Shelter Cove
Vet with

EXHIBIT I

BOIRE ASSOCIATES INC.
Geotechnical Engineering Solutions

Boire Associates Inc.
520 NW 4th Street
Corvallis, Oregon 97330
TEL 541.753.5344
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Jim Hurst
PO Box 240000
Florence, Oregon 97439

December 1, 2003

Re: **Dune Stabilization**
Shelter Cover
Florence, Oregon

Project 203.081

Dear Mr. Hurst:

As requested, Boire Associates Inc. has completed an evaluation and recommended stabilization of an existing sand dune located along a portion of the Shelter Cove subdivision in Florence, Oregon. This letter and accompanying figures detail our findings and recommended corrective actions.

BACKGROUND

The subject of this work consists of examining, analyzing and recommending an appropriate repair to correct a slope instability located within the Shelter Cove residential development in Florence, Oregon. The subject area is specifically located on the east bank of the Siuslaw River and covers approximately 700 ft of west facing frontage for five undeveloped lots. An existing residence is located on a sixth lot to the north, which is also considered part of this development.

Historically, the east bank of the Siuslaw River has had ongoing stability problems due to sand erosion and scouring of the toe from the tide fluctuation, currents, and wave action. Boire Associates Inc. was retained to examine site conditions and provide recommendations to minimize future erosion of the sand slope and improve overall stability of the immediate area. Our scope of work was outlined in a proposal dated October 1, 2003 and formally authorized by an "Agreement for Services" dated November 7, 2003.

FIELD WORK

We made visits to the site on September 18, October 2, 2003, and October 28, 2003 to examine site conditions and compare recent topographic surveys to actual field conditions. As part of our work, we used hand-held clinometers to measure slope angles at discrete locations. We also examined portions of the lower ledge to confirm the presence of sand, underlying compressed silt (mudstone), and seeps at the contact between the soil layers.

DISCUSSION

This subject area is located on an approximate 70 to 110 ft high slope consisting of coastal dune sand. At the base of the slope lies a ledge of stiff silt with occasional inter-beds of organic material. Previous explorations in the area have shown the silt layer to be underlain by weakly cemented sands to unknown depths.

The ledge of compressible silt at the base of the sand dune is generally concealed at high tide and exposed at low tide. The silt stratum is relatively impermeable, which prevents vertical transmission of water from precipitation and tidal fluctuations. Perched runoff on the silt has caused the formation of extensive springs at the base of the dune that, when combined with scouring from river and wave action, has created extensive erosion and undermining at the base of the slope. Given the nature of the cohesionless sand comprising the slope, undermining at the base has caused a continual raveling of the bank and upslope areas. Although not directly reported to us, we estimate significant erosion "events" probably occurred during past flooding events when river levels and subsurface water runoff were significantly increased.

As discussed early in our investigation, complete stabilization of the dune would not be practical or cost-effective due to the high slope area and limited land area being protected. However, it should be possible to minimize the progression of bank failures by implementing selective erosion control and installing active shore protection. This work should allow future development of the area.

RIP-RAP (REVETMENT)

Methodology

Our methodology for recommending a mechanical stabilization for the dune area is based on findings that suggest failures of the slope result from erosion emanating at the toe. Consequently, protecting the toe area from outward seepage, river scour and wave action should prevent continued sloughing and washing of the sand dune.

In our evaluation of the slope, we considered several toe protection schemes including a concrete wall (bulkhead), gabion wall, mechanically stabilized earth (MSE) wall, various pile-supported walls, *Rip-Rap*, and conventional surface protection. Given the harsh environment and difficult access, we determined *Rip-Rap* combined with limited surface erosion protection would afford the most cost-effective solution.

Using *Rip-Rap* and other graded aggregates, we designed a series of revetments as shown in Figure 1. The primary factors directing the design were the ledge of compressed silt at the base of the sand and the elevation of the water during high tide. Based on water elevations, scour, and wave action, we established 12 ft (about the mean high tide elevation) as a practical minimum height of the *Rip-Rap* revetment.

After the minimum revetment height was selected, we continued with the design by placing graded aggregate and *Rip-Rap* armor in a configuration that protects the slope while allowing for a reasonable offset from the edge of the compressed silt ledge. The total slope height and length of the exposed areas were also considered in the analysis.

The final design is shown in the attached plan (Figure 1), corresponding slope sections (Figure 2 through 5) and a revetment detail (Figure 6). Note that two limiting constraints were created by the sand ridges and lack of available ledge space between each of the discrete areas. This created four discrete areas for *Rip-Rap* protections as denoted by cross-section A-A', B-B' C-C' and D-D'. The separating ridge areas would not be protected; however; these areas do not appear to have suffered greatly from erosion since the development was platted. It is possible future maintenance and/or slope protections may be needed in these intermediate areas, depending on the performance and secondary impacts of the shore protection.

