Sediment Management Plan

Rehoboth Bay

STAC Meeting
November 16, 2007

Goals of the Study

- Improve planning for future dredging needs
- Reduce the dependency on dredging

Study Tasks

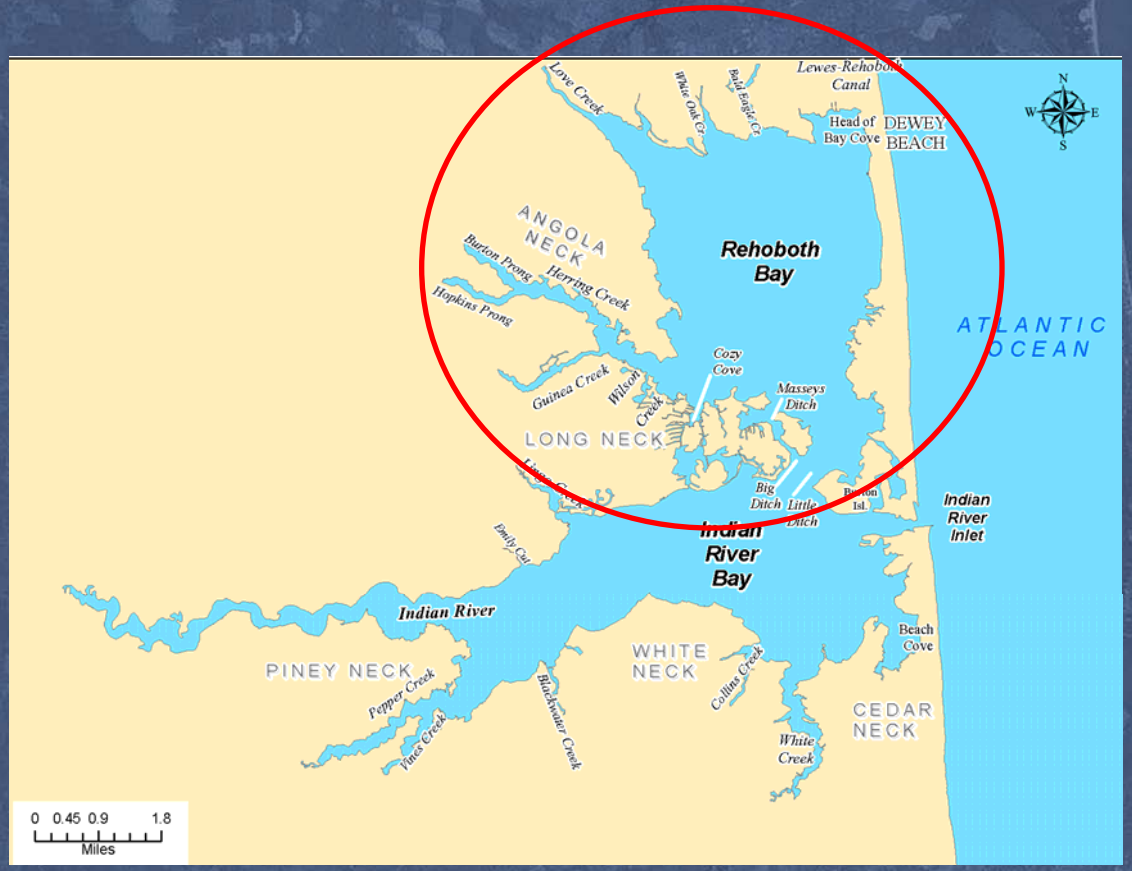
- Environmental data
- Historical dredge records
- Sediment characteristics
- Hydrodynamics
- Sediment deposition and erosion characteristics
- Developing ways to strategize a long term sediment management plan.

M&N's Scope of Work

1. Existing Conditions Assessment
2. Review of Historical Dredging and Disposal
3. Hydrodynamic Modeling
4. Shoaling Estimates
5. Sediment Management Alternatives

Task 1. Existing Conditions

Study Area



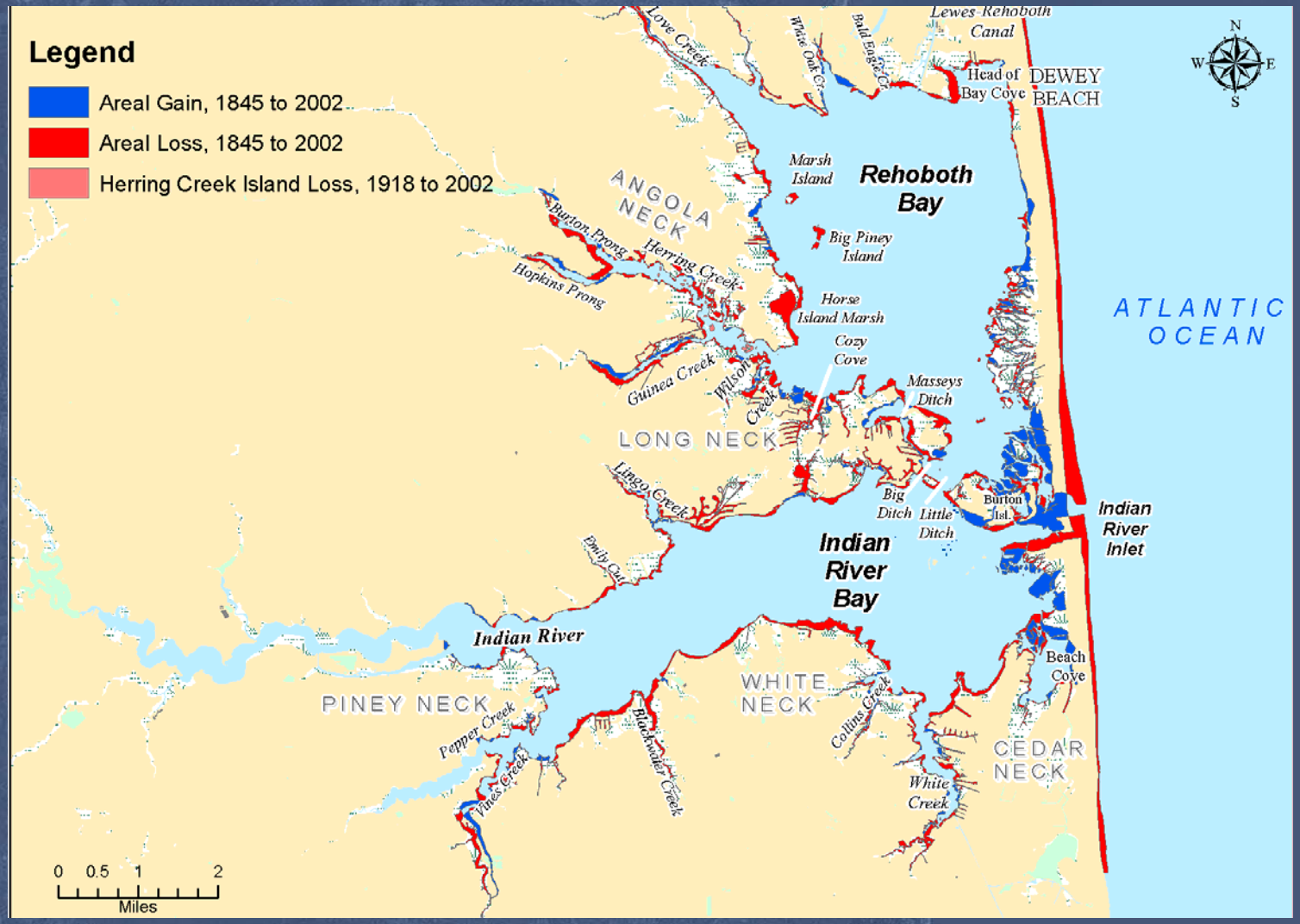
Rehoboth Bay is a shallow bar-built estuary with depths less than 6 to 7 ft (MLLW).

Rehoboth Bay has tidal exchange through the southern link to Indian River Bay and through the Lewes Rehoboth Canal. It also receives freshwater inflow from the many tidal creeks.

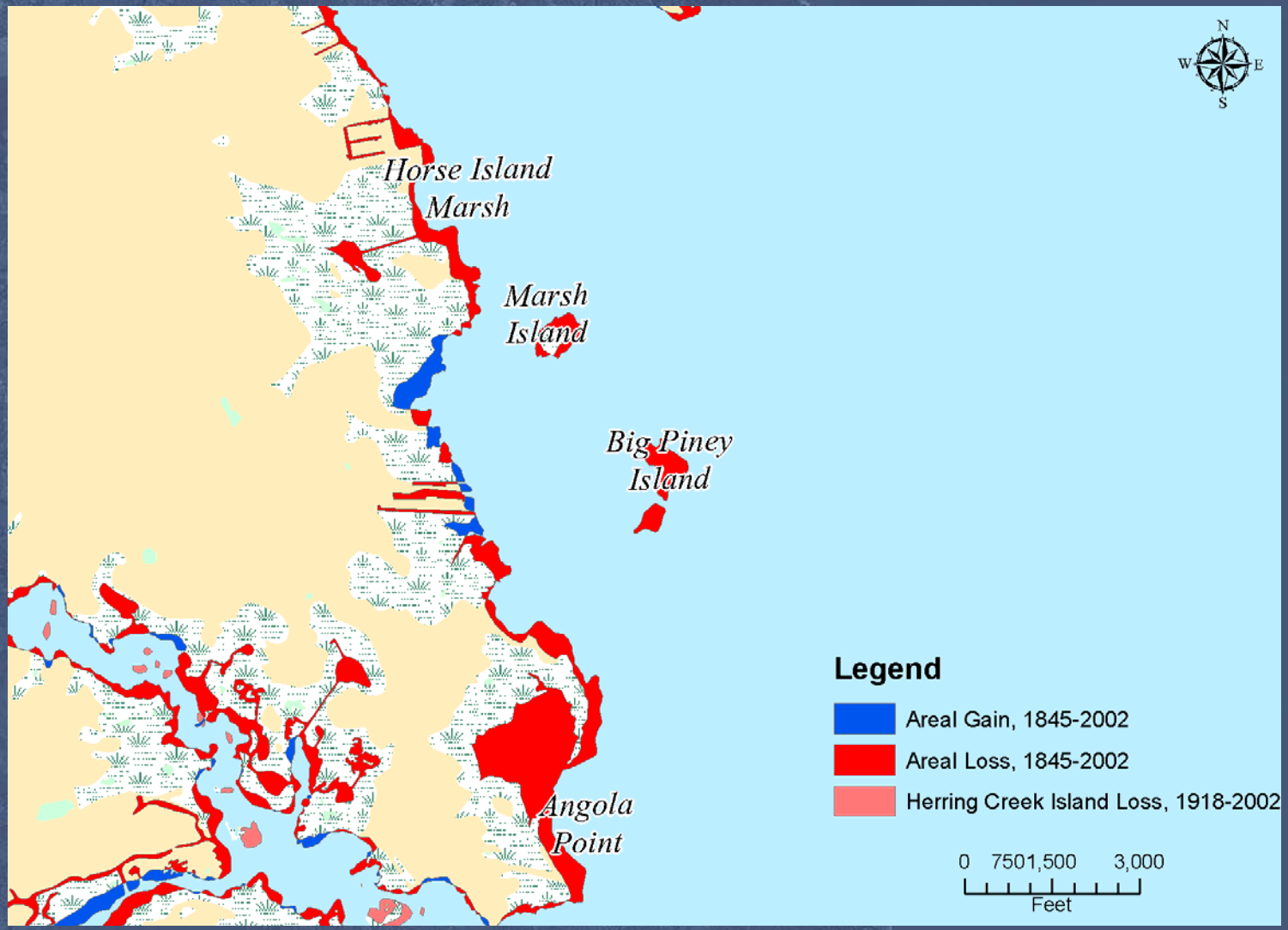
Six primary channel dredging projects within Rehoboth Bay:

- **Lewes-Rehoboth Canal**
- **Love Creek**
- **Herring Creek**
- **Guinea Creek**
- **Wilson Creek**
- **Massey's Ditch**

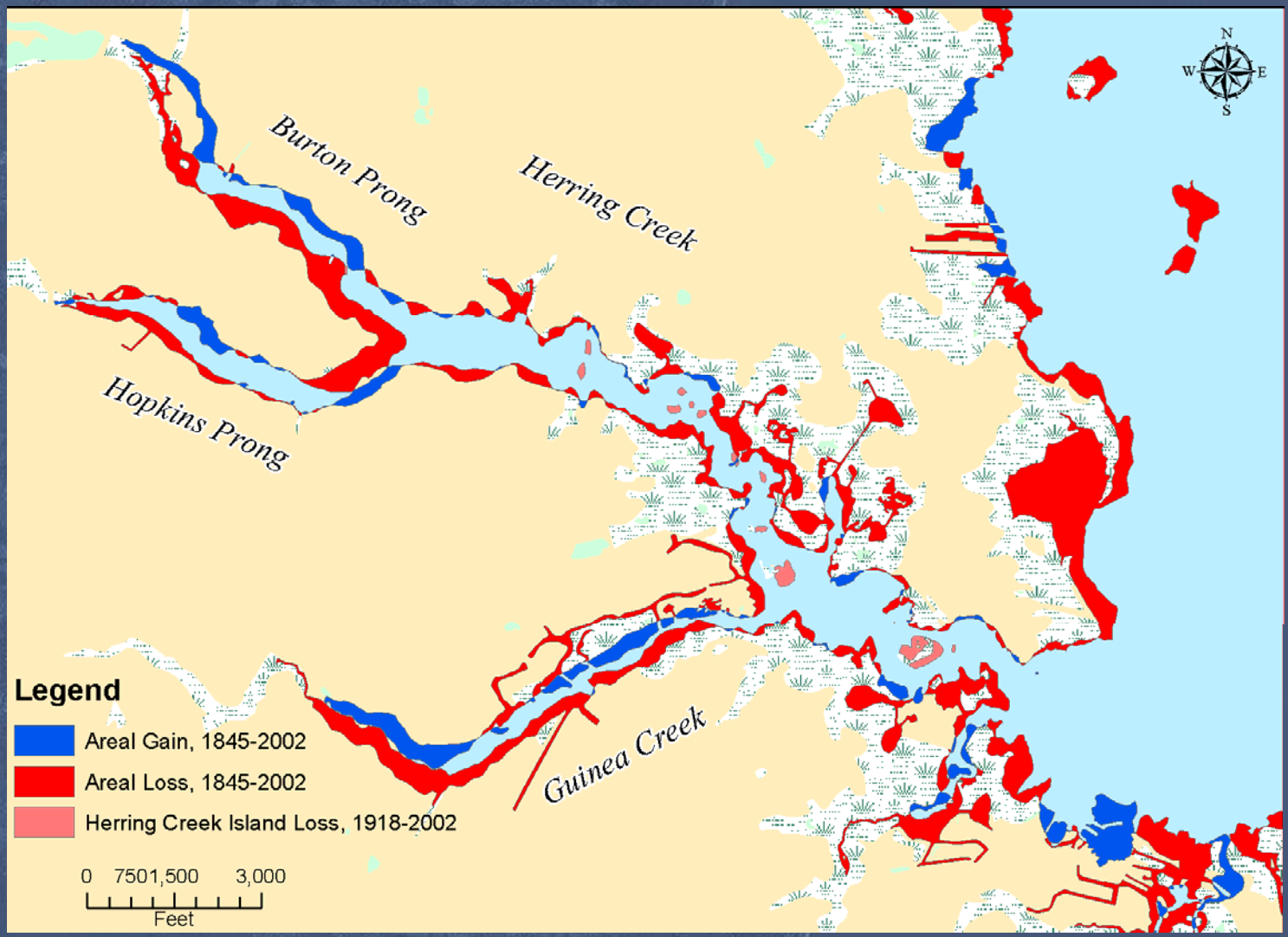
Shoreline Change



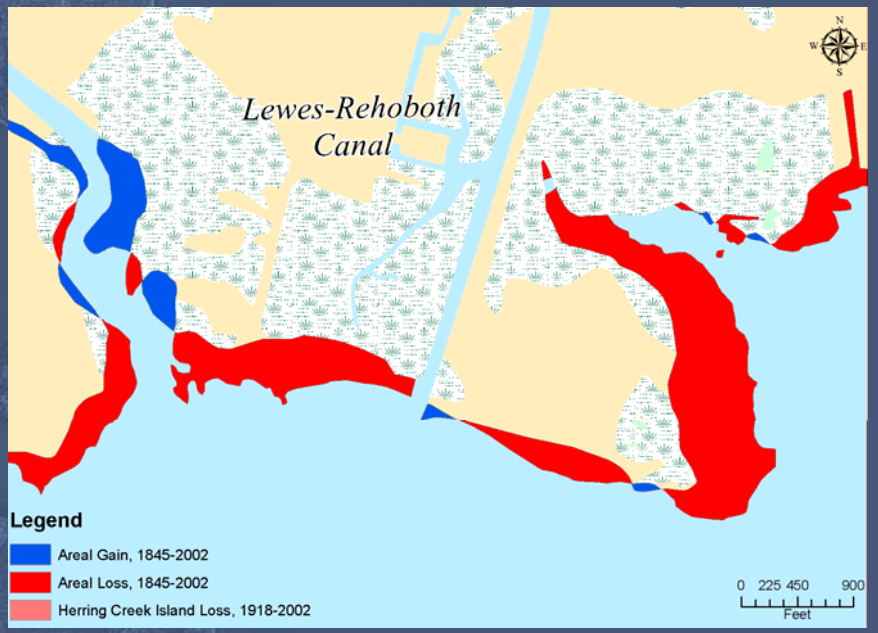
Western Shoreline



Herring Creek



Lewes-Rehoboth Canal



Task 2. Historical Dredging and Disposal

USACE Dredging

In recent years USACE has only maintained the L-R Canal north of the Savannah Ave Bridge

Fiscal Year	Job Name	Dredge Type	Disposal Type	Arrival Date	Departure Date	Volume Removed (CY)
1990	L & R CANAL - ROOSEV.INLET	Pipeline	Beach Nourishment	not avail	not avail	not avail
1994	ROOSEVELT, MURDERKILL, MISPILLION	Pipeline	Mixed (More than one type)	10/23/1994	12/15/1994	94,873
1998	IWW, REH. BAY TO DEL. BAY	Pipeline	Beach Nourishment	10/28/1998	11/30/1998	29,557
2001	IWW, REH. BAY TO DEL. BAY	Pipeline	Beach Nourishment and Upland	10/22/2001	3/1/2002	46,102
2004	ROOSEVELT INLET,DE.	Pipeline	Beach Nourishment	8/25/2004	10/30/2004	180,745

DNREC Dredging since 1970

Decade	Inland Bays Waterway Dredging (x1,000 cy)	Other (x1,000 cy)	Total (x1,000 cy)
1970's	363	437	853
1980's	309	1589	1,898
1990's	244	1,326	1,570
2000-	109	116	225
TOTAL	1,025	3,468	4,546

