Shoreline Change along Buffalo Bayou: A GIS-based Assessment of Proposed Bulkhead Improvements to Archeological Deposits at the San Jacinto Battleground State Historic Site, Harris County, Texas

Draft

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Rachel Feit, Julian A. Sitters, and Joel Butler

Prepared for

Texas Parks and Wildlife Department

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AmaTerra Environmental, Inc.

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Technical Report No. 87

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4009 Banister Lane, Suite 300
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ABSTRACT

Working under contract to Texas Parks and Wildlife Department (TPWD) AmaTerra Environmental (AmaTerra) traced shoreline changes from 1836 to the present day along Buffalo Bayou adjacent to the San Jacinto Battleground State Historical Site. The purpose of the project was to assess the potential for proposed bulkhead improvements along the site's shoreline to impact intact archeological resources associated with the 1836 Battle of San Jacinto as well as other periods (both prehistoric and historic). AmaTerra's work employed a variety of historical maps, photographs, sketches, and narrative accounts to determine how the shoreline along the San Jacinto Battleground has altered over time. Maps were integrated into a Geographic Information System (GIS) database, orthorectified and compared to each other. This report documents the results of this work, and specifically addresses the potential effects of the proposed bulkhead improvements.

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CHAPTER 1
INTRODUCTION

1.1. INTRODUCTION

Texas Parks and Wildlife Department (TPWD) is planning to make improvements to an existing bulkhead along the shoreline of Buffalo Bayou in the San Jacinto Battleground State Historic Site. The site is located on the uppermost extent of the Galveston Bay where the San Jacinto River meets Buffalo and Carpenters bayous to form a smaller, sheltered bay known as Burnet's Bay. The site occupies approximately 1,197 acres along the west side of that bay in Harris County, Texas (**Figure 1.1**). It mainly consists of open, gently rolling grass and marshland, punctuated by clusters of oak trees. The built environment at the site is characterized primarily by a 567-foot (173-meter [m]) high monument, a reflecting pool, roads and walking trails, a restroom facility (which is the oldest building at the site), administrative buildings, and a berth for the Battleship Texas, which has been a feature of the site since 1948. A bulkhead runs along the east bank of Buffalo bayou from the Battleship Texas, south for a distance of approximately 1,600 feet (488 m). It was built between 1971 and 1972 and repairs are neccessitated due to erosion and old age.

Built between 1971 and 1972, the bulkhead stabilizes a portion of shoreline within the San Jacinto Battleground that commemorates the location of the Texan Camp during the 1836 battle in which the ill-equipped and beleaguered Texans surprised and defeated the more numerous Mexican army in a battle lasting just 18 minutes. Although the site of the battle has been officially commemorated since 1883 when 10 acres were purchased as one of the state's first publically owned historical properties (Real Property Records 2014; Steely 1999), since that time, the surrounding landscape has changed radically. Petrochemical plants ring the site in virtually every direction. The adjacent San Jacinto River and Buffalo Bayou have been dredged and widened to create the Houston Ship Channel allowing the City of Houston to become a sheltered inland port. Meanwhile groundwater and oil extraction have caused major subsidence along the entire Galveston Bay area. Construction of monuments and infrastructure within site has also altered the 1836 appearance of the landscape. Therefore, in spite of the more than century-old effort to preserve the San Jacinto Battleground as a monument to Texas independence, the appearance of the battleground landscape is radically different today from what it was in 1836.

1.2 DESCRIPTION OF THE PROJECT AND CONSTRUCTION ALTERNATIVES

This report evaluates changes to the landscape over time, particularly along the stabilized shoreline of the Texan Camp, in order to assess the impacts to possible buried archeological resources from the proposed bulkhead repairs and improvements. As part of the bulkhead repair project, a Preliminary Engineering Report (PER) is required that would outline existing

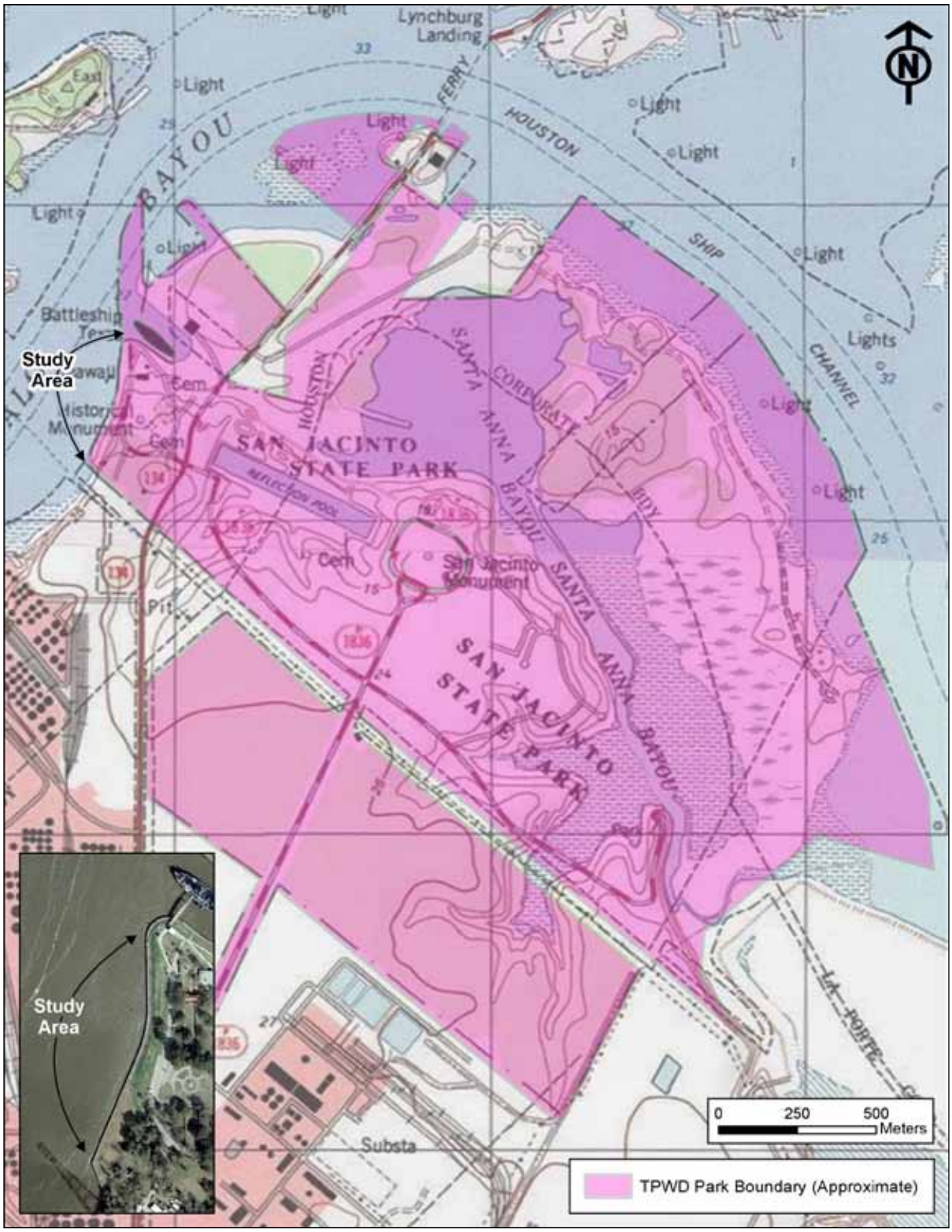

Figure 1.1. San Jacinto Battleground State Historic Site depicted on LaPorte 7.5-minute USGS topographical map.

conditions and proposed alternatives for the undertaking. This report is intended to inform the PER and the decision-making process involved with alternatives selection for the repairs.

A condition assessment of the existing bulkhead was conducted in February 2014, and this assessment found that the 1971 bulkhead is structurally stable with an anticipated lifespan of up to 50 additional years. However, several problems were noted, such as erosion at the ends of, and under the bulkhead, which should be addressed to improve functionality, aesthetics, and extend its lifespan beyond 50 years. Currently there are three repair alternatives under consideration: the Major Repair Alternative, the Moderate Repair Alternative, and the Minor Repair Alternative. Below is a summary of each:

The Major Repair Alternative would address bulkhead issues that require the most immediate attention. These repairs would include:

- replacing existing concrete cap,
- water-tightening of the bulkhead and outfalls,
- upgrading/improving draining system, and
- protecting the steel sheetpiling.

The Moderate Repair Alternative would involve more moderate repairs that would improve safety and functionality, extend lifespan, and enhance aesthetics of the bulkhead and shoreline. These repairs would include:

- replace rubble gabions,
- provide erosion remediation for shoreline erosion at the ends of the bulkhead,
- install concrete walkway immediately landward of the concrete cap, and
- install handrails along the bulkhead.

The Minor Repair Alternative includes suggestions for long-term improvements that would greatly extend lifespan, enhance aesthetics, and enhance recreational use opportunities. These improvements would include:

- remove 1930's relic bulkhead sections from below waterline,
- integrate "natural" design alternatives for upland vegetation, and
- provide docking access for vessels along the bulkhead.

1.3 Organization of the Report

Remainng sections of this report include a brief historical background documenting the Battle of San Jacinto and subsequent land use, a Methodology Section which details the sources AmaTerra consulted, and the methods used for analysis. This is followed by an analysis of the shoreline changes since 1836 using the various sources consulted, and an assessment of the potential for intact archeological resources along the Buffalo Bayou shoreline. The potential effects to archeological resources of each of the alternatives will be explained in the final chapter.

CHAPTER 2
HISTORIC BACKGROUND

2.1 TEXAN REVOLUTION

The war for Texas independence began on October 2, 1835, when 160 Texans engaged 100 Mexican dragoons in the city of Gonzales, Texas. This confrontation would trigger a six and a half-month war between Texans and the Mexican army commanded by President Antonio López de Santa Anna Pérez de Lebrón (Santa Anna). The newly elected Mexican president had campaigned as a liberal, but after winning the election, Santa Anna became an autocratic centralist and suspended the Mexican constitution of 1824 (Pohl 1989). This new dictatorial government enraged Texans resulting in further confrontations between Texans seeking independence and Mexican officials attempting to maintain control.

In October of 1835, following the Gonzales confrontation, 500 Mexican troops led by Santa Anna's brother-in-law, General Martín Perfecto de Cós, marched from Copano Bay to San Antonio de Béxar where they laid siege to the city. General Cós and his troops held San Antonio until December 5, 1835, when 300 Texan volunteers retook the city (Pohl 1989). Following General Cós' surrender, the Mexican troops retreated south of the Rio Grande, and Texans everywhere rejoiced in victory over their oppressor. The war was not over and unbeknownst to the Texans, Santa Anna along with 6,019 troops and 21 field artillery pieces were marching north towards Coahila y Tejas (Cox et al. 2001).

Santa Anna and his troops arrived in San Antonio de Béxar on February 23, 1836, and 11 days later they overtook Mission San Antonio de Valero, otherwise known as the Alamo, killing everyone but the noncombatants, which included women, children and black slaves. Meanwhile, José de Urrea, a General under Santa Anna, led a branch of the Mexican Army up the Gulf Coast toward Goliad, Texas. On March 19, General Urrea intercepted James Walker Fannin, Jr., a Colonel in the Texan army, and his troops in an open flood plain along Coleto Creek near Goliad. A battle ensued and much to the surprise of General Urrea, the Texan army successfully defended their position against three Mexican charges. However, the following day brought with it diminishing supplies and decreasing moral, which resulted in the surrender of Fannin and his men on March 20. The Texan prisoners of war were relocated to Goliad where on March 27, 1836, they were massacred under orders from Santa Anna (Pohl 1989). The Mexican President's callousness towards his adversaries at Goliad would not be forgotten by those fighting for secession from Mexico.

News of the defeat at the Alamo and Goliad reached General Sam Houston, who at the time was stationed in Gonzales along with the approximately 370 volunteers he commanded. As word of the massacres spread, citizens fled in what became known as the Runaway Scrape in which thousands of civilians fled north or east attempting to escape Santa Anna's armies (Cox et al. 2001). General Houston, needing more men to strengthen his forces, as well as

in an attempt to stretch Santa Anna's supply lines, fled northeast towards the Colorado River and eventually towards Harrisburg, Texas. As for Santa Anna, he too marched his armies east in an attempt to intercept the Texan army and members of the government near Harrisburg. To his displeasure, the Texan government was able to successfully escape across Galveston Bay to Galveston Island. After learning of this news, Santa Anna burned New Washington along Galveston Bay and traveled north towards Lynch's Ferry where he focused his efforts on intercepting the Texan army and preventing their retreat to the east (Moore 2004). Santa Anna soon realized that the Texan army was already positioned at Lynch's Ferry, and a battle between the two forces was now inevitable.

