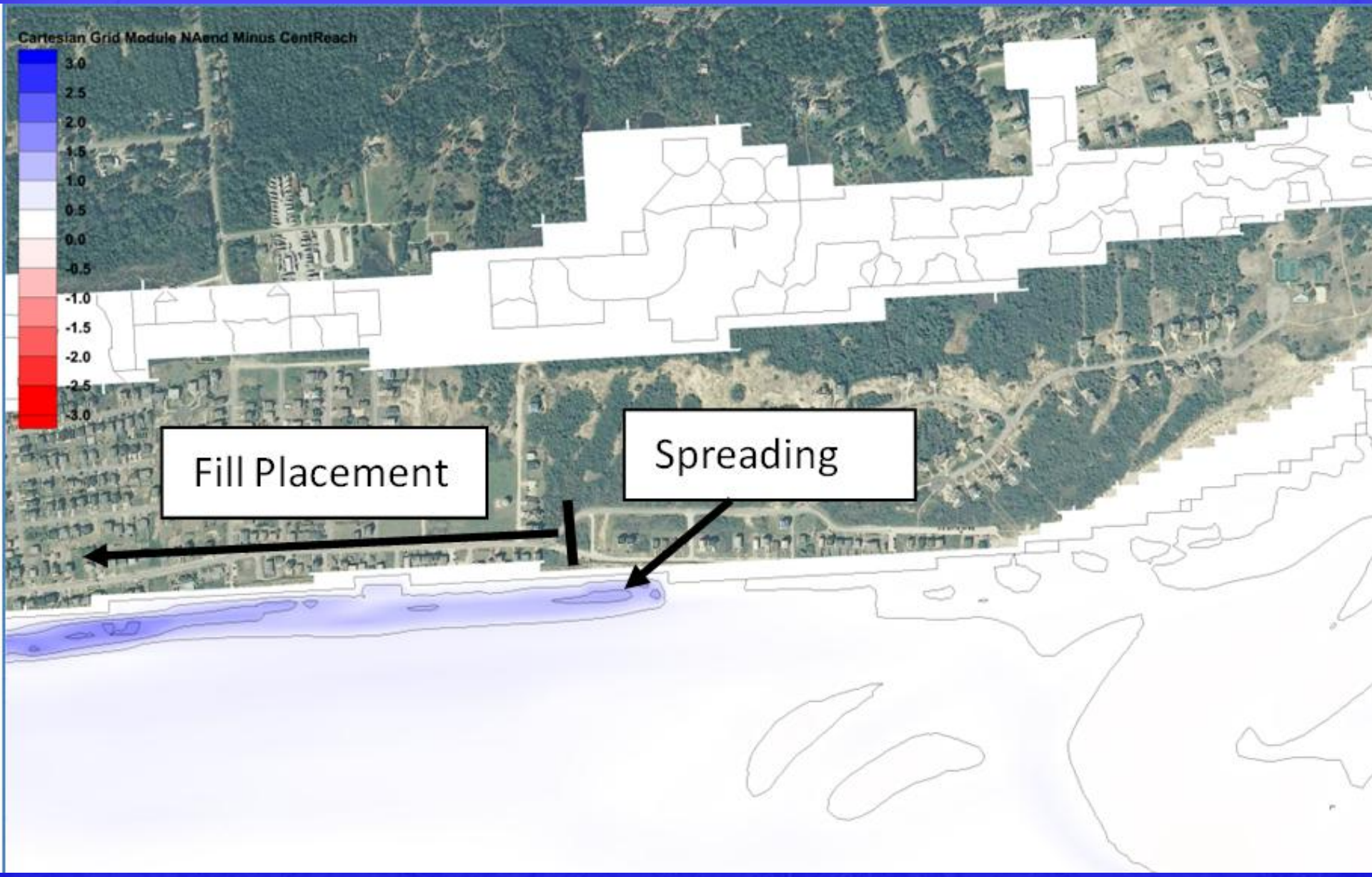
‘Long’ Groin Only (No Nourishment)



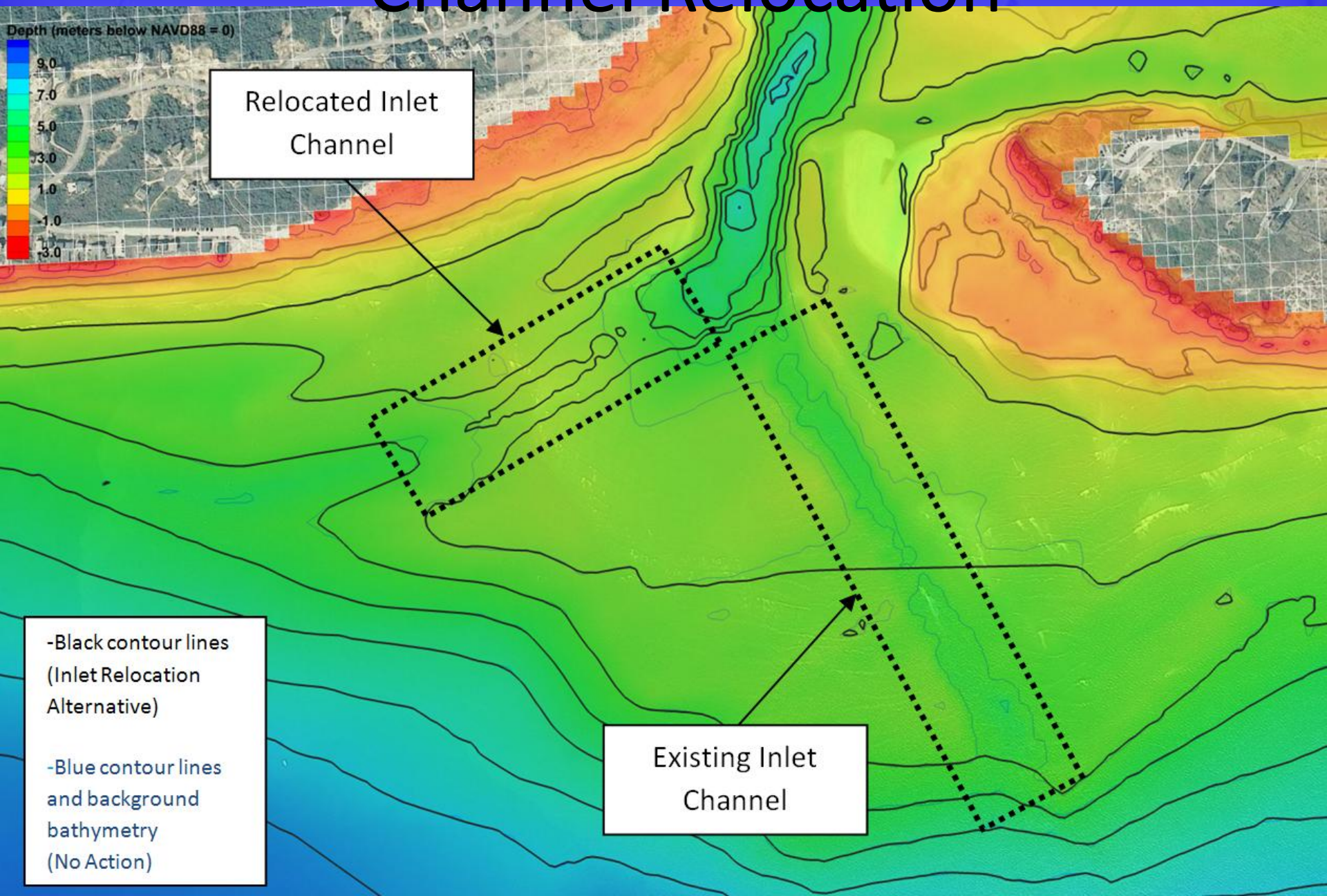
no action (BLACK), long groin only (BLUE), and long groin + nourishment (YELLOW)