DNREC Dredging in Inland Bays

WATERWAY	YEAR	TOTAL	Initial	Maint.
Lewes-Rehoboth Canal	1989 TO 1991	40		40
Love Creek	1970 TO 1971	115	115	
Herring Creek	1978 TO 1983	85	85	
Guinea Creek	1977	75	75	
Wilson Creek	1983	27	27	
Cozy Cove	1978 TO 1979	18	18	
Massey's Ditch	1987, 1990 TO 1991	62		62
Indian River Bay	91 TO 1992, 1995 TO 1996, 2001	147		147
Pepper Creek	1986 TO 1988, 1991 TO 1993	220	220	
Vines Creek	1993	7	7	
White Creek	970 TO 1971, 1997, 1999 TO 200	195	135	60
Assawoman Canal	2006	34		34
Grand Total Navigation		**1,025**	**682**	**343**
Average Annual Maintenance				***9.3***

Task 3. Hydrodynamic Modeling

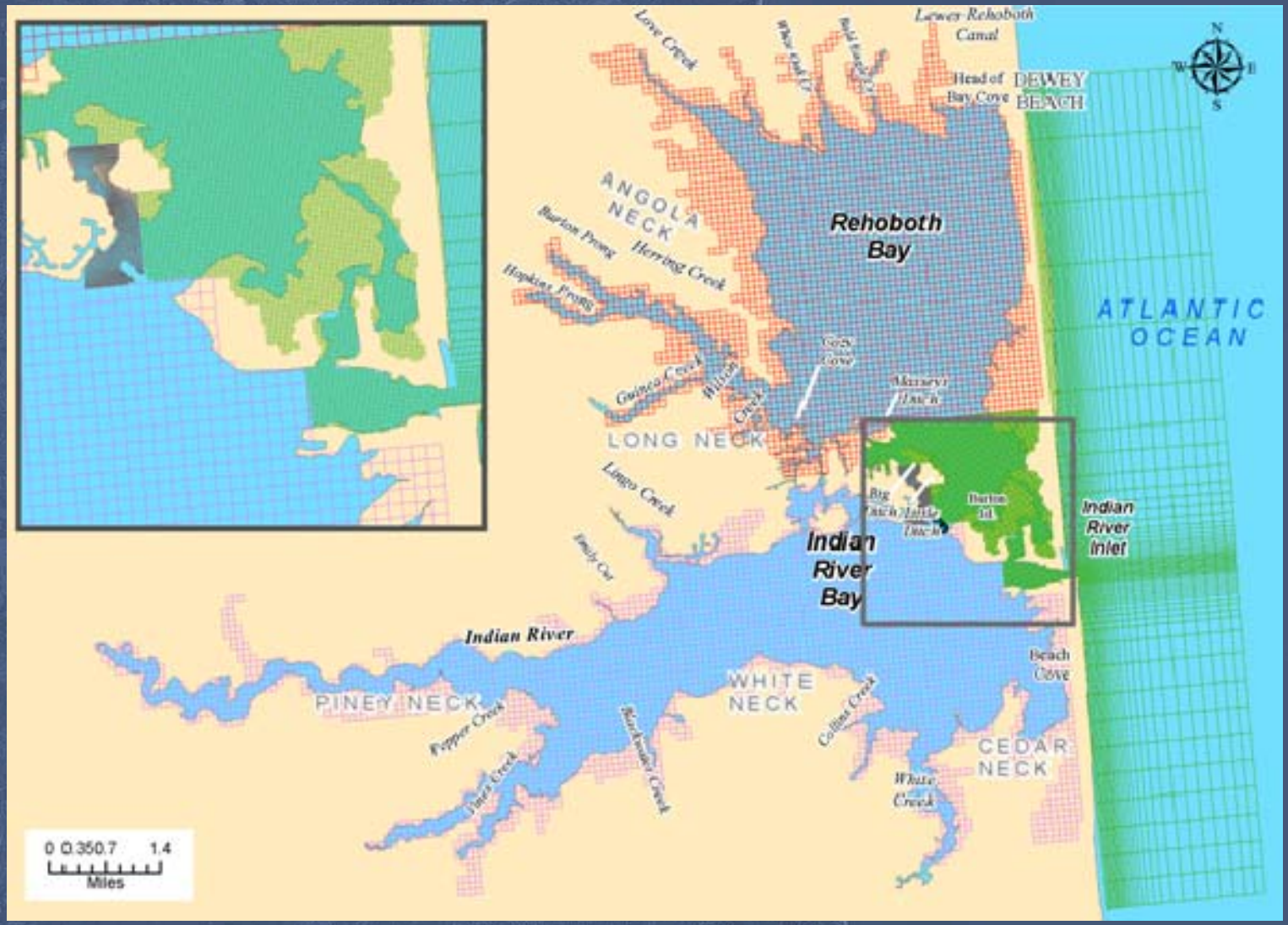
DELFT 3D Modeling System

WL | delft hydraulics

innovative in water management and hydraulic engineering

- An integrated surface water modeling system developed by WL | Delft Hydraulics
- Two and three-dimensional flow, waves, water quality, ecology, sediment transport and bottom morphology

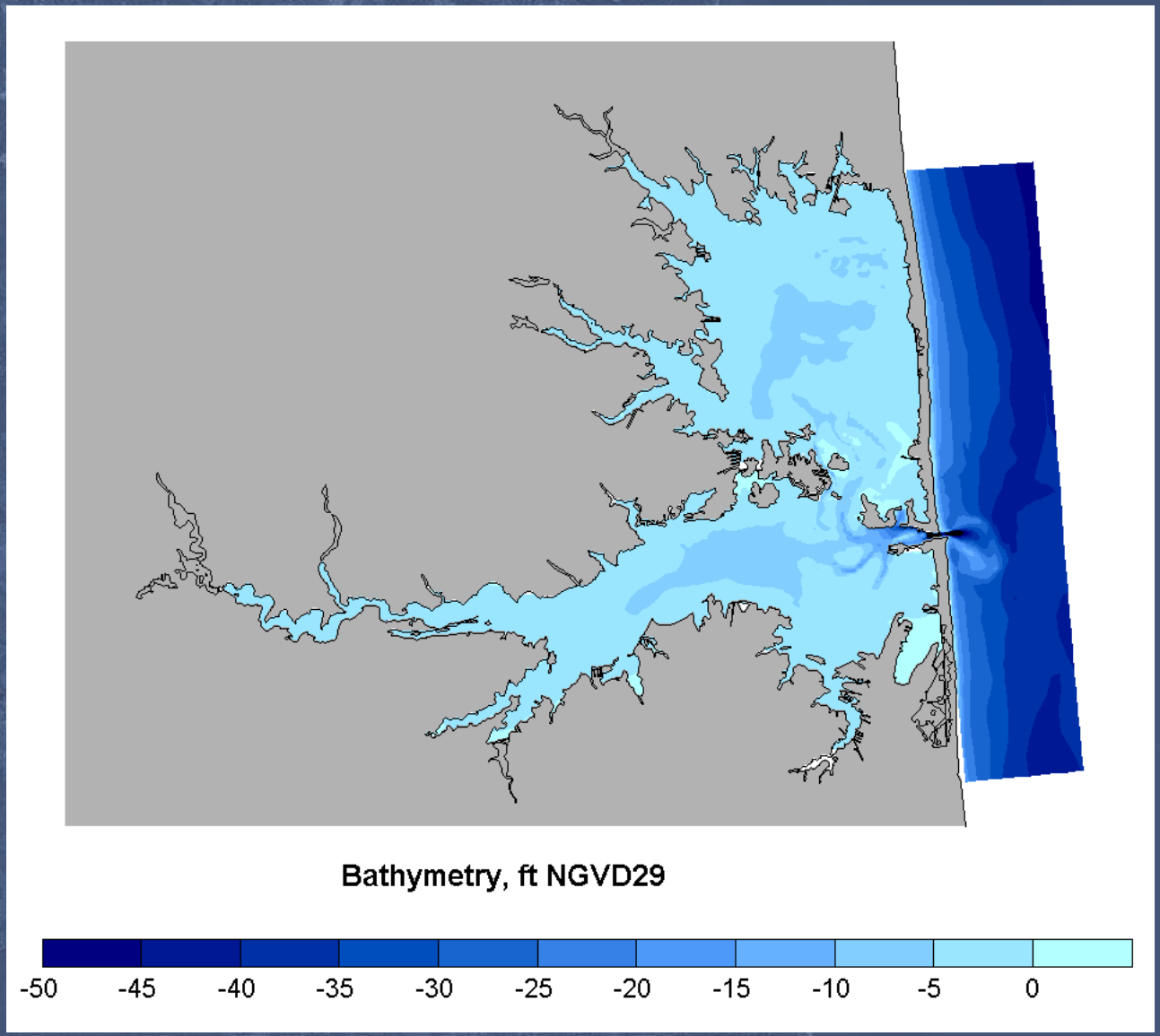
Model Grid


Lewes-Rehoboth Canal
Love Creek
Head of Bay Cove
DEWEY BEACH
ANGOLA NECK
Burton Prong
Herring Creek
Hopkins Prong
Rehoboth Bay
ATLANTIC OCEAN
Guinea Creek
Wilson Creek
Massey Ditch
LONG NECK
Lingo Creek
Big Ditch
Burton Island
Indian River Inlet
Indian River Bay
Indian River
PINEY NECK
Pepper Creek
Swan Creek
Blackwater Creek
WHITE NECK
Beach Cove
Collins Creek
CEDAR NECK
Wreck Creek
0 0.35 0.7 1.4
Miles

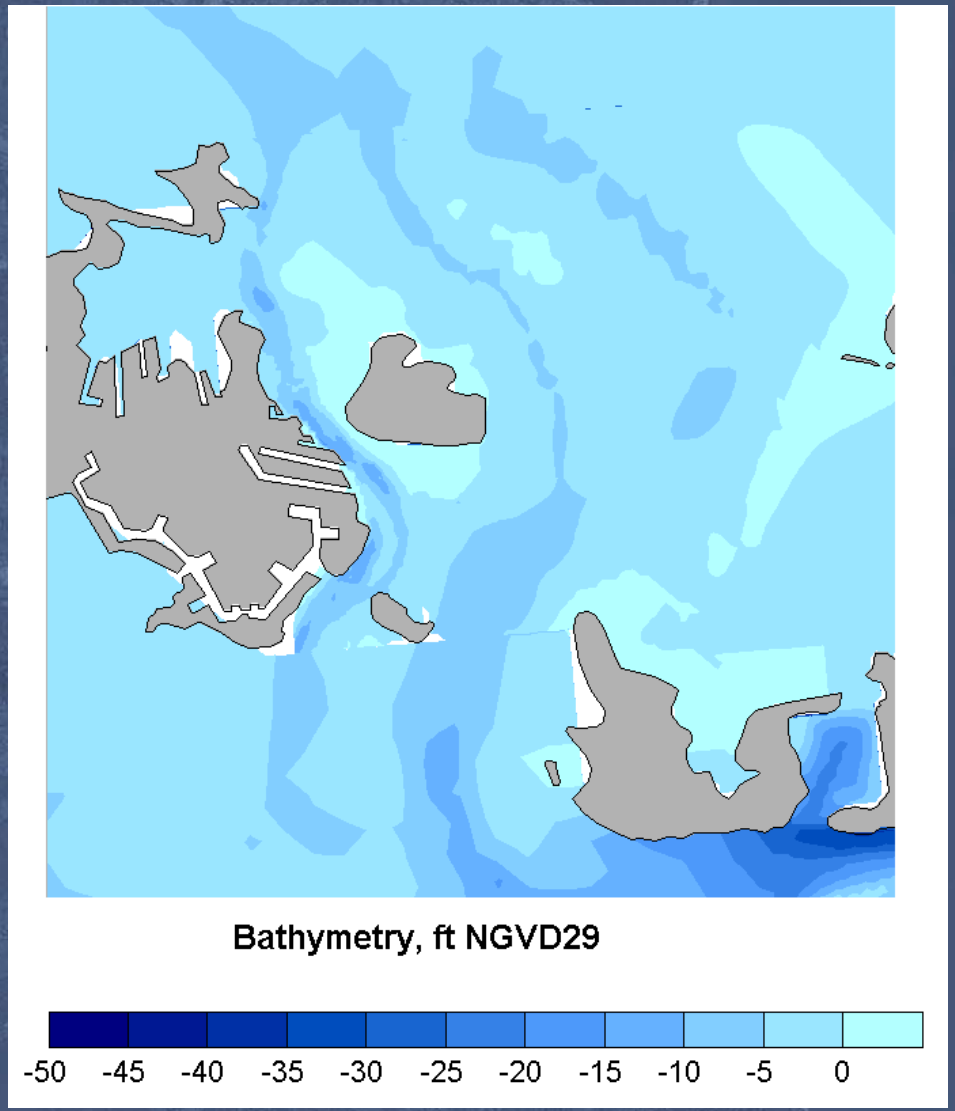
Bathymetry Data

Date	Coverage	Source
2004	IR Inlet and Surrounding areas	USACE
2004	Inland Bays	DNREC
1963,1970,1977, 1984	Offshore	NGDC (GEODAS)
2004	Love Creek	DNREC
2004	Herring Creek	DNREC
1998	Guinea Creek	DNREC
2000	Bald Eagle Creek	DNREC
2005	Roosevelt Inlet (Lewes Rehoboth Canal)	USACE

Model Bathymetry

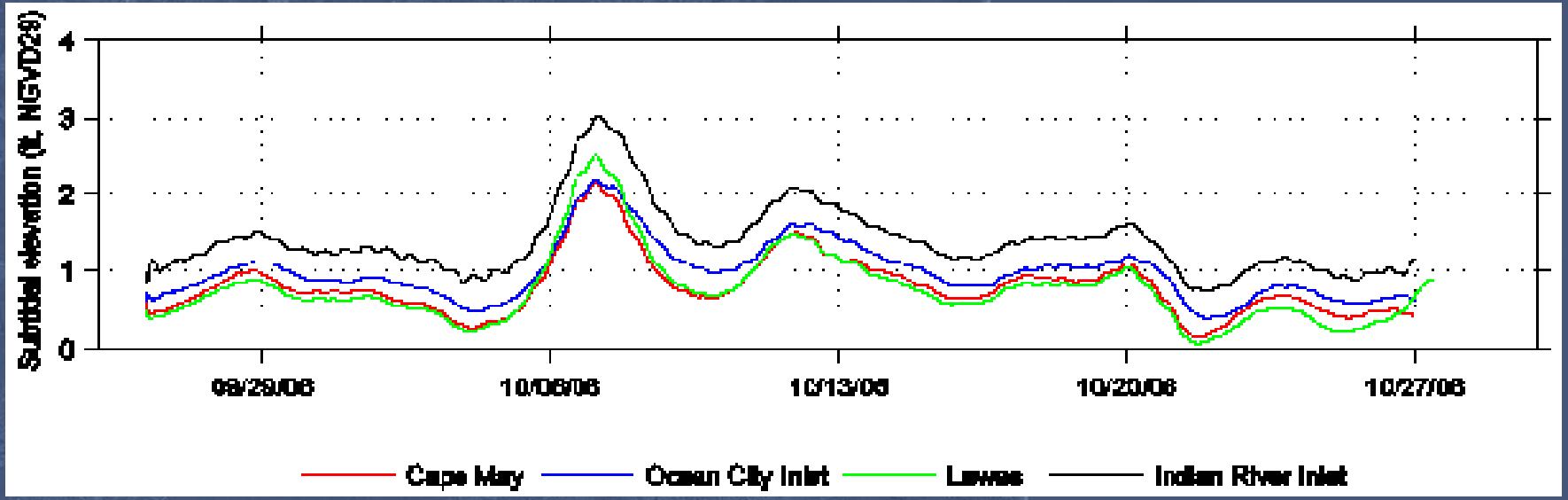


Model Bathymetry



Offshore Boundary

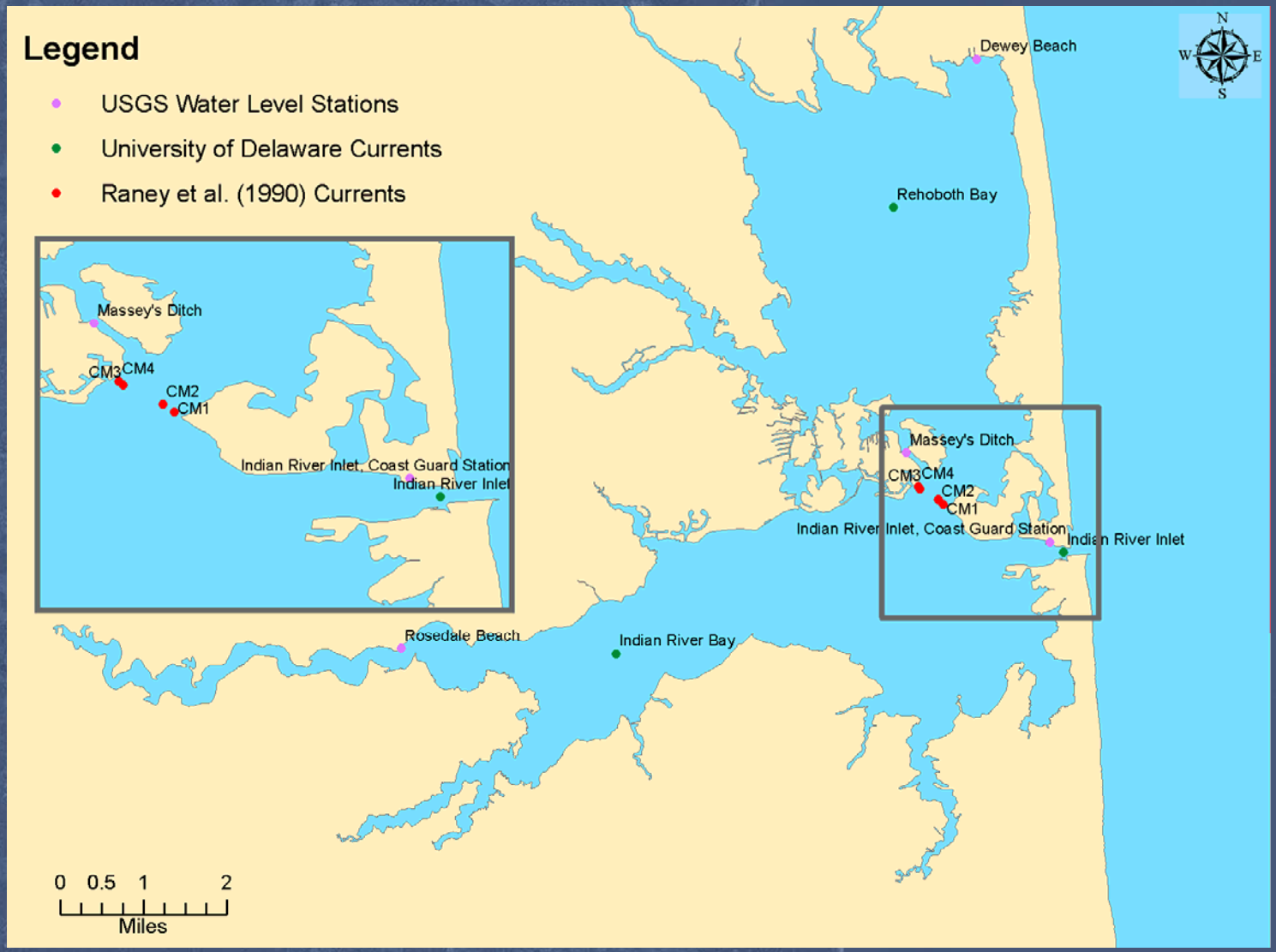
- Tidal constituents were extracted at the north and south ends of the boundary from the Advanced CIRCulation (ADCIRC) model EastCoast2001
- Residuals from three nearby NOAA stations were compared with those at Indian River Inlet.
- Extracted residuals were added to the harmonic components of the boundary



