CAMINADA HEADLAND
BEACH AND DUNE RESTORATION
INCREMENT II (BA-143)

APPENDIX I

CAMINADA HEADLAND GEOTECHNICAL SURVEY AND ENGINEERING ANALYSES REPORT

LAFOURCHE & JEFFERSON PARISHES, LOUISIANA

STATE OF LOUISIANA
COASTAL PROTECTION AND RESTORATION AUTHORITY

MARCH 2014

Geotechnical Engineering Report

Caminada Headland Beach and Dune Restoration Project - Increment II
LaFourche and Jefferson Parishes, Louisiana

for
State of Louisiana
Coastal Protection and Restoration Authority

March 1, 2013

GeoEngineers
Earth Science + Technology

Geotechnical Engineering Report

Caminada Headland Beach and Dune Restoration Project – Increment II
LaFourche and Jefferson Parishes, Louisiana

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Coastal Protection and Restoration Authority

March 1, 2013

GeoEngineers

11955 Lakeland Park Boulevard, Suite 100
Baton Rouge, Louisiana 70809
225.293.2460

Geotechnical Engineering Report

Caminada Headland Beach and Dune Restoration Project – Increment II LaFourche and Jefferson Parishes, Louisiana

File No. 16715-012-02

March 1, 2013

Prepared for:

State of Louisiana
Coastal Protection and Restoration Authority
450 Laurel Street, Suite 1200
Baton Rouge, Louisiana 70804-4027

Attention: Brad Miller

Prepared by:

GeoEngineers, Inc.
11955 Lakeland Park Boulevard, Suite 100
Baton Rouge, Louisiana 70809
225.293.2460

Joshua M. Pruett, EI
Staff Geotechnical Engineer

Charles L. Eustis, PE
Principal

STATE OF LOUISIANA
CHARLES L. EUSTIS
Reg. No. 15789
REGISTERED
PROFESSIONAL ENGINEER
IN
CIVIL ENGINEERING

JMP:CLE:lb

cc: Catherine C. Ricks, PE CPRA

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INTRODUCTION

GeoEngineers, Inc. (GeoEngineers) is pleased to present this geotechnical engineering report in support of the Caminada Headland Beach and Dune Restoration Project – Increment II. The work presented in this report has been completed under DNR contract No. 2503-11-67 "Geotechnical Services for Coastal Restoration Projects" dated February 7, 2011 and specifically under Task Order 8, as prescribed in the Notice to Proceed document dated April 11, 2012. The analyses presented herein are based on geotechnical data collected and presented previously in a geotechnical investigation data report (GIDR) dated September 8, 2010. This GIDR was completed under Taylor Engineering Contract Number C2009-091. Analyses for the first phase of the Caminada Headland Beach and Dune Restoration Project (BA-45) (hereafter referred to as Caminada 1) were presented to the State of Louisiana, Office of Coastal Protection and Restoration (now the Coastal Protection and Restoration Authority (CPRA)) in geotechnical engineering (GER) and calculations reports dated August 16, 2011. Caminada 1 covers from the Belle Pass jetties near Port Fourchon on the western end of the headland to a little less than halfway between the Belle Pass jetties and Caminada Pass. The purpose of this report is to present the results of settlement magnitude and time rate of settlement calculations for the eastern portion of the Caminada Headland. A map showing the approximate limits of the Caminada 1 project and this project is included in Figure 1.

All elevations in this document, including the report and its appendices, are referenced to the North American Vertical Datum of 1988 (NAVD 88).

FURNISHED INFORMATION

Appendix A of this report contains the design fill templates provided to GeoEngineers by Coastal Engineering Consultants, Inc (CEC) for use in our settlement calculations.

ENGINEERING PROCEDURE

Design Template and Cross-section Selection

In the design fill template provided by CEC on May 11, 2012, the proposed fill is shown super-imposed on the existing natural ground surface at 500-foot intervals along the headland. The template shows a few cross-sections from the start of Caminada 1 then skips a few miles to pick up near where Caminada 1 leaves off. The template tapers to the existing beach surface about 2,000 feet west of Caminada Pass. Mean low water (MLW) and mean high water (MHW) levels are shown on the design template cross sections at elevations +0.66 and +1.70 feet, respectively. The template includes a 1-foot overbuild tolerance to better facilitate reaching the design dune elevation of +7.0 feet and the design beach elevation of +4.5 feet during the project life. Beach and dune side slopes are 20 horizontal to 1 vertical (20H:1V), which is shallow enough that slope stability is not a design constraint. Along the beach slope, at elevation +0.5 feet, a slope tolerance is built into the template that changes the slope to 40H:1V. These template elements are summarized in Figure 2.

To evaluate settlement, GeoEngineers selected cross-sections from stations within 2,000 feet of existing GeoEngineers soil borings at which the distance between the top of the design template (including construction tolerances) and the natural ground surface was the greatest. A total of 10 cross-sections were selected; eight cross-sections include combined beach and dune fill, and two include only the beach fill. In order to compute effective vertical stresses due to the applied fill and existing foundation materials, GeoEngineers selected a "mean water (MW) level" of +1.2 feet as an appropriate alternative to either the MHW or the MLW. The sand fill was assumed to be hydraulically placed and mechanically graded, with a unit weight of 102 pounds per cubic foot (pcf).

Effective Vertical Stresses

Due to the irregular nature of the existing ground surface, GeoEngineers simplified the calculation of applied pressure by performing a two-part analysis: First, a suitable "baseline elevation" was selected based on the intersection of the ground surface with the design fill template. The cross-section was divided into convenient geometric areas (using rectangles, triangles, and trapezoids) and pre-fill effective vertical stress on the baseline elevation due to the existing foundation materials was computed for each of the areas. Second, we computed post-fill effective vertical stresses due to the combined fill and foundation materials above the baseline elevation within the same areas as the pre-fill pressures. The pre- and post-fill pressures were input separately into a computer program that computes primary consolidation settlement in layered soils based on Terzaghi's theory of one-dimensional consolidation using Boussinesq stress distribution. The resulting settlement estimate due to pre-fill pressures was subtracted from the settlement caused by post-fill pressures to obtain an estimate of settlement caused by the fill. Settlement in sand layers was not considered in this exercise. Time rate of settlement for each of the selected cross-sections was computed using a spreadsheet program based on Terzaghi's theory.

Primary Consolidation Settlement

Primary consolidation settlement was computed at four points for the combined beach and dune cross-sections and at three points for the beach-only cross-sections. These points are at: 1.) the land-side edge of the dune or beach crown, 2.) the centerline of the dune alignment, 3.) the centerline of the beach alignment, and 4.) the point at which the beach fill slope changes due to construction tolerance considerations in the design fill template. For the beach-only cross-sections, the dune centerline point was eliminated. The analysis considerations described in this and previous paragraphs are summarized in Figure 2.

Secondary Compression Settlement

Secondary compression in clays was computed using consolidation theory and was estimated to be in the range of 2 to 5 inches. For the sake of secondary compression calculations, 99.9 percent consolidation was considered the end of primary consolidation. Higher secondary consolidation values are primarily the result of one or both of the following considerations: 1.) the thickness of the clay layers in the profile; and 2.) rapid completion of consolidation settlement. More secondary consolidation was generally computed in profiles with significant and frequent sand layering, resulting in more rapid completion of primary consolidation settlement.

Elastic Settlement

Two methods were used to estimate elastic settlement. Elastic settlement for sand and clay layers was estimated using the method found in Chapter 14 of Lambe and Whitman's *Soil Mechanics* (1969). Elastic settlement in clays was estimated as 10% of primary consolidation settlement. The estimate included in the table below is the larger of the two elastic settlement estimates. Elastic settlement will occur as the fill is placed and will only be recognizable by the impact to the amount of fill required to reach the design fill surface elevation.

ENGINEERING RESULTS

The table below gives a summary of the settlement magnitude calculation results.

20-YEAR SETTLEMENT CALCULATION RESULTS SUMMARY

Cross-Section Station	Soil Boring	Settlement Point	Construction	Post-Construction		
			Elastic Settlement (in)	Primary Consolidation Settlement (in)	Secondary Compression Settlement (in)	Total Settlement (in)
285+00	B-8	S1	2	13.8	3.8	17.2
		S2	2.8	28.4	3.8	32.2
		S3	2.9	29.4	3.8	34.2
		S4	2	17.5	3.8	21.3
335+00	B-9	S1	2.7	14.7	4.6	19.3
		S2	3.7	36.7	4.6	40.3
		S3	3.0	30.4	4.6	35.0
		S4	2.7	12.5	4.6	17.1
355+00	B-10	S1	3.8	14.3	3.0	17.3
		S2	3.8	19.6	3.0	22.6
		S3	3.8	17.9	3.0	20.9
		S4	3.8	11.3	3.0	14.3
405+00	B-11	S1	3.4	8.8	3.6	12.4
		S2	3.4	11.1	3.7	14.8
		S3	3.4	9.9	3.6	13.5
		S4	3.4	5.0	3.6	8.6
460+00	B-12	S1	2.6	10.5	5.0	15.5
		S2	2.6	13.9	5.0	14.9
		S3	2.6	14.1	5.0	19.1
		S4	2.6	4.7	4.9	9.6

Cross-Section Station	Soil Boring	Settlement Point	Construction	Post-Construction		
			Elastic Settlement (in)	Primary Consolidation Settlement (in)	Secondary Compression Settlement (in)	Total Settlement (in)
490+00	B-13	S1	2.7	7.2	2.7	9.9
		S2	2.7	9.6	2.7	12.3
		S3	2.7	9.5	2.7	12.2
		S4	2.7	3.9	2.7	6.6
510+00	B-14	S1	2.9	20.6	3.1	23.7
		S2	2.9	26.7	3.1	29.8
		S3	2.9	22.3	3.1	25.4
		S4	2.9	7.3	3.0	10.3
545+00	B-15	S1	2.5	13.5	2.7	16.2
		S2	2.5	12.3	2.7	15.0
		S3	2.5	7.8	2.6	10.4
		S4	2.5	4.7	2.6	7.3
605+00	B-16	S1	2.7	26.5	4.9	31.4
		S2	3.2	32.1	4.9	37.0
		S3	2.1	17.7	4.8	22.5
620+00	B-17	S1	1.5	6.1	2.2	8.3
		S2	1.6	16.0	2.2	18.2
		S3	1.5	8.4	2.2	10.6

Elastic settlement occurs rapidly as the fill is being placed and will likely only be recognized in terms of an increase in the amount of fill required to reach the design template fill limits. It is therefore an important number for assisting with fill volume estimates, but has little bearing on the elevation of the fill at the end of the project life.

Graphical and tabular summaries of primary consolidation settlement over time are located in Appendix B. In the appendix figures, settlement is portrayed in terms of elevation change over time.

CONCLUSIONS AND RECOMMENDATIONS

The results table in the previous section shows large settlements at many of the stations. These stations coincide with the "worst case" fill scenarios, so the settlements presented here are likely higher than the average settlement actually experienced during and after project construction. As mentioned above in the Engineering Procedure section, design fill template slopes are shallow enough that slope stability is not a project constraint. As such, no slope stability evaluations were completed. In order to maintain adequate stability on the beach, GeoEngineers recommends a

construction sequence that builds the beach and dune embankments in level lifts from the bottom up and does not allow sand to be stockpiled in tall mounds with steep slopes.

In the event that the design fill cross-section is altered, the estimates presented in this report are no longer valid.

LIMITATIONS

We have prepared this report for the exclusive use of the State of Louisiana, Coastal Protection and Restoration Authority and the BA-45/BA-143 design team in support of the design of Caminada Headland Beach and Dune Restoration Project – Increment II located in LaFourche and Jefferson Parishes, Louisiana.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood.

Please refer to Appendix C titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

We appreciate the opportunity to work with you on this project. If you have questions about this report or need additional information, please call.

FIGURES

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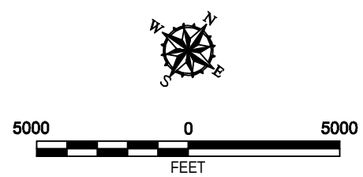
SOIL BORINGS: GEOTECHNICAL INVESTIGATION DATA REPORT, SEPT. 8, 2010

STA. 00+00 — **GEOTECHNICAL ENGINEERING REPORT AUGUST 16, 2011** — **STA. 320+00**

STA. 275+00 — **CURRENT REPORT** — **STA. 680+00**

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Aerial image taken from Google Earth Pro, Licensed to GeoEngineers Inc., Dated 4/2011 - 9/2011



APPROXIMATE PROJECT AREA PLAN

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

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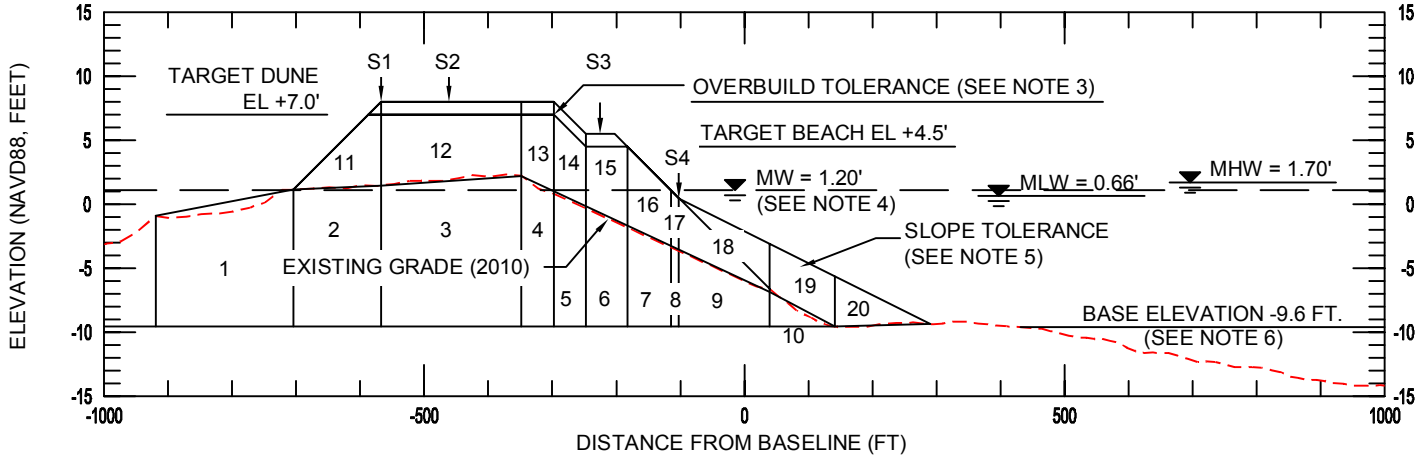
Figure 1

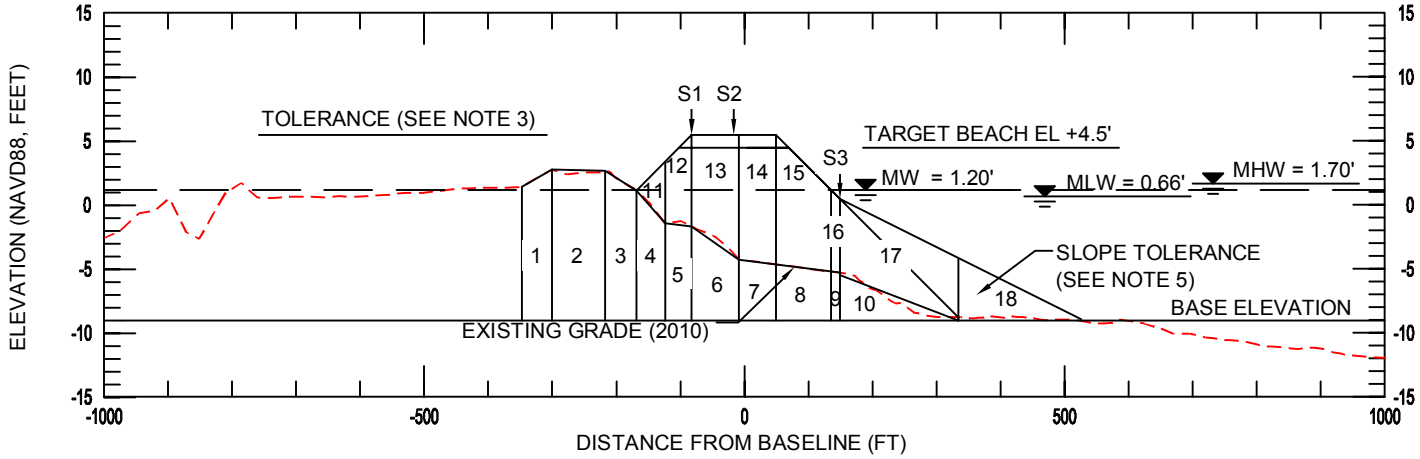
JMP : KMC

P:\16\16715012\02\CAD\Boring Location Plan.dwg\TAB:Layout1 modified on Jul 17, 2012 - 2:24pm

BEACH AND DUNE TEMPLATE STA. 270+00 - 570+00



BEACH TEMPLATE STA. 575+00 - 660+00



Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. A one foot construction tolerance is included to account for construction methods and consolidation/settlement of the fill.
4. Mean Water (MW) level, determined by averaging MLW & MHW, was used in determining effective vertical pressure on the base elevation.
5. Construction slope tolerance of 1V:40H provided from mean low water seaward.
6. Base Elevation generally determined based on intersection of fill template with natural ground surface.

Reference: Fill template & ground surface information from CEC "11126 CAM II Design 05-11-2012 Geo.dwg", Dated 5-11-2012

EXPLANATION OF TEMPLATE & ANALYSIS CONSIDERATIONS

Caminada Headland Beach & Dune Restoration
Project - Increment II
LaFourche & Jefferson Parishes, Louisiana

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Figure 2

APPENDICES

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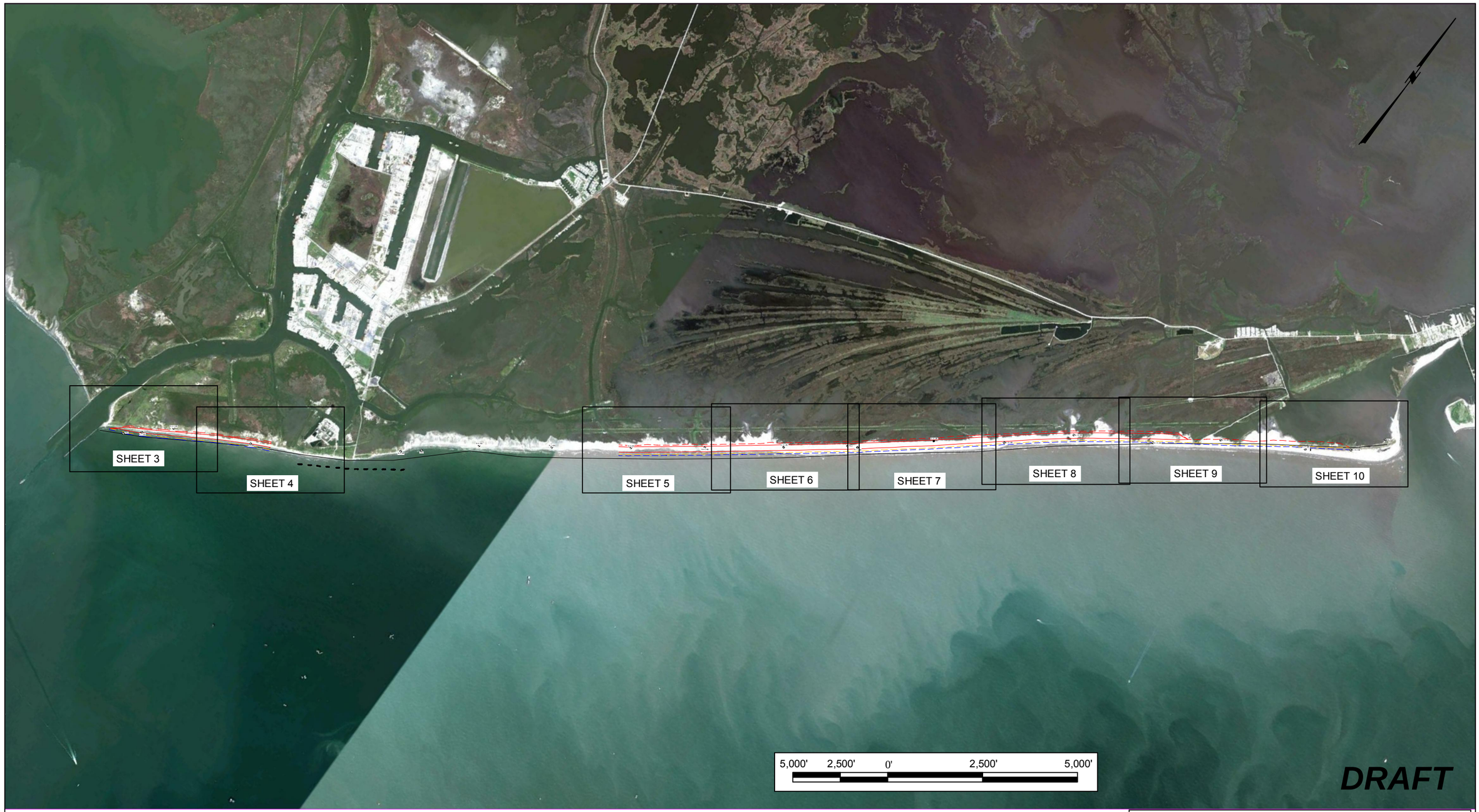
APPENDIX A
Furnished Information



Reference: 1. Drawing provided by Coastal Engineering Consultants, Inc., Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012
2. Aerial image taken from Google Earth Pro, Licensed to GeoEngineers Inc., Dated 4/2011 - 9/2011

