MOFFATT & NICHOL
ENGINEERS

February 12, 2003
(Revised July 23, 2003)

Tim Duff, Project Manager
California State Coastal Conservancy
1330 Broadway, Ste 1100
Oakland, CA 94612

Subject: Development of Shoreline / Trail Alternatives
Princeton Shoreline Improvement Project
M&N File No: 4928-02

Dear Mr. Duff:

We are pleased to present our assessment of potential shoreline protection measures and pedestrian access along the Princeton shoreline in Half Moon Bay. Our proposed services included developing concepts which would incorporate shoreline improvement and pedestrian access to replace existing rip-rap/debris along the shoreline between Romeo Pier and Broadway.

BACKGROUND

Several segments of the shoreline within the Pillar Point Harbor are eroding for various reasons. Moffatt & Nichol Engineers earlier completed a shoreline protection feasibility study for the project reach[1] which included a description of shoreline processes, bank retreat rates and revetment alternatives. We understand that the Coastal Commission has initiated an enforcement action against property owners with illegal rip-rap along the study area. Current objectives are to remove the rip-rap and debris, and improve the shoreline in a manner that will provide shore protection and pedestrian access along the water.

Moffatt & Nichol Engineers was tasked to provide concepts for shoreline protection that include a trail component. The scope included a description, schematic design, performance assessment and opinions of construction costs.

This letter report describes six individual concepts, as described in the proposal: steel or concrete seawalls, groin with beach nourishment, dune or low cost structure such as geotextile bags with beach nourishment, and a revetment with a boardwalk on the seaward side or a promenade on the landward side. Recognizing that individual segments of the shoreline may require different shore protection and access based on differing elevations, these concepts are incorporated into three alternatives for the shoreline, combining individual concepts for shoreline protection and pedestrian access to give an integrated shoreline / trail improvement project for the entire study reach. Other alternatives can be developed by interchanging the

[1] Moffatt & Nichol Engineers, Shoreline Protection Feasibility Study for Princeton, Pillar Point, Half Moon Bay, California, September 2001, prepared for the San Mateo County Harbor District.

concepts described. An opinion of construction costs is provided for each of the three alternatives described below.

PROJECT ALTERNATIVES

A. Groin Anchored Beach Fill and Revetment with Boardwalk

Plate A presents February 2000 conditions of the study reach, with a sketch of Alternative A overlaid.

Alternative A envisions a rock revetment between Denniston Creek (adjacent to Broadway) to the east and Columbia to the west to protect the existing shoreline. It could be constructed by regrading existing riprap, and would anchor the shoreline at or very close to its present location. The embankment section is significantly steep along this portion of the shoreline with no beach at the toe of the bluff, making a revetment the most cost-effective erosion control measure here.

A typical section of the revetment is shown in Figure 1. The revetment would consist of two layers of 200-pound angular quarry rock, with a geotextile and bedding to prevent erosion of the finer underlying material. The top of the structure would follow existing embankment elevation which varies from +14 feet at Columbia to about +18 feet near Denniston Creek. The toe of the structure would be buried about 3 to 4 feet below mean high water to prevent undermining. The revetment would extend over 750 feet of the 1800-foot study reach.

A wooden boardwalk would be constructed on the seaward side of the revetment, supported on concrete or timber piles. ADA-compliant access ramps from street level to the boardwalk could be provided at Columbia and Broadway. At Broadway, the beach would only be exposed at low tide, as is presently the case. Access stairs to the beach could be provided at this end if necessary.

Beach nourishment is envisioned between Romeo Pier to the west and Columbia to the east, with a low-profile groin at Columbia to retain the beach fill. The groin, shown on Figure 2, would be constructed of 200-pound angular quarry rock, with a geotextile and bedding to prevent erosion of the finer underlying material. The top of the structure would follow a 15H:1V slope, which is much flatter than the existing beach profile, allowing a wider beach to be retained. The toe of the structure would be buried to about 2 to 3 feet below the present beach elevation to prevent undermining.

The beach to the west of the groin would be filled to the level of the groin, so that the beach to the east would not be "starved" of sand. The resulting beach width at high tide would be approximately 75 feet. No dune vegetation is included in this alternative due to the more active beach profile. Ramp access over the groin and onto the beach would be provided (see Plate A). As a result of this wide beach, no additional pedestrian access is proposed to be provided west of the groin. The beach fill would extend over 950 feet of the 1800-foot study reach.

Our opinion of the probable cost for this alternative is presented in Table 1. The cost of $990,000 corresponds to $550 per linear foot of study area including engineering and contingencies.

Although the groin and revetment structures would require little to no maintenance, periodic beach fill will be required to maintain the wider beach. We anticipate an interval of about 3 years between beach nourishment events, placing approximately 2,000 cubic yards per event. The cost for the maintenance fill would be about $80,000, or annualized over the 3 year interval, the cost would be about $27,000 per year.

