3.0 AFFECTED ENVIRONMENT

3.1 ENVIRONMENTAL SETTING

The study area for the CCSCCIP encompasses Corpus Christi Bay, including the southern section of Redfish Bay and the northern section of the Laguna Madre, Nueces Bay, the lower Nueces River (12.379 miles), Inner Harbor, La Quinta Channel and the watershed surrounding these water bodies up to roughly 0.5 mile inland from all shorelines. The coastline of this area extends across Nueces and San Patricio counties and is adjacent to the cities of Corpus Christi, Portland, Ingleside-On-The-Bay, and Port Aransas.

3.1.1 Physiography

The study area is characterized by interconnected natural waterways, restricted bays, lagoons, estuaries, narrow barrier islands, and dredged intracoastal canals and channels. The surface topography of the study area is mainly flat to gently rolling and slopes to the southeast. The Nueces River drains areas to the west of the study area and discharges into Nueces Bay. A few short, low-gradient streams drain directly into Nueces and Corpus Christi bays. Vegetation is sparse at most places, but there are oak clusters and other vegetation in more sandy areas and in the uplands along streams. Broad areas of coastal prairies, chaparral pastureland and farmland occur inland from the bays. On the Gulf side of Mustang Island, and for a short distance inland, sand dunes break the flatness of the terrain.

The Nueces and Corpus Christi bay systems are relatively low-energy environments protected on the seaward side by barrier islands. Water depths in Corpus Christi Bay range from a maximum of approximately 13 feet in the central part of the bay to less than 6 feet along the bay margins (Brown, et al., 1976). Tidal channels, passes, and dredged channels are greater than average depth. Water exchange between the bay and the Gulf is normally limited to natural and artificial tidal passes through the barrier island. Fresh water is supplied to the bays by the Nueces River and by small streams that drain local areas adjacent to coastal uplands. The bay systems were formed when rising sea levels inundated and flooded the older Nueces River Valley. The arcuate shoreline of Nueces Bay is a relict of meanders of the old river valley.

The primary physiographic environments of the study area include fluvial-deltaic systems, bay-estuary-lagoon systems, barrier island-strandplain systems, locally distributed marsh-swamp systems, and eolian (wind) systems (Brown et al., 1976). The Coastal Zone within the study area is underlain by sedimentary deposits that originated in ancient, but similar, physiographic environments. These ancient sediments were deposited by the same natural processes that are currently active in shaping the present coastline such as long shore drift, beach wash, wind deflation and deposition, tidal currents, wind-generated waves and currents, delta outbuilding, and river point-bar and flood deposition (Brown et al., 1976).

3.1.2 Geology

Pleistocene age fluvial and deltaic sediments of the Beaumont Formation surround much of Nueces and Corpus Christi bays. These sediments were deposited in both marine and nonmarine environments. Recent alluvium present in the western portion of the study area is associated with the Nueces River and deposits in the eastern portion are related to Mustang Island.

The geologic units consist primarily of mixtures of sand, silt, clay, mud and shell deposited within the last one million years. Exposed sediments are composed primarily of interdistributary mud and lesser amounts of distributary and fluvial sands and silts. The majority of the outcropping Beaumont Formation within the study area consists predominantly of stream channel, point bar, natural levee, and back swamp deposits and, to a lesser extent, coastal marsh, mud flat, lagoonal and sand dune deposits. The Beaumont consists of mainly beach and relict barrier island deposits along a north-south trending belt parallel to the Laguna Madre-Redfish Bay system. These deposits are mostly fine-grained sand and shell, and are probably part of the laterally extensive Pleistocene age Ingleside barrier island system.

Sediment distributions within the bay system consist chiefly of terrigenous clastics. Clean quartz sands can be found in some PAs along parts of the mainland shoreline and in the wind-tidal flats areas. Muddy sands occur adjacent to dredged material placement mounds, in the shallow bay margin areas next to the mainland shore and at the edge of the wind-tidal flats. Muddy sand distribution is not depth controlled, rather it is related to hurricane washovers, dredging activities, and reworking of relict sediment (McGowen and Morton, 1979).

3.1.3 Climate

The coastal climate within the study area may be described as subhumid to semiarid. Major climatic influences are temperature, precipitation, evaporation, wind, and tropical storms/hurricanes. This area is subject to extreme variability in precipitation with rainfalls averaging about 29 inches in the Corpus Christi vicinity, with the greatest concentration falling in the spring and fall months. However, there is an average annual deficit of 12 to 16 inches when evapotranspiration is taken into account. The peak rainfall in late summer and fall coincides with the tropical storm/hurricane season. Rainfall totals decrease toward the southern coastline and inland to the west. The temperatures in the area are fairly high with an average in the lower 70s, punctuated with occasional killing freezes.

The persistent wind is from the southeast from March to September and the northeast from October to February. The hurricane season spans June through November with the greatest number occurring in the area in August and September. Wind velocities may be at least 74 miles per hour (mph), with wind gusts exceeding sustained wind speeds by up to 50 percent (Dunn and Miller, 1964). The winds are important agents in eroding and reworking sediments and sands as well as affecting water levels and circulation patterns depending on the velocity and duration of the wind. The direction and intensity of persistent winds control the orientation and size of wave sequences approaching the shoreline, ultimately eroding or depositing sediment along the shoreline (Brown et al., 1976).

3.2 WATER QUALITY

3.2.1 Water Exchange and Inflows

There are two principal types of water exchanges in the Corpus Christi Bay system: one is bidirectional, involving the tidal exchange of the bay system with the Gulf of Mexico and between components of the bay system, and the other is unidirectional, involving freshwater flow into the system and through-flow to the Gulf.

Tidal influence in the Gulf of Mexico is dominated by the 12.4-hour semidiurnal and the 24.8-hour diurnal lunar tides and the 13.6-day cycle in the magnitude of the declination of the moon (Ward 1997). Because of the constriction provided by the Corpus Christi Jetty Channel, the diurnal tide is severely dampened and the semidiurnal tide is dampened even further. Ward (1997) notes that because of its longer period, the "quasi-periodic" semi-annual rise and fall of Gulf waters pass into the bays with almost no attenuation, leading to high water levels in the spring and fall and low water levels in the winter and summer.

Frontal passages can also cause changes in water levels and exchanges between the bays and the Gulf. As the front approaches from the north, onshore airflow increases, forcing water from the Gulf into the bays. With frontal passage, the wind direction shifts, forcing water from one bay to another for short-lived, low energy fronts and from the bays into the Gulf for longer-duration fronts.

Freshwater flow into the bay system is dominated over the long term by the Nueces River and, to a lesser extent, by other freshwater inputs into the system from runoff. The long-term average freshwater replacement time for the Corpus Christi Bay system (bay volume divided by average inflow rate) is around 50 months (Ward 1997). Ward (1997) notes that while on the long term, diversions of freshwater from entering the bay system for human uses have been "non-negligible but minor when compared to natural watershed inflows and evaporative losses."

3.2.2 Salinity

The mean salinity in the upper 1 meter of the various segments of Corpus Christi Bay, for the period of record (1958 – 1993) examined by Ward and Armstrong (1997) ranges from 26.1 parts per thousand (ppt), near the mouth of Nueces Bay, to 31 ppt in the center of the Bay. This compares to an average mean salinity, based on latitudinal sections of Corpus Christi Bay, from 27°44′N to 27°50′N, which ranges from 28.96 to 29.24 ppt (USACE, 1999a). Ward and Armstrong (1997) note that there is little vertical gradient to the salinity profile and no apparent correlation between salinity and the presence of the ship channels; i.e., no salt wedge, as is apparent in, for example, Galveston Bay. Therefore, changes in channel depth will not cause salinity impacts like those that would be expected in a bay system with a strong salt wedge. The gradient that is evident from the data of Ward and Armstrong (1997) and USACE (1999a) is an increase in salinity from north to south from reduced freshwater inflow and increased evaporation to the south. However, both Corpus Christi Bay and Nueces Bay show almost no gradient from west to east, as one moves farther from the source of freshwater inflow.

Ward and Armstrong (1997) do note that there is a long-term increase in salinity in Corpus Christi Bay of about 0.1 ppt per year. They favor the hypothesis that long-term decreases and changes in the timing of fresh water inflow are the cause for this increase in salinity.

3.2.3 Water and Elutriate Chemistry

The CW determined that both Tier I and Tier II evaluations according to EPA and USACE guidance was to be conducted for both water and sediment quality. To this end, contaminants of concern were identified and all current and historic data were compiled and presented to the CW in both graphical and tabular format (Tier I) for both Gulf areas (covered by the Ocean Dumping Manual (EPA/USACE, 1991) or the Green Book) and inland areas (covered by the Inland Testing Manual (EPA/USACE, 1998) or the ITM). Water and elutriate data were compared with Water Quality Standards and past water column toxicity compliance was determined (Tier II). For those areas where the CW felt there were insufficient data (e.g., the BU Site ZZ), additional data were collected and analyzed (Tier II). After analysis of the data, the CW concluded that there would be no adverse impacts to the waters of the U.S. from the project and that additional testing, including toxicity testing, was not required (Tier II). This information is discussed in this section and in Section 3.3.

Ward and Armstrong (1997) noted a general improvement in water quality in the Corpus Christi Bay system over the 25 years preceding their study. Their study area was much broader than the CCSCCIP study area, as was the scope of their determination. For the present document, concerns are with the channel improvements and beneficial uses included in the CCSCCIP. Therefore, the emphasis will be on areas in and near the CCSC. This need is met by an examination of the data collected at regular intervals by the USACE. For a more general discussion of water and sediment quality in the overall Corpus Christi Bay system, the reader is referred to Ward and Armstrong (1997).

The data collected by the USACE since 1981 were analyzed to determine the water quality of Corpus Christi Bay. Also included below is a discussion of the elutriate, which provides information on those constituents that are dissolved into the water column during dredging and placement. Since the elutriate represents the dissolved concentrations that would be expected in the water column, they are compared to the Texas Surface Water Quality Standards (TWQS) provided by the Texas Natural Resource Conservation Commission (TNRCC, 2000) for the protection of aquatic life and EPA water quality discrete criteria. Since the values are from samples, not long-term composites or averages, and are from a marine environment, the acute marine TWQS are used (there are no TWQS for barium, but the Gold Book Criterion (U.S. Environmental Protection Agency (EPA), 1986, as revised) is 1,000 micrograms per liter (µg/L) barium for domestic water supplies. No value exceeded 1,000 µg/L barium). The CW has reviewed selected-screening criteria and concurs with these findings.

3.2.3.1 Entrance Channel

Water quality tables referred to in this section are contained in Appendix B (tables 3.2-1 through 3.2-11). Historical water and elutriate data for detected compounds from 1984, 1990, and 1999 are presented in Table 3.2-1. No constituents were found in 1990, although detection limits were high; in 1984, however, a few constituents were found despite higher detection limits. Some constituents detected in 1999 could not have been detected with either 1984 or 1990 detection limits. Of the metals, arsenic and copper were found above detection limits in 1984. In 1999, arsenic, barium, cadmium, and zinc concentrations were found above detection limits for water and elutriate samples; nickel was detected in water samples; and chromium and copper were found only in elutriate samples. Elutriate concentrations in 1999 were consistently higher than ambient water concentrations, including Reference samples, for barium and cadmium, but the opposite was true for zinc. All samples were well below the TWQS, except for copper in the elutriate samples from station CC-J-84-01 (0+00). Looking at the other 1984 copper data and those from 1999 (which are in the range of 1.3 to 4 µg/L), the elutriate value of 30 µg/L for CC-J-84-01 may be in error. Consequently, there are no apparent temporal trends in the data; since copper was the only compound detected in more than 1 year, trends for compounds other than copper could not be determined.

Oil and grease were detected in 1984 for water and elutriate samples. No organics were detected in the 1990 or 1999 data for any medium, except for total organic carbons (TOC) and total petroleum hydrocarbons (TPH).

Two sets of elutriate bioassays have been conducted on samples collected from the Entrance Channel (Southwest Research Institute (SWRI), 1980 and EH&A, 1985). The results of these tests are presented in Table 3.2-2, an examination of which indicates that in all tests, survival of organisms exposed to the liquid phase (LP, elutriate) and suspended particulate phase (SPP, unfiltered elutriate) of sediments from the Corpus Christi Entrance Channel was greater than 50 percent. Therefore, no 96-hour LC_{50} (that concentration of a substance which is lethal to 50 percent of test organisms after a continuous exposure time of 96 hours) could be calculated. This indicates that no acute toxicity to water column organisms could be expected from dredging the Entrance Channel or placement of Entrance Channel sediments.

There is no indication of water or elutriate problems in the Entrance Channel.

3.2.3.2 Lower Bay

This reach of the CCSC is not dredged often due to scouring and, therefore, very little data have been collected. Historical water and elutriate data for detected compounds from 1988 and 1991 are presented in Table 3.2-3. No metals were detected for the 1988 and 1991 data for water and elutriate. This is not surprising since the material is 72 to 97 percent sand.

TOC was above detection limits in water and elutriate samples for two stations in 1991, at roughly the same range for both media. No other organics were detected in 1991 and no organics were reported in 1988 for water or elutriate samples.

Water and construction sediment samples were collected for the proposed U.S. Navy Homeport project, for which an EIS was prepared in 1988 (U.S. Navy, 1987). The concentrations of detected compounds can be found in Table 3.2-4. No TWQS were exceeded in the water or elutriate samples. Most noticeable about Table 3.2-4 is the increase in oil and grease and TOC in the elutriate samples, relative to the corresponding water sample. The elutriate oil and grease concentrations are not high, relative to other reaches (there are no other oil and grease data for the Lower Bay Reach), but the elutriate concentrations in the water samples are much lower than in other reaches. For TOC, the values for the water samples are comparable to the other reaches but the elutriate values are much higher. U.S. Navy (1987) indicates no water or elutriate quality problems.

Toxicity testing has been conducted on elutriate samples made with maintenance material from this reach of the project area (Tereco, 1981) and is presented in Table 3.2-5. While the survival of mysids (*Mysidopsis almyra*) exposed to the LP from Station IB-1 was low, it was not significantly less than control survival (97 percent) at the 95 percent confidence level. Since the LP is a subset of the SPP, the low survival in the LP versus the high survival of mysids exposed to the SPP from Station IB-1 is enigmatic. Also, survival in no bioassay was less than 50 percent. Therefore, no 96-hour LC_{50} could be calculated. This indicates that no acute toxicity to water column organisms could be expected from dredging the Lower Bay Channel or placement of Lower Bay Channel sediments.

There is no indication of water or elutriate problems in the Inner Basin to La Quinta Junction Reach.

3.2.3.3 La Quinta

Historical water and elutriate data for detected compounds from 1985, 1990, and 2000 are presented in Table 3.2-6. Arsenic was the only metal found above detection limits in 1985, and it was found in all water and elutriate samples. Although arsenic was not detected in 1990, copper was found in all water and elutriate samples, and nickel was detected in all elutriate samples, indicating a release of nickel with dredging and placement. However, all elutriate values were less than TWQS. In 2000, arsenic was found in most water but no elutriate samples; barium and zinc were detected in all water and elutriate samples; cadmium was found in most water and elutriate samples; lead was found in one water sample at the detection limit; and selenium was found in most elutriate and some water samples near the detection limit. No trends indicated whether elutriate or water concentrations were higher. Moreover, TWQS were not exceeded by any metal, and barium concentrations were well below 1,000 µg/L (ppb). No temporal trends could be determined, since there were no detected chemicals common to more than one data set.

Oil and grease were detected in all samples in 1985, and elutriate concentrations were consistently higher than water concentrations. TOC was above detection limits for elutriates for all stations and most water samples, and were consistently higher in elutriate samples in 1990. No organics, including TOC, were detected in 2000 water and elutriate samples.

Toxicity testing has been conducted on elutriate samples made with maintenance material from this reach of the project area (Tereco, 1982); the results are presented in Table 3.2-7. While the survival of silverside minnows (*Menidia beryllina*) exposed to the LP from Station LQ-1 and grass shrimp (*Palaemonetes pugio*) exposed to the SPP from Station LQ-1 was low and significantly less than the respective control survival (97 percent for both) at the 95 percent confidence level, survival in no bioassay was less than 50 percent. Therefore, no 96-hour LC_{50} could be calculated. Tereco (1982) concluded that, with judicious management, no toxicity to water column organisms could be expected from dredging the La Quinta Channel or placement of La Quinta Channel sediments.

Overall, there is no indication of water or elutriate problems in the Channel to La Quinta Reach.

