NOBLE CONSULTANTS | GEC

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Ronald M. Noble, P.E., President

ENR TOP 500 DESIGN FIRMS

July 8, 2017

Kelly Crowe, PE
Town of Corte Madera
Department of Public Works
300 Tamalpais Drive,
Corte Madera, CA 94901

RE: Mariners Village Levee Improvements

SUBJECT: Preliminary Evaluation of Conditions and Improvement Measures

Dear Me Crowe:

Noble Consultants, Inc., in collaboration with Miller Pacific Engineering Group and WRA, Inc., has prepared an assessment of existing levee conditions, and recommended measures for improvement of the Mariners Village Levees. These levees are subject to continuous settlement due to the underlying bay mud, and thus require routine maintenance to maintain crest elevations. Sea level rise further increases the need to raise levees to maintain current levels of coastal flood protection. Special consideration is required in this work, because the levee borders the Corte Madera Ecological Reserve wetlands which support multiple special status species. This study supports the Town of Corte Madera's (TCM) ongoing effort to improve and maintain the Mariners Village levees in a manner which integrates community flood protection, bayland ecosystem support and recreational use of the levee top trail.

We look forward to responding to your comments on the draft, and any questions you may have.

Sincerely,
NOBLE CONSULTANTS, INC.

Rachel Z. Kamman, P.E.
Principal Engineer/Hydrologist

Attachments

Mariners Village Levee Improvement Study

SCOPE OF THE STUDY:

NCI and MPEG collaborated in the development of levee improvement concepts and supporting earthwork and cost estimates for levee improvements for the Mariners Village community. Concurrently, WRA Inc. prepared a biological constraints assessment to determine what sensitive and special status plant and wildlife are present. Design alternatives seek to minimize impacts to wetlands to the greatest extent possible through avoidance in engineering design, and informed protection measures determined via biological constraints.

Design alternatives are described via typical sections for levee segments identified in Figure 1. NCI delineated levee segments based on variations in existing grades and adjacent land uses (upland urban edge, storm water detention basin, CMER wetlands). Levee Segment 1 was added to the project description because like the adjacent segments it will require additional efforts in environmental compliance and permitting, including monitoring prior/during/post construction to comply with protection measures for special status species (California Ridgeways Rail, Black Rail and Salt Marsh Harvest Mouse).

SECTION 1: LEVEE DESIGN CONSIDERATIONS:

The design rationale and alternatives, summarized below, utilize a green edge on the bayward side to the levee which it serves as upland perimeter to the Corte Madera Ecological reserve. Three alternatives are considered: Earthen fill at a maximum stable slope, and fill with steeper slopes which incorporates engineered stabilization of fill. Engineered stabilization is more expensive than earthen fill alone. It is considered here to permit construction using steeper side slopes which reduces the total volume of fill, the rate of subsidence of the levee and the construction impacts on adjacent wetlands. In addition, the engineered fill provides greater subgrade stability for future levee raising actions.

1.1 General Project Objectives:

- Increase the height of the levee crest to 11 ft. NAVD88 post construction to:
    - improve community flood protection
    - Provide 1-2 ft. of freeboard above a 50 year FEMA still water flood tide at all locations.
- Minimize project construction and maintenance costs
- Minimize levee loading and in turn future settlement
- Increase levee stability and/or the capacity for future levee maintenance
- Minimize impacts to wetlands and resident special status species

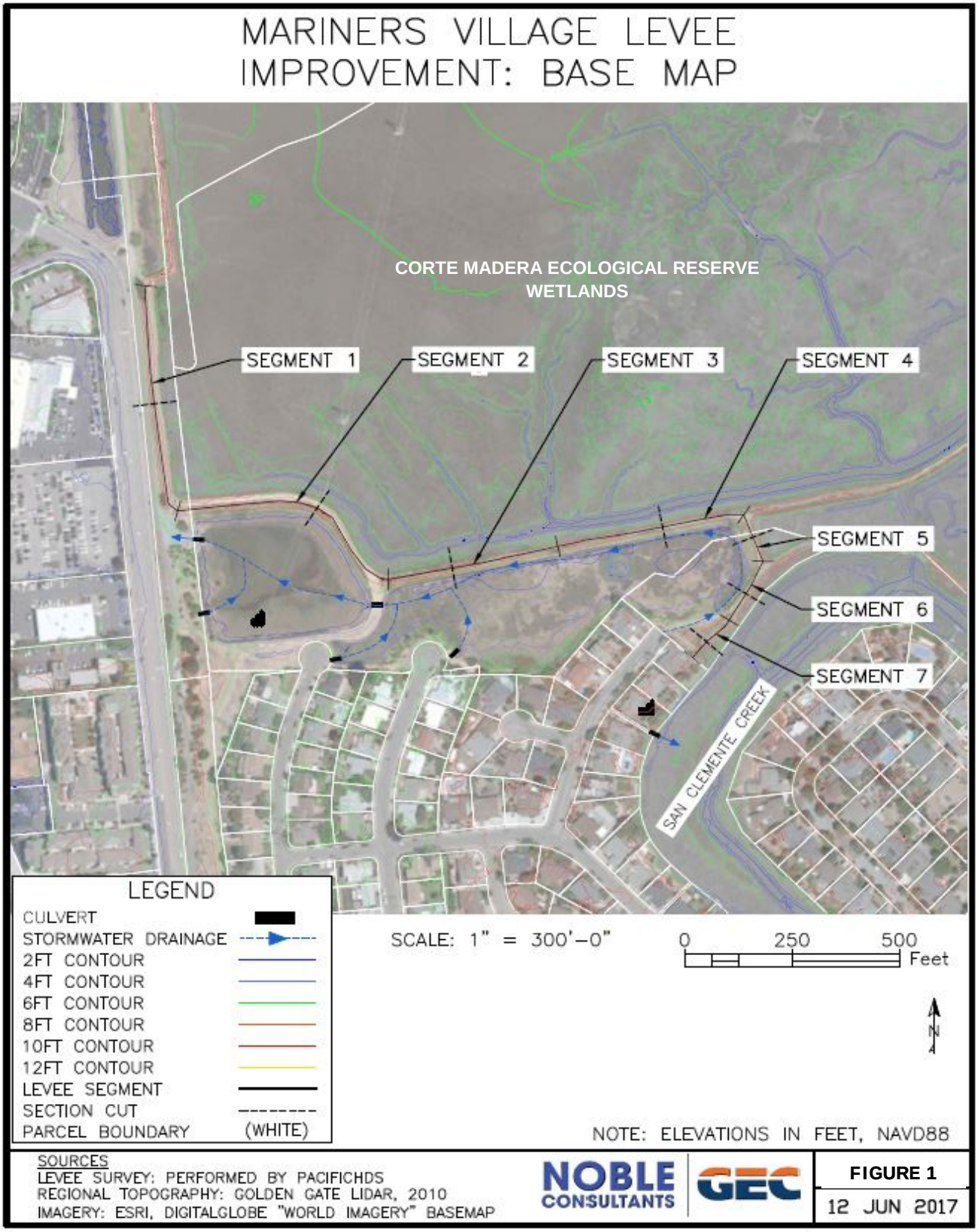


Figure 1: Mariners Village Levees: Site Location, Topography, Drainage and Levee Segments

1.2 General Regulatory Guidance:
WRA prepared the preliminary assessment of biological constraints associated with earthwork atop the levees provided in Attachment A. Conclusions from the report include:

- Identification of sensitive habitat types and species assumed present in the project area including two special status plant species and numerous wildlife species including species California Ridgeways Rail, Black Rail and Salt Marsh Harvest Mouse. These animals utilize both wetland and upland transition zones within the adjacent marsh
- Identification of the outboard sloughs as critical a habitat for green sturgeon and essential habitat for chinook and coho salmon.

In addition to identifying biological constraints to project implementation, WRA identified potential regulatory requirements for work, and recommended actions to meet those requirements. These requirements apply to all work performed in the project area (Figure 1). WRA's summary of the regulatory requirements and recommended actions is provided in Table 1. The endangered species act recommends avoidance as a first measure, and that necessary action be undertaken in a manner which to the greatest extent feasible, minimizes impacts. For the Mariners Village levees this will require delineating and minimizing impacts to wetlands, and retaining upland transition zones within the project area including those on the levee.

Based on the biological constraints identified, NCI utilized the following ecologically driven design guidelines:

- Work to the greatest extent possible in uplands, minimize impacts to wetlands.
- Retain or restore Upland Transition Zone (UTZ) vegetation which provides high tide refugia for special status species know or assumed present in the tidal wetlands and associated upland transitions zone including Ca Ridgeway Rail (CRR), Salt Marsh Harvest Mouse (SMHM).
- Anticipate design, permitting and implementation will require:
    - Consideration of all work actions including stockpile and construction staging areas within the project area
    - Pre- and post-project surveys, and construction monitoring
    - Incorporation of mitigation measures to minimize disturbance included restricted work windows, restricted haul routes, installation of temporary exclusionary fencing; and,
    - Revegetation with and maintenance of native wetland and transitional upland plants.
- Consider adopting disturbance reduction/habitat enhancement measures.
    - Addition of levee top native UTZ plantings, and ongoing native vegetation enhancement and maintenance including restricted mowing / maintenance windows
    - Interpretive and educational signs in combination with leash requirements for dogs and high tide trail closures

Table 1: Biological Constraints Summary of Recommended Next Steps (WRA, 2017)

Recommendations	Agencies Involved	Species / Issue of Concern	Requirements
Wetlands and Non-wetland Waters	Corps RWQCB CDFW	• Extent of regulatory jurisdiction within the Study Area	• Conduct a formal wetland and waters delineation and submit for verification by Corps
Special-Status Plant Surveys	CDFW	• Marin Knotweed • Point Reyes Birds Beak	• Conduct focused surveys from July to October to determine presence/absence
Special-Status Wildlife Species Consultation	USFWS	• Salt Marsh Harvest Mouse • California Ridgeway's Rail	• Consult with USFWS for potential impacts to these species • Prepare a Section 7 Biological Assessment
Regulatory Permitting	Corps RWQCB CDFW BCDC	• Disturbance to potentially regulated wetlands and non-wetland waters	• Section 10 of the Rivers and Harbors Act • Section 404 and 401 of the Clean Water Act • The Porter-Cologne Water Quality Act • Section 1600 of the California Fish and Game Code • BCDC 100' shoreline band and jurisdictional boundaries
Critical Habitat and Essential Fish Habitat	USWS NMFS	• Green sturgeon • White sturgeon • Longfin smelt • Steelhead, central CA coast DPS	• Consult with USFWS and NMFS • Prepare a Section 7 Biological Assessment
Pre-Construction Nesting Bird Survey	CDFW	• MBTA-regulated species	• Conduct surveys if work is to occur between February 1 and August 15
CEQA Compliance	City of Corte Madera State of California	• Compliance with state and local laws	• Preparation and approval of CEQA documentation (IS/MND, EIR, etc.)

1.3 General Geotechnical Guidance:

Miller Pacific Engineering group collaborated on the development of proposed designs, and in doing so reviewed site history, regional geologic data and existing location information for the site. A key observation for the project, MPEG notes that settlement of structure is ongoing, due to underlying bay mud which extends to 50-100 ft. below ground surface (BGS). Based on this and other site constraints the following geotechnical guidelines were adopted in design:

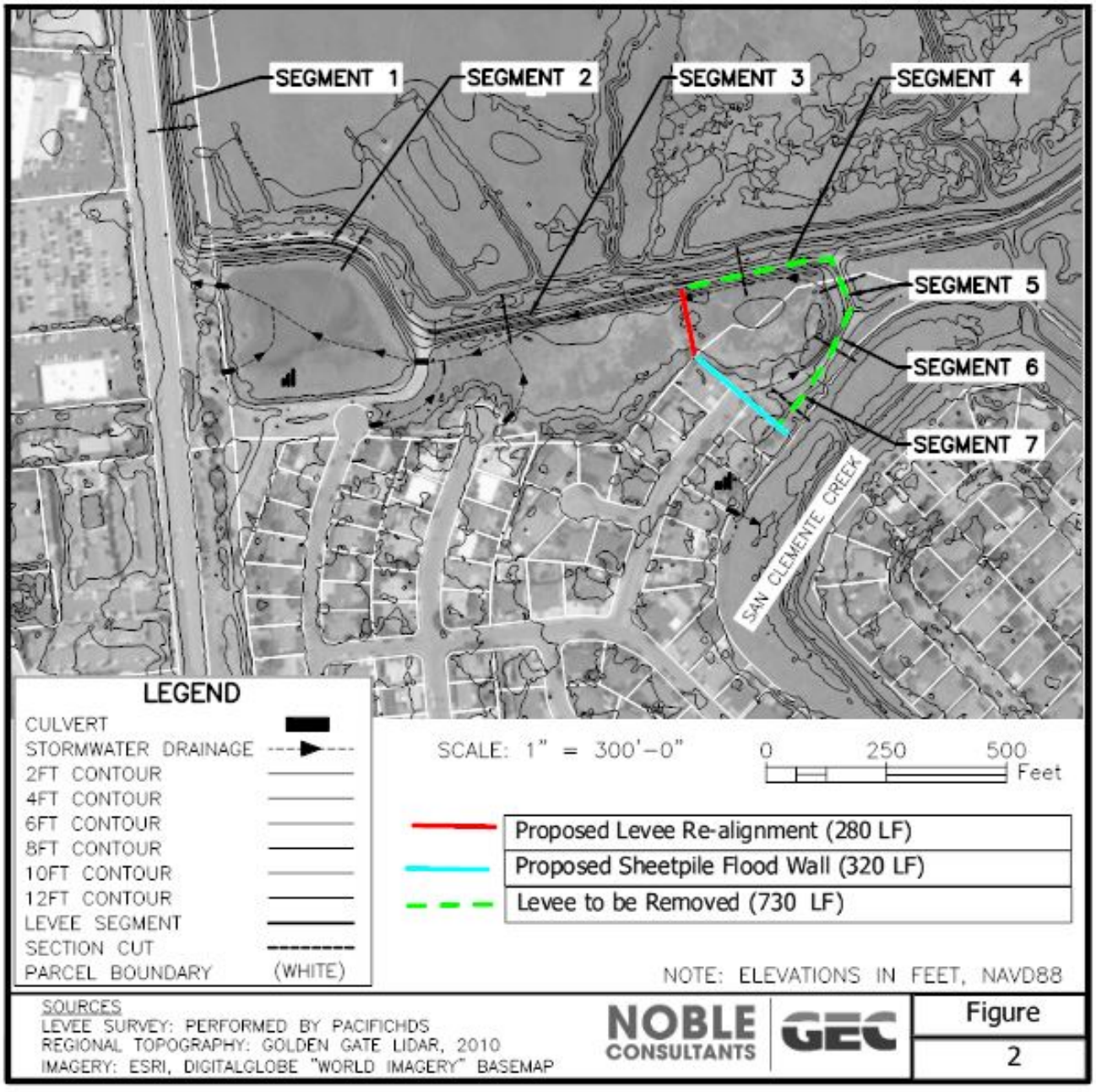
- A maximum fill depth of 3 ft. to minimize levee loading and settlement
- Construct the project in 1.0-ft fill lifts incorporating compaction and erosion control pending borings to check stability and long term settlement
- Maximum side slopes of 2:1(h:v) for earthen fill
- Side slopes of 1.5:1 (or greater) will require reinforced fill or other soil stabilization measures
- Where fill overlies the majority of an existing levee bank, excavation and stabilized backfill will be required to provide structural support
- Utilize only clean fill, suitable for wetland disposal and levee construction

1.4 Potential Sources of Fill:

Based on preliminary earthwork estimates presented below, an estimated 1,500 -3,500 cubic yards of fill will be required to raise the levees to the target design grade of 11 ft. NAVD88. To facilitate project implementation, NCI identified the currently available fill sources including approximately 8,000 CY of material currently stockpiled at Loch Lomond Marina, and approximately 4,000 CY of material currently stockpiled by the Las Gallinas Valley Sanitary District. Although this material is stockpiled, it's availability for use in project construction has not been determined. However, if the Town had a suitable stockpile area, material could be acquired in anticipation of the project. Additional maintenance dredging projects which are anticipated within the county may include Coyote Creek, Las Gallinas Creek and others. The timing of availability, suitability and transportation of the material would need to be determined.

