San Mateo County Harbor District

West Trail Repair – Phase 1

Conceptual Alternatives Analysis

September 2016

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Appendices

1. Introduction and Project Background

The West Trail is a north-south oriented trail located along the western edge of Pillar Point Harbor, as shown on Figure 1, Appendix A. It provides a pedestrian pathway from the West Point Avenue access and parking area to the ocean beach about 2,300 feet to the south. The date of original trail construction is not known. The trail provides public access to the Pillar Point outer harbor and to the Maverick's Beach beyond. It is a popular public access area that is used daily by pedestrians, dog owners, and other recreationists. The trail is heavily used during the annual Mavericks Surf competition.

1.1 Scope of Work

This project includes maintenance repairs for the West Trail erosion damage occurring between approximately 500 feet and 900 feet from the parking area (see Figure 2, Appendix A). Erosion in some locations is significant, undermining substantial portions of the trail and exposing an existing 12" asbestos concrete pipe on the water side. The hillside above the trail has also experienced erosion near the former stone labyrinth site. Without mitigation, this erosion will continue and further degrade the trail and its usefulness. In addition, there is concrete rubble partially strewn along the outer harbor beach that should be removed if it is in conflict with any proposed shoreline protection measure.

The project work along the 300-foot damaged segment of the West Trail from Station 5+00 to 8+00 will include rehabilitation and/or repair along the outer harbor shoreline, replacement and compaction of eroded fill material, and removal of concrete rubble on the outer harbor beach. The shoreline repairs are the subject of this analysis.

As mentioned above, hillside erosion has also occurred on the upslope side of the trail along a 150-foot-long section of hillside, just west of the shoreline erosion and across from the former stone labyrinth site. Within this area, there is also an approximately 50-foot-long section of shoreline erosion that has reduced the trail width. This project element also includes the hillside at the limits of the project area adjacent to the Pillar Point Air Force Station (AFS) property.

No rehabilitation or repair work is recommended at the former labyrinth site and beach access point located between Stations 8+50 and 9+50. The labyrinth site provides sufficient land barrier to preclude any detrimental effects of wave-generated erosion on West Trail at this location.

In summary, the rehabilitation and repair work along the West Trail is expected to include the following:

- Rehabilitate and/or repair eroding areas along the water side of the trail;
- Remove concrete rubble from outer harbor beach;
- Rehabilitate and/or repair other minor eroding areas along trail;
- Rehabilitate and/or repair eroding hillside areas above the trail.

2. General Description and Background

2.1 Site Conditions

The West Shoreline Access Trail, alternatively referred to as West Trail, begins at the public parking lot off West Point Avenue and extends approximately 2,300 feet south along the edge of

the harbor shoreline. The trail is an unpaved, unvegetated, densely compacted dirt pathway, varying in width from 8 to 18 feet. The edges of the trail are generally well-defined. Along the west is hillside with little to no low growing vegetation with the exception of a dense stand of cypress trees. The hillside is generally steep reaching elevations of over 100 above the trail at a 1.5H : 1V slope. At the top of the hill is the Pillar Point Air Force Station (AFS). Adjacent and downhill of AFS, a concrete swale presumed to catch sheet flow has been discovered to be discontinuous and clogged with sediment. At the end of the repair section, across the trail from the labyrinth, the hillside is mostly unvegetated. Shoreline to the east defines the other edge of the trail. Some areas of the trail merge into rocky or sandy coastal edge. Within the project area, the path is generally at or near the harbor's edge, varying in elevation from 5 to 10 feet above mean higher high water.

2.2 Current Concerns and Project Area Deficiencies

The trail has been subject to erosion due to wave action and drainage issues. To address part of the erosion and drainage issue located approximately 500 to 700 feet south of the parking area, an emergency repair was undertaken in early 2016 at the corrugated metal pipe (CMP) culvert stemming from the hillside. The existing CMP drained into a drainage inlet that then diverted flows via dual stacked culverts under the trail to an outfall that discharges into the harbor. The upper culvert was a 12-inch CMP. The lower culvert was an 18-inch inner diameter, 23-inch outer diameter concrete pipe fragmented across the beach at the outfall location. Both culverts were clogged with debris and did not appear to work. Over time, erosion began to undermine the trail where the stacked culverts met the shoreline. The resulting erosion narrowed the trail by at least four feet. In January, 2016, San Mateo County Harbor District (the District) replaced the existing drainage basin at the toe of the hillside along the western edge of the trail and replaced the dual drainage pipes with a larger 36-inch diameter reinforced concrete pipe. Based on the conditions of the Emergency Coastal Development Permit issued by the California Coastal Commission (Coastal Commission) covering the culvert repair, this repair is currently understood to be temporary.

At the top of the hill, it is presumed the drainage facilities are not sufficient to capture runoff adequately enough to prevent or slow down erosion along the hillside. The existing 3 foot wide gunite swale is discontinuous and does not connect to the downstream CMP that flows into the recently installed drainage repair.

At the end of the trail under study, the unvegetated hillside has been subject to sheet erosion which discharges onto to the pathway, building its elevation up over time. It was noted at a District-sponsored Design Charrette held on June 7, 2016, that trail users often scale down the hillside in this area, which exacerbates the erosion issues. Storm water runoff from the Pillar Point AFS at the top of the hill, lack of vegetation, recreational use and underlying geotechnical conditions may be contributing the erosion of the hillside.

2.3 Prior Actions

In 2012, GHD developed alternatives for the shoreline and hillside drainage repairs, including structural and bioengineering (i.e., "soft") solutions to diminish wave energy, and mitigate impacts from varying tides and heavy rain events. Alternatives developed at the time consisted of sheet pile walls, soil nail walls, retaining structures (e.g., stone rip rap, precast concrete shoreline protection), or planted areas. This analysis builds upon that Draft Condition Survey for West Trail.

Since at least 2010, erosion at two existing stacked culverts near Station 6+00 on West Trail created severe encroachment into and under the pathway. By winter of 2012, the void along the water side of the trail was 3 feet wide, with a 3.5-foot drop-off. The trail was also

undermined laterally along the culverts extending at least 8 feet back under the trail. Both culverts were clogged with debris and not functional. These issues created an unsafe condition for trail users and had the potential to preclude use of the trail as an emergency service access to Mavericks Beach.

In 2014, the Harbor District engaged GHD to conduct the design and environmental evaluation for this trail repair project, with the primary focus being the repair of the culverts and undermining and erosion of the trail. As resource agency interaction progressed on that effort and with the occurrence of the annual Maverick's Surf competition each winter, the District opted to focus on the culvert repair and defer the rest of the trail repair efforts to the project currently underway.

As part of this analysis, GHD assisted the Harbor District with conducting a "Design Charrette" on June 7, 2016, involving Harbor District staff, regulatory agency officials – including the Coastal Commission, and other stakeholders. The charrette provided an opportunity for these parties to convene as a group to view field conditions in the project area, share interests and concerns regarding the project, and discuss mutually agreeable solutions to the shoreline erosion issues along this public access trail.

