FIRST DRAFT REPORT

SURVEY OF SEAGRASS BEDS AT PLACEMENT AREAS 62 & 63, WEST BAY CONTRACT FOR GIWW, TEXAS CAUSEWAY

U. S. ARMY CORPS OF ENGINEERS
CONTRACT NO. W912HY-10-C-0036

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TABLE OF CONTENTS

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ABSTRACT:

This report presents methods and findings of Belaire Environmental Inc.'s (BEI) survey of seagrass recovery after dredge disposal at Corps of Engineers Placement Area (PA) 62 and Corps of Engineers Placement Area (PA) 63 during the winter of 2011-2012. BEI conducted a pre-disposal survey at PA 62 from January 9-16, 2012. A follow up survey was conducted at an approximate 383-acre Corps of Engineers Placement Area (PA) 62 and an additional 500 foot beyond the bayward limits of PA 62. The seagrass survey included 272 quadrats and 1,500 post hole samples along 13 transects within the designated survey area of PA 62. Within the survey area, both dredge impacted (5) and non-dredge impacted (8) transects were sampled. For non-impacted dredge transects, 903 post hole samples were collected. Seagrass was observed in 74.9% (677) of these samples. Further, shoalgrass (*Halodule wrightii*) was found in 71.9% (650) of the samples while clover grass (*Halophila englemannii*) was present in 3.0% (27). Elevations in existing seagrass areas ranged from -2.723 ft NAVD 88 to +0.368 ft NAVD 88. Prior to initiation of this survey, dredged material was placed at two locations approximately 47.59 and 42.83 acre areas, respectively. For dredge impacted transects (transects 2-4 and 10-11), 597 post hole samples were collected. Within these dredge impacted transects, 63.3% (378) of post hole samples were covered with dredge material. Further, within the sample grabs directly impacted by placement material, 62.4% (236) of the samples contained dead seagrass roots and rhizomes, whereas, 4.5% (17) contained live seagrass roots and rhizomes and 33.1% (125) contained no seagrass roots or rhizomes. A 1.73 acre area of shoalgrass recolonization was documented along transect 10. The average depth of dredge material along the impacted transects was 0.44 ft and the average depth of deepest seagrass roots within this area was 0.86 ft.

A survey was also conducted at three specific impact areas at Corps of Engineers Placement Area (PA) 63. The survey area totaled 201.5 acres and consisted of the east discharge area (58.4 acres), middle discharge area (39.8 acres) and west discharge area (103.3 acres). The seagrass survey included 1,218 post hole samples and 194 quadrat samples along 9 transects within the designated survey area of PA 63. Within the survey area, both dredge impacted (5) and non-dredge impacted (4) transects were sampled. For non-impacted dredge transects, 594 post hole samples were collected. Seagrass was observed in 49.1% (292) of these samples. Further, shoalgrass (*Halodule wrightii*) was found in 46.6% (277) of the samples while clover grass (*Halophila englemannii*) was present in 2.5% (15). Elevations in existing seagrass areas ranged from -2.348 ft NAVD 88 to +0.545 ft NAVD 88. Prior to initiation of this survey, dredged material was placed at three locations approximately 40.69 acres (east), 27.27 acres (mid) and 47.59 acres (west), respectively. For dredge impacted transects (transects 2, 5 and 7-9), 624 post hole samples were collected. Within these dredge impacted transects, 71.6% (447) of post hole samples were covered with dredge placement material. Further, within the sample grabs directly impacted by placement material, 37.6% (168) of the samples contained dead seagrass roots and rhizomes, whereas, 11.2% (50) contained live seagrass roots and rhizomes and 51.2% (229) contained no seagrass roots and rhizomes. A 1.86 acre area of shoalgrass recolonization was documented along transect 9. The average depth of dredge material along the impacted transects was 0.85 ft and the average depth of deepest seagrass roots within this area was 0.99 ft. Readily available aerial photographs from 2005-2011 were examined to estimate the rate of seagrass development at PA 63. The results of this examination were compared to results of this survey to estimate actual impacts to seagrass within the PA 63 boundary.

