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Marine Archaeological Survey at the Texas Park and Wildlife Department's North Todd, Resignation, and South Dollar Reef Sites, Galveston Bay, Chambers and Galveston Counties, Texas

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HERITAGE MANAGEMENT

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Lead Agency:
United States Army Corps of Engineers, Galveston District

Texas Antiquities Code Permit No. 9514

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Austin, Texas

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ABSTRACT

Under contract to the Texas Parks and Wildlife Department, Gray & Pape, Inc., of Houston, Texas, conducted a Phase I marine archaeological survey for the Texas Parks and Wildlife Department's North Todd, Resignation, and South Dollar proposed artificial reef sites in Chambers and Galveston Counties, Texas. The archaeological survey was sponsored by the Texas Parks and Wildlife Department. The Areas of Potential Effect for the proposed reef sites cover an approximate total of 84.4 hectares (209 acres) over three separate project areas. All three areas are on National Oceanic and Atmospheric Administration nautical chart #11327, Upper Galveston Bay – Houston Ship Channel – Dollar Point to Atkinson. The submerged land for the project areas are in State Tract numbers which administered by the Texas General Land Office; therefore, work was completed under Texas Antiquities Permit Number 9514. The United States Army Corps of Engineers, Galveston District has been identified as the lead federal agency, and the conduct of the project meets the requirements contained in Section 106 of the National Historic Preservation Act of 1966, as amended, the regulations of the Advisory Council of Historic Preservation (30 CFR Part 800), the National Environmental Policy Act of 1969, as amended. All marine fieldwork and reporting activities were completed with reference to state law (Antiquities Code of Texas [Title 9, Chapter 191 of the Texas Natural Resources Code] and Texas State rules found in the Texas Administrative Code [Title 13, part 2, Chapters 26 and 28]) for cultural resources investigations. All project records are curated with the Texas Park and Wildlife Department in Austin, Texas.

The Texas Parks and Wildlife Department requested this archaeological survey over the proposed areas in support of planned oyster reef habitat restoration and enhancement projects. All restoration work will be done under a Nationwide 27 permit to be issued by the United States Army Corps of Engineers. Proposed restoration activities include multiple phases of cultch placement; Texas Parks and Wildlife Department designed the project areas to include more acreage than planned for the first phase of restoration, and all three areas include an additional 60-meter (197-foot) buffer around the proposed Areas of Potential Effect. The Phase I underwater archaeological investigation assessed the number, locations, cultural affiliations, components, spatial distribution, data potential, and other salient characteristics of potential submerged cultural resources within the proposed reefing project areas.

The marine field investigations of the North Todd, Resignation, and South Dollar Artificial Reef Project survey areas consisted of a bathymetric, magnetometer, and side-scan sonar survey of a combined 84.4 hectares (209 acres) covering the three Areas of Potential Effect in safely navigable waters on July 28, 2020. The comprehensive analysis of the magnetometer data resulted in the identification of one magnetic anomaly (NT-040) that is interpreted as a potential cultural resource (i.e. historic shipwrecks). The remaining magnetic anomalies are interpreted as modern debris associated with recreational and commercial fishing activities, miscellaneous debris from previous tropical storms, existing pipelines, and infrastructure installation and/or maintenance, and as such do not represent significant cultural resources. Side-scan sonar imagery identified a total of three sonar targets, none of which were interpreted as potentially significant cultural material. The recommended management action for the North Todd, Resignation, and South Dollar Areas of Potential Effect is avoidance of bottom disturbance activities within the 50-meter (164-foot) avoidance area, as mandated by Texas Administrative Code, Title 13, Part 2, Chapter 26, for magnetic anomaly NT-040. If avoidance is not possible, then Gray & Pape, Inc. recommends archaeological diver-ground truthing to identify and evaluate the potential for National Register of Historic Places significance of each anomaly.

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1.0 INTRODUCTION

Gray & Pape, Inc. (Gray & Pape), of Houston, Texas, in conjunction with BIO-WEST. Inc. (BIO-WEST), also of Houston, conducted a Phase I marine cultural resources survey for the Texas Parks and Wildlife Department's (TPWD's) North Todd, Resignation, and South Dollar Reef Site Locations in Galveston Bay in Chambers and Galveston Counties, Texas (Figures 1-1 and 1-2). The Texas Parks and Wildlife Department plans to create new shallow artificial reefs for oyster restoration and requires a survey of the bay bottom to determine existing hazards/obstructions, characterize the substrate type, and document any magnetic anomalies that could represent historic shipwrecks for avoidance during the oyster reef project.

The submerged land for the are in State Tract administered by the Texas General Land Office (TxGLO), an agency of the State of Texas created to manage the public domain. As such, the Antiquities Code of Texas (Texas Natural Resource Code, Title 9, Chapter 191) applies. Marine fieldwork and reporting activities were completed with reference to state standards (Antiquities Code of Texas [Title 9, Chapter 191 of the Texas Natural Resources Code] and Texas State Guidelines found in the Texas Administrative Code [Title 13, Part 2, Chapters 26 and 28]) for cultural resources investigations. Work was completed under Texas Antiquities Permit Number 9514 issued by the Texas Historical Commission (THC) on July 23, 2020. As the project is within the navigable waters of the United States, the United States Army Corps of Engineers (USACE) has been identified as the lead federal agency, and the conduct of the project meets requirements under Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, the regulations of the Advisory Council of Historic Preservation (30 CFR Part 800), and the National Environmental Policy Act of 1969, as amended.

1.1 Project Overview

The project areas are located on the western side of Galveston Bay and each area includes an additional 60-meter (197-foot) buffer surrounding the original Area of Potential Effect (APE). The combined, buffered APEs include approximately 84.4 hectares (209 acres). The North Todd APE charted depths are in the approximate range of 1.5 to 2.7 meters (5 to 9 feet), according to the National Oceanic and Atmospheric Administration (NOAA) nautical chart # 11327 entitled Upper Galveston Bay – Houston Ship Channel – Dollar Point to Atkinson (NOAA 2017). The actual water depths recorded at the survey area ranged from 2.1 to 3.9 meters (7 to 13 feet).

The Resignation Reef plot APE charted depths are in the approximate range of 2.1 to 2.7 meters (7 to 9 feet), according to the NOAA nautical chart # 11327 entitled Upper Galveston Bay – Houston Ship Channel– Dollar Point to Atkinson (NOAA 2017). The actual water depths recorded at the survey area ranged from 2.4 to 3.3 meters (8 to 11 feet).

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Figure 1-1. The North Todd and Resignation Reef project area locations, Galveston Bay, Chambers and Galveston Counties, Texas.

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Figure 1-2. The South Dollar Reef project area location, Galveston Bay, Galveston County, Texas.

The South Dollar Reef plot APE charted depths in the project area are in the approximate range of 2.4 to 2.7 meters (8 to 9 feet), according to the NOAA nautical chart # 11327 entitled Upper Galveston Bay – Houston Ship Channel – Dollar Point to Atkinson (NOAA 2017). The actual water depths recorded at the survey area were approximately 3.3 meters (11 feet).

The oyster reef habitat will be restored by placing approved cultch material on the bay floor in historical oyster reef areas in mounds or in a uniform layer. The areas chosen must have a bottom firm enough to support materials. The cultch may be laid in either a uniform layer or in mounds. Cultch spread in a uniform fashion will range from 1 meter (3 feet) to 2 meters (6 feet) in depth. Mounded cultch material will be laid in a diameter not to exceed 3 meters (10 feet) in diameter and no taller than 0.6 meters (2 feet) high. It is important to note that mounded cultch will not be a navigation hazard as mound crest will be greater than 1 meter (3 feet) from the surface of the water at Mean Lower Low Water (MLLW).

1.2 Report Organization

This report is organized into seven numbered chapters and three appendices. Chapter 1.0 provides an overview of the project. Chapter 2.0 presents an overview of the environmental setting and geomorphology of the project area. Chapter 3.0 presents a discussion of the cultural context associated with the project area. Chapter 4.0 presents the methodology developed for these investigations. The results of these investigations are presented in Chapter 5.0. Chapter 6.0 presents the investigation summary and provides recommendations based on the results of the field survey. A list of all references cited is provided in Chapter 7.0. The side-scan sonar tables are provided in Appendix A and images of the contacts in Appendix B. Magnetic anomalies are included in Appendix C, with the results addressed in Chapters 5 and 6.

1.3 Curation

No diagnostic or non-diagnostic artifacts were collected in the course of the current survey. As a project permitted through the THC; however, Gray & Pape submitted project records to the TPWD in Austin, Texas.

1.4 Acknowledgements

The successful completion of this project was made possible by a joint effort between BIO-WEST and Gray & Pape personnel. BIO-WEST provided the survey vessel, and all geophysical equipment necessary for the survey. Research on various aspects of this project was conducted by Project Manager Jim Hughey, M.A., RPA, Principal Investigator Amanda Evans, Ph.D., RPA, and Marine Archaeologist Michael Quennoz. Background research included consultation of online research archives maintained by the THC, resources maintained by the Soil Service Staff of the Natural Resources Conservation Service of the United States Agriculture Department (SSS NRCS USDA), and numerous marine targets datasets.

The marine survey was conducted on July 28, 2020 and took 27 total person-hours. The survey team included BIO-WEST's Matt Chastain, Captain Richard Williamson, and Gray & Pape's Dr. Amanda Evans, RPA. Magnetic and acoustic data processing and analyses were conducted by Dr. Amanda Evans. Dr. Evans, Michael Quennoz, John Rawls, M.A., RPA, and Mr. Hughey prepared the report. Tony Scott produced graphics, and Jessica Bludau edited and produced the report.

2.0 PHYSICAL SETTING

2.1 Physiography and Geomorphology

The Texas Coastal Plain makes up part of the larger Gulf Coastal Plain, a low level to gently sloping region extending from Florida to Mexico. The Texas Coastal Plain reaches as far north as the Ouachita uplift in Oklahoma, and as far west as the Balcones escarpment in central Texas. The basic geomorphological characteristics of the Texas coast and associated inland areas resulted from depositional conditions influenced by the combined action of sea-level changes from glacial advance in the northern portions of the continent, and subsequent downcutting and variations in the sediment load capacity of the region's rivers (Abbott 2001; Van Siclen 1991). The present coastline of the Texas Gulf Coast has fluctuated relatively little in the past approximately 3,000 years. However, prior to 8,000 B.C., the Gulf Coast extended gulf ward to the southeast. Towards the end of the Pleistocene era 20,000 years ago, global temperatures rose, and sea levels rapidly began to rise. By 8,000 B.C., shorelines worldwide had progressed inland, with the flooding of the valleys of major streams along the Texas coast, such as the Trinity, Lavaca, Guadalupe, Aransas, and Nueces Rivers (Ricklis and Weinstein 2005). As a result, the earliest forms of the modern coastal bays found in Texas were created.

2.2 Soils

Terrestrial sediments onshore and west of the North Todd and Resignation project areas consist of deep nonsaline soils, specifically Mocarey-Leton-Algoa and Bernard-Verland, both of which are slowly permeable and loamy (USDA 1986). Sediments onshore and west of the South Dollar project area are categorized as saline marshland soils, specifically Narta-Francitas with lower levels of Ijam (United States Department of Agriculture [USDA] 1986). The saline soils are both poorly drained, slowly permeable, and with greater clay content than the nonsaline sediments to the north.

2.3 Climate

Galveston and Chambers Counties' weather is primarily influenced by its proximity to the Gulf of Mexico, producing a humid subtropical climate. Summers are hot and humid, though moderated by gulf winds from the south-southeast, while winters are mild. The mean daily maximum temperature for the year is 23.5° Celsius (74.4° Fahrenheit), and the mean daily minimum temperature is 18.3° Celsius (64.9° Fahrenheit). Precipitation comes in both thunderstorms and trace amounts. The average annual rainfall for Galveston and Chambers Counties is 100.8 centimeters (39.7 inches) (Crenwelge et al. 1988). Galveston Bay, with its location along the Gulf Coast, is regularly struck by tropical storms and hurricanes. Roth (2010) lists no fewer than 15 storms to make landfall along Galveston Island at the entrance to the bay and many of these storms severely impacted the interior bay as well as the Gulf Coast; filling previously existing channels and passes while eroding others; flooding and flattening communities; and wrecking vessels at anchor and on the water.

