



# Second Beach Erosion Mitigation

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## Overview

- Second Beach in Middletown, RI currently facing shoreline retreat and erosion concerns due to sea level rise and wave action
- High tourist destination and natural protection for two water drinking resevoirs
- Proposed long-term shoreline management plan: combined beach replenishment and dune fencing



Figure 1: Aerial (A), and Google Maps (B) View of Second Beach

## Engineering Analysis

**100 Year Storm Erosion:**

$$R_{B,\infty} = S \frac{x_b - \frac{d_b}{m}}{d_b + B - \frac{S}{2}}$$

**Total Storm Timescale:**

$$T_s = \frac{320 \frac{H_b^{3/2}}{g^{1/2} A^3} (1 + \frac{d_b}{B} + \frac{m x_b}{d_b})^{-1}}{3600}$$

**Total Percentage of Erosion:**

$$\frac{R}{R_E} = 1 - \exp(-0.45 (\frac{T_D}{T_s})^{0.82})$$

**Total Volume Needed per Length of Shoreline:**

$$\Delta V/L = W_{add}(B + d_c)$$

**Construction Profile System:**

$$\left\{ \begin{aligned} (\frac{d_i}{A})^{\frac{3}{2}} &= w_c + \frac{d_i}{m} \\ \Delta V/L &= w_c B + \frac{3}{5} d_i (\frac{d_i}{A})^{\frac{3}{2}} - \frac{1}{2} (\frac{d_i}{m})^2 \end{aligned} \right.$$

- $R_{B,\infty}$  = Infinite storm erosion due to a 100 year storm (ft)
- $x_b$  = Distance between shoreline and breaker depth (ft)
- $S$  = Sea level rise (ft)
- $d_b$  = Breaker depth (ft)
- $m$  = Beach slope
- $T_s$  = Storm time scale (hrs)
- $H_b$  = Breaking height (ft)
- $A$  = A-Parameter (ft<sup>1/3</sup>)
- $R/R_E$  = Percentage of erosion
- $T_D$  = Storm dwell time (hrs)
- $\Delta V/L$  = Total volume per length of shoreline (ft<sup>3</sup>/ft)
- $W_{add}$  = Added berm width (ft)
- $d_c$  = Depth of closure (ft)
- $d_i$  = Depth of intersection (ft)
- $w_c$  = Construction profile width (ft)

## Site Evaluation

- 8 bathymetric intersects taken
- Meteorological and oceanographic data
- Collected 3 sediment samples along various intersects along the beach
  - Sand Classification: Very fine
  - D<sub>50</sub> = 0.25 mm
- Spoke with local POC, Dr. Will Cronin
  - Current mitigation strategies and local