This report quantifies the overall recovery of seagrass after dredge material placement. The report also documents the current extent of existing seagrass beds within both survey areas, the density, abundance, and frequency of seagrass by species following the placement of material from maintenance dredge operations of the GIWW.

1.0 INTRODUCTION:

The USACE authorized Belaire Environmental, Inc. (BEI) to conduct this seagrass survey to collect post-dredge disposal placement data at Placement Area (PA) 62 and Placement Area (PA) 63 following the placement of dredge material from the GIWW during the 2011-2012 winter season. The vicinity, location and approximate boundary of the seagrass survey areas are included in Appendix A, Figures 1, 2 and 3. The GIWW dredging project is part of regular authorized maintenance of the channel to ensure adequate depths are maintained. The hydraulically dredged material was placed in various disposal sites including PA's 62 and 63 as shown in Appendix A, Figures 1-4a. An approximately 383-acre area BEI surveyed includes the submerged portion of PA 62 plus 500 feet beyond the bayward limits of PA 62. A 201.5 acre seagrass survey included three specific areas (West, Mid, and East) within the 495 acre boundary of PA 63. The purpose of the seagrass survey was to map the full extent of the seagrass beds and dredge disposal areas and to document the density, abundance and frequency of seagrasses by species in an effort to determine seagrass recovery after dredge disposal placement. This survey data will aid in determining the effect of dredge material on existing seagrass beds as well as the migration of placed dredged material. BEI personnel sampled along 13 transects within the approximately 383-acre survey area of PA 62 and 9 transects within the 201.5 acre survey areas of PA 63 (Appendix A, Figure 3 and Figure 3A). BEI used post-hole samples and the techniques developed by Fourqurean et al (Fourqurean, J. W., A. Willsie, C.D. Rose, and L.M. Rutten. 2001. "Spatial and Temporal Patterns in Seagrass Community Composition and Productivity in South Florida. Marine Biology Journal 138:341-354) to conduct the seagrass survey. BEI personnel, directly responsible for the data collection were Charles Belaire, Royce Williams, Andrea Binion, Bobby Forbes, Zac Giessel, and Dean Adamson. The data analysis and report were the

responsibility of Charles Belaire, Andrea Binion, Royce Williams, and Zac Giessel. The seagrass sampling was conducted between November 15 and November 20, 2012. The following sections of this report provide a description of the environmental setting, methodology, results and conclusions of BEI's field investigations.

2.0 ENVIRONMENTAL SETTING:

The survey areas are situated between the Gulf Intracoastal Waterway (GIWW) to the west and West Bay to the east in Galveston County, Texas. To the west of PA 62 and PA 63 the mainland is undeveloped ranch land. West Bay is situated landward of Galveston Island, and receives runoff from Chocolate Bayou, Mustang Bayou and other local bayous (Lester, 2002). West Bay is bounded by San Luis Pass to its south and Galveston Causeway to the north, where it meets with Galveston Bay (Leatherwood, 2010). West Bay's main extension is Christmas Bay, which extends south into Brazoria National Wildlife Refuge. Other extensions include Chocolate Bay to the west, Jones Bay to the north, and Bastrop Bay to the south (Leatherwood, 2010). Overall, the bay covers roughly 39 square miles and ranges from four to six feet in depth (Lester, 2002). The water quality of the survey area is good as evidenced by the presence of submerged aquatic vegetation (TCEQ, 2002). Historical decline in existing seagrass beds has been well documented. Most of these seagrass meadows (primarily shoalgrass) grew along the barrier island edges of western West Bay. Until recently, the only remaining seagrass beds still in existence were found in Christmas Bay, a semi-isolated embayment adjoining West Bay (Pulich, 1991). Seagrass loss has been attributed primarily to direct and indirect effects of dredging canals for housing developments, increased turbidity and increased wave action after bulkheading (Sheridan, 1999). Within the survey area deeper

seagrass beds provide beneficial fishery habitat while shallower portions of the seagrass bed provide habitat for wading birds and shorebirds.