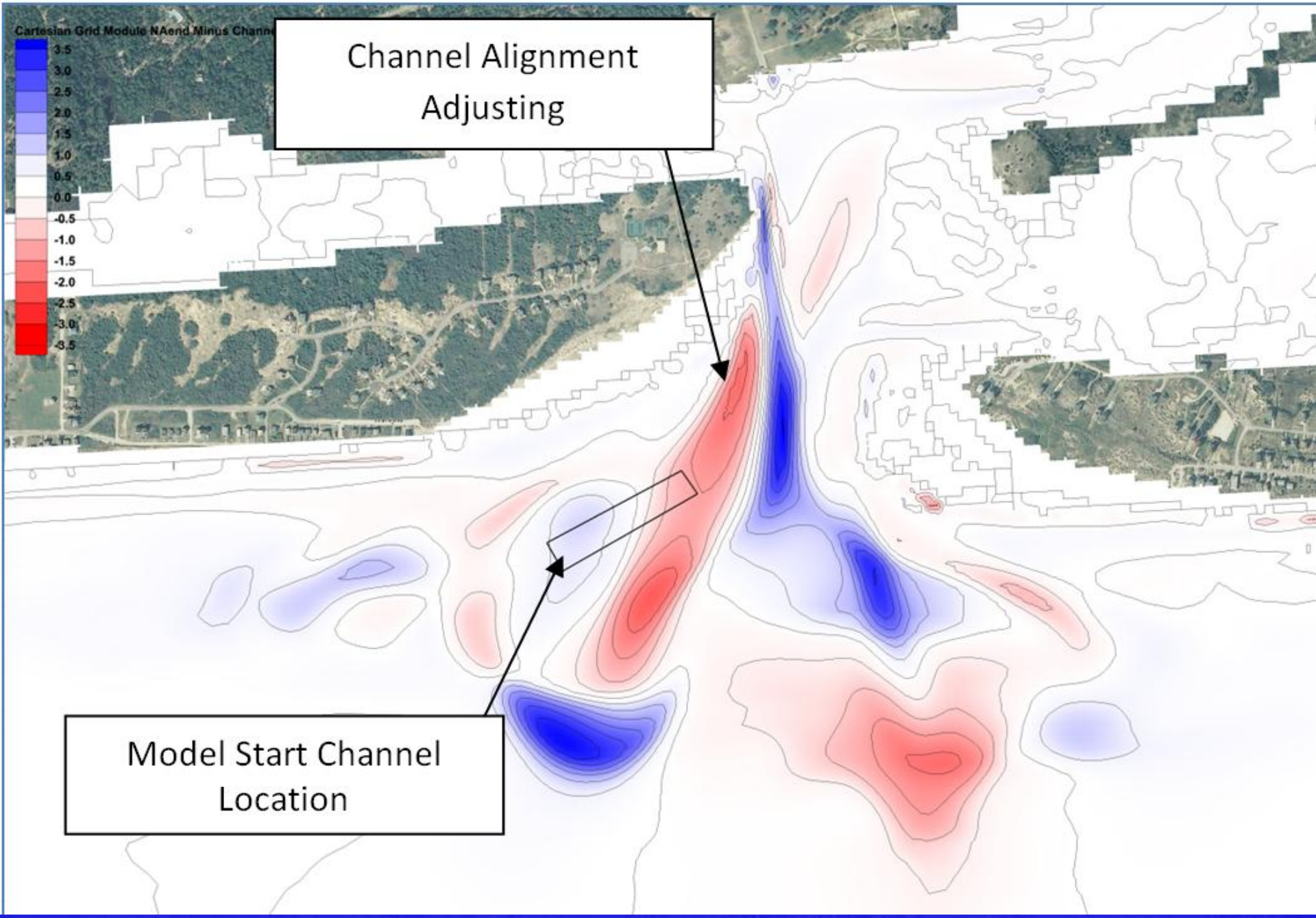


Central Reach Nourishment

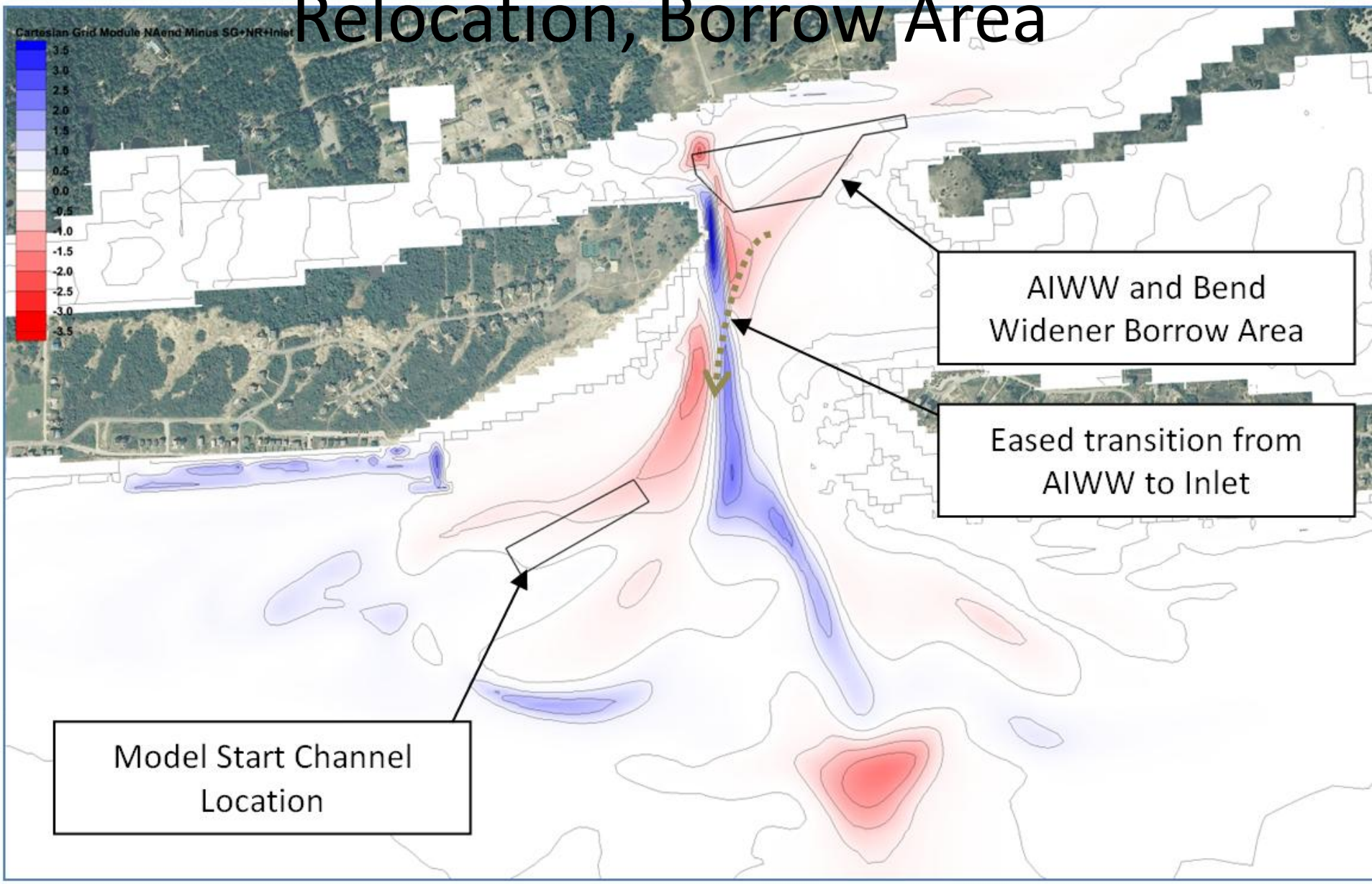


Channel Relocation

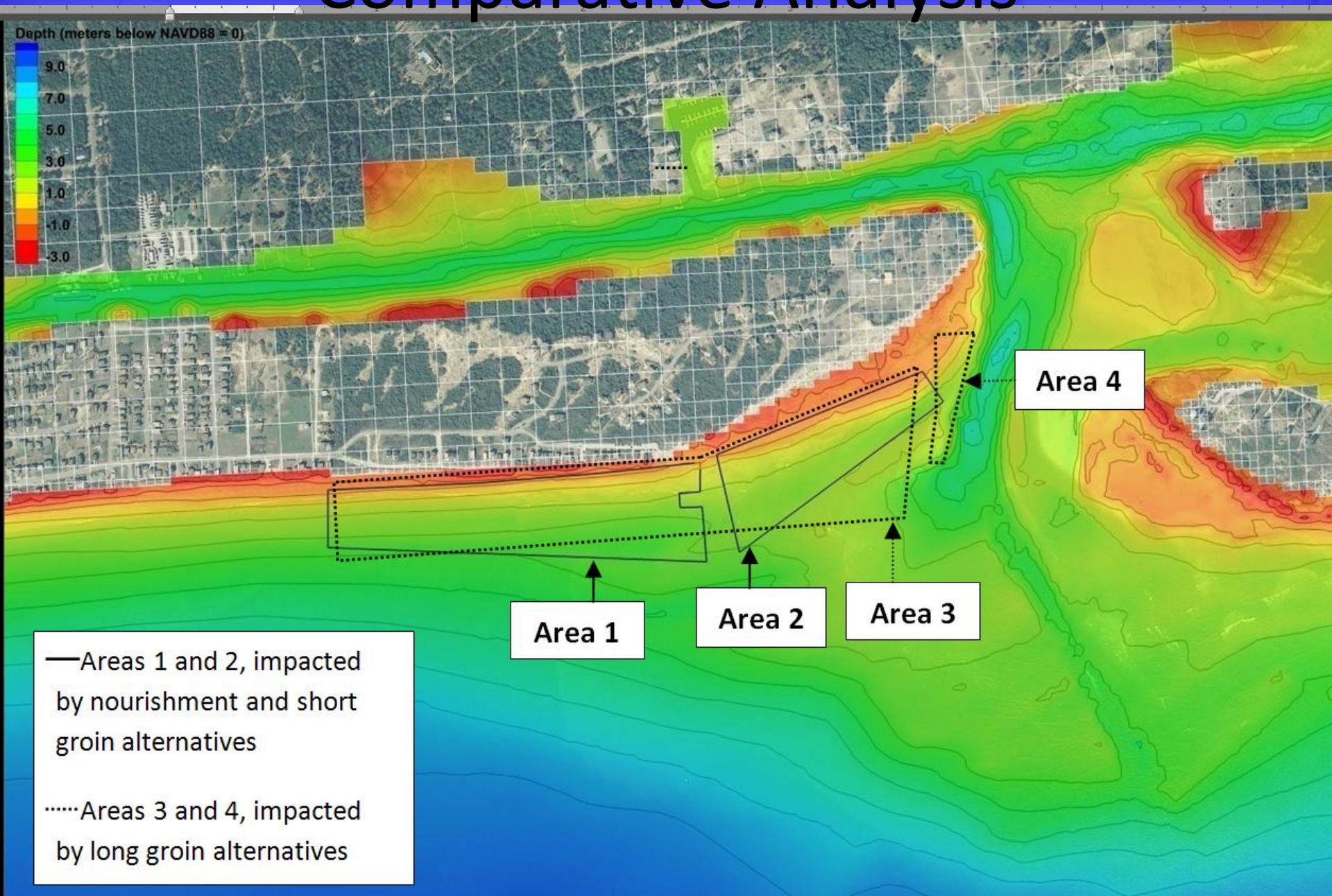



Cartesian Grid Module NAend Minus Channe
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
Channel Alignment Adjusting
Model Start Channel Location