2.4 Tide

The project areas are in Texas' shallow interior bay and experiences tidal influences. During the field activities for this project, verified tides at the Eagle Point Station (ID 8771013), the closest tide monitoring station, were reported to range from a high of 0.65 meters (2.14 feet) to a low of 0.44 meters (1.43 feet) for a total range of 0.21 meters (0.71 feet) (NOAA 2020a). The tide, although not dramatic, does have an influence on the area surveyed.

3.0 CULTURAL CONTEXT

3.1 Prehistoric Context

Traditionally, Southeast Texas has been viewed as a buffer zone between cultural regions in prehistoric times. Patterson (1995) describes the archaeological record in this area as being an interface between the Southern Plains and the Southeast Woodlands. Along similar lines, both Shafer (1975) and Aten (1984) have categorized the Post-Archaic archaeological record of this region as Woodland. This categorization is not meant to literally invoke the exact cultural patterns and chronology of the Woodlands culture found to the east. Aten (1984:74) summarizes his concept by saying, "it loosely connotes activities by populations on a geographic as well as a cultural periphery of the southeastern Woodlands."

Dee Ann Story (1990) has suggested that the culture of Southeast Texas is distinctive enough so as to merit a separate designation by the Late Prehistoric. The Mossy Grove cultural tradition is a heuristic concept based on technological similarities shared by groups in this region. The primary marker of this technological tradition is the plain, sandy-paste Goose Creek pottery that is found in this region from the Early Ceramic through Early Historic periods.

Ethnic affiliations for the region are not entirely clear. Aten (1983) has defined the Brazos Delta-West Bay, Galveston Bay, and Sabine Lake archaeological areas and suggests that they may correlate with the Historic territories of the Coco, Akokisa, and Atakapa groups, respectively. Similarly, historic reconstructions of the inland subregion suggest a number of possible group affiliations (Story 1990). The historic economic inland/coastal cycle of the Akokisa, which stretched from Galveston Bay to the San Jacinto River basin, may mean that archaeological materials in the Lake Conroe area are affiliated with this group. Alternately, these remains may be associated with the Bidais who occupied territory immediately to the north of the Akokisa groups. At this point in time, it is not possible to identify the cultural affiliation of the groups that inhabited the inland subregion. In part, this is a function of the dynamic nature of this region in which a number of cultural traditions met and diffused.

The Southeast Texas region is divided into inland and coastal margin subregions, which have archaeologically distinctive subsistence patterns, settlement patterns, and artifact types. Archaeological and historic evidence suggests that some groups exploited inland resources year-round, while other groups spent parts of the year both inland and on the coast.

Based on aspects of material culture, researchers have identified six archaeological time periods associated with Native Americans in the Southeast Texas region; in general, these include the Paleoindian, Archaic (with Early, Middle, and Late subdivisions), Ceramic, Late Prehistoric, Protohistoric, and Historic Indian. Archaeologists within the region agree on the general framework of cultural time periods while disagreeing on the temporal boundaries of these periods. Patterson's (1995) chronology, for example, includes Early Paleoindian (10,000–8,000 B.C.), Late Paleoindian (8,000–5,000 B.C.), Early Archaic (5,000–3,000 B.C.), Middle Archaic (3,000–1,500 B.C.), Late Archaic (1,500 B.C.–A.D.100), Early Ceramic (A.D. 100–A.D. 600), Late Prehistoric (A.D. 600–1500), Protohistoric (A.D. 1500–1700), and the Historic Indian (A.D. 1700–1800) periods. In contrast, Ensor (1995) offers a Southeast Texas chronology that includes Paleoindian (10,000–8,000 B.C.), Early Archaic (8,000–5,000 B.C.), Middle Archaic (5,000–1,000 B.C.), Late Archaic (1,000 B.C.–A.D. 400), Early Ceramic (A.D. 400–800), and Late Ceramic (A.D. 800–1750). Despite these differences, the chronologies developed by researchers are based primarily on changes in projectile point technologies within the region and the introduction of pottery. It is generally recognized that a broad-based hunting and gathering lifestyle was utilized throughout all time periods.

3.1.1 Paleoindian Period

Evidence is sparse for Paleoindian habitation, and much of what is known about the period in the area comes from a compilation of materials gathered from the state of Texas and North America. At the close of the Pleistocene, large game hunters crossed the Bering Strait, and within a few millennia had penetrated into South America (Culberson 1993; Newcomb 1961). The Paleoindian people traveled in small bands (Culberson 1993) and were mega-fauna hunter-gatherers with the bulk of their meat protein derived from mammoths, mastodons, giant bison, and giant sloths. These groups carried with them an easily recognizable stone tool material culture, though admittedly, little is known about their wooden or bone tools and clothing types. The later Folsom Culture developed a very efficient toolkit that was apparently designed to be portable leading to theories that these people were following buffalo herds across the plains. However, the widespread use of Folsom technology suggests that the technology spread beyond the area for which it was initially designed. Isolated Paleoindian artifacts found across southeastern Texas include Clovis, Angostura, Scottsbluff, Meserve, Plainview, and Golondrina point types (Aten 1983).

The Transitional Archaic period begins about 9,000 years ago and ends around 7,500 years ago (Aten 1983; Story 1990). This stage is also poorly represented in the archaeological work in the area but isolated finds of Bell/Calf Creek, Early-Side Notched, and Early Expanding Stemmed dart points are attributed to this time period.

3.1.2 Archaic Period

With the retreat of the glaciers (the Hypsithermal period), the mega-fauna upon which the Paleoindian peoples depended gradually became extinct. This shift in food supply is seen as the pivotal transition point between the Paleo and Archaic periods (Biesaart et al. 1985; Culberson 1993; Newcomb 1961). Though dates often disagree (ranging from 8,000 B.C. marking the beginning of the Early Archaic [Culberson 1993] to Aten [1984] stating that the transition from Late Archaic to Late Prehistoric-Woodland began around A.D. 100), there are three progressive stages recognizable during the Archaic period: the Early, Middle, and Late.

Much of what is known about the Early Archaic peoples indicates that they were small, isolated bands of hunter-gatherers that remained in relatively restricted regions (Aten 1984). With the loss of the mega-fauna as a food source, the Early Archaic peoples adopted the hunting of smaller game such as bison and deer and increased their reliance on foraging (Culberson 1993). The material record fits the transitional makeup of this period because there was a dramatic shift from the large spear points of the Paleoindian period to a reliance on smaller dart type points. Diagnostic designs for this period are Dalton, San Patrice, Angostura, Golondrina, Merserve, Scottsbluff, Wells, Hoxie, Gower, Uvalde, Martindale, Bell, Andice, Baird, and Taylor (Turner and Hester 1993). These points are much more crudely made than their Paleo precursors but remain designed for use on a spear shaft.

The Middle Archaic period saw the largest growth in technology and in the number of stone tools utilized. Specialized tools appeared for the milling of wild plant foodstuffs (Culberson 1993) along with a large assortment of tools for food preparation and procurement. Gravers, scrapers, axes and choppers, knives, drills, and polished stone tools, also known as ground stone tools, began to appear in large quantities (Newcomb 1961). Diagnostic points such as Gary, Kent, Palmillas, Nolan, Travis, Belvedere, Pedernales, Marshall, Williams, and Lange dominate the spectrum of dart points from the Middle Archaic period (Turner and

Hester 1993; see also the Edwards Plateau Aspect [Newcomb 1961]). The advent of the atlatl also seems to be placed within this period (Culberson 1993).

The Late Archaic period saw a dramatic increase in the population densities of Native American groups. Human habitation of areas rich in diverse flora and fauna intensified, as did the variety of materials and artifacts (Culberson 1993; Aten 1984). Late Archaic peoples began relying heavily on foraging tubers, berries, and nuts and hunting small game such as deer, rabbits, and raccoons, as well as fish and shellfish, and birds. Groups became socially more complex than earlier periods and the result was an increasing intercommunication with neighboring groups. Culberson (1993:55) states that a "Lapidary Industry" developed in which stone artifacts were made from exotic materials (jasper, hematite, quartz, shale, slate, etc.) acquired from sources great distances away. These materials were fashioned into an increasingly complex array of household goods such as celts, plummets, banner stones, mortars and pestles, and pendants; also, during this period, there is an increase in the occurrence of sandstone bowls (Culberson 1993). Diagnostic points of this period are difficult to distinguish from those of the Middle Archaic. Gary and Kent points remain prevalent in southeast Texas, while other points such as Marcos, Montell, San Gabriel, Mahomet, Fairland, and Castroville also appear at times (Turner and Hester 1993).

The Archaic period in southeast Texas ends with the adoption of ceramic technology at the beginning of the Ceramic period. Patterson (1995) places the beginning of the Early Ceramic period on the Texas coast from 100–600 A.D. Aten (1983) placed the appearance of pottery in the Galveston Bay area approximately 100 A.D. The ceramic chronology of the inland areas parallels that of the coast; however, it does not manifest until several centuries later. The inland areas generally lack the earliest ceramic types present in the coastal region as well as some of the later ceramic types (Aten 1983; Story 1990). As a result of trade networks or stylistic/manufacturing influences, it appears that ceramic traits moved from the coast to the inland areas and from the east to the west (Aten 1983).

3.1.3 Late Prehistoric

The transitional period between Late Archaic and Woodland-Late Prehistoric is a period marked by an intensification of group dynamics across Texas. The advent of the bow and arrow is believed by most (Aten 1984; Culberson 1993; Newcomb 1961) to be from this period, though some may place it later. Most importantly for archaeological investigations, the first signs of pottery begin to emerge at sites from this period (Aten 1983). Although the amount and variety of pottery intensify during the Late Prehistoric, it is an excellent way of determining the terminus post quem of a site. Fishing, bison hunting, and the collection of wild flora intensify beyond the level of the Late Archaic period during this stage, but there is no sufficient data to demonstrate the initial advent of sedentary agriculture. The diagnostic points of this period are Catahoula, Friley, Alba, and Bonham (Turner and Hester 1993).

The Late Prehistoric (also known as Woodland and Ceramic periods) continues from the end of the Archaic period to the historic period ushered in by the Spanish Missions and Anglo-American settlers. During this period, there is a shift to the almost total use of arrow points such as Perdiz and, later, Scallorn, and a wide variety of ceramic types. According to Aten (1984), there are nearly 18 different types of pottery from this period currently identified for the east Texas Coast alone based on temper, paste, and design.

Goose Creek and other sandy paste pottery types are often recovered from the Ceramic period and Late Prehistoric sites throughout southeast Texas. Goose Creek appears in Aten's coastal chronology to greater or lesser extents in nearly every period, particularly Mayes Island, Turtle Bay, Round Lake, and the later Orcoquisac periods. Because of the predominance of sandy paste pottery across the region, Story (1990) has suggested the Mossy Grove Tradition as an encompassing cultural tradition for the area. Other ceramic forms that occur in the region include grog-tempered, stamped, and bone-tempered pottery (Patterson 1996).

3.1.4 Protohistoric Period to the Post-Contact Period

It is during this period that peoples known today as the Caddo, Attakapans, and Bidai, to name a few, are identifiable both culturally and materially. This is mostly due to the historical sources of the seventeenth through the nineteenth centuries that aid in the reconstruction of the past cultures in the area. In order to better understand the complexity of the region's cultures, researchers turn to historical sources to get an understanding of the peoples who first occupied southeast Texas. Hernando De Soto encountered the Native Americans of the region during his expedition in 1542 (Hudson 1976); it was the first recorded meeting with the Caddo peoples. The first expeditions by La Salle in 1687 and the subsequent settlement in the eighteenth century by Europeans continued to document the presence of Native American groups in the area (Aten 1984). French traders and Spanish missionaries encountered the Hasinai, also known as the Neches Angelina, who became allies of the Spanish against the western Apache tribes (Newcomb 1961). The later historical sources identify the Hasinai as one of the two main groups in the area of eastern Texas that fall under the Caddo culture (the primary culture that dominated the Piney Woods area), the other of which is the Kadohadacho (La Vere 1998; Gregory 1986).