3. Purpose of Report

For this alternatives analysis, GHD built on prior work and conducted more current analyses to develop budget-level cost estimates for each of the shoreline repair and slope stabilization alternatives presented below. A summary matrix has been developed that applies a rating to the alternatives to assist with the selection of the preferred alternative. The summary matrix is presented in Section 8.

Considerations for the alternatives include aesthetics, environmental permitting, edge effects, future maintenance, and cost guidelines. Commentary and/or alternative repair concepts for drainage conditions are also included.

4. Design Criteria

For this alternative analysis, any given alternative is expected to have a project life of 50 years, as determined in consultation with the California Coastal Commission and agreed upon by the District in May 2016.

Development of alternatives also took into consideration input from the 2016 Design Charrette. The project is to be functional, as well as aesthetically pleasing and accessible, providing a continuation of the trail around the bay and access for district maintenance vehicles.

5. Data Gathering

5.1 Design Charrette

At the request of the District, GHD assisted the District in preparing a presentation previewing a set of three preliminary or initial alternatives considered in prior analyses, as well as a "do-nothing" alternative. The concepts included the soldier pile wall, rock slope protection (RSP), and RSP with vegetation. The concepts were shared with the District prior to the charrette and were further refined based on feedback provided during the charrette.

In addition to the charrette, GHD relied on the following existing information:

- Bathymetry Surveys (1994 and 2006);
- Land Survey (2012); Supplemental Survey (2016)
- Coastal Study (Coast & Harbor Engineering, 2012);
- Geotechnical Investigation (Fisher Geotechnical 2012);
- Regional studies, guidelines, and data applicable to the project site;
- Land Survey (2016) along the existing trail to capture the current trail and coastal line geometries;
- The US Air Force Pillar Point, Air Force Drainage Areas (2006).

6. Alternatives Analysis

For purposes of this study, assumptions included a trail width of 18 feet including a minimum 12 foot wide path for pedestrian and maintenance or emergency vehicular access, maximum 3.5 foot wide drainage swale along the hillside and a shoulder along the waterside as shown in Figure 3. Where the existing 12" pipe is exposed, the trail will be widened to provide adequate cover. The alternatives developed include soldier pile wall, rock slope protection, rock slope protection with vegetation, beach nourishment, shotcrete and soil nail alternative, and a "Do Nothing" alternative.

In addition to these alternatives, and based on it review of the existing conditions of the site to address drainage issues, anticipated sea level rise (SLR) and coastal hazards, GHD also recommends a 425 foot long, 3.5 foot wide drainage swale, a 150 foot long, 3 foot wide drainage swale and buildup of the existing trail to an elevation of 12.2 feet as shown in Figure 2, Appendix A. Note that the buildup of the trail would extend outside of the study area towards the existing parking lot off West Point Avenue. At approximate Station 8+15, there is an abandoned outfall pipe, which was part of the Granada Sanitary District's former treatment plant. The treatment plant no longer exists and the outfall pipe is no longer active. As part of this study, it is recommended that the pipe remain abandoned-in-place and not removed due to its potential asbestos content. These recommendations and the District's desire for a minimum trail width are included in the analyses of alternatives presented herein.

In general, most alternatives can be installed to match the existing curvature and follow the general profile of the trail accounting for the increase of trail elevation due to SLR considerations. Generally, should repairs be necessary, they would span small discrete sections rather than the entire trail length. Disadvantages include additional formwork and increased construction time due to timing of tides.

6.1 Alternative 1 – Soldier Pile Wall

The soldier pile wall would consist of precast reinforced concrete lagging placed between steel soldier piles. The concrete lagging would be textured to be more aesthetically pleasing and blend better with the surrounding area as shown in Figures 4A and 4B, from two vantage points. The lagging would need to be secured at the top to prevent adverse movement due to wave action and may be built to an elevation of 12.7 feet to provide a consistent six inch high curb along the trail.

6.2 Alternative 2 – Rock Slope Protection

Rock slope protection, alternatively called RSP or rip rap revetment, would consist of placing large rock boulders against the bank and at a 1.5H:1V transition to the shore. As recommended by Fisher's Geotechnical Study (2012), a toe key or trench would be excavated to a depth of three feet below grade to provide stability of the revetment. The geotechnical study also anticipates exposed bedrock along the majority of the key. Geotextile fabric would be sandwiched between the existing slope and the revetment for approximately 300 feet. Rip rap would have a maximum diameter of 2.8 feet with voids filled with smaller rock. Figures 5A and 5B provide conceptual views of this alternative from two vantage points.

To keep a consistent look through the shoreline, the rip rap spans approximately 350 feet to taper to towards the landside. This alternative blends well with the existing shoreline due to its similar look. The alignment of the improvement conforms to the existing bank and may be installed in a relatively short timeframe. The cost of this alternative is also relatively low.

Figures 6A and 6B provide a hybrid alternative combining Alternatives 1 and 2, utilizing both a soldier pile wall and rock slope protection. The hybrid alternative provides more aesthetic appeal, but there would be no cost savings with this alternative. Concepts are provided for reference should the District wish to explore this option.

6.3 Alternative 3 – Rock Slope Protection with Vegetation

Rock slope protection with vegetation is similar to Alternative 2 described above. However, instead of smaller rock being placed between the voids of the larger rocks, vegetation can be planted. The selection of planting proposed is dependent on the tidal elevations. Proposed plantings above wave action include California sagebrush, coyote bush, maritime brome, tufted hair grass, and bluff lettuce. Plantings within the area most vulnerable to wave action, but above the mean high tide, include beach saltbush, and salt grass. In the lower zone, still susceptible to wave action through to low tide, alkali heath, pickleweed, and fleshy jaumea are proposed. No planting is proposed below low tide. Figure 7A and 7B provide conceptual views of the proposed plantings per zone from two vantage points. Figure 7C provides a schematic rendering of rock slope protection with vegetation.

6.4 Alternative 4 – Beach Nourishment

Beach nourishment calls for the addition of sediment, typically sand, from elsewhere and placement along the eroding shoreline to create a new, wider beach. The placement of sediment or sand does not necessarily stop the erosion process, but can slow the process down by providing erosional forces like wave action an obstacle to encounter prior to reaching inland. The energy from the erosional forces dissipates over the expanse of beach. As long as beach remains, the structures beyond the beach (i.e., landside) have some protection. Key to successful beach nourishment is providing appropriate grain size and compatibility with the existing native sands.

While the advantage to beach nourishment is that the initial capital cost is less expensive than replacing the structures destroyed by storms and flooding, there are several disadvantages. Sand is erodible. Beach nourishment, in the long term, can be expensive due to routine replenishment required to maintain the desired volume of sand. Beach nourishment may also adversely affect local species habitat within the existing sand bed. As noted above, sediment or sand would need routine replenishment, thereby making the coast line appear to be a constant construction zone which may not be favorable met by the local community. This alternative does not provide the District with the desired trail width, including drainage improvement and access requirements. To be more effective, this alternative would be used in conjunction with Alternatives 2 or 3.