3.0 METHODOLOGY:

Survey methods for both PA 62 and PA 63 are described in the "Proposed Sampling Plan" approved by the Corps of Engineers (Appendix B). To conduct the seagrass surveys, BEI used post-hole samples and the Braun-Blanquet rapid visual assessment technique (Braun-Blanquet, 1972. Plant Sociology: The Study of Plant Communities. Hafner Publishing Company). Also refer to Pulich, et al (Pulich, Warren Jr., Hardegree, Beau, Kopecky, Andrea, Schwelling, Steve, Onuf, Christopher, Dunton, Kenneth. 2000. Texas Seagrass Monitoring Program: 2000 Strategic Plan. TPWD). The survey was taken perpendicular to the seagrass survey baseline as shown in Appendix A, Figures 3 and 3A.

For PA 62, BEI examined 13 survey transects ranging in length from 995 to 1,730 linear Ft. These transects are also shown in Appendix A, Figure 3. The total transect length was 17,327 Ft. Prior to initiating field work, BEI established GPS coordinates every 10 meters along each transect. Seagrass sampling was performed between November 15, 2012 and November 20, 2012. Once in the field, the ends of each transect were marked with PVC pipe. BEI used RTK GPS (subcentimeter RTK GPS receiver with TRSC 2 & 3 data loggers) receiving corrections from the VRS network for the survey work. Elevations were measured and recorded in the North America Vertical Datum 1988 (NAVD 88) at each sample point. A total of 1,629 post-hole digger samples were taken, three at each 10-meter interval sample point, to determine the presence or absence of seagrass roots. Where buried roots were present their depth was recorded. Bayward

sampling was continued along each transect until three consecutive sampling stations did not produce seagrass roots from post hole sampling and if the water was 4 ft deep and getting deeper. A total of 272 sample quadrats, each measuring 0.25 square meters, were located by GPS every 20-meters along each transect. Within each quadrat, each seagrass species was visually identified, and a score based on the cover of the species in that quadrat was assigned according to the analytical techniques developed by Fourqurean et al (2001). The table below summarizes the scoring methodology of Braun-Blanquet abundance scores (S). Each seagrass species was scored in each quadrat according to this scale (from Fourqurean et al., 2001).

S	Interpretation
0	Species absent from quadrat
0.1	Species represented by a solitary short shoot, <5% cover
0.5	Species represented by a few (<5%) short shoots, <5% cover
1	Species represented by many (>5%) short shoots, <5% cover
2	Species represented by many (>5%) short shoots, 5%-25% cover
3	Species represented by many (>5) short shoots, 25%-50% cover
4	Species represented by many (>5) short shoots, 50%-75% cover
5	Species represented by many (>5%) short shoots, 75%-100% cover

The data for each quadrat was recorded and was analyzed to determine density, abundance and frequency by species for the seagrass bed (Fourqurean J.W., A. Willsie, C.D. Rose, and L.M. Rutten. 2001. Spatial and Temporal Patterns in Seagrass Community Composition and Productivity in South Florida. Marine Biology Journal 138:341-354.). Seagrass root systems were not removed or disturbed during the performance of the rapid visual assessment. At each sample quadrat, BEI characterized the soil type as sand, dredge material, mud, silt, oyster shell or rock. At each sample quadrat, BEI also probed for depth of soft sediment with a 1-1/2 –inch diameter pvc sounding rod.

The same sampling methodology was also performed for PA 63. The limits for the PA 63 survey were provided and approved by the USACE prior to the initiation of the survey. The PA 63 survey boundary totaled 201.5 acres which included the east survey area (40.69 acres), the mid-survey area (27.27 acres) and the west survey area (47.59 acres), respectively

4.0 PROJECT RESULTS:

The sample results from the seagrass survey are illustrated in Appendix A, Figures 4 and 4a. Appendix C, Tables 1 and 2 includes the seagrass survey data analysis for density, abundance and frequency for each species. Appendix A, Figure 5 shows the 2009-2010 aerial seagrass interpretation of PA 63 as compared to the seagrass boundary determined by this survey.

