Draft Environmental Assessment
Rollover Pass Closure Project

Galveston County, TX

March 2010

10151 Deerwood Park Blvd., Bldg. 300, Suite 300, Jacksonville, FL 32256
(904) 731-7040 ~ www.taylorengineering.com

Draft Environmental Assessment
Rollover Pass Closure Project
Galveston County, Texas

Prepared for
Texas General Land Office

by
Taylor Engineering, Inc.
10151 Deerwood Park Blvd., Bldg. 300, Suite 300
Jacksonville, Florida 32256
(904) 731-7040

C2009-063
March 2010

DRAFT ENVIRONMENTAL ASSESSMENT

ROLLOVER PASS CLOSURE PROJECT

GALVESTON COUNTY, TEXAS

TABLE OF CONTENTS

LIST OF TABLES ..... **iv**

LIST OF FIGURES ..... **iv**

1.0 PROJECT PURPOSE AND NEED **1**

1.1 PROJECT AUTHORITY 1

1.2 PROJECT DESCRIPTION AND LOCATION 1

1.3 PROJECT PURPOSE AND NEED 1

2.0 PROJECT ALTERNATIVES **2**

2.1 NO-ACTION 2

2.2 ROLLOVER PASS CLOSURE (PREFERRED ALTERNATIVE) 2

3.0 AFFECTED ENVIRONMENT **4**

3.1 WETLANDS AND VEGETATION 4

3.2 FISH AND WILDLIFE RESOURCES 5

3.3 ESSENTIAL FISH HABITAT 6

3.4 PROTECTED SPECIES 8

3.5 WATER QUALITY 9

3.6 WATER SALINITY 10

3.7 AIR QUALITY 10

3.8 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE 11

3.9 NOISE 11

3.10 CULTURAL RESOURCES 11

3.11 RECREATION RESOURCES 11

3.12 AESTHETIC RESOURCES 12

3.13 COASTAL BARRIER RESOURCES 12

3.14 SOCIOECONOMICS 12

3.15 ENVIRONMENTAL JUSTICE 12

3.16 NAVIGATION 13

4.0 ENVIRONMENTAL EFFECTS **13**

4.1 WETLANDS AND VEGETATION 13
4.1.1 No-Action *13*
4.1.2 Rollover Pass Closure (Preferred Alternative) *13*
4.2 FISH AND WILDLIFE RESOURCES 14
4.2.1 No-Action *14*
4.2.2 Rollover Pass Closure (Preferred Alternative) *14*
4.3 ESSENTIAL FISH HABITAT 17
4.3.1 No-Action *17*
4.3.2 Rollover Pass Closure (Preferred Alternative) *17*
4.4 THREATENED AND ENDANGERED SPECIES 18
4.4.1 No-Action *18*
4.4.2 Rollover Pass Closure (Preferred Alternative) *18*
4.5 WATER QUALITY 18
4.5.1 No-Action *18*
4.7 AIR QUALITY 21
4.7.1 No-Action *21*
4.7.2 Rollover Pass Closure (Preferred Alternative) *21*
4.8 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE 21
4.8.1 No-Action *21*
4.8.2 Rollover Pass Closure (Preferred Alternative) *21*
4.9 NOISE 21
4.9.1 No-Action *21*
4.9.2 Rollover Pass Closure (Preferred Alternative) *22*
4.10 CULTURAL RESOURCES 22
4.10.1 No-Action *22*
4.10.2 Rollover Pass Closure (Preferred Alternative) *22*
4.11 RECREATION RESOURCES 22
4.11.1 No-Action *22*
4.11.2 Rollover Pass Closure (Preferred Alternative) *22*
4.12 AESTHETIC RESOURCES 23
4.12.1 No-Action *23*
4.12.2 Rollover Pass Closure (Preferred Alternative) *24*
4.14 ENVIRONMENTAL JUSTICE 25
4.14.1 No Action *25*

4.14.2 Rollover Pass Closure (Preferred Alternative) *25*
4.15 NAVIGATION 25
4.15.1 No Action *25*
4.15.2 Rollover Pass Closure (Preferred Alternative) *25*
4.16 COASTAL BARRIER RESOURCES 26
4.16.1 No Action *26*
4.16.2 Rollover Pass Closure (Preferred Alternative) *26*
4.17 MITIGATION 26
4.18 CUMULATIVE IMPACTS 26
4.19 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS 27
4.19.1 National Environmental Policy Act of 1969, as amended *27*
4.19.2 Endangered Species Act of 1973, as amended *27*
4.19.3 Fish and Wildlife Coordination Act of 1958, as amended *27*
4.19.4 National Historic Preservation Act of 1966, as amended *27*
4.19.5 Clean Water Act of 1972, as amended *28*
4.19.6 Clean Air Act of 1972, as amended *28*
4.19.7 Coastal Zone Management Act of 1972 ..... *28*
4.19.8 Farmland Protection Policy Act of 1981 ..... *28*
4.19.9 Coastal Barrier Resources Act and Coastal Barrier Improvement Act of 1990 *28*
4.19.10 Marine Protection, Research and Sanctuaries Act of 1972 ..... *29*
4.19.11 Magnuson-Stevens Fishery Conservation and Management Act *29*
4.19.12 E.O. 11990 Protection of Wetlands *29*
4.19.13 E.O. 11988 Flood Plain Management *29*
4.19.14 E.O. 12898 Environmental Justice *29*
5.0 COORDINATION WITH OTHERS 29
6.0 CONCLUSIONS 30
7.0 REFERENCES 32