3.2.3.4 Upper Bay

Historical water and elutriate data for detected compounds from 1981, 1983, 1985, 1987, 1988, 1989, 1991, 1994, 1995, 1997, and 1998 are presented in Table 3.2-8. Arsenic was found above detection limits in 1983 and 1985 (water and elutriate samples), 1994 (water only), and from one reference station in 1998 (elutriate only), with the highest concentrations in 1983. Barium, for which analyses were not conducted before 1994, was detected for both water and elutriate in 1994, 1995, 1997, and 1998 (highest concentrations in 1995); chromium in both media in 1994 and for water only in 1997; mercury at only two of 15 stations in the elutriate in 1998; and nickel in both media in 1988. Copper was also detected in 1981, 1985, 1988, 1991, 1994, 1997 (water only), and 1998, with higher concentrations in 1988 and 1994 than in 1998. Zinc was detected in 1985 at one station each for water and elutriate, in 1987, 1988 (water only), 1989, 1991, 1994, 1997, and 1998, and was only high in 1987 when the TWQS was exceeded in 13 of 19 water samples and one elutriate sample. For that one elutriate sample, the concentration in the water was higher than in its corresponding elutriate sample. Barium concentrations are generally higher in elutriate than in water. Concentrations of zinc in the elutriate samples were less than in water samples in 1987 and 1998, but in 1989, the opposite was generally true.

TOC was not measured until 1991 and was above detection limits for water and elutriates for most stations in 1991, 1994, 1995, and 1998 (one station) (Table 3.2-8). Detected concentrations in the historic data for TOC were similar in value for all water and elutriate samples. Oil and grease were detected in 1981, 1983, 1985, 1987, and 1988 for water and elutriate samples. All oil and grease values were similar for water and elutriate; however, there were increased concentrations in 1981 and 1988 when compared with the other historical data.

As noted above, the only metal found above TWQS was zinc in 1987, and no trends indicated increasing concentrations with time.

Toxicity testing has been conducted on elutriate samples made with maintenance material from this reach of the project area (Tereco, 1982); the results are presented in Table 3.2-9. While the survival of mysids exposed to the LP from Station MT-1 was low, it was not significantly less than the control survival (90 percent) at the 95 percent confidence level. Since the LP is a subset of the SPP, the low survival in the LP versus the high survival of mysids exposed to the SPP from Station MT-1 is enigmatic. Also, survival in no bioassay was less than 50 percent. Therefore, no 96-hour LC_{50} could be calculated. This indicates no acute toxicity to water column organisms could be expected from dredging the Lower Bay Channel or placement of Lower Bay Channel sediments.

3.2.3.5 Inner Harbor

All material from this reach will be placed in Upland Confined Placement Areas (UCPA). Elutriates are, thus, of key interest in this reach, since the elutriate most nearly represents discharge from the UCPAs.

Historical water and elutriate data for detected compounds from 1983, 1988, 1991, 1994, 1997, and 2000 are presented in Table 3.2-10. Of the metals, arsenic, barium, cadmium, chromium, copper, nickel, and zinc were found above detection limits in water and elutriate samples. Arsenic was detected in both media at all stations in 1983; not detected in 1988, 1991, 1997, and 2000; and detected in water only at two stations in 1994. Barium was found above detection limits in 1994, 1997, and 2000 (there was no analysis for barium in 1983, 1988, or 1991), as was chromium in 1994 and 1997, nickel in 1988, and zinc in 1988, 1991, 1997, and 2000 for both water and elutriate samples. For 1988, copper was detected in both water and elutriate samples; however, it was only found in water samples for 1994 and 1997. Cadmium was only found in 1997 at two stations in elutriate samples. In 1997, station CC-TB-97-09 (1500+00) had an elevated barium concentration when compared to other stations of the same year and to previous years, but all concentrations were less than 1,000 µg/L. Interestingly, zinc concentrations were lowest (i.e., not detected) in 1994 when sediment concentrations were the highest in the data set, and were similar to other years in 1997 when sediment zinc concentrations were also high. Copper levels were generally lower in 1997 than in 1994; none was detected in 2000. All concentrations for both media and for all years were less than the TWQS.

TOC was above detection limits for water and elutriates for most stations in 1991 and 1994 (it was not determined in 1988) (Table 3.2-10). Oil and grease were detected in 1983 and 1988 for water and elutriate samples. Oil and grease were replaced by TPH after 1988 but TPH was not detected in any water or elutriate samples until 2000, when it was found in all water and elutriate samples from channel stations, PAs, and Reference sites. Concentrations of TPH in water were numerically higher than in the elutriates at all stations.

There is no indication of water or elutriate problems in the Beacon 82 to the Viola Turning Basin Reach.

3.2.3.6 GIWW Across Corpus Christi Bay

Most of the GIWW across Corpus Christi Bay is in water deeper than 12 feet and, therefore, does not require maintenance dredging. However, on the south side of the Bay, where the Upper Laguna Madre begins, the water shoals and maintenance dredging is conducted. This section discusses the data from that portion of the GIWW, roughly USACE channel stations 0+000 to 10+000.

Historical water and elutriate data for detected compounds from 1983, 1990, and 1993 are presented in Table 3.2-11. Of the metals, arsenic was found above detection limits for 1983 for water and elutriate samples, but was not detected in 1990 or 1993. Barium was detected for both water and elutriate at all stations in 1993, but was not included in the analyses in 1983 or 1990. No TWQS were exceeded.

Oil and grease were detected in 1983 at one station in the elutriate. Also in 1983, hexachlorocyclohexane (the gamma isomer of which is lindane) was detected in all water and elutriate samples below or equal to the TWQS (Table 3.2-11). TOC was above detection limits for water and elutriate samples for all stations in 1990 and 1993. No other organics were detected in 1990 or 1993 for either medium.

Since no evidence of hexachlorocyclohexane has been present since 1983 and all other constituents were below TWQS (or the EPA criterion, for barium), there is no indication of water or elutriate problems in the GIWW across Corpus Christi Bay.

3.2.4 Brown Tide

A major water quality concern since the early 1990s has been the phytoplankton, brown tide (*Aureoumbra lagunensis*) (De Yoe et al., 1997). Although brown tide has been and continues to be in general decline throughout the study area, there are sporadic patches of algal blooms throughout the area, generally in canals and near developments (Villareal and Dunton, 2000). However, Dr. Tracy Villareal reported in May 2000 (Villareal, 2000) that brown tide counts at Marker 53, roughly 2 miles south of the JFK Causeway, were similar to those in the long brown tide bloom from 1989 to 1997.

There are several potential impacts of algal blooms to estuarine ecosystems. Buskey et al. (1996) estimates that brown tide has caused a recent loss of 10 square kilometers (2,471 acres) of seagrass coverage in the Upper Laguna Madre and has also contributed to impacts such as decreased abundance, biomass, and diversity of benthic fauna, and reduced larval fish populations. Stockwell (1993) suggests that the persistent brown tide has temporarily changed the phytoplankton/seagrass production ratio and altered nutrient cycles within the Laguna Madre. Barrera et al. (1995) report that under normal conditions, turbidity is minimal and seagrass meadows are extensive in the Laguna Madre, but the persisting brown tide bloom has caused serious problems to the seagrasses of the Laguna Madre.

3.2.5 Ballast Water

The National Invasive Species Act of 1996 (NISA) calls for a variety of measures to reduce the risk of exotic species invasions associated with release of ballast water by ships. Ballast water is carried by ships to provide stability and adjust a vessel's trim for optimal steering and propulsion. The use of ballast water varies among vessel types, among port systems, and according to cargo and sea conditions. Ballast water often originates from ports and other coastal regions which are rich in planktonic organisms. It is variously released at sea, along coastlines, and in port systems. As a result, a diverse mix of organisms is transported and released around the world with ballast water of ships (Smithsonian Environmental Research Center [SERC], 1998).

Today, ballast water appears to be the most important vector for marine species transfer throughout the world. Ballast water transfers have been identified as a potential source of non-indigenous invasive species (NIS) (Carangelo, 2001). Refer to Table 3.2-12 for the Gulf of Mexico Program list on non-indigenous marine species, a list generated in a cooperative program between the EPA's Gulf of Mexico Program and the Gulf Coast Research Laboratory Museum of the University of Southern Mississippi. It has been estimated that as few as 5 to 10 percent of the vessels worldwide represent 80 to 95 percent of the risks on non-native species introductions through ballast water (Carangelo, 2001).

Although the effects of many introductions remain unmeasured, it is clear that some invaders are having significant economic and ecological impacts as well as human-health consequences. These organisms have the potential to become aquatic nuisance species (ANS). ANS may displace native species, degrade native habitats, spread disease, and disrupt human social and economic activities

TABLE 3.2-12

GULF OF MEXICO NON-INDIGENOUS MARINE SPECIES

Common Name	Scientific Name
Shrimp Viruses	
Infectious Hypodermal and Hematopoietic Necrosis Virus (IHHNV)*	
Taura Syndrome Virus	
White Spot Baculovirus complex	
Yellow Head Virus	
Bacteria	
	Mycobacterium marinum (C)
Cholera	*Vibrio cholerae*, serotype Inaba, biotype El Tor*
	Vibrio parahaemolyticus (including O3:K6 strain*)
Tunicates	
A sea squirt	*Botryllus niger* (C)
A sea squirt	*Botryllus schlosseri**
A tunicate	*Diademnium perleucidum**
A sea squirt	*Styela plicate**
Bryozoans	
A bryozoan	*Conopeum* "seurati" (C)
A bryozoan	*Cryptosula pallasiana**
A bryozoan	*Sundanella sibogae**
A bryozoan	*Victorella pavida**
A bryozoan	*Watersipora subovoidea**
A bryozoan	*Zoobotryon verticillatum* (C)
Coelenterates	
A hydroid	*Cordylophora caspia**
Orange-striped anemone	*Diadumene lineata**
A scyphoid jellyfish	*Phyllorhiza punctata**
Flatworms (Phylum Platyhelminthes)	
Eurasian strigeid trematode	*Bolbophorus confusus**
Marine blackspot	*Cryptocotyle lingua**

TABLE 3.2-12 (cont'd)

Common Name	Scientific Name
A flatworm	*Taenioplana teredini*
Roundworms (Phylum Nematoda)	
Eel parasite	*Anguillicola crassus**
Segmented Worms (Phylum Annelida)	
A polychaete worm	*Boccardiella ligerica**
A polychaete worm	*Hydroides elegans**
Mollusks	
Lake Merrit cuthona	*Cuthona perca*
A California nudibranch	*Ercolania fuscovittata*
An Indo-Pacific shipworm	*Lyrodus medilobatus*
European salt-marsh snail	*Ovatella myosotis**
Brown mussel	*Perna perna**
Green mussel	*Perna viridis**
Black-lipped pearl oyster	*Pinctada margaritifera*
Atlantic rangia	*Rangia cuneata*
Striped falselimpet	*Siphonaria pectinata*
Giant clam	*Tridacna crocea**
Giant clam	*Tridacna maxima**
Crustaceans	
Striped barnacle	*Balanus amphitrite**
A barnacle	*Balanus reticulatus**
A barnacle	*Balanus trigonus**
A copepod	*Centropages typicus**
Portunid crab	*Charybdis hellerii**
An amphipod	*Chelura terebrans**
Chinese mitten crab	*Eriocheir sinensis**
Potted bumblebee shrimp	*Gnathophyllum modestum*
An isopod	*Ligia exotica**
An isopod	*Limnoria pfefferi* (C)
An isopod	*Limnoria saseboensis* (C)
Pacific white shrimp	*Litopenaeus vannamei**
Jumbo tiger prawn	*Penaeus monodon**

Common Name	Scientific Name
Serrated swimming crab; Somoan crab	*Scylla serrata**
A wood-boring isopod, gribble	*Sphaeroma terebrans**
An isopod	*Sphaeroma walkeri**
A tanaid	*Zeuxo maledivensis**
Fishes	
Spotted seatrout	*Cynoscion nebulosus*
Spotted seatrout x orangemouth corvina	*Cynoscion nebulosus x C. xanthulus**
Sheepshead minnow	*Cyprinodon variegatus*
Gulf killifish	*Fundulus grandis*
Naked goby	*Gobiosoma bosc*
Spot	*Leiostomus xanthurus*
Atlantic croaker	*Micropogonias undulatus*
White bass	*Morone chrysops*
Wiper	*Morone chrysops x M. saxatilis*
Striped bass	*Morone saxatilis*
Coho salmon	*Oncorhynchus kisutch*
Rainbow trout	*Oncorhynchus mykiss*
Chinook salmon	*Oncorhynchus tshawytscha*
Rainbow smelt	*Osmerus mordax*
Gulf flounder	*Paralichthys albiguttata*
Pacific batfish	*Platax orbicularus**
Amazon molly	*Poecilia formosa*
Sailfin molly	*Poecilia latipinna*
Black drum	*Pogonias cromis*
Blackdrum x red drum	*Pogonias cromis x Sciaenops ocellatus*
Atlantic salmon	*Salmo salar*
Red drum	*Sciaenops ocellatus*
Algae	
A green tropical alga	*Caulerpa taxifolia*
A red alga	*Prionitis* sp.

* Exotic
C Cryptogenic

Source: Gulf of Mexico Program, 2000.

that depend on water resources (U.S. Coast Guard (USCG), 2000). Ballast-mediated introductions, such as the zebra mussel in the U.S. Great Lakes and toxic dinoflagellates in Australia, have had tremendous ecological and economic impacts (SERC, 1998).

The issue of regulating, controlling, or otherwise reducing the risk of ballast mediated introductions is a topic of ongoing national and international debate and investigation. The complexity of the issue led to the development or implementation of various foreign nation, domestic state, port-specific, or species-specific strategies (Carangelo, 2001). The U.S. Coast Guard is responding to these concerns through a comprehensive national ballast water management program.

3.2.5.1 The U.S. Coast Guard Ballast Water Management Program

Purpose of Regulations

The USCG Interim Rule on ballast water management, Implementation of the NISA of 1996, was published in the Federal Register on May 17, 1999. The new regulations amend 33 CFR Part 151, Vessels Carrying Oil, Noxious Liquid Substances, Garbage, Municipal or Commercial Waste, and Ballast Water. These regulations are intended to limit the introduction and spread of aquatic nuisance species into the waters of the United States. Presently, the primary means of preventing this is to replace ballast water taken on in foreign ports with deep ocean water through an at sea ballast water exchange. The new USCG rule establishes voluntary ballast water management guidelines for all waters (except the Great Lakes and sections of the Hudson River) of the U.S. and establishes mandatory reporting and sampling procedures for nearly all vessels entering U.S. waters.

Key Provisions of the USCG Guard Ballast Water Management Program

Voluntary Guidelines & Recommended Practices. These guidelines include suggested practices that should be taken by every vessel to minimize the uptake and release of harmful aquatic organisms, pathogens, or sediments. Additionally, the rule recommends that vessels carrying ballast water into the waters of the U.S. after having operated beyond the Exclusive Economic Zone (EEZ) to employ one of the following ballast water management practices:

- Conduct an exchange of ballast water beyond the EEZ, in an area no less than 200 miles from any shore and where the water depth exceeds 2,000 meters
- Retain the ballast water on board
- Use an alternative method of ballast water management
- Discharge ballast water to an approved reception facility
- Conduct the exchange in an approved Alternative Exchange Zone.

Mandatory Requirements. All vessels calling in a U.S. port must submit a completed Ballast Water Report Form (Appendix to 33 CFR 151, Subpart D) to the Smithsonian Environmental Research Center (SERC). Submission of the International Maritime Organization Ballast Water Reporting Form will also fulfill this reporting requirement. The reports must be kept on board the vessel and available for inspection for 2 years.

3.3 SEDIMENT QUALITY

The data collected by the USACE, on maintenance material, and others since 1981 were analyzed to determine the sediment quality of Corpus Christi Bay. The data presented here are from bulk sediment analyses, which tend to vary, even within duplicates, by a factor of up to five times. The data are compared to one type of Sediment Quality Guidelines (SQG), a co-occurrence type of SQG known as the Effects Range Low (ERL, originated by Long and Morgan, 1990), as given in the National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (Buchman, 1999). The CW has reviewed selected parameters of concern and screening criteria for this analysis and have concurred with the findings.