Nourishment, Groin, Channel Relocation, Borrow Area



Comparative Analysis

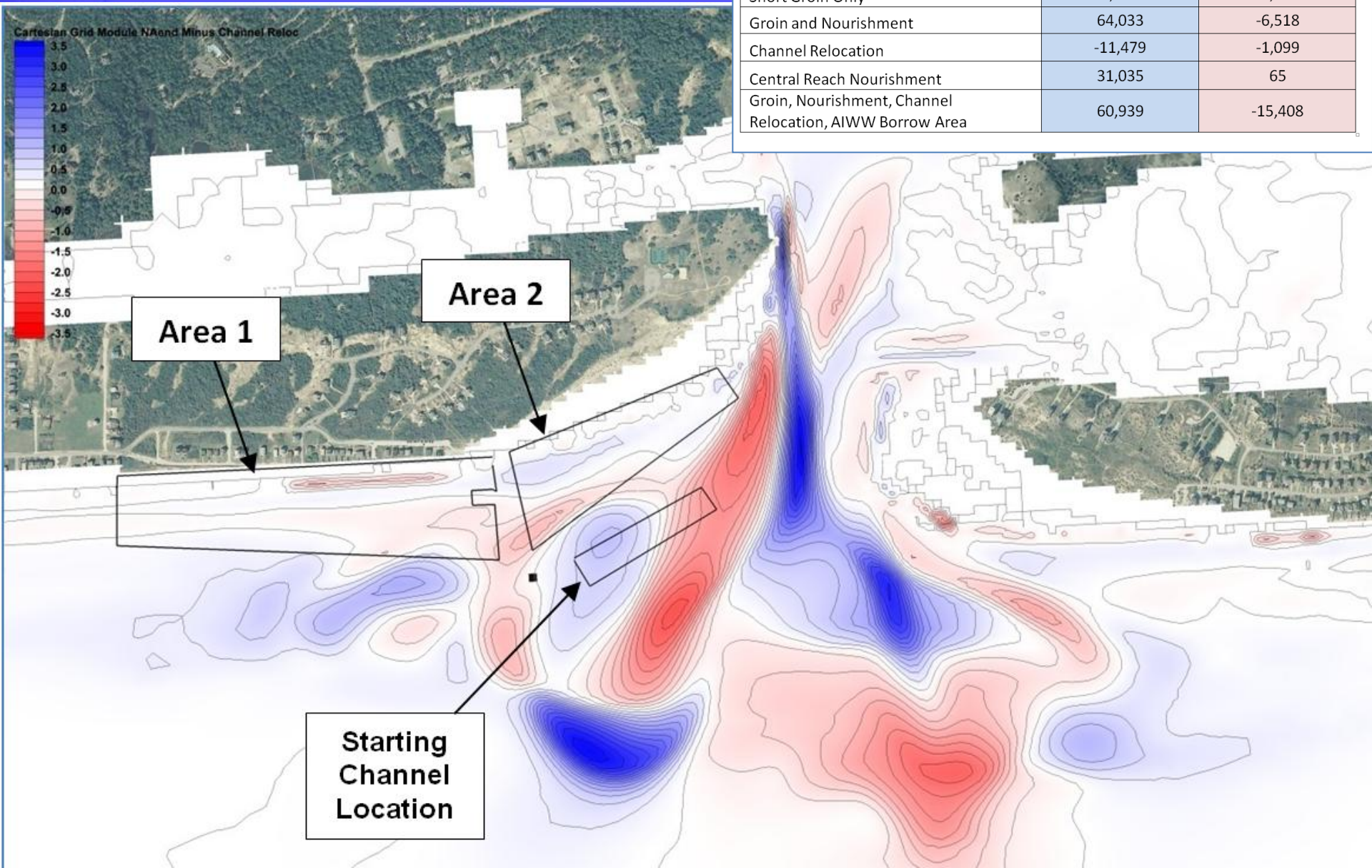


‘Short’ Groin Related Areas

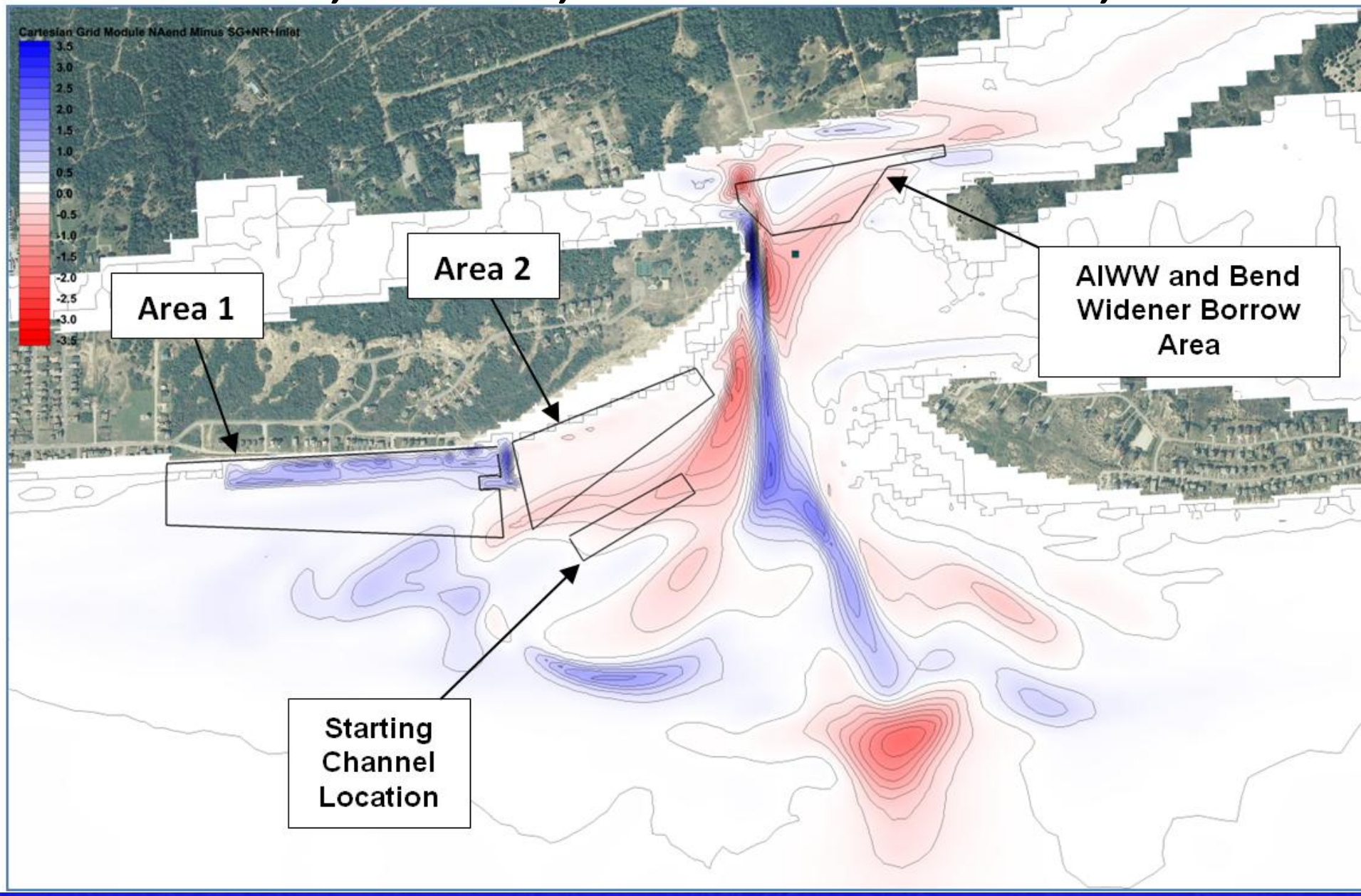
	AREA 1	AREA 2
Alternative	**Volume Change (cy)**	**Volume Change (cy)**
60,000 cy Nourishment Only	55,029	1,451
Short Groin Only	9,004	-8,032
Groin and Nourishment	64,033	-6,518
Channel Relocation	-11,479	-1,099
Central Reach Nourishment	31,035	65
Groin, Nourishment, Channel Relocation, AIWW Borrow Area	60,939	-15,408