The most viable potential future source of fill is the Corte Madera Marsh Restoration project which is currently being planned by the Golden Gate Bridge District's (GGBHTD). The design of this project is well underway, and an anticipated 60,000 cy of material will be excavated to restore an adjacent dredge disposal area to tidal wetland. This presents an opportunity for coordinated beneficial reuse of the material, which is favored by both resource and regulatory agencies. This would likely also be a cost efficient source of material because of the haul distance is less than one (1) mile. The project will entail removal of existing levee, which is assumed to be directly suitable fill for reuse on the Mariners Village levee. Materials excavated from within the basin more predominantly bay mud, and would require testing, and perhaps blending with courser material prior to reuse for levee improvement. It is recommended that TCM investigate the suitability and availability of this readily available local source, and seek to coordinate actions between projects, as it may permit both parties to reduce both the costs and impacts of earthwork.

A final option for consideration is the reconfigure levees as illustrated in Figure 2. If it is feasible to reduce the size of the existing storm water basin, installation of a new earthen cross levee and a sheet pile wall in combination with removal of a segment of the eastern levee should be considered as a design option. This option would reduce the total length of levee for future maintenance by 435 LF, and removes approximately 0.1 acres of wetland fill which can offset mitigation obligations associated with unavoidable impacts to wetlands. If feasible, this effort to incrementally reduce TCMs coastal infrastructure obligation is recommended to reduce the long term cost and environmental impact of community flood protection.
NCI continues to monitor local civil works projects for potential sources of levee fill. Sources of fill should be identified and secured once a stockpile area becomes available and the project



implementation schedule is known.

SECTION 2: LEVEE DESIGN SUMMARY:

Presented below is a summary of levee design objectives and assumptions which served as the basis for levee improvement recommendations.

Engineering Design Objectives:

- Levee Crest Target Grade: 11 ft., NAVD88 post construction
- Target top width: 7-10 ft. to maintain existing public access
- Minimize levee loading to reduce ongoing levee settlement
- Minimize impacts to wetlands:
    - Minimizing disturbance and fill below 7.2 ft. (Section 404 jurisdiction elevation)
    - Retain UTZ vegetation and refuge for special status species.

Design Assumptions:

- Existing levee is stable and work required is limited to increasing crest elevation.
- Maximum depth of fill <= 3 ft. to maintain stability (To be confirmed by MPEG with site borings)
- Improvements should minimize impacts to wetlands by minimizing disturbance and fill below 7.2 ft., prioritizing bay-side wetlands
- Target crest height = 11 ft. NAVD88[1];
- Target top width:
    - 10 ft. to maintain existing access (K. Crowe, TCM);
    - Decrease to 7 ft., as needed to support raising crest up to 1 ft. (per RK, NCI)
    - Minimize reduction in trail width to maintain public access and current maintenance.
- Land based transport of fill and construction
- Post construction revegetation and maintenance of native wetland/UTZ plants
- Project will be constructed in 2018

Conceptual Design Alternatives:

The conceptual design alternatives described below considered both earthen fill only improvements which maintain a minimum side slope of 2:1 (H:V) and engineered fill

[1] The 11.0 ft. NAVD88 levee crest design grade assumes a 9 ft. (FEMA 50 yr. WSE) + 2 ft. (upper limit of the range of predicted sea level rise between 2000 and 2050; OCOF, 2014).

alternatives which incorporate segmented blocks or geotextile fabrics which retain stability at side slopes of 1.5:1 and above.

Earthen fill scenarios:

NCI evaluated two earthen fill (EF) alternatives, described below and illustrated in Figure 3A and 3B. Both EF scenarios use a maximum stable side slope of 2:1.

- EF-A: Variable Levee Top Width: The levee top width tapers in and varies from 7-10 ft. depending on fill profile. Work occurs only in upland, and a trail width reduction of 4 ft. occurs with each foot of levee crest increases. Some location may be infeasible due to reduction in top width. Reduction in trail width may be feasible given the recommended use of natives in replanting the renovated.

- EF-B: Fixed Levee Top Width: Levee top maintains a 10 ft. width, expanding the footprint of fill only on the landward side of the levee. Work occurs in upland and may occur in within USCOE/BCDC wetland jurisdictions on the landward side of the levee. This approach increases the volume of fill and loading placed on the levee. Where level fill must extend down the levee bank, temporary over excavation and engineered stabilization would be required to support the additional fill. These conditions occur for all levee segments. Unless a narrower trail width is assumed, a steeper slope would be adopted for the engineered fill to minimize cost and loading. Therefore, in subsequent design analysis, this scenario is superseded by the engineered fill scenario described below which utilizes the stabilized steeper side slopes.

The designated levee segments, section locations and topographic data are mapped in Figure 1.

Preliminary Earthen Fill Estimates:

To support earthwork analysis and preliminary design, NCI divided the subject levee into segments (Figure 1) based on the location and typical crest elevation/cross section.
NCI estimated the volume of fill required for earthen fill (at 2:1 slopes) along each segment of the project reach for the two fill scenarios described above. Attachment C provides cross sections for the 7 levee segments considered in the project, and illustrates the estimated footprint of fill for these two scenarios. The cross sections are based on project surveys conducted in 2016.

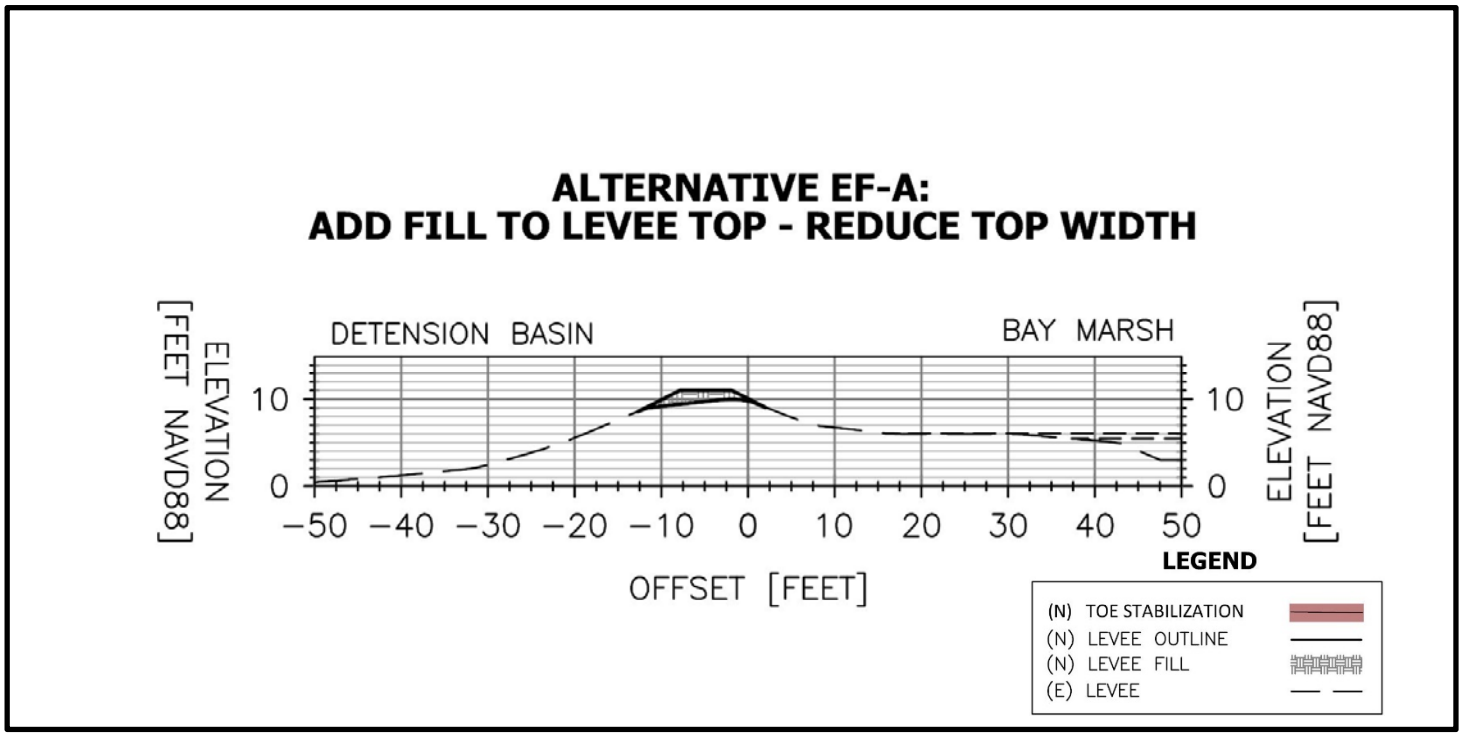


Figure 3-A: Typical Fill Section - Alternative EF -A (2:1 Slope, Levee crest top width varies @ 6-7 ft.)

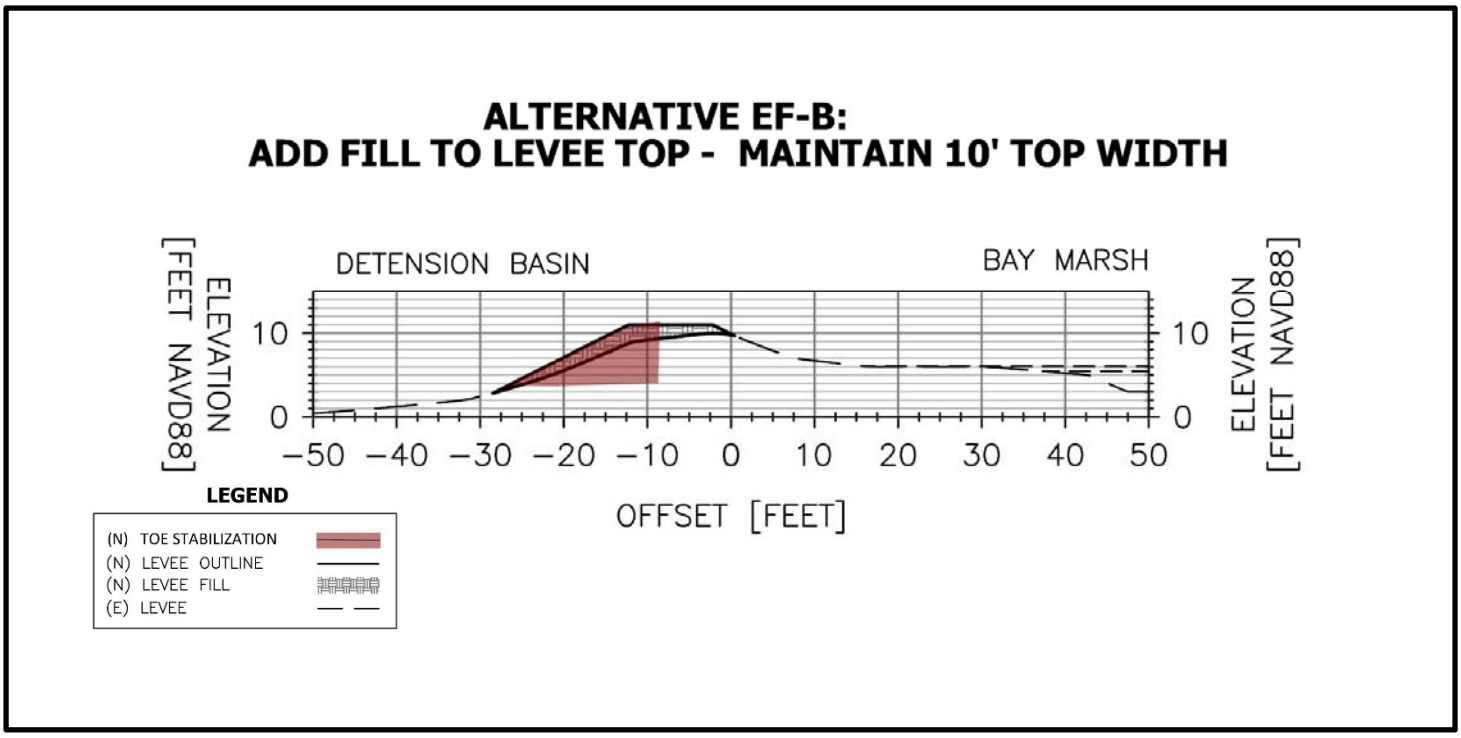


Figure 3-B: Typical Fill Section - Alternative EF-B (2:1 Slope, Levee crest top width = 10 ft.)

The design top widths and estimated volumes of fill required to construct levees for scenarios EF-A and EF-B are summarized in Table 2. The total estimated volume of earthen fill for scenarios EF-A and EF-B are 1,300 CY and 3,400 CY respectively, indicating that a reduction in top width provides a substantial reduction in fill and loading. The Scenario EF-A volume estimates serve as the basis for preliminary cost estimates provided in the following section. Additional levee improvement measures anticipated in levee design include installing erosion protection, revegetating levees with native UTZ/Upland plants, and conducting annual or bi-annual maintenance of native plant communities.

For an earthen fill levee improvement project, the total estimated volume of fill required for import ranges from 1,300 to 1,600 CY (assuming a 20% contingency). In evaluating Scenario EF-A, the design team notes that reducing levee top widths to 6-7 ft. in this maintenance cycle may not be desirable to the extent that it reduces public access and constrains future efforts to maintain the levee. If selected, intermediate trail widths can be evaluated in design.

If Scenario EF-B is constructed, MPEG recommends an engineered foundation to stabilize fill placed along the inboard levee slope. This stabilization requires temporary excavation and engineered fill as suggested by the brown shaded area in Figure 3B. Given that engineered fill would be required, it is logical that the engineered fill be installed at a steeper slope which is feasible (as described below), and reduces the volume of fill and levee loading. As such, Scenario EF-B is subsequently evaluated below as Scenarios TM-I and BW-I, which utilizing engineered fill on the inboard (I) side of the levee.

Table 2: Geometry and Fill Estimates for Earthen Fill (EF) Levee Improvement Scenarios

Earthen Fill (EF) Levee Improvement Scenarios: (2:1 Levee Slopes)								
Levee Segment	Levee Length [ft]	Typical Crest Elevation (ft)	Design Alternative	Typical Cross-Sectional Area [ft^2]	Typical Top Width [ft]	Lower Limit of Fill (ft.,NAVD88)	Typical Surface Area [ft^2/LF]	**Fill Volume [yd^3]**
1	557	10	A	9.4	6.0	7.5	14.8	194
			B	28.6	10.0	5.9	23.6	590
2A	448	9	A	12.1	6.0	8.6	15.8	201
			B	38.3	10.0	2.9	31.7	635
2B	129	8	A	12.1	6.0	8.6	19.0	58
			B	38.3	10.0	2.9	33.1	183
3	402	10	A	8.0	6.0	10.0	14.6	119
			B	37.3	10.0	2.1	34.0	555
4	442	9	A	22.5	6.0	6.9	18.8	368
			B	51.1	10.0	2.4	35.7	837
5	120	8	A	39.9	6.0	8.6	21.8	177
			B	62.0	10.0	5.5	29.9	276
6	163	9	A	22.1	7.0	8.8	20.5	133
			B	41.2	10.0	2.2	35.7	249
7	125	9	A	11.1	6.0	9.1	23.5	51
			B	19.9	10.0	8.8	24.1	92
Totals:	**2386**				**Alternative EF-A:** (2:1 side slope Top Width Varies)			**1,302**
					Alternative EF-B: (2:1 side slope Top Width @ 10 ft)			**3,417**

Mechanically Stabilized Earth Fill

The reinforced fill alternatives combine earthen fill with interlocking retaining wall elements/or engineered mesh to increase the levee crest height while minimizing the total volume of imported fill and the reduction in crest width. Adoption of these techniques is considered to address the slope stability and the levee geometry constraints mentioned above. For the Mariners Village Levee Improvement project, MPEG developed two alternatives for reinforced fill which reduce the fill required, maintain a 10' crest width, and add stability for future levee improvements. The two systems identified for the project are:

- Interlocking retaining wall elements which permit steeper (up to 8:1) levee side slopes. This backfilled concrete block wall can be installed on one or both levee faces. Installation on only one face is likely to be preferable to retain the soft edge adjacent to the CMER marshes.
- Terramesh™ or Geogrid ™ soil retention systems which consist of metal or synthetic plastic mesh which is anchored to the levee and backfilled with soil. The structured mesh retains a design geometry, permits steeper (1:1) levee side slopes and retains the opportunity to re-establish a vegetated upland transition zone edge which provides important refugia habitat for wetland species during high tides and storm events.

In evaluating these options, it is recommended that TCM consider the following advantages and disadvantages associated with mechanically stabilized solutions.

