Ebb Delta Development at a “New” Old Inlet, Shark River Inlet, NJ

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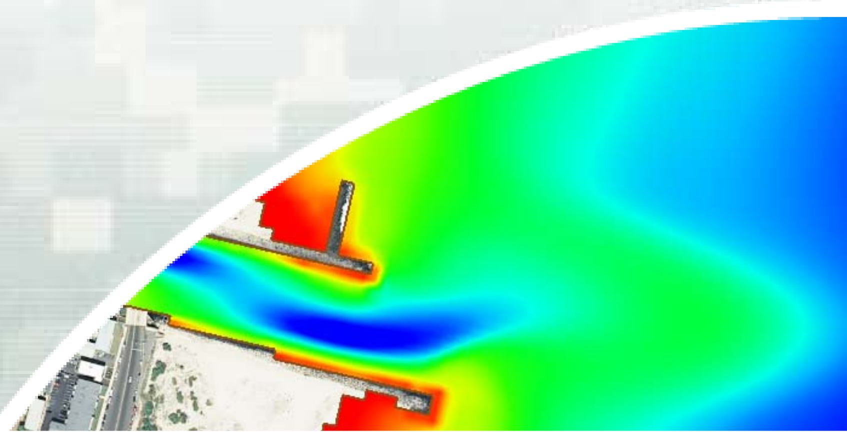

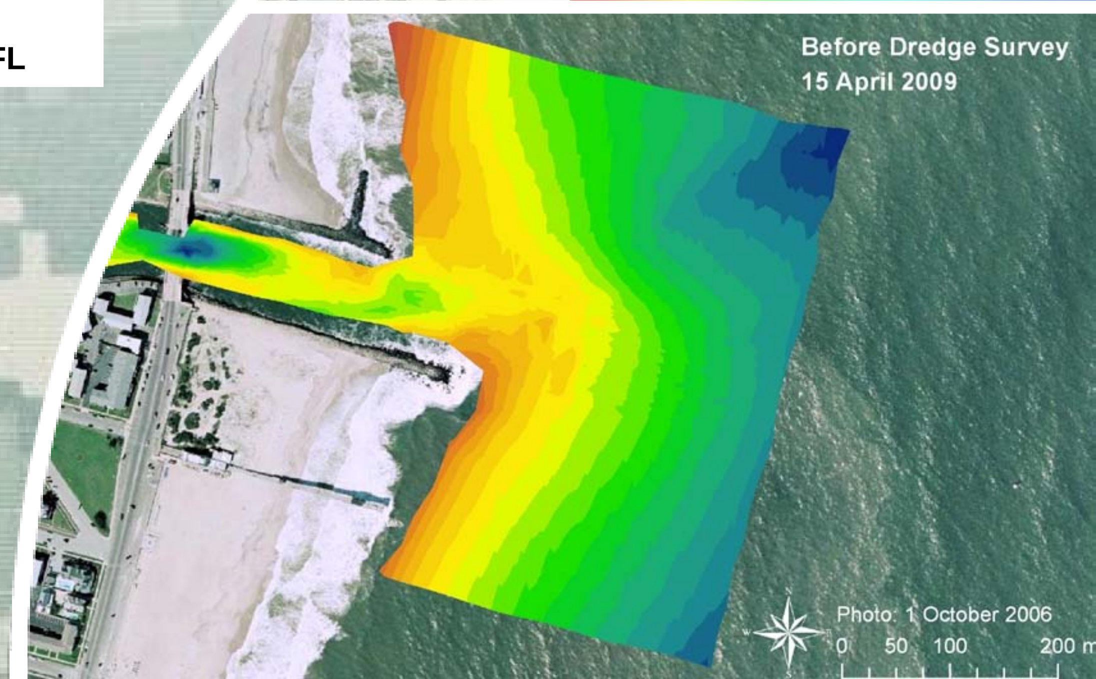

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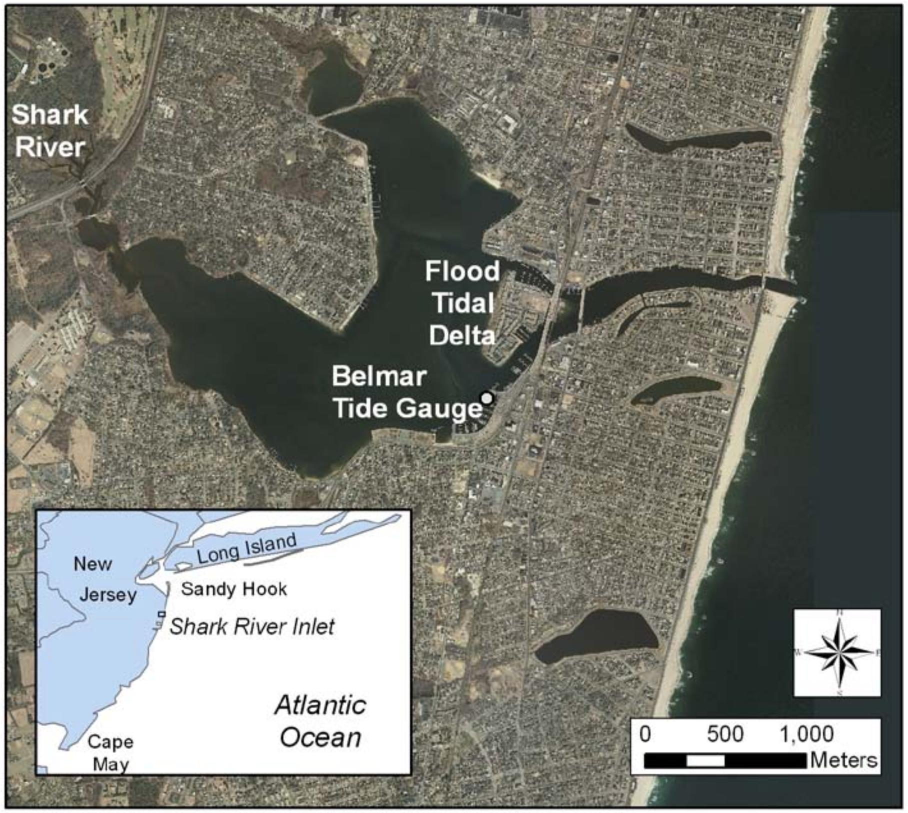
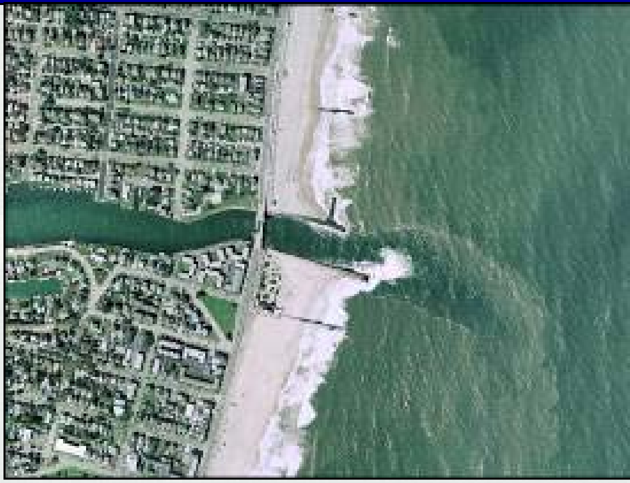
Introduction



- Federally maintained; southernmost inlet in NY District
- Northernmost inlet on NJ coast; Atlantic Highland region (bluffs, historically steep nearshore)
- Small estuary; narrow inlet, small width:depth ratio
- Densely structured coast
  - ▸Short north jetty with spur; longer south jetty
  - ▸Groins recently notched (2000)

What is Unique about Shark River Inlet?



- Deep-draft channel maintained to 18 ft MLW, 150 ft across **– width/depth = 17**
- Historically efficient with little dredging necessary (every 7-10 years)
- 1997 & 2000 Beach Erosion Control Project (nourishment) added 2 million cy to north and to the south of the inlet
  - Nourished a severely sediment-starved system
  - District planned for increase of dredging interval of every 2-3 years
- CIRP also anticipated the increase in dredging, but did not anticipate the formation of an ebb shoal

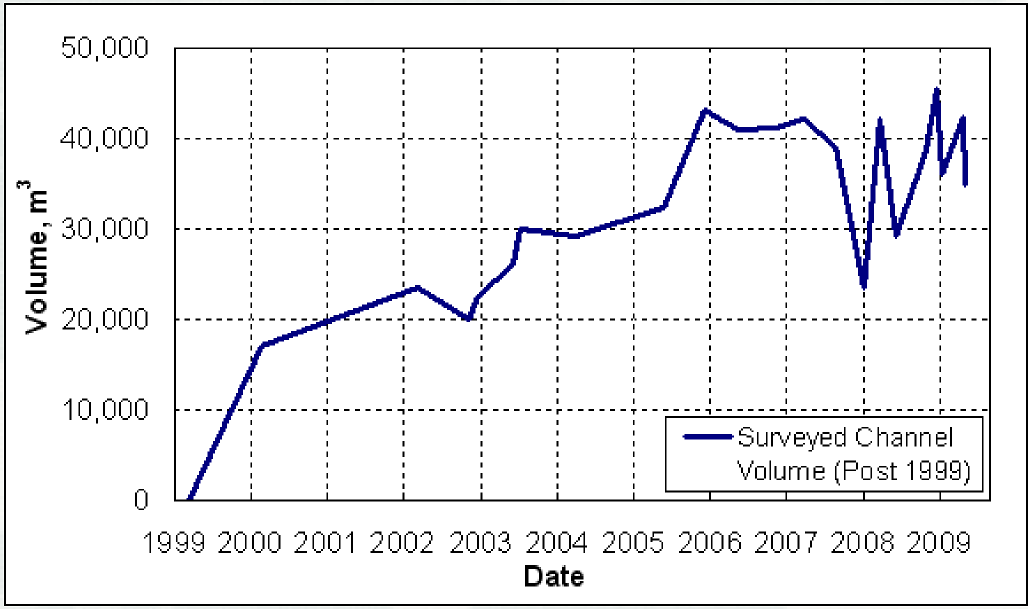
Littoral Processes

- Angas (1960)
  - ► Up-drift (south) jetty impoundment
  - ► 1958-59 Sand Bypassing Project
    - 137,000 cy of the 225,000 cy projected in the first winter
- Others: USACE 1954, Caldwell 1956, Johnson 1956
- USACE NY District (2006)
  - ► 200,000 cy/year - net potential transport to north
  - ► 910,000 cy/year - potential gross transport
- Beck & Kraus (2009)
  - ► 235,000 cy/year – average net potential transport to north