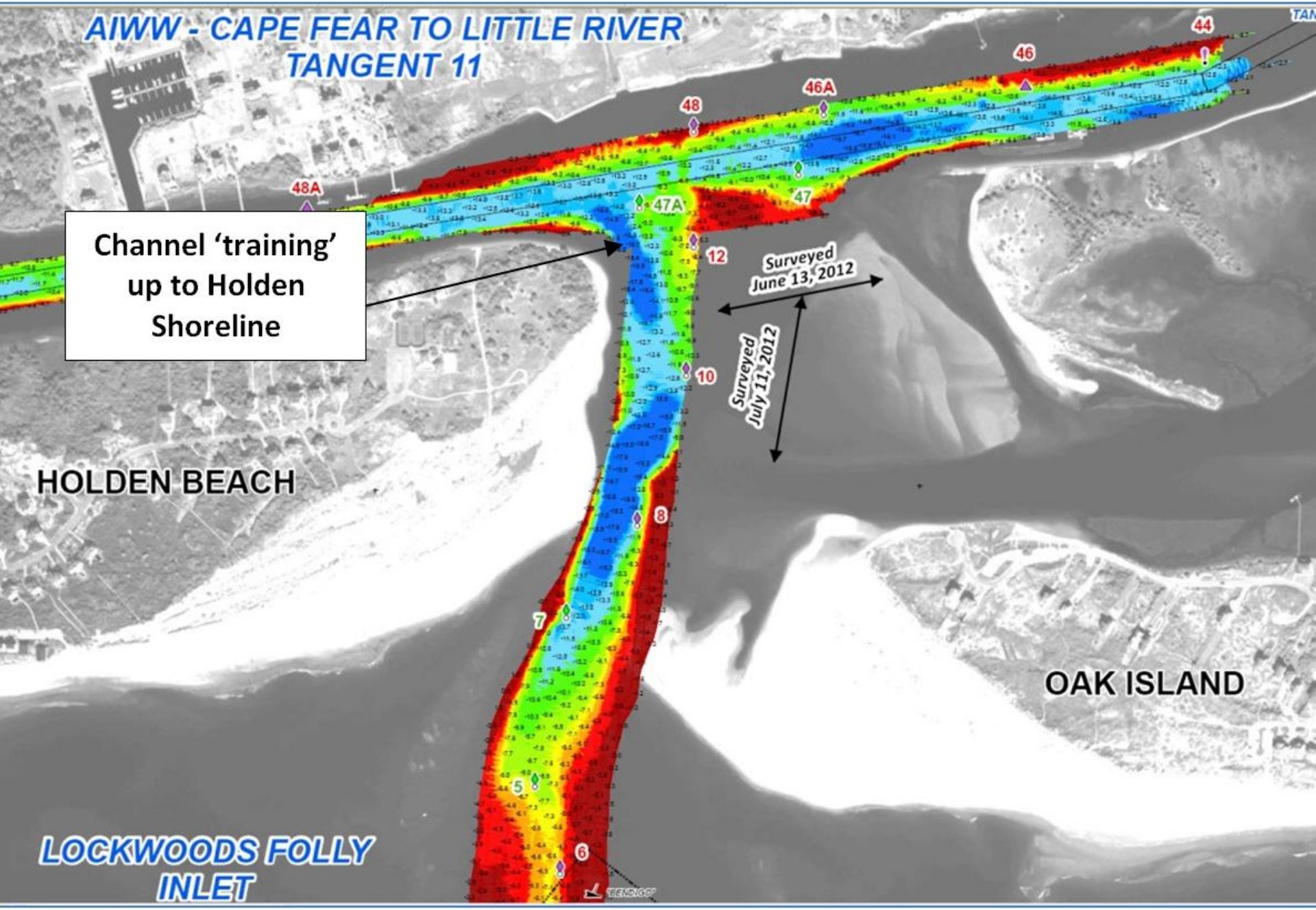
Channel Relocation (w Areas 1&2)

	AREA 1	AREA 2
Alternative	**Volume Change (cy)**	**Volume Change (cy)**
60,000 cy Nourishment Only	55,029	1,451
Short Groin Only	9,004	-8,032
Groin and Nourishment	64,033	-6,518
Channel Relocation	-11,479	-1,099
Central Reach Nourishment	31,035	65
Groin, Nourishment, Channel Relocation, AIWW Borrow Area	60,939	-15,408



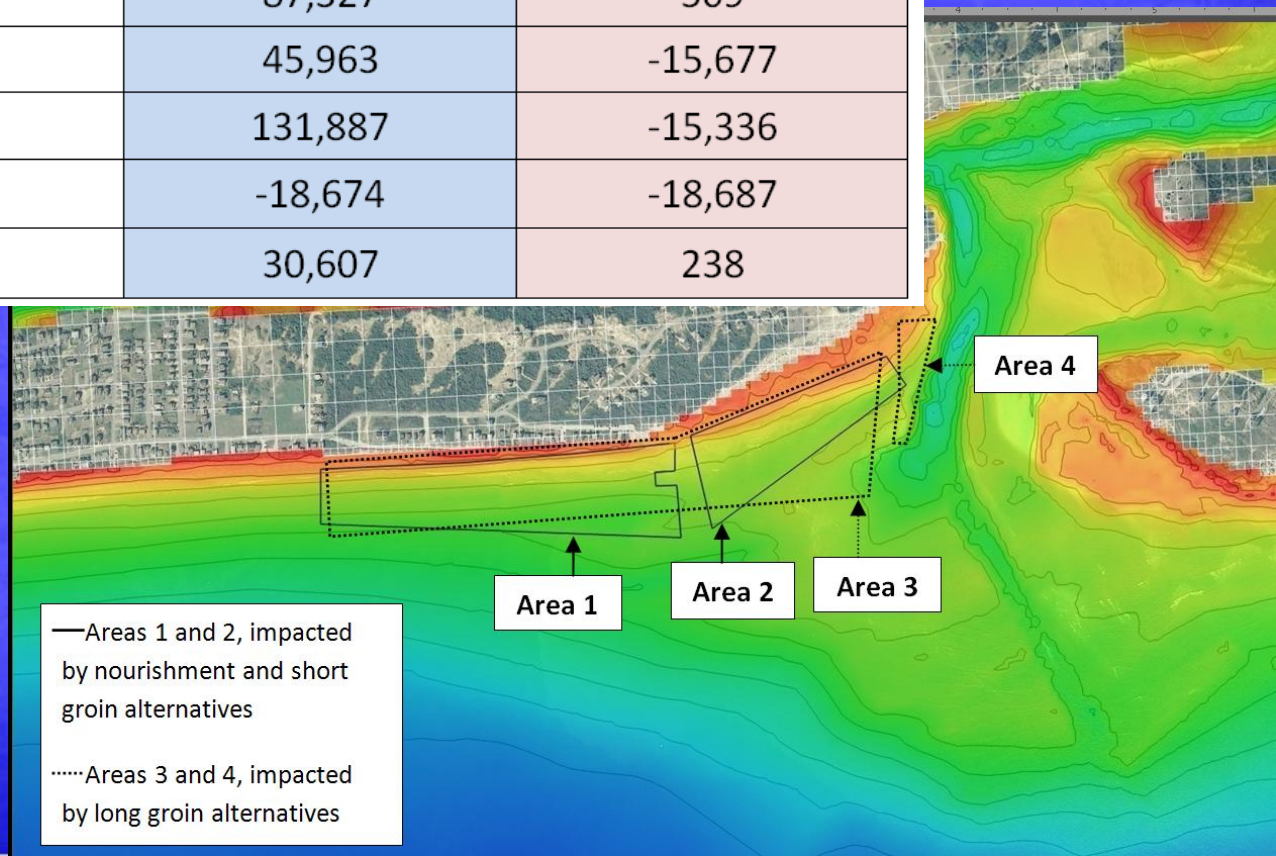
Nour., Groin, Channel Reloc., BA

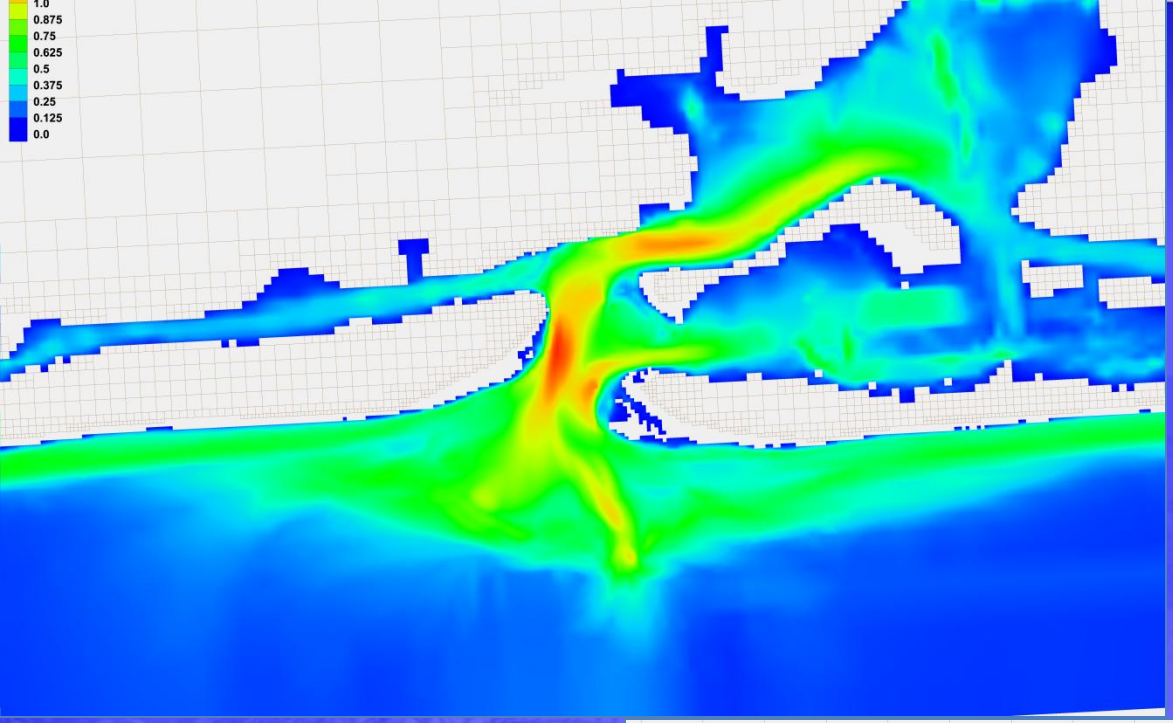



AIWW - CAPE FEAR TO LITTLE RIVER
TANGENT 11
Channel 'training' up to Holden Shoreline
HOLDEN BEACH
OAK ISLAND
LOCKWOODS FOLLY INLET
Surveyed June 13, 2012
Surveyed July 11, 2012
44
46
46A
48
48A
47A
47
12
10
8
7
5
6