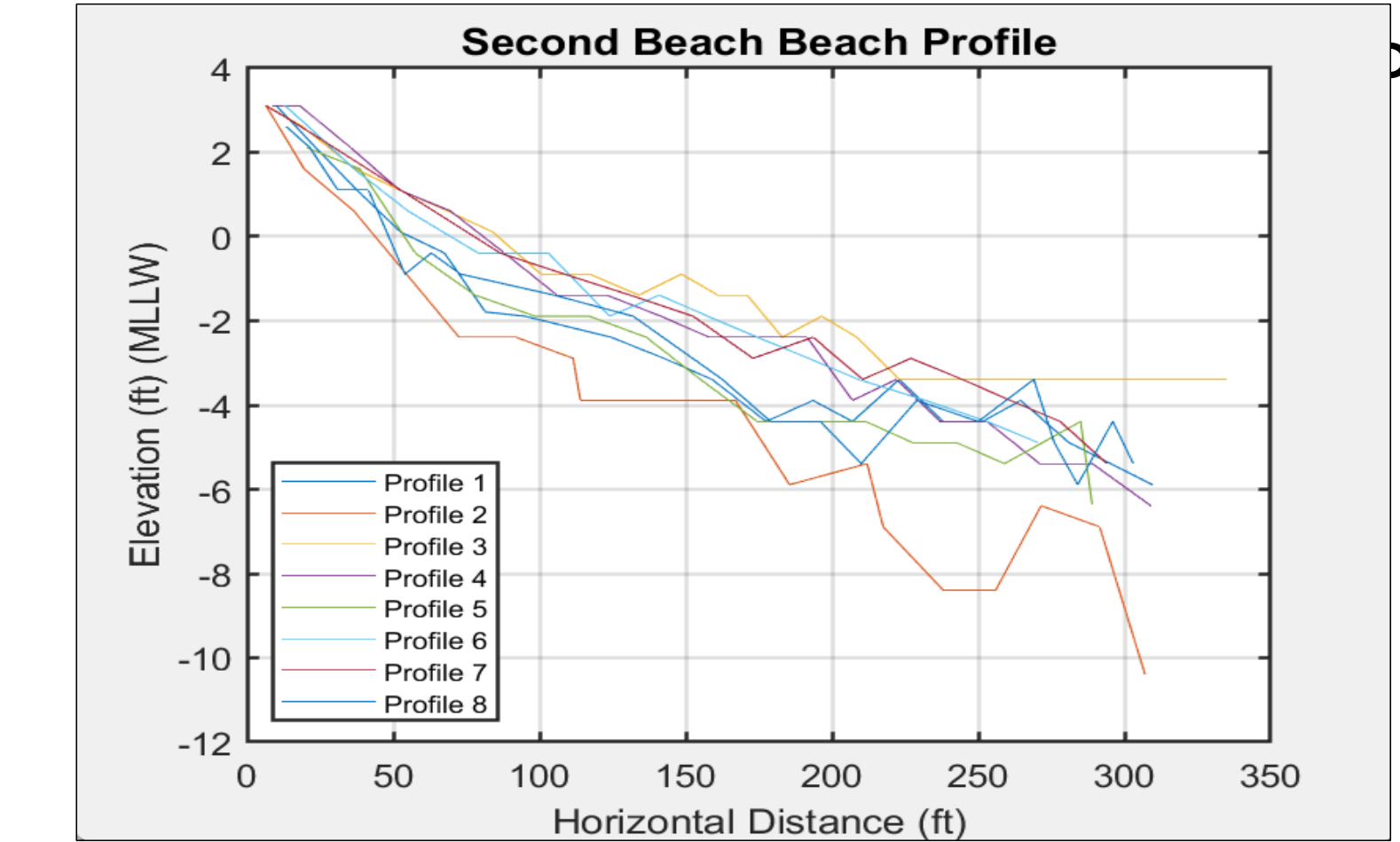


Figure 2: Beach Profile of Second Beach from Site Visit Relative to MLLW Datum.



Figure 3: 100 Year Storm Water Level.