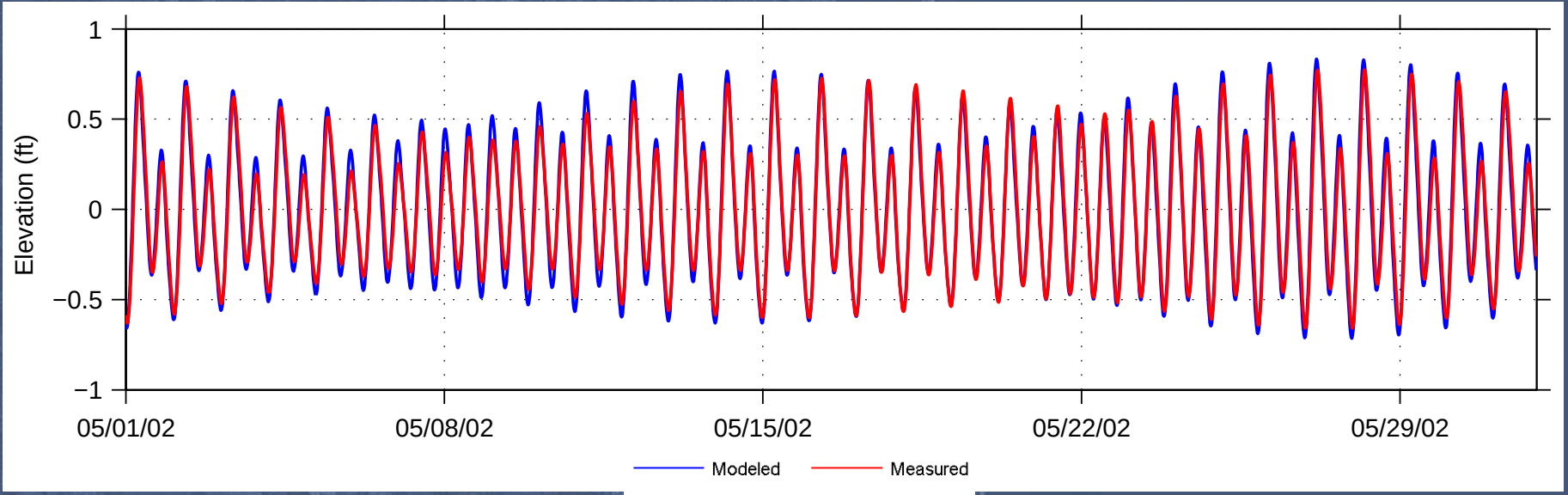
Additional Forcing

- River Discharge was found to have negligible effects on hydrodynamic conditions with the exception of Indian River.
- Wind forcing has the greatest impact in Rehoboth Bay. The closest available source for the tested time periods was at Georgetown-Sussex Airport

Calibration

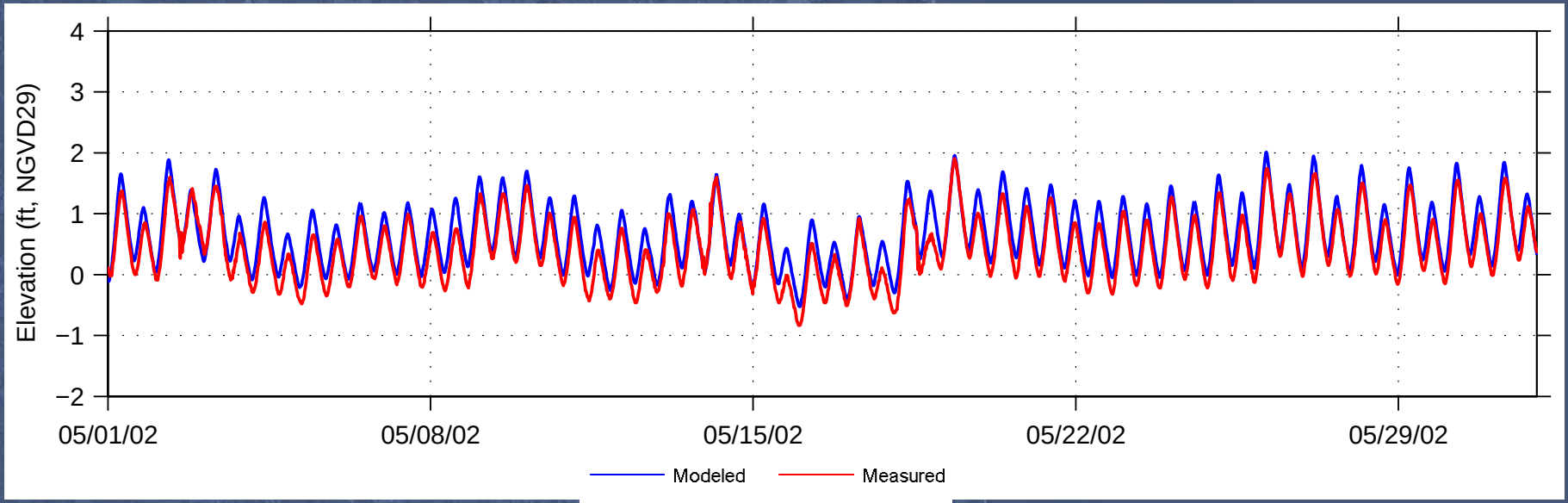


Harmonic Calibration



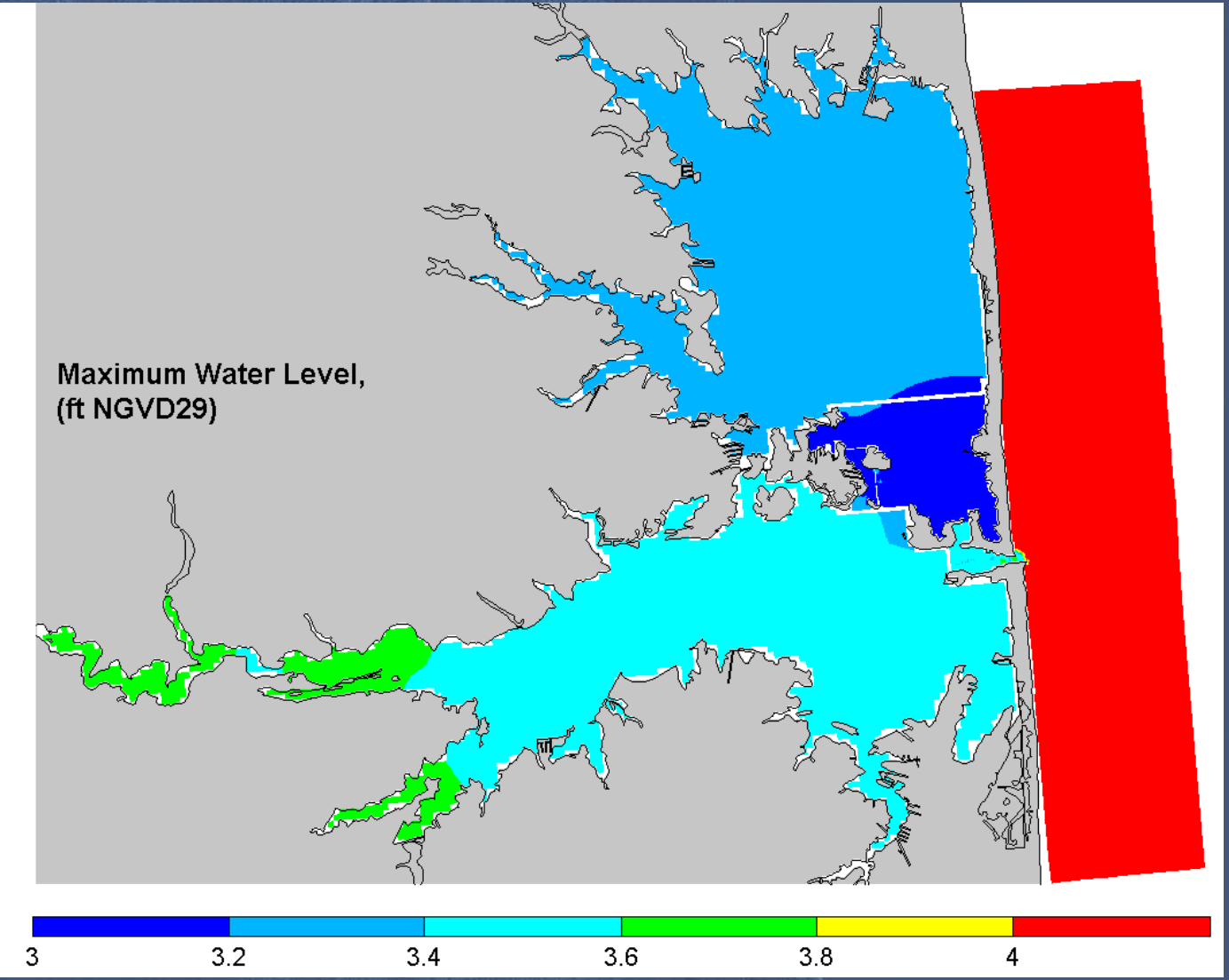
Station	Correlation	RMS error (ft)	Percent error
Indian River Inlet (Coast Guard Station)	0.99	0.20	5.8%
Indian River Bay (Rosedale Beach)	0.99	0.13	4.3%
Rehoboth Bay (Dewey Beach)	0.98	0.08	5.3%

Water Level Calibration



Station	Correlation	RMS error (ft)	Percent error
IRI (Coast Guard Station)	0.98	0.22	4.5%
Indian River Bay (Rosedale Beach)	0.98	0.25	5.2%
Rehoboth Bay (Dewey Beach)	0.95	0.27	8.4%

Water Levels



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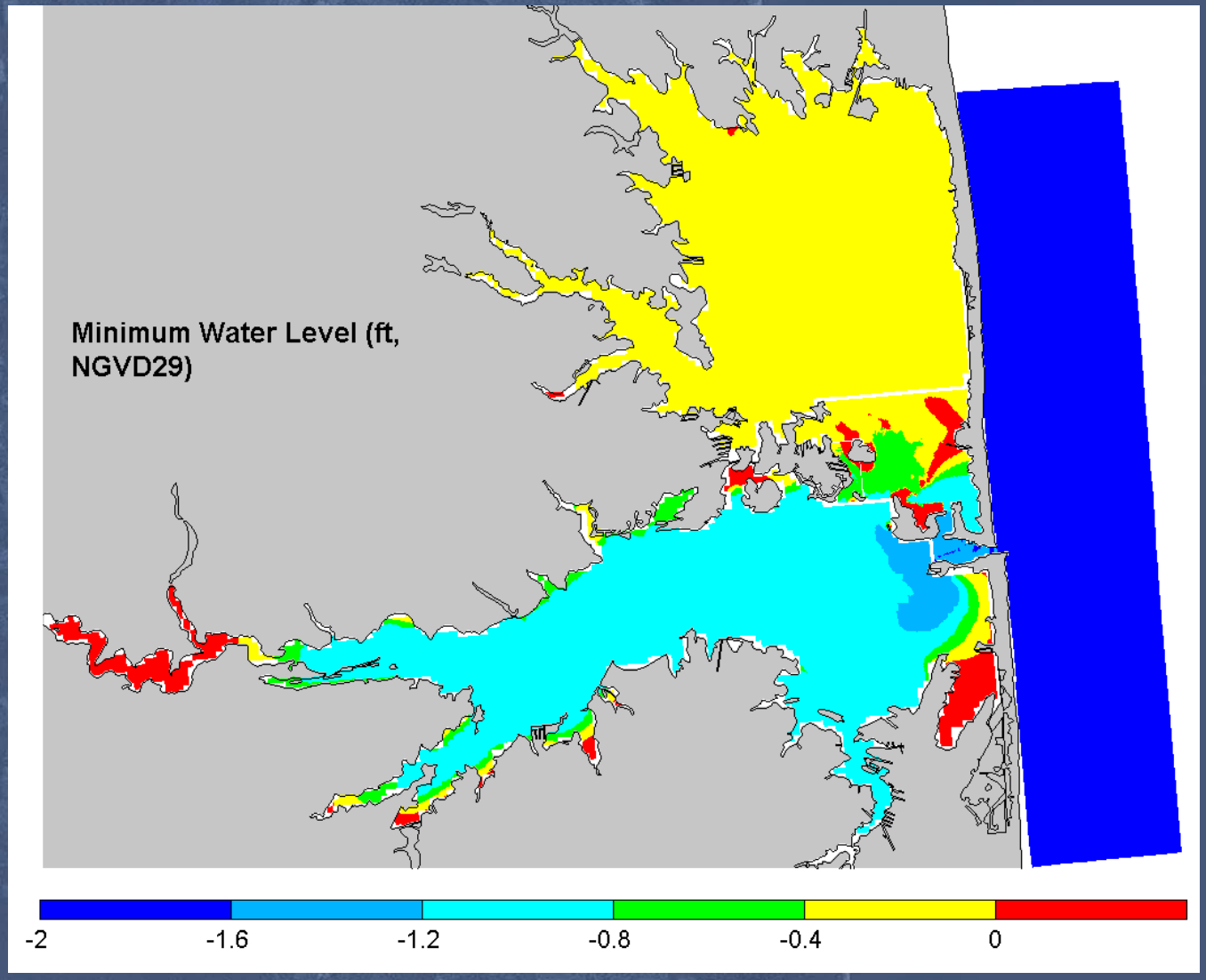
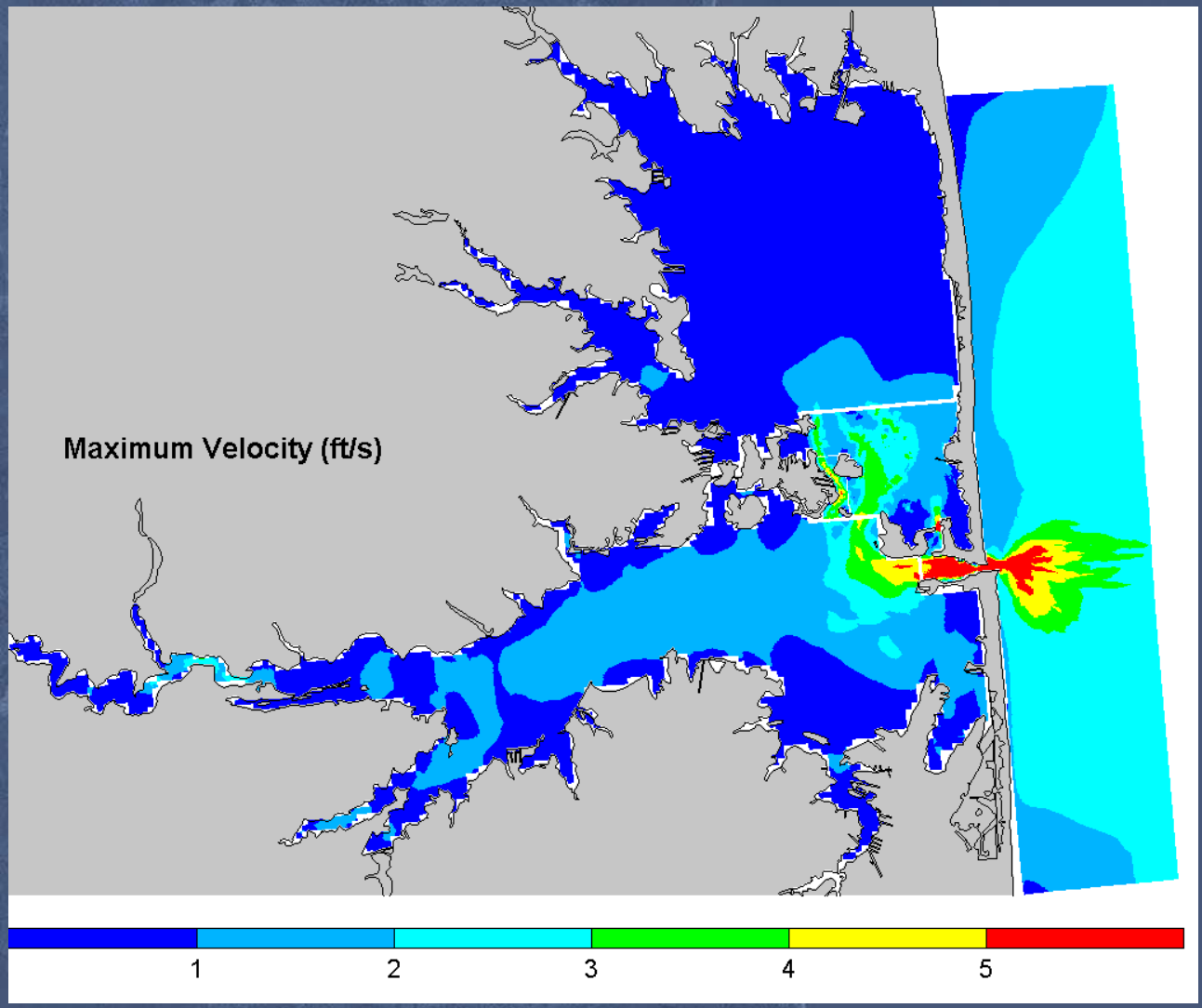
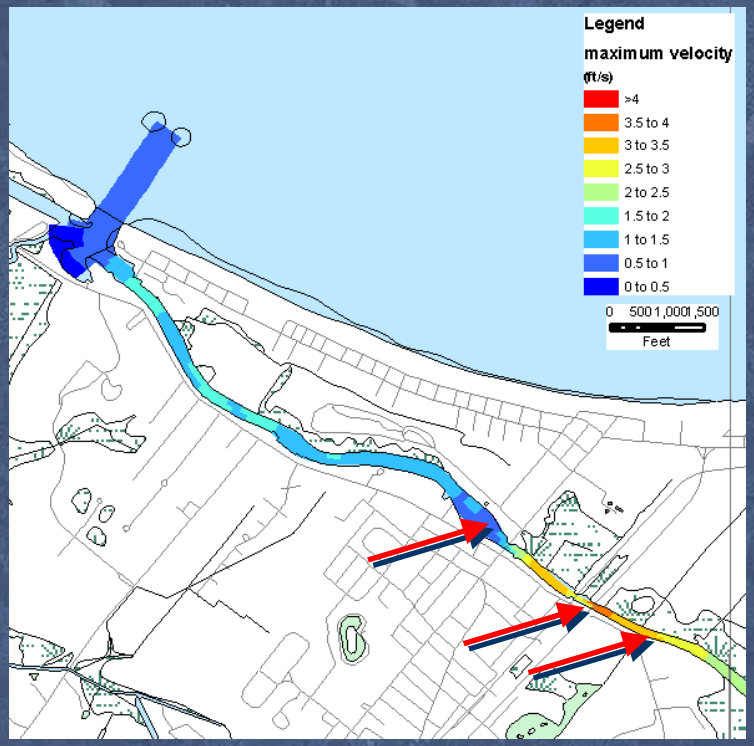