Advantages:

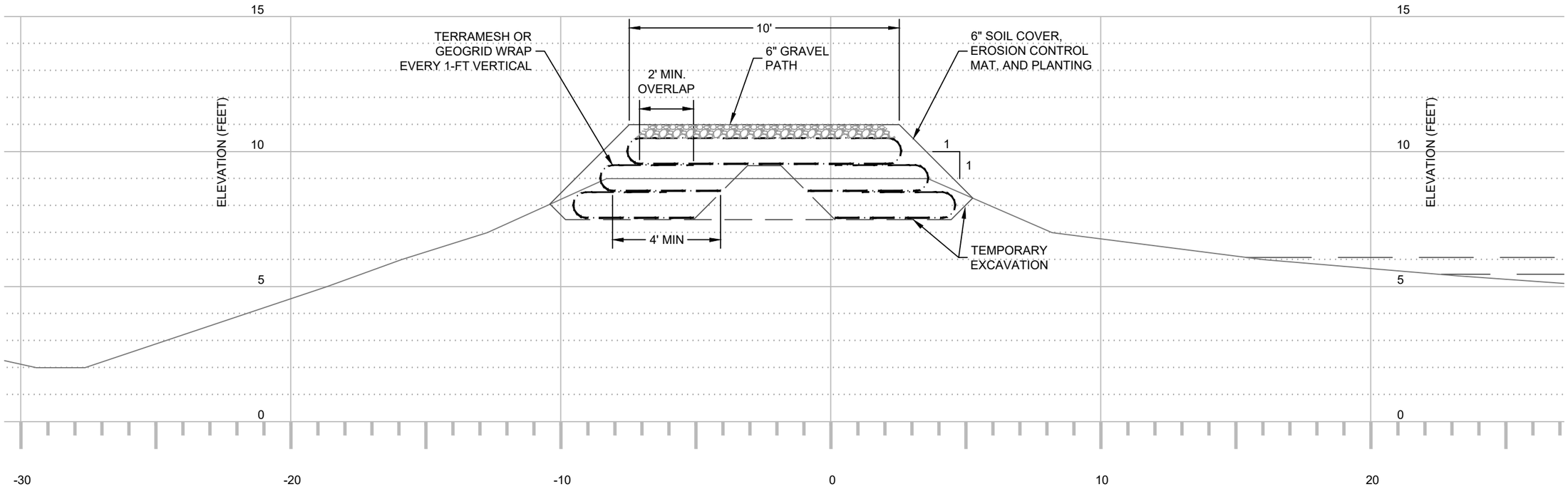
- Permits an increase in side slope to 1:1 – 1:8 (h:v) (above stable soil slopes), reducing the levee footprint, and the volume of required fill
- Adds stability to the structure to support future levee improvements
- Minimizes impacts to existing wetlands
- Retains a top width of 10 ft.

Disadvantages:

- Requires temporary excavation to 1 ft. below grade
- More expensive to construct than earthen fill levee
- May hardens levee, converting UTZ to hard surface;
- May increase annual veg. maintenance and limit root depth

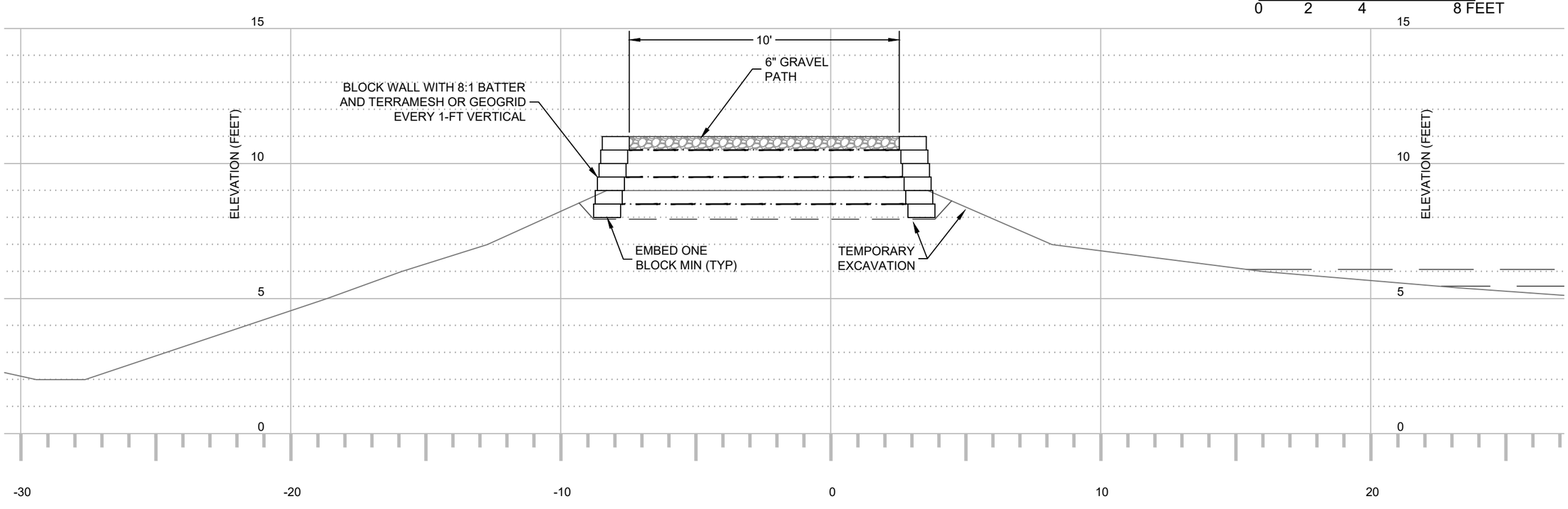
MPEG prepared typical cross sections and construction elements for these concepts considering one (outboard) and both sides of the levee respectively in Figures 4 and 5. Given the biological constraints due to the adjacent marsh, it is likely that improvements which retain a vegetated earthen slope on the bayland side of the levee would be preferred. Terramesh can be planted, while block wall is unlikely to support a healthy native plant community. With this in mind, three mechanically stabilized fill solutions are considered:

1) Terramesh on both sides of the levee (Scenario TM-B)
2) Terramesh on the inland side of the levee. (Scenario TM-I)
3) Blockwall on the inland side of the levee (Scenarios BW-I)



OPTION A: REINFORCED EARTH SLOPE

SCALE
0 2 4 8 FEET



OPTION A: REINFORCED EARTH SLOPE

SCALE
0 2 4 8 FEET

Revisions

Description	Mark	Date	By

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www.millerpac.com

MILLER PACIFIC ENGINEERING GROUP

FILE: 657.074 Typ Levee Xsec.dwg

Designed	Date	Drawn	Date	Checked	Date
ABC		SLM		ABC	

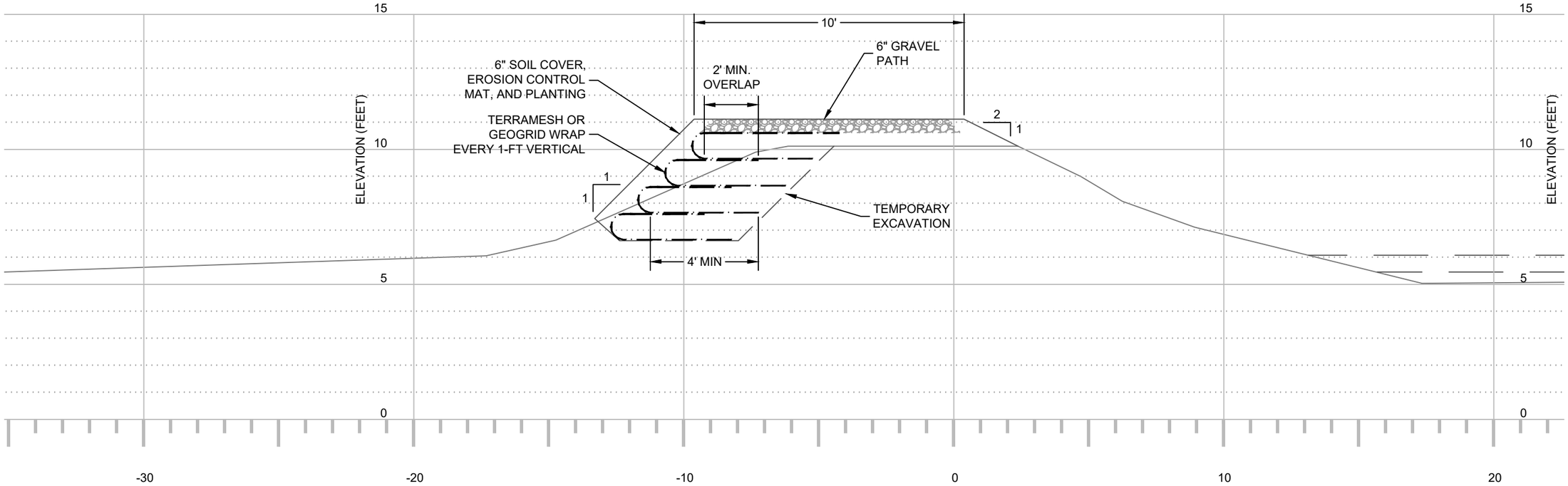
FULL WIDTH LEVEE OPTIONS

Marina Village Levee Improvements
Corte Madera, California

Date: 6/6/2017

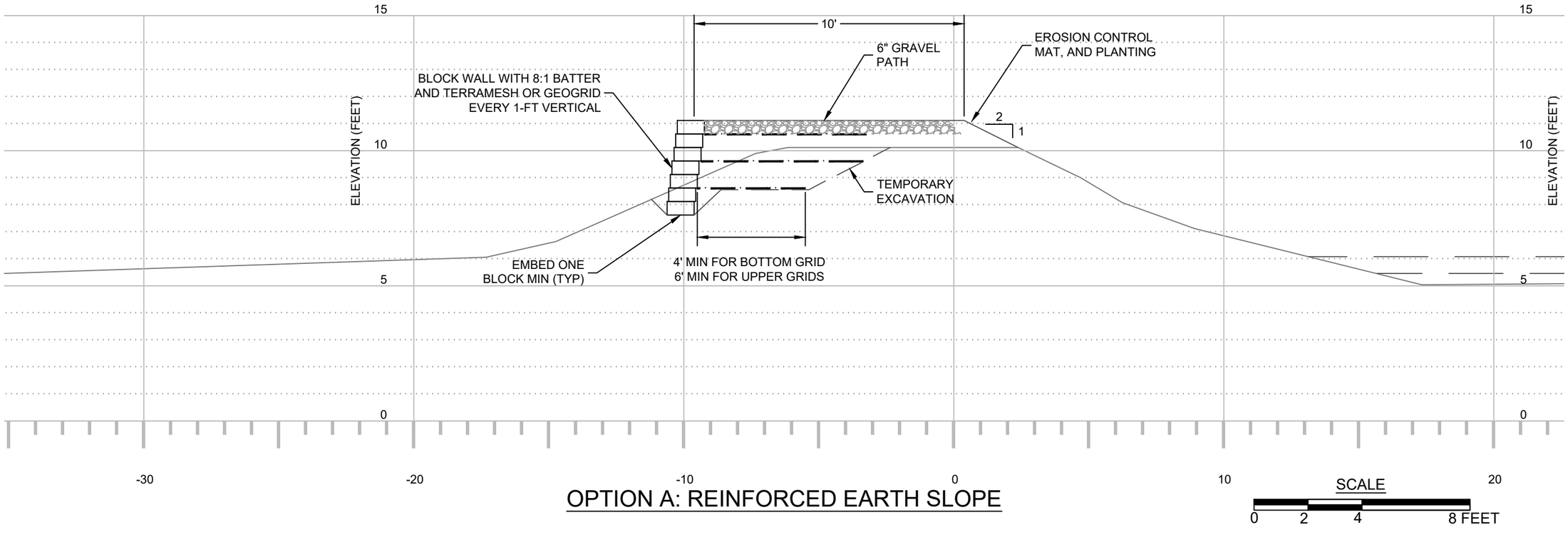
Project No. 657.074

Figure
4



OPTION A: REINFORCED EARTH SLOPE

SCALE
0 2 4 8 FEET



OPTION A: REINFORCED EARTH SLOPE

SCALE
0 2 4 8 FEET

Revisions

Description	Mark	Date	By

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MILLER PACIFIC ENGINEERING GROUP
MPEG

FILE: 657.074 Typ Levee Xsec.dwg

BASIN SIDE LEVEE OPTIONS

Marina Village Levee Improvements
Corte Madera, California

Designed ABC Date
Drawn SLM Date
Checked ABC Date

Date: 6/6/2017

Project No. 657.074

FIGURE
5

Preliminary Engineered Fill Estimates:

Using the same methodology described for the earthen fill scenarios, NCI estimated the volume of fill required for stabilized fill scenarios for each segment of the project reach. These volume estimates, based on the levee geometry and an assumed 1:1 engineered slope serve as the basis for preliminary cost estimates provided in the following section. Table 3 summarizes preliminary engineered fill volume estimates. Additional design assumptions detailed by MPEG and incorporated in the earthwork estimates:

- Construction in 1 ft. lifts
- a 1 ft. deep temporary excavation to key fill into the existing levee
- Terramesh fill is placed on a 1:1 slope in a 4 ft. minimum widths
- Block wall is placed at an 8:1 slope

Utilizing these assumptions, NCI generated estimates of fill volume, reinforced surface area, and revegetated surface area for the three mechanically stabilized fill alternatives (Table 3).

Table 3: Geometry and Fill Estimates for Stabilized Fill Levee Improvement Scenarios

Stabilized Fill (SF) Levee Improvement Scenarios: (1:1 Levee Slopes)											
A: Terra Mesh on 2 Sides; B: Terra Mesh on 1 Side; C: Block Wall (4:1) on 1 side											
Levee Segment	Levee Length [ft]	Typical Crest Elevation (ft)	Design Scenario	Typical Top Width [ft]	Lower Limit of Fill (Land/Bay) (ft.,NAVD88)	Typical Cross-Sectional Area of Fill [ft^2]	Stabilized Surface Area [ft^2/LF]	Reveg Surface Area [ft^2/LF]	Cut Volume [ft^3]	Fill Volume [ft^3]	Import Volume [yd^3]
1	557	10	A	10.0	5 / 9	38.6	36.0	24.0	7,631	21,500	502
			B	10.0	5 / 9	33.8	30.0	23.7	7,241	18,827	418
			C	10.0	7 / 9	17.8	4.0	17.1	3,509	9,915	232
2A	448	9	A	10.0	6 / 8	42.3	42.0	23.9	10,080	18,950	314
			B	10.0	6 / 9	34.5	30.0	22.6	6,989	15,456	303
			C	10.0	7 / 9	22.0	4.5	17.8	3,539	9,856	229
2B	129	8	A	10.0	6 / 8	37.8	30.0	22.4	1,419	4,876	126
			B	10.0	7 / 9	35.8	22.0	22.2	1,419	4,618	116
			C	10.0	7 / 9	29.8	4.5	18.0	645	3,844	118
3	402	10	A	10.0	6 / 9	38.4	30.0	23.0	7,196	15,437	295
			B	10.0	6 / 9	33.5	26.0	23.0	5,507	13,455	286
			C	10.0	7 / 9	14.2	4.5	18.7	2,935	5,688	98
4	442	9	A	10.0	6 / 8	43.5	34.0	22.5	6,630	19,227	457
			B	10.0	6 / 9	39.5	26.0	21.0	4,287	17,459	481
			C	10.0	6 / 8	33.0	5.5	19.4	3,713	14,586	397
5	120	8	A	10.0	6 / 8	56.9	34.0	25.0	1,968	6,828	177
			B	10.0	6 / 9	52.0	26.0	24.5	1,368	6,240	178
			C	10.0	6 / 8	40.7	5.0	19.4	1,248	4,884	133
6	163	9	A	10.0	8 / 8	30.6	22.0	18.3	978	4,988	147
			B	10.0	7 / 9	27.7	18.0	19.5	701	4,515	140
			C	10.0	7 / 9	23.8	3.5	18.0	571	3,879	122
7	125	9	A	10.0	9 / 8	24.2	22.0	19.6	375	3,025	98
			B	10.0	7 / 9	19.4	18.0	17.7	163	2,425	84
			C	10.0	7 / 10	20.0	3.5	16.9	588	2,500	70
Totals:	**2386**					**Alternative SInative SF-A: Terra Mesh (1:1) on 2 Sic**			**36,277**	**94,831**	**2,115**
						Alternative SInative SF-B: Terra Mesh (1:1) on 1 Sic			**27,675**	**82,995**	**2,008**
						Alternative SInative SF-C: Block Wall (8:1) on 1 side			**16,747**	**55,153**	**1,398**

In evaluating the stabilized fill alternatives, the use of block wall structure adds efficiency in the reduction of levee fill and loading, reducing the volume of imported fill for a 10 ft. wide trail to

1,400 CY which is comparable to that associated with a 6 ft. earthen trail. Fill requirements for the terra mesh stabilized levee are larger at 2,100CY, but provide a 40% reduction compared to the estimated earthen fill volume.

