Developing a Sand Management Plan for Galveston Island

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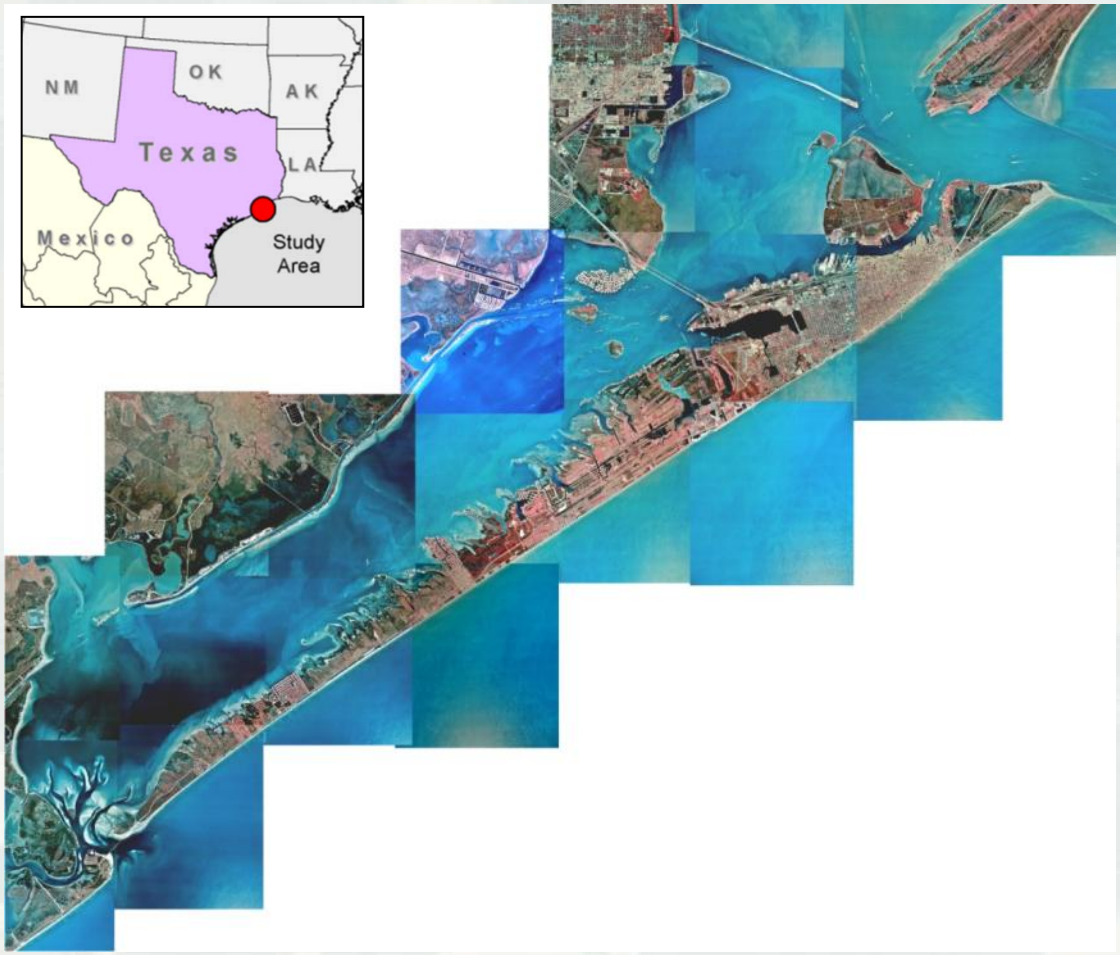
Outline

- Problem Statement and Approach
- Sediment Budget
- GenCade Calibration
- Sand Management Options at East Beach
- Large-Scale Beach Fill
- GenCade Alternatives
- Sand Management Alternatives and Plan
- Beach Nourishment Project



Problem Statement/Approach

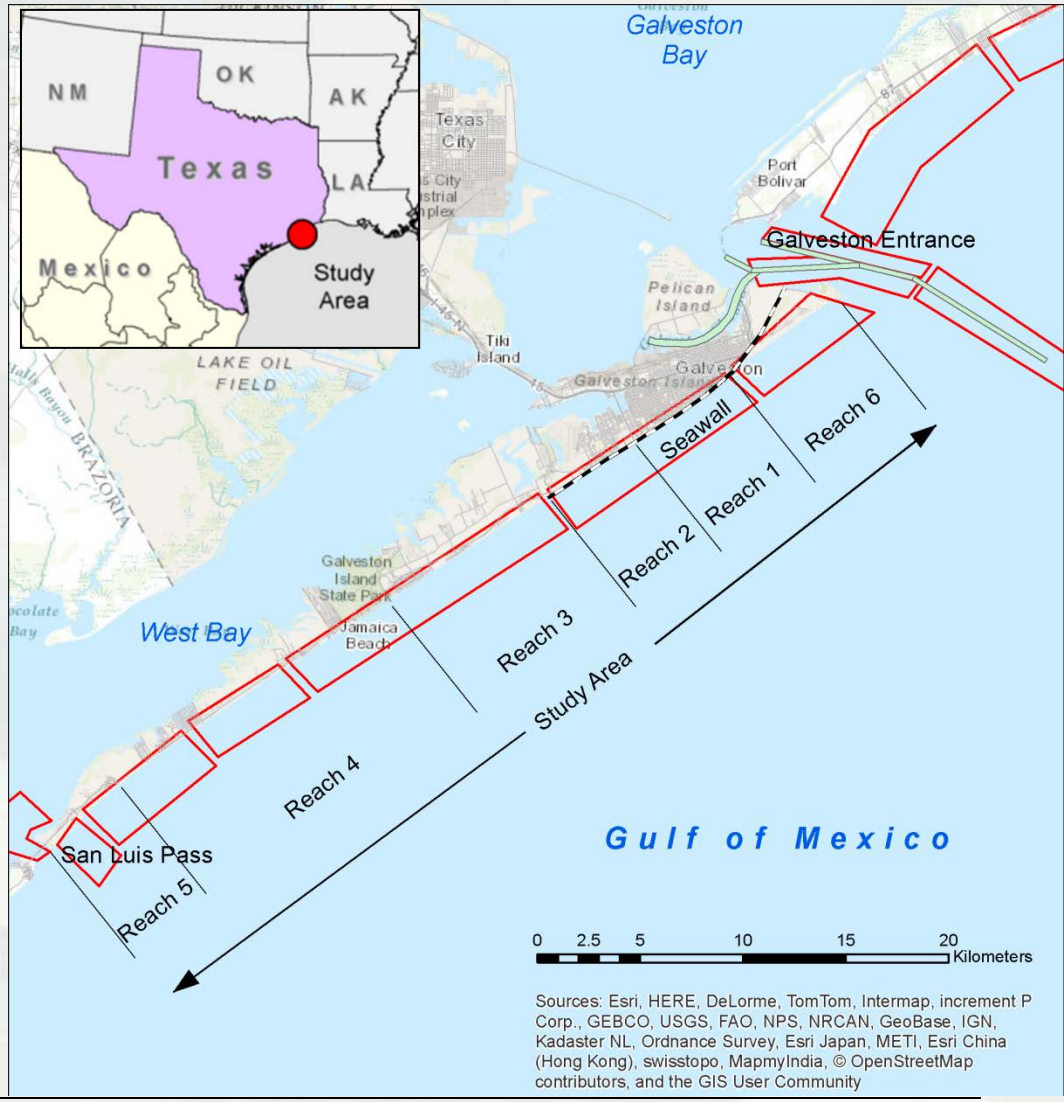
Recommend a long-term plan of actions to better manage sands on Galveston Island

Initial Tasks – Understand physical processes

- Update sediment budget
- Update shoreline change model

Final Tasks

- Evaluate potential solutions/actions
- Formalize and document Galveston Island Sand Management Plan



Sediment Budget Objectives

- Identify sources and sinks of sediment in coastal system
  - Beach fills
  - Littoral and offshore sources
  - Dredge data
- Compute quantities
- Determine direction of movement using morphologic evidence
- Evaluate sand management alternatives to reduce costs and improve beach resources

Sediment Budget Equation and the Sediment Budget Analysis System (SBAS)