As indicated in Appendix A, Figures 4 and 4a, and Appendix C, only two seagrass species (Shoalgrass, *Halodule wrightii*, and clovergrass grass, *Halophila englemannii*) were found during the survey. The PA 62 seagrass survey included 1,500 post hole samples along 13 transects within the designated survey area of PA 62. Within the survey area, both dredge impacted (5) and non-dredge impacted (8) transects were present. For non-impacted dredge transects, 903 post hole samples were collected. Seagrass was observed in 74.9% (677) of these samples. Further, shoalgrass (*Halodule wrightii*) was found in 71.9% (650) of the samples while clover grass (*Halophila englemannii*) was present in 3.0% (27). Two dredge material areas were observed at PA 62. The eastern most disposal area totaled 47.59 acres and began immediately east of Transect 2 and extended west toward Transect 5. The second disposal area (42.83 acres)

began east of Transect 10 and extended west toward Transect 12. Shoalgrass (1.73 acres) was documented recolonizing atop of dredge material near the shoreline at Transect 10 (Appendix A, Figure 4). One live shoalgrass post-hole digger "hit" was also recorded on Transect 12 (Appendix A, Figure 4). Post-hole samples were examined for presence or absence of seagrass roots and rhizomes, depth of deepest seagrass roots, depth of dredge material and sediment type. These findings are presented separately in Appendix C, Table 1. An average depth of 0.44 ft of previously placed dredge material and an average buried seagrass root depth of 0.86 ft was observed within the two disposal areas within PA 62 (Appendix A, Figure 4 and Appendix C, Table 1). In this 90.42 acre area impacted by dredge material 62.4% (236 of 378 samples on dredge impacted transects) of the samples contained dead seagrass roots and rhizomes. Based on this data, approximately 90.42 acres of dredge disposal has settled within the limits of PA 62 which resulted in approximately 78.02 acres of seagrass impacts.

Placement Area (PA) 62:	
	Acres
Seagrass Impacts:	40.47
	37.55
Total Impacts:	**78.02**
Dredge Material Areas:	47.59
	42.83
Total DMA:	**90.42**
Seagrass Recolonization:	1.73
Total Area of Live Seagrass:	**173.28**

The PA 63 seagrass survey included 1,218 post hole samples along 9 transects within the designated survey areas of PA 63. Within the survey areas, both dredge impacted (5) and non-dredge impacted (4) transects were present. For non-impacted dredge transects, 594

post hole samples were collected. Live seagrass was observed in 49.1% (292) of these samples. Further, shoalgrass (*Halodule wrightii*) was found in 46.6% (277) of the samples while clover grass (*Halophila englemannii*) was present in 2.5% (15). In Appendix C, Tables 1 and 2, density, abundance and frequency of each of these species are presented for each transect as well as an overall comparison for each placement area. Overall elevations within the PA 62 survey area ranged from-3.668 Ft NAVD 88 to +8.189 Ft NAVD 88. Shoalgrass elevations ranged from -2.723 Ft NAVD 88 to +0.368 Ft NAVD 88. Elevations of clover grass ranged from -2.169 Ft NAVD 88 to -.024 Ft NAVD 88. The elevations at the shoalgrass sample stations with the greatest coverage (scores 4 and 5) ranged from -2.642 Ft NAVD 88 to -0.021 Ft NAVD 88. See Appendix A, Figure 4.

Three dredge material areas were surveyed at PA 63. The eastern most disposal area totaled 40.69 acres and began immediately west of Transect 1 and extended west toward Transect 3. The mid disposal area (27.27 acres) began immediately west of Transect 4 and extended west past Transect 5 and terminating outside of the survey area. The west disposal area (47.59 acres) began immediately west of Transect 6 extended westward to Transect 9. Shoalgrass (1.86 acres) was documented recolonizing atop of dredge material near the shoreline at Transect 9. One live shoalgrass post-hole digger "hit" was also recorded on Transects 5 and 8 (Appendix A, Figure 4a). Post-hole findings are presented separately in Appendix C, Table 2. An average depth of 0.85 ft of previously placed dredge material and an average buried seagrass root depth of 0.99 ft was observed within the three disposal areas (Appendix A, Figure 4 and Appendix C, Table 1). In this 115.5 acre area impacted by dredge material 37.6% (168 of 447 samples on dredge impacted transects) of the samples contained dead seagrass roots and rhizomes. Based on this data,