6.5 Alternative 5 – Shotcrete and Soil Nail Wall

The shotcrete and soil nail wall alternative calls for installing approximately two rows of soil nails into the bank under the trail. The soil nail is typically rebar installed in a predrilled hole in the face of the bank at a typical angle of 15 degrees. The rebar is set, with grout injected in the annular space between the rebar and the hole to anchor it into the bank. Reinforced mesh would be placed against the bank and fastened to the soil nails. Shotcrete, which is comprised of low pressure concrete with low slump, would be pumped at high pressure against the mesh at the bank. To create an aesthetically pleasing look, the shotcrete can be colored and/or texturized.

As part of the trail needs to be build up, additional forms may be needed at the top of the bank to set the shotcrete in place before the trail is built up. Additional environmental permitting may be needed for placing shotcrete in a marine environment.

6.6 Alternative 6 – "Do Nothing"

The "Do Nothing" alternative means that no restoration of the trail and protection of the shoreline would occur, as shown in Figure 8. The existing issues of shoreline erosion and retreat, diminishing trail width, and possibly physical loss of the trail due to expected sea level rise would continue. There are no capital costs associated with the "Do Nothing" alternative, but ongoing operation maintenance and repair would continue to a point where repairs could no longer be cost effective to ensure safe use of the trail.

7. Estimated Probable Construction Costs

For purposes of this study, these preliminary cost estimates were developed with a 30% contingency for the alternatives presented. The engineer's estimate of probable construction costs are summarized below. These estimates are for comparison purposes only and should not be construed as final estimates.

Table 1 Estimated Construction Costs

Alternative	Estimated Preliminary Cost ($1,000)
1. Soldier Pile Wall	2,187
2. Rock Slope Protection	482
3. Rock Slope Protection with Planting	507
4. Beach Nourishment	552
5. Shotcrete and Soil Nail Wall	995
6. Do Nothing	0

8. Evaluation Parameters

The concept alternatives for the shoreline repair were evaluated by performing a value or benefit/cost (B/C) analysis of each for the selected parameters described below. The proposed evaluation consists of the following steps:

1. Determine applicable evaluation parameters.
2. Assign relative weighting factors to each evaluation parameter.
3. Assign relative rating factors for each parameter and conceptual alternative.
4. Determine a total rating for each concept by summing the weighted ratings for each concept parameter. This total rating represents the relative benefit of the project.
5. Plot the concept estimated cost against the concept rating and determine the B/C ratio.

8.1 Parameters

Evaluation parameters used as a basis for assessment should be significant to the project and preferably should show some variation among the conceptual alternatives. Based on GHD's understanding of District preferences for this project, and considering input provided during the Design Charrette, cost, schedule, permitting, technical feasibility, green construction, aesthetics, and accessibility issues are primary considerations for this project. The associated weighting factors are subjective, but are based on consensus among District decision makers. The evaluation parameters and associated weighting and rating factors applied to these alternatives are, therefore:

8.1.1 Cost

It is assumed that the cost of each alternative is of primary concern to the District and has been assigned a weighting factor of 30 percent. The estimated cost of each alternative is presented in Table 1. The lowest cost alternative is assigned a rating of 100 percent, the highest cost alternative is assigned a rating of 0 percent, and the alternatives in between are rated linearly.

8.1.2 Schedule

It is assumed that schedule is of relatively moderate concern and has been assigned a weighting factor of 15 percent. The "best schedule" alternative is assigned a rating of 100 percent, with the other alternatives assigned a rating based on perceived relative schedule.

8.1.3 Permitting

It is assumed that permitting is of minor concern and has been assigned a weighting factor of 10 percent. Alternatives with no permitting concerns are assigned a rating of 100 percent. Alternatives with significant permitting concerns are assigned rating of 0 percent. Other alternatives are assigned a rating based on perceived relative permitting issues.

8.1.4 Technical Feasibility

It is assumed that technical feasibility (i.e., the ability for the concept to perform as expected) is of high priority. It has been assigned a weighting factor of 20 percent. However, concepts that are not technically feasible would not be considered further and receive zero rating for all evaluation parameters. Technically feasible concepts would receive a rating of 100 percent.

8.1.5 Aesthetic Appearance

It is assumed that aesthetic appearance of the alternative concepts is of relatively significant concern and has been assigned a weighting factor of 15 percent. Alternatives that are aesthetically compatible are assigned a rating of 100 percent. Alternatives which detract from the natural look of the area are assigned rating of 0 percent. Other alternatives are assigned a rating based on projected permitting issues.

8.1.6 Accessibility

It is assumed that site accessibility in terms of ADA, public enjoyment, and emergency vehicular operations is of relatively significant concern and has been assigned a weighting factor of 10 percent. An alternative that provides accessibly per the requirements mentioned above is assigned a rating of 100 percent. Alternatives that tend not to provide or enhance such accessibility are assigned rating of 0 percent. Other alternatives are assigned a rating based on projected relative permitting issues.

Table 2 Evaluation Criteria and Scoring

Evaluation Criteria	%	Comment	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
			Soldier Pile Wall	Rock Slope Protection	Rock Slope Protection with Vegetation	Beach Nourishment	Soil Nail Wall	Do Nothing
Cost	30	One time cost to the District; Operation and Maintenance Costs	**22%**	**100%**	**95%**	**87%**	**49%**	**0%**
Schedule	15	Project acceptance with a year	**60%**	**100%**	**90%**	**100%**	**70%**	**0%**
Permitting	10	Ease of obtaining approvals and permits	**50%**	**100%**	**75%**	**55%**	**45%**	**0%**
Technical Feasibility	20	Ease of Construction	**75%**	**100%**	**60%**	**50%**	**65%**	**100%**
Aesthetic Appearance	15	Impact on existing and proposed aesthetic value	**50%**	**75%**	**100%**	**80%**	**75%**	**10%**
Accessibility	10	Impact on public safety with respect to ADA requirements	**50%**	**100%**	**75%**	**15%**	**80%**	**0%**
		Total Rating	48	96	84	70	62	22
		RANK	5	1	2	3	4	6

The Total Rating is a standardized summation of the weighted rating factors for each alternative. A perfect score would be 100.

9. Recommendations and Conclusions

Based on the parameters and analysis presented in this report, Alternative 2 (Rock Slope Protection) is the most preferred alternative. This alternative received high ranking for all parameters, except Aesthetic Appearance, where it scored a 75 percent on a 15-percent-weighed parameter.