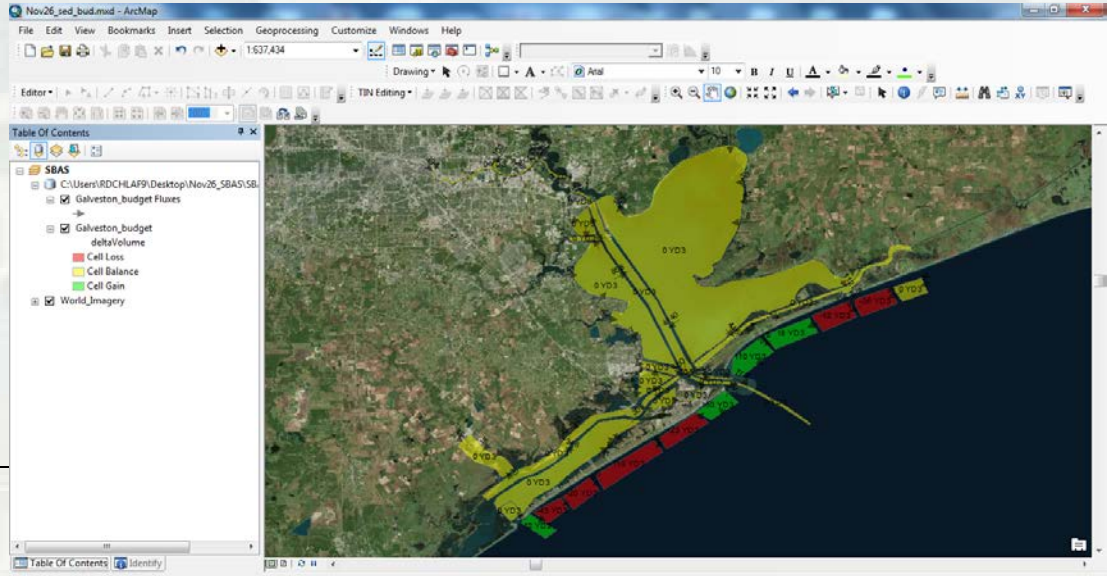
$$\sum Q_{source} - \sum Q_{sink} - \Delta V + P - R = \text{Residual}$$

Q_{source} and Q_{sink} = sources and sinks to each cell

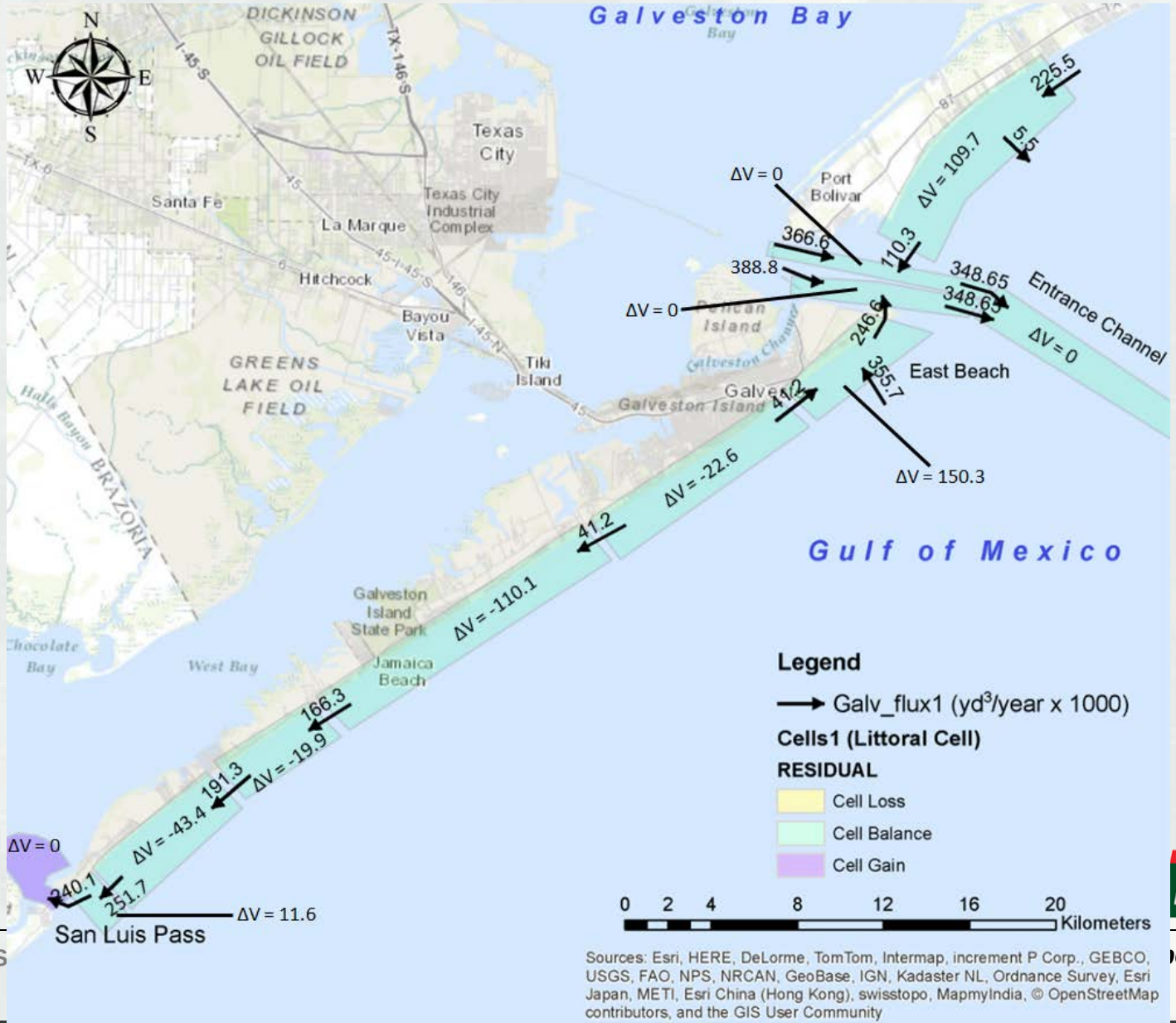
ΔV = net change in volume in each cell

P = material placed (beach fill)

R = material removed (dredging)



Sediment Budget in SBAS

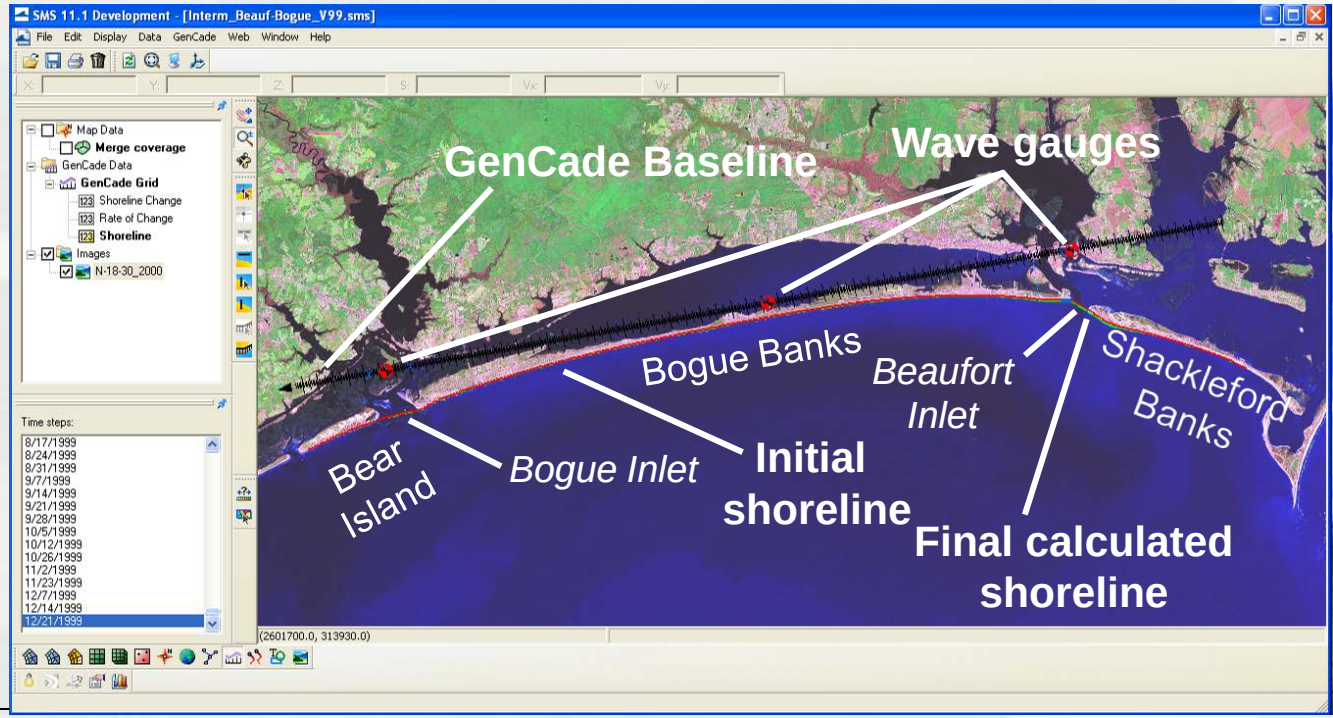


GenCade Modeling

- Integrated GENESIS and Cascade models for shoreline change and regional sediment calculation
- Connects inlets, navigation channels, ebb and flood shoals, and beaches in engineering activities in a regional framework
- Decision-making support for planning, operation, and engineering
- In SMS 11.1 and higher; PC, user-friendly interface for engineers & scientists

Purpose:

- Assess shoreline change and longshore transport
- Evaluate sediment management solutions

