COASTAL BLUFF PROTECTION ANALYSIS
and
GEOTECHNICAL INVESTIGATION
for
Two Areas near Esplanade Park and the Area In-between
Three Areas near Sea Palm Street
Pacific Grove Recreational Trail
Ocean View Boulevard
Pacific Grove, California

Prepared for
City of Pacific Grove
Public Works Department

Prepared By
HARO, KASUNICH AND ASSOCIATES, INC.
Geotechnical & Coastal Engineers
Project No. M10997
December 2016

HARO, KASUNICH AND ASSOCIATES, INC.
CONSULTING GEOTECHNICAL & COASTAL ENGINEERS

Project No. M10997
20 December 2016

CITY OF PACIFIC GROVE PUBLIC WORKS DEPARTMENT
300 Forest Drive
Pacific Grove, California 93950

Attention: Mr. Daniel Gho

Subject: Coastal Bluff Protection Analysis and Geotechnical Investigation

Reference: Recent Coastal Erosion Areas at Edge of Public Access Pathway
Three Areas near Esplanade Park
Three Areas near Sea Palm Street
Pacific Grove Recreational Trail
Pacific Grove, California

Dear Mr. Gho:

In accordance with your authorization, we have prepared Coastal Bluff Protection Analysis and Geotechnical Investigation of the coastal bluff adjacent the Pacific Grove Recreational Trail. It is focused on six areas within two regions of the Pacific Grove Recreation Trail.

The trail is situated at the top of the coastal bluff along Ocean View Boulevard. The six areas are located near and just upcoast of Esplanade Park (at the seaward end of Esplanade Street) and seaward of and just upcoast of Perkins Park (at the seaward end of Sea Palm Street). In these areas, the Recreational Trail has been undermined, or is on the verge of being undermined by coastal erosion. All 6 of the areas studied in this investigation were studied because the Trail is in danger of erosion there.

The California Coastal Commission requires that alternative means of responding to coastal erosion damage be evaluated prior to selecting the best method. They require an analysis of what will occur if nothing is done, and an evaluation whether whatever improvement is threatened can be relocated landward to avoid the necessity of armoring.

This report includes evaluation of four Alternatives related to protection of the Recreational Trail, Ocean View Boulevard, and the Sanitary Sewer Force Main under Ocean View Boulevard from coastal bluff recession and instability in six areas along the Recreational Trail, which is immediately seaward of Ocean View Boulevard. These Alternatives are conceptually depicted on the drawings that are attached in the Appendices.

These four Alternatives are:

1) **No Project**
2) **Relocate Threatened Elements**
3) **Retaining Walls (Seawalls)**
4) **Rip Rap Bluff Protection**

As previously discussed, the areas we evaluated are:

1) **Esplanade West**
2) **Esplanade East**
3) **Locations Either Side of Esplanade East**
4) **Sea Palm West**
5) **Sea Palm Central**
6) **Sea Palm East**

The accompanying report presents our conclusions and recommendations, as well as the results of the geotechnical investigation on which they are based.

In summary, we recommend relocation of the trail inland of the bluff in three of these areas, and construction of coastal protection structures in the other three areas.

If you have any questions concerning the data or conclusions presented in this report, please call our office.

Very truly yours,

HARO, KASUNICH & ASSOCIATES, INC.

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Project No. M10997
20 December 2016

COASTAL BLUFF PROTECTION ANALYSIS AND GEOTECHNICAL INVESTIGATION

Introduction

We have prepared this Coastal Bluff Protection Analysis and Geotechnical Investigation of the coastal bluff adjacent the Pacific Grove Recreational Trail. It is focused on six areas within two regions of the Pacific Grove Recreation Trail. The Recreation Trail presently runs from the eastern edge of Pacific Grove to Esplanade Park (near the seaward end of Esplanade Street); with informal trails extending further west.

The trail is situated at the top of the coastal bluff along Ocean View Boulevard.

Figure 1: Vicinity Map (from Google Maps)

The six areas are located seaward and just upcoast of Esplanade Park (at the seaward end of Esplanade Street) and seaward of and just upcoast of Perkins Park (at the seaward end of Sea Palm Street). At these locations, the Recreational Trail has been undermined, or is on the verge of being undermined by coastal erosion. Oblique aerial photography of the Esplanade areas is attached in Appendix A. Oblique aerial photography of the Sea Palm areas is attached in Appendix B.

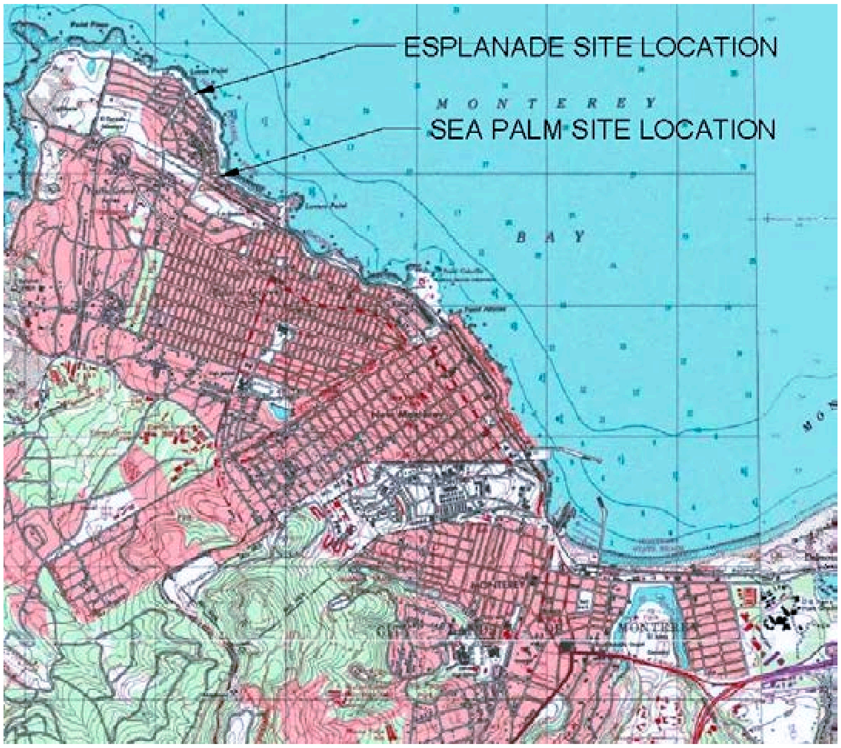

Figure 2: Site Vicinity Map (from USGS Topographic Map)

These areas are subject to further damage as a result of large ocean storms, especially those that occur during high tides and that include persistent large swells. Under these conditions rapid erosion has the potential to damage several areas of the Recreational Trail.

This report presents the results of our Coastal Bluff Protection Analysis and Geotechnical Investigation.

Purpose

The purpose of our investigation was to:

1) Analyze coastal erosion hazards

2) Explore and evaluate surface and subsurface conditions at the five coastal bluff sites

3) Evaluate alternative means of responding to the coastal erosion hazards at each site, and

4) Provision of geotechnical criteria for design and construction of the proposed repairs where we recommend coastal protection structures.

We understand that where coastal protection is the preferred alternative to preserve public access, the City prefers to pursue permits for retaining walls that are faced with artificial rock, similar to the previous structures we (HKA) designed and were constructed along the recreation trail between 2004 and 2009.

The California Coastal Commission requires that alternative means of protecting areas from coastal erosion be evaluated prior to selecting the best method. In general, the Coastal Commission prefers that bluff armoring (in the form of seawalls or retaining walls) be avoided whenever possible. As such they require an analysis of what will occur if nothing is done, and an evaluation whether whatever improvement is threatened can be relocated landward to avoid the necessity of armoring. This report includes an Alternatives Analysis for each of the six sites that includes the following alternatives; 1. No Project, 2. Relocate Threatened Elements trail, 3. Blufftop Retaining Walls (Seawalls), and 4. Rip Rap Bluff Protection. The Alternatives Analysis briefly addresses why the proposed long term solution is the least damaging “feasible” shoreline protective measure in terms of impacts to coastal resources, including public access, sand supply and visual resources. Feasible, as defined in the Coastal Act means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors.

Where there is room to relocate the trail inland, we have prepared plan view sketches of possible trail realignments that will protect the trail by virtue of the setback. This will allow discussion of the pros and cons of “relocating the threatened structure” with the Coastal Commission staff. The purpose of this report is to provide consultation and prepare conceptual plans, as necessary for Coastal Development Permit submittal.

Scope of Services

Our work included the following tasks:

1) Administration and file review of the data in our files pertinent to the site.

2) Coordination of topographic surveys at each site. We coordinated preparation of topographic bluff surveys by an experienced coastal bluff surveyor (Brodie French, PLS of Bowman and Williams).

3) Site visits

4) Preparation of five geologic sketch maps using the topographic base maps

5) Preparation of seven geologic cross sections

6) Subsurface exploration. Seven exploratory borings were drilled to evaluate soil density, strength, consistency and variability. A specialized limited access drill rig was utilized for this portion of the project.

7) Laboratory testing of selected soil samples.

8) Drafting of field data and preparation of schematic conceptual plans for various alternatives, including trail relocation, vertical bluff-top walls and a bluff-top rip-rap revetment.

9) Alternatives analysis including the elements discussed by the California Coastal Commission above, including drawings depicting various alternatives.

10) Preparation of this report addressing the proposed project.

11) Preparation of conceptual design plans and cross sections at each site.

Site Descriptions

Near Esplanade Park, we have looked at 2 areas, which we have named Esplanade West and Esplanade East. Early in our evaluation the Esplanade East area was referred to in two segments (then called Esplanade Central and Esplanade East), however as our investigation continued it revealed that the areas are in such close proximity, and their conditions are so similar, that we now refer to them both as Esplanade East. We also looked at areas either side of Esplanade East where the existing trail is immediately adjacent to the coastal bluff edge.

The Esplanade West Area is directly seaward of Esplanade Park. The area of concern is about 20 feet wide. Below are photographs that show the Esplanade West area:

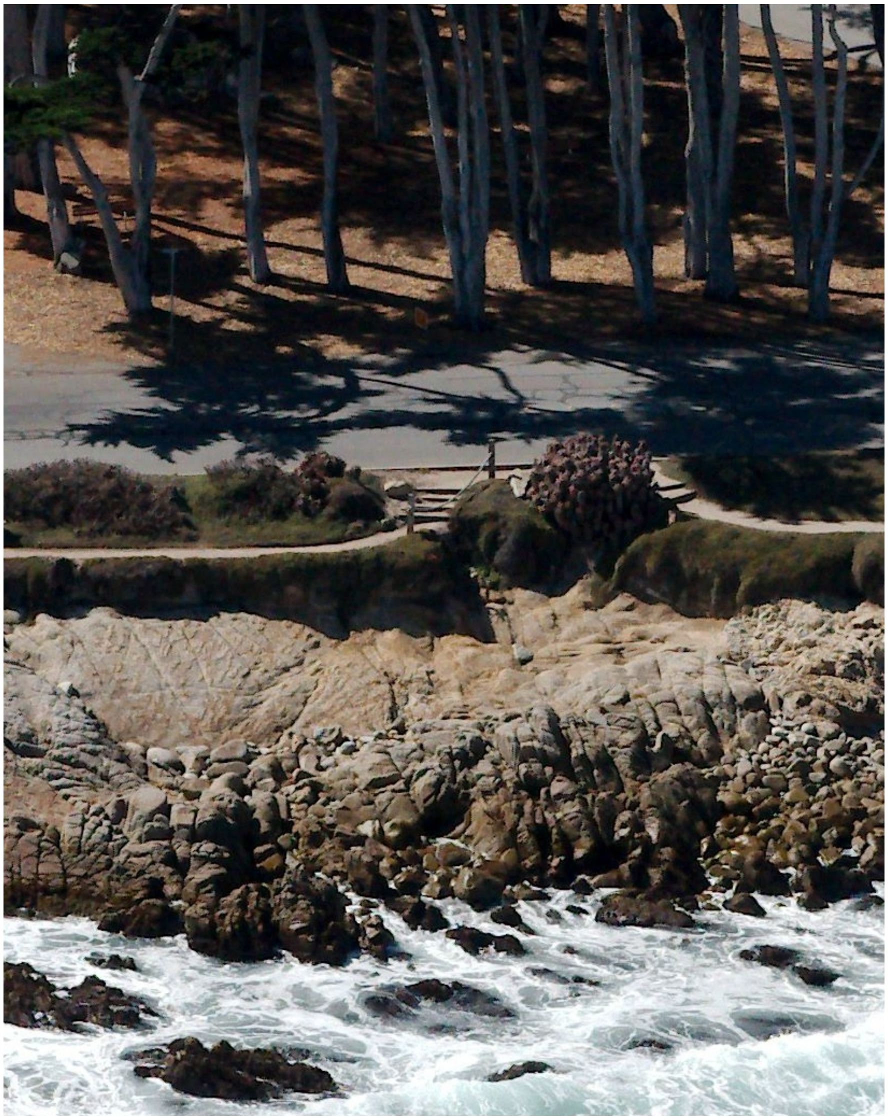

Figure 3: 2013 Esplanade West Area Oblique Aerial Photo View Looking South (courtesy of www.californiacoastline.org)

Figure 4: 2015 Esplanade West Area Vertical Image View looking South (Area is obscured by Shadows) (courtesy of Google Earth Pro)

The Esplanade East area is about 100 to 180 feet towards Monterey from Esplanade West. The total area of concern is about 75 feet wide. Below are photographs that show the Esplanade East area:

Figure 5: 2013 Esplanade East Area Oblique Aerial Photo View looking South
(The broad gully in the center of the photo has been referred to as Esplanade Central area in prior discussions. An exposed white water line is visible at the Esplanade East area to the left. Together the entire eroded area pictured is referred to in this report as Esplanade East)
(courtesy of www.californiacoastline.org)

Figure 6: 2015 Esplanade East Area Vertical Image View looking South (courtesy of Google Earth Pro)

The Trail is threatened in the locations either side of Esplanade East, where it is located immediately adjacent to the bluff edge. In these area there is adequate room to relocate the trail inland away from the coastal bluff edge.

Figure 7: 2013 Photo of Locations on Either Side of Esplanade East Where the Trail is now at the Edge of Bluff (Esplanade East Is in Center of Photograph) (courtesy of www.californiacoastline.org)

Near Perkins Park and Sea Palm Street we have looked at 3 areas, which we have named Sea Palm West, Sea Palm Central and Sea Palm East. Below are photographs that show the Sea Palm West area:

Figure 8: 2015 Sea Palm West Area Oblique Aerial Photo View looking South (courtesy of www.californiacoastline.org)

Figure 9: 2013 Sea Palm West Area Aerial Photo View looking South (courtesy of Google Earth Pro)

The Sea Palm Central area is about 270 feet towards Monterey from the Sea Palm Park beach stairs.

At the Sea Palm Central Area the bluff has receded landward due to repeated ocean wave impact. At the top of the bluff, the public access path is on the verge of being undermined. The bluff has receded landward due to repeated ocean wave impact that flows up a cobble beach and impacts the bluff. The upper portion of the coastal bluff has a very steep slope within the terrace deposits; and the public access path is being undermined. Some bedrock is exposed in the lower portion of the bluff face. The bluff extends down to the back edge of the beach. The area of concern is about 30 feet wide. It may be possible to realign the trail since the bluff edge is approximately 25 feet from the adjacent roadway. Below are photographs that show the Sea Palm Central area:

Figure 10: 2013 Sea Palm Central Area Aerial Photo Oblique View looking South (courtesy of www.californiacoastline.org)

Figure 11: 2015 Sea Palm Central Area Vertical Image View (courtesy of Google Earth Pro)

The Sea Palm East area is about 445 feet towards Monterey from the Sea Palm Park beach stairs. Below are photographs that show the Sea Palm East area:

Figure 12: 2013 Sea Palm East Area Oblique View Aerial Photo looking South (courtesy of www.californiacoastline.org)

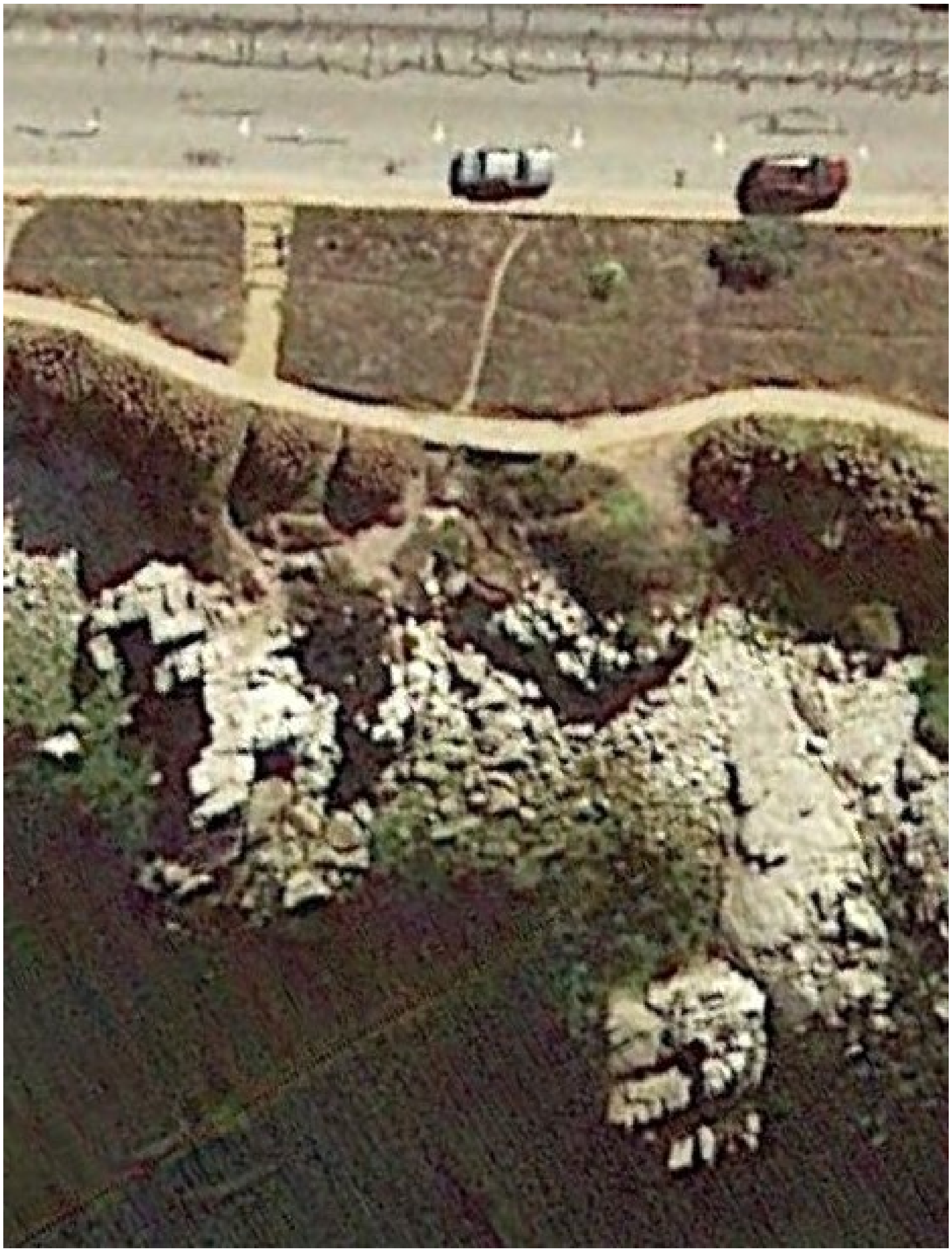

Figure 13: 2015 Sea Palm East Area Vertical Image View looking South (courtesy of Google Earth Pro)

GEOLOGY

The earth materials at all of the sites consist of granitic bedrock overlain by marine terrace deposits. A thin deposit of beach cobbles and sand locally exists at the base of the bluff. Our observations of the earth materials on the site are in general agreement with the published regional geologic maps of the area.

The marine terrace deposits are typically between 2 and 12 feet thick at the site. And are capped by topsoil. The marine terrace deposits generally consist of uncemented, friable, thinly laminated to thickly bedded silty very fine to coarse grained sand with pebbles and cobbles. The upper six inches to four feet of the marine terrace deposits are dark brown and clay rich due to topsoil development. The base of the unit is marked in spots by a cobble and pebble rich deposit where the terrace deposits rest on top of the ancestral wave-cut platform. The contact between the granite and marine terrace deposits typically has a seaward gradient, however in some areas, portions of the bedrock platform surface slope gently landward.

The granite bedrock is exposed on the bedrock platform and in the bluff face and consists of a black and white to light orange brown, pervasively jointed igneous bedrock. We observed steeply-dipping jointing within the bedrock at the site, which tends to control bedrock erosion and the morphology of the bedrock portion of the bluff face. The upper portion of the granite is highly weathered, and portions can be excavated with hand tools.

These portions are prone to erosion. At depth the granite is less weathered and is very erosion resistant. The morphology of the bluff reflects the erodibility of the earth materials and contributes to the prominent bedrock platforms that extend toward the ocean below the upper bluff face at Esplanade East, Esplanade West and Sea Palm West.

There is some artificial fill exposed in the Sea Palm West bluff face, which is presumably from historical development associated with the historical construction of Ocean View Boulevard, Perkins Park and the Recreational Trail.

GEOLOGIC HAZARDS

The geologic hazards that will cause the coastal bluff to continue to fail are seismic shaking and coastal bluff retreat. Both of these processes will continue to destabilize the bluff in the future.

The terrace deposits exposed in the upper bluff are extremely erodible, and are over-steepened and are unstable. When ocean wave runup impacts the terrace deposits, they erode, particularly near the base. That process undermines the terrace deposits and the upper terrace deposits slump downward onto the bedrock platform. The failed terrace deposits form a wedge of slough that temporarily protect the intact terrace deposits; then wave attack removes the slough, and the process repeats itself.

At Esplanade East and Esplanade West, and to some degree at Sea Palm East, a relatively broad bedrock platform is present, creating an opportunity to protect the eroding upper bluff portion without constructing a seawall that extends all the way down to beach level. This option would be less expensive and have less environmental impact, while still providing protection for the Recreational Trail.

If the upper bluff is supported with rip-rap or a concrete seawall then the seismic shaking hazard will be greatly reduced. Coastal bluff retreat has been eroding the bluff for thousands of years causing it to retreat landward. Future sea level rise will likely increase coastal bluff retreat rates.

In order to evaluate the Alternatives in the areas near Esplanade Street in the two small areas where the Recreational Trail has been undermined by bluff recession (Esplanade West and Esplanade East) and adjacent areas on either side of Esplanade East where the trail tread is immediately adjacent to the bluff edge drop off, it is useful to understand that the bluff face is from 3 to 8 feet high and consists of erodible topsoil, terrace deposits and highly weathered granitic rock atop granite bedrock that morphologically forms a platform well above sea level. The granite bedrock at the base of the bluff and underlying the earth materials that form the uppermost part of the coastal bluff is very resistant to erosion and abrasion from wave action, and thus is eroding at an extremely slow rate. The topsoil, terrace deposits and highly weathered granitic rock atop the granite bedrock are composed of softer earth material and are much more susceptible to erosion and instability than the bedrock is. The differential erosion rate between the granite bedrock and the overlying earth materials is what has formed the exposed bedrock platform.

Historical oblique aerial photographs of the Esplanade Street area are included in Appendix A, (courtesy of www.californiacoastline.org). These photographs illustrate shoreline and bluff changes from 1972 through 2015. In the vicinity of Esplanade Street, review of stereoscopic aerial photography and satellite imagery from 1945, 1976 and 2015 indicates that 3 to a maximum of 6 feet of bluff recession has occurred since 1976 in the area where the Trail is undermined. This implies an average annual long term bluff recession rate of 0.07 to 0.15 feet per year. Lesser amounts of recession occurred in the1945 to 1976 time period. That would suggest that long term average annual bluff recession rates are slower than indicated above. Our site observations revealed that these areas are located where ocean wave runup energy focuses on the bluff face. Use of long term average annual bluff recession rates to characterize erosion hazards and the risk of trail damage is likely to be misleading, since the processes are so episodic. From our review of historical oblique aerial photography and our historical observations along the Pacific Grove shoreline, it is our opinion that much of the measured erosion may have occurred during the extreme El Nino winter ocean storm years of 1983 and 1998. Our qualitative slope stability analysis and observations of recent bluff face erosion indicate the segment of recreational trail adjacent to the bluff edge in the three Esplanade Street areas is in danger from erosion, and may be damaged in a single winter ocean storm season. The bluff is subject to episodic erosion damage, whether in a single strong storm, or in a series of storms occurring during 1 to 3 winter seasons, erosion that results in several (3 to 8) feet of bluff retreat occurs, with greater amounts of probable retreat where the terrace and topsoils are thicker and where wave energy is concentrated due to the geomorphology. Whatever is done with the segments of bluff being studied in this investigation, it is clear that the coastal bluffs upcoast and downcoast of the site will continue to erode.

Historical oblique aerial photographs of the Sea Palm Street area are included in Appendix B, (courtesy of www.californiacoastline.org). These photographs illustrate shoreline and bluff changes from 1972 through 2015. In the vicinity Sea Palm Street, review of stereoscopic aerial photography and satellite imagery was inconclusive due to the photographic resolution and the ground surface being obscured by vegetative cover. The earth materials at Sea Palm are generally similar to those at Esplanade, however the geologic contact between the granite bedrock and the overlying earth materials is at lower elevation and the erosion rates are more similar. Thus the overall bluff is generally steeper. The topsoil, terrace deposits and highly weathered granitic rock atop the granite bedrock forms a greater portion of the bluff height in these areas and is more subject to mass instability (landsliding) caused by undermining from ocean wave impact or from saturation from wind-blown ocean spray and rainfall, since those weaker earth materials have been over-steepened relative to their height by historical erosion. This is especially true at Sea Palm West where the weaker earth materials, which include some fill soils from trail construction that are exposed at the bluff edge, extend almost all the way down to the elevation of the landward edge of the beach. Our qualitative slope stability analysis and observations of recent bluff face erosion indicate the segment of recreational trail adjacent to the bluff edge in the three Sea Palm Street areas is in danger from erosion, and may be damaged in a single winter ocean storm season. The bluff is subject to episodic erosion damage, whether in a single strong storm, or in a series of storms occurring during 1 to 3 winter seasons, erosion that results in several (3 to 8) feet of bluff retreat occurs, with greater amounts of probable retreat where the terrace and topsoils are thicker and where wave energy is concentrated due to the geomorphology. Sea Palm West is particularly subject to erosion risk because of the soft soils that form most of the bluff face there.

Protection of the bluff will “buy time” during which the Recreational Trail is preserved. An upper bluff retaining structure may be effective in protecting the multi-use path for 50 to 100 years.

GEOTECHNICAL ANALYSES

Field Exploration

On 25 April 2016 three (3) exploratory test bore holes were advanced along the recreation trail on Ocean View Boulevard between Sea Palm Avenue and Clyte Street. One test boring was advanced at each of the following locations we have named; Sea Palm East, Sea Palm Central, and Sea Palm West. On 26 April 2016 we advanced four (4) test borings along the public access pathway on Ocean View Boulevard near Esplanade Park. Two test borings were advanced at each of the following locations we have tentatively named; Esplanade East and Esplanade West. The exploratory test borings were advanced to depths of 19.8 to 30 feet below the ground surface (bgs) at the Sea Palm sites and 6.0 to 13.5 feet bgs at the Esplanade sites. A limited access drill rig with solid flight augers was set up at each of the test boring locations.

Samples were obtained by driving a California Sampler (3 inch outside diameter) or split spoon sampler (2 inch outside diameter) up to18 inches in depth at select elevations using a standard 140 pound hammer over a 30 inch drop. The amount of blows to drive the sampler 1 foot were recorded and presented on our logs of borings attached to this letter (Appendix F Figures 2 to 8).

The approximate location of test bore holes are shown on our Site Maps for the Esplanade and Sea Palm sites (Appendix C). The soil encountered in the borings was continuously logged in the field and described in accordance with the Unified Soil Classification System (ASTM D2487).

Laboratory Testing

The laboratory testing program was directed toward determining pertinent soil engineering and index properties.

The natural moisture content was determined on select samples and is recorded on the Logs of Test Borings at the appropriate depths. Since water has a significant influence on soil, the natural moisture content is considered in the development of the soil's strength.

Saturated direct shear tests were completed to determine strength properties for the topsoil, coastal terrace, and weathered portion of the granite bedrock formation. Density tests were also performed to aid in the assignment of soil properties to each soil type.

A Key to the logs of test borings is shown in Figure 1 of Appendix F. The results of the field and laboratory testing appear on the "Logs of Test Borings" opposite the samples tested (Appendix F Figures 2 through 8).