Recommendations:

The block wall creates the most efficient engineered section. As noted earlier it is less desirable adjacent to high value wetlands, but may considered favorable for levee segments 1 and 2, which are adjacent to uplands and detention ponds respectively. Terra mesh is favorable in that it provides both stability and opportunity to replant the stabilized fill. Terra mesh on the landward side of the levee is recommended for levee segments 3 through 5, where the grade of the low lying adjacent storm water basin narrows the available section. Earthen fill is recommended for Levee segments 1, 6 and 7 where there is room adjacent to the levee to accommodate an expanded footprint.

Preliminary Recommendations for levee improvements are summarized in Table 4:

Table 4: Recommended Levee Improvement Measures and Earthwork Estimates

Recommendations for Levee Improvement			Earthwork Estimates						
Levee Segment	Levee Length [ft.]	Recommended Improvement Measures (Interior/Bayland)	Lower Limit of Fill (Land/Bay) (ft.,NAVD88)	Typical Cross-Sectional Area of Fill [ft^2]	Total Stabilized Surface Area [ft^2]	Total Reveg. Surface Area [ft^2]	Cut Volume [ft^3]	Fill Volume [ft^3]	Import Volume [yd^3]
1	**557.0**	**Block Wall/ Earth Fill**	5 / 9	17.8	2,228	9,525	4,294	18,827	532
2A	**448**	**Block Wall/ Earth Fill**	7 / 9	22.0	2,016	7,974	3,509	9,915	232
2B	**129**	**Block Wall/ Earth Fill**	7 / 9	29.8	581	2,322	645	3,844	118
3	**402**	**Terra Mesh / Earth Fill**	6 / 9	33.5	8,844	9,246	5,507	13,455	286
4	**442**	**Terra Mesh / Earth Fill**	6 / 9	39.5	9,724	9,282	3536.0	17459.0	510.4
5	**120**	**Terra Mesh / Earth Fill**	6 / 9	52.0	2,640	2,940	1368.0	6240.0	178.4
6	**163**	**Earthen Fill**	9 / 10	41.2	-	2,934	0	5,315	197
7	**125**	**Earthen Fill**	9 / 10	29.8	-	3,013	0	2,488	92
Earth Fill:	**288**				**-**	**5,947**	**-**		**289**
Block Wall:	**1,134**				**4,825**	**19,821**	**8,449**		**350**
Terra Mesh:	**964**				**21,208**	**21,468**	**10,411**		**1,507**
Totals:	**2,386**				**26,033**	**47,236**	**18,860**		**2,145**

Table 5: Preliminary Cost Estimate for Mariners Village Levee Improvements

Project: Mariner's Village Levee Improvements — **Estimate By:** rzk
Location: Corte Madera, CA — **Date:** 08/03/17
Unit Prices based on 2017 RSMeans Cost Data — **Reviewed By:** S. Stephens (MPEG)
Date: 08/02/17

Preliminary Levee Improvement Recommendations: Earthen Slopes (2:1), and Engineered Fill

Item Type	Description	Qty.	Unit	Total Cost/Unit	TOTAL
Sub-total: Planning and Design					**$ 200,000**
	Engineering & Design (PS&E)	1.00	LS	$60,000	$ 60,000
	Geotechnical Study	1.00	LS	$15,000	$ 15,000
	Hydraulic Study	1.00	LS	$0	$ -
	Wetland Delineation / Rare Plant Surveys	1.00	LS	$15,000	$ 15,000
	Levee UTZ Revegetation Plan	1.00	LS	$15,000	$ 15,000
	Environmental Compliance and Permitting	1.00	LS	$45,000	$ 45,000
	Biological Resources (Monitoring and Mitigation)	1.00	LS	$25,000	$ 25,000
	Interpretive Trail Planning and Design	1.00	LS	$10,000	$ 10,000
	Community Outreach and Education	1.00	LS	$15,000	$ 15,000
Sub-total: Environmental Clearances					**$ 73,000**
	SWPPP	1.0	LS	$10,000.00	$ 10,000
	Bird surveys/clearing	21	Days	$1,500.00	$ 31,500
	Salt Marsh Harvest Mouse surveys/clearing	21	Days	$1,500.00	$ 31,500
Sub-total: Site Preparation and Field Engineering					**$ 136,900**
Site Preparation and Cleanup					
	Construction Fencing (Exclusionary and Sediment	5000	LF	$3.74	$ 18,700
	Site Staging and Access Grading (2 ramps)	2.0	LS	$5,000.00	$ 10,000
	Equipment Mob/DeMob	1.0	LS	$20,000.00	$ 20,000
	Access /Haul Road Cleaning & Repairs	1.0	LS	$15,000.00	$ 15,000
Field Engineering					
	Pre-Construction Surveys	1.0	LS	$8,500.00	$ 8,500
	Construction Oversight	30	Days	$1,540.00	$ 46,200
	As-built survey	1.0	LS	$8,500.00	$ 8,500
	Permit Filings (Start and Closure)	2	LS	$5,000.00	$ 10,000
Sub-Total Construction (Earthwork):					**$ 227,955**
Excavate, Haul and Stockpile Fill					
	Excavation - Excavator	2,145	BCY	$10.00	$ 21,455
	Haul and Place in Local Stockpile: 20 mi. cycle	2,360	CY	$8.65	$ 20,414
	Stockpile Preparation and Maintenance	1	LS	$20,000.00	$ 10,000
	Erosion Control, Water and Dust Management	1	LS	$10,000.00	$ 5,000
Levee Preparation and Earthen Fill					
	Subgrade preparation (Clear/Grub/Env.. Ctrls.)	5,248	SY	$5.00	$ 26,242
	Levee Foundation Excavation	699	CY	$30.00	$ 20,956
	Excavate and Haul to Levee (1 mi cycle)	2,360	CY	$10.00	$ 23,600
	Backfill (dozer/common earth/300' haul) & Track walk Compact	3,059	CY	$10.00	$ 30,585
	Fine grading	3,059	CY	$7.05	$ 21,563
	RSP at Outfall	1.0	LS	$12,000.00	$ 12,000
Reveg. and Erosion Control					
	Cover stockpile with erosion control fabric	1000	SY	$3.61	$ 3,610
	Levee Erosion Control and Revegetation	1.30	AC	$25,000	$ 32,531
Sub-Total Mechanically Stabilized Earth Construction:					**$ 691,254**
Levee Stabilization (Materials and Installation)					
	Mobilization and Staging	1	LS	$10,000	$ 10,000
	Geosynthetic Slope Protection (Segments 3,4 & 5)	3,059	cy	$65	$ 198,804
	Versa Lock Style Block Wall (Segments 1 & 2)	4,825	SF	$100	$ 482,450
Preliminary Levee Improvement Recommendations: Earthen Slopes (2:1), and Engineered					**$1,329,109**
Design Contingency		10	Percent		$132,911
Subtotal					**$1,462,020**
Overhead		14	Percent		$204,683
Profit		10	Percent		$146,202
Subtotal					**$1,812,904**
Contracting Method Adjustment		0	Percent		$0
Inflation Escalation (12 months to midpoint of construction)		2.50	Percent		$45,323
TOTAL Estimated Construction Cost					**$1,448,327**
TOTAL Estimated Project Cost:					**$1,858,227**

Cost/LF = $425

Notes:
SY = square yards
LF = linear foot
LS = lump sum
CY = cubic yards
SF = square foot
MSF=1000 SF

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ATTACHMENTS:

ATTACHMENT A: WRA Biological Constrains Assessment

ATTACHMENT B: Levee Sections: Existing and Improved

ATTACHMENT C: Engineering in Support of Design

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Attachment A:

WRA Mariners Village Levee Biological Constraints Evaluation:

June 9, 2017

Rachel Z. Kamman, PE Principal Engineer
Noble Consultants – G.E.C., Inc.
Direct Phone: (415) 884-0727 x202 | Fax: (415) 884-0735
Email: rkamman@nobleconsultants.com

RE: Mariner's Village Levee Biological Constraints Evaluation

Dear Ms. Kamman,

This letter describes the methods and results of a literature review and biological site reconnaissance and a summary of resource agency permit requirements for the proposed improvements to the existing levee adjacent to Muzzi Marsh at Mariner's Village ('Study Area') located in the town of Corte Madera, Marin County, California. The purpose of the biological site reconnaissance was to identify potential biological constraints at the site, such as wetlands or riparian habitats, and to determine the potential for sensitive plant and wildlife species to occur at the site based on a database search for known occurrences from the vicinity of the Study Area and the types and condition of habitats present at the site. The results of the biological reconnaissance and the existing project concept plans were used to determine what regulatory permits, if any, would be needed for the proposed work.

Methods

The literature review and database search consisted of queries to the following databases and sources for special-status species records from the San Rafael, Novato, Petaluma Point, San Quentin, San Francisco North, and Point Bonita U.S. Geological Survey ('USGS') 7.5-minute quadrangles:

- California Native Plant Society ('CNPS') Inventory of Rare and Endangered Plants (CNPS 2017)
- California Department of Fish and Wildlife ('CDFW') California Natural Diversity Database ('CNDDB'; CDFW 2017)
- U.S. Fish and Wildlife Service ('USFWS') list of species occurring within Marin County (USFWS 2017)
- eBird bird occurrence database (eBird 2017)
- The Marin County Breeding Bird Atlas (Shuford 1993)

Following the literature review, WRA biologists conducted an assessment of the Study Area on May 12, 2017. During the site assessment, the biologists traversed the site on-foot and noted the habitats present in the Study Area, including their location, approximate extent, and condition. In addition, the biologists noted the general location of any areas potentially subject to regulatory jurisdiction by the U.S. Army Corps of Engineers ('Corps'), the Regional Water Quality Control Board ('RWQCB'), or the CDFW. The biologists noted all plant species observed in the Study Area, as well as any signs of wildlife activity. Following the site visit, the biologists made an assessment of the potential for the special-status species documented from the referenced quadrangles to occur within the Study Area based on the type, extent, and condition of habitats observed there.

Results

Literature Review

The database searches revealed eighty-nine special-status plant species and fifty-eight special-status wildlife species which have been documented from within the referenced quadrangles. For many of these species, suitable habitat, such as serpentine soils, alkaline soils, vernal pools, chaparral, grassland, coastal scrub, or other upland habitats does not occur within the Study Area, and as such, it is assumed that these species have no potential to occur. A discussion of the special-status species determined to have at least moderate potential to occur within the Study Area is included in the results of the biological reconnaissance provided below.

Survey Results

The Study Area occurs along a levee, including a 50-foot buffer on either side of the levee to account for potential widening of the levee, installation of armoring on one or both sides of the levee, use of heavy equipment inboard or outboard of the levee, and other potential construction options. The Study Area is located on the eastern edge of Corte Madera, Marin County, located directly south of the Corte Madera Marsh State Marine Park. The Study Area is primarily comprised of the levee itself, as well as, three plant communities described in more detail below (Northern Coastal Salt Marsh, Muted Tidal/Brackish Marsh, and Non-Native Annual Grasslands). The Study Area also contains developed and landscaped areas along San Clemente Drive, including a pedestrian path. The levee portion of the Study Area contains disturbed ruderal vegetation that covers the levee footprint. Elevations within the Study Area range from approximately 2 to 10 feet NAVD88. Biological communities and potentially jurisdictional features observed within the Study Area are discussed in detail below (Exhibit 'A' and Exhibit 'B'). A list of plant species observed during the site assessment is attached as exhibit 'C'. A list of wildlife species observed during the site assessment is attached as Exhibit 'D'. Photographs taken during the site assessment are attached as Exhibit 'E' and Photo Points are included in Exhibit 'A'.

Developed/Disturbed Area

Developed/disturbed areas within the Study Area consisted of non-vegetated, landscaped, and ruderal vegetated that exhibit signs of regular human use. The Study Area contained 2.75 acres of developed or disturbed land composed of the area along San Clemente Drive, along the top of the levee within the pedestrian path, and along the southern extent of the Study Area adjacent to a residential neighborhood (Photograph E.1, Exhibit E). Disturbed Areas along the inboard portions of the levee extend approximately 15 feet from the levee top south before transitioning into either Muted Tidal/Brackish Wetlands or Non-Native Annual Grassland. Developed/disturbed areas are not considered sensitive under the California Environmental Quality Act (CEQA).

Northern Coastal Salt Marsh

Approximately 1.94 acres of northern coastal salt marsh occurs along the outer perimeter of the Study Area, in areas of tidal influence from Corte Madera Bay (Photographs E.1, E.2, E.3, and E.6, Exhibit E). Northern coastal salt marsh is a community typically found along sheltered margins of bays, lagoons, and estuaries, where tidal inundation of salt water occurs (Holland 1986). This highly productive herbaceous and suffrutescent biological community is composed of salt-tolerant hydrophytes forming moderate to dense cover. This community correlates to the Pickleweed Mats herbaceous alliance (*Salicornia pacifica* Herbaceous Alliance) described by

Sawyer et al. (2009). This community is protected by the CDFW as a sensitive plant community, is regulated by the Corps and the RWQCB as wetland habitat, and would be considered sensitive under the CEQA.

Muted Tidal/Brackish Wetlands

Approximately 0.73 acres of muted tidal/brackish wetlands occurs along portions of the inboard perimeter levee within the Study Area. A small pocket of Muted Tidal/Brackish Wetlands was observed within the stormwater basin adjacent to the levee. The stormwater basin appears to be connected upstream by a culverted drainage and connected downstream on the eastern edge by a culvert which eventually connects to San Francisco Bay. In high rainfall events the stormwater basin may receive tidally influenced waters which may have led to the establishment of this pocket of Muted Tidal/Brackish Wetlands.

This plant community was largely dominated by salt-tolerant and/or halophytic species. Three wetland plant communities were observed on the Study Area corresponding to the following alliances described by Sawyer et al. (2009): salt marsh bulrush marshes (*Bolboschoenus maritimus* Herbaceous Alliance), Italian rye grass seasonal wetlands (*Festuca perennis* Semi-Natural Herbaceous Stands), and pickleweed mats (non-tidal) (Photograph E.4, Exhibit E). The first and third alliances are considered sensitive by the CDFW, whereas the second alliance is not. However, all three alliances would be regulated by the Corps and RWQCB as wetland habitat.

Non-Native Annual Grasslands

Non-native annual grassland composes 0.22 acres of the Study Area (Photograph E.5, Exhibit E). Non-native annual grassland is highly variable throughout the Study Area and throughout California in general. Non-Native Annual Grasslands were observed within the inboard portion of the levee within the stormwater basin and adjacent detention basins. This community was also observed along the top of the levee on either side of the pedestrian path. Along the top of the levee, harding grass (*Phalaris aquatica*) and ripgut brome (*Bromus diandrus*) were the dominant grasses observed. Non-native grassland is usually dominated by non-native annual grasses and forbs, along with scattered native and non-native wildflowers. This community is classified by Holland as non-native grassland (Holland 1986). Sawyer et al. (2009) describe a variety of non-native grassland alliances which were observed on the Study Area including annual brome grasslands (*Bromus diandrus*, *B. hordeaceus* Semi-Natural Herbaceous Stands) and Italian rye grass fields (*Festuca perennis* Semi-Natural Herbaceous Stands). Ripgut brome (*Bromus diandrus*) is rated by the Cal-IPC as having “moderate” invasive potential (Cal-IPC 2017). Italian rye grass is rated by the Cal-IPC as having “moderate” potential for invasiveness. No rarity ranking exists for non-native annual grasslands and they are not considered sensitive under the CEQA.

Special-Status Species

Plants

Eighty-nine special-status plant species have been documented within the referenced USGS 7.5-minute quadrangles (CDFW 2017; CNPS 2017). No special-status plant species were identified in the Study Area during the site assessment. Many of the species identified in the CNDDB, CNPS and USFWS queries are associated with specific habitats not found within the Study Area;

these are species associated with coastal scrub, serpentine soils, alkaline soils, vernal pools, chaparral, grassland, or other habitats. Of the species identified in these queries, two special-status plant species were determined to have a moderate to high potential to occur in the Study Area. These are species associated with coastal salt marshes or wetlands.

The two special-status plant species that were determined to have moderate to high potential to occur within the Study Area include:

- Point Reyes salty bird's beak (*Chloropyron maritimum ssp. palustre,* CNPS Rank 1B.2)
- Marin knotweed (*Polygonum marinense,* CNPS Rank 3.1).

These species are discussed in further detail below.

Point Reyes Bird's-Beak (*Chloropyron maritimum* ssp. *palustre*), CNPS Rank 1B.2. Moderate Potential. Point Reyes bird's-beak is an annual herb in the figwort family (Scrophulariaceae) that blooms from June to October. It typically occurs in coastal salt marsh habitat at elevations ranging 0 to 33 feet (CDFW 2017, CNPS 2017). Observed associated species include saltgrass (*Distichlis spicata*), pickleweed, cord grass (*Spartina* spp.), fleshy jaumea (*Jaumea carnosa*), bulrushes (*Bolboschoenus* spp., *Schoenoplectus* spp., *Scirpus* spp.), and Baltic rush (*Juncus balticus*) (CDFW 2017).