Construction Guidelines

Based on established guidelines for *Rip-Rap* placement, as well as our specific engineering knowledge of site conditions, we developed some guidelines for construction of the revetment. Our suggestions are as follows:

1. Install all required sediment and erosion control devices, as required by federal, state and local codes.
2. Excavate the toe areas as shown to a stable foundation consisting of compressed (stiff) silt. The foundation subgrade should be smooth, firm, and free from protruding objects or voids that would effect the proper positioning of the first layer of stones. Remove all brush, trees, stumps, and other deleterious materials from the immediate revetment area. Do not disturb upper portions of the slope.
3. Install a *Filter Fabric* along the face of the native slope where the rock fill meets the sand to prevent the migration of the dune material through the revetment. Given the gradation of the sand, plugging is not expected to be a concern. Long-term degradation of the geotextile material is possible (especially from UV exposure); however, the *Graded Rock Ballast* should provide adequate (long-term) sand separation and filtration. Deleting the *Filter Fabric* might be possible but we would have to reexamine conditions to determine if secondary granular filter would be needed.
4. Use *Coarse Granular Fill*, if necessary, to create a level foundation base for the initial fill and *Rip-Rap* placement.
5. Use the appropriate *Buttress Fill* and *Rip-Rap*, as detailed in Figure 6.
6. Place stone for *Rip-Rap* as shown in the drawings in a manner which will produce a reasonably well-graded, compact mass of stone with the proper portions and minimum practicable percentage of voids. Avoid distributions that create large accumulations of

either the larger or smaller sizes of stone. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the results specified. The toe trench should receive the largest-sized *Rip-Rap* stones.

7. Continue to place the *Rip-Rap* and *Graded Rock Ballast* concurrently. Ensure the *Rip-Rap* is neatly stacked with staggered joints so that each stone rests firmly on two stones in the tier below. Additionally, smaller stones should be used to fill voids so that each rock rests solidly on the previous rock layer with minimal opportunity for movement.
8. Cover all upper portions of the exposed sand dune (slope) with an *Erosion Control Blanket*. Application of the product should follow the manufactures' guidelines.
9. Hydro-seed and/or plant the upper portions of the slope with beach grass or appropriate vegetation that is capable of establishing and thriving in a coastal environment (wind, rain, salt spray) with sandy soil. We recommend consulting with a landscaping specialist to select the best vegetation species.

SPECIFICATIONS

The following are general descriptions and definitions that have been used in our design. In general, the material descriptions are intended to provide recommended guidelines for selecting and using imported and on-site earth materials. Unless otherwise specified, all materials should conform to Oregon Department of Transportation (ODOT) specifications for gradation and quality.

<u>Rip-Rap</u>

Quality

Stone used for *Rip-Rap* shall be hard, durable, angular in shape; resistant to weathering and to water action; free from overburden, spoil, shale and organic material; and shall meet the gradation requirements specified herein. Neither breadth nor thickness of a single stone should be less than one-third its length. Rounded stone or boulders are not acceptable. Shale and stone with shale seams are not acceptable.

The minimum specific weight of the stone material shall not be less than 2.55. In accordance with the abrasion test in the Los Angeles machine (AASHTO Test T 96), stones should have a percentage loss of not more than 40 after 500 revolutions. In accordance with the sulfate soundness test (AASHTO Test T 104 for ledge rock using sodium sulfate), stones should have a loss not exceeding 10 percent after 5 cycles.

Size

The *Rip-Rap* shall consist of a typical Class 700 stone (English units), as defined by ODOT. The maximum size of the *Rip-Rap* is generally expected to be about 28 inches. The D_{50} is expected to be on the order of 16 inches. The following table is provided as a guideline for individual rock selection:

Table 1. Rip-Rap Rock Size (Class 700)

Approximate Weight (lbs)	Approximate Diameter (inches)	Percent by Weight (%)
700 – 500	28 – 24	20.0
500 – 200	24 – 18	30.0
200 – 20	18 – 12	40.0
20 – 0	Less than 12	10.0 – 0

Graded Rock Ballast (Buttress Fill)

Material used as *Graded Rock Ballast* should generally consist of 6-inch minus, well-graded, clean, hard, angular crushed rock with less than 5% material passing the No. 200 sieve. The specification is intended to be flexible with regard to gradation; however, unprocessed, rounded gravel would not be acceptable. A suggested gradation is as follows:

Table 2. Gradation Limits for Graded Rock Ballast

Sieve Size (US Standard)	Percent Passing (by weight)
6 inch	95 – 100
4 inch	60 – 80
2 inch	40 – 60
½"	20 – 40
No. 10	0 – 10
No. 100	0 – 5

Filter Fabric

The *Filter Fabric* should consist of a non-woven Amoco 4553 geotextile. An alternate geotextile type may be substituted if deemed comparable and approved by us.

Erosion Control Blanket

The *Erosion Control Blanket* should consist of a North American Green SC150 straw/coconut product. An alternative type may be substituted if deem comparable and approved by us.

OTHER COMMENTS

Existing House

As authorized, our work has not included any specific recommendations with regard to the existing house located at the north end of the development. Specifically, the subject house is elevated above the neighboring parcels and the current setback from the slope edge is minimal. The shore and erosion protections recommended by us should decrease further slope raveling and provide an added measure of safety. However, stability of slope is still a concern. Given the site constraints, additional stabilization work would likely require building an intermediate wall on the slope to retain the dune. Our preliminary opinion indicates a soldier pile wall with timber lagging and Manta Ray anchors would be the most cost-effective approach; however, we have not completed any analyses to evaluate the feasibility of constructing such a wall.