Maximum velocities



Task 4. Shoaling Calculations

Lewes-Rehoboth Canal – Lewes Reach

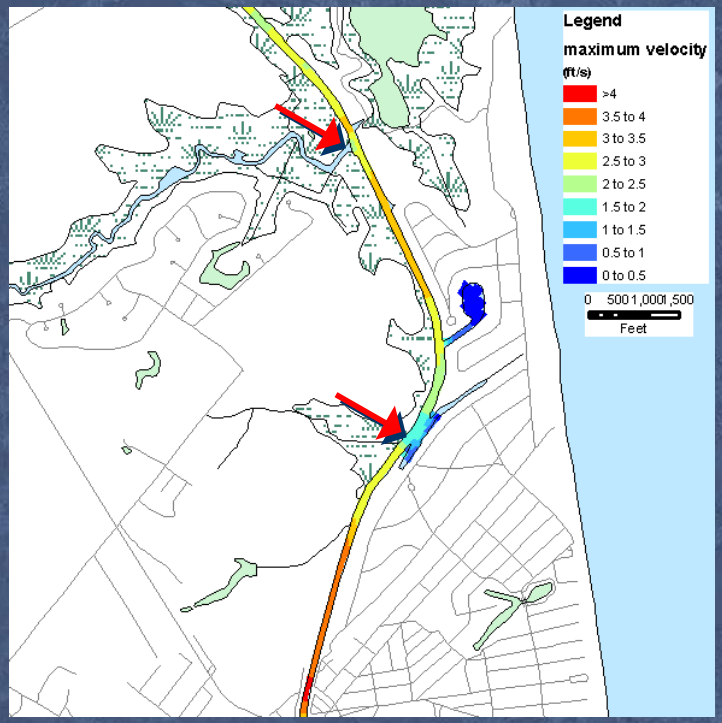


5,000 to 10,000 cy/year (excluding RI inlet) >90% sand

2-4 yr cycle

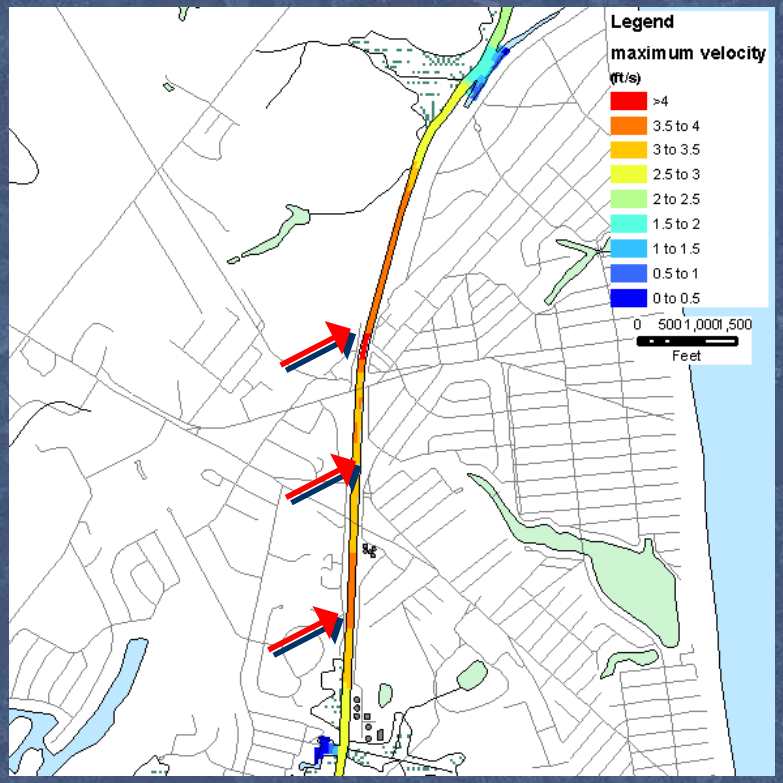
Most sedimentation occurs in the turning basin and bend immediately north of this area

Lewes-Rehoboth Canal – Henlopen Acres Reach



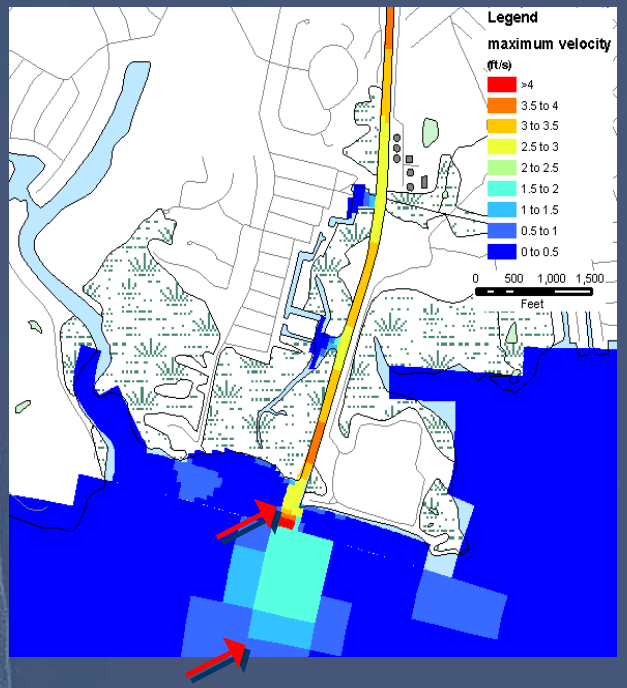
1,000 to 2,000 cy/yr, 2-4 yr cycle.
Less than 30% sand

Lewes-Rehoboth Canal – Rehoboth Bridge



2,000 cy/yr, 2-4 yr cycle. More than 90% sand

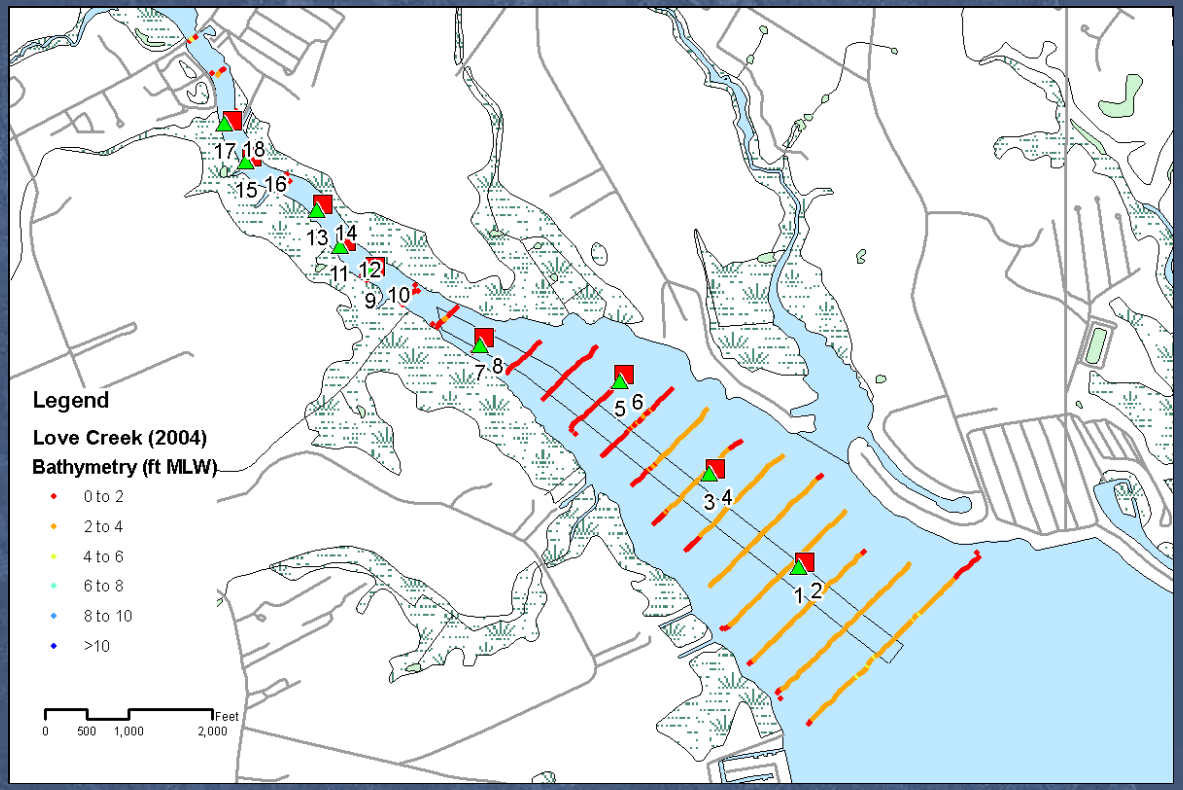
Lewes-Rehoboth Canal – Rehoboth Bay Jetties



4,000 cy/yr, 1-2 yr cycle. 50% sand 50% silt/clay

Total initial volume for L-R Canal: 40,000 cy

Love Creek



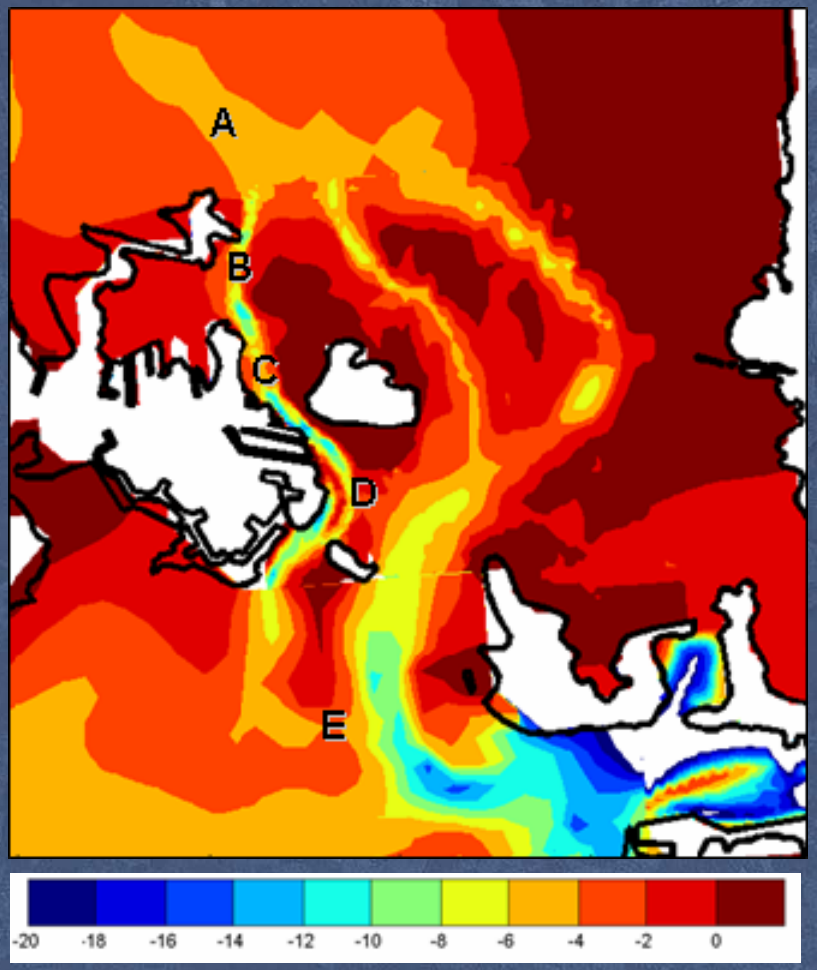
3-5,000 cy/yr. Mostly silt/clay

Total initial volume for -4 ft MLW channel: 60,000 cy

Herring and Guinea Creek

4-8,000 cy/yr for a channel at -4ft MLW. Mostly silt/clay

Massey's Ditch



Problem Areas:

A. North of Bluff Point

B. Pullover

C. Massey's Ditch

D. Middle Island shoal

E. Channel from Big Ditch to Little Ditch

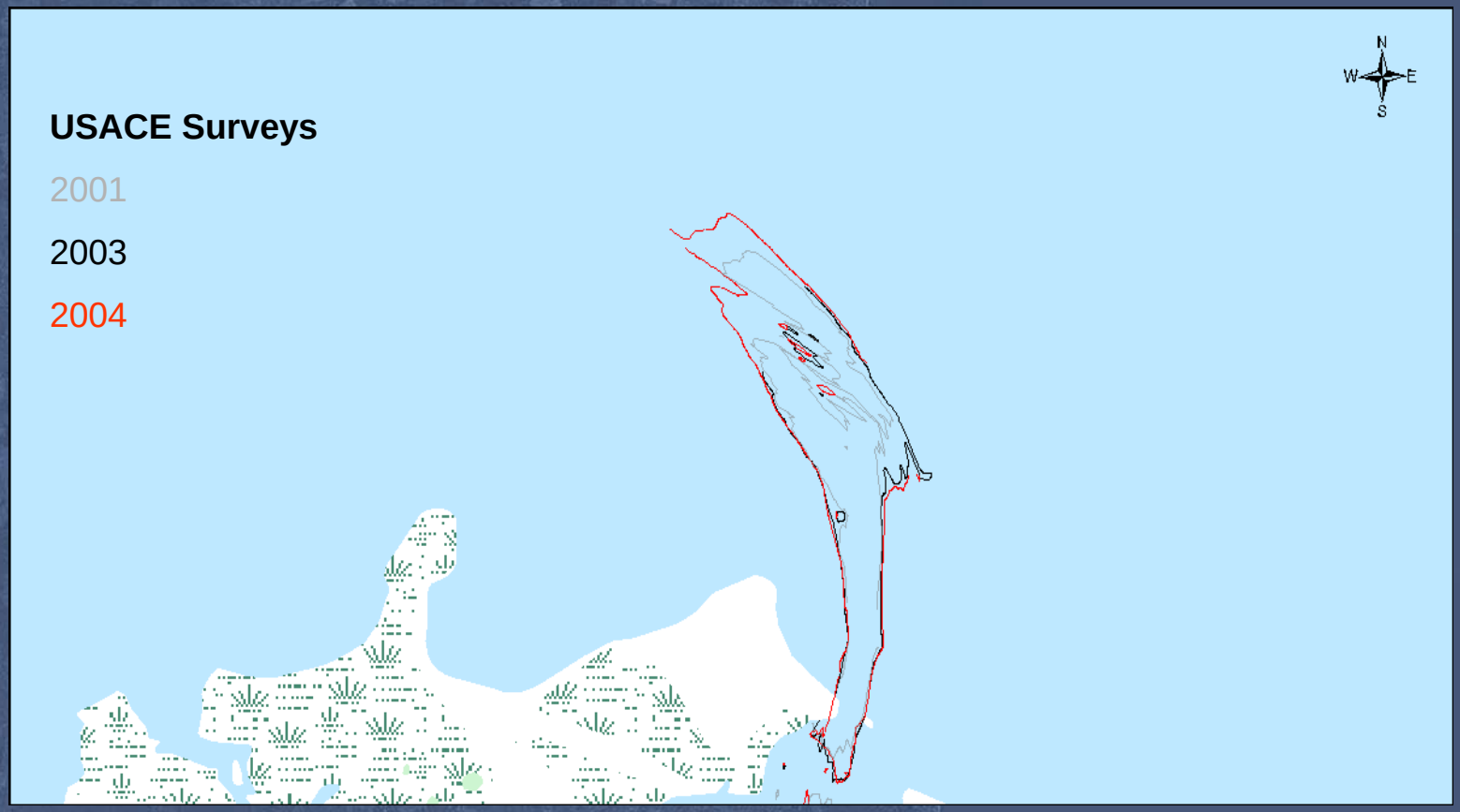
Analytical Sedimentation Model

Analytical methodology originally developed by Eysink and Vermaas (1983) which accounts for:

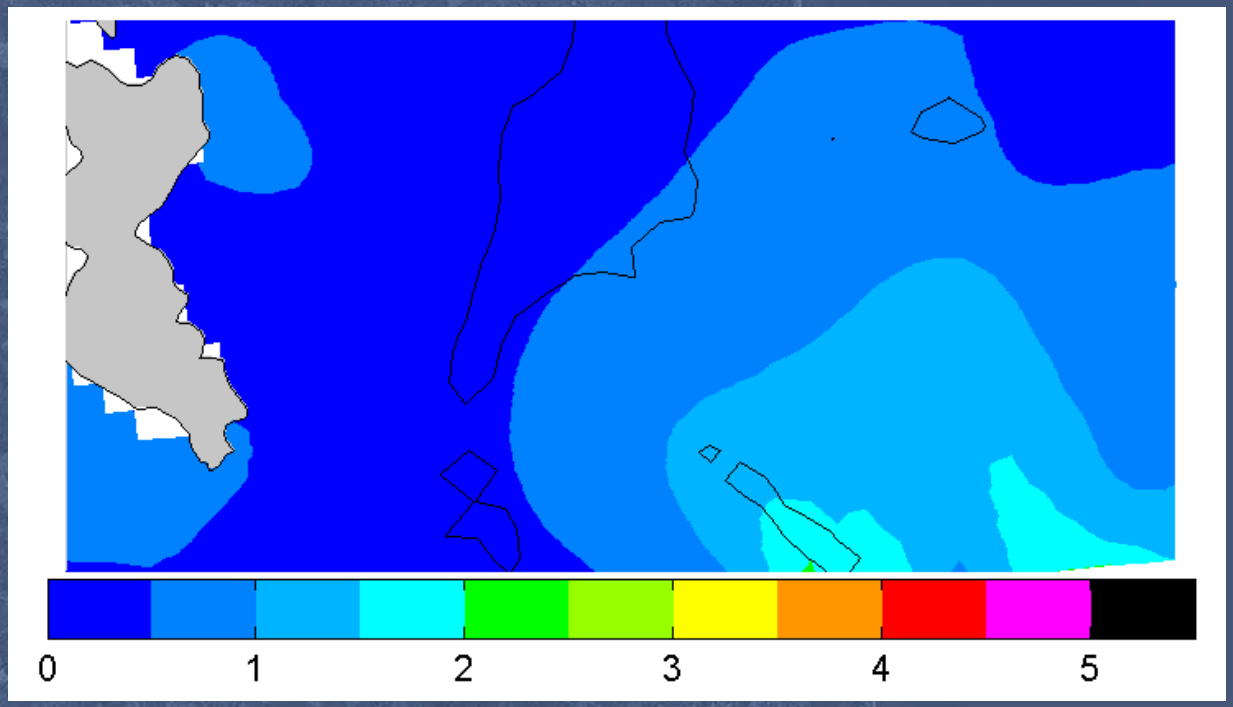
- Channel dimensions
- Natural water depth
- Settling velocity of sediment
- Estimated wave conditions

Hydrodynamic model was modified to represent post-dredge conditions.