Subsurface Conditions

In general, within the test bore holes advanced in the area of the Esplanade Park sites, the soil profile encountered consisted of 4 to 5 feet of coastal terrace deposits over a Granite bedrock formation. Within the test bore holes advanced in the area of the Sea

Palm sites the soil profile consisted of 7 to 12 feet of coastal terrace deposits over granite bedrock. The upper 1 to 4 feet of the coastal terrace was capped with top soil. The granite bedrock encountered had a weathered zone in the top 3 to 4 feet that was very dense, but rippable meaning it can be excavated using conventional construction equipment. Below the upper 3 to 4 feet of the granite bedrock formation it became much harder competent rock that may require specialty drilling equipment to advance into.

Groundwater

Groundwater was encountered within our test bore holes at the three Sea Palm sites during the time of our field drilling operation. The groundwater encountered was perched upon the granite bedrock within the coastal terrace. The groundwater level may fluctuate seasonally from the locations noted on our boring logs. That being said saturated soils and active seeps in the top soil and coastal terrace soils should be anticipated and planned for by designers and contractors. Retaining wall back drains will be an essential part of the design for this project. It is recommended to relieve drainage collected in these subsurface systems through gravity flow. Temporary cut slopes should be assumed to have seepage within the top soil and coastal terrace.

Soil Properties

Based on our field exploration and results of laboratory tests the soils encountered were simplified into two soil types. Soil Type 1: Top Soil, Soil Type 2: Coastal Terrace, Soil

Type 3: Weathered Granite Bedrock, and Soil Type 4: Hard Granite Bedrock. The geotechnical strength parameters of the soil types are summarized in the table below.

Table 1: Geotechnical Design Values

Soil Stratum	Density (lbs/ft^3)	°(degrees)	Cohesion (lbs/ft^2)
Soil 1	100	35	200
Soil 2	108	38	100
Soil 3	113	41	350
Soil 4	130	45	1,000

Seismicity

The following is a general discussion of seismicity in the project area. The known active faults nearest to the property are:

1) The Palo Colorado-San Gregorio Fault, located about 7.1 miles to the southwest;

2) The Monterey Bay Fault complex, located about 1.1 miles to the northeast; and

3) The San Andreas Fault, located about 26.3 miles to the northeast.

The known potentially active faults nearest to the property are:

1) The Cypress Point Fault, located about 3.8 miles to the southwest; and

2) The Chupines Fault, located about 4.2 miles to the northeast;

The site is likely to be shaken by earthquakes of approximate magnitude 7.9, with an average recurrence interval between 138 and 188 years along the North Coast segment of the San Andreas Fault (Working Group on California Earthquake Probabilities, 1990). Earthquakes of magnitude 6 or 7 are also likely along many of the faults within the Monterey Bay area.

Geotechnical Related Seismicity

The improvements should be designed in conformance with the most current California Building Code (2013 CBC). For seismic design, the soil properties at the site are classified as **Site Class "C"** based on definitions presented in Table 1613.5.2 in the 2013 CBC. The longitude and latitude were determined using a satellite image generated by Google Earth. These coordinates were taken from the approximate middle of the area of the proposed improvements:

Longitude = -121.9216, Latitude = 36.6285

The coordinates listed above were used as inputs in the Java Ground Motion Parameter Calculator created by the USGS to determine the ground motion associated with the maximum considered earthquake (MCE) SM and the reduced ground motion for design SD. The results are as follows:

Site Class C

SM_S= 1.544 g

SM_1= 0.737 g

SD_S= 1.030 g

SD_1= 0.491 g

A maximum considered earthquake geometric mean (MCE_G) peak ground acceleration (PGA) was estimated using the Figure 22-7 of the ASCE Standard 7-10. The mapped PGA was 0.60 g and the site coefficient F_{PGA} for Site Class C is 1.0. The MCE_G peak ground acceleration adjusted for Site Class effects is $PGA_M = F_{PGA} * PGA$

$$\boxed{PGA_M = 1.0 * 0.60\text{ g} = 0.60\text{ g}}$$

California Building Code Seismic Surcharge

In accordance with Section 1802.2.6 of the 2013 California Building Code (CBC), the project retaining wall systems should be designed to accommodate lateral pressures due to earthquake motions. We recommend a seismic surcharge of 10 H psf per linear foot of wall acting at 0.5 H, where H is the height of the active zone, be used for vertical shotcrete tied back retaining walls.

Wave Runup and Overtopping

The referenced project is exposed to the Pacific Ocean, which borders the site to the northeast. We qualitatively evaluated wave runup. The purpose of the wave runup and overtopping evaluation was to assist in evaluation of coastal erosion potential, and also aid in estimating minimum quarrystone rip-rap size for the proposed rip-rap alternative at Esplanade East. During severe coastal storms, large surf will runup the beach platform and overtop the coastal bluff. Wave runup and wind-blown sea spray impact the bluff face during large storms. Evidence of overtopping consisting of seaweed deposits and displaced vegetation was observed along the recreational trail.

Sea Level has risen and the rate at which it is rising is accelerating. The National Research Council prepared a 2012 report entitled "Sea Level Rise for the Coasts of California, Oregon and Washington: Past, Present and Future." This report stated the following sea level rise projections for areas South of Cape Mendocino using the year 2000 as a base line:

Sea Level Rise Amounts from the National Research Council (2012)	
Year	Sea Level Rise
2050	Lower Range 5 inches
	Higher Range 24 inches
2100	Lower Range 16 inches
	Higher Range 66 inches

Wave runup and overtopping hazards are expected to become worse as sea level rises. Sea level rise will make future coastal bluff recession rates faster than measured historical coastal bluff recession rates.

ALTERNATIVES ANALYSIS AND DISCUSSION

This report considered alternatives for each of the six sites. The Alternatives Analysis briefly addresses the following factors:

> Alternatives analysis – this analysis should include a detailed explanation as to why the proposed long term solution is the least damaging "feasible" shoreline protective measure in terms of impacts to coastal resources, including public access, sand supply and visual resources. Feasible, as defined in the Coastal Act means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors.

The California Coastal Commission requires that alternative means of responding to coastal erosion damage be evaluated prior to selecting the best method. They require an analysis of what will occur if nothing is done, and an evaluation whether whatever improvement is threatened can be relocated landward to avoid the necessity of armoring.

This report includes evaluation of four Alternatives related to protection of the Recreational Trail, Ocean View Boulevard, and the Sanitary Sewer Force Main under Ocean View Boulevard from coastal bluff recession and instability in six areas along the Recreational Trail, which is immediately seaward of Ocean View Boulevard. These Alternatives are conceptually depicted on the drawings that are attached in the Appendices.

These four Alternatives are:

1) **No Project**
2) **Relocate Threatened Elements**
3) **Retaining Walls (Seawalls)**
4) **Rip Rap Bluff Protection**

Because of the inherent uncertainty in predicting future bluff recession, it is appropriate to design for erosion rates greater than those that have historically occurred, if the structure at risk cannot be easily relocated. In general, a path or trail can be designed for a location closer to the bluff edge than a parking area, street or sewer main. As future erosion occurs, and the bluff edge retreats inland, then the position of the bluff edge can be monitored and additional relocation can take place in a manner that provides for safe use of the structures. This seems to be appropriate for trails especially, where the trail use experience is enhanced by being as close to the coastal bluff edge as safety permits, since trail users value being able to see the shoreline, bluff and beach from the trail location.

The alternatives to preserve public access along the recreational trail are discussed below:

A. No Project

The coastal bluff is slowly eroding, with the result that the coastal bluff edge is receding landward. This poses a long term hazard to the Trail. In some areas the Trail is so close to the coastal bluff edge that it is subject to episodic erosion damage, whether in a single strong storm, or in a series of storms occurring during 1 to 3 winter seasons, that may cause erosion that results in several (3 to 8) feet of bluff retreat occurs. In these areas, if the Trail is not relocated or if the bluff is not protected from erosion by retaining walls or seawalls, then public access along the Trail will be eliminated. All 6 of the sites studied in this investigation were studied because the Trail is in danger of erosion there. This alternative has no immediate cost, but significant cost as future damage to the Trail and Ocean View Boulevard occurs.

That erosion may consist of progressive grain-by-grain loss of soil, or of larger mass instability (landsliding) as a single episode or as a series of cumulative effects. As depicted in Appendix B the areas at Esplanade West and Esplanade East have been compromised by erosion and the trail is immediately adjacent to the curb on the edge of Ocean View Boulevard. In the locations on either side of the Esplanade East area, and at Sea Palm Central and Sea Palm East, the present trail tread alignment borders the edge of the vertical coastal bluff. In our opinion, these trail locations pose a significant safety hazard for trail users. At Sea Palm West, the trail is presently safe but is particularly subject to erosion risk because of the soft soils that form most of the bluff face there extend almost all the way down to the elevation of the landward edge of the beach. Thus at these locations the “No Project” alternative does not meet the project goals and is not considered feasible.

B. Relocate Threatened Elements

Where there is room to relocate the trail inland, we have prepared drawings of possible trail realignments that will protect the trail by virtue of the setback. This will allow discussion of the pros and cons of “relocating the threatened structure” with the Coastal Commission staff. Where there is sufficient room between the bluff edge and Ocean View Boulevard, relocation of the Trail will be the least expensive alternative. This alternative has no impact on beach sand supply. Other than no project, this is the least costly alternative, in terms of initial cost.

As noted in Alternative 1, if nothing is done, in our opinion, areas within 3 to 8 feet of the top edge of the bluff are in danger of erosion. That erosion may consist of progressive grain-by-grain loss of soil, or of larger mass instability (landsliding) as a single episode or as a series of cumulative effects.

Relocation of the Trail has been considered at all 6 areas that are the subject of this study:

1) Esplanade West,
2) Areas to either side of Esplanade East
3) Esplanade East
4) Sea Palm West
5) Sea Palm Central
6) Sea Palm East

Relocation of the Trail is feasible in the area on either side of Esplanade East, (Appendix D Drawings 1, 2 and 3), at Sea Palm Central (Appendix C Sheets 9 and 10), and at Sea Palm East (Appendix C Sheets 11 and 12), as depicted in Appendix B and C. Relocation of the Trail will be done in conjunction with the construction of seawalls at Esplanade East and Esplanade West (Appendix D Drawing 4).

In our opinion, relocation of the Trail is not feasible at Esplanade East, Esplanade West and Sea Palm West because of the small amount of land between Ocean View Boulevard and the bluff edge. We have considered the possibility of realigning the Trail landward to avoid the need for coastal protection. This would require that the Trail alignment encroach into the area presently used for parallel parking along Ocean View Boulevard. The complications associated with such an encroachment are discussed further below.

At Esplanade East and Sea Palm West, residential development is located across the Boulevard. Elimination of the seaward parallel parking strip would narrow Ocean View Boulevard there and hinder the public access for automobiles and bicycles there. This unavoidable impact makes relocation of the Trail at Esplanade East not feasible.

At Esplanade West, a community park is located across the Boulevard. Relocation of the Trail into the Ocean View Blvd. parking strip and bicycle lane was considered there (Appendix D, Drawings 5 and 6). Elimination of the seaward parallel parking strip there would narrow Ocean View Boulevard and also hinder the public access for automobiles and bicycles there, however the inland edge of Ocean View Boulevard could potentially be widened into Esplanade Park. This would result in encroachment of Ocean View Boulevard into the area under the dripline of the cypress trees within Esplanade Park. From our experience on other projects we understand this would negatively and significantly impact the health of the trees; and thus their removal would likely be required if this option were selected. At Esplanade West we have drawn a realigned trail that encroaches into the area presently used for parallel parking along Ocean View Boulevard (Appendix D Drawings 5 and 6) but does not realign the traffic lanes of Ocean View Boulevard. Review of this drawing by the City of Pacific Grove Public Works Department have revealed that elimination of the seaward parallel parking strip there, which forces Bikeway traffic out into the automobile lane there is an unsafe design. In our opinion, creation of a horizontal curve in the Ocean View Boulevard traffic lanes to allow automobile and bicycle traffic to swerve inland without traffic lane conflicts would create a dangerous traffic pattern. Our observations indicate motorists on Ocean View Boulevard are often distracted by gazing at the ocean scenery, increasing that potential danger. In our opinion the safety of pedestrians, bicyclists and motorists should be considered prior to implementing any realignment of Ocean View Boulevard. Our firm does not include any professionals qualified to do traffic engineering, so we rely on the City of Pacific Grove Public Works Department for traffic engineering expertise. The City traffic engineer has prepared Memorandum that indicates that blocking the seaward parallel parking strip to allow relocation of the Trail at Esplanade West is not a feasible alternative (see Appendix E).

In the areas to either side of Esplanade East, the present Trail tread alignment borders the edge of the vertical coastal bluff, and there is sufficient room to relocate the Trail landward there. Thus, this alternative meets the project goals and is considered feasible (Appendix D Drawings 1, 2 and 3).

C. Construct Rip-rap Revetment

Rip rap structures can be designed that buttress the coastal bluff. They have sloping seaward faces and a broad footprint, as measured in a landward-seaward direction. As such they are usually not feasible in many environments because of the associated impacts to the area that is buried by rip-rap at the base of the structure, which is usually at beach level. This alternative has a comparatively large impact on beach sand supply.

Because relocation of the trail is feasible in the locations adjacent to Esplanade East, at Sea Palm Central, and at Sea Palm East, we have not considered coastal bluff protection (rip-rap or vertical retaining walls/seawalls) in these areas.

In this Alternative we considered utilizing Rip Rap Bluff Protection to stabilize the coastal bluff at these areas:

1) Esplanade West
2) Sea Palm West
3) Esplanade East

At Esplanade West rip-rap is not feasible because of the sloping granitic bedrock platform geomorphology, which would geometrically mandate extending the rip-rap down to sea level, which is not economically or environmentally feasible.

At Sea Palm West the rip-rap would be founded into bedrock at beach level at its base which would require excavation into the natural granite below the beach sand and cobbles. Because of the bluff height and slope, which would mandate a large structure with a wide base that covers the beach, which is not feasible due to the present value of the beach for recreation, which is frequently used because of the public access provided by the adjacent stairs from the parking area above down to the beach. For these reasons, at Sea Palm West rip-rap is not feasible.

At Esplanade East rip-rap could be effective at preventing erosion and may be feasible. We have prepared drawings of a conceptual rip-rap structure there (Appendix C Sheets 4A, 5A and 6A). At Esplanade East the rip-rap would be founded into bedrock well above sea level at its base which would require excavation into the natural granite bedrock platform. In order to be stable, a rip-rap revetment would have to be constructed as a rip-rap wedge with a sloping seaward face; thus it would cover much more area (bedrock platform or beach) than a vertical wall. This alternative would have significant visual impacts and would result in greater topographic alteration of the bluff morphology vertical retaining walls or seawalls, particularly if an artificial rock facing were utilized on the walls. The impacts of this alternative would be greater than a vertical wall. For these reasons, at Esplanade East rip-rap is not recommended.

D. Construct Retaining Walls or Seawalls

Because relocation of the trail is feasible in the locations adjacent to Esplanade East, at Sea Palm Central and at Sea Palm East, we do not recommend coastal bluff protection (rip-rap or vertical retaining walls/seawalls) in these areas. At Sea Palm Central (Appendix C Sheets 9A and 10A) and at Sea Palm East (Appendix C Sheets 11A and 12A) a full bluff height seawall was considered, but not recommended due to the greater impact that would have compared to trail relocation .

A retaining structure or seawall will have a longer life expectancy than a rip-rap structure, will have a smaller footprint, and can be designed to be less visible. In general, construction of a retaining wall/seawall is feasible to protect the Recreational trail. If selected to protect the trail, such a wall should be designed to buttress the highly weathered bedrock, terrace deposits and topsoils; and protect those earth materials from erosion. The height and length of the walls can be minimized based on the geology and geomorphology where protection is needed. The structure should be designed so that groundwater seepage from the terrace deposits is not obstructed. These structures require post-tensioned tiebacks and can be surfaced with “artificial rock’; shotcrete that is sculpted, textured and colored to resemble adjacent bedrock or terrace deposits. This alternative has a comparatively small impact on beach sand supply, compared to a rip-rap revetment. This is the most costly alternative.

In this Alternative we considered utilizing retaining walls or seawalls to stabilize the coastal bluff at these areas:

1) Esplanade West
2) Sea Palm West
3) Esplanade East

This Alternative considers and recommends the construction of the artificial rock faced seawalls depicted in Appendix C at Esplanade West (Sheets 1, 2 and 3), Esplanade East (Sheets 4,5 and 6) and Sea Palm West (Sheets 7 and 8).

These three retaining walls have the following lengths and heights:

1) Esplanade West (20 feet long and 8.5 feet high with 6 to 7.5 feet exposed)
3) Esplanade East (33 feet long and 10.5 to 11 feet high with 8.5 to 9.5 feet exposed)
4) Sea Palm West (30 feet long and 18 feet high with 16 feet exposed)

At Esplanade East and West the Trail will be relocated in a manner so that it is setback a minimum of 3 feet from both the bluff edge and from the Ocean View Boulevard curb. The plans for the Esplanade areas include minimum 4 foot long wing walls embedded into the bluff to help protect the ends of the wall from being quickly outflanked by future erosion. The visual impacts of this alternative will be mitigated by constructing the surface of the proposed retaining structure to resemble the adjacent bedrock and earth materials. In addition, appropriate landscaping will be incorporated into the project to reduce the visibility of the wall. In these areas the walls will be vertical and situated only to protect the uppermost bluff above the granite bedrock.

The artificial rock surfaced blufftop seawalls located in the two small areas where the Recreational Trail has been undermined by bluff recession (Esplanade West and Esplanade East) and the seawall in the area where the Trail is on the brink of being undermined (Sea Palm West) is the preferred alternative that will best achieve the project goals and have the minimum impact on the Recreational Trail, the Bikeway, Ocean View Boulevard. This alternative will be effective at protecting the Trail.

At Sea Palm West, the artificial rock surfaced seawall will be sloped to match the contours of the existing bluff, and will abut the existing coastal protection that is present both upcoast and downcoast.

As previously mentioned in Alternative 2, in the area between the Esplanade West and Esplanade East sites, and at the Sea Palm Central and Sea Palm East areas, there is adequate room to relocate the Trail landward and create a safe trail tread alignment without impinging on Ocean View Boulevard.

Various conceptual drawings of the alternatives are illustrated in the drawings included in Appendix C. The conceptual plans are not sufficiently detailed for construction, but should be adequate for the purpose of permit consideration and rough cost estimating.

Alternatives Analysis Conclusion:

In our opinion, Alternative D, the artificial rock surfaced blufftop seawalls located in the two small areas where the Recreational Trail has been undermined by bluff recession (Esplanade West and Esplanade East) and the artificial rock surfaced full bluff height seawall in the area at Sea Palm West are the preferred alternatives that will best achieve the project goals and have the minimum impact on the Recreational Trail, the Bikeway, Ocean View Boulevard. In the locations on either side of the Esplanade East area, and the areas at Sea Palm Central and Sea Palm East there is adequate room to relocate the Trail landward and create a safe trail tread alignment without impinging on the Bikeway and Ocean View Boulevard, therefore that is the preferred alternative there.

Area #1: Esplanade West

The Esplanade West Area is directly seaward of Esplanade Park. The site consists of an approximately 23 foot high coastal bluff, with the top 6 feet being near vertical, then a sloping granite bedrock surface in the middle of the bluff that descends down to the shoreline. The upper 6 feet of bluff has receded landward due to repeated ocean wave impact. The upper portion of the coastal bluff has a nearly vertical slope within the terrace deposits; and the public access path is on the verge of being undermined.

At the top of the bluff is a relatively level uplifted marine terrace where the Recreational Trail and Ocean View Boulevard are located. The Trail has been undermined by erosion and is only 2½ feet wide; immediately bordering the curb of Ocean View Boulevard. The area of concern is about 20 feet wide.

In this area the Trail is subject to episodic erosion damage, whether in a single strong storm, or in a series of storms occurring during 1 to 3 winter seasons, erosion may occur that results in several (3 to 8) feet of bluff retreat.

Below are photographs that show the Esplanade West area:

Figure 14: Eroded Area as seen from Trail Looking Downcoast (Esplanade West)

Figure 15: Esplanade West Eroded Area as seen from Trail Looking Upcoast (Trail is along curb)

Figure 16: Esplanade West Eroded Area as seen from Bedrock Platform Looking Landward (Trail is undermined at rope)

The bluff edge is immediately adjacent to the Recreational Trail, a path which is frequently used. Landward of the path is Ocean View Boulevard, a two lane scenic road, used by residents and coastal visitors. If the bluff is left unsupported, the near-vertical bluff face will erode and the Trail will be undermined which will cut off access along the path.

The recommended alternative is to construct a 20 foot long artificial rock blufftop seawall, 8.5 feet in height as measured from the bottom of the keyway to the top, with 6 to 7.5 feet of wall height exposed. It will be faced with an artificial rock surface to resemble the adjacent natural bedrock outcrops. After this alternative is constructed, the Recreational Trail can be relocated seaward from its present position immediately on the edge of Ocean View Boulevard, providing greater safety for trail users (Appendix D Drawings 1 and 2). This alternative is depicted in Appendix C on Sheets 1, 2 and 3.

Area #2: Esplanade East

The Esplanade East area is about 100 to 180 feet towards Monterey from Esplanade West. The total area of concern is about 75 feet wide. At the beginning of our investigation, this area was divided into two areas called Esplanade East and Esplanade Central. Because these two areas are in such close proximity, and have similar geology, we now refer to them both as Esplanade East.

Esplanade East includes a broad eroded gully approximately 5 to 8 feet wide. The bluff has receded landward due to repeated ocean wave impact that flows up a notch in the bedrock platform. The upper portion of the coastal bluff has a nearly vertical slope within the terrace deposits; and the public access path is being undermined. A sloping bedrock platform extends seaward of this upper bluff face, 6 to 10 feet below the path elevation. Here, the bluff has also receded landward due to repeated ocean wave impact. The upper portion of the coastal bluff has a nearly vertical slope within the terrace deposits; and the public access path is being undermined. A water line has been damaged by erosion and has been patched. A few pieces of rip-rap were placed in the gully during winter 2015 to reduce the rate of erosion. Below are photographs that show the Esplanade East area:

Figure 17: Trail along Bluff Edge at Eroded Area at Esplanade East

**Figure 18: Esplanade East Eroded Areas
as seen from Bedrock Platform Looking Landward**

Figure 19: Esplanade East Eroded Area as seen from Bedrock Platform Looking Landward (Emergency rip-rap boulders below waterline)

At Esplanade East the bluff edge is immediately adjacent to the Recreational Trail, a path which is frequently used by bicyclists and pedestrians. Landward of the path is Ocean View Boulevard, a two lane scenic road, used by residents and coastal visitors. If the bluff is left unsupported, the near-vertical bluff face will erode and the Trail will be undermined which will cut off access along the path. Ocean View Boulevard is presently in danger of erosion. Wave runup has contributed to the damage.

At Esplanade East, the existing trail is crowded immediately against Ocean View Boulevard, which results in safety concerns for Trail users. There is no room to relocate the trail without relocating a portion of Ocean View Boulevard.

One concept we considered is a rip-rap structure which is 34 feet long and is 10.5 feet high. The footprint of the rip-rap is 16 feet wide in a landward-seaward direction. It has two layers of armor rock, with underlayer rock below that. The total volume of the structure is about 120 cubic yards which represents about 150 tons of rip-rap.

The recommended alternative is to construct a 33 foot long artificial rock blufftop seawall, 10.5 to 11 feet in height as measured from the bottom of the keyway to the top, with 8.5 to 9.5 feet of wall height exposed. It will be faced with an artificial rock surface to resemble the adjacent natural bedrock outcrops. When this alternative is constructed, the Recreational Trail can be relocated seaward from its present position immediately on the edge of Ocean View Boulevard, providing greater safety for trail users (Appendix D Drawings 1 and 2). This alternative is depicted in Appendix C. on Sheets 4, 5 and 6.

Area #3: Locations on Either Side of Esplanade East

The Trail is threatened in the locations on either side of Esplanade East, where it is located immediately adjacent to the bluff edge. In these areas (pictured below) there is adequate room to relocate the trail inland away from the coastal bluff edge. A drawing of the proposed relocations are shown in Appendix D Drawings 1, 2 and 3.

Figure 21: Photo of Location Downcoast of Esplanade East Where the Trail is now at the Edge of Bluff And Trail Relocation is Feasible View Looking Downcoast

Figure 22: Photo of Location Downcoast of Esplanade East Where the Trail is now at the Edge of Bluff And Trail Relocation is Feasible View from Bedrock Platform Looking Landward

**Figure 23: Photo of Location Upcoast of Esplanade East
Where the Trail is now at the Edge of Bluff
And Trail Relocation is Feasible
View Looking Upcoast**

**Figure 24: Photo of Location Upcoast of Esplanade East
Where the Trail is now at the Edge of Bluff
And Trail Relocation is Feasible
View Looking Downcoast**

**Figure 25: Photo of Location Upcoast of Esplanade East
Where the Trail is now at the Edge of Bluff
And Trail Relocation is Feasible
View from Bedrock Platform Showing Geology**

Area #4: Sea Palm West

The Sea Palm West Area is immediately adjacent to the beach access stairs at Sea Palm Park. At Sea Palm West the bluff has receded landward due to repeated ocean wave impact. Both the areas immediately upcoast and downcoast of the Sea Palm West Area are armored. At the top of the bluff, the public access path is on the verge of being undermined. The bluff extends down to the back edge of the beach. The area upcoast (toward Monterey) was protected with an artificial rock seawall in 2007; at the same time, the beach access stairs were supported with artificial rock where they were undermined. The area of concern is about 30 feet wide. Below are photographs that show the Sea Palm West area:

Figure 26: Sea Palm West Eroded Area as seen from Perkins Park Beach Stairs

Figure 27: Sea Palm West Eroded Area as seen from Beach

Figure 28: Sea Palm West Eroded Area as seen from Trail Edge (Green Vegetation Covers Eroding Soil)

At Sea Palm West, the bluff edge is immediately adjacent to the Recreational Trail, a path which is frequently used by bicyclists and pedestrians. Landward of the path is Ocean View Boulevard, a two lane scenic road, used by residents and coastal visitors. If the bluff is left unsupported, the near-vertical bluff face will erode or fail as a result of mass instability (landsliding) and the Trail will be undermined, which will cut off access along the path. Ocean View Boulevard is presently in danger of erosion. Wave runup has contributed to the damage. There is no room to relocate the trail without relocating Ocean View Boulevard. The seaward edge of the trail is supported on topsoil and fill several feet deep.

One concept we considered was a rip-rap structure which is 45 feet long and is 24 feet high. The footprint of such a rip-rap would be at least 36 feet wide in a landward-seaward direction. This concept was rejected because it would extend 15 to 20 feet out onto the Perkins Park beach, which would result in a very undesirable loss of beach area. We have not drawn this alternative.

The recommended alternative is to construct a 33 foot long artificial rock seawall, 18 feet in height as measured from the bottom of the keyway to the top, with 16 feet of wall height exposed. It will be faced with an artificial rock surface to resemble the adjacent natural bedrock outcrops. It could be founded landward of the inland edge of the beach to minimize impact to beach users. This tied back wall would provide structural stability to the Recreational Trail, and would infill the gap between the Perkins Park beach stairs and the artificial rock surfaced seawall immediately upcoast. This alternative is depicted in Appendix C on Sheets 7 and 8.

Area #5: Sea Palm Central

The Sea Palm Central area is about 270 feet towards Monterey from the Sea Palm Park beach stairs. At the Sea Palm Central Area the bluff has receded landward due to repeated ocean wave impact. At the top of the bluff, the public access path is on the verge of being undermined. The bluff has receded landward due to repeated ocean wave impact that flows up a cobble beach and impacts the bluff. The upper portion of the coastal bluff has a very steep slope within the terrace deposits; and the public access path is being undermined. Some bedrock is exposed in the lower portion of the bluff face. The bluff extends down to the back edge of the beach. The area of concern is about 30 feet wide. Below are photographs that show the Sea Palm Central area:

Figure 29: Sea Palm Central Eroded Area as seen from Trail

Figure 30: Sea Palm Central Eroded Area as seen from Beach

Figure 31: Existing Trail and Ocean View Boulevard at Sea Palm Central

Discussion of Alternatives:

At Sea Palm Central, the Recreational Trail is presently in danger from erosion, however Ocean View Boulevard is not in danger. It appears feasible to realign the trail since the bluff edge is approximately 28 feet from the adjacent roadway and there is ample room to do so, as shown in Figure 31. This alternative is depicted in Appendix C on Sheets 9 and 10.

A second alternative is to construct a 20 foot long artificial rock seawall, 20 feet in height as measured from the bottom of the keyway to the top, with 18 feet of wall height exposed. It could be faced with an artificial rock surface to resemble the adjacent natural bedrock outcrops. It could be founded at the inland edge of the beach to minimize impact to beach users. This alternative is depicted in Appendix C. Eventually, bluff recession will undermine the relocated trail, however relocation will buy time and allow public access preservation for an estimated 20 to 30 years or more.