New Houses

Development of specific recommendations for house building on the subject lots was beyond the scope of our services. However, we have developed some general guidelines for area development and slope maintenance to maximize protection of the area. Our suggestions are as follows:

1. If possible, lower the elevation of the lots prior to building. Sand generated from grading may be pushed over the slope (i.e., on top of the new revetment); however, this would require new slope erosion protection and planting.
2. Maximize offsets between the rear sides of new structures and the slope edge. We would discourage building within 40 ft of the top edge of the slope. Prospective homebuilders should consider houses with small, compact building footprints. Sprawling structures and/or residences with detached decks and other ancillary buildings are likely to be more susceptible to future problems.
3. Establish a homeowners association to provide regular maintenance of the slope. This might include summer watering and fertilizing as appropriate. Natural landscaping should be maintained wherever possible.
4. Do not discharge runoff from future structures on the slope or into drywells or other subsurface disposal systems. All runoff should be collected and tight-lined to the City drainage system.

We trust this information meets your current needs. We are available at your convenience to provide onsite construction monitoring. Please contact us with any questions.

Sincerely,

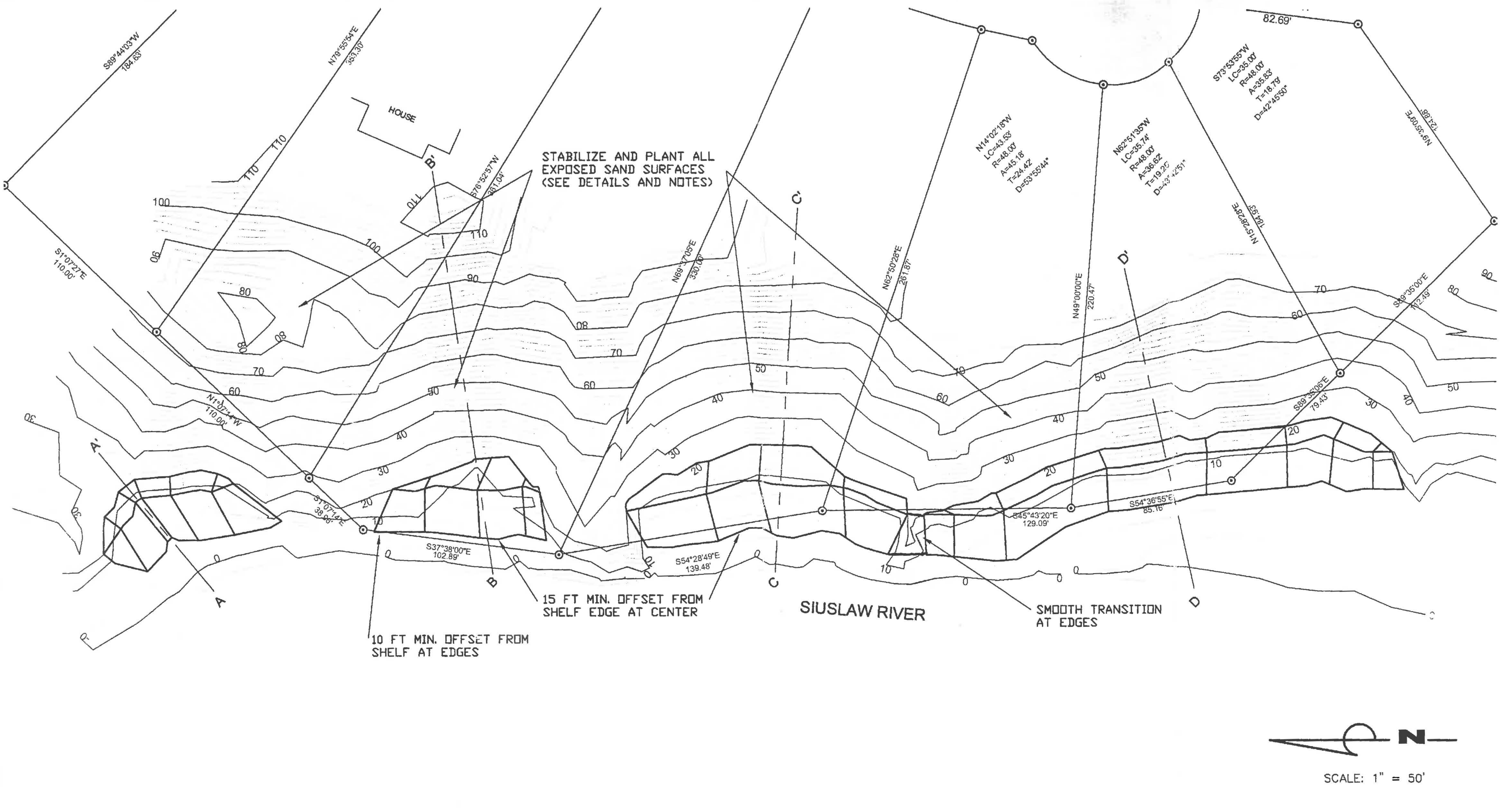
Boire Associates Inc.