OVERALL SITE MAP

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

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Figure A-1

JMP : KMC

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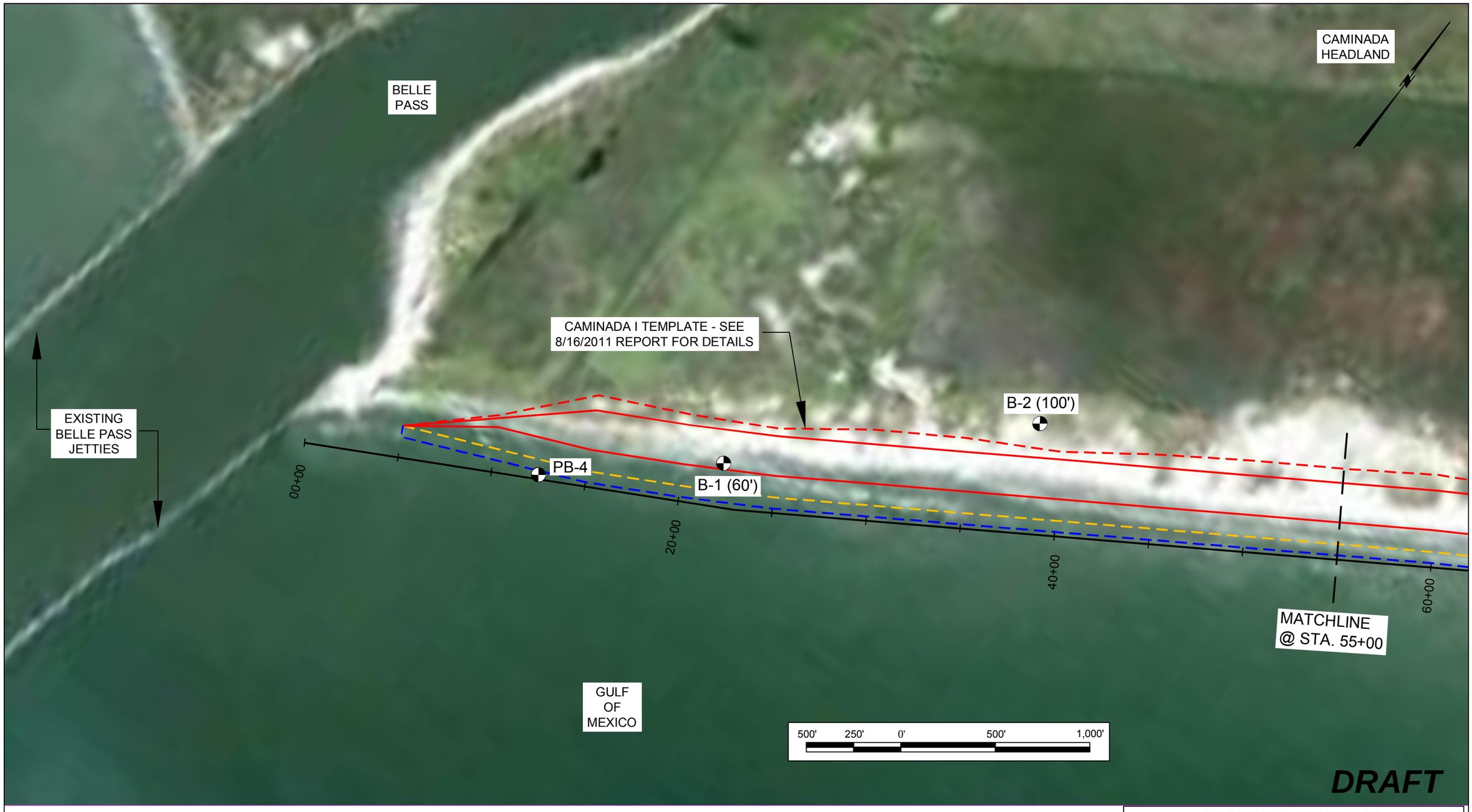

LEGEND

B-1 (60')	Borehole Location (Depth)		Beach Crest
	Dune Crest		MHW
	Dune Toe		

Reference: 1. Drawing provided by Coastal Engineering Consultants, Inc., Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012
2. Aerial image taken from Google Earth Pro, Licensed to GeoEngineers Inc., Dated 9/12/2011

DRAFT FILL TEMPLATE
SHEET 3

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

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Figure A-2

JMP : KMC

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LEGEND

B-3 (60') — Borehole Location (Depth)
Dune Crest
Dune Toe
Beach Crest
MHW

Reference: 1. Drawing provided by Coastal Engineering Consultants, Inc., Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012
2. Aerial image taken from Google Earth Pro, Licensed to GeoEngineers Inc., Dated 9/12/2011

DRAFT FILL TEMPLATE
SHEET 4

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

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Figure A-3

JMP : KMC

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LEGEND

B-8 (60') — Borehole Location (Depth)
Dune Crest
Dune Toe
Beach Crest
MHW

Reference: 1. Drawing provided by Coastal Engineering Consultants, Inc., Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012
2. Aerial image taken from Google Earth Pro, Licensed to GeoEngineers Inc., Dated 4/15/2011

DRAFT FILL TEMPLATE
SHEET 5

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

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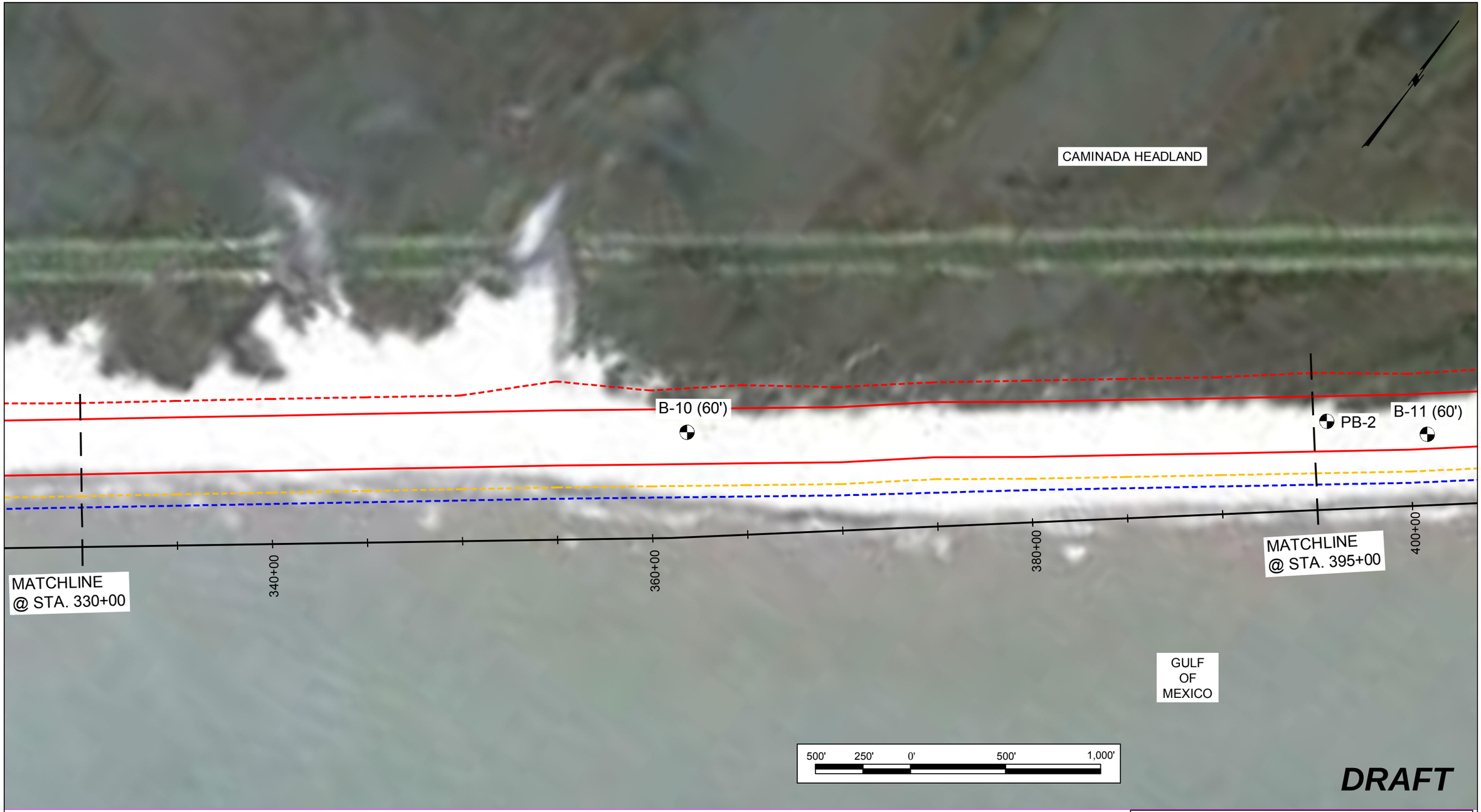
Figure A-4



LEGEND

B-10 (60') — Borehole Location (Depth)
Dune Crest
Dune Toe
Beach Crest
MHW

Reference: 1. Drawing provided by Coastal Engineering Consultants, Inc., Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012
2. Aerial image taken from Google Earth Pro, Licensed to GeoEngineers Inc., Dated 4/15/2011

DRAFT FILL TEMPLATE
SHEET 6

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

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Figure A-5

JMP : KMC

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LEGEND

B-12 (60') — Borehole Location (Depth)
Dune Crest
Dune Toe
Beach Crest
MHW

Reference: 1. Drawing provided by Coastal Engineering Consultants, Inc., Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012
2. Aerial image taken from Google Earth Pro, Licensed to GeoEngineers Inc., Dated 4/15/2011

DRAFT FILL TEMPLATE
SHEET 7

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

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Figure A-6

JMP : KMC

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LEGEND

B-13 (60') Borehole Location (Depth)
Dune Crest
Dune Toe
Beach Crest
MHW

Reference: 1. Drawing provided by Coastal Engineering Consultants, Inc., Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012
2. Aerial image taken from Google Earth Pro, Licensed to GeoEngineers Inc., Dated 4/15/2011

DRAFT FILL TEMPLATE
SHEET 8

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

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Figure A-7

JMP : KMC

B-15 (60')

B-16 (60')

MATCHLINE
@ STA. 535+00

540+00

560+00

580+00

600+00

MATCHLINE
@ STA. 605+00

500' 250' 0' 500' 1,000'

DRAFT

LEGEND

B-15 (60') Borehole Location (Depth)
Dune Crest
Dune Toe
Beach Crest
MHW

Reference: 1. Drawing provided by Coastal Engineering Consultants, Inc., Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012
2. Aerial image taken from Google Earth Pro, Licensed to GeoEngineers Inc., Dated 4/15/2011

BORING LOCATION PLAN
SHEET 9

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

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Figure A-8

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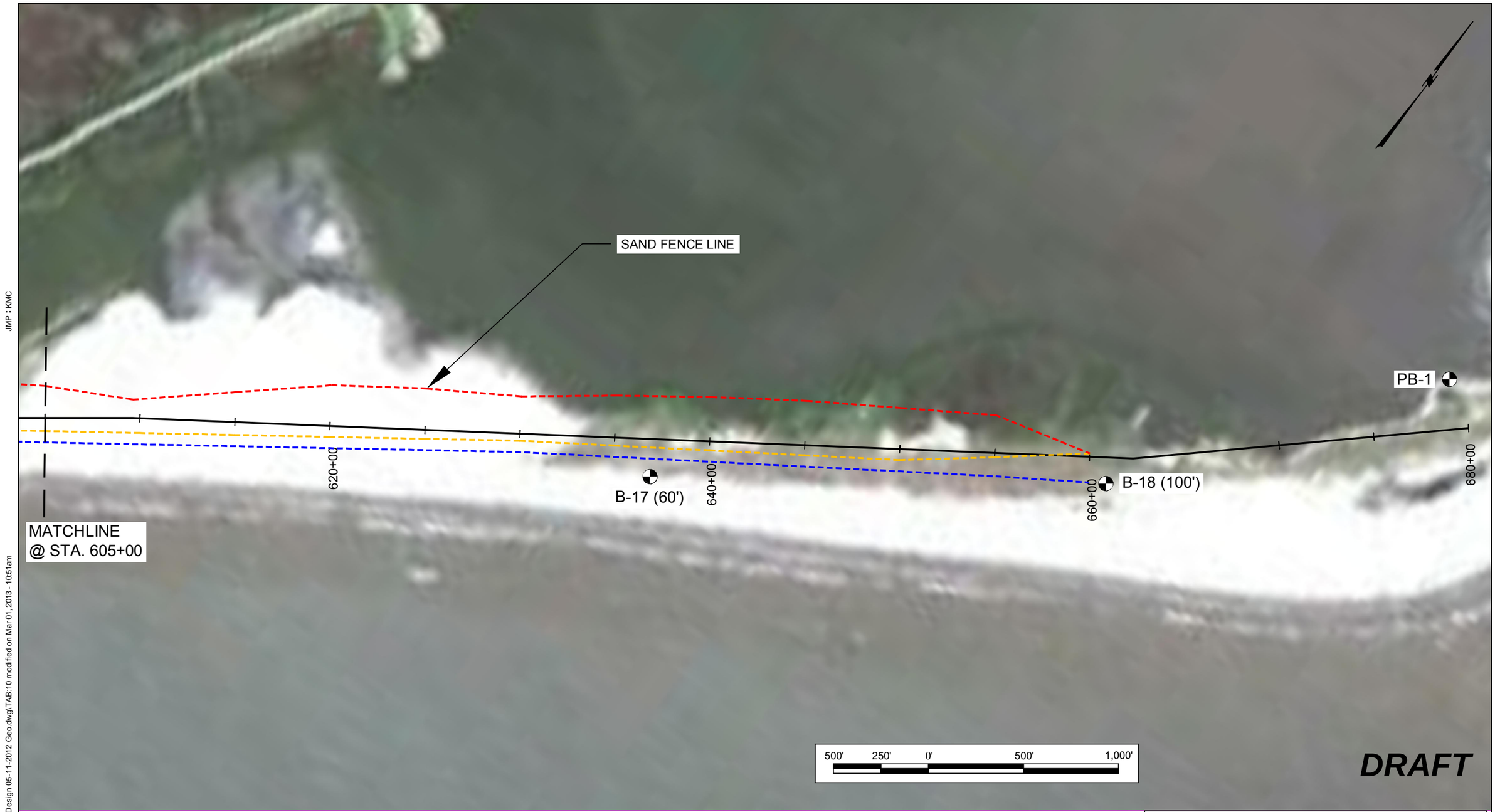

LEGEND

- B-17 (60') — Borehole Location (Depth)
- Dune Crest
- Dune Toe
- Beach Crest
- MHW

Reference: 1. Drawing provided by Coastal Engineering Consultants, Inc., Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012
2. Aerial image taken from Google Earth Pro, Licensed to GeoEngineers Inc., Dated 4/15/2011

DRAFT FILL TEMPLATE
SHEET 10

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

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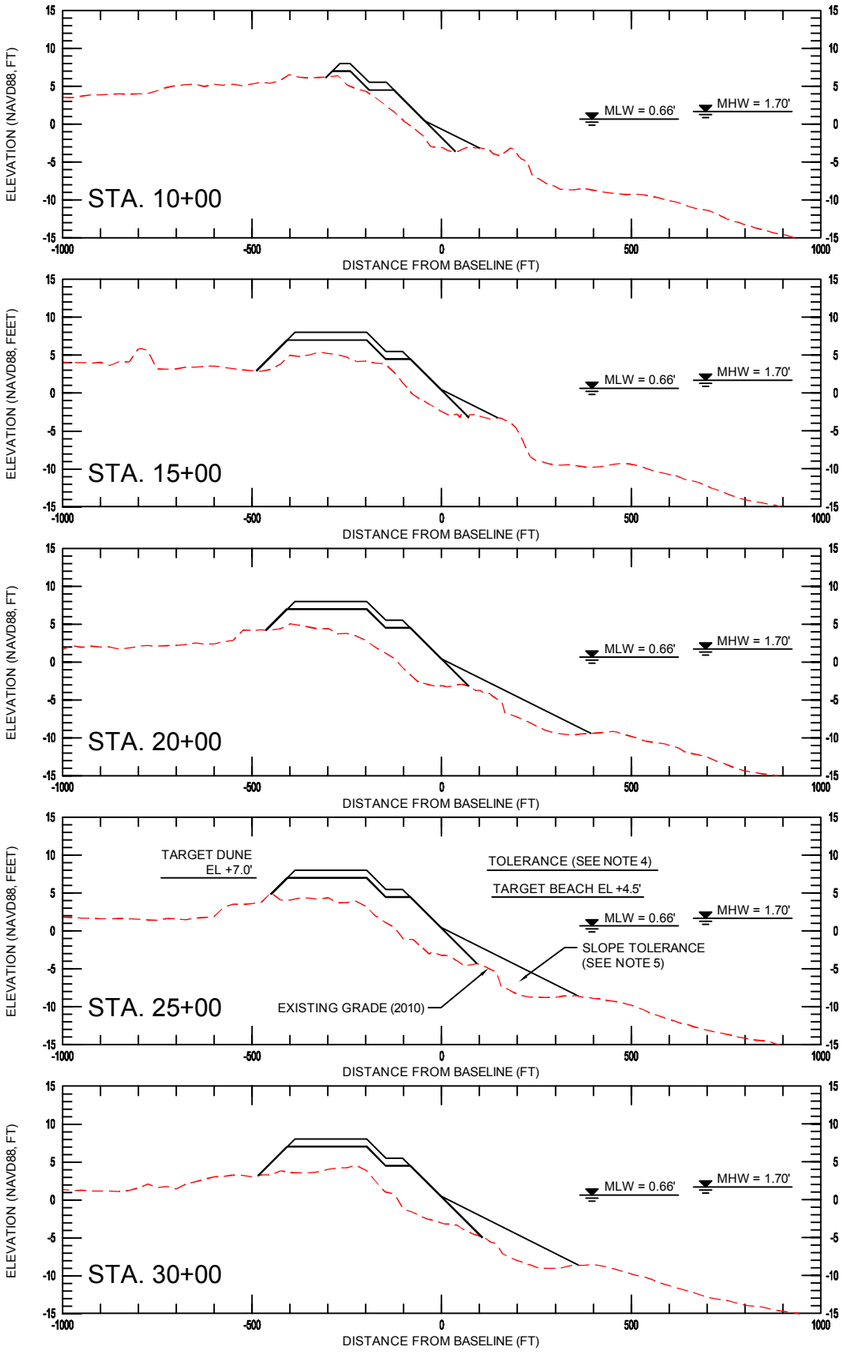
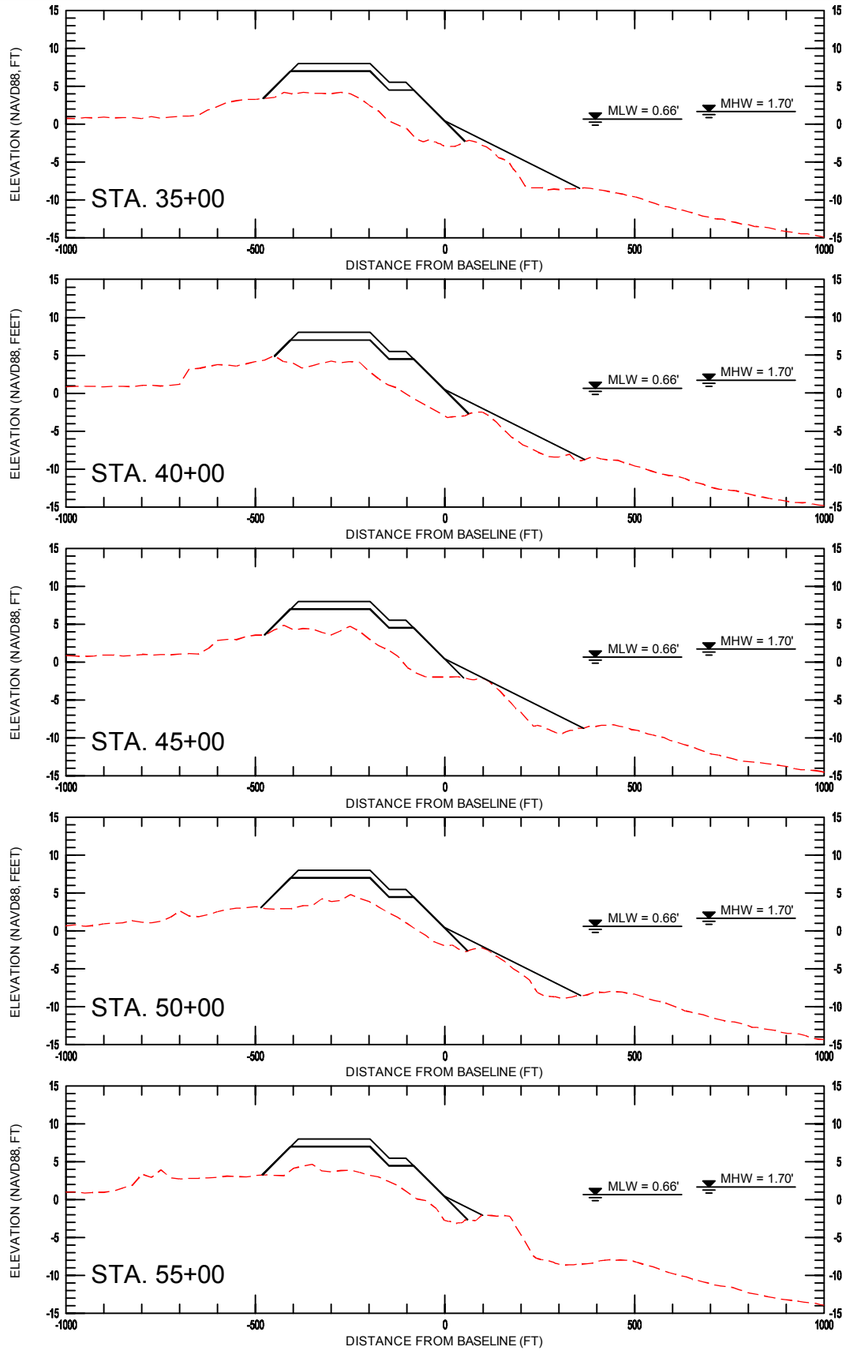
Figure A-9





NOTES:

1. SECTIONS ARE VIEWED AS LOOKING EAST.
2. SURVEY CONDUCTED BY PICCIOLA & ASSOCIATES, INC. 2010.
3. ALL SLOPES 1V:20H UNLESS OTHERWISE DESIGNATED.
4. A ONE FOOT TOLERANCE IS INCLUDED TO ACCOUNT FOR CONSTRUCTION METHODS AND CONSOLIDATION/SETTLEMENT OF THE FILL.
5. CONSTRUCTION SLOPE TOLERANCE OF 1V:40H PROVIDED FROM MEAN LOW WATER SEAWARD.