approximately 115.5 acres of dredge disposal has settled within the limits of PA 63 resulting in approximately 91.94 acres of seagrass impacts. Appendix A, Figure 4a shows, elevations in the PA 63 survey areas ranged from -3.612 Ft NAVD 88 to +3.369 Ft NAVD 88. Shoalgrass elevations ranged from -2.348 Ft NAVD 88 to +0.545Ft NAVD 88. Elevations of clover grass ranged from -1.514 Ft NAVD 88 to -.584 Ft NAVD 88. The elevations at the shoalgrass sample stations with the greatest coverage (scores 4 and 5) ranged from -1.243 Ft NAVD 88 to +.087 Ft NAVD 88.

Placement Area (PA) 63:	
Seagrass Impacts:	**Acres**
East Survey Area	27.33
Mid-Survey Area	16.57
West Survey Area	48.04
Total Impacts:	**91.94**
Dredge Material Areas:	
East Survey Area	40.69
Mid-Survey Area	27.27
West Survey Area	47.59
Total DMA:	**115.55**
Seagrass Recolonization:	1.89
Total Area of Live Seagrass:	**150.35**

BEI identified the landward and bayward edge of seagrass on each transect. Based on the edge of seagrass and transect data at PA 62, approximately 173.28 acres of seagrass beds exist outside of the areas where dredge disposal occurred. Approximately 150.35 acres of seagrass beds currently exist at PA 63. See Appendix A, Figures 4 and 4a.

Throughout PA 62 and PA 63 the natural bay bottom consisted of a hard sand substrate. Dredge material throughout both placement areas was sandy clay. The outer fringes of the disposal areas contained a soft, silty mud.

At the request of the USACE, readily available aerial imagery from 2005 to present was analyzed to estimate seagrass distribution within the boundaries of PA 63. This analysis was presented in BEI's Final Seagrass Report dated August 29, 2012. In an effort to approximate seagrass distribution for a respective year, BEI identified different habitat signatures within the image. These signatures included the open water, shallow water bottom sediment, sandflats, mudflats, upland communities, marsh communities and seagrass. A summary table of BEI's analysis is included below.

	Approximate Seagrass Area	
Image Date	**PA 62 (Ac)**	**PA 63 (Ac)**
August 2005	68.2-71.6	13.1-23.8
January 2006	30.0-100.7	2.4-4.6
April 2008	108.8-121.5	101.0-128.7
January 2009	123.5-133.8	155.5
January 2010	111.3-114.4	116.0

As a result of the analysis performed in February 2012, the USACE has requested that estimation be made of the acreage of seagrass present pre-disposal in the impacted areas of PA 63. Based on the analysis above along with identifying the extent of buried seagrass during this survey, it is BEI's estimate that approximately 91.94 acres of seagrass were impacted as a result of the disposal placement. Approximately 150.35 acres of seagrass beds currently exist within the PA 63 boundary (Appendix A, Figure 4a). Therefore, a total of approximately 242.29 acres of seagrass beds were present prior to the dredge disposal operations conducted during the winter of 2011-2012.

5.0 CONCLUSIONS:

As noted in BEI's August 2012 pre-construction survey report, approximately 251.4 acres of seagrass beds were present in PA 62 prior to the placement of dredge disposal. Currently, approximately 173.28 acres of seagrass beds exist within the PA 62 survey area. Thus, approximately 78.02 acres of seagrass beds were buried as a result of the placement of approximately 90.42 acres of dredge material during the 2011-2012 winter season. Dead seagrass roots and rhizomes were found in 62.4% of the post-hole digger samples in this area. The average depth of the areas where material was placed is 0.44 ft. A 1.73 acre area of shoalgrass bed has begun recolonizing atop dredge material since the placement of material in 2011-2012.