10. References

Fisher Geotechnical (2012). Geotechnical Assessment Pillar Point Harbor West Trail Erosion Repair, Princeton-by-the Sea, San Mateo County, California

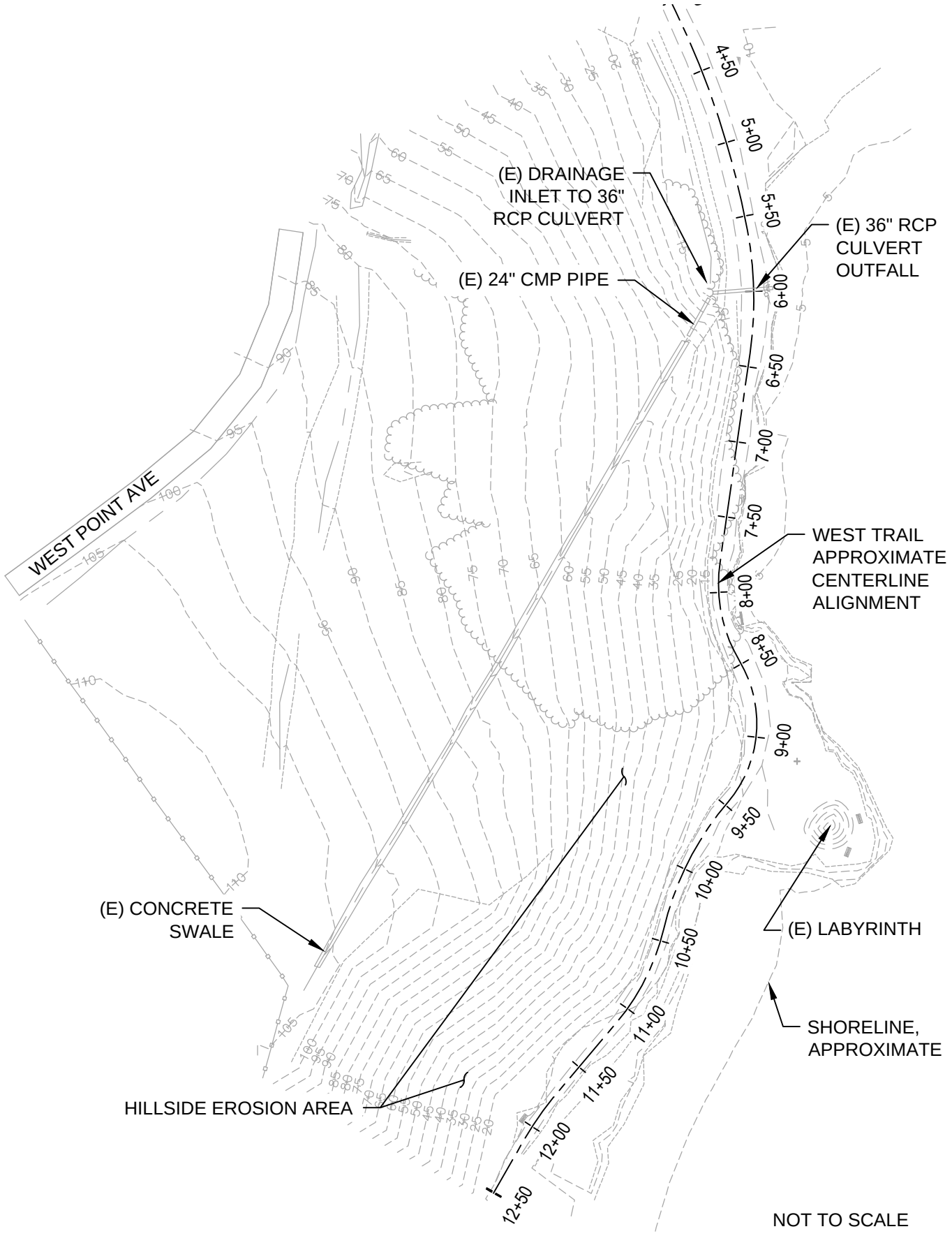
Moffatt and Nichol (2015). Facility Condition Survey, Pillar Point Harbor.

GHD (2016) San Mateo County Harbor District Drainage Study for West Trail Repair – Phase 1 - Draft

GHD (2016) San Mateo County Harbor District Sea Level Rise and Erosion Study for West Trail Repair – Phase 1 - Draft

Appendices

Appendix A – Figures



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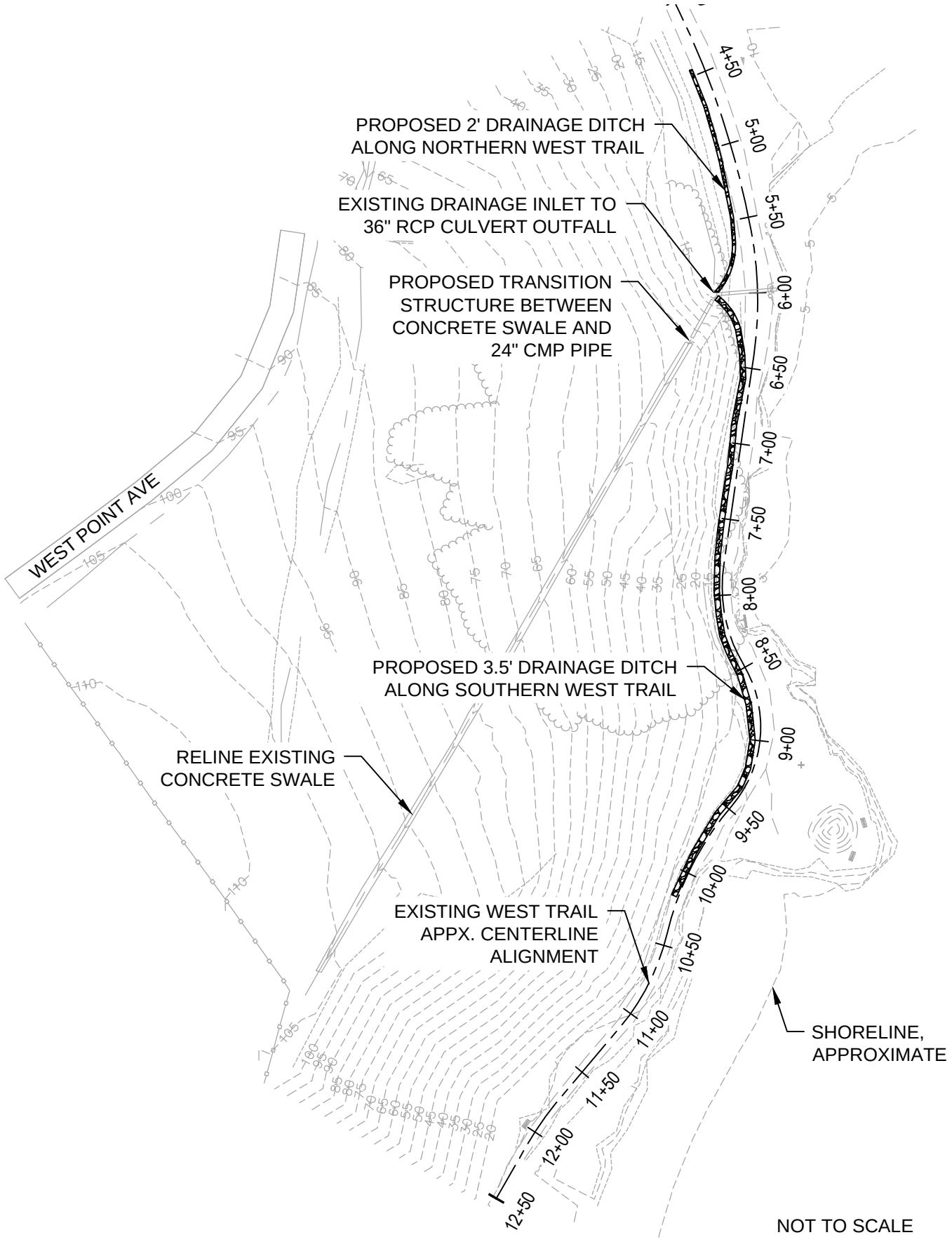
SAN MATEO COUNTY HARBOR DISTRICT
PILLAR POINT HARBOR
WEST TRAIL REPAIR - PHASE 1
EXISTING SITE CONDITIONS

