CONCEPTUAL DESIGN REPORT
PROPOSED BAYFRONT LEVEE

BEL MARIN KEYS UNIT V RESTORATION PROJECT
NOVATO, CALIFORNIA

Prepared For:

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Appendix B – Memorandum – Feasibility Study for Temporary Stockpiling of NAF-UBO Material, Bel Marin Keys Unit V Restoration Project, Moffatt & Nichol, January 8, 2010

ABBREVIATIONS AND ACRONYMS

BMKV	Bel Marin Keys Unit V
cy	Cubic Yards
BL	Flood Control Levee
FEMA	Federal Emergency Management Agency
FUDS	Formerly Used Defense Site
GRR	General Reevaluation Report
HAAF	Hamilton Army Airfield
HWRP	Hamilton Wetland Restoration Plan
M&N	Moffatt & Nichol
MHW	Mean High Water
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MTL	Mean Tide Level
NAF	North Antenna Field
NAVD	North American Vertical Datum
NGVD	National Geodetic Vertical Datum
NSD	Novato Sanitary District
PCG	Preliminary Cleanup Goal
UBO	Soils for Use By Others
USACE	U.S. Army Corps of Engineers

1. INTRODUCTION

The Bel Marin Keys Unit V Wetland Restoration Project (BMKV) is a proposed expansion of the Hamilton Wetlands Restoration Plan (HWRP), providing an additional 1,576 acres for wetlands restoration. It is located in the City of Novato, Marin County, California approximately 25 miles north of San Francisco as shown in Figure 1 Site Map. The restoration plan includes construction of a new levee inland of the existing bayfront levee; this new levee will ultimately define the shoreline after the existing bayfront levee is breached and the restoration of the site is complete.

The Supplemental EIR/S (reference 1 for this report) for the BMKV expansion to the HWRP was completed in 2003, which proposed a preferred levee alignment. As part of M&N's task to determine the feasibility of incorporating selected material – specifically, "Soils for Use by Others (UBO)" – from the North Antenna Field (NAF), a revised, simplified alignment for the new Bayfront Levee (BL) is selected.

M&N has recently prepared a Memorandum describing the temporary stockpiling of NAF-UBO soil, which describes how this material may be either directly incorporated into the BL or merely stockpiled in the vicinity of the BL . This memorandum is included herein as Appendix B. Because the disposition of this NAF-UBO material will not be known for some time, this report will address both possibilities.

The scope of this report is limited to a description of the work performed to date on the conceptual design of the BL , including alignment and cross-sectional features. A full description of the existing condition of the site and the proposed restoration elements is available in the Final SEIR/S.

2. STOCKPILED NAF MATERIAL

Excavated soils from the North Antenna Field (NAF) Formerly Used Defense Site (FUDS) Hamilton Army Airfield (HAAF) site which meet the criteria for “Soils for Use by Others (UBO)” is planned to be delivered to the BMKV site, and to be used for the construction of the BL . The total volume of NAF-UBO material suitable for BMK is estimated by the FUDS to be roughly 74,000 CY.

As described in the M&N memorandum, the NAF-UBO material will be stockpiled either in uncompacted stockpiles or as an engineered berm. When construction begins on the BL , the material will be incorporated as part of the core of the BL ; ultimately the NAF-UBO material will be covered with a minimum of 3-ft thick layer of material suitable for use as wetland cover.

3. BAYFRONT LEVEE DESIGN

3.1 INTRODUCTION

Each of the alternatives considered in the GRR analysis of the BMKV restoration project (reference 2 for this report) included the construction of a new levee. The levee will serve as the new bayfront shoreline once the existing bay front levee is breached as part of the planned wetlands restoration.

The levee will be designed in accordance with the U.S. Army Corps of Engineers Levee Design Manual; however it is not intended to be a FEMA-certified flood control levee.