There are nine CNDDB (CDFW 2017) records from the referenced quadrangles. The nearest known occurrence is from August 1987, less than half a mile north of the Study Area in the Corte Madera Marsh Ecological Reserve (CMMER), where 100 to 200 plants were reportedly present along the south bank of Corte Madera Creek in a dense stand of pickleweed with sparse stands of California sea lavender (*Limonium californicum*) (CDFW 2017). Point Reyes bird's-beak was determined to have moderate potential to occur outboard of the levee perimeter in the Study Area due to the presence of coastal salt marsh habitat, the close proximity of the nearest occurrences, and the presence of associated species within the Study Area. However, this species was determined to have low potential to occur inboard of the perimeter levee due to the lack of tidal influence and the disturbed nature of the seasonal wetlands in this part of the Study Area.

Marin Knotweed (*Polygonum marinense*), CNPS Rank 3.1. Moderate Potential. Marin knotweed is an annual forb in the buckwheat family (Polygonaceae) that blooms from as early as April to as late as October. It usually habituates in salt and brackish coastal marshes at elevations ranging up to 35 feet above sea level (CDFW 2017, CNPS 2017). Observed associated species include pickleweed, saltgrass, Oregon gumweed, alkali seaheath, sedges (*Carex* spp.), salt marsh bulrush, and fathen (CDFW 2017).

Three documented occurrences of Marin knotweed have been reported within the greater vicinity of the Study Area (CDFW 2017). The nearest occurrence was documented in 1989, less than half a mile north of the Study Area, where approximately 20 plants were observed in high marsh habitat between the Larkspur ferry parking lot and the mouth of Corte Madera Creek. All documented occurrences describe habitat consisting of tidal salt marsh with pickleweed and saltgrass. Marin knotweed was determined to have moderate potential to occur outboard of the perimeter levee in the Study Area due to the presence of suitable tidal salt marsh habitat and the proximity of documented occurrences for this species. This species was determined to have low potential to occur inboard of the perimeter levee where a lack of tidal activity and the disturbed nature of seasonal wetlands limits the potential for this species to occur. It should be noted that

the site assessment was conducted during the blooming period for this species and it was not observed within the Study Area.

Wildlife

Fifty-eight special-status wildlife species have been documented within the referenced USGS 7.5-minute quadrangles (CDFW 2017). Of these species, 15 were determined to have a moderate to high potential to occur within the Study Area:

- Salt-marsh harvest mouse (*Reithrodontomys raviventris,* Federal Endangered, State Endangered, CDFW Fully Protected)
- California black rail (*Laterallus jamaicensis coturniculus,* State Threatened, CDFW Species of Special Concern, CDFW Fully Protected)
- California Ridgway's rail (*Rallus obsoletus obsoletus,* Federal Endangered, State Endangered, CDFW Fully Protected)
- White-tailed kite (*Elanus leucurus,* CDFW Fully Protected)
- Northern harrier (*Circus cyaneus,* CDFW Species of Special Concern)
- San Francisco common yellowthroat (*Geothlypis trichas sinuosa,* CDFW Species of Special Concern, USFWS Bird of Conservation Concern)
- San Pablo song sparrow (*Melospiza melodia samuelis,* CDFW Species of Special Concern, USFWS Bird of Conservation Concern)
- Bryant's savannah sparrow (*Passerculus sandwichensis alaudinus*, CDFW Species of Special Concern)
- Loggerhead shrike (*Lanius ludovicianus*, CDFW Species of Special Concern, USFWS Bird of Conservation Concern)
- River lamprey (*Lampetra ayresii,* CDFW Species of Special Concern)
- Pacific lamprey (*Entosphenus tridentatus*, CDFW Species of Special Concern)
- Green sturgeon (*Acipenser medirostris*, Federal Endangered, CDFW Species of Special Concern)
- White sturgeon (*Acipenser transmontanus,* CDFW Species of Special Concern)
- Longfin smelt (*Spirinchus thaleichthys*, Federal Candidate, State Threatened, CDFW Species of Special Concern)
- Steelhead, central California coast DPS (*Oncorhynchus mykiss irideus*, Federal Threatened)

Salt-marsh harvest mouse exclusively inhabits San Francisco Bay Area bayshore wetlands and has been documented to occur in the north portion of the Corte Madera Marsh Ecological Reserve (CMMER) adjacent to the Study Area (CDFW 2017). This species generally occupies dense wetland vegetation, but is also known to opportunistically forage within adjacent upland habitats up to 330 feet (100 meters) away from the primary wetland habitat (USFWS 2013). Thus, both wetlands and uplands within the Study Area have potential to support salt-marsh harvest mouse.

California Ridgeway's rail and California black rail occur in San Francisco Bay Area bayshore wetlands and have been documented to occur within the CMMER adjacent to the Study Area (CDFW 2017). These species may forage or nest within portions of the Study Area within tidal wetlands located on the perimeter of the Study Area.

The remaining six bird species are known to occur in the vicinity of the Study Area and have potential to forage and nest within the Study Area (CDFW 2017, eBird 2017, Shuford 1993).

Northern harrier, San Francisco common yellowthroat, Bryant's savannah sparrow, and San Pablo song sparrow may nest in dense vegetation throughout the Study Area. Loggerhead shrike and white-tailed kite may nest in dense shrubs or trees within or directly adjacent to the Study Area. In addition, most breeding birds are protected under the federal Migratory Bird Treaty Act (MBTA) and the California Fish and Game Code (CFGC), regardless of their conservation status.

The six fish species with potential to occur within the Study Area may occur in tidal sloughs and channels within the Study Area outboard of the levee. These species may occasionally forage or shelter within these sloughs and channels, however, no freshwater spawning habitat for any of these species is present within or upstream of the Study Area. Additionally, the sloughs and channels within the Study Area do not connect to any potential upstream spawning habitat. Finally, the stormwater basin and adjacent detention basins do not appear to contain regular flows that support fish.

Critical Habitat and Essential Fish Habitat

The tidal sloughs and channels within the Study Area outboard of the levee contain designated USFWS Critical Habitat for green sturgeon and are designated National Oceanic and Atmospheric Administration (NOAA) Essential Fish Habitat for chinook and coho salmon. These species use nearshore habitats, sloughs, and channels during migration and juvenile rearing. However, neither of these species is likely to be present within the Study Area. Although coho salmon historically occurred in the region, they are considered extirpated from San Francisco and San Pablo Bays and are thus unlikely to occur within the Study Area (Leidy et al. 2005). Chinook salmon are not known to spawn in Marin County streams that empty into San Pablo Bay (NOAA 2017a). Chinook salmon that enter San Pablo Bay are primarily in-migrating adults on their way to spawn in the Sacramento and San Joaquin Rivers and their tributaries as well as out-migrating juveniles who have reared in more brackish waters in the Delta and are on their way to the ocean (Williams 2012). Because the sloughs within the Study Area do not lead to spawning habitat and are past primary rearing areas and are not directly along migrations routes, chinook salmon are unlikely to occur within the Study Area.

Summary and Recommendations

Below is a brief summary of recommendations for avoidance measures and potential regulatory requirements related to this project. Although this project has "segments" associated with its engineering design, the recommendations provided below would be relevant to all segments surveyed within the Study Area. Table 1 provides an outline of recommendations and requirements as discussed below.

Wetlands and Non-Wetland Waters

If Project work will occur within the northern coastal salt marsh, including tidal sloughs, outboard of the levee or the muted tidal/brackish wetlands inboard of the levee, a formal delineation to determine the extent of regulatory jurisdiction within the Study Area is recommended. These areas are potentially subject to federal or state jurisdiction under Section 404 and 401 of the Clean Water Act (CWA), Section 10 of the Rivers and Harbors Act, the Porter-Cologne Water Quality Control Act, and Section 1600 of the CFGC. Section 404 jurisdiction extends to the high tide line. Within the Study Area, outboard of the levee, the high tide line was preliminarily determined to be approximately 7.71 feet above sea level (NAVD88) (NOAA 2017b). Section 10 jurisdiction extends to the mean high water line. Within the Study Area, outboard of the levee, the mean high

water line was preliminarily determined to be 5.35 feet above sea level (NAVD88) (NOAA 2017b). Determination of a more accurate high tide line and mean high water line would require further mapping in the field and aerial mapping analysis associated with the preparation of a formal delineation report.

Consultation with the USFWS and NMFS may also be required for potential impacts to special-status wildlife species. These agencies may require compensatory mitigation for any impacts to wetlands within the Study Area.

Additionally, the Study Area contains lands that may be regulated by the San Francisco Bay Conservation and Development Commission (BCDC) which would require a regulatory permit for any impacts within their jurisdictional limits. BCDC takes jurisdiction over a 100 foot shoreline band leading inland which would also be subject to their regulatory permit requirements.

Special-Status Plant Species

Focused surveys for the special-status plant species determined to have potential to occur within the Study Area are recommended prior to any project work within areas of impact within the northern coastal salt marsh or muted tidal/brackish wetland portions of the Study Area. Such surveys should be conducted between July to October, which coincides with the blooming period for the two special-status plant species that have potential to occur within the Study Area.

Special-Status Wildlife Species

Salt Marsh Harvest Mouse

Given the potential for salt-marsh harvest mouse to occur within and adjacent to the Study Area, formal consultation with the USFWS may be necessary. Typical avoidance measures for this species include specialized vegetation removal, exclusion fencing, and biological monitoring.

Nesting Birds

If Project work is to occur during the nesting bird season (February 1 to August 15), a nesting bird survey may be necessary to avoid impacts to special-status birds and non-status birds protected during nesting by the MBTA and CFGC. Additionally, formal or informal consultation with the USFWS and/or CDFW for California Ridgway's rail may be required. Typical avoidance measures for this species include avoiding work during the nesting season. If work is to be conducted during the nesting season, focused surveys and 700-foot nesting buffers are often required to avoid impacts to nests. Avoidance measures for California Ridgway's rail are generally sufficient to avoid impacts to California black rail.

Critical Habitat and Essential Fish Habitat

If Project work will occur within the wetlands outboard of the levee during the dry season (June 1 to October 31), then informal consultation may be necessary with the NMFS to avoid impacts to special-status fish. If Project work is proposed in wetlands outboard of the levee during the rainy season (November 1 to May 31), a formal consultation will likely be required with the NMFS. If no work in these areas is proposed for the Project, no consultation with NMFS will likely be necessary.

Table 1. Summary of Recommended Next Steps

Recommendations	Agencies Involved	Species / Issue of Concern	Requirements
Wetlands and Non-wetland Waters	Corps RWQCB CDFW	• Extent of regulatory jurisdiction within the Study Area	• Conduct a formal wetland and waters delineation and submit for verification by Corps
Special-Status Plant Surveys	CDFW	• Marin Knotweed • Point Reyes Birds Beak	• Conduct focused surveys from July to October to determine presence/absence
Special-Status Wildlife Species Consultation	USFWS	• Salt Marsh Harvest Mouse • California Ridgeway's Rail	• Consult with USFWS for potential impacts to these species • Prepare a Section 7 Biological Assessment
Regulatory Permitting	Corps RWQCB CDFW BCDC	• Disturbance to potentially regulated wetlands and non-wetland waters	• Section 10 of the Rivers and Harbors Act • Section 404 and 401 of the Clean Water Act • The Porter-Cologne Water Quality Act • Section 1600 of the California Fish and Game Code • BCDC 100' shoreline band and jurisdictional boundaries
Critical Habitat and Essential Fish Habitat	USWS NMFS	• Green sturgeon • White sturgeon • Longfin smelt • Steelhead, central CA coast DPS	• Consult with USFWS and NMFS • Prepare a Section 7 Biological Assessment
Pre-Construction Nesting Bird Survey	CDFW	• MBTA-regulated species	• Conduct surveys if work is to occur between February 1 and August 15
CEQA Compliance	City of Corte Madera State of California	• Compliance with state and local laws	• Preparation and approval of CEQA documentation (IS/MND, EIR, etc.)

Please contact me if you have any questions.

Sincerely,

Tanner Harris, MS
Ecologist

Enclosures: Exhibits A-E

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Exhibit A. Biological Communities Map

Path: L:\Acad 2000 Files\25000\25063\GIS\ArcMap\Biological Communities.mxd

Basemap Source: Sonoma Veg 2013 Aerial

Exhibit A. Biological Communities Observed within the Study Area

Mariner's Village Levee Improvements
Corte Madera, California

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Map Prepared Date: 6/7/2017
Map Prepared By: czumwalt
Data Source(s): WRA

Exhibit B. Potentially Jurisdictional Features Map

Path: L:\Acad 2000 Files\25000\25063\GIS\ArcMap\Jurisdictional Features.mxd

Basemap Source: Sonoma Veg 2013 Aerial

Exhibit B. Potentially Jurisdictional Features Observed within the Study Area

Mariner's Village Levee Improvements
Corte Madera, California

wra
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Map Prepared Date: 6/9/2017
Map Prepared By: czumwalt
Data Source(s): WRA

Exhibit C. Plant species observed during May 12, 2017 field visit

Scientific Name	Common Name	Origin	CAL-IPC Status
Agave sp.	agave	-	-
Albizia lophantha	stink bean	non-native (invasive)	-
Arbutus marina	strawberry tree		
Atriplex prostrata	fat-hen	non-native	-
Avena barbata	slim oat	non-native (invasive)	moderate
Baccharis pilularis	coyote brush	native	-
Bolboschoenus maritimus ssp. paludosus	saltmarsh bulrush	native	-
Bromus diandrus	ripgut brome	non-native (invasive)	moderate
Bromus hordeaceus	soft chess	non-native (invasive)	limited
Bromus madritensis	foxtail chess, foxtail brome	non-native	-
Carduus pycnocephalus ssp. pycnocephalus	Italian thistle	non-native	-
Carpobrotus chilensis	sea fig	non-native (invasive)	moderate
Ceanothus thyrsiflorus var. thyrsiflorus	blue blossom	native	-
Claytonia parviflora ssp. parviflora	miner'slettuce	native	-
Convolvulus arvensis	field bindweed	non-native (invasive)	-
Cotula coronopifolia	brass buttons	non-native (invasive)	limited
Dipsacus fullonum	wild teasel	non-native (invasive)	moderate
Distichlis spicata	salt grass	native	-
Elymus triticoides	beardless wild rye	native	-
Erodium moschatum	whitestem filaree	non-native (invasive)	-
Festuca arundinacea	reed fescue	non-native (invasive)	moderate

Scientific Name	Common Name	Origin	CAL-IPC Status
Festuca perennis	Italian rye grass	non-native	-
Foeniculum vulgare	fennel	non-native (invasive)	high
Frankenia salina	Yerba reuma, alkali heath	native	-
Genista monspessulana	French broom	non-native (invasive)	high
Geranium dissectum	wild geranium	non-native (invasive)	limited
Grindelia stricta var. angustifolia	marsh gumplant	native	-
Hedera helix	English ivy	non-native (invasive)	-
Helminthotheca echioides	bristly ox-tongue	non-native (invasive)	-
Heteromeles arbutifolia	toyon	native	-
Hordeum brachyantherum	meadow barley	native	-
Hordeum marinum ssp. gussoneanum	barley	non-native	-
Hordeum murinum	foxtail barley	non-native (invasive)	-
Hypochaeris radicata	hairy cats ear	non-native (invasive)	moderate
Jaumea carnosa	marsh jaumea	native	-
Kniphofia uvaria	redhot poker	non-native	-
Lactuca serriola	prickly lettuce	non-native (invasive)	-
Lepidium latifolium	perennial pepperweed	non-native (invasive)	high
Ligustrum sp.	-privet	non-native-	-
Limonium californicum	marsh rosemary	native	-
Lotus corniculatus	bird's foot trefoil	non-native (invasive)	-
Lysimachia arvensis	scarlet pimpernel	non-native	-
Malva nicaeensis	bull mallow	non-native	-

Scientific Name	Common Name	Origin	CAL-IPC Status
Matricaria discoidea	pineapple weed	native	-
Medicago polymorpha	California burclover	non-native (invasive)	limited
Melilotus indicus	annual yellow sweetclover	non-native	-
Microseris bigelovii	coast microseris	native	-
Myoporum laetum	lollypop tree	non-native (invasive)	moderate
Nerium oleander	oleander	non-native (invasive)	-
Oxalis pes-caprae	Bermuda buttercup	non-native (invasive)	moderate
Phalaris aquatica	Harding grass	non-native (invasive)	moderate
Phoenix canariensis	Canary island date palm	non-native (invasive)	limited
Phormium tenax	New Zealand flax	non-native	
Phragmites australis	common reed	native	-
Plantago coronopus	cut leaf plantain	non-native (invasive)	-
Plantago lanceolata	ribwort	non-native (invasive)	limited
Polypogon monspeliensis	annual beard grass	non-native (invasive)	limited
Prunus cerasifera	cherry plum	non-native (invasive)	limited
Pyracantha angustifolia	firethorn	non-native (invasive)	-
Quercus agrifolia	coast live oak	native	-
Raphanus raphanistrum	jointed charlock	non-native	-
Raphanus sativus	jointed charlock	non-native (invasive)	limited
Rubus ursinus	California blackberry	native	-
Rumex crispus	curly dock	non-native (invasive)	limited
Rumex pulcher	fiddleleaf dock	non-native	-

Scientific Name	Common Name	Origin	CAL-IPC Status
Salicornia pacifica	pickleweed	native	-
Schinus molle	Peruvian pepper tree	non-native (invasive)	limited
Schinus terebinthifolius	Brazilian pepper tree	non-native (invasive)	limited
Sonchus asper ssp. asper	sow thistle	non-native (invasive)	-
Sonchus oleraceus	sow thistle	non-native	-
Spartina alterniflora	salt water cord grass	non-native (invasive)	-
Spergularia rubra	purple sand spurry	non-native	-
Tragopogon porrifolius	salsify	non-native	-
Trifolium fragiferum	strawberry clover	non-native	-
Vicia villosa	hairy vetch	non-native (invasive)	-

Exhibit D. Wildlife species observed during May 12, 2017 field visit

Scientific Name	Common Name
Mammals	
Lepus californicus	Black-tailed Jackrabbit
Birds	
Agelaius phoeniceus	Red-winged black bird
Anas platyrhynchos	Mallard
Ardea alba	Great egret
Cathartes aura	Turkey vulture
Corvus brachyrhynchos	American crow
Melospiza melodia	Song sparrow
Melozone crissalis	California towhee
Saynoris nigricans	Black phoebe
Tachycineta thalassina	Violet-green swallow

Exhibit E. Site Photographs

Exhibit E. Study Area Photographs

Photograph E.1 (Top): View facing east of levee and northern coastal salt marsh.