The loose cultural group, known as the Attakapans, dominated the majority of the land north of present-day Harris County in what is now Montgomery County. Their language group extended along the Gulf coast to the Trinity and San Jacinto Rivers and they had much in common with the coastal group known as the Karankawa (Aten 1984). The Attakapanswere subdivided into regional groups. The Akokisas dwelled primarily on the shores of the Trinity and San Jacinto Rivers. The Patiris group occupied the land north of the San Jacinto valley. The Bidai group dominated the Trinity Valley and to their north was the small group known as the Deadoso. Most of what is known about the Attakapans culture comes from the early accounts of the French explorer DeBellise. They are described as primarily hunter-gatherer groups who relied somewhat on agriculture and fishing (Sjoberg 1951).

In the seventeenth and eighteenth centuries, the Spanish and French used the Native American groups as pawns in the two nations' quest to settle the area (Newcomb 1961). Most destructive for all native groups in the region was the influx of European diseases. When Anglo-American settlers began moving into the area in mass around the 1850s, disease and warfare had decimated the groups to near extinction. During the early 1800s, Alabama and Coushatta Indians, displaced from Alabama, began to settle in the area, in some cases incorporating the last remaining members of the local tribes. As late as the 1820s a group of Cocos and Cujanes were recorded occupying the area of what is now San Leon adjacent to Red Fish Bar and the project area (Aten 1983:32).

3.2 Historical Context

3.2.1 Colonial to Republic Period

Starting with the discovery of the New World by Columbus in 1492, the Spanish conducted numerous voyages of exploration along the American continents during the early sixteenth century. J.H. Parry (1966) indicates that the Spanish had three general stages of growth in the New World: the island stage, the Mexican stage, and the Isthmian or Peruvian stage. After the Caribbean Islands were exploited of their easy wealth, Hernán Cortes' conquest of Mexico 1519–1521 encouraged the settlement and exploration of the continent proper. From 1522, the average size and number of ships sailing from Spain to the Americas steadily increased (Parry 1966). It was during this period when the Texas coast was initially examined, and at a high cost.

The earliest Spanish examination along the west Gulf Coast was that of Alonso Alvarez de Pineda, which began in 1518. From Florida to Mexico, via the Mississippi and the coast of modern-day Texas, new discoveries were made and the Gulf of Mexico was successfully mapped despite much of the crew dying of disease and conflict with native groups (Morison 1974; Johnson 2002). The next voyage to the region was that of Panfilo Narvaez in 1527–1528. Like that of Pineda, this exploration ended in tragedy. Narvaez sailed to Florida with five vessels and several hundred soldiers, sailors, and colonists. Dismissing his vessels, he and 260 of his men landed and attempted to venture around parts of the Gulf and meet the ships at a prearranged point. All did not go as planned, the Spanish came into conflict with native populations, the ships never reestablished contact, and somewhere near the Mississippi River new vessels were constructed in an attempt to return to Mexico. Only four adventurers survived the expedition to make their way to safety. One of the survivors was named Alvar Nunez Cabeza de Vaca, who left an account of this 8-year misadventure on the Texas coast and interior (Morison 1974; Johnson 2002).

In the late seventeenth and early eighteenth century, French expeditions pushed into territory the Spanish saw as theirs. In response to French incursions such as that by La Salle in Matagorda Bay and Joseph Blancpain on the lower Trinity (1754), the Spanish sent multiple expeditions both to expel the French and better document the Gulf coast. Spain's direct interest in the Texas gulf coast region would continue to wax and wane in response to intrusions from other colonial powers. Galveston Bay would not be fully charted until 1785. In addition to the more official state-sponsored expeditions, by 1730 French merchants began trading with native groups on the lower Trinity and San Jacinto Rivers, anchoring in the bay and proceeding upstream in canoes. With the French loss of Louisiana in 1763 to Spain, the first official Spanish survey of Galveston Bay was undertaken in 1785, with the area named Galvez after Bernardo de Galvez the governor and later viceroy who ordered the expedition (Henson and Ladd 1988; Henson 1993).

The nineteenth century brought Mexican independence, increasing Anglo settlement from the United States, and a series of filibusters to the region. Luis de Aury, a privateer established a port on Galveston Island in 1816 and was followed by Jean Lafitte the following year. Lafitte's settlement of Campeachy had as many as 200 houses, stores, boarding houses, and a billiard parlor before being leveled in a hurricane in 1818. Lafitte would abandon the settlement by 1820 (Henson 1993). Following Mexican independence in 1821, American settlers increasingly moved into Texas, some legally, others less so. However, Galveston Island and much of the surrounding territory was off limits to Anglo settlers. Despite this, Galveston Bay provided one of the favored routes for colonists headed to the interior where they established landings on the lower San Jacinto (Henson 1993). The land adjacent to the project area was part of a land grant to Amos Edward in 1828 which he and his family would live on for the next decade, establishing themselves at what was then called Davis Point, which is known today as Eagle Point (County of Galveston 2020).

Wider settlement of the lower bay did not occur until restrictions were lifted after the establishment of the Republic of Texas in 1836 and the opening up of Galveston Island the following year (Henson 1993). In 1837, on the Edwards League, Monroe Edwards and William Gaines platted the first township of San Leon, which replaced the short-lived Powhaten destroyed by a hurricane the previous year. The first San Leon community does not appear to have been successful and by the 1880s, was pastureland (THC 2020; County of Galveston 2020). The 1850 census following the annexation to the United States showed Galveston to be the largest town in the state with more than 4,000 residents (Henson 1993).

3.2.2 Civil War

During the American Civil War, the Union developed and implemented a naval blockade, called the Anaconda Plan, against the seceding southern states. Initially unprepared for the war, the north did not establish an effective blockade immediately, but over time resources were developed and employed to strangle southern trade, beginning along the Atlantic coast and slowly moving westward to include Gulf coast ports. The Confederate government did not have a well-developed navy, or merchant marine infrastructure at the beginning of the conflict, nor did it have the resources to develop one. In lieu of a Confederate navy, Jefferson Davis attempted to establish privateering in the South. Later in the war, when the Federal forces were more effective, decreased supply coupled with increased demand meant that blockade running was a financial boon for successful ventures. As the Union Anaconda Plan began to be effective along the Atlantic coast of the Confederacy, the coast of Texas became more appealing to those who wished to move cotton out and various military and luxury goods into the Confederacy.

Geographically at the western end of the Confederacy, Texas was at the margins of initial strategic thinking, as the Mississippi River and the Atlantic Coast regions were the primary focus. Texans sympathetic to the Confederacy prepared to protect their shores and repel northern attacks and occupations, and the port of Galveston and the Sabine Pass to the north were the sight of several major operations throughout the war (Scharf 1996).

In Galveston, Confederates dismantled navigational aids and sunk ships to obstruct shipping channels, but Galveston Island was still occupied by Union forces in October 1862. The island was retaken the following January, but the Union blockade of the Gulf remained in effect and blockade running became increasingly difficult (Henson 1993).

3.2.3 Post-Civil War and the Twentieth Century

In the period following the Civil War, Galveston and Houston competed to be the Texas port of choice with both cities striving to improve their access to the Gulf of Mexico as well as to the burgeoning national railroad network. Houston supporters worked to create a ship channel from the bay to Buffalo Bayou 3.7 meters (12 feet) deep, including passes through the treacherous Red Fish Bar and Cloppers Reef. The initial 3.7-meter (12-foot) target depth would be increased as the USACE worked to increase the entrance to the bay to 7.6 meters (25 feet). As late as the 1900 census, Galveston continued to be the largest city in the state (Henson 1993). Galveston in turn worked to increase its connection to the growing railroad network. As part of that strategy, the San Leon peninsula was again platted as a townsite, now called North Galveston. The new town was connected to Galveston Island by rail and plans called for building a railway bridge across Galveston Bay, bypassing Houston rail lines completely. However, the 1900 hurricane that so devastated Galveston Island also hit North Galveston; reports of the devastation indicated that "a tidal wave had crossed the peninsula, carrying destruction in its path" (Lester 1900). Following the disastrous 1900 hurricane, North Galveston largely failed to recover and Houston was able to draw on ever greater resources for deepening and widening the Houston Ship Channel (formally opened 1914), siphoning off much of the maritime traffic (Henson 1993; THC 2001).

The discovery of oil in Tabbs Bay, near the mouth of the San Jacinto, brought offshore drilling to Galveston Bay and increasing tanker cargo traffic, which collected oil from pipelines routed to Hog Island in the center of the channel. Portions of the bay became increasingly industrial (Henson 1993). Fishing in the bay also became increasingly industrial during this period. Oyster harvesting progressed from tongs to large rakes to the introduction of powered dredging in 1913. The oyster harvest would peak in 1904 before declining as a result of overharvesting and pollution. Shell was also dredged to be used in road construction in place of gravel. The former township of North Galveston would be rebranded with its former San Leon name and sold as a gulf side resort town with fruit orchards and fishing industry (THC 2001).

3.3 Maritime Context

Researching the types of watercraft ubiquitous to the region throughout history can aid in the identification and temporal association of encountered shipwrecks and vernacular watercraft within the APE. Probing historic documentation of vessel losses is another avenue to assist in identifying submerged cultural resources reportedly lost within a specific area. Because of the project areas' location along the Houston Ship Channel and at the natural choke point formed by Red Fish Bar dividing Galveston Bay, it can be assumed that a large variety of types of watercraft may have been active in the area; from the earliest prehistoric inhabitants to the modern-day local residents and commercial enterprises.

Vernacular watercraft were developed, constructed, and modified for use in the shallow lakes and bayous and shoaled, snag-filled rivers throughout coastal Texas, while sea-going vessels with deeper drafts were confined within a maintained navigation channel or dispersing their cargo among smaller vessels or boats for transport inland. During travel, vessels from prehistoric canoes to historic sailing vessels to steamboats were subject to overloading, foundering, snagging, collision, and even boiler explosion. As such, many vessels have been lost throughout the centuries in these waterways. Though there are no specific watercraft that are unique to the project area, a discussion of the types of watercraft that were used in and around the project area throughout prehistory and history and the requisite characteristics of each will be presented to demonstrate changes in morphology and continued trends that may be evident in the archeological record.

3.3.1 Aboriginal Watercraft

The dugout canoe, also called a pirogue or piragua, represents one of the earliest forms of vernacular watercraft to ply the waters of the APE. These watercraft were utilized by the Karankawa and other indigenous groups of coastal Texas. The dugout canoe typically is a long, narrow, flat-bottomed, double-ended vessel that could be paddled or rowed. They were primarily used for transportation within the shallow waters of lagoons and inlets (Francaviglia 2010:36). The early dugout canoe was constructed by felling a tree and using fire and hand tools to burn and hollow out the log. Cypress was typically the wood of choice, though Native Americans in the region also used cottonwood (Comeaux 1985:164). The degree of variation in size of the dugout depended largely on the size of available logs and for function. For maneuverability and portability, the Karankawa probably restricted dugouts to a maximum length of approximately 6.1 meters (20 feet) with a beam of 0.8 meters (2.5 feet) (Francaviglia 2010:38).

While there are no reported dugout canoes in either Chambers of Galveston Counties, one archaeological example of a dugout canoe in coastal Texas is Site 41CL51. It was discovered in 1974 by Jack Purcell on Vanderveer Island in Espritu Santo Bay in Calhoun County (THC 2020). It measured 6.1 meters (20 feet) in length and weighed approximately 350 pounds (lbs.). Information regarding other attributes of the vessel such as wood type is not available on the online Texas Archeological Sites Atlas site form. Due to the lack of any potential magnetic components, the probability of identifying a dugout canoe buried beneath bottom sediments via remote sensing survey is extremely limited; however, a dugout canoe could possibly be detected in the sonar data if exposed on the seafloor but would be difficult to positively identify from the geophysics alone.