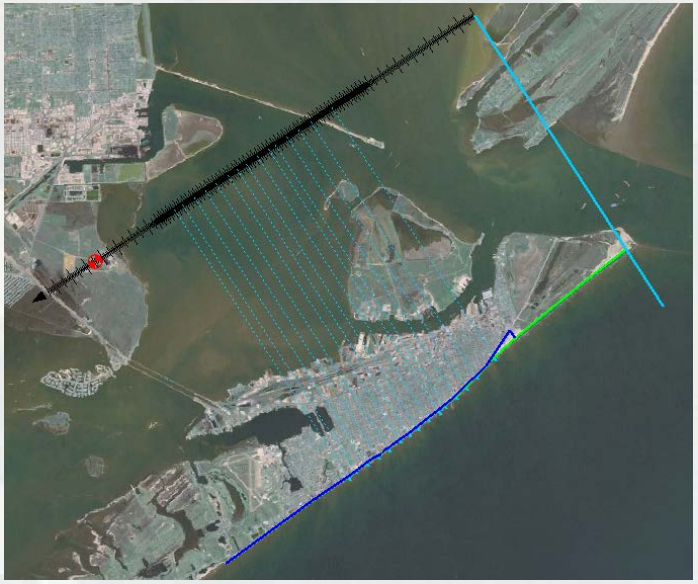


GenCade Calibration

GenCade Input:

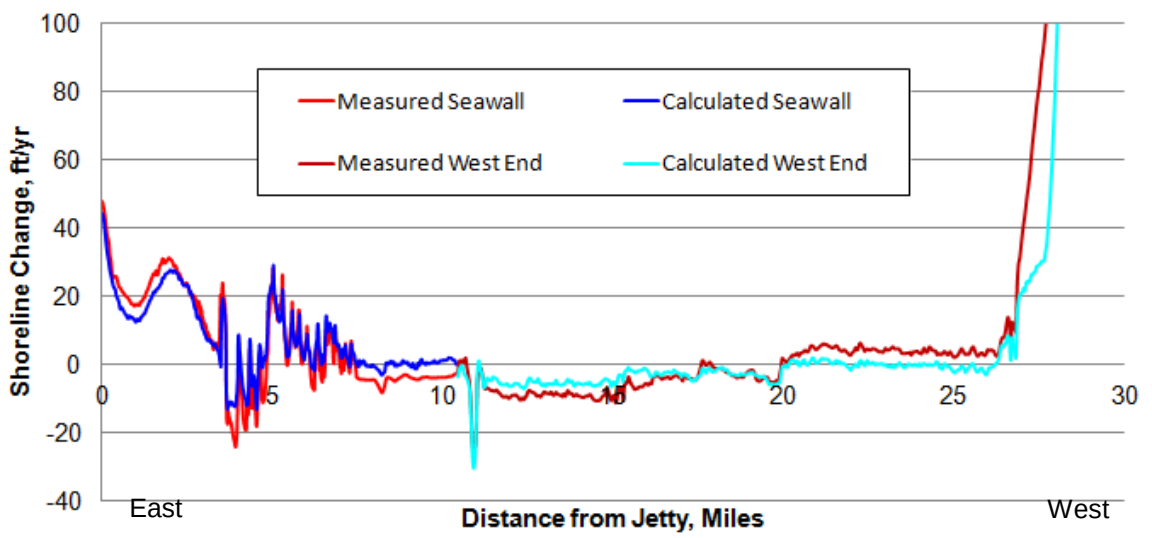
- Two separate grids were used in order to improve results near the west end of the seawall and increase efficiency
- 1995 and 2000 shorelines
- Historical shorelines averaged and smoothed to create regional contour
- Cell spacing ranging from 50 ft (near groins) to 200 ft
- Galveston seawall, groins, and beach fills
- Waves (WIS 73067, 73070)

GenCade Calibration



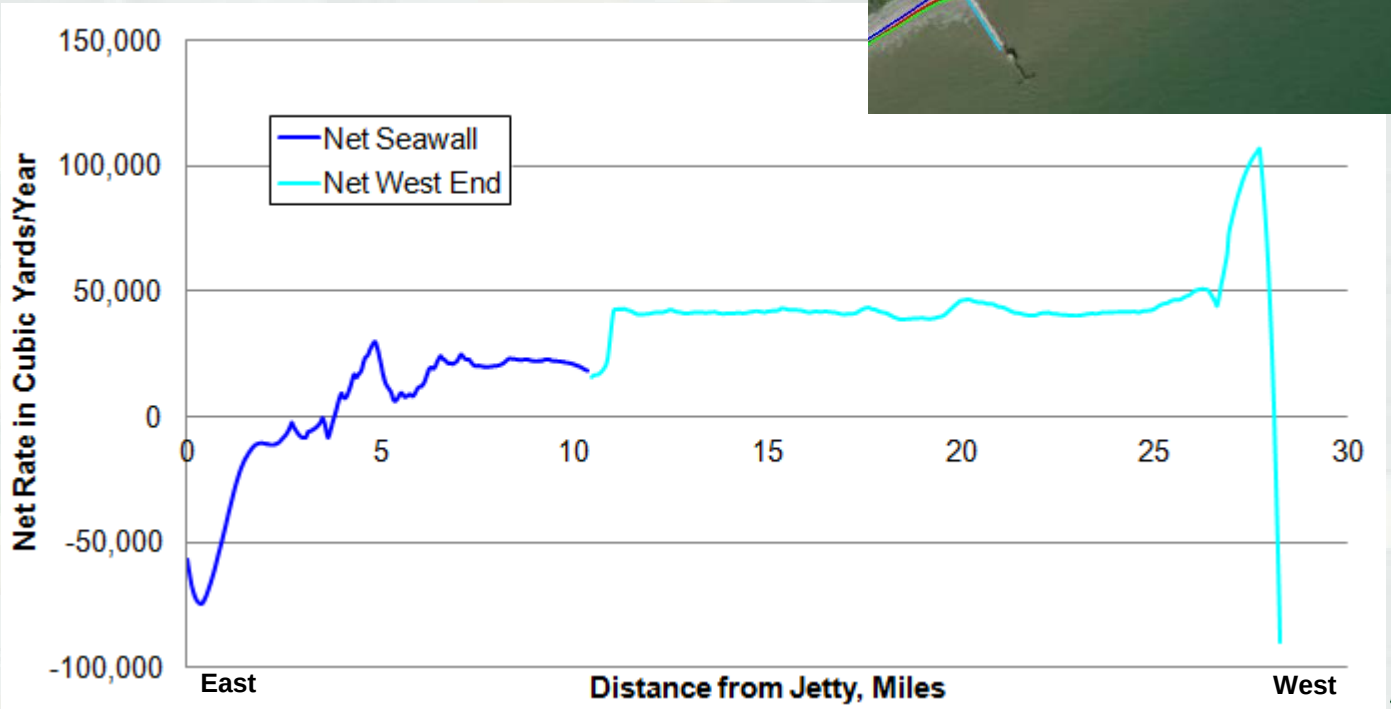
Parameter	Value
Start Date	1/1/1995 0:00
End Date	12/31/1999 0:00
Time Step	0.1 hr
Recording Time Step	168 hr
Effective Grain Size, mm	0.17
Average Berm Height, ft	4
Average Depth of Closure, ft	20
Left Lateral Boundary Condition, Seawall Grid	Gated
Right Lateral Boundary Condition, Seawall Grid	Pinned
Left Lateral Boundary Condition, West End Grid	Moving, -18 ft
Right Lateral Boundary Condition, West End Grid	Moving, 780 ft
K1	0.4
K2	0.2
ISMOOTH	11

GenCade Calibration: Shoreline Change Statistics



Cell	Average Shoreline Change, ft/year		RMS Error, ft/year	Brier Skill Score
	Measured	Modeled		
Jetty to first groin	18.2	15.1	3.8	0.96
Groin field	1.6	5.5	5.0	0.82
Seawall west of groin field	-3.4	0.5	4.0	0.87
West end (to 13 Mile Rd)	-8.1	-5.2	3.6	0.84
13 Mile Rd. to Jamaica Beach	-3.3	-2.9	1.3	0.87
Jamaica Beach	-0.7	-1.5	1.1	-0.27
Jamaica Beach to Indian Beach	-3.3	-3.4	0.9	0.94
Indian Beach to Sea Isle	4.1	0.5	3.8	0.22
Sea Isle area	3.6	-0.4	4.1	-0.23
West end 1	5.7	-1.2	4.7	0.54
West end 2	91.3	50.0	45.5	0.79