Dredging History

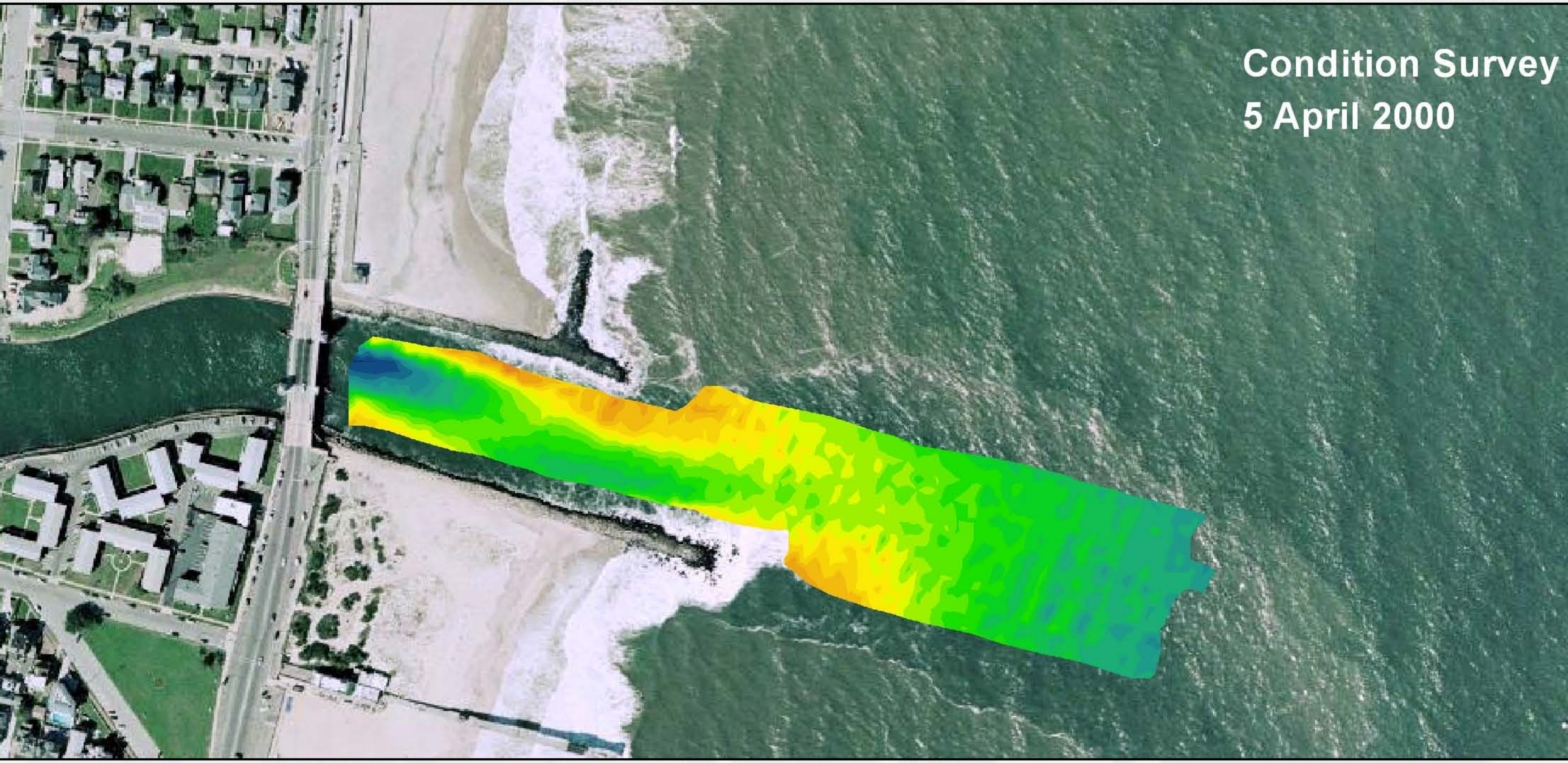
Date	Survey Type	Date	Survey Type
1-Jan-1995	Condition	28-Mar-2007	Condition
6-Jan-1998	Condition	30-Aug-2007	Before Dredge
6-May-1999	Condition	4-Jan-2008	After Dredge
11-Apr-2000	Condition	25-Mar-2008	Condition
16-Apr-2002	Condition	9-Jun-2008	After Dredge
6-Dec-2002	Before Dredge	31-Oct-2008	After Dredge
18-Jan-2003	After Dredge	8-Dec-2008	Before Dredge
7-Jul-2003	Condition	6-Jan-2009	After Dredge
7-Aug-2003	After Dredge	15-Apr-2009	Before Dredge
28-Apr-2004	Condition	1-May-2009	After Dredge
10-Jun-2005	Condition	20-Aug-2009	Before Dredge
23-Dec-2005	After Dredge	10-Dec-2009	After Dredge
23-May-2006	Condition	6-Jan-2010	After Dredge
27-Nov-2006	Condition		

- Volume is largely being controlled by frequent unanticipated dredging



- NY District increases condition survey interval following shoaling reports around north and south jetty tips

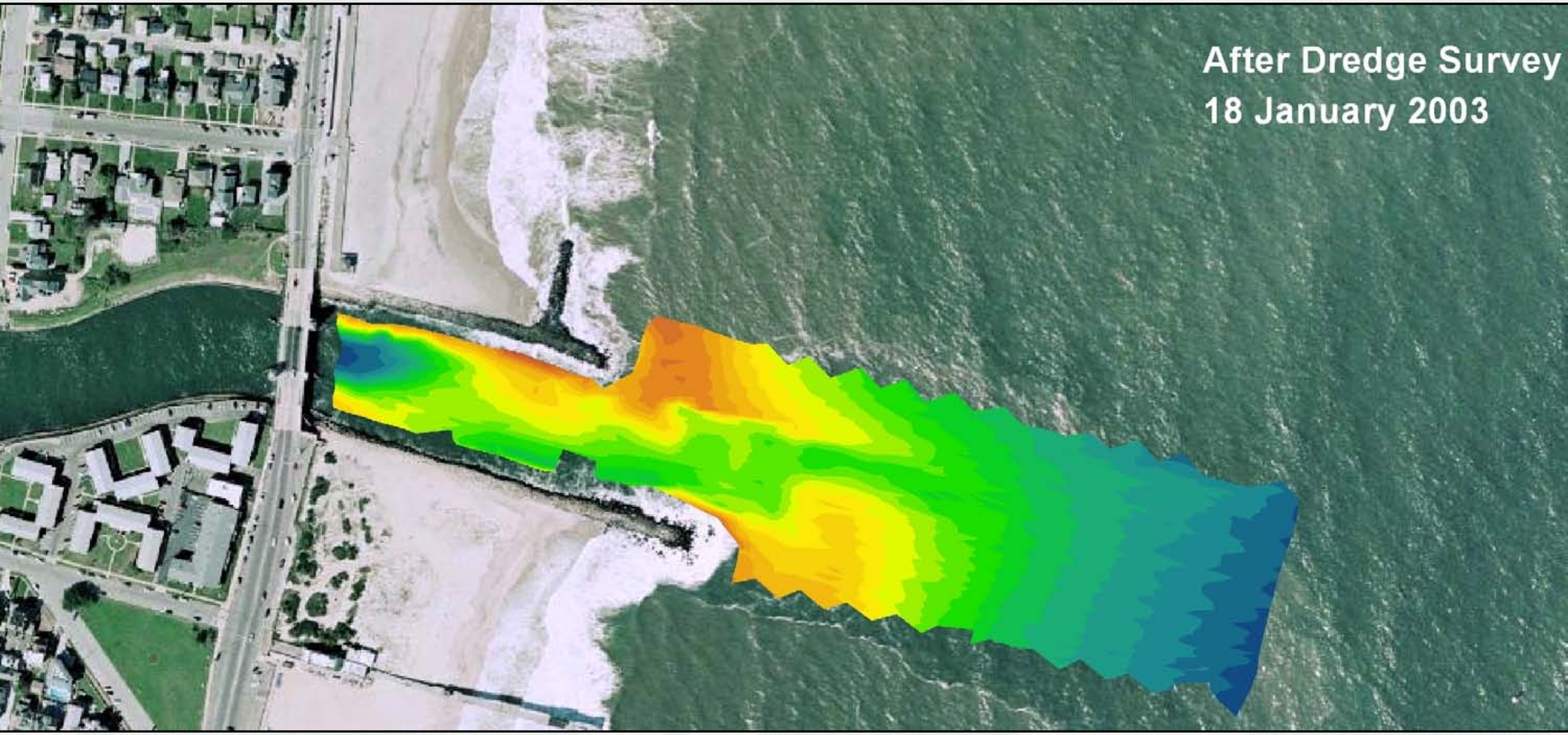
1995 & 2000 Ebb Delta Formation



Elevation, MLW (m)										
-1 - -0.5	-2 - -1.5	-3 - -2.5	-4 - -3.5	-5 - -4.5	-6 - -5.5	-7 - -6.5	-8 - -7.5	-9 - -8.5	-10 - -9.5
-1.5 - -1	-2.5 - -2	-3.5 - -3	-4.5 - -4	-5.5 - -5	-6.5 - -6	-7.5 - -7	-8.5 - -8	-9.5 - -9	-10.5 - -10