A. Bluff Point

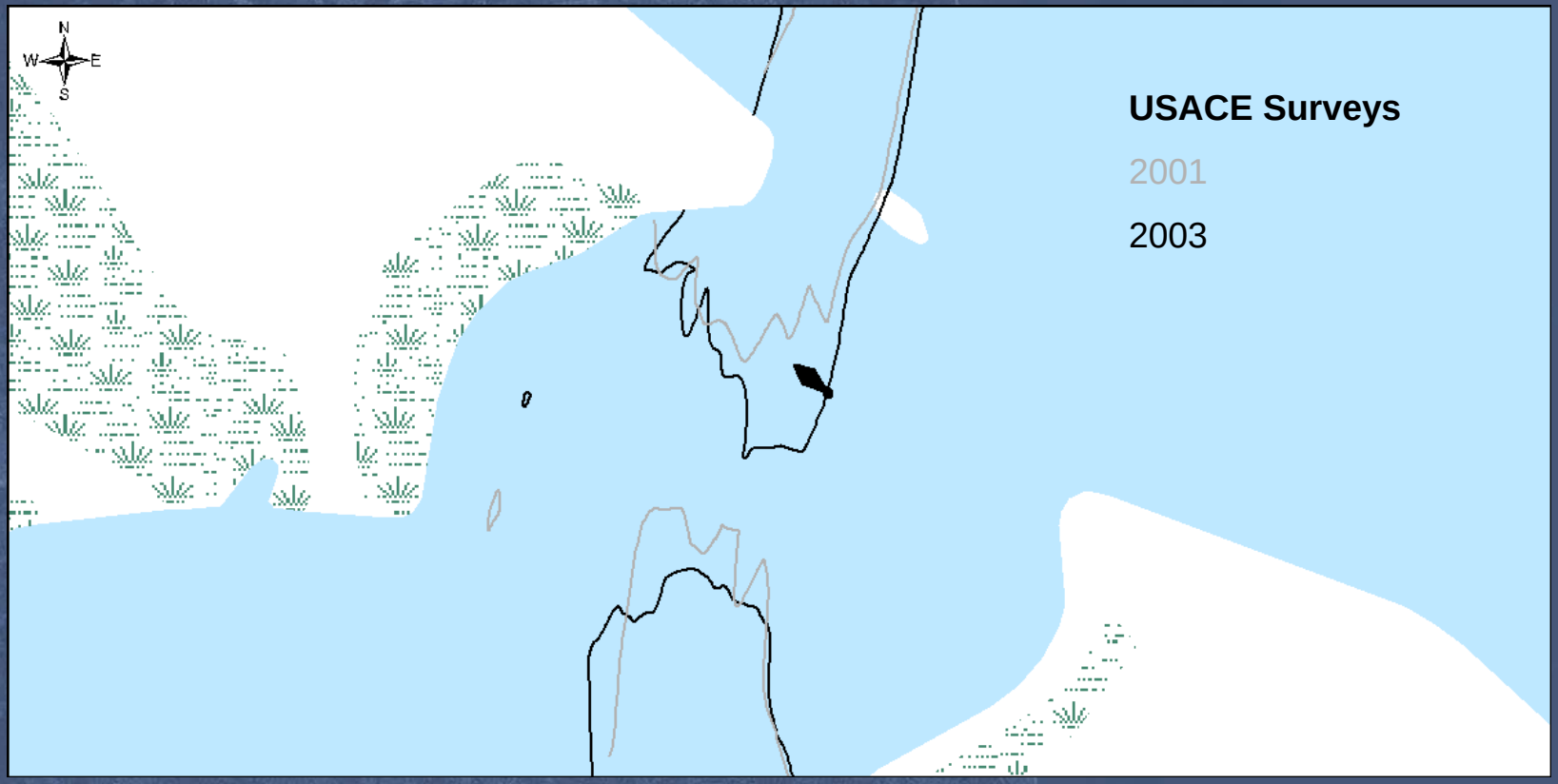


A. Bluff Point

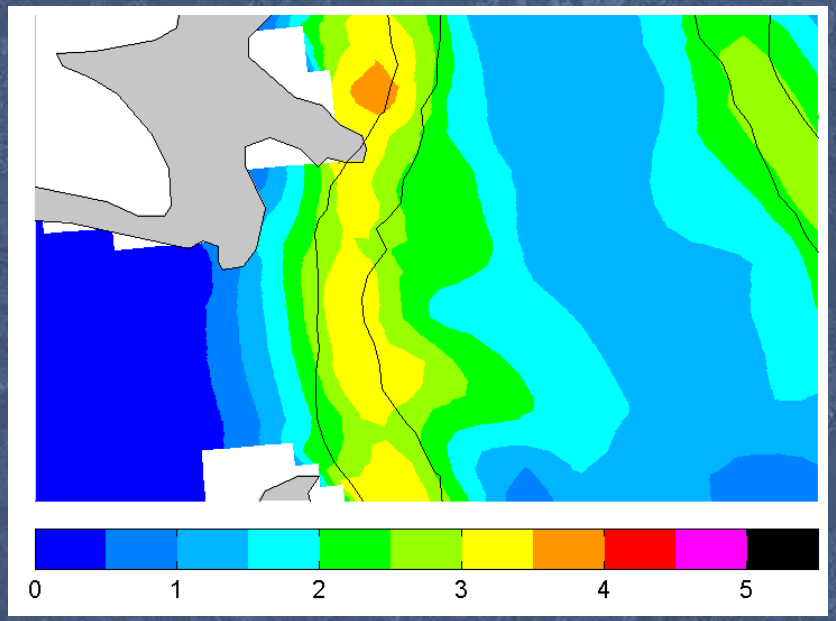


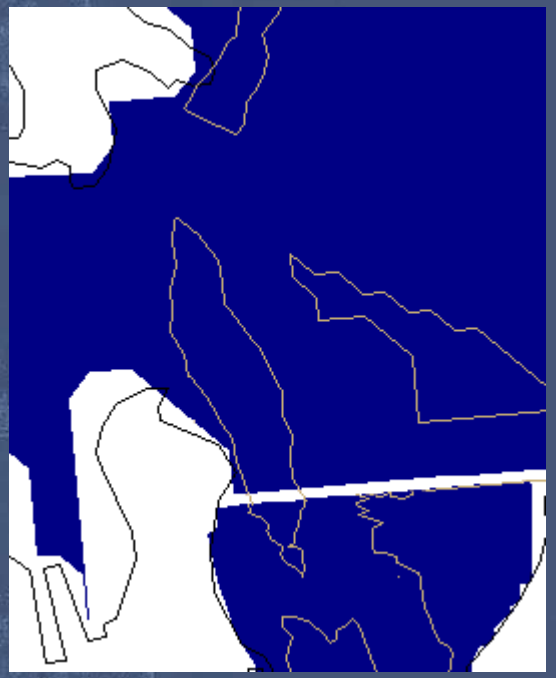
Maximum Velocity (ft/s)

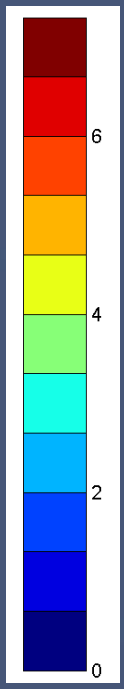
B. Pullover



B. Pullover

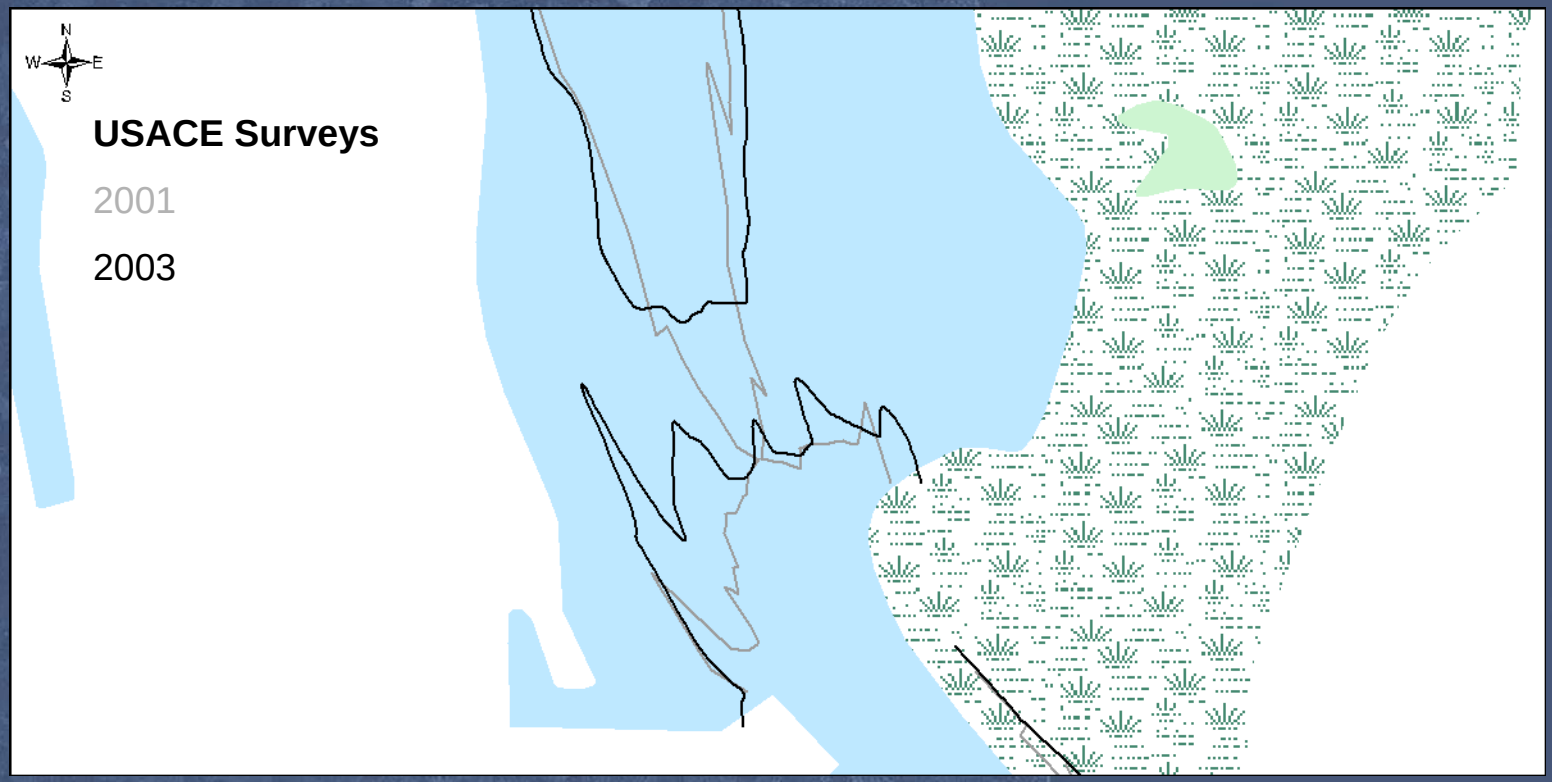






Velocity (ft/s)

C. Massey's Landing



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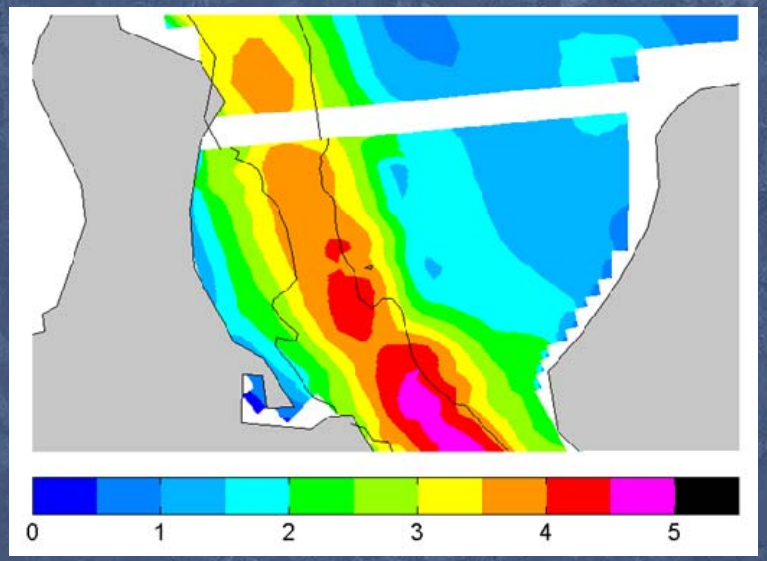
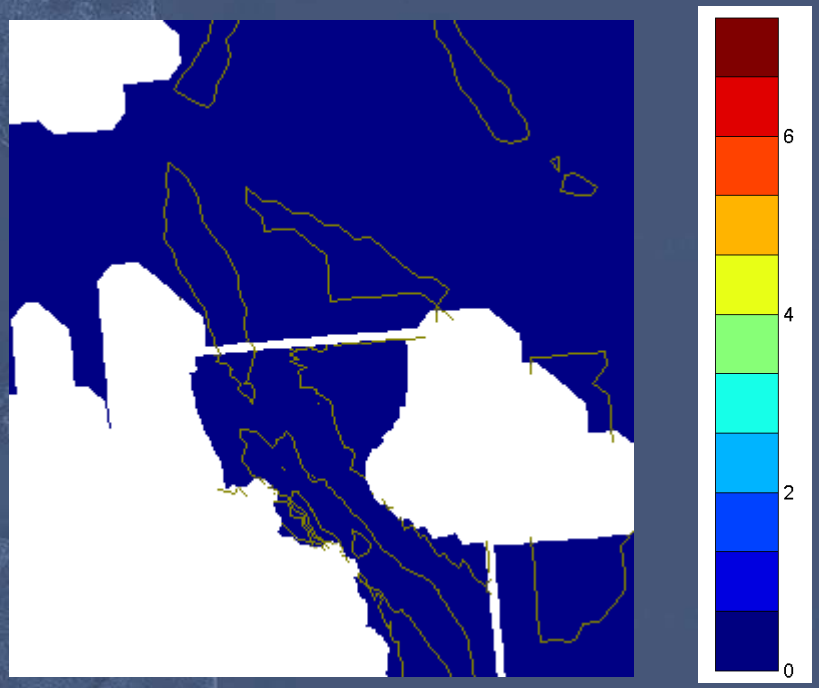
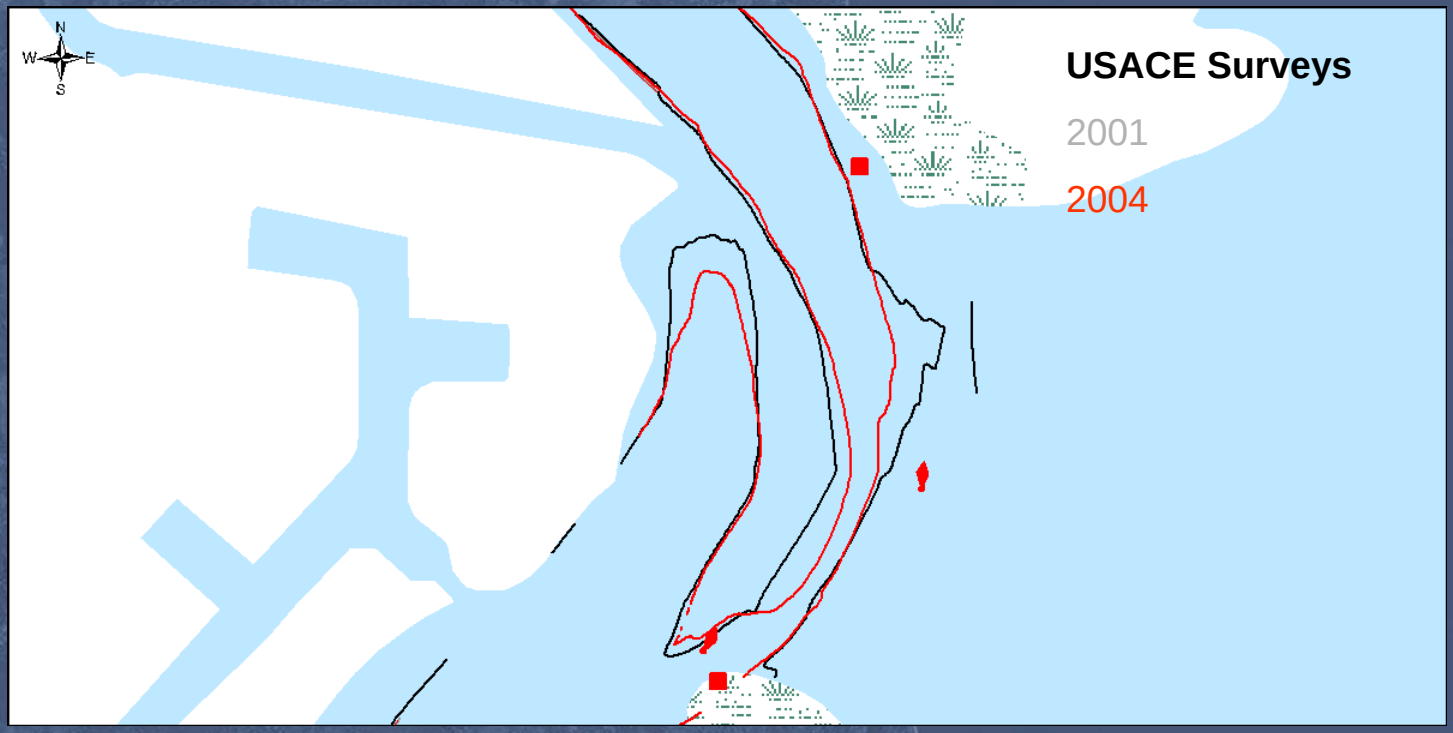