M. Todd Boire, P.E.

REGISTERED PROFESSIONAL ENGINEER
17,796
OREGON
JULY 25, 1995
M. TODD BOIRE

EXPIRES 12/31/03

APPENDIX A
(Figures)



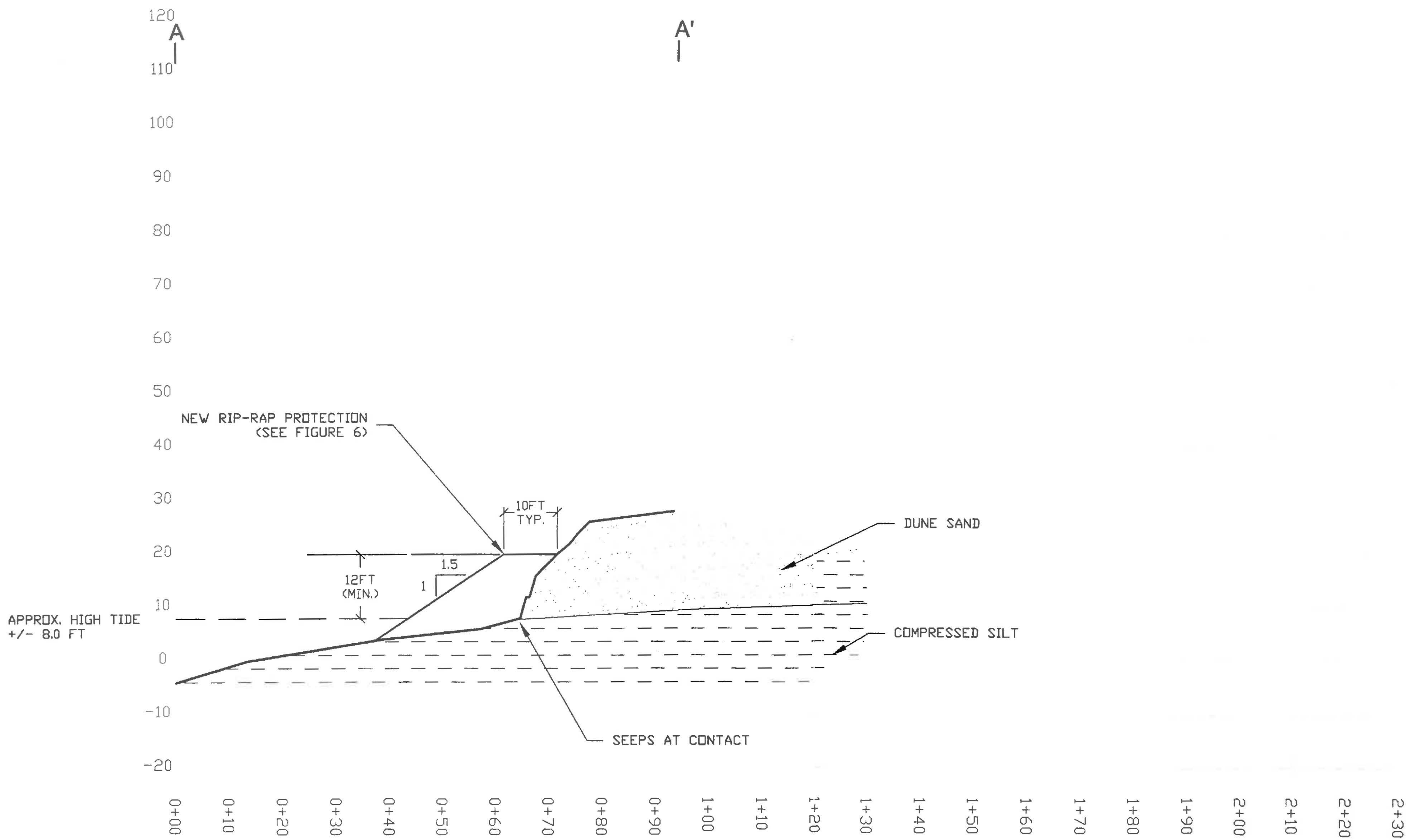
BOIRE ASSOCIATES
Geotechnical Engineering Solutions

SHELTER COVE DUNE STABILIZATION

FLORENCE, OREGON

SITE PLAN

FIGURE NO.
1



SECTION A - A'

