Erosion Mitigation And Shoreline Management Feasibility Study

Town of Duck, North Carolina

Coastal Planning & Engineering of North Carolina

May 15, 2013

Ken Willson

Goals of the Study

- Evaluate shoreline changes along entire town

- Develop a long term shoreline management strategy for the entire Town

- Investigate the cause, extent, and severity of the chronic erosion area or "Hot Spot" just north of the Research Pier

- Develop an erosion mitigation strategy to address this "Hot Spot"

- **Evaluate Storm Damage Vulnerability***

Shoreline Change Analysis

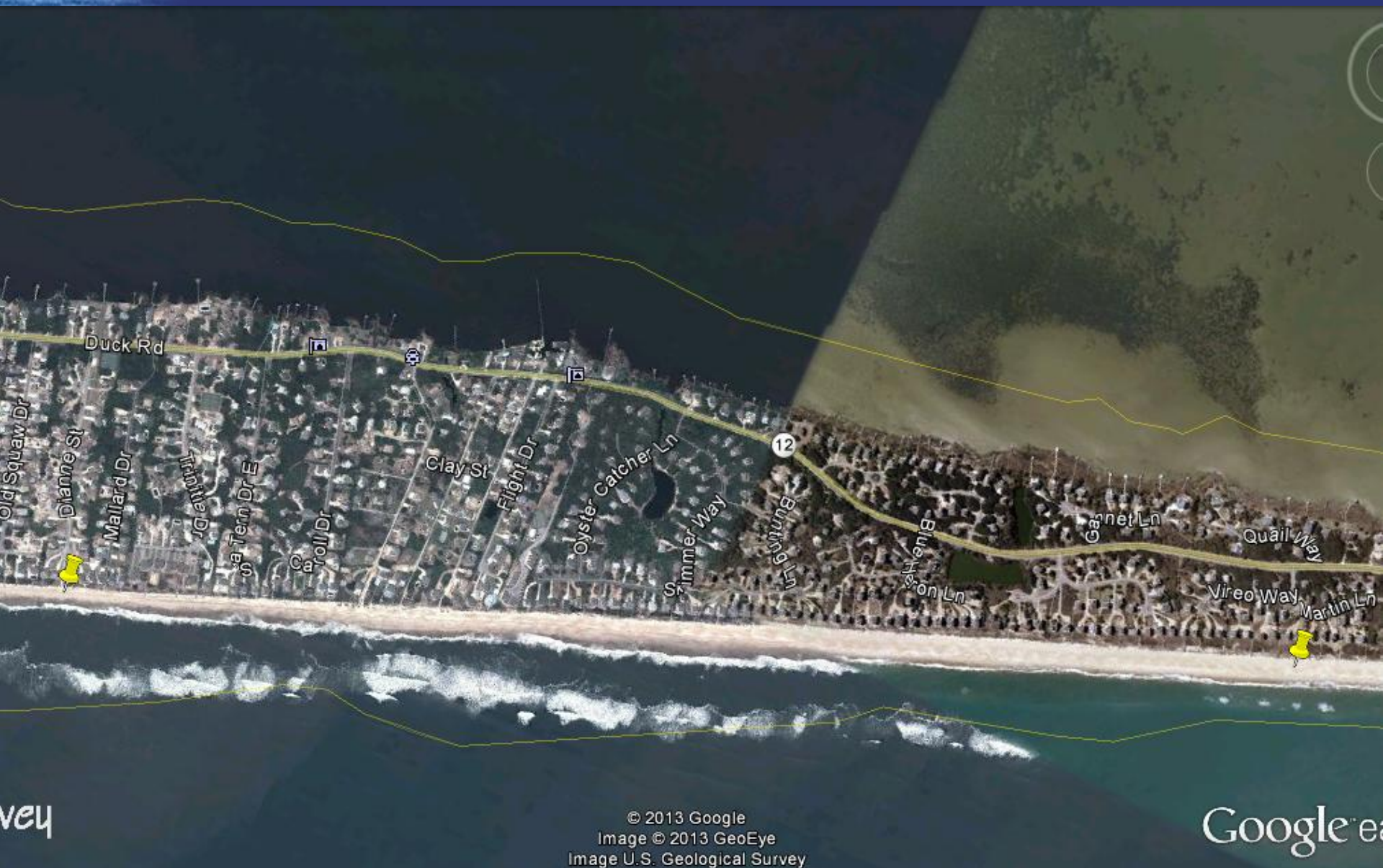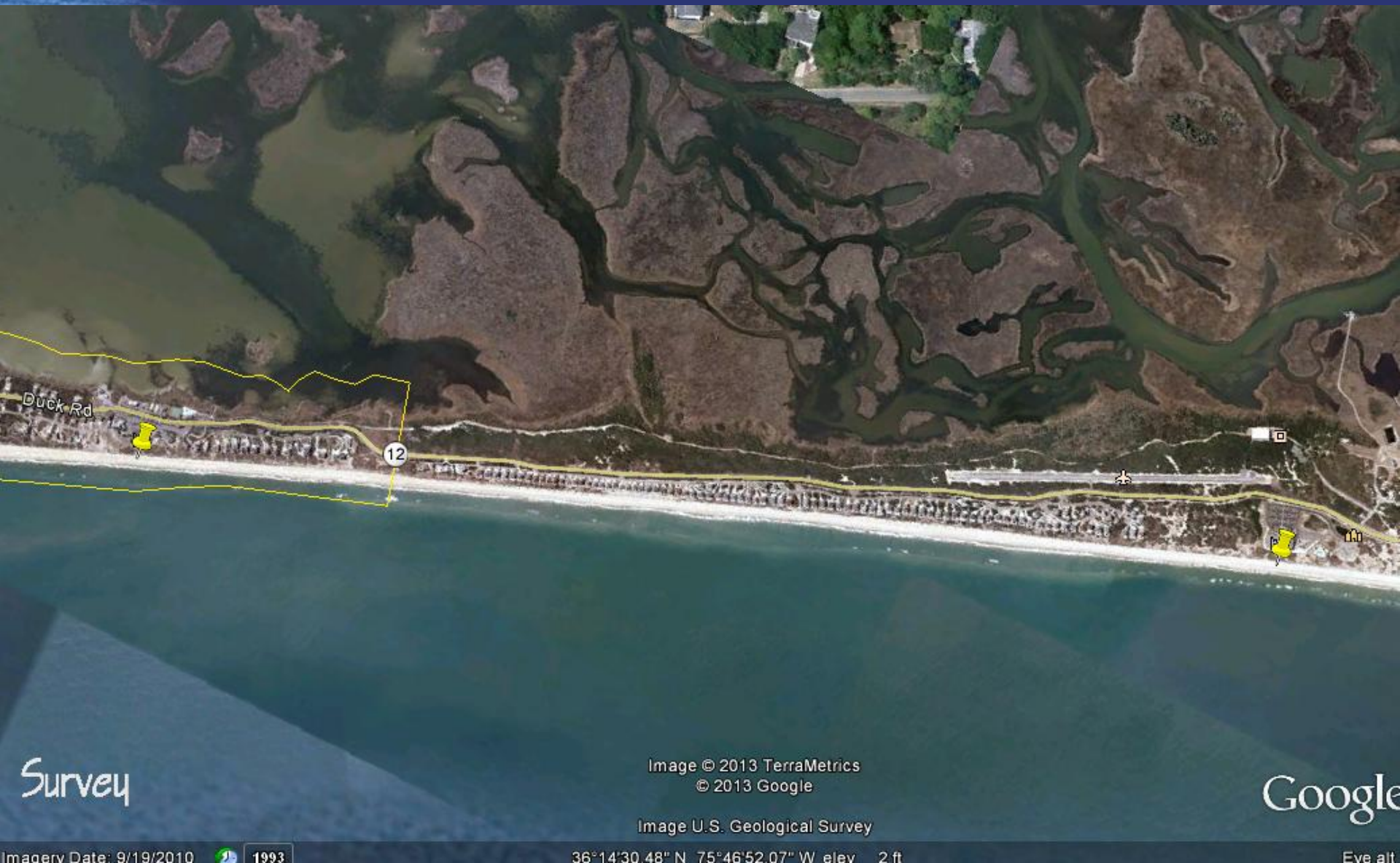| Shoreline Segment	Transect Grouping	Boundaries by Landmark (Approximate)	Shoreline Length (ft)
1	9 to 89	Dolphin Run to 9th Ave.	8,000
2	89 to 149	9th Ave. to Four Seasons Drive	6,000
3	149 to 169	Four Seasons Drive to Duck Landing Ln.	2,000
4	169 to 209	Duck Landing Ln. to Ships Watch Dr.	4,000
5	209 to 229	Ships Watch Drive to FRF Pier	2,000
6	229 to 239	FRF Pier to N. FRF Property Line	1,000
7	239 to 289	N. FRF Property Line to Dianne St.	5,000
8	289 to 369	Dianne St. to Martin Ln.	8,000
9	369 to 389	Martin Ln. to Sanderling Resort	2,000
10	389 to 529	Sanderling Resort to Hampton Inn	14,000