GenCade Calibration: Net transport

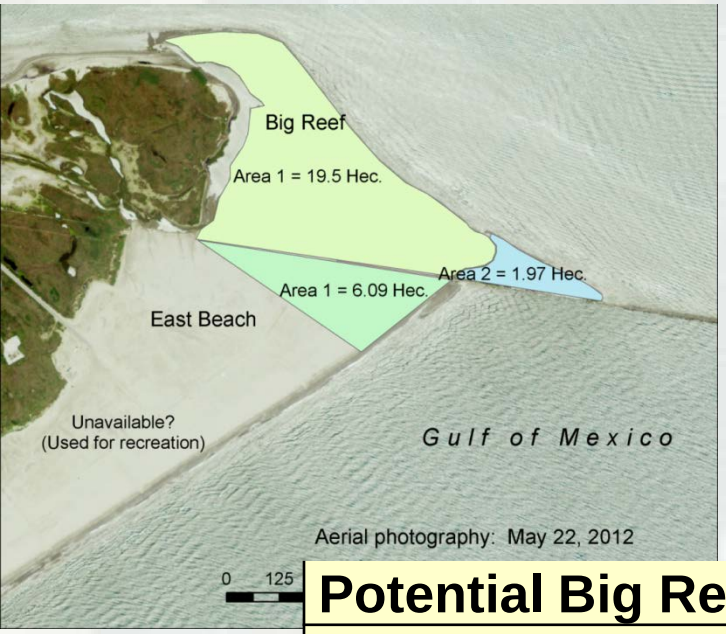


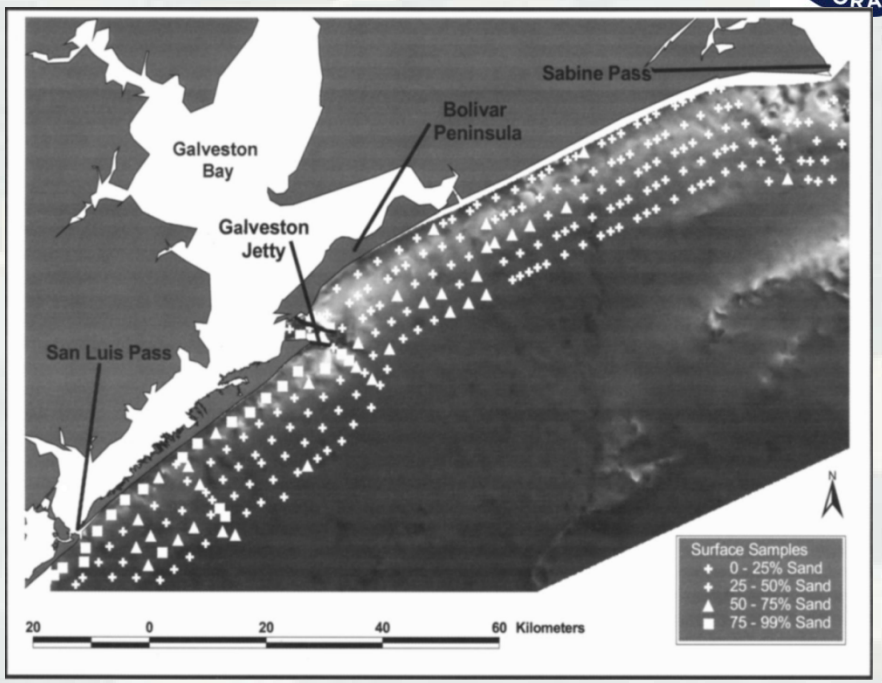
Sediment Management Options

1. Identify sand sources
   - Big Reef
   - East Beach
   - Offshore
2. Deposition basin off East Beach
3. Reduce trans. through S. jetty
4. Reduce Aeolian sand transport
5. Sand backpass system

Identifying Sand Sources

Big Reef and East Beach east of Boddeker Rd (without recreational or environmental restrictions) = 2+ million yd^3
(Incl. offshore Big Reef: 3+ million yd^3)





Heald Bank: 35 mi offshore with ~ 765,000,000 yd^3

Sabine Bank: 70 mi offshore with ~ 1,600,000,000 yd^3

Potential Big Reef Mining Volumes

Polygon	Area (m^2)	Vol. 1.1 yd layer (yd^3)	Vol. 2.2 yd layer (yd^3)	Vol. 5.5 yd layer (yd^3)
Big Reef Area1	195,000	255,100	510,100	1,275,300
Big Reef Area2	19,660	25,800	51,400	128,600
East Beach Area1	60,900	79,700	159,300	398,300
Total	275,560	360,600	720,800	1,802,200

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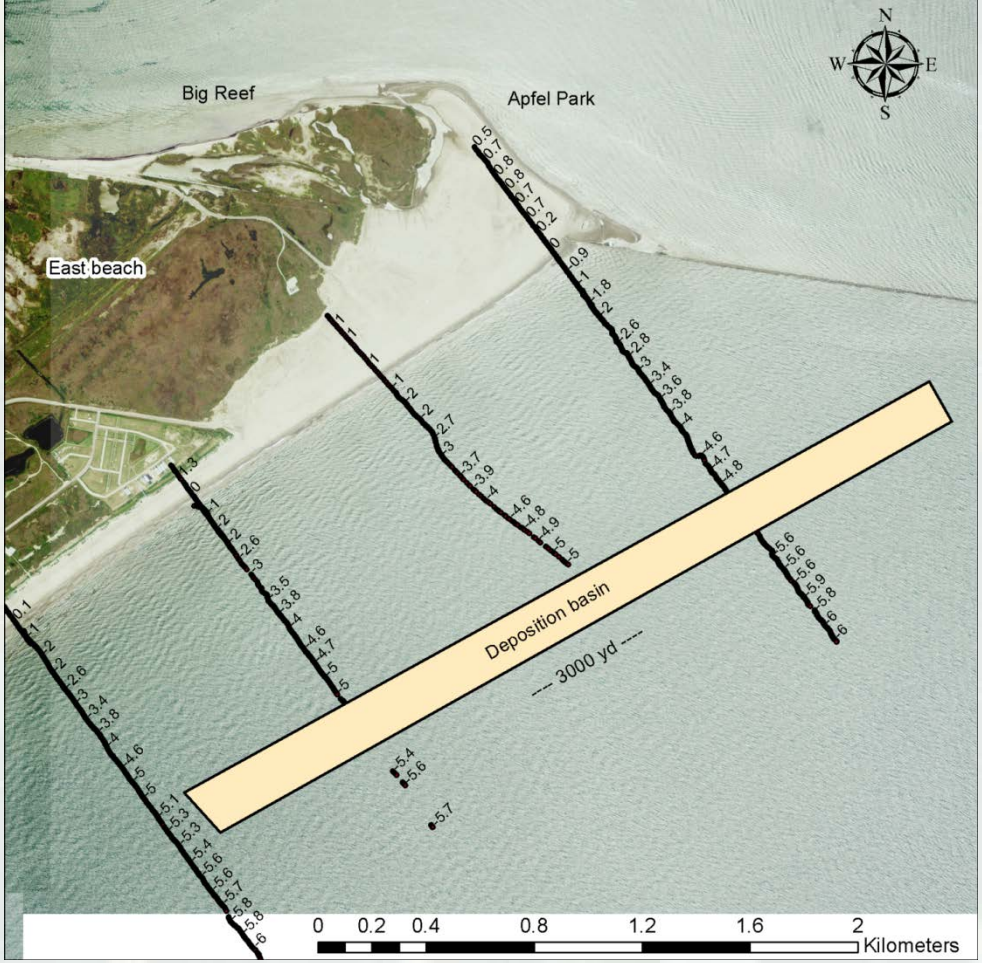
Deposition Basin off East Beach



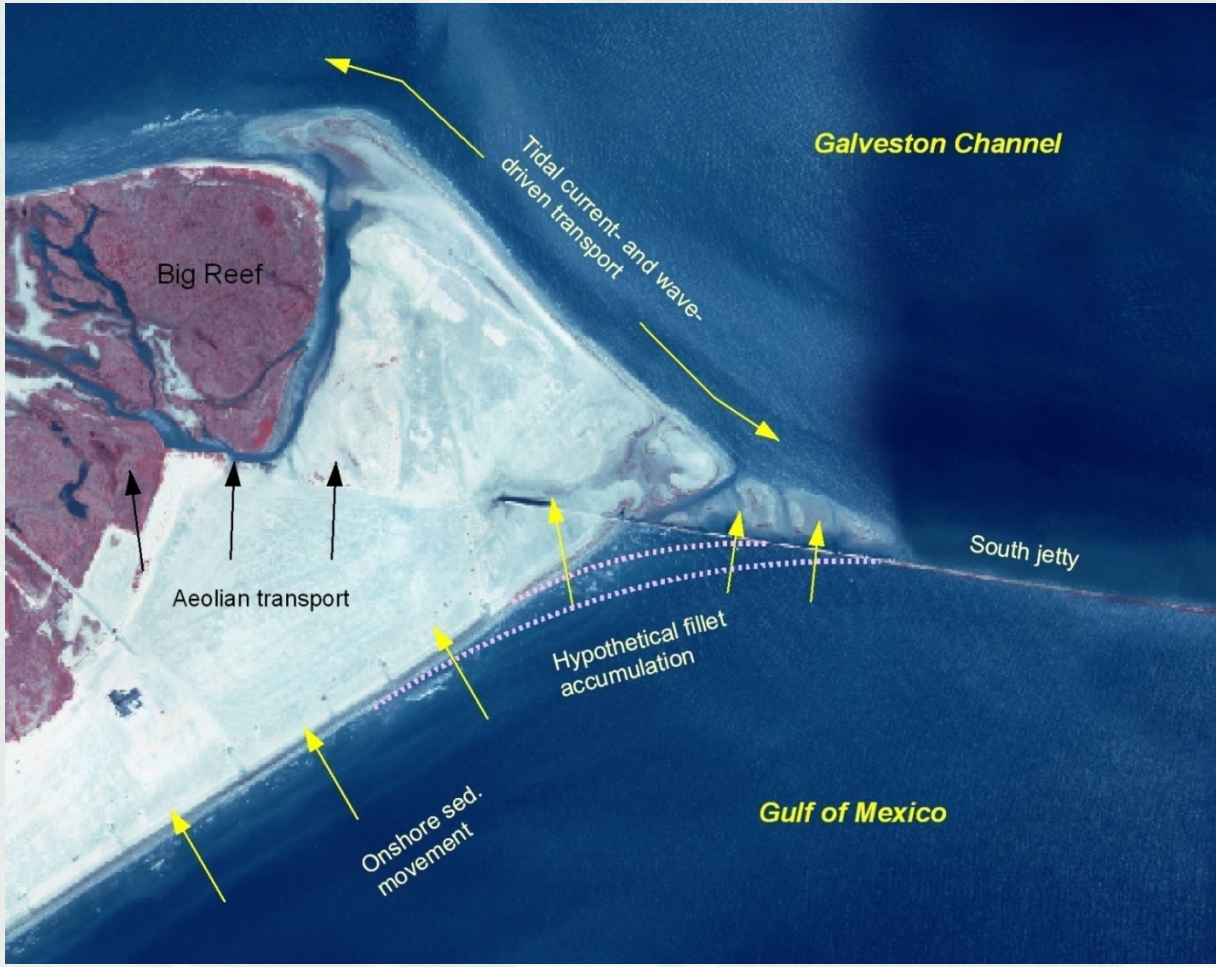
Sediment Basin Parallel to East Beach				
East beach coverage (percent)	Length (yd)	1 yd depth initial volume (yd^3)	2 yd depth initial volume (yd^3)	Annual vol. trapped at 50% efficiency (yd^3) (based on sed. budget)
50	3000	450,000	900,000	90,000
75	4500	675,000	1,350,000	135,000
100	6000	900,000	1,800,000	180,000
Note: Initial dredged volume based on basin 150 yd wide				