3.3.2 Historic watercraft

The most common vessels that would have navigated the waters surrounding the project area include historic period watercraft such as schooners, sloops, luggers, and steamboats, as well as more recent gas-powered vessels. The distinct characteristics of each are described below.

3.3.2.1 Schooners

The schooner is a type of sailing vessel whose name refers to its sail configuration and is typically a sharp-built vessel, with two masts of considerable length and rake, with a small top mast, and fore and aft sails. Schooners are usually larger than sloops due to the larger sail area required by their deeper hull, which resulted in a deeper draft. As such, these vessels were regularly used for longer voyages transporting cargoes in the coastwide trade.

Schooners can be divided and further specified according to their type of rigging, function, or region of use. Originally rigged with square topsails, early schooners were referred to as topsail schooners. Later schooners were referred to as fore-and-aft schooners due to their rigging with Bermuda sails aligned fore and aft rather than squared to the masts (Saltus 1987:68). Schooners were also built in two, three, and four-masted configurations. Even within a single category of mast configuration, schooners were highly variable in size. For example, a two-masted scow schooner could range from 7.19 to 26.82 meters (23.6 to 88 feet) in length, 3.04 to 7.46 to meters (10 to 24.5 feet) in beam, with a depth of hold ranging from 0.76 to 2.86 meters (2.5 to 9.4 feet) (Saltus 1988:90).

When defined by their function, schooner types included: pilot schooners, trading schooners, fishing schooners, and packet schooners. Those defined by hull form included: scow schooners, barge schooners, pungy schooners, file bottom schooners, and ram schooners (Saltus1988:90). Schooners defined by region of use included: Chesapeake Bay schooners, Great Lakes schooners, and Coastal schooners (Saltus 1987:68). Saltus argued that among schooners, “the diagnostic attribute is the vessel’s shallow draft and wide beam, dictated by the environment, depth, and functional need” (Saltus 1988:90).

The most common type of schooner to operate in the western Gulf Coast region is the Gulf scow schooner. Its versatility allowed the schooner to operate in the open ocean, shallow bay waters, rivers, or inland lakes of southern Texas. The vessel evolved from the scow, a versatile flat-bottom sailing craft that has been used in shallow harbors and inland waters along the East Coast since the early nineteenth century. By the late nineteenth century, the Gulf Coast builders developed a V-bottom scow. The V-bottom scows were framed and planked lengthwise on the bottom with deep transom at bow and stern, with the bow transom set at a great rake; and measured 9.75 (32 feet) to 15.24 meters (50 feet) long. These vessels were very popular from New Orleans westward to the Mexican border (Chapelle 1951:333–334). A typical schooner operating in coastal Texas is presented in Figure 3-1 which shows a two-masted, cargo-laden schooner in transit in Galveston Bay taken in 1910.

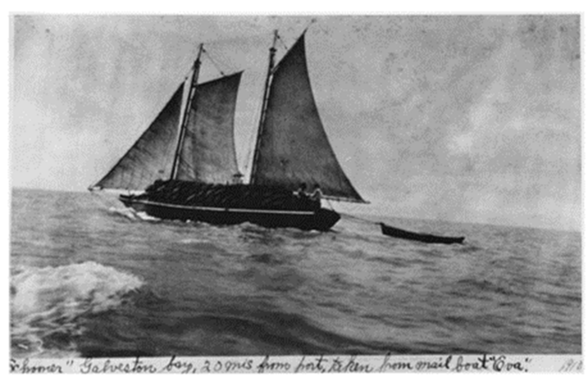

Figure 3-1. Photograph taken in 1910 on Galveston Bay showing a two-masted scow schooner in transit loaded with cargo (photograph courtesy: The Portal to Texas History).

Review of THC records indicates that 56 schooners are reportedly lost in Galveston County and 1 reportedly lost in Chambers County. None of the reported schooners are within or near the APE but given the numbers of schooners lost in the project counties, a low to moderate probability of discovering a historic schooner within the project area remains due to their frequency and duration of usage in the area.

3.3.2.2 Sloops

The sloop, another versatile sailing craft, can be described as a vessel with one mast like a cutter but having a jib stay, which a cutter does not. Also, sloop is the general name of ships of war below the size of frigates (Brande 1856 as presented in Saltus 1987:71). Like the schooner, sloop also refers to the vessel's sail configuration. Other varieties of the sloop include the sloop-of-war, ship-sloop, brig-sloop, and corvette (Saltus 1988:92). Sloops were capable of sailing in various environments including the narrow inland rivers and the open ocean.

The "Texas scow sloop", also known as the "Port Isabel sloop" and "Laguna Madre sloop" evolved to meet the unique conditions within the various and many shallow lagoons of the Texas coast (Figure 3-2). The basic form and rig consist of a gaff-rigged sloop with a single mast, with transom ends, a bit of V-bottom fore and aft, and two trunk cabins. The rigging configuration, along with a centerboard, made the Texas scow sloop very maneuverable in the variable winds of the lagoons. The vessel's shallow draft, drawing less than 0.61 meters (2 feet) of water, allowed for navigation into shallow waters in the vicinity of shoals and oyster beds.

Sloops ranged in length from 7.92 to 9.75 meters (26 to 32 feet) with beam measurements ranging from 3.04 to 3.65 meters (10 to 12 feet), and draft of 0.3 meters (1 foot), with the centerboard raised into the hull (Doran 1987:54). These vessels were constructed of local yellow pine and cypress; and near the Mexican border, boat builders used mesquite knees in lieu of cypress crooks. They were built upside down using the frames and the end-transoms as molds, retained chine logs, and were cross planked on the bottom (Chapelle 1951:336). A typical Texas scow sloop operating in coastal Texas is presented in Figure 3-3 which is a historic photograph of a scow sloop in transit.

Figure 3-2. A historic photograph (date unknown) showing a Texas scow sloop underway (as presented in Chappelle 1951:175).

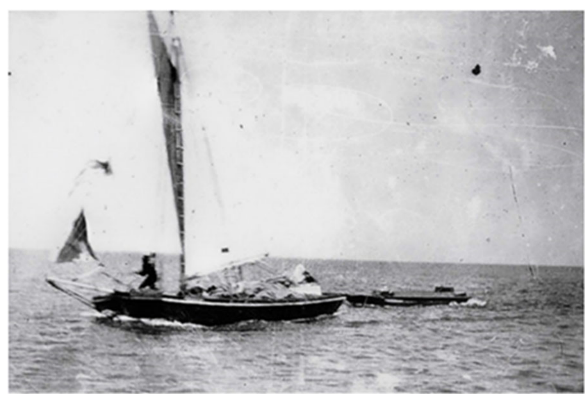

Figure 3-3. A historic photograph (date unknown) showing a Texas scow sloop underway (photograph courtesy: https://thedolphintalk.com/?p=10537).

Texas scow sloops were constructed by small-boat builders from the mid-1850s until as late as 1952 (Francaviglia 2010:247–248) and were very popular in the commercial fishing industry. These vessels would fish in pairs with gill nets extended between them which could yield thousands of pounds per netting. Paired gill netting resulted in overfishing, and nearly decimated the fisheries in coastal Texas. In 1952, Texas banned the use of gill nets, essentially marking the end of the Texas scow sloop. A replica of a Texas scow sloop, La Tortuga, built in 1990, is on display at the Texas Maritime Museum in Rockport, Texas (Figure 3-4).

Figure 3-4. Photograph of La Tortuga, a replica Texas scow sloop (photograph courtesy: Dolphin Talk 2020).

Review of the Atlas database indicates that there are no reported sloops in Chambers County, and two reported sloops in Galveston County, both of which are State Antiquities Landmarks (Unknown Confederate Sloop, no THC Shipwreck number given, Atlas No. 8200001604; and Unknown Sloop, Atlas No. 8200002220). Neither of the reported sloops in Galveston County are within or near the APE. However, due to the prevalent use and popularity of these vessels, the potential still exists that historic sloop remains may be identified.

3.3.2.3 Lugger

The early lugger, whose name is derived from the rig of Mediterranean sailing boats, had rounded hulls and used centerboards (Pearson et al. 1989:198; Comeaux 1985:172). Employed as work boats for oystering and shrimping activities, luggers operated frequently in the shallow coastal lakes, bayous, and marshes as well as the deeper bays. Construction of the boats was conventional consisting of sawn frames, carvel planking, and the usual plank keel of the centerboard. The timbering and plank were often local longleaf pine and cypress (Pearson et al. 1989:198).

With the advent of the motorized lugger, older sailing luggers were surpassed in quantity and popularity. Motorized luggers, omitting the centerboard, allowed for rapid transport of fishing commodities to the market unlike the slower sailing luggers (Comeaux 1985:172). The motorized luggers included a cabin to house the engine and operating controls. Motorized luggers appear typically as flat-bottomed, small craft, generally 6 to 9 meters (20 to 30 feet) long. More seaworthy luggers, commonly 12 to 15 meters (40 to 50 feet) length, were introduced later to access offshore oyster and fishing resources (Comeaux 1985:172).

Review of the Atlas database indicates that there are no reported luggers lost in Chambers or Galveston Counties or near the APE. However, due to the prevalent use and popularity of these vessels, the potential still exists that historic lugger remains may be identified.

3.3.2.4 Steamboats

Steamboats represent one of the most technologically innovative watercraft used in the nineteenth century. Propelled by steam engines, boilers, and paddlewheels, they were designated as side-wheelers or sternwheelers according to where the paddlewheel(s) was located on the vessel. Steamboats developed on the eastern rivers in the early nineteenth century but rapidly spread throughout the western rivers (Pearson et al. 1989:107).

By the 1840s and early 1850s, the western river steamboat began to take on the attributes now associated with the classic riverboat. The most significant change during this time was hull design. Rounded hulls became less preferred to rectangular, single-framed hulls with either no keel or only a vestigial keel (Pearson and Saltus 1993:15). The purpose of this design change allowed boat builders to construct a hull that could transport as much cargo as possible and at the same time draw as little water as possible to allow maneuverability with sufficient speed in shallow water, as well as to reduce listing tendencies, a feature critical to steam power operation (Tuttle et al. 2001:13). The most buoyant and stable hull was a flatboat; a long, flat bottom intersecting two short sides at right angles. Besides the stability, the cost of constructing a straight-lined hull with flat surfaces was more economically feasible than constructing one with the sheered lines of a sailing ship (Tuttle et al. 2001:13).

After the Civil War, sternwheel propulsion became preferred to sidewheel propulsion. Cheaper to construct and more effective in shallower water depths than sidewheelers, sternwheelers became the most common type of steamboat by 1870. Two sidewheel steamships associated with the Civil War, the blockade runner Denbigh and Union gunboat USS Hatteras, are located in or immediately offshore of Galveston County. There are no reported steamboat losses reported near the project area.

3.3.2.5 Post-Civil War and other Modern Craft

Modern watercraft in the coastal Texas region have evolved from the earliest vessels used in the expansion of the native and American populations and growth of commerce and industry. These vessels are often designated by terms that also refer to markedly different historic vessel types such as bateau, flatboat, or barge. As such, these vessels will not be described in great detail as early watercraft forms were described above. Modern watercraft are used primarily for the transportation of commodities and raw materials, pleasure craft, or participation in the seafood procurement industry throughout the project area. These vessels have typically abandoned the sailing rigging for motorized propulsion though a few old-fashioned holdouts still remain. Modern watercraft include skiffs, john boats, yachts, and trawlers. However, there is a moderate probability that they may be discovered within the project area.