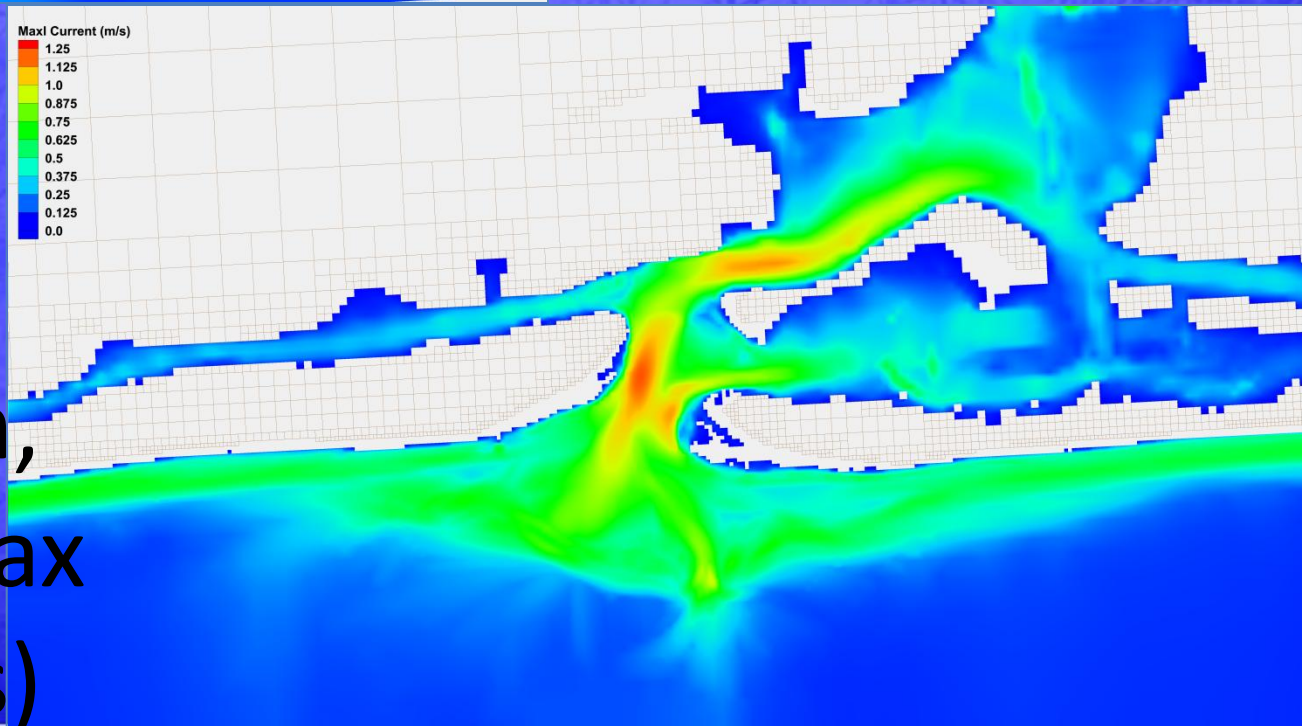
‘Long’ Groin Related Areas

	AREA 3	AREA 4
Alternative	**Volume Change (cy)**	**Volume Change (cy)**
90,000 cy Nourishment	87,327	509
Long Groin Only	45,963	-15,677
Groin and Nourishment	131,887	-15,336
Channel Relocation	-18,674	-18,687
Central Reach Nourishment	30,607	238

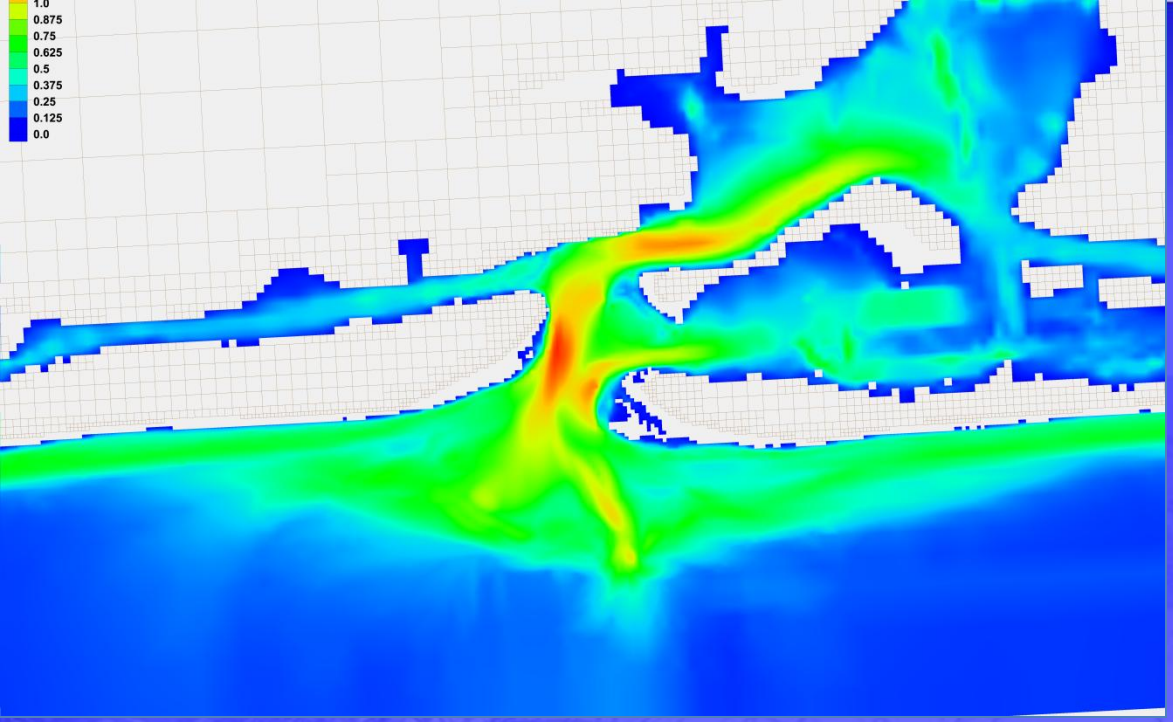




No Action - Max Current (m/s)

