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Engineering & Environmental Consultants

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**PIPING PLOVER HABITAT SURVEY OF
DREDGED MATERIAL PLACEMENT AREAS ALONG THE
GULF INTRACOASTAL WATERWAY FROM
PORT ISABEL BAY TO THE MUD FLATS**

**Prepared for
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NOS 210-236

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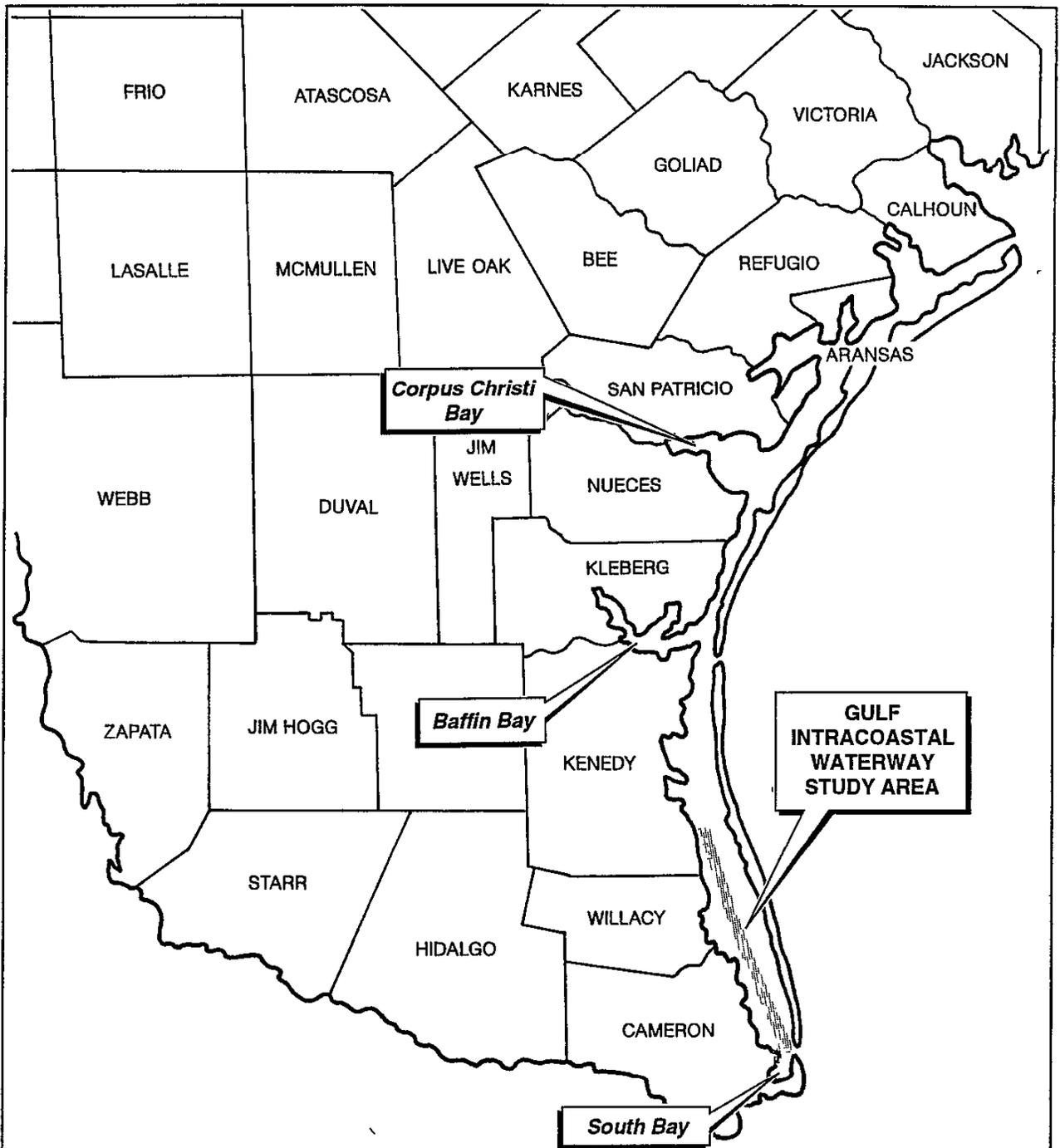
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1.0 INTRODUCTION

In February 1997, Espey, Huston & Associates, Inc (EH&A) performed a reconnaissance of Placement Area nos. 210-236 along the Gulf Intracoastal Waterway (GIWW) for the U S Army Corps of Engineers, Galveston District (USACE) and the Laguna Madre Interagency Coordination Team (ICT). The project area is approximately 55 miles long and stretches from the southern portion of the Mud Flats (Land Cut), southward to Port Isabel (Figure 1-1). The purpose of the survey was to determine whether piping plover (*Charadrius melodus*) habitat occurred at the placement areas and to determine if other members of the maritime shorebird guild were utilizing the placement areas. The Scope of Work for the Project was approved by the ICT and attached to Delivery Order 44 of Contract No. DACW64-94-D-0006.



north

Not to Scale

Figure 1-1

LOCATION MAP
OF STUDY AREA

2.0 BIOLOGICAL BACKGROUND

2.1 PIPING PLOVER

The piping plover has been a species of concern throughout North America since the early 1900's (U.S. Fish and Wildlife Service (FWS), 1988). Shorebird hunting during the early 1900s caused the first known major decline of piping plovers (Bent, 1929). Since then, loss or modification of habitat due to commercial, residential, and recreational developments, dune stabilization, damming and channelization of rivers (eliminating sandbars, encroachment of vegetation, and altering water flows), and wetland drainage have further contributed to the decline of the species (FWS, 1995). Additional threats include human disturbances through recreational use of habitat, and predation of eggs by skunks, foxes and domestic pets (FWS, 1995). In January 1986, the piping plover was listed as endangered in the watershed of the Great Lakes and threatened throughout the remainder of its range (50 FR 50726).

The piping plover is a small migratory shorebird which breeds in the northern Great Plains of the U.S. and Canada, along beaches of the Great Lakes, and along the Atlantic coastline from North Carolina to Newfoundland (Haig and Oring, 1987). Nesting habitat includes sandy beaches along the ocean or inland lakes, bare to sparsely vegetated areas on dredge-created and natural alluvial islands in rivers; gravel pits along rivers; and salt-encrusted bare areas of sand, gravel, or pebbly mud on alkaline interior lakes and ponds, fly-ash disposal ponds, dike roads adjacent to lakes; and gravel roads and parking lots (FWS, 1995). Wintering sites include the southern U.S. Atlantic coastline, the Gulf of Mexico from Florida to Veracruz, Mexico, and on scattered Caribbean islands (Haig and Oring, 1985). Important post-breeding habitat includes Atlantic and Gulf coast beaches, dunes and sand flats. Little is known of the migration routes of the piping plover.