A single shipwreck is charted within the APE of the North Todd project area and is identified as the fishing vessel *Nellie Meta* (Automated Wrecks & Obstructions Information System [AWOIS] Record 9232), which reportedly ran aground and sank in 1986 (NOAA 2020b). The wreck is listed as being “submerged, dangerous to surface navigation” (NOAA 2020b). No other wrecks are located within a half-mile of the APEs; a full listing of wrecks reported within 1.6 kilometers (1 mile) of the project area is given in Section 3.4 below.

Post-Civil War watercraft continued to utilize steam engine technology until they were gradually phased out by the invention of diesel and gasoline-powered motors. The slow-moving steamboats gave way to towboats and barges for transporting large quantities of goods. According to Pearson et al. (1989:180), towboats and barges became the predominant mode of commercial freight transportation (Pearson et al. 1989:180). Railroads, combined with motorized vessels, played a significant role in the demise of the steamboat.

3.3.3 Preservation of Submerged Cultural Resources

The natural environment and human action are the two factors that directly influence the preservation of submerged cultural resources. The nature of the marine environment can aid in the preservation of wrecks or it can initiate rapid degradation of these fragile resources. For example, changes in a river course can lead to complete burial and eventual land-locking of shipwrecks that originally were lost in riverine locations. Vessels abandoned along a riverine embankment can be filled with sediments or scoured by a high current. Storm surges from hurricanes also carry a high sediment load and are likely to bury historic shipwrecks lost within the project area under tens of feet of silt and sand, forming a protective anaerobic environment. Burial by sediment overburden often results in a greater chance of preservation. However, scouring actions from storm surges also can cause dispersal of hull fragments and artifacts along the seabed or allow the hull to settle lower and lower into soft bottom. Upon settling down to hardpan, though, portions of the vessel remaining exposed above the seafloor can become subject to erosion.

Another environmental factor that is detrimental to the preservation of a shipwreck's wooden components and artifacts in saltwater environments is the naval shipworm (Teredo navalis), a species of wood consuming bivalve mollusk in the family Teredinidae. The bivalve is called a shipworm because it resembles a worm in general appearance. At the anterior end it has a small shell/mantle with two valves that are adapted to boring into wood. Degradation of wooden components is also exacerbated by other marine organisms, such as the sheepshead (Archosargus probatocephalus), which destroys already infested wood while foraging for teredo worms. Additional damage can result from stone crabs (Menippe mercenaria) which not only dismember wood in search of inhabiting teredo worms but will also break apart ship timbers in an effort to create a nest or den.

Human action can cause as much destruction to historic shipwrecks as the above-mentioned environmental factors. Salvage activities remove valuable (and diagnostic) machinery and structural elements. Diagnostic artifacts can be disturbed or entirely removed from their context making identification of a shipwreck much more difficult. Historical dredging and snag removal operations often destroyed and removed shipwrecks from the archeological record. Wake from passing vessels, both small craft and commercial boats, can create substantial wave action to dislodge fragments of wooden-hulled wrecks. Repetitive wave action against shallow or partially exposed wrecks will rapidly accelerate their destruction. Finally, looting is a recurring problem that dramatically affects the ability of the archeologist to identify a shipwreck site. Often, diagnostic artifacts and vessel components such as bells, anchors, rudders, or propellers are removed by treasure seekers and souvenir hunters, thereby removing much of a vessel's identity. The above factors must be acknowledged when determining the likelihood of preservation of watercraft within the project area. The probability of preservation is high if bottom sediments buried vessels quickly. Preservation is low in areas where vessels lie exposed to the elements and human activities. Those vessels lost or abandoned near shore may have been picked clean by salvage, eroded by scour, or damaged by repetitive exposure to boat wakes and/or wind-generated waves.

Other potential impacts to shipwrecks in the area may be from the harvesting of oyster shell. During a survey in the vicinity of Red Fish Bar, numerous divots were noted along the bay bottom and were identified as the result of dredges collecting oyster shell. Sediment disruptions associated with shrimp and oyster trawlers were also noted (Maddox 2005). These activities would also likely have a negative impact on any shipwrecks on the bay bottom.

3.3.4 Navigational Improvements

Within the project area, by far the most significant navigational improvements have been focused on the construction, modification, and maintenance of the Houston Ship Channel. Although early private and local civic efforts had worked to improve the water route between the Gulf of Mexico and communities along Buffalo Bayou and the San Jacinto River, significant progress did not occur until the second half of the nineteenth century. In 1867, Charles Morgan cut a canal across Morgan's Point, bypassing one of the two main bars that limited entrance into the San Jacinto River from Galveston Bay. Beginning in the 1870s, the USACE took a leading role in establishing a channel 3.65 meters (12 feet) deep between

Galveston and Houston (Vincent et al. 2015). A major component of this work was creating an adequate channel through Red Fish Bar, located north of the project area.

Red Fish Bar, although not named, is shown as a navigational hazard as early as an 1828 map of the bay (Thompson 1828). Though the map does depict two narrow passes towards the western end of the bar near what was then called Davis Point (now known as Eagle Point). An 1851 nautical chart does not label passes but does show a pass in what appears to be the same area with a depth of 1.4 meters (4.5 feet). Surveyors recommended the construction of a lighthouse at the pass (United States Coast Survey 1851). An 1858 chart (United States Coast Survey) labels the two western passes as West Pass and Middle Pass, each with a depth of 1.5 meters (5 feet). A lighthouse is shown just west of Middle Pass. In 1872, the same two channels existed across the bar but were safe only for vessels drawing less than 1.2 meters (4 feet). Dredging was financed for an initial cut undertaken at West Pass where a 457-meter (1,500-foot) long, 21-meter (70-foot) wide channel was excavated to a depth suitable for a vessel with a 2.1-meter (7-foot) draft. The West Pass location was chosen because of the narrowness of the bar at that point. This cut appears to have been abandoned and filled with sediment by 1875, necessitating a new cut (Congressional Serial Set 1872; United States War Department 1883). An 1885 (United States Coast Survey) chart depicts yet another cut through the bar, this time in the approximate location of the modern Houston Ship Channel. The new channel is shown as between 4.5 and 6.4 meters (15 and 21 feet) deep.

In 1892, the federal government purchased Morgan's canal and made plans for a 7.6-meter (25-foot) deep, 45.7-meter (150-foot) wide channel. Deepening projects would continue throughout the twentieth century averaging an additional 1.2 meters (4 feet) of depth every 10 years (Vincent et al. 2015). Additional modifications have come from the installation of pipelines. Several existing lines run adjacent to but outside of the South Dollar Reef APE (Texas Railroad Commission 2020).

3.4 Site File and Literature Review

Prior to field investigations, a desktop review was conducted that included a state site file search. Consulting the online Texas Archeological Sites Atlas database resulted in a listing of all recorded marine archaeological sites, shipwrecks, and National Register of Historic Places (NRHP) properties within 1.6 kilometers (1 mile) of the project APE (Figure 3-5 and 3-6). The site file research was used as a basis for developing a historical context and to gather information about past cultural resource survey activities near the project area. Background historical research incorporated material and data gathered during previous archaeological investigations and primary and secondary historical sources. The historical research aided in identifying potential types of marine resources that may have been deposited in the vicinity of the project areas and determining the nature and extent of subsequent activities that may have removed or disturbed such resources.

Data sources available for background research include historical maps, primary and secondary shipwreck lists, primary historical accounts, newspapers, the NOAA's AWOIS and Electronic Navigational Charts (ENC), the THC online Atlas databases, and county and thematic histories. Information gleaned from these sources aided in developing a list of potential resources as well as identifying resources that may be expected to be located within the project area. Additionally, the TxGLO Coastal Resource Management Map was reviewed for the project area.

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Figure 3-5. Previous cultural resources surveys and cultural resources within 1.6 kilometers (1 mile) of the North Todd and Resignation Reef project area locations, Galveston Bay, Chambers and Galveston Counties, Texas.

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Figure 3-6. Previous cultural resources surveys and cultural resources within 1.6 kilometers (1 mile) of the South Dollar Reef project area location, Galveston Bay, Galveston County, Texas.

3.4.1 Previously Recorded Surveys

Background research revealed approximately 21 surveys have been conducted with 1.6 kilometers (1 mile) radius of the three project areas (Figures 3-5 and 3-6). Research also revealed that portions of the North Todd and Resignation APEs have been surveyed for submerged cultural resources (Figure 3-5), while no part of South Dollar has been surveyed for cultural resources (Figure 3-6).

The majority of the North Todd project area was included in 2000–2001 Redfish Island Survey conducted by PBS&J, now Atkins, under Texas Antiquities permit number 2372 (Atlas No. 8700000022). The survey identified 21 targets. Based on further study, none were identified as significant cultural resources and no further work was recommended (Watts et al. 2003).

The western margin of the North Todd project area is within survey coverage acquired in 2005 by Panamerican Consultants, Inc. (Panamerican) under Texas Antiquities permit number 3665 (Atlas No. 8700000025). The surveys resulted in the identification of five side-scan sonar targets. None of the five targets are considered significant cultural resources and no further work was recommended (Krivor 2006).

The Resignation project area overlaps with the southwestern corner of the Redfish Island Survey conducted by PBS&J under Texas Antiquities permit number 2372 (Atlas No. 8700000022). The survey did not identify potential cultural resources within the current project area.

3.4.2 Previously Recorded Cultural Resources

Background research revealed one previously recorded archaeological site within 1.6 kilometers (1 mile) of the project areas; there are no National Register Properties within the project APEs.

Verified by PBS&J divers in February 2001, Site 41CH372 is an extant steel-hulled shipwreck measuring approximately 23 meters by 3.7 meters (76 feet by 12 feet) that dates to the 1940s–1960s. The unnamed vessel is believed to have been a towboat that ran aground and burnt in the 1970s. The site was initially identified as a significant magnetic anomaly and subjected to diver investigation. Additional features observed on the site included a steel anchor, rope, wire rope, steel cable, and brass pipe. Site 41CH372 is located approximately 1.5 kilometers (0.9 miles) north-northeast of the project area and determined ineligible for nomination to the NRHP by the Texas State Historic Preservation Office (SHPO) in 2003 (Determination ID 23023; THC Atlas Number 8600023023).

3.4.3 Previously Recorded Shipwrecks and Obstructions

Research identified one reported shipwreck within the North Todd project area; there are no wrecks reportedly located in either the Resignation or South Dollar project areas (Figure 3-5 and 3-6).

The fishing vessel *Nellie Meta* (AWOIS Record 9232) reportedly ran aground and sank in 1986 (NOAA 2020b). The wreck is listed as being "submerged, dangerous to surface navigation" (NOAA 2020b). The charted position of *Nellie Meta* is located along the northern boundary of the APE, and completely within the additional survey area provided by the 60-meter (197-foot) buffer.

In addition to *Nellie Meta*, there are 34 reported shipwrecks and 7 obstructions within the 1.6-kilometer (1-mile) study radii of the APEs (Figures 3-5 and 3-6).

3.4.4 State Antiquities Landmarks and Historical Markers

Review of the Texas State Atlas revealed that there are 16 State Antiquities Landmarks in Chambers County and 134 in Galveston County. None of the identified States Antiquities Landmarks are located within 1.6 kilometers (1 mile) of the APEs.

Review of the Atlas database also revealed that despite there being 300 historical markers in Galveston County and 49 in Chambers County, none are within 1.6 kilometers (1 mile) of the APEs.

3.4.5 National Register of Historic Places

Review of the NRHP searchable online database revealed that there are six NRHP-listed properties in Chambers County, and 78 in Galveston County, none of which are within the 1.6-kilometer (1-mile) study radius (NRHP 2020).

4.0 FIELD METHODOLOGY

Field investigation of the project consisted of an intensive marine survey. The underwater survey employed a variety of remote sensing technologies deployed from a survey vessel to examine the bays' beds and locate anomalies and acoustic targets on or buried in submerged sediments that might be affected by project activities. On Tuesday morning July 28, 2020, the survey crew assembled at the boat ramp at Bayshore Park in Bacliff, Texas. Located just west of Eagle Point and the North Todd project area, the boat ramp provided convenient access to all three project areas. The weather during the survey included partly sunny to overcast skies and occasional rainfall. Seas were less than 0.3 meters (1 foot) for the majority of the survey, with occasional swells up to 0.6 meters (2 feet).