Job Number 11121528
Revision
Date July 2016

Figure 1

655 Montgomery Street, Suite 1010 San Francisco CA 94111 USA **T** 1 415 283 4970 **F** 1 415 283 4980 **E** sanfrancisco@ghd.com **W** www.ghd.com

Plot Date: 28 July 2016 - 11:23 AM Cad File No: N:\US\Santa Rosa\Projects\111\11121528 SMCHD West Trail Repair\06-CAD\Figures\WATERSHEDS\11121528 Figure 1_Existing_Conditions.dwg



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SAN MATEO COUNTY HARBOR DISTRICT
PILLAR POINT HARBOR
WEST TRAIL REPAIR - PHASE 1
PROPOSED SITE CONDITIONS

Job Number 11121528
Revision
Date July 2016

Figure 2

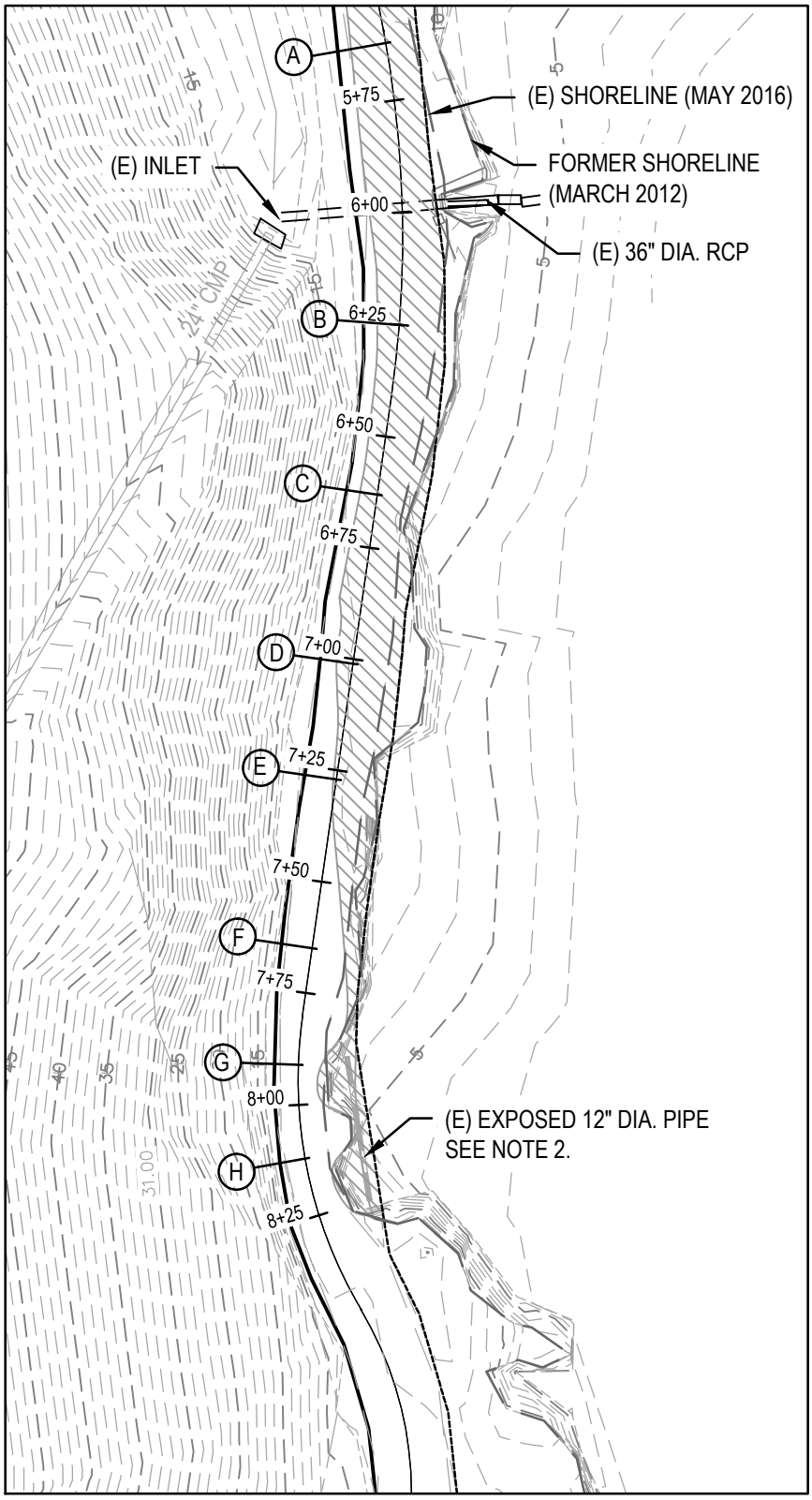
655 Montgomery Street, Suite 1010 San Francisco CA 94111 USA **T** 1 415 283 4970 **F** 1 415 283 4980 **E** sanfrancisco@ghd.com **W** www.ghd.com

Plot Date: 28 July 2016 - 11:23 AM Cad File No: N:\US\Santa Rosa\Projects\111\11121528 SMCHD West Trail Repair\06-CAD\Figures\WATERSHEDS\11121528 Figure 2_Proposed_Conditions.dwg

		MARCH 2012	MAY 2016
	STATION	TRAIL WIDTH (FEET)	
A	5+62.00	16.5	17.9
B	6+25.00	15	18.3
C	6+63.00	13	12.7
D	7+01.00	17	21.1
E	7+27.00	16	15.7
F	7+65.00	15	15.7
G	7+91.00	13	11.6
H	8+12.00	14	13.7

NOTES:
1. 18' TRAIL WIDTH NECESSARY TO PROVIDE SETBACK AND DRAINAGE SWALE.
2. EXTEND TRAIL WIDTH A MINIMUM OF 2' BEYOND OUTERMOST EDGE OF EXPOSED 12" DIA. PIPE.