Reduce transmission through South Jetty

Options:

- Grout
- Geotube
- Sheetpile

Need to be mined regularly



Reduce Wind-Blown Sand

Options:

- Moisture
- Mechanical traps (fencing)
- Vegetation
- 22,000 ft fence or oats = 60-80,000 yd^3/year

Sand Back-Passing/ Pumping

Design:
- Annual vol.
- Intake location
- Distance
- Intake equipment
  - Movable
  - Fixed plant
- Outlets

Advantages:
- No trucks
- Steady use most of year
- Electric supply
- Paved roads
- No need to cross water

Note: similar plant at San Luis Pass not shown

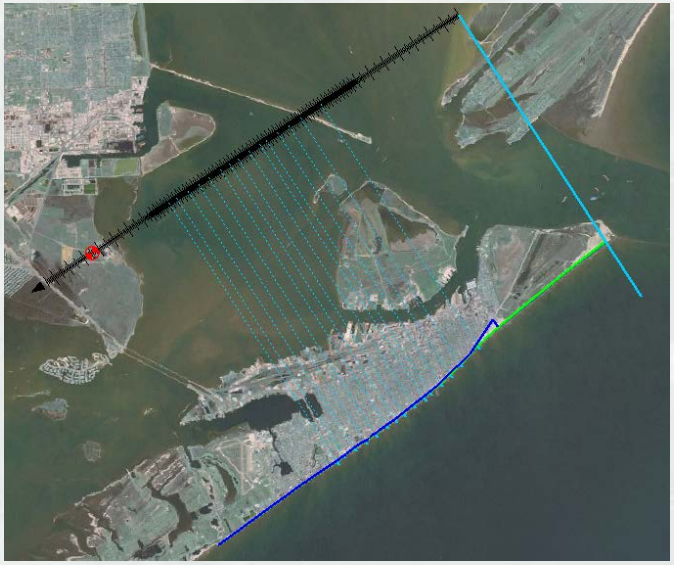
Comprehensive Beach Fill

Proposed width:
- Dune: 100 ft
- Berm/beach: 200 ft

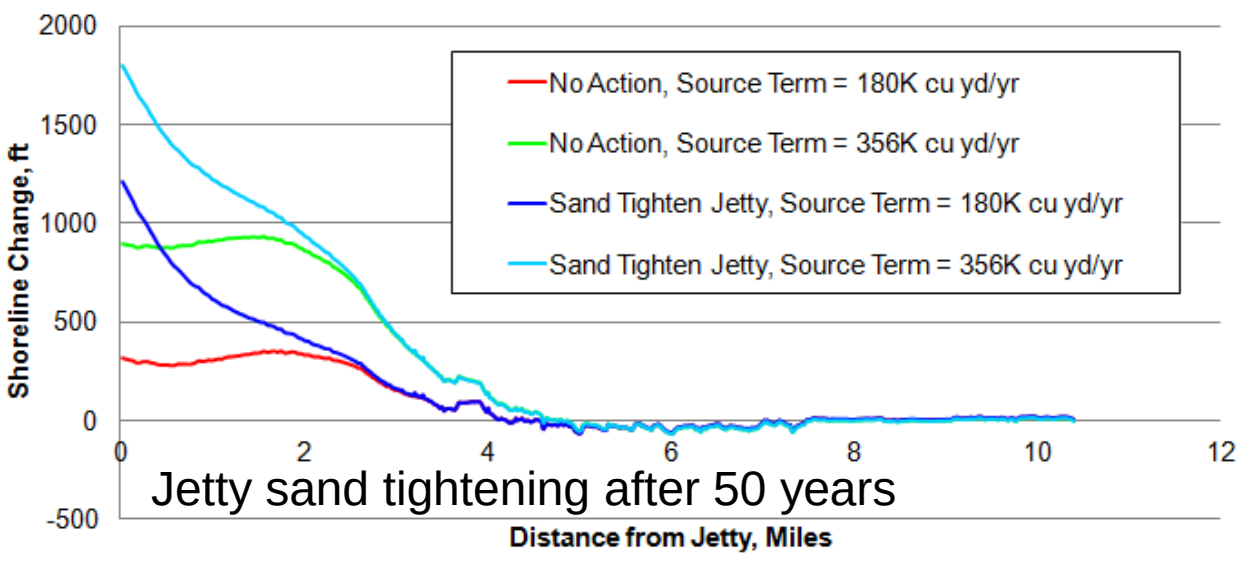
Reach 1: 1,900,000 yd^3
Reach 2: 3,600,000 yd^3
Reach 3: 2,500,000 yd^3
Reach 4: 4,400,000 yd^3
Reach 5: 500,000 yd^3
Total: 13,000,000 yd^3
Plus advance nourishment @50%:
19,500,000 yd^3