ERLs were developed by assembling a large group of sediment data sets, comprised of samples for which there was both bulk sediment chemistry and exhibition of toxicity. For each chemical in the data set, the concentrations are ranked in ascending order and the ERL is calculated as the lower 10th percentile of the concentrations. However, this approach demonstrates no cause and effect from the chemicals in the data set, since the fact that a chemical was detected does not demonstrate that it was responsible for the toxicity exhibited by the sediment. Not surprisingly, when ERLs derived from sets of data from different areas are compared, the results are inconsistent (WES, 1998). For example, when the ERLs of a number of chemicals were compared using a northern California data set versus a southern California data set, the ERLs differed by a range, from only a factor of three for total polychlorinated biphenyls (PCB) to a factor of 2,689 for p,p'-DDE. Since the ERLs are not based on cause and effect data, one would expect them to exhibit low predictive ability and to give a high number of false positives, both of which are true (WES, 1998). ERLs could only be compared to detected compounds. Although some detection limits were greater than ERLs, primarily for acenapthene, chlordane, and DDT, these were not listed as exceedances since there was no way to determine what the true values were.

In Section 3.2.3, it was noted that water and elutriate samples were compared to TWQS, which are regulatory standards, promulgated by the TNRCC (2000), and tied to effects from empirical data presented in the scientific literature. Because of the reasons noted above, the SQG are guidelines with no regulatory authority, used only to determine a "cause of concern".

3.3.1 <u>Surficial Sediments</u>

Surficial sediments have been examined by several studies (Barrera et al., 1995 [U.S. Fish and Wildlife Service (FWS)]; Ward and Armstrong, 1997 [Corpus Christi Bay National Estuary Program (CCBNEP)]; Carr et al., 1997 [CCBNEP], Fugro South, 2000 [PCCA]). Some of these studies encompassed an area greater than the study area for this FEIS, but only data from the study area are discussed here.

Barrera et al. (1995) collected sediment and biota samples from Redfish, Nueces, and Baffin bays; the Upper Laguna Madre; the Nueces River, in addition to samples from Corpus Christi Bay; and the Inner Harbor. The samples were analyzed for PAHs, organochlorine compounds, PCBs, and trace elements (Table 3.3-1). Sediment quality tables referred to in this section are contained in Appendix B (tables 3.3-1 through 3.3-3). Sediment PAHs, organochlorine compounds, and PCBs were below detection limits or were detected at very low concentrations. While Barrera et al. (1995) compared the sediment data to a number of guidelines, including data from other systems and guidelines used in Florida and Puget Sound, the comparison here is with the ERLs noted in Section 3.3 (Table 3.3-1). As an examination of Table 3.3-1 reveals, there were exceedances only in the Inner Harbor. Cadmium, copper, lead, mercury, and zinc samples in the Inner Harbor all exceeded ERLs at one or more stations.

Ward and Armstrong (1997) found that, in general, the highest metals concentrations in sediments were in the Inner Harbor and that these concentrations were often an order of magnitude higher than in other parts of their study area. Aside from the Inner Harbor, other areas found to contain elevated metals in sediments were Corpus Christi Bay for chromium and lead, the Gulf of Mexico near the Entrance Channel for copper and lead, and Nueces Bay and the Upper Laguna Madre for most metals. Note that these elevated concentrations are not relative to any guideline, like ERLs, but to other parts of the Ward and Armstrong CCBNEP study area. Ward and Armstrong also found probable temporal trends in that, for most metals in most of the system, including the Inner Harbor, concentrations are declining. However, zinc shows a possible increasing trend in many parts of Corpus Christi Bay. In contrast to the metals, sediment pesticides are not noticeably high in the Inner Harbor or Nueces Bay (Ward and Armstrong, 1997), except for toxaphene in Nueces Bay. However, they found PCBs to be high in the Inner Harbor and PAHs to be high in both the Inner Harbor and Nueces Bay (some polycyclic aromatic hydrocarbons (PAHs)). They also found a temporal trend of increasing naphthalene in both of these areas.

Carr et al. (1997) used a Sediment Quality Triad (SQT), composed of sediment chemistry, toxicity testing, and benthic invertebrate community analyses, to examine sediment quality near storm water outfalls and other selected sites. The sampling sites included 15 storm water sites, 8 reference areas, and 13 additional sites that the authors felt deserved attention. Based on the SQT results, the stations were ranked from the worst (Station S1, storm water outfall near the L-head in Corpus Christi Marina) to the best (Station 11, in the La Quinta Channel adjacent to industrial activity and dredging operations). Only a few of the stations are in a position to impact or be impacted by the CCSCCIP: Stations 11 and 12, in the La Quinta Channel (ranked 35 and 36, where 36 is the best); Station R3, a reference station near Indian Point (ranked 16); Station 5, in a PA (ranked 23); and Station 3, near the largest discharge into the Inner Harbor (ranked 19).

Construction or new work material will also be included in this section, since some of it (e.g., from channel widening) will be surficial sediments, even though other construction material will be deep sediments. However, none will be maintenance material.

There have been three studies, which evaluated construction material, that are pertinent to the CCSCCIP: U.S. Navy (1987), Fugro (2000), and Tereco (1982).

U.S. Navy (1987) took samples along the Lower Bay reach of the CCSC, from approximately Channel Station 12+55 to Channel Station 521+70. The concentrations of detected parameters are in Table 3.2-4. There are no patterns to the sediment concentrations but ERLs were exceeded for several parameters: arsenic, 8 of 9 stations; cadmium, 4 stations; and mercury, 2 stations.

However, no elutriate concentrations were greater than the TWQS for these, or any other parameters, so the meaning of the ERL exceedances is unclear.

The concentrations of detected parameters from Fugro (2000) are in Table 3.3-2. Two of the Fugro (2000) stations were in the Lower Bay (C-60 and C-67), two were in the Upper Bay (C-71A and C-76), and three were in the La Quinta Extension (L-24, L-27, L-30). The range of values for the samples collected provide such overlap that there is no notable difference among the reaches. For the three stations for which shallower and deeper samples were collected, there is no pattern concerning concentration versus depth. No ERLs were exceeded in any sample.

Tereco (1982) looked at construction material, but the study was concerned with the Inner Harbor area, and all of that material, both construction and maintenance will go into UCPAs. Therefore, elutriate is the medium of concern. Water and elutriate values for detected parameters are included in Table 3.3-3. In general, water and elutriate concentrations are similar except that oil and grease was generally higher in elutriate samples than in the respective water samples, the arsenic in the water sample from IC-1 was high compared to the IC-1 elutriate and all other water and elutriate samples, and zinc was generally lower in elutriate samples. No TWQS were exceeded, indicating that there should be no water quality concerns from the discharge from UCPAs which receive construction material from the Inner Harbor.

3.3.2 Maintenance Material

3.3.2.1 Entrance Channel

Maintenance material concentrations of detected parameters in 1984, 1990, and 1999 are found in Table 3.2-1. Since the RACT, at the recommendation of the CW, agreed that sediment concentrations would be compared to ERLs, they are also included in all tables. Arsenic was the only metal above detection limits in 1984; zinc was detected at all stations, chromium and nickel at three stations, and copper at one station in 1990, all below the ERLs. Of the metals, only mercury (three stations), silver (one station), and selenium (no stations) were not found at all stations in 1999 samples. Only one 1999 sample, CC-J-99-03, exceeded an ERL: mercury at a concentration of 0.20 milligrams per kilogram (mg/kg), versus an ERL of 0.15 mg/kg. Aside from the one exceedance noted, there is no indication of a cause for concern relative to maintenance material quality in the Entrance Channel. Sampling of any future project maintenance material will be routinely conducted to determine sediment quality prior to actual dredging. Additionally, prior to placement of maintenance material in PA 1, the material must meet all of the environmental criteria and regulatory requirements pursuant to MPRSA (40 CFR 220-228). Environmental criteria are based on toxicological and bioaccumulative effects on marine organisms.

Table 3.2-2 also presents the data for solid phase (SP, or sediment) bioassays with Entrance Channel sediments from 1980, 1985, and 1995. These bioassays were conducted according to protocols in both the old (EPA/USACE, 1978) and new (EPA/USACE, 1991) Green Books. The LC_{50} is not pertinent for SP bioassays, but the fact that test survival was not significantly less than Reference Control survival, at the 95 percent confidence level, provides reasonable assurance that no significant undesirable impacts would occur from ocean placement of the maintenance material dredged from the Entrance Channel reach of the CCSC.

3.3.2.2 Lower Bay

Maintenance material concentrations of detected parameters in 1988 and 1991 are found in Table 3.2-3. In 1988, chromium, copper, lead, and nickel were all above detection limits for one station and zinc was detected at all stations. In 1991, cadmium, chromium, copper, nickel, and zinc were found at most stations. The values for chromium, copper, nickel, and zinc for 1988 and 1991 were similar. No organics were detected in sediments, and no ERLS were exceeded. Grain size data indicate the maintenance material in this reach is coarse (72-97 percent sand). There is no indication of a cause for concern relative to maintenance material quality in the Inner Basin to La Quinta Junction Reach. Sampling of any future project maintenance material will be routinely conducted to determine sediment quality prior to actual dredging.

Table 3.2-5 also presents the data for SP bioassays with Lower Bay CCSC sediments from 1981. Test survival was not significantly less than Reference Control survival, at the 95 percent confidence level, providing reasonable assurance that no significant undesirable impacts would occur from open water placement of the maintenance material dredged from the Lower Bay reach of the CCSC.

3.3.2.3 La Quinta

Maintenance material concentrations of detected parameters in 1985, 1990, and 2000 are found in Table 3.2-6. Arsenic, chromium, nickel, and zinc were above detection limits in 1985 at most stations, and arsenic exceeded the ERL at all stations. In 1990, arsenic was not detected but chromium, copper, nickel, and zinc were detected in all sediment samples. The values for nickel were numerically higher in 1990 than in 1985 but by less than a factor of three, and no metal exceeded its ERL. In 2000, arsenic, barium, chromium, copper, lead, nickel, and zinc were detected at all stations, cadmium and mercury were found in two samples near the detection limit, and selenium was found at one station, also near the detection limit. No ERLs were exceeded. Oil and grease was detected in 1985 but was discontinued before 1990. TOC was not detected in 1990 and was the only organic detected, at a range of 2,560 mg/kg to 12,800 mg/kg. The test sediments were mostly sand. Since arsenic was not detected in 1990 and did not exceed the ERL in 2000, there is no indication of a cause for concern relative to maintenance material quality in the Channel to La Quinta Reach. Sampling of any future project maintenance material will be routinely conducted to determine sediment quality prior to actual dredging.

3.3.2.4 Upper Bay

Maintenance material concentrations of detected parameters in 1981, 1983, 1985, 1987, 1988, 1989, 1991, 1994, 1995, 1997, and 1998 are found in Table 3.2-8. Zinc was found above detection limits for all years at all stations. Lead was found at all stations, except in 1985 when it was found at all stations but one, and in all years except 1989. Chromium, copper, and nickel were detected for all years, except 1985, and at all stations, except in 1989 when chromium and copper were found at all but two stations. Arsenic was also detected in 1983, 1985, 1987, 1988, 1997, and 1998; barium in 1994, 1995, 1998, and 1998; cadmium in 1981, 1997, and 1998; mercury at all stations and selenium at one station in

1998. There are sufficient data to determine whether temporal trends exist but, although there are fluctuations, no trends are apparent. However, there are some interesting aspects to the data. For instance, in 1995, chemical concentrations from channel stations are consistently higher than those at the Reference or Placement Area (PA) stations, but for other years (1985, 1998) there is no difference in the ranges from channel stations versus Reference or PA stations. In fact, in 1989, most of the high values were found at the Reference stations. Although the ERL was exceeded for copper for three channel stations, one reference station in 1987, and one reference station in 1989, these values are suspect and may actually be typographical errors: two were reported as 40.00 mg/kg and three were reported as 50.00 mg/kg, whereas the range of all other copper concentrations was 2.20 to 5.60 mg/kg. Nickel (20.92 mg/kg) and zinc (157.9 mg/kg) exceeded their respective ERLs (20.9 and 150 mg/kg) at station CC-B-95-05 (750+00) in 1995.

TOC was above detection limits for all sediment samples in 1997 and 1998. Oil and grease was detected in 1981, 1983, 1985, 1987, and 1988. TOC concentrations in 1998 sediment samples were much higher than compared with previous years, but this is likely due to a change in methodology. Total PAH was found at most stations in 1987, ranging from 0.2 micrograms per kilogram (µg/kg) to 0.4 µg/kg. DDT was also found in 1987 at four stations, ranging from 0.2 µg/kg to 3.1 µg/kg. The latter value exceeded the ERL for DDT of 1.58 µg/kg. Fluoranthene (12 stations, 1.3 – 6.1 µg/kg) and benzo(a)pyrene (5 stations, 1.0 – 1.6 µg/kg) were also found in 1987. These values are questionable since they are below the required detection limit of 10.0 µg/kg for these two compounds in 1987. In any case, there is no ERL for fluoranthene and the ERL for benzo(a)pyrene is 430 µg/kg, so there were no exceedances for these PAHs.

An examination of all data presented above for this reach does not indicate a cause for concern relative to maintenance material quality in the La Quinta Junction to Beacon 82 Reach. Sampling of any future project maintenance material will be routinely conducted to determine sediment quality prior to actual dredging.

Table 3.2-9 also presents the data for SP bioassays with Upper Bay CCSC sediments from 1982. Test survival was not significantly less than Reference Control survival, at the 95 percent confidence level, providing reasonable assurance that no significant undesirable impacts would occur from open water placement of the maintenance material dredged from the Upper Bay reach of the CCSC.

3.3.2.5 Inner Harbor

The CW agreed that there appears to be no significant contaminant concerns with new work and maintenance materials from the CCSCCIP, except in the Inner Harbor. Because of concern with contaminants in the Inner Harbor, the workgroup supports a plan to place any dredged material from this reach in existing upland confined placement areas. Sampling of any future project maintenance material will be routinely conducted to determine sediment quality prior to actual dredging.

Since all material from this reach will be placed in UCPAs, the elutriates (Section 3.2.3.5) are of key interest. The elutriate most nearly represents the discharge from the UCPAs, which will reenter the Inner Harbor as at present. However, to determine the baseline conditions, maintenance sediment data for this reach will be discussed in this section.

Maintenance sediment concentrations of detected parameters in 1983, 1988, 1991, 1994, 1997, and 2000 are also found in Table 3.2-10. Chromium, copper, lead, and zinc were found above detection limits for all years for all stations. Arsenic was also detected in 1983, 1988, 1997, and 2000; barium in 1994, 1997, and 2000 (it was not determined in 1983-1991); and nickel in 1988, 1991, 1994, 1997, and 2000 for all stations. Cadmium was found in 1983 at one station, in 1997 at all stations, and in 2000 at nine of fifteen stations. Mercury was found only in 1997 at nine of ten stations and in 2000 at all stations. Arsenic concentrations were generally less in 1988 than in 1983, and it was not detected in 1991 or 1994. In 1997, it was detected at a range of 2.2 to 5.9 mg/kg, and in 2000, the range was 4.8 to 9.9 mg/kg. While this could indicate a trend of increasing arsenic in sediment of this reach, without sufficient data with which to conduct statistical analyses, a trend cannot be confirmed. It certainly is not supported by the concentrations of the other sediment metals, most of which were lower in 2000 than in 1994 and 1997. There is also no evidence of a similar trend for arsenic in the other reaches.

ERLs were exceeded by arsenic at four stations in 2000; cadmium at one station in 1983 and all stations in 1997; copper at two stations in 1994 and one station in 1997; lead at one station in 1994; mercury at four stations in 1997 and one reference station in 2000; and zinc at one station in 1983, six stations in 1994, and seven stations in 1997.

Oil and grease was detected in 1983 and 1988 at all stations, but was replaced by TPH, which was not detected until 2000, when it was found in all channel stations, PA samples, and Reference Stations. TOC was above detection limits for all sediment samples in 1994, 1997, and 2000. TOC concentrations were much higher in 2000 than in 1994 and 1997, but this was due to a change in methodology. Fluoranthene and benzo(a,e)pyrene were detected in 1991, 1994, and 1997, and benzo(e)pyrene was also found in 1997. Benzo(a)pyrene (637 µg/kg) exceeded the ERL (430 µg/kg) at one station in 1994.

One can see from the data presented that the detection of constituents of concern is much more prevalent in this reach than in the others. Also, the number of exceedances is much higher for this reach than for the others. Ward and Armstrong (1997) note, "Contaminants such as coliforms, metals, and trace organics show elevated levels in regions of runoff and waste discharge, with generally the highest values in the Inner Harbor..." However, as noted above, all dredged material from the Inner Harbor will be placed in Upland Confined Placement Areas, and the elutriate results discussed in Section 3.2.3.5 show no indications of concerns. The decant water from UCPA in the Inner Harbor will return to the Inner Harbor as currently done with the existing 45-foot project.

No SP bioassays have been conducted with maintenance material from the Inner Harbor reach of the CCSC because this material has not been placed in the past nor intended in the future for aquatic placement.