Segment 2
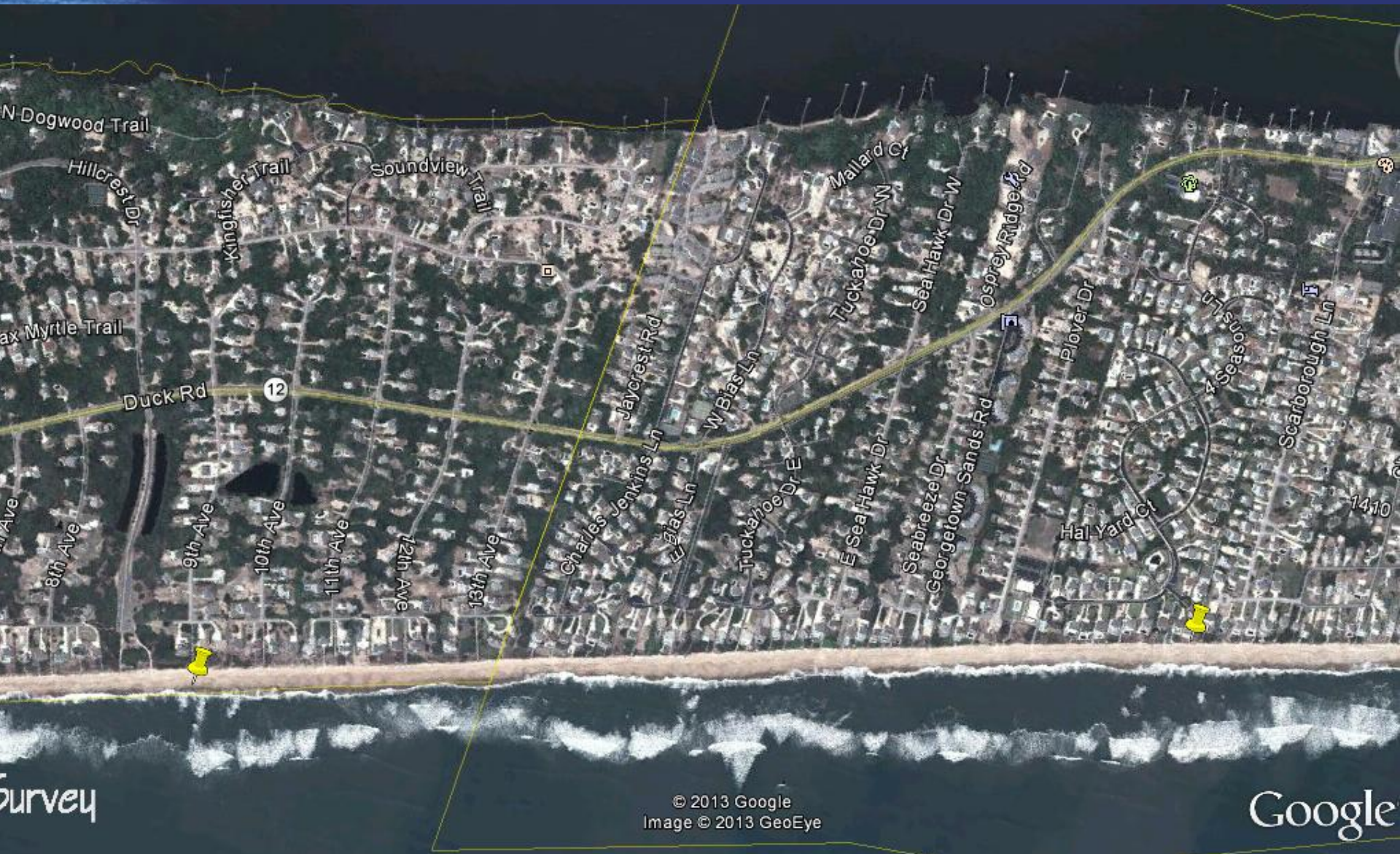
Segment 3 & 4
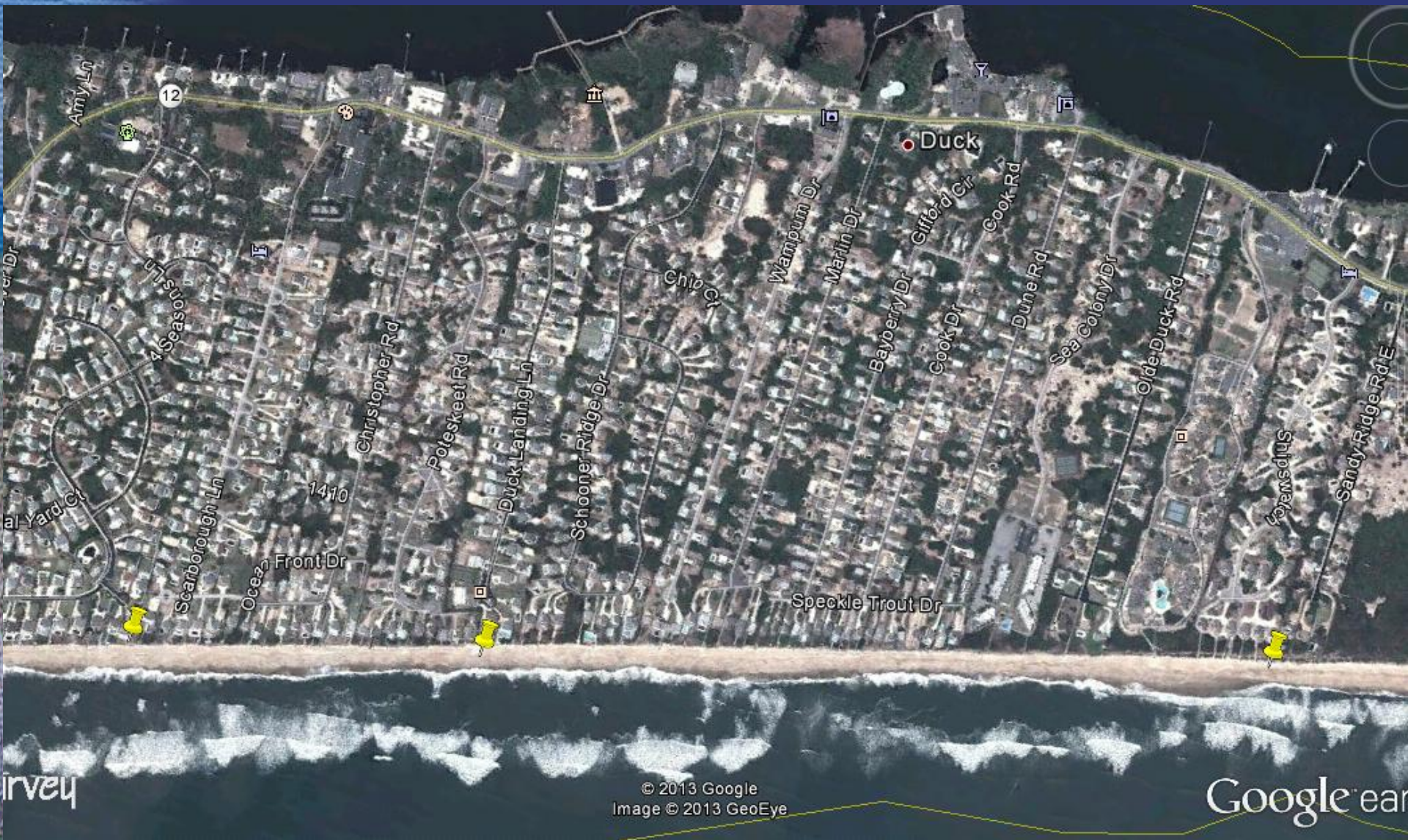
Segment 5 & 6

Segment 7

Segment 8

Segment 9

Segment 10

Shoreline Change Analysis

Shoreline Segment	Transect Grouping	Average Shoreline Trend by Segment for 1996 to 2011	
		Overall Trend (ft/yr)	Total Movement (ft)
1	9 to 89	+0.60	+9.1
2	89 to 149	-0.36	-4.7
3	149 to 169	+1.82	+27.5
4	169 to 209	-1.04	-15.8
5	209 to 229	+0.15	+2.2
6	229 to 239	-1.68	-25.4
7	239 to 289	-4.82	-72.9
8	289 to 369	+1.12	+15.5
9	369 to 389	-0.56	-8.5
10	389 to 529	+1.27	+23.7

Phase 1: Coastal Process and Shoreline Impact Analysis
## 4: Economic Losses Due To Shoreline Change Rates

Segment Number	Timeframe				Total
	2011-2016	2016-2021	2021-2026	2026-2041	
1	-	-	-	-	-
2	5.1%	2.3%	0.9%	2.6%	2.2%
3	0.1%	0.0%	0.0%	0.0%	0.0%
4	9.8%	5.7%	2.2%	6.0%	4.9%
5	-	-	-	-	-
6	-	-	-	-	-
7	83.5%	91.7%	96.7%	91.0%	92.4%
8	0.9%	0.2%	0.1%	0.3%	0.3%
9	0.7%	0.1%	0.1%	0.1%	0.2%
10	0.0%	0.0%	0.0%	0.0%	0.0%
Total	$3,772,882	$6,207,321	$16,028,100	$17,706,989	$43,715,292

Conceptual Alternatives

- No Action Alternative

- Retreat

- Beach Restoration By Truck Haul

- Dune Replenishment By Truck Haul

- Erosion Mitigation Project By Offshore Dredging

- Storm Damage Reduction Project By Offshore Dredging

Beach Fill (Truck Haul):
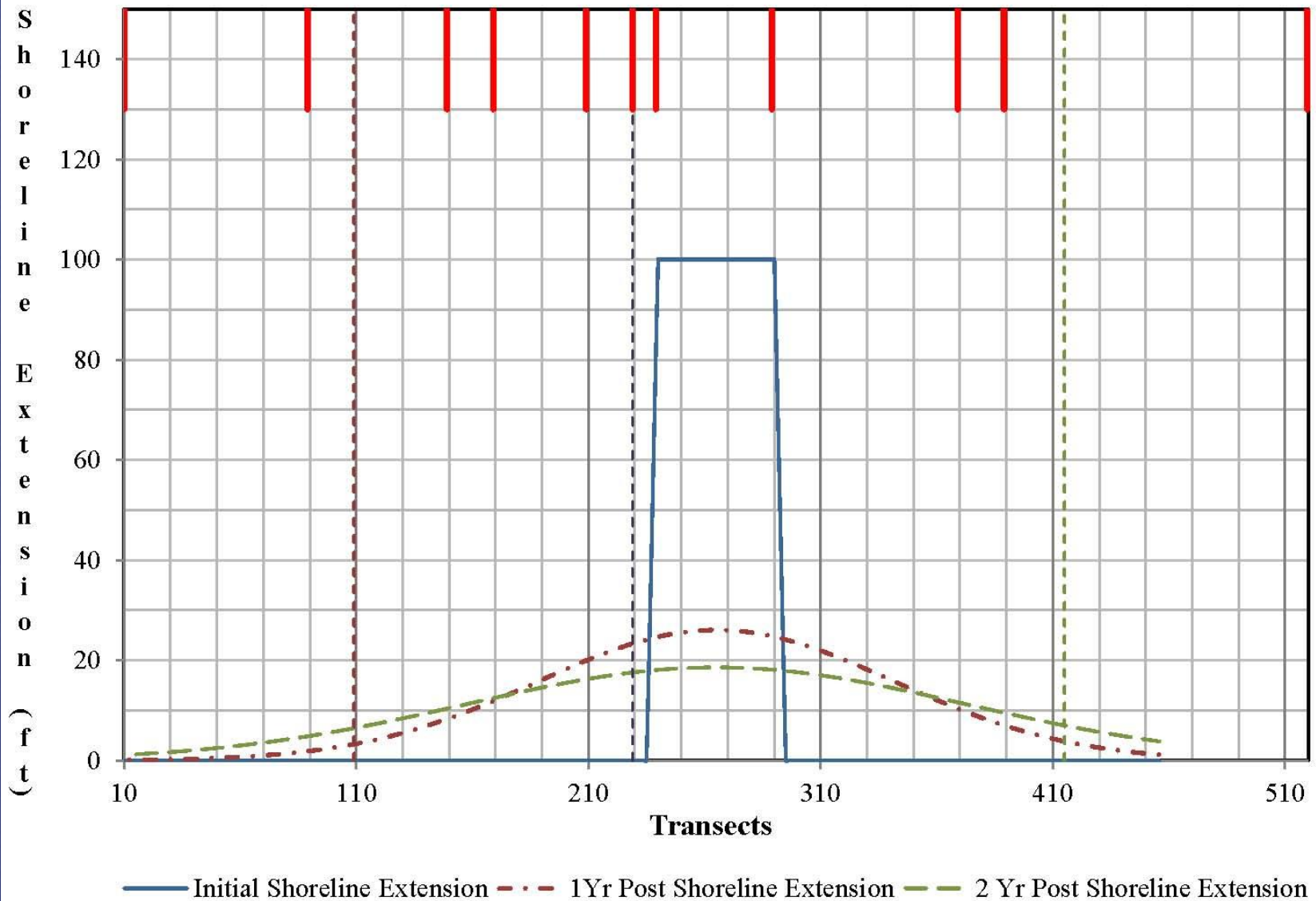
Beach Fill (Truck Haul): $1.7 Million - $1.8 Million

- 43,000 cy of Fill
- 8 – 36 month permitting
- 11-week construction period
- Placed along 5,000 ft. of Hot Spot
- Provide 1 year of erosion mitigation and some fill along the adjacent beaches.

CPE
COASTAL PLANNING & ENGINEERING

Dune Fill (Truck Haul): $939,000

- 30,000 cy of Fill
- 6 – 8 months permitting
- 8-week construction period
- Placed along 5,000 ft. of Hot Spot
- Provide 1 year of erosion mitigation

Beach Fill (dredge and fill):

- Nags Head style project.