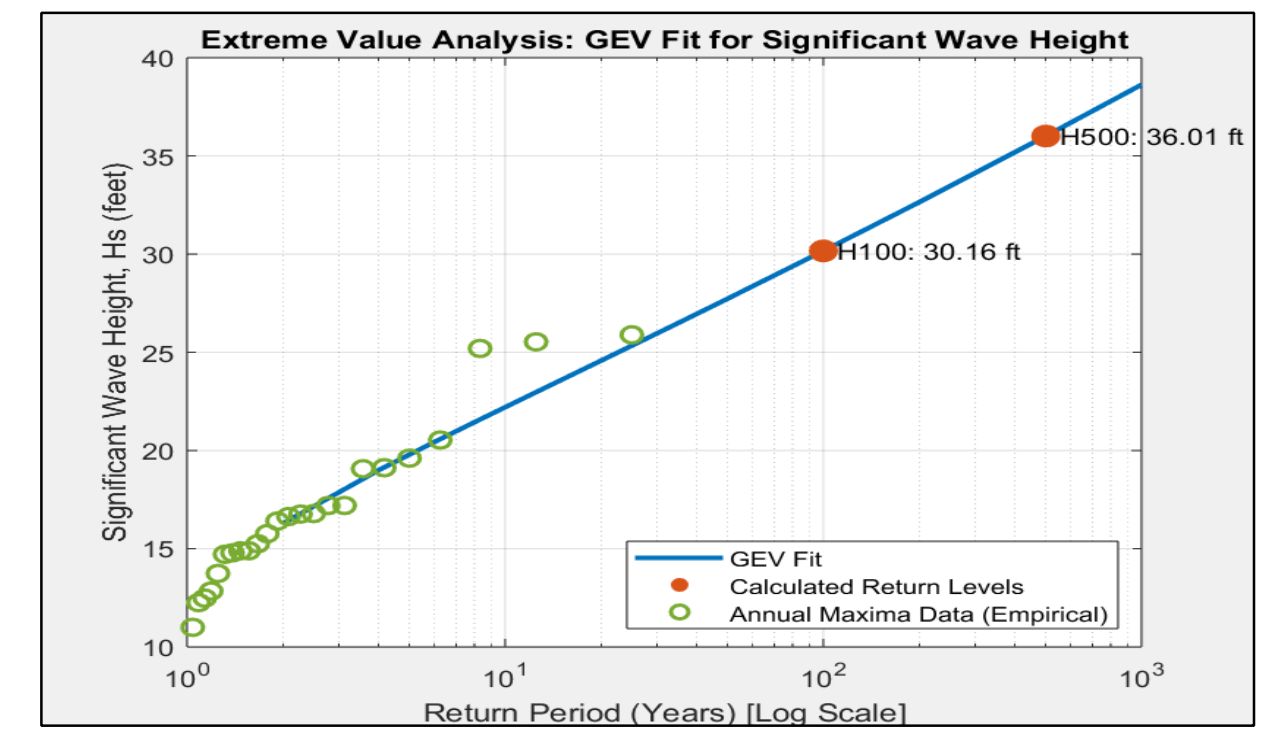


Figure 4: 100 Year Storm Significant Wave Height.

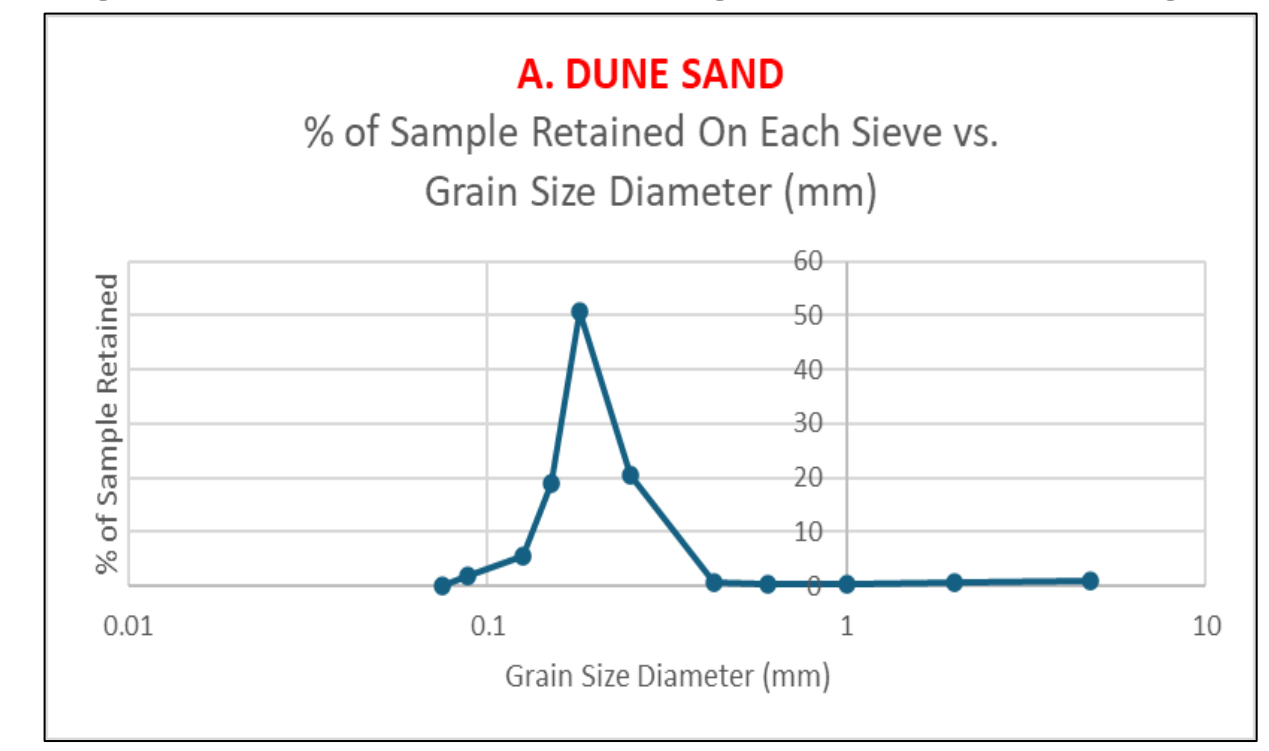


Figure 5: Sieve Analysis at the Dune.