APPENDIX A Coastal Impact Analysis Report
APPENDIX B Vegetation and Ecological Community Assessment Report
APPENDIX C Wetland Delineation Report
APPENDIX D Biological Assessment
APPENDIX E Pertinent Correspondence
APPENDIX F Hydrodynamic and Salinity Modeling Report

APPENDIX G Preliminary Air Conformity Analysis

APPENDIX H Section 404(b)(1) Evaluation

APPENDIX I Coastal Zone Management Consistency Determination

LIST OF TABLES

Table 1 Federally-Listed Threatened and Endangered Species Occurring in Galveston County, Texas..... 9

Table 2 2008 Texas Water Quality Inventory Data..... 10

Table 3 Summary of Salinity Sampling in June 1954 – 1956 (Reid 1958) and Taylor Engineering Salinity Modeling Results, Spring Season (April – May)..... 20

LIST OF FIGURES

Figure 1 Cover Sheet

Figure 2 Overview

Figure 3 Key Sheet

Figure 4 Rollover Pass Closure Plan and Profile

Figure 5 Rollover Pass Closure Plan and Profile

Figure 6 Rollover Pass Closure Plan and Profile

Figure 7 Pipeline Route

Figure 8 Salinity Distribution in East Bay, Texas from 1954 – 1956 as Reported in Reid (1958)

DRAFT ENVIRONMENTAL ASSESSMENT

ROLLOVER PASS CLOSURE PROJECT

GALVESTON COUNTY, TEXAS

1.0 PROJECT PURPOSE AND NEED

1.1 PROJECT AUTHORITY

The 81st Texas Legislature, through Senate Bill 2043, has appropriated $5.85 million, available from September 1, 2009 through August 31, 2011, to the Texas General Land Office (GLO) for the closure of any man-made Pass that is causing or contributing to significant erosion to the adjacent land. The GLO plans to use this appropriation to close Rollover Pass. Notably, the GLO has also applied for a FEMA 404 Hazard Mitigation Grant Program (HMGP) grant through the Texas Governor's Division of Emergency Management to help defray the cost of closing Rollover Pass. The Federal share for this grant would equal approximately $4.4 million, with a $1.45-million State match from the 81st Texas Legislature appropriation. If FEMA approves the 404 HMGP application, the remaining $4.4 million of the 81st Texas Legislature appropriation will become available for any additional costs to close Rollover Pass and the construction of a pier and/or any other recreational activities seen fit by the GLO, Galveston County, and the local community.

1.2 PROJECT DESCRIPTION AND LOCATION

Rollover Pass, an artificial inlet created in 1955, lies on the Bolivar Peninsula in Galveston County, Texas about 30 km (19 miles) northeast of the Galveston Bay entrance. The Pass provides a tidal connection between the Gulf of Mexico and Rollover Bay in the southeastern portion of East Bay (Figures 1 and 2). The Texas Game and Fish Commission (now the Texas Parks and Wildlife Department [TPWD]) constructed Rollover Pass through a natural wash-over area, periodically breached during extreme high tides and hurricanes, to promote fish passage from the Gulf to the inshore waters and improve local fishing conditions. Since construction, Rollover Pass has had adverse effects on the coastal system including accelerated beach erosion, sediment deposition in the Gulf Intracoastal Waterway (GIWW), and increased salinity levels in Rollover Bay and East Bay.

The proposed action entails the closure of Rollover Pass to alleviate beach erosion along the Bolivar Peninsula, reduce the required frequency and costs of maintenance dredging the GIWW, increase the effectiveness of beach restoration projects, and restore the Bay waters to more natural water quality (salinity) conditions.

1.3 PROJECT PURPOSE AND NEED

Rollover Pass' adverse impacts on the coastal system began immediately after construction in 1955 and continue today. The impacts — namely, accelerated beach erosion and increased deposition in the GIWW — arise primarily from the Pass' flood-dominant characteristics that transport and deposit sediments into the Rollover and East Bays and effectively diminish the natural sediment supply to the adjacent beaches. This process starves the beaches of the sand volume required to maintain the natural beach conditions; without this sand, erosion increases. Erosion also results from the trapping of littoral sediments against the Pass' updrift side and through ebb tidal effects. Similar to the above flood tidal

process, the Pass' ebb tidal currents disrupt the natural longshore sediment transport by directing sediment offshore where they deposit in an ebb tidal shoal.

Though numerous past studies disagree on impact quantities, the studies, without exception, acknowledge that Rollover Pass traps sediment that would normally reach downdrift beaches and consequently causes beach erosion and increases GIWW dredging requirements. Appendix A summarizes the previous studies, provides a detailed coastal analysis of Rollover Pass' impacts to adjacent beaches, and further justifies the need for the proposed project.