LEGEND:

- EXISTING GRADE (2010)
- DESIGN
- CONSTRUCTION TOLERANCE (SEE NOTE 4)

DRAFT

DESIGN SECTION
STATION 10+00 - STATION 55+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

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Figure A-10

Reference: Drawing provided by Eustis Engineering, Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012

JMP : KMC

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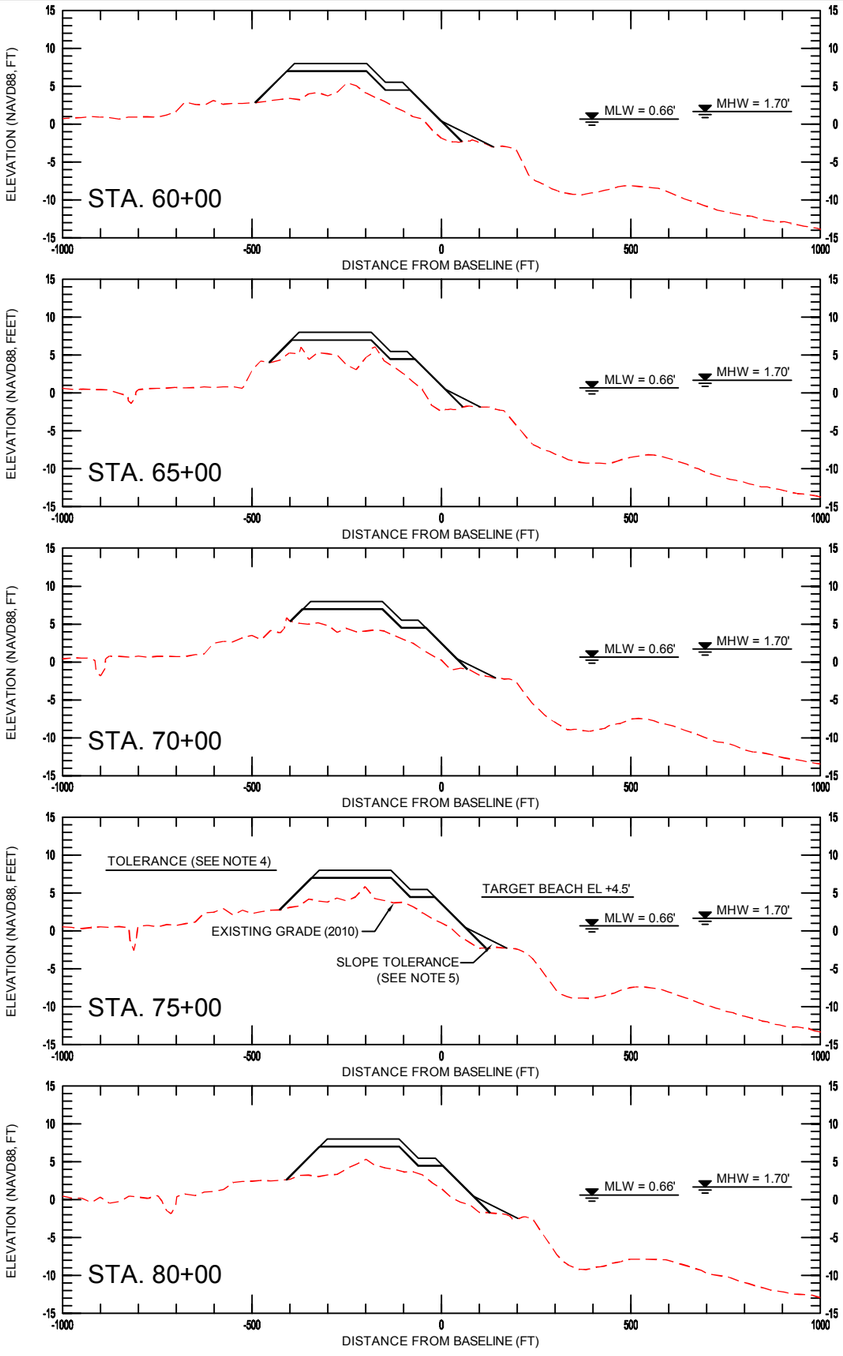

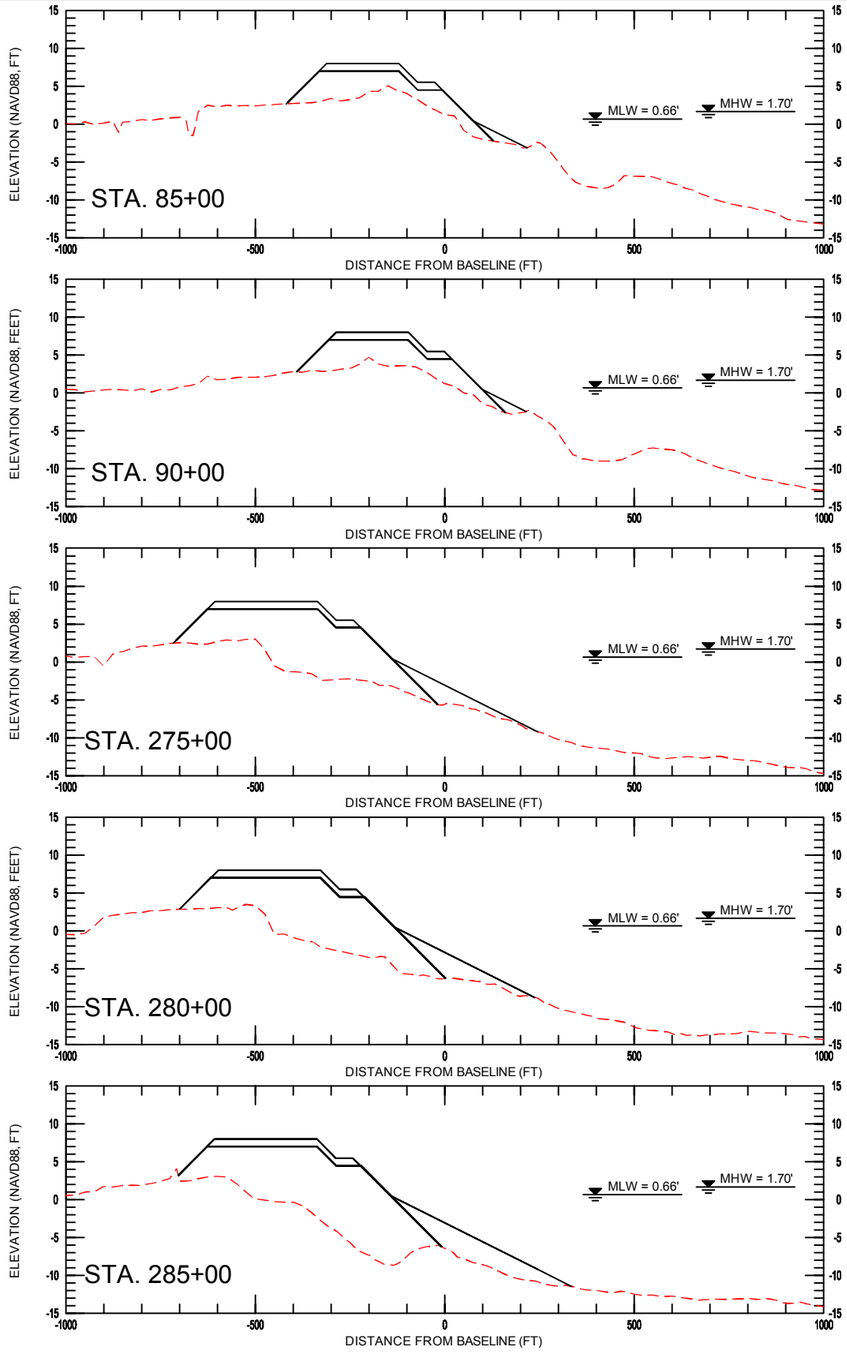

LEGEND:

- EXISTING GRADE (2010)
- DESIGN
- CONSTRUCTION TOLERANCE (SEE NOTE 4)

Reference: Drawing provided by Eustis Engineering, Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012

DRAFT

DESIGN SECTION
STATION 60+00 - STATION 285+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

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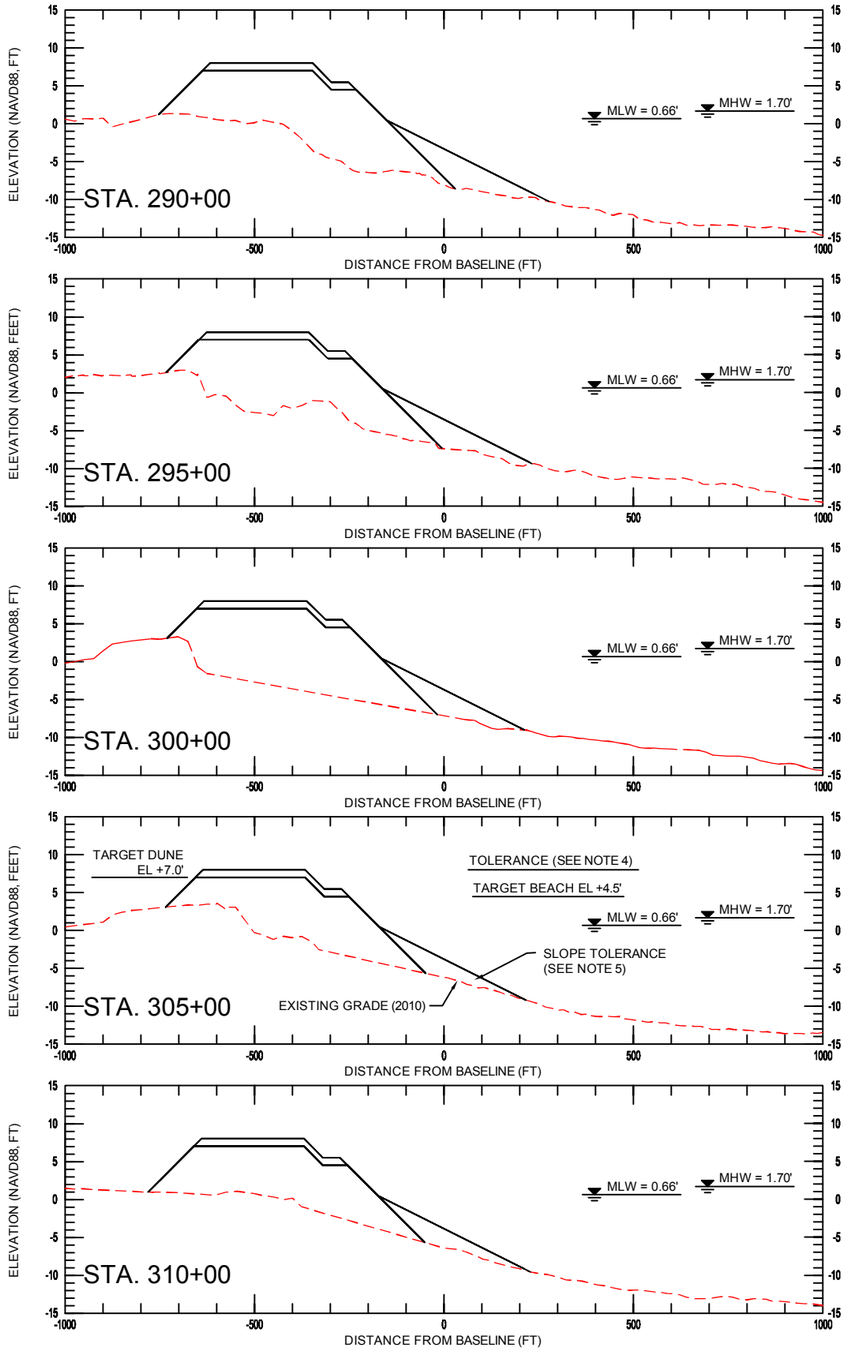
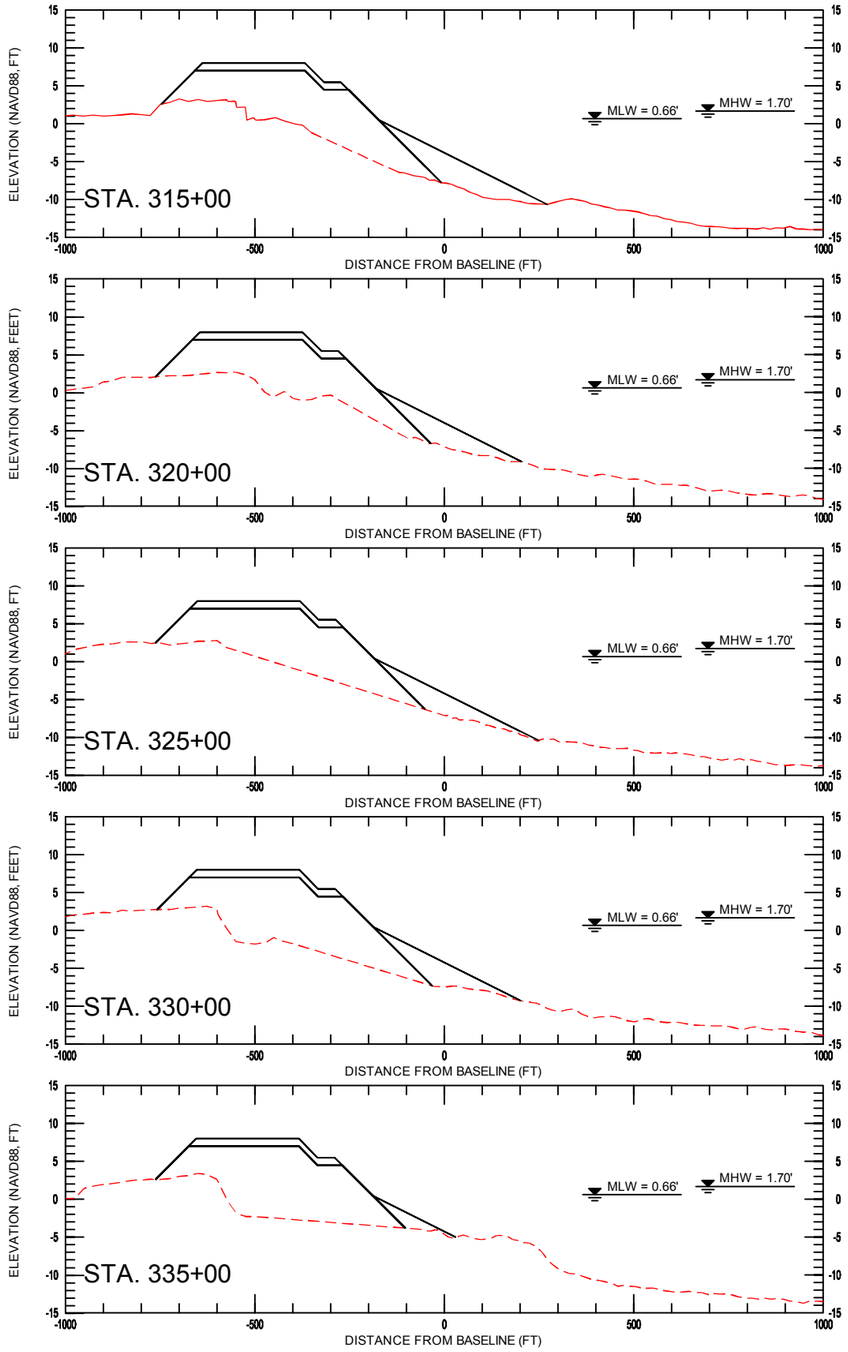
Figure A-11





LEGEND:

- EXISTING GRADE (2010)
- DESIGN
- CONSTRUCTION TOLERANCE (SEE NOTE 4)

Reference: Drawing provided by Eustis Engineering, Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012

DRAFT

DESIGN SECTION
STATION 290+00 - STATION 335+00

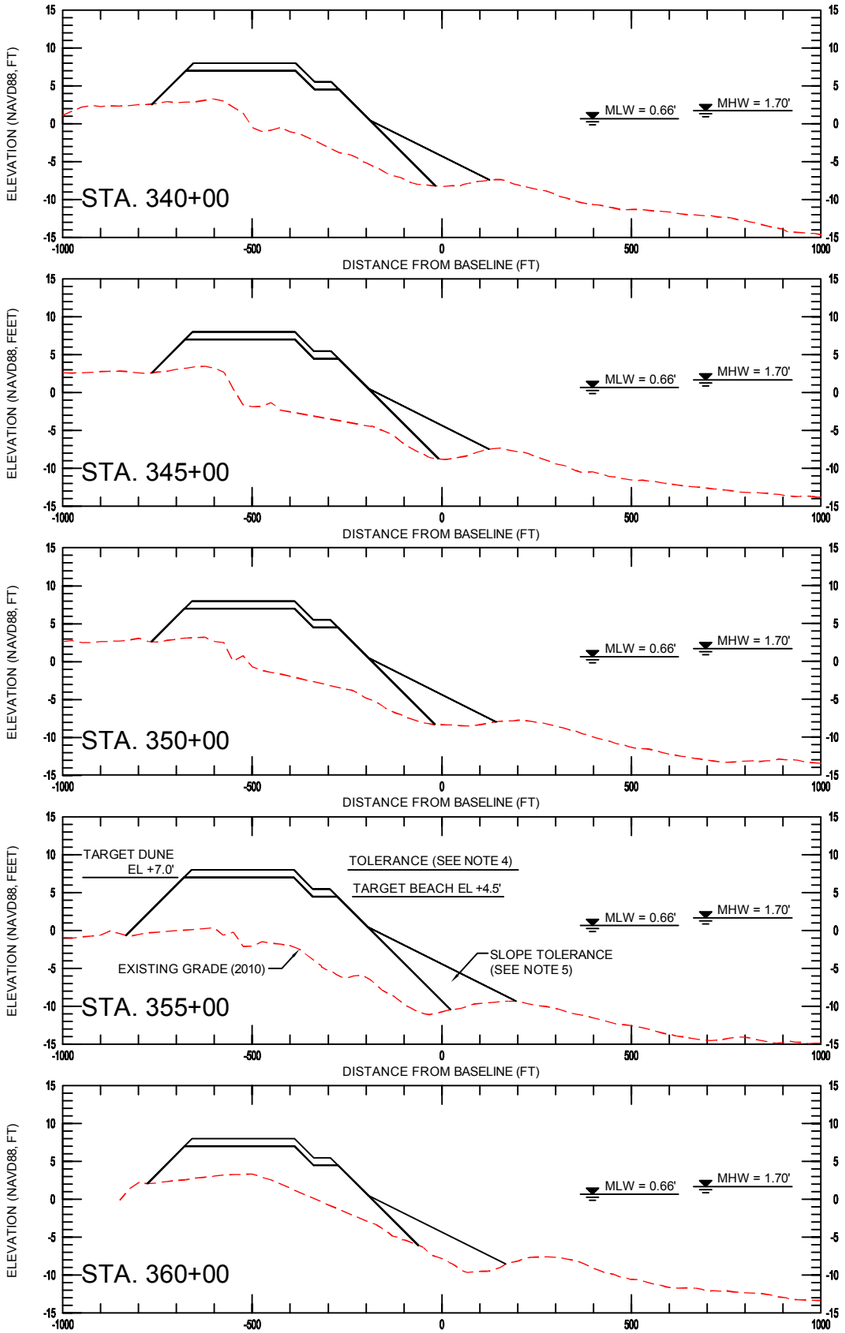
Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

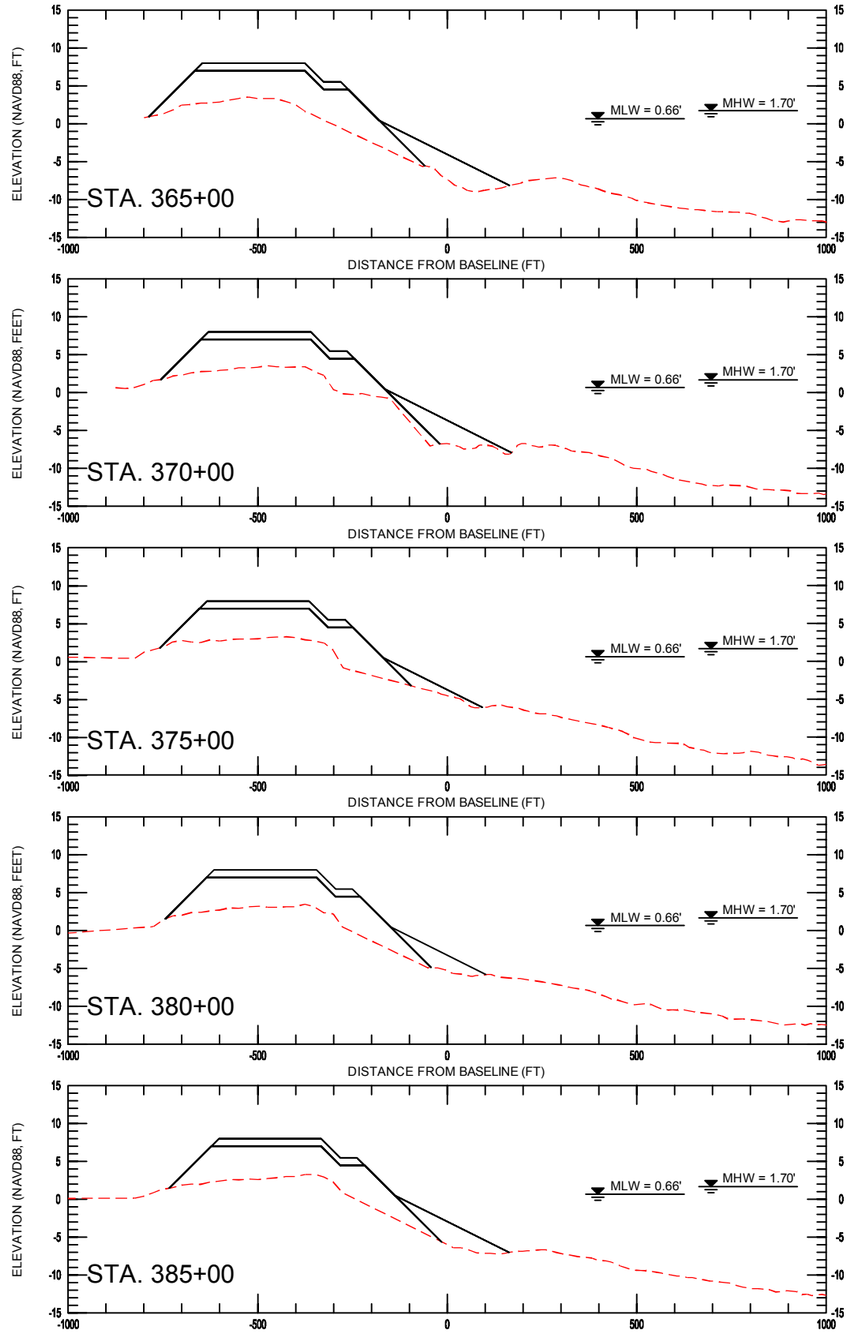
GeoEngineers

Figure A-12

JMP : KMC

P:\16\16715012\02\CAD\11126 CAM II Design 05-11-2012 Geo.dwg\TAB:S3 modified on Mar 01, 2013 - 10:55am