Based on BEI's previous historical aerial analysis, approximately 156 (2009)-116 (2010) acres of seagrass beds were present at PA 63 prior to the placement of dredge disposal. Based on the edge of seagrass and BEI's transect data, approximately 150.4 acres of seagrass beds currently exist within the PA 63 survey area. Approximately 91.9 acres of seagrass beds were buried as a result of the placement of approximately 115.6 acres of dredge material during the 2011-2012 winter season. Dead seagrass roots and rhizomes were found in 37.6% of the post-hole digger samples in this area. The average depth of the disposal areas in PA 63 is 0.85 ft. A 1.86 acre area of shoalgrass has begun recolonizing atop dredge material in PA 63 since the placement of material in 2011-2012.

The seagrass beds surrounding all of the dredge disposal areas appear to be healthy and thriving. The five dredge disposal areas delineated by BEI appear to have settled and are apparently no longer impacting adjacent seagrass beds. The results of this survey suggest that seagrass may be at least temporarily impacted by the placement of dredge material

but may recover to some degree. Historically, some seagrass beds have recovered to varying degrees over time (Sheridan, 1999).

6.0 REFERENCES CITED:

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7.0 APPENDICES:

Appendix A

Figure 1 – Vicinity Map

Figure 2 – Location Map

Figure 3 – PA 62 Seagrass Survey Area

Figure 3A—PA 63 Seagrass Survey Area

Figure 4 – PA 62 Seagrass Survey Data Map

Figure 4A – PA 63 Seagrass Survey Data Map

Figure 5– PA 63 Historical Seagrass Boundary Map

Appendix B

PA 62 Approved Sampling Plan

PA 63 Approved Sampling Plan

Appendix C

Table 1: PA 62 Transects 1-13 Seagrass Survey Results, Data Analysis

Table 2: PA 63 Transects 1-9 Seagrass Survey Results, Data Analysis

Appendix A

Figure 1 – Vicinity Map

Figure 2 – Location Map

Figure 3 – PA 62 Seagrass Survey Area

Figure 3A – PA 63 Seagrass Survey Area

Figure 4 – PA 62 Seagrass Survey Data Map

Figure 4A – PA 63 Seagrass Survey Data Map

Figure 5– PA 63 Historical Seagrass Boundary Map