- Placed along most of segment 7 and 8

Beach Fill (dredge and fill):
Why Place Fill In Segment 7 & 8

- Historical Erosional Trends (1980 – 1999)

- Diffusion Losses

- Vulnerability to Storm Damage

Beach Fill (dredge and fill):

- Nags Head style project.

- Placed along most of segment 7 and 8

- ~ 828,200 cy of fill

- Offshore borrow area

- Tapers to minimize spreading losses.

- Widen the beach berm by 40 ft.

- Provide ~ 5 years of erosion mitigation.

- $13.04 Million - $14.96 Million

- Limited storm damage reduction

Storm Damage Reduction

Getty Images

WRAL

Before Fran (After Bertha)

USGS

After Fran

Approx. February 1993
Wet/Dry Line

2/2/1993

N 4th Ave

N 3rd Ave

Fort Fisher Blvd N

Atlantic Ave

Ave L

Ave K

421

S 3rd Ave

Fort Fisher Blvd S
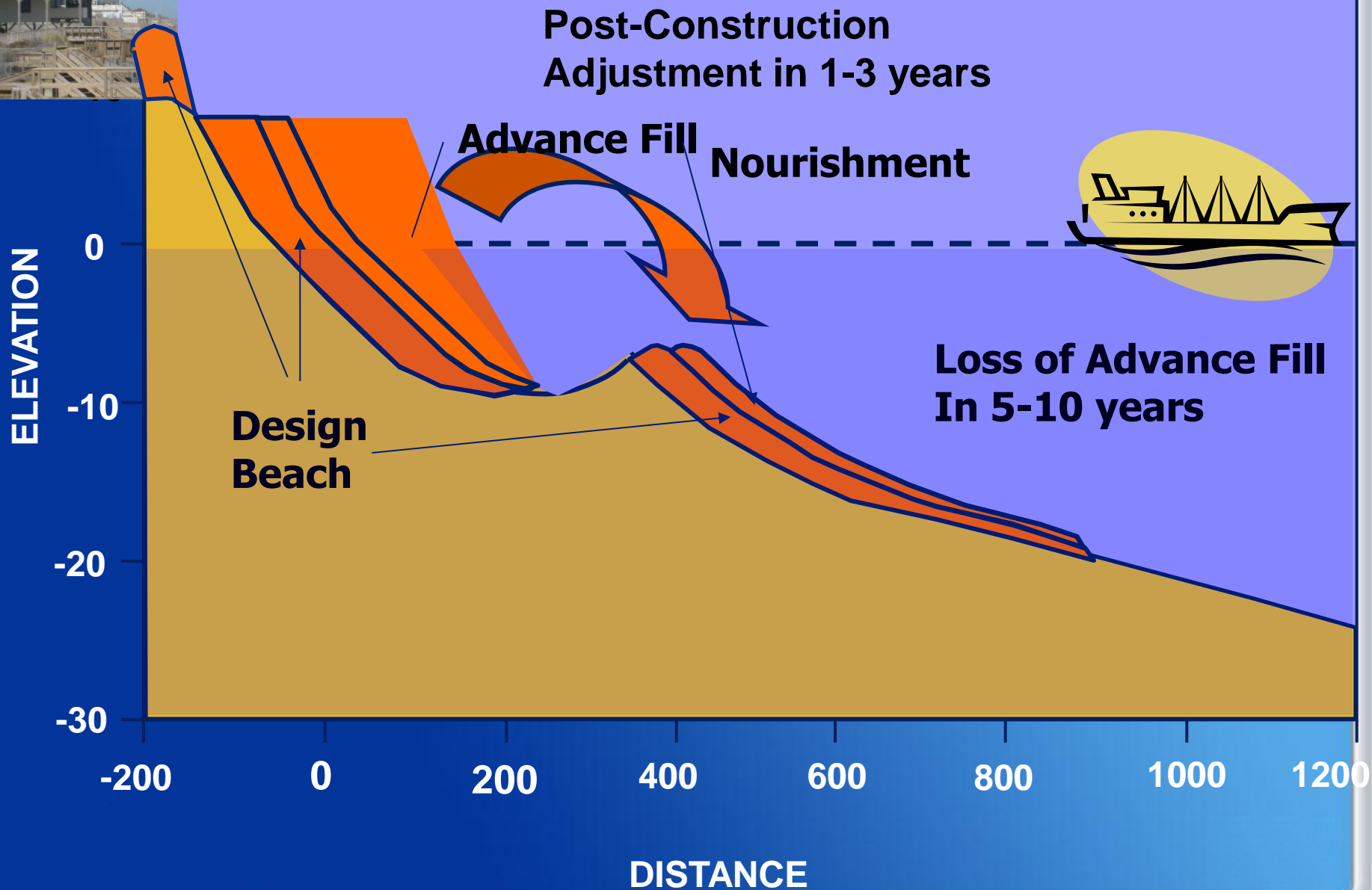
Survey

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Image U.S. Geological Survey

Tracking No. 00.00.2011

Approx. February 1993
Wet/Dry Line

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Image © 2012 New Hanover County, NC

Approx. February 1993
Wet/Dry Line

10/22/2010
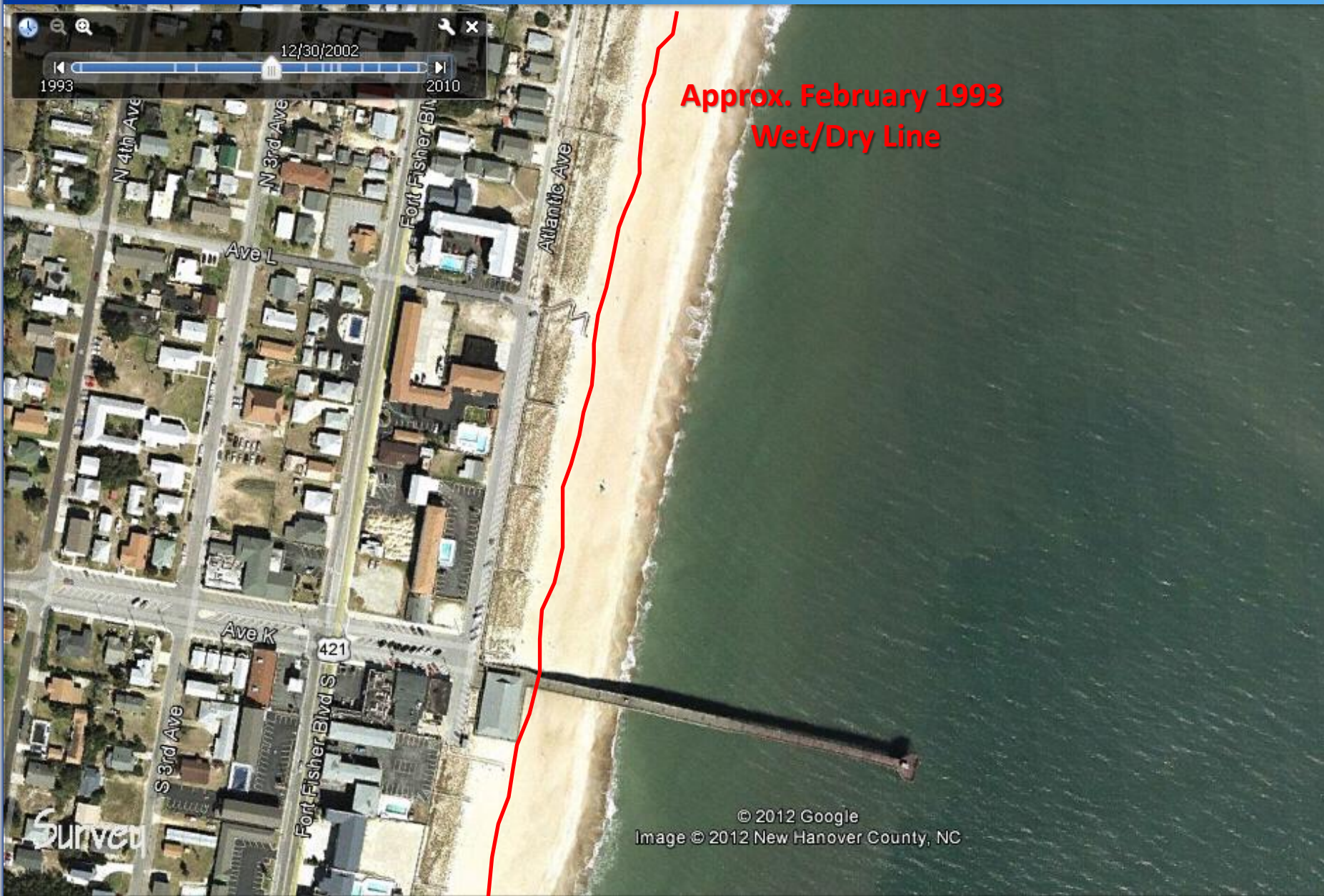
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SBEACH

- **S**torm-induced **BE**Ach **CH**ange Model

- Simulates cross-shore erosion of the dune, berm, and foreshore caused by storm waves and water levels

SBEACH
Storm Damage Analysis

Return Period	H_S (ft.)	T_p (s)	Water Level (ft. NAVD)
1	17.6	9.9	4
5	21.2	12.9	4.2
10	22.7	14.2	4.8
20	24.3	15.5	5.7
25	24.8	16	5.8
50	26.3	17.3	6.2

		Measured Data			Approximate Return Period (years)		
Storm	Date	H_S (ft)	T_p (s)	Water Level (ft. NAVD)	H_S	T_p	Water Level
Perfect Storm	Oct-91	15.1	22.5	4	< 1	> 50	1
Hurricane Isabel	Sep-03	27.3	15.6	5.6	>50	20	10 to 20
Hurricane Irene	Aug-11	24.8	13.6	3	25	5 to 10	< 1
Hurricane Sandy	Oct-12	17.3	13.3	4.5	~ 1	5 to 10	5 to 10