Photograph E.2 (Bottom): View facing north disturbed/developed of the Study Area.

Photographs taken May 12, 2017

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Exhibit E. Study Area Photographs

Photograph E.3 (Top): View facing west of northern coastal salt marsh.

Photograph E.4 (Bottom): View of muted tidal/brackish wetland dominated by Italian rye grass.

Photographs taken May 12, 2017

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Exhibit E. Study Area Photographs

Photograph E.5 (Top): View facing east of levee and non-native annual grassland within the Study Area.

Photograph E.6 (Bottom): View facing south of levee and northern coastal salt marsh.

Photographs taken May 12, 2017

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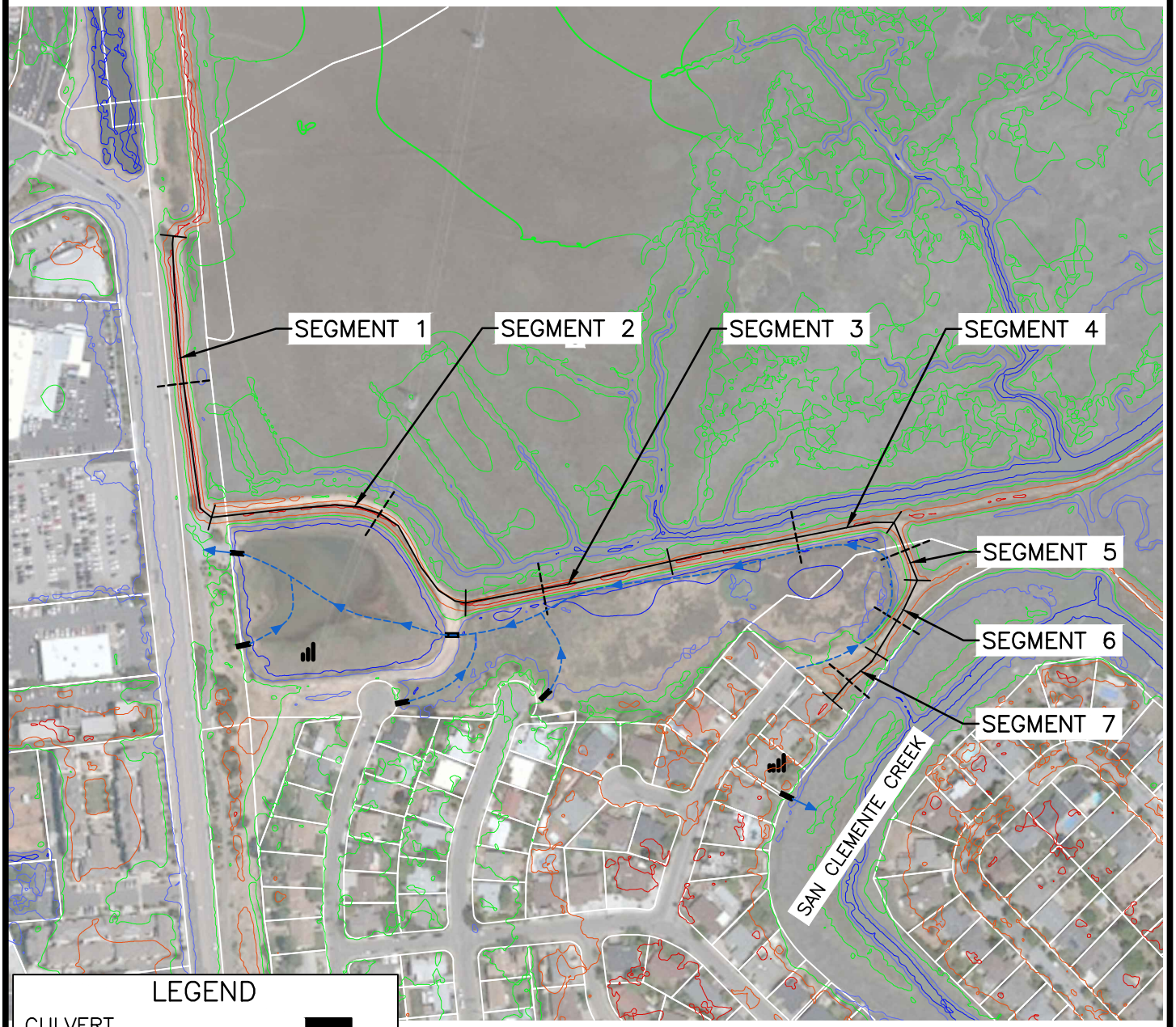
Attachment B:

Mariners Village Levee Sections: Existing and Improved:

MARINERS VILLAGE LEVEE IMPROVEMENT: BASE MAP



LEGEND

- CULVERT
- STORMWATER DRAINAGE
- 2FT CONTOUR
- 4FT CONTOUR
- 6FT CONTOUR
- 8FT CONTOUR
- 10FT CONTOUR
- 12FT CONTOUR
- LEVEE SEGMENT
- SECTION CUT
- PARCEL BOUNDARY (WHITE)

SCALE: 1" = 300'-0"

0 250 500 Feet

N

NOTE: ELEVATIONS IN FEET, NAVD88

SOURCES
LEVEE SURVEY: PERFORMED BY PACIFICHDS
REGIONAL TOPOGRAPHY: GOLDEN GATE LIDAR, 2010
IMAGERY: ESRI, DIGITALGLOBE "WORLD IMAGERY" BASEMAP

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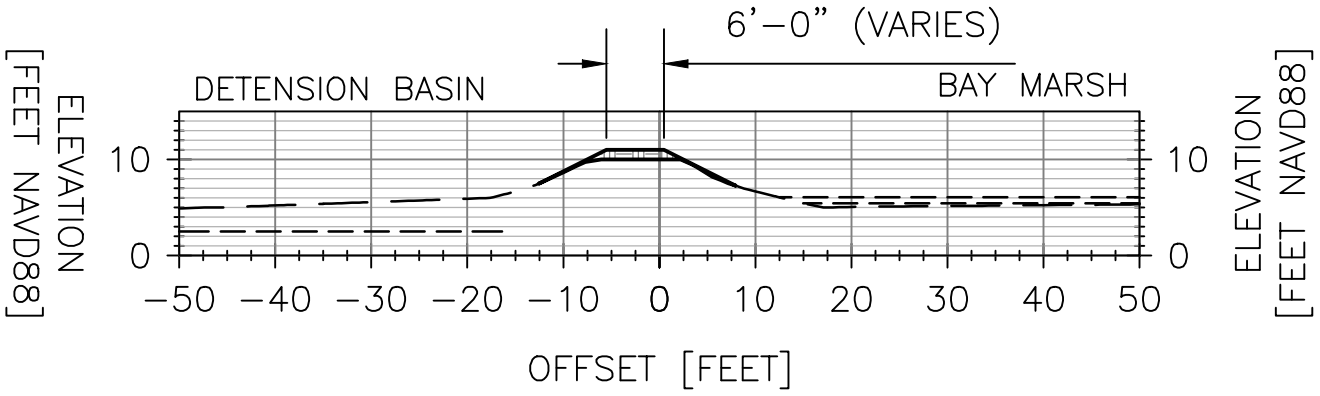
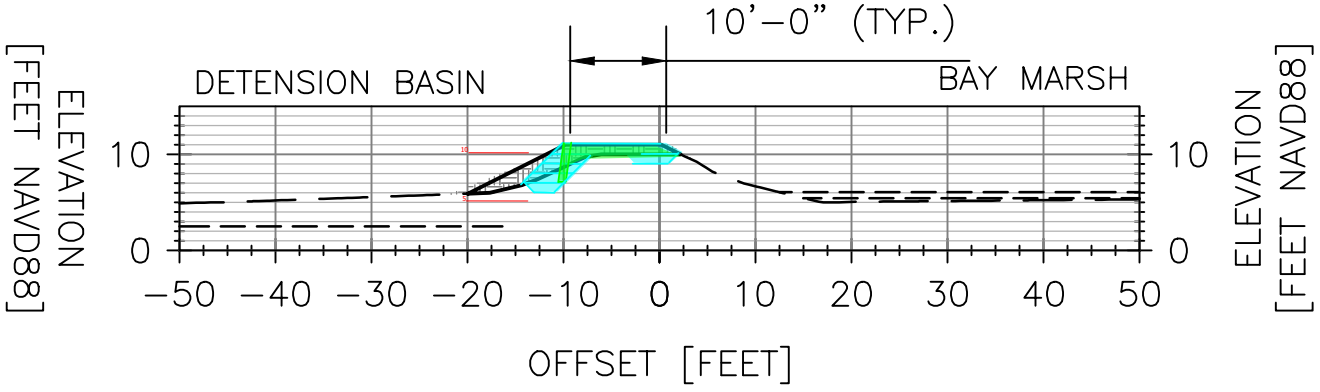
ALTERNATIVE 1C: TOP LEVEE WITH FILL



ALTERNATIVE 3C: EXPAND LEVEE FOOTPRINT



LEGEND

(N) LEVEE OUTLINE

(N) LEVEE FILL

(E) LEVEE

FILL ALTERNATIVES

EARTHEN:

TERRAMESH:

BLOCKWALL:

SCALE: 1" = 20'–0"

SEGMENT 1 – INCREASED SLOPE
LEVEE IMPROVEMENT ALTERNATIVES

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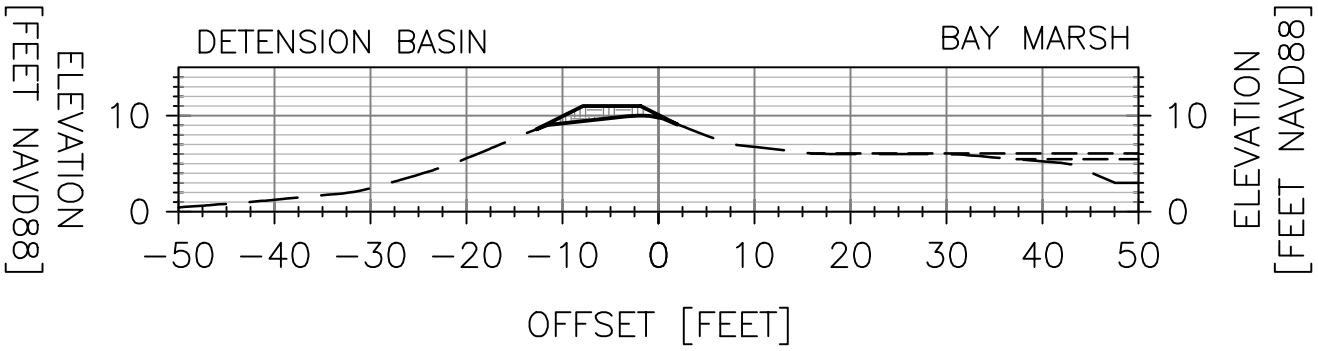
ALTERNATIVE 1C: TOP LEVEE WITH FILL



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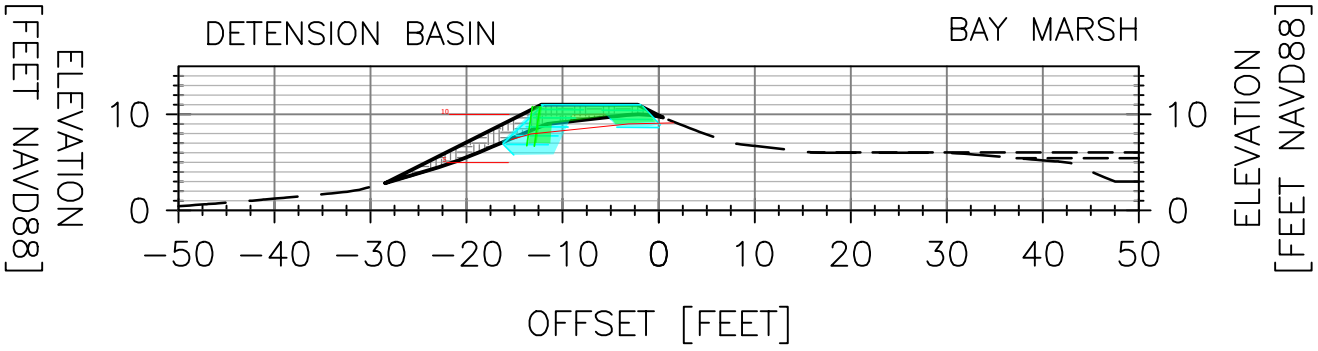

LEGEND

(N) LEVEE OUTLINE

(N) LEVEE FILL

(E) LEVEE

FILL ALTERNATIVES

EARTHEN:

TERRAMESH:

BLOCKWALL:

SCALE: 1" = 20'−0"

SEGMENT 2 – INCREASED SLOPE
LEVEE IMPROVEMENT ALTERNATIVES

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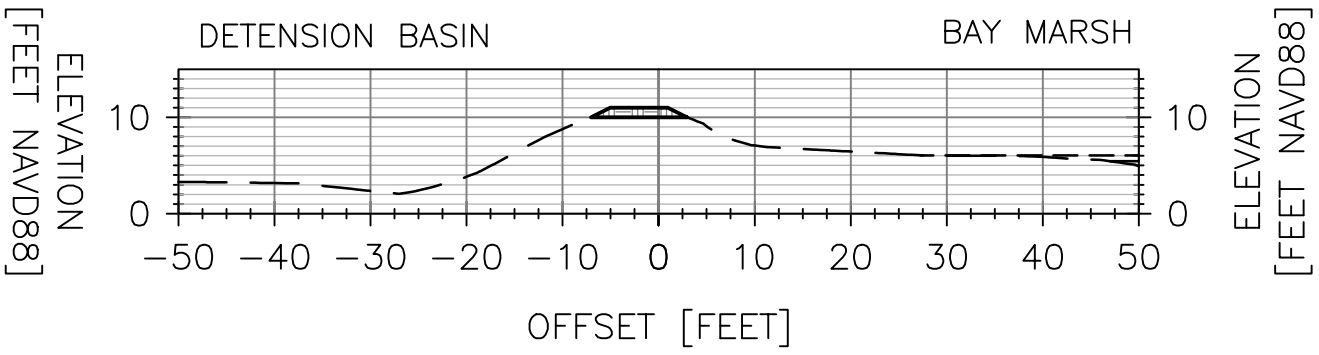
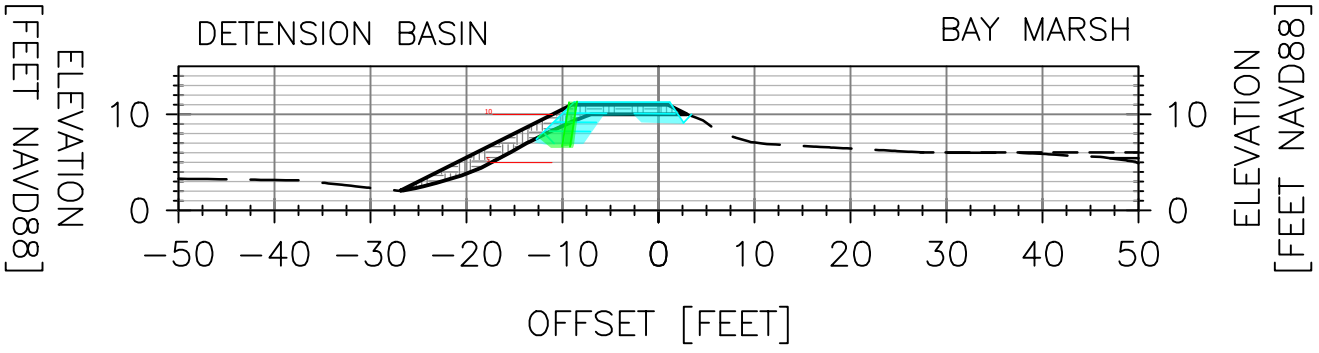
ALTERNATIVE 1C: TOP LEVEE WITH FILL