B. Geotube Anchored Beach Fill and Revetment with Boardwalk

Plate B presents February 2000 conditions of the study reach, with a sketch of Alternative B overlaid.

Alternative B envisions a pair of geotubes placed along most of the study reach, from Romeo Pier to east of Columbia – 1200 feet of the 1800 foot study reach. A beach fill would be constructed over and between the geotubes. The landward geotube would provide protection to properties landward of the beach, and the seaward geotube would maintain the beach fill in place. Geotubes are large-diameter tubes (10 to 12 feet diameter) fabricated from geotextile material. They are usually filled hydraulically with a sand-water slurry. Water flows out the exit ports at the opposite end of the tube as it is filled. A typical section for the geotubes is shown in Figure 3. Dune plants would be established over the back 30 feet of beach to stabilize the sand further; it would be necessary to restrict public access over the dunes until the plants were well established. Plate B illustrates ramps across the dunes at Vassar and Columbia, allowing public access to the beach while the dune plants are becoming established. The beach width at high tide would be approximately 80 feet.

The remaining 600 feet of the study reach would be protected by a revetment with a wooden boardwalk, as in Alternative A. A ramp at the western end of the boardwalk would allow public access onto the filled beach.

Our opinion of the probable cost for construction of this alternative is presented in Table 2. The cost of $1,440,000 corresponds to $800 per linear foot of study area including engineering and contingencies. The higher cost of this alternative is largely due to the fact that the geotube anchored beach proposed here requires more sand per unit length of beach than the beach fill retained by the groin.

Similar to Alternative A, the revetment structure would require little to no annual maintenance, however, periodic beach fill will be required to maintain the wider beach. We anticipate an interval of about 3 years between beach nourishment events, placing approximately 2,000 cubic yards per event. The cost for the maintenance fill would be about $80,000, or annualized over the 3 year interval, the cost would be about $27,000 per year. The geotubes should not require maintenance provided the tubes are not damaged by equipment or vandalism if exposed.

C. Seawall and Revetment with Landside Public Access Path

Plate C presents February 2000 conditions of the study reach, with a sketch of Alternative C overlaid.

Alternative C envisions a pre-cast concrete seawall from Romeo Pier to Columbia, with an asphalt or concrete walkway landward of the seawall providing public access. A typical

section for the seawall is shown in Figure 4. The seawall would be constructed of steel H piles with pre-cast concrete panels between the piles. Tie-backs will most likely be required to maintain stability of the wall, and are included in the estimate. Scour protection in the form of 200-pound angular quarry rock and geotextile fill is recommended at the toe, in the event that the beach erodes down.

From Columbia to Broadway, a revetment is envisioned, with an asphalt or concrete walkway landward of the revetment. A typical section of the revetment is shown in Figure 5. The walkway would run continuously along the length of the study reach, with public access to the walkway and down to the beach at Broadway, Columbia and Vassar. The walkway would terminate at Romeo Pier, and could tie in directly to the pier.

Another possible seawall concept is shown in Figure 6. This shows a steel sheet pile seawall with tiebacks and scour protection. The steel sheet pile seawall would be more expensive than the pre-cast concrete seawall, and has a higher potential for corrosion.

Our opinion of the probable construction cost for Alternative C is presented in Table 3. The cost of $1,830,000 corresponds to about $1015 per linear foot of study area including engineering and contingencies. Steel sheet piles would increase the cost substantially (by as much as 50%).