The piping plover begins arriving at its post-breeding and wintering grounds in Texas in mid- to late-July. Haig and Oring (1985, 1987) found that early in the post-breeding season, piping plovers frequented beaches, but later tended to inhabit ephemeral sand flats along the backside of barrier islands. Observations of wintering piping plovers in Alabama did not indicate a seasonal preference between habitats, but that wintering plovers spent >85% of their time on sand flats or mud flats each month (Johnson and Baldassarre, 1988). Along the upper Texas coast, a correlation appears to exist between tidal height and habitat selection, with piping plovers actively feeding on tidal flats during periods of low tides, and on the Gulf beaches during high tides (Eubanks, 1991). Bay side passes as foraging areas appear to be the underlying factor in wintering birds along the mid and upper Texas coast (Withers 1994). Winter distribution studies along the Atlantic and Gulf coasts found piping plovers

usually occurring in small, unevenly distributed groups along the coast, however the sites with largest concentrations of plovers consisted of expansive sand flats or mud flats with sandy beach in close proximity (Nicholls and Baldassarre, 1990) Piping plover concentrations in Texas occur in the following counties: Aransas, Brazoria, Calhoun, Cameron, Chambers, Galveston, Jefferson, Kleberg, Matagorda, Nueces, San Patricio and Willacy (FWS, 1988) Some of the largest known wintering populations of the piping plover and the snowy plover occur in the Laguna Madre of south Texas (Haig and Plissner 1993)

Several areas along the Texas coast have been identified by the FWS as essential wintering habitat for the piping plover Essential wintering habitat for the piping plover provides the space and requisite resources necessary for the continued existence and growth of piping plover populations and consists of coastal beach, sand flat and mud flat habitats Within Cameron, Willacy, and Kenedy counties, Padre Island has been identified as essential habitat for the piping plover (FWS, 1988)

2.2 SNOWY PLOVER

The snowy plover is a cosmopolitan species which is widely distributed in warmer parts of all continents except Antarctica (Oberholser, 1974). In Texas it is an uncommon migrant across the state, and an uncommon resident along the coast and in north Texas Two breeding populations are known from the state: one along the lower coast from Calhoun to Cameron County, and one in the playa lakes region of north and west Texas (Eubanks, 1992) Along the Texas coast, habitat for the snowy plover is similar to that of the piping plover, and consists of beaches and tidal flats where it forages for small mollusks, polychaetes, crustaceans, and insects. The snowy plover usually appears singly or in small groups, where it may be seen foraging with other members of the shorebird guild to which it belongs

The snowy plover is currently not listed by the FWS as an endangered or threatened species But because it is believed that snowy plover numbers have been significantly reduced, it is considered as a species of concern by the FWS.

3 0 METHODOLOGY

From 17-20 February 1997, EH&A biologists performed surveys to delineate habitats along the GIWW from Placement Area No. 210 at the Land Cut to Placement Area No. 236 near Port Isabel, Texas. Habitats at each placement area were delineated on 1995 color-infrared aerial photographs (scale 1:33,000) supplied by the USACE. Prior to the field survey, the boundaries of each placement area had been transferred onto the aerial photographs from preliminary data from the Texas General Land Office (GLO). Because the boundaries of the placement areas were not rigidly defined, EH&A biologists examined all potential habitat near each placement area. It should be noted, however, and is depicted in figures 4-1 through 4-10 in Appendix I, that much of the flats area discussed in this report appear to be outside the actual limits of the placement area, but were included since they probably resulted from past placement of dredged material.

Each photograph was enclosed in an acetate sheath for waterproofing, and habitats were delineated directly onto the acetate with waterproof ink. All sightings of maritime shorebird guild species were recorded on the habitat maps.

Transportation to each site was via boat since all of the placement areas were inaccessible to vehicular traffic. Upon arriving at each placement area, two EH&A biologists would traverse the site on foot, recording habitat descriptions, delineating habitats, and noting which bird species were present on the site.

Following the conclusion of field surveys, EH&A digitized the study area on Microstation 95 from the aerial photographs and the GLO information. Habitats were then transferred from the field maps to the final map and digitized.

4.0 RESULTS

The field surveys of Placement Area No 210-236 were performed from 17-20 February 1997. The timing of the survey was between cold fronts, resulting in similar weather conditions throughout the four-day period. Temperatures were gradually warming throughout the week, with low temperatures in the high 50s (°F) and low 60s (°F) and high temperatures in the low to mid 70s (°F). Skies were overcast to partly cloudy and winds were light in the mornings, increasing to 15-25 miles per hour (mph) in the afternoons. Winds were southerly on all survey dates.

The habitat assessment of Placement Area nos 210-236 revealed very little suitable habitat for the piping plover. No piping plovers or snowy plovers were recorded from any of the placement areas. The following provides a general description of each placement area and the maritime shorebird guild species observed at the placement areas.

Placement Area No 210, the northernmost placement area, is approximately 11,200 feet (ft) long and is located on the east side of the GIWW at the Land Cut. The placement area is bisected by a channel running in an east-west direction. North of the channel the placement area is dominated by vegetated uplands. Species commonly occurring in the uplands were sea ox-eye daisy (*Borrchia frutescens*), marshhay cordgrass (*Spartina patens*), honey mesquite (*Prosopis glandulosa*), Texas prickly pear (*Opuntia lindheimeri*), goldenrod (*Solidago* sp.), seacoast bluestem (*Schizachyrium scoparium* var. *littorale*), and yellow sophora (*Sophora tomentosa*). Vegetated mud and sand flats occurred at the lower elevations with sea ox-eye daisy, glassworts (*Salicornia bigelovii* and *S. virginica*), maritime saltwort (*Batis maritima*), sea purslane (*Sesuvium portulacastrum*), and sea lavender (*Limonium nashii*) comprising the dominant vegetation. Barren mud flats occurred along the GIWW and at the northeast corner of the placement area. The southern half of the placement area contained vegetated uplands, mud flats along the GIWW, and sand and algal flats along the back (east) edge of the placement area. Habitat delineations for the entire study area are presented at the back of this document in Appendix I.

An extensive algal flat occurred southeast of the placement area where the Lower Laguna Madre and the Mud Flats meet. This algal flat appears to provide good-quality habitat for the piping plover, although none were observed in the area.

Table 4-1 presents guild species observed at the placement areas during the habitat assessment. Three species were observed at Placement Area No 210: the black-bellied plover (*Pluvialis squatarola*), willet (*Catoptrophorus semipalmatus*), and dunlin (*Calidris alpina*).

TABLE 4-1
 MARITIME SHOREBIRD GUILD MEMBERS OBSERVED AT THE
 GIWW PLACEMENT AREA NOS. 210-236, FEBRUARY 1997

Disposal Areas	Species																Total No of Guild Species	
	Piping Plover (<i>Charadrius melodus</i>)	Black bellied Plover (<i>Pluvialis squatarola</i>)	Snowy Plover (<i>Charadrius alexandrinus</i>)	Wilson's Plover (<i>Charadrius wilsonia</i>)	Semipalmated Plover (<i>Charadrius semipalmatus</i>)	American oystercatcher (<i>Haematopus palliatus</i>)	American avocet (<i>Recurvirostra americana</i>)	Willet (<i>Catoptrophorus semipalmatus</i>)	Long billed curlew (<i>Nanenus americanus</i>)	Marbled godwit (<i>Limosa fedoa</i>)	Ruddy turnstone (<i>Arenaria interpres</i>)	Red knot (<i>Calidris canutus</i>)	Sanderling (<i>Calidris alba</i>)	Western sandpiper (<i>Calidris mauri</i>)	Least sandpiper (<i>Calidris minutilla</i>)	Dunlin (<i>Calidris alpina</i>)		Short billed Dowitcher (<i>Limnodromus griseus</i>)
No 210		X					X									X	3	
No 211		X						X			X					X	4	
No 212											X						0	
No 213																	0	
No 214																	0	
No 215																	0	
No 216																	0	
No 217																	0	
No 218																	0	
No 219																	0	
No 220						X					X		X				3	
No 221						X		X	X								3	
No 222		X					X	X	X			X			X		5	
No 223		X					X	X	X	X	X	X		X			6	
No 224							X	X		X		X			X		5	
No 225																	0	
No 226							X	X									2	
No 227							X							X			2	
No 228		X					X			X			X		X		5	
No 229						X	X	X									3	
No 230							X										1	
No 231		X					X	X		X		X	X				6	
No 232		X					X	X		X		X			X		6	
No 233		X					X	X	X	X		X			X		7	
No 234																	0	
No 235							X					X					2	
No 236		X										X		X			3	
Total No of Placement Areas where each Species Occurred	0	9	0	0	0	3	0	14	9	2	8	0	9	2	3	7	0	

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Placement Area No 211 is located on the east side of the GIWW south of Placement Area No 210 (Appendix I). It is approximately 6,200 ft long and consists of four islands separated by broad passes. The islands are composed primarily of upland habitats vegetated with species such as honey mesquite, seacoast bluestem, sea ox-eye daisy, Texas prickly pear, and marshhay cordgrass. A narrow mud flat occurred along the perimeter of each island. Portions of the placement area contained poorly-developed algal mats in the lower lying areas of the mud flats. Glasswort and maritime saltwort occurred within portions of the algal flat and mud flat habitats, especially near the western edge of the placement islands. Maritime guild species observed at the placement area were the black-bellied plover, long-billed curlew (*Numenius americanus*), ruddy turnstone (*Arenaria interpres*), and dunlin.