Area #6: Sea Palm East

The Sea Palm East area is about 445 feet towards Monterey from the Sea Palm Park beach stairs. At the Sea Palm East Area the bluff has receded landward due to repeated ocean wave impact. At the top of the bluff, the public access path is undermined. A failing short wooden retaining wall supports the trail. The bluff extends down to the back edge of the beach. The bluff has receded landward due to repeated ocean wave impact that flows up a cobble beach and impacts the bluff. The upper portion of the coastal bluff has a very steep slope within the terrace deposits; and the public access path is undermined. Bedrock is exposed in the lower portion of the bluff face, where a broad bedrock platform is present. The area of concern is about 15 feet wide.

Below are photographs that show the Sea Palm East area:

Figure 32: Sea Palm East Eroded Area as seen from Trail

Figure 33: Sea Palm East Eroded Area as seen from Beach

Figure 34: Existing Trail and Ocean View Boulevard at Sea Palm East

Discussion of Alternatives:

At Sea Palm East the Recreational Trail is presently in danger from erosion, however Ocean View Boulevard is not in danger. It appears feasible to realign the trail since the bluff edge is approximately 38 feet from the adjacent roadway and there is ample room to do so, as shown in Figure 34. This alternative is depicted in Appendix C on Sheets 11 and 12. Eventually, bluff recession will undermine the relocated trail, however relocation will buy time and allow public access preservation for an estimated 20 to 30 years or more.

A second alternative is to construct a 20 foot long artificial rock seawall, 20 feet in height as measured from the bottom of the keyway to the top, with 18 feet of wall height exposed. It could be faced with an artificial rock surface to resemble the adjacent natural bedrock outcrops. This coastal protection structure could be founded on the bedrock platform above beach elevation, to eliminate impact to beach users. This alternative is depicted in Appendix C on Sheets 11A and 12A.

CONCLUSIONS

1) At the five sites we studied, the coastal bluff adjacent to the Recreational Trail is eroding and the bluff edge is retreating landward.

2) The upper bluff consists of topsoil and highly erodible marine terrace deposits. Less erodible granite bedrock exists below the marine terrace deposits. At depth the granite is less weathered and very erosion resistant

3) The Recreational Trail is threatened and may be undermined in the vicinity of the study areas during the next three winters (2016/17 thru 2018/9) if nothing is done.

4) At the Esplanade sites, Ocean View Boulevard itself will be undermined within the next couple decades if nothing is done, and is at risk of undermining in the next couple of years.

5) The bedrock at the sites is adequate to support a retaining structure or seawall to protect the bluff.

6) Two types of coastal protection structures may be feasible to retain the upper bluff, protect the Recreational Trail from erosion and undermining, and protect public access:

    A) Rip-rap buttress (Esplanade West). This is not recommended.

    B) Vertical concrete seawalls (Esplanade West, Esplanade East and Sea Palm East). At The Esplanade areas, the seawalls would be at the upper portion of the bluff.

7) Full bluff height seawalls are feasible to retain the upper bluff, protect the Recreational Trail from erosion and undermining, and protect public access at Sea Palm West. At Sea Palm Central a full bluff height seawall may be feasible but is not recommended.

8) Relocation of the recreational trail is a feasible method of preserving access at Sea Palm Central, Sea Palm East, and on either side of Esplanade East.

9) Based on the results of our investigation, the proposed project, as outlined herein appears compatible with the site, provided the following recommendations are incorporated into the design and construction of the proposed project.

RECOMMENDATIONS

General

1) At Esplanade East, Esplanade West and Sea Palm West, to reduce the potential for continued or future damage to the Recreational Trail resulting from future erosion and failure of the bluff, and to preserve public access, the bluff at these sites should be buttressed by a retaining structure/seawall. At the Esplanade sites, the retaining structure/seawall only needs to protect the uppermost portion of the bluff from erosion. At Sea Palm West, the retaining structure/seawall should be founded on bedrock at the base of the bluff to protect the entire bluff from erosion.

2) At Sea Palm Central and Sea Palm East, to reduce the potential for continued or future damage to the Recreational Trail resulting from future erosion and failure of the bluff , the Recreational Trail should be relocated inland a minimum of 8 feet from the bluff edge.

3) In the locations on either side of Esplanade East, to reduce the potential for continued damage to the Recreational Trail resulting from near future erosion and failure of the bluff, the Recreational Trail should be relocated inland a minimum of 3 feet from the bluff edge. This lesser setback is based on the short height of the portion of the bluff face composed of terrace deposits and topsoil in this area, which results in the bluff being more stable in this location; and the ability to further

evaluate this area in the future to assess whether more costly coastal bluff protection is required.

4) We recommend this work be done as quickly as possible to prevent the Recreational Trail from becoming damaged and unsafe to utilize.

The following recommendations should be used as guidelines for preparing project plans and specifications:

Site Grading

1. The geotechnical engineer should be notified at least four (4) working days prior to any site clearing or grading so that the work in the field can be coordinated with the grading contractor, construction staking can be arranged and arrangements for testing and observation can be made. The recommendations of this report are based on the assumption that the geotechnical engineer will perform the required testing and observation during grading and construction. It is the owner's responsibility to make the necessary arrangements for these required services.

2. Where referenced in this report, Percent Relative Compaction and Optimum Moisture Content shall be based on ASTM Test Designation D1557-00.

3. Areas to be graded should be cleared of all obstructions including loose fill, surface vegetation, trees and bushes not designated to remain, or other unsuitable material. Existing depressions or voids created during site clearing should be backfilled with engineered fill.

4. Areas to receive engineered fill should be scarified to a depth of 6 inches, moisture conditioned, and compacted to at least 90 percent relative compaction. Portions of the site may need to be moisture conditioned to achieve a suitable moisture content for compaction. These areas may then be brought to design grade with engineered fill.

5. Engineered fill should be placed in thin lifts not exceeding 8 inches in loose thickness, moisture conditioned or dried back to a moisture content 2 to 4 percent over optimum, and compacted to at least 90 percent relative compaction.

6. If grading is performed during or shortly after the rainy season, the grading contractor may encounter compaction difficulty, such as pumping or bringing free water to the surface, in the upper surface clayey and silty sands. If compaction cannot be achieved after adjusting the soil moisture content, it may be necessary to over-excavate the subgrade soil and replace it with compacted aggregate baserock to stabilize the subgrade.

7. Fills should be keyed and benched into firm soil or bedrock in areas where existing slope gradients exceed 6:1 (horizontal to vertical). Subdrains will be required in areas where keyways or benches expose potential seepage zones.

8. The on-site soils generally appear suitable for use as engineered fill. Materials used for engineered fill should be free of organic material, and contain no rocks or clods greater than 6 inches in diameter, with no more than 15 percent larger than 4 inches.

9. We estimate shrinkage factors of about 15 percent for the on-site materials when used in engineered fills.

10. All permanent fill slopes should be inclined no steeper than 2:1 (horizontal to vertical).

11. Following grading, all exposed slopes should be planted as soon as possible with erosion resistant vegetation.

12. After the earthwork operations have been completed and the geotechnical engineer has finished his observation of the work, no further earthwork operations shall be performed except with the approval of and under the observation of the geotechnical engineer.

Cut and Fill Slopes

13. Temporary excavations should laid back to a safe slope gradient or be properly shored and braced during construction to prevent sloughing and caving at sidewalls. The contractor should be aware of all CAL OSHA and local safety requirements and codes dealing with excavations and trenches.

14. If sea walls are chosen as the mitigation vertical cut slopes on the order of 4 to 5 feet tall will be required. The cut slopes are expected to be excavated primarily into granite bedrock and would be able to stand vertical at the estimated heights without the use of shoring. Taller excavations or those made into coastal terrace should be laid back to safe slope gradients or properly shored.

15. It should be anticipated that perched ground water will be actively seeping from the face of the coastal bluff and or cut slopes excavated into the coastal terrace deposits. The thickness of the seepage layer will depend upon the time of year the excavation is made. Designers and contractors should plan accordingly.

16. Temporary cut slopes excavated into the coastal terrace deposits should be inclined at a slope gradient of 1:1 (H:V) or flatter where no seepage is observed from face of cut slope and 2:1 (H:V) or flatter where seepage is observed. Depending on the amount of seepage from the face of the cut slope shoring may be required. Vertical cut slopes

excavated into the coastal terrace should be shored. Granite bedrock can be cut vertical without shoring. Temporary cut slopes excavated for the project are considered those that are to remain from 24 hours up to the start of the rain season. For estimating lateral shoring pressures use the values summarized in Table 1 of this report.

17. There should be a minimum of 10 feet horizontal separation between the top of supporting bedrock for the sea wall keyway and the face of slope.

18. Following grading, exposed soil should be planted as soon as possible with erosion-resistant vegetation.

19. After the earthwork operations have been completed and HKA has made the required observations of the work, no further earthwork operations shall be performed without the direct observation of HKA.

Potential Scour Mitigation

20. The base or toe of the tied back seawall should be keyed into the bedrock as directed by the Engineer during construction. The wall keyway system should also extend at least one and a half feet below any undulations of the top of the bedrock platform as measured within 4 feet of the seaward perimeter of the seawall system, or to the depths shown on the plans, as directed by the Engineer during construction. The project

Geotechnical Engineer or Engineering Geologist should observe the bedrock platform seaward of the toe of the retaining wall system after the terrace deposits have been excavated and removed and make any necessary recommendations to deepen the keyway of the wall system to mitigate premature undermining of the wall due to localized weakness and erosion of the bedrock platform.

The wing walls at the ends of the walls should be embedded at least 4 feet laterally into the terrace deposits to stall outflanking of the blufftop retaining wall. The ends of the wall shall be configured to conform to the adjacent natural bluff face. Disturbance of the areas beyond the ends of the wall shall be avoided.

A regular inspection and maintenance schedule should be established after the seawalls are constructed to monitor scour of the bedrock at the base of the seawalls over time. If significant scour occurs, maintenance should be performed by filling any voids that are discovered with concrete grout.

Ease of Excavation For Retaining Wall/Seawall Foundations

21. Excavation ease in the granitic rock at the base of the proposed wall may be typically classified as follows:

Moderate: 1 to 2 feet below surface

Backhoe, jackhammer blade

Moderate to difficult: 2 to 6 feet below surface

Excavator, jackhammer blade

We estimate the upper 3 feet of the granite formation to be rippable using conventional construction methods. Non-conventional construction methods may need to be employed below a depth of 3 feet. Occasional thin layers of very hard granitic rock may be encountered at the project site.

Foundations – Retaining Walls/Seawalls

22. The proposed retaining wall/seawall foundation zone should be cleared of existing topsoil, terrace deposits and debris, and cleaned of sand and small rock to expose the bedrock surface irregularities in order to maximize the mechanical bonding of the wall foundation to the adjacent and underlying bedrock. The toe of the wall should be embedded at least 18 inches into the bedrock.

The foundation of the tied-back retaining walls/seawalls should be keyed into the bedrock as directed by the Engineer during construction. Prior to placement of reinforcing steel or formwork, the project Geotechnical Engineer or Engineering Geologist should observe the bedrock platform seaward of the toe of the seawall system after the keyway has been excavated and make any necessary recommendations to deepen the seaward perimeter in the seawall system to mitigate premature undermining of the seawall due to localized scour of the bedrock platform.

Retaining Walls/Seawalls - Design Criteria

23. A structural shotcrete, tied back wall with artificial rock facing is recommended to prevent or reduce undermining of the recreation trail. The following criteria should be used for design of this type of system.

24. The walls at the project site will be subject to overtopping and should be designed for saturated unit weight backfill conditions. If a well-constructed retaining wall backdrain is installed, partially saturated conditions can be assumed by the designer. The backdrain should be equipped with multiple discharge outlets in the event of plugging. Passive pressure along the seaward face of the footing should be neglected in the design of the walls.

25. The tied back upper bluff face retaining wall should be designed for a restrained (rectangular) loading condition. For restrained type sea wall /retaining walls (rectangular loading condition) use the following design table specific to each of the 5 project sites:

Table 1: Lateral Earth Pressure Design Values for Saturated and Partially Saturated Backfill Conditions

Project Location	Partially Saturated Condition EFW (PSF)	Saturated Condition EFW (PSF)
Esplanade West	32H	60H
Esplanade East	35H	63H
Sea Palm West	41H	69H
Sea Palm Central	39H	67H
Sea Palm East	28H	56H

26. The tied back seawalls and the upper bluff face retaining wall system wall should be designed to include a seismic surcharge. To account for seismic earth pressure add 10H PSF per foot of wall height, in addition to the aforementioned active earth pressures in Table 1, where H is the sea wall/retaining wall height.

27. For seawall and retaining wall foundation elements embedded at least 18 inches into granitic bedrock, a bearing capacity of 10 ksf may be used.

28. For design of the erosion control buttress and the upper bluff face cantilever retaining wall, a coefficient of friction against sliding of rough concrete on granitic bedrock (μ) = 0.6 may be used. Lateral resistance is limited to sliding friction as no passive pressure is granted for the granite bedrock at the seaward face of the foundation excavations.

29. The wall keyway system should also extend at least 18 inches below the bottom of any undulations of the top of the bedrock platform as measured within 4 feet of the seaward perimeter of the seawall system, or to the depths shown on the plans, as directed by the Engineer during construction.

30. The wing walls at the ends of the seawall should be embedded at least 4 feet laterally into the terrace deposits to stall outflanking of the wall. At the ends of the wall the face of the wall shall be flush with the face of the adjacent natural bluff face. Disturbance of the areas beyond the ends of the upper wall shall be avoided.

Tieback Anchor Criteria

31. Tieback anchor criteria:

   A. Tiebacks may only be bonded in the granitic bedrock including the weathered zone;

   B. Small diameter, non-pressure grouted, drilled anchors may be used for development of project design specifications. Secondary grouting of anchors is a recommended quality control practice for post tensioned anchors;

   C. Minimum inclination below horizontal plane = 14º (4H:1V);

   D. Maximum inclination below horizontal plane = 26.5º (2H:1V);

E. Allowable or working shaft bond friction for drilled anchors:

Terrace deposits – None

Weathered Granitic bedrock – 25 psi,

Granitic bedrock – 62 psi,

F. Minimum bond length:

Bonding in hard granite bedrock = 5 feet; bonding in weathered granite is permitted so long as it is done in conjunction with bond into hard granite bedrock.

G. Minimum spacing between grouted anchors without special provisions such as simultaneous testing of adjacent anchors:

Spacing Between Anchors = 6 feet;

H. Unbonded length of tieback tendon:

10 feet minimum

I. All tiebacks should be protected from corrosion for a 50 year minimum service life in accordance to the manufacturer's specifications;

J. Minimum concrete cover on reinforcing:

6 inches - front of walls (provided corrosion inhibitors are used in the concrete mix);

6 inches - back of walls without waterproofing

4 inches - back of walls with waterproofing

K. Fifty percent of the tiebacks must be tested by the contractor in the presence of the Geotechnical Engineer to 125 percent of their total design loads, in conformance to the proof test requirements of the latest edition of the Post Tensioning Institute Recommendations for Pre-stressed Soil and Rock Anchors. Any tiebacks that fail during testing must be replaced and retested at the expense of the contractor. At the discretion of the Geotechnical Engineer, additional tiebacks shall be proof tested. All tiebacks shall be tied off at 80% of their static design loads.

Tie backs should be designed using the following table;

Table 2: Grouted Tie-Back Anchor Design Criteria

Project Location	Unbonded Length (ft)	Bonded Length (ft) Top/Bottom (Row)	Bond Stress (psi) Top/Bottom (Row)
Esplanade West	10	5	62
Esplanade East	10	5	62
Sea Palm West	12	8/5	25/62
Sea Palm Central	10	6/5	25/62
Sea Palm East	N/A	N/A	N/A

Site Drainage

32. Thorough control of runoff is essential. Terrestrial drainage may contribute to future erosion and cause Trail damage, unless controlled.

33. Surface drainage should include provisions for positive gradients so that surface runoff is not permitted to pond adjacent to the top of the coastal bluffs. Surface drainage should be directed away from sensitive areas along the bluff top edge towards appropriate storm drain facilities where possible.

34. The migration of water or spread of extensive root systems behind the seawalls may cause undesirable differential movements. Landscaping should be planned accordingly.

35. Depending on the time of the year, perched water may be encountered above the terrace deposit and bedrock contact. Provisions should be made to allow this water to seep away from the construction area.

Design Life and Maintenance Requirements

36. The retaining wall /seawall systems must be monitored regularly by a geotechnical engineer or engineering geologist and repaired as needed. As with all retaining walls and seawalls, the wall ends should be inspected for outflanking, the seaward perimeter of the walls should be inspected for undermining, and the structural concrete or shotcrete should be inspected for evidence of corrosion.

Anticipated future maintenance of the proposed wall systems includes:

- Repair of bluff face wall ends as the un-retained, adjacent bluff faces continue to recede. Wing walls or re-entrant wall ends may need to be constructed or extended into the bluff face;
- Repair of wall as the bedrock platform below it is eroded by wave action. The wall foundation may need to be extended downward towards the bluff toe;

37. The seawalls and bluff face retaining walls should be inspected on a yearly basis and if significant abrasive wear, opening of cold joints or concrete cracks appear; or if rust stains occur on their face, or the structure becomes undermined at its base, then the Coastal Engineer should be alerted. The tieback anchors should be double corrosion protected. If significant wear or cracking occurs that jeopardizes the structural section of the wall or exposes the epoxy covered rebar, these areas should be patched with colored shotcrete or mortar to match the existing wall surface. If the surface of the wall becomes damaged due to impact or some other unforeseen occurrence, a reinforced concrete mat can be tied into the seawall face with epoxy rebar ties and covered with shotcrete or facing stone to re-establish the original structural section of the structure. If and when and where undermining occurs, a vertical wall should be extended downward from the base of the wall that penetrates deep into the bedrock and is tied to the base of the existing wall to repair the undermined area.

Plan Review, Construction Observation and Testing

38. The recommendations presented in this report are contingent upon:

    A. Our observation and, where necessary, testing of the earthwork, foundation excavations and construction of the retaining walls.

    B. Our geotechnical and coastal engineering recommendations being properly interpreted and implemented in the retaining wall plans.

    C. Our observation of the project site activities, including: earthwork, specifically the clearing of the bedrock, keyway and wing wall construction; foundation excavations; tieback anchor installation/testing; and retaining wall systems construction. This observation allows anticipated soil and bedrock conditions to be correlated to those actually encountered in the field during construction. Because unanticipated or hidden conditions are sometimes encountered, we should be retained to provide construction observation services. We anticipate that special inspection and /or testing will be necessary for the tieback anchors, as well as the concrete and shotcrete utilized for the project.

Revetment Specifications

If selected for construction, in order to construct a rip-rap revetment it will be necessary to place Filter Fabric, Underlayer Rock and Armor Rock. The revetment must consist of a layered structured that will form a compact mass in place. Rock shall be placed by equipment suitable for handling material of the sizes required. The armor rock shall be placed a minimum of two layers thick. Suitable equipment shall be used to carefully place the rock. Armor rocks shall not be dropped onto exposed filter fabric. Fill shall be placed as required to provide uniform support for the filter fabric and overlying layers of rock. Fill and backfill shall be soil, sand, rock and/or rubble predominantly less than 25 lbs. in size and free from organic matter and building debris. Fill material shall have no individual pieces larger than 8 inches.

To the extent practicable, the larger rocks shall be placed in the keyway and lower section of the outer layer of facing of armor rock. Rocks facing the toe shall be as nearly cubical as possible with the least dimension of any rock being not less than one-third its greatest dimension. The armor rock and smaller stone shall be underlain with a plastic filter cloth, Tencate 500X or approved equal. The cloth shall contain stabilizers or inhibitors to prevent deterioration of the fabric due to ultraviolet light or heat exposure. The fabric shall be free of tension, stress, folds, wrinkles or creases.

Rip-rap rock shall be approved material that is hard, durable, sound, free from lamination, cleavage planes, and be of such type that will not break during handling, or disintegrate in salt air or salt water. Quarrystones shall be angular quarried material, free from building debris, soil, metal, refuse, organic material and coatings. Individual quarrystones shall have the least dimension greater than one-third the greatest dimension. The Contractor shall designate the source quarries and accompany the Engineer on an inspection of same. Quarrystones shall be subject to testing and approval or rejection at the job site regardless of prior quarry acceptance testing or approval. Rock which is delivered to the job site, which does not meet the specifications for quality or size, shall not be paid for. If any given load of rock contains more than five percent non-conforming material, the entire load shall be rejected. Individual pieces in any load may be rejected.

Construction Observation and Testing

39. The recommendations presented in this report are contingent upon our observation and, where necessary, testing of the earthwork, foundation excavations and construction of the seawall repair systems. Observation of the earthwork and foundation excavations allows anticipated site conditions to be correlated to those actually encountered in the field during construction.

LIMITATIONS AND UNIFORMITY OF CONDITIONS

1. Our work is based on presently accepted geotechnical and coastal engineering practices and standards; our conclusions do not imply that the site is free from geologic hazards or that the site will not be subject to coastal erosion, ground failure, or inundation.

2. The recommendations of this report are based upon the assumption that the soil conditions do not deviate from those disclosed in the borings. If any variations or undesirable conditions are encountered during construction, or if the proposed construction will differ from that planned at the time, our firm should be notified so that supplemental recommendations can be given.

3. This report is issued with the understanding that it is the responsibility of the owner, or his representative, to ensure that the information and recommendations contained herein are called to the attention of the Architects and Engineers for the project and incorporated into the plans, and that the necessary steps are taken to ensure that the Contractors and Subcontractors carry out such recommendations in the field. The conclusions and recommendations contained herein are professional opinions derived in accordance with current standards of professional practice. No other warranty expressed or implied is made.

4. The findings of this report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they be due to natural processes or to the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated, wholly or partially, by changes outside our control. Therefore, this report should not be relied upon after a period of three years without being reviewed by a geotechnical engineer and engineering geologist.

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Esplanade 1987
Esplanade 2013

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Oblique Aerial Photography
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Coastal Bluff Protection Analysis Site Maps and Cross Sections
(Twenty 11 by 17 Sheets)

APPENDIX D
Relocated Trail Map and Cross Sections
Locations on Either Side of Esplanade East and at Esplanade West
(Six 11 by 17 Sheets)

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APPENDIX F
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Figure 9 through 14 -- Direct Shear Test Results

Project No. M10997
20 December 2016

APPENDIX A

Esplanade 1972 Oblique Aerial Photograph

Esplanade 1987 Oblique Aerial Photograph

Esplanade 2013 Oblique Aerial Photograph

(All courtesy of www.californiacoastline.org)

Esplanade 1972 Oblique Aerial Photograph
(courtesy of www.californiacoastline.org)

Esplanade 1987Oblique Aerial Photograph
(courtesy of www.californiacoastline.org)

Project No. M10997
20 December 2016

Esplanade 2013 Oblique Aerial Photograph
(courtesy of www.californiacoastline.org)

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20 December 2016

APPENDIX B

Sea Palm 1972 Oblique Aerial Photograph

Sea Palm 1987 Oblique Aerial Photograph

Sea Palm 2015 Oblique Aerial Photograph

(All courtesy of www.californiacoastline.org)

Project No. M10997
20 December 2016

Sea Palm 1972 Oblique Aerial Photograph
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Sea Palm 2015 Oblique Aerial Photograph
(courtesy of www.californiacoastline.org)

Project No. M10997
20 December 2016

APPENDIX C

Coastal Bluff Protection Analysis Site Maps and Cross Sections
(Twenty 11 by 17 Sheets)

PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

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BLUFFTOP SEAWALL
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BLUFFTOP SEAWALL

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SHEET 9 - SEA PALM CENTRAL ALTERNATIVE 1 SITE MAP
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SHEET 10 - SEA PALM CENTRAL ALTERNATIVE 1 CROSS SECTION
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PROPOSED SEAWALL
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RELOCATED RECREATIONAL TRAIL
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PROPOSED SEAWALL
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PROPOSED SEAWALL

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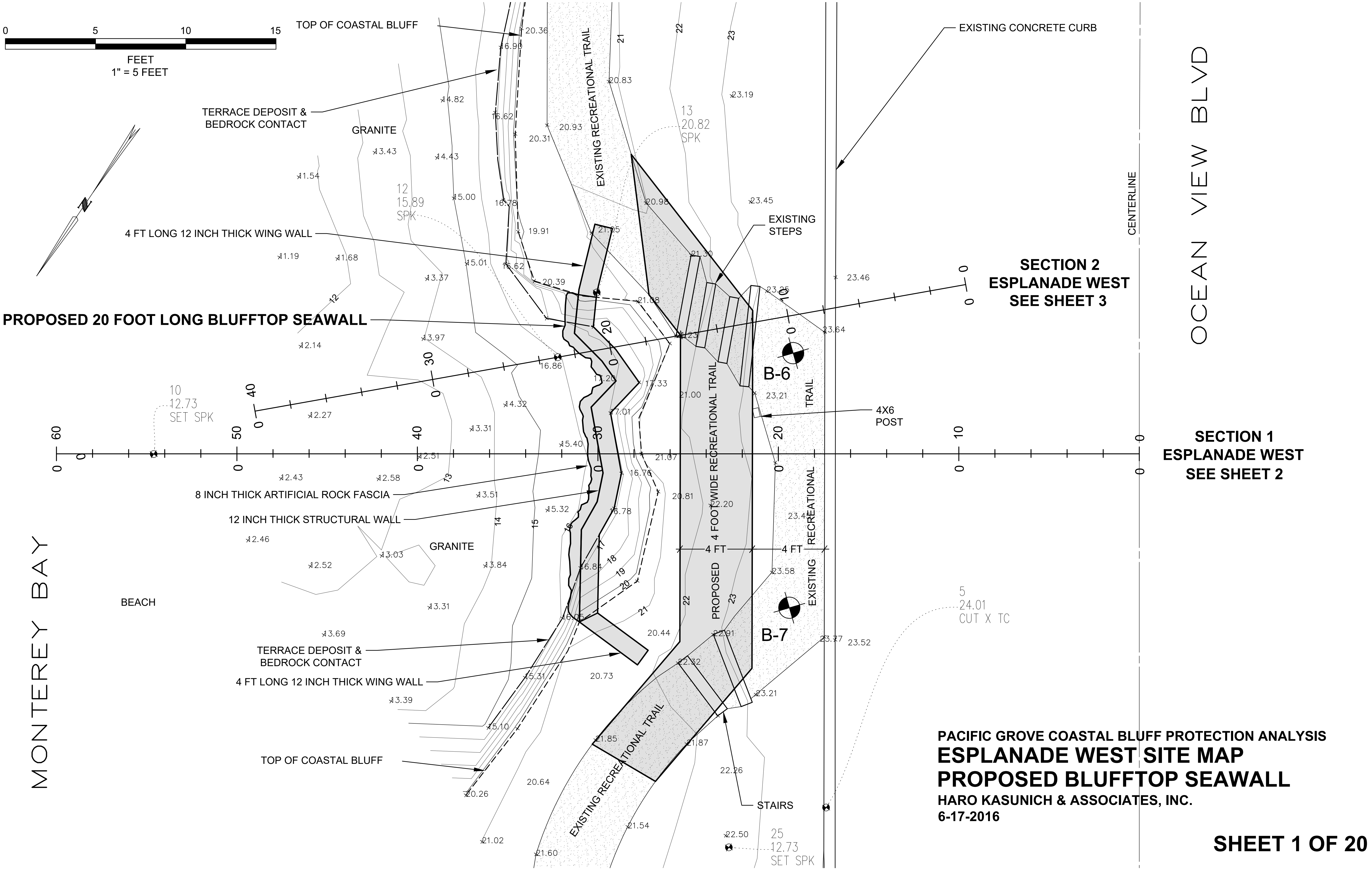
TITLE SHEET



PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

ESPLANADE WEST SITE MAP

PROPOSED BLUFFTOP SEAWALL

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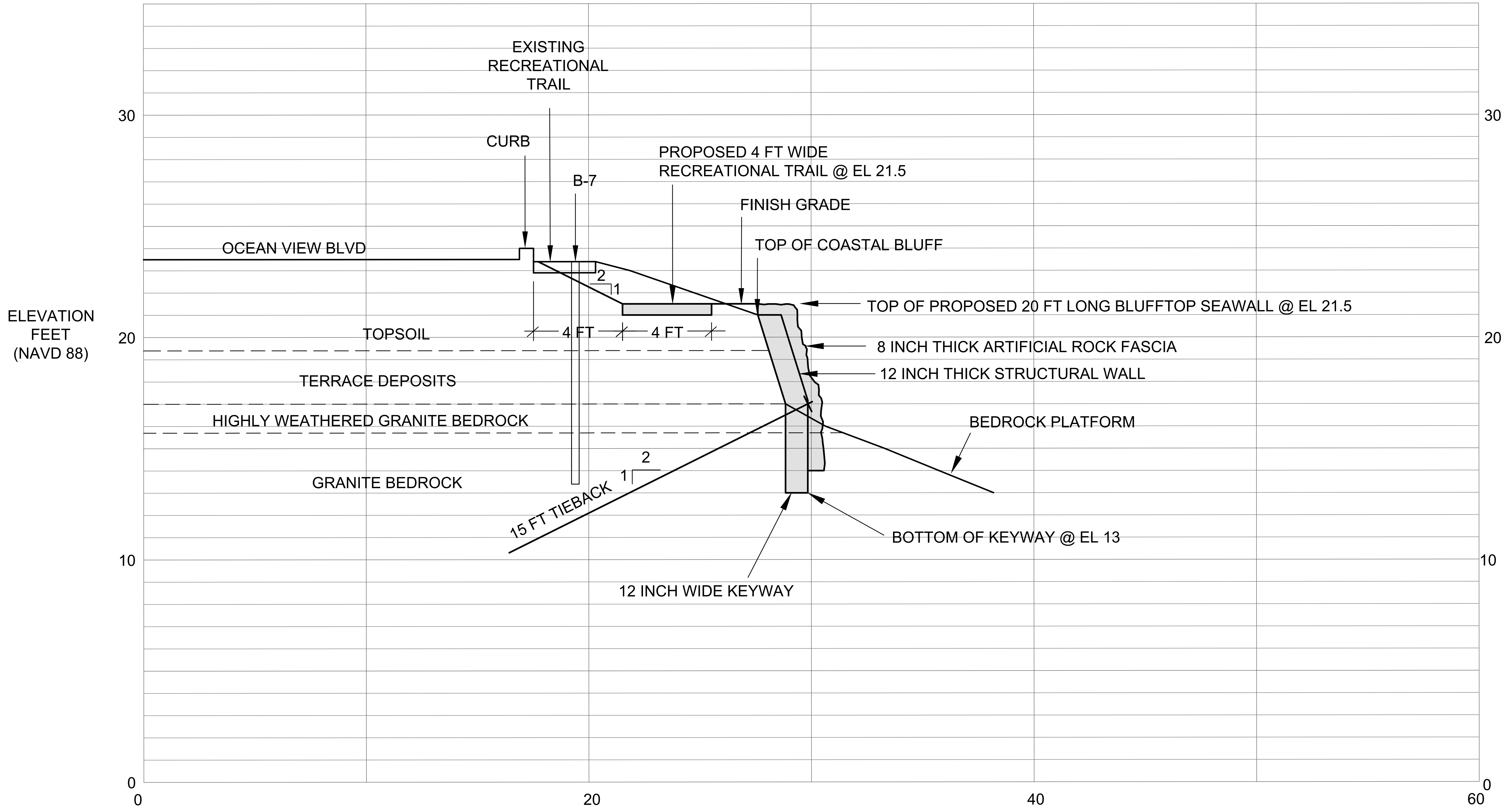
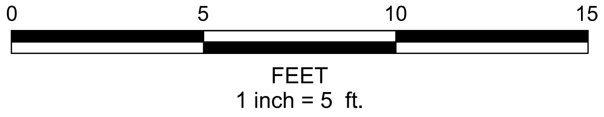
SHEET 1 OF 20





PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

ESPLANADE WEST CROSS SECTION 1
PROPOSED BLUFFTOP SEAWALL

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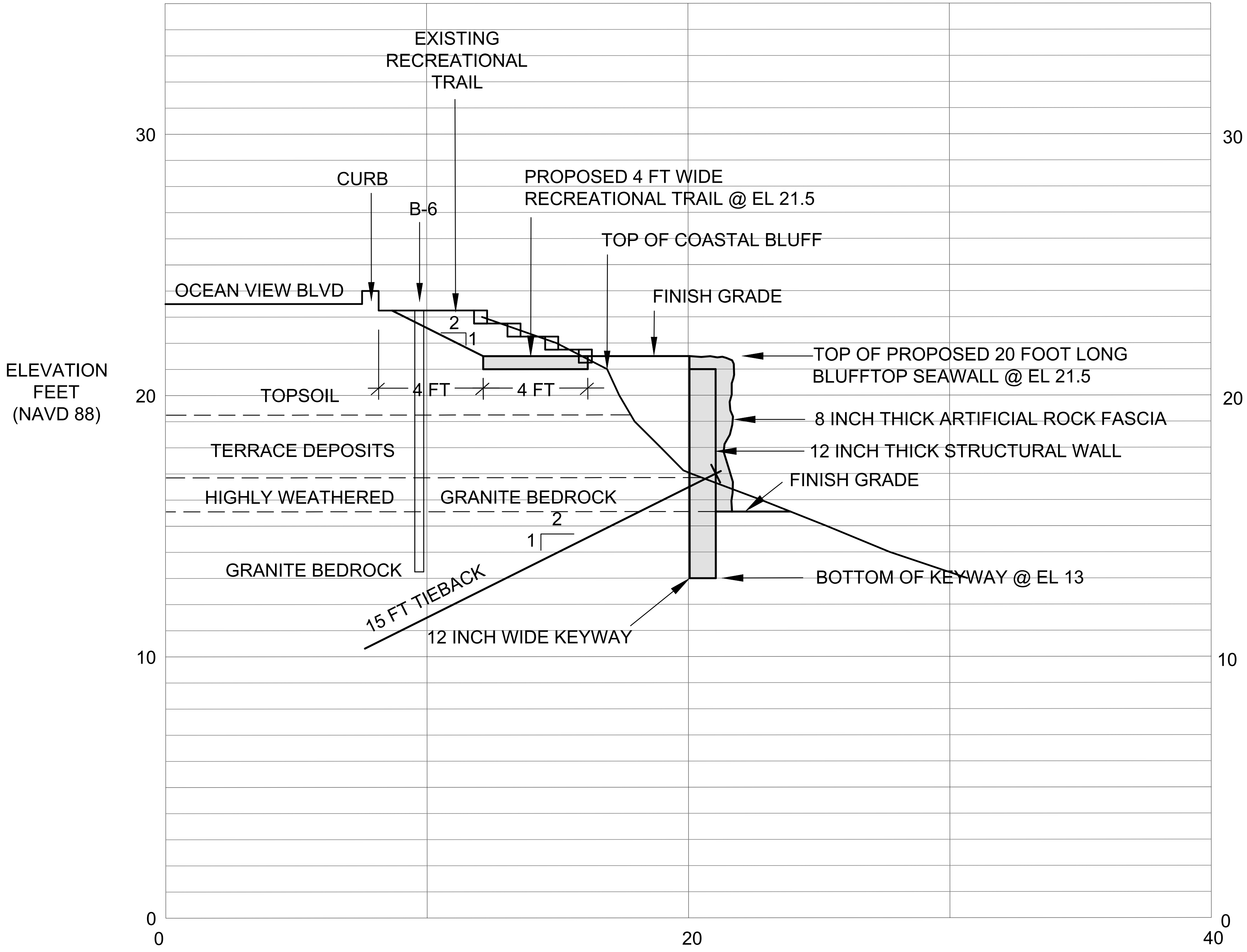

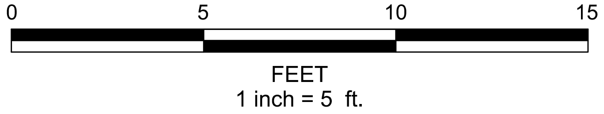

PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

ESPLANADE WEST CROSS SECTION 2
PROPOSED BLUFFTOP SEAWALL

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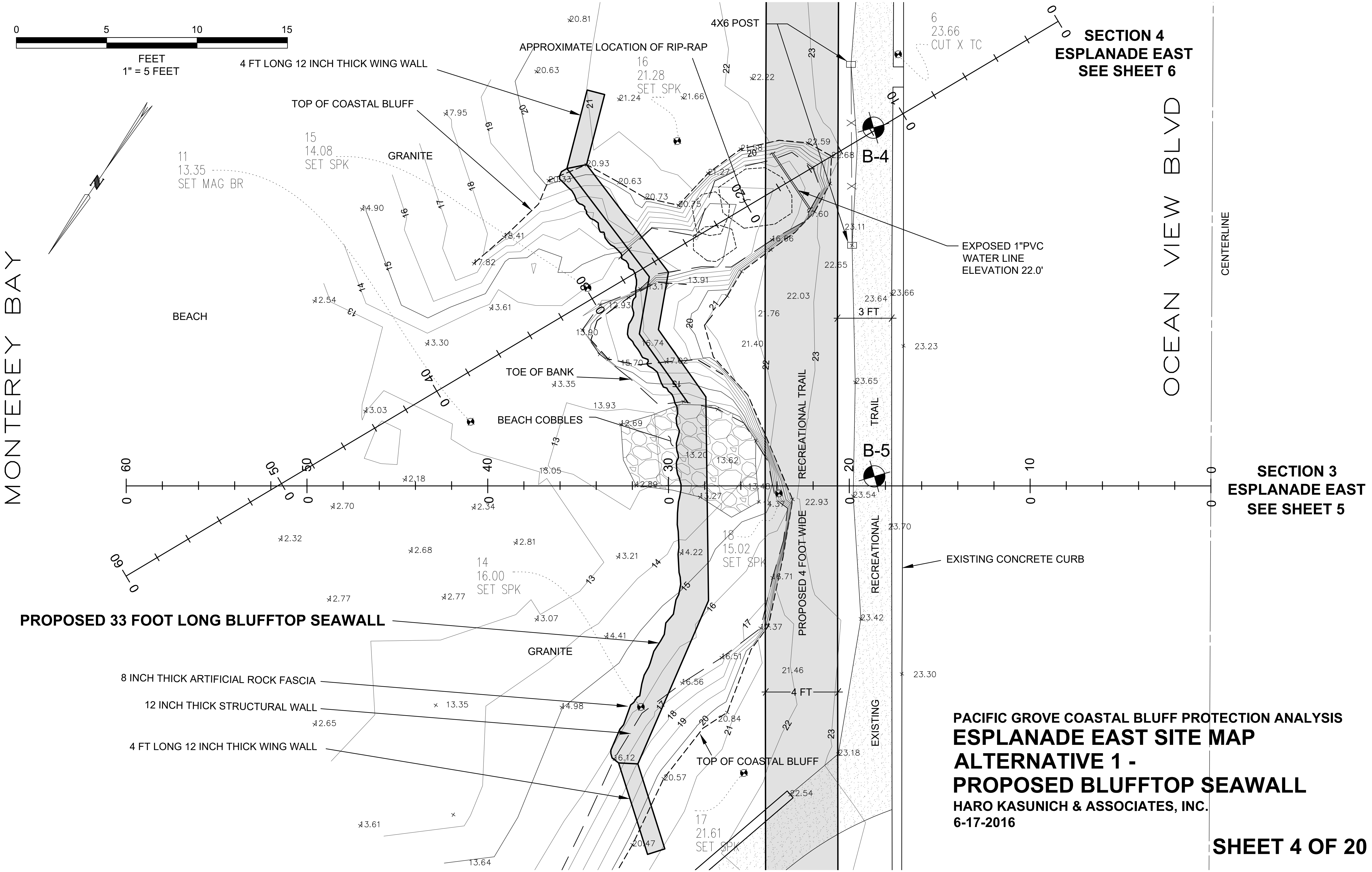

PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

ESPLANADE EAST SITE MAP
ALTERNATIVE 1 -
PROPOSED BLUFFTOP SEAWALL

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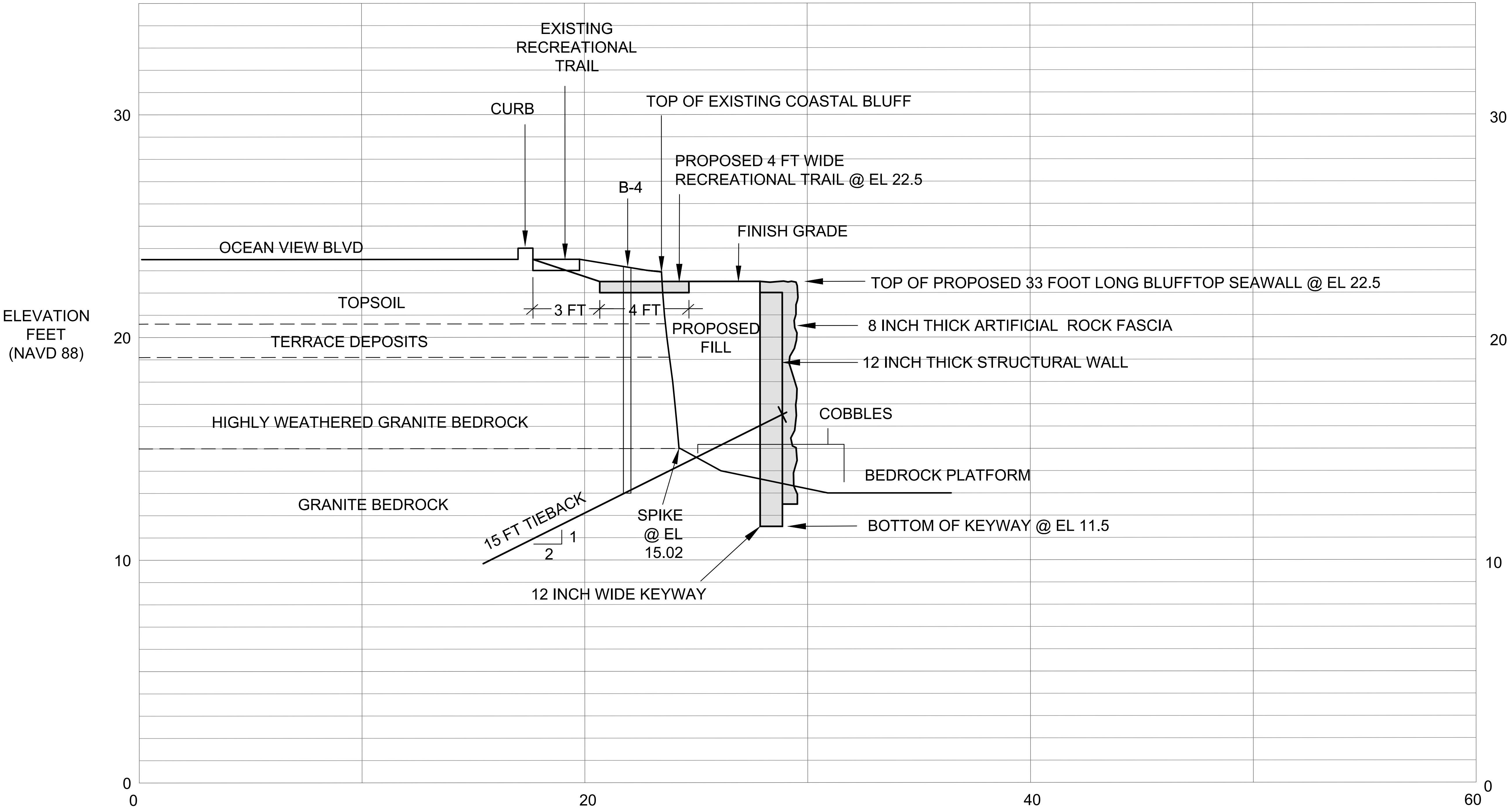

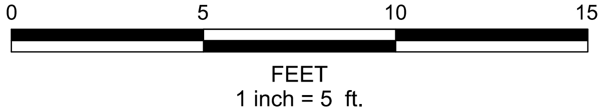

PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

ESPLANADE EAST CROSS SECTION 3
ALTERNATIVE 1 - PROPOSED BLUFFTOP SEAWALL

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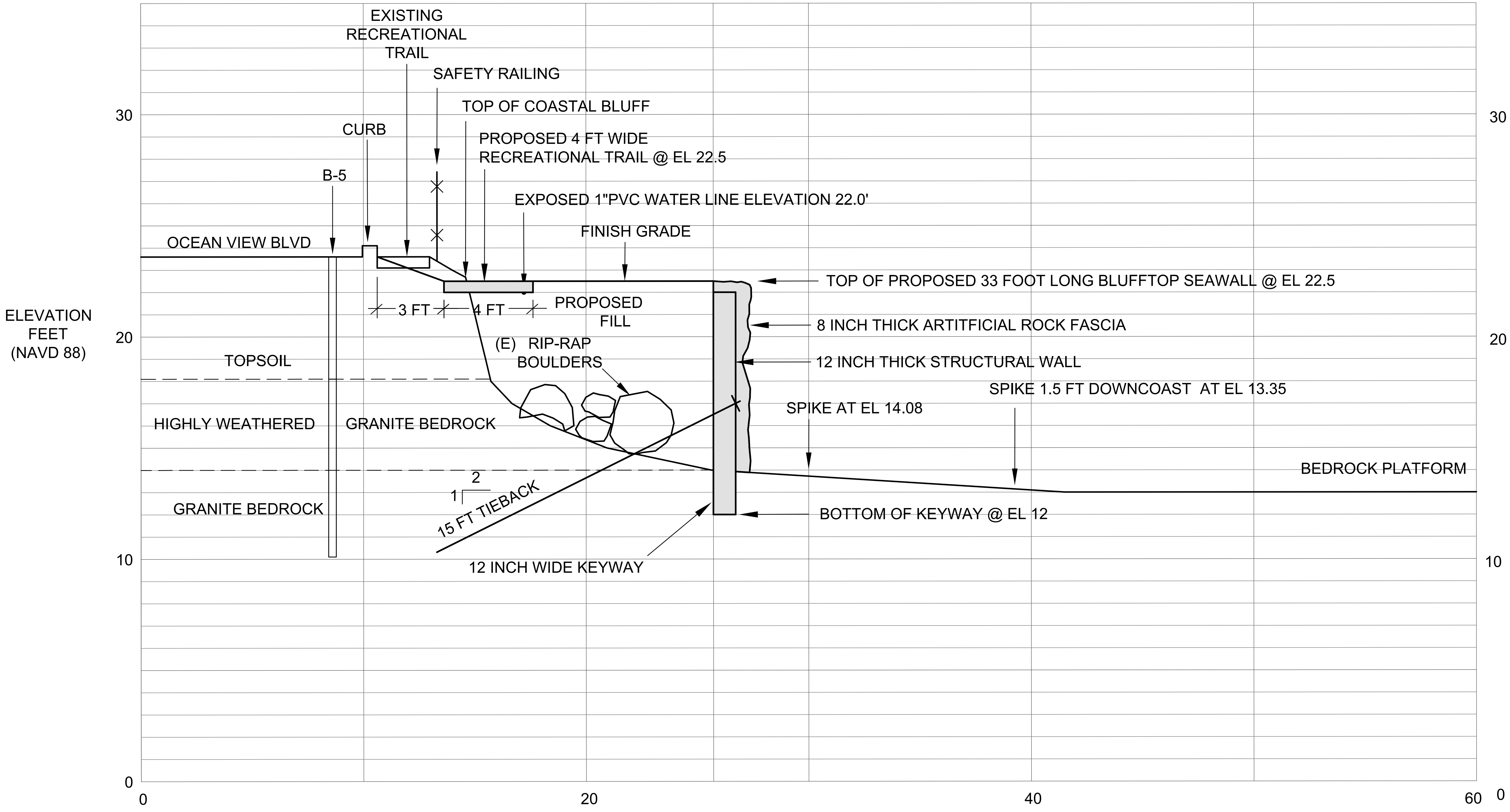

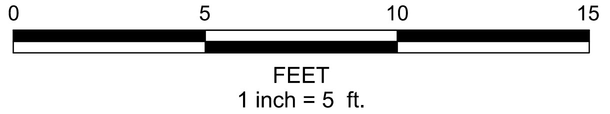

PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

ESPLANADE EAST CROSS SECTION 4
ALTERNATIVE 1 - PROPOSED BLUFFTOP SEAWALL

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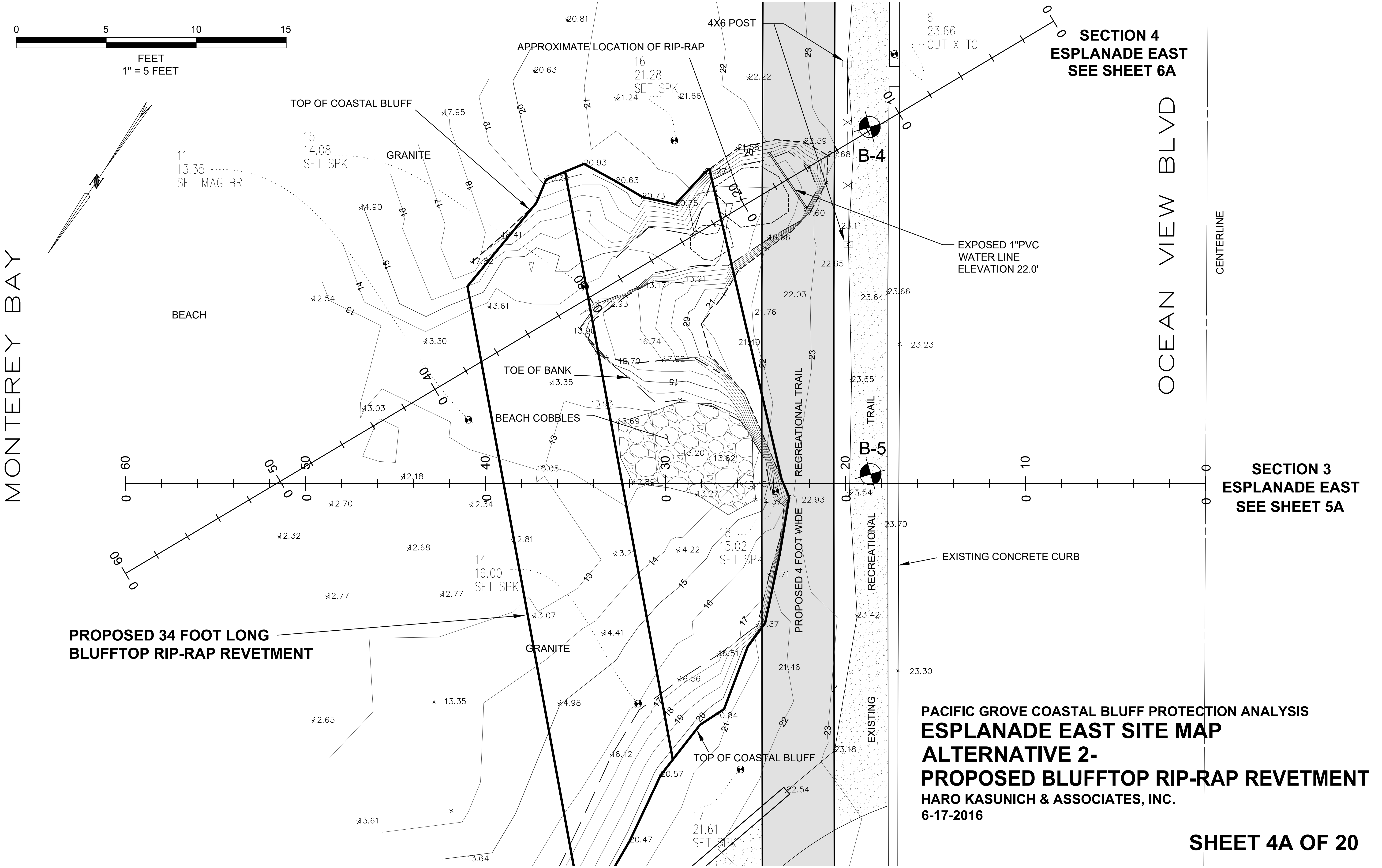

PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

ESPLANADE EAST SITE MAP
ALTERNATIVE 2-
PROPOSED BLUFFTOP RIP-RAP REVETMENT

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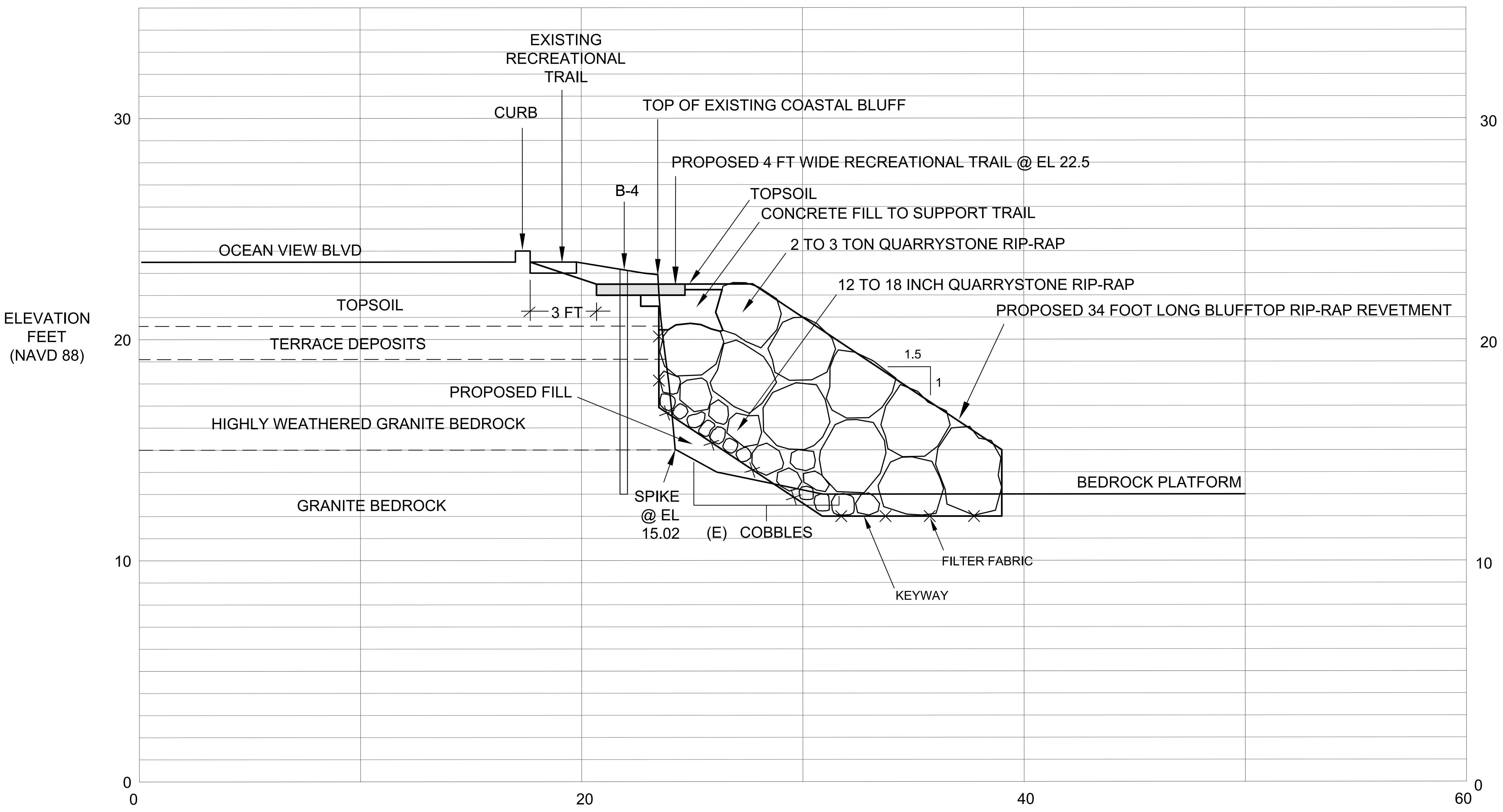