LEGEND:

- EXISTING GRADE (2010)
- DESIGN
- CONSTRUCTION TOLERANCE (SEE NOTE 4)

Reference: Drawing provided by Eustis Engineering, Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012

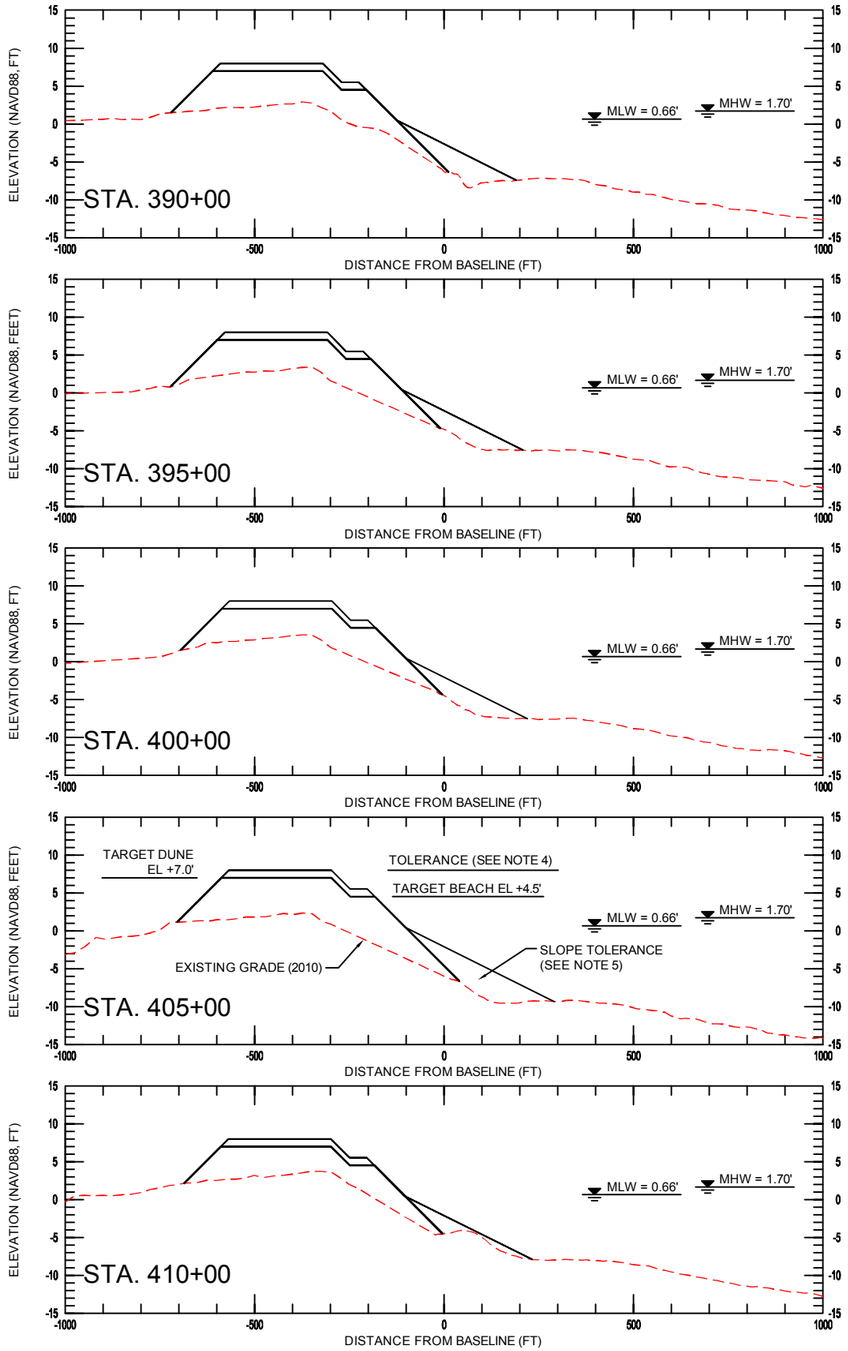
DRAFT

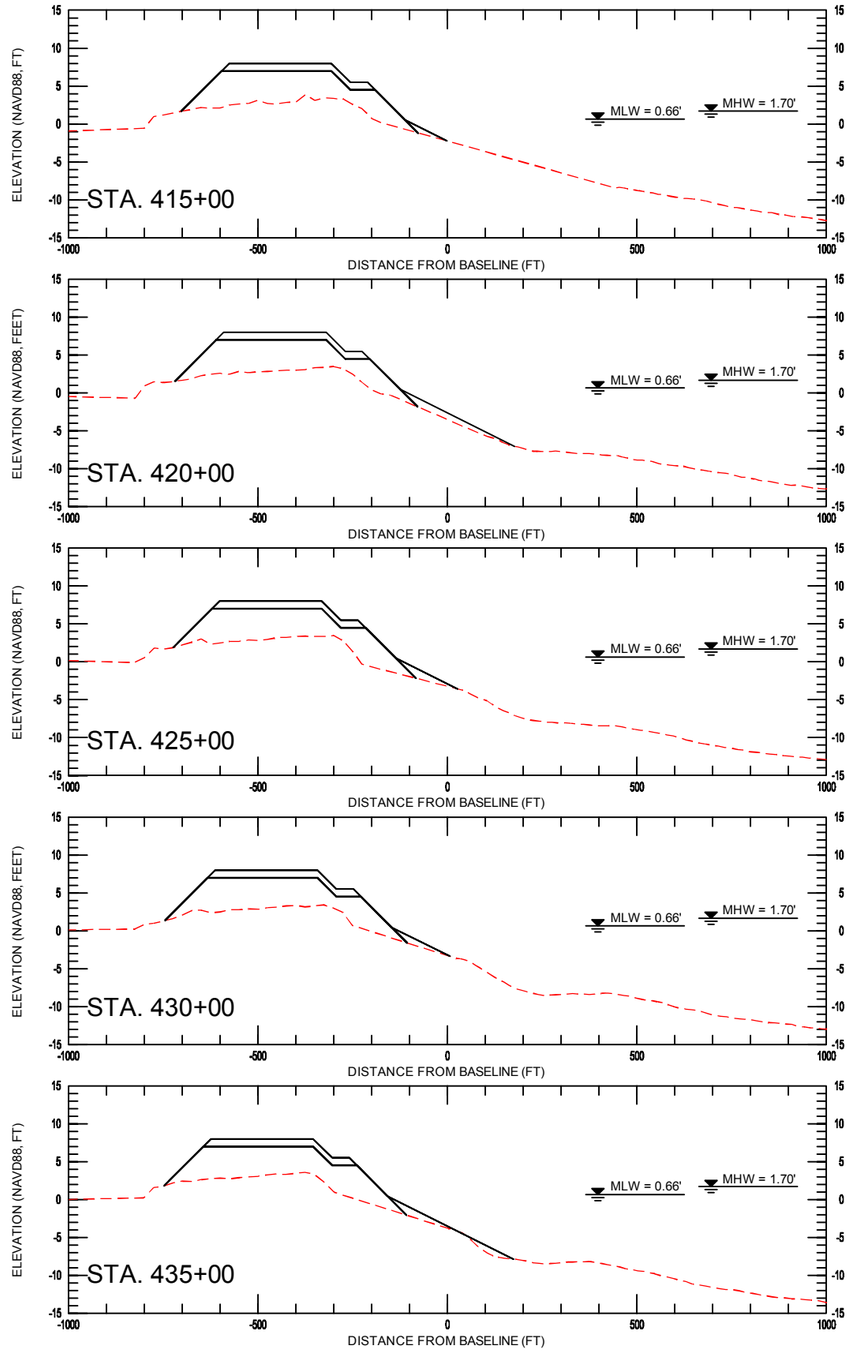
DESIGN SECTION
STATION 340+00 - STATION 385+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure A-13





LEGEND:

- EXISTING GRADE (2010)
- DESIGN
- CONSTRUCTION TOLERANCE (SEE NOTE 4)

Reference: Drawing provided by Eustis Engineering, Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012

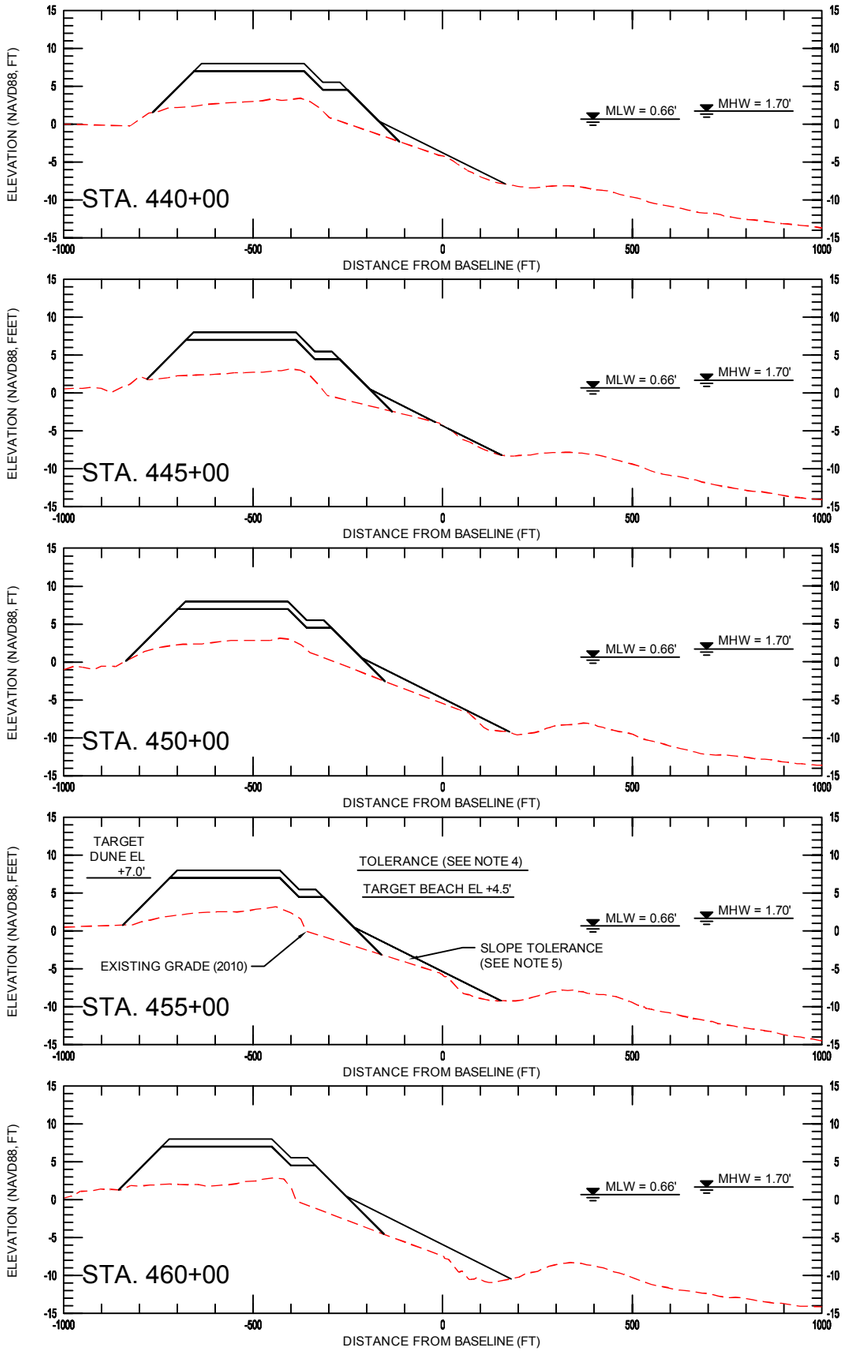
DRAFT

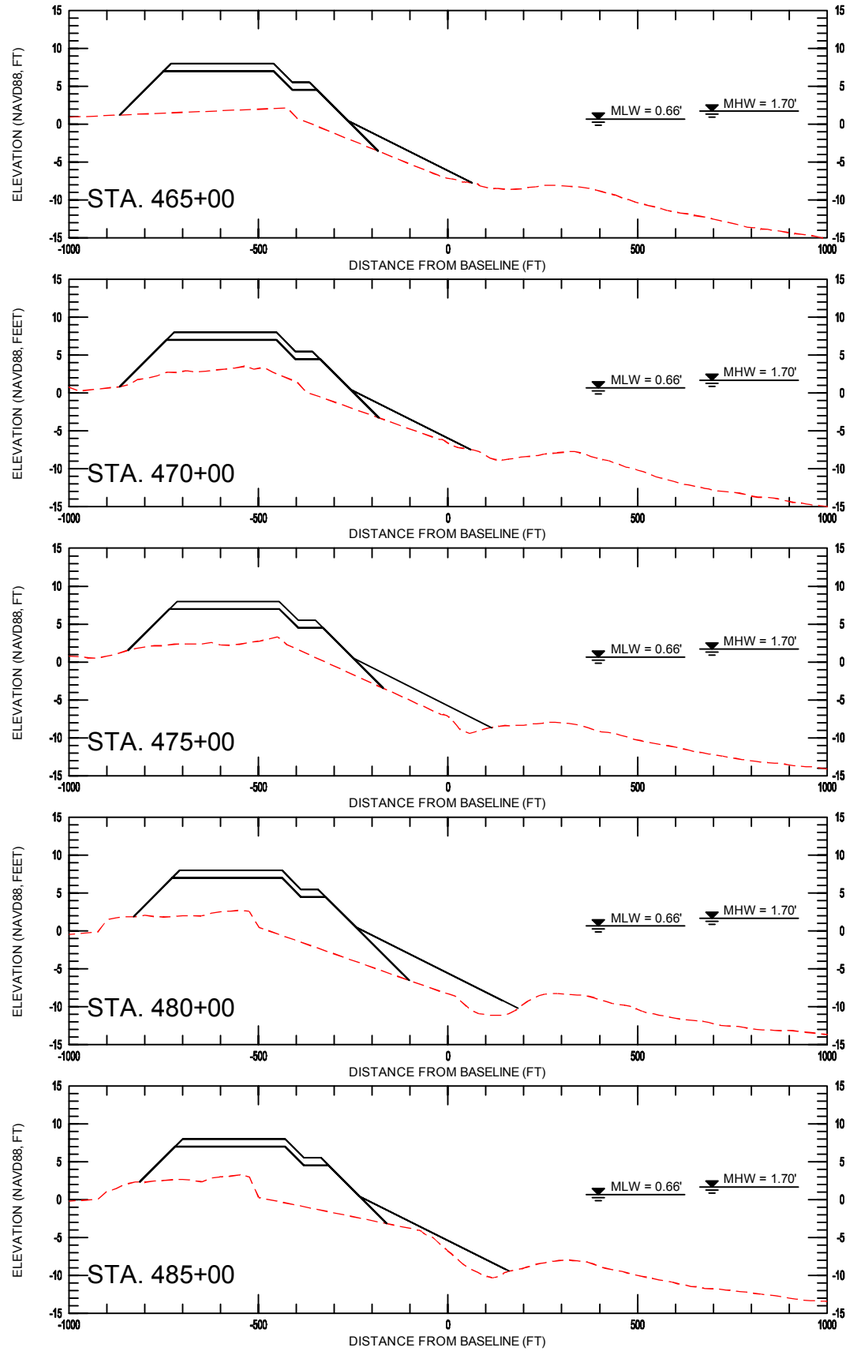
DESIGN SECTION
STATION 390+00 - STATION 435+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure A-14





LEGEND:

- EXISTING GRADE (2010)
- DESIGN
- CONSTRUCTION TOLERANCE (SEE NOTE 4)

Reference: Drawing provided by Eustis Engineering, Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012

DRAFT

DESIGN SECTION
STATION 440+00 - STATION 485+00

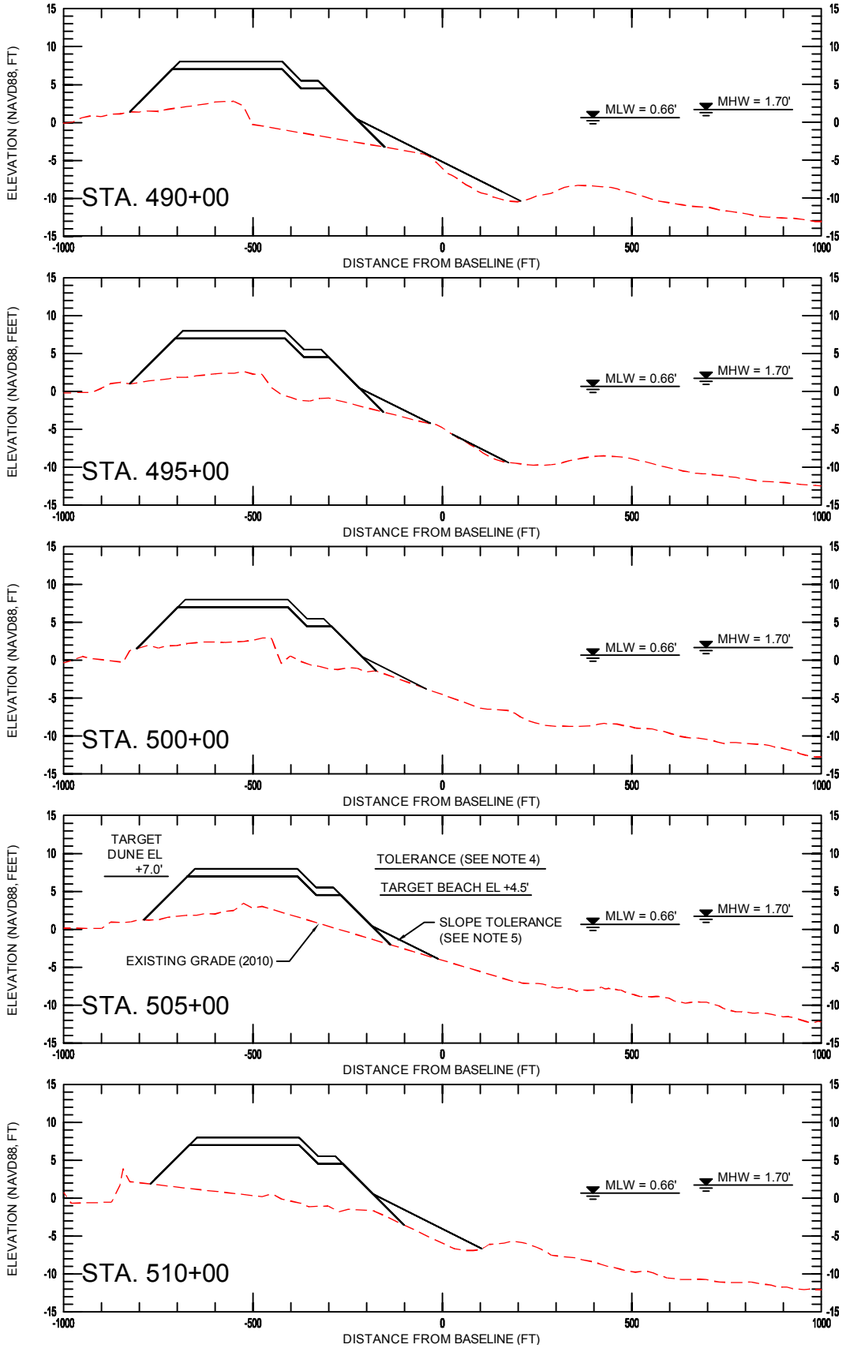
Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

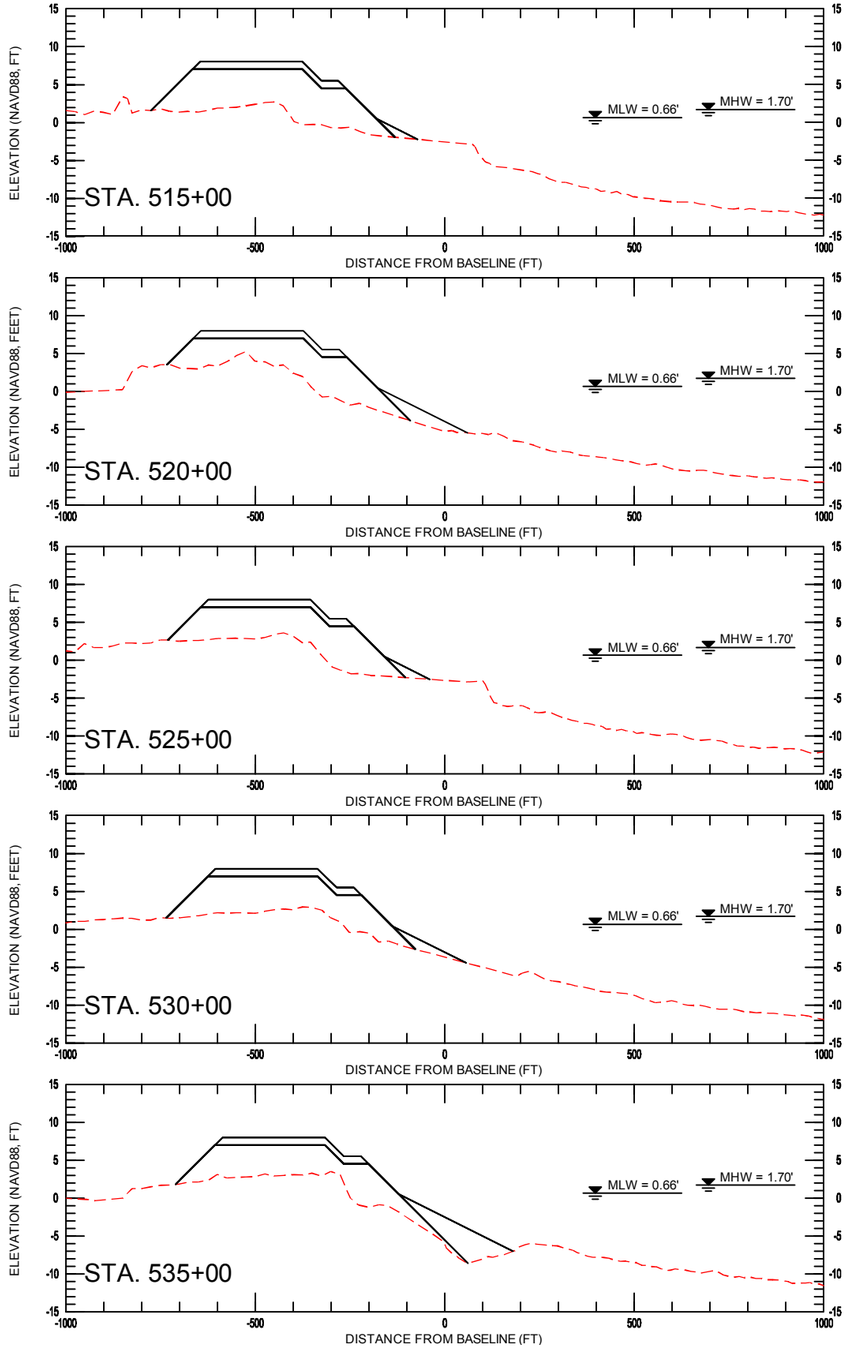
GeoEngineers

Figure A-15

JMP : KMC

P:\16\16715012\02\CAD\111126 CAM II Design 05-11-2012 Geo.dwg\TAB:S6 modified on Mar 01, 2013 - 10:56am