2.2 The Battle of San Jacinto

On April 19, 1836, General Sam Houston and his army arrived on a small promontory landform along Buffalo Bayou, which extends out to the northeast towards Lynchburg, Texas. According to veteran accounts, the Texan army camped within a grove of timber situated along the banks of the Buffalo Bayou (Labadie 1967; **Figure 2.1**). More specifically, the camp was located "about two or three feet above the water's edge and ran back from fifty to one hundred yards on a level plain, covered with trees, but with little or no undergrowth, to a second bank about ten feet high" (Swisher 1932: 40). Today, the second bank is no longer evident (EDAW 2005). In a letter dated January 19, 1891, Ricardo de Zavala wrote that "the distances from Houston[']s camp [to] the Soldier[']s Graves is 155 steps which [is] supposed to be yards. From the Graves to where Houston formed lines of battle 450 steps from lines of battle to where the Mexicans were when they commenced [sic] firing [sic] (which is about the same as to

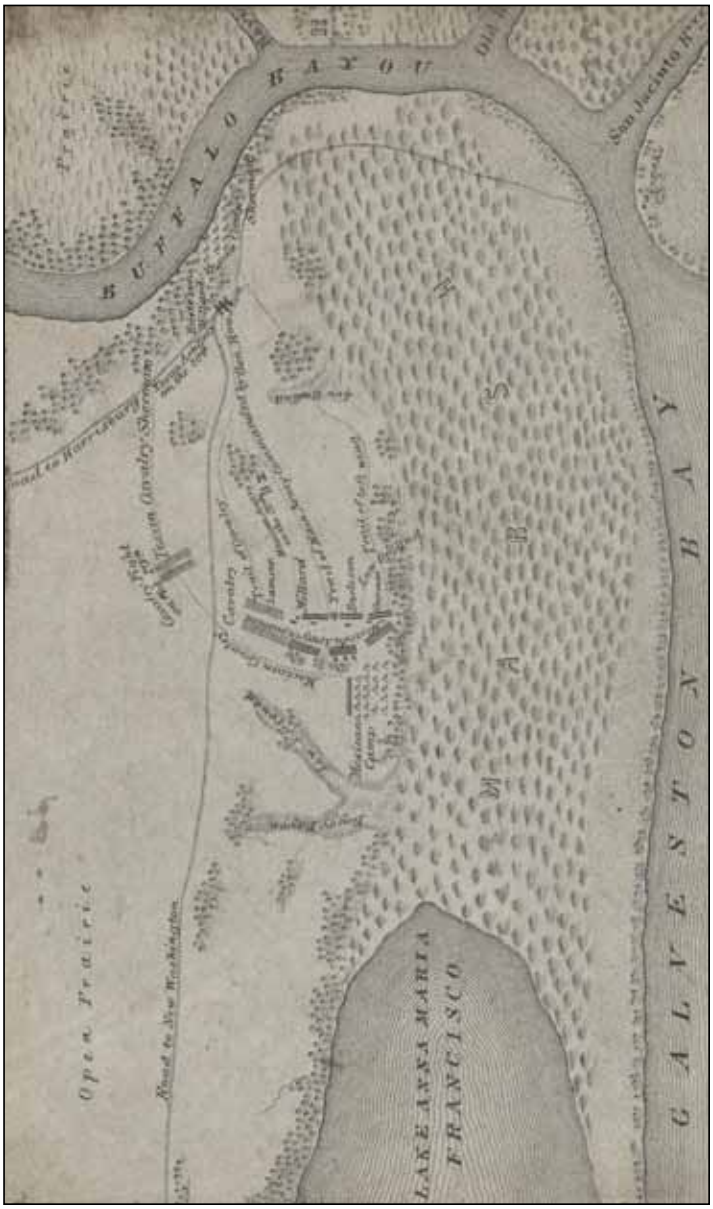

Figure 2.1. 1856 Yoakum Map of the San Jacinto Battleground.

Habermehl's house) 425 steps from Houston's Camp to the graves you might call an air line & from them Houston formed [the] line of battle" (McArdle Notebooks 2014).

Santa Anna and his army arrived on April 20, 1836, and immediately engaged the Texans in an attempt to draw them into battle. As a result, Captain Urizia of the Mexican army was severely wounded and the Mexican army "withdrew to a position on the bank of the San Jacinto, about three quarters of a mile from [the Texan] encampment" (Houston 1925:588–589; **Figure 2.2**). Here Santa Anna constructed fortifications made from mule packsaddles and awaited reinforcements from General Cós. The reinforcements eventually arrived and brought Santa Anna's forces to approximately 1,200 troops compared to the Texan force of 910 men (Hardin 1994). Meanwhile, the Texan army sent Erastus "Deaf" Smith to burn Vince's bridge, situated along Sims Bayou to prevent additional reinforcements from reaching the Mexican Army and also eliminate an escape route (Cox et al. 2001).

At approximately 3:30 p.m. on April 21, 1836, with the Mexican Army resting, General Sam Houston ordered the attack on the Mexican encampment. Due to the topography and the natural vegetation between the Texan and Mexican camps, as well as the inattentiveness of the Mexican Army, the Texan troops managed to get within a half-mile of the enemy before being spotted and fired upon (Cox et al. 2001). It was too late. The Mexican army was not prepared for the fast approaching Texan force and within 18 minutes the battle was over. However, the killing continued for an additional hour as Texans chased the Mexican troops southward, repaying them for the massacres that occurred at the Alamo and at Goliad. It was not until the evening of April 22, that Santa himself was captured attempting to escape.

The War for Texan Independence concluded along Buffalo Bayou under a post oak tree (**Figure 2.3**) where Sam Houston extracted a general cease-fire from Santa Anna, who later officially surrendered, granting Texas its independence (DeWees 1968). In fact, veterans visiting the battleground on July 5, 1894, noted that "the famous tree was very near the water of the bayou on a level plat between the water's edge and the sharp decline of the bank or hill (Hill 1936:10)." Writing in 1936, Hill went on to say that, "the tree is thought to have rolled down and all trace of it has disappeared, but they fixed upon its location at a point near the bayou northwest from where the monument stands (Hill 1936:10)." From Hill's comments, it is not clear whether the actual tree was identified or not during the 1894 visit.

In total, Texan forces sustained only eight casualties and 28 wounded (Swisher 1932), while the Mexican Army suffered 630 deaths and 208 wounded during the battle. On May 14, 1836, the Treaty of Velasco was signed by President Burnet and President Santa Anna. This treaty required the expulsion of Mexican troops from Texas, the end of all hostilities between the two nations, and the agreement that the Rio Grande River would serve as Texas' southern border. The Battle of Jacinto would become known to some as one of the most decisive battles in the world's history (San Jacinto Monument 2014).

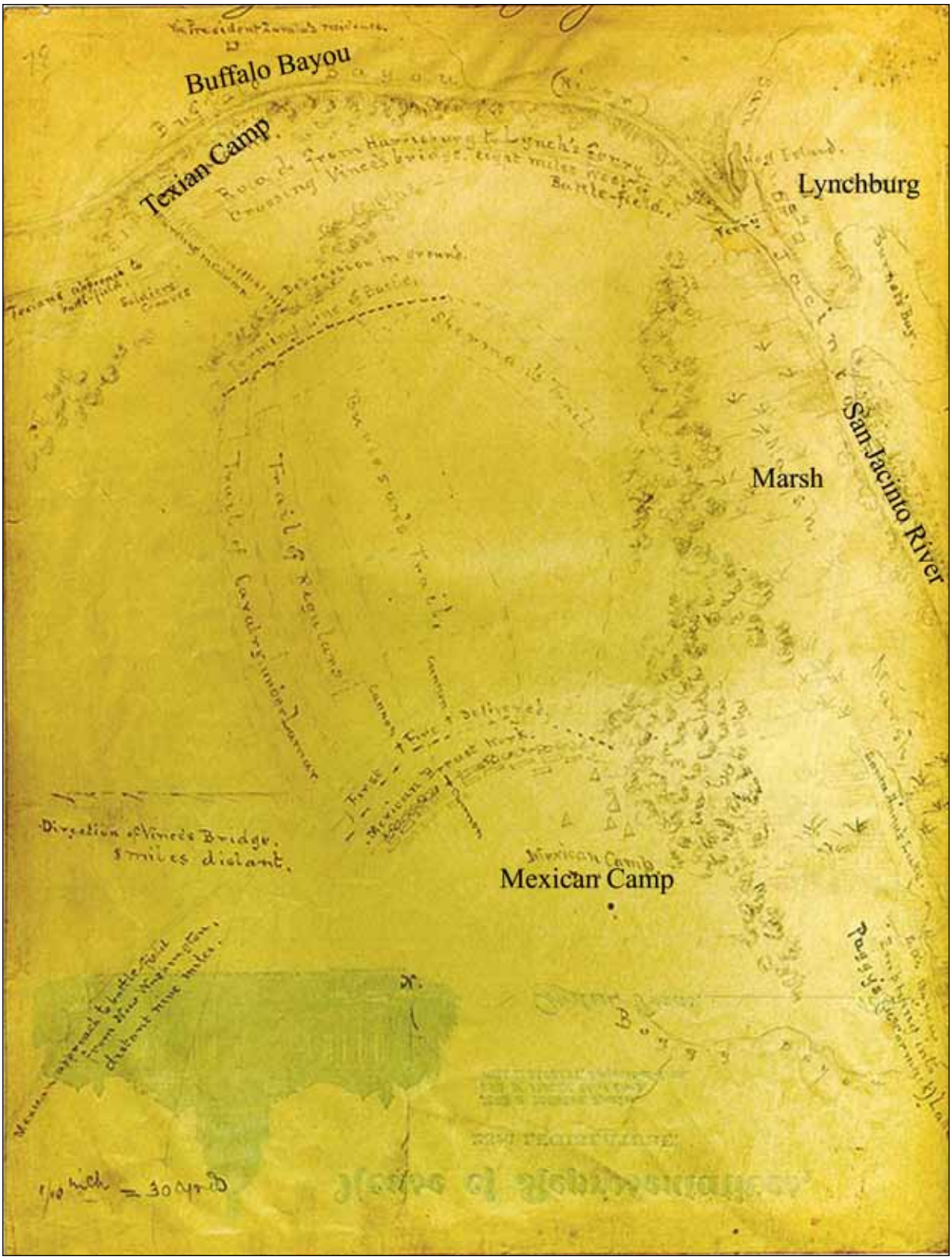

Figure 2.2. Henry McArdle's 1890 Sketch of the San Jacinto Battleground showing army positions and troop movements.

Figure 2.3. Undated photograph (ca. 1890s) of the grove wherein the Texan army camped and where Houston interviewed Gen. Santa Anna. A note on the back of it, dated 1939 indicates that the post-oak tree in the foreground is supposed to be the one Houston and Santa Anna sat under after the battle (*Photo courtesy of Herzstein Library*).

2.3 Subsequent History and Subsidence

At the conclusion of the battle, life along the Buffalo Bayou seemingly returned to normal with the landowners returning to work on their farms and plantations. Land prospectors platted towns within the area to promote settlement and industry. Nathaniel Lynch, who had operated Lynch's fairy during the Runaway Scrape, platted the town of San Jacinto to the east of the battleground in 1836. The town of San Jacinto remained small, and the economy survived on the building and repairing of ships (Marek 2011). That same year, two brothers, John and Augustus Allen, strategically purchased land along the Buffalo Bayou upstream from Harrisburg, which would become Houston (Sibley 2014).