The following U.S. Army Corp of Engineers publications shall be used in the design:

- EM 1110-2-1913 Design and Construction of Levees
- EM 1110-2-1607 Tidal Hydraulics
- EM 1110-2-1614 Design of Coastal Revetment, Seawall, and Bulkheads
- ER 1110-2-1407 Hydraulic Design for Coastal Shore Protection Projects

3.2 ALIGNMENT ALTERNATIVES

Three (3) levee alignment alternatives were developed based on the alignment recommended in the GRR. While the GRR revised alternative 2 alignment follows a sinuous path, the three alternatives developed all utilized straightened alignments to simplify the design and construction which will result in relatively lower construction cost compared to a curved alignment. The alignments are shown in Figure 2.

The three alternatives share a common northernmost alignment. At approximately the southern half, the alignment of each alternative diverges from each other. Alignment 1 follows a path fairly straight southward; Alignment 2 follows the GRR revised Alignment 2 and then goes straight southward; Alignment 3 follows a path further inland. The intent of considering these alternative alignments was to assess the effects of locating the levee at the approximate GRR revised alternative 2 Alignment, further inland, or closer to the Bay on the wetlands restoration project.

An analysis of the resultant habitat distributions for each of the alternatives was performed to compare the percentages of tidal marsh in front (outboard) of the proposed levee with the intended seasonal wetlands behind (inboard) the levee. The analysis was conducted using similar methodology presented in the GRR. Alignment 1 has the shortest levee length, least tidal marsh area, and greatest amount of seasonal wetlands. Alignment 2 most closely matches the GRR Revised Alternative 2 in the distribution of areas for tidal marsh and seasonal wetlands. Alignment 3 is furthest inland and creates the greatest amount of tidal marsh while decreasing the

amount of seasonal wetland. Table 1 presents the results below.

Table 1: Distribution of Restored Habitat For Levee Alignment Alternatives

Levee Alignment	Percent Tidal Marsh	Percent Seasonal Wetland	Total Levee Length (ft)
1	60%	40%	9,100
2	75%	25%	9,600
3	90%	10%	10,200

Based on the results above, Levee Alignment 2 was selected as the preferred alignment for the new levee . This alignment provides the best combination of tidal marsh and seasonal wetland habitat.

At the southern end of the levee where it will intersect with the existing N-2 levee, there is an existing underground sewer outfall pipe that runs parallel to and just to the north of the N-2 levee. The outfall belongs to Novato Sanitary District (NSD). There have been plans that consider relocating the outfall and therefore the existing outfall will be abandoned. However, if NSD decide to keep the pipe active, some measures should be made to protect the pipe since the levee fill will impose additional loads to the pipe.

3.3 CROSS-SECTION ALTERNATIVES

The levee will have a 20-ft wide crest to provide adequate width for inspection and maintenance vehicles and equipments.

The levee design crest elevation shall be +10 ft (NGVD29 datum) which is the same elevation stated in the GRR. This results in an average height of approximately 15 feet from existing ground elevations on the BMKV parcel. This elevation is the minimum required “final” elevation that occurs after settlement and/or consolidation processes are complete. An elevation of +10 NGVD is approximately 3.5 ft above the 100-yr tide in San Pablo. The minimum crest elevation of the levee should be higher than the elevation exceeded by a combined high tide and wind-wave runup event. Although calculations for wave runup and combined occurrences of high tides and waves has not been performed, the final required crest elevation is not anticipated to be very different from the +10 ft NGVD elevation described in the GRR.

To accommodate construction phase and long-term settlement, levees are typically overbuilt (constructed higher than the required crest elevation), by an amount determined through geotechnical analyses. One benefit of the proposed BMKV project schedule is that the proposed levee will not function as a bayfront levee for several years while dredged material is being disposed on the site. This allows a

“phased” construction of the levee, thereby saving material as well as construction costs. The first phase would be built to just higher than the required elevation of +10 ft (to accommodate construction stage settlement only). Disposal of dredged material will continue for several years, and when completed, the levee would be “topped off” to make up for the settlement that occurred during the disposal time frame plus any allowance for long-term settlement (secondary consolidation).

Three (3) alternative side slopes were considered in estimating the required volume of material for construction of the levee, such that the NAF-UBO material could be encapsulated as intended. Side slopes of 2H:1V, 3H:1V, and 4H:1V were considered. In comparing the 3 alternative side slopes, the alignment used was Alternative 2. The cross-sections focused on the levee core, defined as the essential portion of the levee that performs the “structural” function for stability of the levee. The results are presented in Table 2 below.