SBEACH Change at Profile 39+04
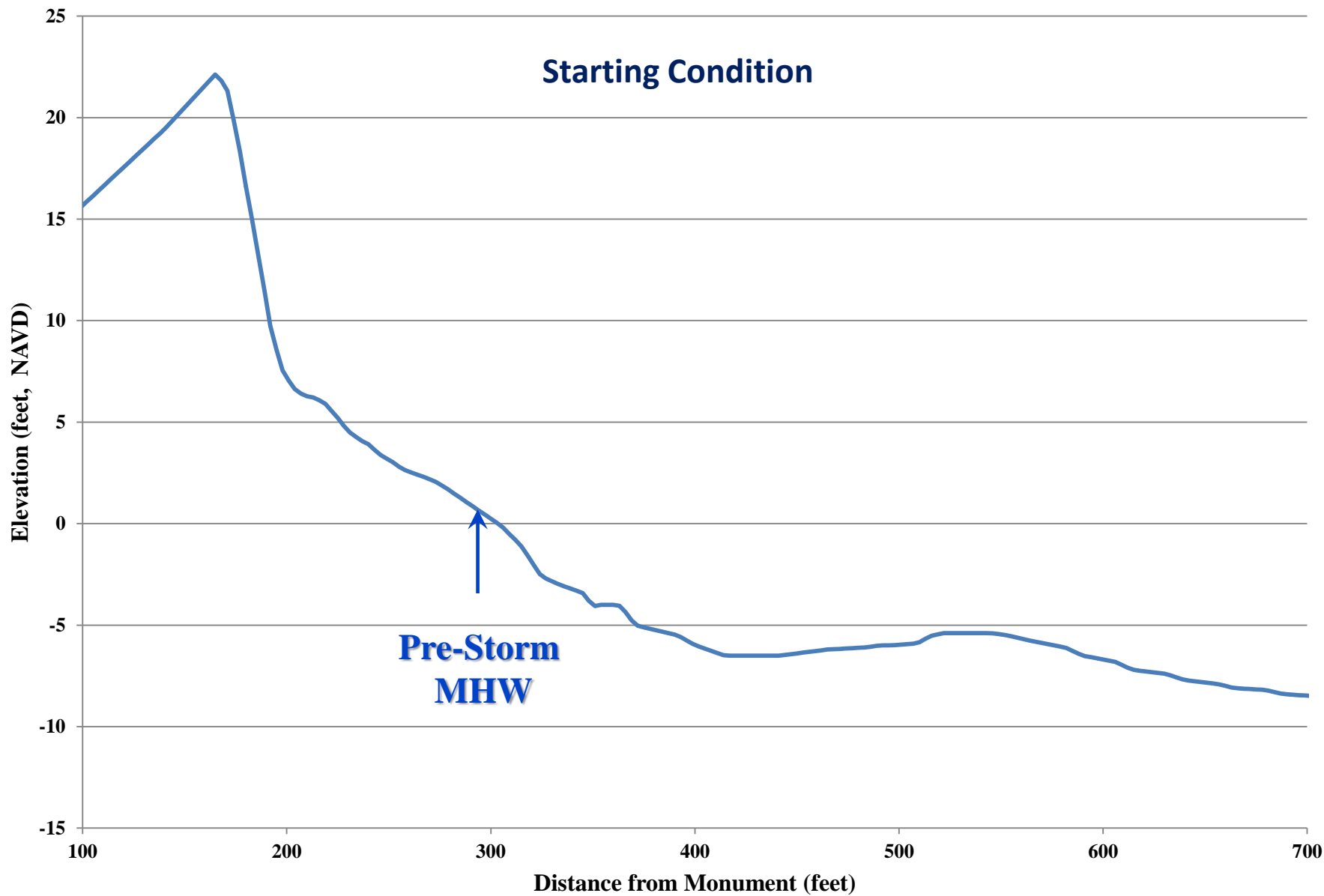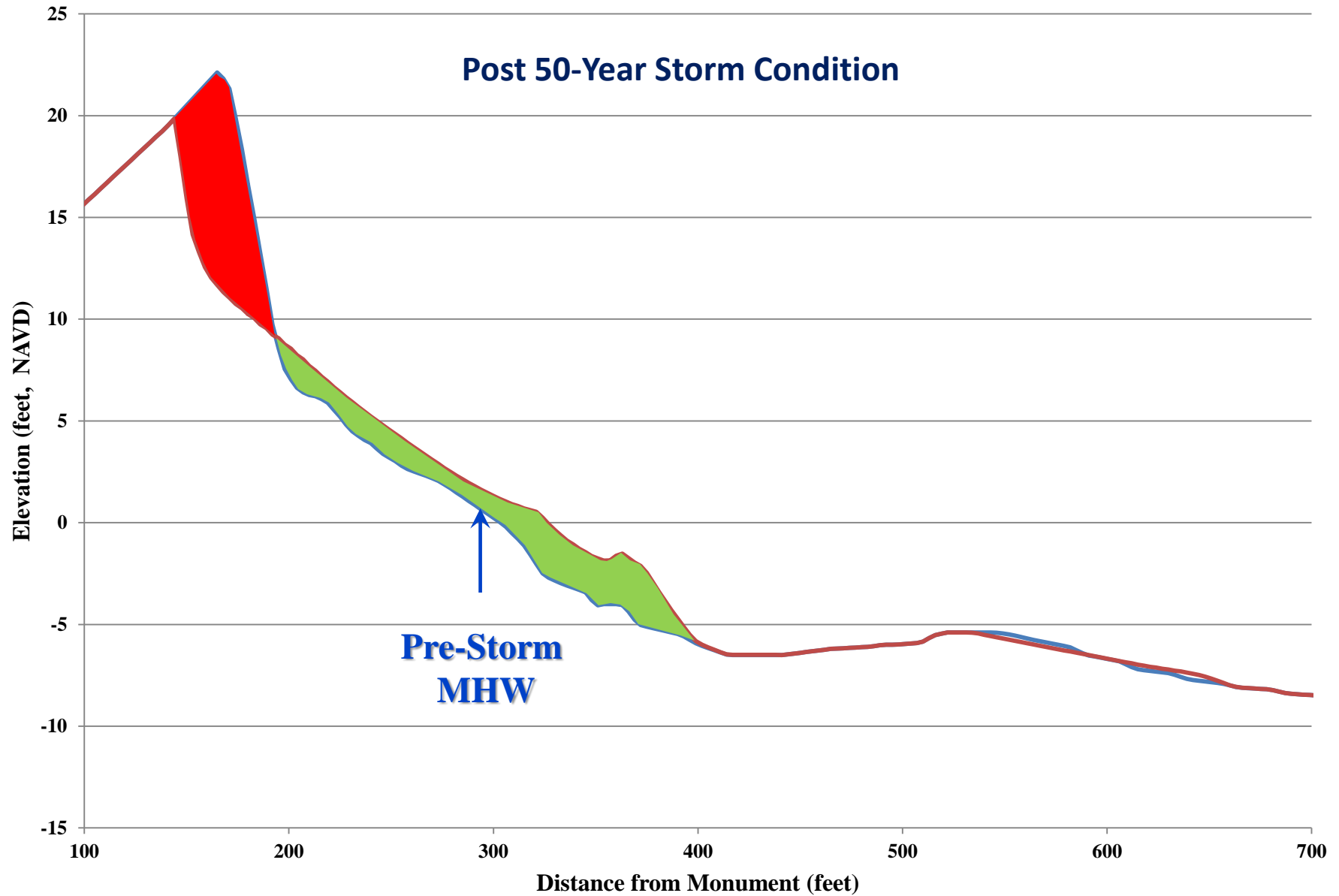
SBEACH Change at Profile 39+04

Post 50-Year Storm Condition

Pre-Storm MHW

SBEACH Change at Profile 39+04

Post 50-Year Storm Condition

Offset

Profile Drops 1.0 ft.

Pre-Storm MHW

Elevation (feet, NAVD)

Distance from Monument (feet)
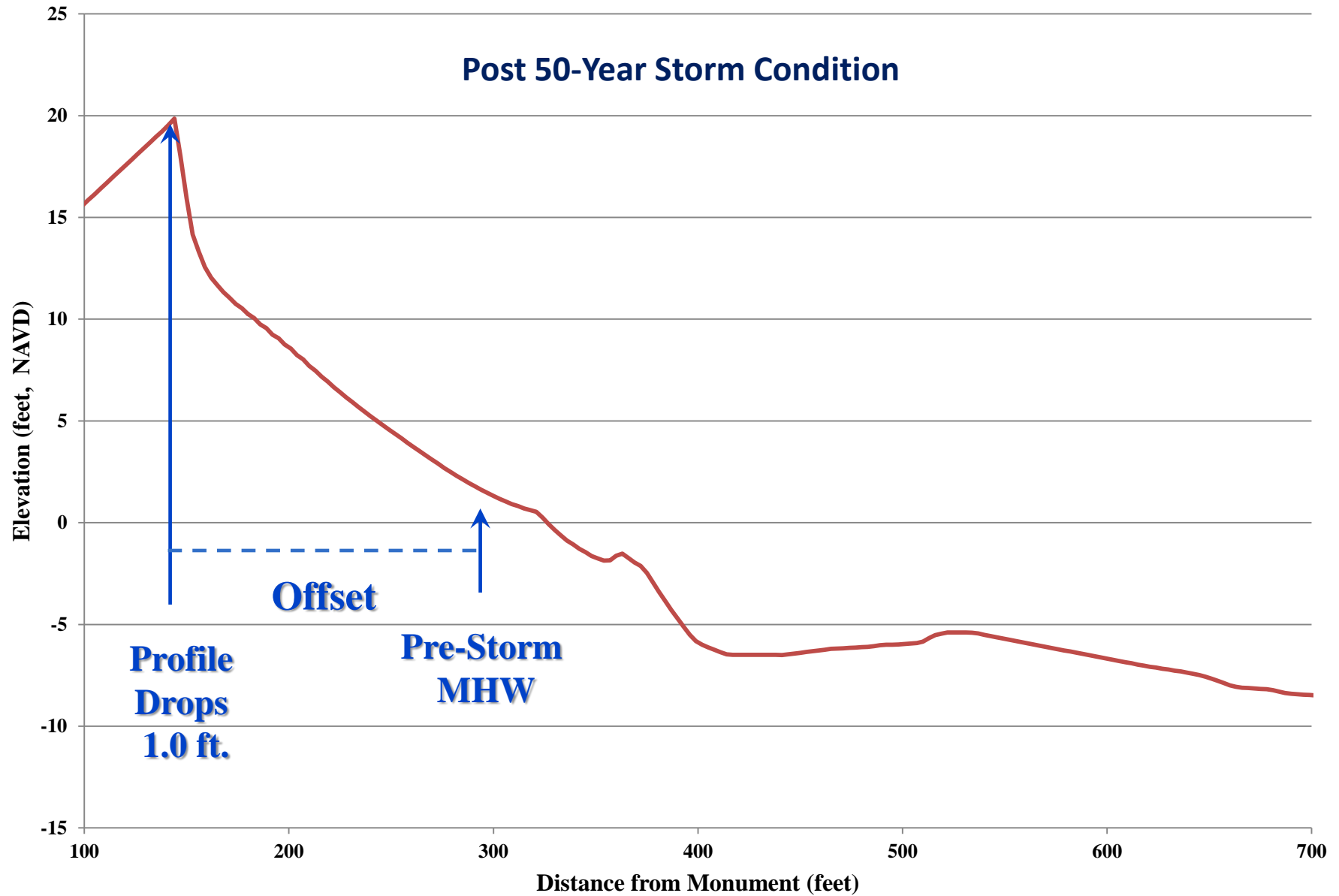
SBEACH
Storm Damage Analysis

Segment	Structures Impacted during Storm Event under Existing Conditions					
	1-Year	5-Year	10-Year	20-Year	25-Year	50-Year
1	-	-	-	-	-	-
2	-	-	-	-	2	2
3	-	-	-	1	1	2
4	-	-	-	1	1	8
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	15	19	23	27	32	36
8	2	6	14	20	22	23
9	-	-	-	-	-	-
10	-	-	-	-	-	-

SBEACH
Storm Damage Analysis

SBEACH Change at Profile 39+04

SBEACH Change at Profile 39+04

Starting Condition with Beach Fill Design

20 Ft. Width

15 Ft. Elevation

100 Ft. Wide Berm

Elevation (feet, NAVD)