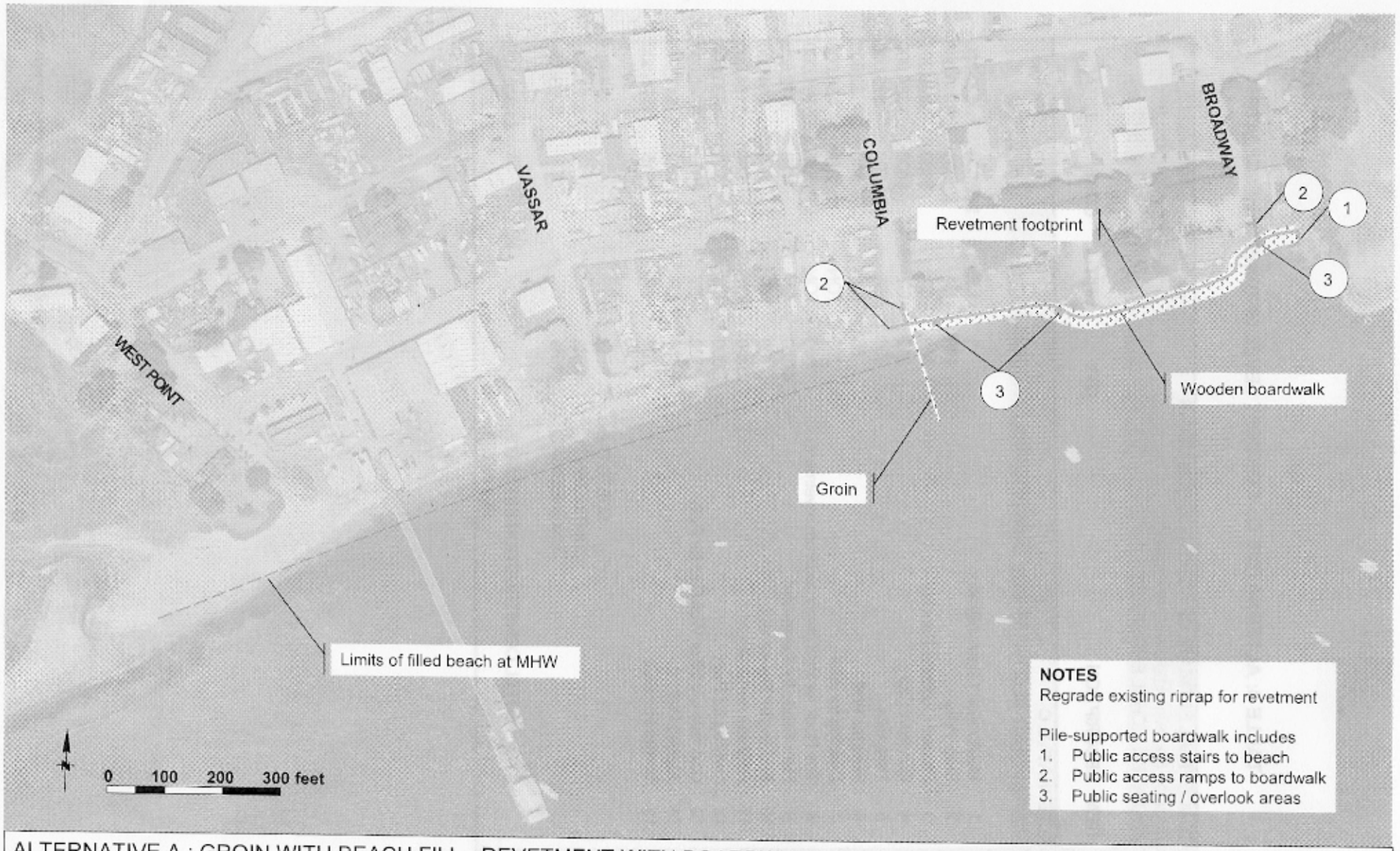
Little to no maintenance would be required for the seawall structure and walkway however periodic visual inspections should be conducted. For planning purposes, an annual maintenance allowance of about $10,000 should be included for beach material that may be required in the front of the structure due to scour at the toe.

Thank you for giving us the opportunity to assist you and the Conservancy once again. Should you have any questions or comments on the above please call me at your convenience.