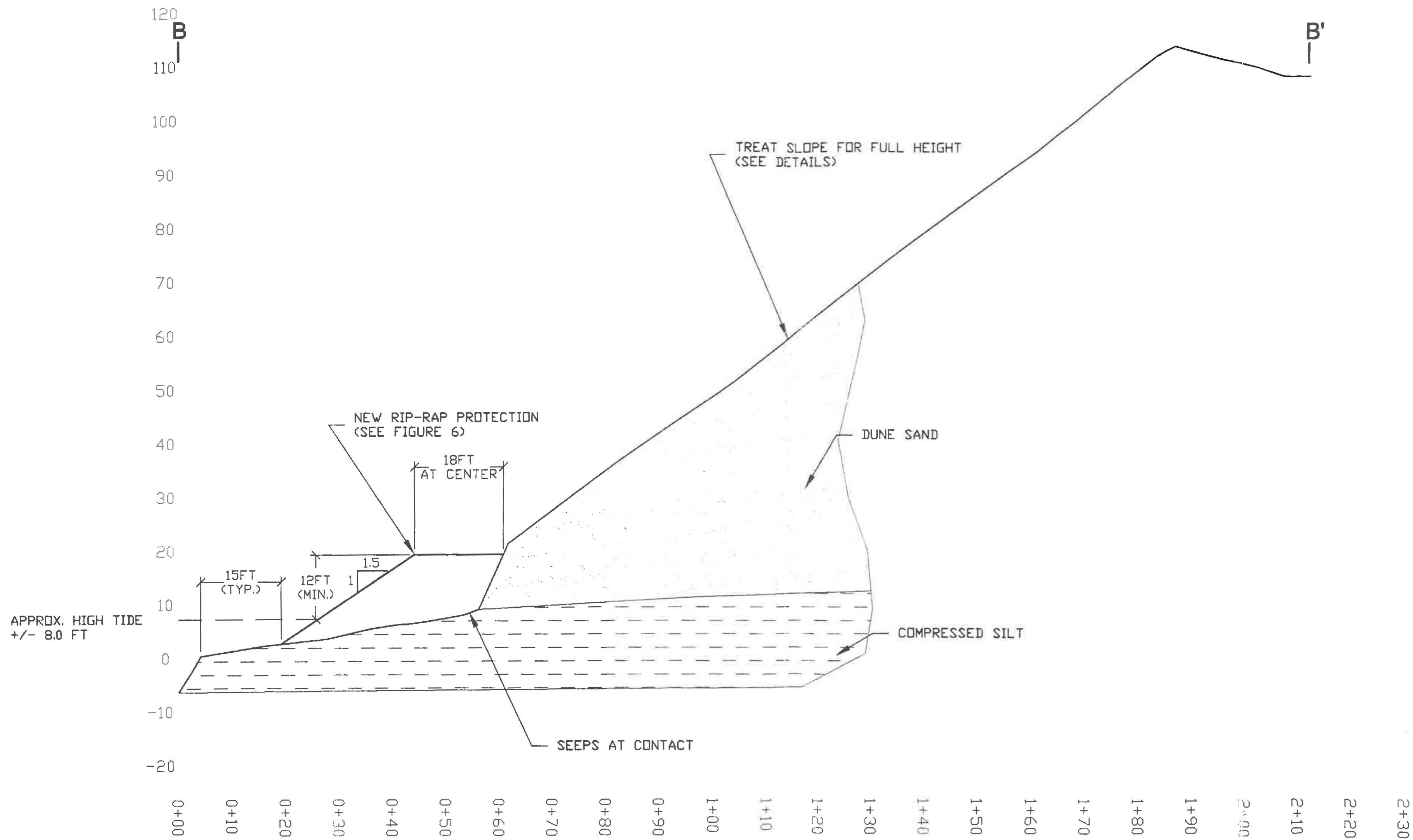
SCALE: 1" = 20'

BOIRE ASSOCIATES
Geotechnical Engineering Solutions

SHELTER COVE DUNE STABILIZATION
FLORENCE, OREGON

SECTION A

FIGURE NO. 2



SECTION B - B'

SCALE: 1" = 20'

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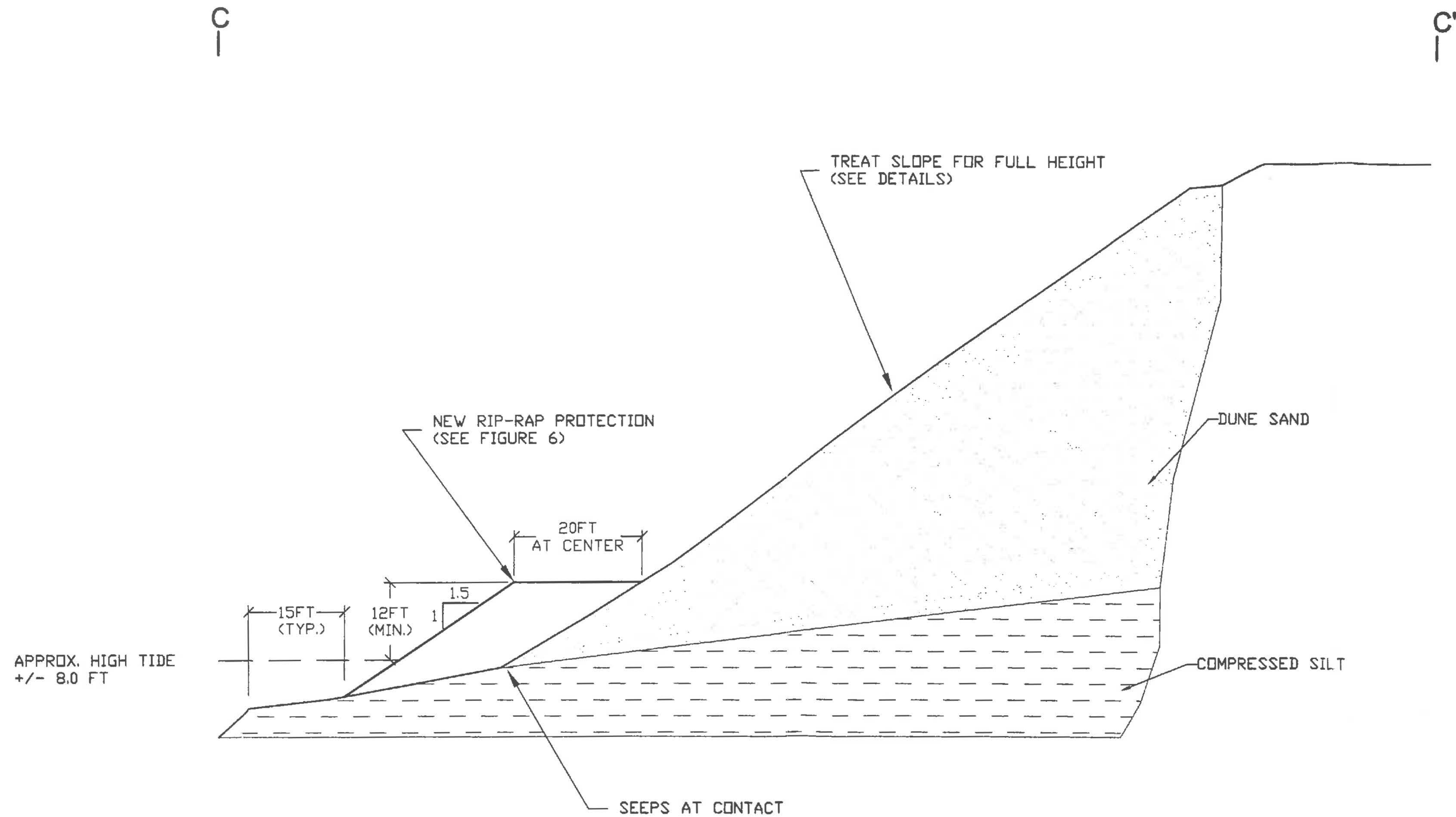
SHELTER COVE DUNE STABILIZATION