Placement Area No 212 is also located on the east side of the GIWW and is approximately 8,400 ft in length. The majority of the placement area is open water, although five small islands occur along the western edge of the area (Appendix I). These islands are smaller than those to the north and are not as high in elevation. Upland habitats are not well-developed and did not contain a diverse vegetation assemblage. Marshhay cordgrass, sea purslane and sea ox-eye daisy were the predominant species. Sand and shell were the primary substrate in the southern half of the placement area while clay was the primary sediment in the northern half. No guild species were recorded from Placement Area No 212.

Placement Area nos 213-219 are all submerged and contained only open water habitat during the survey (Appendix I). All are located east of the GIWW and cumulatively total 10.4 miles in length. No guild species occurred at any of these placement areas.

Placement Area No. 220 is located on the northeast corner of the intersection of the GIWW and the Channel to Port Mansfield and is approximately 9,350 ft in length. Most of the placement area is open water except for one clay island where the placement area bends to the east (Appendix I). This island rises abruptly from the waters edge and is composed mostly of upland habitat. A thin mud flat encircles the island and a clay spit extends westward toward the mainland. The upland habitat is vegetated primarily with grasses, Texas prickly pear, camphor daisy (*Machaeranthera phyllocephala*), and sea ox-eye daisy. This island provides little shorebird habitat but serves as a loafing area for both brown pelicans (*Pelecanus occidentalis*) and white pelicans (*Pelecanus erythrorhynchos*). Guild species observed on the site included the American oystercatcher (*Haematopus palliatus*), ruddy turnstone, and sanderling (*Caldris alba*).

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Placement Area No 221 is located south of the channel to Port Mansfield on the west side of the GIWW (Appendix I) It is approximately 18,700 ft long and contains mostly open water habitat. A submerged sand bar lies along the western boundary and is periodically exposed at very low tides. During the February 1997 survey, a small portion of the sand bar was exposed in the southern half of the placement area A small island also occurs at the southwest corner of the placement area This island contains a mixture of sand and clay along the periphery of the island and clay uplands in the center The uplands were vegetated with sea ox-eye daisy, marshhay cordgrass, honey mesquite, Texas prickly pear, salt-flat grass (*Monanthochloe littoralis*), camphor daisy, ironweed (*Vernonia* sp), and Carolina wolfberry (*Lycium carolinianum*) Shorebird habitat is limited to the narrow sand flat encircling the island Guild members observed at Placement Area No. 221 were the American oystercatcher, willet, and long-billed curlew.

Placement Area No 222 is approximately 12,900 ft long and consists of two separate islands on the west side of the GIWW (Appendix I). The northern island is rather small and consists of a thin strip of uplands and sand flats within the placement area boundaries Vegetation on the island is similar to that of Placement Area No. 221 with the addition of tasajillo (*Opuntia leptocaulis*), saltgrass (*Distichlis spicata*), and sea blite (*Suaeda linearis*) South of this island is a much longer island of which the northern 7,200 ft is enclosed within a levee This levee appears to have been recently constructed The interior is composed of dredged materials, primarily clay. West of the levee is a large mud flat which provides potential foraging habitat for shorebirds South of the levee, are a series of upland mounds, separated by mud flats and poorly developed algal mats Upland vegetation consisted of honey mesquite, saltgrass, tasajillo, sea ox-eye daisy, seacoast bluestem, and Texas prickly pear. Lower elevations along the border of the mud flats contained sea blite, sea purslane, saltwort, and glasswort Guild species recorded on the site were the black-bellied plover, willet, marbled godwit (*Limosa fedoa*), sanderling and dunlin.

Placement Area No 223 is approximately 9,900 ft long and consists of two islands. Habitats are similar to those of Placement Area No. 222 and consist of upland mounds separated by mud and algal flats (Appendix I) The upland mounds are partially vegetated with species common to the placement areas previously described. Mud flats and algal flats are sparsely vegetated with saltwort, salt flat grass, and sea blite Six guild species were encountered on the site, primarily on the mud flats near the water's edge They were the black-bellied plover, willet, long-billed curlew, ruddy turnstone, sanderling, and least sandpiper (*Calidris minutilla*)

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Placement Area nos. 224 and 225 are both partially-leveed placement areas west of the GIWW (Appendix I). Placement Area No. 224 is approximately 10,900 ft in length, Placement Area No. 225 is 3,600 ft in length. An old levee runs along portions of the eastern side of the islands. Habitats are similar to those of the previously described placement areas with vegetated and barren uplands, mud flats and algal flats. Placement Area No. 224 contains more mud flats than many of the placement areas, however, it is rapidly being colonized by glasswort. West of the two placement areas is an extensive mud flat with scattered pockets of algal mats, grading into extensive algal flats to the southwest. A small bay occurs just southwest of Placement Area No. 225 and is bordered by a thick band of black mangroves (*Avicennia germinans*). Large flocks of shorebirds were seen flying over the mud and algal flats west of the two placement areas, although only a few individuals were seen at Placement Area No. 224. Guild species observed at this placement area included the willet, long-billed curlew, ruddy turnstone, sanderling and dunlin (Table 4-1). No guild members were recorded from Placement Area No. 225.

Placement Area No. 226 is located on the north side of the Arroyo Colorado and is approximately 9,350 ft in length. It is completely enclosed within a levee system (Appendix I). The interior is vegetated and provides no shorebird habitat. The southern and eastern perimeters outside the levee consist of barren mud flats. North of the levee are mud and algal flats which may provide high quality shorebird foraging habitat. The willet and long-billed curlew were the only guild members observed in the vicinity of the placement area, and they were recorded from the mud flats just outside the levee.

Placement Area No. 227 is located on the east side of the GIWW across from the mouth of the Arroyo Colorado (Appendix I). This placement area is approximately 4,000 ft in length and is composed mostly of clay sediments, most of which are unvegetated. The upland habitats are primarily barren except for a few Texas prickly pear. Mud and algal flats occurred around the perimeter of the uplands and contained a dense stand of dead glasswort in many areas. The willet and dunlin were the only guild species observed.

Placement Area No. 228 is approximately 18,250 ft long and is located south of the Arroyo Colorado on the west side of the GIWW (Appendix I). It consists of a series of nine islands, most of which are sparsely vegetated. Habitats consist of uplands, mud flats and algal flats. Sediments on the islands are predominantly clay. Upland habitats are barren in most areas; however at least four of the upland mounds support honey mesquite and various grass. Mud flats occur between the uplands and along their perimeters. Along the water's edge is a fringe of saltwort and glasswort. Algal mats occur

in several areas of the placement area but are thin and not well-developed. Guild species recorded from the site were the black-bellied plover, willet, ruddy turnstone, western sandpiper (*Calidris mauri*) and dunlin.