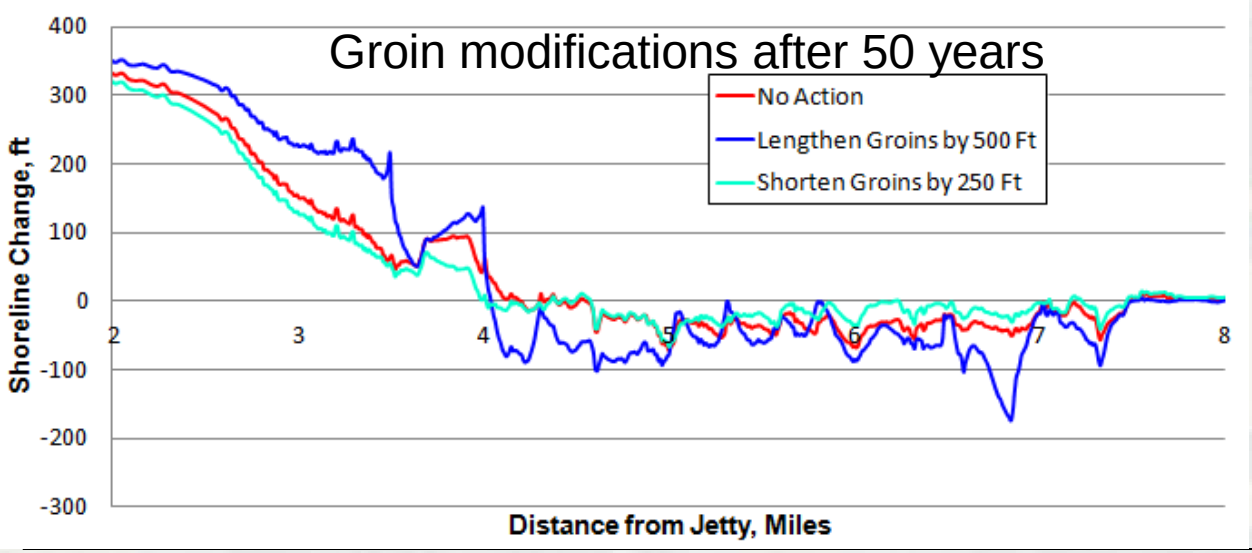
GenCade Alternatives

- No Action
- Sand tighten jetty
- Beach fills
- Backpassing



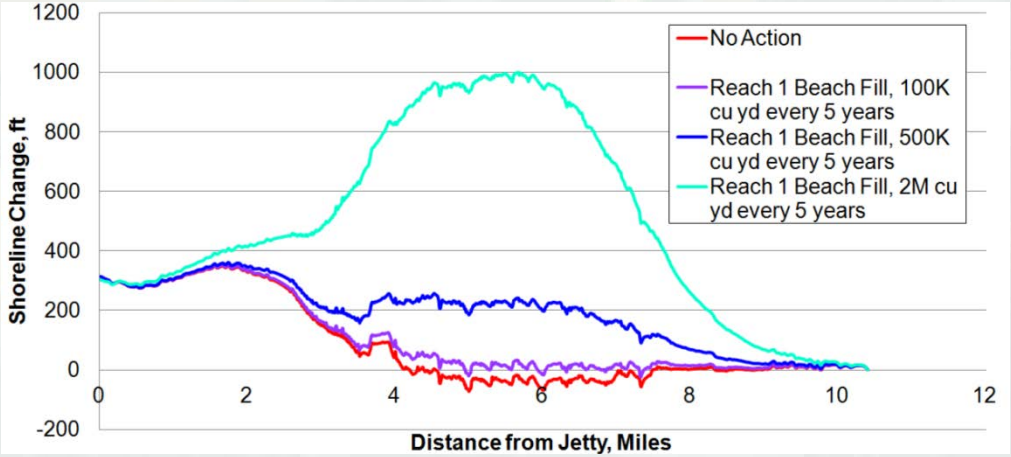
Structural Alternatives

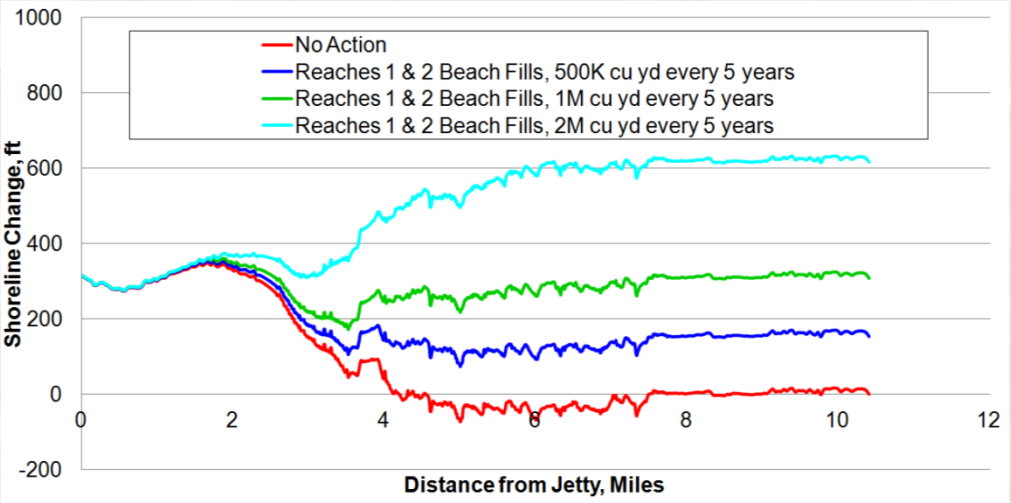




- Sand tightening the jetty advances the shoreline significantly and provides more material for backpassing and beach fills
- Lengthening, shortening, or removing groins makes little difference in shoreline position after 50 years
- If a beach fill is also constructed, shortened or existing groins will mostly be buried

Beach Fill Alternatives (Seawall)

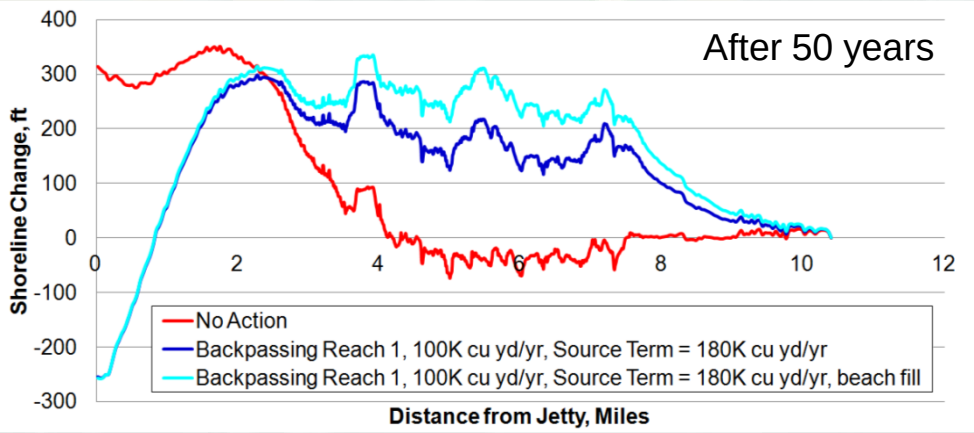


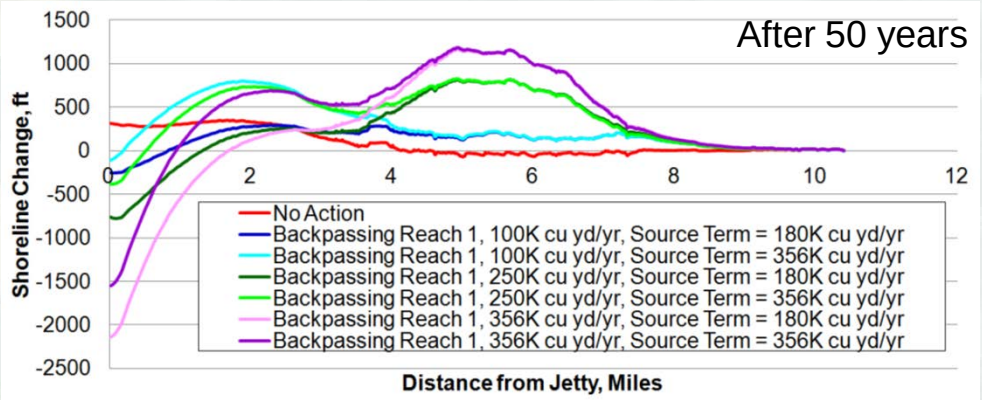


100,000 yd^3, 500,000 yd^3, and 2,000,000 yd^3 every 5 years (Top: Reach 1 only, Bottom: Reaches 1 and 2)

- Renourishment volume equal to initial fill volume
- 100,000 yd^3 every 5 years (Reach 1 only) is enough sand to keep beach similar to present conditions
- 500,000 yd^3 advances beach 200 ft after 50 years (Reach 1)
- Material not taken from near jetty (either channel dredging or offshore)

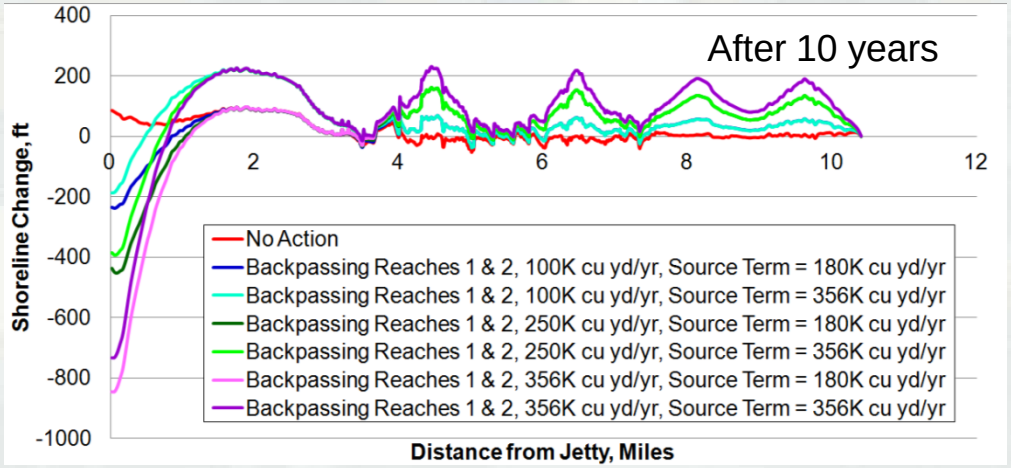
Backpassing (Seawall)

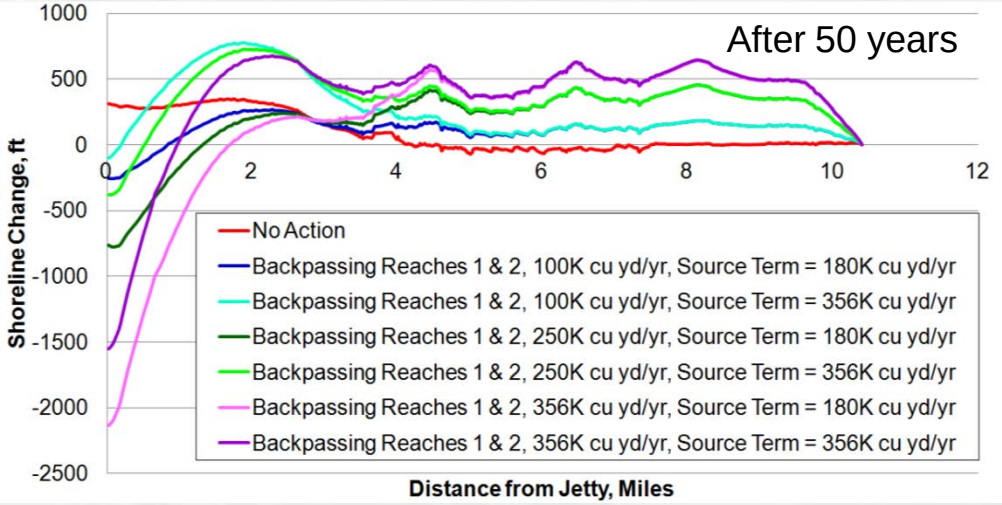




Top: 100,000 yd^3/yr backpassed to Reach 1, with and without 1,900,000 yd^3 initial beach fill
Bottom: 100,000, 250,000, and 356,000 yd^3 backpassed with different rates of material moving onshore