FLORENCE, OREGON

SECTION B

FIGURE NO. 3



SECTION C - C'

SCALE: 1" = 20'

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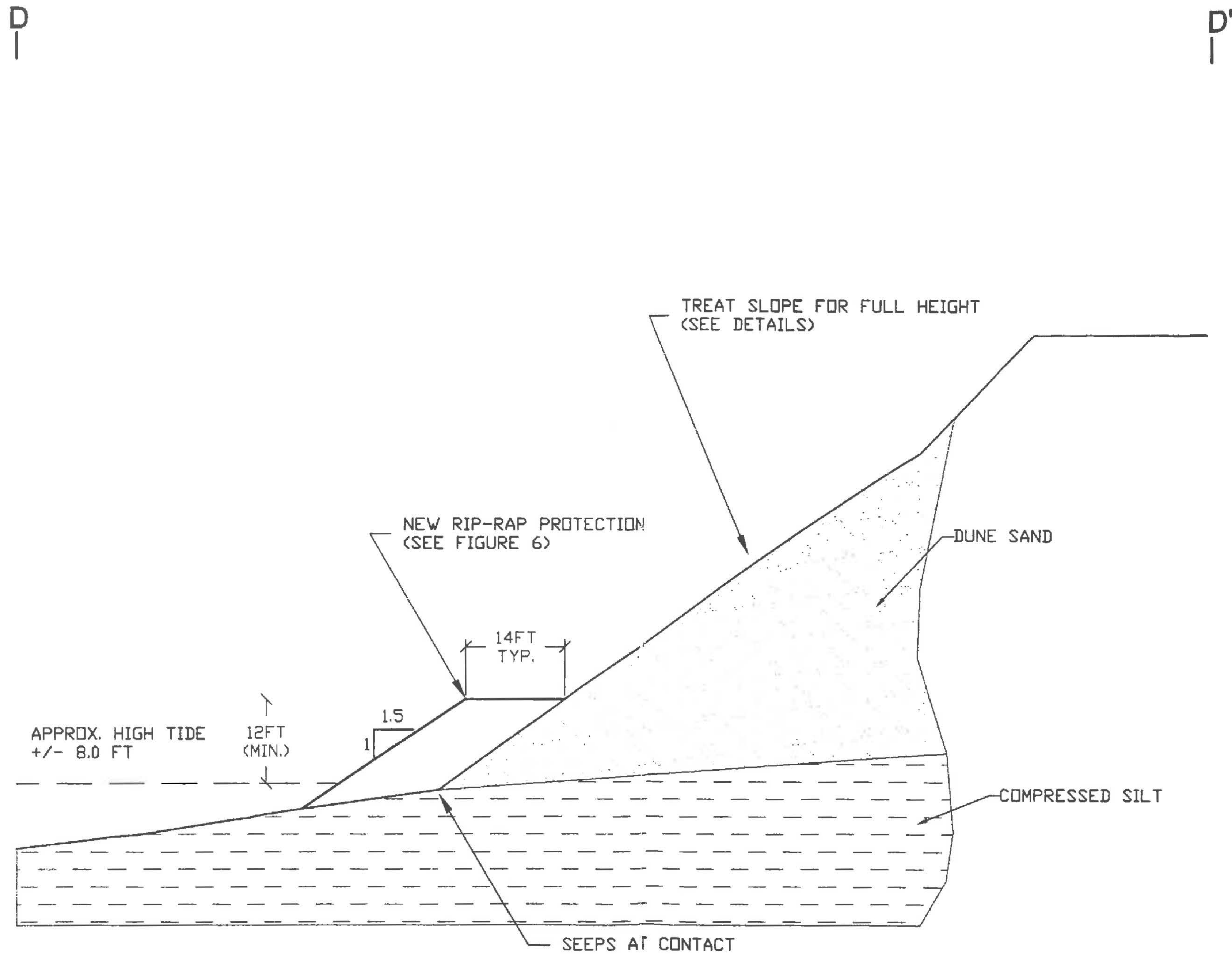
Geotechnical Engineering Solutions

SHELTER COVE DUNE STABILIZATION
FLORENCE, OREGON

SECTION C

FIGURE NO. 4



SECTION D - D'

SCALE: 1" = 20'