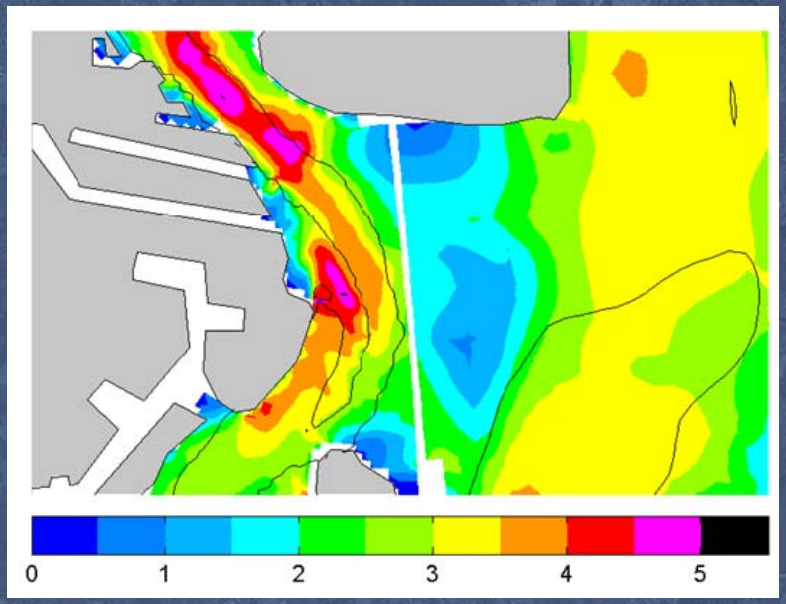


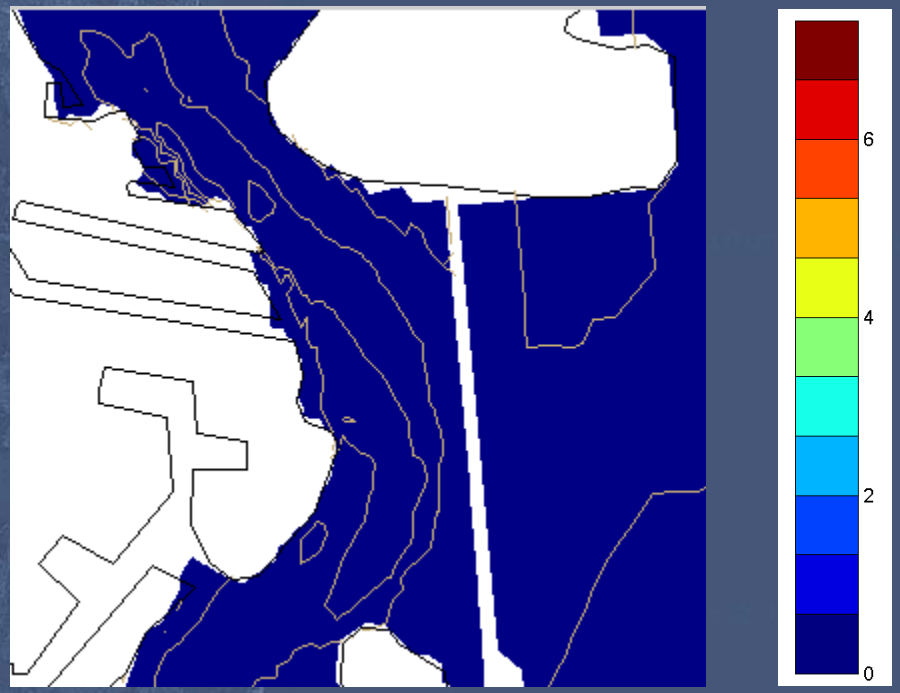
Velocity (ft/s)

D. Middle Island



D. Middle Island





Velocity (ft/s)

E. Big Ditch to Little Ditch Channel

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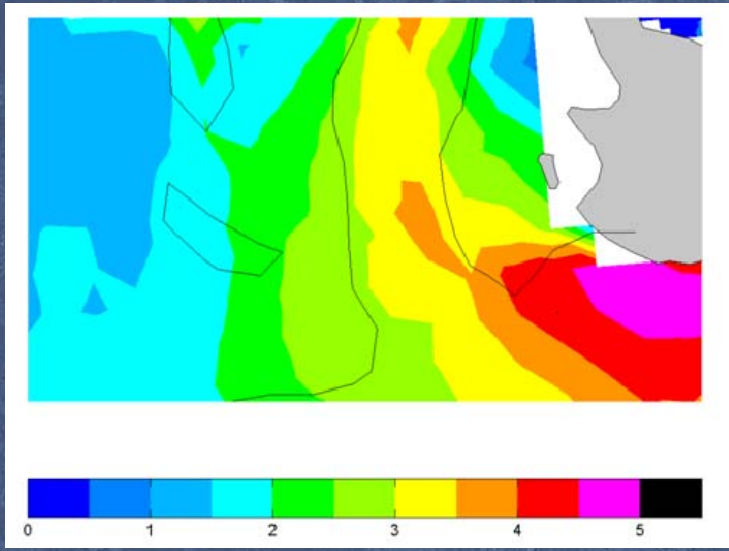
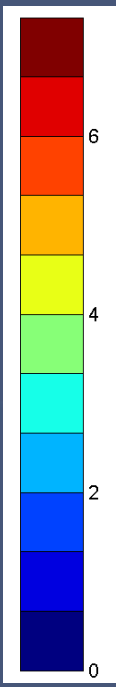




Velocity (ft/s)

Massey's Ditch Shoaling Rates

Location	Shoaling Rate ft/yr	Shoaling Rate cy/yr	Dredging frequency (1)
A: Bluff Point	2.2	8,000	2-4
B: Pullover	2.7	3,000	1-2
C: Massey's Landing	2.3	3,000	1-2
D: Middle Island	3.4 (2)	8,000	2-4
E: Big Ditch to Little Ditch Channel	1.8	2,000	2-4

(1) Approximate Dredging frequency required to maintain a channel at -6 ft MLW
(2) This rate is not across the entire width of the channel, only at the leading edge of the shoal

Task 5. Sediment Management Alternatives

Shoaling Reduction Measures

KSO: *Keep Sediment Out*

- Dikes
- Sills
- Harbor entrance modifications
- Sedimentation basins/traps

KSM: *Keep Sediment Moving*

- Flow training structures
- Flow augmentation

Volume Reduction Measures

Mechanical Dewatering: Belt Press Dredging

- *Garrisons Lake near Smyrna (8,000 cy)*

Beneficial Reuse Measures

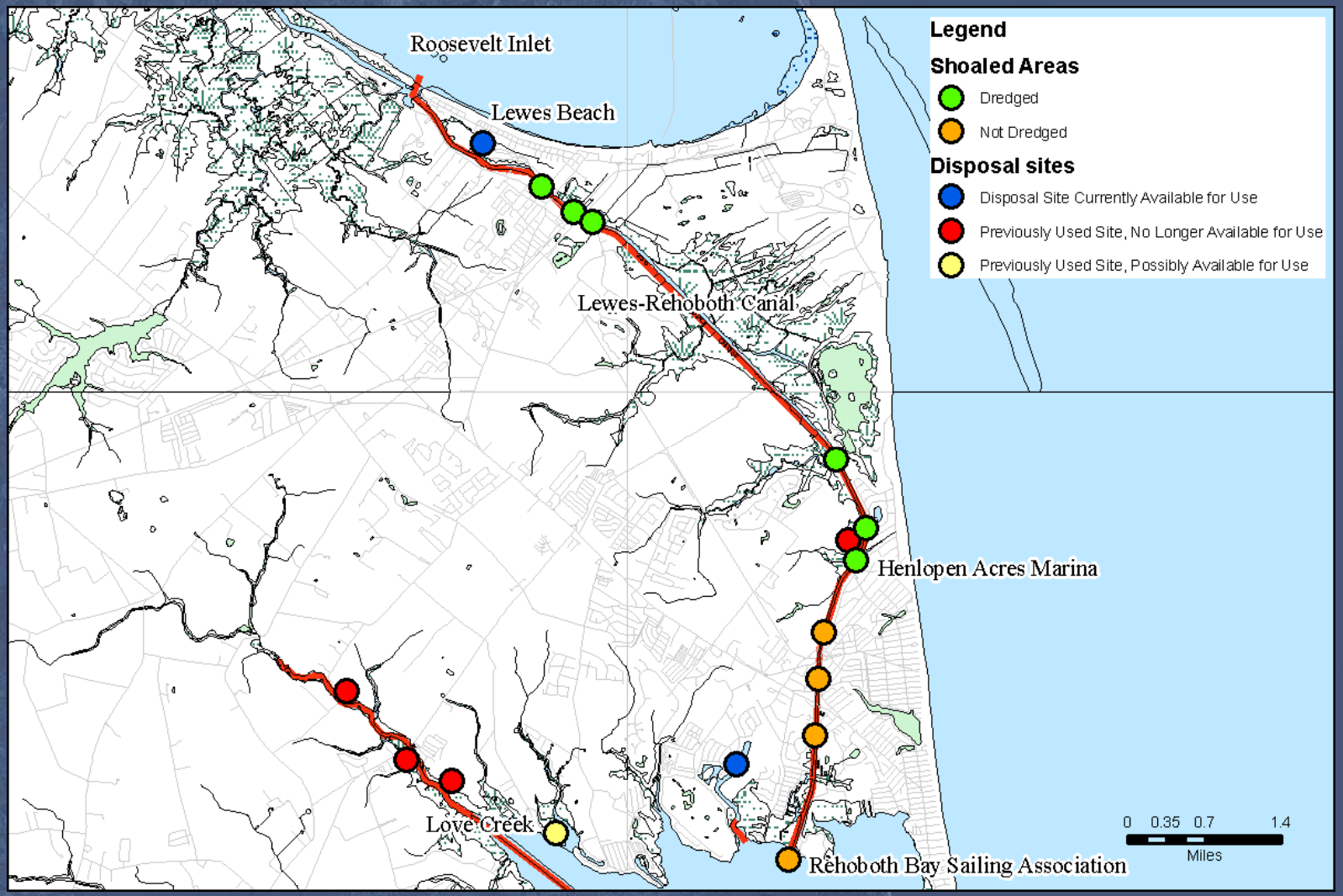
Habitat Restoration & Development

- Wetlands (2,000 acres lost over last century)
  - –Thin Layer Spreading
- Aquatic Habitat
  - –Filling anoxic holes & dead en canals
  - –Island Restoration

Beach Restoration

Camp Arrowhead

Lewes-Rehoboth Canal



Lewes-Rehoboth Canal

Projected Maintenance Dredging Volumes & Frequency

- Estimates are based on authorized project dimensions, including a channel depth of -6 ft MLW.
- Lewes Reach: 5,000 to 10,000 cy/yr (RI not included). 2-4 year cycle. > 90% sand.
- Cape Henlopen State Park Reach: no dredging required.
- Henlopen Acres Reach: 1,000 to 2,000 cy/yr. 2-4 year cycle. < 30% sand.
- Rehoboth Beach Reach: 2,000 cy/yr. 2-4 year cycle. > 90% sand.
- Thompson Island Reach: 4,000 cy/yr. 1-2 year cycle. 50% sand and 50% silt/clay.
- Initial dredging volume likely to exceed 40,000 cy.

Current Management & Issues

- Canal north of Savannah Ave Bridge last dredged by USACE in 2002. Disposal to Lewes CDF.
- The State dredged between Lewes and Henlopen Acres Marina in 1989-91. Disposal to two CDFs: City of Lewes' and Mr. Andersen's Property across from Henlopen Acres.
- From Rehoboth Beach to the confluence with Rehoboth Bay the canal has not been dredged since the 1960's. The State planned to dredge in this area but did not for lack of practical disposal options.
- Very limited federal funding available. USACE dredging unlikely south of RI

Potential SM Strategies

Disposal

- Continued disposal to City of Lewes CDF for areas north Savannah Bridge

KSM

- Removal of RR bridge abutment > Smoother flow conditions and increased exchange between Lewes and Rehoboth.
- Flow training wall at Henlopen Acres Marina
- Restoration of the Thompson Island Jetties
- No practical KSM elsewhere

KSO

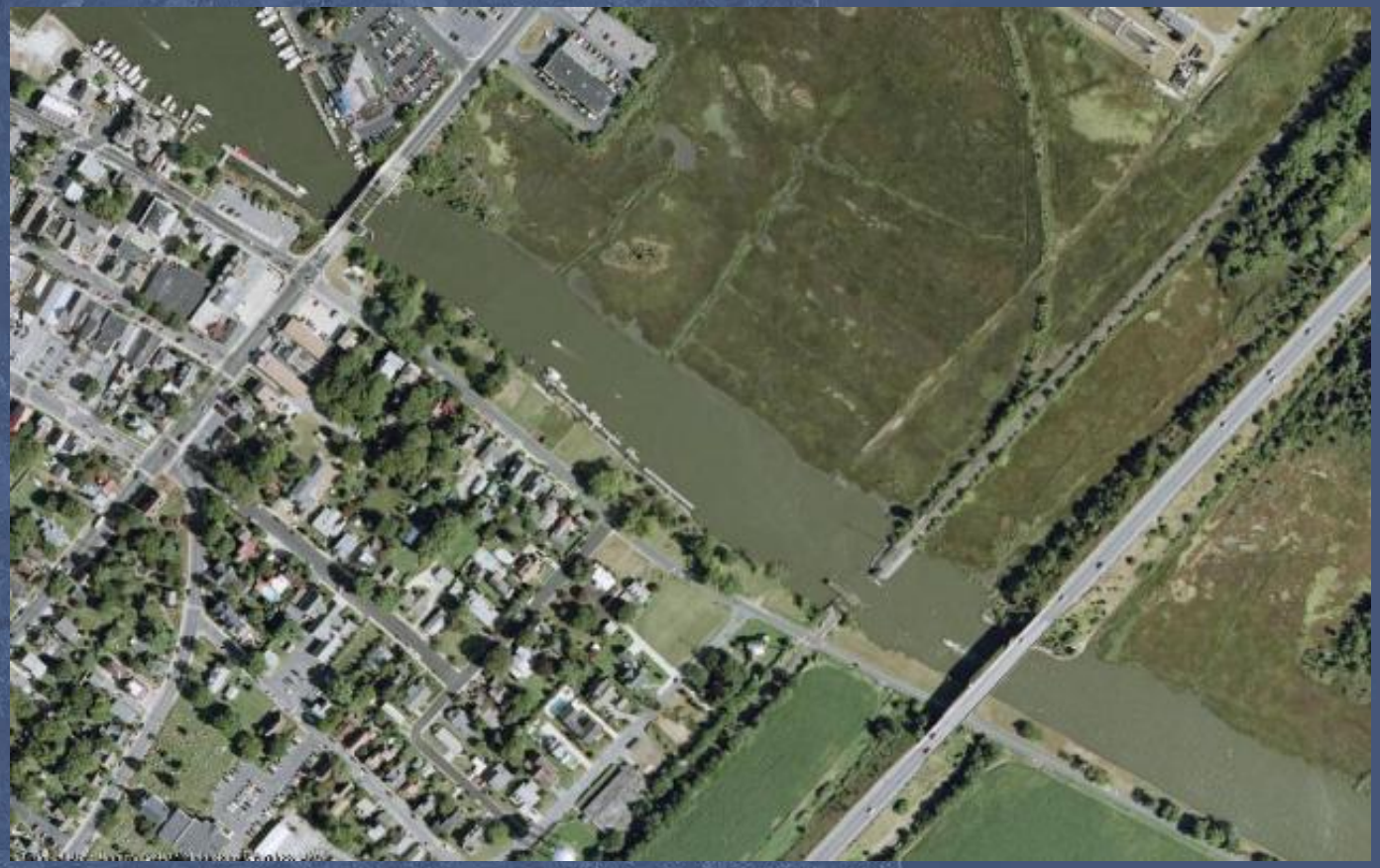
- Bank stabilization in Rehoboth.

Potential SM Strategies

Beneficial Reuse

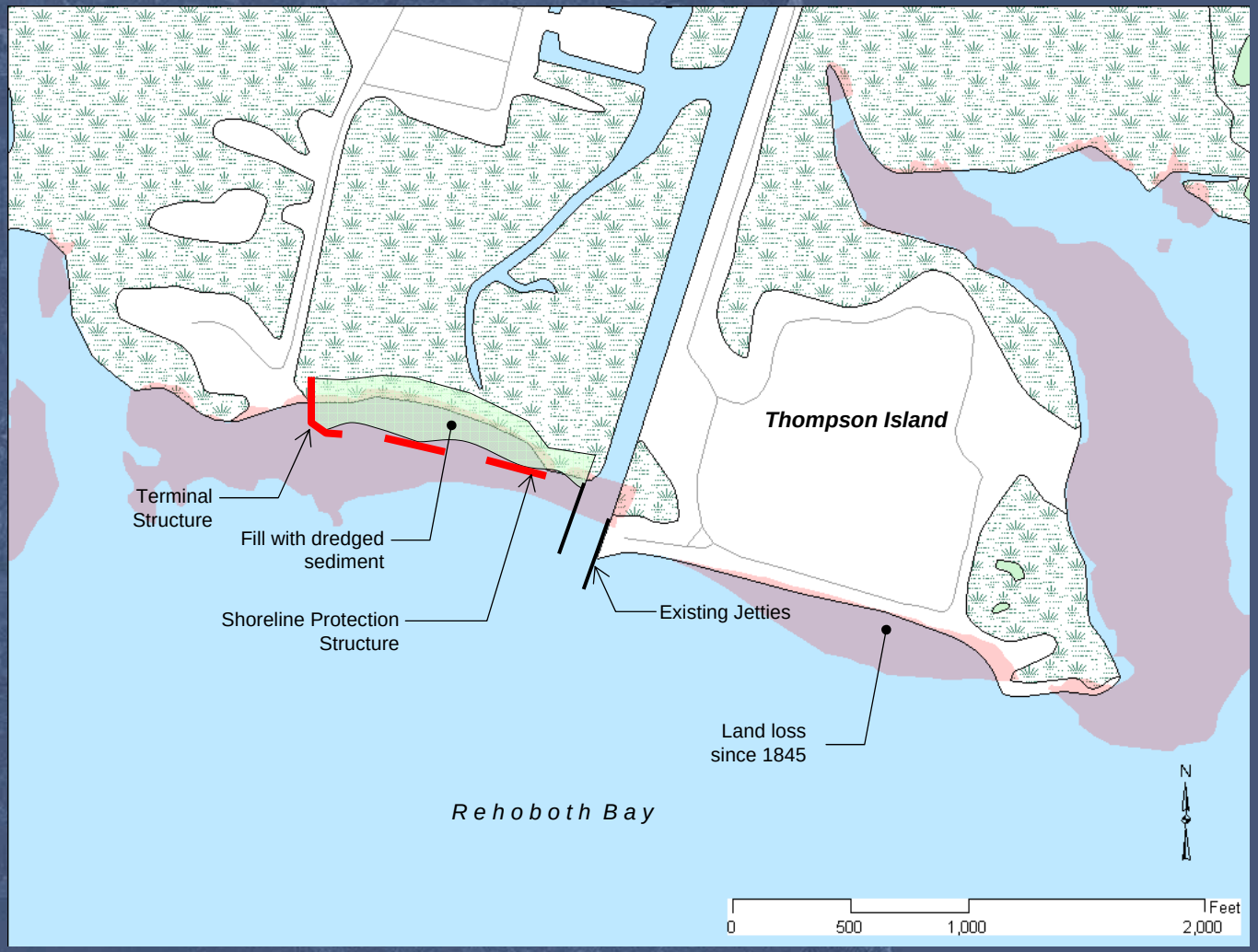
- Beach restoration at Lewes
- Marsh restoration on Thompson Island. Will likely require structural stabilization
- Thin-layer spraying
- Filling of anoxic holes in Bald Eagle Creek