NY District Survey

2002 & 2003 Ebb Delta Formation

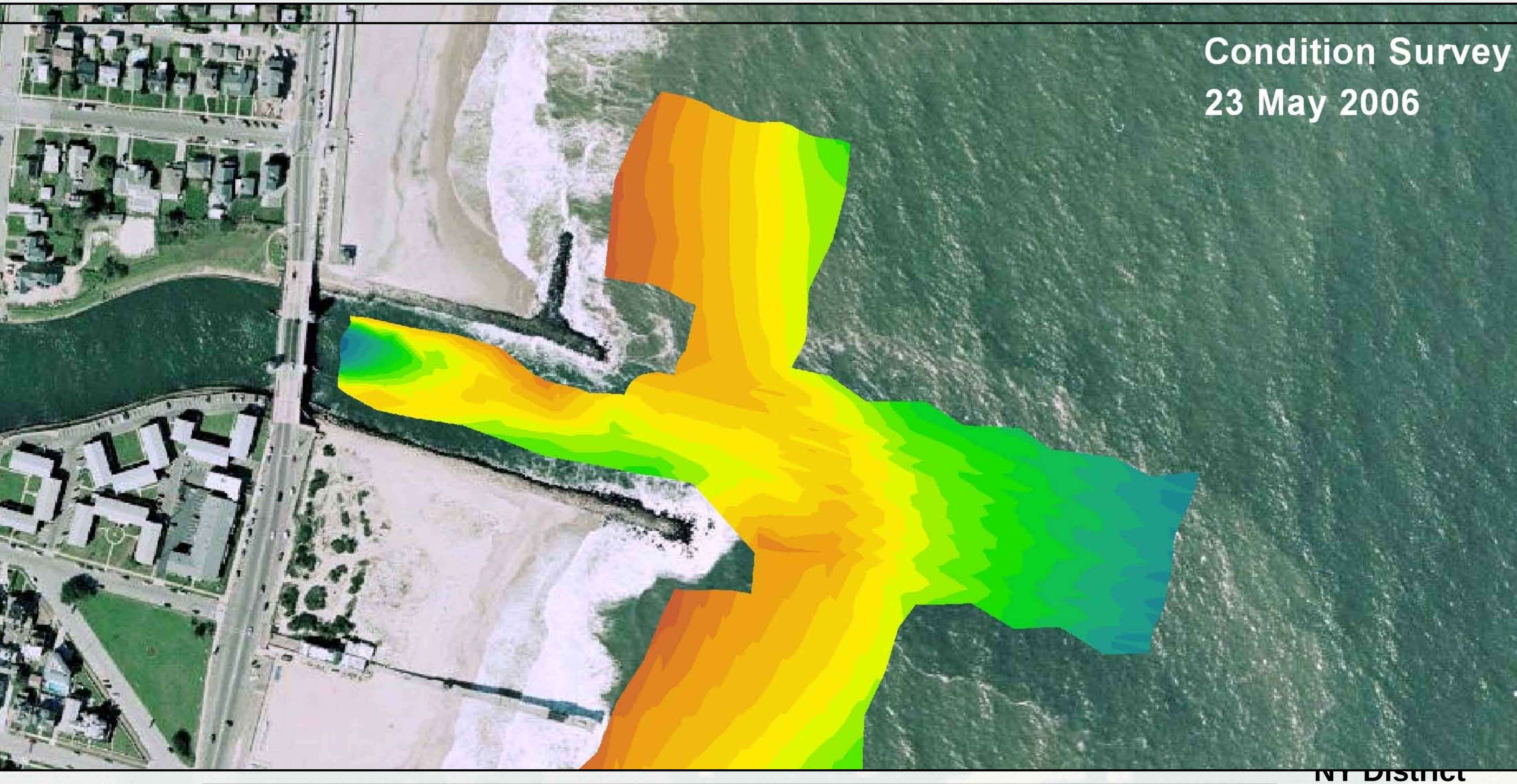


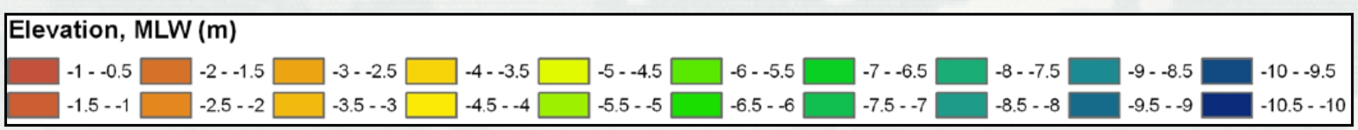
NY District Survey

Elevation, MLW (m)

-1 - -0.5	-2 - -1.5	-3 - -2.5	-4 - -3.5	-5 - -4.5	-6 - -5.5	-7 - -6.5	-8 - -7.5	-9 - -8.5	-10 - -9.5
-1.5 - -1	-2.5 - -2	-3.5 - -3	-4.5 - -4	-5.5 - -5	-6.5 - -6	-7.5 - -7	-8.5 - -8	-9.5 - -9	-10.5 - -10