LEGEND
- (E) EDGE OF TRAIL
- PROPOSED TRAIL WIDTH
- ADDITIONAL FILL FOR TRAIL BUILD-UP



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SAN MATEO COUNTY HARBOR DISTRICT
PILLAR POINT HARBOR
WEST TRAIL REPAIR - PHASE 1
PROPOSED TRAIL WIDENING

Job Number 11121528
Revision
Date Aug 2016

Figure 3

505 Montgomery Street, Suite 2300 San Francisco CA 94111 USA **T** 1 415 283 4970 **F** 1 415 283 4980 **E** sanfrancisco@ghd.com **W** www.ghd.com

Plot Date: 1 September 2016 - 5:50 PM Cad File No: N:\US\Santa Rosa\Projects\111\11121528 SMCHD West Trail Repair\06-CAD\Figures\TRAIL WIDENING\11121528 Figure 3_Proposed Trail Widening.dwg

SAN MATEO COUNTY HARBOR DISTRICT
PILLAR POINT HARBOR
WEST TRAIL REPAIR - PHASE 1

SOLDIER PILE WALL RENDERINGS
VIEW FROM BEACH

PROJECT NO.
11121528
DATE
AUG 2016

Figure 4A

655 Montgomery Street Suite 1010 San Francisco CA 94111 USA **T** 1 415 283 4970 **F** 1 415 283 4970 **E** sanfrancisco@ghd.com

SAN MATEO COUNTY HARBOR DISTRICT
PILLAR POINT HARBOR
WEST TRAIL REPAIR - PHASE 1

SOLDIER PILE WALL RENDERINGS
VIEW FROM LABYRINTH

PROJECT NO.
11121528
DATE
AUG 2016

Figure 4B

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SAN MATEO COUNTY HARBOR DISTRICT
PILLAR POINT HARBOR
WEST TRAIL REPAIR - PHASE 1

ROCK SLOPE PROTECTION RENDERING
VIEW FROM BEACH

PROJECT NO.
11121528
DATE
AUG 2016

Figure 5A

655 Montgomery Street Suite 1010 San Francisco CA 94111 USA **T** 1 415 283 4970 **F** 1 415 283 4970 **E** sanfrancisco@ghd.com

SAN MATEO COUNTY HARBOR DISTRICT
PILLAR POINT HARBOR
WEST TRAIL REPAIR - PHASE 1

ROCK SLOPE PROTECTION RENDERING VIEW FROM LABYRINTH

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DATE
AUG 2016

Figure 5B

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SAN MATEO COUNTY HARBOR DISTRICT
PILLAR POINT HARBOR
WEST TRAIL REPAIR - PHASE 1

ROCK SLOPE PROTECTION WITH VEGETATION RENDERING
VIEW FROM BEACH

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DATE
AUG 2016

Figure 6A

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SAN MATEO COUNTY HARBOR DISTRICT
PILLAR POINT HARBOR
WEST TRAIL REPAIR - PHASE 1

ROCK SLOPE PROTECTION WITH VEGETATION RENDERING
VIEW FROM LABYRINTH

PROJECT NO.
11121528
DATE
AUG 2016

Figure 6B

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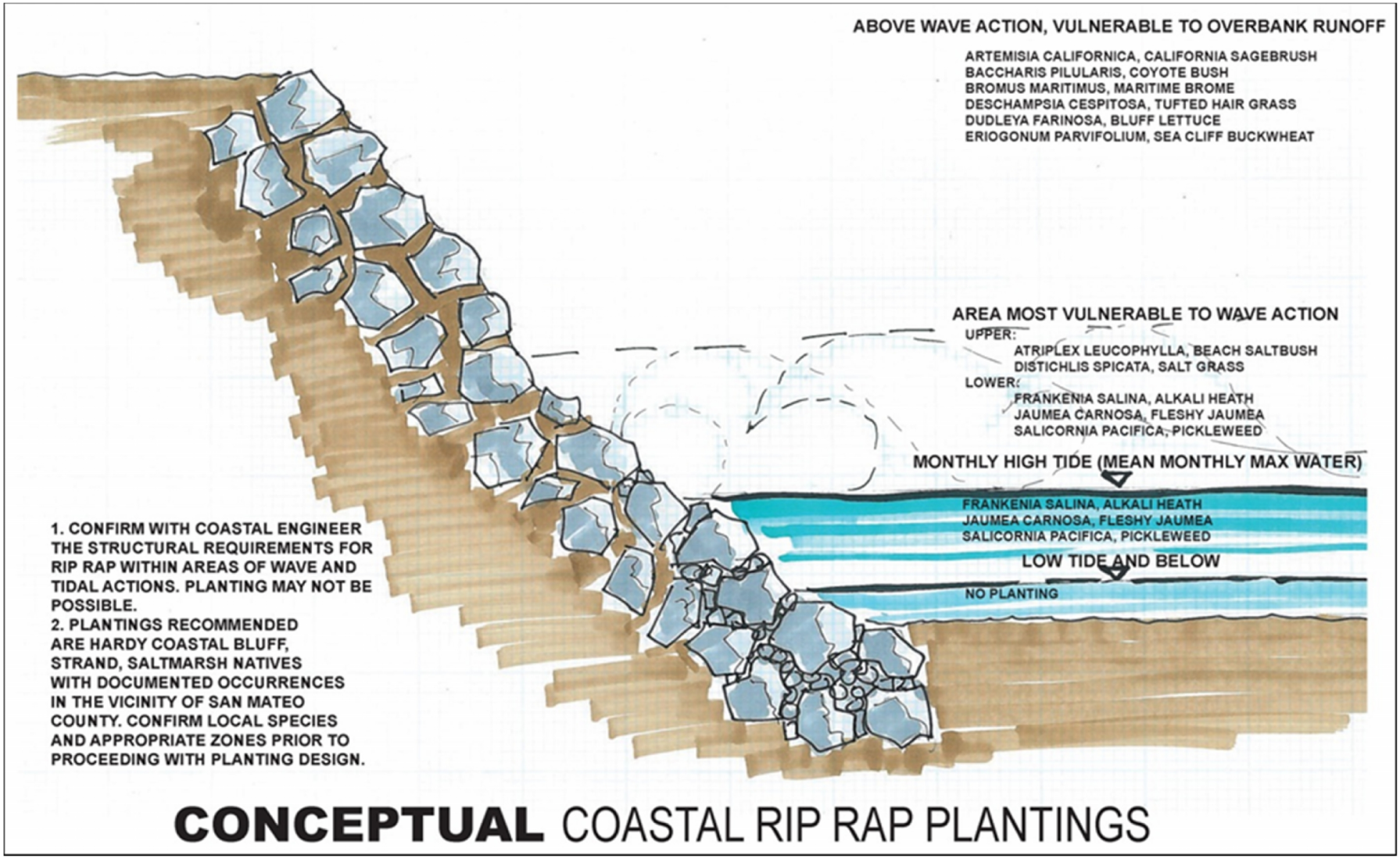