Distance from Monument (feet)
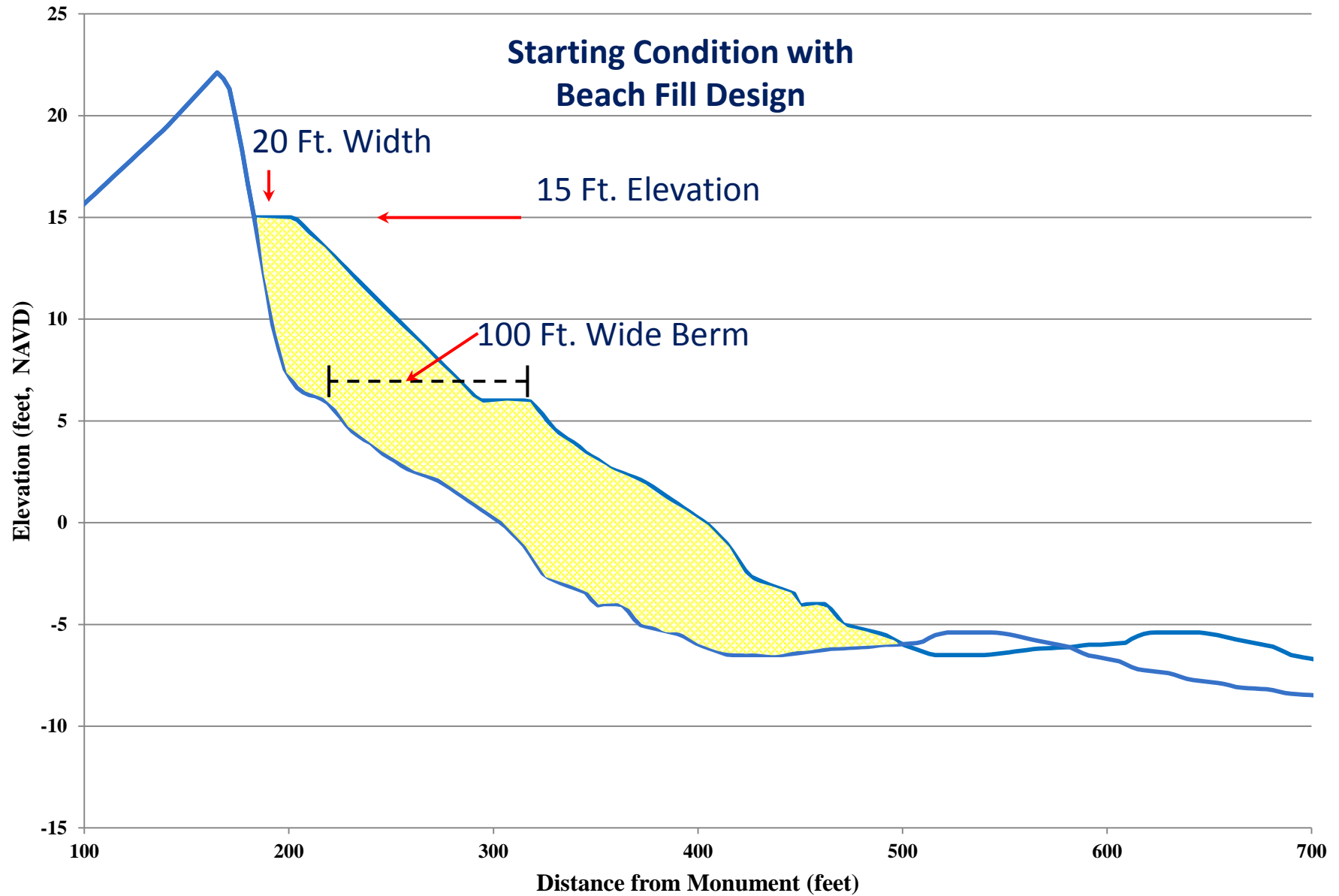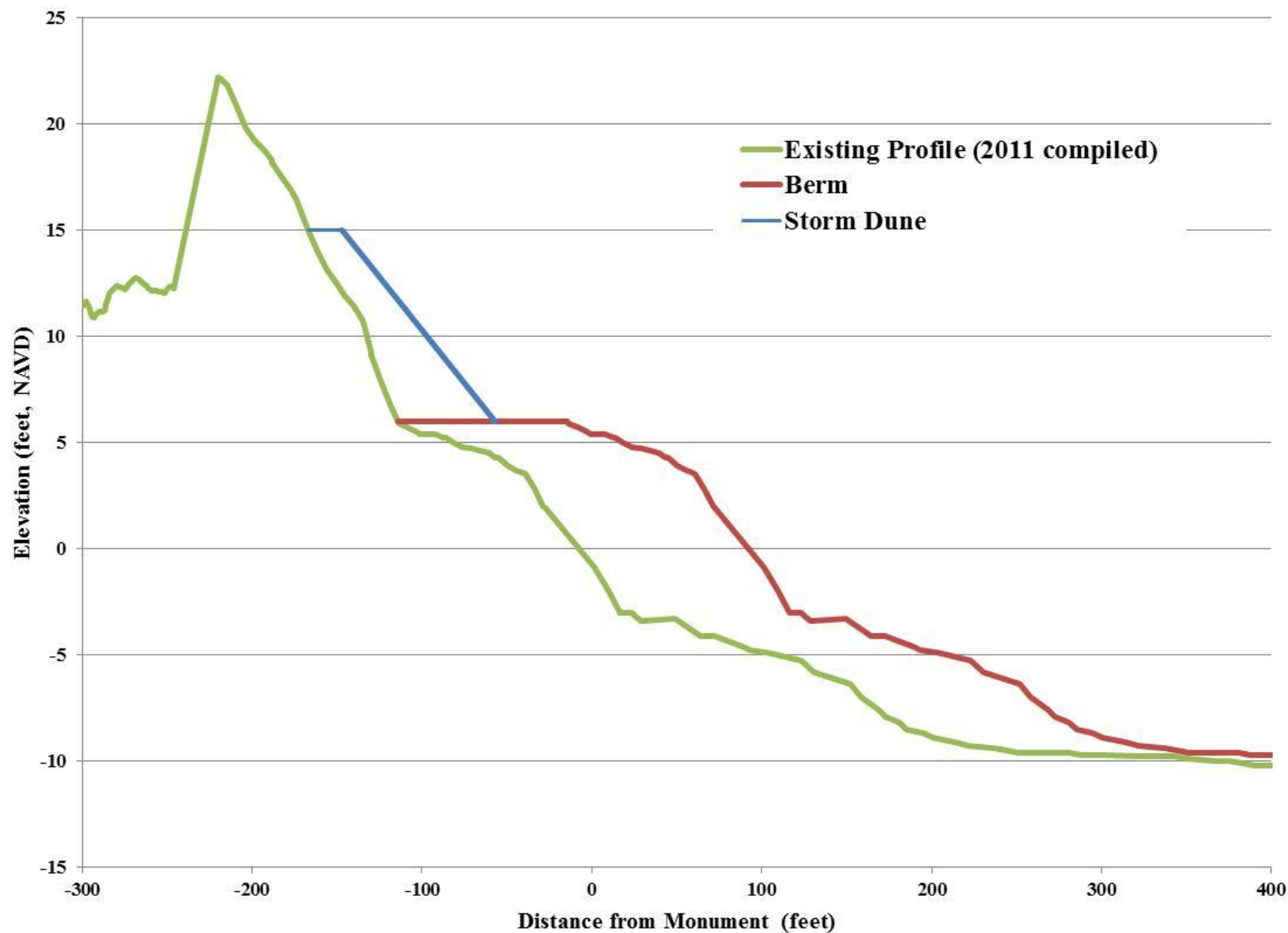
Typical Cross-Section of Design 5 at Profile 126+75

Dune Crest

Berm Crest
(6.0 ft. Elevation)

New River Inlet Realignment
with Beach Renourishment

Image # 121120 0010
Date 11.20.12

Aero Photo

727.520.8181
www.aerophoto.com

**New River Inlet Realignment
with Beach Renourishment**

Image # 130220 0009
Date 02.20.13

SBEACH Change at Profile 39+04

Starting Condition with Beach Fill Design

20 Ft. Width

15 Ft. Elevation

100 Ft. Wide Berm

Elevation (feet, NAVD)