LEGEND:

- EXISTING GRADE (2010)
- DESIGN
- CONSTRUCTION TOLERANCE (SEE NOTE 4)

DRAFT

DESIGN SECTION
STATION 490+00 - STATION 535+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

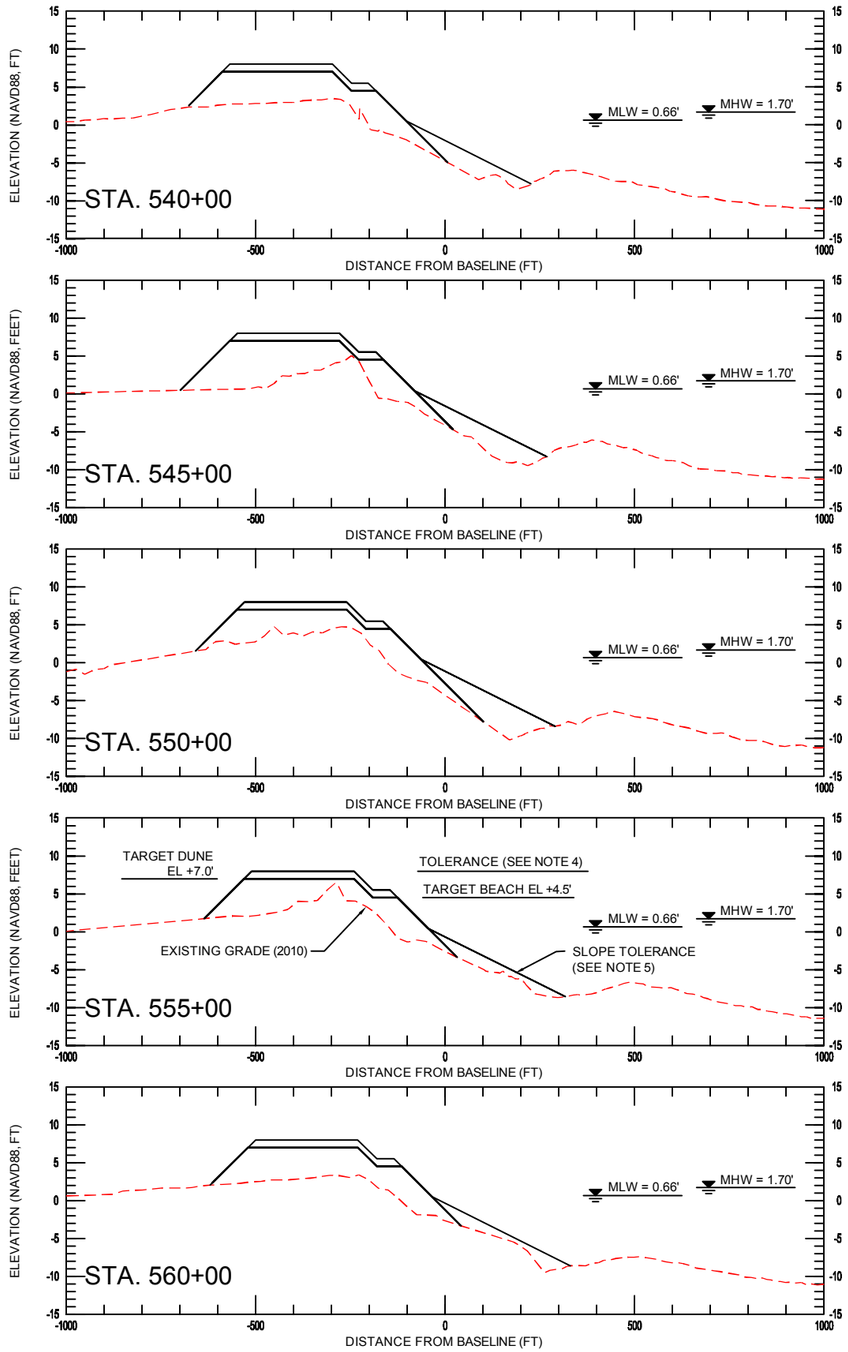
GeoEngineers

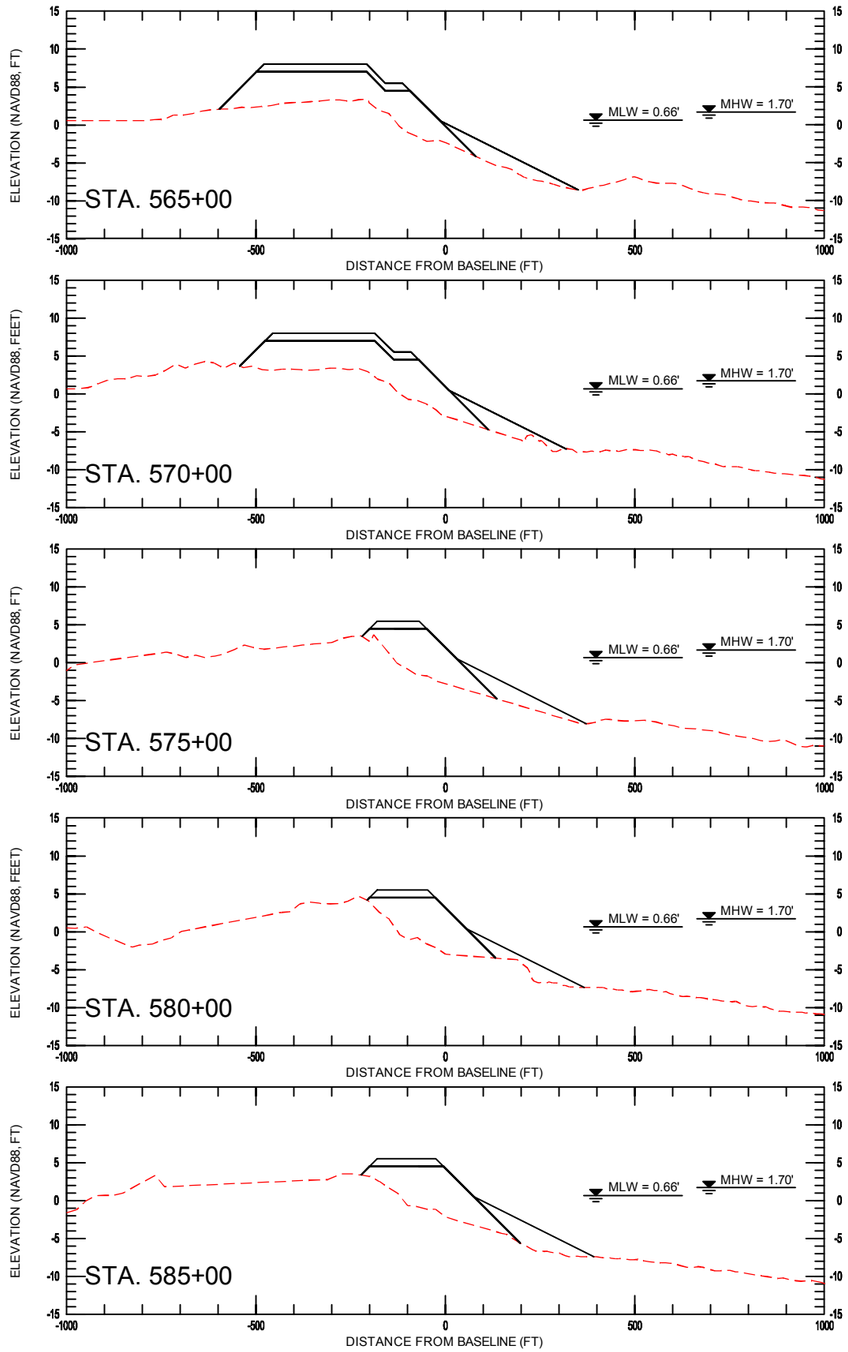
Figure A-16

Reference: Drawing provided by Eustis Engineering, Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012

JMP : KMC

P:\16\16715012\02\CAD\11126 CAM II Design 05-11-2012 Geo.dwg\TAB:S7 modified on Mar 01, 2013 - 10:57am





LEGEND:

- EXISTING GRADE (2010)
- DESIGN
- CONSTRUCTION TOLERANCE (SEE NOTE 4)

Reference: Drawing provided by Eustis Engineering, Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012

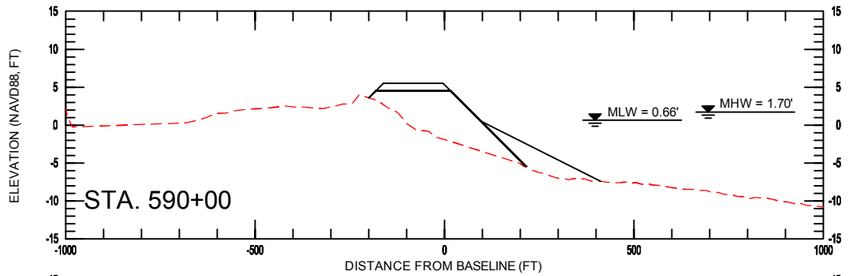
DRAFT

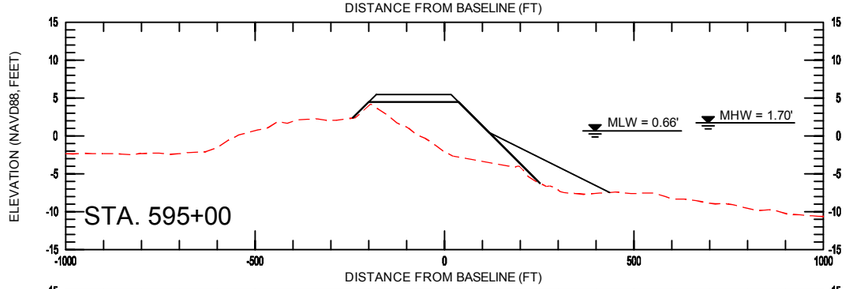
DESIGN SECTION
STATION 540+00 - STATION 585+00

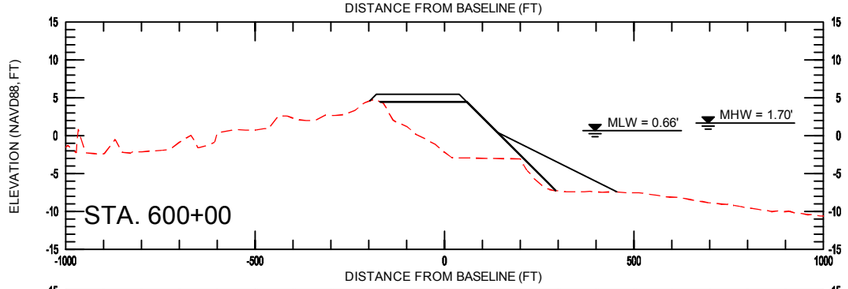
Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

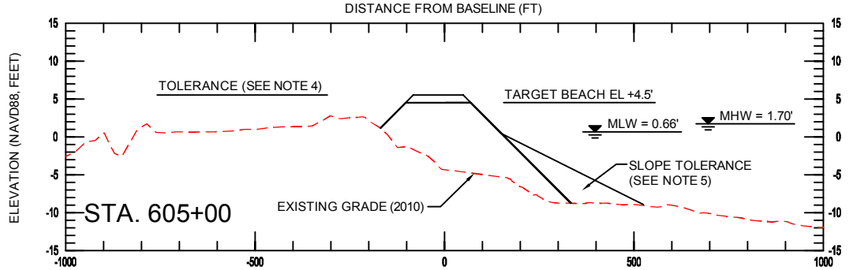
GeoEngineers

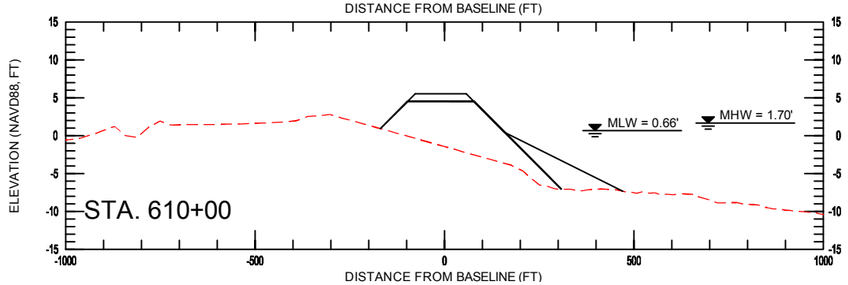
Figure A-17

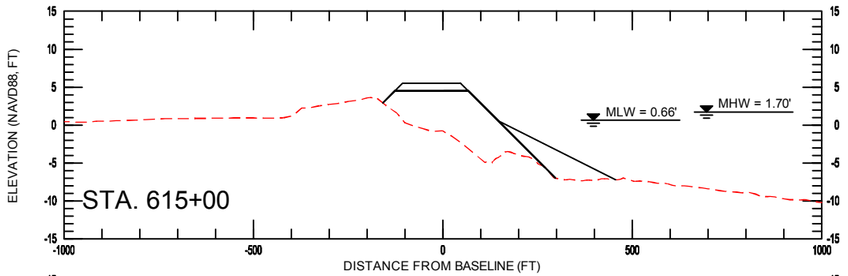


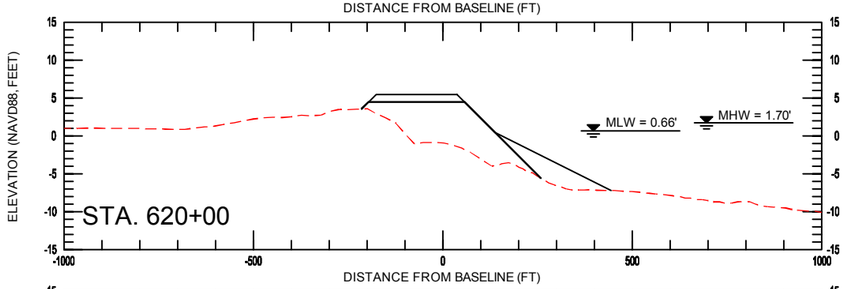


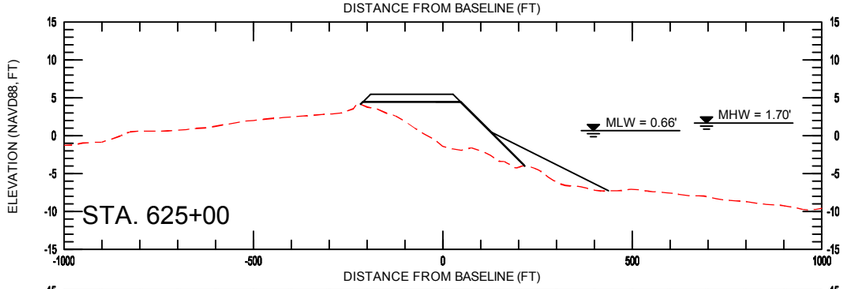


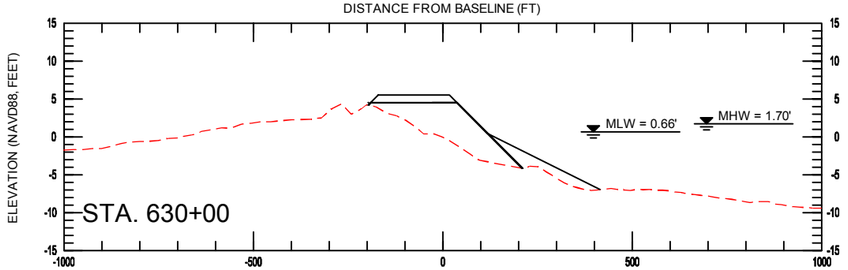


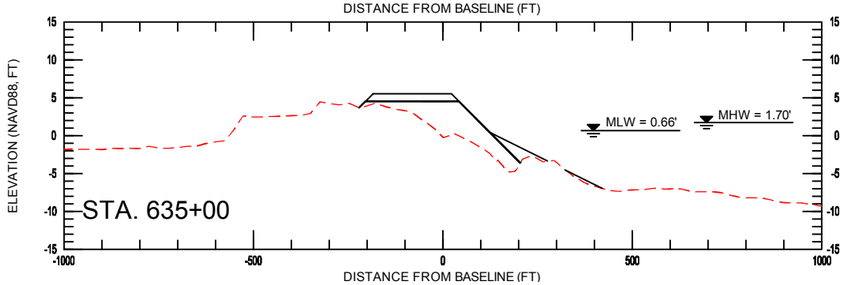












LEGEND:

- EXISTING GRADE (2010)
- DESIGN
- CONSTRUCTION TOLERANCE (SEE NOTE 4)

Reference: Drawing provided by Eustis Engineering, Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012

DRAFT

DESIGN SECTION
STATION 590+00 - STATION 635+00

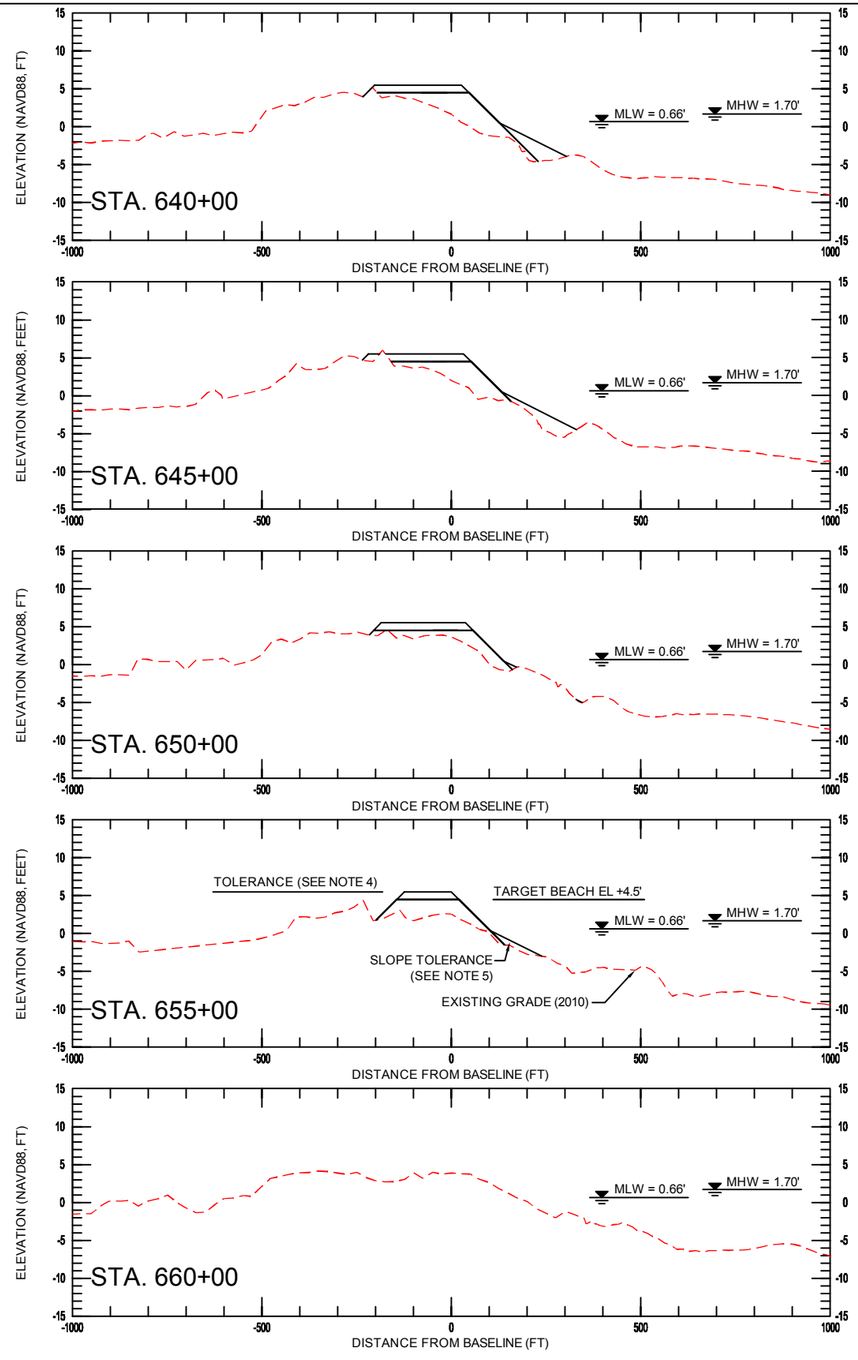
Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure A-18

JMP : KMC

P:\16\16715012\02\CAD\11126 CAM II Design 05-11-2012 Geo.dwgTAB:S9 modified on Mar 01, 2013 - 10:58am



LEGEND:

- EXISTING GRADE (2010)
- DESIGN
- CONSTRUCTION TOLERANCE (SEE NOTE 4)

JMP : KMC

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Reference: Drawing provided by Eustis Engineering, Drawing: 11126 CAM II Design 05-11-2012 Geo.dwg, Dated 5/11/2012