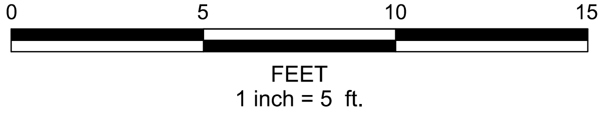

PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

ESPLANADE EAST CROSS SECTION 3

ALTERNATIVE 2 - PROPOSED BLUFFTOP RIP-RAP REVETMENT

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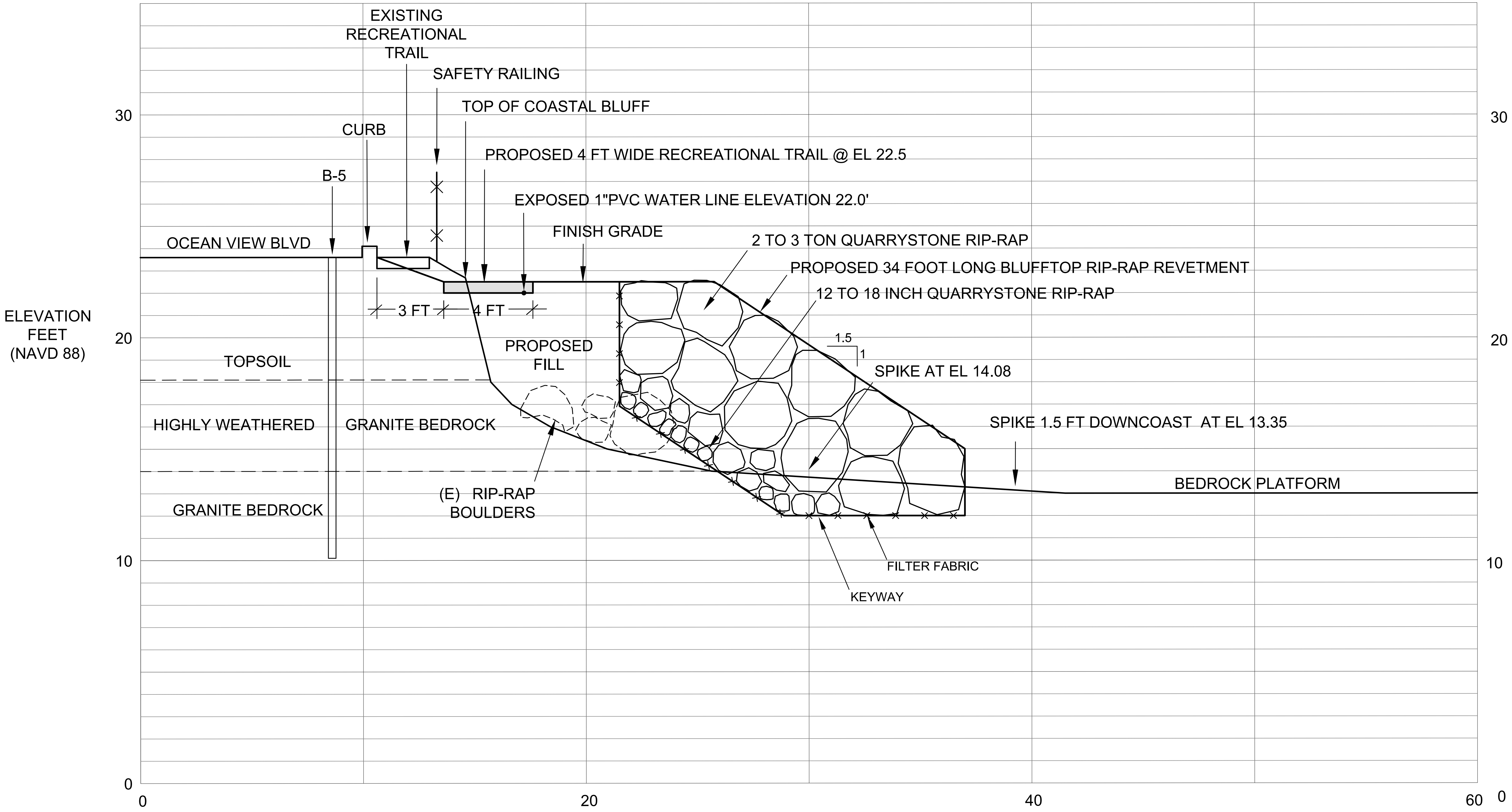

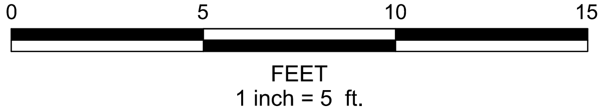

PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

ESPLANADE EAST CROSS SECTION 4

ALTERNATIVE 2 - PROPOSED BLUFFTOP RIP-RAP REVETMENT

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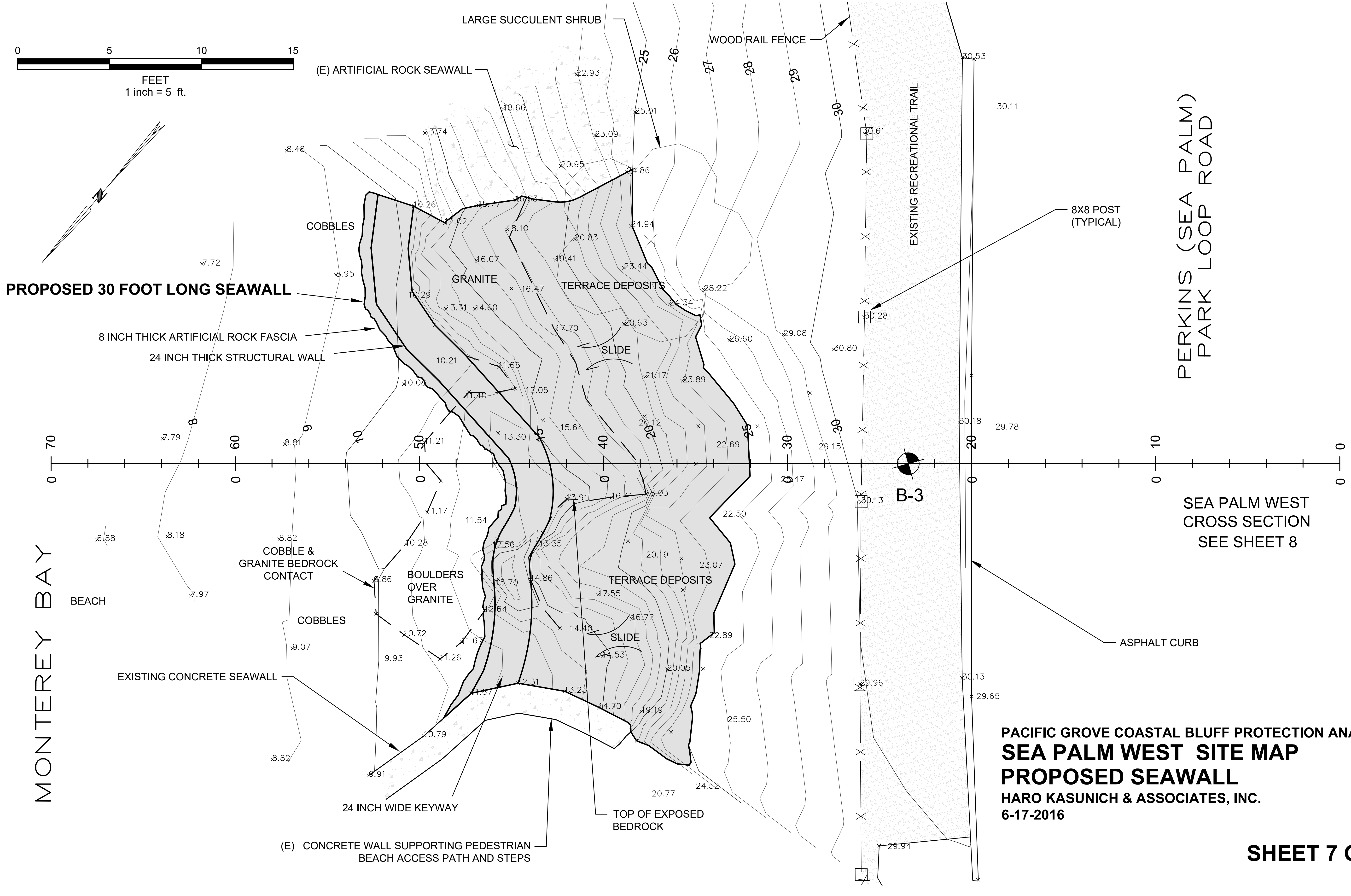

PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

SEA PALM WEST SITE MAP
PROPOSED SEAWALL

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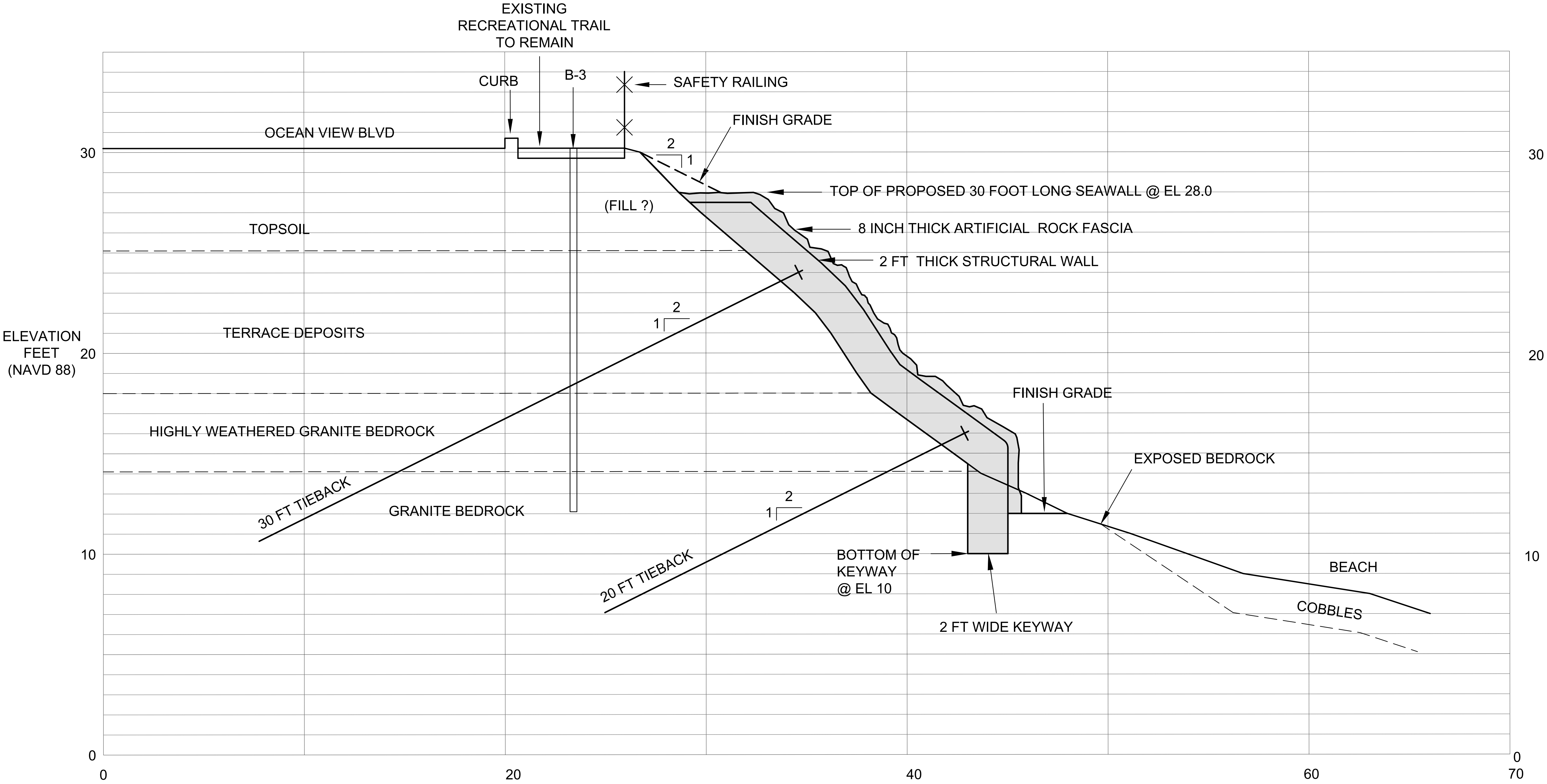
6-17-2016

SHEET 7 OF 20



0 5 10 15

FEET
1 inch = 5 ft.

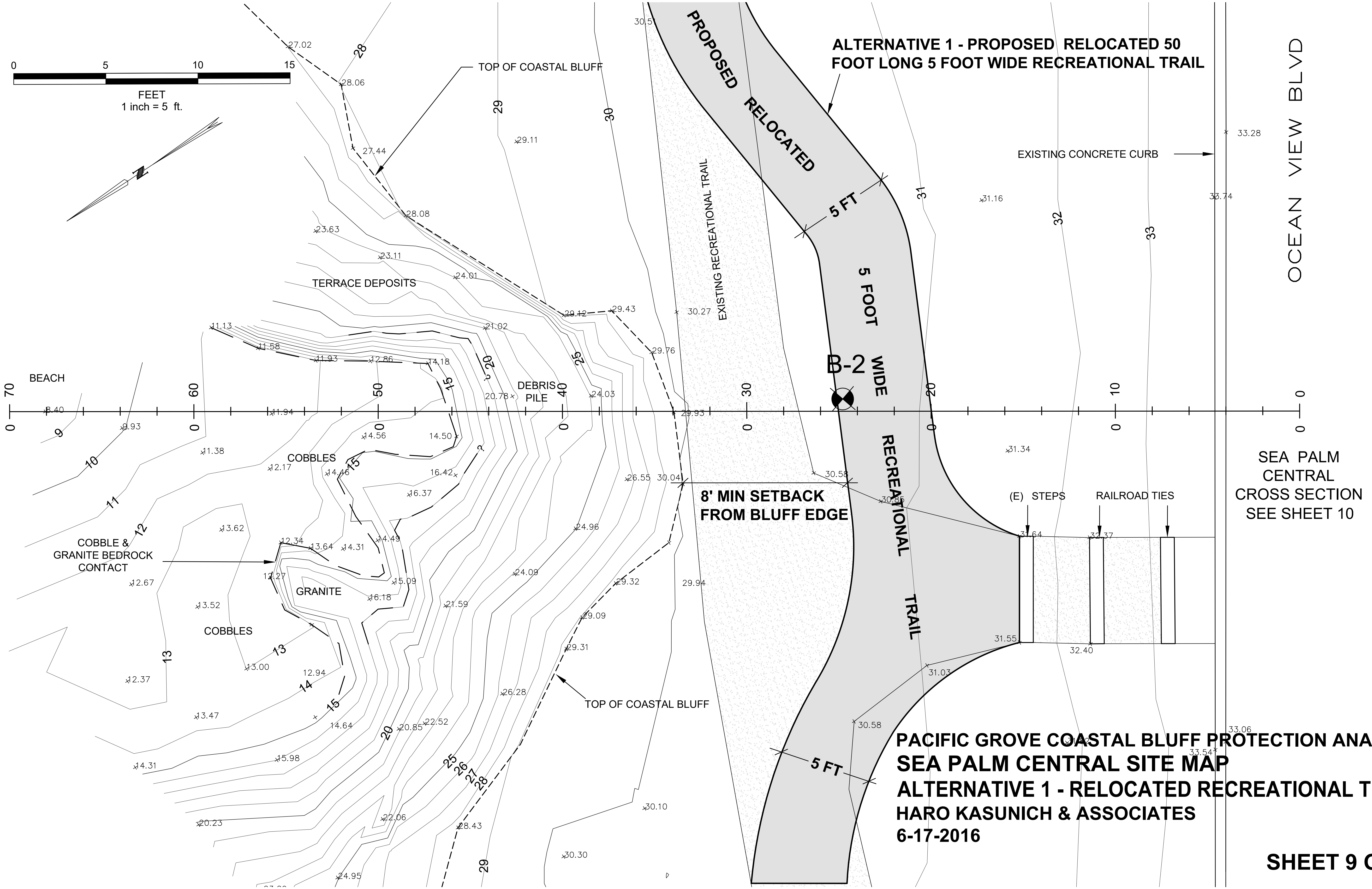
PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

SEA PALM WEST CROSS SECTION
PROPOSED SEAWALL

HARO KASUNICH & ASSOCIATES, INC.

6-17-2016

SHEET 8 OF 20



PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

SEA PALM CENTRAL SITE MAP

ALTERNATIVE 1 - RELOCATED RECREATIONAL TRAIL

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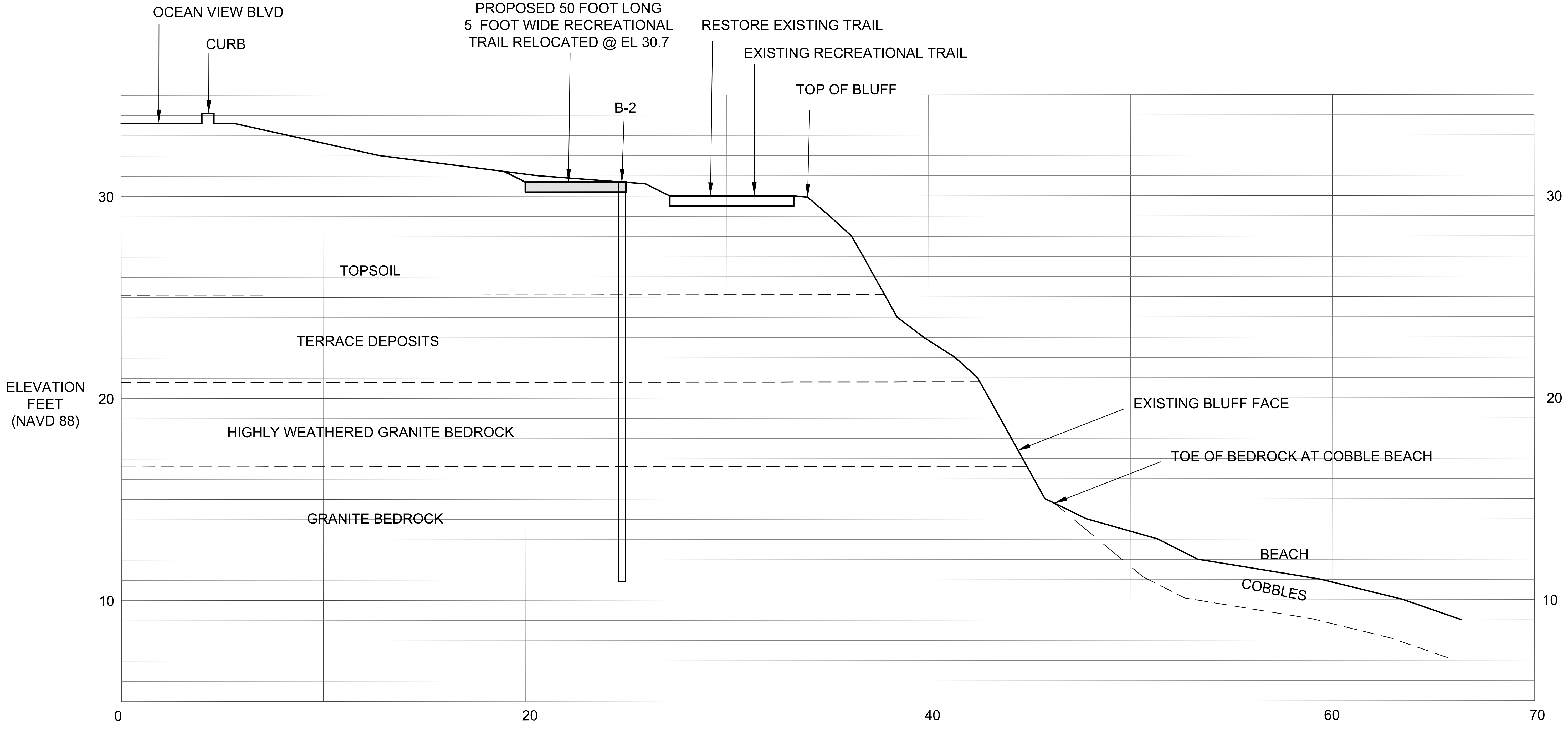
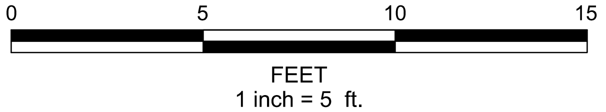
SHEET 9 OF 20





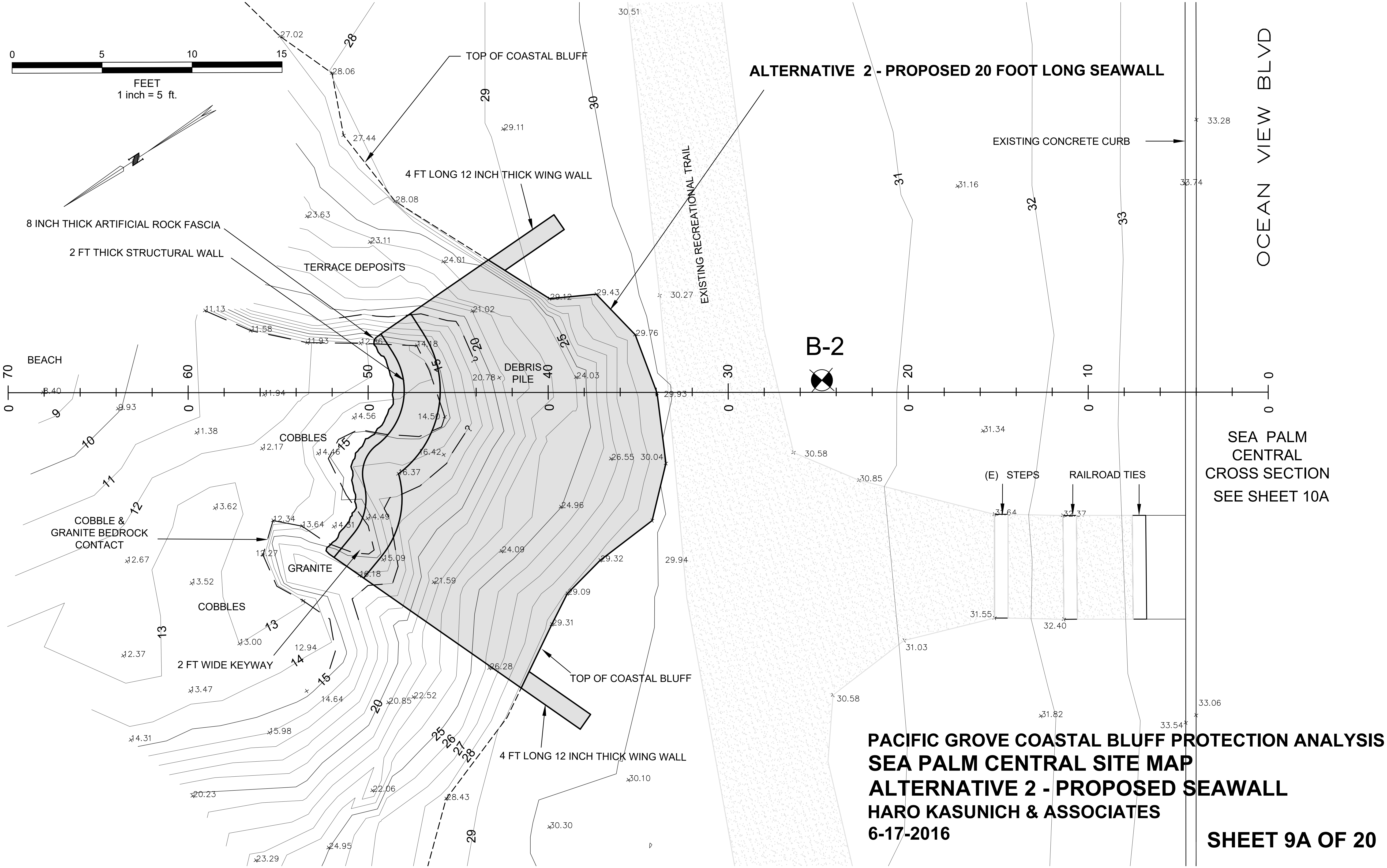
PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

SEA PALM CENTRAL CROSS SECTION

ALTERNATIVE 1 - RELOCATED RECREATIONAL TRAIL

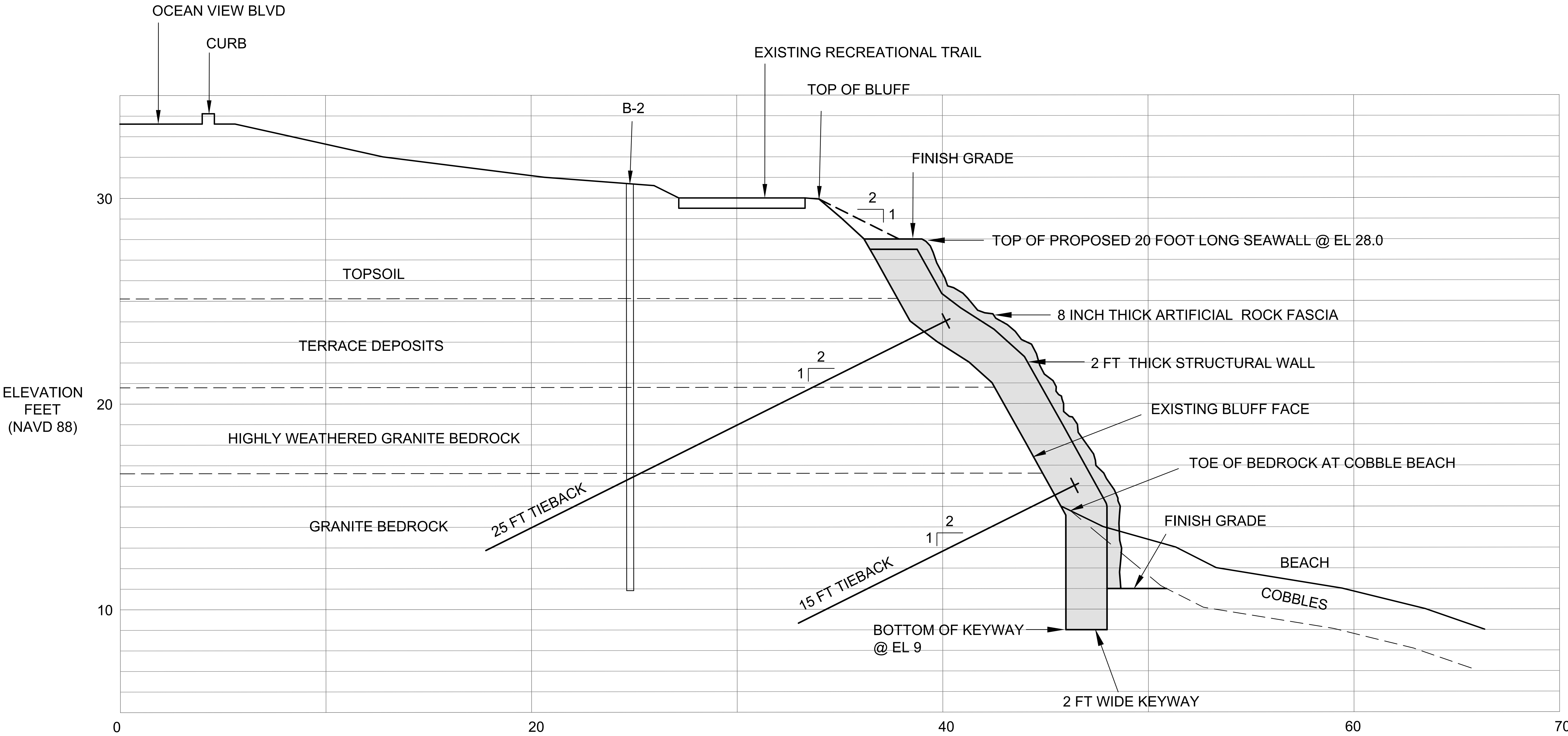
HARO KASUNICH & ASSOCIATES, INC.

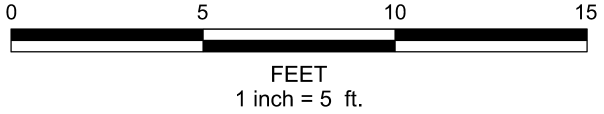
6-17-2016



PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS
SEA PALM CENTRAL SITE MAP
ALTERNATIVE 2 - PROPOSED SEAWALL
HARO KASUNICH & ASSOCIATES
6-17-2016

SHEET 9A OF 20





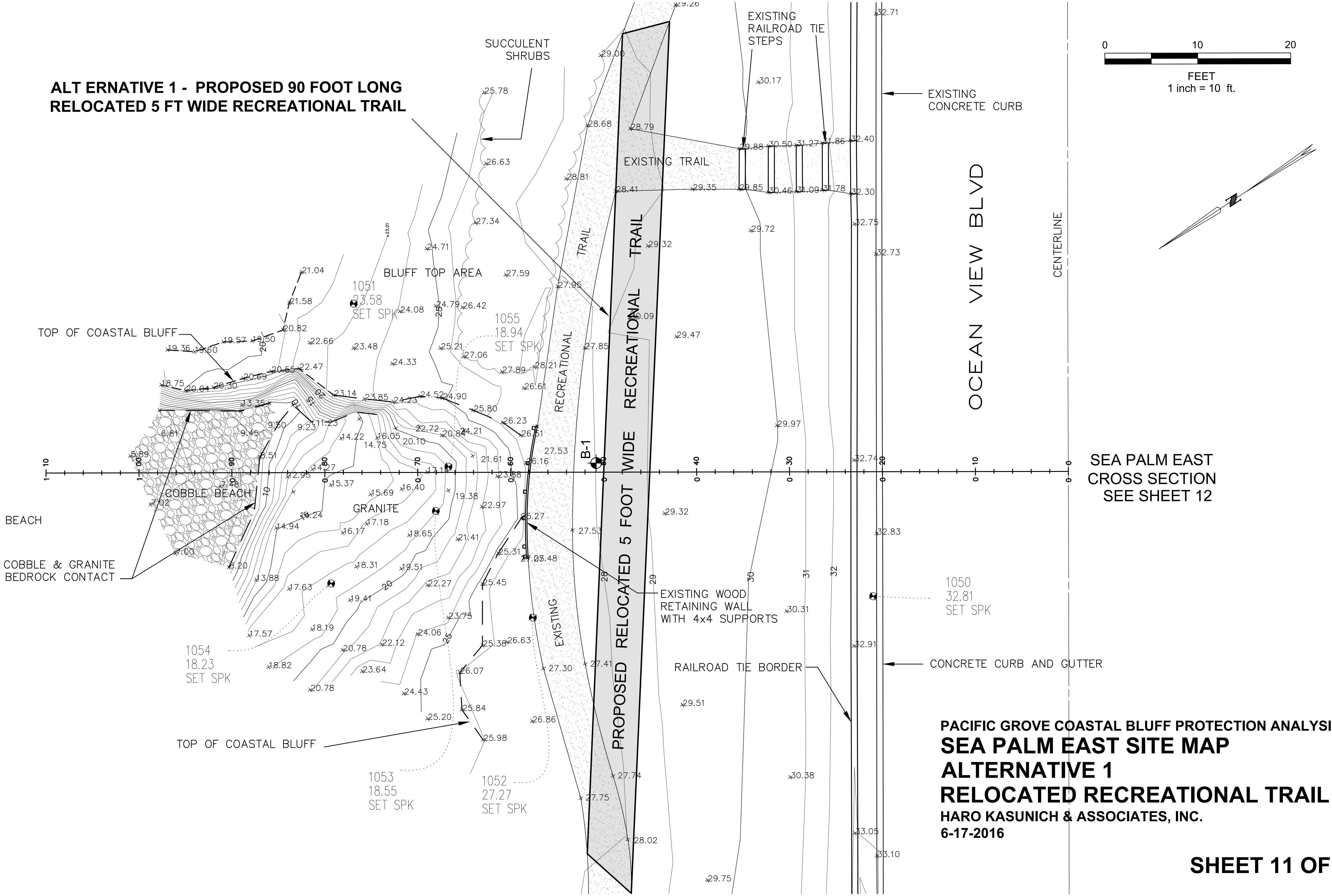
PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

SEA PALM CENTRAL CROSS SECTION
ALTERNATIVE 2 - PROPOSED SEAWALL

HARO KASUNICH & ASSOCIATES, INC.