Placement Area No. 229 is located on the east side of the GIWW and is approximately 8,000 ft in length. It contains three islands within its boundaries (Appendix I). The southernmost island is the most extensive, containing upland, mud flat, and algal flat habitats. A thin algal mat occurs along the western edge of the island, however it is being colonized by glasswort. Upland habitats are barren except at the north end of the large island. The northern two islands are very small and comprised of unvegetated clay mounds. Guild species observed on the site include the willet, American oystercatcher, and long-billed curlew.

Placement Area nos. 230 and 231 contain a series of islands which are sparsely vegetated. These two placement areas are located on the west side of the GIWW and are 5,165 ft and 7,900 ft in length, respectively. They contain upland, mud, and algal flat habitats (Appendix I). The upland habitats are mostly barren, although honey mesquite, sea ox-eye daisy, saltgrass, and Texas prickly pear occur in a few areas. Mud flats are mostly unvegetated except along the fringe of each island where there is a thin band of saltwort, sea purslane, glasswort, and patches of black mangrove. Algal mats are typically thin and not well developed and seem to be located on the west side of the islands. Colonization of glasswort on the mud and algal flats is apparent, indicated by a high incidence of dead glasswort plants from the previous growing season. The willet was the only species observed on Placement Area No. 230, the black-bellied plover, willet, long-billed curlew, ruddy turnstone, sanderling, and western sandpiper were recorded from Placement Area No. 231.

Placement Area No. 232 is 7,900 ft in length and consists of four islands along the west side of the GIWW (Appendix I). Habitats are similar to those of Placement Area No. 231, although upland habitats contain more vegetation, primarily saltgrass, marshhay cordgrass, Carolina wolfberry, Texas prickly pear, and sea ox-eye daisy. The fringe of the islands contain a strip of vegetated mud flat comprised of sea purslane, saltwort, black mangrove, and glasswort. Guild members occurring at the placement area were the black-bellied plover, willet, long-billed curlew, ruddy turnstone, sanderling, and dunlin.

Placement Area No. 233 is 12,900 ft in length and is predominantly open water except for a thin island at the northern end (Appendix I). This island does not have the mounded uplands found on the other placement areas, but is rather low in profile and comprised of sand and mud flats. Mud flats

occur at the center of the island and contain a fringe of vegetation dominated by sea purslane, saltwort, glasswort, Carolina wolfberry, and black mangrove. Sand flats occur along the perimeter of the island and are unvegetated. Although this placement area has one of the smallest areas of shorebird habitat, it contained the most guild species (7) of any of the placement areas. Guild members observed include the black-bellied plover, willet, long-billed curlew, marbled godwit, ruddy turnstone, sanderling, and dunlin.

Placement Area No. 234 is approximately 11,900 ft long and is an open water area with no emergent habitat (Appendix I).

Placement Area nos. 235 and 236 are primarily open water habitats, although Placement Area No. 235 has five small islands exposed and Placement Area No. 236 has one (Appendix I). They are 7,900 ft and 6,600 ft in length, respectively. The islands in Placement Area No. 235 have steep banks and rise approximately 1-2 ft above the water level. Most are unvegetated, although small patches of glasswort and saltwort are beginning to colonize the highest elevations. The emergent area at Placement Area No. 236 was barely exposed at the time of the survey and was a very small spot of exposed mud. This area is likely to be totally submerged during periods of high tides. The sanderling and willet were observed at Placement Area No. 235, the sanderling and dunlin were seen at Placement Area No. 236.

5.0 DISCUSSION AND CONCLUSIONS

The survey of Placement Area nos 210-236 revealed very little suitable habitat for the piping plover. Placement Area nos 210, 211, 224, and 225 are the most likely to be utilized by the piping plover due as much to their locations, as to the habitats they contain. These four areas contain suitable mud and algal flat habitats and are contiguous to, or are located in close proximity to areas of extensive algal flats. Placement Area nos 210 and 211 occur at the south end of the Land Cut where algal flats occur along the edge of the Laguna Madre. Placement Area nos 224 and 225 are located east of extensive area of algal flats at the Laguna Atascosa National Wildlife Refuge. Although no piping plovers were observed on any of these placement areas, it is possible that portions of the placement areas may be periodically utilized under various tidal regimes or storm events. However, the majority of these four placement areas do not constitute suitable habitat and would not be utilized by the piping plover. Because of the limited nature of suitable habitats in these placement areas, and the large amount suitable habitat adjacent to these areas, disposal of dredged material at these four placement areas should have no direct impact to the piping plover.

None of the other placement areas in the Lower Laguna Madre are likely to be utilized by the piping plover, except on a very infrequent basis. None provide preferred habitat or areas which should be considered important habitats. Many of the mud and algal flats are being colonized by glasswort, reducing their likelihood of being utilized. Eight (30%) of the placement areas contain no emergent habitats and could not be utilized by the piping plover. Five (19%) placement areas (nos 220, 221, 233, 235, and 236) are almost entirely open water and contain only small areas of exposed habitat. The likelihood of these areas being utilized by piping plovers is very small.

While none of the placement areas are considered to be important habitat to the piping plover, many of the emergent placement areas provide rookeries to numerous species including shorebirds, wading birds, gulls, and terns. If at all possible, use of these areas should be timed to avoid the nesting season (March-August).

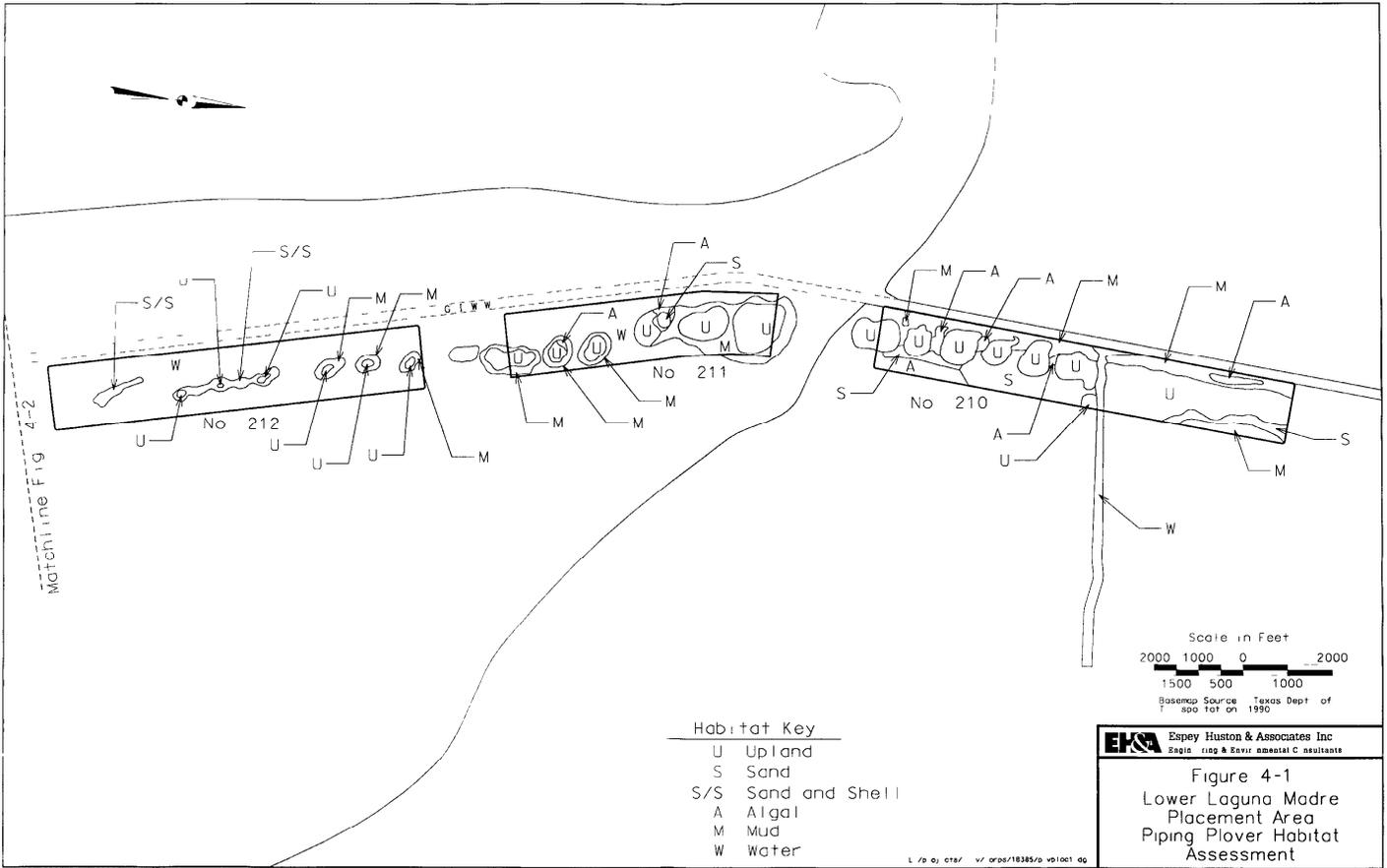
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APPENDIX I