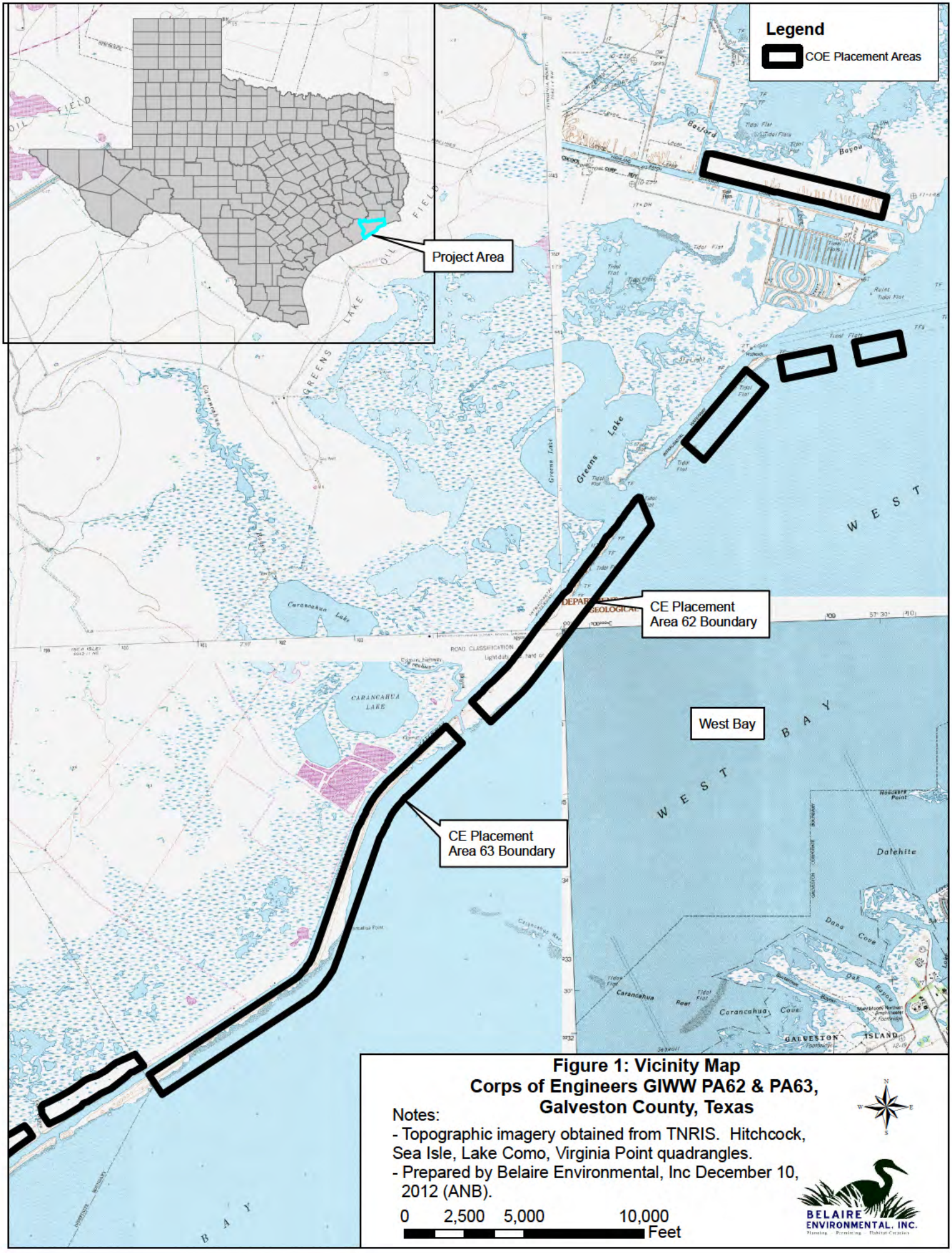

Figure 1: Vicinity Map
Corps of Engineers GIWW PA62 & PA63,
Galveston County, Texas

Notes:
- Topographic imagery obtained from TNRIS. Hitchcock, Sea Isle, Lake Como, Virginia Point quadrangles.
- Prepared by Belaire Environmental, Inc December 10, 2012 (ANB).

0 2,500 5,000 10,000 Feet

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Figure 2: Location Map
Corps of Engineers GIWW PA62 & PA63,
Galveston County, Texas
Notes:
- Imagery obtained from TNRIS, Galveston, County, 2009
- Prepared by Belaire Environmental, Inc. December 10, 2012 (ANB).
-For planning purposes only; not for construction.
0 2,500 5,000 10,000 Feet
BELAIRE ENVIRONMENTAL, INC.
Legend
CE Channels
Texas Counties
COE Placement Areas
59
60
61
62
63
64
65
Greens Lake
Project Site:
CE Placement Area 62
CE Placement Area 63
West Bay
Galveston County
Brazoria County
Galveston Island
Gulf of Mexico

Figure 3: Seagrass Survey Area
Corps of Engineers GIWW PA62,
Galveston County, Texas

Notes:
- Imagery obtained from TNRIS, Galveston, County, 2009
- Prepared by Belaire Environmental, Inc. December 10, 2012 (ANB).

0 500 1,000 2,000 Feet

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Planning – Permitting – Habitat Creation

Legend
- CE Placement Area 62 Boundary
- Seagrass Sample points

Transect 1
Survey Starting Point

Transect 2

Transect 3

Survey Extends 500-ft Beyond PA Boundary

Transect 4

Transect 5

GIWW

Transect 6

CE Placement Area 62 Boundary

Seagrass Sample Points
-3 Post Hole Grabs at 10-m Intervals
-0.25-m Quadrat at 20-m Intervals

Transect 7

Transect 8

Transect 9

Seagrass Survey Baseline

Transect 10

Transect 11

Transect 12

Transect 13

Notes:
-Placement Area 62 boundary provided by the U.S. Army Corps of Engineers (M. Nelson).

-13 Survey Transects
-3 Post-Hole Samples at 10-m;1,629 total
-0.25-m quadrats at 20-meters; 272 total

Seagrass Survey Plan:

-Prior to start of the survey, BEI determined the deep edge of seagrass at all 13 transects. Elevations at these deep edge points were used to establish the bayward boundary of the survey.