6-17-2016

SHEET 10A OF 20



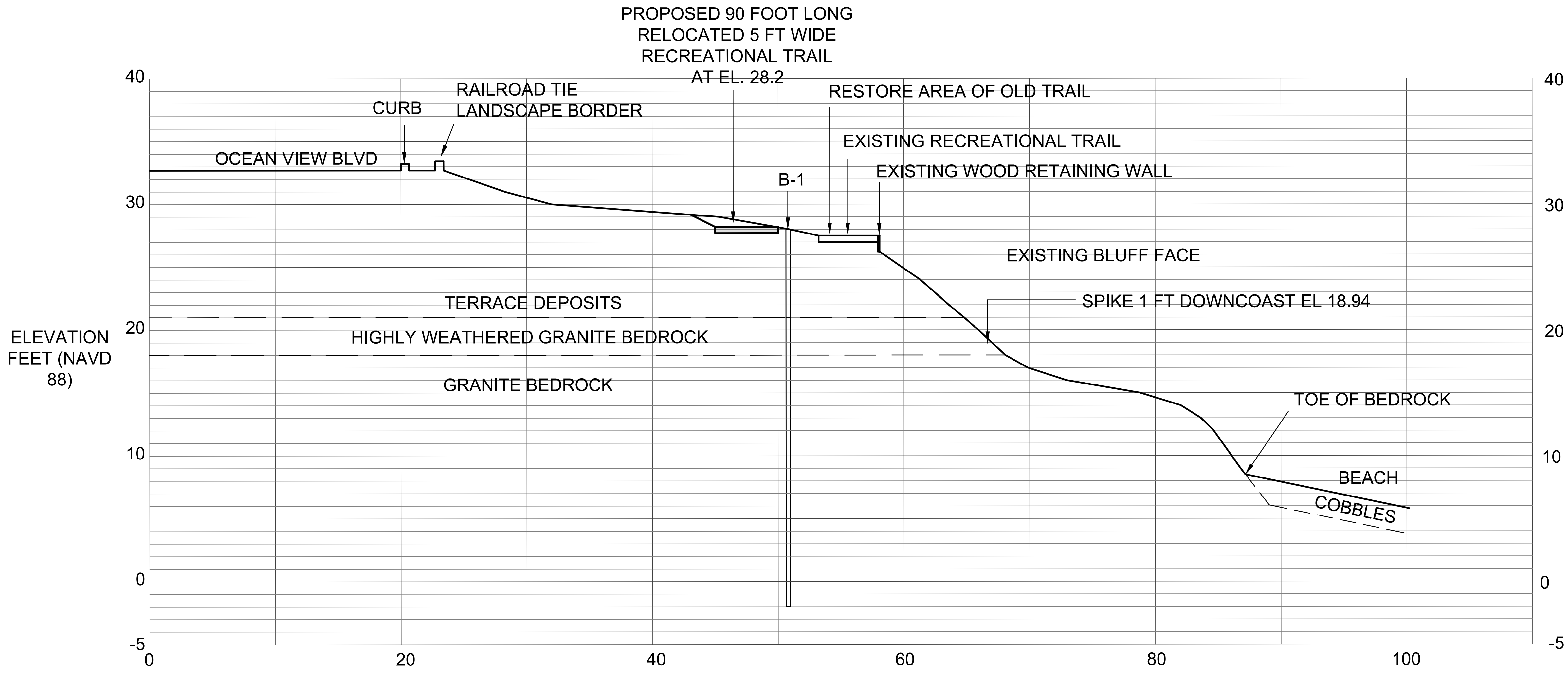
PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

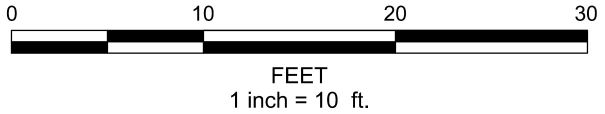
SEA PALM EAST SITE MAP
ALTERNATIVE 1
RELOCATED RECREATIONAL TRAIL

HARO KASUNICH & ASSOCIATES, INC.

6-17-2016

SHEET 11 OF 20





PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

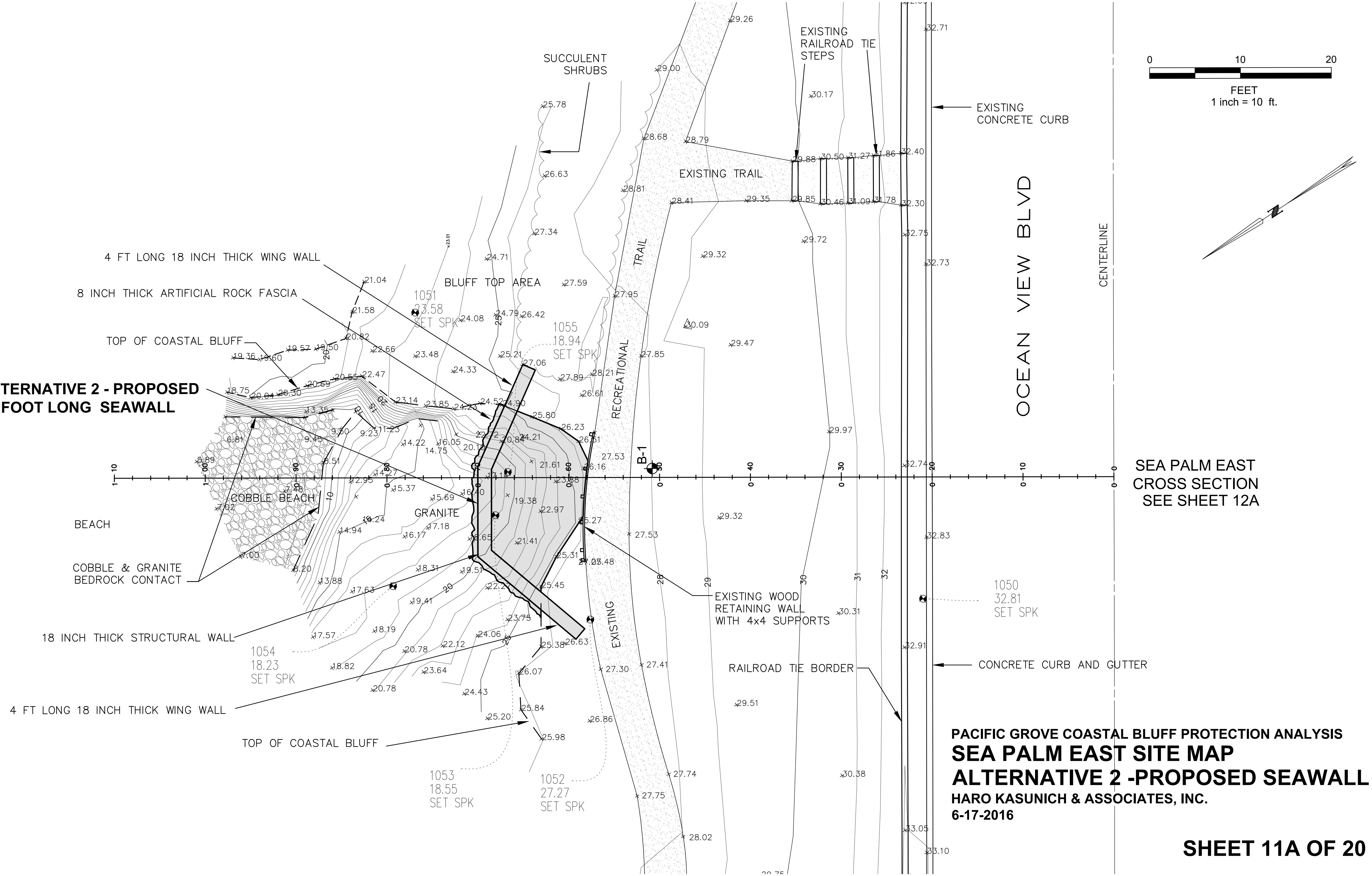
SEA PALM EAST CROSS SECTION

ALTERNATIVE 1 - RELOCATED RECREATIONAL TRAIL

HARO KASUNICH & ASSOCIATES, INC.

6-17-2016

SHEET 12 OF 20



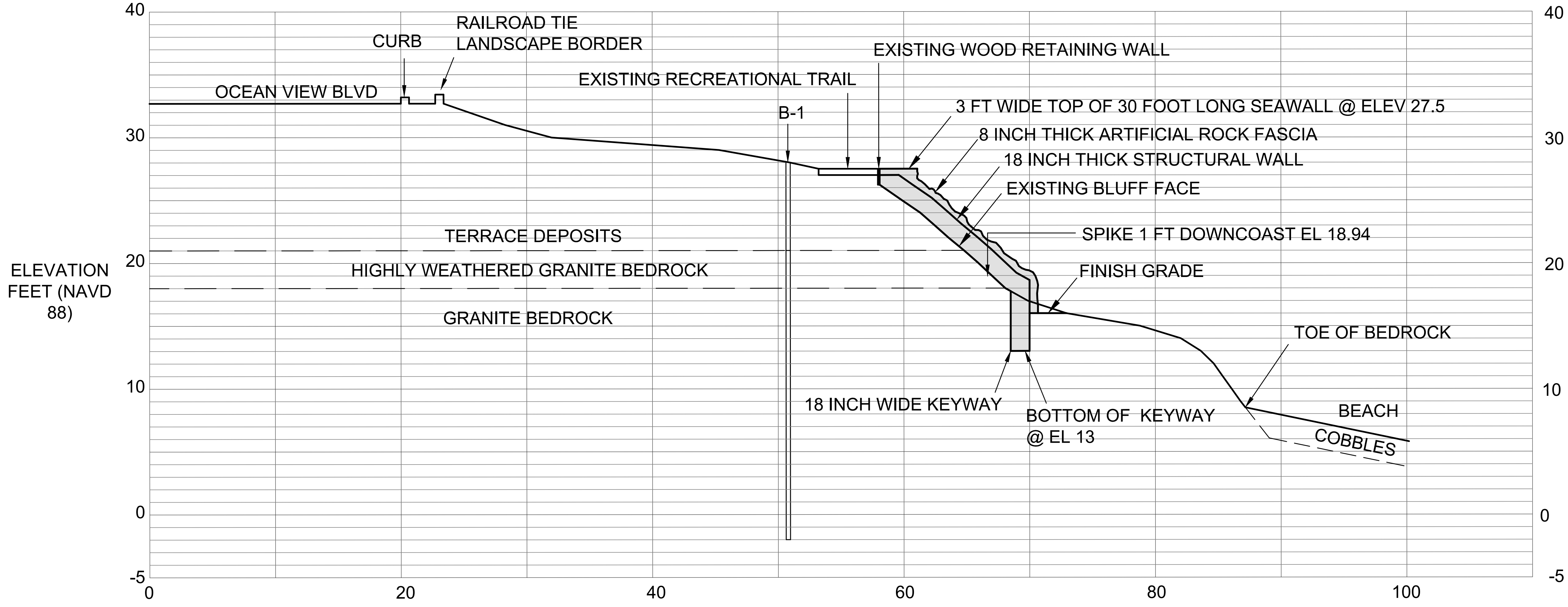
PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

SEA PALM EAST SITE MAP
ALTERNATIVE 2 -PROPOSED SEAWALL

HARO KASUNICH & ASSOCIATES, INC.

6-17-2016

SHEET 11A OF 20

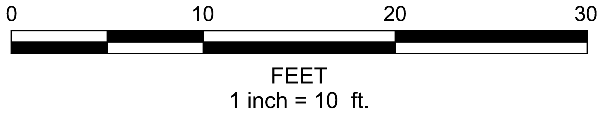


PACIFIC GROVE COASTAL BLUFF PROTECTION ANALYSIS

SEA PALM EAST CROSS SECTION
ALTERNATIVE 2 - PROPOSED SEAWALL

HARO KASUNICH & ASSOCIATES, INC.

6-17-2016



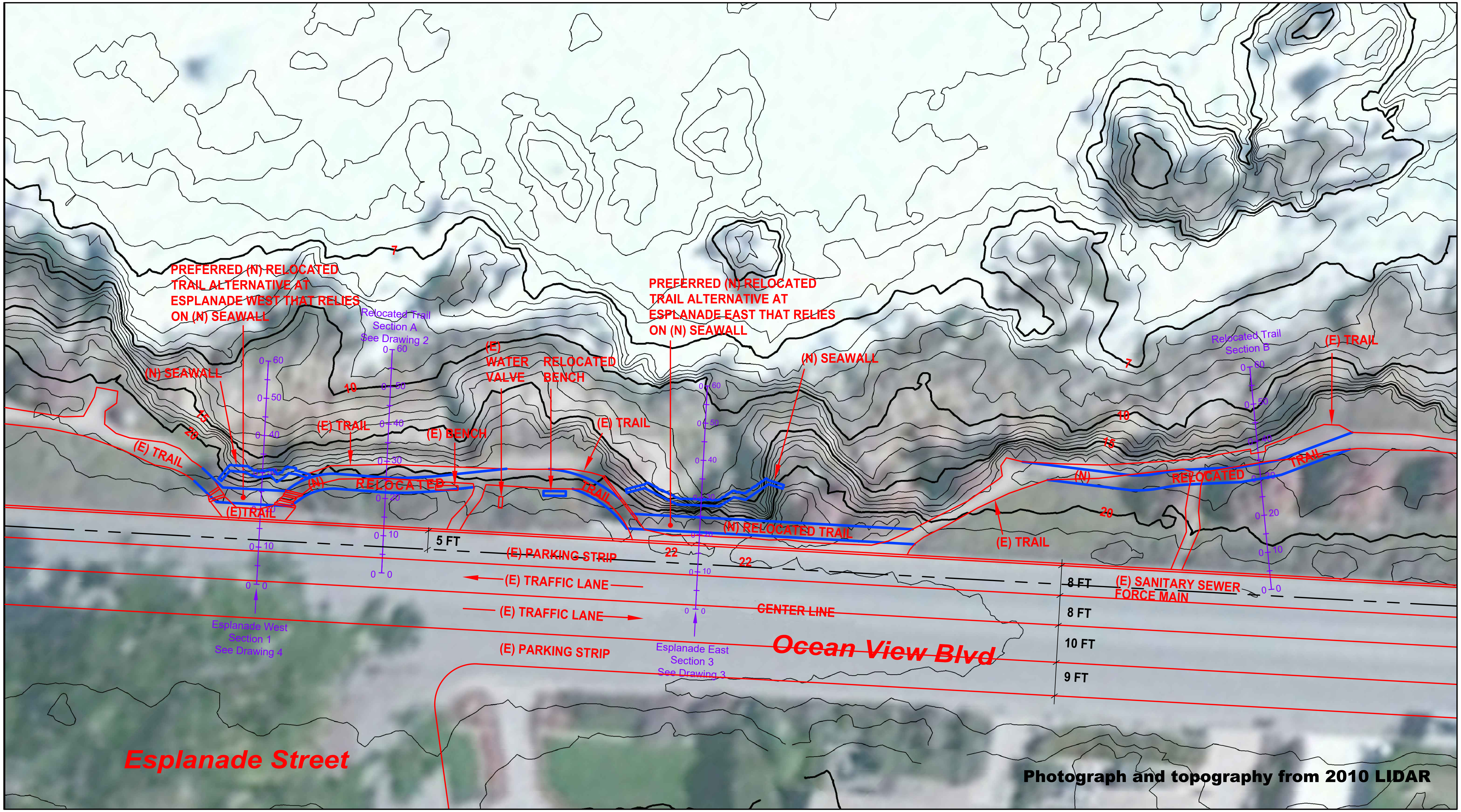
SHEET 12A OF 20

Project No. M10997
20 December 2016

APPENDIX D

Relocated Trail Map and Cross Sections Locations on Either Side of Esplanade East And at Esplanade West

(Six 11 by 17 Drawings)

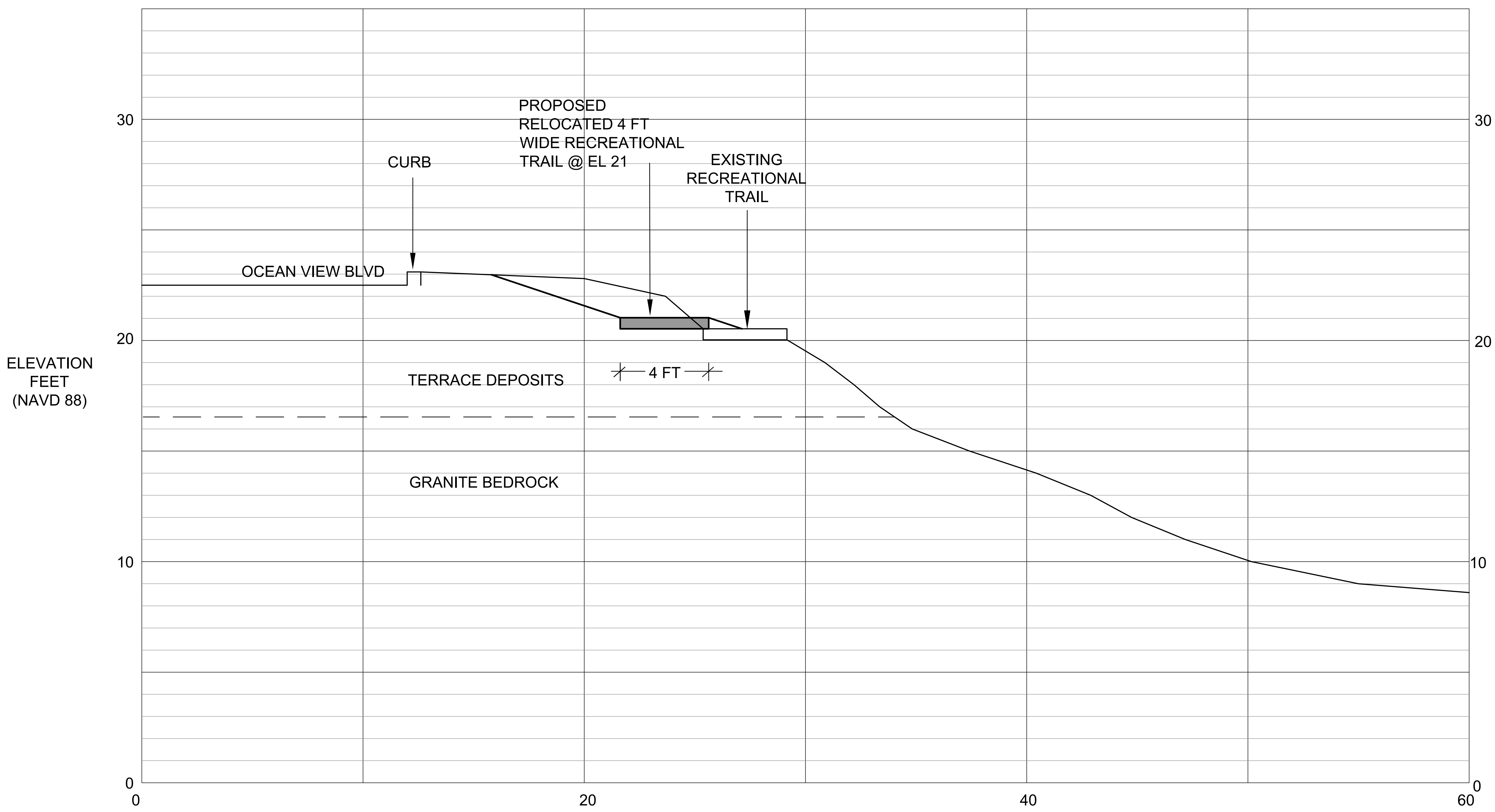


RELOCATED TRAIL SEGMENTS ON EITHER SIDE OF ESPLANADE EAST
AND AT BOTH ESPLANADE EAST AND ESPLANADE WEST
THAT RELY ON PROPOSED SEAWALLS
OCEAN VIEW BLVD AT ESPLANADE STREET
PACIFIC GROVE, CA

0 25 50 75
FEET
1 inch = 25 ft.

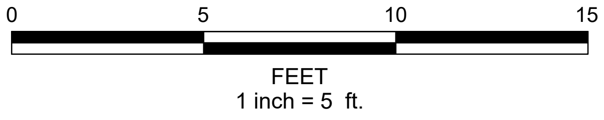
HARO KASUNICH & ASSOCIATES, INC.
PACIFIC GROVE RELOCATED TRAIL
12-19-2016

DRAWING 1 OF 6



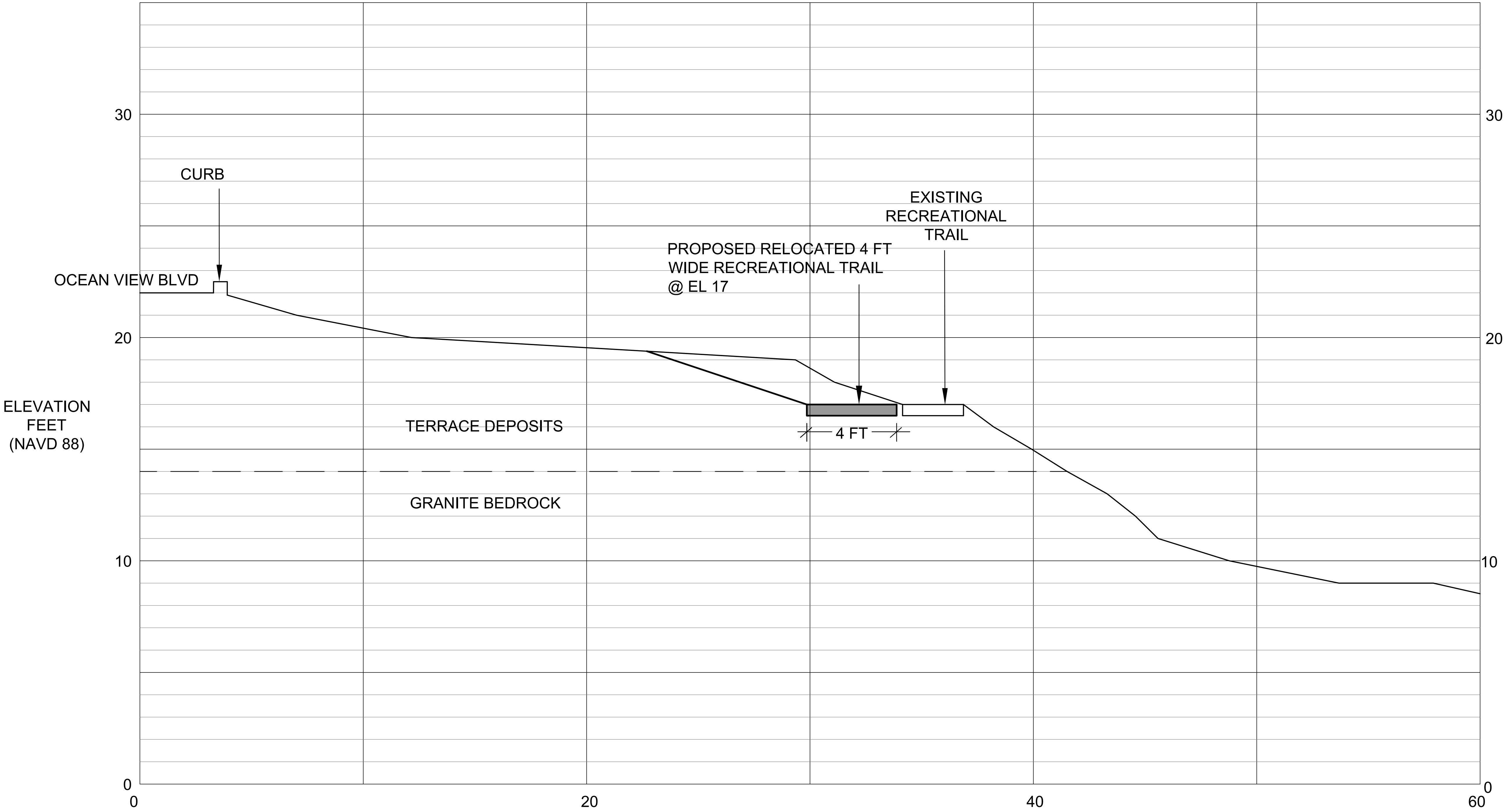
CROSS SECTION SHOWING RELOCATED TRAIL SEGMENT DOWNCOAST OF ESPLANADE EAST AREA

Section A
Showing proposed
relocated recreational trail



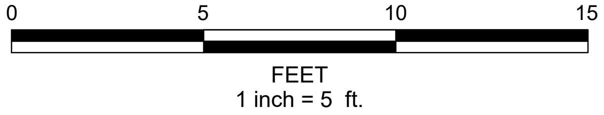
HARO KASUNICH & ASSOCIATES, INC.
PACIFIC GROVE RELOCATED TRAIL
12-19-2016