Savannah Bridge



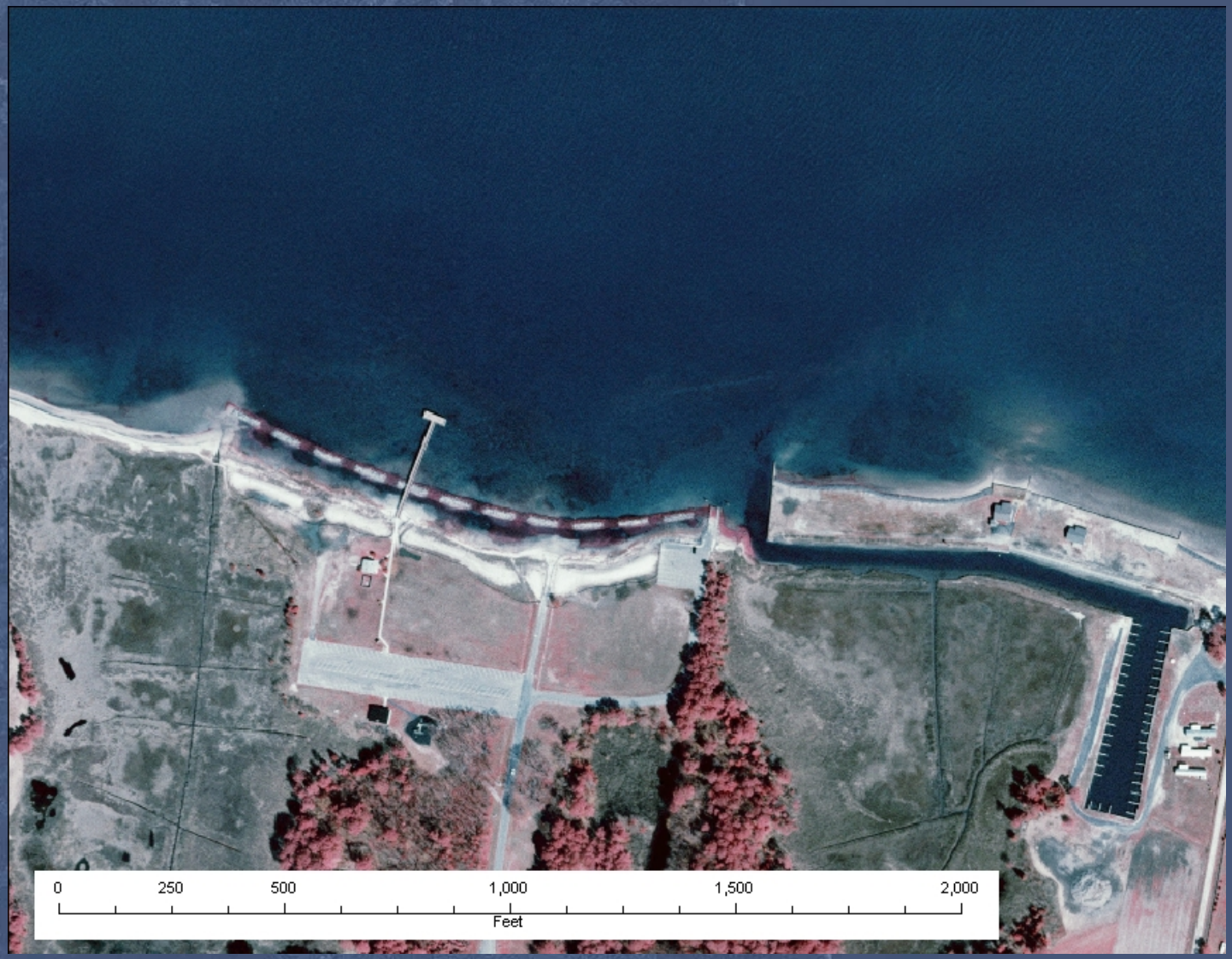
Henlopen Acres Marina

Thompson Island Marsh Restoration

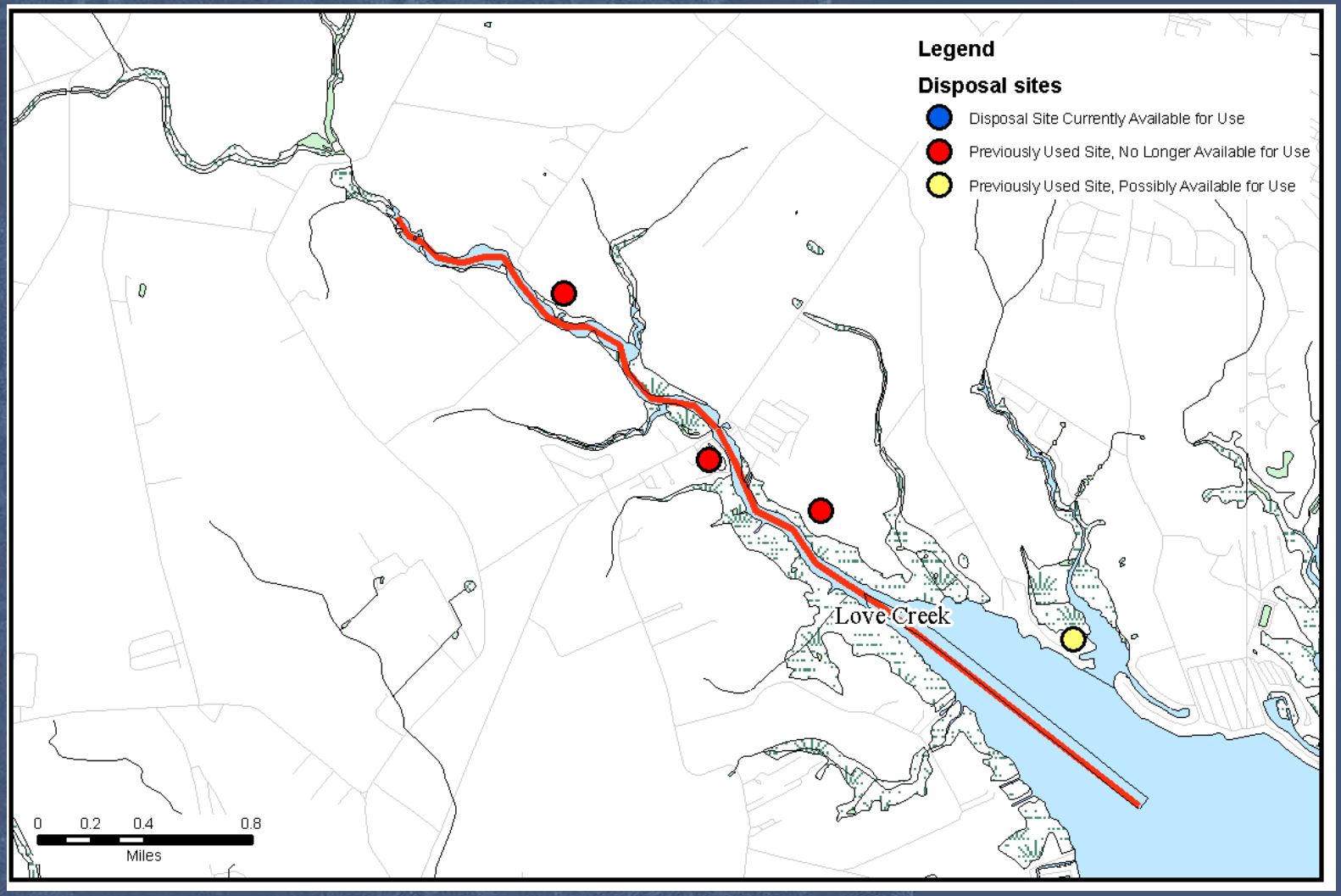


Low relief protection wall

Holt's Landing



Love Creek


Legend
Disposal sites
Disposal Site Currently Available for Use
Previously Used Site, No Longer Available for Use
Previously Used Site, Possibly Available for Use
Love Creek
0 0.2 0.4 0.8
Miles

Potential SM Strategies

Disposal

- Exiting Robinson Landing site. Limited Capacity. 2 miles to the Rt 24 bridge

KSM

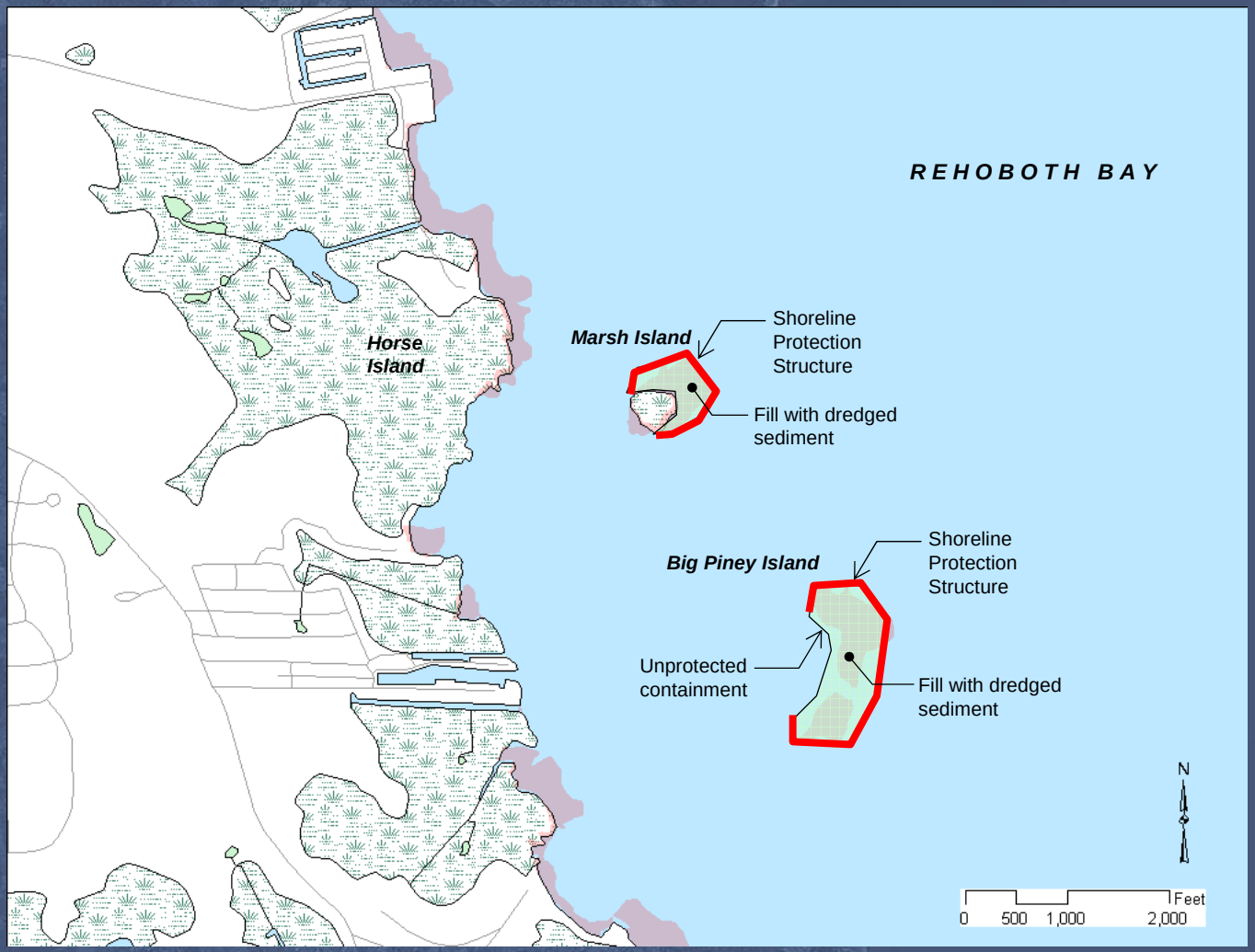
- Channel marking: Boat traffic effects.

KSO

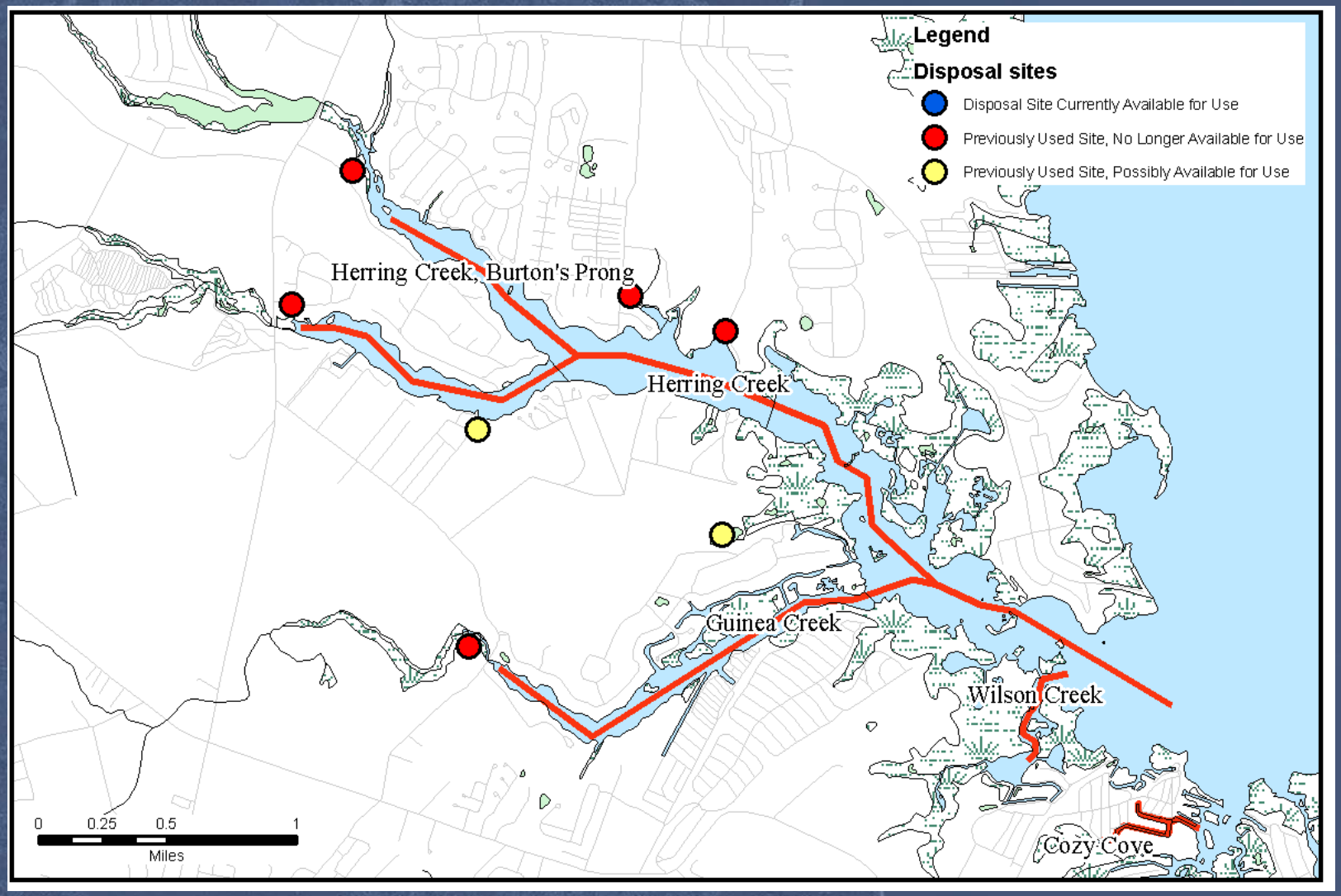
- Not possible

Beneficial Reuse

- Island restoration: Marsh and Big Piney, 5-10 acres. 1 mile to 3 miles. Will require containment and protection structures.
- Mainland marsh restoration (e.g., south of Joy Beach)


REHOBOTH BAY
Horse Island
Marsh Island
Shoreline Protection Structure
Fill with dredged sediment
Big Piney Island
Shoreline Protection Structure
Unprotected containment
Fill with dredged sediment
N
0 500 1,000 2,000
Feet

Herring & Guinea Creek



Potential SM Strategies

Disposal

- Two areas possibly available: Shawns Hideaway & Winding Creek Village. Limited capacity