3.3.2.6 GIWW Across Corpus Christi Bay

Most of the GIWW across Corpus Christi Bay is in water deeper than 12 feet, and therefore, does not require maintenance dredging. However, on the south side of the Bay, where the Upper Laguna Madre begins, the channel shoals and maintenance dredging is conducted. This section discusses the data from that portion of the GIWW.

Sediment concentrations of detected parameters in 1983, 1990, and 1993 are found in Table 3.2-11. Arsenic, chromium, nickel, and zinc were above detection limits at most stations in 1983; chromium, copper, nickel, and zinc in 1990; and barium, chromium, copper, lead, nickel, and zinc in 1993. No ERLs were exceeded.

Oil and grease was detected in 1983 at all stations. Hexachlorocyclohexane was not detected in the sediments in 1983, although it was detected in the water and elutriate samples. In 1993, TOC was detected at station GIC-CBB-93-01 (0+000), but at a concentration below the required detection limit. No other organics were detected.

There is no indication of a cause for concern relative to maintenance material quality in the GIWW reach of Corpus Christi Bay. However, sampling of any future project maintenance material will be routinely conducted to determine sediment quality prior to actual dredging.

3.4 COMMUNITY TYPES

The study area lies within the southeastern portion of the Gulf Prairies and Marshes vegetational region, as described by Gould (1975). This vegetational area is a nearly level plain less than 250 feet in elevation, covering approximately 10 million acres (Hatch et al., 1990). The region is subdivided into two vegetation units: 1) the low marshes with tide water influence (where the study area is located), and 2) the prairies or grasslands farther inland (Hatch et al., 1990). The study area is a highly adaptive community that changes in response to constant environmental fluctuations. The diverse flora of this vegetational region creates a valuable resource for all forms of life. The following paragraphs provide a brief description of the various coastal habitats found within the study area.

3.4.1 Submerged Aquatic Vegetation

SAV includes the true seagrasses such as shoalgrass (*Halodule wrightii*), turtlegrass (*Thalassia testudinum*), manateegrass (*Syringodium filiforme*), and clovergrass (*Halophila engelmannii*), but also includes widgeongrass (*Ruppia maritima*) which is not considered a true seagrass because it grows in freshwater environments as well. Seagrass/SAV meadows typically occur in water shallower than –4 feet MLT. In the study area, they occur both as narrow bands along bay and channel margins and as extensive beds in broad shallow, relatively low energy areas in bays and lagoons (CCBNEP-06A, 1996a). These seagrass communities generate high primary productivity and provide refuge for numerous species including shrimp, fish, crabs and their prey. Animal abundances in seagrass beds can be 2-25 times greater than in adjacent unvegetated areas (Pulich, 1998). All five taxa are found within the study area of Corpus Christi Bay and Redfish Bay/Harbor Island with shoalgrass being the most abundant. Shoalgrass and widgeongrass occur in Nueces Bay (Pulich et al., 1997).

Figure 3-1 depicts SAV coverages for the defined study area as reported by the Texas Parks and Wildlife Department (TPWD) (1994). There are approximately 19,900 acres of seagrass beds in the study area. The net acreage of seagrass in Corpus Christi Bay and Redfish Bay/Harbor Island has remained relatively stable since 1958, although there has been fragmentation of this habitat and some local losses in Redfish Bay/Harbor Island. The acreage of seagrass beds in Nueces Bay fluctuates with inflows, but there has been a net increase since 1958. There have also been increases in seagrass coverage in the Harbor Island and Mustang Island areas.

Several factors may impact seagrass communities. A study by Quammen and Onuf (1993) has suggested that probable causes for shifts in cover of seagrass species in the Laguna Madre include changing salinity regimes (due in part to changes in Bay/Gulf interchange as channels [including ship channel and GIWW] and passes open and/or close), increased turbidity caused by maintenance dredging of the GIWW, and eutrophication resulting from nutrient inputs. Other researchers have suggested that brown tide has played a major role in the alteration of Laguna Madre seagrass communities (Buskey et al., 1996; Stockwell, 1993; Barrera et al., 1995; Pulich, 1998). Recently, the USACE funded an investigation into the potential impacts of open bay disposal of maintenance dredge material from the GIWW on seagrass beds in the Laguna Madre. This study included field verification of predictions made by sediment transport (Teeter, 2000) and seagrass modeling (Burd and Dunton, in press), which indicated no significant difference in seagrass survival or productivity for sites one mile or more from placement sites compared to sites in a non-dredging-and-placement scenario. Even sites that were 100 meters from the disposal event showed full recovery after a 2-week period of decreased biomass.

3.4.2 Coastal Wetlands

The coastal estuarine wetlands of Corpus Christi Bay, Nueces Bay and Redfish Bay/Harbor Island play an important part in sustaining the health and abundance of life within the ecosystem. Coastal wetlands are distinct areas between terrestrial and aquatic systems where the water table is at or near the surface or the land is covered by shallow water with emergent vegetation. They are extremely important natural resources that provide essential habitat for fish, shellfish, and other wildlife (McHugh, 1967; Turner, 1977; Sather and Smith, 1984). Coastal wetlands also serve to filter and process agricultural and urban runoff and buffer coastal areas against storm and wave damage. Coastal wetlands of the study area are shown on Figure 3-2.

3.4.2.1 Salt Marshes/Shrublands

In contrast to the upper Texas coast, only a small percentage of smooth cordgrass (*Spartina alterniflora*) is associated with the salt marshes of the Laguna Madre and Coastal Bend. The more common plant species include saltwort (*Batis maritima*), seashore saltgrass (*Distichlis spicata*), and seashore dropseed (*Sporobolus virginicus*). The estuarine intertidal scrub-shrub category describes coastal wetlands dominated by woody vegetation and periodically flooded by tidal waters. Examples of estuarine intertidal scrub-shrub species in the study area include black mangrove (*Avicennia germinans*) and bushy sea-ox-eye (*Borrichia frutescens*).

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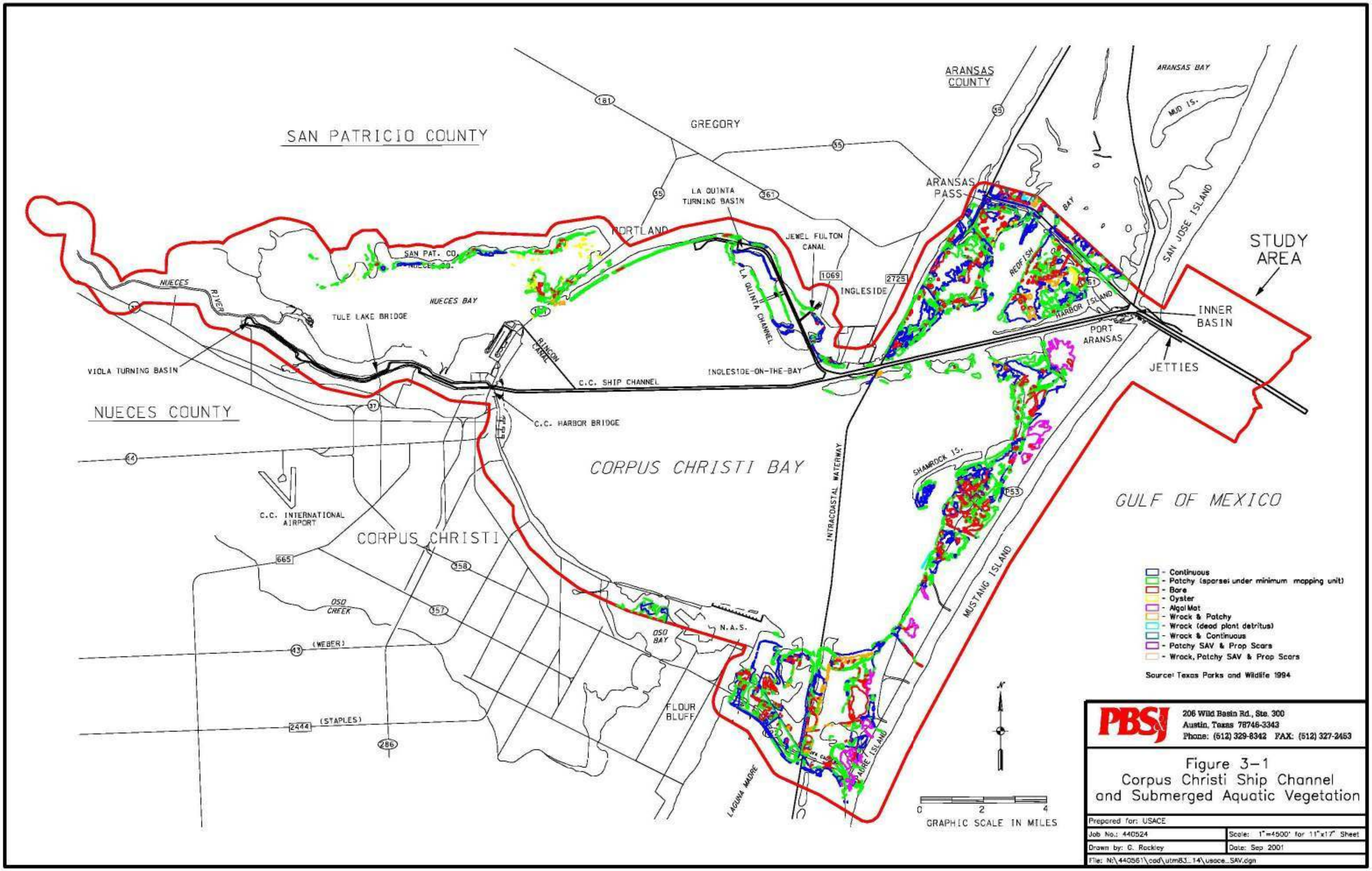

Figure 3–1
Corpus Christi Ship Channel and Submerged Aquatic Vegetation

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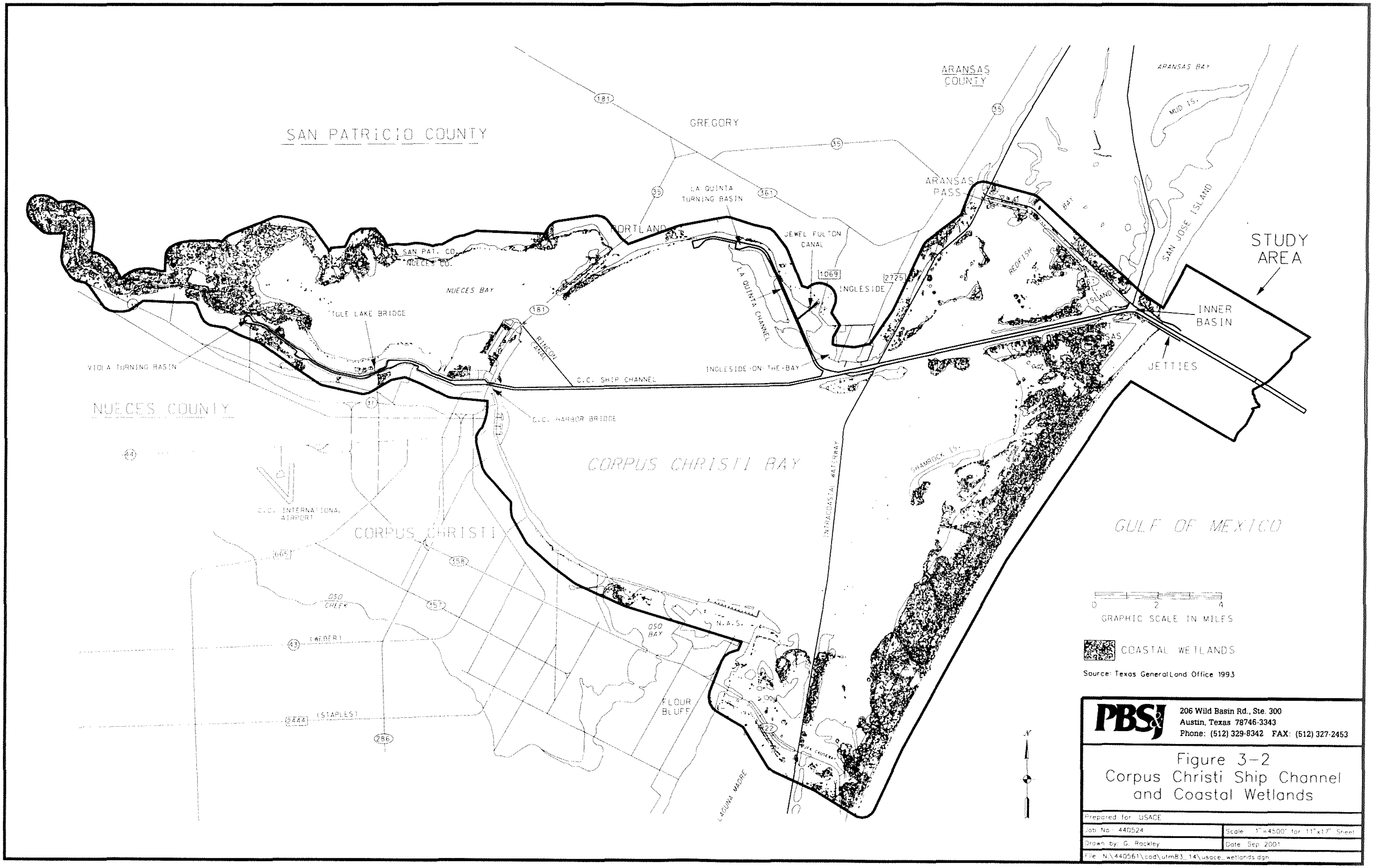
STUDY AREA
INNER BASIN
JETTIES
ARANSAS BAY
MUD IS.
SAN JOSE ISLAND
ARANSAS COUNTY
ARANSAS PASS
SAN PATRICIO COUNTY
GREGORY
PORTLAND
LA QUINTA TURNING BASIN
JEWEL FULTON CANAL
INGLESIDE
LA QUINTA CHANNEL
INGLESIDE-ON-THE-BAY
REDFISH BAY
SAN PAT. CO.
NUECES CO.
NUECES BAY
TULE LAKE BRIDGE
RINCON CANAL
C.C. SHIP CHANNEL
C.C. HARBOR BRIDGE
VIOLA TURNING BASIN
NUECES COUNTY
CORPUS CHRISTI BAY
INTRACOASTAL WATERWAY
SHAMROCK IS.
GULF OF MEXICO
C.C. INTERNATIONAL AIRPORT
CORPUS CHRISTI
OSO CREEK
(WEBER)
(STAPLES)
OSO BAY
N.A.S.
FLOUR BLUFF
LAGUNA MADRE
0 2 4
GRAPHIC SCALE IN MILES
COASTAL WETLANDS
Source: Texas General Land Office 1993
PBSJ
206 Wild Basin Rd., Ste. 300
Austin, Texas 78746-3343
Phone: (512) 329-8342 FAX: (512) 327-2453
Figure 3-2
Corpus Christi Ship Channel and Coastal Wetlands
Prepared for: USACE
Job No. 440524
Scale 1"=4500' for 11"x17" Sheet
Drawn by: G. Rockley
Date Sep 2001

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The estuarine wetlands potentially affected by the proposed dredging would be those in close proximity to the channel itself. There are approximately 12,700 acres of estuarine wetlands (not including flats as described below) in the study area.

3.4.2.2 Estuarine Sand Flats/Mud Flats/Algal Mats

This community type includes coastal wetlands periodically flooded by tidal waters and with less than 30 percent areal coverage by vegetation. This category includes sandbars, mud flats, and other nonvegetated or sparsely vegetated habitats called salt flats. Sparse vegetation of salt flats may include glasswort (*Salicornia* spp.), saltwort, and shoregrass (*Monanthochloe littoralis*). These tidal flats serve as valuable feeding grounds for coastal shorebirds, including the threatened piping plover, fish, and invertebrates. There are approximately 5,100 acres of this category within the study area.

Many of the tidal flats in the study area are considered wind tidal flats because they are exposed primarily by wind and storm tides as opposed to astronomical tides. These areas are generally hypersaline, which prevents or restricts macrophytic vegetation. Blue-green algal mats form in these areas. There are approximately 807 acres of algal mats in Corpus Christi Bay (including Oso Bay) and 87 acres in Redfish Bay/Harbor Island (Pulich et al., 1997).

3.4.3 Open Water/Reef Habitat

Open water areas include the unvegetated, bottom portion (excludes hard substrates such as oyster reefs) of the subtidal estuarine environment. Open water habitats support communities of benthic organisms and corresponding fisheries populations. Approximately 154,000 acres of open water habitat are in the study area.