Sincerely
MOFFATT & NICHOL ENGINEERS

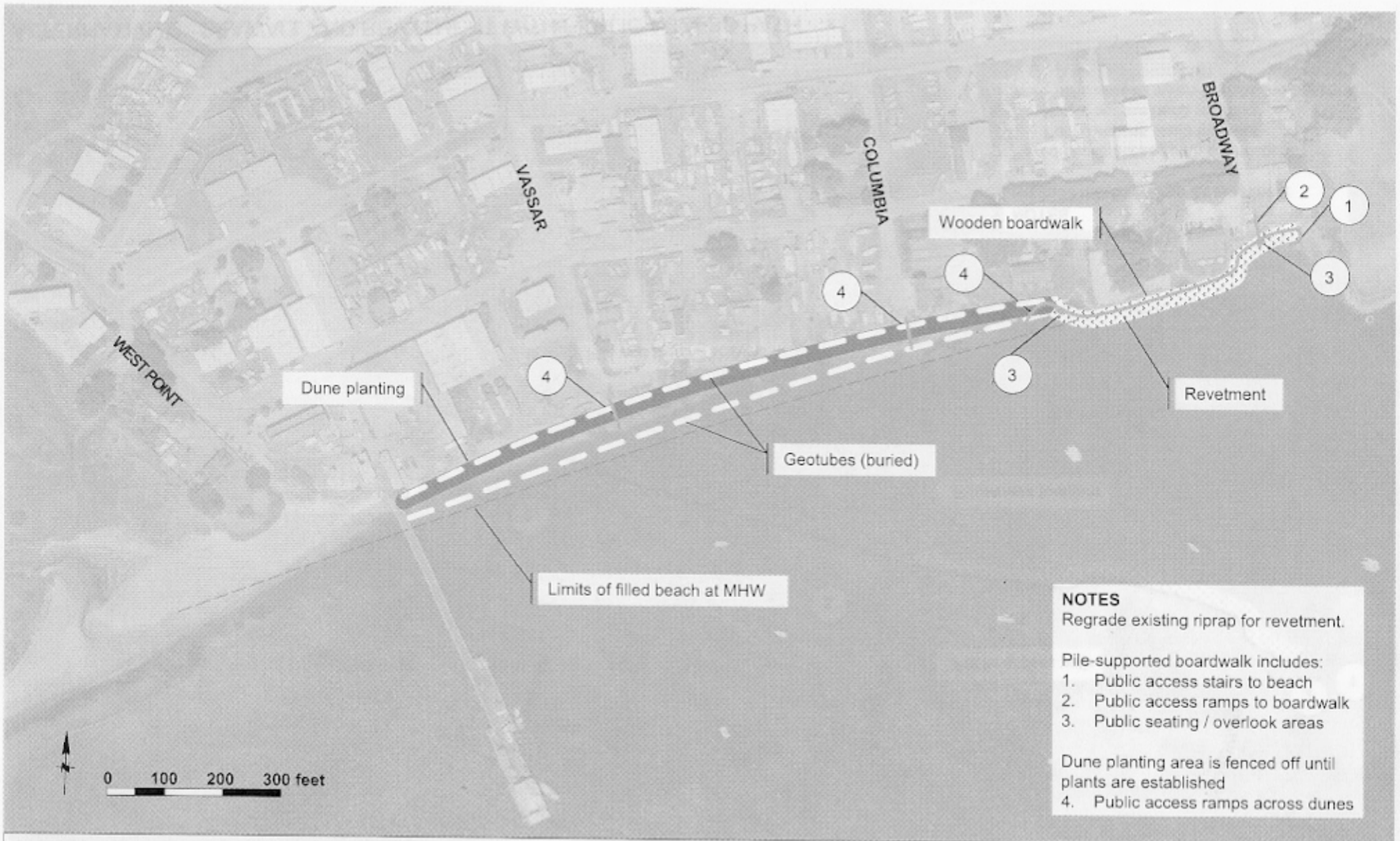
Dilip Trivedi, Dr. Eng., P.E.
Civil Engineer