Very little is known about San Jacinto during the mid-nineteenth century. In 1837, when Nathaniel Lynch died, only five lots of 232 had been sold (Cox et al. 2001). The town of San Jacinto grew very modestly between 1836 and the end of the nineteenth century. Its economy relied primarily on farming from adjacent tracts and the shipping industry, with two shipyards built along the bayou (Cartier and Hole 1972). Among the farmers and laborers living in or around the small settlement of San Jacinto, the 1850 census lists a number of carpenters and shipwrights. Additionally, at least one timber mill, the New Hope sawmill, was built in 1846 on land a little west of the town of San Jacinto (Cartier and Hole 1972). Census records from 1850 and 1860 suggest that several larger timber mills were built farther south near Morgan's point, and presumably timber up and down the shoreline area in Harris County was harvested for these mills.

The Allen brothers were intent on utilizing the numerous navigable waterways around the City of Houston to promote a burgeoning shipping industry. In order for Houston to compete with other established ports, such as Galveston, the bayou would have to be modified to accommodate larger ships. As a result, the Buffalo Bayou Ship Channel Company was formed to improve the channel. The company also encouraged Congress to designate Houston as a port of delivery, which it did in 1870. During the early 1870s, the Buffalo Bayou Ship Channel Company maintained the water's depth at nine feet (BBP 2014a). In 1874, Charles Morgan purchased the Buffalo Bayou Ship Company and changed the name to the Houston Ship Channel (**Figure 2.4**). By 1876, Morgan had dredged a channel from Galveston to the town of Clinton near Houston (Farrar 1926). During a visit by the veterans to the San Jacinto Battleground in on July 5, 1894, "they all declared that the bayou looked wider now than it did then. Others... who knew the history of the bayou said it had been very materially widened by Government appropriations." Following Morgan's purchase, Buffalo Bayou was dredged to a depth of 18.5 feet (5.6 m) by 1897, 25 feet (7.6 m) in 1914, and finally 40 feet (12 m) in the 1960s (BBP 2014a). According to a 1905 U.S. Army Corps of Engineers (USACE) map, the width of the bayou had been expanded to approximately 400 feet (122 m). Today, the Bayou is over 1,000 feet (305 m) in width in some places.

Modifications in the form of dredging, channel maintenance, and industrial activities along the bayou have resulted in land subsidence (Cox et al. 2001). For example, the extraction of subsurface reservoirs (e.g., water, oil, and gas) is responsible for a one-inch rise in sea level per year (Coplin and Galloway nd), which contributes to land subsidence within the area. In fact, reliance on groundwater resulted in approximately 9 feet (2.7 m) of subsidence around

Figure 2.4. View of the Houston Ship Channel along Buffalo Bayou from the southern ferry landing in 1914. Note tugboats pulling barges near the opposite shore (*Photo courtesy of Herzstein Library*).

the confluence of Buffalo Bayou and the San Jacinto River (Henson 2014). Locally, Cox et al. (2001) reported that subsidence has led to the loss of public roads, dredge spoil deposits, levies, brackish marsh habitat, and the community of San Jacinto at the eastern and southern ends of the San Jacinto Battleground State Historic Site. In localized cases along the Buffalo Bayou, several hundred feet of the shoreline have been lost due to subsidence (Takac et al. 2000). For example, a deed filed March 20, 1909, for the donation of land to the State of Texas indicates a size of 15.312 acres; however, a 1936 Work Progress Act (WPA) resurvey of the same tract showed only 12.481 acres (Real Property Records). This difference in acreage may be a result of shoreline loss or subsidence. Lastly, additional anthropogenic impacts on the bayou (e.g., controlled releases of water) have accelerated bank erosion (BBP 2014b).

2.4 Site History

In 1883, the State of Texas purchased 10 acres of the San Jacinto Battleground from J. Cambell. This area encompassed the cemetery containing those that perished during the Battle of San Jacinto. Subsequent land purchases were negotiated by the Daughters of the Republic of Texas, who after forming in 1891, "urge[d] the state to purchase the San Jacinto battleground and erect a monument in commemoration of its heroes" (DeVault 1999). Over the next decade, an additional 327 acres were purchased by the state-appointed commission. On the 74th year anniversary (April 21, 1910) of the battle, the San Jacinto Battleground Site opened to the public. The site grounds currently encompass four known cemeteries: De Zavala #2 (HR-C049); Unknown (San Jacinto State Park, HR-C110); the Habermehl Cemetery (HR-C201); and the Adams-Campbell Cemetery (HR-C009). With the exception of the unknown or unnamed cemetery where fallen soldiers from the Battle of San Jacinto are thought to be buried, the other park cemeteries relate to people associated with the land after 1836.

Prior to the battleground's grand opening in 1910, two concrete landings, a crescent-shaped promenade along the water's edge, an artesian well, iron gates, granite markers, and a driveway were installed throughout the site. Photographs suggest that over the next decade, the banks of the Buffalo Bayou within the site boundaries were graded. Additional structures erected post-1910 include two pavilions, a keeper's lodge, a gardener's residence, a barn, tool house, well house, pergola, and a work shop (Marek 2011; Cox et al. 2001). Memorial markers, such as planted trees, a sun dial, and small stone monuments dot the landscape specifically near the northwestern end of the site (**Figure 2.5**). However, the most drastic modifications to the landscape are likely those associated with the construction of the San Jacinto monument and the reflecting pool (**Figure 2.6**), as well as the berth excavated for Battleship Texas.

The monument and reflecting pool were constructed by the WPA from 1936 to 1939 and were built between the former location of the Texan and Mexican camps. The base of the monument is approximately 15,500 square feet (1,440 m^2 while the reflecting pool encompasses an area approximately 1,750 feet (533.4 m) long by 200 feet (61 m) wide. At the same time, a steel bulkhead, which encompasses the shoreline along the Texan camp, was built. During the 1970s, the bulkhead was replaced once again altering the shoreline near the Texan camp. Modifications included filling the eroded area with shell to grade the adjacent ground, as well as terracing the shoreline. In addition to the bulkhead, other alterations to the landscape near

the Texan camp included an earthen levee, asphalt park road and parking lot(s), memorial markers, the USS Texas ship store, and utility poles. Today, the bank near the Texan camp rises to form an earthen levee before sloping back down towards the water. Between the levee and the bulkhead is a stabilized surface consisting of gravel overlain by erosion control netting.

Figure 2.5 Landscape improvements and commemorative features within San Jacinto Battleground Site.

Battleship Texas, otherwise referred to as USS Texas, was destined for the scrap yard before being purchased by the State (**Figure 2.7**). The ship was "recommissioned as the flagship of the Texas Navy on April 21, 1948," before being acquired by TPWD in 1983 (Cox et al. 2001:35). The berthing area required an inlet within the northwestern end of the site to be dredged, resulting in a loss of approximately four acres of the Buffalo Bayou bank near the former location of the Texan camp. The berthing area requires periodic maintenance and widening to prevent further damage to the USS Texas (Ing 1996).

Figure 2.6. View of the San Jacinto Monument and reflecting pool, built in 1936.

In addition, small scale projects have occurred across the park area. These projects included the installation of water and sewage lines (Cartier and Hole 1972; Ralph 1996; Tomka and Smart 2000; Hollingsworth 2001), the installation of an interpretive trail (Feit et al. 2002), the depositing of dredge spoil (Ing 1983), and looting (Cartier and Hole 1972). Archeological investigations conducted in advance of projects suggest that the

Figure 2.7. View of the Battleship Texas seen from San Jacinto Monument.

surface soils have remained relatively intact (EDAW 2005). After conducting geoarcheological investigations of the San Jacinto Battleground, Charles Frederick (2007) concluded that soils south of the monument were *in situ*; however, some areas indicated disturbances through the presence of dredge spoil. It is important to note that the entire site was not tested during the 2007 geoarcheological investigations.

There are nine previously recorded sites within 1,640 feet (1 kilometer) of the project area (**Table 2.1**). These include prehistoric shell middens, as well as historic period sites thought to possibly pertain to the 1836 battle, although no definitive remains related to the 1836 battle have been unearthed at any of them.

Table 2.1. Archeological Sites Near the Proposed Project.

Trinomial	Year Recorded	Description	Distance from Project	Status
41HR33	1956	Prehistoric shell midden recorded by Neyland	0.44 km	Ineligible
41HR104	1956	Prehistoric shell midden recorded by Neyland	0.33 km	Ineligible
41HR105	1956	Prehistoric shell midden recorded by Neyland	0.19 km	Ineligible
41HR277		19th and 20th century debris scatter containing artifacts pertaining to the Battle of San Jacinto and later periods. Site encompasses entire battleground	0.5 km	Eligible/listed in NRHP district
41HR526	1984	San Jacinto Townsite	0.2 km	Undetermined
41HR576	1986	19th and 20th century debris scatter.	0.37 km	Undetermined
41HR744	1994	Battleship Texas	0.1 km	Listed on NRHP
41HR808	1997	Prehistoric shell midden	0.32 km	Undetermined
41HR1085	2010	19th and 20th century debris including square nails, glass, ceramics, and melted lead. Some may pertain to Battle of San Jacinto	0.22 km	Eligible

CHAPTER 3
RESEARCH METHODOLOGY

Research methods for this project were based on those used previously to identify the Harrisburg-Lynchburg and New Washington Road locations (Feit and Clark 2004). Researchers drew on evidence from maps, historical accounts, historical photographs, and aerial photography to develop a series of geo-referenced overlays, and to map the 1836 shoreline in relation to the current shoreline.

AmaTerra used current 7.5 minute USGS topographic maps and aerial photographs as base-maps to which all other depictions were orthorectified and compared. USGS 6-inch resolution imagery was obtained from The National Map (2014) and from ESRI's Base Worldmap imagery. Additionally aerial images were available for 1930, 1953, 1962, 1966, 1996, 2010, and 2012. Images prior to 1996 were obtained as raw images, necessitating georeferencing and rectification to later aerial photographs in ArcMap 10.2.1. This was done by using common index points, such as survey benchmarks, roads, topographical features and various built environment landmarks to make point to point comparisions. By using this method, imagery was georeferenced back through time. The same was done using unreferenced topographic, survey, and schematic maps, finding common unchanged points back through time, beginning with the most recently available imagery and topographic digital raster graphics (DRG).

Twelve historical maps along with historic aerial imagery were then orthorectified and analyzed to derive the shoreline's approximate changes through the past 178 years (**Table 3.1**). The data quality varies from hand drawn maps based on the Texas Revolution veteran's recollections to fairly accurate topographical renderings. Many of the historical maps were already collected and available from TPWD. Land records were also consulted. Finally AmaTerra used historical images to visually reconstruct the shoreline. These were assessed at the TPWD State Headquarters in Austin, Texas, the TPWD Austin Archeology Lab, the TPWD Region 4 office in Houston, and at the Albert and Ethel Herzstein Library in La Porte. Lastly, the Center for American History, the archives of Jan DeVault, and online records provided additional information.

Once maps were integrated into the GIS database AmaTerra drew out the shorelines from each source and compared them. Accuracy, as expected decreases with age and therefore many of the older maps likely contain a high degree of error. Maps from 1916 onward, however, were accurate to within a few feet. Nonetheless, once the shorelines from all maps were compared, including the pre-1916 maps, it was clear that the current position of the bayou shoreline in the park has not changed as much as researchers initially expected.

To augment the map overlay, AmaTerra also used historical photographs, bulkhead construction plans, narrative accounts of the battle, and various cultural resource reports to assess the degree of disturbance along the shore of Buffalo Bayou near the Texan camp. These sources were extremely useful in documenting both natural and human-induced changes to the landscape.

AmaTerra staff integrated all the various sources to develop a landscape analysis aimed at understanding the potential for intact archeological deposits to be affected by the proposed bulkhead replacement. The results of this analysis are presented in the following chapter.

Table 3.1. Table of Sources.