There are a few scattered reefs of the Eastern oyster (*Crassostrea virginica*) present in some areas of Corpus Christi Bay (1.14 acres), Redfish Bay/Harbor Island (112.6 acres) and Nueces Bay (24.99 acres) (Pulich et al., 1997). According to the Corpus Christi National Estuary report (CCNEP-06C, 1996b), Gatsoff found most oyster reefs in Corpus Christi Bay to be dead; but did find living oyster reefs in Nueces Bay and the intertidal zone. Periodic TPWD surveys since that time also support these early findings.

3.4.4 Coastal Shore Areas/Beaches/Sand Dunes

The coastal shore areas function primarily as buffers protecting upland habitats from erosion and storm damage, and adjacent marshes and waterways from water-quality problems. A variety of birds occur on coastal shores of the Coastal Bend, and few are restricted to one particular habitat (Britton and Morton, 1989). Cranes, rails, coots, gallinules, and other groups can be found on the shorelines and in fringing marshes of the study area.

Beaches along the south Texas and Coastal Bend coastline are dynamic habitats subject to a variety of environmental influences, such as wind and wave action, salt spray, high temperature, and moisture stress. The harsh conditions associated with the beach/dune system support a relatively small number of adapted animals and plants. Sand dunes help absorb the impacts of storm surges and high waves and also serve to slow the intrusion of water inland. In addition, dunes store sand that helps deter shoreline erosion and replenish eroded beaches after storms. The dune complexes are of two types, primary and secondary, each of which supports a unique plant community. The primary dunes are taller and offer more protection from wind and hurricane storm surge. The secondary dunes are leeward (relative to Gulf winds) of the primary dunes, shorter and more densely vegetated. On the barrier islands of the Texas Coastal Bend, typical plant species of the primary dunes include sea oats *(Uniola paniculata*), bitter panicum (*Panicum amarum*), Gulf croton (*Croton punctatus*), beach morning glory (*Ipomea pes-caprae*) and fiddleleaf morning glory *(Ipomea stolonifera*). Secondary dune species include marshhay (*Spartina patens*), seashore dropseed, seashore saltgrass, pennywort (*Hydrocotyle bonariensis*) and partridge pea (*Chamaecrista fasciculata*).

3.5 FISH AND WILDLIFE RESOURCES

3.5.1 Finfish and Shellfish

The study area includes Corpus Christi Bay, Nueces Bay, and small portions of the Upper Laguna Madre, Redfish Bay, and the Gulf nearshore waters at the entrance channel in Port Aransas. Within the study area, environmental fluctuations are extreme and the inhabitant biota reflect and are adapted to this lack of stability in the environment (Warshaw, 1975). Large changes in habitat occur on a daily basis with respect to wind, tidal action, salinity regimes, and freshwater inflow. These ongoing natural processes are coupled with other natural events such as freezes, droughts, hurricanes, and anthropogenic pressures (i.e., management practices and coastal projects) in the study area. Nevertheless, the biological community present in the study area remains diverse and abundant. For example, Tunnell et al. (1996) reports 234 fish species within the CCBNEP study area which includes the study area for this project. The Gulf nearshore fish community includes many species found in both estuarine and offshore oceanic habitats (Tunnell et al., 1996). Most of the species in the Gulf nearshore waters are temperate in biogeographic distribution with a few tropical species (Tunnell et al., 1996).

Although adding pressure to the ecosystem, natural processes and events increase the diversity and abundance of organisms in the study area. The high energy flow in the study area is attributed in part to the shallow water depth with respect to a large surface area and results in high phytoplankton primary production (Tunnell et al., 1996). Higher salinities within the Upper Laguna Madre mean a reduced level of nutrients due to the lack of freshwater inflow, and these also play major roles in increasing the ecological efficiency. This high ecological efficiency found in this portion of the study area results in high abundances of the higher level consumers, such as benthic mollusks and fishes (Tunnell et al., 1996). Salinities within the study area can vary greatly depending on the time of year and location of the system. For example, the Upper Laguna Madre, lacking any river inflow, is a hypersaline lagoon having a much higher salinity than Corpus Christi Bay, whereas Nueces Bay has the lowest salinity of the study area due to inflow from the Nueces River (Tunnell et al., 1996).

A second factor regarding the diversity and abundance of organisms is past and present management strategies. As stated in CCBNEP-06C (1996b), "Management strategies are affected by estimated population densities, biology of target organisms, habitat quality, fishing technology, consumer demand, economic value, and special interest group demands." The competing forces of recreational and commercial fisheries have led to increased management activities along the Texas coast, including the elimination of gillnets in Texas bays and designation of red drum (*Sciaenops ocellatus*) and spotted seatrout (*Cynoscion nebulosus*) as "game species" (CCBNEP-06C, 1996b). Inlets such as Aransas Pass have also played a role in biological productivity by lowering salinity concentrations and providing a means for the ingress/egress of aquatic organisms, including species of red drum and spotted seatrout. In the study area, the Nueces River is one of the major freshwater inputs and is a vital part of the system, providing nutrients and sediment and affecting salinity, nutrient levels, circulation patterns and erosion (Tunnell et al., 1996).

3.5.1.1 Recreational and Commercial Species

The principal finfish harvested by sport-boat anglers in the study area from 1982 to 1992 were spotted seatrout, red drum, Atlantic croaker (*Micropogonias undulatus*), southern flounder (*Paralichthys lethostigma*), sheepshead (*Archosargus probatocephalus*), sand seatrout (*Cynoscion arenarius*), and black drum (*Pogonias cromis*) (Warren et al., 1994). Statistics for the Texas Coastal Fisheries show the Corpus Christi Bay system received bay and pass party-boat fishing pressure of 22 percent and landings of 51 percent of the total from 1991 to 1992, whereas the Upper Laguna Madre received 11 percent of coastwide fishing pressure and 7 percent of total Texas landings from 1983 to 1992 (Warren et al., 1994). Recreational boat landings from 1983 to 1991 for all finfish have shown an increased trend in the Nueces-Corpus Christi Bay and a decreased trend in the Upper Laguna Madre (Tunnell et al., 1996). Offshore, private anglers accounted for 25 percent of landings and 54 percent of the fishing pressure (1982-1992) with sand seatrout, king mackerel (*Scomberomorus cavalla*), and red snapper the most commonly landed finfish (Warren et al., 1994).

The most important commercial finfish species currently reported from the study area are black drum, flounder (*Paralichthyes* spp.), sheepshead, and striped mullet (*Mugil cephalus*) (Robinson et al., 1998). Leading Gulf landings for commercial finfish include grouper and snapper, with lesser numbers of cobia (*Rachycentron canadum*), black drum, and flounder also caught (Robinson et al., 1998). Overall, from 1972 to 1997, black drum, flounder, and sheepshead landings have declined in the study area (Robinson et al., 1998). However, from 1972 to 1993, 48 percent of the finfish in Texas bays were landed in the study area (Tunnell et al., 1996). In 1979, 1983, 1984, 1986, and 1987 in the Nueces-Corpus Christi Bay area, there has been an upward trend in landings, whereas in the Upper Laguna Madre, there has been a downward trend. It is not known if this is due to a shift in abundance of resources, fishing effort among bay systems, or a change in consumer demands (Tunnell et al., 1996).

The main shellfish species in the study area include brown shrimp (*Penaeus aztecus*), pink shrimp (*Penaeus duorarum*), white shrimp (*Penaeus setiferus*), blue crab (*Callinectes sapidus*), and eastern oyster (*Crassostrea virginica*). Within the study area, as with the Texas coast in general, brown shrimp are far more common than the other two penaeid species. The Upper Laguna Madre does not support a significant commercial shellfish industry; however, in the Nueces-Corpus Christi Bay system, shrimp has dominated the commercial harvest since 1975 (Tunnell et al., 1996). In addition, there were no eastern oyster landings reported by TPWD from the study area from 1993 to 1997 (Robinson et al., 1998). The commercial harvest of blue crabs in the Nueces-Corpus Christi Bay system remained low between 1972 to 1984, and from this point on, the harvest has exhibited patterns of increases and decreases. In the Upper Laguna Madre, the blue crab catch has remained low from 1972 to the present (Tunnell et al., 1996).

3.5.1.2 Aquatic Communities

In addition to the finfish discussed above as having high recreational and commercial value to humans, many additional aquatic communities are present in the study area that serve to support the ecological diversity and abundance. Other species found mainly in shallow areas include the longnose killifish (*Fundulus similis*), Gulf killifish (*F. grandis*), and tidewater silverside (*Menidia peninsulae*) (Warshaw, 1975). Inhabitants of seagrass meadows include the pinfish (*Lagodon rhomboides*), silver perch (*Bairdiella chrysura*), sheepshead, and pigfish (*Orthopristis chrysoptera*) (Warshaw, 1975). Species often found in deeper water, including the GIWW, are the Atlantic croaker, Gulf menhaden (*Brevoortia patronus*), and sea catfish (*Arius felis*), while a number of fish occur in abundance in both seagrass meadows and deeper areas, including the bay anchovy (*Anchoa mitchilli*), spot (*Leiostomus xanthurus*), and striped mullet (Warshaw, 1975). A study by Shaver (1984) of surf-zone fish revealed that almost 90 percent of the species sampled were larvae and small juveniles including sardine (*Harengula jaguana*), anchovy, Atlantic croaker, mullet, Gulf menhaden, Atlantic thread herring (*Opisthonema oglinum*), and Florida pompano (*Trachinotus carolinus*).

The entire food chain is dependent on the microscopic plankton which utilizes nutrients and provides an abundant food source. The plankton community consists of small plants (phytoplankton) and animals (zooplankton) that are suspended in the water column. Diverse and abundant plankton communities exist throughout the study area. The abundance of plankton has been directly related to salinity and temperature (Tunnell et al., 1996). Seasonal patterns have also been found with phytoplankton and zooplankton (Tunnell et al., 1996).

The benthic macroinvertebrates of the study area form a highly diverse group of organisms with a wide variety of functions in the aquatic community. Their diversity is related to salinity and, as salinity levels rise, marine species are able to colonize the system. In addition to serving as a major food source for vertebrate predators such as fish, macroinvertebrates have important roles as herbivores, detritivores, and carnivores. Tunnell et al. (1996) reported that benthic macroinvertebrates found in the sediments of the study area were primarily polychaetes, bivalves, gastropods, and crustaceans. In Nueces Bay, polychaetes and bivalves comprised the majority of the benthic macroinvertebrates. Polychaetes composed 60 percent of total abundance in Corpus Christi Bay, and bivalves were seasonally abundant. The abundance of macroinvertebrates in Corpus Christi Bay is highest during the winter and spring (Tunnell et al., 1996). Benthic communities in the Gulf nearshore waters undergo widely fluctuating, dynamic, and harsh physical conditions resulting in a few dominant organisms which are low in species diversity but high in density, including polychaetes, mollusks, and crustaceans (Tunnell et al., 1996).

Benthic fauna found in natural sand mud bottom areas offshore from Corpus Christi (for the Corpus Christi Ship Channel ocean dredged material disposal site study) include polychaetes, gastropods, decapods, bivalves, echinoderms, ribbon worms (*Rhynchocoela*), and peanut worms (*Sipuncula*) (EPA, 1988). Within this EPA document, Science Applications (1984) reported on 1983 EPA findings at the CCSC site and indicated that the sampling locations in natural mixed bottom habitat represented higher numbers of individuals, taxa, and species diversity in comparison to those found in the primarily sand-bottomed disposal sites.

3.5.1.3 Essential Fish Habitat

The proposed Project is located in an area that has been identified by the Gulf of Mexico Fishery Management Council (GMFMC) as Essential Fish Habitat (EFH) for postlarval, juvenile, and subadult red drum, brown shrimp and white shrimp, adult Spanish mackerel (*Scomberomorus maculatus*), and juvenile pink shrimp. Coordination with NMFS has been completed. EFH for these species known to occur in the project area includes estuarine emergent wetlands, estuarine mud, sand and shell substrates, SAV, estuarine water column, non-vegetated bottom, and artificial reefs. Detailed information on red drum, shrimp, and other Federally managed fisheries and their EFH is provided in the 1998 amendment of the Fishery Management Plans for the Gulf of Mexico prepared by the GMFMC. The 1998 EFH amendment was prepared as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (P.L. 104–297) as amended.

The following describes the preferred habitat of each species and relative abundance of each species based on information provided by GMFMC (1998).

Juvenile brown shrimp are considered abundant within the project area from February to April with a minor peak in the fall. The density of postlarvae and juveniles is highest in marsh edge habitat and SAV, followed by tidal creeks, inner marsh, shallow open water and oyster reefs. Juveniles and sub-adults of brown shrimp occur from secondary estuarine channels out to the continental shelf but prefer shallow estuarine areas, particularly the soft, muddy areas associated with the plant-water interface. Adult brown shrimp occur in neritic Gulf waters (i.e., marine waters extending from mean low tide to the edge of the continental shelf) and are associated with silt, muddy sand, and sandy substrates (GMFMC, 1998).

Juvenile white shrimp are considered abundant within the project area from May through November with peaks in June and September. Postlarval white shrimp become benthic upon reaching the nursery areas of estuaries, where they seek shallow water with muddy-sand bottoms high in organic detritus. As juveniles, white shrimp are typically associated with estuarine mud habitats with large quantities of decaying organic matter or vegetative cover. Densities are usually highest in marsh edge and SAV, followed by marsh ponds and channels, inner marsh, and oyster reefs. As adults, white shrimp move from estuaries to coastal areas, where they are demersal and generally inhabit bottoms of soft mud or silt (GMFMC, 1998).

Red drum occur in a variety of habitats, ranging from depths of 40 meters offshore to very shallow estuarine waters. In the juvenile life stages they are considered common within the project area year-round. They are commonly known to occur in all Gulf estuaries where they are found over a variety of substrates including sand, mud and oyster reefs. An abundance of juvenile red drum has been reported around the perimeter of marshes in estuaries (Perret et al., 1980). Young fish are found in quiet, shallow, protected waters with grassy or slightly muddy bottoms (Simmons and Breuer, 1962). Shallow bay bottoms or oyster reef substrates are especially preferred by subadult and adult red drum (Miles, 1950). Spawning occurs in deeper water near the mouths of bays and inlets and on the Gulf side of the barrier islands (Pearson, 1929; Simmons and Breuer, 1962; Perret, et al., 1980). Larvae are transported into the emergent estuarine wetlands where they mature before moving back to the Gulf.

As juveniles, Spanish mackerel are considered common in relative abundance only during the high salinity season between August and October. Although nursery areas are in emergent estuarine communities, juveniles are found offshore and in beach surf and are generally not considered estuarine dependent. Adult Spanish mackerel are usually found along coastal areas, extending out to the edge of the continental shelf (GMFMC, 1998).

Postlarvae and juveniles of pink shrimp occur in estuarine waters of wide-ranging salinity (0 to >30 ppt). Juveniles are commonly found in estuarine areas with seagrass where they burrow into the substrate by day and emerge at night. Postlarvae, juveniles, and subadults may prefer coarse sand/shell/mud mixtures. Densities are highest in or near seagrasses, low in mangroves, and near zero or absent in marshes. Adults inhabit offshore marine waters with the highest concentrations in depths of 9 to 44 meters. Preferred substrate of adults is coarse sand and shell with a mixture of less than 1 percent organic material (GMFMC, 1998).

3.5.2 Wildlife Resources

The study area lies within Blair's (1950) Tamaulipan Biotic Province. The area is semi-arid and hot, with marked deficiency of moisture for plant growth. The vertebrate fauna of this province includes considerable elements of neotropical as well as grassland species. Wildlife habitats found within the study area include upland prairies, salt marsh and seagrass beds, and tidally influenced lowlands. The coastal wetlands of the bay system are represented by salt marshes (previously defined in Section 3.4) on the delta of the Nueces River and Nueces Bay. The Upper Laguna Madre supports two Audubon sanctuaries, documented migratory/waterbird nesting sites, Padre Island National Seashore, Mollie Beattie Habitat Community and Mustang Island State Park. The Audubon sanctuaries are associated with North and South Bird islands in the Upper Laguna Madre south of the study area.

The Tamaulipan Biotic Province supports a diverse fauna composed of a mixture of species that are common in neighboring biotic provinces. The fauna includes a substantial number of neotropical species from the south, a large number of grassland species from the north and northwest, a few Austroriparian species from the northeast, and some Chihuahuan species from the west and southwest (Blair, 1950).