The proposed Rollover Pass Closure Project will alleviate the above adverse impacts and return the project site to a more natural state by completely filling the man-made Pass, from the Gulf shoreline to the Bay shoreline. Sediment transport, uninterrupted by the Pass, will feed downdrift beaches and salinity should decrease to some extent with the elimination of that salt water source.

2.0 PROJECT ALTERNATIVES

2.1 NO-ACTION

Under the No-Action alternative, the proposed project will not occur and Rollover Pass will remain open. Rollover Pass will continue to exacerbate beach erosion along the Bolivar Peninsula, increase sediment deposition rates and maintenance dredging frequency within the GIWW, and allow highly saline waters to enter the Bay, resulting in elevated salinities.

2.2 ROLLOVER PASS CLOSURE (PREFERRED ALTERNATIVE)

The preferred alternative involves closing Rollover Pass. Figures 2 through 7 depict the preliminary project design in both plan and sections views. Project construction will occur in two primary locations, the dredge material source and the Pass closure location. The proposed project will use a hydraulic dredge connected to a floating pipeline to pump fill material from the borrow source to Rollover Pass. The project may use up to three potential fill sources including a nearby upland dredge material placement area (DMPA #36), the permitted Rollover Bay sand source (Galveston County, SWG 21755 and amendments), or the GIWW (from annual maintenance dredging) in the Rollover Pass vicinity. Material fill removal from the GIWW would coincide with annual maintenance dredging conducted by the U.S. Army Corps of Engineers (USACE). Heavy equipment will grade the infill to meet the elevations of adjacent lands. The specified construction methodology will use a combination of permanently installed steel sheet pile walls and geotextile bags to close the Pass. Implementing this methodology will minimize water quality impacts and structural impacts to the existing bridge and utilities. The existing State Highway 87 Bridge, maintained by the Texas Department of Transportation, and all utilities that currently cross Rollover Pass will remain intact. Demolition and/or removal of the existing steel and concrete walls throughout the Pass will occur after the fill stabilizes.

Filling Rollover Pass will require approximately 6 months of construction, preceded by about one month of equipment mobilization and followed by approximately one month of demobilization. The project will progress in multiple steps, some of which will run concurrently. The remainder of this section details a typical construction process for the work environment and required construction activities. The selected contractor may find alternatives at different construction steps that create less environmental disturbance.

Project mobilization will proceed primarily over the water due to the size of the required equipment, the necessity to work across the channel from east to west on both north and south sides of the State Highway 87 Bridge, and the condition of the existing sheetpile walls that line the Pass. The majority

of heavy equipment will operate from barges. Anchors or spuds (large pipes driven into the bottom) will hold the equipment barges in place.

For construction south of the State Highway 87 Bridge, the contractor will use tugboats or motorized barges to transport the large construction cranes and pile-driving equipment necessary to install pilings and geotubes at the project site. For construction north of the bridge, the contractor will transport equipment to the project site through the GIWW and Rollover Pass channel. A shallow-draft tugboat will push/pull the floating crane and piling-driving assembly. The contractor will likely use 20-30 foot workboats to shuttle workers between the shore and the crane platform, and perform other work tasks. Similar size boats will provide the platform to perform any necessary in-water monitoring work.

DMPA #36 north of the GIWW west of Rollover Bay will provide the primary source of material to fill the Pass. The contractor will create a slurry of the dredge material within the DMPA and transport, via hydraulic dredge, the material from the DMPA to Rollover Pass. A floating pipeline will extend from the DMPA east along the north side of the GIWW, except for a short submerged segment across the GIWW, and then south through Rollover Bay to the Pass (Figure 7). Floating pipeline allows easy inspection and maintenance compared to a pipeline secured to the bottom. The pumping distance along the proposed pipeline route will likely require 3 anchored booster pumps in addition to the main dredge platform. Spuds will anchor the dredge and booster pump platforms.

The contractor will likely assemble and anchor the floating pipeline along the GIWW in place. The remainder of pipeline assembly will occur in East Bay. The contactor will drag the assembled pipeline through Rollover Bay using a hawser, and workboats to control pipeline movement during transport. Once in place, anchors spaced about every 200 to 400 feet will hold the pipeline in the desired location. All equipment (dredge platform, booster pumps, and pipeline) will locate in waters with depths below the mean lower low water (MLLW) elevation. Flags, signs, and lights will provide the necessary warning information to protect boaters from colliding with the equipment.

Once mobilization is complete, construction may begin. Construction will start with installation of sheetpile on the Gulf side of the Highway 87 Bridge. The sheetpile wall will stop tidal exchange and will help reduce lateral pressure on the bridge pilings during construction. Installation of the bayside sheetpile will occur after completion of the gulfside wall. Following sheetpile installation, the contractor will install pilings east to west across the width of the Pass at several locations. These pilings will establish the geotube location. The geotubes will provide the means to contain the sand within a set of cells along the length of the Pass and allow the contractor to fill the Pass in stages. This approach will minimize turbidity in the surrounding waters. Once pile installation is complete, the contractor will place the geotubes and pump them full of seawater followed by dredged material. The final geotube elevation will lie well below the finished project elevation. The filled geotubes will effectively create individual cells that the contractor will fill with dredged material. Material placement will commence at the bridge to fill the space in between the sheetpile and under the bridge. After filling this space, the contractor will proceed toward the adjacent water body (Gulf of Mexico or Rollover Bay). The contractor will continue filling the Pass at a speed that allows settling of fine materials and sufficient to maintain turbidity within acceptable limits. The contractor will use large earthmoving equipment to grade and compact the sediment during the construction process.