Susan Tonkin, Ph. D.
Coastal Engineer



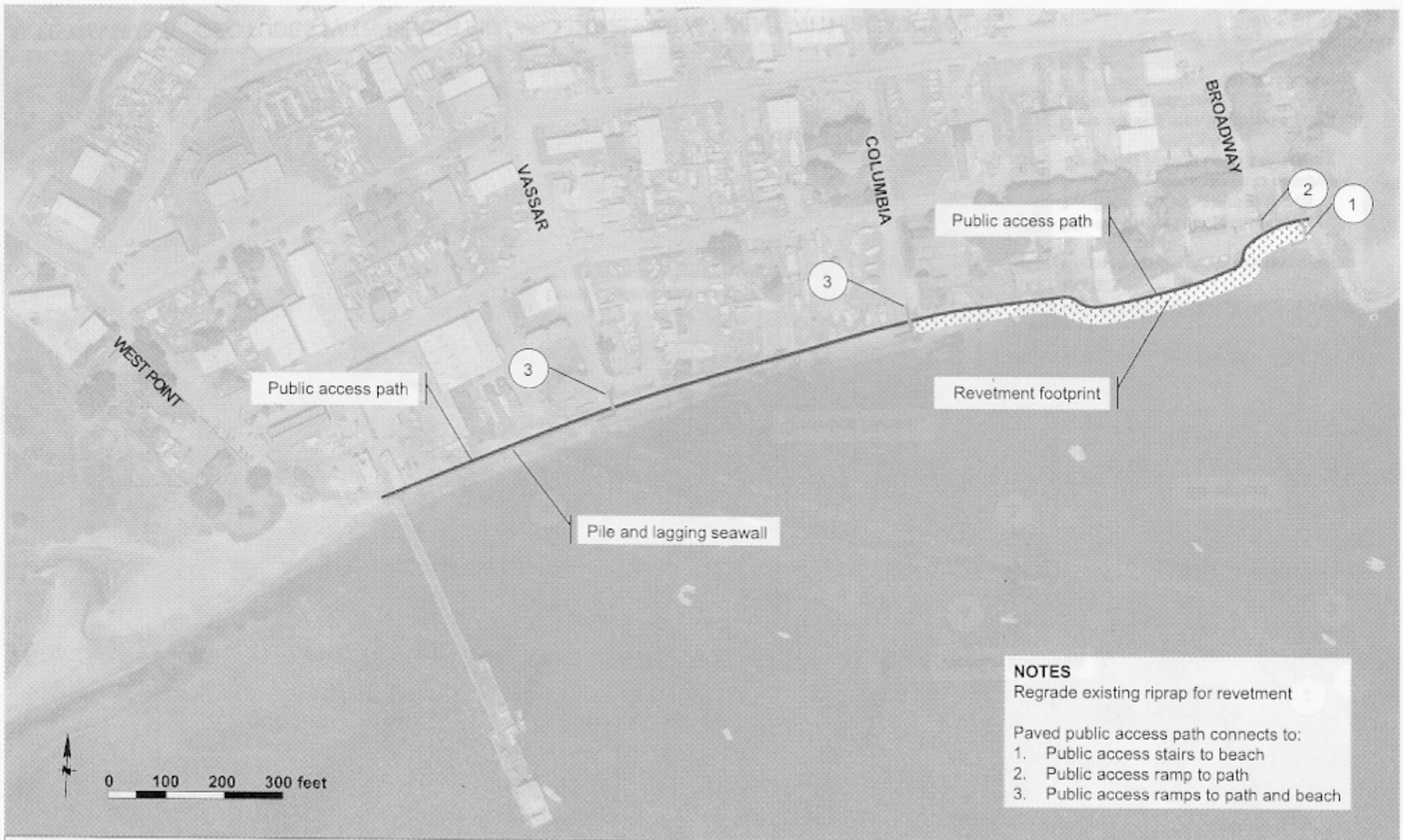
ALTERNATIVE A : GROIN WITH BEACH FILL - REVETMENT WITH BOARDWALK

PLATE A



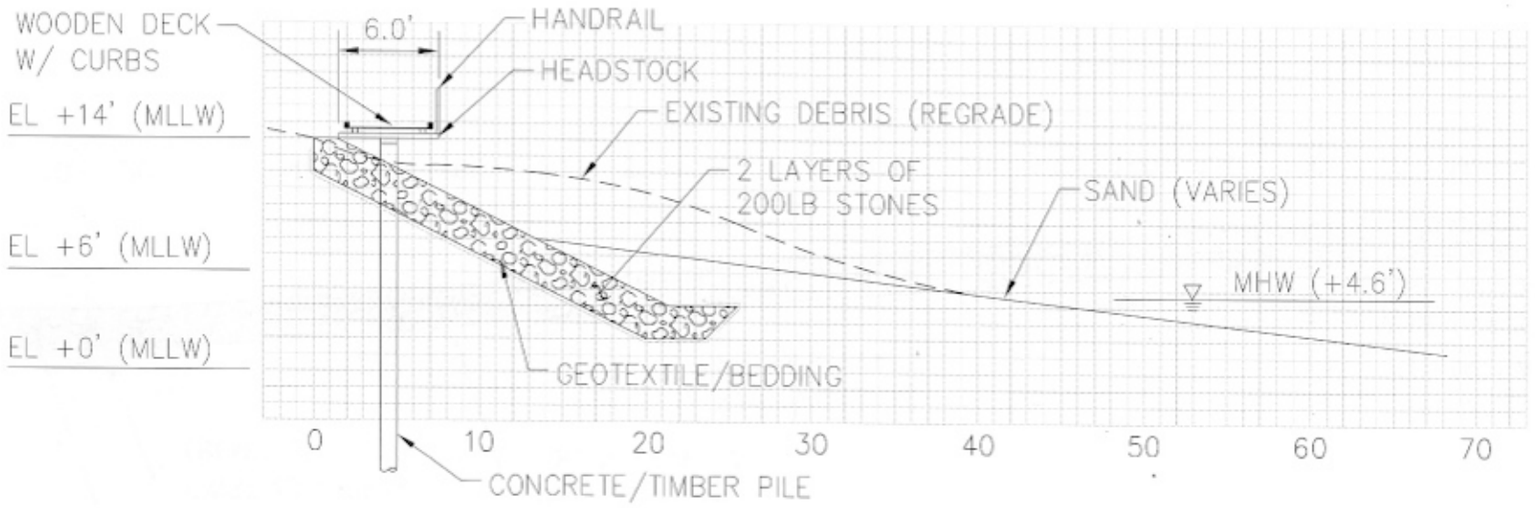
ALTERNATIVE B : GEOTUBES WITH BEACH FILL AND DUNE - REVETMENT WITH BOARDWALK

PLATE B



ALTERNATIVE C : SEAWALL AND REVETMENT WITH PUBLIC ACCESS PATH

PLATE C



RIPRAP AND BOARDWALK
SCALE: 1"= 10'