KSM

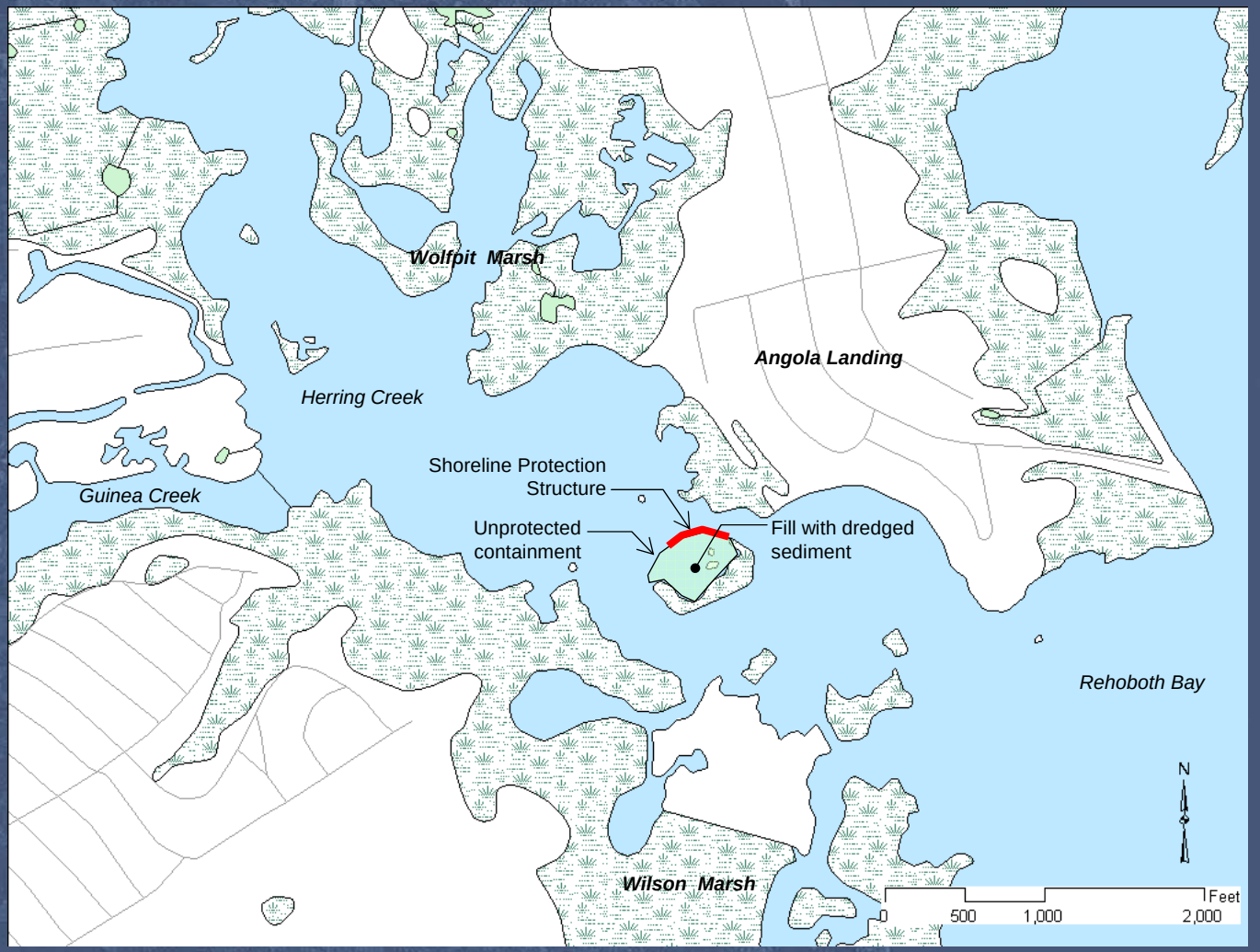
- Channel marking. Expanded program into the Prongs and Guinea Creek

KSO

- Not possible

Beneficial Reuse

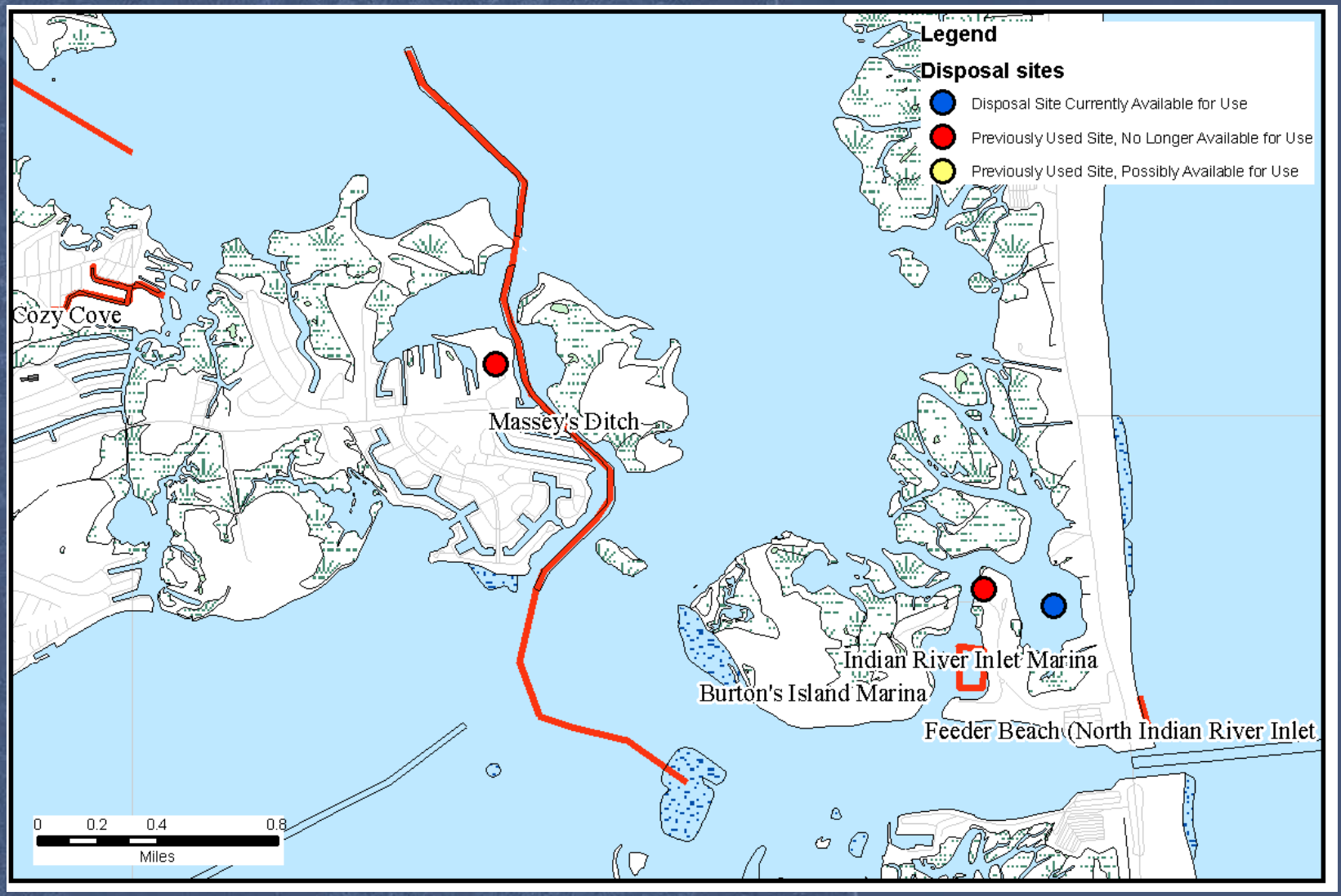
- Island restoration: Island in the Narrows.
- Mainland marsh restoration in the creek and along Long Neck
- Restoration at Joseph Lee Creek
- Filling of dead-end canals and ponds. Mouth of Joseph Lee Creek (Lingo Landing). Bayview Lane in Lingo Cove
- Thin-layer spreading


Wolfpit Marsh
Angola Landing
Herring Creek
Shoreline Protection
Structure
Guinea Creek
Unprotected
containment
Fill with dredged
sediment
Rehoboth Bay
N
Wilson Marsh
Feet
0
500
1,000
2,000

Potential Marsh Restoration Area at Joseph Lee Creek

Lingo Cove

Massey's Ditch



Potential SM Strategies

Disposal

- No disposal sites available in the immediate vicinity
- Bottom Hills Drain. 2 to 3 miles transport distance. 320,000 cy capacity.

KSM

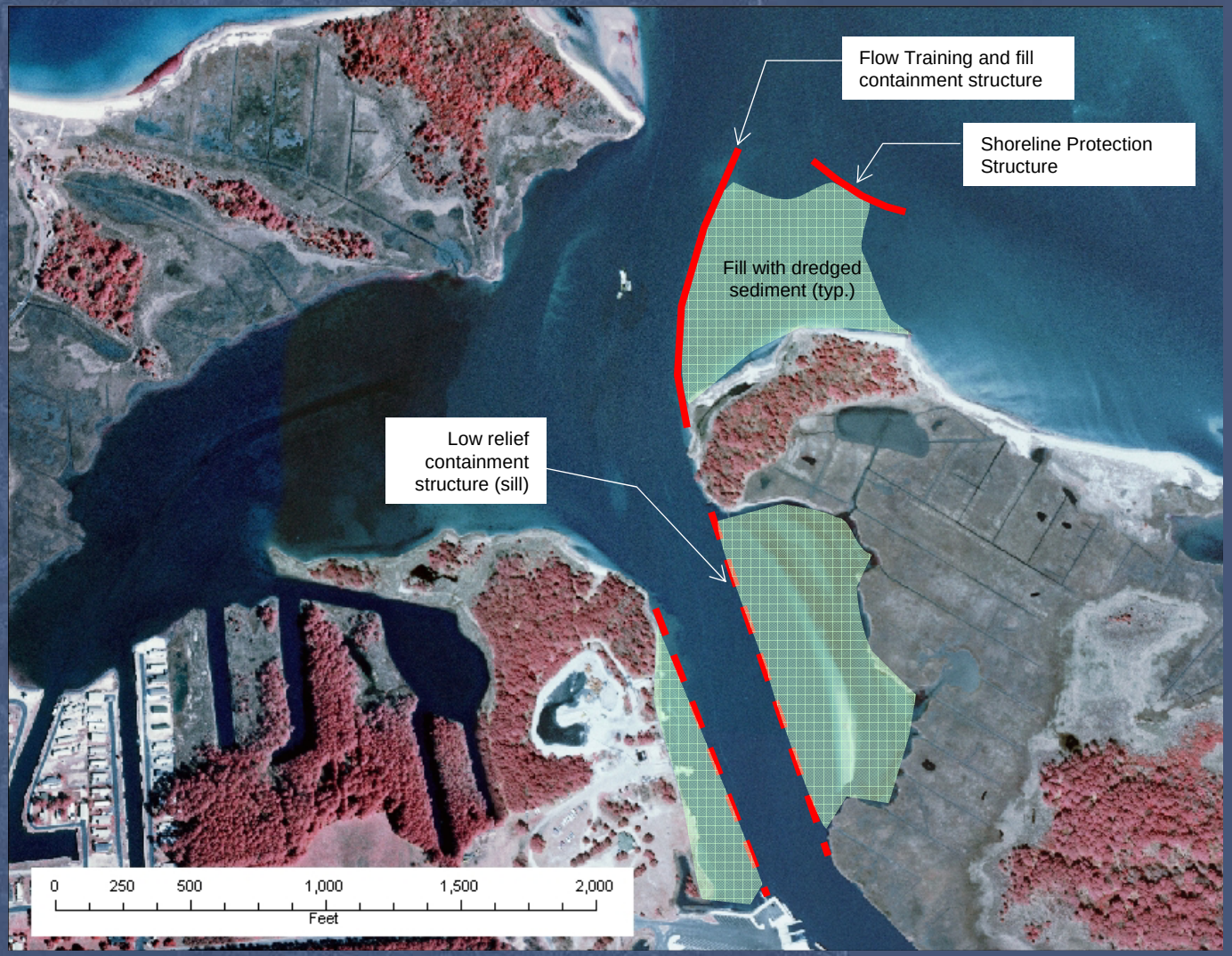
- Flow training features. Possibly in combination with marsh restoration

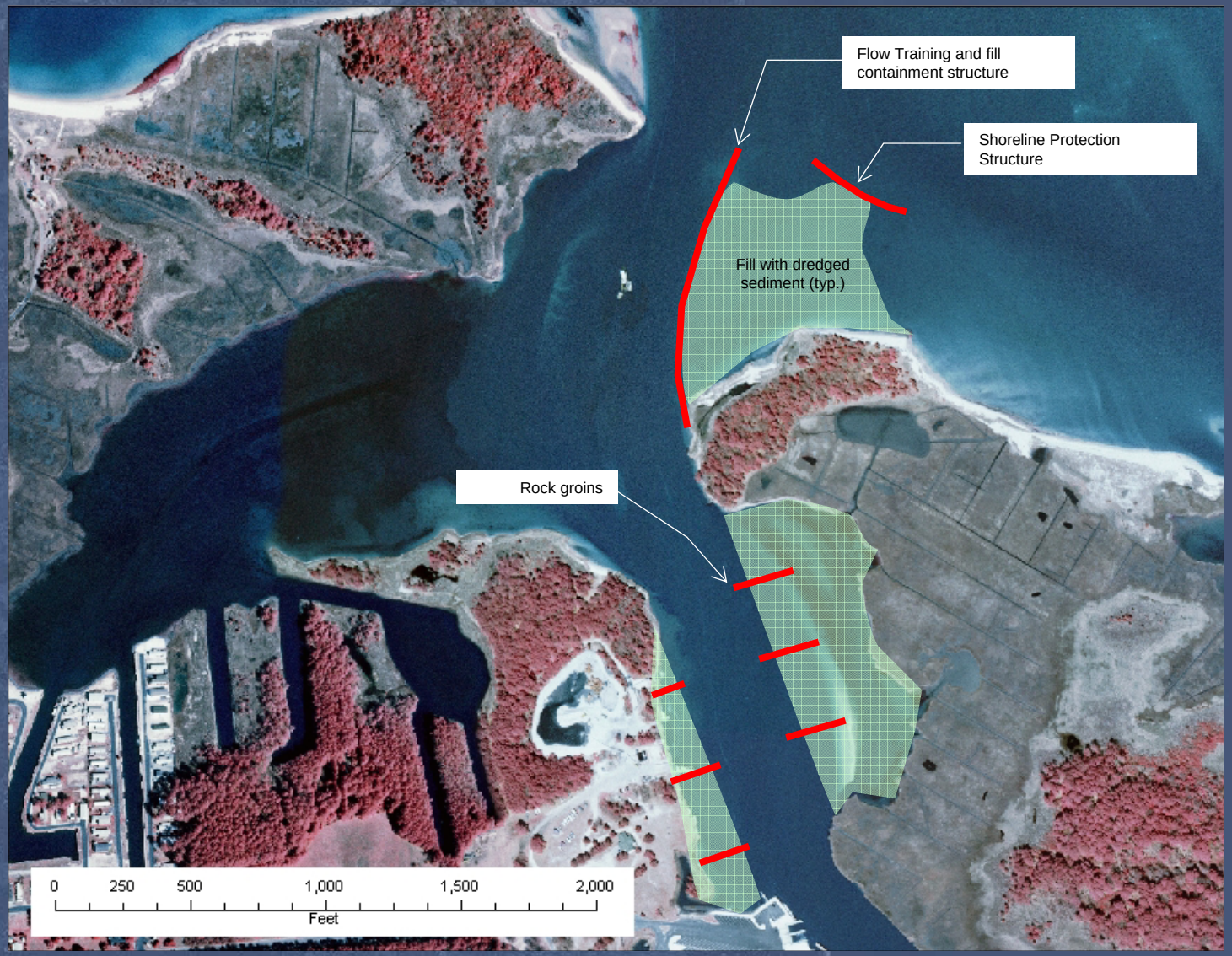
KSO

- Not possible

Beneficial Reuse

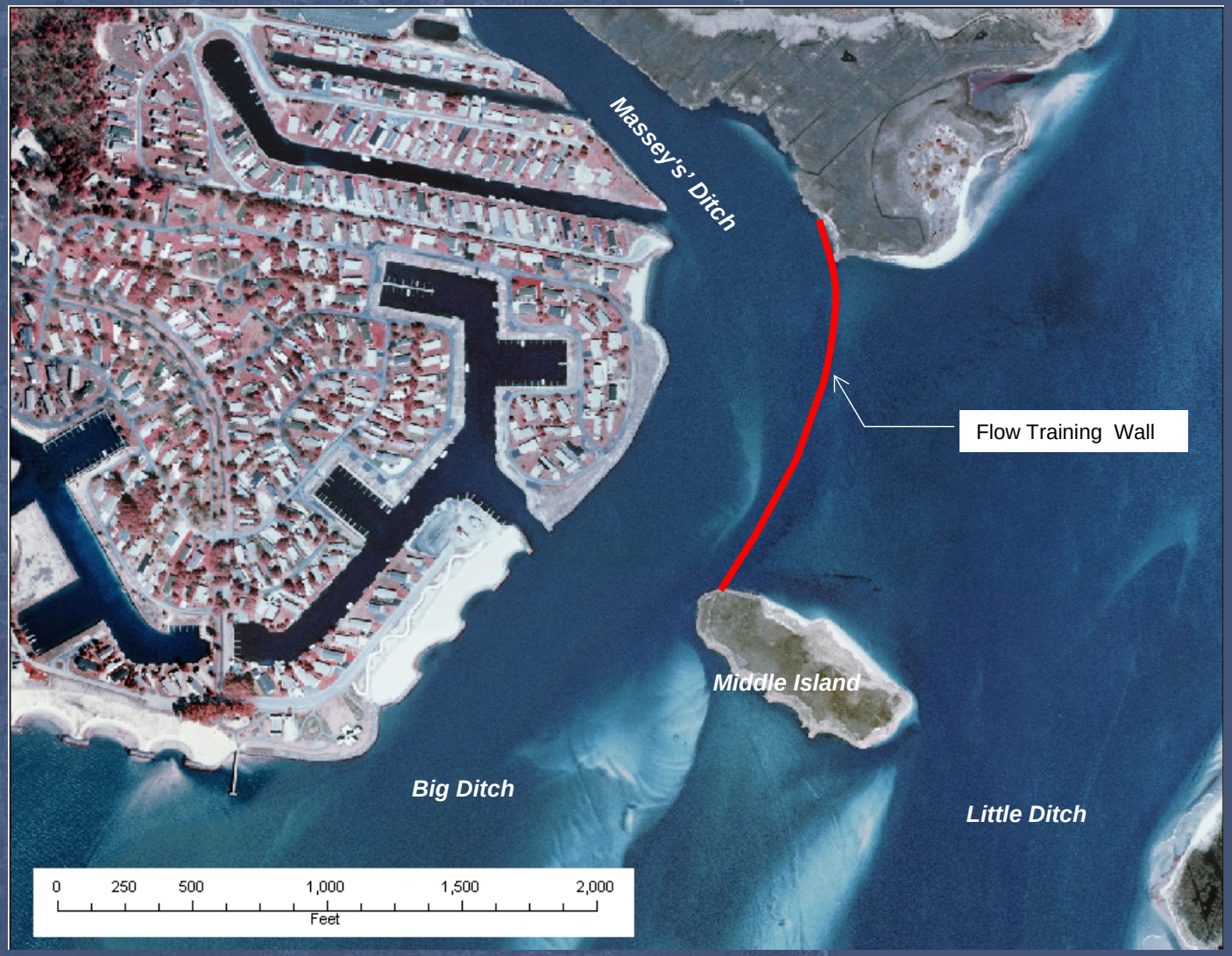
- Aquatic habitat restoration at BHD
- Marsh restoration
- Beach restoration: bay and ocean shorelines


Flow Training and fill containment structure
Shoreline Protection Structure
Fill with dredged sediment (typ.)
Low relief containment structure (sill)
0
250
500
1,000
1,500
2,000
Feet


Flow Training and fill containment structure
Shoreline Protection Structure
Fill with dredged sediment (typ.)
Rock groins
0
250
500
1,000
1,500
2,000
Feet

Angola Landing Restoration

Massey's to Middle Island



THANK YOU !