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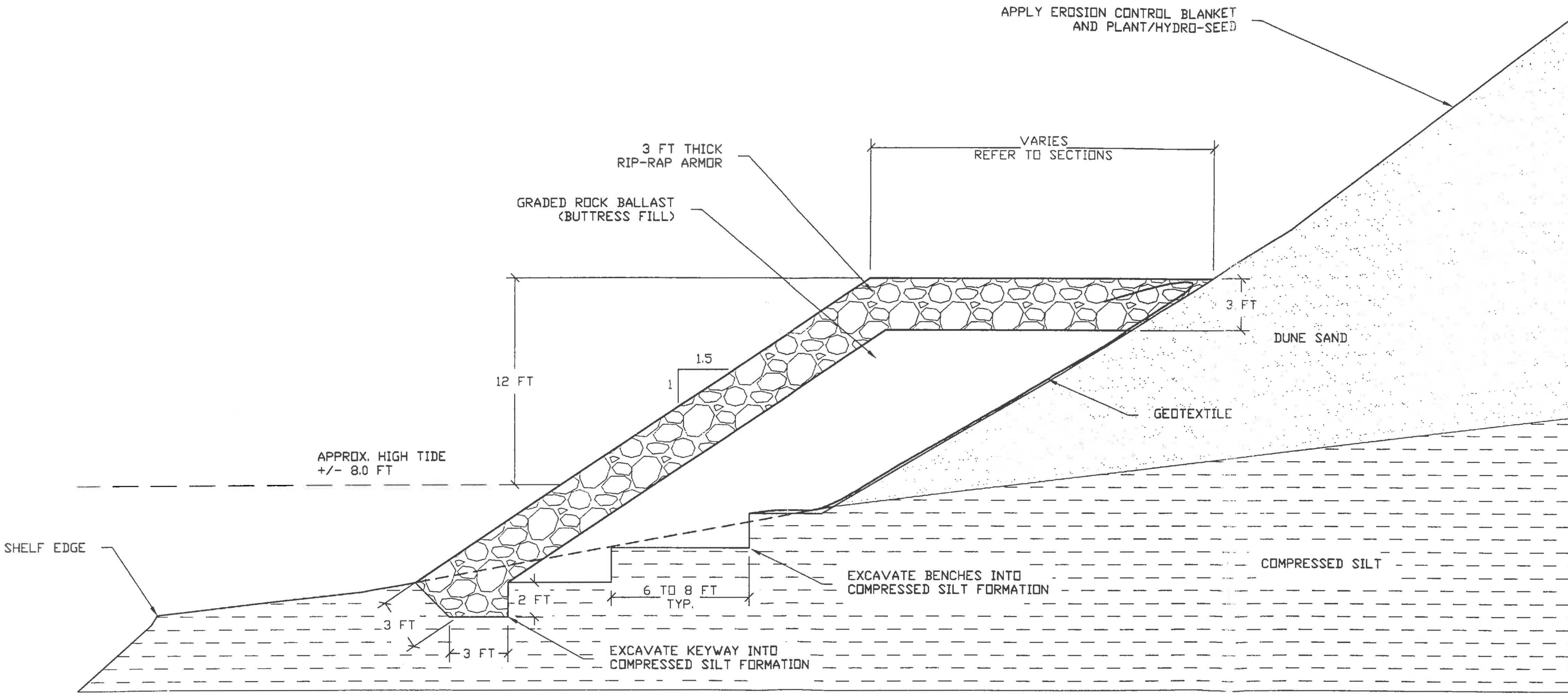
SHELTER COVE DUNE STABILIZATION

FLORENCE, OREGON

SECTION D

FIGURE NO. 5



SECTION DETAIL

SCALE: 1" = 6'

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SHELTER COVE DUNE STABILIZATION
FLORENCE, OREGON

REVETMENT DETAILS

FIGURE NO.
6

APPENDIX B
(Addenda)

Boire Associates Inc.

Geotechnical Engineering Solutions

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Addendum #1 (Technical Memorandum)

To:	Jim Hurst	**From:**	Todd Boire, P.E.
Fax:	541.903.9777	**Pages:**	3 (including figure)
Phone:	541.991-0450	**Date:**	May 2, 2004
Re:	Shelter Cove	**Cc:**	

As you are aware, we recently completed a site investigation and engineering design/recommendations to stabilize a portion of a sand dune located along the east bank of the Siulsaw River within the Shelter Cove subdivision in Florence, Oregon. The results of our work were summarized in a letter-report with accompanying figures dated December 1, 2003. Upon obtaining construction cost estimates, you indicated our plan to extend the riprap buttress toward the river (to allow lost lot area to be reclaimed) would be too expensive and requested a least costly alternative. You also indicated you would be working from above the slope, rather than using a barge. This technical memorandum provides a revised alternative for the revetment design and clarifies some other items contained in our report.

DESIGN MODIFICATIONS

Revetment Section

The revetment section has been reduced to a minimum, uniform width as shown on Figure 6 (Modified). We have not provided a plan drawing; however, the modified revetment would run the full length of the project area previously identified. The rock fill and riprap should cross over the intermediate sand ridges, which would require removing the soil overburden in these areas to expose the underlying layer of compressed silt. The compressed silt should then be benched and/or terraced to provide a keyway for rock fill and riprap placement. After completion of the work, there should be no discontinuities in the revetment along the full length. Revised material quantities are as follows:

Graded Rock Ballast:	1,400 cubic yards
Riprap:	2,250 cubic yards

Geotextile

The contractor inquired as to whether a graded aggregate filter could be used in lieu of the synthetic, non-woven, geotextile for drainage. We would approve of this change if the proposed gradation of the filter rock were provided to us. Alternatively, we could conduct a field approval.

OTHER ISSUES

Slope Disturbance

You indicated construction equipment would access the dune from the top. We recognize this would involve some slope disturbances. Any slope areas that are disturbed from access and related construction should be re-graded following completion of the work. Erosion protection should be applied as previously detailed.