DRAWING 2 OF 6



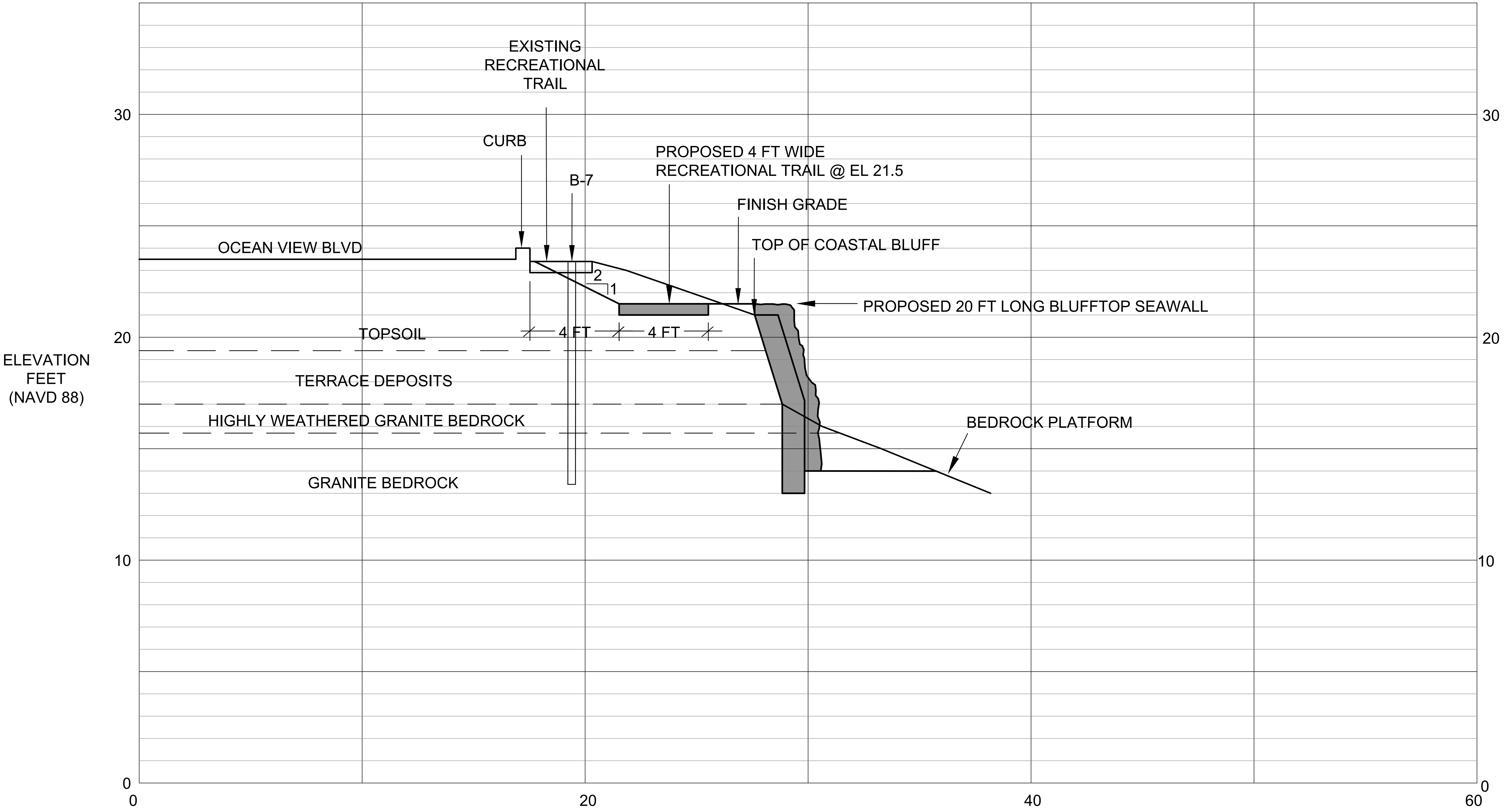
CROSS SECTION SHOWING RELOCATED TRAIL SEGMENT UPCOAST OF ESPLANADE EAST AREA

Section B
Showing proposed
relocated recreational trail

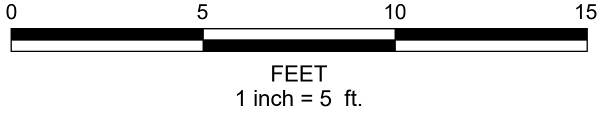


HARO KASUNICH & ASSOCIATES, INC.
PACIFIC GROVE RELOCATED TRAIL
12-19-2016

DRAWING 3 OF 6



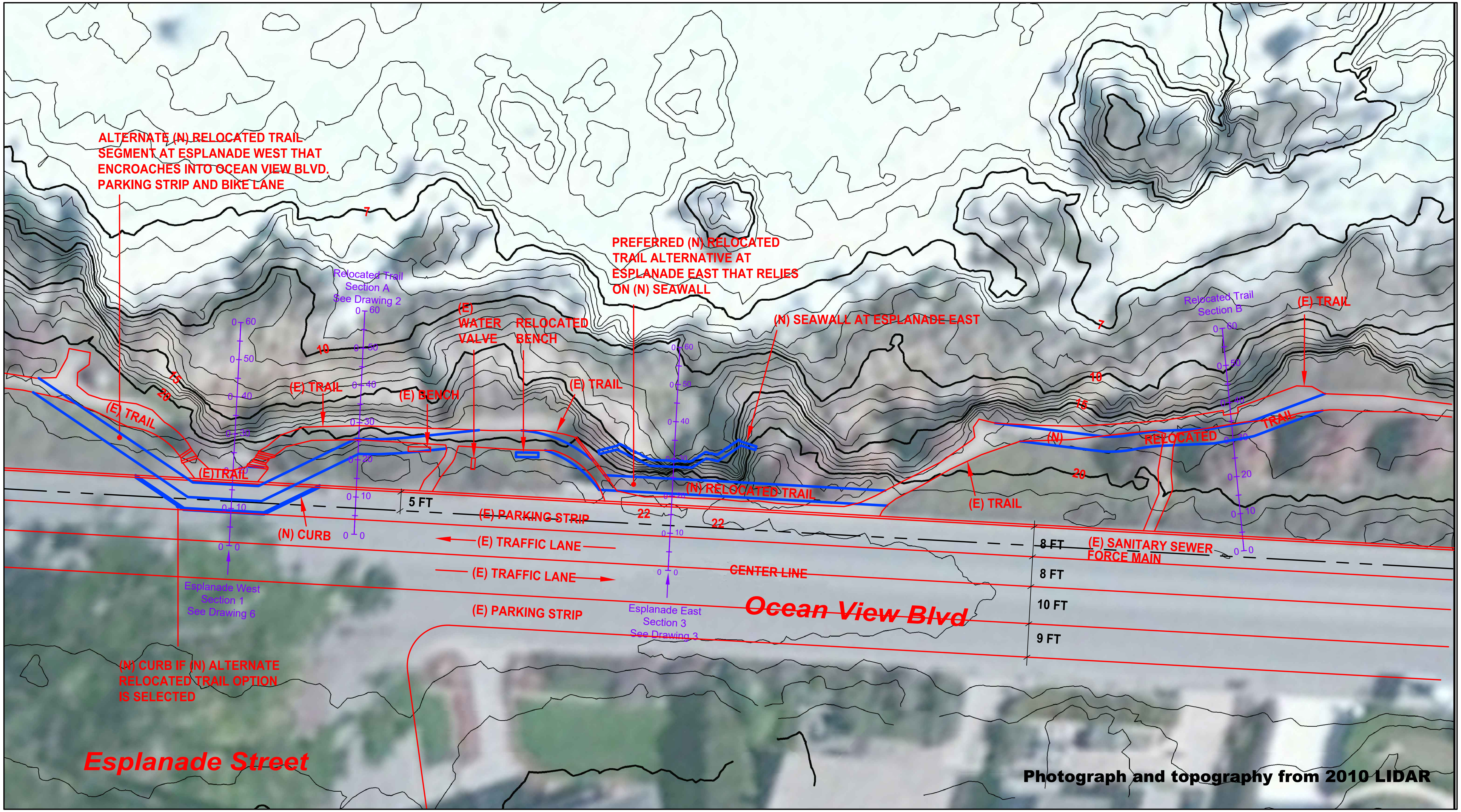
CROSS SECTION SHOWING RELOCATED TRAIL SEGMENT
AT ESPLANADE WEST THAT RELIES ON PROPOSED SEAWALL
OCEAN VIEW BLVD AT ESPLANADE STREET
PACIFIC GROVE, CA



Esplanade West - Cross Section 1
Showing proposed new blufftop seawall
and relocated trail

HARO KASUNICH & ASSOCIATES, INC.
PACIFIC GROVE RELOCATED TRAIL
12-19-2016

DRAWING 4 OF 6

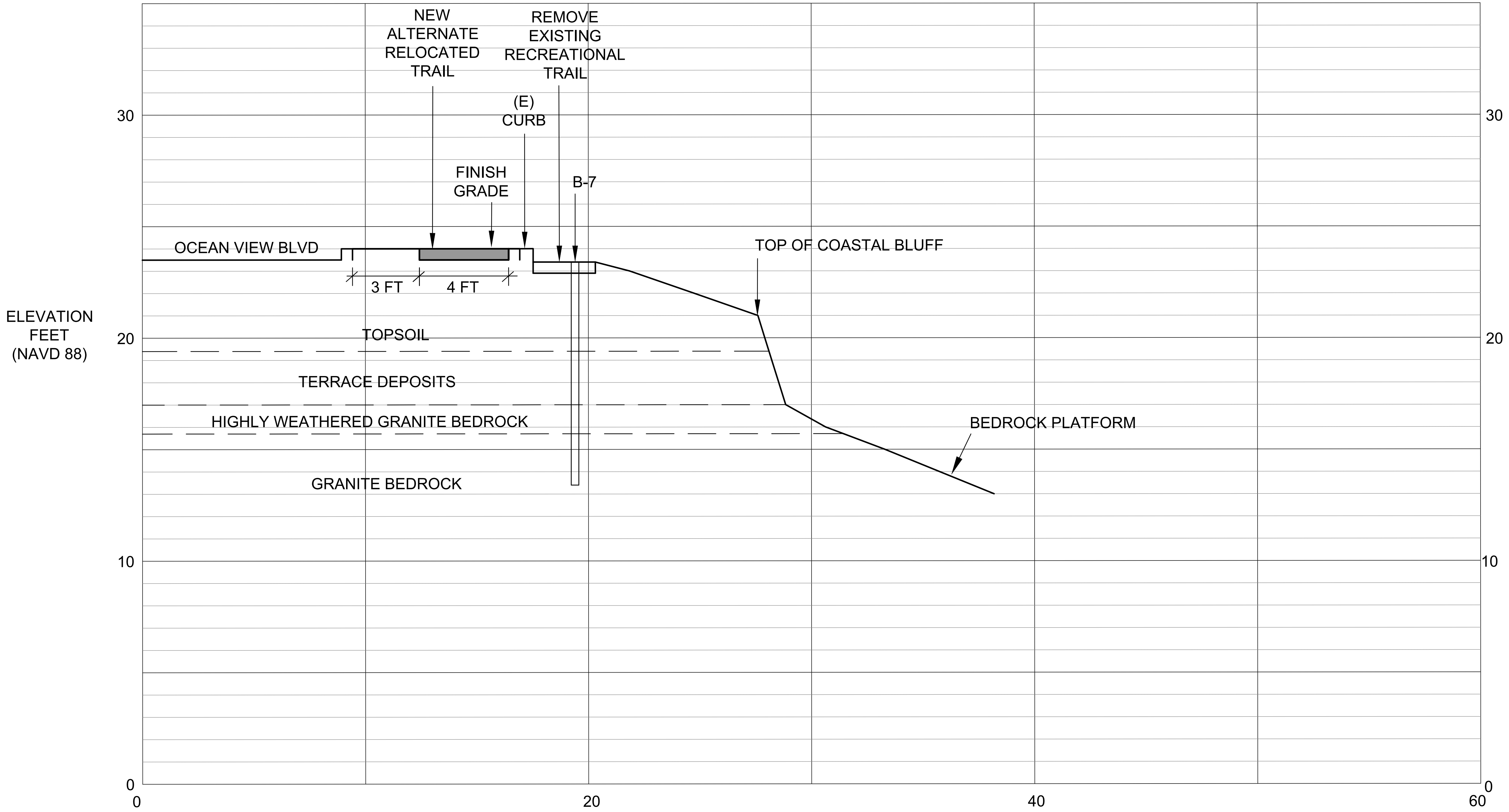


ALTERNATE RELOCATED TRAIL SEGMENT AT ESPLANADE WEST THAT
ENCROACHES INTO OCEAN VIEW BLVD. PARKING STRIP AND BIKE LANE **BUT DOES**
NOT RELY ON A NEW SEAWALL AT ESPLANADE WEST
OCEAN VIEW BLVD AT ESPLANADE STREET
PACIFIC GROVE, CA

0 25 50 75
FEET
1 inch = 25 ft.

HARO KASUNICH & ASSOCIATES, INC.
PACIFIC GROVE RELOCATED TRAIL
12-19-2016

DRAWING 5 OF 6



CROSS SECTION SHOWING ALTERNATE RELOCATED TRAIL SEGMENTS AT ESPLANADE WEST THAT ENCROACHES INTO OCEAN VIEW BLVD. PARKING STRIP AND BIKE LANE **BUT DOES NOT RELY ON A NEW SEAWALL AT ESPLANADE WEST**
OCEAN VIEW BLVD AT ESPLANADE STREET, PACIFIC GROVE, CA

Section 1 Esplanade West
Showing new alternate relocated trail within present Ocean View Blvd. parking strip

0 5 10 15
FEET
1 inch = 5 ft.

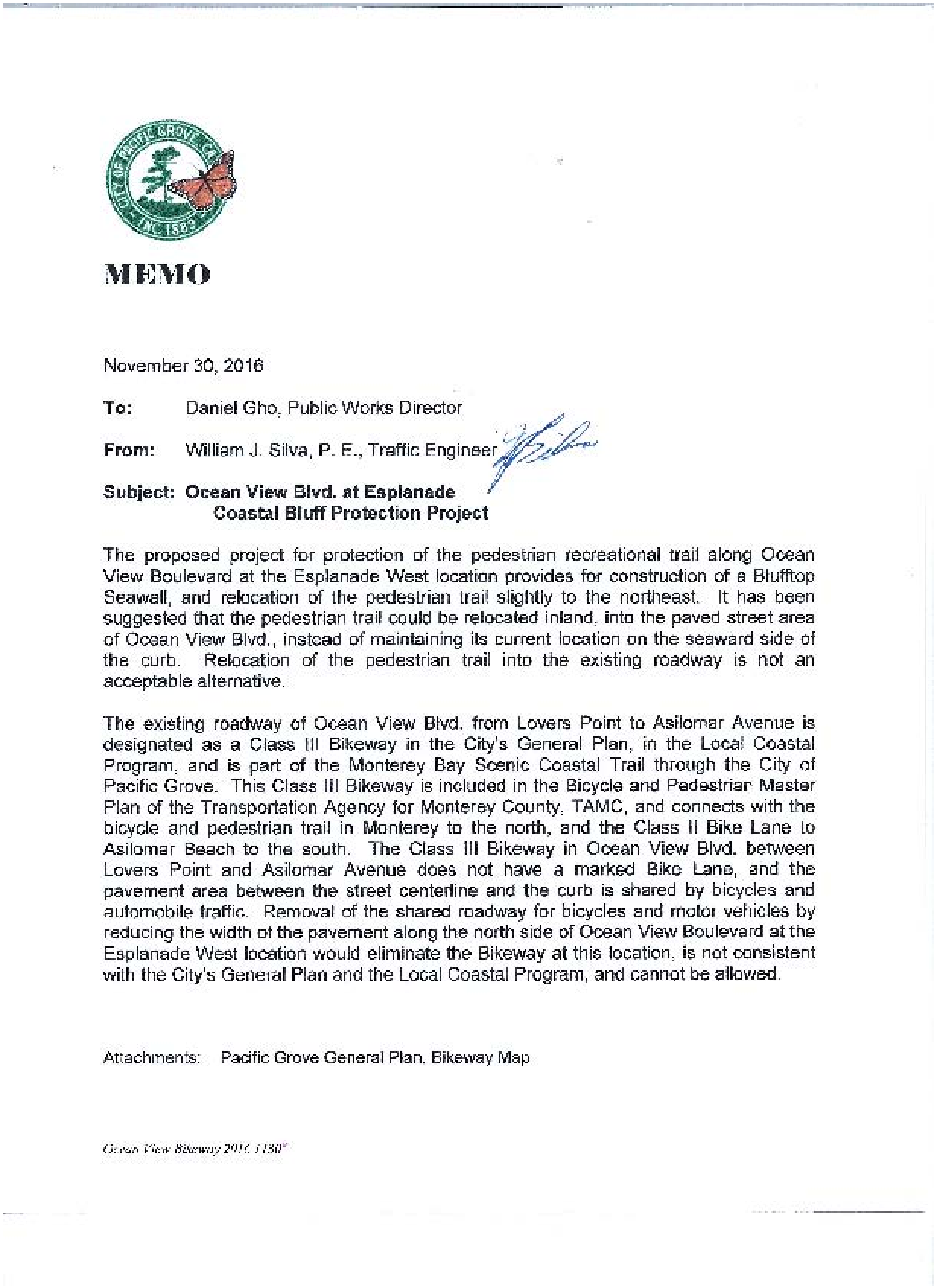
HARO KASUNICH & ASSOCIATES, INC.
PACIFIC GROVE RELOCATED TRAIL
12-19-2016

DRAWING 6 OF 6

Project No. M10997
20 December 2016

APPENDIX E

City Of Pacific Grove Traffic Engineering Letter



MEMO

November 30, 2016

To: Daniel Gho, Public Works Director

From: William J. Silva, P. E., Traffic Engineer

**Subject: Ocean View Blvd. at Esplanade
Coastal Bluff Protection Project**

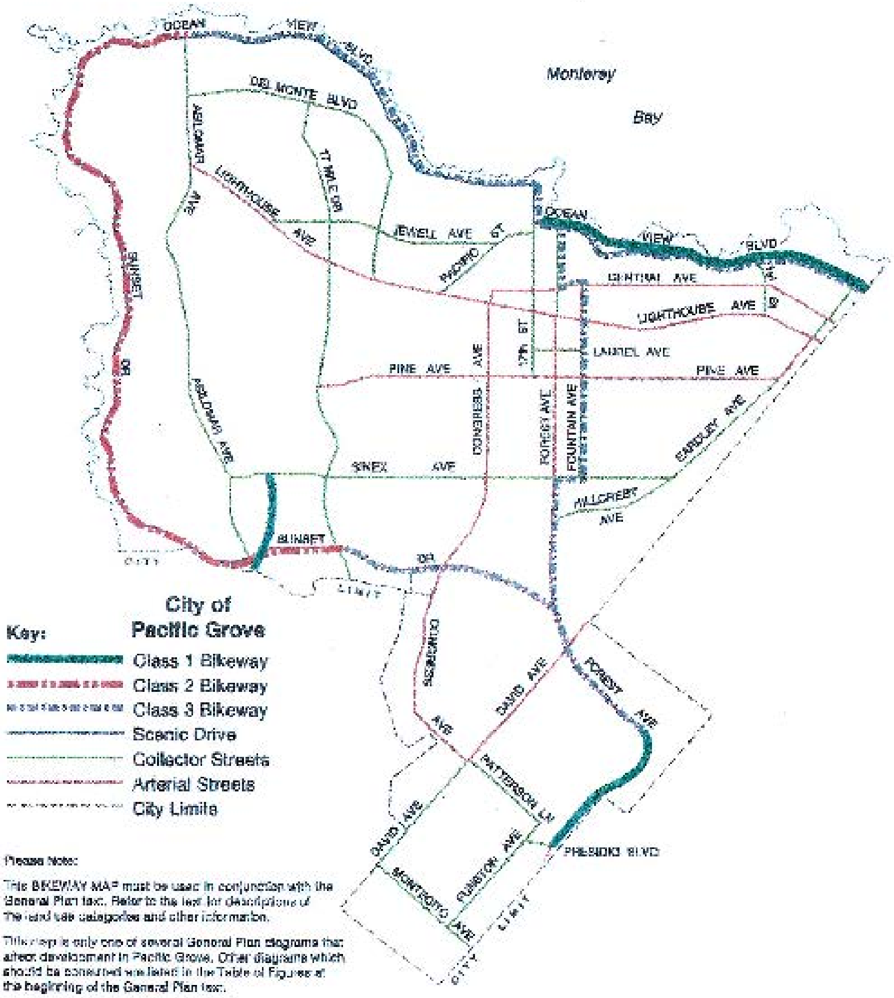
The proposed project for protection of the pedestrian recreational trail along Ocean View Boulevard at the Esplanade West location provides for construction of a Blufftop Seawall, and relocation of the pedestrian trail slightly to the northeast. It has been suggested that the pedestrian trail could be relocated inland, into the paved street area of Ocean View Blvd., instead of maintaining its current location on the seaward side of the curb. Relocation of the pedestrian trail into the existing roadway is not an acceptable alternative.

The existing roadway of Ocean View Blvd. from Lovers Point to Asilomar Avenue is designated as a Class III Bikeway in the City's General Plan, in the Local Coastal Program, and is part of the Monterey Bay Scenic Coastal Trail through the City of Pacific Grove. This Class III Bikeway is included in the Bicycle and Pedestrian Master Plan of the Transportation Agency for Monterey County, TAMC, and connects with the bicycle and pedestrian trail in Monterey to the north, and the Class II Bike Lane to Asilomar Beach to the south. The Class III Bikeway in Ocean View Blvd. between Lovers Point and Asilomar Avenue does not have a marked Bike Lane, and the pavement area between the street centerline and the curb is shared by bicycles and automobile traffic. Removal of the shared roadway for bicycles and motor vehicles by reducing the width of the pavement along the north side of Ocean View Boulevard at the Esplanade West location would eliminate the Bikeway at this location, is not consistent with the City's General Plan and the Local Coastal Program, and cannot be allowed.

Attachments: Pacific Grove General Plan, Bikeway Map

Ocean View Bikeway 2016 1130

Figure 4-14
Bikeways



Please Note:

This BIKEWAY MAP must be used in conjunction with the General Plan text. Refer to the text for descriptions of the land use categories and other information.

This map is only one of several General Plan diagrams that affect development in Pacific Grove. Other diagrams which should be consulted are listed in the Table of Figures at the beginning of the General Plan text.

This map was developed in 1994, primarily for the General Plan. The City of Pacific Grove is neither responsible nor liable for use of this map beyond its intended use.

Project No. M10997
20 December 2016

APPENDIX F

Figure 1 -- Key to Logs
Figures 2 through 8 -- Boring Logs
Figure 9 through 14 -- Direct Shear Test Results

PRIMARY DIVISIONS				GROUP SYMBOL	SECONDARY DIVISIONS
COARSE GRAINED SOILS	MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LESS THAN 5% FINES)	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
				GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.
			GRAVEL WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
				GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
		SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LESS THAN 5% FINES)	SW	Well graded sands, gravelly sands, little or no fines
				SP	Poorly graded sands or gravelly sands, little or no fines
			SANDS WITH FINES	SM	Silty sands, sand-silt mixtures, non-plastic fines.
				SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS	MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT IS LESS THAN 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
				OL	Organic silts and organic silty clays of low plasticity.
		SILTS AND CLAYS LIQUID LIMIT IS GREATER THAN 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
				CH	Inorganic clays of high plasticity, fat clays.
				OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS				Pt	Peat and other highly organic soils.

GRAIN SIZES

U.S. STANDARD SERIES SIEVE: 200 40 10 4

CLEAR SQUARE SIEVE OPENINGS: 3/4" 3" 12"

SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

RELATIVE DENSITY

SANDS AND GRAVELS	BLOWS PER FOOT*
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	OVER 50

CONSISTENCY

SILTS AND CLAYS	STRENGTH (TSF)**	BLOWS PER FOOT*
VERY SOFT	0 - ¼	0 - 2
SOFT	¼ - ½	2 - 4
FIRM	½ - 1	4 - 8
STIFF	1 - 2	8 - 16
VERY STIFF	2 - 4	16 - 32
HARD	OVER 4	OVER 32

SAMPLING METHOD

STANDARD PENETRATION TEST	T	⧅
MODIFIED CALIFORNIA	L or M	◫
PITCHER BARREL	P	⊠
SHELBY TUBE	S	◨
BULK	B	▲

H_2O

Final	▽
Initial	▼

Water level designation

*Number of blows of 140 lb hammer falling 30 inches to drive a 2" O.D. (1⅜" I.D.) split spoon sampler (ASTM D-1586)

**Unconfined compressive strength in tons/ft² as determined by laboratory testing or approximated by the Standard Penetration Test (ASTM D-1586), pocket penetrometer, torvane, or visual observation

Haro Kasunich & Associates, Inc.	**KEY TO LOGS** **OCEAN VIEW BLVD RECREATIONAL TRAIL PACIFIC GROVE, CALIFORNIA**	**Project No. M10997** **December 2016**	**Figure No. 1**

Haro, Kasunich & Associates, Inc.
Coastal and Geotechnical Engineers

Esplanade Park and Sea Palm Street Acces

PROJECT NO. M10997

LOGGED BY MC **DATE DRILLED** 4-25-16 **BORING DIAMETER** 4" **BORING NO.** B-1

Depth, ft.	Sample No. and type	Symbol	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t.s.f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
0			Brown Silty SAND, fine grain, moist, very loose	SM					
	1-1-1 (L)				8				
	1-2 (T)		Tan brown SAND, fine grain, moist, loose	SP	7				
5	1-3-1 (L)		Same as above but wet		15		97	11.1	Saturated Direct Shear Test C = 83 psf ϕ = 39
	1-4 (T)	▼	Brown fine to coarse SAND, quartz, damp, very dense, weathered granite	SW	79				
10	1-5-1 (L) 1-6 (T)		Brown white SAND, fine to coarse grain, dry, very dense, weathered granite		50/4" 50/5"				
15	1-7 (T)		Same as above		50/3"				
20			Interbedded layers of harder and easier drilling to 30 feet						
25									
30			Boring terminated at 30 feet						
35									

SuperLog CivilTech Software, USA www.civiltech.com File: C:\superlog4\HKALOGS\M10997 Esplanade Park and Sea Palm Access Pathway.log Date: 6/24/2016

HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr

FIGURE NO. 2

Haro, Kasunich & Associates, Inc.
Coastal and Geotechnical Engineers

Esplanade Park and Sea Palm Street Acces

PROJECT NO. M10997

LOGGED BY MC DATE DRILLED 4-25-16 BORING DIAMETER 4" BORING NO. B-2

Depth, ft.	Sample No. and type	Symbol	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t.s.f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
0			Black Silty SAND, fine grain, white shell fragments, dry, possible midden?	SM					
					13				
	2-1-1 (L)						95	9.0	Saturated Direct Shear Test C = 211 psf ϕ = 36
5									
	2-2-1 (L)				12				
			Brown fine SAND, damp, loose	SP	16				
	2-3 (T)		Yellow fine SAND, moist, medium dense	SP					
10									
	2-4-2 (L)		Same as above, moist, dense		51				
			▼						
			Orange white black SAND with SILT, fine to coarse grain, quartz, moist, very dense, granite bedrock	SW-ML					
15	2-5-1 (L)				50/2"				
	2-6 (T)				50/3"				
			Very hard drilling at 19 feet						
20	2-7 (T)		Boring terminated at 19.8 feet		50/3"				
25									
30									
35									

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HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr

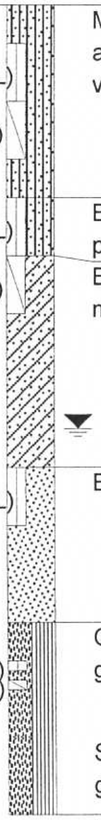
FIGURE NO. 3

Haro, Kasunich & Associates, Inc.
Coastal and Geotechnical Engineers

Esplanade Park and Sea Palm Street Acces

PROJECT NO. M10997

LOGGED BY MC   DATE DRILLED 4-25-16   BORING DIAMETER 4"   BORING NO. B-3



Depth, ft.	Sample No. and type	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t.s.f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
0		Mixed brown tan Silty SAND, fine to coarse grain, angular 1/2 inch gravels, asphalt pieces, damp, very loose (FILL)	SM					
	3-1-1 (L)			6		92	8.5	Saturated Direc Shear Test C = 239 psf ϕ = 39
	3-2 (T)			2				
5	3-3-1 (L)	Black Silty SAND, fine grain, moist, loose, possible midden? (FILL)	SM	13				
	3-4 (T)	Brown orange Clayey SAND, fine grain, moist, medium dense, (NATIVE)	SC	18				
10								
	3-5-1 (L)	Brown fine SAND, saturated, medium dense	SP	35		94	23.7	Saturated Direct Shear Test C = 174 ϕ = 39
15								
		Grey white black SAND with SILT, fine to medium grain, wet, dense, granite bedrock	SW-ML					
	3-6 (L)			50/2"				
	3-7 (T)			50/3"				
		Same but fine to coarse grain, 1/4 inch quartz gravels, moist, very dense granite bedrock						
20								
		Boring terminated at 21 feet						
25								
30								
35								

SuperLog CivilTech Software, USA www.civiltech.com File: C:\superlog4\HKALOGS\M10997 Esplanade Park and Sea Palm Access Pathway.log Date: 6/24/2016

HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr   FIGURE NO. 4

Haro, Kasunich & Associates, Inc.
Coastal and Geotechnical Engineers

Esplanade Park and Sea Palm Street Acces

PROJECT NO. M10997

LOGGED BY MC   DATE DRILLED 4-26-16   BORING DIAMETER 4"   BORING NO. B-4

Depth, ft.	Sample No. and type	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t.s.f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
0		Dark brown Silty SAND, fine to medium grain, moist, very loose	SM					
	4-1-1 (L)			9		93	9.8	Saturated Direct Shear Test C = 215 psf ϕ = 38
	4-2 (T)	Light brown Silty SAND, fine to coarse grain, damp, loose	SM	6				
5	4-3-1 (L)			50/6"				
	4-4 (T)	Light brown and white SAND with SILT, fine to coarse grain, damp, very dense, granite bedrock	SW-ML	50.6"				
10		Very hard drilling at 10.5 feet Boring terminated at 10.6 feet						
15								
20								
25								
30								
35								

HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr   FIGURE NO. 5

Haro, Kasunich & Associates, Inc.
Coastal and Geotechnical Engineers

Esplanade Park and Sea Palm Street Acces

PROJECT NO. M10997

LOGGED BY MC

DATE DRILLED 4-26-16

BORING DIAMETER 4"

BORING NO. B-5

Depth, ft.	Sample No. and type	Symbol	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t.s.f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
0			Tan AB FILL	AB					
	5-1-1 (L)		Brown Silty SAND, fine grain, dry, loose, angular gravels, FILL	SM	10				
	5-2 (T)		Black Silty SAND, fine grain, white shell fragments, moist, possible midden?, very loose (FILL)	FL SM	3				
5	5-3-1 (L)		Brown Silty SAND, fine to coarse grain, gravels 1/4 inch, trace of mica, very loose (NATIVE)		35		102	9.3	Saturated Direct Shear Test C = 676 psf ϕ = 41
	5-4 (T)		White grey Clayey SAND, fine to coarse grain, moist, quartz mica, dense, highly weathered granite SAND	SC	50/3"				
10			Orange white SAND with SILT, fine to coarse grain, damp, granite bedrock, very dense	SW-ML					
	5-5 (T)		Grey white SAND with trace of CLAY, fine to medium grain, damp to moist, very dense granite bedrock	SW	50/2"				
15			Boring terminated at 13.5 feet						
20									
25									
30									
35									

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HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr

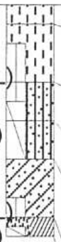
FIGURE NO. 6

Haro, Kasunich & Associates, Inc.
Coastal and Geotechnical Engineers

Esplanade Park and Sea Palm Street Acces

PROJECT NO. M10997

LOGGED BY MC **DATE DRILLED** 4-26-16 **BORING DIAMETER** 4" **BORING NO.** B-6



Depth, ft.	Sample No. and type	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t.s.f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
0		AB FILL	FL					
	6-1-1 (L)	Brown Silty SAND, fine to medium grain gravels, moist, loose, FILL	FL	11				
	6-2 (T)	Black Silty SAND, fine to medium grain, abalone shells, midden, loose, NATIVE	SM	14				
5		Brown Silty SAND, fine to medium grain, moist, medium dense	SM					
	6-3-1 (L)	Grey brown orange Clayey SAND, fine to coarse grain, moist, dense, highly weathered granite SAND	SC	50/4"				
10	6-4 (T)	Grey white SAND with CLAY binder, fine to coarse grain quartz, damp-moist, very dense granite bedrock	SW-CL	50/1"				
		Boring terminated at 6 feet						
15								
20								
25								
30								
35								

SuperLog CivilTech Software, USA www.civiltech.com File: C:\superlog4\HKALOGS\M10997 Esplanade Park and Sea Palm Access Pathway.log Date: 6/24/2016

HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr

FIGURE NO. 7

Haro, Kasunich & Associates, Inc.
Coastal and Geotechnical Engineers

Esplanade Park and Sea Palm Street Acces

PROJECT NO. M10997

LOGGED BY MC　DATE DRILLED 4-26-16　BORING DIAMETER 4"　BORING NO. B-7

Depth, ft.	Sample No. and type	Symbol	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t.s.f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
0			Tan AB FILL	FL					
			Brown Silty SAND, fine to medium grain, moist, medium dense, NATIVE	SM					
	7-1-1 (L)				35				
	7-2 (T)		Orange brown SAND with CLAY binder, fine to coarse grain, mica, dense, highly weathered granite SAND	SW-CL	34				
5	7-3 (L)		Grey orange Clayey SAND, fine to medium grain, moist, dense, highly weathered granite SAND	SC	39				
	7-4 (T)				50/6"				
			Orange black and white SAND with SILT, fine to coarse grain, damp, very dense, granite bedrock	SW-ML					
10	7-5 (T)		Grey white black SAND with SILT, damp, fine to coarse grain, very dense, granite bedrock		50/4"				
			Boring terminated at 10.4 feet						
15									
20									
25									
30									
35									

HARO, KASUNICH AND ASSOCIATES, INC.