CONCEPTUAL COASTAL RIP RAP PLANTINGS

SAN MATEO COUNTY HARBOR DISTRICT
PILLAR POINT HARBOR
WEST TRAIL REPAIR - PHASE 1
CONCEPTUAL COASTAL RIPRAP PLANTINGS

PROJECT NO.
11121528
DATE
AUG 2016
Figure 6C

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SAN MATEO COUNTY HARBOR DISTRICT
PILLAR POINT HARBOR
WEST TRAIL REPAIR - PHASE 1

HYBRID ALTERNATIVE RENDERING - COMBINING ALTERNATIVES 1 & 2
VIEW FROM BEACH

PROJECT NO.
11121528
DATE
AUG 2016

Figure 7A

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SAN MATEO COUNTY HARBOR DISTRICT
PILLAR POINT HARBOR
WEST TRAIL REPAIR - PHASE 1

PROJECT NO. 11121528

DATE AUG 2016

HYBRID ALTERNATIVE RENDERING - COMBINING ALT. 1 & 2
VIEW FROM LABYRINTH

Figure 7B

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SAN MATEO COUNTY HARBOR DISTRICT
PILLAR POINT HARBOR
WEST TRAIL REPAIR - PHASE 1

DO NOTHING ALTERNATIVE
VIEW FROM BEACH

PROJECT NO.
11121528
DATE
AUG 2016

Figure 8

655 Montgomery Street Suite 1010 San Francisco CA 94111 USA **T** 1 415 283 4970 **F** 1 415 283 4970 **E** sanfrancisco@ghd.com

Appendix B – Cost Estimates

ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COST
WEST TRAIL REPAIR - Phase 1

Client: San Mateo Harbor District
Project: Pillar Point Harbor - West Trail Phase 1

Date: 7-27-16

	Description	Quantity No	Quantity Unit	Cost Mat'l	Cost Labor	Total Material Cost	Total Labor Cost	Total Unit Cost	Total Cost
	General Description of Work								
	Soldier Pile Wall at West Trail - Alt Analysis								
	Mobilization	1	LS		$40,000.00		$40,000.00	$40,000.00	$40,000
	Site Demolition								
	Protect in place Ex AC Pipe	1	LS		$5,000.00		$5,000.00	$5,000.00	$5,000
	Removal of Concrete Rubble	1	LS		$11,200.00		$11,200.00	$11,200.00	$11,200
	Erosion Control	1	LS	$4,000.00			$0.00	$4,000.00	$4,000
	Trail Drainage								
	Trailside 3.5 foot wide Drainage Ditch	425	LF	$50.00	$80.00	$21,250.00	$34,000.00	$130.00	$55,250
	Trailside 3 foot wide Drainage Ditch	150	LF	$49.00	$80.00	$7,350.00	$12,000.00	$129.00	$19,350
	Trail Repair								
	Place Backfill and Compact for Trail	370	CY	$85.00	$119.00	$31,450.00	$44,030.00	$204.00	$75,480
	Soldier pile retaining wall	300	LF	$1,075.00	$2,785.00	$322,500.00	$835,500.00	$3,860.00	$1,158,000
	Hillside Improvements								
	Vegetate hillside	20,000	SF	$0.07	$1.50	$1,400.00	$30,000.00	$1.57	$31,400
	Temporary Fencing	600	LS	$6.50	$10.00	$3,900.00	$6,000.00	$16.50	$9,900
	Materials Subtotal					$387,850.00			
	Subtotal Labor + Materials								$1,409,580
	Hard Costs Estimating Contingency	5%							$70,479
	Subtotal Hard Costs								$1,480,059
	Sales Tax on Materials	8.50%							$32,967
	General Conditions	10%							$0
	Bond & Insurance	3%							$44,402
	Subtotal								$77,369
	General Contractor's Fee (OH&P)	8%							$124,594.24
	Overall Estimating Contingency	30%							$504,606.68
	TOTAL ESTIMATED CONSTRUCTION COSTS								**$2,186,629**

ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COST
WEST TRAIL REPAIR - Phase 1

Client: San Mateo Harbor District
Project: Pillar Point Harbor - West Trail Phase 1

Date: 7-27-16

	Description	Quantity No	Quantity Unit	Cost Mat'l	Cost Labor	Total Material Cost	Total Labor Cost	Total Unit Cost	Total Cost
	General Description of Work								
	RSP at West Trail - Alt Analysis								
	Mobilization	1	LS		$40,000.00		$40,000.00	$40,000.00	$40,000
	Site Demolition								
	Protect in place Ex AC Pipe	1	LS		$5,000.00		$5,000.00	$5,000.00	$5,000
	Removal of Concrete Rubble	1	LS		$11,200.00		$11,200.00	$11,200.00	$11,200
	Erosion Control	1	LS	$4,000.00			$0.00	$4,000.00	$4,000
	Trail Repair								
	Trailside 3.5 foot wide Drainage Ditch	425	LF	$50.00	$80.00	$21,250.00	$34,000.00	$130.00	$55,250
	Trailside 3 foot wide Drainage Ditch	150	LF	$49.00	$80.00	$7,350.00	$12,000.00	$129.00	$19,350
	Place Backfill and Compact for Trail	370	CY	$85.00	$119.00	$31,450.00	$44,030.00	$204.00	$75,480
	Place 1/4 ton Riprap in void space	69	CY	$87.00	$105.00	$6,041.67	$7,291.67	$192.00	$13,333
	Place 1/2 ton Rip Rap along shoreline	208	CY	$89.00	$129.00	$18,541.67	$26,875.00	$218.00	$45,417
	Hillside Improvements								
	Vegetate hillside	20,000	SF	$0.07	$1.50	$1,400.00	$30,000.00	$1.57	$31,400
	Temporary Fencing	600	LS	$6.50	$10.00	$3,900.00	$6,000.00	$16.50	$9,900
	Materials Subtotal					$89,933.33			
	Subtotal Labor + Materials								$310,330
	Hard Costs Estimating Contingency	5%							$15,517
	Subtotal Hard Costs								$325,847
	Sales Tax on Materials	8.50%							$7,644
	General Conditions	10%							$0
	Bond & Insurance	3%							$9,775
	Subtotal								$17,420
	General Contractor's Fee (OH&P)	8%							$27,461.30
	Overall Estimating Contingency	30%							$111,218.26
	TOTAL ESTIMATED CONSTRUCTION COSTS								**$481,946**

ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COST
WEST TRAIL REPAIR - Phase 1

Client: San Mateo Harbor District
Project: Pillar Point Harbor - West Trail Phase 1