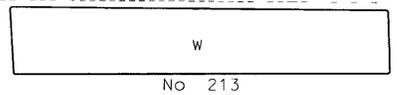
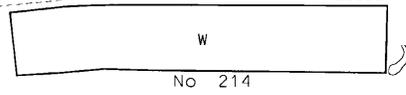
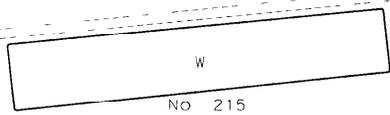
HABITAT DELINEATIONS OF PLACEMENT AREA
NOS 210-236



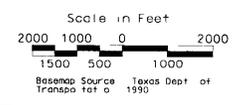


Matchline Fig. 4-3

Matchline Fig. 4-1



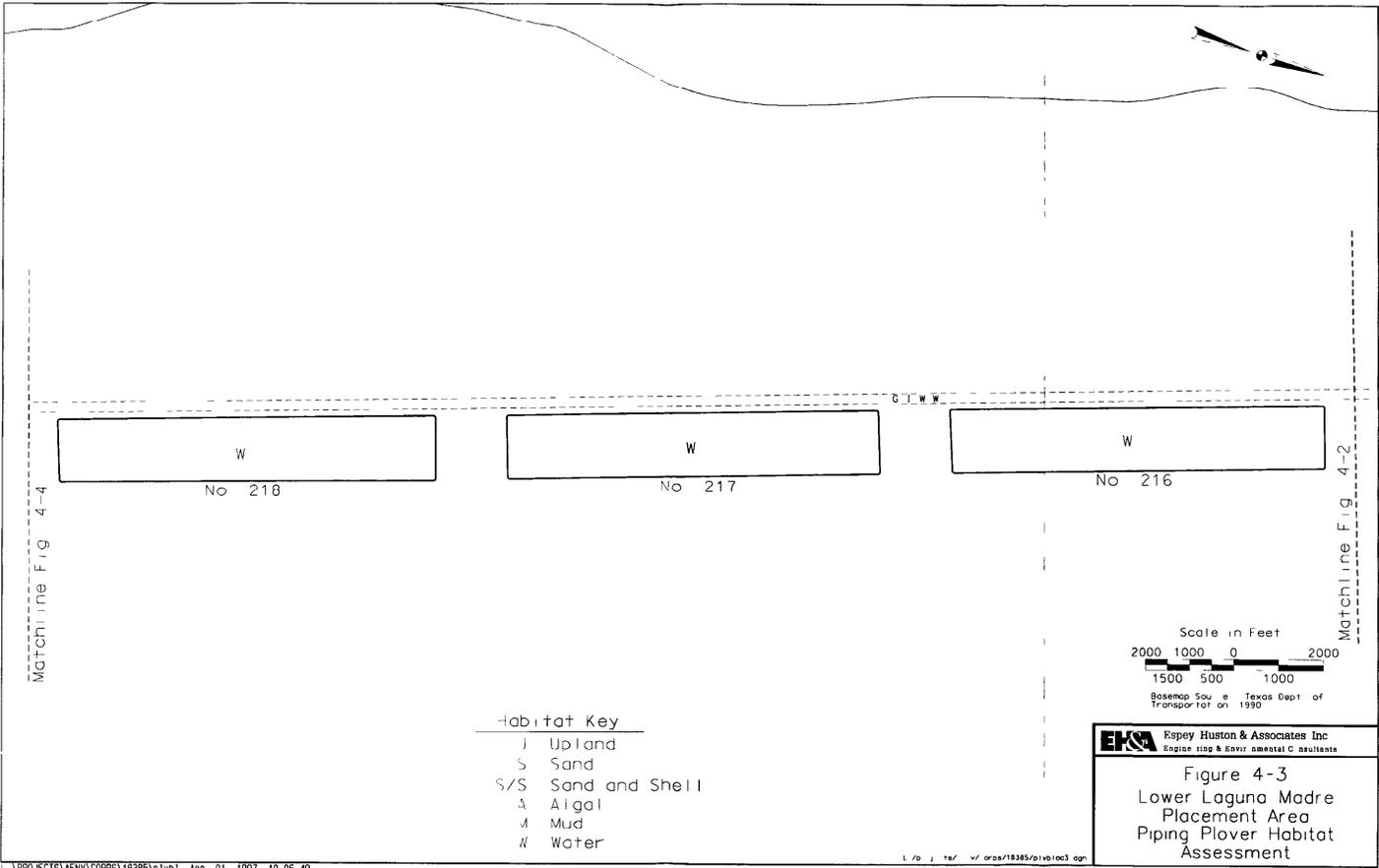
H O U S I N G L A G U N A M A D R E



- Habitat Key
- U Upland
 - S Sand
 - S/S Sand and Shell
 - A Algal
 - M Mud
 - W Water

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Figure 4-2
Lower Laguna Madre
Placement Area
Piping Plover Habitat
Assessment