The existing bayfront levee is protected by rock rip-rap above the elevation of the fringe marsh. Since the proposed levee will function as the new bayfront levee, it will be exposed to tides and waves, which implies that it will require similar armor protection to prevent erosion. However, since the proposed levee will not have the protection of the fringe marsh, the amount of riprap will be significantly higher than that on the existing levee. To address this issue, an alternate erosion protection concept is proposed. It consists of placing material at a flat slope (approximately 10H:1V) along the bayward face of the levee. This material will not provide a structural function, and could therefore be constructed using dredged material from Bay navigation projects. Dredged material could also be placed within the area created between the existing and proposed levee (approximately 1200 acres), thereby reducing the potential for erosion below the elevation of the constructed fill surface.

Table 2 - Levee Characteristics for different side slopes

	Alternative Side Slopes		
Levee Characteristics	2H:1V	3H:1V	4H:1V
Height (approx)	15 ft	15 ft	15 ft
Crest Width	20 ft	20 ft	20 ft
Daylight Line Footprint Area †	17.8 acres	24.4 acres	31.0 acres
Approx.Fill Volume	275,050 cy	357,800 cy	439,750 cy
Approx. Fill Volume with 15% allowance for compaction ‡	323,550 cy	420,950 cy	517,350 cy
Assumed available NAF Material Volume	74,000 cy	74,000 cy	74,000 cy
Required Borrow Volume	249,550 cy	346,950 cy	443,350 cy
Required Borrow Area based on 1.5-ft thick stripping of source material	103 acres	143 acres	183 acres

† "Daylight Line Footprint Area" was determined by comparing the levee side-slope alternatives with the LiDAR surface surveyed in 2000.

‡ Soil shrinkage was assumed to be 15%, which was the value found by ENGEO for the NAF material.

Borrow Material

Structural fill material to construct the levee is assumed to be obtained from the southern portion of the site. The existing soil at the surface is considered suitable for the levee core due to soil type and moisture content. Since the soil moisture content increases with depth, soils at depths greater than 24 inches would likely need to be dried for use as fill to be able to achieve the design requirements for compaction. Using an assumed borrow depth of 18-inches, the required borrow areas were also calculated for each of the levee side-slope alternatives. Fill material may be obtained from both sides of the levee.

The required acreage of borrow areas east and west of the levee were estimated for different offset distances (parallel to the levee alignment) from the levee to get an estimate of the distance that excavation equipment would have to move material at

the site. The areas are summarized in Table 3 below. For example, Table 2 indicates that if 18 inches of borrow material is excavated, about 143 acres would need to be stripped and excavated for a 3H:1V levee. Table 3 implies that if material were to be borrowed from one side of the levee only, excavation would have to extend to over 1000 feet from the levee. If material is borrowed from both sides of the levee, then the distance would be 600 feet. If over 18 inches of borrow material can be efficiently excavated, then these offset distances would be further reduced, thereby allowing the use of scrapers (versus excavators and trucks) which would reduce excavation costs.

Table 3 - Borrow Area Versus Distance from Levee
(for 18 inches of borrow thickness)