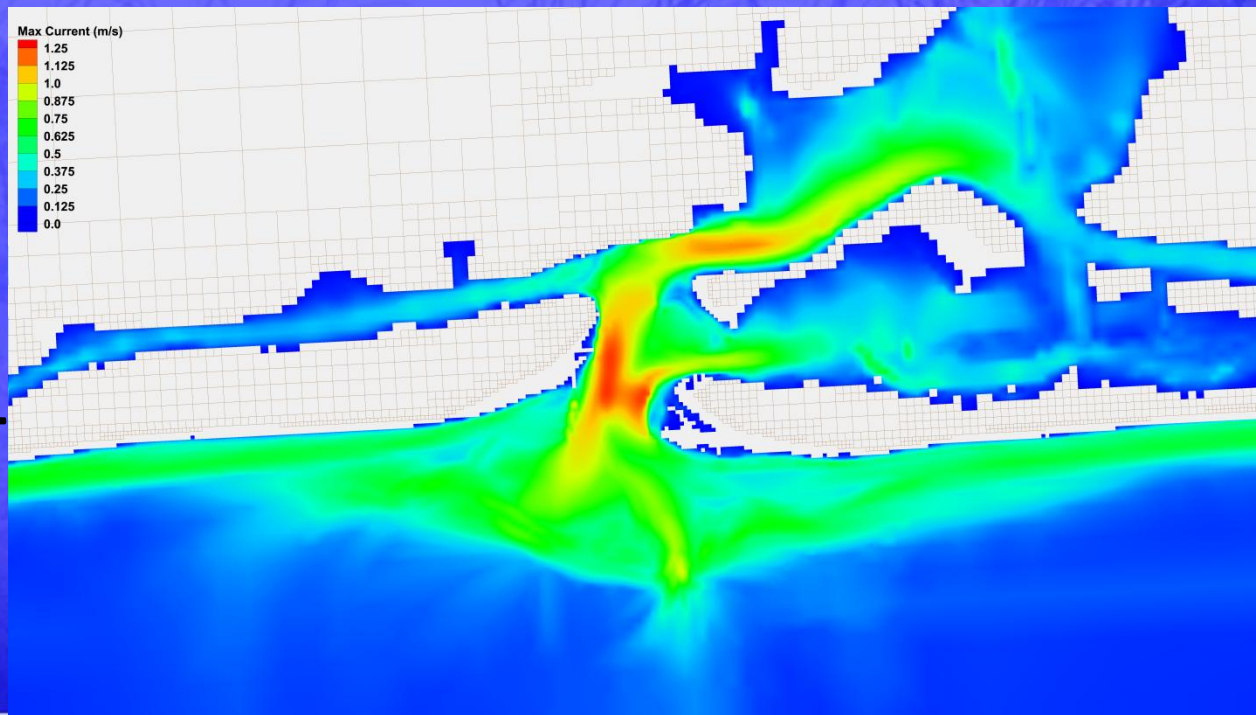


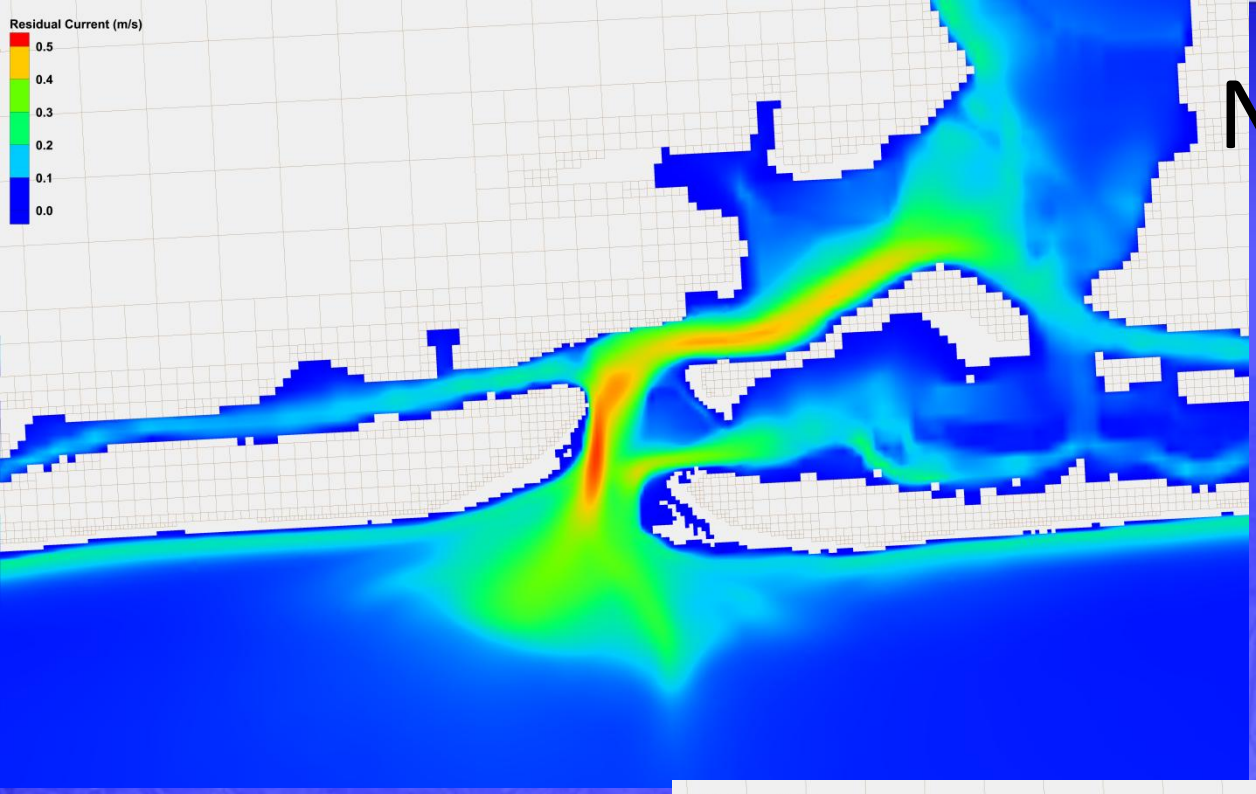
‘Short’ Groin, Nour., BA - Max Current (m/s)



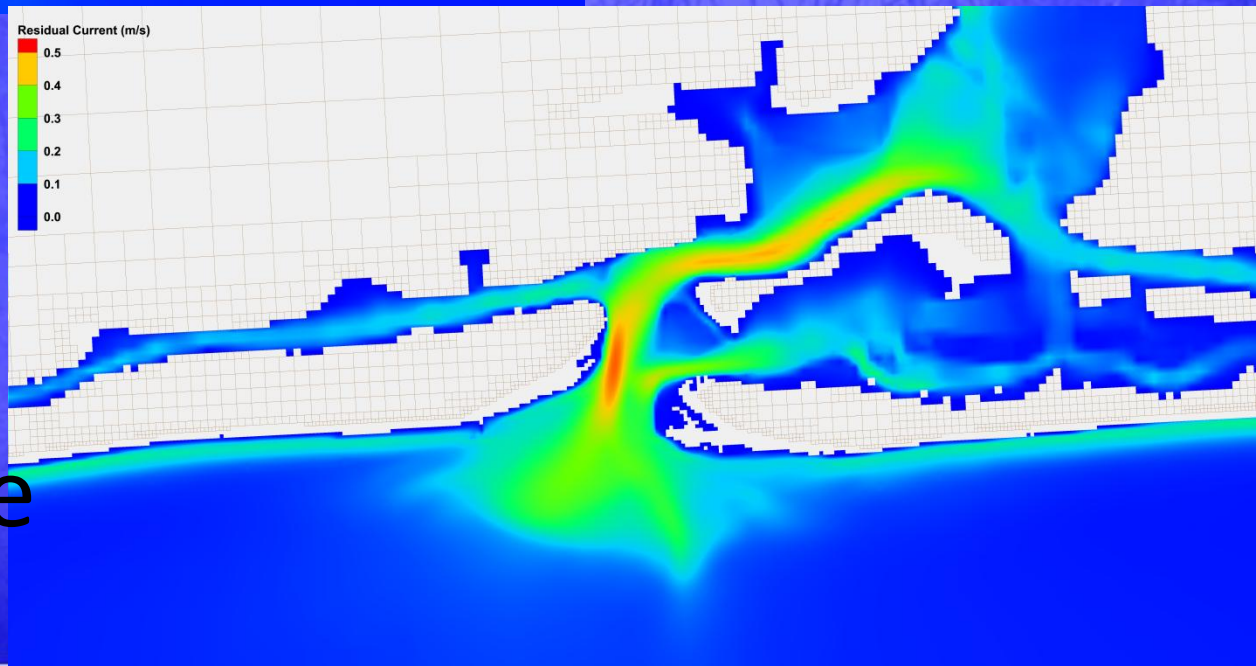
No Action - Max Current (m/s)

‘Long’ Groin, - Max Current (m/s)