At least 19 species of lizards and 36 species of snakes occur in the Tamaulipan Biotic Province (Blair, 1950). Reptile species of potential occurrence in the study area include such amphibians as Blanchard's cricket frog (*Acris creptians blanchardi*), Texas toad (*Bufo speciosus*), Great Plains narrowmouth toad (*Gastrophryne olivacea*), and bull frog (*Rana catesbiana*). Terrestrial reptiles of potential occurrence in the study area include the western glass lizard (*Ophisaurus attenuatus attenuatus*), six-lined racerunner (*Cnemidophorus sexlineatus sexlineatus*), keeled earless lizard (*Holbrookia propinqua propinqua*), Texas spotted whiptail (*Cnemidophorus gularis*), western coachwhip (*Masticophis flagellum tesaceus*), ground snake (*Sonora semiannulata*), and western diamondback rattlesnake

(*Crotalus atrox*). Five species of sea turtles are also known to occur within the Gulf of Mexico and associated bays. These sea turtles include the loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea*), Atlantic hawksbill sea turtle (*Eretmochelys imbricata*), and Kemp's Ridley sea turtle (*Lepidochelys kempii*).

The immediate study area and vicinity support an abundant and diverse avifauna. Tidal flats and beaches create excellent habitat for numerous species of gulls, terns, herons, shorebirds, and wading birds. Some common species which occur within the study area include the laughing gull (*Larus atricilla*), ring-billed gull (*Larus delawarensis*), royal tern (*Sterna maxima*), sandwich tern (*Sterna sandvicensis*), great blue heron (*Ardea herodias*), little blue heron (*Egretta caerulea*), sanderlings (*Calidris alba*), least sandpiper (*Calidris minutilla*), roseate spoonbill (*Ajaia ajaja*), and white ibis (*Eudocimus albus*). Thousands of sandhill cranes (*Grus canadensis*) utilize tall grass coastal prairies and fallow agricultural fields throughout the south Texas coast.

Other bird species which are associated with prairies and marshes include many species of raptors, songbirds, and migratory waterfowl. Texas is one of the most significant waterfowl wintering regions in North America with three to five million waterfowl annually (recent years) wintering in the state (Texas Coastal Management Program (TCMP), 1996).

At least 61 mammalian species occur or have occurred within recent times in the Tamaulipan Biotic Province (Blair, 1950). Terrestrial mammals likely to occur in the study area include the black-tailed jack rabbit (*Lepus californicus*), Gulf Coast kangaroo rat (*Dipodomys compactus*), marsh rice rat (*Oryzomys palustris*), fulvous harvest mouse (*Reithrodontomys fulvescens*), common raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and coyote (*Canis latrans*). Marine mammals are also likely to occur within the study area. The bottle-nosed dolphin (*Tursiops truncatus*) is the marine mammal most likely to be encountered.

3.6 THREATENED AND ENDANGERED SPECIES

The Endangered Species Act (ESA) [16 U.S.C. 1531 et. Seq.] of 1973 as amended, was enacted to provide a program for the preservation of endangered and threatened species and to provide protection for the ecosystems upon which these species depend for their survival. All Federal agencies are required to implement protection programs for these designated species and to use their authorities to further the purposes of the act. The FWS and the NMFS are the primary agencies responsible for implementing the ESA. The FWS is responsible for birds and terrestrial and freshwater species, while the NMFS is responsible for non-bird marine species.

An endangered species is one that is in danger of extinction throughout all or a significant portion of its range in the U.S. A threatened species is one likely to become endangered within the foreseeable future throughout all or a significant portion of its range. State-listed threatened and endangered species, while addressed in this assessment, are not protected under the ESA, nor are Species of Concern (SOC), which are species for which there is some information showing evidence of vulnerability, but not enough data to support a Federal listing. Only those species listed as endangered or threatened by the FWS or NMFS are afforded complete Federal protection. It should be noted that inclusion on the following lists does not imply that a species is known to occur in the study area, but only acknowledges the potential for occurrence. County lists of special species provided by the Texas Parks and Wildlife Biological Conservation Data System (TXBCD, 1999) in addition to the most recent list of threatened and endangered species of Texas by county disseminated by the FWS (2000) were reviewed. TXBCD data files were also reviewed in order to obtain specific species' locations within the study area.

3.6.1 Flora

Table 3.6-1 presents Federally and State-endangered plant species and SOC that may occur in the study area. Texas Parks and Wildlife uses the same listing designations as the FWS for plants. Plants having a geographic range including Nueces and San Patricio counties are briefly discussed.

Three plant species listed by both the FWS and TPWD as endangered may potentially occur within the study area. These plants include south Texas ambrosia (*Ambrosia cheiranthifolia*), slender rush-pea (*Hoffmannseggia tenella*), and black lace cactus (*Echinocereus reichenbachii* var. *albertii*).

South Texas ambrosia is an inhabitant of open prairies in grassland/mesquite-dominated savannah in clay loam to sandy loam soils (FR 59 43648-43652). Much of its original habitat has been converted to cropland or introduced forage species. It is known from Nueces, Kleberg, and Jim Wells counties in the U.S. and Tamaulipas in Mexico. Known stands of this species occur in rights-of-way along highways and railways, where the species is subject to weed-control measures including mowing and herbicide applications (Turner, 1983). This species has a record of occurrence within the study area adjacent to the Nueces River.

The slender rush-pea is known from only four populations in Kleberg and Nueces counties. It is found in barren openings within native grassland and brush in calcareous clay soils (FWS, 1997). Introduction of non-native grasses and conversion of prairies to agriculture are thought to be responsible for its decline. It is of possible occurrence within the study area.

One endangered cactus is known to have a geographic range which includes the study area. The black lace cactus has a range in the south Texas plains which includes Jim Wells, Kleberg, and Refugio counties (Poole and Riskind, 1987). This cactus occurs in brushy, grassy areas along streams in an area where the coastal plain meets the inland mesquite/huisache/blackbrush savannah (Poole and Riskind, 1987). The occurrence of this species within the study area is unlikely due to lack of suitable soils and habitat. Texas Parks and Wildlife includes this species on their Nueces County list of rare species (TXBCD, 1999).

Six plant species identified as SOC by the FWS have records in Nueces or San Patricio counties. These species include: lila de los llanos (*Echeandia chandleri*); Texas windmillgrass (*Chloris texensis*); Thieret's skullcap (*Scutellaria thieretii*); Roughseed sea-purslane (*Sesuvium trianthemoides*); Welder machaeranthera (*Psilactis heterocarpa*); and Mathis spiderling (*Boerhavia mathisiana*). Thieret's skullcap is known from within the study area; lila de los llanos, roughseed sea-purslane, and Texas

TABLE 3.6-1

ENDANGERED, THREATENED, AND SPECIES OF CONCERN
POTENTIALLY OCCURRING IN THE PROJECT AREA
NUECES AND SAN PATRICIO COUNTIES, TEXAS[1]

Common Name[2]	Scientific Name[2]	Status[3]	
		FWS	TPWD
AMPHIBIANS			
Sheep frog	*Hypopachus variolosus*	--	T
Black-spotted newt	*Notophthalmus meridionalis*	--	T
South Texas siren	*Siren* sp.[1]	--	T
Rio Grande lesser siren	*Siren intermedia texana*	SOC	--
BIRDS			
Brown pelican	*Pelecanus occidentalis*	E	E
Reddish egret	*Egretta rufescens*	--	T
White-faced ibis	*Plegadis chihi*	--	T
Bald eagle	*Haliaeetus leucocephalus*	T/PDL	T
Northern gray hawk	*Buteo mitidus maximus*	SOC	--
White-tailed hawk	*Buteo albicaudatus*	--	T
Ferruginous hawk	*Buteo regalis*	SOC	--
American peregrine falcon	*Falco peregrinus anatum*	--	E
Arctic peregrine falcon	*Falco peregrinus tundrius*	--	T
Black rail	*Lateralus jamaicensis*	SOC	--
Whooping crane	*Grus americana*	E	E
Piping plover	*Charadrius melodus*	T	T
Mountain plover	*Charadrius montanus*	PT	--
Eskimo curlew	*Numenius borealis*	E	E
Sooty tern	*Sterna fuscata*	SOC	T
Black tern	*Chilidonias niger*	SOC	--
Loggerhead shrike	*Lanius ludovicianus*	SOC	--
Cerulean warbler	*Dendroica cerulea*	SOC	--
Texas olive sparrow	*Arremonops rufivirgatus*	SOC	--
Texas Botteri's sparrow	*Aimophila botteri texana*	SOC	T
Sennett's hooded oriole	*Icterus cucullatus sennetti*	SOC	--
Audubon's oriole	*Icterus graduacauda audubonii*	SOC	--
Wood stork	*Mycteria americana*	--	T

TABLE 3.6-1 (Cont'd)

Common Name[2]	Scientific Name[2]	Status[3]	
		FWS	TPWD
FISH			
Opossum pipefish	*Microphis brachyurus*	--	T
MAMMALS			
Southern yellow bat	*Lasiurus ega*	--	T
Maritime pocket gopher	*Geomys personatus maritimus*	SOC	--
Red wolf (extirpated)	*Canus rufus*	E	E
Ocelot	*Leopardus pardalis*	E	E
Jaguarundi	*Herpailurus yagouaroundi*	E	E
West Indian manatee	*Trichechus manatus*	E	E
REPTILES			
Loggerhead sea turtle	*Caretta caretta*	T	T
Green sea turtle	*Chelonia mydas*	T	T
Leatherback sea turtle	*Dermochelys coriacea*	E	E
Atlantic hawksbill sea turtle	*Eretmochelys imbricata*	E	E
Texas tortoise	*Gopherus berlandieri*	--	T
Kemp's Ridley sea turtle	*Lepidochelys kempii*	E	E
Texas diamondback terrapin	*Malaclemys terrapin littoralis*	SOC	--
American alligator	*Alligator mississipiensis*	T/SA	--
Texas horned lizard	*Phrynosoma cornutum*	--	T
Scarlet snake	*Cemophora coccinea*		
Timber/canebrake rattlesnake	*Crotalus horridus*		T
Indigo snake	*Drymarchon corais*	--	T
Northern cat-eyed snake	*Leptodeira septentrionalis*	--	T
Gulf saltmarsh snake	*Nerodia clarkii*	SOC	--
PLANTS			
Black-laced cactus	*Echinocereus reichenbachii* var,	E	E
South Texas ambrosia	*Ambrosia cheiranthifolia*	E	E
Slender rush-pea	*Hoffmanseggia tenella*	E	E
Lila de los llanos	*Echeandia chandleri*	SOC	--
Texas windmill grass	*Chloris texana*	SOC	--

TABLE 3.6-1 (Concluded)

Common Name[2]	Scientific Name[2]	Status[3] FWS	TPWD
PLANTS (Concluded)			
Theiret's skullcap	*Scutellaria thieretii*	SOC	--
Roughseed sea-purslane	*Sesuvium trianthemoides*	SOC	--
Welder machaeranthera	*Psilactis heterocarpa*	SOC	--
Mathis spiderling	*Boerhavia mathisiana*	SOC	--
INSECTS			
Maculated manfreda skipper	*Stallingsia maculosus*	SOC	

[1] According to FWS (1995, 2000), TPWD (1997), and TXBCD (1999).

[2] Nomenclature follows AOU (1998), Collins (1990), Hatch et al. (1990), and Jones et al. (1997).

[3] FWS - U.S. Fish and Wildlife Service; TPWD - Texas Parks and Wildlife Department.

E Endangered; in danger of extinction E/SA, T/SA - No longer biologically threatened or endangered but because of the similarity of appearance to other protected species, it is necessary to restrict commercial activities of specimens taken in the USA to ensure the conservation of similar species that are biologically threatened or endangered.

T Threatened; severely depleted or impacted by man.

-- Not listed.

PDL Proposed delisting.

PT Federally proposed threatened.

SOC Species of concern - species for which there is some information showing evidence of vulnerability but not enough data to support listing at this time.

windmillgrass have records of occurrence near the study area, thus the potential for occurrence of these species within the study area exists.

Lila de los llanos occurs on level to gently undulating sites along and somewhat inland from the Gulf Coast of Texas. It prefers full sunlight and grows among prairies and chaparral thickets on heavy clay and loamy clay soils (Poole, 1985). Texas windmillgrass occurs along the Gulf Coast and throughout the northeastern Rio Grande Plains of Texas. It prefers silty and sandy loam soils and is known from Nueces County (Poole et al., 2000). Thieret's skullcap occurs on shell, sand, shell ridges, or sandy meadows usually not far from brackish marshes. It is also found growing in close association within woodlands dominated by honey locust (*Gleditsia tricanthos*) and sugar hackberry *(Celtis laevigata*) in non-disturbed soils (Kral, 1983). Roughseed sea-purslane occurs on dunes of south Texas (Correll and Johnston, 1970) and in brackish swales, marshes and depressions along the coast (Jones, 1977). Poole et al. (2000), show its range occurring only in Kenedy County. Welder machaeranthera occurs in shrub-invaded grasslands and open mesquite-huisache woodlands on mostly gray clays to silty soils overlying the Lissie and Beaumont formations (Texas Organization for Endangered Species [TOES], 1993). It has been documented in both Kleberg and Nueces counties (Poole et al., 2000). Mathis spiderling is recorded in San Patricio and Live Oak counties; however, the greatest known populations are located in Mexico. This small, perennial herb grows on thin soils over limestone, in limestone cracks or rubble in tall thorn shrub, growing in the open and under shrubs (54 FR 27413-27414). No known occurrence of this species has been recorded within or in the vicinity of the study area.

3.6.2 Wildlife

Table 3.6-1 lists wildlife taxa that may occur in the study area that are considered by FWS and TPWD to be endangered, threatened or SOC. Table 3.6-1 is composed of endangered and threatened species that have a geographic range which may include Nueces or San Patricio counties. As with the flora noted above, inclusion on the list does not imply that a species is known to occur in the study area, but only acknowledges the potential for occurrence. The following paragraphs present distributional data concerning each Federally or State-listed species, along with a brief evaluation of the potential for the species to occur within the study area.

3.6.2.1 Amphibians

Four amphibians are listed by the TXBCD and FWS as potentially occurring within the study area counties. Three species that are State-listed as threatened include the sheep frog (*Hypopachus variolosus*), black-spotted newt (*Notophalmus meridionalis*), and South Texas siren (*Siren* sp.). The Rio Grande lesser siren (*Siren intermedia texana*) is identified as a SOC by the FWS. The sheep frog is known to occur in moist burrows of subterranean mammals, under vegetative debris, and around pond edges and irrigation ditches (Garrett and Barker, 1987). This species has been recorded from counties within the study area (Dixon, 1987). The black-spotted newt inhabits heavily vegetated, shallow water lagoons, streams, ditches and swamps (Garrett and Barker, 1987). The black-spotted newt may occur in wetland sites within the study area. The South Texas siren is known to occur in the study area in habitat similar to that occupied by the black-spotted newt. However, the newt requires year-round open water since it cannot aestivate in dry ground like the siren. The Rio Grande lesser siren prefers warm, shallow waters with vegetative cover such as those in ponds, irrigation canals and swamps in permanently to semipermanently inundated areas in counties along the lower coast of Texas and along the Rio Grande (Bartlett and Bartlett, 1999).

3.6.2.2 Birds

Twenty-four endangered, threatened, and SOC bird species are listed by the FWS and/or TXBCD as occurring or potentially occurring in the study area. Several of these are predominantly inland species that are not ordinarily expected on the coast, or are migrants that pass through the region seasonally. Others may occur as breeding birds, permanent residents, or post-nesting visitors. Federally listed species are described below, followed by descriptions of State-listed species and then Federal SOC.

The Federally and State-endangered brown pelican (*Pelecanus occidentalis*) is primarily a coastal species that rarely ventures very far out to sea or inland. In Texas, it occurs primarily along the lower and middle coast, and now common sightings are reported on the upper coast and inland to central, north-central and eastern Texas, usually on large freshwater lakes (Texas Ornithologists Union (TOS), 1995). Brown pelicans are colonial nesters, usually nesting on undisturbed offshore islands in small bushes and trees, including mangroves (National Fish and Wildlife Laboratory (NFWL), 1980; Guzman and Schreiber, 1987). This species is a common resident of the area and is likely to occur in the open water habitat and sand/mud flats in the study area. Pelican Island, located just south of the CCSC, is a major brown pelican nesting site.