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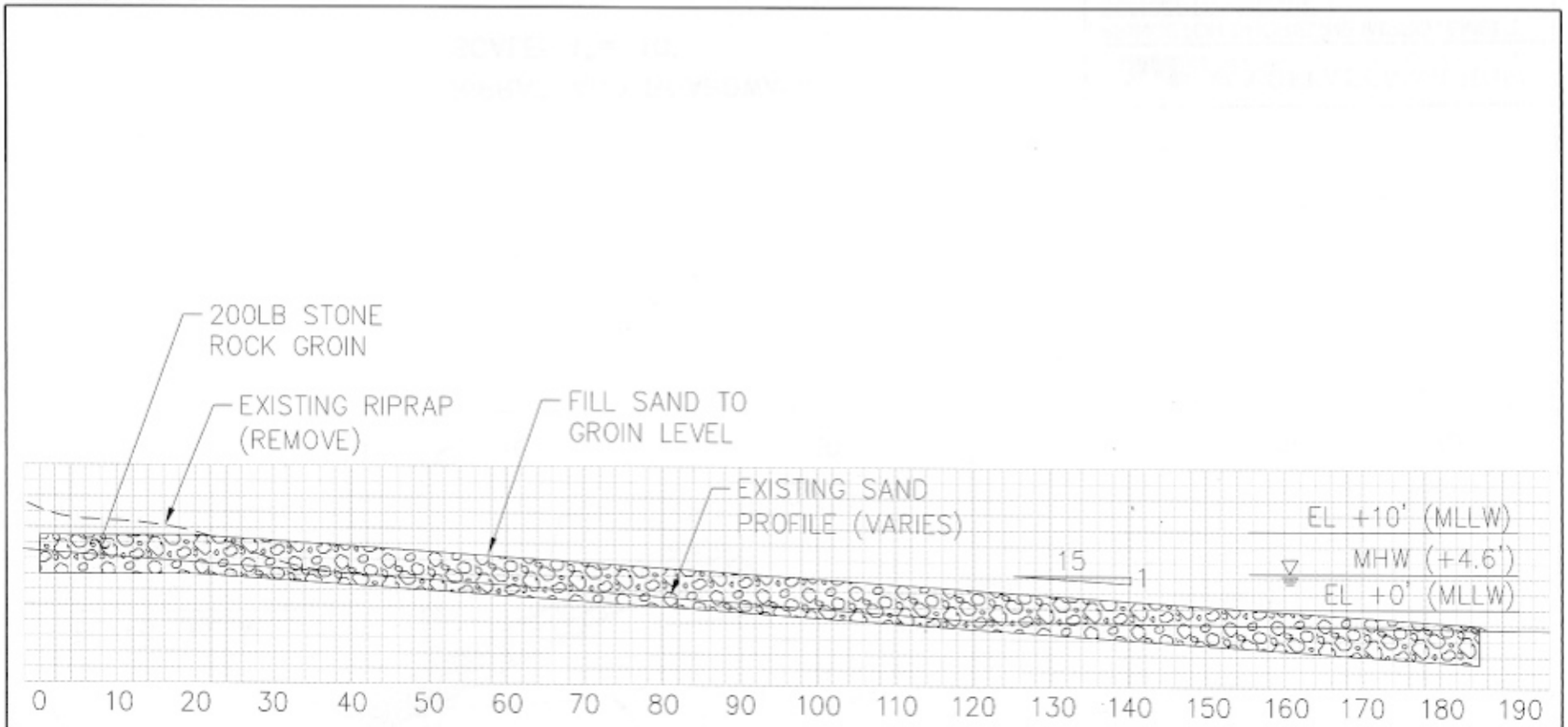
PRINCETON SHORELINE IMPROVEMENT
CONCEPTS - FIGURE 1



BEACH FILL WITH ROCK GROIN
SCALE: 1"= 20'

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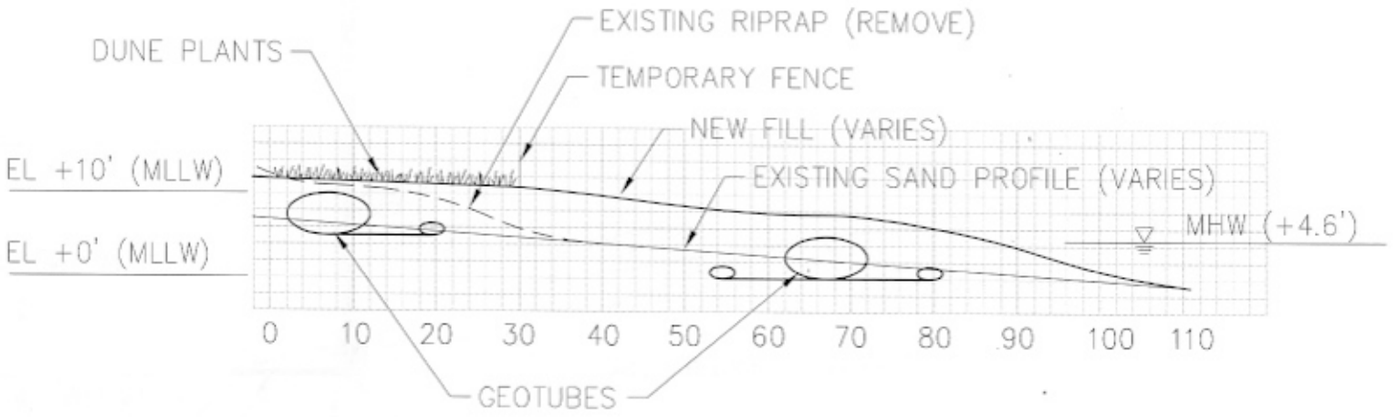
PRINCETON SHORELINE IMPROVEMENT
CONCEPTS - FIGURE 2