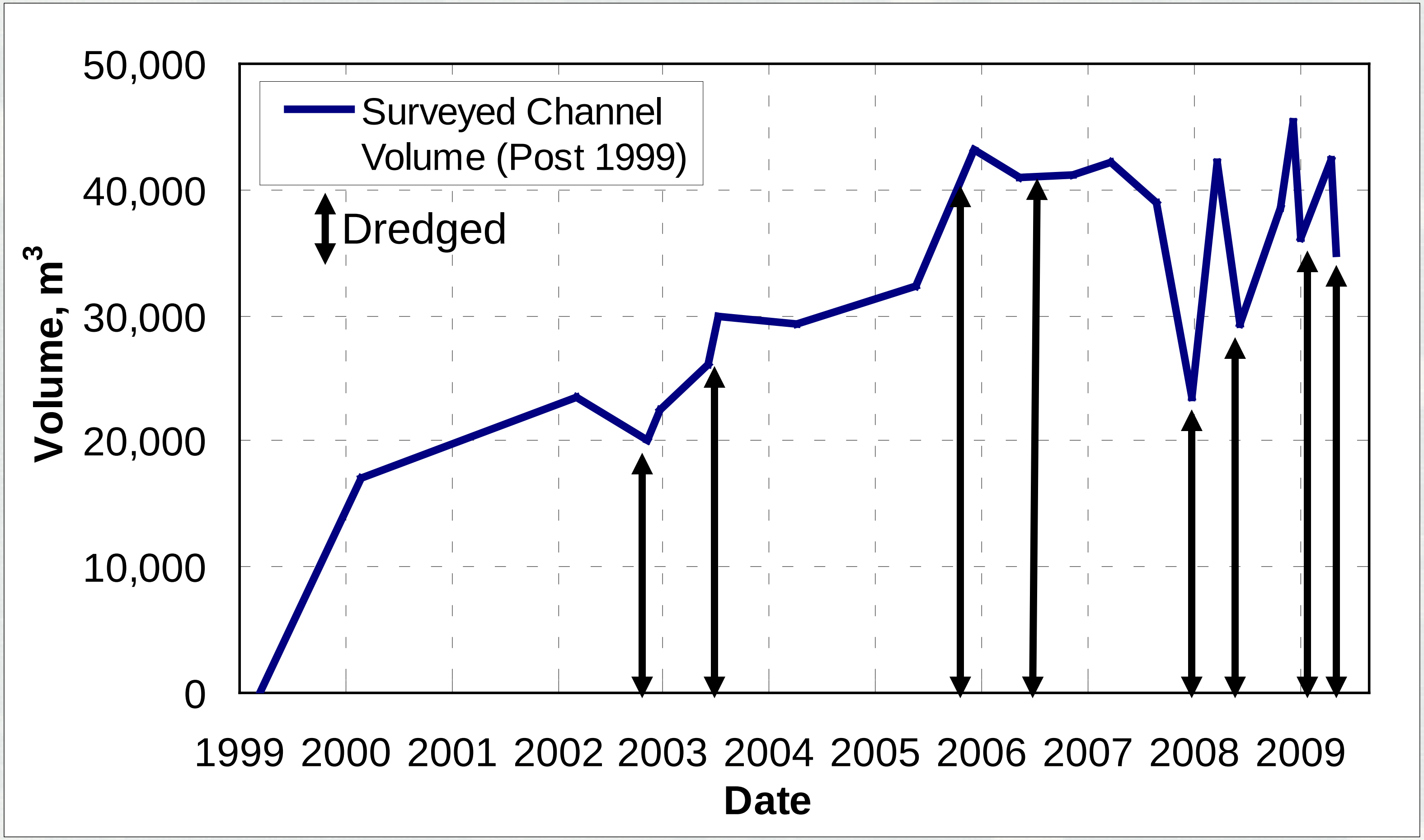
2003 & 2006 Ebb Delta Formation



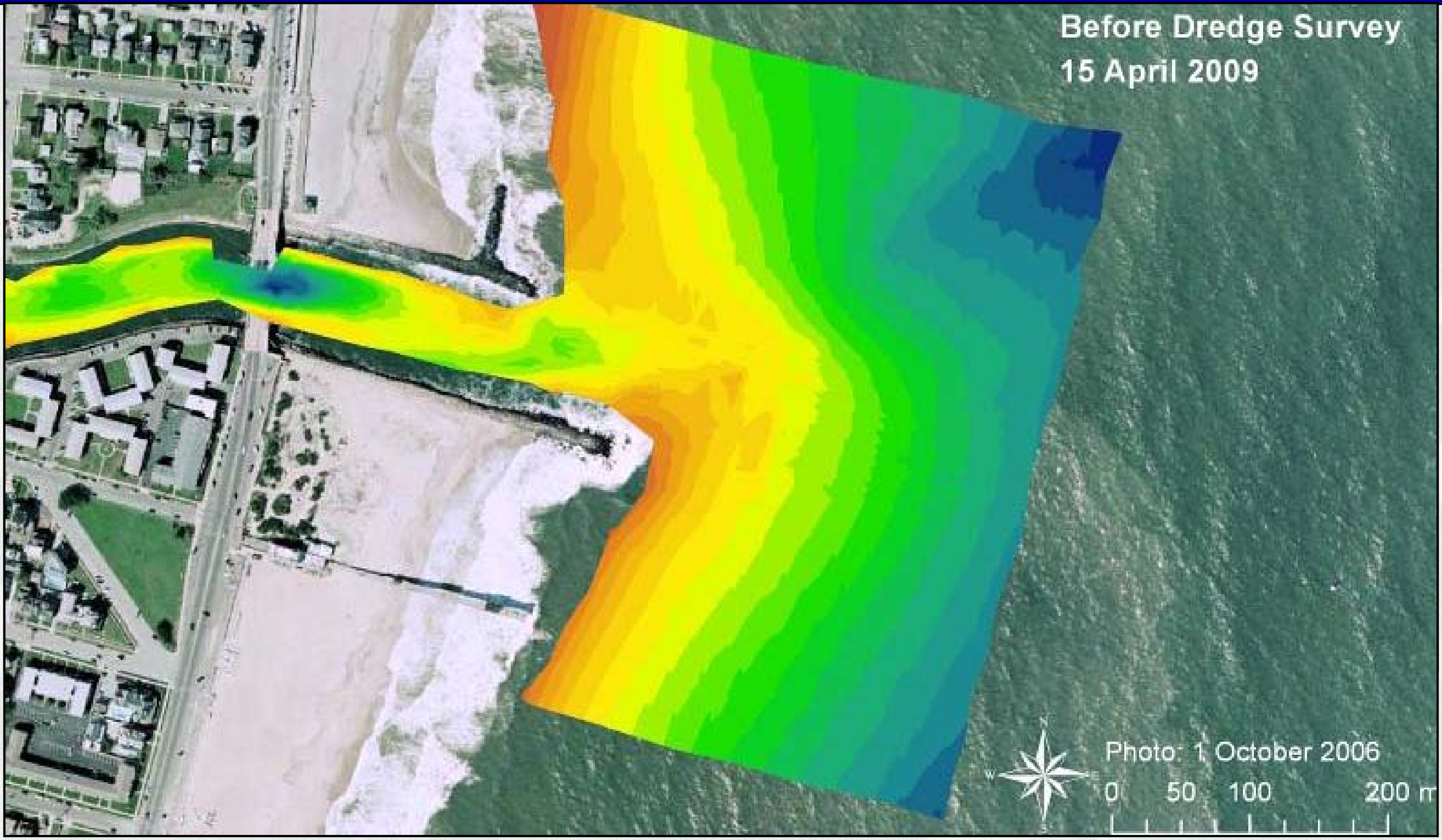


NY District
Survey

Dredging Events & Volume Post 1999



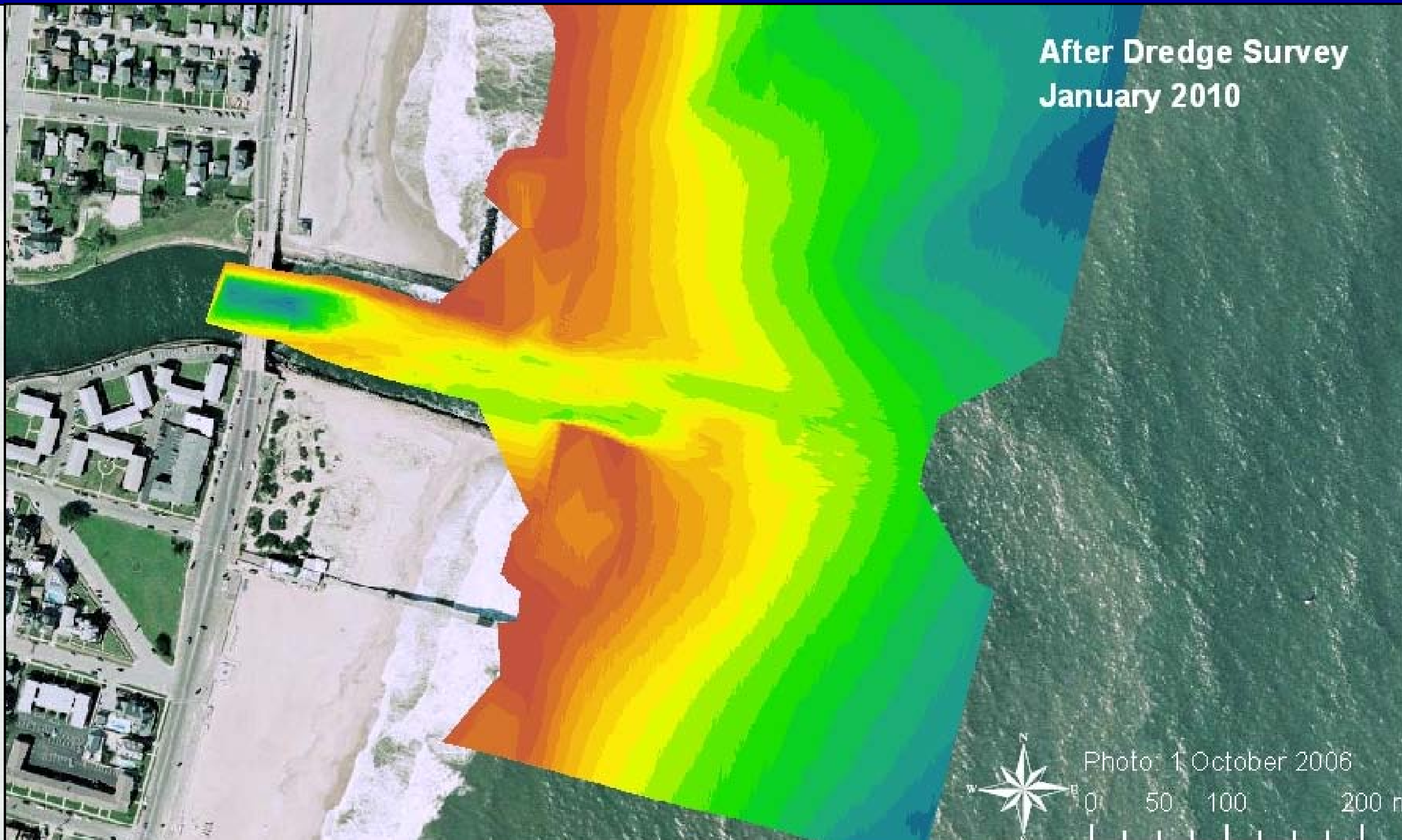
2008 & 2009 Ebb Delta Formation



Elevation, MLW (m)

-1 - -0.5, -1.5 - -1, -2 - -1.5, -2.5 - -2, -3 - -2.5, -3.5 - -3, -4 - -3.5, -4.5 - -4, -5 - -4.5, -5.5 - -5, -6 - -5.5, -6.5 - -6, -7 - -6.5, -7.5 - -7, -8 - -7.5, -8.5 - -8, -9 - -8.5, -9.5 - -9, -10 - -9.5, -10.5 - -10

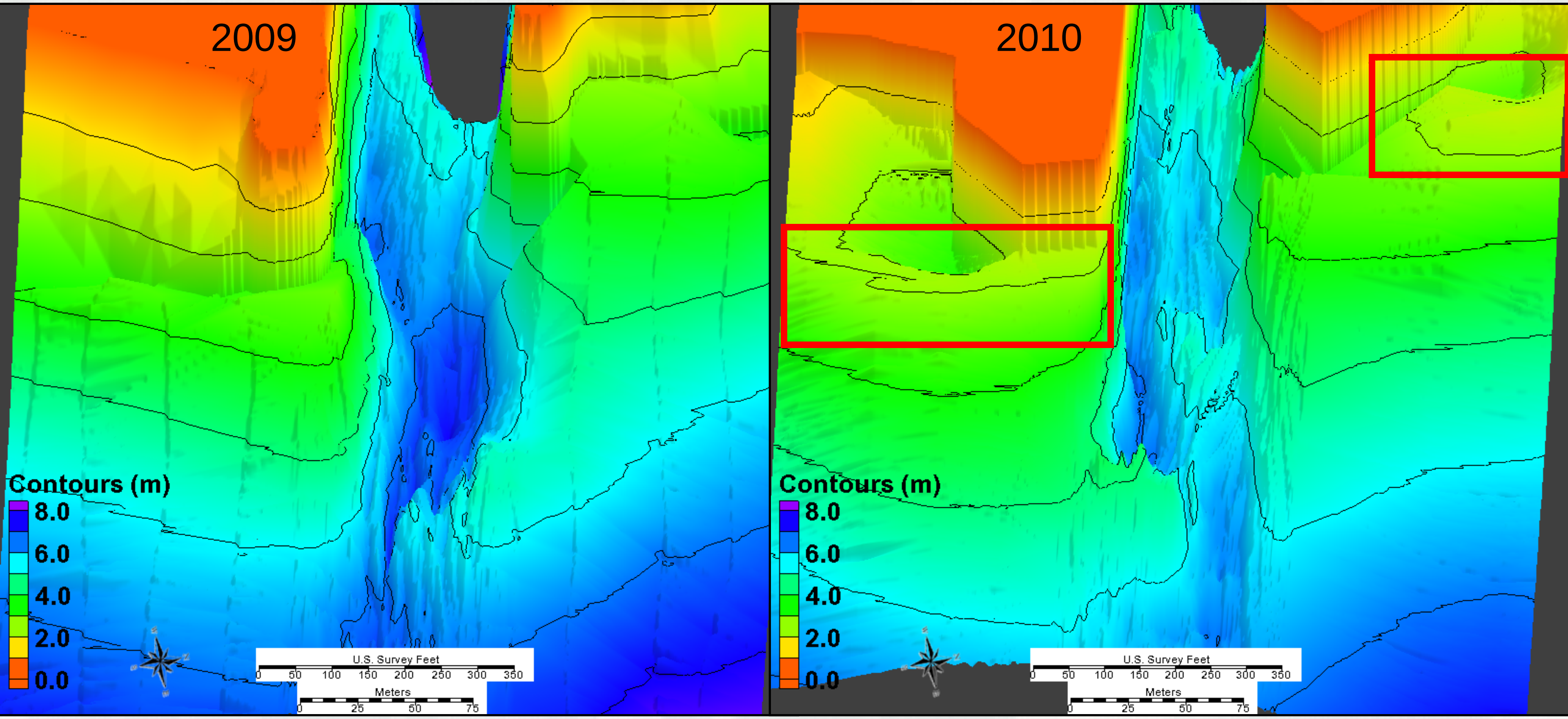
2010 – Post Dredging



Elevation, MLW (m)									
-1 - -0.5	-2 - -1.5	-3 - -2.5	-4 - -3.5	-5 - -4.5	-6 - -5.5	-7 - -6.5	-8 - -7.5	-9 - -8.5	-10 - -9.5
-1.5 - -1	-2.5 - -2	-3.5 - -3	-4.5 - -4	-5.5 - -5	-6.5 - -6	-7.5 - -7	-8.5 - -8	-9.5 - -9	-10.5 - -10

NY District Survey

January 2009 & 2010 – After Dredging Survey



NY District Survey

Coastal Modeling System (CMS)