-BEI sampled along transects spaced 1,000-ft a part beginning at the east end of PA 62. Transects began at the edge of emergent land and extended bayward toward the PA boundary plus an additional 500-ft bayward of the PA boundary.

-GPS coordinates were established every 10 meters along each transect. PVC pipe marks the ends of each transect. On this grid, two sampling strategies were employed: 1) 0.25 square meter sampling quadrats occurred every 20-meters along each transect. BEI utilized the Braun-Blanquet rapid visual assessment technique for each quadrat sample; 2) Three separate grabs with a post-hole digger were taken every 10-meters to obtain root samples. The stems were examined to determine the presence or absence of live or dead seagrass roots and species identification, if possible.

-Where 3 consecutive grid sampling locations did not produce seagrass roots from post hole grab sampling and if water depths was 4-ft deep no futher seagrass sampling was required along the subject transect. BEI documented the lack of seagrass presence and the water depth.

Figure 3A: Seagrass Survey Area
Three Dredge Material Areas Placed on Corps of Engineers GIWW PA 63
Galveston County, Texas

Notes:
- Imagery obtained from TNRIS, Galveston, County. Image date January 19, 2009.
- Prepared by Belaire Environmental, Inc. December 10, 2012 (ANB).

0 750 1,500 3,000 Feet

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Planning - Permitting - Habitat Creation

Table of Coordinates:		
	X	Y
1	3234848.79	13651087.97
2	3236026.27	13650668.40
3	3236679.00	13652500.20
4	3235731.92	13653109.87
5	3231676.52	13645087.19
6	3232222.57	13644249.44
7	3233650.97	13645180.48
8	3232801.94	13645937.11
9	3226829.01	13641943.40
10	3227653.91	13640690.59
11	3230159.53	13642340.40
12	3229334.62	13643593.21

*Note: Coordinates listed above provided by the CE and outlinet he corner points of the three survey areas.

GIWW

4
3 Transect 1 Survey Starting Point
Transect 2
1
2 Transect 3
East Survey Boundary 58.4 Acres
Seagrass Sample Points
-3 Post Hole Grabs at 10-m intervals
-0.25-m Quadrat at 20-m intervals
PA 63 Boundary
8
7 Transect 4
5
6 Transect 5
Mid Survey Boundary 39.8 Acres
12
11 Transect 6
See Corresponding Coordinate Table for Survey Boundary Corner Points
9
Transect 7
West Survey Boundary 103.3 Acres
Transect 8
10
Transect 9

Notes:
-Placement Area 63 boundary provided by the U.S. Army Corps of Engineers (M. Nelson).

-Placement Area 63 survey areas provided by the Corps of Engineers.

-9 Survey Transects
-3 Post-Hole Samples at 10-m; 1,164 total
-0.25-m quadrat samples at 20-meters; 194 total

Seagrass Survey Plan:

-Prior to start of the survey, BEI determined the deep edge of seagrass at all 9 transects. Elevations at these deep edge points were used to establish the bayward boundary of the three (East, Mid, and West) survey areas.

-BEI sampled along transects spaced 1,000-ft a part beginning at the east end of PA 63. Transects began at the edge of emergent land and extended bayward toward each of three survey areas provided by the CE.

-GPS coordinates were established every 10 meters along each transect. PVC pipe was placed to mark the ends of each transect. On this grid, two sampling strategies were employed: 1) 0.25 square meter sampling quadrats occurred every 20-meters along each transect. BEI utilized the Braun-Blanquet rapid visual assessment technique for each quadrat sample; 2) Three separate grabs with a post-hole digger were taken every 10-meters to obtain root samples. The stems were examined to determine the presence or absence of live or dead seagrass roots and species identification, if possible.

-Where 3 consecutive grid sampling locations did not produce seagrass roots from post hole grab sampling and where water depths are 4-ft deep no futher seagrass sampling was collected along the subject transect. BEI documented the lack of seagrass presence and the water depth.

Legend
- Survey Corner Points
- Seagrass Sample Points
- PA 63 Survey Areas
- CE Placement Area 63 Boundary