The bald eagle (*Haliaeetus leucocephalus*) has recovered sufficiently to be downlisted to threatened throughout its range, and the FWS has proposed to completely delist the species in the near future (64 FR 36453-36363; July 6, 1999). Two subspecies are currently recognized based on size and weight: the northern bald eagle and the southern bald eagle. The northern population nests from central Alaska and the Aleutian Islands through Canada into the northern U.S. The southern population primarily nests in estuarine areas of the Atlantic and Gulf coasts, northern California to Baja California, Arizona and New Mexico (Snow, 1981). Wintering ranges of the two populations overlap. The bald eagle inhabits coastal areas, rivers and large bodies of water as fish and waterfowl comprise the bulk of their diet. Nests are seldom far from a river, lake, bay, or other water body. Nest trees are generally located in woodlands, woodland edges, or open areas, and are frequently the dominant or co-dominant tree in the area (Green, 1985). The 1999 bald eagle nesting survey in Texas identified 82 nesting territories statewide, the southernmost found in Refugio, Goliad, Victoria, and Matagorda counties (Mitchell, 1999). Concentrations of wintering northern eagles are often found around the shores of reservoirs in Texas, with most wintering concentrations occurring in the eastern part of the state. Wintering bald eagles in Texas have been observed as far south as Cameron County (Oberholser, 1974), and are considered to be a rare permanent resident in the Coastal Bend (Rappole and Blacklock, 1985). No nests are known to occur in the study area, nor have any been reported from Nueces County (Mitchell, 1999). The bald eagle should occur in the study area only as a rare migrant or post-nesting visitor.

Each year, the entire breeding population of the Federal and State-endangered whooping crane (*Grus americana*) migrates 2,600 miles from Canada's Northwest Territories and winters in the prairies, salt marshes and bays along a narrow section of the Texas coast centered around the Aransas

National Wildlife Refuge. Rest areas along the migration route include the central and eastern panhandle of Texas (FWS, 1995). In Texas, the principal winter habitat is brackish bays, marshes, and salt flats, and whooping cranes will feed in nearby upland sites characterized by oak mottes, grassland swales, and ponds (Campbell, 1995). In Texas, they eat a wide variety of plant and animal foods, including blue crabs, clams, berries of Carolina wolfberry (*Lycium carolinianum*), acorns, snails, crayfish, and insects (Campbell, 1995). The whooping crane has been recorded from counties within the study area but is generally restricted to the Aransas National Wildlife Refuge in Aransas, Refugio, and Calhoun counties. Though the leeward side and interior of Padre Island provide suitable winter habitat for whooping cranes, they are unlikely to occur in the study area.

The Federally and State-threatened piping plover is a winter resident and spring and fall migrant of the study area. This small shorebird 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). Post-breeding and 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). The piping plover can be found along Texas beaches, tidal flats, mud flats, sand flats, dunes, and offshore spoil islands (American Ornithologists Union (AOU), 1998; FWS, 1995) arriving in mid- to late July (Haig and Oring, 1985). The piping plover is a regular migrant and winter resident along the lower Texas coast (Oberholser, 1974; Haig and Oring, 1985). The checklist of birds of Mustang Island State Park lists the piping plover as a fairly common winter resident and a common migrant (Pulich et al., 1985). This species is also known to occur within the Mollie Beattie Habitat Community (Zonick and Ryan, 1996; GLO and FWS, 1998). This species has been documented here as recently as August 2001 (PBS&J, in-house data). As a result of a lawsuit, critical habitat was designated for this species in its nesting and wintering grounds (65 FR 41781-41812, July 6, 2000). Designation of critical habitat became final on July 10, 2001 (66 FR 36038). Portions of the study area, but not the footprint of the project, are within Critical Habitat units TX-6, TX-7, TX-8, TX-9, TX-10, TX-11, TX-12, TX-13, TX-14, and TX-16. Designation of critical habitat became final on July 10, 2001 (66 FR 36038).

The mountain plover (*Charadrius montanus*) was proposed for listing as a Federally threatened species on February 16, 1999 (64 FR 7587). Non-breeding birds prefer short-grass plains, fields, plowed fields, sandy deserts, and sod farms (NatureServe, 2000a). The mountain plover is a rare to uncommon local winter resident on the coastal plains and inland from south Texas through the Edwards Plateau into the South Plains (TOS, 1995). The mountain plover has been recorded from Nueces County (Oberholser, 1974). It is most likely to occur in agricultural areas away from the seashore. This species appears as an uncommon migrant on the checklist for birds of the Corpus Christi area (Audubon Outdoor Club of Corpus Christi (AOCCC), 1994), but is absent from checklists for Mustang Island State Park (Pulich et al., 1985) and the Padre Island National Seashore (Southwest Parks and Monuments Association (SPMA), 1990). This species is unlikely to occur within the study area.

The current status of the Eskimo curlew (*Numenius borealis*) is considered uncertain and possibly extinct (TOS, 1995), but the species is considered Federally and State-listed as endangered. This species was extremely abundant in the nineteenth century, but was subject to extreme hunting pressures. The breeding habitat of the Eskimo curlew was treeless arctic and subarctic tundra (Gill et al., 1998). Non-breeding birds use a variety of habitats, such as grasslands, pastures, plowed fields, and less frequently, marshes and mud flats (AOU, 1983). Spring migration would bring them through Texas and the midwestern U.S. (Gill et al., 1998) from mid-March to late April in Texas (Oberholser, 1974). One record does exist from Galveston, Texas, in 1962, and others since have been reported, but the validity of these records is uncertain (TOS, 1995). The Eskimo curlew is unlikely to occur in the study area due to its extreme rarity and the lack of recent records of occurrence.

The reddish egret (*Egretta rufescens)*, a State-threatened species, typically inhabits saltwater bays and marshes. Its breeding range is restricted to the Gulf Coast where it commonly nests in yucca-prickly pear thickets (Oberholser, 1974). The white-faced ibis (*Plegadis chihi*), State-listed as threatened, is a common resident along the coast. Preferred habitats of the white-faced ibis have been described as ranging from freshwater marshes and sloughs and irrigated rice fields to salt marshes (Oberholser, 1974). Both of these species occur within the study area.

The white-tailed hawk (*Buteo albicaudatus*) is listed as State threatened and is considered an uncommon local resident along the Texas coastal plain (TOS, 1995). The white-tailed hawk could be present in savannah-like, grassland habitats within the study area.

All North American peregrine falcons were delisted from the endangered species list (64 FR 46541-46558, August 2, 1999). The Arctic peregrine falcon (*Falco peregrinus tundrius*), which was listed as endangered due to similarity of appearance (E/SA) was delisted Federally but remains on the TPWD threatened list. The Arctic peregrine falcon winters along the entire Gulf Coast and occurs statewide during migration (FWS, 1995). The American peregrine falcon (*Falco peregrinus anatum*) remains on the State endangered list.

The sooty tern (*Sterna fuscata*), State-listed as threatened and a Federal SOC, is considered a rare local summer resident along the central and lower coast (TOS, 1995). This pelagic bird spends almost its entire life at sea. Many records have been reported on the Texas coast following large tropical storms. Oberholser (1974) shows a breeding and a summer record of the sooty tern in Nueces County. This species is a rare but potential vagrant to the study area.

The Texas Botteri's sparrow (*Aimophila botterii texana*) is an uncommon to locally common summer resident on the lower coastal plain, with isolated breeding records from Duval, Jim Wells, and San Patricio counties (TOS, 1995). This sparrow is an inhabitant of tall bunch grass prairie with widely scattered shrubs and small trees mostly within 20 miles of the Gulf Coast (Oberholser, 1974). The reason for a decline in numbers of this species is attributed mostly to depletion of habitat due to agriculture practices (Oberholser, 1974). Texas Parks and Wildlife considers this sparrow to be State threatened.

The wood stork (*Mycteria americana*) is listed as threatened by TPWD. This bird is an uncommon to common post-breeding visitor to the central and upper coastal prairies and a regular visitor of lakes and reservoirs in central and east Texas. This species has been recorded within the study area counties (Oberholser, 1974; TOS, 1995).

Two additional *Buteo* species, northern gray hawk (*Buteo nitidus maximus*) and ferruginous hawk (*Buteo regalis*), are considered SOC by the FWS. The northern gray hawk is a rare to uncommon local resident in the Lower Rio Grande Valley (TOS, 1995). In Texas, this hawk inhabits mature woodlands of the river valleys and nearby semi-arid mesquite and scrub grasslands (Oberholser, 1974). Oberholser (1974) shows a fall record of the northern gray hawk from Nueces County. This species is unlikely to occur in the study area. The ferruginous hawk ranges the wide open spaces of the dry Great Plains and Great Basin in western North America (Oberholser, 1974). It may occur in the study area as a migrant or winter resident. It is considered locally uncommon on Texas' barrier islands and the central and south coastal plains (TOS, 1995). Two ferruginous hawks are known to overwinter in the study area (Beasley, 1998).

Three additional avian SOC of potential occurrence in the study area include the black rail (*Laterallus jamaicensis*), black tern (*Chlidonias niger*), and loggerhead shrike (*Lanius ludovicianus*). The black rail is a rare migrant and winter resident in the state (Oberholser, 1974) and a potential migrant to the study area. It is primarily a bird of coastal marshes, typically dominated by smooth cordgrass. The black tern is a common migrant in all parts of Texas including offshore waters (TOS, 1995). It breeds in marshy areas of the northern U.S. and Canada, and may migrate through Texas during all months except January, February, and March (Oberholser, 1974). This species occurs within the study area. The loggerhead shrike is an inhabitant of open country with scattered trees and shrubs. It is a rare to common resident throughout the state, except for portions of the South Texas Plains. It is a possible resident/migrant within the study area.

Four songbirds of potential occurrence within the study area are considered SOC by the FWS. These four species are: cerulean warbler (*Dendroica cerulea*), Texas olive sparrow (*Arremonops rufivirgatus*), Sennett's hooded oriole (*Icterus cucullatus sennettii*), and Audubon's oriole (*Icterus gradaucada audubonii*). The cerulean warbler is a rare to uncommon spring migrant in the eastern half of the state, mostly on the coast, and south to the Rio Grande Valley (TOS, 1995) and prefers deciduous or mixed woodlands near stream bottoms. It is likely to occur within the study area only during migration. The olive sparrow is a common resident in south Texas, extending north to Goliad, Karnes, Uvalde, and Val Verde counties (TOS, 1995). This sparrow inhabits dense brushy areas where it spends much of its life on or near the ground. This species is unlikely to inhabit the study area, due to lack of appropriate habitat. Sennett's oriole is a summer resident and rare winter resident in south Texas. It inhabits areas closely associated with towns where it nests in palm (*Washingtonia* sp. and *Sabal* sp.) and pecan (*Carya illinoinensis*) trees (Oberholser, 1974). Audubon's oriole is a rare to uncommon resident in south Texas and is typically found in wooded or brushy areas. During the warmer months, it tends to prefer mesquite woodlands; in winter it can be found in evergreen trees such as live oak (*Quercus virginiana*) along with huisache (*Acacia smallii*) and Texas ebony (*Pithecellobium flexicaule*) (Oberholser, 1974). The presence of either of these orioles in the study area is unlikely.

3.6.2.3 Fish

A candidate species is, as its name implies, a candidate for listing under the ESA. More specifically, it is a species or vertebrate population for which sufficient reliable information is available that a listing under the ESA may be warranted. There are no mandatory Federal protections required under the ESA for a candidate species (NMFS, 2001).

The dusky shark (*Carcharhinus obscurus*), also known as the bronze whaler or black whaler, was added to the NMFS candidate species list in 1997. It has a wide-ranging (but patchy) distribution in warm-temperate and tropical continental waters (NMFS, 2001). It is coastal and pelagic in its distribution where it occurs from the surf zone to well offshore and from surface depths to 400 meters (Compagno, 1984). Because it apparently avoids areas of lower salinities, it is not commonly found in estuaries (Compagno, 1984; Musick et al., 1993).

The Atlantic and Gulf of Mexico populations of the sand tiger shark (*Odontspis taurus*) were added to the candidate species list in 1997. Sand tiger sharks have a broad inshore distribution. In the western Atlantic, this shark occurs from the Gulf of Maine to Florida, in the northern Gulf of Mexico, in the Bahamas and in Bermuda. Although first reported in Texas in the 1960s, this species does not seem to be uncommon (Hoese and Moore, 1998). A cool temperate species, it is more common north of Cape Hatteras (Hoese and Moore, 1998). They are generally coastal, usually found from the surf zone down to depths around 75 feet. However, they may also be found in shallow bays, around coral reefs and to depths of 600 feet on the continental shelf. They usually live near the bottom, but may also be found throughout the water column (NMFS, 2001).

NMFS designated the night shark (*Carcharhinus signatus*) a candidate species in 1997. Data on this species are minimal because the shark is a deepwater shark. The shark has been reported in waters from Delaware south to Brazil, including the Gulf of Mexico. It has also been reported from West Africa. It was formerly abundant in deep waters off the northern coast of Cuba and the Straits of Florida (NMFS, 2001).

The speckled hind (*Epinephelus drummondhayi*) inhabits warm, moderately deep waters from North Carolina to Cuba, including Bermuda, the Bahamas and the Gulf of Mexico. The preferred habitat is hard bottom reefs in depths ranging from 150 to 300 feet, where the temperatures are from 60 to 85 degrees Fahrenheit (°F). The speckled hind was added to the candidate species list in 1997 (NMFS, 2001).

NMFS designated the saltmarsh topminnow (*Fundulus jenkinsi*) as a candidate species in 1997. This rare species is restricted to coastal streams and adjacent bay shores on the western side of Galveston Bay and from Vermilion Bay to the Florida Panhandle. Usually found in low salinities, it has been taken from the Chandeleur Islands (Hoese and Moore, 1998). This species tends to live in salt marshes and brackish water, although it has been known to survive in freshwater. This species can also be found in shallow tidal meanders of *Spartina* marshes (NMFS, 2001).

The goliath grouper (*Epinephelus itajara*), formerly named the jewfish, was added to the candidate species list in 1991 for the region of North Carolina southward to the Gulf of Mexico, which encompasses the entire range of this species in U.S. waters. Historically, goliath grouper were found in tropical and subtropical waters of the Atlantic Ocean, both coasts of Florida, and from the Gulf of Mexico down to the coasts of Brazil and the Caribbean. They were abundant in very shallow water, often associated with piers and jetties along the Florida Keys and southwest coast of Florida (NMFS, 2001).

The Warsaw grouper (*Epinephelus nitrigus*) was added to the candidate species list in 1997. It is a very large fish found on the deepwater reefs of the southeastern United States. Warsaw grouper range from North Carolina to the Florida Keys and throughout much of the Caribbean and Gulf of Mexico to the northern coast of South America. The species inhabits deepwater reefs on the continental shelf break in waters 350 to 650 feet deep. As for all of the candidate species above, the main threat to them has been mortality associated with fishing (NMFS, 2001).

The TXBCD includes one State-threatened fish, which may potentially occur in the project area. The opossum pipefish (*Microphis brachyurus*) has been reported from the Rio Grande River, and in *Spartina* marshes as well as in *Sargassum* mats in the Gulf of Mexico (Hoese and Moore, 1998). Brooding adults are found in fresh or low salinity waters and the young move into more saline waters (TXBCD, 1999).

3.6.2.4 Mammals

The red wolf (*Canis rufus*) has been considered extinct in the wild since 1980 according to Davis and Schmidly (1994). This species inhabited brushy and forested areas along the coastal prairies throughout the eastern half of Texas (Davis and Schmidly, 1994).

The ocelot (*Leopardus pardalis*) and the jaguarundi (*Herpailurus yagouaroundi*) are listed by the FWS and TPWD as endangered. Both of these cat species' historic range included San Patricio and Nueces counties and both are included on TXBCD's Special Species List as potentially occurring in the counties in which the study area occurs The ocelot is a medium-sized cat which ranges from southern Texas and Arizona to northern Argentina (Campbell, 1995). According to Campbell (1995), the ocelot prefers habitat described as dense thorn scrub with a dense canopy cover. Ocelots have been known to prey on small mammals, birds, reptiles, amphibians and some fish (Davis and Schmidly, 1994). The ocelot currently occurs only in the extreme southern part of the state (Davis and Schmidly, 1994) and is unlikely to occur in the study area, due to the lack of suitable brushy habitat.

The Federally and State-listed endangered jaguarundi occurs in south Texas, eastern and western portions of Mexico, and south into South America (Hall, 1981). In Texas, this cat inhabits very similar habitat as described for the ocelot: very dense thornscrub (Davis and Schmidly, 1994) with a preference for streams (Goodwyn, 1970; Davis and Schmidly, 1994). Jaguarundi distribution in Texas should be considered restricted to the Rio Grande Valley (Tewes and Everett, 1987). Due to the lack of suitable brushy habitat and any known populations in the area, this species is unlikely to occur in the study area.