House Drainage

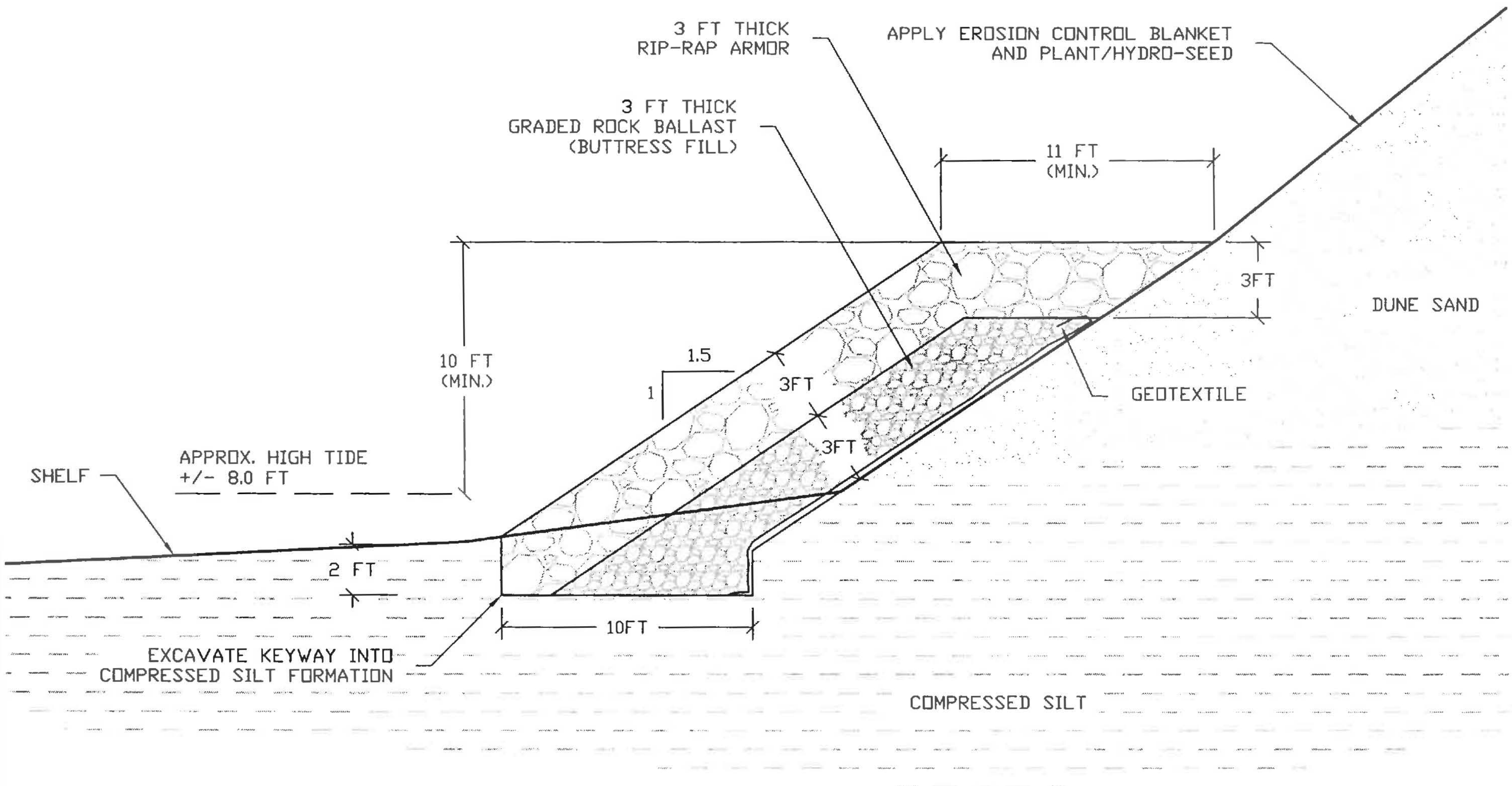
You indicated there is no city storm drainage in the area. Still, our preference is that all roof and yard area drainage be tight-lined to the street. Discharging below the slope is less preferred but may be allowed if other disposal methods are not possible. Discharging on the slope should not be completed.

Setbacks

In our letter, we recommended a 40 ft setback from the slope edge for all homes. For the reduced revetment size (where the lot areas would not be increased), we realize this setback may not be possible. It should be understood that lessening the setback would involve some increased risk for future homes that would have to be assumed individual landowners. Since actual plans are not available, we would recommend reviewing the setbacks for each individual building and lot on a case-by-case basis. For planning, we strongly encourage house footprints be minimized and that simple, square-shaped structures be used wherever possible. Making foundations continuous and rigid, and as deep as possible would also provide added benefit. Extended portions of houses, including projected viewing areas and decks, would be more susceptible to undermining and the effects of differential settlement when slope erosion does occur.

REGISTERED PROFESSIONAL
ENGINEER
17,796
OREGON
JULY 25, 1995
M. TODD BOIRE

EXPIRES 12/31/05



SECTION DETAIL

SCALE: 1" = 6'

BOIRE ASSOCIATES
Geotechnical Engineering Solutions

REVETMENT DETAILS (MODIFIED)
SHELTER COVE DUNE STABILIZATION
FLORENCE, OREGON

FIGURE NO.
6
(MODIFIED)