3.0 AFFECTED ENVIRONMENT

3.1 WETLANDS AND VEGETATION

Corrigan Consulting, Inc. performed a detailed field investigation in November 2009 to identify, map, and characterize natural communities in the project vicinity. On February 6, 2010, Corrigan performed a follow-up field investigation to delineate jurisdictional wetlands and surface waters adjacent to the Pass. This section of the EA provides a brief summary of its findings. Appendices B and C contain Corrigan's complete natural community assessment report and wetland delineation report, respectively.

Dominant wetland habitats within Rollover Bay include large expanses of unvegetated, intertidal mud flats that become aerially-exposed during low tides. Two small, low-density oyster reefs occur within Rollover Bay east of the Pass. Intertidal marsh and coastal uplands fringe Rollover Bay. Groups of small dredged material spoil islands line the north and south sides of the GIWW adjacent to Rollover Bay. Estuarine unconsolidated shore comprises the majority of these islands, but some contain fringing marsh dominated by smooth cordgrass (*Spartina alterniflora*). To some extent, the rounded crown of some of the islands support intermediate marsh assemblages and include vegetative species such as vidrillos (*Batis maritima*), glasswort (*Salicornia bigelovii*), seaside heliotrope (*Heliotropium curassavicum*), and shoregrass (*Monathochloe littoralis*).

Natural habitats east of Rollover Bay and south of the GIWW include a mix of low and intermediate estuarine marsh with intermittent salt pans and irregularly-exposed mudflats. Two islands occur east of Rollover Bay and immediately north of the GIWW. Dredged material disposal likely created both islands. The larger of the two islands contains a DMPA that covers most of the island. The center of the DMPA holds water and concrete mats armor the south shoreline of the island. Estuarine marsh consisting primarily of smooth cordgrass fringes the north, west, and east shoreline of the DMPA. The smaller island located northeast of the DMPA island consists of high quality low to intermediate marsh dominated by smooth cordgrass and black needlerush (*Juncus roemerianus*).

Prior to dredging the GIWW, Goat Island and the portion of the Bolivar Peninsula south of the channel composed a contiguous complex of estuarine marsh and tidal flats. Historical dredging has resulted in a substantial accumulation of dredged spoil along the southern shoreline of Goat Island and immediately north of the GIWW. Vegetation associated with the dredged material disposal areas, characterized as ruderal communities, includes western ragweed (*Ambrosia psilostachya*), marsh hay cordgrass (*Spartina patens*), smooth cordgrass, flatsedge (*Cyperus tenius*), wooly croton (*Croton capitatus*), pit seed goose foot (*Chenopodium berlendieri*), marsh elder (*Iva frutescens*), baccharis (*Baccharis halimifolia*), dodder (*Cuscuta cuspidate*), sea oxeye daisy (*Borrichea frutescens*), and seaside heliotrope. Salt cedar (*Tamarix gallica*), live oak (*Quercus virginiana*), youpon (*Ilex vomitoria*), and sugarberry (*Celtis laevigata*) grow on the higher areas of the dredged spoil. Concrete mats armor almost the entire length of Goat Island's south shoreline. A narrow band of smooth cordgrass grows in front of the armoring. Patches of common reed (*Phragmites autralis*) occur in some areas along the south shoreline, just above the high tide line.

The field investigation indicated that additional dredging and dredged material disposal activities have occurred within the Goat Island interior, particularly in the northwest portion of the island. The majority of Goat Island consists of high quality emergent marsh. Low marsh species, primarily smooth cordgrass, occupies the eastern half the island while the western side of the island provides habitat for intermediate marsh species.

Estuarine wetlands comprising low to high marsh, mudflats, intertidal pools, and intermittent salt pans characterize the estuarine environment south of Goat Island and the GIWW. Smooth cordgrass dominates the marsh community and glasswort commonly occurs within the mudflats and salt pans.

The north shoreline of East Bay across from Goat Island consists of relatively pristine estuarine marsh habitat dominated by gulf cordgrass (*Spartina spartinae*) and smooth cordgrass. The low marsh abruptly transitions to high marsh followed by scrub-shrub wetlands dominated by baccharis, gulf cordgrass, and sea-oxeye daisy. The north shoreline across from Rollover Bay comprises a portion of the Anahuac Wildlife Refuge. Smooth and marsh hay cordgrass with small, sporadic patches salt cedar characterize the shoreline vegetation.

During its February 6, 2010 field investigation, Corrigan identified three community types adjacent to the Pass that may fall under USACE jurisdiction. These community types include vegetated intertidal marsh, non-tidal freshwater pools, and tidal pools (Appendix C).

The vegetated intertidal marsh consists of sparse, perennial communities of smooth cordgrass. Two very small, discrete marsh patches lie near the northwest corner of the Pass. An area mapped near the northeast corner of the Pass comprises a portion of a larger marsh community (Appendix C, Figure 1). All three of the mapped areas occur outside of the proposed construction boundary. These intertidal wetlands fall under USACE jurisdiction through Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act (RHA).