Matchline Fig. 4-4

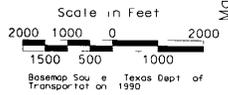
Matchline Fig. 4-2

W
No. 218

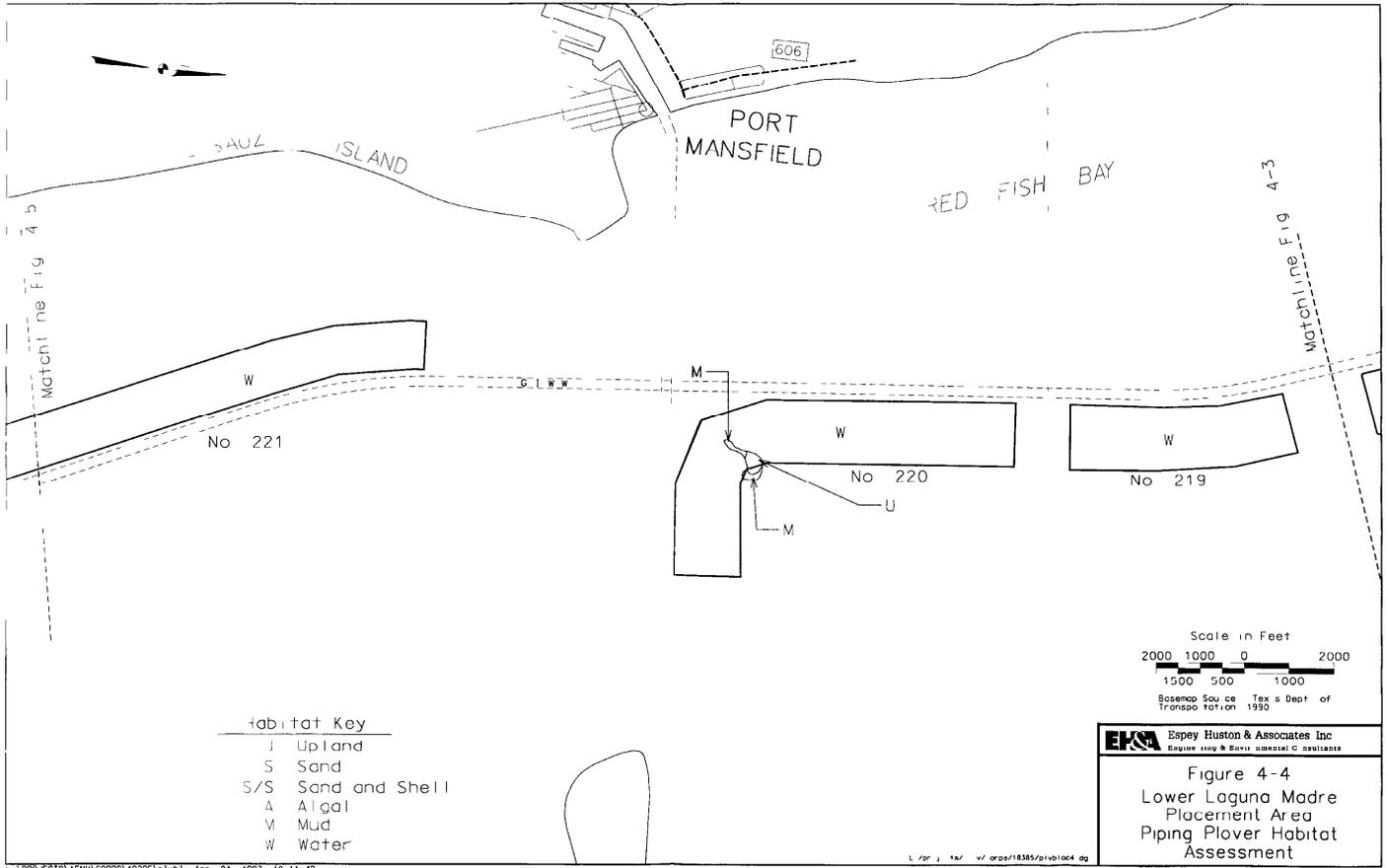
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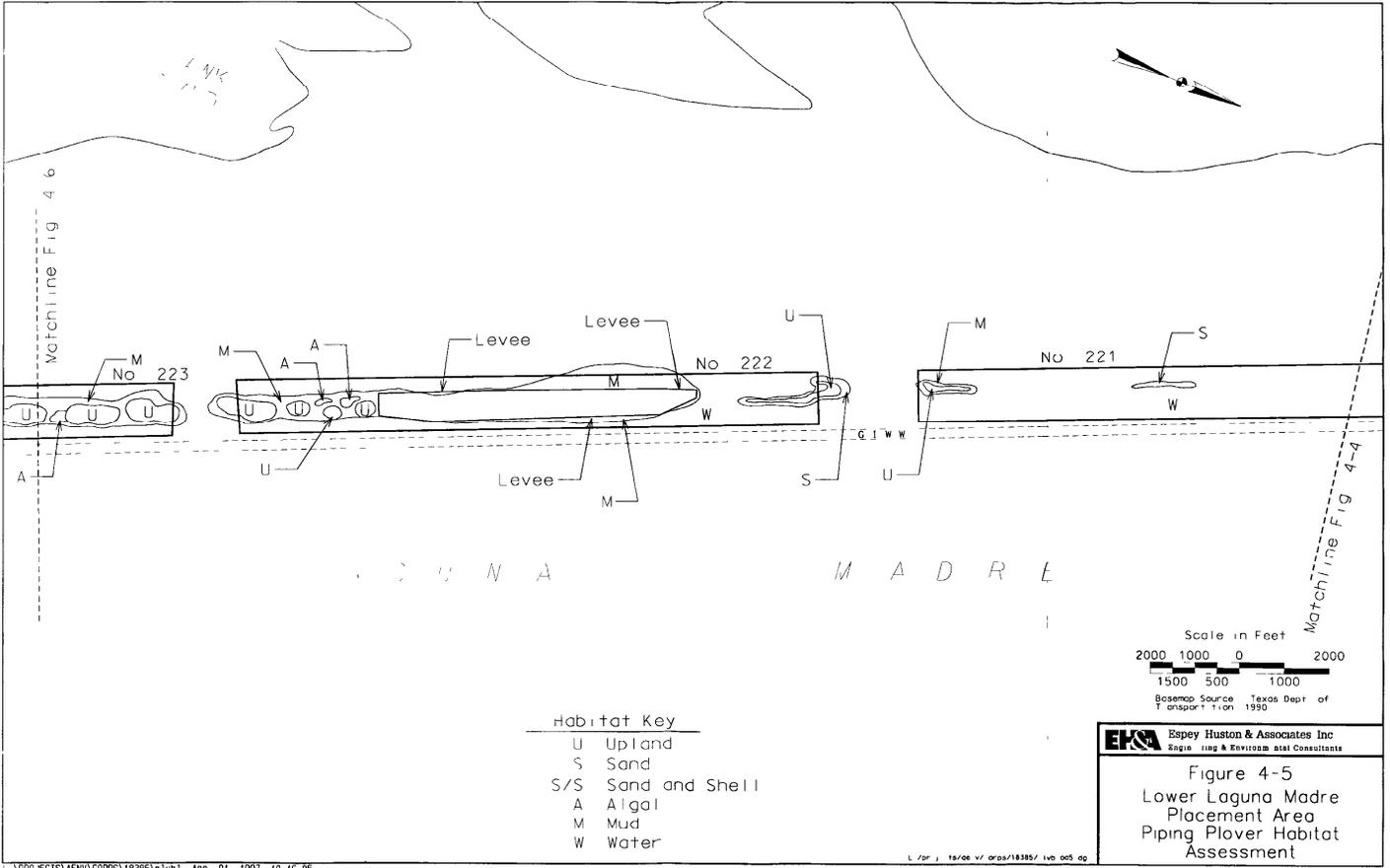
W
No. 216

- Habitat Key
- J Upland
 - S Sand
 - S/S Sand and Shell
 - A Algal
 - M Mud
 - W Water