ALTERNATIVE 3C: EXPAND LEVEE FOOTPRINT



LEGEND

(N) LEVEE OUTLINE

(N) LEVEE FILL

(E) LEVEE

FILL ALTERNATIVES

EARTHEN:

TERRAMESH:

BLOCKWALL:

SCALE: 1" = 20'−0"

SEGMENT 3 – INCREASED SLOPE
LEVEE IMPROVEMENT ALTERNATIVES

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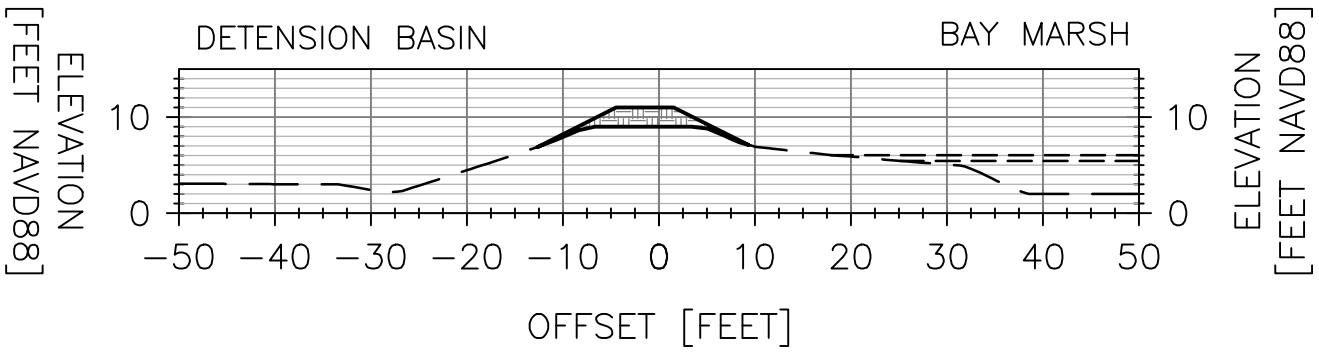
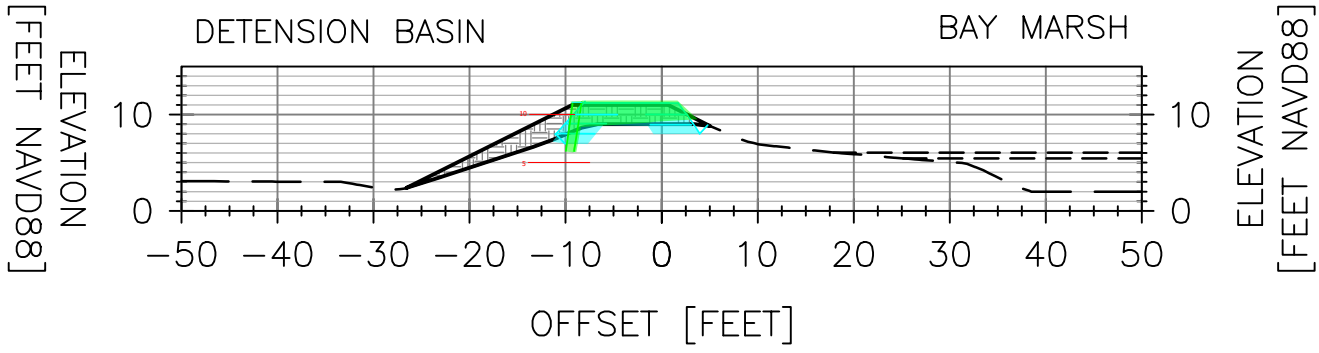
ALTERNATIVE 1C: TOP LEVEE WITH FILL



ALTERNATIVE 3C: EXPAND LEVEE FOOTPRINT



LEGEND

(N) LEVEE OUTLINE

(N) LEVEE FILL

(E) LEVEE

FILL ALTERNATIVES

EARTHEN:

TERRAMESH:

BLOCKWALL:

SCALE: 1" = 20'−0"

SEGMENT 4 – INCREASED SLOPE
LEVEE IMPROVEMENT ALTERNATIVES

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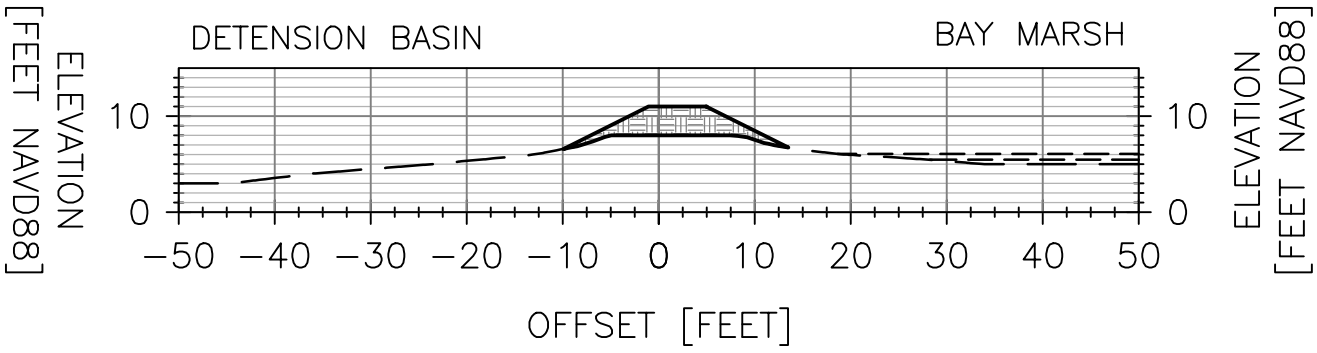
ALTERNATIVE 1C: TOP LEVEE WITH FILL



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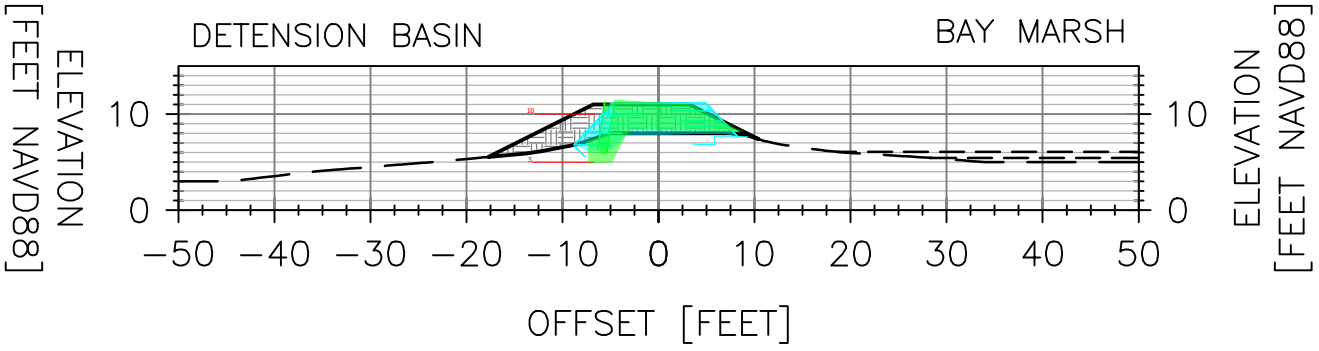

LEGEND

(N) LEVEE OUTLINE

(N) LEVEE FILL

(E) LEVEE

FILL ALTERNATIVES

EARTHEN:

TERRAMESH:

BLOCKWALL:

SCALE: 1" = 20'−0"

SEGMENT 5 – INCREASED SLOPE
LEVEE IMPROVEMENT ALTERNATIVES

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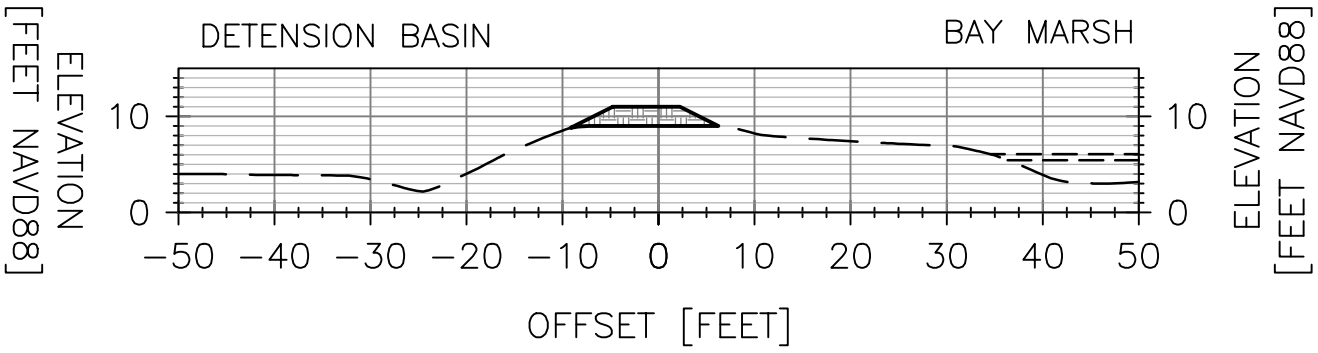
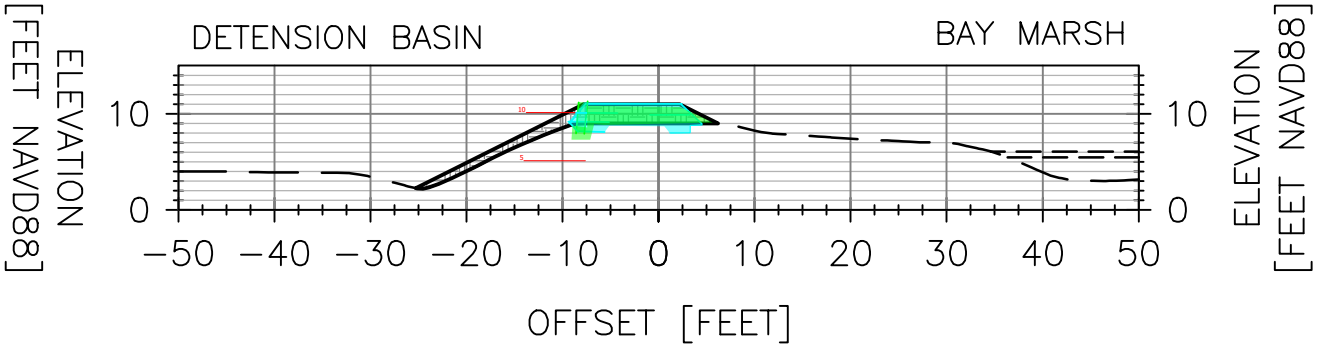
ALTERNATIVE 1C: TOP LEVEE WITH FILL



ALTERNATIVE 3C: EXPAND LEVEE FOOTPRINT



LEGEND

(N) LEVEE OUTLINE

(N) LEVEE FILL

(E) LEVEE

SCALE: 1" = 20'−0"

SEGMENT 6 – INCREASED SLOPE
LEVEE IMPROVEMENT ALTERNATIVES

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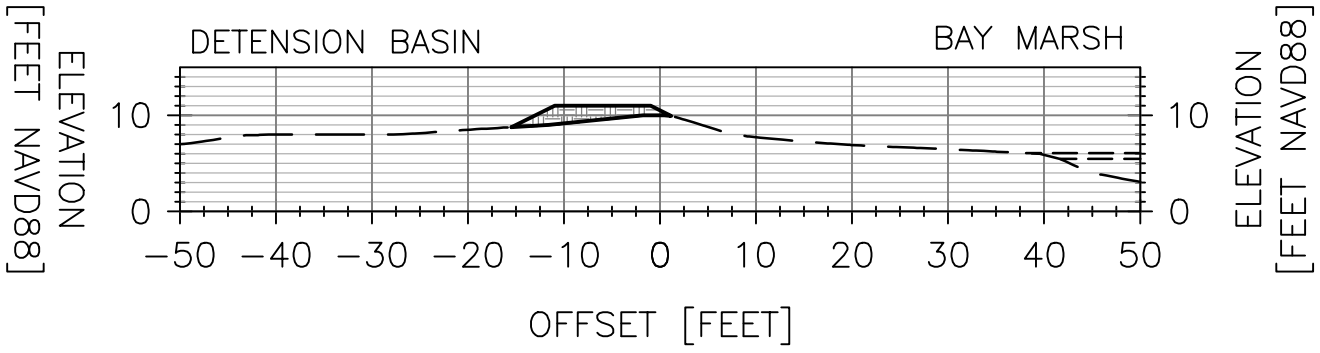
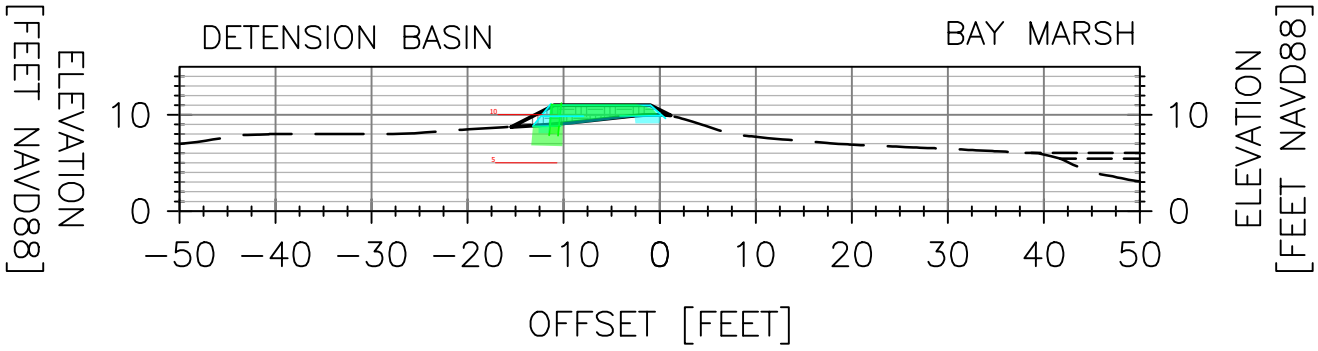
ALTERNATIVE 1C: TOP LEVEE WITH FILL



ALTERNATIVE 3C: EXPAND LEVEE FOOTPRINT



LEGEND

(N) LEVEE OUTLINE

(N) LEVEE FILL

(E) LEVEE

SCALE: 1" = 20'−0"

SEGMENT 7 – INCREASED SLOPE
LEVEE IMPROVEMENT ALTERNATIVES

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Attachment C:

Engineering in Support of Design:

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ENR TOP 500 DESIGN FIRMS

Attachment C:
Engineering in Support of Design:

Tidal Datums:

Unless otherwise noted at elevations provided reference a NAVD88 vertical datum.

Assumed tidal datums are based on:

1) NGS tidal datums for the Richmond Gage (PID HT0940)
2) NCI Tidal Inundation Frequency Analysis
3) FEMA Coastal Food Projections (2014)

Table 1: Tidal Datum's Near Marina Village, Corte Madera CA

Tidal Datum or Elevation (Richmond, CA PID#HT0940)	Elevation, NAVD88 (ft.)	
Highest Observed Tide (2017)	8.10	TBD when verified data released
Highest Predicted Tide (2017)	6.92	
MHHW	6.06	
MHW	5.45	Section 10 Jurisdictional Line
MTL	3.29	
MSL	3.26	
NGVD29	2.66	
MLW	1.13	
MLLW	0.06	
NAVD88	0.00	

Note: NAVD88=NGVD29+2.66 ft. (NOAA, 2016)

Tidal Inundation Analysis:

To characterize the percentage of time water levels near or exceed existing levee top grades along the Mariners Village levees, NCI prepared an annual observed tidal stage frequency distribution (Figure 1) based on local tidal observations (NOAA, 2016). This curve identifies the percent time (y-axis) the water surface elevation (x-axis) is exceeded. This curve was developed utilizing nearby observed 2016 San Quentin tides. Table 2 presents the typical crest elevation of the Mariners Village Levee segments.