Distance from Monument (feet)
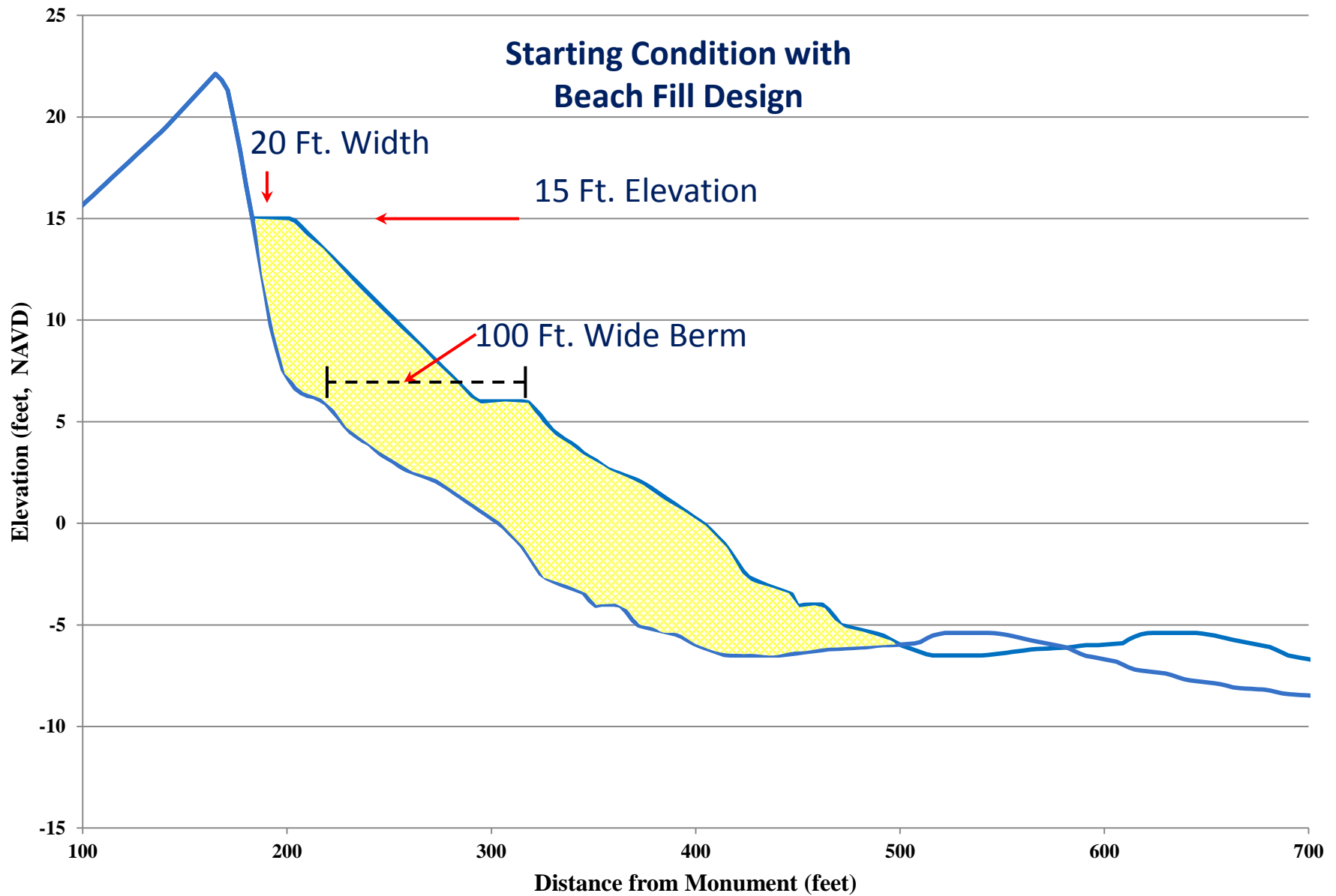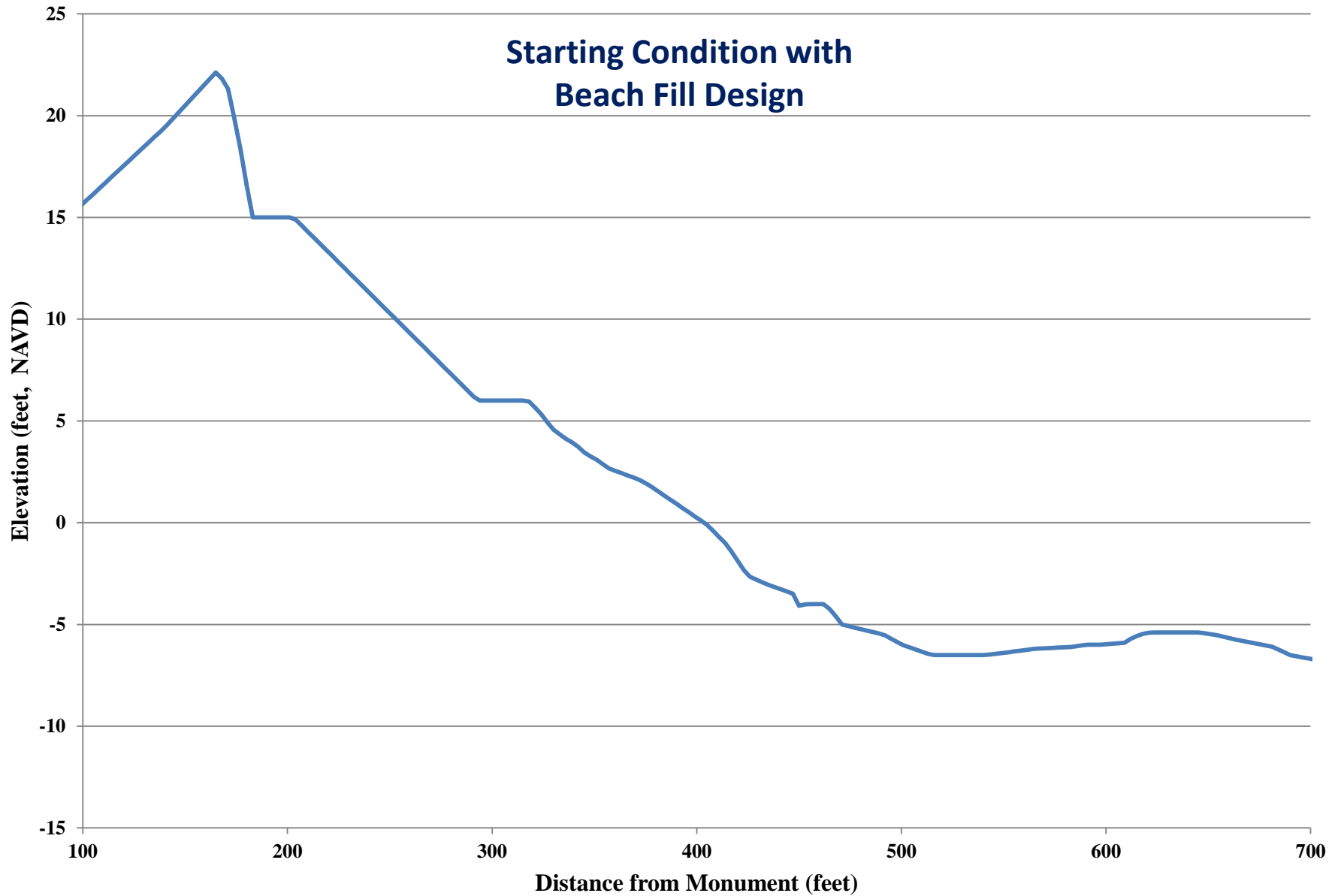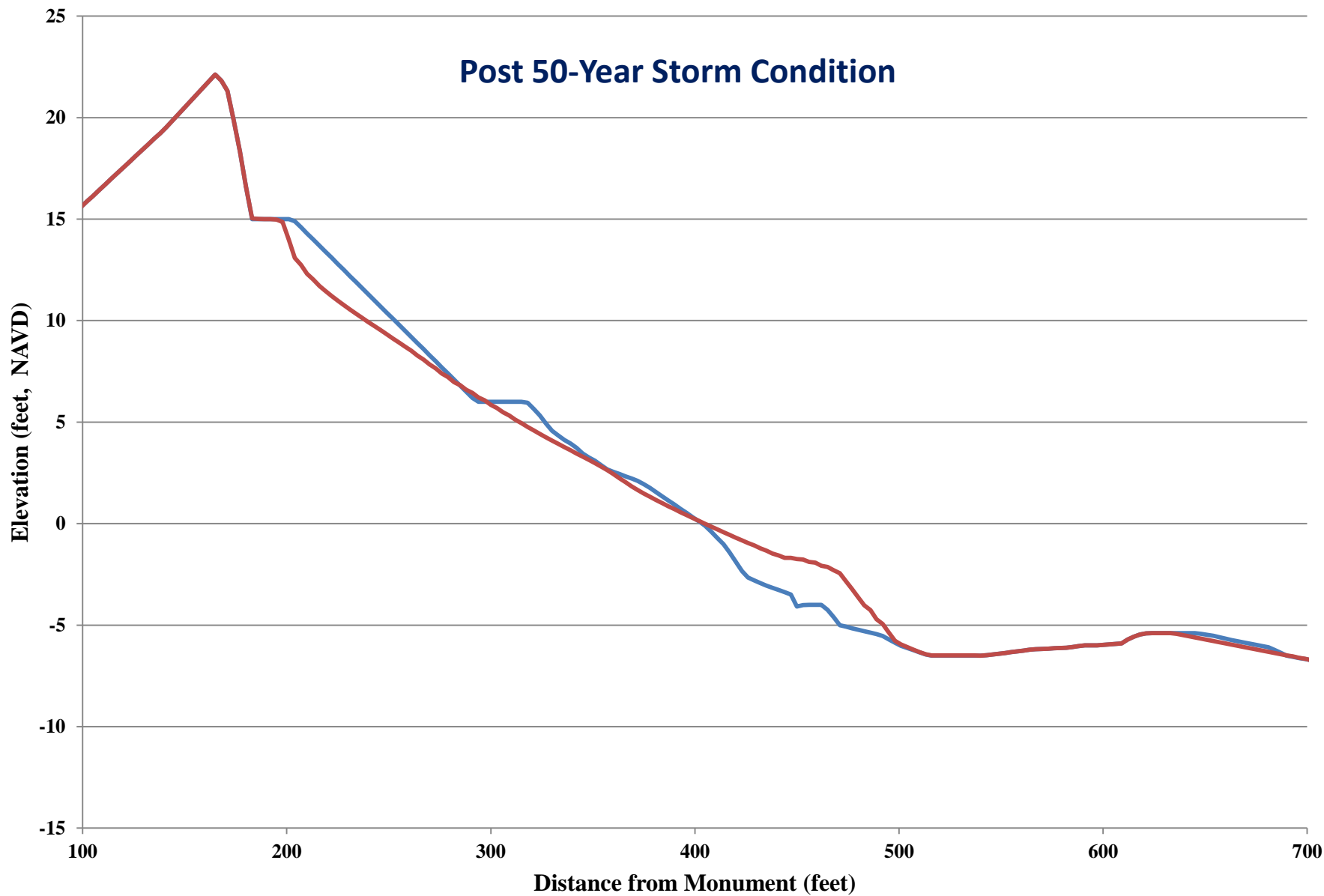
SBEACH Change at Profile 39+04

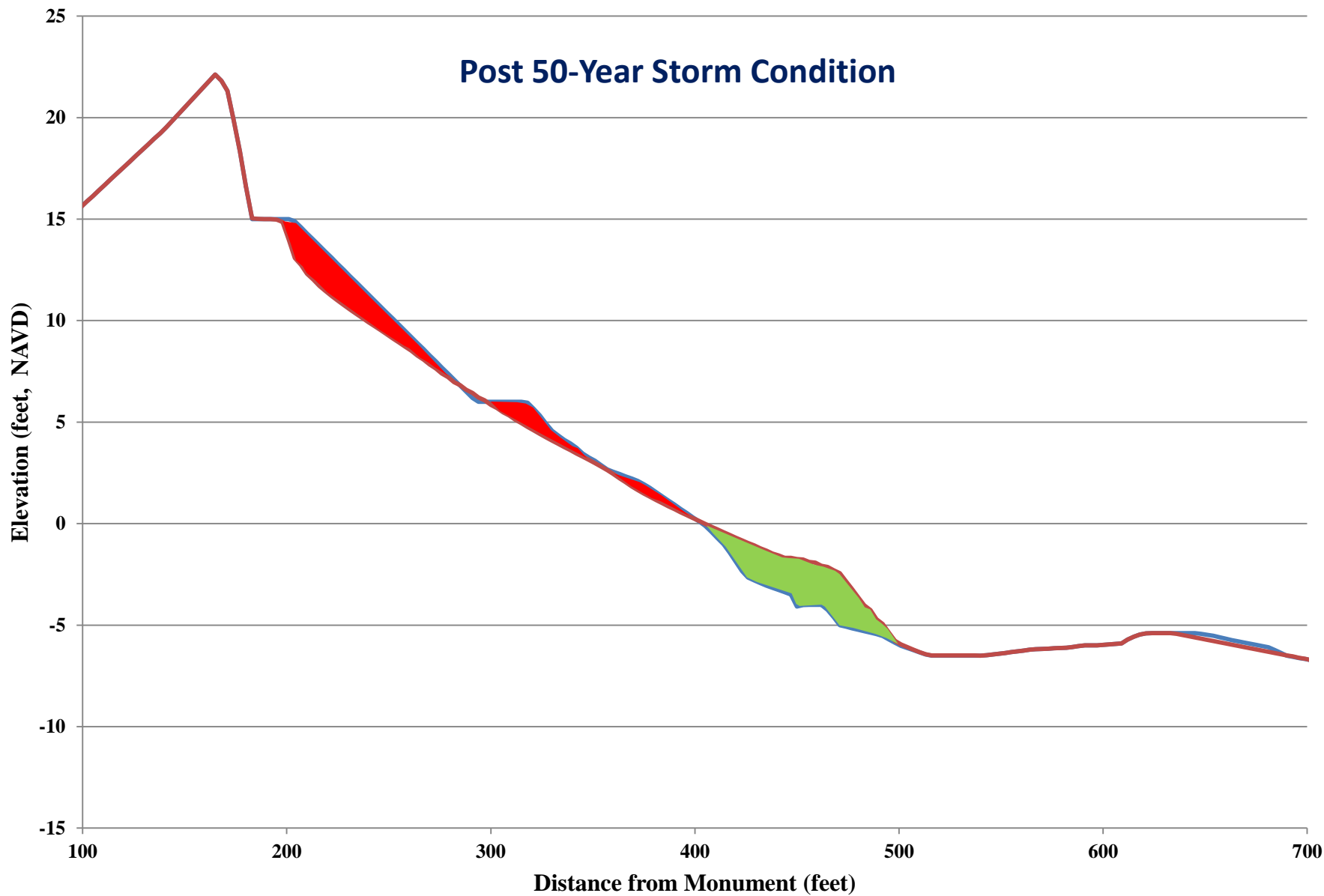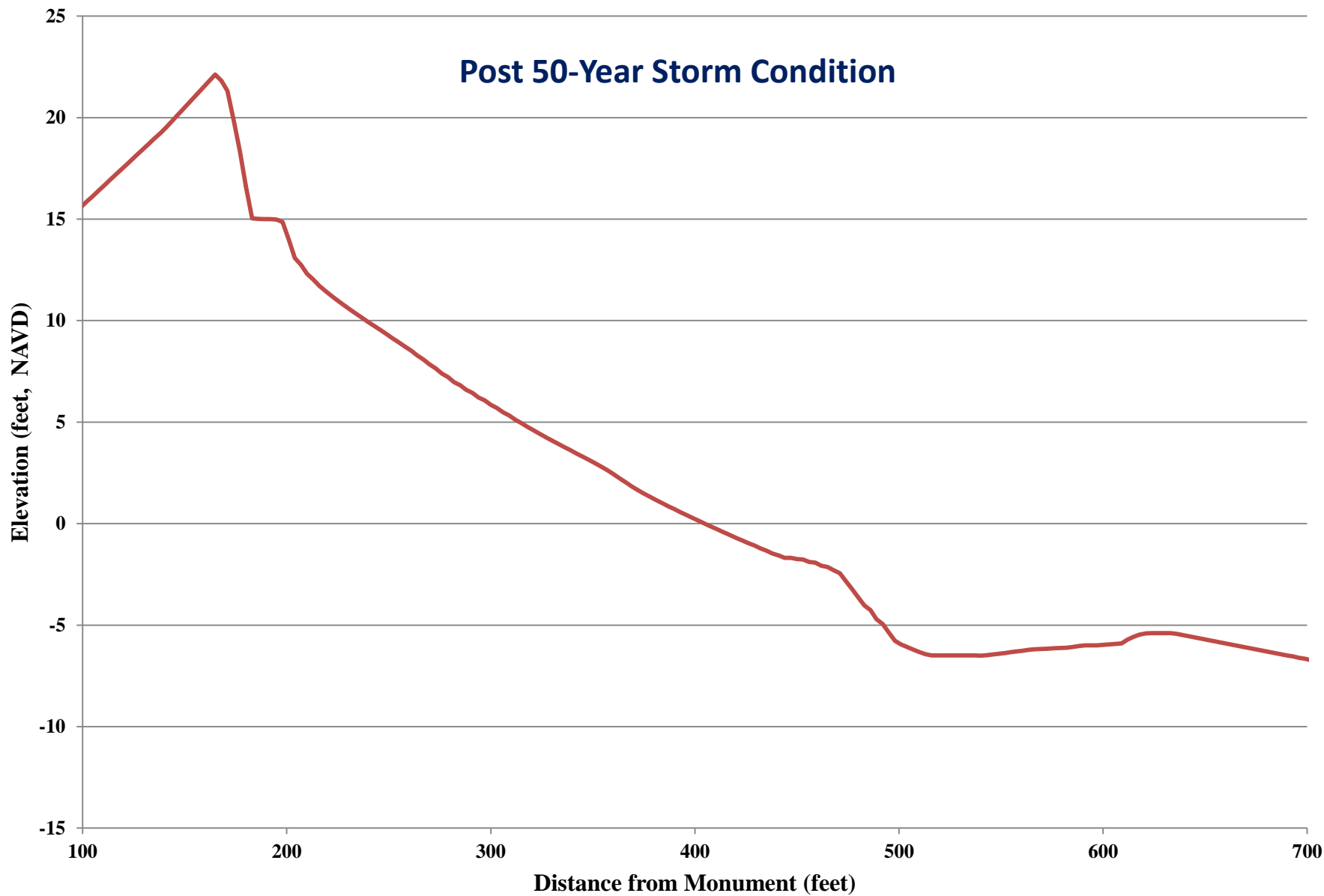Starting Condition with
Beach Fill Design