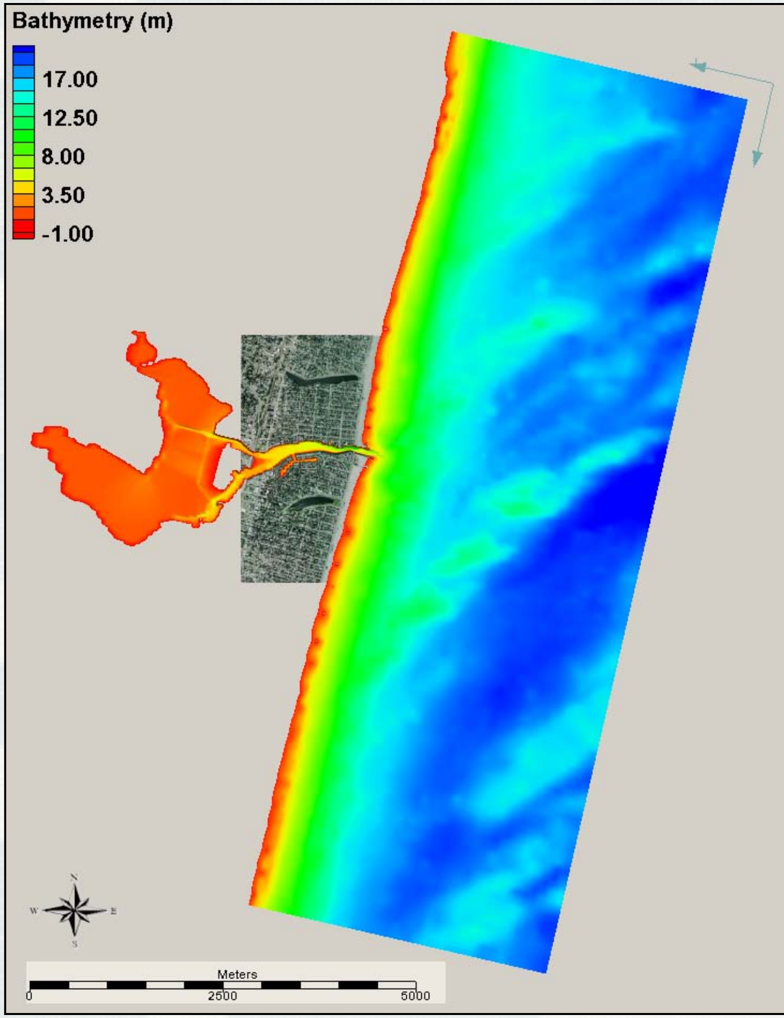
- Finite Volume Method; explicit (HPC) or implicit (PC)
- Inline code: flow, waves, and sediment in a single program
- Fully unstructured telescoping (quadtree) mesh
  - Flexible
  - Computationally efficient
  - Backward compatible with previous CMS grids
- 10-30 times for faster than the explicit version of CMS-Flow
  - Typical speed - <u>1 year morphology change calculated in 1 day</u>
- Robust, reliable
  - 5-30 min time step of for tidal circulation with waves
  - Wetting and drying
- Several choices for sediment transport rate formulas

Shark River Inlet Simulation

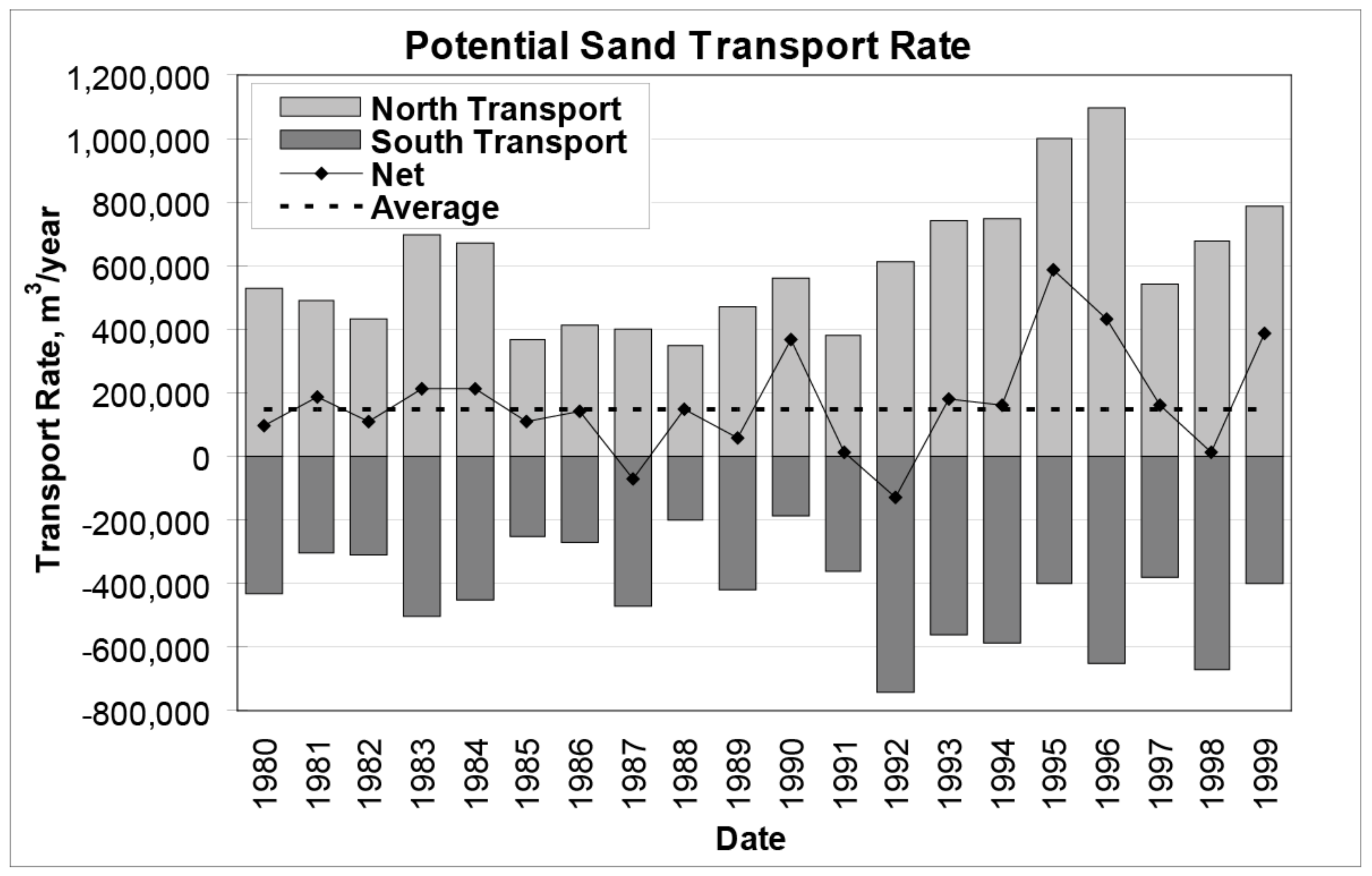
- CMS – Implicit Solution for Morphology Change
  - Short term to calibrate to dredging data (shorter cycle of 4-6 months)
  - Long term to test alternatives
    - General morphology characteristics: generate ebb delta, jetty-tip shoaling under dominant wave pattern
    - Engineering alternatives: dredging configuration (widen channel); jetty extension
  - Sediment Grain Size (D_{50}) – 0.20 to 0.30 mm
    - Variable D_{50}
    - Choose 0.26 mm for constant grain size (Kraus and Gravens, 1988)
  - Use Default Transport Coefficients
  - Applied Non-Equilibrium Transport Procedure

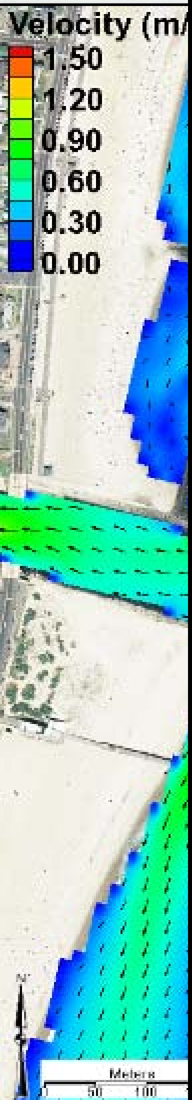
Defining the Modeling Domain

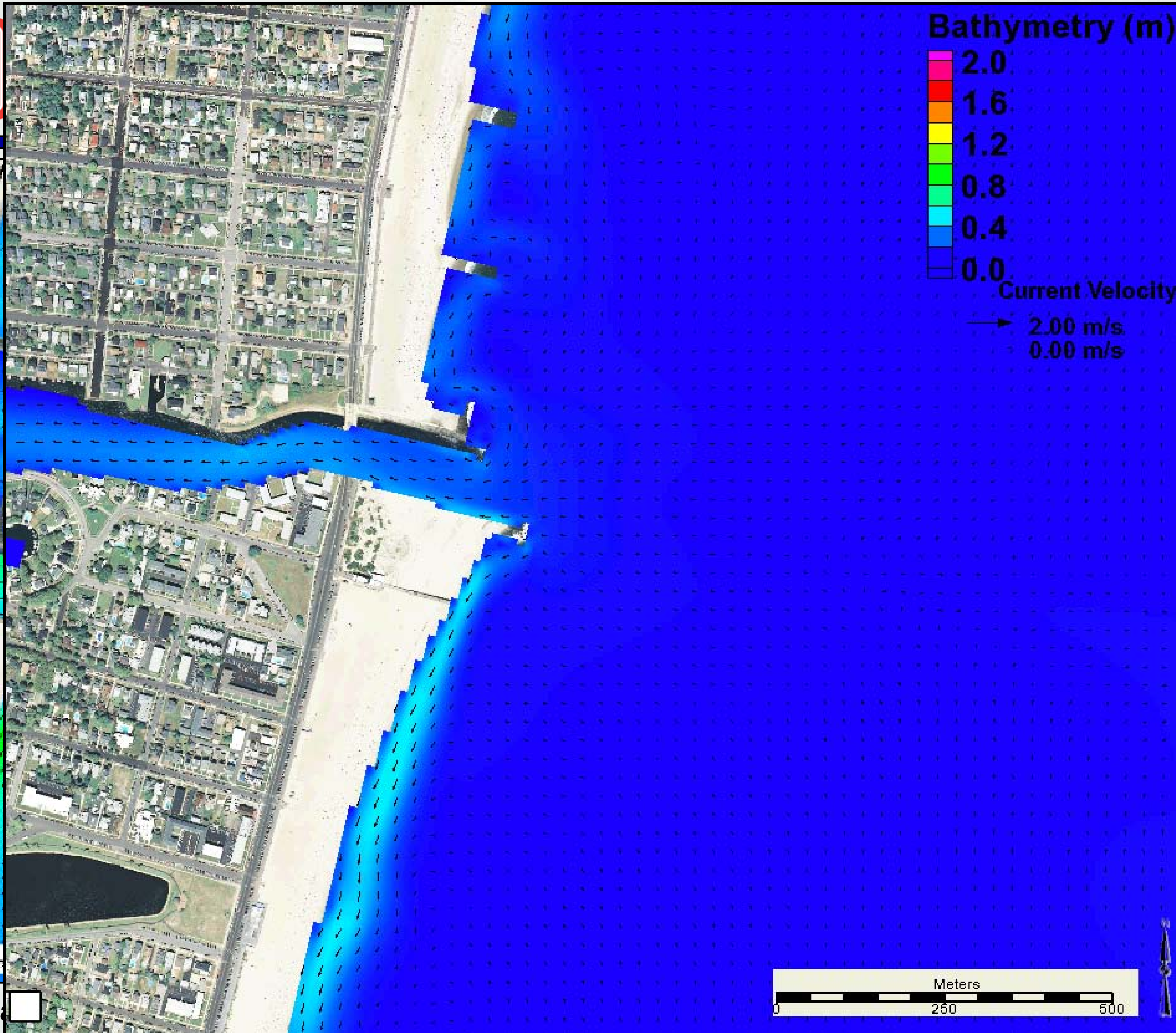
- Small estuary; Covers ~10 km of coastline
  - Resolve groin “circulation cells”
  - Lateral boundaries at relatively unstructured stretch
- Channels accurately represented
  - At least 10-15 cells across inlet
  - Federally maintained entrance and south channel (15 years of data)
- Ocean boundary
  - 3 or 4 times the ebb jet distance
  - Resolve the shallow transverse shoals; not too shallow on the edge