Winter seasonal values are adopted for the study to address typical wet winter conditions which are the focus of the study. The curve indicates that 2016 winter observed water levels exceeded 7.0 ft. NAVD88 less than 2% of the time.

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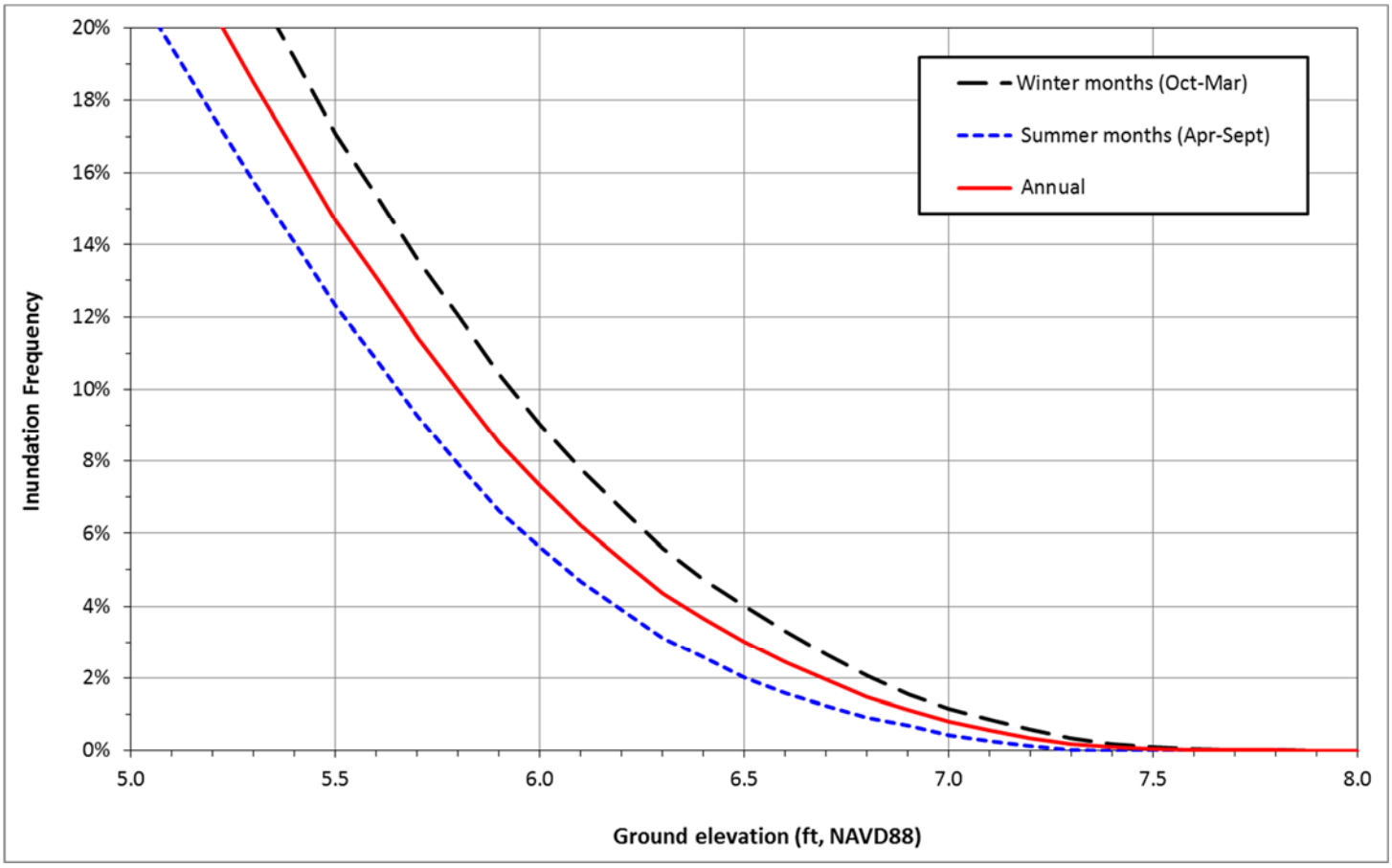
Figure 1: Observed Tidal Stage Frequency Analysis, (San Quentin (2016)



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FEMA/NCI Estimates of Flood Elevations and Return Periods:

Table 2 presents FEMA (2016) estimates of return periods and the associated predicted stillwater tidal elevations near the project site for large magnitude storms with return periods of 1—500yrs. NCI utilized the extended San Francisco gage record, and published local stage corrections to estimate maximum stillwater water surface elevations (WSEs) for return periods of one to five years.

Table 2: FEMA/NCI Flood Elevations and Return Periods

Return Period (yr.)	% Chance Annual Exceedance	WSE (ft.,NAVD88)	Source
1	100%	7.1	NCI/USACE (2012)
2	50%	7.9	NCI/USACE (2012)
5	20%	8.3	NCI/USACE (2012)
10	10%	8.4	FEMA (3/16/2016)
50	2%	8.7	FEMA (3/16/2016)
100	1%	9.7	FEMA (3/16/2016)
500	0.2%	10.8	FEMA (3/16/2016)

These elevations are correlated with the existing levee crest elevations in Table 3, to characterize annual tidal inundation risk for each of the levee segments.

Table 3: Estimated Tidal Inundation Frequency for Mariners Village Levee Segments

Site	Minimum Grade (ft., NAVD88)	Typical Grade (ft., NAVD88)	Anticipated Tidal Inundation Frequency
Levee Segment A	9.6	10.0	
Levee Segment B	8.6	9.5	
Levee Segment x			

Source: Pre-Construction Topo. Survey (2017)

The FEMA Flood Insurance Rate Map (FIRM),[1] defines the 100-year flood elevation, or the base flood elevation (BFE), as +9' NAVD88 for the project site. This BFE not only applies for the areas fronting the Bay, but also applies for inland areas. This value is below

[1] FEMA Flood Insurance Rate Map (FIRM), Marin County, California and Incorporated Areas, Panel 0467E. Revised March 17, 2014.

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the expected 100 yearr flood value for the area. We suspect the wave contribution, or the wave runup on the levees, was not included in the determined BFE. Therefore we also reviewed the FEMA Flood Insurance Study (FIS) for Marin County[2]. One shoreline section (Transect B88), which transverses the nearby Corte Madera Marsh, was included in FEMA's coastal flooding analysis. The 100-year (1% annual chance) stillwater elevation determined for this transect is +9.7' NAVD88, and the BFE is +10' NAVD88. To be conservative, the current 100-year flood elevation on the levees surrounding the Mariners Village neighborhood, including both the stillwater level and the wave contribution (runup), is estimated to be +10' NAVD88 under the existing condition.

Sea Level Rise Estimates:

Sea level has been rising since the end of the last ice age. NCI reviewed sea level rise (SLR) predictions for state and federal agencies. A summary of findings is presented below.

State of Ca Guidance on SLR: National Research Council (NRC) and CO-CAT Guidance

The National Research Council (NRC) issued a report in June 2012[3]on sea level rise for the coasts of California, Oregon, and Washington. Based on the predictions of future SLR from this NRC (2012) report, the Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT) developed State SLR guidance[4] to advise California on planning efforts. Using the range of SLR presented in the NRC (2012) report, CO-CAT selected SLR values based on agency and context-specific considerations of risk tolerance and adaptive capacity. The SLR predictions recommended by CO-CAT are listed in Table 4.

Table 4. CO-CAT Sea Level Rise Projection Using 2000 as the Baseline

Time period	South of Cape Mendocino
2000-2030	0.13 to 0.98 ft.
2000-2050	0.39 to 2.00 ft.

[2] Flood Insurance Study, Marin County, California and Incorporated Areas. Revised March 24, 2014.

[3] National Research Council (NRC), 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future (2012). http://www.nap.edu/catalog.php?record_id=13389.

[4] CO-CAT, 2013."State of California Sea-Level Rise Guidance Document", March 2013 update.

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2000-2100	1.38 to 5.49 ft

State of Ca Guidance on SLR: California Coastal Commission (2015)

This range of values estimated by CO-CAT is consistent with 2015 California Coastal Commission Sea Level Rise Policy Guidance (Table 5) which projects that 1-2 feet of sea level rise will occur in the San Francisco bay area between 2030 to 2050. For the Mariners Village levees (and most bayland levees in Marin County) , a 1-2 ft. increase in sea level would increase the frequency of tidal overtopping significantly. Statistics suggest that the frequency of levee overtopping will shift from an annually or storm driven frequency, to monthly (2-3 times per month) in the lowest portions of the levee where existing grades are 8-9 ft. NAVD88.

Table 5: Sea Level Rise Projections for California (NRC, 2012)

TIME PERIOD*	NORTH OF CAPE MENDOCINO[19]	SOUTH OF CAPE MENDOCINO
by 2030	-2 – 9 in (-4 – +23 cm)	2 – 12 in (4 – 30 cm)
by 2050	-1 – 19 in (-3 – + 48 cm)	5 – 24 in (12 – 61 cm)
by 2100	4 – 56 in (10 – 143 cm)	17 – 66 in (42 – 167 cm)

*with Year 2000 as a baseline

US Army Corps of Engineering (USACE) Sea Level Rise Guidance

Three SLR scenarios are presented in the Corps' guidance EC 1165-2-212[5] (USACE, 2013). The three SLR scenarios include: (1) the "low" SLR rate using the historic rate of sea level change, (2) the “intermediate” SLR rate using the modified NRC Curve I, and (3) the “high”

[5] USACE, EC 1165-2-212, Sea-Level Change Considerations for Civil Works Programs. October 2011.

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rate using the modified NRC Curve III. Based on this guidance, SLR values between year 2000 and years 2050 and 2100 are listed in Table 1.

Based on the CO-CAT and USACE guidance, sea level will increase by approximately 0.3 feet to 2 feet between 2000 and 2050. Assuming the wave contribution remains the same in the future, the future wave runup elevation or the flood elevation will increase with the sea level rise. The 100-year flood elevation on the levees surrounding Corte Madera Marsh in 2050 is expected to be range from +10.3' NAVD88 to +12.0' NAVD88.

Table 1. Sea Level Rises Estimated with USACE Guidance

Scenarios	2000-2050	2000-2100
Low Scenarios: Historic Rate	0.3 ft	0.7 ft
Intermediate Scenarios: Modified NRC-I	0.6 ft	1.6 ft
High Scenario: Modified NRC-III	1.5 ft	4.9 ft

In conclusion, the 100-year flood elevation, including both the extreme stillwater level and the wave action (runup) on these levees, is approximately +10' NAVD88 under the existing condition, and will be +10.3' to 12.0' NAVD88 in 2050. Based on the topographic survey that was conducted by Hogan Land Services in September 2014, the crest elevations of the existing eastern and southern levees vary between +9' to +11' NAVD88. Portions of these levees will be overtopped under the existing condition. If the worst scenario of sea level rise is considered, these levees will be completely overtopped in 2050.

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SUMMARY AND RECOMMENDATIONS

This hydraulic analysis was conducted by Noble Consultants, Inc. (NCI) to assist in the wetland restoration design and permitting services at Corte Madera Ecological Reserve, Marin County, CA. The proposed restored Corte Madera Marsh will be connected to the northern drainage control channel by breaching a segment of the levee on the north side of the marsh. Among the five alternatives that were developed by WRA, three preliminary alternatives (Alternatives 1, 2B, and 3B) were selected to be included in our hydraulic analysis.

Based on the model results for these three preliminary alternatives, it was determined that the breach and internal channels were too small and would likely result in significant scour within the breach, internal channels and segments of the northern drainage channel. Therefore, a series of revisions were made to the breach and internal channel sections and further hydraulic analyses were conducted for these revised configurations until the optimized channel section was determined. For simplicity, Alternative 2B was selected for the channel size optimization analysis.

The hydraulic analysis was conducted using the unsteady flow HEC-RAS model. The physical features of the model included the northern drainage channel, Shorebird Marsh, the small tidal marsh that is located to the northwest of the restoration area, and the selected project alternatives. The analysis included seasonal fluctuations in the operation of the water control structures that are located between the Shorebird Marsh and the northern drainage channel. These control structures are used by the Town of Corte Madera to manage water for flood control and water fowl. The model results included estimates of the water elevation in the drainage channel and restored marsh alternatives. Model results also included estimates of flow rates, flow velocities, and shear stress with the northern drainage channel, the proposed breach, and the proposed tidal channels within the restored marsh.

Our findings and recommendations are summarized in the following:

- For WRA's three preliminary alternatives, the water levels in the proposed restored Corte Madera Marsh will vary between approximately the bottom elevation of the breach channel (+3.0' NAVD88) and the highest water level in the existing northern drainage channel (+7.2' NAVD88). This indicates that the northern drainage channel

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has enough capacity to provide approximately non-muted tidal fluctuation range between the bottom elevation of the breach channel and the highest water level in the drainage channel. Further enlarging of the breach and internal tidal channels will not significantly improve the tidal exchange for the marsh.

- For WRA's three preliminary alternatives, the peak flow velocities and the peak bottom shear stresses in the breach channel will be much higher than the existing condition in the northern drainage channel. This is particularly true for Alternatives 2B and 3B. The existing northern drainage channel seems to be in a dynamical equilibrium condition in long term. If using the existing bottom shear stress in the northern drainage channel as a baseline measure, channel scour is expected to occur in the breach channel and in part of the internal tidal channel that is close to the breach location. A "stable" or "equilibrium" channel is typically recommended for channel design.

- Based on the channel size optimization analysis, the size of the breach channel and the internal tidal channel for Alternative 2B need to be increased in order to maintain a relatively equilibrium condition in these channel. As shown in **Error! Reference source not found.**, the optimized breach channel has a bottom width of 6' at the elevation of 0' NAVD88, a side slope of 5(H):1(V) below the elevation of +3' NAVD88, 6 feet wide benches at this elevation on both sides, and then a side slope of 8(H):1(V) for the elevation above +3' NAVD 88. The internal tidal channel near the breach will have the same configuration as the breach section. The cross section of the internal channels should become smaller as the distance from the breach location increases in order to be consistent with the reduction of tidal prism and the resulting water exchange volume. This can be done by reducing the channel width or elevating the channel bottom.

- Alternative 2B with optimized (increased) size for the breach and internal tidal channels will provide a water level fluctuation between +1.1' and +7.2' NAVD88 in the proposed restored Corte Madera Marsh. The northern drainage channel has enough capacity to provide approximately non-muted tidal fluctuation range in the marsh between the bottom of the breach channel and the highest water level in the drainage channel. The peak bottom shear stress in the breach channel will be similar to the condition in the existing northern drainage channel, which will result in a relatively stable condition in

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the breach channel and in the internal tidal channel, without significant scour or sedimentation.

- WRA's three preliminary alternatives and Alternative 2B with optimizing breach and internal channel size will have negligible impact (0.1 feet or less) to the water levels in the northern drainage channel, but will increase the flow discharges and flow velocities in the lower reach of this drainage channel that is downstream of the breach. On the other hand, these project alternatives will have insignificant impact to middle and upper reaches that are upstream of the breach location.

- If the existing northern drainage channel is relatively stable, Alternatives 2B and 3B may induce insignificant scour in the lower reach of the northern drainage channel that is downstream of the breach location. On the other hand, Alternative 1 and Alternative 2B with optimized channel size will not induce any noticeable morphologic change to the northern drainage channel.

- In addition to breaching the levee on the north side of Corte Madera Marsh to provide tidal action to the marsh, it is feasible to breach the southern and eastern levees to introduce additional tidal action to the marsh. It will reduce potential scour in the northern breach channel and in the internal tidal channel close to this breach, and alleviate the project impact to the northern drainage channel. We recommend breach these levees at elevation of approximately +6.0' NAVD88 to minimize the project impact to the small tidal sloughs outside of Corte Madera Marsh.

- The FEMA Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS) for the project site were reviewed. The 100-year flood elevation, including both the extreme stillwater level and the wave action (runup) on these levees, is approximately +10' NAVD88 under the existing condition, and will be +10.3' to +12.0' NAVD88 in 2050. The crest elevations of the existing eastern and southern levees vary between +9' to +11' NAVD88. Portions of these levees will be overtopped under the existing condition. If the worst scenario of sea level rise is considered, these levees will be completely overtopped in 2050.