Source Type	Origin	Date	Archive location	Relevant Notes	Web Link
Map	William D. Duke	1871	National Archives and Records Administration (NARA) See also Texas Historic Overlay	"Sketch of Buffalo Bayou" from the Texas Historic Overlay	
Map	USACE	1897	Texas Historic Overlay	"Survey of Buffalo Bayou" from the Texas Historic Overlay	
Map	USACE bathymetric maps of Galveston Bay	1905	Texas General Land Office	Accurately depicts shoreline in 1903, shows roads, fence lines and bathymetric data in waterways	
Map	Yoakum hand drawn sketch	1856	Rare Book and Texana Collections - UNT, Denton	Depicts shoreline and roads with general accuracy. Shows position and lines of advance of Texian and Mexican armies	http://texashistory.unt.edu/ark:/67531/metapth2490/
Map	USGS topographical map	1916	USGS Store Online Map Locator & Downloader	Accurately depicts shoreline in 1916, shows roads, survey markers, buildings and other landscape features	http://store.usgs.gov/b2c_usgs/usgs/maplocator/(ctype=areaDetails&xcm=r3standardpitrex_prd&carea=%24ROOT&layout=6_1_61_48&uiarea=2)/.do
Map	Docking Diagram for US Government Boats- Hand drawn	1936	Herzstein Library	Depicts shoreline, docking sites for barges, and early 20th century concrete wharf broken	
Aerial photo	Tobin aerial photograph	1930	Tobin	Depicts shoreline along Buffalo Bayou at confluence with San Jacinto River	
Aerial photo	USGS aerial photograph	1953	USGS EarthExplorer	Depicts shoreline along Buffalo Bayou at confluence with San Jacinto River. Bulkhead is evident in photo	http://earthexplorer.usgs.gov/
Aerial photo	USGS aerial photograph	1966	USGS EarthExplorer	Depicts shoreline along Buffalo Bayou at confluence with San Jacinto River. Shoreline erosion is evident in photo behind existing bulkhead	http://earthexplorer.usgs.gov/
Map	Survey map	1969	Herzstein Library		

Table 3.1. Table of Sources (continued).

Source Type	Origin	Date	Archive location	Relevant Notes	Web Link
Map	State Board of Control Engineering Division	1948	Herzstein Library	Depicts park landscape features, town of San Jacinto, shoreline, steel bulkhead, and the Battleship Texas berth. Based off of 1936 topographic map	
Map	Port of Houston-San Jacinto Waterfront and Adjacent Territory	1936	Herzstein Library	Depicts shoreline along Buffalo Bayou, concrete wharf, bulkhead, barge docks, and various landscape features at the San Jacinto Battleground. Also depicts water depths around concrete wharf.	
Map	Port of Houston-Map of Houston Ship Channel	1938	Herzstein Library	Depicts shoreline, property boundaries, town of San Jacinto, and roads. Shows dredged route for ship channel running along opposite bank from San Jacinto	
Photo	Unknown	1893	Herzstein Library	Shows shoreline along Buffalo Bayou, looking west	
Photo	WPA	1937	Herzstein Library	View looking north of bulkhead and stabilized shoreline along Buffalo Bayou at San Jacinto	
Photo	F.J. Schleuter	1920	Herzstein Library	Boat docking at San Jacinto. View of shoreline at concrete wharf at San Jacinto. Depicts landscaping and brush management right along shore edge	
Photo	F.J. Schleuter	1914	Herzstein Library	Boat docking at San Jacinto. View of shoreline at concrete wharf at San Jacinto. Depicts brushy vegetation leading to shore edge.	
Photo	Unknown	Ca. 1890s	Herzstein Library	Lottie Allen and another boat docking at San Jacinto along Buffalo Bayou. View suggests no landscape maintenance along shoreline	
Deed Transaction Summary	Willard et al. to State of Texas, Vol. 226, pg. 549	1909	TPWD Real Property files-Austin, Texas	15.312 acres of land along Buffalo Bayou. Note on Transaction Summary indicates that a 1936 resurvey showed only 12.48 acres. Plat map shows a comparison of shorelines in 1909 and 1936	

Table 3.1. Table of Sources (continued).

Source Type	Origin	Date	Archive location	Relevant Notes	Web Link
Deed	J. Campbell to State of Texas Vol. 67, pg. 525-527	1883	TPWD Real Property files-Austin, Texas	Ten acres known as old graveyard at San Jacinto Battleground. Plat map shows meander of Buffalo Bayou to San Jacinto River	
Hand drawn sketch	Henry McArdle Notebooks	1890	Texas State Library and TPWD Austin, Texas	Depicts San Jacinto Battleground, positions of Texan and Mexican armies and lines of advance	
As Built plans	State Building Commission	1971	TPWD Austin, Texas	Construction plans for 1971/72 bulkhead, depicts landscape features, 1936 bulkhead, shoreline and bathymetry	

Chapter 4
Analysis of Shoreline Changes 1836 to the Present Day

4.1 Buffalo Bayou at the San Jacinto Battleground, 1836 to 1916

Memorialization of the San Jacinto battleground began shortly after 1836. In fact, Nathaniel Lynch platted the nearby town of San Jacinto shortly after the battle, hoping to attract new landowners from the relic hunters that passed through the area (Cox et al. 2001). By the mid-nineteenth century, steamboats made excursions from Houston to visit and commemorate the battleground every April. Around this same time, a timber mill and shipyards were built along the east bank of Buffalo Bayou near where the Texan army camped. Timber cutting began in wooded areas near San Jacinto, affecting the appearance of the field on which the battle of San Jacinto was fought.

In spite of these changes, the landscape around San Jacinto probably altered very little from 1836 to 1900, and shoreline loss was probably minimal. Few accurate maps exist that depict the shoreline of Buffalo Bayou prior to 1900. Surveyors' sketches and plat maps show property divisions and generally depict the curve of buffalo bayou as it flows into the San Jacinto River, forming the distinctive bend that defines the battleground area. Likewise, battle maps such as Yoakum's 1856 map and Henry McArdle's 1890 sketch, drawn with input from battle veterans, are useful for pinpointing the probable location of the various camps. However, they do not render actual shoreline position and contours with the type of accuracy required to evaluate shoreline loss over time.

Nonetheless, several pre-1916 cartographic sources have been useful in evaluating changes in shoreline. The 1905 Corps of Engineers (COE) Map of Galveston Bay and the 1916 Corps of Engineers Topographical Map of Burnett Bay do offer very accurate depictions of Buffalo Bayou, its meanders, and the shoreline at San Jacinto. Overlay of those maps onto modern aerial photographs show how radically the landscape around San Jacinto has changed since the beginning of the twentieth century (**Figure 4.1**).

However, up to 1900, the population around San Jacinto was very low, and oil and groundwater extraction on an industrial scale had only recently begun. Maps from the end of the nineteenth century suggest that the bayou was about 325–400 feet (100–121 m) wide at the time (**Figure 4.2A**).

Dredging of Buffalo Bayou began in the 1870s and until the end of the century, the water depth in the channel was initially maintained at about nine feet (2.7 m) (BBP 2014a). An 1897 COE map shows the channel with a depth of 19 feet (5.7 m) indicating that dredging had

Figure 4.1. Overlay of the 1916 USGS topographical map onto 2010 aerial basemap.

increased depth by that time (**Figure 4.2B**). However, dredging of the bayou near the Texan camp occurred on the opposite bank from San Jacinto. This is reflected in the 1905 COE map (and in subsequent maps) depicting the channel meander (**Figure 4.3**). At this time, Buffalo Bayou was about 400 feet (121 m) wide near the battleground. Today the bayou is nearly 1,400 feet (426.7 m) wide resulting from dredging and subsidence. However, the deepest part of the channel is on the opposite bank, not near the San Jacinto Battleground.

Early photographs of the shoreline at the San Jacinto Battleground help confirm that the bayou banks were little altered until 1914. An 1893 photograph of Buffalo Bayou near the Texan camp depicts a steep bank along Buffalo Bayou above the water level (**Figure 4.4A**). The height

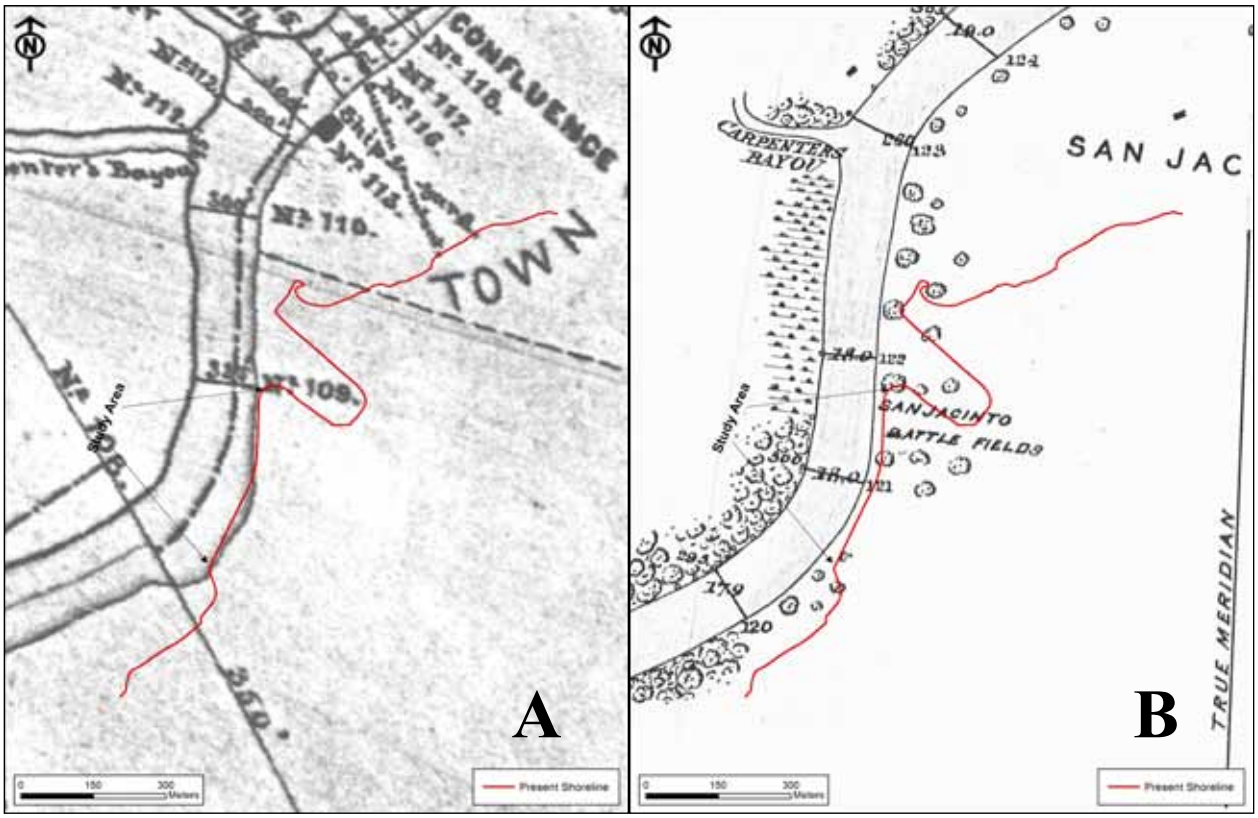

Figure 4.2. A) detail from 1871 sketch of Buffalo Bayou shown in relation to current shoreline. Width of Bayou near project area is 325 feet (100 m), B) detail from 1897 COE sketch of Buffalo Bayou (source: *Texas Historic Overlay*)

of the bank above the water line is unclear, though it appears to be at least six feet. The 1916 topographical map also depicts a steep bank at the Texan camp and indicates that the camp area was between 10 and 15 feet above mean sea level. At the time that the 1893 photograph was taken, there were no landscape alterations along the shore. Another photograph—taken during the 1894 veteran's visit to the battleground—depicts a marshy landing with no landscape infrastructure along the bank (**Figure 4.4B**).