SBEACH Change at Profile 39+04

Post 50-Year Storm Condition

SBEACH Change at Profile 39+04
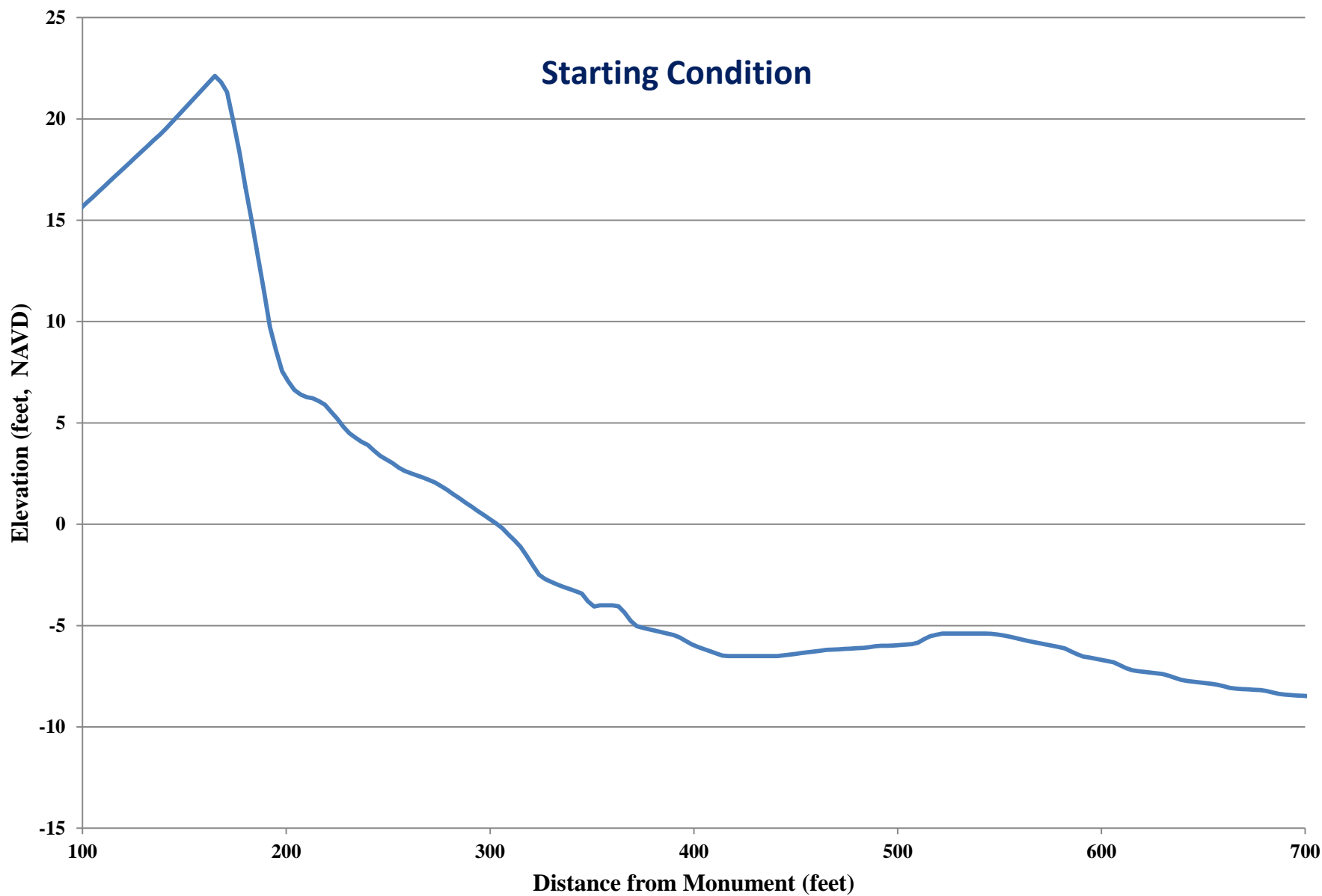
Post 50-Year Storm Condition

SBEACH Change at Profile 39+04

Post 50-Year Storm Condition

SBEACH Change at Profile 39+04

Starting Condition

SBEACH

Design	Storm Dune Width[1] (ft)	Storm Dune Crest (ft, NAVD)	Storm Dune Side Slope	Berm Width[2] (ft)	Berm Crest (ft, NAVD)	Depth of Closure (ft, NAVD)	Fill Density (CY/ft)
1	-	-	-	50	6	-24	55.6
2	-	-	-	100	6	-24	111.1
3	-	-	-	100	8	-24	118.5
4	-	-	-	100	12	-24	133.4
5	20	15	1V:10H	100	6	-24	124.3
6	35	15	1V:10H	100	6	-24	129.3
7	20	15	1V:10H	75	6	-24	96.5
8	20	15	Variable[3]	100	6	-24	120.8
9	20	15	Variable[3]	75	6	-24	93.0

[1] Width of the storm dune was measured as the horizontal distance from the crest to the intersection of the existing profiles at the +15.0 feet, NAVD contour.

[2] Width of the berm was measured as the horizontal distance from the crest to the intersection of the existing profiles at the +6.0 feet, NAVD contour.

[3] The toe of the storm dune extended 20 feet seaward from the +6.0 feet, NAVD contour of the existing profile. Thus, the side slope of the dune was a function of the existing profile.

Table 8. Beach fill designs modeled with SBEACH

SBEACH

Segment	Minumum Design Required for Storm Event					
	1-Year	5-Year	10-Year	20-Year	25-Year	50-Year
1	-	-	-	-	-	-
2	-	-	-	-	1	1
3	-	-	-	1	1	7
4	-	-	-	1	1	1
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	1	9	9	7	7	5
8	1	1	1	7	5	6
9	-	-	-	-	-	-
10	-	-	-	-	-	-

SBEACH

| h (ft)	Construction Volume Required for Storm Event (CY)					
	1-Year	5-Year	10-Year	20-Year	25-Year	50-Year
8,000	-	-	-	-	-	-
6,000	-	-	-	-	508,000	508,000
2,000	-	-	-	363,800	116,700	198,500
4,000	-	-	-	443,600	443,600	443,600
2,000	-	-	-	-	-	-
1,000	-	-	-	-	-	-
5,000	651,400	1,000,800	1,000,800	1,018,300	1,018,300	1,157,300
8,000	609,400	609,400	609,400	1,072,500	1,294,900	1,334,900
2,000	-	-	-	-	-	-
14,000	-	-	-	-	-	-
Total:	**1,260,800**	**1,610,200**	**1,610,200**	**2,898,200**	**3,381,500**	**3,642,300**
Total (7 & 8):	**1,260,800**	**1,610,200**	**1,610,200**	**2,090,800**	**2,313,200**	**2,492,200**