The West Indian manatee (*Trichechus manatus*) is a Federally and State-listed endangered aquatic mammal which inhabits brackish water bays, large rivers, and salt water (Davis and Schmidly, 1994). They feed upon submergent, emergent, and floating vegetation with the diet varying according to plant availability (O'Shea and Ludlow, 1992). The manatee is more common in the warmer waters off of coastal Mexico, the West Indies, and Caribbean to northern South America (NatureServe, 2000b). In the U.S., populations are primarily found in Florida, but occasional vagrants migrate along the coast into Texas. Although extremely rare in Texas, recent Texas records include specimens from Cameron, Galveston, Matagorda, and Willacy counties (FWS, 1995). Davis and Schmidly (1994) describe a record of a manatee which was found dead in the surf near the Bolivar Peninsula near Galveston, Texas. Albert Oswald of the Texas State Aquarium spotted a manatee in the inlet between the Texas State Aquarium and the Lexington Museum on 23 September 2001. This is the third and probably most reliable sighting of the manatee in Corpus Christi Bay (Beaver, 2001). While the West Indian manatee has been recently sighted in Corpus Christi Bay, such occurrences are rare.

The southern yellow bat (*Lasiurus ega*) is a neotropical bat that is listed as State threatened. In the U.S., this bat has been recorded from southern California, southern Arizona, extreme southwestern New Mexico and south Texas (Schmidly, 1991). In Texas, the southern yellow bat occurs in the extreme south where it utilizes trees as roosting sites. In some areas of south Texas, palm trees appear to be preferred roosting sites (Davis and Schmidly, 1994). This mammal is unlikely to be found in the study area.

The maritime Texas pocket gopher (*Geomys personatus maritimus*), a Federal SOC, is known from Kleberg and Nueces counties (TOES, 1995; TXBCD, 1999). It inhabits areas with deep, sandy soils where it constructs its burrows and tunnels. It is a possible resident of the study area.

3.6.2.5 Reptiles

Five sea turtles are Federally and State endangered within Nueces and San Patricio counties. These sea turtles include the loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea*), Atlantic hawksbill sea turtle (*Eretmochelys imbricata*), and Kemp's Ridley sea turtle (*Lepidochelys kempii*). These sea turtles are known to occur in the Gulf of Mexico, including associated bay and estuarine waters and sometimes nest along the Gulf beaches (Garrett and Barker, 1987). It is a possibility for any of these species to be observed within the study area.

The loggerhead sea turtle is widely distributed within its range. It can be found in waters hundreds of miles offshore as well as inshore areas such as bays, lagoons, salt marshes, ship channels, and mouths of large rivers (FWS, 1995). This species feeds on various marine invertebrates – crustaceans, mollusks, sponges, echinoderms, gastropods and some plants, fish, and jellyfish. They nest on high energy beaches on barrier islands with steeply sloped beaches and gradually sloped offshore approaches. The nesting range in the U.S. is mainly the Atlantic Coast, although nesting on barrier islands along the Texas coast has been recorded (NMFS and FWS, 1991a; Shaver, 2000).

The green sea turtle's favored habitat appears to be lagoons and shoals with an abundance of marine grasses and algae (FWS, 1995). The adults are primarily herbivorous while the juveniles consume more invertebrates. Foods consumed include seagrasses, macroalgae and other marine plants, mollusks, sponges, crustaceans, and jellyfish (Mortimer, 1982). Terrestrial habitat is typically limited to nesting activities on deep, coarse to fine sands with little organic content, along high energy beaches. Major nesting activity occurs in Costa Rica and Surinam with small numbers nesting in

Florida and rarely in Texas, Georgia and North Carolina (NMFS and FWS, 1991b). This species has been recorded in Nueces County (Dixon, 2000).

Leatherback sea turtles are considered to be the most pelagic of the sea turtles, seldom approaching land except for nesting. They are mainly found in coastal water only when nesting and when following concentrations of jellyfish, which is the principal food source (TPWD, 2000; FWS, 1995; Garrett and Barker, 1987). The leatherback nests on sandy, sloping beaches, often near deepwater and rough seas (NMFS and FWS, 1992). The largest nesting beaches are found in the U.S. Virgin Islands, Puerto Rico, and Florida (NMFS, 2000).

The Atlantic hawksbill sea turtle is found in rocky bottom, shallow, coastal water areas, lagoons, estuaries, and mangrove-bordered bays in water generally less than 60 feet deep (FWS, 1995). This species prefers foraging habitat of coral reefs, rocky outcrops, and high energy shoals, which are optimum sites for sponge growth; sponge being one of their principal food sources. Other forage foods include crabs, sea urchins, shellfish, jellyfish, plant material, and fishes. Nesting activities may include deep sand beaches of low energy to high energy beaches. Nesting in the Continental U.S. is limited to the southeast coast of Florida, Florida Keys, Puerto Rico, and U.S. Virgin Islands. Most of the Texas sightings involve posthatchlings and juveniles which are primarily associated with stone jetties and originated from nesting beaches in Mexico (NMFS, 2000).

The Kemp's Ridley sea turtle is known to inhabit shallow coastal and estuarine waters usually over sand or mud bottoms where a food source of crabs can be found (FWS, 1995). Other food items include shrimp, snails, bivalves, sea urchins, jellyfish, sea stars, fish, and occasional marine plants (Campbell, 1995). Nesting activities are essentially restricted to the Gulf of Mexico at Rancho Nuevo, Tamulipas, Mexico. Sporadic nesting has been reported from Mustang Island, Texas southward to Isla Aquada, Campeche, Mexico (NMFS, 2000; Hildebrand 1983, 1986, 1987).

The American alligator (*Alligator mississippiensis*) was first Federally-listed as endangered in 1967 because hunting and poaching had substantially reduced its numbers. It was reclassified as threatened in certain parts of Texas in 1977 because of partial recovery. In 1983, it was further reclassified in Texas as threatened due to similarity of appearance (T/SA) reflecting complete recovery of the species in the state. Thus, in Texas, the alligator is no longer biologically threatened or endangered, but because of the similarity of appearance of its hides and parts to those of protected crocodilians elsewhere, it is necessary to restrict commercial activities involving alligators taken in Texas to safeguard against excessive harvesting, and to ensure the conservation of other crocodilians that are still biologically threatened or endangered. The potential for this species to occur within the study area is low.

The Texas tortoise (*Gopherus berlandieri*) and Texas horned lizard (*Holbrookia lacerata*) are listed as threatened species by TPWD. Texas tortoise is confined to arid south Texas and northeastern Mexico. The Texas tortoise prefers sandy soils in areas of low, sparse vegetation (Garrett and Barker, 1987). If appropriate habitat is present then some potential for their occurrence exists within the study area. The Texas horned lizard was historically found throughout the state in areas with flat, open terrain, scattered vegetation, and sandy or loamy soils. Over the past 20 years, it has almost vanished from the eastern half of the state, but still maintains relatively stable numbers in west Texas. This species has been recorded from counties within the study area (Dixon, 1987) and may occur within the study area.

Three snakes that are listed as threatened by TPWD, but not by the FWS, and may potentially occur in the study area are scarlet snake (*Cemophora coccinea*), timber/canebrake rattlesnake (*Crotalus horridus*), and Texas indigo snake (*Drymarchon corais*) (Dixon, 1987; TXBCD, 1999). In addition, the Gulf salt marsh snake (*Nerodia clarkii*) is considered a SOC by the FWS (2000). The scarlet snake inhabits loose, sandy soil potentially associated with baygall thickets, live oaks scattered across sand dunes, watermelon patches, and dry, sandy land dominated by honey mesquite, huisache and prickly pear (*Opuntia* sp.) (Werler and Dixon, 2000; Tennant, 1984). The timber rattlesnake prefers moist lowland forests and hilly woodlands near rivers, streams, and lakes characterized by hollow logs and decaying tree stumps within the eastern third of Texas (Werler and Dixon, 2000). Potential for occurrence would likely be associated with brushy or woody lowland areas adjacent to the bay or Nueces River. The Texas indigo snake is most common in thorn brush woodland in riparian corridors and in mesquite savannah (Tennant, 1984). The Gulf salt marsh snake inhabits crayfish and fiddler crab burrows in the saltgrass-lined margins of tidal mud flats (Garrett and Barker, 1987). This species is shown to be outside of its range in Nueces County by Dixon (1987), yet the FWS (2000) indicates Nueces County to be within its range. Although there is potential for the scarlet snake to occur within the study area, this rare snake is unlikely to be found. Potential occurrence of the Texas indigo snake is low due to the lack of suitable habitat, except inland or on Padre Island. Habitat for the Gulf salt marsh snake is present in the study area, thus there is potential for its occurrence.

The Texas diamondback terrapin (*Malaclemys terrapin littoralis*) is identified as a SOC by the FWS (2000) in Nueces County. This species occurs from the Texas-Louisiana border south to Nueces County (Dixon, 1987). The Texas diamondback terrapin is the only turtle in the world entirely restricted to estuarine habitat, where it lives in coastal marshes, tidal mudflats, and tidal creeks (Garrett and Barker, 1987). This species has been observed in the Upper Laguna Madre (EH&A, 1993) and may occur in the study area.

3.6.2.6 Insects

One insect species, the maculated manfreda skipper (*Stallingsia maculosus*), is a rare butterfly known from several south Texas counties and northern Mexico. The FWS (2000) identifies this species as a SOC in Nueces and Kleberg counties. The larvae of this species are closely associated with Texas tuberose (*Manfreda maculosus*) which grows on prairies and chaparral covered hills of the Rio Grande Valley and Plains (Tilden and Smith, 1986; Correll and Johnston, 1970). Its presence in the study area is unlikely.

3.7 HAZARDOUS, TOXIC, RADIOACTIVE WASTE

The purpose of the Hazardous, Toxic, Radioactive Waste (HTRW) assessment is to identify indicators of potential hazardous materials or waste issues relating to the study area. A review of a regulatory agency database information search, an aerial photographic review, interviews with regulatory officials, and a site reconnaissance were conducted to determine the location and status of sites regulated by the State of Texas and the EPA and any unreported hazardous material sites. The support data for the assessment can be found in PBS&J Document No. 010095 entitled "Hazardous, Toxic, and Radioactive Waste Assessment, Corpus Christi Ship Channel – Channel Improvements Project, Corpus Christi and Nueces Bays, Nueces and San Patricio Counties, Texas" dated April 2001. A review of oil and gas wells and pipelines located within the study area was also conducted.

The review of the regulatory agency database search indicated a total of 1,611 sites or listings associated with 257 facilities or properties located within the study area. Several of these listings were associated with the same facilities or property (e.g., a facility/property containing multiple petroleum storage tanks and is the site of several reported spills or emergency response actions). On the basis of the results of the regulatory database searches, the following sites are located within the subject area:

- 16 CERCLIS/NFRAP/CORRACT sites;
- 27 RCRA generators sites;
- 5 RCRA treatment, storage, and disposal sites;
- 296 petroleum storage tanks;
- 55 leaking underground storage tank sites;
- 2 State voluntary cleanup sites;
- 528 reported emergency response actions at 60 facilities/properties;
- 323 reported spills at 58 facilities/properties;
- 7 NPDES sites;
- 152 TRI listings associated with one facility; and
- 200 FINDS listings associated with 69 facilities/properties.

No National Priority List, State Superfund or City/County solid waste landfill sites were located within the study area.

Examination of the aerial photographic coverage indicated that the study area includes a variety of land uses which include highly developed residential-urban, heavy industrial, government land, recreational, range-pasture, and saline and brackish-water marsh. Generally, the land immediately adjacent to the southern shore of Corpus Christi and Nueces Bays is highly developed, while the land immediately adjacent to northern shore is moderately developed to undeveloped. Mustang Island is sparsely developed.

The urban areas of the cities of Corpus Christi (including Flour Bluff), Port Aransas, Aransas Pass, Ingleside, and Portland include residential, commercial, governmental, and some industrial development. The Inner Harbor, which is identified as the land-locked segment of the CCSC, is a highly developed industrial area. Similarly, the northern shore of Corpus Christi Bay includes industrial development and a U.S. Department of Defense (DoD) facility.

According to TNRCC regional officials, the industrial activity adjacent to the Inner Harbor of the CCSC and La Quinta Channel has caused measurable impacts to the groundwater adjacent to the waterways. The seepage of contaminated groundwater to the waterway has been nearly contained through the efforts of the TNRCC and the responsible parties. Historically, the groundwater seepage to the Inner Harbor is reported to occur adjacent to Elementis Chrome and involves hydrocarbon from an upgradient petroleum refinery and chrome from the Elementis facility. The release of hydrocarbon contaminated groundwater has been under control since mid-2000, while some contaminated groundwater containing chromium has likely seeped into the surface water in the channel within the last year. Groundwater seepage to La Quinta Channel is reported by the TNRCC to occur adjacent to the DuPont Corpus Christi Plant. A total of five contaminate plumes are documented to exist at the facility. According to a DuPont Baseline Risk Assessment Report (March 7, 1997), which presents results from groundwater modeling and a risk assessment, contaminants are discharging to Corpus Christi Bay. The TNRCC approved a Response Action Plan for one of the areas of concern (Bulk Storage and Rail Loading Area) in January 2000. The constituents of concern are carbon tetrachloride and perchloroethane (PCE).

The results of the oil/gas well review indicate a total of 1,568 permitted well sites located within the study area. These well sites include 1,368 vertical wells and 200 directional wells. The database indicates that the vertical well sites include the following types/status:

- 378 are listed as active producing oil/gas wells;
- 573 as plugged;
- 291 as dry holes;
- 75 as permitted locations;
- 41 as abandoned locations;
- 5 as injection wells; and
- 5 well sites as unknown.

The database indicates that the directional well sites include the following types/status:

- 67 active producing oil/gas wells;
- 56 plugged wells;
- 40 dry holes;
- 20 permitted well sites;
- 10 abandoned locations;
- 3 shut-in wells;
- 1 injection well; and
- 3 well sites were listed as the type/status of unknown.

A total of 473 pipelines/pipeline segments were identified within the study area. Two hundred sixty-six of the pipelines are listed as active, 193 are listed as inactive, and the status of 14 pipelines was unknown. The pipelines are reported to transport the following material:

- 199 transport natural gas;
- 93 crude oil;
- 91 oil and gas;
- 25 gasoline;
- 12 gas and condensate;
- 7 condensate;
- 10 propane/propylene;
- 6 ethane/ethylene;

- 22 miscellaneous gases and products; and
- 8 were listed as idle.

Based on the findings of the HTRW survey, there is moderate potential of encountering contaminated material during construction of the project. According to TNRCC regional officials, the industrial activity adjacent to the Inner Harbor of the CCSC and the turning basin of La Quinta Channel has caused measurable impacts to the groundwater adjacent to the waterways. The seepage of contaminated groundwater to these waterways has resulted in the potential of impacting channel sediments (refer to Section 3.3 for sediment quality). However, all material from the Inner Harbor will be placed in confined upland areas and the only project activity for the La Quinta Channel is extension beyond the turning basin.

The TNRCC reported a contaminate plume containing hydrocarbons and chromium seeping into the Inner Harbor adjacent to the Elementis Chrome facility. According to analytical results of sediment samples collected from the channel in 1983, 1988, 1991, 1994, 1997, and 2000, chromium was found above detection limits, but well below the ERL, at all sampling stations for each year. Hydrocarbons were not detected in the samples until the 2000 sampling event. The TNRCC reports that the release of hydrocarbon-contaminated groundwater to the waterway has been significantly reduced or eliminated since mid-2000.

The TNRCC also reported a contaminate plume containing carbon tetrachloride and perchloroethane seeping into the La Quinta Channel turning basin adjacent to the DuPont Corpus Christi Plant. Previous analytical testing of water and sediment samples included basic and supplemental parameters but did not include these two constituents of concern.

In addition, with the laws and regulations which govern the handling of hazardous material, there is a decreased risk of future releases of hazardous material causing long-term detrimental impacts to the sediments of the study area. However, any activity regarding releases of hazardous material into the waters of the study area and the resulting remediation should be monitored through the regulatory agencies.

3.8 HISTORIC RESOURCES

The Corpus Christi study area is located in the Southern Coastal Corridor (SCC) Archeological Region of the Central and Southern Planning Region of Texas as delineated by the Texas Historical Commission (Mercado-Allinger and Ricklis, 1996). This Archeological Region encompasses the Coastal Bend from the Colorado River in Matagorda County south to the Rio Grande (Bailey, 1987; Ricklis, 1990). The study area is confined to the Corpus Christi and Nueces bays in San Patricio and Nueces counties.

The SCC Archeological Region contains five subareas, each possessing unique geographic and cultural features. The current study area in Corpus Christi Bay is in the Aransas/Guadalupe subarea with a small portion in Nueces County being included in the Baffin/Oso subarea. In these subareas the primary resource zones are the coastal estuaries and terrestrial flood plains with adjacent prairies.