DRAFT

DESIGN SECTION
STATION 640+00 - STATION 660+00

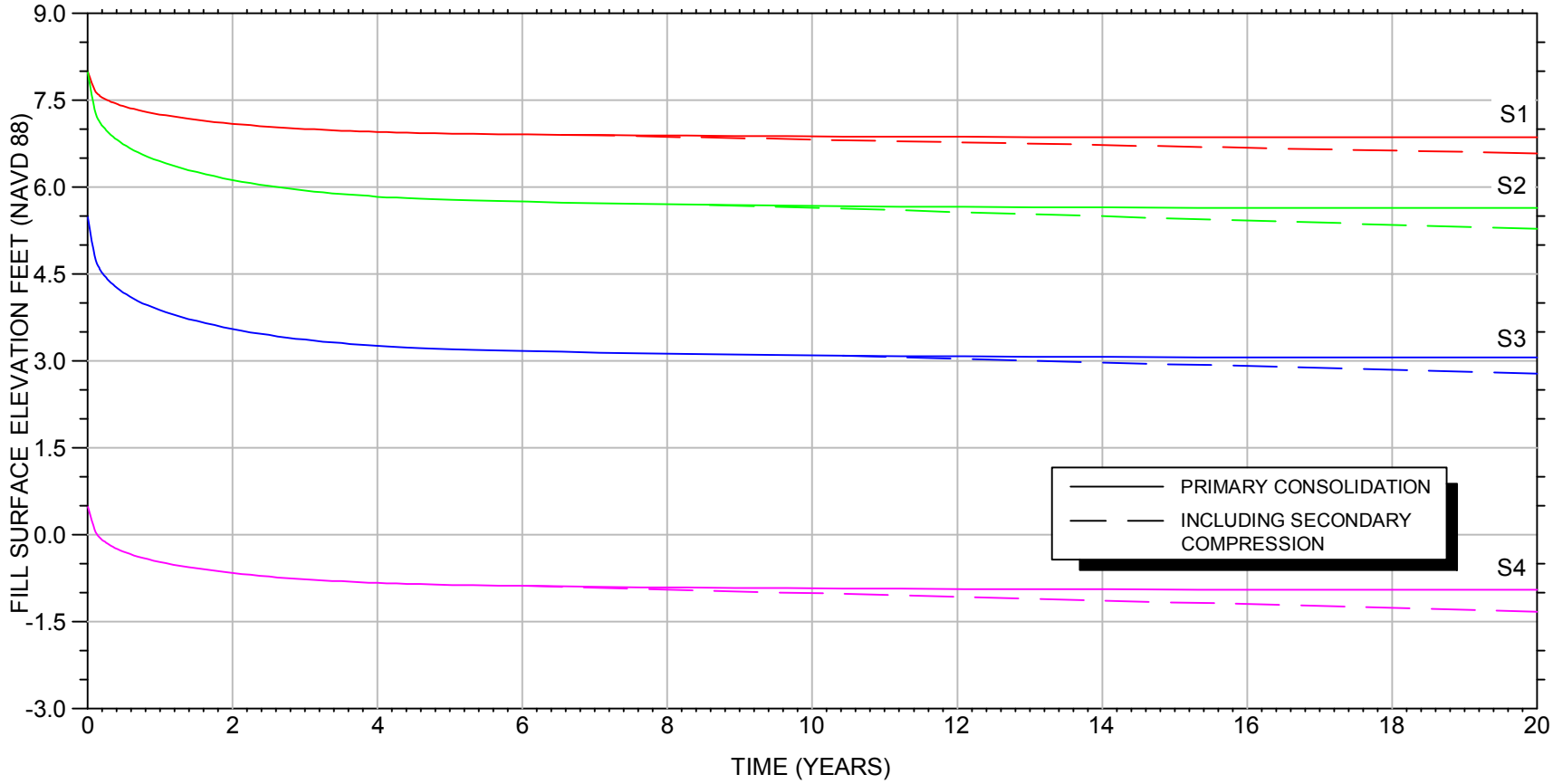
Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure A-19

APPENDIX B
Primary Consolidation Settlement Results

P:\16\16715012\02\CAD\SETTLEMENT1_recover.dwg\TAB:STA 285+00 modified on Mar 01, 2013 - 11:01am VT : KMC



	ELEVATION (FEET)								INCLUDING SECONDARY COMPRESSION @ 20 YEARS (FEET)
	0 DAYS	6 MONTHS	1 YEAR	2 YEAR	5 YEAR	10 YEAR	20 YEAR	LONG TERM	
S1	8.0	7.4	7.2	7.1	6.9	6.9	6.9	6.9	6.5
S2	8.0	6.7	6.4	6.1	5.8	5.7	5.6	5.6	5.3
S3	5.5	4.1	3.8	3.5	3.2	3.1	3.1	3.1	2.7
S4	0.5	-0.3	-0.5	-0.7	-0.9	-0.9	-1.0	-1.0	-1.3

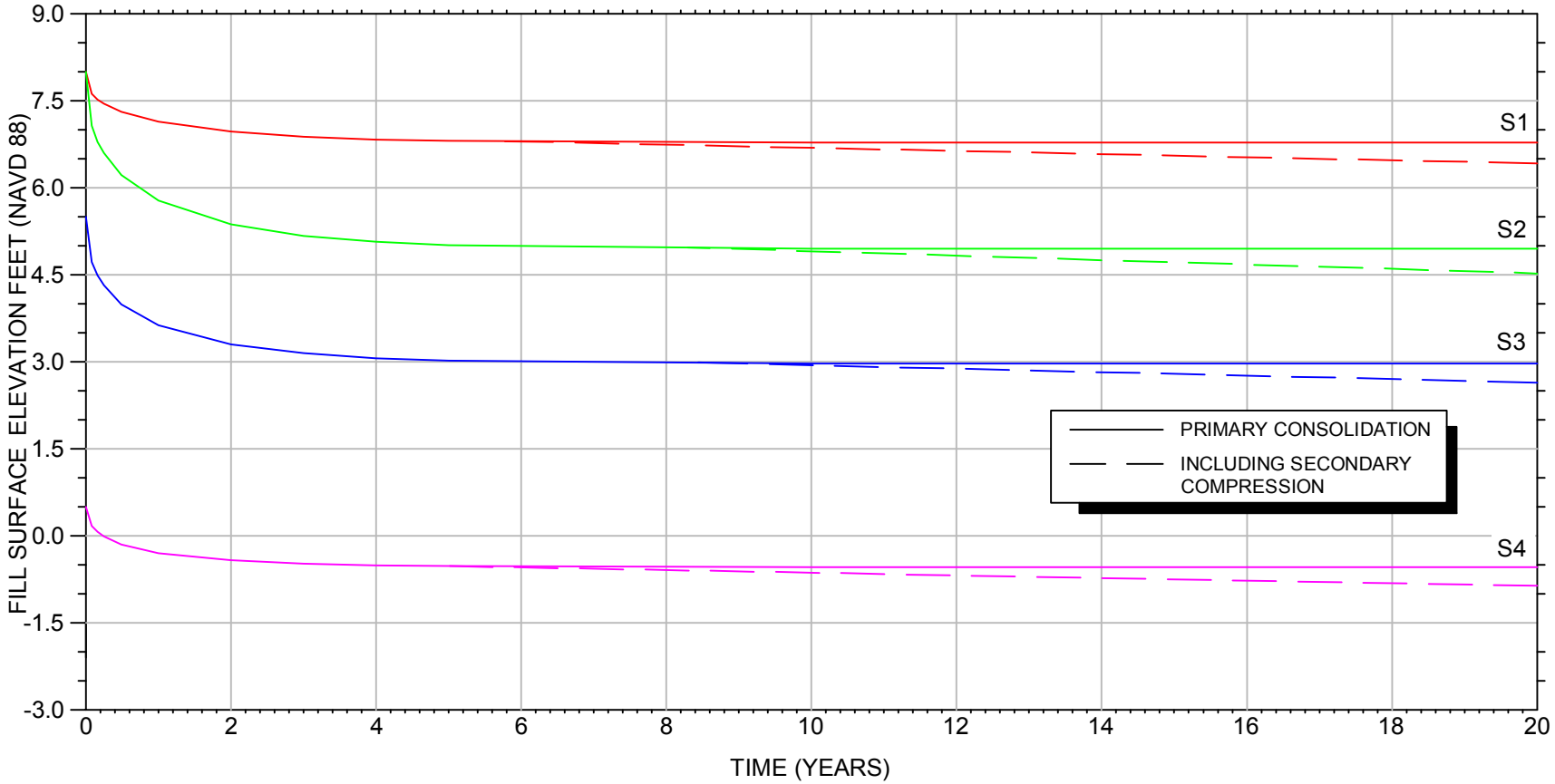
SETTLEMENT VS TIME
STATION 285+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure B-1

P:\16\16715012\02\CAD\SETTLEMENT1_recover.dwg\TAB:STA 335+00 modified on Mar 01, 2013 - 11:11am VT : KMC



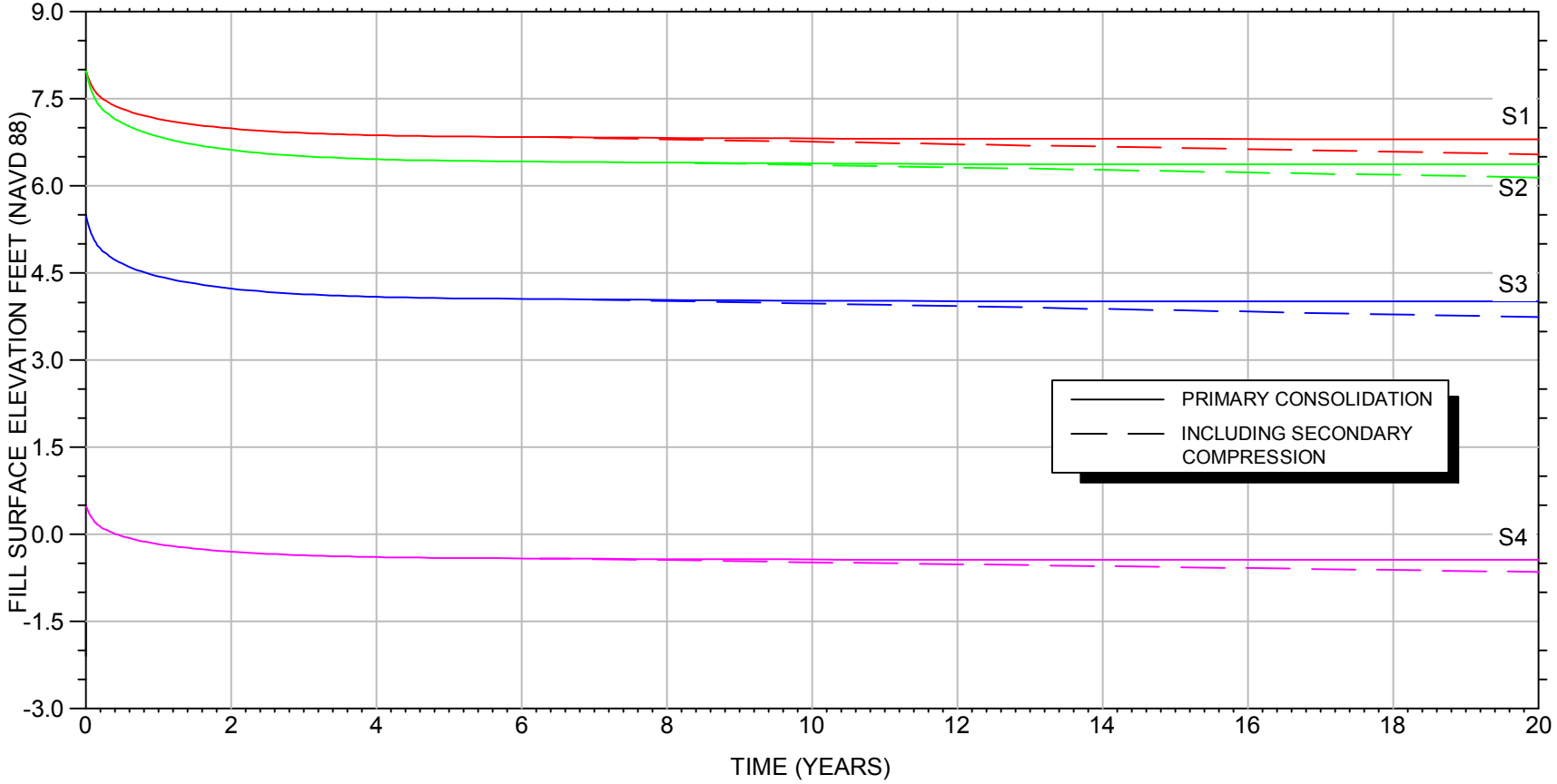
	ELEVATION (FEET)								INCLUDING SECONDARY COMPRESSION @ 20 YEARS (FEET)
	0 DAYS	6 MONTHS	1 YEAR	2 YEAR	5 YEAR	10 YEAR	20 YEAR	LONG TERM	
S1	8.0	7.3	7.1	7.0	6.8	6.8	6.8	6.8	6.4
S2	8.0	6.2	5.8	5.4	5.0	4.9	4.9	4.9	4.6
S3	5.5	4.0	3.6	3.3	3.0	3.0	3.0	3.0	2.6
S4	0.5	-0.2	-0.3	-0.4	-0.5	-0.5	-0.5	-0.5	-0.9

SETTLEMENT VS TIME
STATION 335+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure B-2



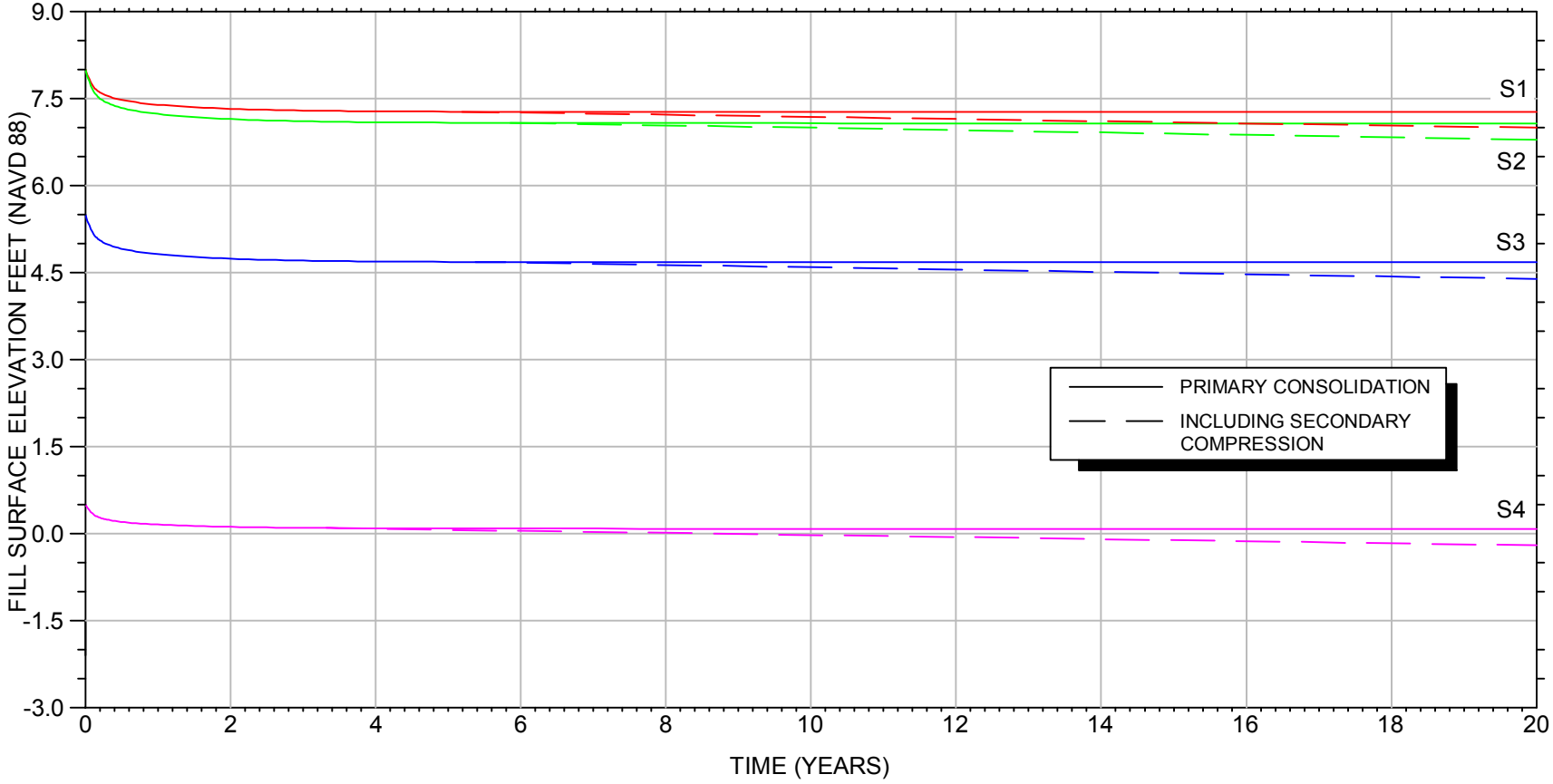
	ELEVATION (FEET)								INCLUDING SECONDARY COMPRESSION @ 20 YEARS (FEET)
	0 DAYS	6 MONTHS	1 YEAR	2 YEAR	5 YEAR	10 YEAR	20 YEAR	LONG TERM	
S1	8.0	7.3	7.1	7.0	6.8	6.8	6.8	6.8	6.6
S2	8.0	7.1	6.8	6.6	6.4	6.4	6.4	6.4	6.1
S3	5.5	4.6	4.4	4.2	4.1	4.0	4.0	4.0	3.8
S4	0.5	0.0	-0.2	-0.3	-0.4	-0.4	-0.4	-0.4	-0.7

SETTLEMENT VS TIME
STATION 355+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure B-3



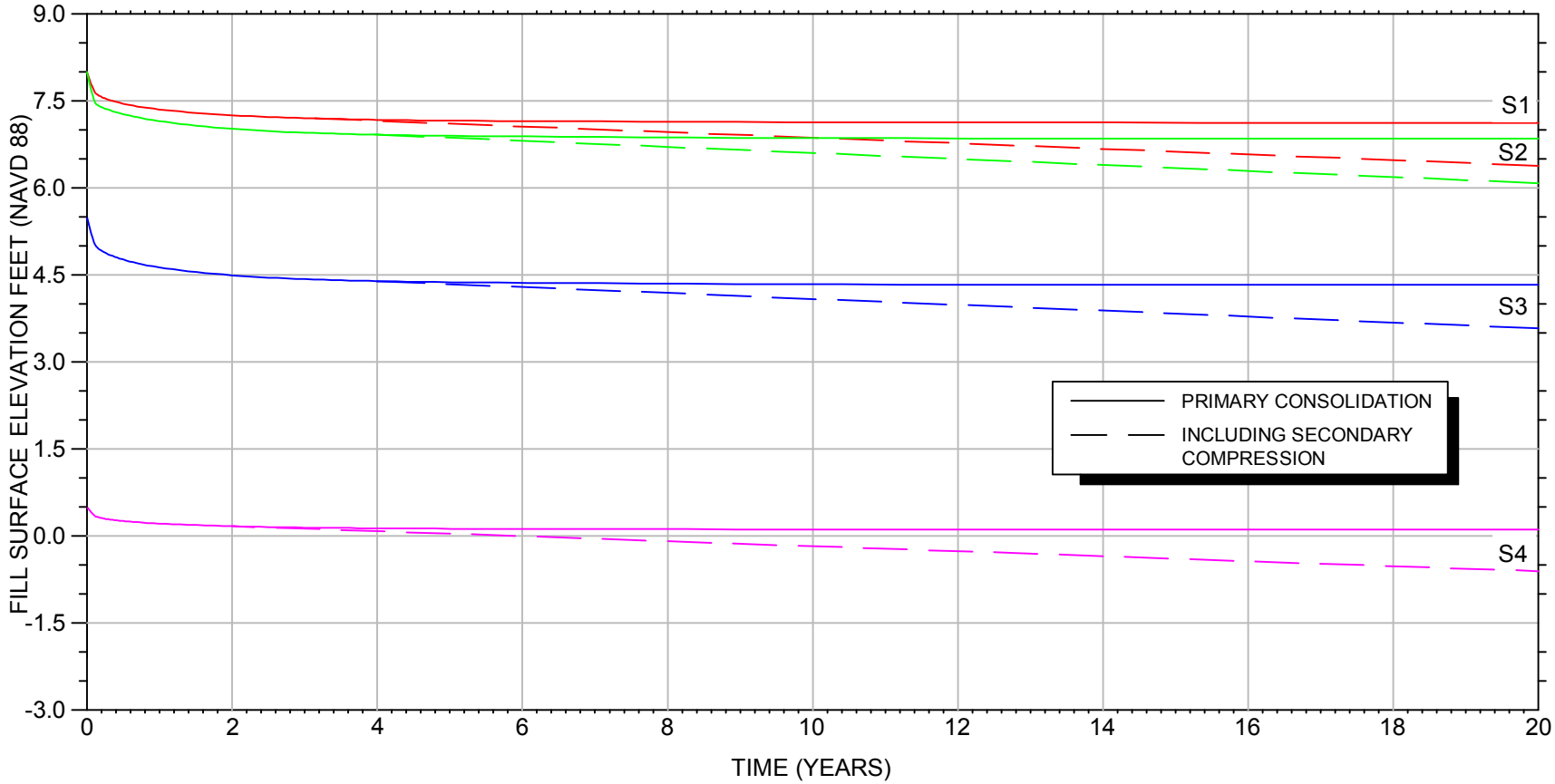
ELEVATION (FEET)									INCLUDING SECONDARY COMPRESSION @ 20 YEARS (FEET)
	0 DAYS	6 MONTHS	1 YEAR	2 YEAR	5 YEAR	10 YEAR	20 YEAR	LONG TERM	
S1	8.0	7.5	7.4	7.3	7.3	7.3	7.3	7.3	7.0
S2	8.0	7.3	7.2	7.1	7.1	7.1	7.1	7.1	6.8
S3	5.5	4.9	4.8	4.7	4.7	4.7	4.7	4.7	4.4
S4	0.5	0.2	0.2	0.1	0.1	0.1	0.1	0.1	-0.2

SETTLEMENT VS TIME
STATION 405+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure B-4