Corrigan mapped and characterized eight surface water features adjacent to the Pass (Appendix C, Figure 1), outside of the proposed construction boundary. These features range from 247 to 5,109 square feet and did not exist prior to Hurricane Ike in 2008. They comprise isolated features that do not support established vegetative communities and do not provide any appreciable habitat value. Although the hydrologic characteristics proved difficult to establish during Corrigan's field investigation, these areas may fall under USACE jurisdiction by way of the CWA.

Two saltwater tidal pools occur south of State Highway 87 and east of Rollover Pass (Appendix C, Figure 1). The eastern tidal pool occurs outside of the construction boundary and most of the western tidal pool (0.42 acre) lies within the construction boundary (Figure 3). A review of pre- and post-Hurricane Ike aerial photographs show that the Category II hurricane created these features. Prior to the impact, houses and parking areas existed where the tidal pools currently occur. The tidal pools contain storm-generated debris and do not support vegetation or other significant biological communities. A review of aerial photographs from 2007 – 2009 indicate that the tidal pools are naturally filling over time. However, Corrigan's field investigation suggests that the tidal pools currently occur at or below the annual high tide line and likely fall under USACE jurisdiction through the CWA and RHA.

3.2 FISH AND WILDLIFE RESOURCES

Natural communities in the vicinity of Rollover Pass comprise a complex of estuarine habitats including vegetated estuarine marsh, intertidal sand and mud flats, oyster reefs, and subtidal mud and sand estuarine bottom. These productive habitats support a wide range of fish and wildlife species during various life cycle stages.

Colonial shorebirds and waterbirds use the vegetated marshes, oyster reefs, and intertidal flats for foraging and resting. Species that commonly occur in the project vicinity include American white pelican (*Pelecanus eryhtrorhynchos*), brown pelican (*Pelecanus occidentalis*), laughing gull (*Larus atricilla*), royal tern (*Sterna maxima*), Forster's tern (*Sterna forsteri*), Caspian tern (*Sterna caspia*), black skimmer (*Rynchops niger*), roseate spoonbill (*Ajaia ajaja*), Wilson's plover (*Charadrius wilsonia*), snowy plover

(*Charadrius alexandrinus*), American avocet (*Recurvirostra americana*), black-necked stilt (*Himantopus mexicanus*), American oystercatcher (*Haematopus palliates*), willet (*Catotrophorus semipalmatus*), great blue heron (*Ardea herodias*), little blue heron (*Egretta caerulea*), tricolored heron (*Egretta tricolor*), great egret (*Ardea alba*), snowy egret (*Egretta thula*), and reddish egret (*Egretta rufescens*). Piping Plover?

The United States Fish and Wildlife Service (USFWS) Texas Colonial Waterbird Census identifies the spoil islands adjacent to Rollover Bay and the GIWW as a significant rookery. Since 1973, the USFWS has attempted to count colonial waterbird nesting pairs within all of the colonies along the Texas coast. Species that have recently (1995-2006) nested on the Rollover Bay spoil islands include American oystercatcher, black-crowned night heron, cattle egret, Forster's tern, great blue heron, great egret, laughing gull, neotropic cormorant (*Phalacrocorax brasilianus*), olivaceous cormorant (*Phalacrocorax olivaceus*), reddish egret, roseate spoonbill, snowy egret, tricolored heron, and white ibis.

The Galveston Bay estuarine environments provide valuable habitat for a variety of commercially and recreationally important fisheries including fish, shrimp, and crabs. The Galveston Bay finfish and shellfish harvest constitutes approximately one-third of the State total. Most of the commercial finfish catch (~75%) comprises consists of mullet (*Mugil* spp.), black drum (*Pogonias cromis*), sheepshead (*Archosargus probatocephalus*), and southern flounder (*Paralichthys lethostigma*). White and brown shrimp (*Penaeus setiferus* and *Penaeus aztecus*), blue crabs (*Callinectes sapidus*), and eastern oysters (*Crassostrea virginica*) account for most (>99%) of the shelfish catch (Kennish, 2000). In addition to the primary commercial species, recreationally important fish species include Atlantic croaker (*Micropogonias undulatus*), sand seatrout (*Cynoscion arenarius*), spotted seatrout (*Cynoscion nebulosus*), and red drum (*Sciaenops ocellatus*). The shallow water, vegetated marshes, oyster reefs, and shorelines provide important nursery areas for juvenile fishes and feeding grounds for adult species.

Oyster reefs provide important ecological, hydrological, and commercial functions within the Galveston Bay estuary. A significant fraction of U.S. oyster production comes from Galveston Bay (Quast et al. 1988). Oysters are often considered a "keystone species", providing valuable cover and habitat for other organisms, improving water quality, and reducing bank erosion. Oysters are fairly tolerant organisms and can withstand wide variations in environmental conditions including temperature, salinity, dissolved oxygen, and turbidity. Natural oyster reefs of the eastern oyster generally fall within a salinity range from 10 – 30 ppt (Berrigan et al. 1991). Wilson et al. (2005) identify an optimal salinity range of 10 – 28 ppt for eastern oyster growth and reproduction.