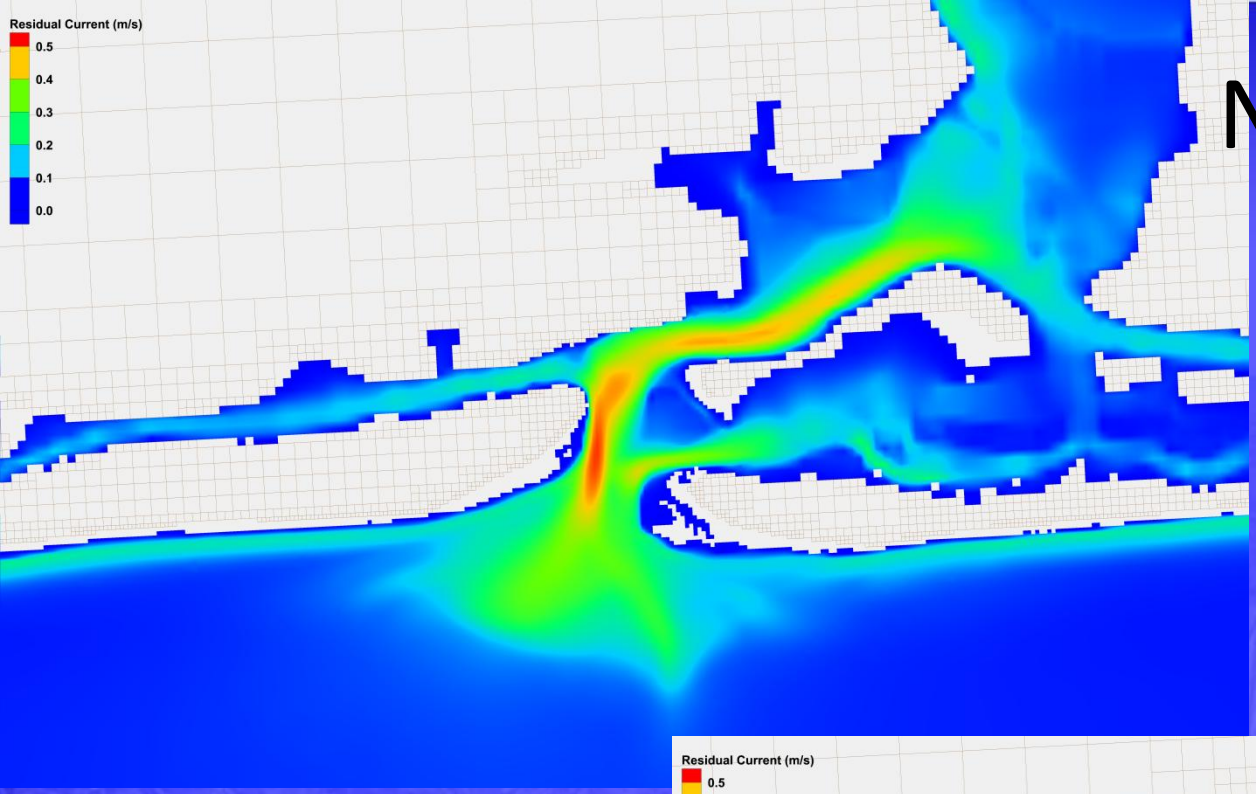




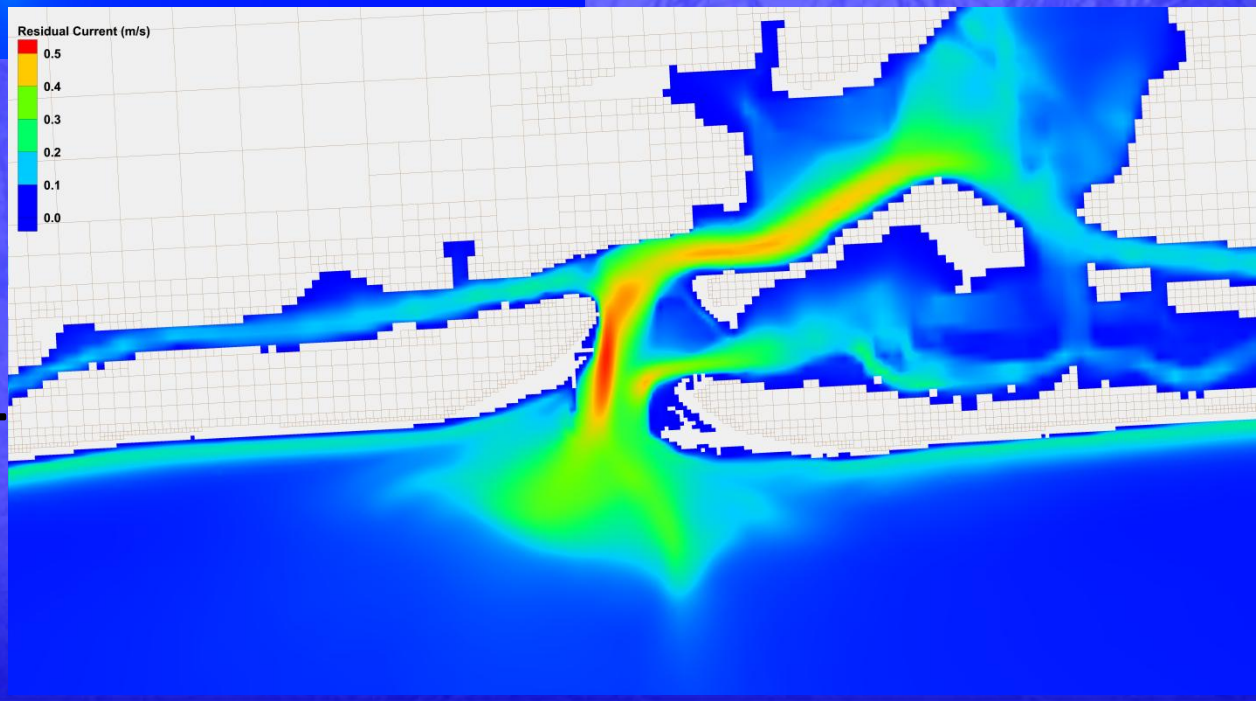
No Action - Ave Current (m/s)



‘Short’ Groin, Nour., BA – Ave Current (m/s)

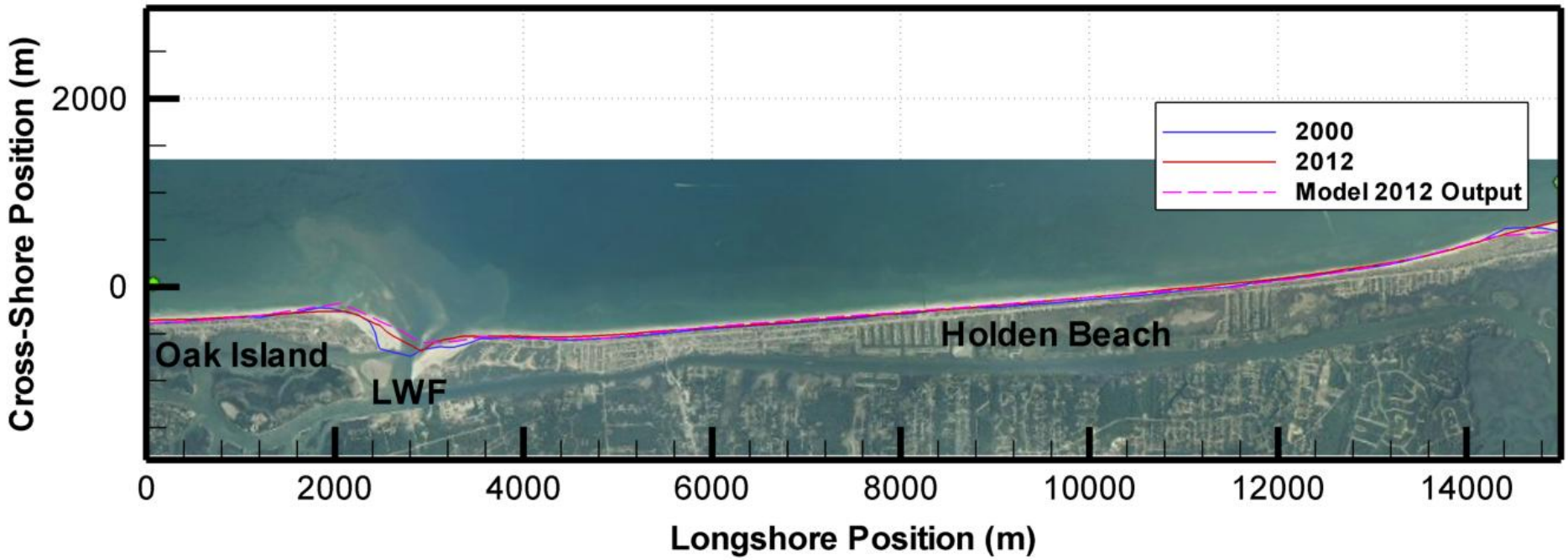


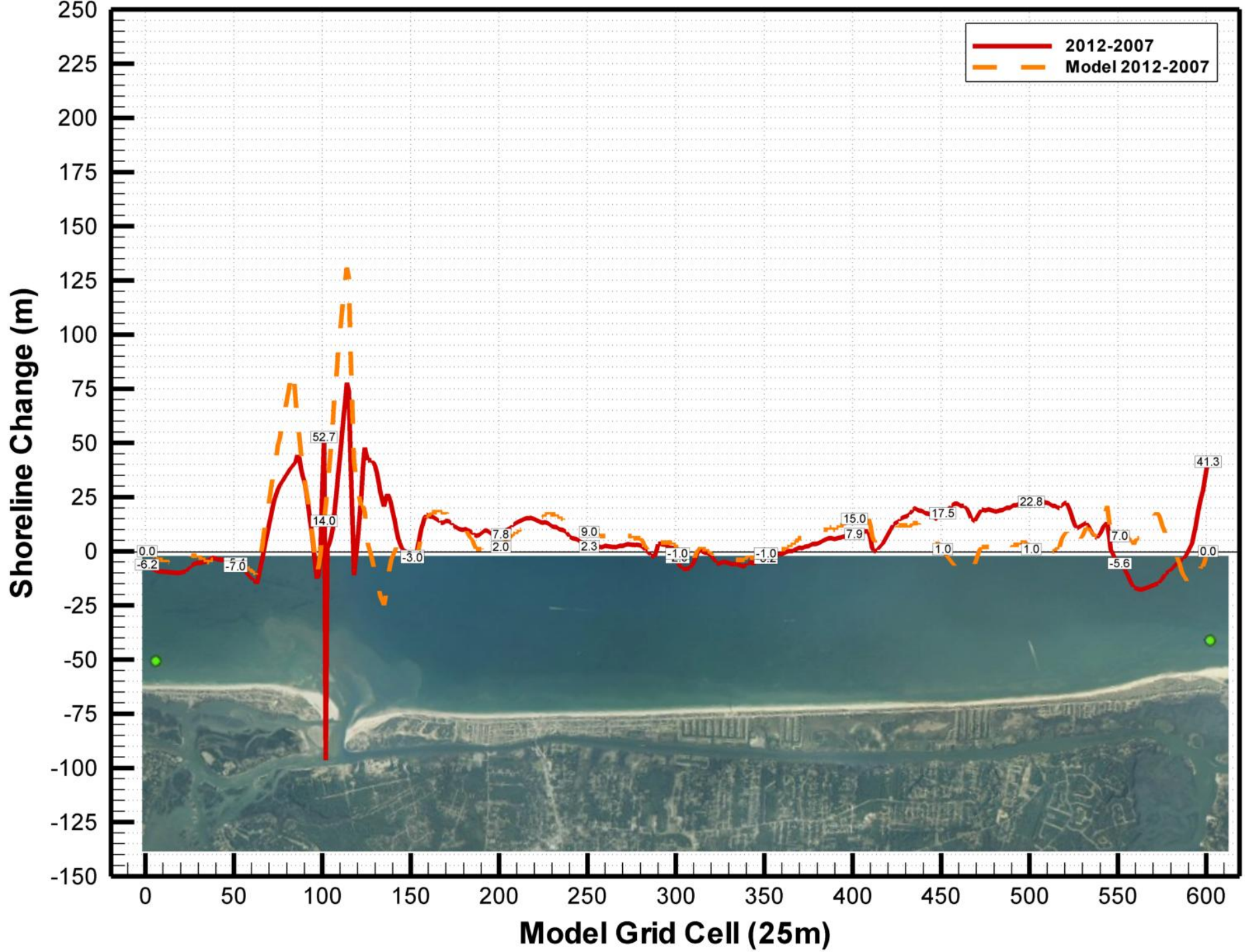
No Action - Ave Current (m/s)