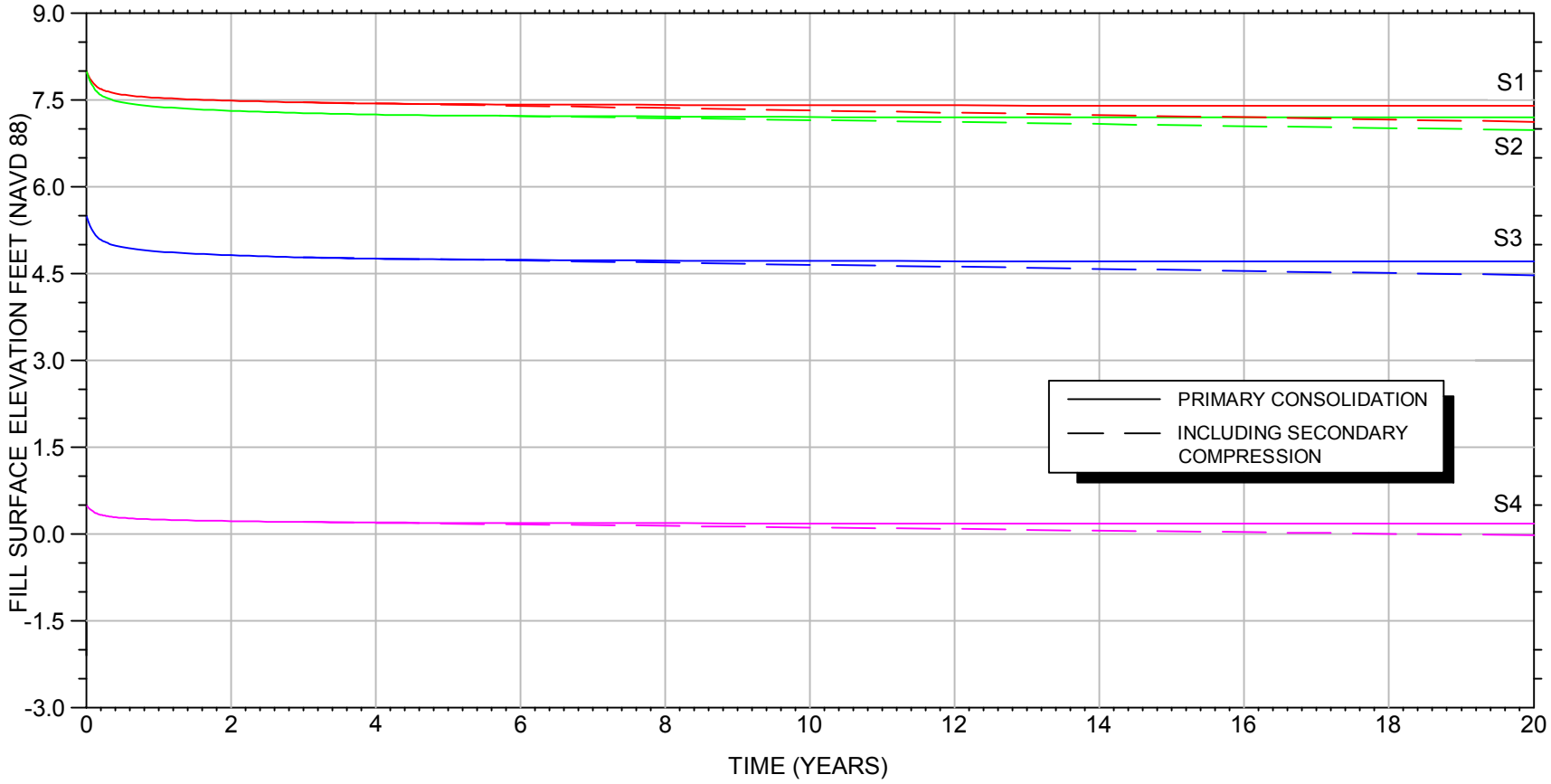
	ELEVATION (FEET)								INCLUDING SECONDARY COMPRESSION @ 20 YEARS (FEET)
	0 DAYS	6 MONTHS	1 YEAR	2 YEAR	5 YEAR	10 YEAR	20 YEAR	LONG TERM	
S1	8.0	7.4	7.3	7.2	7.2	7.1	7.1	7.1	6.7
S2	8.0	7.3	7.1	7.0	6.9	6.9	6.8	6.8	6.4
S3	5.5	4.8	4.6	4.5	4.4	4.3	4.3	4.3	3.9
S4	0.5	0.3	0.2	0.2	0.1	0.1	0.1	0.1	-0.3

SETTLEMENT VS TIME
STATION 460+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure B-5



	ELEVATION (FEET)								INCLUDING SECONDARY COMPRESSION @ 20 YEARS (FEET)
	0 DAYS	6 MONTHS	1 YEAR	2 YEAR	5 YEAR	10 YEAR	20 YEAR	LONG TERM	
S1	8.0	7.6	7.5	7.5	7.4	7.4	7.4	7.4	7.2
S2	8.0	7.4	7.4	7.3	7.2	7.2	7.2	7.2	7.0
S3	5.5	4.9	4.9	4.8	4.7	4.7	4.7	4.7	4.5
S4	0.5	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.0

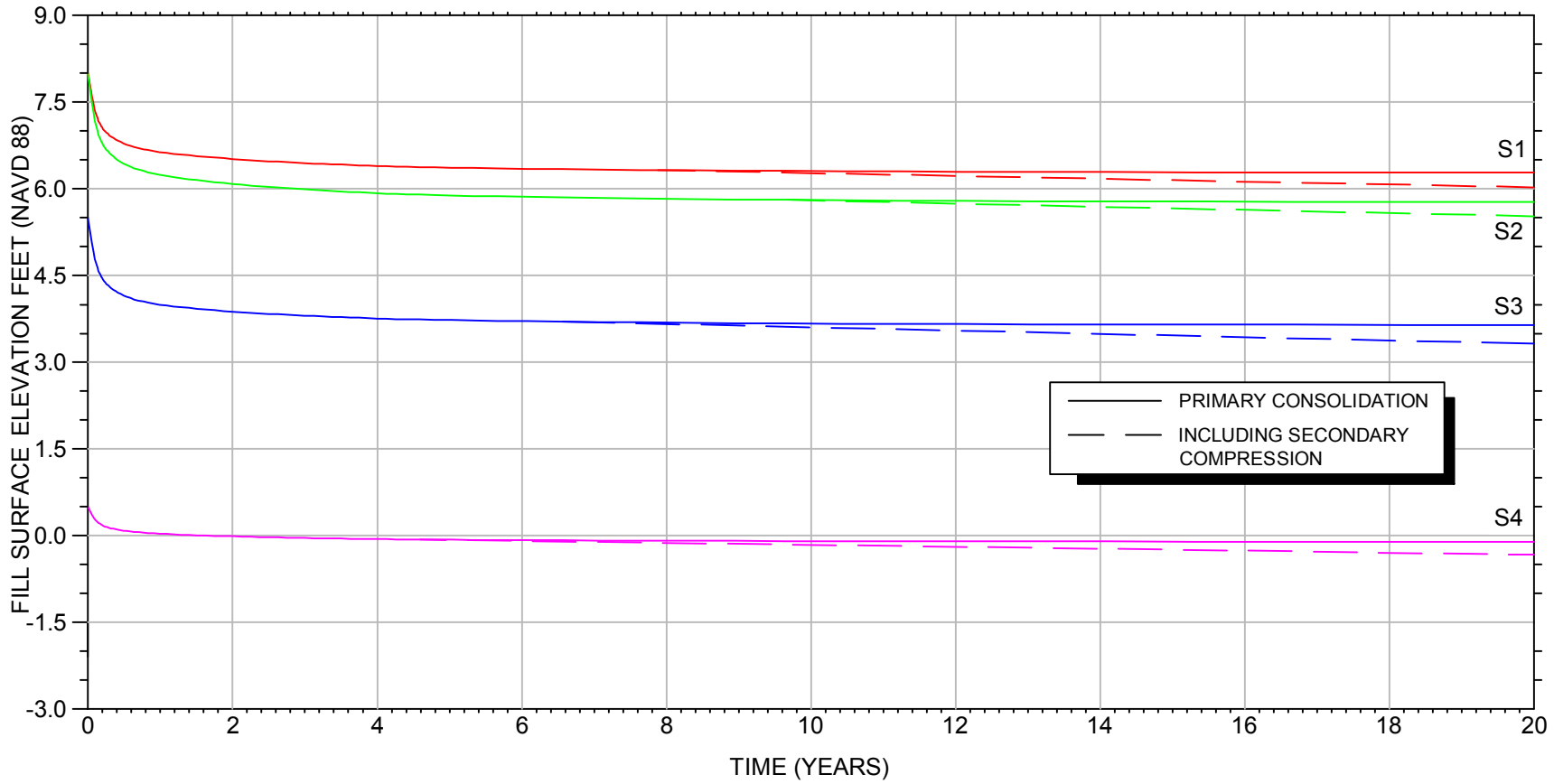
SETTLEMENT VS TIME
STATION 490+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure B-6

P:\16\16715012\02\CAD\SETTLEMENT1_recover.dwg\TAB:STA 510+00 modified on Mar 01, 2013 - 11:03am VT : KMC



	ELEVATION (FEET)							
	0 DAYS	6 MONTHS	1 YEAR	2 YEAR	5 YEAR	10 YEAR	20 YEAR	LONG TERM
S1	8.0	6.7	6.6	6.5	6.4	6.3	6.3	6.3
S2	8.0	6.4	6.2	6.1	5.9	5.8	5.8	5.8
S3	5.5	4.1	4.0	3.9	3.7	3.7	3.6	3.6
S4	0.5	0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.1

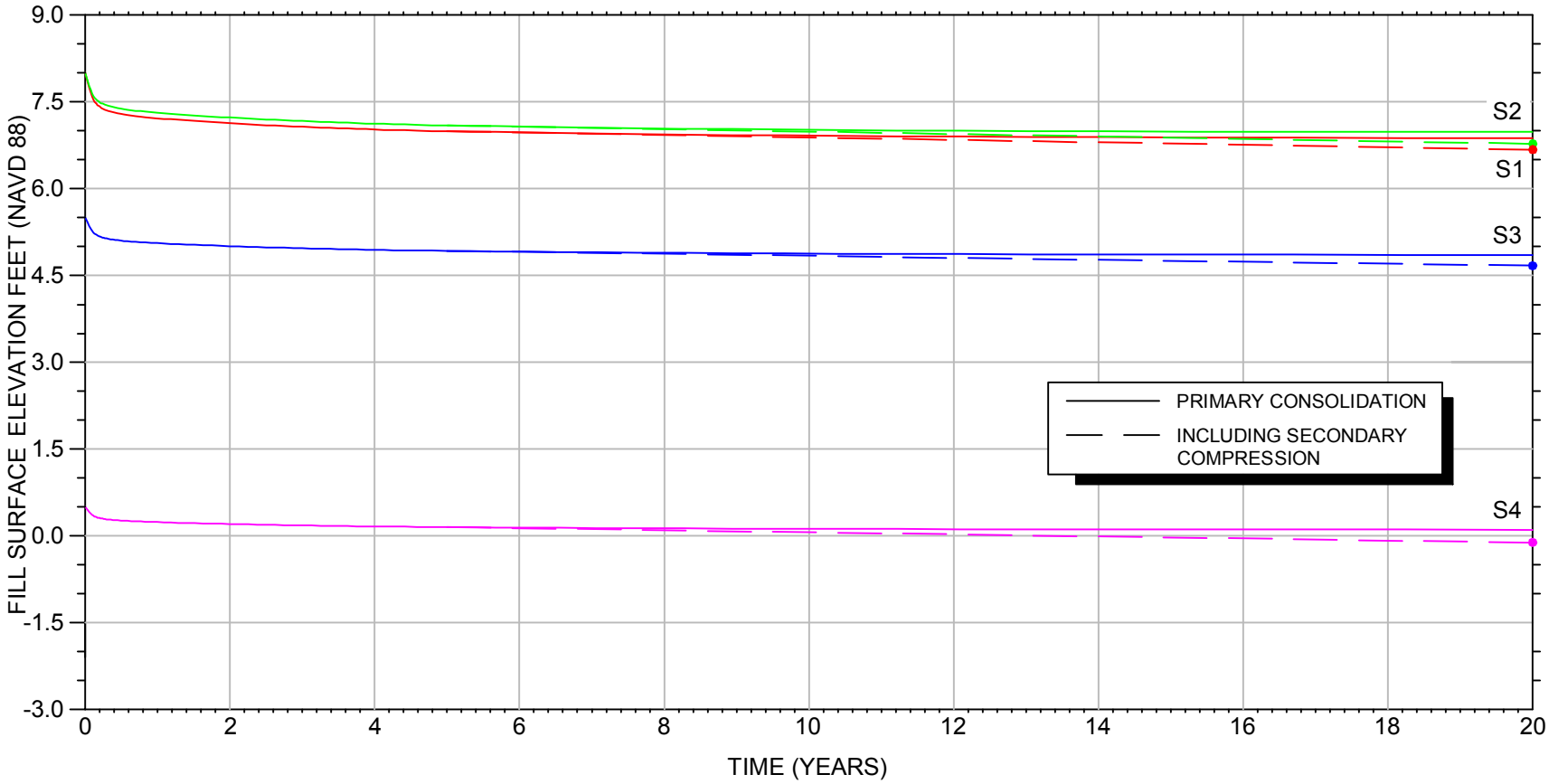
INCLUDING SECONDARY COMPRESSION @ 20 YEARS (FEET)
6.0
5.5
3.4
-0.4

SETTLEMENT VS TIME
STATION 510+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure B-7



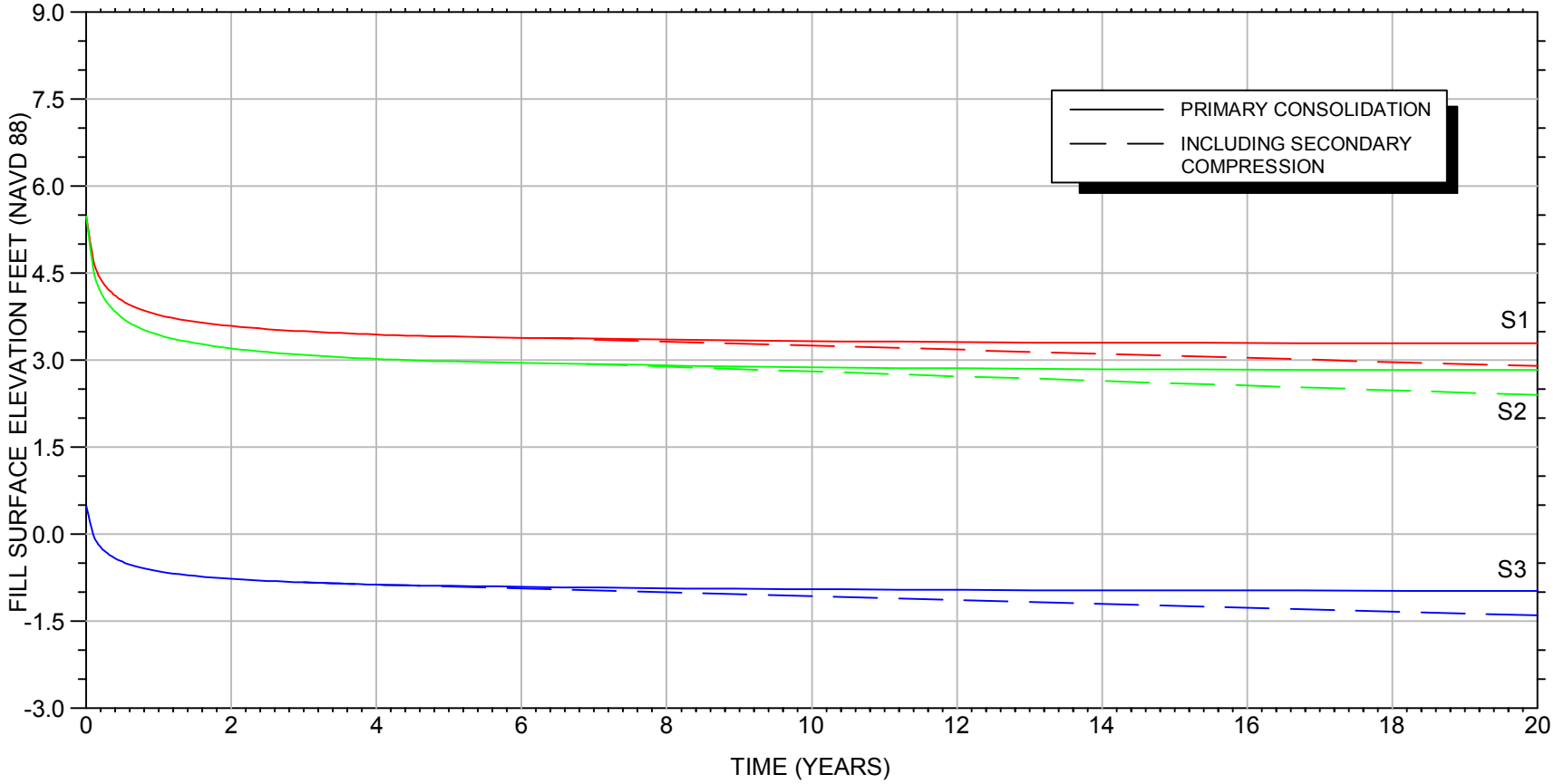
	ELEVATION (FEET)								INCLUDING SECONDARY COMPRESSION @ 20 YEARS (FEET)
	0 DAYS	6 MONTHS	1 YEAR	2 YEAR	5 YEAR	10 YEAR	20 YEAR	LONG TERM	
S1	8.0	7.3	7.2	7.1	7.0	6.9	6.9	6.9	6.7
S2	8.0	7.4	7.3	7.2	7.1	7.0	7.0	7.0	6.8
S3	5.5	5.1	5.1	5.0	4.9	4.9	4.9	4.9	4.6
S4	0.5	0.3	0.2	0.2	0.1	0.1	0.1	0.1	-0.1

SETTLEMENT VS TIME
STATION 545+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure B-8



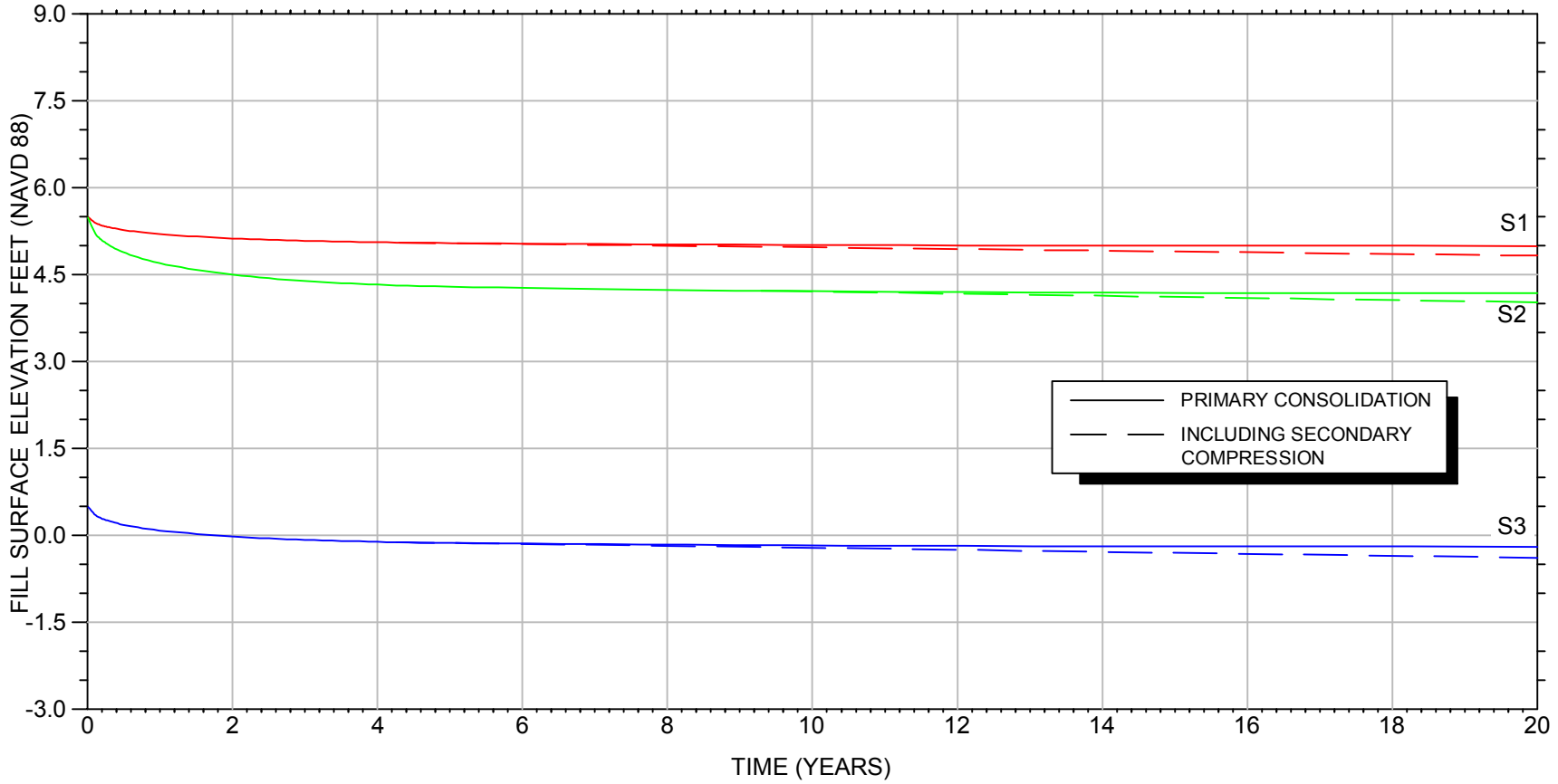
	ELEVATION (FEET)								INCLUDING SECONDARY COMPRESSION @ 20 YEARS (FEET)
	0 DAYS	6 MONTHS	1 YEAR	2 YEAR	5 YEAR	10 YEAR	20 YEAR	LONG TERM	
S1	5.5	4.0	3.7	3.6	3.4	3.3	3.3	3.3	2.9
S2	5.5	3.7	3.4	3.2	3.0	2.9	2.8	2.8	2.4
S3	0.5	-0.5	-0.7	-0.8	-0.9	-0.9	-1.0	-1.0	-1.4

SETTLEMENT VS TIME
STATION 605+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure B-9