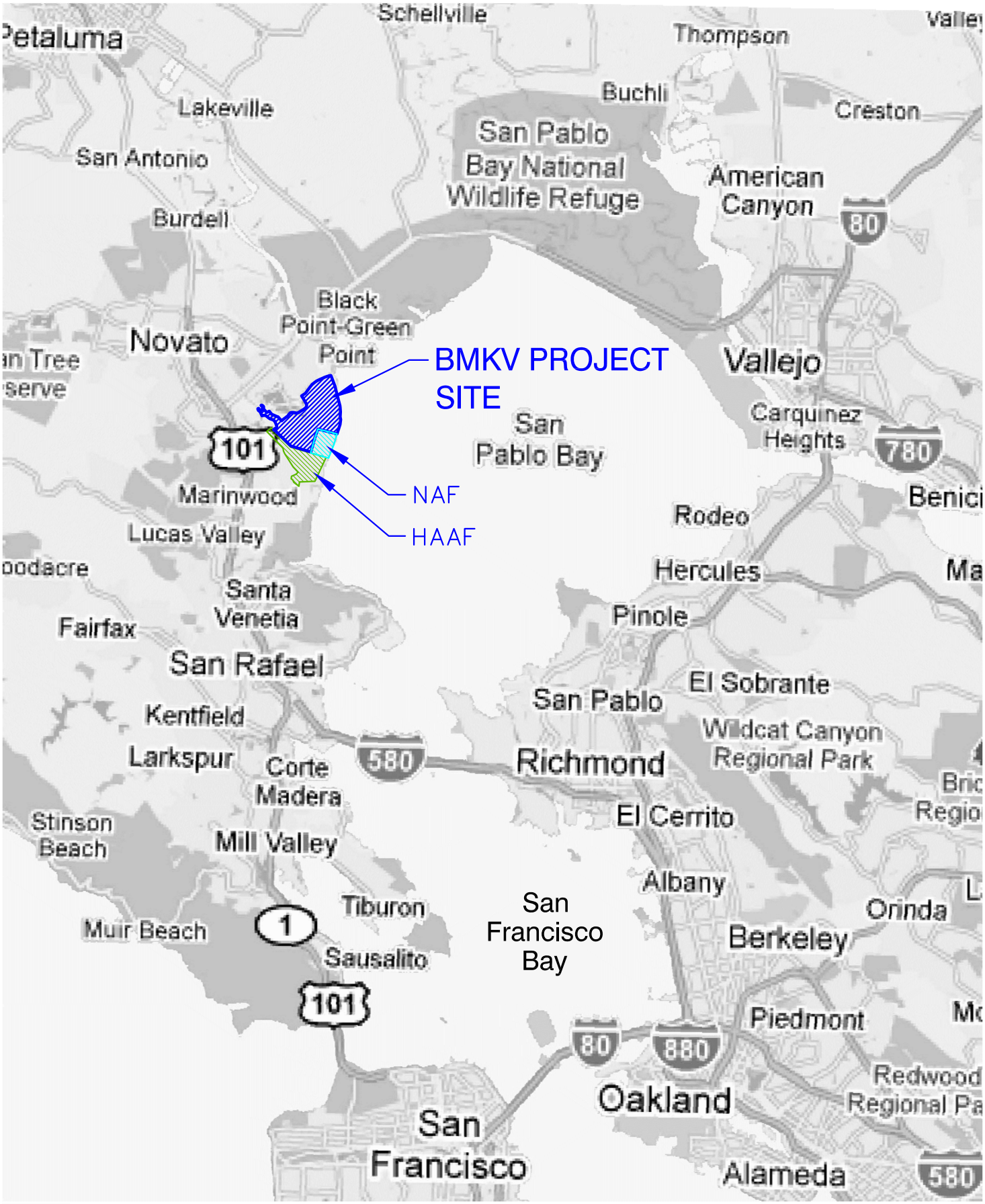
Offset Distance From Levee (feet)	Surface Area West of Levee (acres)	Surface Area East of Levee (acres)	Combined E-W Surface Area (acres)
200	25.3	25.5	50.8
400	50.2	51.1	101.3
600	74.5	76.8	151.3
800	98.1	102.5	200.6
1000	120.9	128.3	249.2

3.4 GEOTECHNICAL DESIGN

Concurrent to the habitat analysis and development of alternatives, a geotechnical investigation and analysis was performed by Engeo Incorporated. Review of previous studies (by others), data from the existing adjacent levees, and supplemental field exploration conducted in 2009 helped Engeo perform geotechnical analysis for the proposed levee. In summary, their work determined the following:

- Settlement of existing soils due to new levee fill
- Levee stability during and after construction
- Levee stability during seismic loading

The complete ENGEO report is attached as Appendix A to this report.