4.1 Underwater Archaeological Survey

The survey vessel used for the present project was BIO-WEST's 8.2-meter (26-foot) aluminum work vessel (Figure 4-1). The vessel's attributes (ample deck space, shallow draft, high maneuverability, davits, and winches) made it an excellent platform from which to conduct survey while towing numerous pieces of gear. The vessel was propelled by two 130 horsepower (HP) outboard motors and has a top speed of 25 knots to transit to the survey site, while a survey speed of approximately 4 knots was easily maintained during survey. The onboard 5-kilowatt power system provided more than enough electricity to power all the remote sensing equipment, computers, navigation gear, deck hoists and winches, and safety equipment.

Positioning is considered a critical aspect of marine remote sensing projects. In order to recreate or relocate survey targets, accurate positioning is critical. For navigation and positional control, BIO-WEST utilized a Hemisphere® VS110 differentially corrected global positioning system (DGPS) receiver.

Vessel guidance, position, and data logging were accomplished with a navigation processor utilizing Trimble® HYDROpro™ Navigation software. Positional information for the survey vessel and each instrument sensor, via layback calculations, was stored in the navigation processor at a rate of one reading per second. The navigation system was the basis around which the survey was built. Project area coordinates and pre-plotted survey lines were pre-programed into the computer. The onboard computer converted positioning data from the DGPS receiver to NAD 83, Zone Texas South Central in Meters, in real-time. These coordinates were then used to guide the survey vessel precisely along the predetermined track lines (Figures 4-2, 4-3, and 4-4). While surveying, vessel positions were continually updated on the computer monitor to assist the vessel operator while the processed easting and northing data were continually logged to the computer storage disk for post-processing and plotting. All survey lines were positioned down the pre-plotted tracklines. The entire area was safely navigable, and each project area was fully covered.

Figure 4-1. BIO-WEST's project survey vessel.

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Figure 4-2. Planned and actual survey tracklines for the North Todd Artificial Reef project area (Area A), Chambers and Galveston Counties, Texas.

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Figure 4-3. Planned and actual survey tracklines for the Resignation Artificial Reef project area (Area B), Galveston County, Texas.

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Figure 4-4. Planned and actual survey tracklines for the South Dollar Artificial Reef project area (Area C), Galveston County, Texas.

To examine the seabed, an EdgeTech 4125 dual frequency all digital side-scan sonar system was used (Figure 4-5). The dual frequency, 400/900 kilohertz (kHz), side-scan sensor collected and gave a real time display of the acoustic data throughout survey operations. Due to the shallow waters of the bay, the sonar towfish was deployed from the port side of the survey vessel 0.5 meters (1.6 feet) deep in conjunction with a pole mount and side bracket, in an effort to obtain the most diagnostic acoustic images of the bay bottom (Figure 4-6). The sonar unit was operated at a 75-meter (164-foot) range, which at the defined 20-meter (65-foot) transect interval resulted in over 300 percent overlapping coverage of the project area.

Figure 4-5. EdgeTech 4125 dual frequency side-scan sonar system.

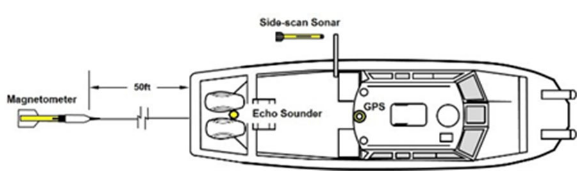

Figure 4-6. Hydrographic survey equipment layout.

Magnetic data were collected with a Geometrics G-882 Cesium marine magnetometer (Figure 4-7). Its operating principle is based on self-oscillating split-beam Cesuim vapor, with an operating range of 20,000 to 100,000 nano-Tesla (nT) and a counter sensitivity of 0.004 nT. The water depth of the project area is approximately 2.1–3.9 meters (7–13 feet) deep. Due to the shallow waters of the bay, the magnetometer sensor was floated at the surface using life preservers and was towed 15.8 meters (52 feet) behind the survey vessel (see Figure 4-6).

Figure 4-7. Geometrics G-882 Marine Magnetometer with life preservers attached for towing in shallow water.

Magnetic readings were recorded at a sample rate of 1 hertz, or 1 sample per second. Magnetic “anomalies” have been defined by Garrison et al. (1989) as a deviation in the ambient magnetic field measuring 5 nT (1nT = 1 gamma) or more and recorded across three or more consecutive data samples. Enright et al. (2006) restated this definition using the same intensity criteria but using a distance measurement of 6 meters (19.7 feet) or more rather than using a predefined duration of time. Neither definition explicitly addresses water depth as a function of anomaly identification; however, both intensity and duration are relative to the separation between sensor and source, therefore, ferromagnetic sources in extremely shallow water will produce artificially inflated intensities and durations than the same source in deeper water where there is greater distance between the source and the magnetometer (Figure 4-8). Magnetometers should not exceed a maximum altitude of 6 meters (20 feet). For the purposes of this survey, magnetic variations with a peak to peak change in intensity less than 5nT or duration of less than meters (20 feet) were not mapped as “anomalies).

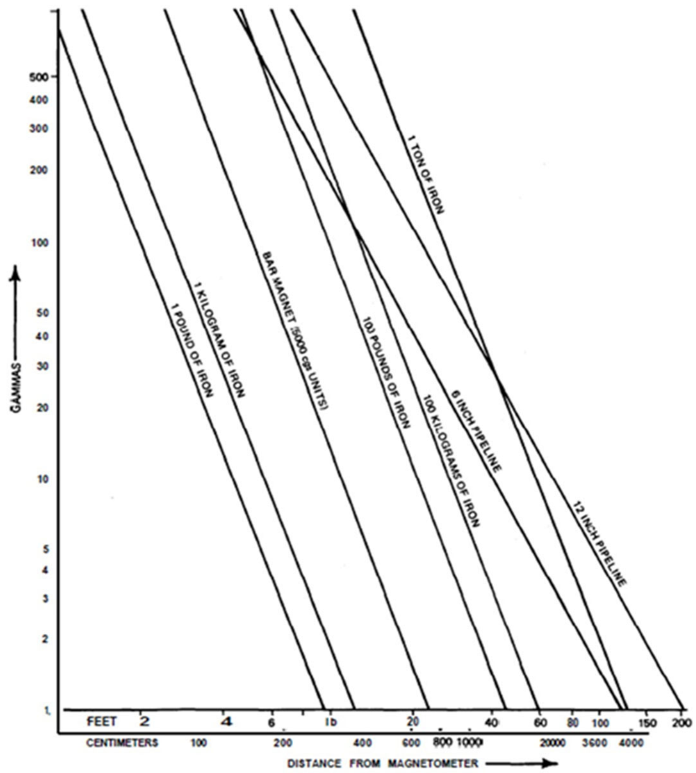

Figure 4-8. Nomogram for estimating magnetic anomalies from typical objects (assuming dipole moment M = 5 x 105 cgs/ton, i.e., k = 8 cgs) (Breiner 1999:43).

4.1.1 Data Products- Side-scan Sonar

The side-scan sonar derives its information from reflected acoustic energy that is recorded onto a survey computer. Side-looking sonar transmits and receives swept high-frequency bandwidth signals from transducers mounted on a sensor that is towed from a survey vessel. Two sets of transducers mounted in an array along both sides of the towfish generate the short duration acoustic pulses required for high-resolution images. The pulses are emitted in a thin, fan-shaped pattern that spreads downward to either side of the towfish in a plane perpendicular to its path. As the fish is towed along the survey trackline, this acoustic beam sequentially scans the bottom from a point beneath the towfish outward to each side of the trackline.

Acoustic energy emitted from the transducer travels towards the seafloor where it is reflected from the bottom sediments, and any other bottom features, such as exposed pipelines, rocks, unexploded ordnances (UXOs) or other solid submerged objects, absorbed, or scattered. The acoustic energy reflected back towards the towfish is received by the transducers, amplified, and transmitted to the survey computer via a towed data cable. The digital output illustrates in graphic form the speed and strength of the returned acoustic energy, providing detailed representations of bottom features and characteristics. Sonar allows the display of positive relief (features extending above the bottom) and negative relief (such as depressions) in either light or dark opposing contrast modes on a video monitor. Additionally, the reflectivity of bottom sediments can indicate transitions between harder and softer seabed materials. Examination of the images thus allows a determination of significant features and objects present on the bottom within a survey area.

Acoustic targets are normally defined according to their spatial extent, configuration, location, and environmental context. Characteristics of an acoustic target to be scrutinized in a sonar image are spatial extent, association or configuration, location, and the environmental context. Shipwrecks are generally easy to discern as are other large, regular, articulated cultural features. Additionally, many natural features, such as rock outcrops, oyster reefs, sunken logs, and even schooling fish create reflections that can be identified in the data. It can be difficult to discern natural from anthropogenic features within the data.

Sonar data were recorded digitally in the field using Edgetech's Discover software and processed using SonarWiz Ver 7.06.04. Following import, the data were bottom tracked, and TVG/gains adjusted for optimal display. Offsets were confirmed to adjust for the distances between the sensor and navigation antenna. Sonar targets were interpreted line by line, and then rationalized; only those features observed on multiple lines within overlapping coverage were interpreted as seafloor targets. Sonar mosaics were generated from the processed data and exported in geotiff format for each of the three separate project areas.

4.1.2 Data Products-Magnetometer

The Geometrics G-882 Marine Magnetometer measures the earth's ambient magnetic field strength at the sensor's location. Although the earth's magnetic field does change with both time and distance, over short periods and distances the earth's field can be viewed as relatively constant. The presence of magnetic material and/or magnetic minerals, however, can add to or subtract from the earth's magnetic field creating a localized magnetic anomaly. Rapid changes in total magnetic field intensity, which are not associated with normal background fluctuations, mark the locations of these anomalies.

Magnetometer data were interpreted using SonarWiz, with individual anomalies picked line by line. Background noise was confined to +/- 1 nT. The overall ambient field increased northward by approximately 70nT from the South Dollar project area to the North Todd project area. Magnetometer data used in contouring were corrected for diurnal variation using IAGA2000 formatted data from Observation Station BSL operated by the USGS. The ambient magnetic field was not removed from the diurnally corrected data, as this negated the ability to identify smaller duration point source anomalies within the data set. The diurnally corrected ambient data were then gridded in Surfer using the natural neighbor algorithm to reduce data exaggeration within non-normal polygons along the perimeter of the project area. The final contours were exported at 5nT intervals to illustrate the picked anomalies.

4.1.3 Remote Sensing Interpretation-Magnetometer

The magnetometer and side-scan sonar are the primary tools for identifying potential archaeological materials in submerged contexts. The magnetometer can indicate metal objects, which are some of the main components of shipwrecks, while the side scan can create an image of the seabed that allows for detailed analysis of recorded objects. Unfortunately, the analysis and interpretation of remote sensing data is a process that is not 100 percent accurate in identifying a target source. While a physical examination is the only way to positively identify the source of a remote sensing target, in most cases, it is economically unfeasible to examine every recorded anomaly. Therefore, a rational method has to be used to discriminate the likelihood that a magnetic anomaly source or side-scan sonar image represents a potentially significant cultural resource. Numerous factors should be considered while interpreting remote sensing data.

The factors that make up the basis for remote sensing interpretation are just as important as quality data acquisition. Magnetometer data present several properties which can be used for analysis. One characteristic examined is magnetic amplitude, or the deviation recorded from background readings. The change from background may be either positive or negative or both. If the amplitude change is only in a single direction it is known as a monopole, while a single combined positive and negative change is a dipole. If the anomaly source has more than two opposing peaks, it is complex. Another significant characteristic for analysis is the anomaly's duration and how long it occurs in the record. Again, an anomaly is a local event and the closer the sensor is to its source the greater the amplitude recorded (see previous Figure 4-8). Within this local field, the recorded duration will change from and return to the ambient background readings where it is no longer detected by the sensor. Another attribute of an anomaly that has been receiving more attention in analysis lately is its orientation, the way the poles of the anomaly are oriented relative to the earth's magnetic field. Magnetic deviation recorded is, in part, a function of distance between the sensor and magnetic source material, for example, the closer the sensor to the material, the larger the reading.