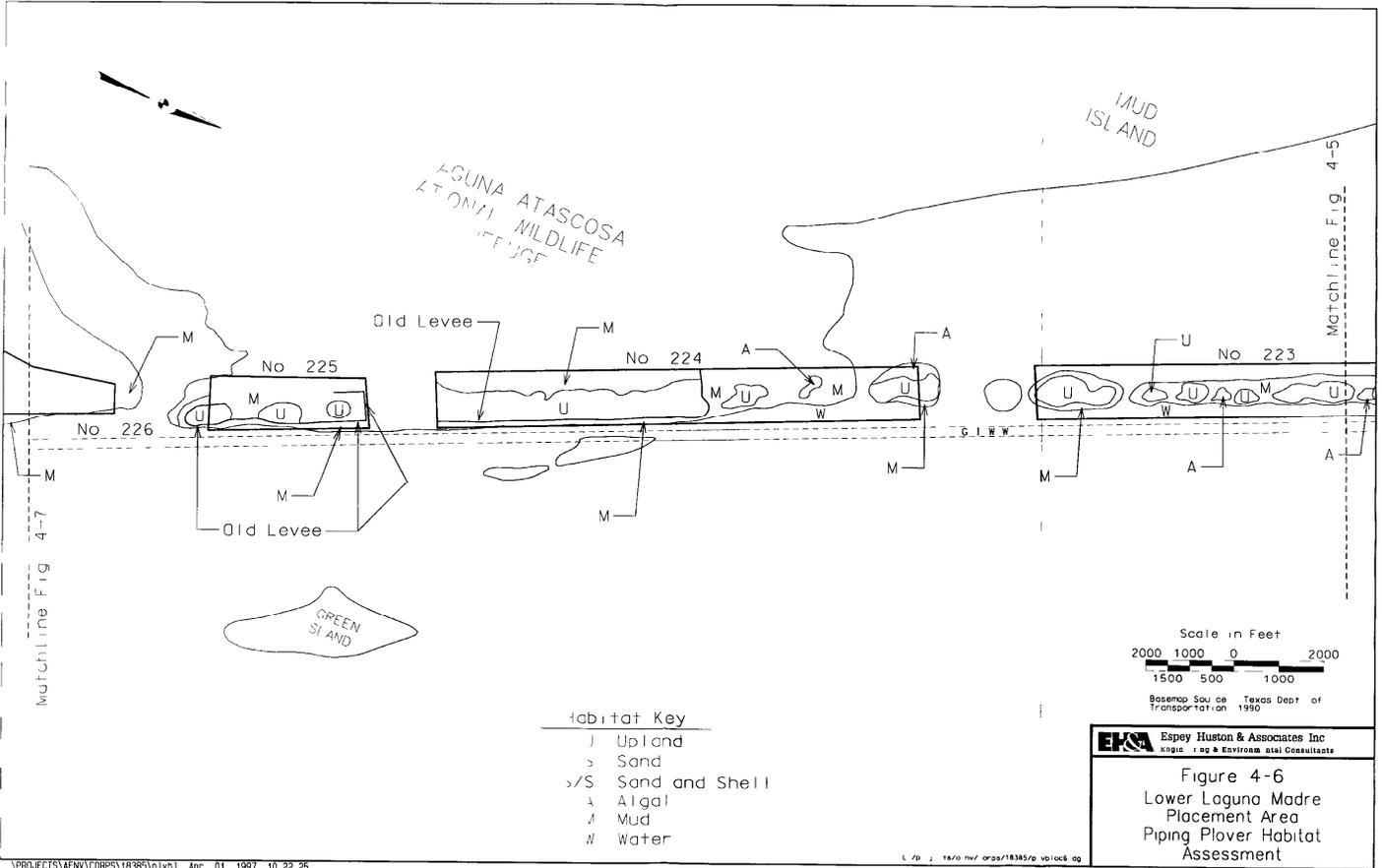
	Espy Huston & Associates Inc. Ecological & Environmental Consultants
<p>Figure 4-3 Lower Laguna Madre Placement Area Piping Plover Habitat Assessment</p>	