BEACH FILL WITH GEOTUBES
SCALE: 1"= 20'

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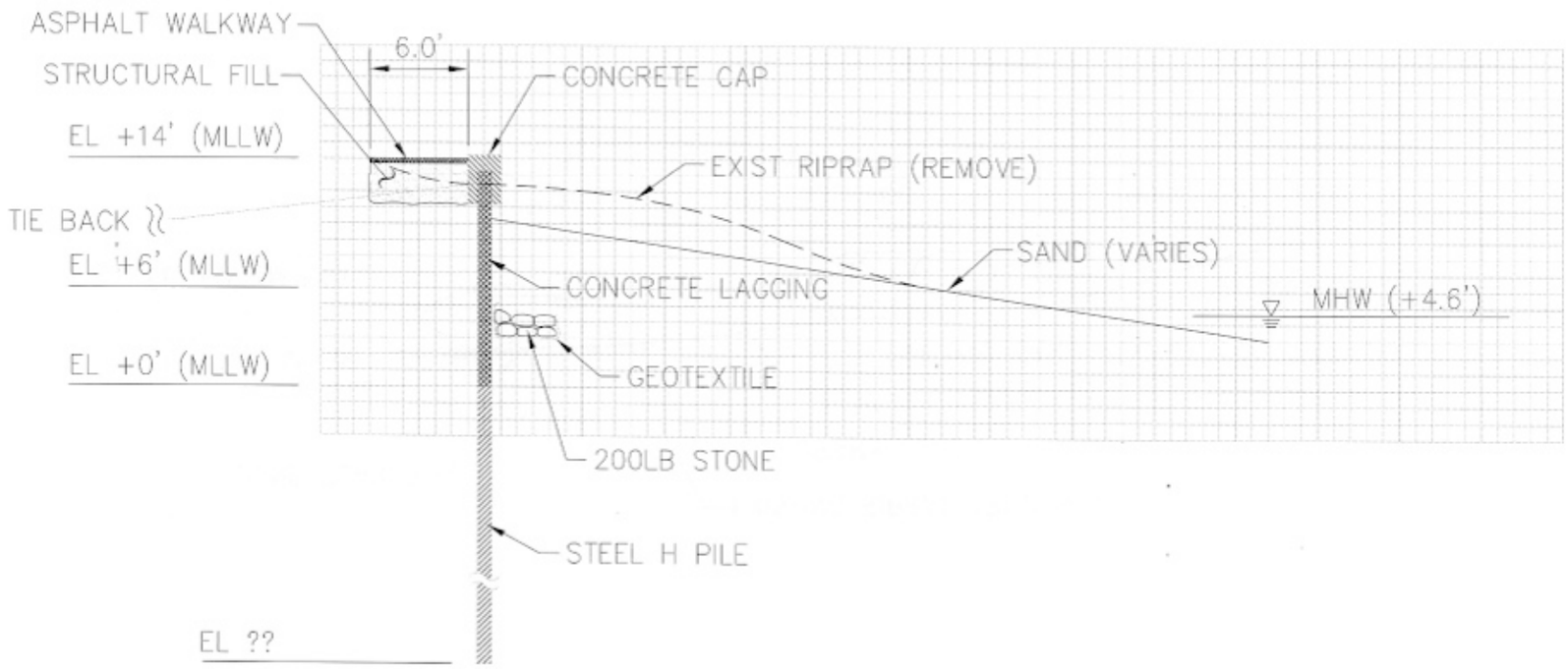
PRINCETON SHORELINE IMPROVEMENT
CONCEPTS - FIGURE 3



PRE-CAST CONCRETE PANEL SECTION
SCALE: 1"= 10'