Effective analysis of magnetic remote sensing data depends on quality data collection, knowledge of the environment from which the data are collected, and experience with examining anomaly sources. Through the years, several authors have created models to aid in interpreting remote sensing data, especially magnetometer data. Garrison et al. (1989) created an early model based on selected shipwrecks in the Northern Gulf of Mexico. The authors suggest that "a shipwreck as an archaeomagnetic feature can be defined as a cluster of multiple anomalies within an area of 50,000 sq m or less" (Garrison et al. 1989: Vol II, 222). They further state that "isolated anomalies over a large spatial area with little or no expression on adjacent survey lines of reasonable width will, in most instances, be marine debris" (Garrison et al. 1989: Vol II, 222). The authors do warn that both statements are generalizations and cite the magnetic signature of a coil of cable, modern debris, as mimicking their expected pattern for a historic shipwreck. The authors conclude by providing eight criteria for characterizing historic shipwrecks from sonar and magnetometer data. Those criteria specific to magnetometer data include multiple peak anomalies, varying amplitudes, areal distribution of anomalies over greater than 10,000 square meters, axial or linear orientation of anomalies, and long durations (Garrison et al. 1989: Vol II, 223).

Later, Pearson et al. (1991), considering the earlier work, developed a new model in order to suggest the presence of shipwrecks based on observed magnetic amplitude and duration of a known sample of shipwreck sites. Threshold data for potential shipwreck sites were set at 50-gamma total magnetic deflection from background with a linear duration of greater than 24 meters (80 feet). Recently, Linden and Person, "recognizing a considerable amount of variability," have revised Pearson's initial quantitative measurements downward to eliminate targets with magnetic signatures of 50-gamma deflection and less than 20 meters (65 feet) duration (Linden and Pearson 2014). In addition to these quantitative limits, Pearson with Hudson (1990) have argued for a qualitative assessment of remote sensing data as well. The environmental context in which an anomaly is located is an important factor in its analysis and interpretation.

The present project area environments consist of relatively shallow areas within Galveston Bay. Maritime activity within the Houston Ship Channel, which is located east of the project areas, allows access through the bay to multiple port facilities. Besides commercial vessels transiting the areas, recreational vessels are also common in the bays. Additionally, the South Dollar project area is located just north of a charted pipeline area; multiple submerged pipes, markers, wells, and a platform are scattered within the bay surrounding the project areas. Review of the Railroad Commission of Texas Public GIS Viewer revealed that there are no records of existing pipelines or any plugged oil wells located within or partially within the current project areas (Railroad Commission of Texas 2020). These environmental and cultural factors should be taken into consideration while conducting an analysis of the project anomaly data.

A third model does not rely exclusively on a specific magnetic deflection or area of coverage but on the very essence of the earth's magnetic field and the orientation characteristics of a recorded magnetic anomaly. In order to increase the efficiency of magnetic analysis as, "Only a tiny fraction of seafloor magnetic anomalies are associated with shipwrecks," Gearhart (2011:91) has created a model for identifying shipwreck sites based, in part, on the principles of magnetic orientation. Using 29 known shipwreck sites comprising a varied selection of vessel types exhibiting a wide range of horizontal dimensions and magnetic amplitudes, the basis of other magnetic interpretive models, Gearhart highlights the orientation of the represented anomaly itself, an overall dipole configuration. One unique magnetic characteristic of all known shipwrecks in the sample presented is the magnetic orientation of the anomaly over all shipwreck sites, the negative component of a dipolar anomaly unfailingly resides to the geographic north. Additionally, it is recognized that the magnetic deviation of the graphically represented signature did not vary greater than 26 degrees from magnetic north (Gearhart 2011). Thus, a dipolar anomaly with a positive gamma deflection to the north is not consistent with known shipwreck sites and therefore should not be considered a potential shipwreck. The smallest shipwreck located by this method is known as Site 41CL92. The magnetic anomaly for this site had a total magnetic deviation of 191 gamma made up of a positive and negative component and could be detected over an area of 1,580 square meters (0.4 acres) at a 5-gamma interval. The site, when examined by divers, measured roughly 7 by 16 meters (23 by 52 feet) and is thought to be the remains of a nineteenth-century sailing vessel (Gearhart 2011).

A study in a context very different from the present research, Boston Harbor, examined 67 previously identified remote sensing targets. The historic importance of the water body to American history cannot be discounted. The examination found approximately 15 percent of the initially identified anomalies were mobilized following data acquisition and could not be relocated during the subsequent survey; the sources for the remaining targets were identified. The materials examined spanned the gamut from metal debris, pipes, and chain to modern fishing gear and several watercraft. Four barges, one modern vessel, and the remains of a potentially significant wooden-hulled shipwreck were observed. In the context of a harbor that has had centuries of historic traffic and is still actively used today, only one potentially historic site was located (Tuttle 2004). Locating one potentially significant site indicates the rarity and difficulty of distinguishing remote sensing data as significant archaeological sites. However, it also indicates the necessity to examine anomalies in the proper context to ensure that the rare sites that are indicated in the record are protected.

Interpreting the context of an archaeologically surveyed area relative to remote sensing analysis is the grayest of the evaluation criteria. There are no baseline numbers or qualitative assessments to be referred to or consulted. Experience and in some respects common sense are required to make a subjective evaluation based upon the variables pertaining to the environment worked in. The only way to know the source of every magnetic anomaly or side-scan image is to have a complete examination either by an archaeological diver or remotely operated vehicle. "Hands-on inspection of every buried anomaly source may not be an economic possibility, so researchers must trust their interpretive abilities" (Gearhart 2011). In the context of the present research, the environmental and historic considerations will be one of the factors considered while interpreting for potential significance of the sources of magnetic anomalies.

The present investigation in the shallow waters of Galveston Bay uses the above-mentioned methods to filter anomalies to determine potential significance as a necessity, as every anomaly is not a shipwreck. The main filters employed are those developed by Linden and Pearson (2014), Garrison et al. (1989), and Gearhart (2011). Anomalies interpreted as monopoles, or diploes with a positive magnetic deflection to magnetic north were not considered potentially significant and thus removed from consideration of potential significance. Small single point sources were not considered significant either.

5.0 RESULTS OF INVESTIGATIONS

Survey operations were conducted on July 28, 2020 using a pole-mounted Edgetech 4125 dual frequency side scan sonar system operating at 400 and 900 kHz, a pole-mounted Odom singlebeam echosounder, and a towed Geometrics G-882 total field magnetometer. The magnetometer was deployed behind the boat and buoyed at the surface, with sufficient cable out to avoid interference from the vessel or its outboard engines. Sensors were deployed during reconnaissance lines and tuned for optimal data quality prior to the start of survey acquisition. Sonar data were acquired using Discover software; magnetometer and fathometer data were integrated into Trimble's HydroPro navigation software package, which also provided real-time vessel positioning and horizontal control.

The survey was designed to cover three separate APEs, each including a 60-meter (197-foot) buffer. The North Todd project area (Area A) included a total of 23 primary transect lines spaced at 20-meter (65.6-foot) intervals and oriented approximately east to west across the proposed project area. Resignation Reef, also known as Area B, included a total of 18 primary survey lines spaced at 20-meter (65.6-foot) intervals and oriented approximately east to west. South Dollar Reef, also known as Area C, included a total of 14 primary survey lines spaced at 20-meter (65.6-foot) intervals and oriented approximately north to south. All planned and as-run lines are shown in Chapter 4, Figures 4-2, 4-3, and 4-4.

5.1 Bathymetry Data

5.1.1 North Todd Reef Area (Area A)

Water depths in the North Todd Reef area (Area A) range from a minimum of 2.1 meters (7 feet) below sea level (bsl) to a maximum of 3.9 meters (13 feet) bsl in the project area (Figure 5-1). The seafloor slope is relatively shallow, with depths generally increasing to the southeast. Areas of bathymetric irregularity generally correlated with areas of increased reflectivity on the sonar data, suggesting possible mounds of increased seafloor density, possibly representing concentrations of shell. No bathymetric irregularities were over observed correlating with the charted position of *Nellie Meta*.

5.1.2 Resignation Reef Area (Area B)

Water depths in the Resignation Reef area (Area B) range from a minimum of 2.4 meters (8 feet) bsl to a maximum of 3.3 meters (11 feet) bsl in the project area (Figure 5-2). The seafloor slope is relatively consistent over the project area, with a ridge of slightly shallower depths along the western margin of the area correlating with an area of increased seafloor reflectivity.

5.1.3 South Dollar Reef Area (Area C)

Water depths in the South Dollar Reef area (Area C) are a relatively consistent 3.3 meters (11 feet) bsl (Figure 5-3). Minor bathymetric fluctuations are observed in the contours that correlate with areas of differential reflectivity in the sonar data and may indicate softer, collapsed sediments and denser, more consolidated sediments.

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Figure 5-1. Bathymetric contour map of the North Todd Reef area (Area A), Chambers and Galveston Counties, Texas, at 0.3-meter (1-foot) intervals.

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Figure 5-2. Bathymetric contour map of the Resignation Reef area (Area B), Galveston County, Texas, at 0.3-meter (1-foot) intervals.

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Figure 5-3. Bathymetric contour map of the South Dollar Reef area (Area C), Galveston County, Texas, at 0.3-meter (1-foot) intervals.

5.2 Side-Scan Sonar Data

Side-scan sonar data were acquired at 75-meter (246-foot) range, resulting in greater than 300 percent coverage of the project area. Sonar mosaics were trimmed to the innermost 30-meter (98-foot) per channel for geotif production.

5.2.1 North Todd Reef Area (Area A)

The sonar data in the North Todd Reef area (Area A) depict a generally weakly reflective seafloor in the northern portion of the project area interrupted by linear trends of increased reflectivity (Figure 5-4). Seafloor sediments generally increase in reflectivity towards the south. A single sonar target was recorded and is located towards the eastern end of the project area. Target NT-001 is an irregularly shaped linear feature measuring approximately 2.7 meters x 1.0 meters (8.8 feet x 3.3 feet) with a maximum calculated height above the seafloor of 0.4 meters (1.3 feet). Given its acoustic reflection, lack of corresponding magnetic anomaly, and close proximity to a larger area of increased reflectivity, this target is interpreted as a probable shell reef or modern pile of discarded shell.

5.2.2 Resignation Reef area (Area B)

The sonar data in the Resignation Reef area (Area B) depict a mottled seafloor with generally moderately reflective sediments interrupted in the central portion of the area by weakly reflective sediments (Figure 5-5). Two sonar targets were recorded. Target R-001 is located in the southeastern corner of the project area, within the buffered area. The target is a linear feature measuring approximately 1.3 meters x 0.3 meters (4.3 feet x 1 feet) with a maximum calculated height above the seafloor of 0.4 meters (1.3 feet). The target is interpreted as a probable sediment berm, given its acoustic reflection and lack of corresponding magnetic anomaly. Target R-002 is located in the southwestern corner of the project area. The target is an irregularly shaped feature measuring approximately 1.1 meters x 1 meter (3.6 feet x 3.3 feet) with a maximum calculated height above the seafloor of 1 meter (3.3 feet). The target is interpreted as probable modern debris, given its correlation with a single, point source anomaly (anomaly R-022).

5.2.3 South Dollar Reef area (Area C)

The sonar data in the South Dollar Reef area (Area C) depict a generally weakly reflective seafloor with a pronounced area of increased reflectivity in the central portion of the project area that corresponds with the bathymetric contours (Figure 5-6). Probable drag scars were observed across the project area, most of which are approximately parallel and extend from northwest to southeast. No sonar targets were observed within the recorded sonar data.