3.3 ESSENTIAL FISH HABITAT

In 2005, the United States Congress enacted amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) that establish procedures for identifying Essential Fish Habitat (EFH) and interagency coordination requirements to further the conservation of Federally-managed fisheries. The National Marine Fisheries Service (NMFS) published rules (50 CFR Sections 600.805-600.930) that require any Federal agency that authorizes; funds or undertakes; or proposes to authorize, fund, or undertake an activity which could adversely affect EFH is subject to the consultation provisions of the MSFCMA, and identify consultation requirements. This EA serves to initiate EFH consultation with NMFS under the MSFCMA. The NMFS will review this EA and provide comments pertinent to EFH impacts.

The MSFCMA defines EFH as "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity." Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery

and the managed species' contribution to a healthy ecosystem; and spawning, breeding, feeding, or growth to maturity covers a species' full life cycle (EFH Interim Final Rule, 62 FR 66531). The Gulf of Mexico Fishery Management Council (GMFMC) has identified EFH in the project region for the following fishery management plans: red drum, reef fish, coastal migratory pelagics, shrimp, and stone crab. The estuarine areas of East and Rollover Bays contain EFH for the red drum, shrimp, and coastal migratory pelagics fishery management plans. In the project vicinity, the GMFMC identifies estuarine EFH for the following species: brown shrimp, white shrimp, Spanish mackerel (*Scomberomorus maculatus*), and red drum.

Depending on life stage, brown shrimp are pelagic or demersal and occur in offshore waters and estuaries. In Texas, brown shrimp spawn in the Gulf of Mexico in water depths ranging from about 150 to 300 feet. Brown shrimp larvae occur offshore and begin to migrate to estuaries as postlarvae. Postlarvae migrate through passes on flood tides primarily from February – April. In estuaries, brown shrimp postlarvae and juveniles most commonly occur in shallow vegetated habitats, but also inhabit silty sand and non-vegetated mud bottoms. The highest density of late postlarvae and juveniles occurs within marsh edge habitat and submerged vegetation, followed by tidal creeks, inner marsh, shallow open water, and oyster reefs. Postlarvae and juveniles can tolerate a broad salinity range. As brown shrimp grow from juveniles to sub-adults, they begin to feed more on detritus and benthic organism such as polychaete worms and amphipods. Sub-adults migrate from the estuaries to the offshore waters at night during ebb tides. Adult brown shrimp live in neritic (low tide mark to edge of continental shelf) Gulf waters and associate with silt, muddy sand, and sandy substrates. (GMFMC, 1998)

Similar to brown shrimp, white shrimp eggs and larvae are planktonic and occur in offshore waters. During the postlarval stage, white shrimp migrate into estuaries primarily from May – November. Once in the estuaries, postlarvae prefer shallow water with muddy-sand bottoms high in organic detritus or vegetated marsh to develop into juveniles. Juveniles are common to highly abundant in the Galveston Bay estuary during all seasons of the year. Marsh edges and submerged aquatic vegetation typically hold the highest densities followed by marsh ponds and channels, inner marsh, and oyster reefs. Juveniles prefer lower salinities (less than 10 ppt) and frequently inhabit tidal rivers and tributaries. Sub-adult white shrimp migrate from the estuaries to Gulf waters to mature and spawn. Migration generally occurs in late August and September. Demersal, adult white shrimp typically inhabit the soft silt or mud bottoms of the relatively shallow (less than 100 feet) nearshore Gulf waters. (GMFMC, 1998)

A pelagic species, the Spanish mackerel occurs in depths up to 250 feet throughout the coastal zone of the Gulf of Mexico. Adult Spanish mackerel spawn offshore over the inner continental shelf from May – October. Larvae also spend most of their time offshore in depths less than 150 feet. Juveniles inhabit the nearshore and estuaries. Juveniles commonly occur within the Galveston Bay estuary from April – October. Adults typically occur in neritic waters and along coastal areas. Adults may inhabit high salinity areas of estuaries during seasonal migrations, but these occurrences are generally rare. (GMFMC, 1998)

In the Gulf of Mexico, red drum occur in a variety of habitats ranging from shallow estuarine waters to water depths up to 130-feet deep offshore. The species commonly occurs in virtually all of the Gulf estuaries and is associated with various substrates including sand, mud, and oyster reefs. Red drum can tolerate a broad spectrum of salinities ranging from near freshwater to highly saline. Red drum spawn during the late summer and early fall near mouths of bays and inlets within estuaries or in nearshore coastal waters. Newly hatched red drum spend about 20 days in the water column before becoming demersal. Small juvenile red drum seek out and inhabit rivers, bays, canals, tidal creeks, boat basins, and passes within estuaries. Subadults are found in these habitats and in large aggregations over seagrass beds, oyster reefs, mud flats, or sand bottoms. Adult red drum use estuaries, but mostly inhabit the nearshore shelf waters. (GMFMC, 1998)

The Rollover Pass project vicinity includes a variety of habitats designated as EFH for these species. These include estuarine and marine water column, saltwater marsh, mud and sand intertidal flats, oyster reefs, and unvegetated sand and mud bottom.