ABBREVIATIONS

BMKV	BEL MARIN KEYS UNIT V
NAF	NORTH ANTENNA FIELD
HAAF	HAMILTON ARMY AIRFIELD

BEL MARIN KEYS UNIT V
WETLANDS RESTORATION PROJECT
CONCEPT DESIGN - FLOOD CONTROL LEVEE

Coastal Conservancy | Moffatt & Nichol

PROJECT SITE

FIGURE 1

ALIGNMENT DEFINITION	
ALIGNMENT	WORK POINTS
1	A B C
2	A B D E
3	A B D F

BEL MARIN KEYS UNIT V
WETLANDS RESTORATION PROJECT
CONCEPT DESIGN - FLOOD CONTROL LEVEE

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LEVEE PLAN
ALIGNMENT ALTERNATIVES

FIGURE 2

BEL MARIN KEYS UNIT V
WETLANDS RESTORATION PROJECT
CONCEPT DESIGN - FLOOD CONTROL LEVEE

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LEVEE PLAN
NO BAYSIDE FILL

FIGURE 3

BEL MARIN KEYS UNIT V
WETLANDS RESTORATION PROJECT
CONCEPT DESIGN - FLOOD CONTROL LEVEE

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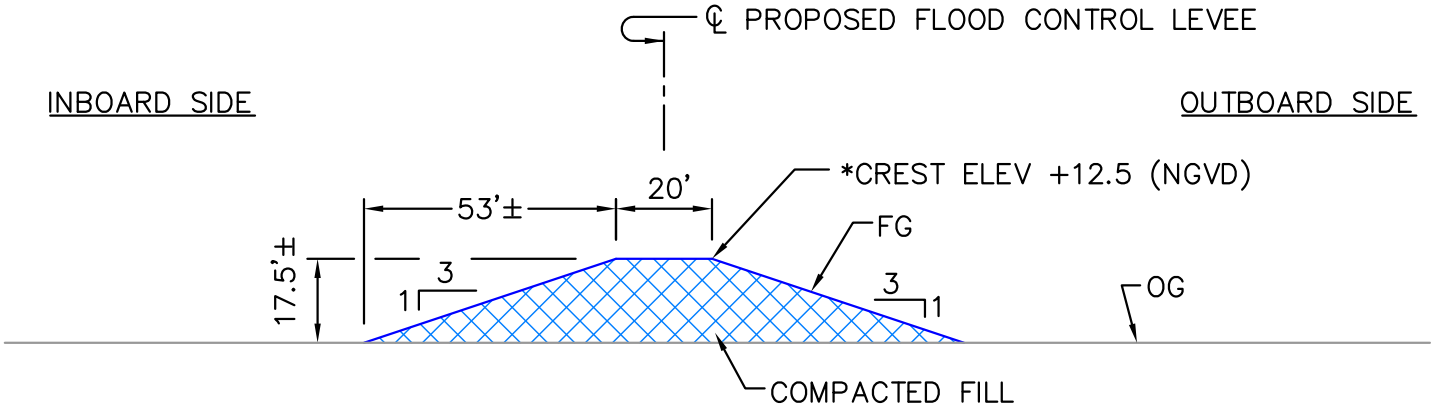
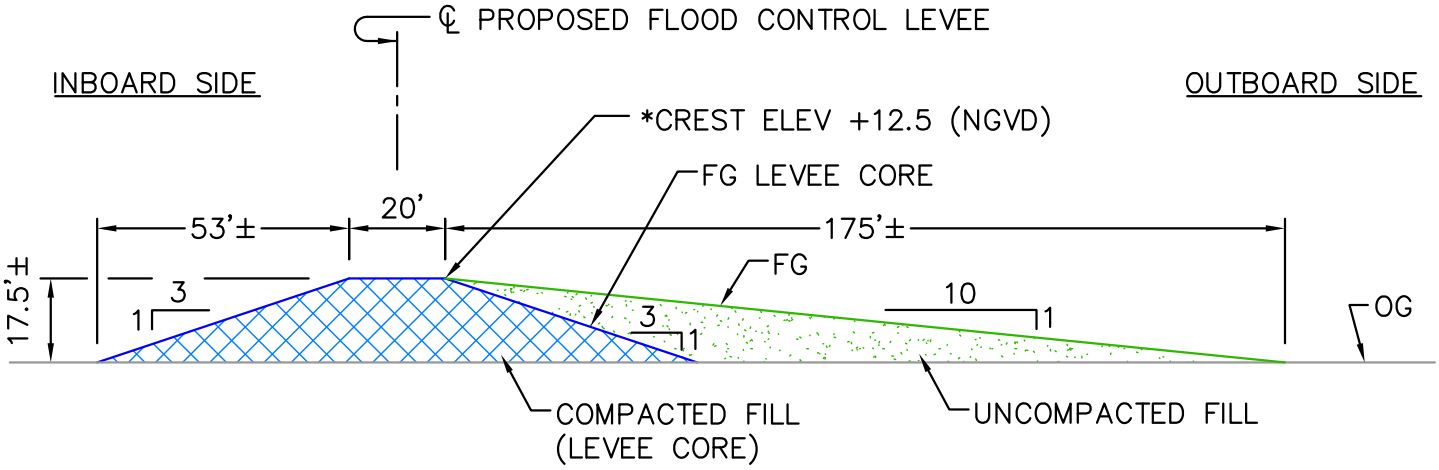
LEVEE PLAN
WITH BAYSIDE FILL