Date: 7-27-16

	Description	Quantity No	Quantity Unit	Cost Mat'l	Cost Labor	Total Material Cost	Total Labor Cost	Total Unit Cost	Total Cost
	General Description of Work								
	RSP with vegetation at West Trail - Alt Analysis								
	Mobilization	1	LS		$40,000.00		$40,000.00	$40,000.00	$40,000
	Site Demolition								
	Protect in place Ex AC Pipe	1	LS		$5,000.00		$5,000.00	$5,000.00	$5,000
	Removal of Concrete Rubble	1	LS		$11,200.00		$11,200.00	$11,200.00	$11,200
	Erosion Control	1	LS	$4,000.00			$0.00	$4,000.00	$4,000
	Trail Repair								
	Trailside 3.5 foot wide Drainage Ditch	425	LF	$50.00	$80.00	$21,250.00	$34,000.00	$130.00	$55,250
	Trailside 3 foot wide Drainage Ditch	150	LF	$49.00	$80.00	$7,350.00	$12,000.00	$129.00	$19,350
	Place Backfill and Compact for Trail	370	CY	$85.00	$119.00	$31,450.00	$44,030.00	$204.00	$75,480
	Place 1/4 ton Riprap in void space	52	CY	$87.00	$105.00	$4,531.25	$5,468.75	$192.00	$10,000
	Place 1/2 ton Rip Rap along shoreline	208	CY	$89.00	$129.00	$18,541.67	$26,875.00	$218.00	$45,417
	Place planting in void space	1	LS		$20,000.00		$20,000.00	$20,000.00	$20,000
	Hillside Improvements								
	Vegetate hillside	20,000	SF	$0.07	$1.50	$1,400.00	$30,000.00	$1.57	$31,400
	Temporary Fencing	600	LS	$6.50	$10.00	$3,900.00	$6,000.00	$16.50	$9,900
	Materials Subtotal					$88,422.92			
	Subtotal Labor + Materials								$326,997
	Hard Costs Estimating Contingency	5%							$16,350
	Subtotal Hard Costs								$343,347
	Sales Tax on Materials	8.50%							$7,516
	General Conditions	10%							$0
	Bond & Insurance	3%							$10,300
	Subtotal								$17,816
	General Contractor's Fee (OH&P)	8%							$28,893.03
	Overall Estimating Contingency	30%							$117,016.76
	TOTAL ESTIMATED CONSTRUCTION COSTS								**$507,073**

ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COST
WEST TRAIL REPAIR - Phase 1

Client: San Mateo Harbor District
Project: Pillar Point Harbor - West Trail Phase 1

Date: 8-27-16

	Description	Quantity No	Quantity Unit	Cost Mat'l	Cost Labor	Total Material Cost	Total Labor Cost	Total Unit Cost	Total Cost
	General Description of Work								
	Beach Nourishment at West Trail - Alt Analysis								
	Mobilization	1	LS		$50,000.00		$50,000.00	$50,000.00	$50,000
	Site Demolition								
	Protect in place Ex AC Pipe	1	LS		$5,000.00		$5,000.00	$5,000.00	$5,000
	Removal of Concrete Rubble	1	LS		$11,200.00		$11,200.00	$11,200.00	$11,200
	Erosion Control	1	LS	$4,000.00			$0.00	$4,000.00	$4,000
	Trail Repair								
	Trailside 3.5 foot wide Drainage Ditch	425	LF	$50.00	$80.00	$21,250.00	$34,000.00	$130.00	$55,250
	Trailside 3 foot wide Drainage Ditch	150	LF	$49.00	$80.00	$7,350.00	$12,000.00	$129.00	$19,350
	Place Backfill and Compact for Trail	370	CY	$85.00	$119.00	$31,450.00	$44,030.00	$204.00	$75,480
	Beach Nourishment Sand	475	CY	$50.00	$150.00	$23,750.00	$71,250.00	$200.00	$95,000
	Hillside Improvements								
	Vegetate hillside	20,000	SF	$0.07	$1.50	$1,400.00	$30,000.00	$1.57	$31,400
	Temporary Fencing	600	LS	$6.50	$10.00	$3,900.00	$6,000.00	$16.50	$9,900
	Materials Subtotal					$89,100.00			
	Subtotal Labor + Materials								$356,580
	Hard Costs Estimating Contingency	5%							$17,829
	Subtotal Hard Costs								$374,409
	Sales Tax on Materials	8.50%							$7,574
	General Conditions	10%							$0
	Bond & Insurance	3%							$11,232
	Subtotal								$18,806
	General Contractor's Fee (OH&P)	8%							$31,457.18
	Overall Estimating Contingency	30%							$127,401.59
	TOTAL ESTIMATED CONSTRUCTION COSTS								**$552,074**

ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COST
WEST TRAIL REPAIR - Phase 1

Client: San Mateo Harbor District
Project: Pillar Point Harbor - West Trail Phase 1

Date: 8-27-16

	Description	Quantity No	Quantity Unit	Cost Mat'l	Cost Labor	Total Material Cost	Total Labor Cost	Total Unit Cost	Total Cost
	General Description of Work								
	Soil Nail Wall at West Trail - Alt Analysis								
	Mobilization	1	LS		$40,000.00		$40,000.00	$40,000.00	$40,000
	Site Demolition								
	Protect in place Ex AC Pipe	1	LS		$5,000.00		$5,000.00	$5,000.00	$5,000
	Removal of Concrete Rubble	1	LS		$11,200.00		$11,200.00	$11,200.00	$11,200
	Erosion Control	1	LS	$4,000.00			$0.00	$4,000.00	$4,000
	Trail Repair								
	Trailside 3.5 foot wide Drainage Ditch	425	LF	$50.00	$80.00	$21,250.00	$34,000.00	$130.00	$55,250
	Trailside 3 foot wide Drainage Ditch	150	LF	$49.00	$80.00	$7,350.00	$12,000.00	$129.00	$19,350
	Place Backfill and Compact for Trail	370	CY	$85.00	$119.00	$31,450.00	$44,030.00	$204.00	$75,480
	Shotcrete and Soil Nail	1,800	SF	$42.00	$176.00	$75,600.00	$316,800.00	$218.00	$392,400
									$0
	Hillside Improvements								
	Vegetate hillside	20,000	SF	$0.07	$1.50	$1,400.00	$30,000.00	$1.57	$31,400
	Temporary Fencing	600	LS	$6.50	$10.00	$3,900.00	$6,000.00	$16.50	$9,900
	Materials Subtotal					$140,950.00			
	Subtotal Labor + Materials								$643,980
	Hard Costs Estimating Contingency	5%							$32,199
	Subtotal Hard Costs								$676,179
	Sales Tax on Materials	8.50%							$11,981
	General Conditions	10%							$0
	Bond & Insurance	3%							$20,285
	Subtotal								$32,266
	General Contractor's Fee (OH&P)	8%							$56,675.61
	Overall Estimating Contingency	30%							$229,536.22
	TOTAL ESTIMATED CONSTRUCTION COSTS								**$994,657**

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