Backpassing (Seawall)

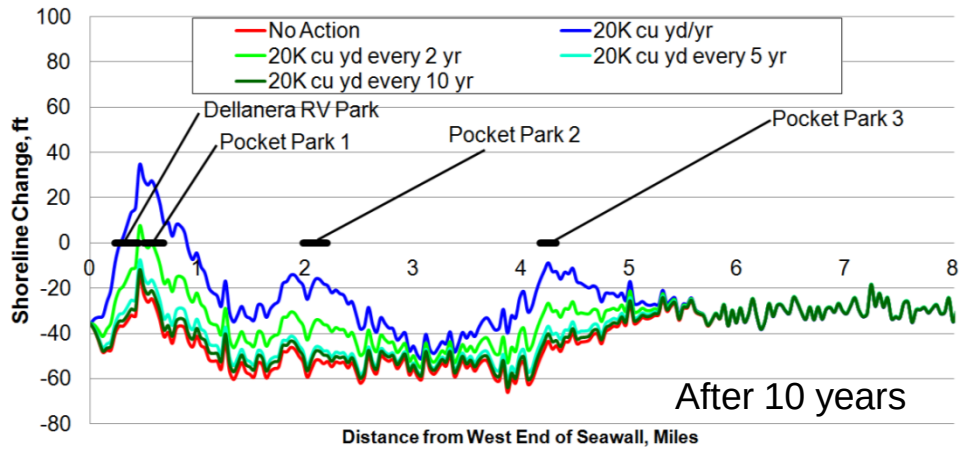


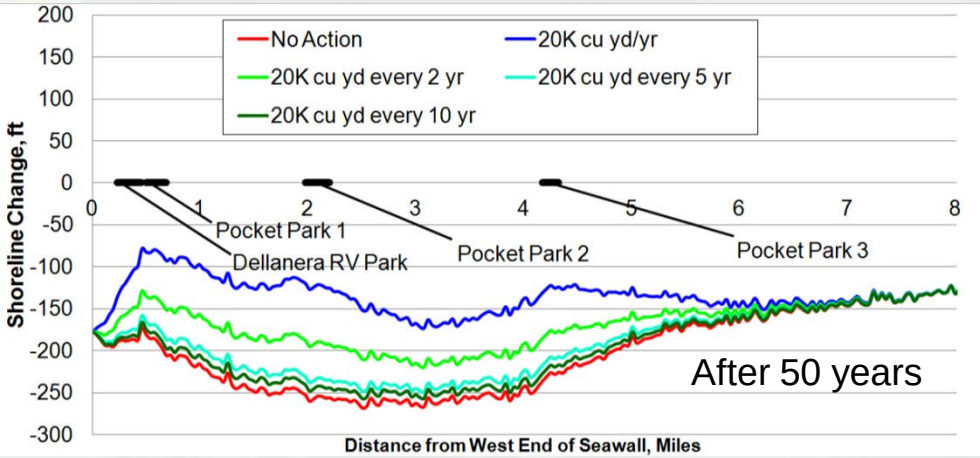


100,000, 250,000, and 356,000 yd^3 backpassed onto Reaches 1 and 2

- various rates of sand moving onshore to illustrate impact on shoreline

Beach Fills (West End)

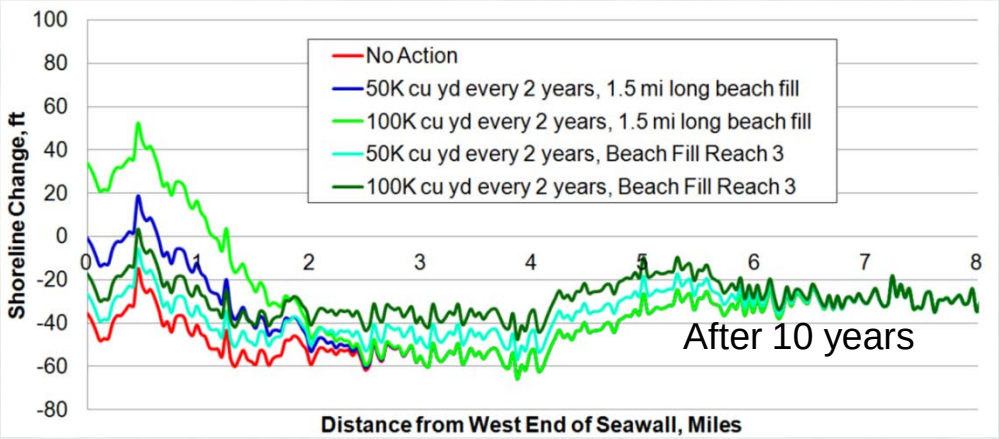


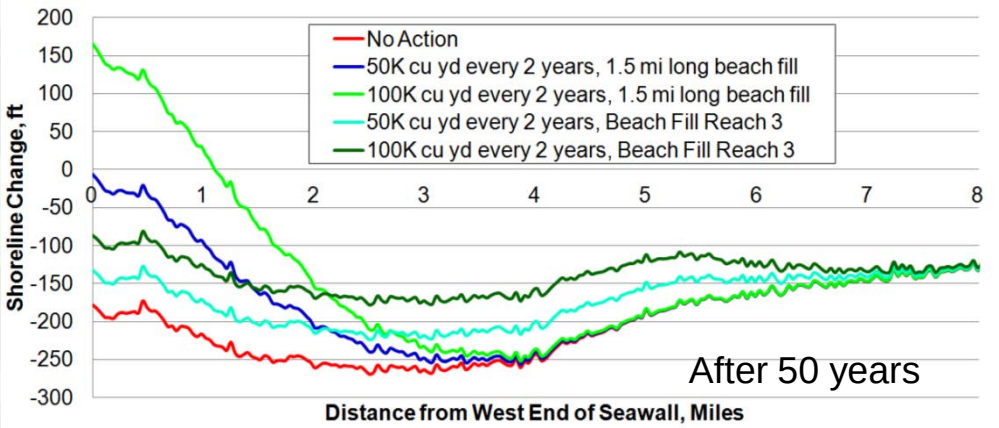


Beach fills placed on Park Board property

- 20,000 yd^3 at each property = 80,000 yd^3 total per placement
- Placement every year = 4,000,000 yd^3 total; still more than 100 ft of erosion

Beach Fills (West End)

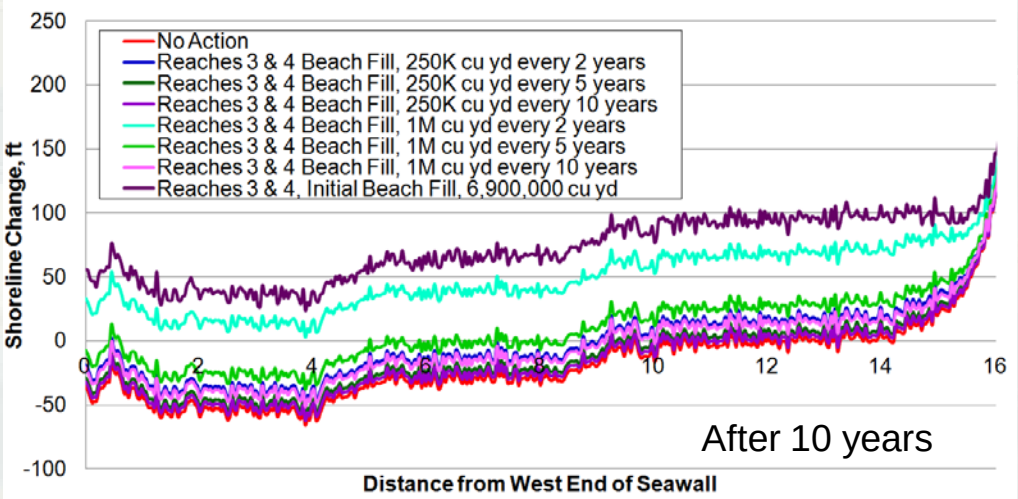


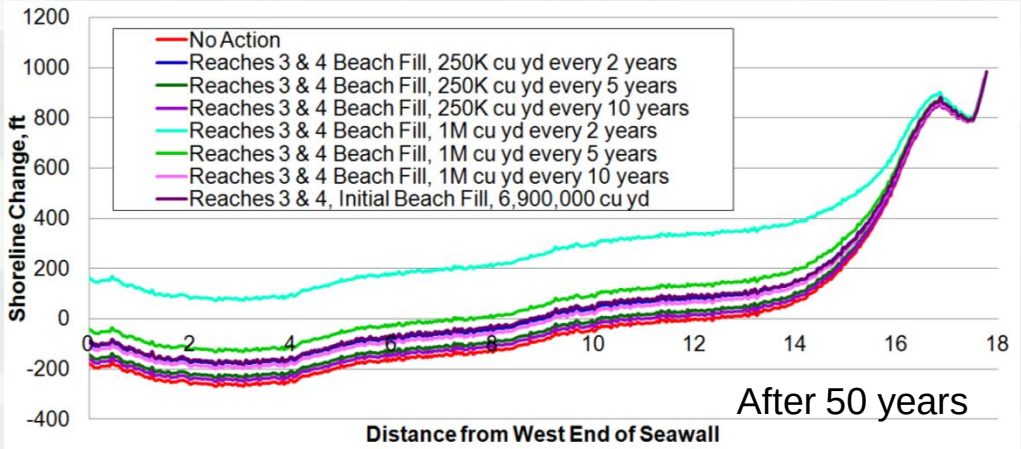


Beach fills along first 1.5 mi past seawall and along Reach 3

- 50,000 or 100,000 yd^3 placed every 2 years
- After 50 years, no alternative results in shoreline advance along Reach 3