All of the interpreted sonar targets are shown on the sonar mosaics and detailed in Appendix B.

5.3 Magnetometer Data

Digital magnetometer data were interpreted line by line in SonarWiz for anomalies as previously defined in Chapter 4. A total of 120 unidentified anomalies were interpreted from the combined data sets. The anomalies are discussed in detail below, by project area.

5.3.1 North Todd Reef Area (Area A)

Magnetometer data recorded a total of 67 unidentified anomalies within the North Todd Reef area (Area A), of which 7 exceeded the intensity (50nT) and duration (20-meter [65.6-foot]) criteria defined by Linden and Pearson (2014) for anomalies representative of potential cultural resources (Figure 5-7). These anomalies, including numbers NT-005, NT-025, NT-026, NT-036, NT-040, NT-044, and NT-058, were then scrutinized using the criteria for historic shipwrecks defined by Garrison et al. (1989) and Gearhart (2011) and are discussed in greater detail below (Figure 5-8).

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Figure 5-4. Side-scan sonar mosaic of the North Todd Reef area (Area A) with sonar target, Chambers and Galveston Counties, Texas.

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Figure 5-5. Side-scan sonar mosaic of the Resignation Reef area (Area B) with sonar targets, Galveston County, Texas.

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Figure 5-6. Side-scan sonar mosaic of the South Dollar Reef area (Area C), Galveston County, Texas.

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Figure 5-7. Magnetic anomalies interpreted within the North Todd Reef area (Area A), Chambers and Galveston Counties, Texas.

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Figure 5-8. Magnetic contours within the North Todd Reef area (Area A), Chambers and Galveston Counties, Texas in 5nT intervals.

- Anomaly NT-005 is spatially isolated, with no correlating anomalies observed from the adjacent lines. The contoured data depict a positive monopolar anomaly that is interpreted as probable modern debris.

- Anomalies NT-025 and NT-036 are located on adjacent survey lines, but contour as spatially distinct monopolar anomalies. Anomaly NT-025 is a negative monopole, with NT-036 a positive monopole oriented immediately northward of NT-025. Both anomalies are interpreted as probable modern debris.

- Anomaly NT-026 is oriented in an approximately linear trend with anomalies NT-045 and NT-002 on the next two southern lines. Anomalies NT-026 and NT-002 form a positive monopolar contour to the east (but not on adjacent survey lines) with anomaly NT-045 forming a negative monopole to the west on the survey line in between anomalies NT-026 and NT-002. Both anomalies NT-045 and NT-002 are below the Linden and Pearson (2014) threshold. All three anomalies are interpreted as probable modern debris.

- Anomaly NT-040 is a positive monopolar anomaly that corresponds with anomaly NT-039 on the adjacent transect to the north, which is a negative monopole. Although the contours appear to represent spatially isolated anomalies, together they represent a possible dipolar contour with the negative lobe oriented almost due north. Anomaly NT-039, as well as NT-042 (located on the same transect as NT-040) and NT-020 (located northeast of NT-039 on the next northern transect), are all below the Linden and Pearson (2014) threshold but form a cluster as suggested by Garrison et al. (1989). Combined with the northward negative lobe consistent with the Gearhart (2011) model, and proximity of the reported remains of the *Nellie Meta*, anomaly NT-040 is interpreted as a possible cultural resource. It should be avoided by a distance of 50 meters (164 feet); this radius will encompass all other associated anomalies, including NT-039, NT-042, and NT-020 (Figures 5-7 and 5-8).

- Anomaly NT-044 is spatially isolated, with no correlating anomalies observed from the adjacent lines. The contoured data depict a negative monopolar anomaly that is interpreted as probable modern debris.

- Anomaly NT-058 is spatially isolated, with no correlating anomalies observed from the adjacent lines. The anomaly is a dipolar feature, but because it is spatially restricted to the single survey transect, it appears as an east-west lobed feature and is interpreted as probable modern debris.

The magnetic contours are plotted in 5nT intervals (Figure 5-8). Anomalies NT-018, NT-060, and NT-061 correlate with the AWOIS charted position of the *Nellie Meta*, but these anomalies are interpreted as being coincidental in location, and unlikely to represent a buried shipwreck. Anomaly NT-060 is the largest of the three anomalies and is a 29nT dipole with a recorded duration of 21 meters (69 feet); both anomalies NT-018 and NT-061 are positive monopolar anomalies less than 8nT intensity and relatively short durations. All three are interpreted as probable modern debris.

5.3.2 Resignation Reef Area (Area B)

Magnetometer data recorded a total of 29 unidentified anomalies within the Resignation Reef area (Area B), of which one (R-013) exceeded the intensity (50nT) and duration (20-meter [65.6-foot]) criteria defined by Linden and Pearson (2014) for anomalies representative of potential cultural resources (Figure 5-9). This anomaly was then scrutinized using the criteria for historic shipwrecks defined by Garrison et al. (1989) and Gearhart (2011) and is discussed in greater detail below (Figure 5-10).

- Anomaly R-013 is a high intensity (173nT) dipolar anomaly with a relatively short duration (27.5 meters [90 feet]). The contoured data are spatially restricted and do not reach the adjacent survey transects; the resulting contoured dipole is oriented positive east to negative west. Anomaly R-010 is a 15nT positive monopolar anomaly located on the adjacent line to the south but does not form a larger cluster in the contoured data. Both anomalies are within the additional data acquired as part of the 60-meter (197-foot) buffer and are interpreted as probable modern debris.

The Resignation Reef area (Area B) magnetic contours are plotted in 5nT intervals (Figure 5-10).

5.3.3 South Dollar Reef Area (Area C)

Magnetometer data recorded a total of 24 unidentified anomalies within the South Dollar Reef area (Area C), of which 3 (SD-005, SD-012, and SD-019) exceeded the intensity (50nT) and duration (20-meter [65.6-foot]) criteria defined by Linden and Pearson (2014) for anomalies representative of potential cultural resources (Figure 5-11). These anomalies were then scrutinized using the criteria for historic shipwrecks defined by Garrison et al. (1989) and Gearhart (2011) and are discussed in greater detail below.

- Anomaly SD-005 is spatially isolated, with no correlating anomalies observed from the adjacent lines. The contoured data depict a positive monopolar anomaly that is interpreted as probable modern debris.

- Anomaly SD-012 is spatially isolated, with no correlating anomalies observed from the adjacent lines. The contoured data depict a largely positive dipolar anomaly; the negative lobe is below the threshold to appear in contours. Anomaly SD-012 is interpreted as probable modern debris.

- Anomaly SD-019 is spatially isolated, with no correlating anomalies observed from the adjacent lines. The contoured data depict a largely negative monopolar anomaly; in profile view, the anomaly is a complex signature feature with two negative peaks that lack separation from one another or any trend toward a positive peak. Anomaly SD-019 is interpreted as probable modern debris.

The South Dollar Reef area (Area C) magnetic contours are plotted in 5nT intervals (Figure 5-12). All of the interpreted magnetic anomalies are tabulated in Appendix C.

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Figure 5-9. Magnetic anomalies interpreted within the Resignation Reef area (Area B), Galveston County, Texas.

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Figure 5-10. Magnetic contours within the Resignation Reef area (Area B), Galveston County, Texas in 5nT intervals.

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Figure 5-11. Magnetic anomalies interpreted within the South Dollar Reef area (Area C), Galveston County, Texas.

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Figure 5-12. Magnetic contours within the South Dollar Reef area (Area C), Galveston County, Texas in 5nT intervals.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Under contract to TPWD, Gray & Pape conducted a submerged cultural resources remote sensing survey for the proposed North Todd, Resignation, and South Dollar Artificial Reef Project APEs. The purpose of these surveys was to evaluate the bay bottom to determine if any potential significant cultural resources are present within the APEs and provide recommendations for any such potential cultural resources.

The rectangular North Todd project area is centered at 29° 30′ 25.47″N Latitude and 94° 53′ 28.86″W Longitude and located on the Bacliff, Texas 7.5-minute USGS topographic quadrangle map. The trapezoidal Resignation project area is centered at 29° 29′ 29.76″N Latitude and 94° 52′ 53.35″W Longitude and located on the Texas City, Texas 7.5-minute USGS topographic quadrangle map. The rectangular South Dollar project area is centered at approximately 29° 27′ 20.43″N Latitude and 94° 52′ 2.26″W Longitude and located on the Port Bolivar, Texas 7.5-minute USGS topographic quadrangle map. All three areas are on NOAA nautical chart #11327, Upper Galveston Bay – Houston Ship Channel – Dollar Point to Atkinson (NOAA 2017).

Review of the Texas Archeological Atlas indicated that two previous cultural resources surveys extend across the majority of the North Todd Reef area (Texas Antiquities permit number 2372 [Atlas No. 8700000022] and Texas Antiquities permit number 3665 [Atlas No. 8700000025]), and part of the Resignation Reef area (Texas Antiquities permit number 2372 [Atlas No. 8700000022]). No previous cultural resources survey work has been conducted in the South Dollar Reef area. Research also revealed that there is one archeological site (41CH372; Figure 3-5) located within 1.6 kilometers (1 mile) of the APE. The review of the AWOIS and ENC data indicates that there is one reported shipwreck within the current APE (Figure 3-5), located along the northern boundary of the North Todd Reef area.

The marine archaeological fieldwork was conducted on July 28, 2020 and consisted of a comprehensive remote sensing survey within the APEs utilizing magnetic and acoustic profiling devices correlated with DGPS. The predetermined grids for the remote sensing surveys within the open waters of Galveston Bay consisted of a combined total of 55 track lines at 20-meter (65.6-foot) line spacing. The comprehensive analysis of the combined magnetic data recorded in across all three APEs resulted in the identification of one magnetic anomaly (NT-040) interpreted as a potential cultural resource (i.e. historic shipwreck). This anomaly exhibits characteristics of contoured magnetic orientation (Gearhart 2011), spatial criteria (Garrison et al. 1989), and Linden and Pearson (2014) 50-gamma/ 20-meter (65-foot) threshold indicative of a potential shipwreck site (Figures 5-7, 5-8).

This magnetic anomaly requires a 50-meter (164-foot) avoidance area, as mandated by the Texas Administrative Code, Title 13, Part 2, Chapter 26 (Figure 5-8). The shipwreck, the *Nellie meta*, is reportedly located within the northern margin of the North Todd Reef area, based on publicly available information published in AWOIS. As discussed in detail in Chapter 5, three magnetic anomalies correlate with the reported wreck position, but do not meet any of the defined criteria for identifying potentially significant magnetic anomalies. It is more likely that any shipwreck materials related to the vessel charted in AWOIS are associated with the NT-040 magnetic anomaly cluster, already designated for avoidance, and that the actual position of the wreck is south of the reported position. The anomalies correlating with the charted AWOIS feature are considered coincidental and not interpreted as potential archaeological features.

The remaining magnetic anomalies are interpreted as modern debris associated with recreational and commercial fishing activities, and miscellaneous debris from previous tropical storms as well as existing infrastructure.

Side-scan sonar imagery did not indicate any potentially significant cultural material laying above or on the bay bed within the survey area. It did however distinguish between the harder and softer sediments, as represented by the reflectivity of the acoustic signal, as well as bottom disturbances in the form of drag scars associated in the South Dollar reef area (Figure 5-6).

The recommended management action for the North Todd, Resignation, and South Dollar Artificial Reef Area APEs is avoidance of bottom disturbing activities within the 50-meter (164-foot) avoidance area, as mandated by Texas Administrative Code, Title 13, Part 2, Chapter 26, for magnetic anomaly NT-040. If avoidance is not possible, then Gray & Pape recommends archaeological diver-ground truthing to identify and evaluate the NRHP significance of this magnetic anomaly.

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APPENDIX A

SONAR TARGET TABLE

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APPENDIX B

SONAR TARGET IMAGES

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APPENDIX C

MAGNETIC ANOMALY TABLES

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