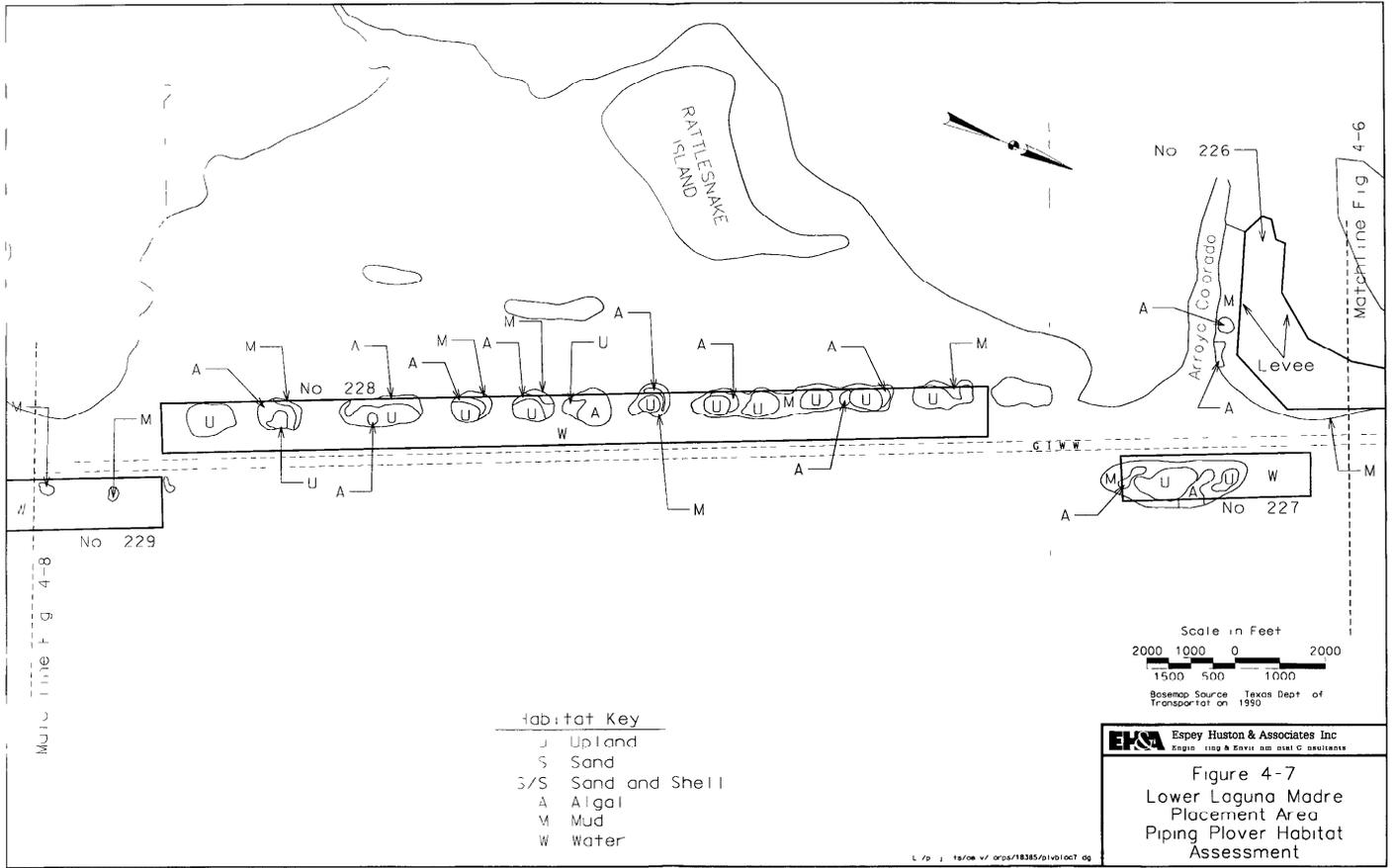


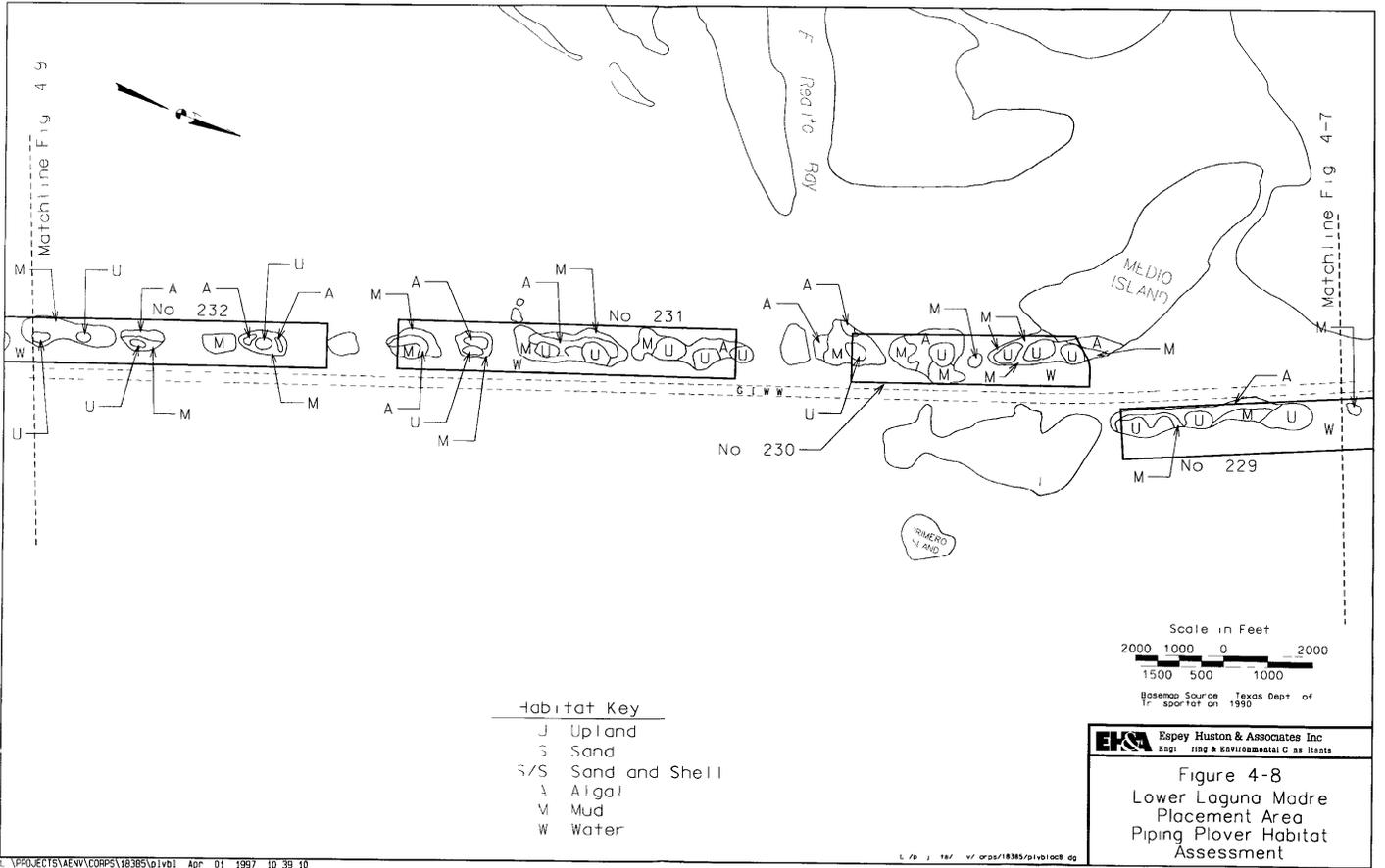


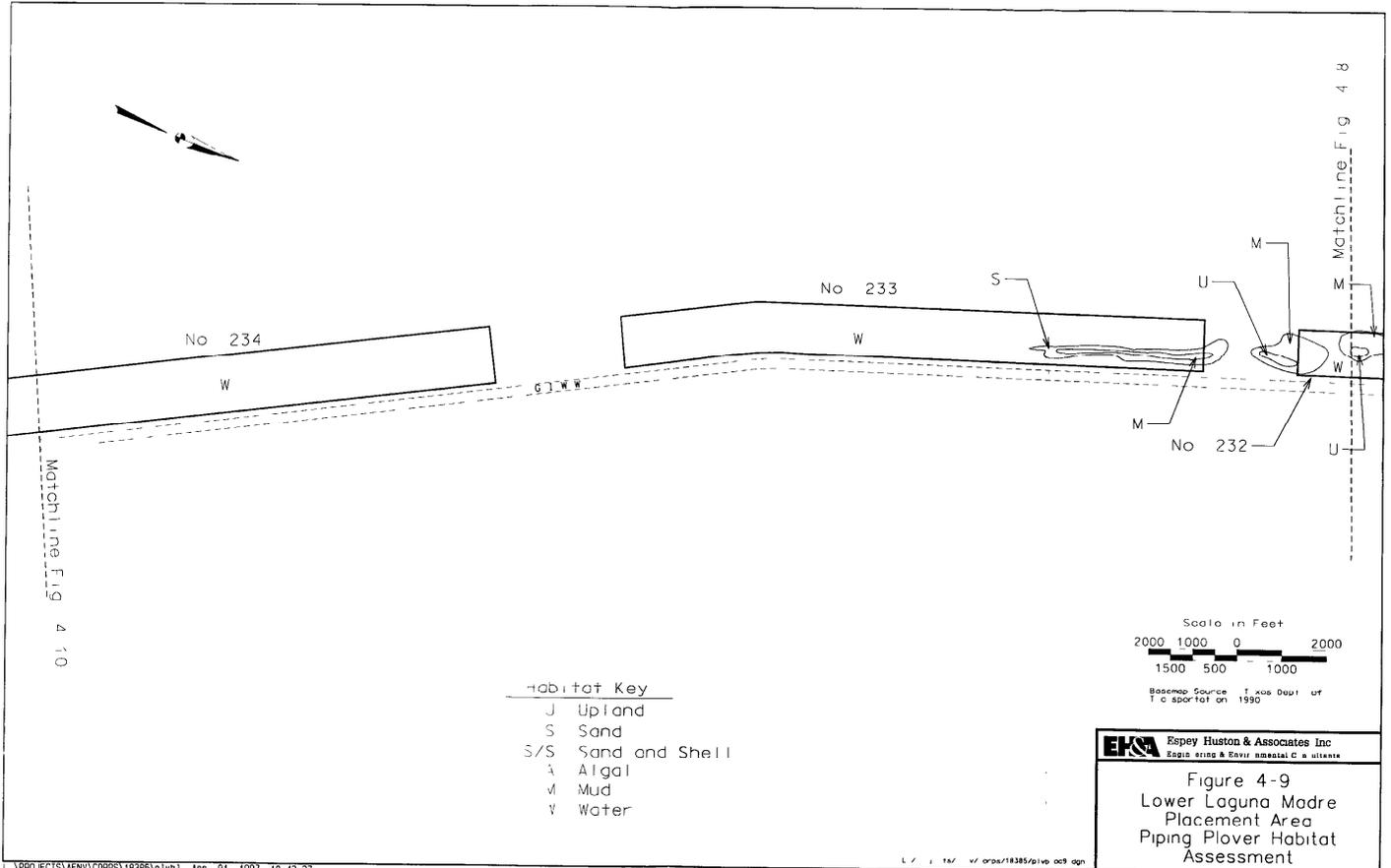
Habitat Key

- U Upland
- S Sand
- S/S Sand and Shell
- A Algal
- M Mud
- W Water









Matchline Fig 4-10

Matchline Fig 4-8

- Habitat Key
- J Upland
 - S Sand
 - S/S Sand and Shell
 - A Algal
 - M Mud
 - W Water

Scale in Feet
 2000 1000 0 2000
 1500 500 1000
 Base Map Source: Texas Dept. of Transportation 1990

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Figure 4-9
 Lower Laguna Madre
 Placement Area
 Piping Plover Habitat
 Assessment