Beach Fills (West End)

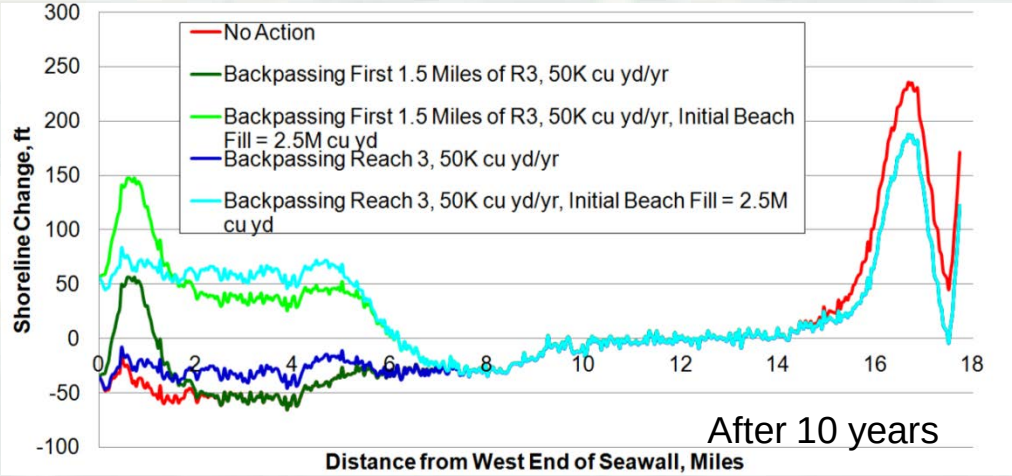


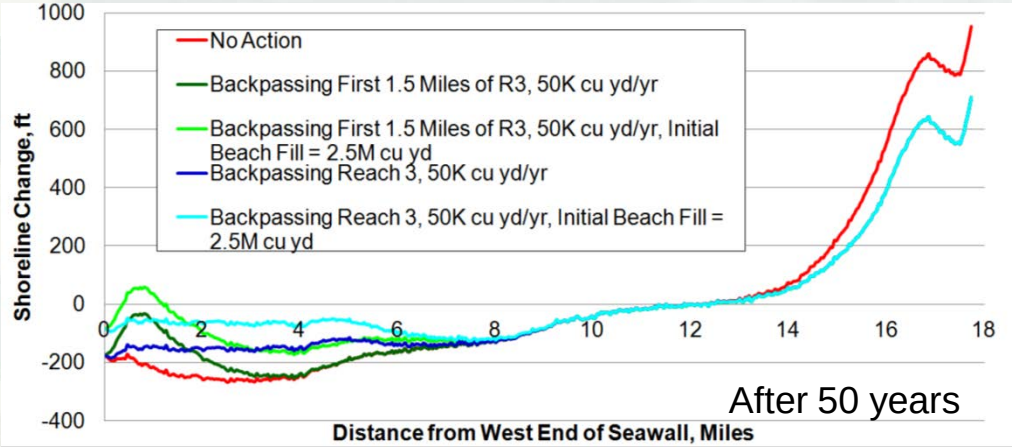


Beach fills along Reaches 3 and 4

- 250,000 or 1,000,000 yd^3 placed every 2, 5, or 10 years
- After 50 years, the only alternative resulting in shoreline advance is 1,000,000 yd^3 placed every 2 years

Backpassing (West End)



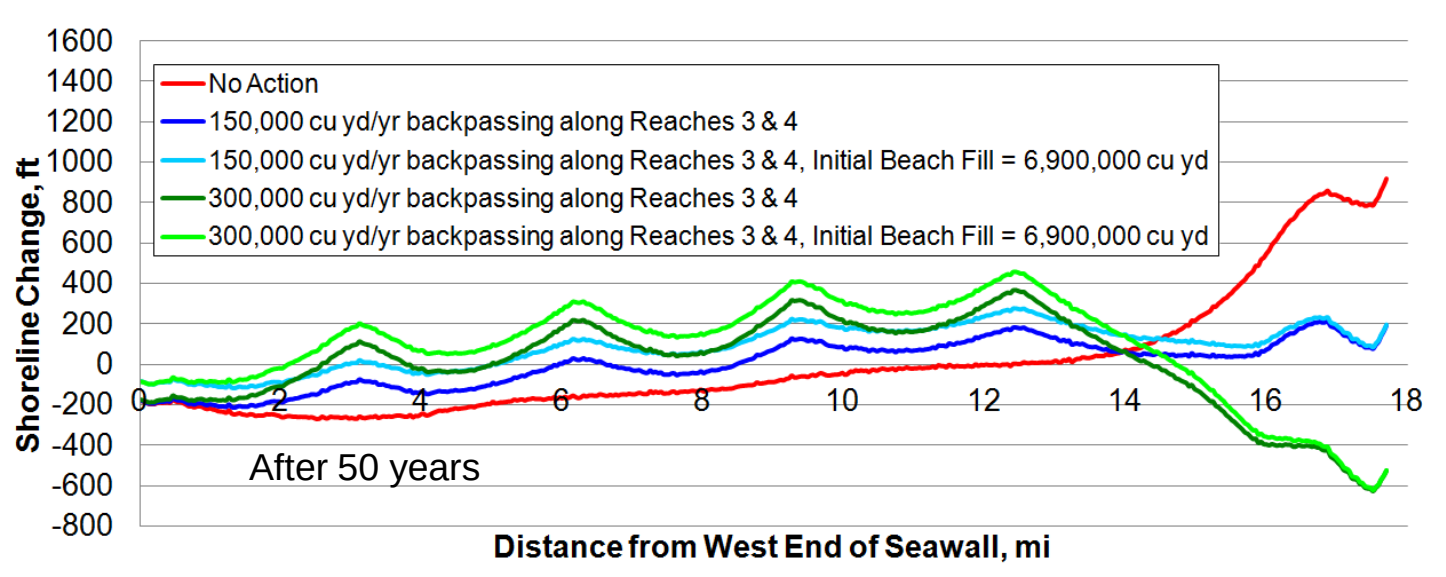


Backpassing to first 1.5 mi beyond seawall and to Reach 3

- 50,000 yd^3/yr backpassed
- With and without initial beach fill along Reach 3 = 2,518,800 yd^3

Backpassing (West End)

Backpassing to Reaches 3 and 4
- 150,000 and 300,000 yd^3/yr backpassed
- With and without initial beach fill = 6,926,700 yd^3



Sand Management Alternatives

Plan	Coverage	New Material (offshore or other sources)	Management and recycling of existing sand sources and dredge material	Performance monitoring
Comprehensive beach fill	Reaches 1-5	√	√	√
Limited area beach fill	1, 2, 3(?)	√	√	√
Systematic recycle	1, 2		√	√
Present action plan	1		√	
No action				

Sand Management Plan

Make preliminary decisions on alternatives

Investigate funding sources

Additional studies

Public outreach

Design beach fill and backpassing plant

Construct beach fill for selected reach and reduce transport through south jetty

Monitor growth of fillet along jetty and monitor shoreline position along selected reach

Construct backpassing plant

Monitor backpassing and shoreline position for selected reach

Construct beach fill on next reach*

Monitor shoreline position for second selected reach*

Extend backpassing to second selected reach or renourish periodically*

* Continue process until all desired reaches are completed

Adaptive Management and Monitoring

- Implement adaptive management strategy
  - Construct limited fill and monitor to ensure it is responding as expected
  - Modify design if necessary
- Recommended monitoring actions
  - Beach profiles, lidar, and/or shoreline position should be collected prior to and every 6 months after construction
  - Georeferenced aerial photography once a year

Beach Nourishment Project

- Project began in August
- 725,000 yd^3 dredged from Galveston Entrance Channel
- Placing material on Reach 2 (between 61st and 81st St.)
- Collaborative effort between Galveston Park Board, City of Galveston, Texas General Land Office, and U.S. Army Corps of Engineers, Galveston
- Channel dredged every 18 to 24 months and material will be placed on beach instead of offshore

Questions?

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