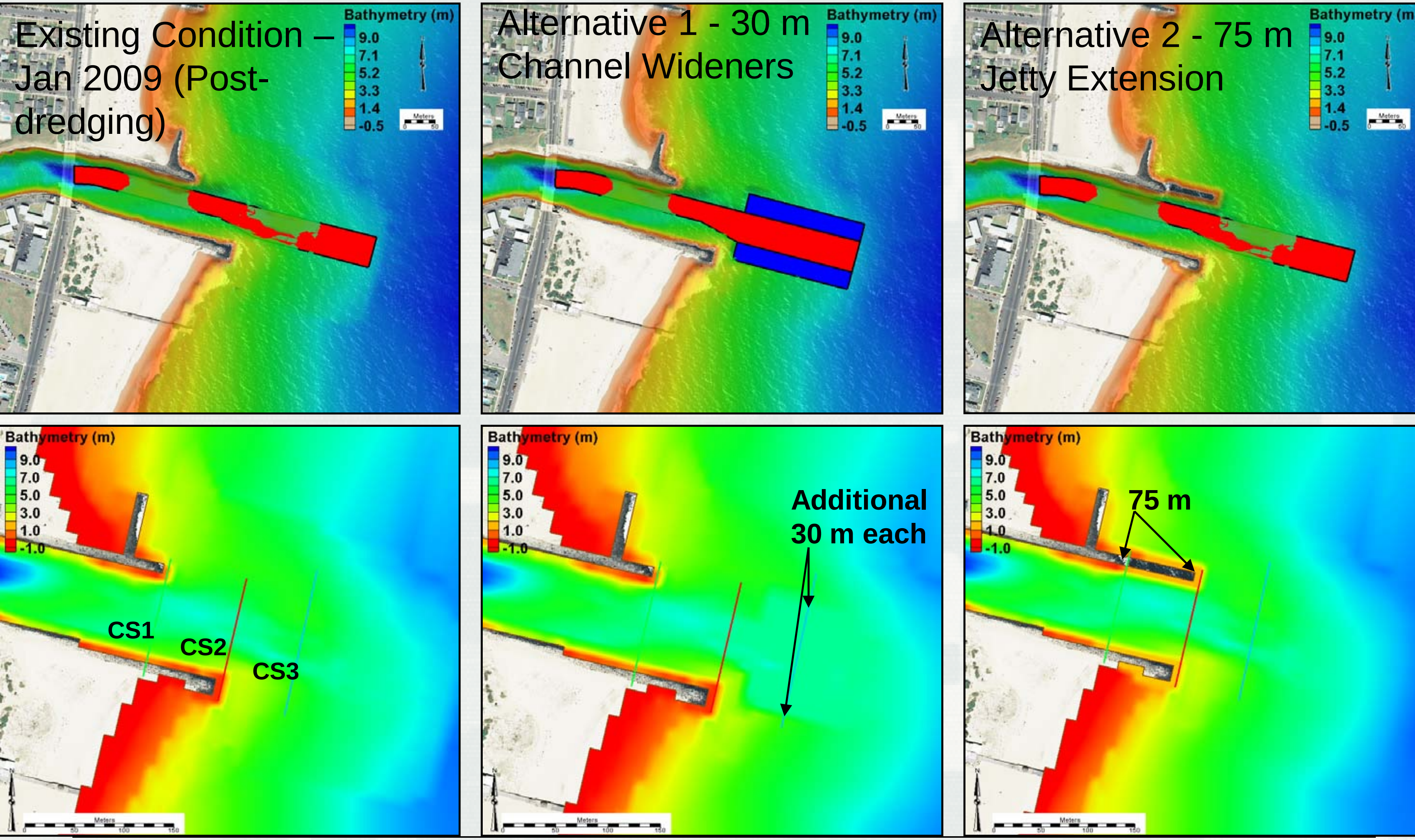
Sediment Transport (WIS Waves)

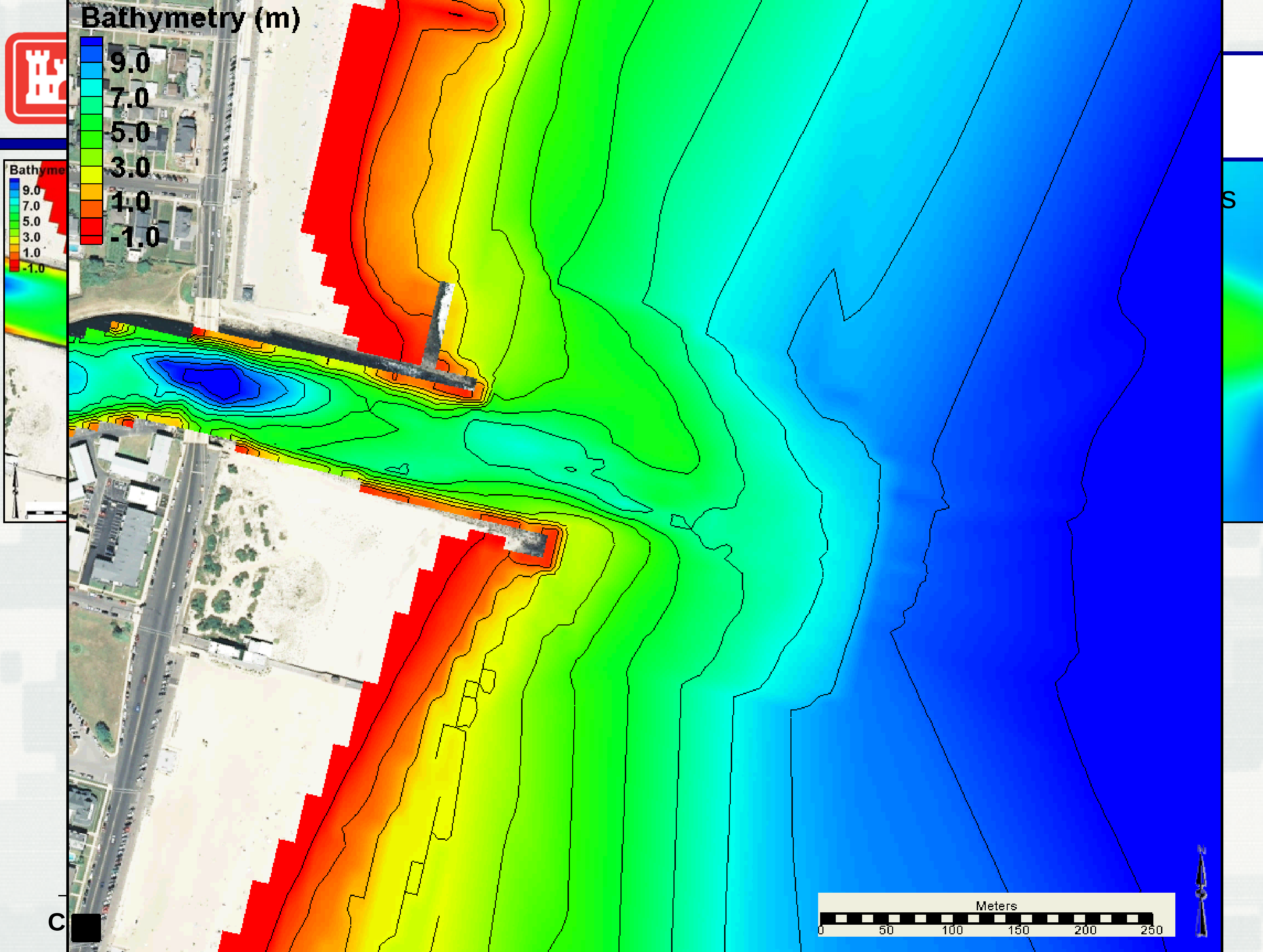



Velocity (m/
1.50
1.20
0.90
0.60
0.30
0.00
Meters
50
100

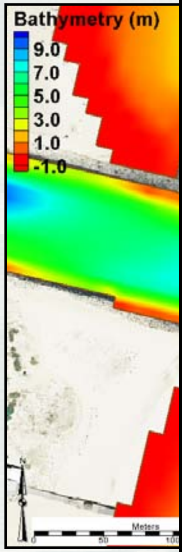

Bathymetry (m)
2.0
1.6
1.2
0.8
0.4
0.0
Current Velocity
2.00 m/s
0.00 m/s
Meters
0
250
500