BY: sr　FIGURE NO. 8

Direct Shear

Project:	Esplanade Park & Sea Palm
Sample #	1-3-1
Description	Brown Silty Sand

Date	6/16/2016
Tested By:	MA/AA

Test Number	1	2	3	4
Normal Pressure (PSF)	530	1030	2030	4030
Max Shear Stress	18.3	30.5	59.8	
Shear Stress (PSF)	538.6	897.1	1758.2	

Equation of Trendline	
Intercept	Slope
83.452	0.8199

C (PSF)	PHI
83	39

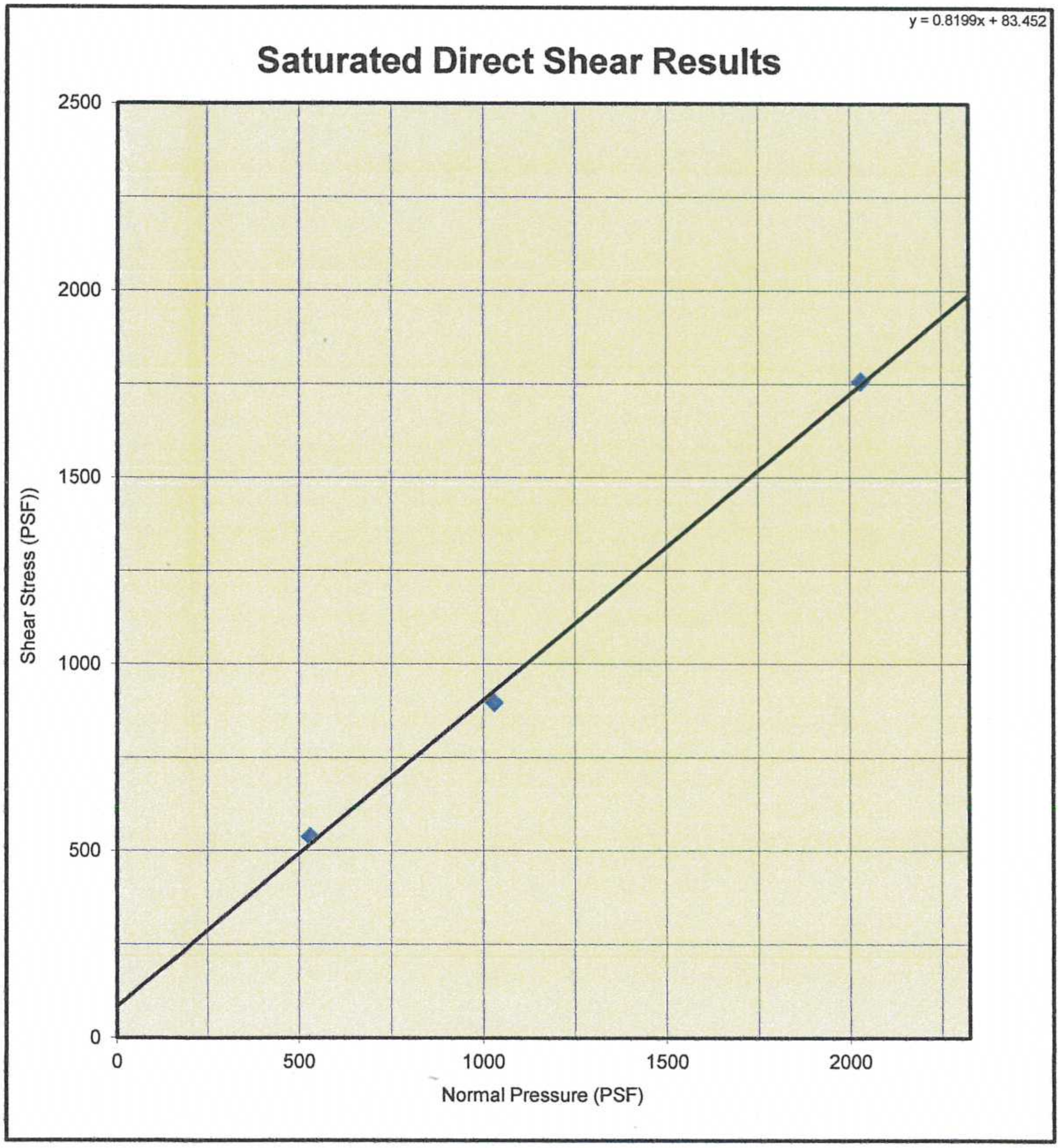


Figure No. 9

Direct Shear

Project:	Esplanade Park & Sea Palm
Sample #	2-1-1
Description	Black Silty Sand w/ fractured Seashells

Date	6/13/2016
Tested By:	MA/AA

Test Number	1	2	3	4
Normal Pressure (PSF)	530	1030	2030	4030
Max Shear Stress	19.5	34.2	57.4	
Shear Stress (PSF)	574.6	1005.1	1687.7	

Equation of Trendline	
Intercept	Slope
211.29	0.7336

C (PSF)	PHI
211	36

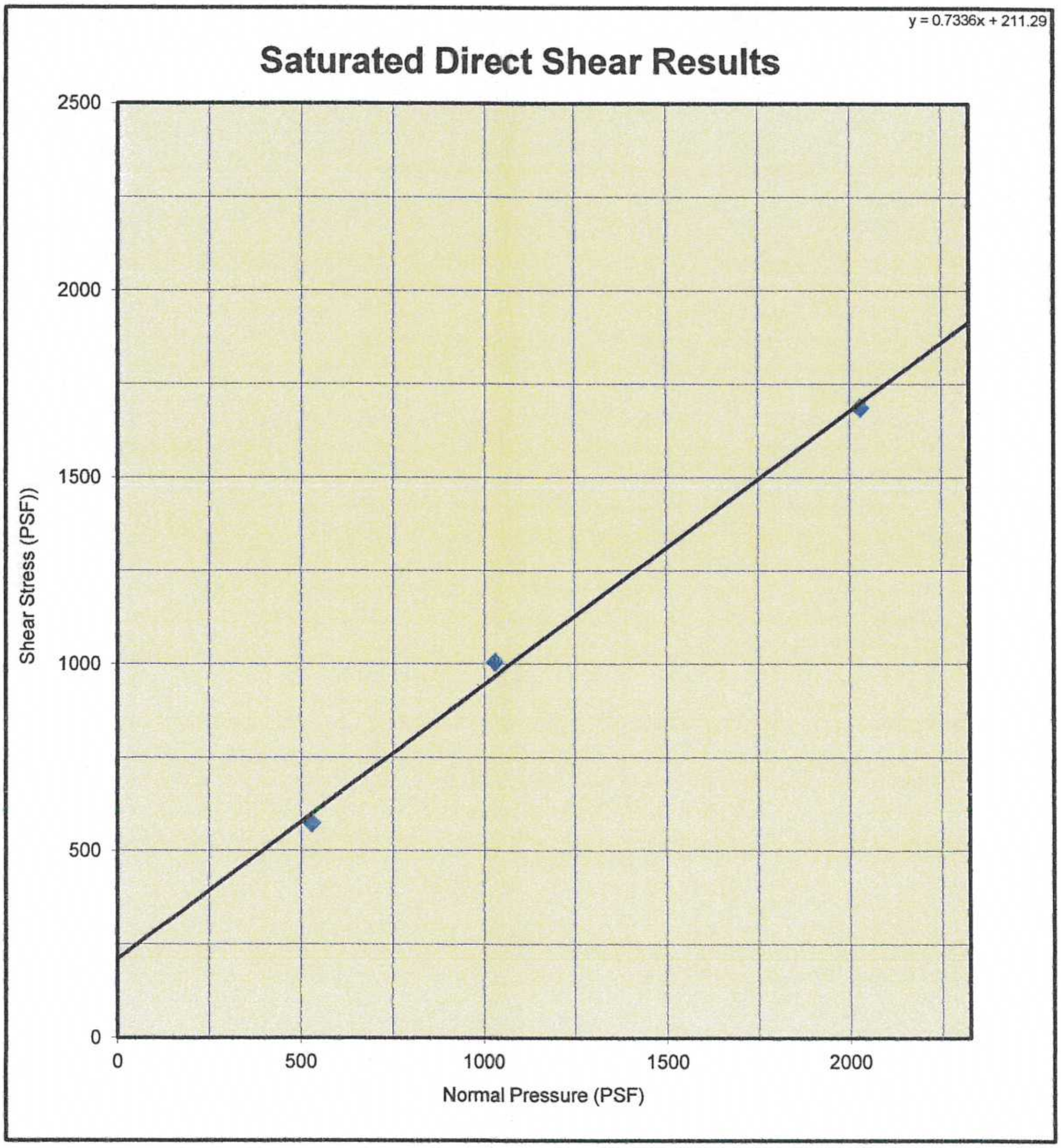


Figure No. 10

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Geotechnical and Coastal Engineers

Direct Shear

Project:	Esplanade Park & Sea Palm
Sample #	3-1-1
Description	Dk Brown Silty Sand w/ gravel

Date	6/16/2016
Tested By:	MA/AA

Test Number	1	2	3	4
Normal Pressure (PSF)	530	1030	2030	4030
Max Shear Stress	23	35.4	63.5	
Shear Stress (PSF)	675.4	1041.1	1866.2	

Equation of Trendline	
Intercept	Slope
238.9	0.7983

C (PSF)	PHI
239	39

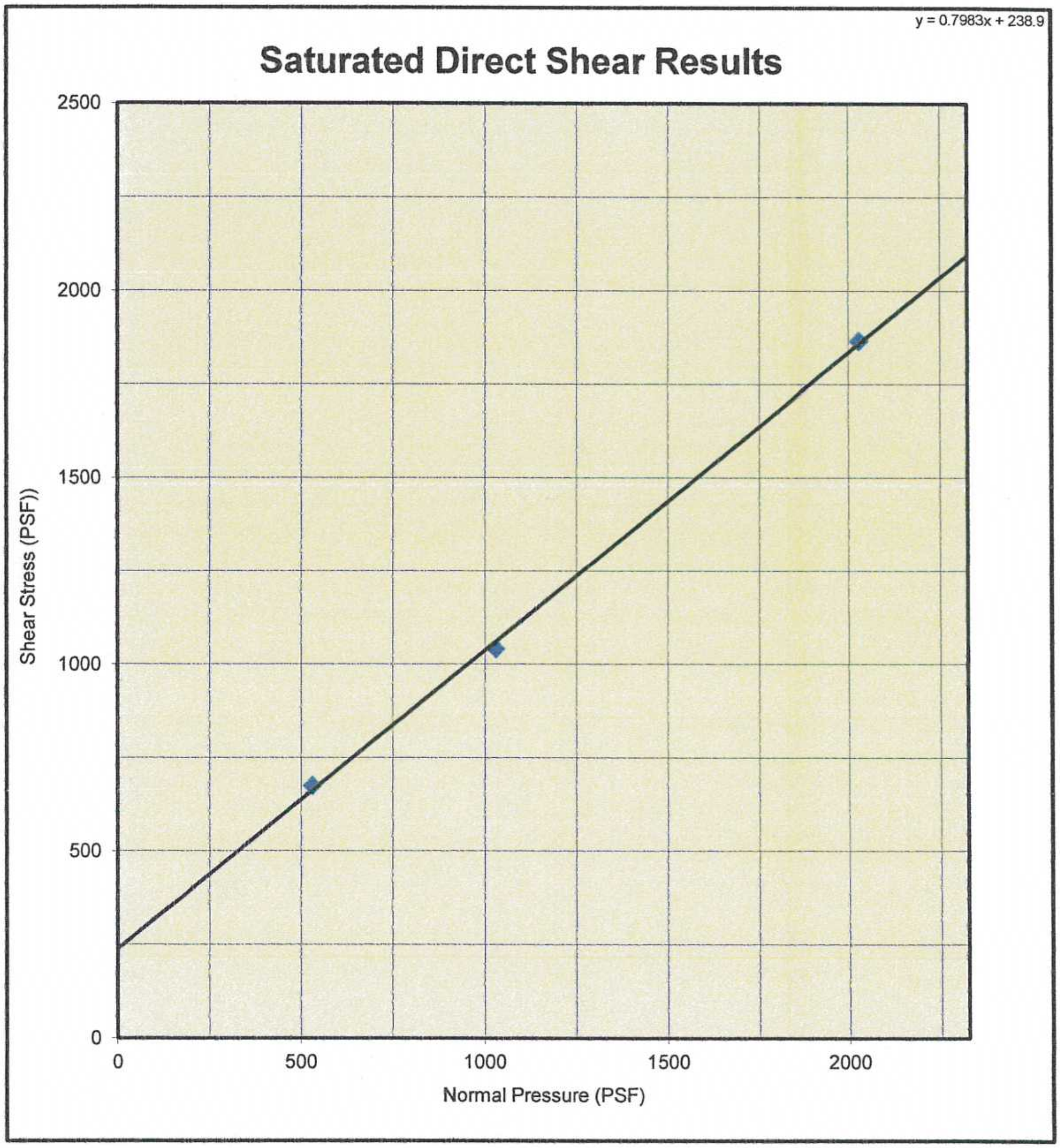

Figure No. 11

Direct Shear

Project:	Esplanade Park & Sea Palm
Sample #	3-5-1
Description	Brown Sand w/ silt

Date	6/14/2016
Tested By:	MA/AA

Test Number	1	2	3	4
Normal Pressure (PSF)	530	1030	2030	4030
Max Shear Stress	20.8	34.2	62.2	
Shear Stress (PSF)	610.6	1005.1	1830.2	

Equation of Trendline	
Intercept	Slope
173.61	0.8148

C (PSF)	PHI
174	39

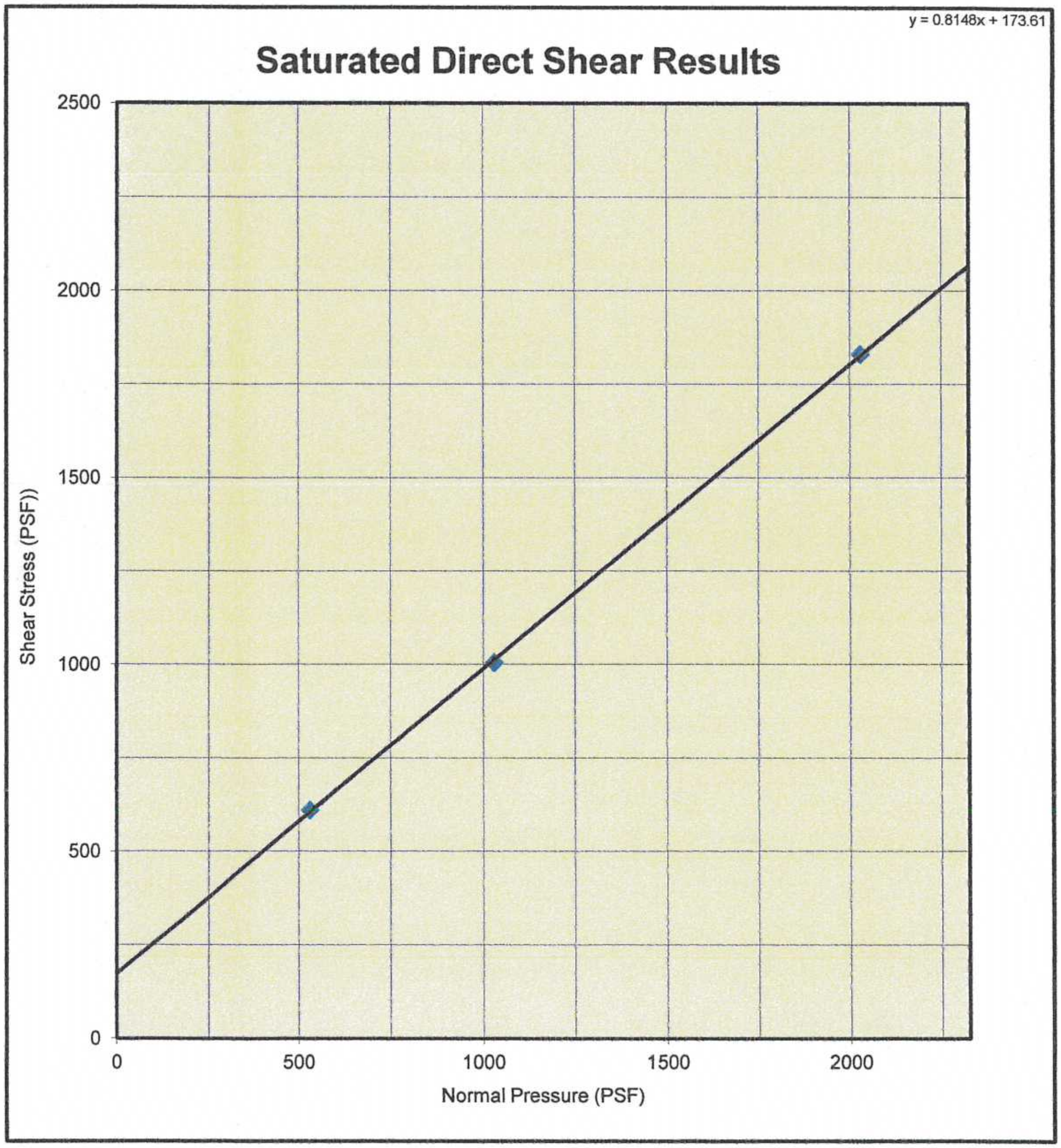

Figure No. 12

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Direct Shear

Project:	Esplanade Park & Sea Palm
Sample #	4-1-1
Description	Black Brown Silty Sand w/ gravel

Date	6/16/2016
Tested By:	MA/AA

Test Number	1	2	3	4
Normal Pressure (PSF)	530	1030	2030	4030
Max Shear Stress	19.5	36.6	59.5	
Shear Stress (PSF)	574.6	1077.1	1751	

Equation of Trendline	
Intercept	Slope
214.6	0.7685

C (PSF)	PHI
215	38

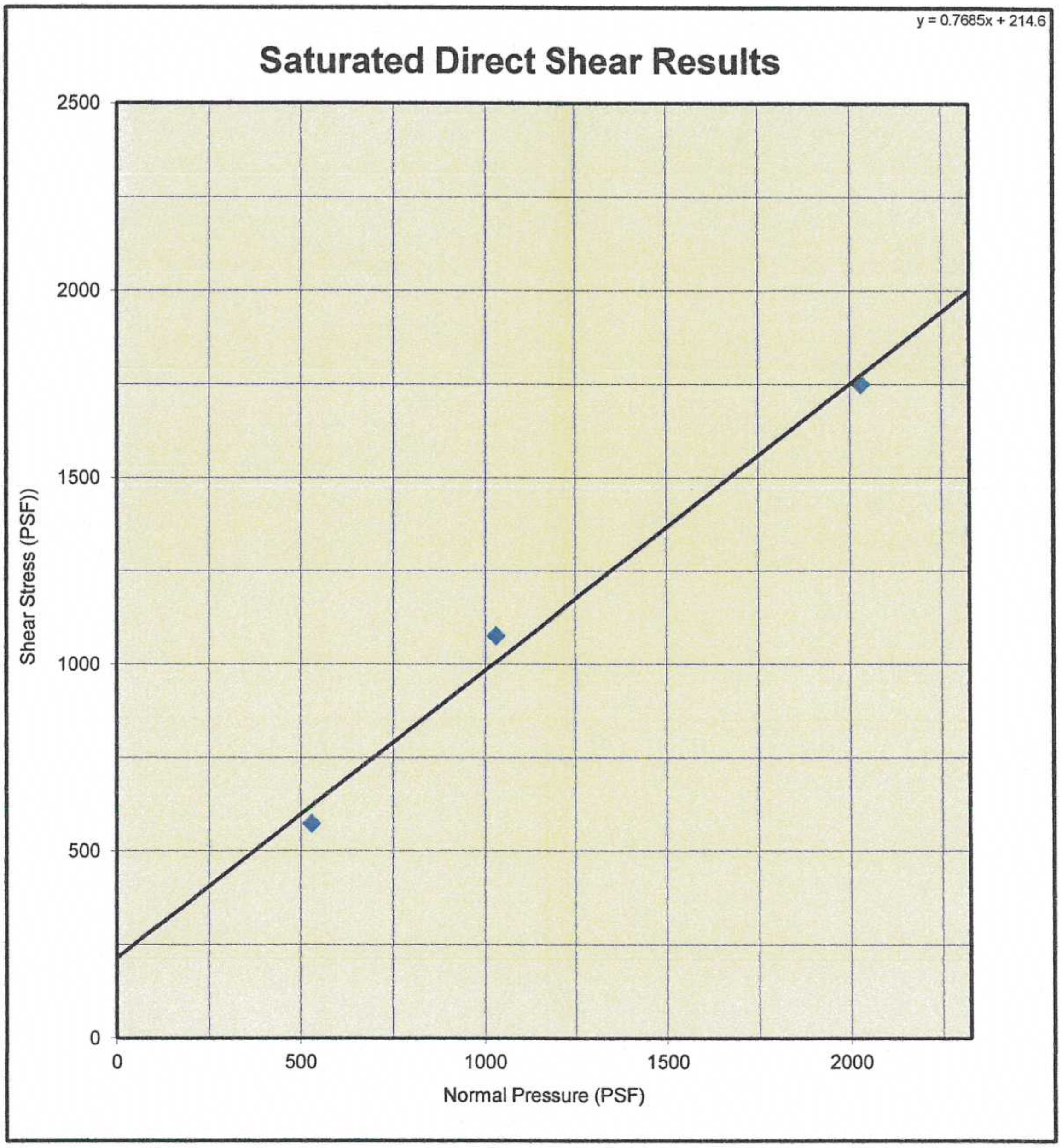

Figure No. 13

Haro Kasunich and Associates
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Direct Shear

Project:	Esplanade Park & Sea Palm
Sample #	5-3-1
Description	Brown Silty Sand w/ binder

Date	6/16/2016
Tested By:	MA/AA

Test Number	1	2	3	4
Normal Pressure (PSF)	530	1030	2030	4030
Max Shear Stress	41.5	50	85.2	
Shear Stress (PSF)	1219.7	1471.7	2505.6	

Equation of Trendline	
Intercept	Slope
676.28	0.8825

C (PSF)	PHI
676	41

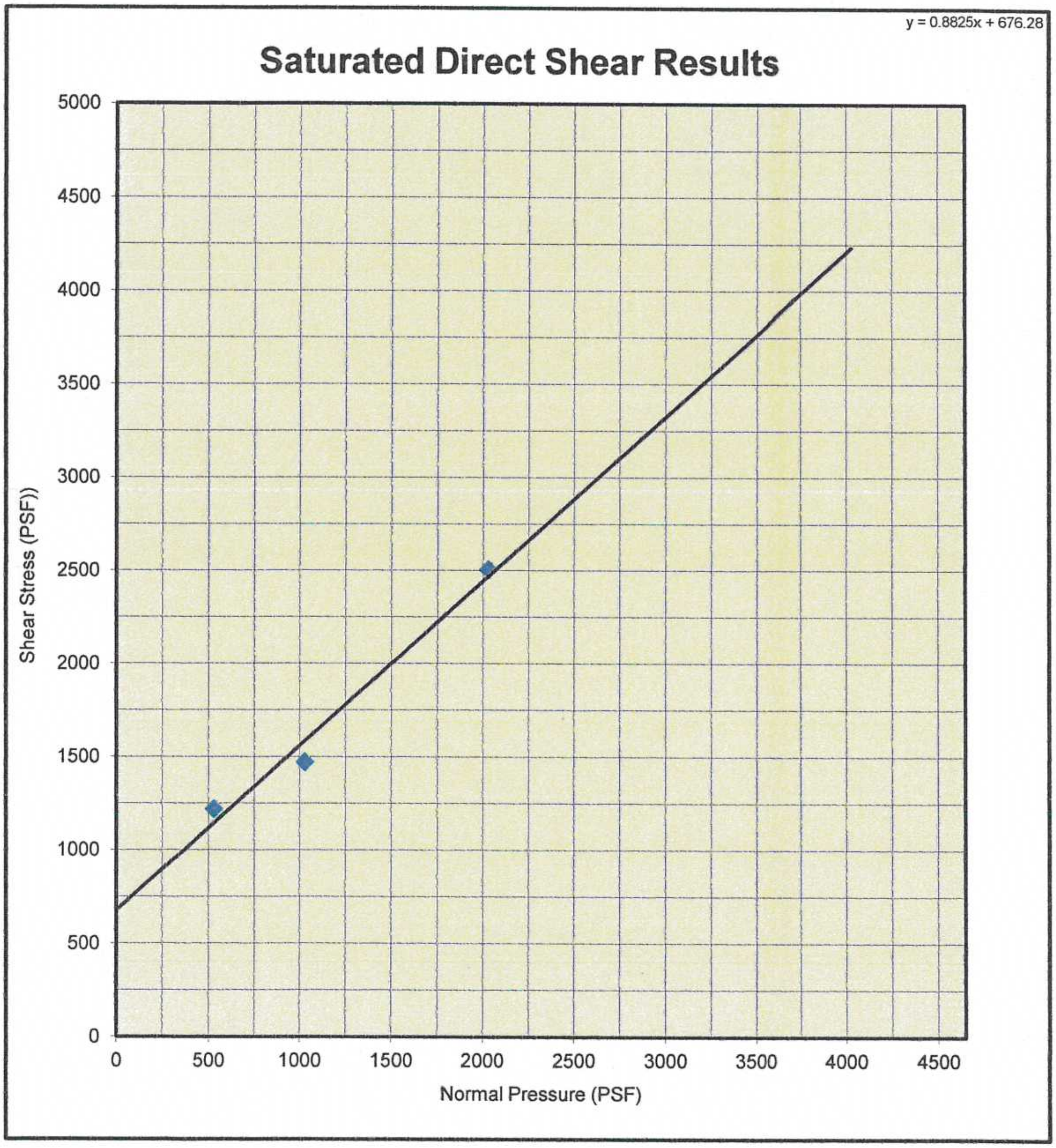

Figure No.

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