When veterans of the battle came to San Jacinto in 1894 to identify the locations of significant landmarks, they confirmed that the topography of the area had changed very little since 1836 (Hill 1936:17). Two late nineteenth century paintings done from the battleground looking toward the Texan and Mexican camps depict the area as undulating open prairie and marshlands punctuated by small groves of trees (see Figure 3 in Feit and Clark 2004). However, the veterans also noted that almost none of the trees that had shielded the Texan camp were still present in 1894, having been harvested for timber during the intervening years. Nonetheless, they had no trouble locating or agreeing on key landmarks. With respect to the location where Houston interviewed the captured Santa Anna after the battle, "Colonel Hill pointed out the same place on the bank of the bayou that has been designated by other veterans of the battle on former occasions, but there is nothing there to mark the spot." Hill further noted that he thought the bayou had cut into the shoreline, making the location of Houston's grove closer to the water's edge than it had been

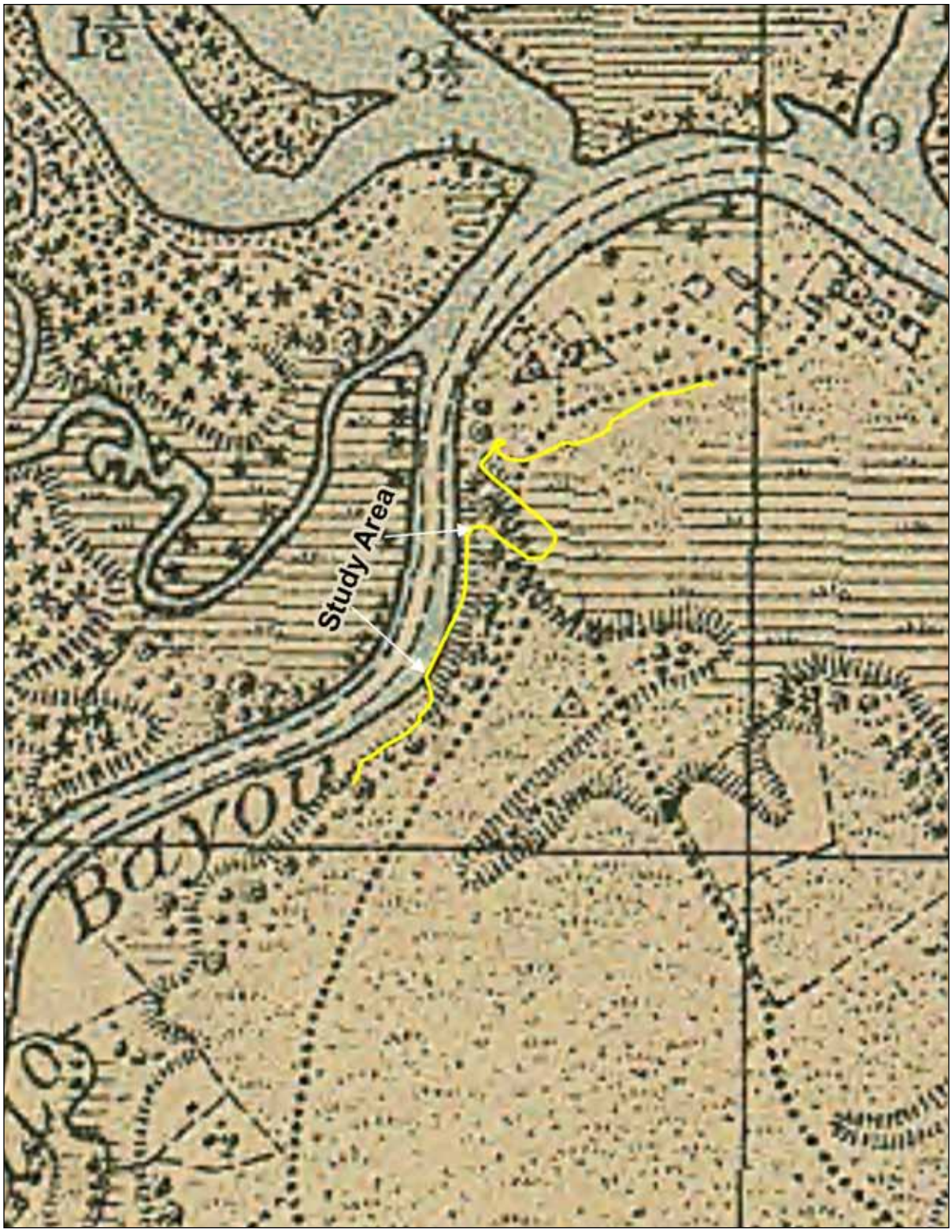

Figure 4.3. Detail from 1905 Corps of Engineers Map of Galveston Bay showing San Jacinto Area. Current shoreline is depicted.

previously (Hill 1936:17). Worth pointing out though, is that the lack of vegetation along the shore may have made it appear closer than the veterans recalled it being 60 years earlier.

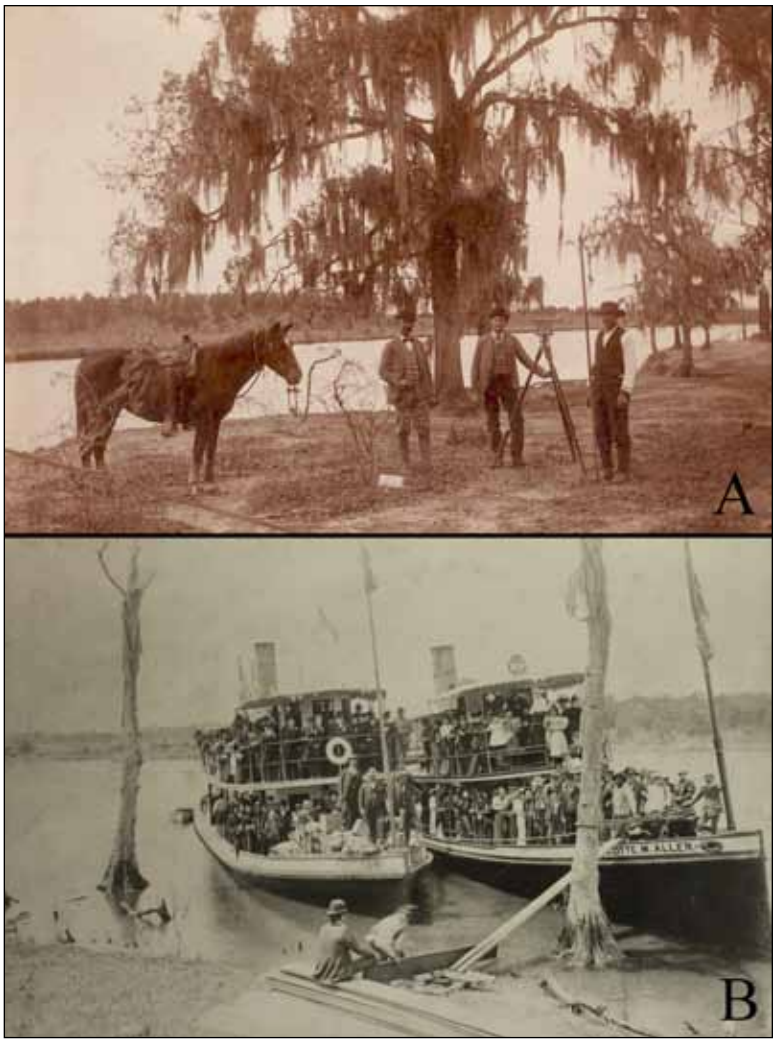

Figure 4.4. Two views of Buffalo Bayou near the battleground: A) 1893 photo of men surveying the banks of Buffalo Bayou; B) Steamboats bringing veterans and visitors to the battleground in 1894.

In 1909, the State purchased the 15.312-acre Willard tract encompassing the presumed location of the Texan camp along Buffalo Bayou. When the San Jacinto State Historic Site was officially dedicated in 1910, among other infrastructure, two decorative concrete ferry landings, and two concrete staircases had been built, the southernmost of which led to a flagpole at the top of the bank. An undated photograph taken shortly after the site opened shows manicured and graded banks along the bayou edge. Most importantly, the photograph depicting the northernmost of the concrete ferry landings and staircases also depicts a boardwalk or bulkhead running along the water's edge (**Figure 4.5**). Several structures (one of which still survives and is now used as a restroom) are also visible. To confirm the veterans' 1894 descriptions of the site, trees were thin along the shoreline and most appear to be less than 75 years in age, suggesting that the dense grove of trees once shading the Texan camp area did not survive past the end of the nineteenth century.

A Daughters of the Texas Republic Report from 1910 describes the improvements:

> The splendid landings of solid concrete, and the crescent shaped promenade leading near the water's edge from one landing to the other, and the terraced banks, even down to their dressing of Bermuda sod, give a fine idea of the elegance and strength of the work which will grow more beautiful each year and as time verifies the wisdom and care with which….plans have been made (DeVault 1999:20).

Figure 4.5. Undated photograph of the Buffalo Bayou shoreline at the San Jacinto site. The photograph shows the northernmost of the two concrete staircases and the boardwalk (or possibly a bulkhead) along the shoreline. This boardwalk extended down to the southern staircase and ferry landing which lead to a flagpole at the top of the bank.

A 1915 report gives more precise specifications for these improvements, describing the landings as being made of reinforced concrete, each 100 feet in length. "These landings were 1100 feet apart. Connecting them, is a six-foot concrete walk running along the bank at the base of the grass-sodded high sloping bank. (DeVault 1999)."

4.2 Shoreline Changes from 1917 to 1947

Shoreline changes and shoreline loss from erosion and bayou dredging probably began to accelerate after 1916. This is best represented again through photographs taken along the shoreline between 1917 and 1948. An undated postcard photograph (taken sometime around 1920s based on clothing worn by subjects) of the concrete ferry landing indicates that landscaping had begun to occur (**Figure 4.6**) It shows a wooden boardwalk extending along the bayou edge and manicured, possibly contoured banks leading down to the waterline. In this photo, the top of the bank rises approximately 6–10 feet (1.8–3 m) above the water line. By this time, gravel roads looped around the Texan camp as part of an interpretive trail commemorating the battle.

During this period, the Houston population expanded rapidly. The 1900 hurricane that devastated Galveston, and the 1901 discovery of oil at Spindletop made the need for a sheltered inland port essential. To make Houston a viable inland port, a reliable ship channel in Buffalo Bayou was required. Business leaders succeeded in convincing the U.S. Congress to share the costs for dredging a deepwater channel to Houston and the Harris County Ship Channel Navigation District formed in 1910 (Port of Houston 2012). Dredging for the deepwater channel significantly widened and deepened Buffalo Bayou for the Houston Ship Channel, which by 1936

Figure 4.6. Undated early twentieth century postcard of the concrete ferry landing. Note the built improvements and grading along the shoreline. View is looking south.

had been expanded to nearly 700 feet (213.4 m) wide by 30 feet (9.1 m) deep (**Figure 4.7**). However, maps suggest that all dredging occurred on the opposite bank, leaving the San Jacinto side of the shoreline free from industrial expansion. Nonetheless, erosion and subsidence was already taking its toll. A 1930 aerial photograph of the site does suggest some shoreline erosion was occurring along the bayou shore near San Jacinto, resulting in a loss of about 5–10 feet (1.6–3 m) in some places (**Figure 4.8**).

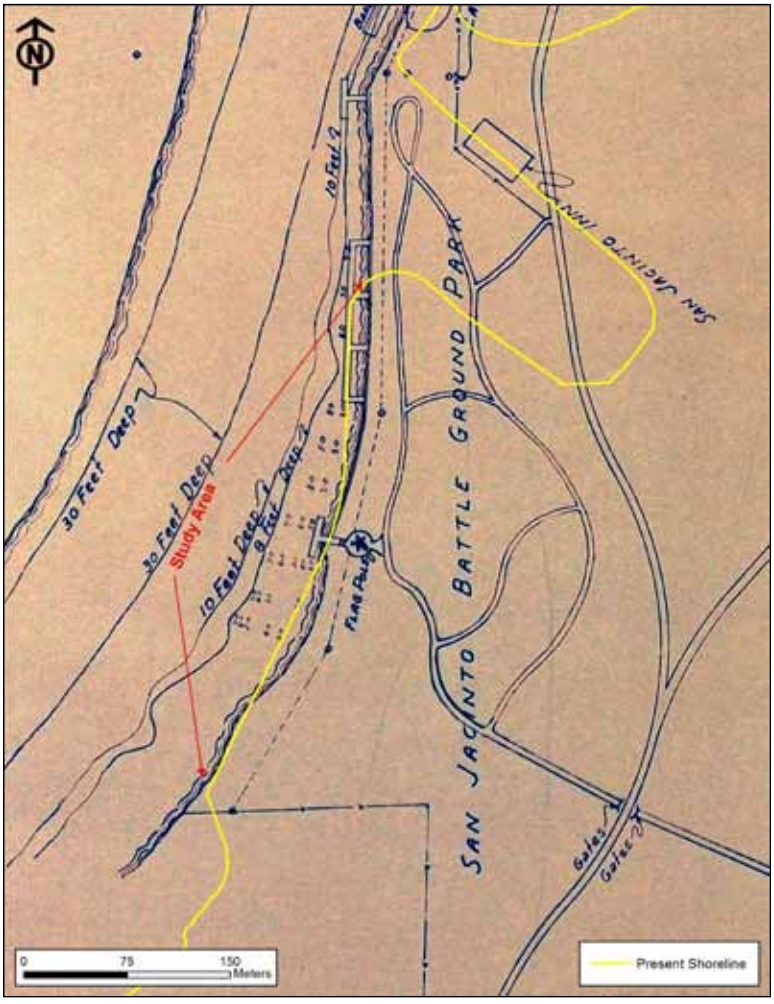

Figure 4.7. Detail from 1936 Port of Houston map of the ship channel depicting bathymetry, shoreline and the San Jacinto Battleground site.