	ELEVATION (FEET)								INCLUDING SECONDARY COMPRESSION @ 20 YEARS (FEET)
	0 DAYS	6 MONTHS	1 YEAR	2 YEAR	5 YEAR	10 YEAR	20 YEAR	LONG TERM	
S1	5.5	5.3	5.2	5.1	5.0	5.0	5.0	5.0	4.8
S2	5.5	4.9	4.7	4.5	4.3	4.2	4.2	4.2	4.0
S3	0.5	0.2	0.1	0.0	-0.1	-0.2	-0.2	-0.2	-0.4

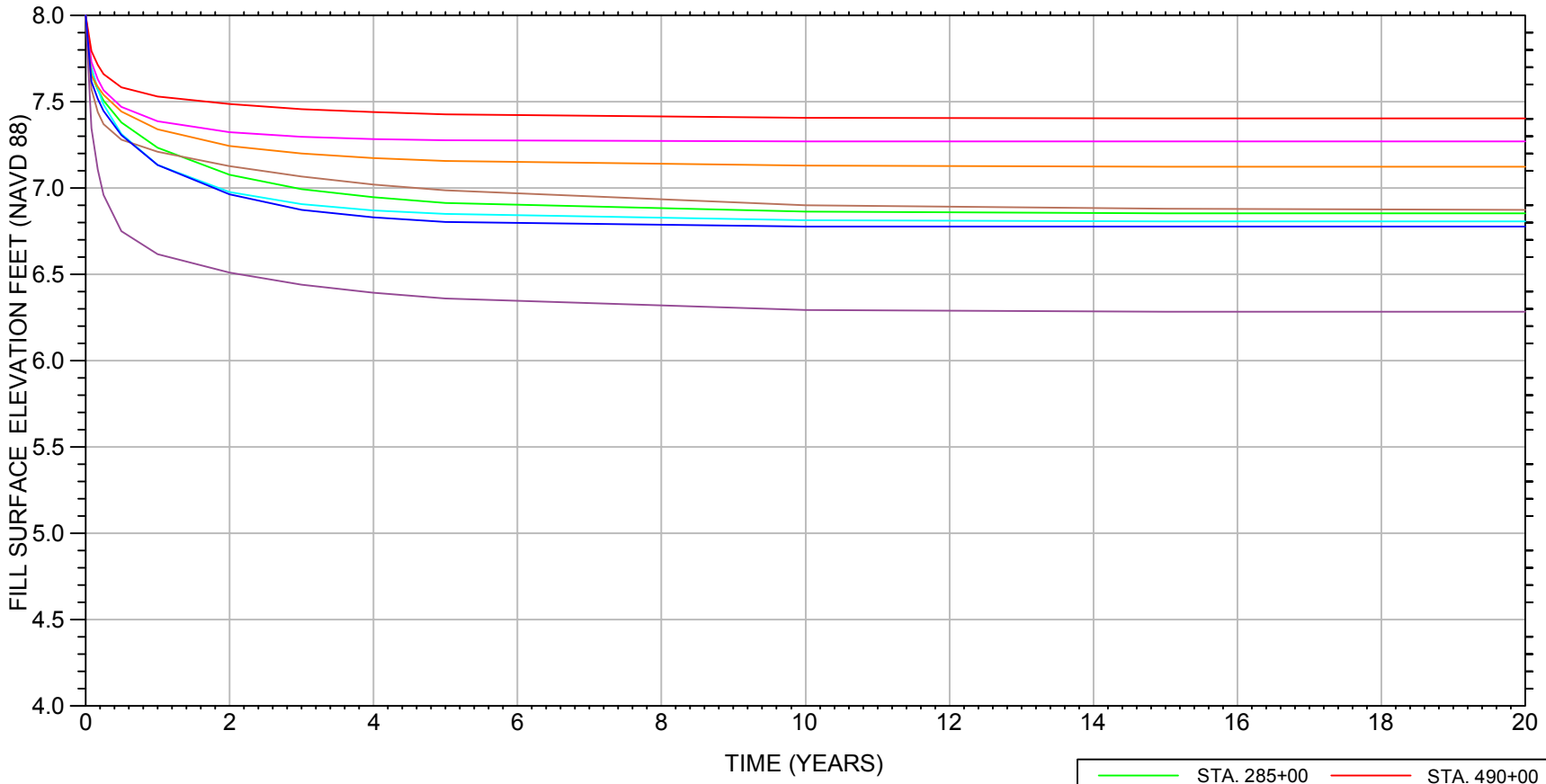
SETTLEMENT VS TIME
STATION 620+00

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure B-10

P:\16\16715012\02\CAD\SETTLEMENT1_recover.dwg\TAB:S1 modified on Mar 01, 2013 - 11:04am JMP : KMC



ELEVATION (FEET, NAVD 88)								
STATION	0 DAYS	6 MONTHS	1 YEAR	2 YEAR	5 YEAR	10 YEAR	20 YEAR	LONG TERM
STA. 285+00	8.00	7.38	7.23	7.08	6.91	6.86	6.85	6.85
STA. 335+00	8.00	7.30	7.13	6.96	6.80	6.78	6.78	6.78
STA. 355+00	8.00	7.31	7.13	6.97	6.85	6.81	6.81	6.81
STA. 405+00	8.00	7.47	7.38	7.32	7.28	7.27	7.27	7.27
STA. 460+00	8.00	7.44	7.34	7.24	7.16	7.13	7.12	7.12
STA. 490+00	8.00	7.58	7.53	7.49	7.43	7.41	7.40	7.40
STA. 510+00	8.00	6.75	6.62	6.51	6.36	6.29	6.28	6.28
STA. 545+00	8.00	7.28	7.21	7.13	6.98	6.90	6.87	6.87

S1

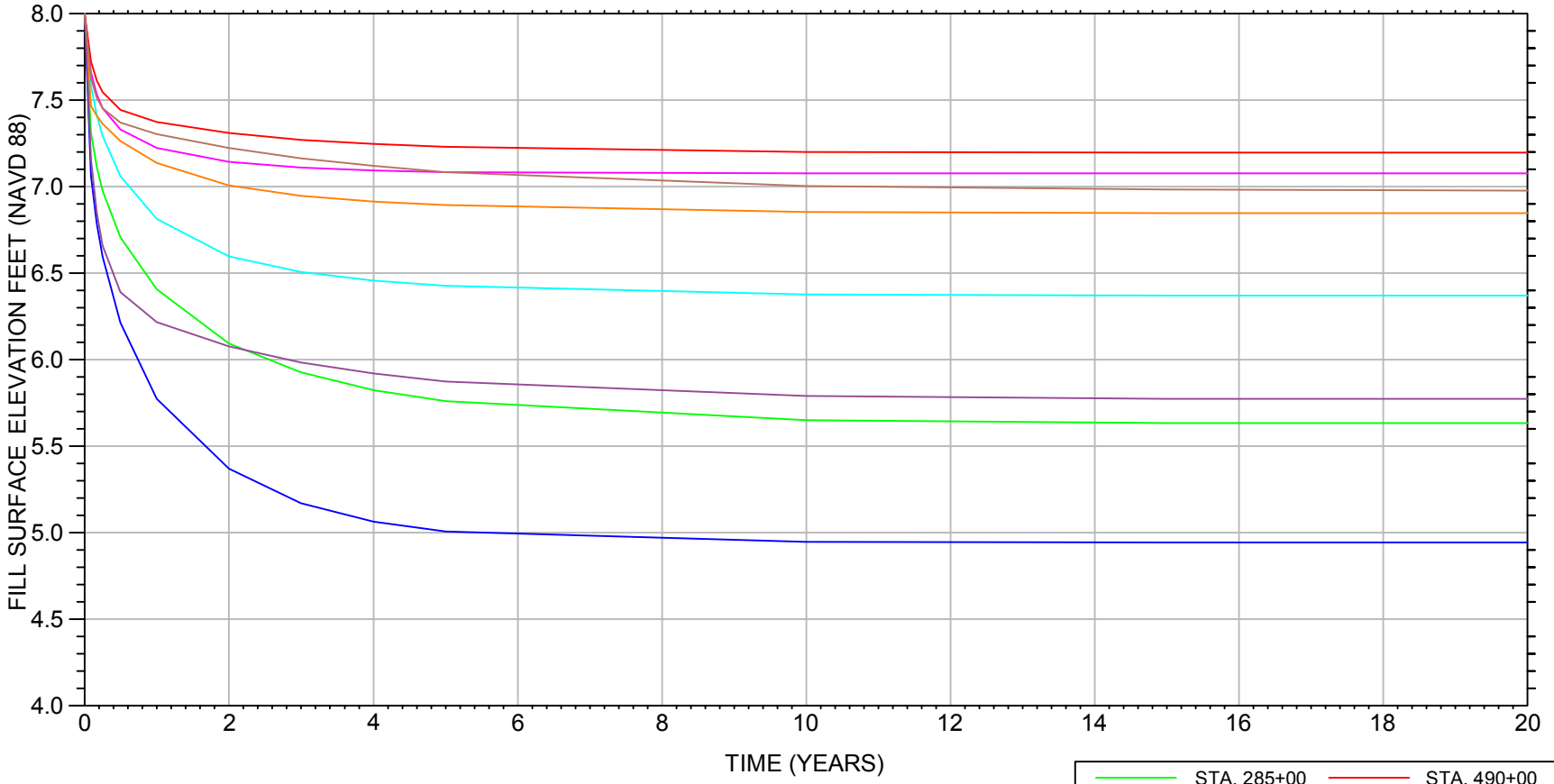
ELEVATION VS. TIME

Caminada Headland Beach & Dune Restoration Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure B-11

P:\16\16715012\02\CAD\SETTLEMENT1_recover.dwg\TAB:S2 modified on Mar 01, 2013 - 11:05am JMP : KMC



ELEVATION (FEET, NAVD 88)								
STATION	0 DAYS	6 MONTHS	1 YEAR	2 YEAR	5 YEAR	10 YEAR	20 YEAR	LONG TERM
STA. 285+00	8.00	6.71	6.41	6.09	5.76	5.65	5.63	5.63
STA. 335+00	8.00	6.21	5.78	5.37	5.01	4.95	4.94	4.94
STA. 355+00	8.00	7.06	6.81	6.60	6.43	6.38	6.37	6.37
STA. 405+00	8.00	7.33	7.22	7.14	7.09	7.08	7.08	7.08
STA. 460+00	8.00	7.27	7.14	7.01	6.89	6.85	6.85	6.85
STA. 490+00	8.00	7.44	7.37	7.31	7.23	7.20	7.20	7.20
STA. 510+00	8.00	6.39	6.22	6.08	5.88	5.79	5.77	5.77
STA. 545+00	8.00	7.37	7.30	7.22	7.09	7.00	6.98	6.98

S2

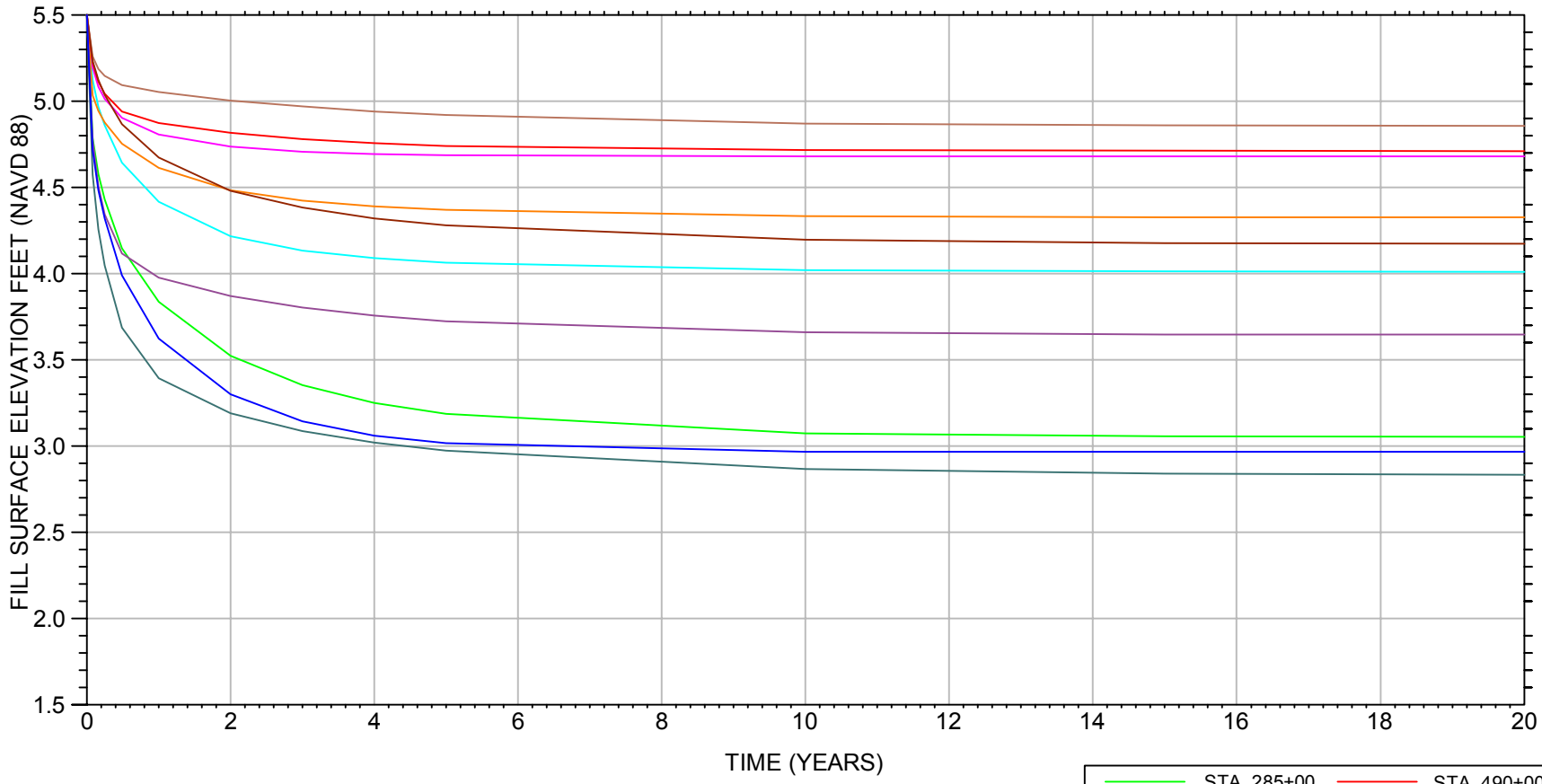
ELEVATION VS. TIME

Caminada Headland Beach & Dune Restoration Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure B-12

P:\16\16715012\02\CAD\SETTLEMENT1_recover.dwg\TAB:S3 modified on Mar 01, 2013 - 11:05am JMP : KMC



ELEVATION (FEET, NAVD 88)

STATION	0 DAYS	6 MONTHS	1 YEAR	2 YEAR	5 YEAR	10 YEAR	20 YEAR	LONG TERM
STA. 285+00	5.50	4.14	3.83	3.52	3.18	3.07	3.05	3.05
STA. 335+00	5.50	3.99	3.62	3.30	3.01	2.97	2.96	2.96
STA. 355+00	5.50	4.64	4.42	4.22	4.06	4.02	4.01	4.01
STA. 405+00	5.50	4.90	4.81	4.74	4.69	4.68	4.68	4.68
STA. 460+00	5.50	4.75	4.61	4.48	4.37	4.33	4.33	4.33
STA. 490+00	5.50	4.94	4.87	4.82	4.74	4.71	4.71	4.71
STA. 510+00	5.50	4.11	3.98	3.87	3.72	3.66	3.65	3.65
STA. 545+00	5.50	5.09	5.05	5.00	4.92	4.87	4.85	4.85
STA. 605+00	5.50	3.69	3.39	3.19	2.97	2.87	2.83	2.83
STA. 620+00	5.50	4.87	4.67	4.48	4.28	4.20	4.17	4.17

S3
ELEVATION VS. TIME

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure B-13

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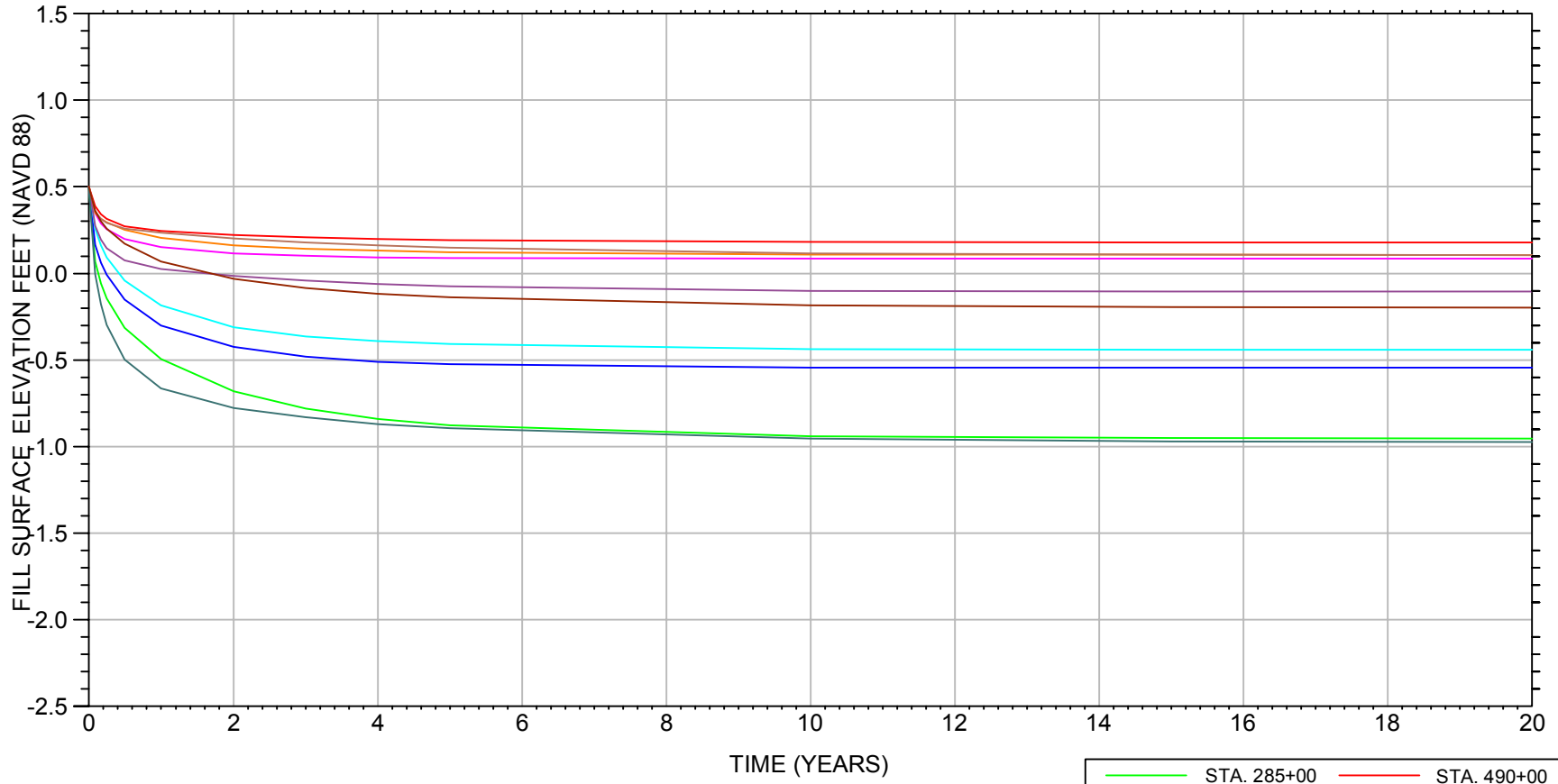

ELEVATION (FEET, NAVD 88)								
STATION	0 DAYS	6 MONTHS	1 YEAR	2 YEAR	5 YEAR	10 YEAR	20 YEAR	LONG TERM
STA. 285+00	0.50	-0.31	-0.50	-0.68	-0.88	-0.94	-0.95	-0.96
STA. 335+00	0.50	-0.15	-0.30	-0.42	-0.53	-0.54	-0.54	-0.54
STA. 355+00	0.50	-0.04	-0.19	-0.31	-0.41	-0.44	-0.44	-0.44
STA. 405+00	0.50	0.20	0.15	0.12	0.09	0.09	0.09	0.09
STA. 460+00	0.50	0.25	0.21	0.16	0.12	0.11	0.11	0.11
STA. 490+00	0.50	0.27	0.25	0.22	0.19	0.18	0.18	0.18
STA. 510+00	0.50	0.07	0.03	-0.02	-0.08	-0.10	-0.11	-0.11
STA. 545+00	0.50	0.26	0.23	0.20	0.15	0.12	0.11	0.11
STA. 605+00	0.50	-0.50	-0.67	-0.78	-0.90	-0.96	-0.98	-0.98
STA. 620+00	0.50	0.17	0.07	-0.03	-0.14	-0.19	-0.20	-0.20

S4
ELEVATION VS. TIME

Caminada Headland Beach & Dune Restoration
Project - Increment II
Lafourche & Jefferson Parishes, Louisiana

GeoEngineers

Figure B-14

APPENDIX C
Limitations and Guidelines for Use

APPENDIX C
REPORT LIMITATIONS AND GUIDELINES FOR USE

This appendix provides information to help you manage your risks with respect to the use of this report.

Geotechnical Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for the State of Louisiana Coastal Protection and Restoration Authority and their authorized agents and regulatory agencies. The information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. No party other than the State of Louisiana Coastal Protection and Restoration Authority may rely on the product of our services unless we agree to such reliance in advance and in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. Use of this report is not recommended for any purpose or project except the one originally contemplated.

A Geotechnical Engineering or Geologic Report Is Based on a Unique Set of Project-Specific Factors

This report has been prepared for the Caminada Headland Beach and Dune Restoration Project - Increment II project in LaFourche and Jefferson Parishes, Louisiana GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If important changes are made after the date of this report, we recommend that GeoEngineers be given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Most Geotechnical and Geologic Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an informed opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Geotechnical Engineering Report Recommendations Are Not Final

The construction recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers is unable to assume responsibility for the recommendations in this report without performing construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings.

Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

Give Contractors a Complete Report and Guidance

To help prevent costly problems associated with unanticipated subsurface conditions, we recommend giving contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report's accuracy is limited. In addition, encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

Contractors Are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

Read These Provisions Closely

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) are less exact than other engineering and natural science disciplines. Without this understanding, there may be expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

Have we delivered World Class Client Service?
Please let us know by visiting **www. geoengineers.com/feedback**.

GeoEngineers