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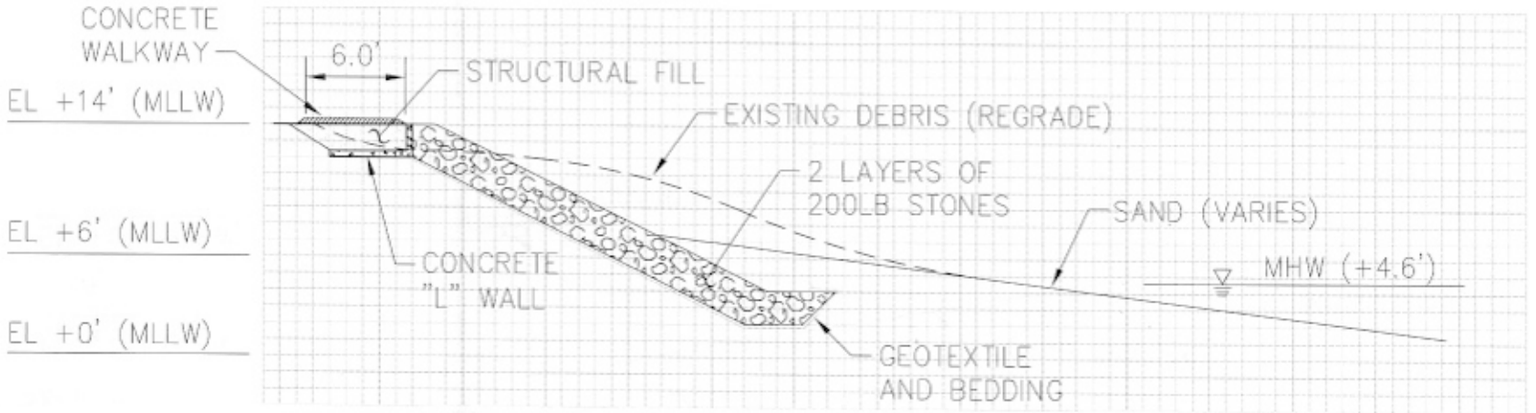
PRINCETON SHORELINE IMPROVEMENT
CONCEPTS - FIGURE 4



REVETMENT AND LANDWARD TRAIL
SCALE: 1"= 10'

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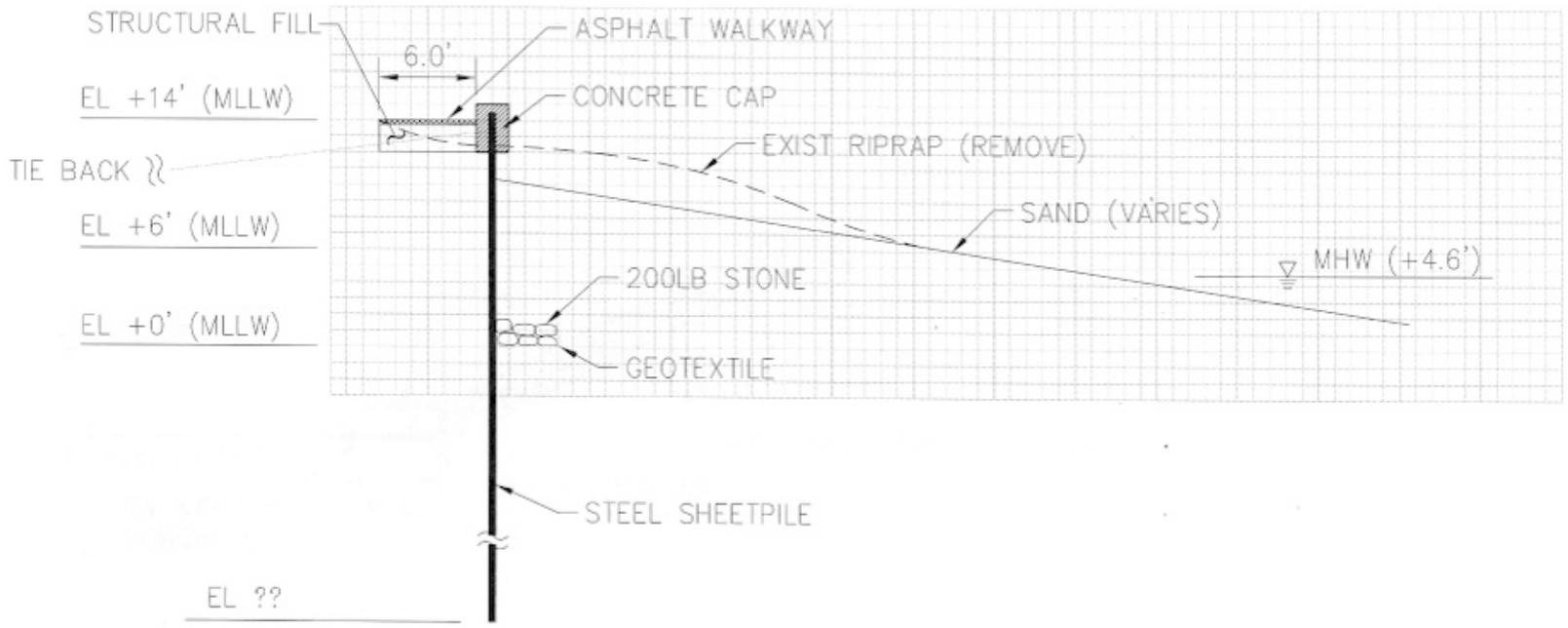
PRINCETON SHORELINE IMPROVEMENT
CONCEPTS - FIGURE 5



CANTILEVER SHEET PILE WALL
SCALE: 1"= 10'

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PRINCETON SHORELINE IMPROVEMENT
CONCEPTS - FIGURE 6