FIGURE
4



LEVEE SECTION
NO BAYSIDE FILL



LEVEE SECTION
WITH BAYSIDE FILL

* DESIGN LEVEE CREST ELEV +10' (NGVD)

BEL MARIN KEYS UNIT V WETLANDS RESTORATION PROJECT CONCEPT DESIGN - FLOOD CONTROL LEVEE		FIGURE 5
Coastal Conservancy / Moffatt & Nichol	LEVEE SECTIONS	

REFERENCES

1. U.S. Army Corps of Engineers San Francisco District / Jones & Stokes – Final Supplemental Environmental Impact Report / Environmental Impact Statement, Bel Marin Keys Unit V Expansion of the Hamilton Wetlands Restoration Project, April 2003.

2. U.S. Army Corps of Engineers San Francisco District – General Reevaluation Report and Technical Appendices, Bel Marin Keys Unit V Expansion of the Hamilton Wetlands Restoration Project, April 2003.

APPENDIX A

GEOTECHNICAL DESIGN REPORT
ENGEO, INC.
JANUARY 2010

GEOTECHNICAL DESIGN REPORT

BEL MARIN KEYS UNIT V
WETLANDS RESTORATION
NOVATO, CALIFORNIA

Submitted to:

Mr. Dilip Trivedi
Moffatt & Nichol
2001 North Main St., Suite 360
Walnut Creek, CA 94596

February 22, 2010
Project No. 7349.000.000

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GEOTECHNICAL
ENVIRONMENTAL
WATER RESOURCES
CONSTRUCTION SERVICES

Project No.
7349.000.000

February 22, 2010

Mr. Dilip Trivedi
Moffatt & Nichol
2001 North Main St., Suite 360
Walnut Creek, CA 94596

Subject: Bel Marin Keys Unit V Wetland Restoration Project
Levees and Borrow Sources
Novato, California

GEOTECHNICAL DESIGN REPORT

Dear Mr. Trivedi:

We are pleased to present this Geotechnical Design Report for the proposed levee for the wetland restoration within the former Bel Marin Keys V (BMKV) property in Novato, California. The accompanying report contains characterization of the geotechnical and geologic conditions present as well as our conclusions and geotechnical recommendations in connection with the proposed levee improvements. It is our opinion that the proposed improvements are feasible from a geotechnical standpoint, provided the recommendations included in this report are incorporated into the design of the project and implemented during construction.

As requested, we are as also preparing a report evaluating potential borrow sources on the BMKV property. The Borrow Report will be delivered under separate cover.

If you have any questions concerning the contents of our report, please do not hesitate to contact us.

Sincerely,

ENGEO Incorporated

Joe Gray, PE

R. William Rudolph, GE

REGISTERED PROFESSIONAL ENGINEER
JEFFREY A. FIPPIN
No. 2631
Exp. 6/30/2010
GEOTECHNICAL
STATE OF CALIFORNIA

Jeff Fippin, GE

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