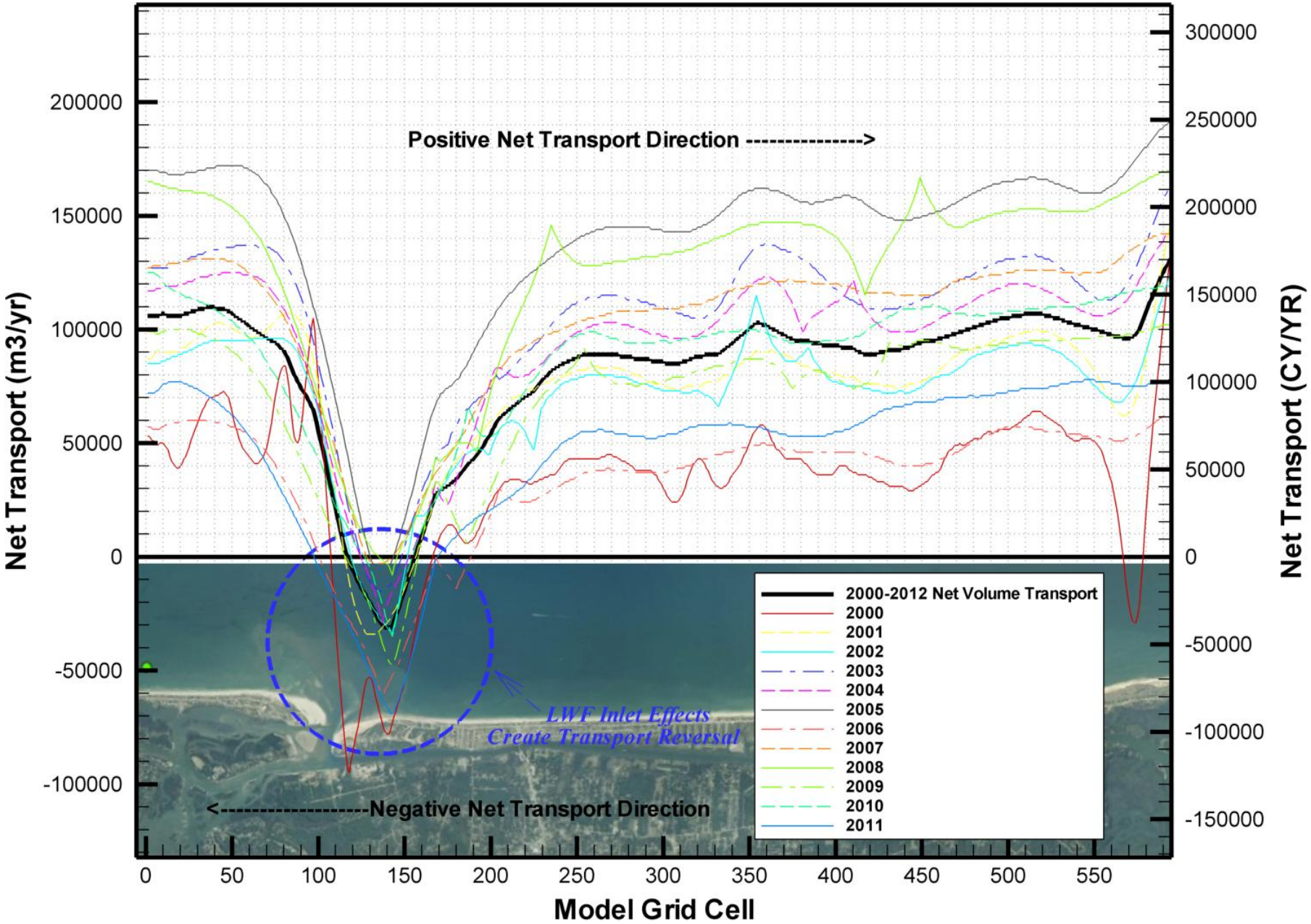


‘Long’ Groin, - Ave Current (m/s)

GENESIS-T

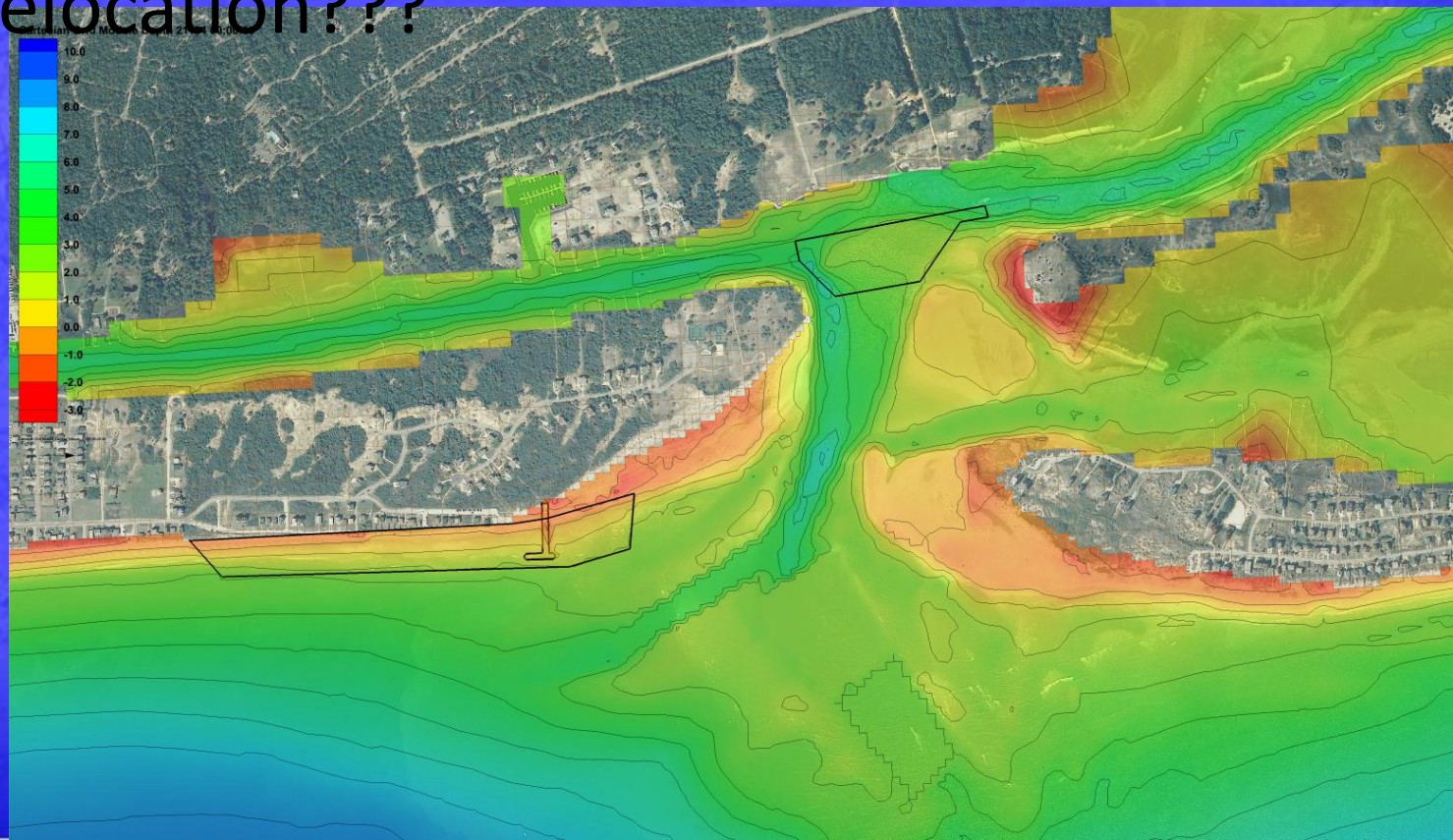

Cross-Shore Position (m)
2000
0
2000
2012
Model 2012 Output
Oak Island
LWF
Holden Beach
0
2000
4000
6000
8000
10000
12000
14000
Longshore Position (m)


2012-2007
Model 2012-2007
Shoreline Change (m)
Model Grid Cell (25m)
250
225
200
175
150
125
100
75
50
25
0
-25
-50
-75
-100
-125
-150
0
50
100
150
200
250
300
350
400
450
500
550
600
52.7
14.0
41.3
22.8
17.5
15.0
7.9
7.8
2.0
9.0
2.3
7.0
-5.6
-3.0
-1.0
-1.0
1.0
1.0
0.0
0.0
-6.2
-7.0


Positive Net Transport Direction ---------->
<----------Negative Net Transport Direction
LWF Inlet Effects
Create Transport Reversal
2000-2012 Net Volume Transport
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Net Transport (m3/yr)
Net Transport (CY/YR)
Model Grid Cell
200000
150000
100000
50000
0
-50000
-100000
300000
250000
200000
150000
100000
50000
0
-50000
-100000
-150000
0
50
100
150
200
250
300
350
400
450
500
550

Preferred Project

- ‘Short’ Groin (~500’)
- 80,000 cy to 100,000 cy nourishment
- AIWW-Bend Widener Borrow Area
- Channel Relocation???



State Terminal Groin Report

- Total Value >34 Million

ANNUALIZED COSTS

- **Nourishment** – 100,000 cy - $1,000,000
  - Interval is key (1 yr, 2 yr, 3 yr, 4yr)
- **Groin** – 500 ft + Seaward Head Stone – $1,000,000 (includes engineering)
- **Channel Relocation** - $1,000,000/yr (~$250,000 per quarter)
- **Monitoring** - $100,000 to $200,000/yr

Preliminary Study Area

- Developed Based on Range of Alternatives
- Consider All Environmental and Biological Resources
- Finalize after Alternative Analysis and Modeling is Complete

Extra Slides