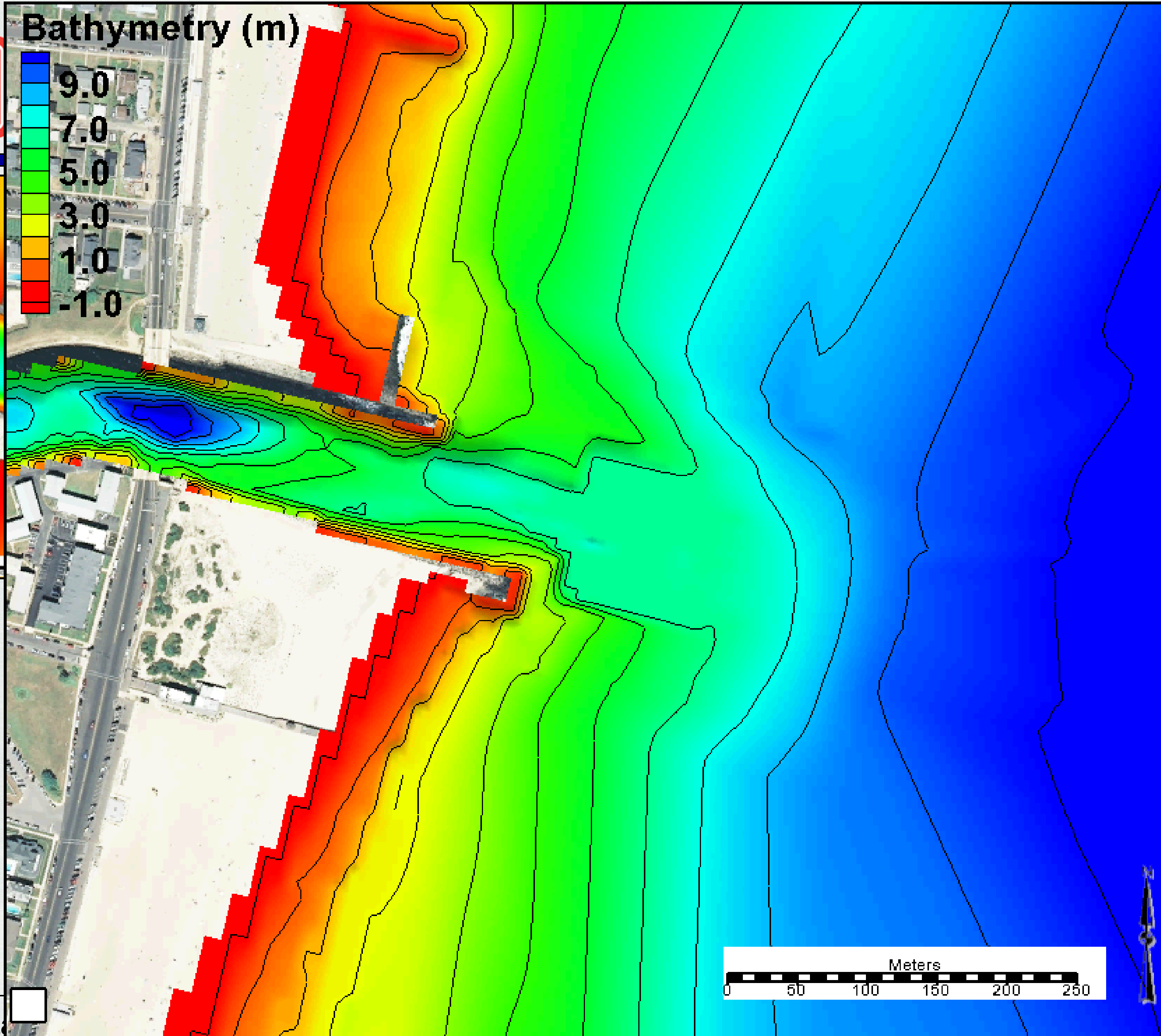
Selected Alternatives

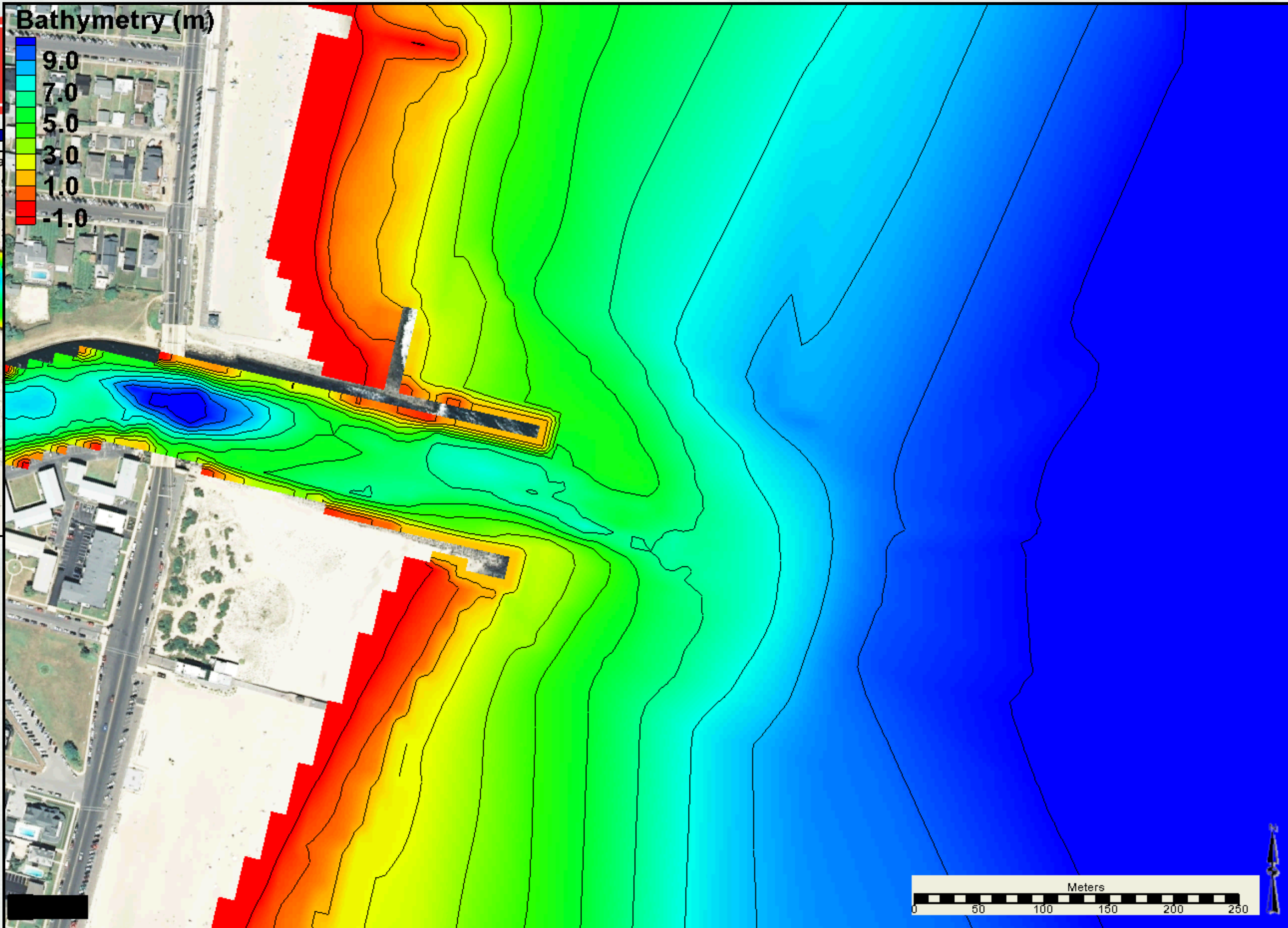



Bathymetry (m)
9.0
7.0
5.0
3.0
1.0
-1.0
Meters
0
50
100
150
200
250

onths

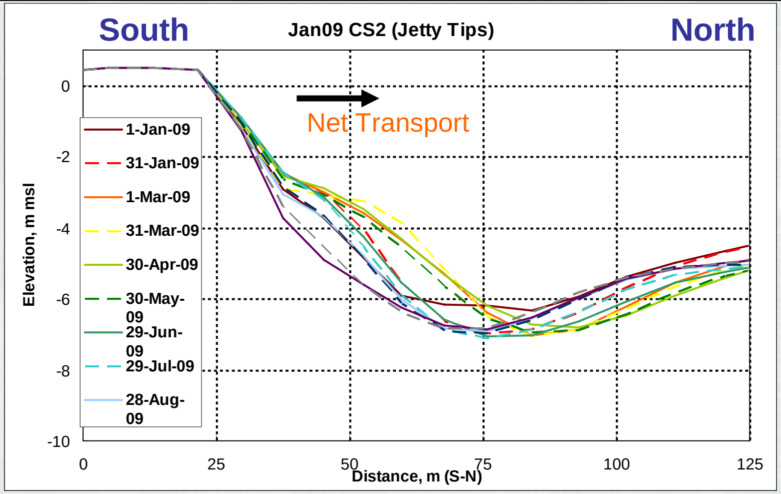

Bathymetry (m)
9.0
7.0
5.0
3.0
1.0
-1.0
Meters


Bathymetry (m)
9.0
7.0
5.0
3.0
1.0
-1.0
Meters
0 50 100 150 200 250

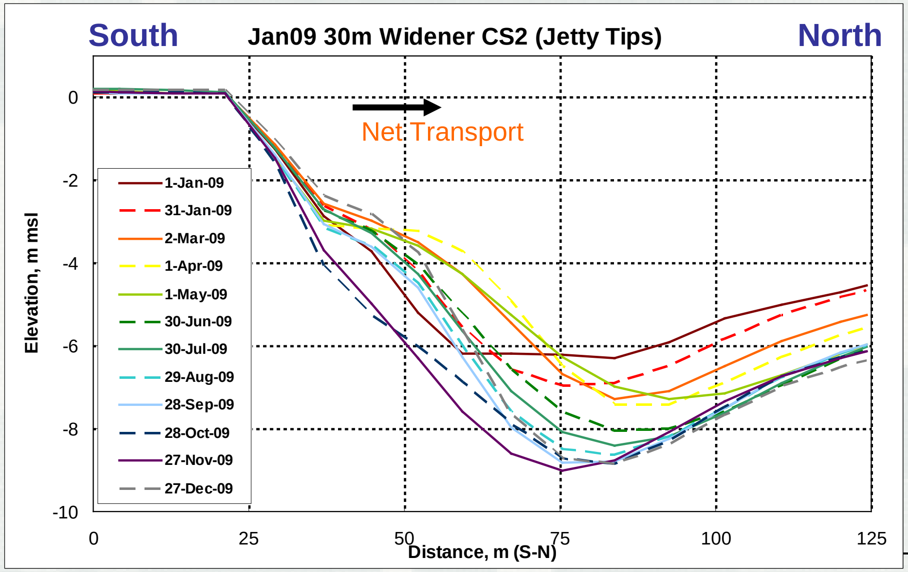

Bathymetry (m)
9.0
7.0
5.0
3.0
1.0
-1.0
Meters
0
50
100
150
200
250

Channel Infilling

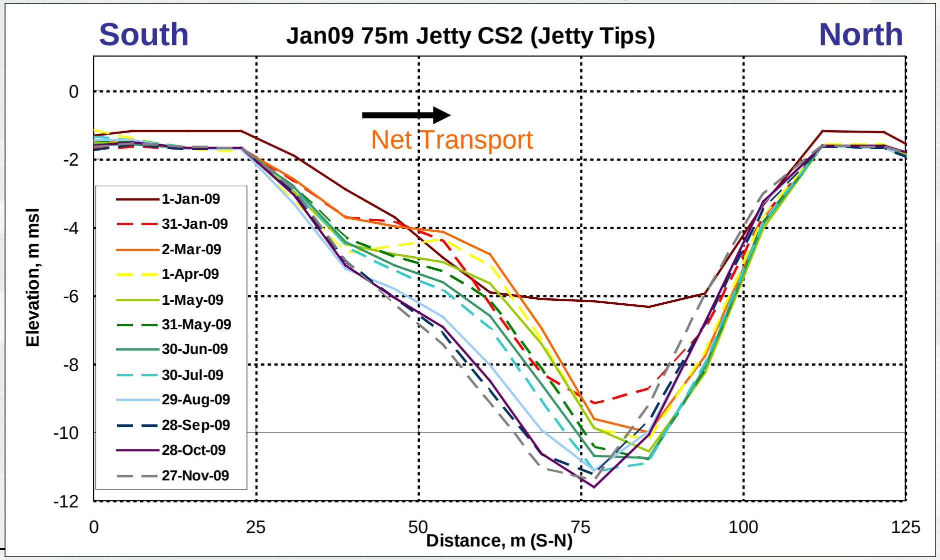
Existing Condition
January 2009
(Post-dredging)



Alternative 1 - 30 m Channel Wideners



Alternative 2 - 75 m Jetty Extension



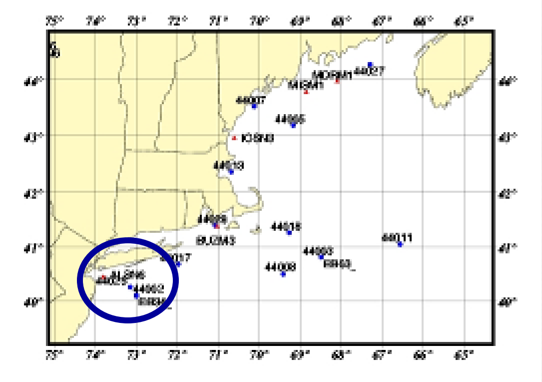
Summary

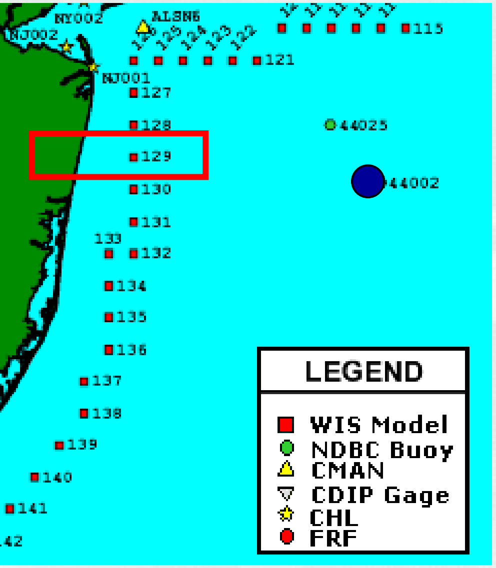
- CMS calculations of circulation patterns and magnitudes agree with measurements of current and water level
- Morphology change agrees with expected trends