Sand Sources

Sand Sources
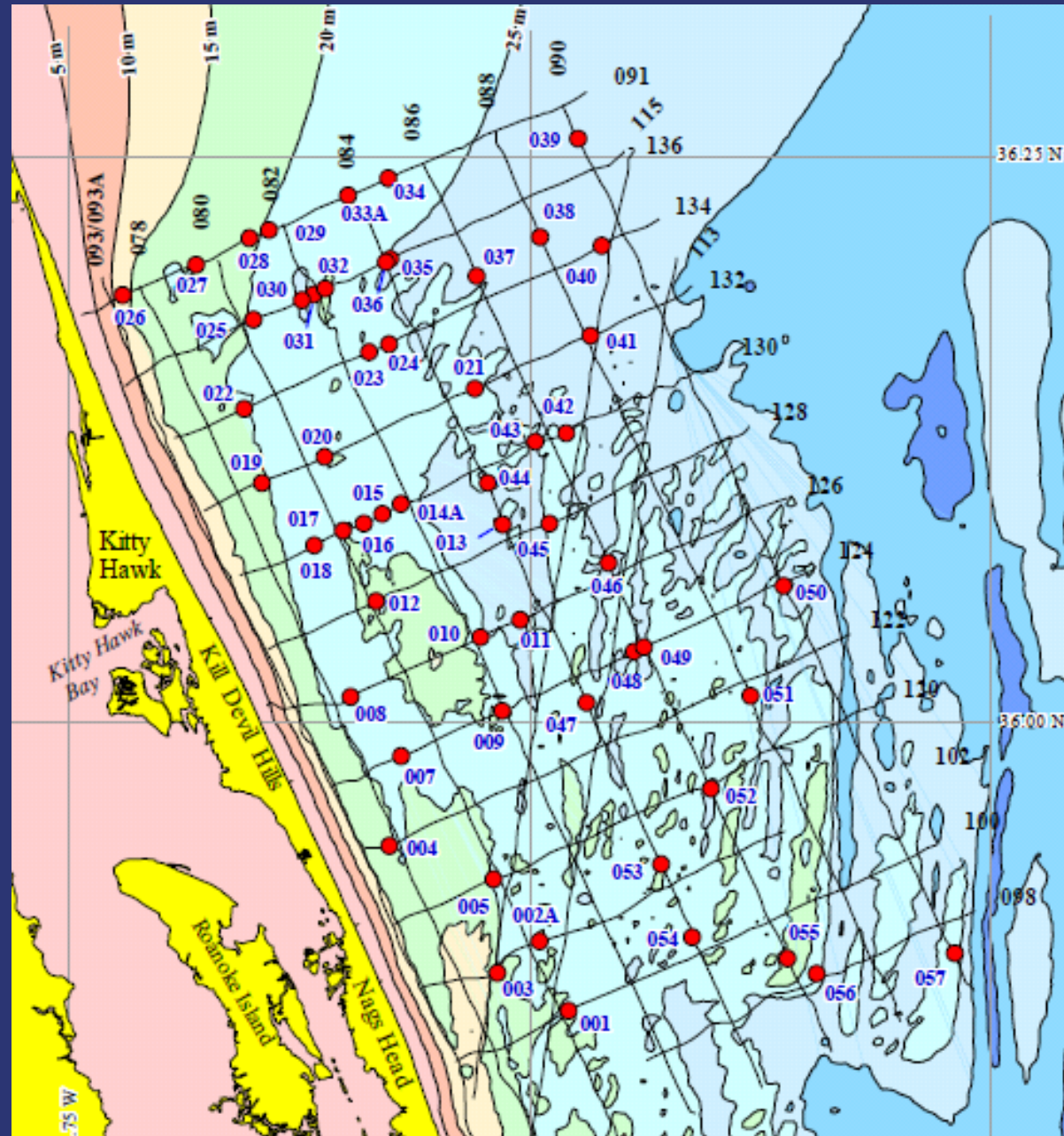
(Boss & Hoffman, 2001)

Sand Sources
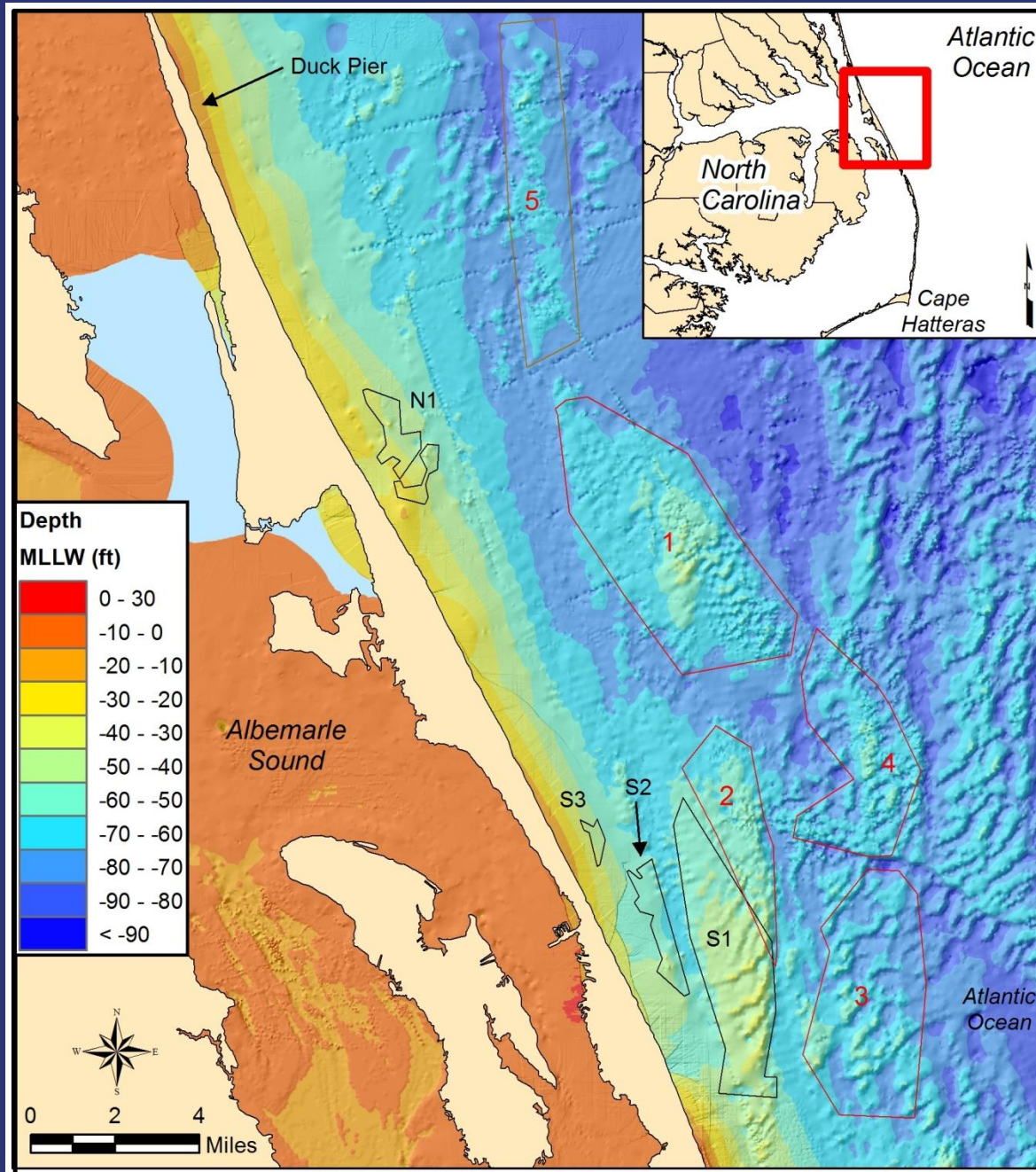
Recommendations:

- **Large Scale Beach Nourishment (Dredging)**
  - Determine a budget/Justification
  - Choose the appropriate Scale of the project

Conceptual Alternative Summary

Plan	Project Extent	Volume of Sand (CY)	Sand Source	Re-Nourishment Interval	Cost (x $1,000,000)
Dune Replenishment	Segment 7 (5000 Feet)	30,000	Upland/ Truck Haul	1 Year	**0.94**
Beach Replenishment	Segment 7 (5000 Feet)	43,000	Upland/ Truck Haul	1 Year	**1.75 - 1.85**
Long-Term Erosion Mitigation Project	Segments 7 & 8 (13,000 Feet)	828,200	Offshore/ Dredge & Fill	5 Years	**13.04 - 14.96**
1 Year Strom Damage Reduction Project	Segments 7 & 8 (13,000 Feet)	1,260,800	Offshore/ Dredge & Fill	5 Years	**17.42 - 20.35**
5 & 10 Year Storm Damage Reduction Project	Segments 7 & 8 (13,000 Feet)	1,610,200	Offshore/ Dredge & Fill	5 Years	**20.88 - 24.62**
20 Year Storm Damage Reduction Project	Segments 7 & 8 (13,000 Feet)	2,090,800	Offshore/ Dredge & Fill	5 Years	**25.64 - 30.49**
25 Year Storm Damage Reduction Project	Segments 7 & 8 (13,000 Feet)	2,313,200	Offshore/ Dredge & Fill	5 Years	**27.84 - 33.21**
50 Year Storm Damage Reduction Project	Segments 4, 7, & 8 (17,000 Feet)	2,935,800	Offshore/ Dredge & Fill	5 Years	**34.00 - 40.82**

Tracking No. 00.00.2011

Recommendations:

- **Large Scale Beach Nourishment (Dredging)**
  - Determine Budget/Justification
  - Choose the Appropriate Scale of the project
  - Inter-Agency Coordination
  - Reconnaissance Offshore Sand Investigation
  - Initiate Permitting & Design
  - Design Level Offshore Sand Investigation
  - Initiate Construction Phase
    - Pre-Construction Surveys and Monitoring
    - Development of Plans & Specifications
    - Solicit Bids
    - Evaluate and Award Contract
    - Construction/Construction Oversight
    - Post-Construction Surveys and Monitoring

Recommendations:

- **Small Scale Truck Haul Project**
  - – **Limited Protection/Emergency Use**
  - – **Up to $425 Additional Permitting and Design Costs**
  - – **Up to 8 months for Permitting and Design**
  - – **Hold Permits If Needed**

- **Continue Comprehensive Town-Wide Beach Monitoring Plan**
  - – **Regular Surveys**
  - – **Adaptive Management**

Thank You For Your Time!!

Questions?

Ken Willson – Kenneth.Willson@CBI.com

Conceptual Alternative Summary

Phase 1: Coastal Process and Shoreline Impact Analysis
4: Economic Losses Due To Shoreline Change Rates

Segment Number	Timeframe					Total
	2011-2016	2016-2021	2021-2026	2026-2041	2041-2061	
1	n/a	n/a	n/a	n/a	n/a	**n/a**
2	$324,562	$247,875	$260,436	$798,100	$1,064,036	**$2,695,009**
3	$7,463	$0	$0	$0	$0	**$7,463**
4	$699,299	$668,680	$671,670	$2,017,491	$3,292,775	**$7,349,915**
5	n/a	n/a	n/a	n/a	n/a	**n/a**
6	n/a	n/a	n/a	n/a	n/a	**n/a**
7	$5,491,742	$9,113,056	$19,111,284	$24,820,203	$15,173,810	**$73,710,095**
8	$66,129	$30,016	$30,028	$89,642	$2,618,890	**$2,834,705**
9	$42,142	$12,425	$12,997	$41,964	$61,292	**$170,820**
10	$0	$0	$0	$0	$0	**$0**
Total	**$6,631,337**	**$10,072,052**	**$20,086,415**	**$27,767,400**	**$22,210,803**	**$86,768,007**

SBEACH
Storm Damage Analysis

Segment	Shoreline Length (ft)	Construction Volume Required for Storm Event (CY)					
		1-Year	5-Year	10-Year	20-Year	25-Year	50-Year
1	8,000	-	-	-	-	-	-
2	6,000	-	-	-	-	508,000	508,000
3	2,000	-	-	-	363,800	116,700	198,500
4	4,000	-	-	-	443,600	443,600	443,600
5	2,000	-	-	-	-	-	-
6	1,000	-	-	-	-	-	-
7	5,000	651,400	1,000,800	1,000,800	1,018,300	1,018,300	1,157,300
8	8,000	609,400	609,400	609,400	1,072,500	1,294,900	1,334,900
9	2,000	-	-	-	-	-	-
10	14,000	-	-	-	-	-	-
Total:		1,260,800	1,610,200	1,610,200	2,898,200	3,381,500	3,642,300
Total (7 & 8):		1,260,800	1,610,200	1,610,200	2,090,800	2,313,200	2,492,200