## Design Images



Figure 7: Dune Fencing Located At Second Beach

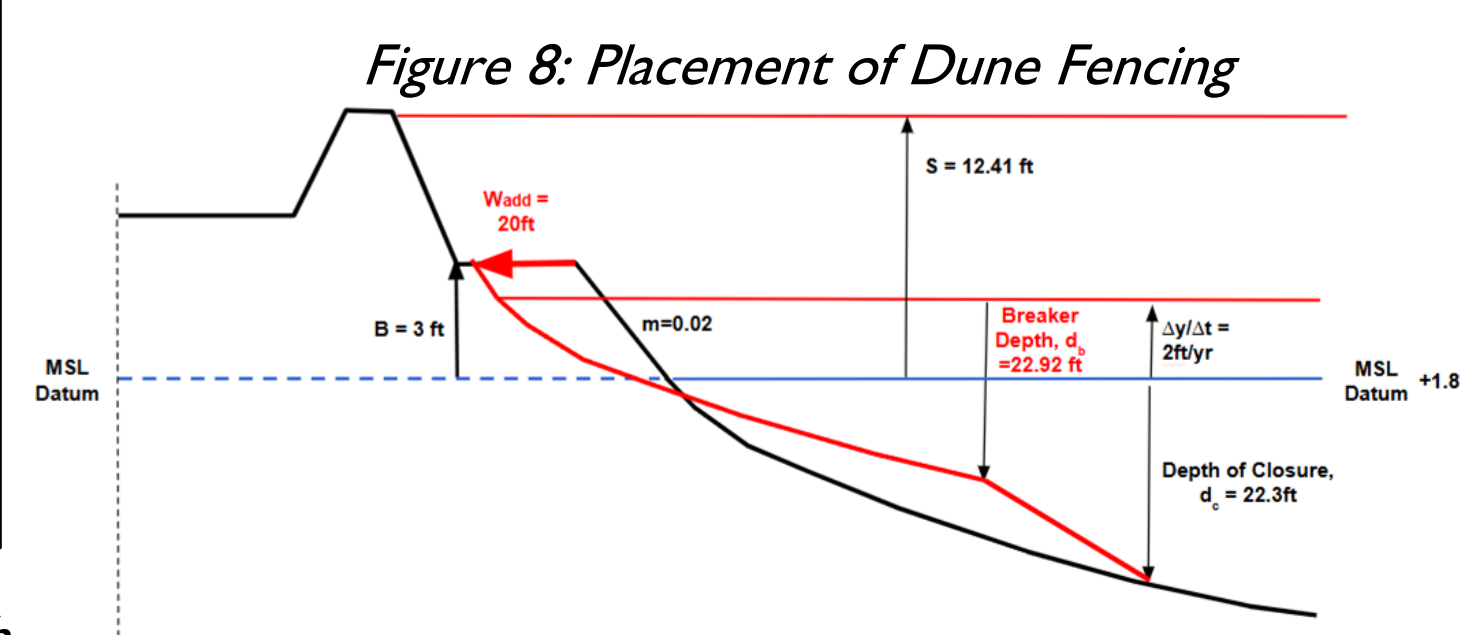


Figure 9: Construction Profile of Beach Replenishment

| Team: Rhody's                               | Effectiveness (Beach Erosion) | Effectiveness (Dune Erosion) | Longevity | Cost | Aesthetic | Construction Time | Local Disturbance | Total |
|---|-------------------------------|------------------------------|-----------|------|-----------|-------------------|-------------------|-------|
| Weight                                      | 0.20                          | 0.20                         | 0.17      | 0.15 | 0.12      | 0.08              | 0.08              | 1.00  |
| Beach Replenishment + Dune Fencing          | 4.50                          | 4.50                         | 2.50      | 4.70 | 4.00      | 5.00              | 4.25              | 4.15  |
| Submerged Breakwaters + Beach Replenishment | 4.75                          | 4.50                         | 5.00      | 1.50 | 3.50      | 3.50              | 2.50              | 3.83  |
| Submerged Breakwaters + Dune Fencing        | 4.75                          | 4.50                         | 5.00      | 1.50 | 3.25      | 2.50              | 3.00              | 3.76  |

Table 1: Possible Solution Decision Matrix.

## Final Design

**Beach Replenishment:**

- Quantity: 10,030,744 ft<sup>3</sup>
- Material: Sand
- Method of Implementation:
  - Sand redistribution using bulldozers (1/2)
  - Sand dredged from Newport Harbor (1/2)
- Cost: \$8.17 million
  - Machinery
    - Bulldozers: \$50,000
    - Dredging: \$500,000
  - Material (sand): \$7.43 million
  - Permits: \$150,000

**Dune Fencing:**

- Quantity: 7600 ft
  - 30,400 wooden slats
    - Height: 3.5 ft.
    - Width: 1.5 in.
- Material: Treated Brushwood, steel wire, steel nails, hammers
  - Provides resistance against rot
- Option for 2 parallel rows
  - Reduces sediment transport rates from 72-91% to 13-44%
- Method of implementation:
  - Every slat hammered into the sand
- Cost: \$87,800
  - Machinery: \$30,900
  - Materials: \$57,000

## Acknowledgements



Operations Manager: Dr. Will Cronin