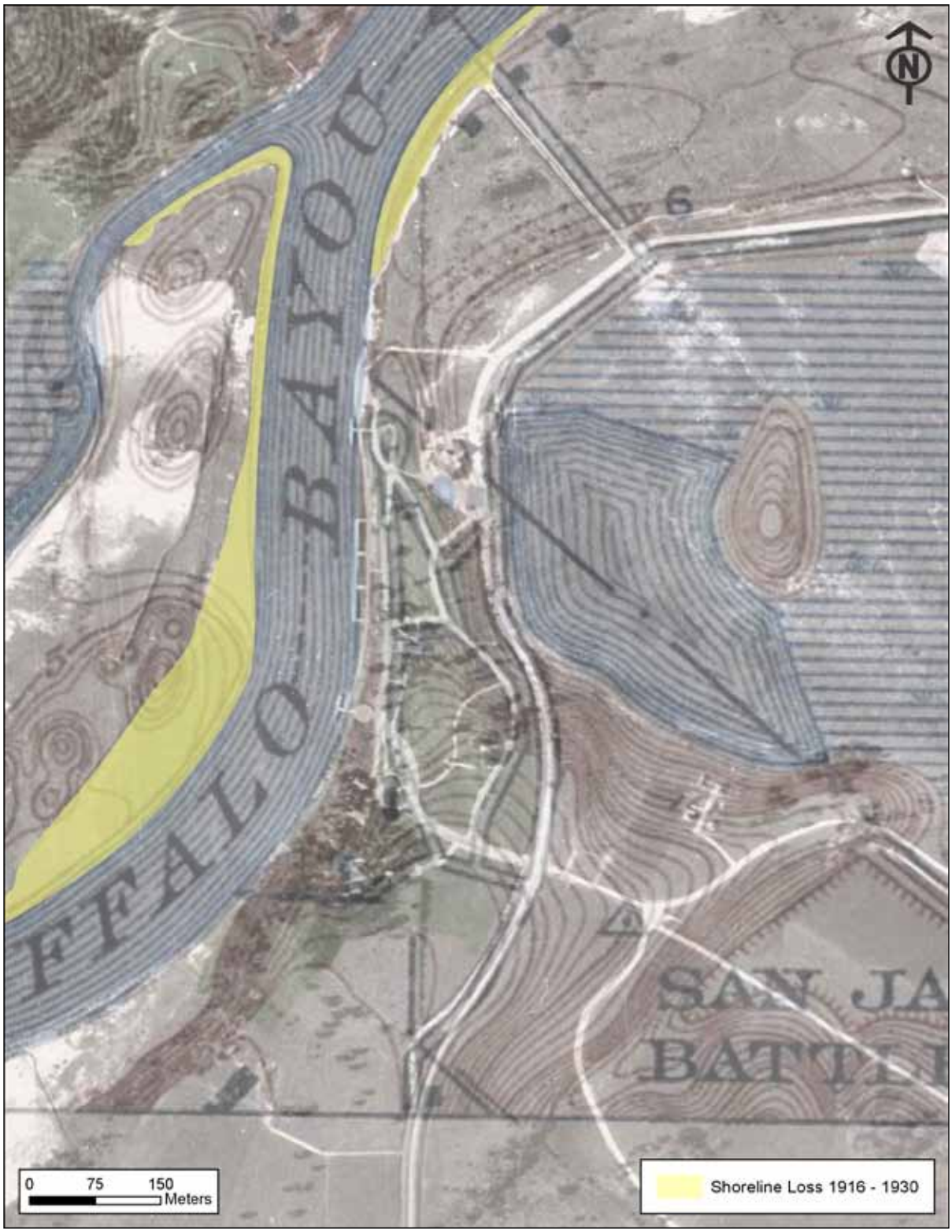

Figure 4.8. 1930 Tobin aerial photograph compared with 1916 topographical map.

Natural erosion along the eastern bank of the bayou was observed as early as the 1894 veterans visit to the site (Hill 1936). However, those shoreline changes were likely minimal until industrial development combined with groundwater and oil extraction began to transform the landscape around Houston. The immediate need for more proactive bank stabilization along the San Jacinto side of Buffalo Bayou must have been recognized by 1936, when a resurvey of the Willard tract found it encompassed only 12.48 acres, rather than the original 15.312 acres sold in 1909, due to shoreline loss (TPWD Real Property Files, "Willard Tract"). Indeed, a docking diagram prepared during 1936 depicts the 25 year old concrete boat dock as broken, suggesting that erosion and/or subsidence was adversely affecting the shoreline at the battleground (**Figure 4.9**).

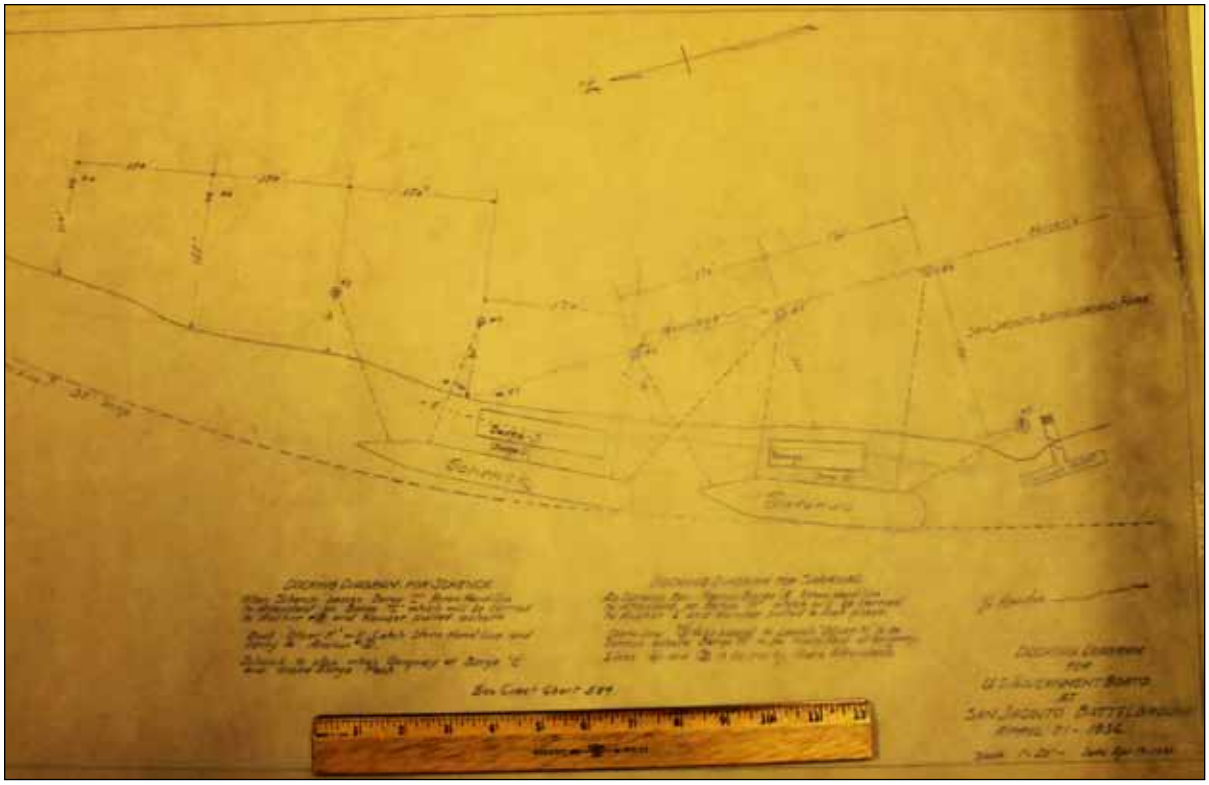

Figure 4.9. Detail from April 1936 sketch of the battleground shoreline showing the broken concrete dock (*Courtesy of Herzstein Library*).

Proactive efforts to protect the shoreline began around that time. Up to this date, preservationists, property owners, and even various business interests such as the Navigation District had been passively preserving the shoreline where the Texan army camped during the battle of San Jacinto. Regular dredging and widening of the bayou occurred on the opposite bank from the Texan camp. Meanwhile, walkways, landscaping and docks, and possibly even an early wooden bulkhead along the water's edge memorialized the stretch of ground where Houston and his army camped in 1836. By the 1930s, however, this was not enough.

In 1936, the WPA provided funds for construction of a steel bulkhead along Buffalo Bayou to stabilize the shoreline. This was part of a broader park improvement project under which the reflecting pool and the monument were built. Overlay of 1930 shoreline position with its current position suggests that the bulkhead was built a few feet channelward of the shoreline in places (**Figure 4.10**). Detailed plans for that construction project were not found among TPWD's archives. However, later plans suggest that the 1936 bulkhead construction utilized an anchor and tie rod system to hold sheetpiling in place. The anchors were set about 30 feet (9.1 m) landward from the bulkhead structure, suggesting that most of the area from the bulkhead to the anchors would have been disturbed in order to install the tie rods.

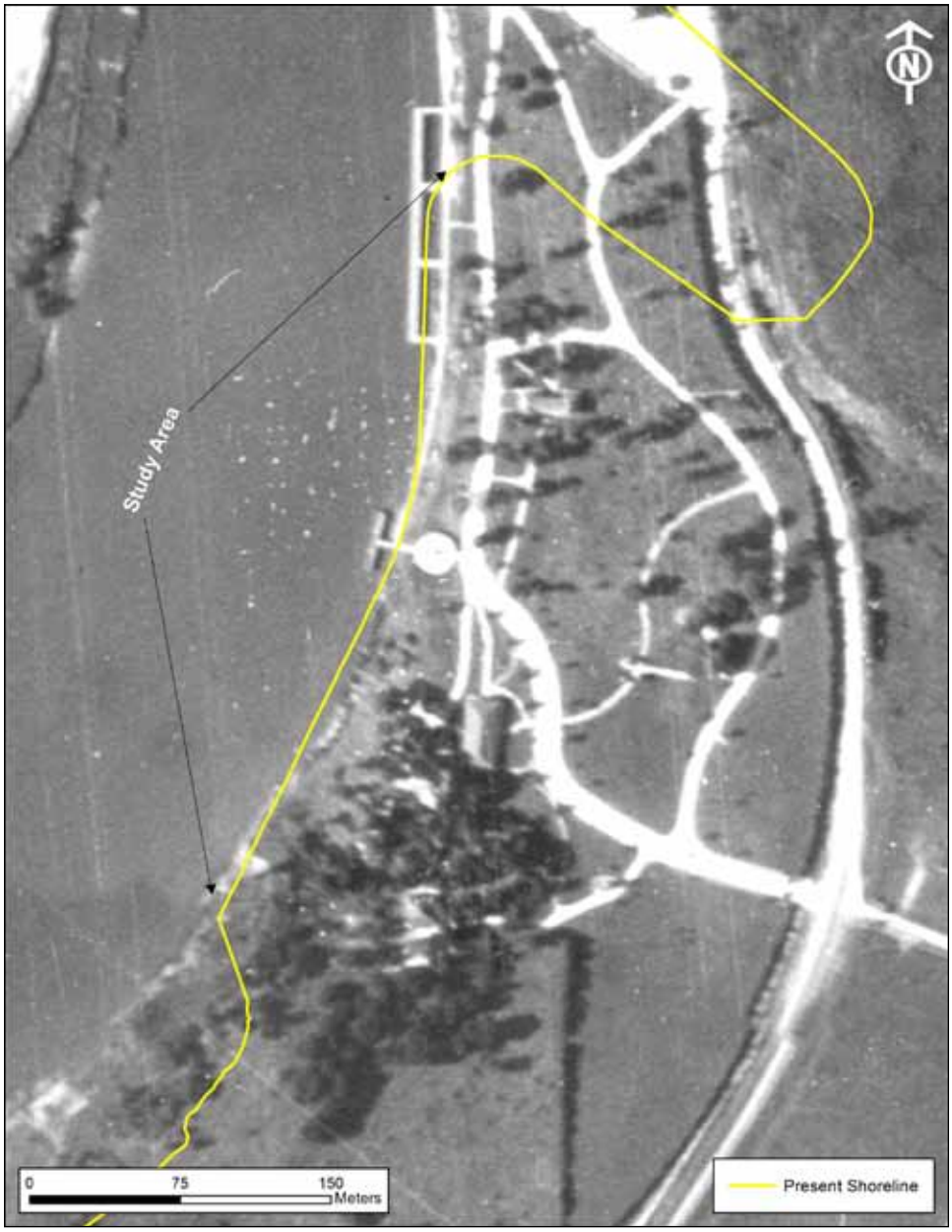

Figure 4.10. Current shoreline position plotted onto 1930 Tobin aerial imagery (*Courtesy of TPWD*).