3.4 PROTECTED SPECIES

The project area lies within the coastal area of Galveston County, Texas. The U.S. Fish and Wildlife Service (USFWS) and the NMFS identified the threatened and endangered species listed in Table 1 as likely occurring in Galveston County. Of the species listed in Table 1, the piping plover and the five species of sea turtles are most likely to occur in the project vicinity. Due to lack of suitable habitat, known range limits, or presumed extinction (i.e. Eskimo curlew), the other species listed in Table 1 are not likely to occur in the project vicinity.

Three piping plover critical habitat units — TX-35, TX-36, and TX-37 — occur in the vicinity of the proposed project. Units TX-35 and TX-36 occur adjacent to Galveston Inlet near the entrance to the Gulf of Mexico. Unit TX-37 occurs north of Rollover Pass and includes the intertidal areas of Rollover Bay. The USFWS provides the following unit descriptions:

<u>TX-35: Big Reef. 47 ha (117 ac) in Galveston County</u>

This unit consists of beach and sand flats on the north, west, and east shore of Big Reef, down to MLLW. South Jetty is not included. The area is currently managed by the City of Galveston. This unit includes the lands known as wind tidal flats that are infrequently inundated by seasonal winds.

<u>TX-36: Bolivar Flats. 160 ha (395 ac) in Galveston County</u>

This unit extends from the jetties on the southwest end of the Bolivar Peninsula to a point on the Gulf beach 1km (0.6 mi) north of Beacon Bayou. It includes 5.0 km (3 mi) of Gulf shoreline. The landward boundary is the line indicating the beginning of dense vegetation, and the gulfside boundary is MLLW. The area is leased from the TGLO by Houston Audubon Society and managed for its important avian resources. The upland areas are used for roosting by the piping plover. This unit includes lands known as wind tidal flats that are infrequently inundated by seasonal winds.

<u>Unit TX-37: Rollover Pass 6 ha (16 ac) in Galveston County</u>

This unit consists of Rollover Bay on the bayside of Bolivar Peninsula. The landward boundary is the line indicating the beginning of dense vegetation, and the bayside boundary is MLLW. It includes flats on State-owned land managed by the TGLO. This unit captures the intertidal complex of the Bay, and is bounded by the Town of Gilchrist to the east and the Gulf beach of the Bolivar Peninsula to the south. This unit includes lands known as wind tidal flats that are infrequently inundated by seasonal winds.

The Biological Assessment (BA), Appendix D of this EA, discusses threatened and endangered species in detail, identifies potential project impacts on the species, and provides protection and conservation recommendations. The BA fulfills USACE requirements under Section 7(c) of the Endangered Species Act of 1973 (ESA), as amended, and will assist the USFWS and the NMFS in fulfilling their obligations under the ESA.

Table 1 Federally-Listed Threatened and Endangered Species Occurring in Galveston County, Texas

Common Name	Scientific Name	Listing Status	
		USFWS	NMFS
BIRDS			
Eskimo curlew	*Numenius borealis*	Endangered	-
Attwater's greater prairie-chicken	*Tympanuchus cupido attwateri*	Endangered	-
Piping plover	*Charadrius melodus*	Threatened	-
MAMMALS			
Blue whale	*Balaenoptera musculus*	-	Endangered
Finback whale	*Balaenoptera physalus*	-	Endangered
Humpback whale	*Megaptera novaeangliae*	-	Endangered
Sei whale	*Balaenoptera borealis*	-	Endangered
Sperm whale	*Physeter macrocephalus*	-	Endangered
REPTILES			
Green sea turtle	*Chelonia mydas*	Threatened	Threatened
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened	Threatened
FISH			
Smalltooth sawfish	*Pristis pectinata*	-	Endangered

Sources: (USFWS website: http://www.fws.gov/southwest/es/EndangeredSpecies/lists/ListSpecies.cfm accessed December 2009 and NOAA/NMFS website: http://sero.nmfs.noaa.gov/pr/pdf/Texas.pdf accessed December 2009)

3.5 WATER QUALITY

Rollover Pass lies adjacent to the GIWW, the southeastern portion of East Bay, and the Gulf of Mexico. The Texas Commission on Environmental Quality (TCEQ) classifies all three of these water bodies and identifies the GIWW as Segment 0702 (Neches-Trinity Coastal Basin), East Bay as Segment 2423 (Bays and Estuaries category), and the Gulf of Mexico as Segment 2501 (Gulf Waters category). The GIWW, East Bay, and Gulf of Mexico water body uses include aquatic life use, fish consumption use, general use, oyster waters use (East Bay only), and recreation use. The TCEQ 2008 Texas Water Quality Inventory indicates these water bodies fully support all uses with the exceptions listed in Table 2.