  - Jetty tip shoals; ebb delta shape (wave-dominated, Atlantic coast type); dominant shoaling along the south jetty
- Short-term simulations produce sedimentation volume within order of magnitude (uncertainty in wave input)
- NET captured channel infilling and development of shallow south jetty tip shoal
- 1-year simulation takes 30 hr to complete on a PC
- Next steps:
  - Engineering options (jetty modification, orientation change)
  - Nourishment impact
  - Long-term (decade) calculations

Thank You!

Any Questions?

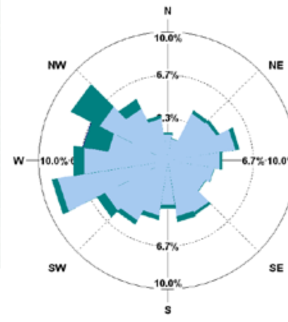
Waves



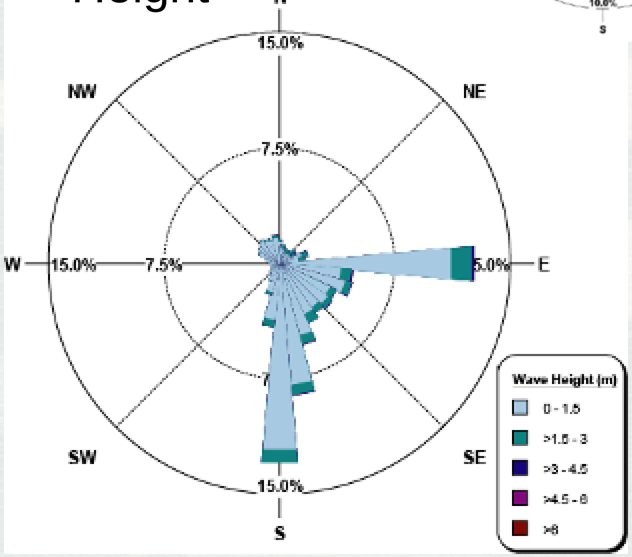


- NOAA Buoy
- Wave Information Study (WIS)

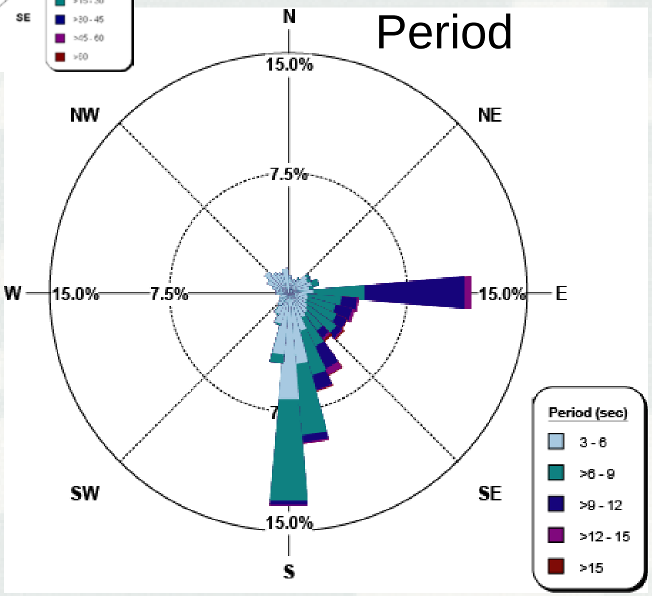
Wind (Sandy Hook)



Height

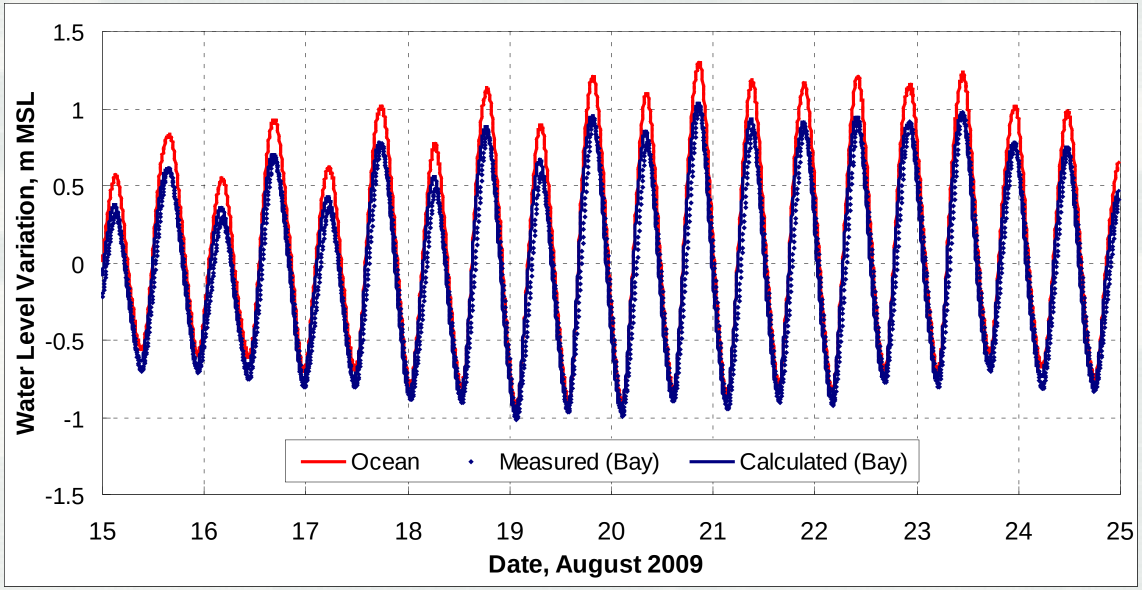


Period



Tide

- Forcing data from Sandy Hook gauge
  - Ocean gauge (located on pier)
- Belmar tide gauge (bay)
  - Tidal benchmark
  - Field measurements set to this gauge



Current Velocity