Construction of the bulkhead essentially fixed the water's edge at a 1936 position, and roughly followed the natural contour of the shoreline by the Texan camp. Part of the bulkhead construction project involved completely regrading the shoreline banks back to the tree line at the time, a distance estimated from various aerial photos to be about 30–50 feet (9.1–15.2 m). The project also demolished the early twentieth-century shoreline improvements such as the boardwalk, the concrete boat dock, and the steps leading to the flagpole (**Figure 4.11**), as well as commercial docks farther downstream. Other improvements made during that time include the removal of all other boat docks near the Texan camp, and re-configuration of the park roads around the Texan camp. Worth noting, however, is that while the 1936 improvements did alter the appearance and grade of the shoreline from the water's edge to the top of the bank, the existing tree line at the top of the bank remained largely unaffected (**Figure 4.12**).

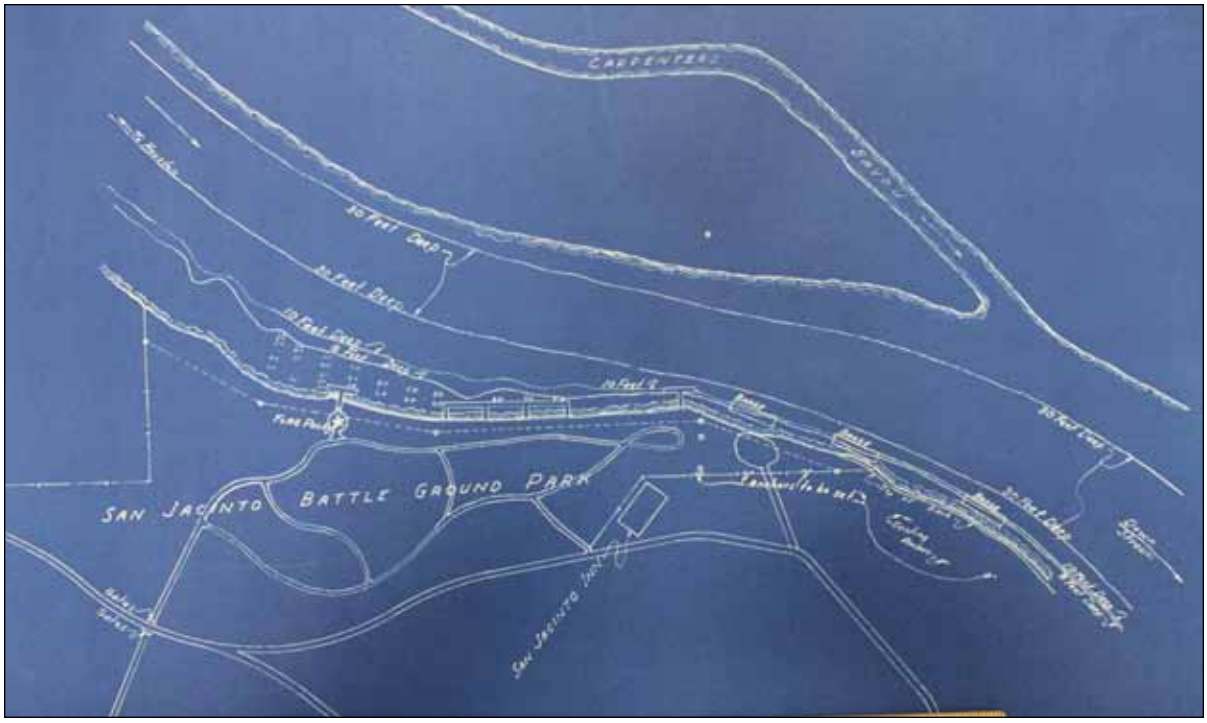

Figure 4.11. 1936 Port of Houston Map showing various improvements along the shoreline in 1936. Many were removed or altered after the 1936 construction projects that created the bulkhead, monument and reflecting pool images (*Courtesy of Herzstein Library*).

4.3 Shoreline Changes from 1948 to the Present Day

A major change to the shoreline occurred in 1948, when a berth was constructed to house the Battleship Texas. To accommodate the battleship, the state excavated nearly 882,900 cubic feet (25,000 m^3) from the shoreline at the presumed location of the Texan camp and specifically in the area where Sherman and his men were believed to have camped. A new promenade leading from the battleship through the Texan camp area, with a circular plaza in the middle was built around this time, covering other possible Texan camp remains with concrete. A statue, which is still in place today, stands at the center of the plaza.

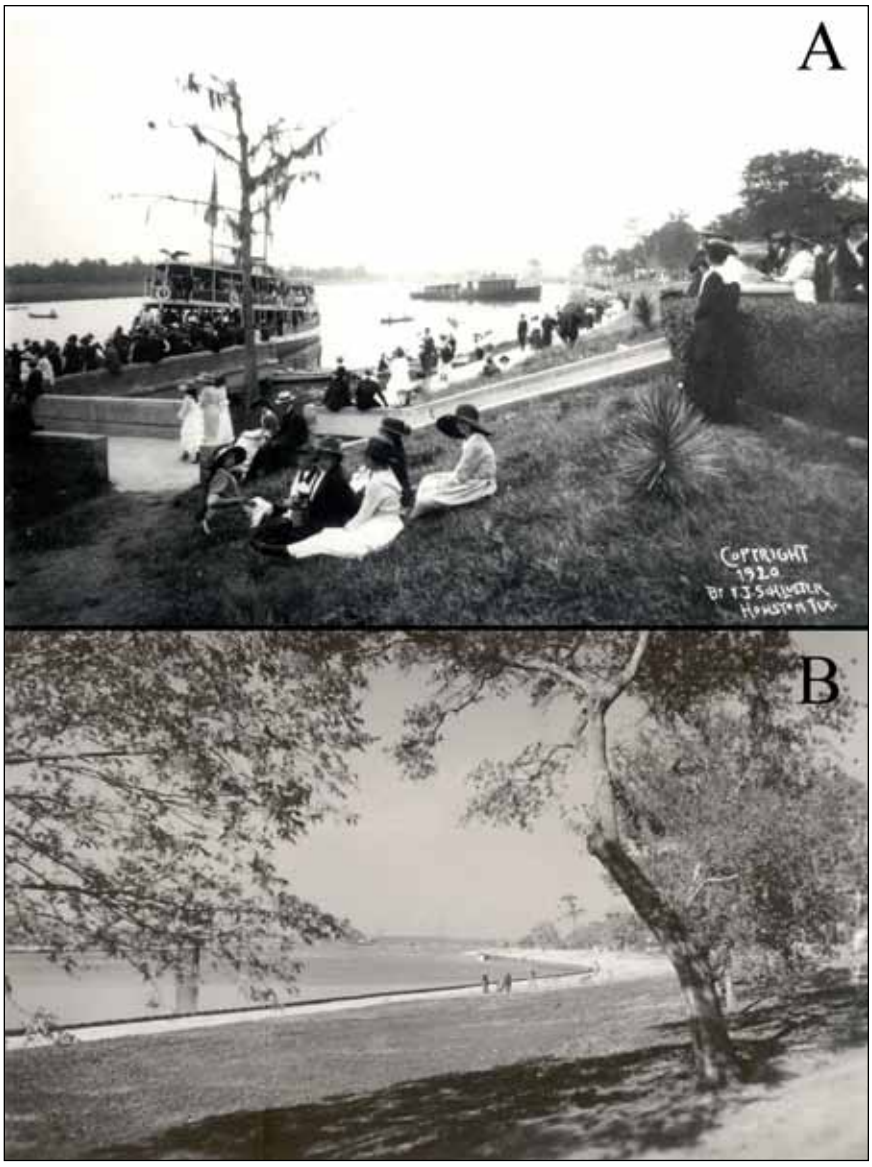

Figure 4.12. Comparative views of Buffalo Bayou shoreline from similar vantages: A) 1920 view of boats docking at the concrete ferry landing; and B) 1936 WPA photograph of newly built bulkhead and shoreline maintenance. Note treeline has not been altered between two images (*Courtesy of Herzstein Library*).

Although the 1936 bulkhead had fixed the position of the shoreline, protecting it from further subsidence and ship channel dredging, erosion along the San Jacinto side of Buffalo Bayou continued to occur. By 1962, Buffalo Bayou was 1,000–1,300 feet (304–396 m) wide and the ship channel was 40 feet (12.2 m) deep. A 1966 aerial photograph demonstrates that the shore was beginning to subside or pull back from the bulkhead in places, allowing water to come in behind it (**Figure 4.13**). Plans for construction of a new bulkhead were underway by 1969, when a survey was made of the shoreline at the site (**Figure 4.14**). The new bulkhead, completed in 1972 was placed two feet channelward of the old bulkhead. Construction plans for that bulkhead indicate that it too utilized an anchor and tie rod system in which anchors were placed 42 feet (12.8 m) from the sheetpiling forming the bulkhead wall. Crushed shell and fill material were added into the gap between the old and new bulkhead structures, as well as directly over the tie rods joining the sheetpile bulkhead to the anchors. Plans suggest that a levee was built atop the bulkhead sometime between 1972 and 1985 (**Figure 4.15**). This involved raising the shore near the water's edge by several feet, and adding gabion boxes between the bulkhead and the top of the levee (approximately 25 feet [7.6 m] of width) for additional shoreline stabilization. According to as-built plans provided by TPWD, these gabion boxes were replaced in 1985.

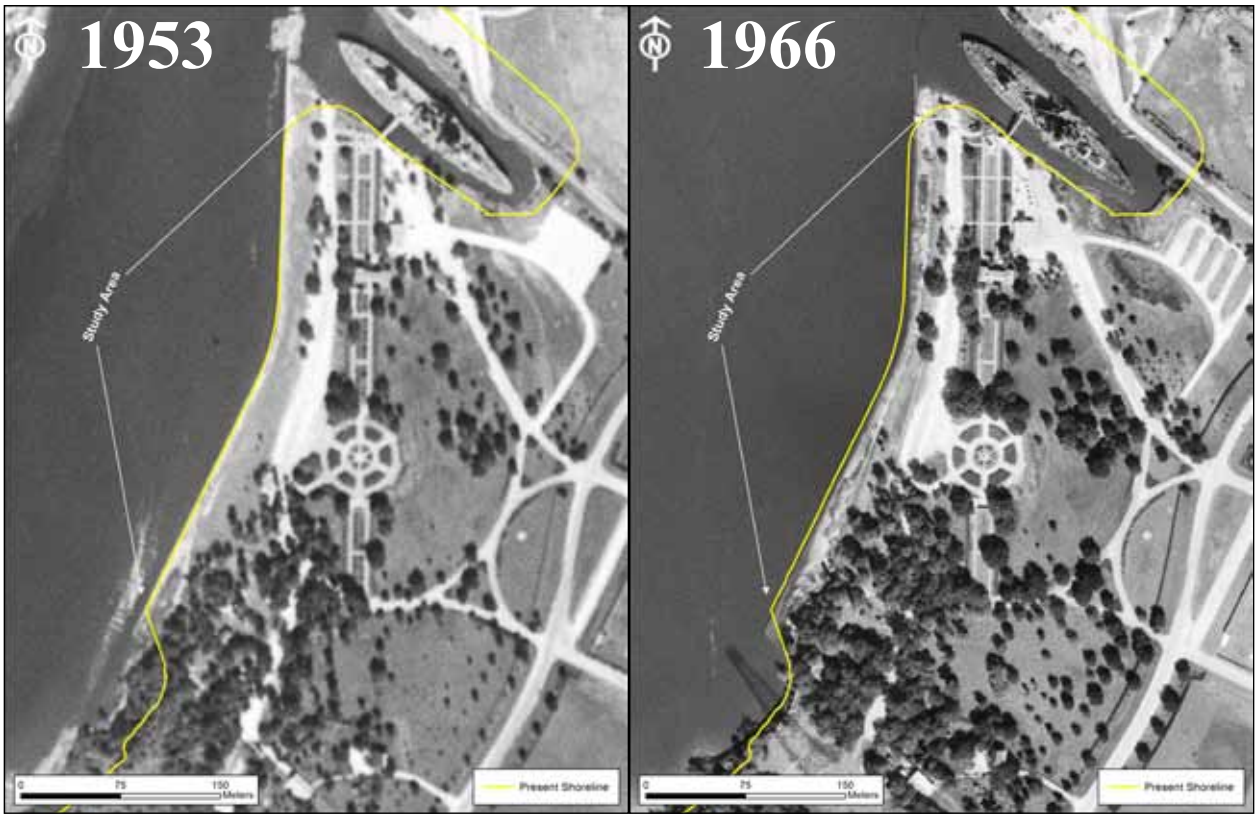

Figure 4.13. Comparison of 1953 and 1966 aerial photographs showing erosion along 1936 bulkhead.

Since that time, no further changes to the shoreline have occurred except for the expansion of the berth for the Battleship Texas, which took place in 1989. At that time, archeological monitoring occurred and found nearly three feet (0.9 m) of dredge spoil atop the former location of the San Jacinto Inn, located along the northern margins of the site from the edge of the bayou to the end of the berth (Ing 1996). The current bulkhead and shoreline has not moved or been altered since that time.

4.4 SUMMARY

To summarize, while many natural and human induced changes have taken place at the San Jacinto Battleground and specifically in the area thought to be the Texan camp, the shoreline along Buffalo Bayou has not changed position or orientation as much as some have posited (e.g., Takac et al. 2000). In fact, early awareness of the site's historical significance and continuous commemoration of it from the mid-nineteenth century to the present day have resulted in timely intervention to maintain the eastern bayou shoreline at roughly the 1836 position.

Two bulkheads are known to have been built along the Buffalo Bayou shoreline: the current one constructed between 1970 and 1972, and an earlier steel bulkhead constructed in 1936. The current bulkhead is a few feet channelward from the 1936 structure. An even earlier structure, a boardwalk, was built for the 1910 site opening or shortly thereafter. The boardwalk, which may have also been intended to stabilize the shoreline, can be seen in a number of photographs

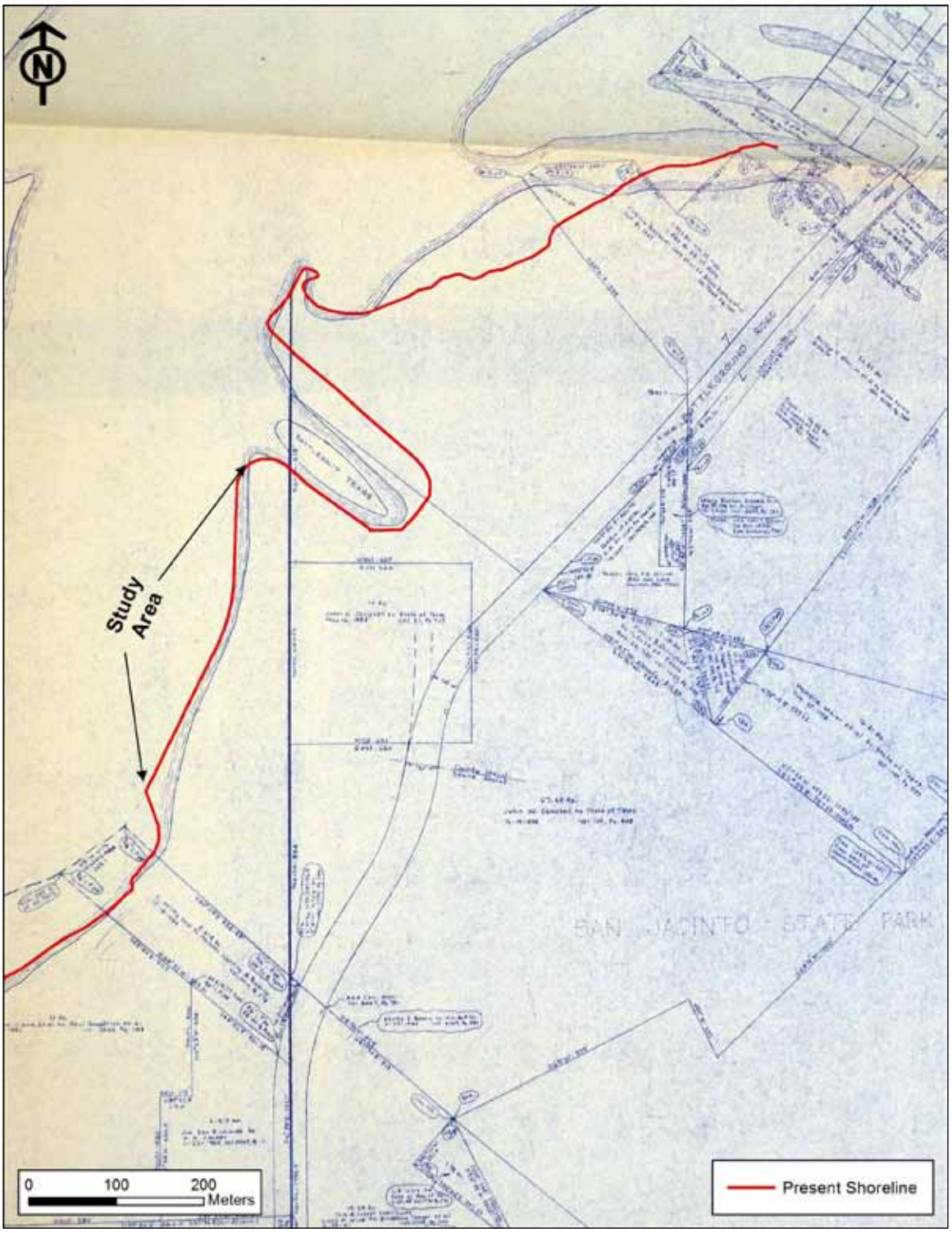

Figure 4.14. Detail from 1969 survey of San Jacinto Battleground Site. Current bulkhead position and shoreline is overlaid.

Figure 4.15. Photograph taken 2014 showing shoreline bulkhead and shoreline along Buffalo Bayou. Compare view to photos in Figure 4.11.

from the 19-teens (see Figures 4.5, 4.6 and 4.12A) and an aerial photograph from 1930 (see Figure 4.10). This was built of concrete to match the boat docks and staircases leading from the water's edge up to the site (DeVault 1999). These early interventions likely did much to preserve the shoreline along the Texan camp area of the San Jacinto Battlefield State Historic Site.

This is not to say that shoreline loss has not occurred along the east bank of Buffalo Bayou. Indeed, comparison of the shoreline contours and position from 1871 to the present day, does suggest some degree of migration. However, we believe the maximum amount of loss near the presumed location of the Texan camp is probably only about 10–15 feet (3–4.6 m), and only in certain places. This shoreline loss is minimal when compared to the hundreds of feet that have been lost just on the other side of the bayou and elsewhere.

Nonetheless, other factors affect the potential for intact archeological deposits to be present in the area of the Texan camp. The 1948 construction and subsequent 1985 enlargement of the berth for the Battleship Texas has had the biggest impact, completely removing a large portion of the area thought to be the Texan camp. Other alterations include landscaping, grading, bulkhead construction, road maintenance, and levee construction which have occurred with regularity for a century or more. Photographs, construction plans, and other sources suggest that an area from the edge of the water back for a distance of 50 feet (15.2 m) is most likely completely disturbed from these activities with no potential for intact, battle-related

archeological remains, or prehistoric archeological remains. Father away from the shoreline, under the existing parking lot for instance, or father landward, Texan army-related remains are still possible. However, as findings from sites such as 41HR576 and 41HR1085 confirm, battle-related materials are likely to be overprinted or mixed with later remains related to subsequent land use.

CHAPTER 5
IMPACT OF THE ALTERNATIVES AND RECOMMENDATIONS

As previously described, there are three alternatives: the Major Repair Alternative, the Moderate Repair Alternative, and the Minor Repair Alternative. These are summarized in the Introduction with a brief description of the actions they entail. The actual footprint of impacts from these three alternatives is discussed below along with the potential to affect intact archeological resources.

The Major Repair Alternative would include replacing the existing concrete cap over the bulkhead, water-tightening of the bulkhead and outfalls, upgrading/improving draining system, and protecting the steel sheetpiling. Ground disturbance related to the Major Repair Alternative would include excavation behind the bulkhead for drainage and water tightening of the steel sheetpile down to the bottom of the existing outfall pipe (roughly four feet [1.2 m] below the top of the steel bulkhead). These ground disturbing activities would take place at the existing shoreline within 6–8 feet (1.8–2.4 m) immediately adjacent to the steel sheetpile wall, and along the shore for a distance of no more than 1,600 linear feet (4.87.7 m) of the extent of the existing sheetpile.

The Moderate Repair Alternative would include replacing rubble gabions, providing erosion remediation for shoreline erosion at the ends of the bulkhead, installing concrete walkway immediately landward of the concrete cap, and installing handrails along bulkhead. Ground disturbance related to the Moderate Repair Alternative would include excavation behind the bulkhead for drainage and along the waterward slope of the levee. These ground disturbing activities would take place at the existing shoreline for a distance of approximately 1,200 linear feet (3.65.8 m) along the existing levee.

The Minor Repair Alternative includes removing 1930's relic bulkhead sections from below waterline, integrating "natural" design alternatives for upland vegetation, and providing docking access for vessels along the bulkhead. Ground disturbance related to the Moderate Repair Alternative would include excavation in the channel itself in front of the bulkhead, as well as minor surface disturbances along the channelward portion of the levee. These ground disturbing activities would take place from the channel and along the shore for a distance of approximately 1,200 linear feet (365.8 m) along the existing levee.

5.1 POTENTIAL IMPACTS ON CULTURAL RESOURCES

Analysis of shoreline changes and alternations that have occurred along Buffalo Bayou at the San Jacinto Battleground State Historic Site suggest that while the shoreline position has not changed greatly over the years, a number of landscape modifications have occurred to affect

the integrity of deposits from the edge of the water to a distance of at least 50 feet (15.2 m) (the approximate distance to the top of the levee). These modifications have included docks, staircases, roads, paved surfaces, bulkheads, landscaping, and more recently, gabion baskets and levee construction which have involved extensive grading and filling along the shore. Gabion baskets alone extend from the bulkhead wall landward for 25 feet (7.6 m) . This report concludes, as a result, that the potential for intact archeological deposits of any sort is very limited directly along the shoreline.

In conclusion, none of the proposed repairs or improvements to the existing bulkhead will require substantial construction or ground disturbance in any area not previously disturbed by the various historical landscape and shoreline improvements. Under each of the three construction alternatives, ground disturbance would be limited to less than 50 feet (15.2 m) landward from the bulkhead. Therefore, this report recommends that all alternatives have low potential to affect intact archeological resources.

It should be noted, however, that despite low potential for impact from the current proposed undertaking, there is potential for intact archeological remains under existing parking lots, roads, and under the landward side of the levee. In these areas, surface disturbances will have been localized, and/or shallow and therefore, it is possible that archeological remains, particularly those pertaining to the Battle of San Jacinto and later could be present, although integrity is likely compromised by 170 years of continuous land use and commemoration.

Nonetheless, given the potential importance of any battle-related artifact finds along the Buffalo Bayou shoreline (even those without context), monitoring of bulkhead improvements could be warranted, particularly around the levee. In addition, equipment staging areas could affect the ground surface in unpaved areas and should the project require such staging, those areas should be investigated through shovel testing and/or controlled metal detecting prior to use.

Finally, for future planning, this report recommends that a controlled metal detector survey or targeted testing of the entire Texan camp area could be productive to determine whether remnants of the camp do exist and if so, their degree of integrity. This last recommendation falls outside the scope of the currently planned project and is offered for long-term planning and management purposes only.

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