Table 2 2008 Texas Water Quality Inventory Data

Parameter	Assessment Area ID	Assessment Area Description	Support Level
East Bay – General Use			
Chlorophyll-a	2423-02	Segment area not adjacent to GIWW	Concern for screening level
East Bay – Oyster Waters Use			
DSHS Shellfishing Restrictions	2423-01	Segment area adjacent to GIWW	Non-supporting
DSHS Shellfishing Restrictions	2423-OW1	East end of Bay adjacent to GIWW and East Bay Bayou	Non-supporting
Gulf of Mexico – Fish Consumption Use			
Mercury	2501-02	Jefferson-Chambers County line area	Non-supporting
Mercury	2501-03	Bolivar Point to San Louis Pass area	Non-supporting

3.6 WATER SALINITY

Taylor Engineering, Inc. calibrated RMA2 and RMA4 models of Galveston and Rollover Bays based on the TxBLEND Model and tidal stage, current velocity, and salinity data collected by Taylor Engineering from July to September 2009. The model domains (extents) included Galveston Bay, Rollover Bay, portions of the GIWW, Galveston Inlet, Rollover Pass, a portion of the Gulf of Mexico and freshwater input from Buffalo Bayou, San Jacinto River, Cedar Bayou, and Trinity River. The models incorporated bathymetric survey data collected by Naismith Marine Services from August 6 - 21, 2009.

The RMA2 model provided a solution to the hydrodynamic conditions and the RMA4 model applied this solution to determine the circulation and mixing of saline water and freshwater throughout the system. The calibration adequately reproduced the measured tidal stage, current, and salinity data.

The model results indicate that spring and summer average salinities range from about 16 – 22 ppt within the eastern portion of East Bay and from about 22 – 28 ppt within Rollover Bay. During the fall and winter seasons, average salinities increase with decreased freshwater inflow and range from about 21 – 26 ppt within the eastern portion of East Bay and from 27 – 32 ppt within Rollover Bay.

3.7 AIR QUALITY

In compliance with the Clean Air Act of 1970 (CAA) and 1990 Amendments, the U.S. Environmental Protection Agency (EPA) has developed National Ambient Air Quality Standards (NAAQS) for pollutants to protect public health and the environment. The EPA Office of Air Quality Planning and Standards has set NAAQS for six principal pollutants, termed "criteria" pollutants. These include carbon monoxide, lead, nitrogen dioxide, particulate matter, ozone, and sulfur dioxide.

The project area locates in Galveston County, Texas and falls within an area the EPA designates as the Houston-Galveston-Brazoria Intrastate Air Quality Control Region (HGB). The HGB is in attainment or unclassified with the NAAQS for all criteria pollutants except ozone. On October 31, 2008, the EPA reclassified the HGB from a “moderate” to a “severe” nonattainment area for the 1997 8-hour ozone NAAQS. For severe nonattainment areas, the CAA established *de minimus* threshold levels of 25 tons per year each for volatile organic compounds (VOC) and nitrogen oxide (NOx) emissions (ozone precursors). The State of Texas has until April 15, 2010 to submit a revised State Implementation Plan (SIP) to address severe ozone nonattainment requirements of the CAA. SIPs describe the State’s strategy for meeting clean air quality standards and CAA requirements.

3.8 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

Preparation of this EA included a preliminary assessment of hazardous, toxic, and radioactive waste (HTRW) for the proposed project. The assessment aimed to identify known and potentially unknown HTRW sites in the project vicinity that could pose a threat to the environment or endanger human health. The preliminary assessment methodology included a review of historical aerial photographs and a State and Federal regulatory database search. Environmental Data Resources, Inc. (EDR) provided the State and Federal regulatory records. The EDR records search did not identify any facilities or sources of contamination in the Federal or State ASTM standard databases. In addition, a review of historical aerials dating back to the 1930s-1940s (exact date unknown) did not identify any potential hazardous substances or petroleum product concerns for the project vicinity. The results of the preliminary HTRW assessment do not warrant further investigation.

3.9 NOISE

Pursuant to the Noise Control Act of 1972 as amended by the Quiet Communities Act of 1978, the EPA has developed noise level guidelines for the purpose of protecting citizens from potential hearing loss and other adverse effects associated with noise. The EPA generally recognizes an average day-night noise level (Ldn) of less than 50 decibels a weighting (dBA) in rural areas and between 55 and 60 dBA for urban areas (EPA, 1978). Hearing loss could result if the average outdoor noise level is in excess of 70 dBA or more for 24 hours over a 40-year period (EPA, 1974). Several factors affect one's response to noise levels including background noise level, noise composition, noise level fluctuation, time of year, time of day, history of exposure, community tolerance, and emotional factors. In general, people tend to tolerate a given noise better if the background level is close to the level of the new noise source. Additionally, noise tolerance generally decreases at night when ambient noise typically diminishes and one's sound awareness increases. Residents tend to have greater tolerance for a noise-generating activity if the activity benefits the economic and social well-being of the community. Prior to Hurricane Ike making landfall in 2008, the project area exhibited urban environmental qualities with ambient noise levels greater than that of a rural setting. Noise sources included vehicular traffic on local roads, construction activities in the area, and commercial and residential activities. However, Hurricane Ike resulted in almost complete loss of residential and commercial buildings and substantial loss of supporting infrastructure. Damage associated with Hurricane Ike substantially reduced the sources of ambient noise in the project area. The current project area ambient noise level more closely resembles a rural environmental condition.

3.10 CULTURAL RESOURCES

Coordination with the Texas State Historic Preservation Officer (SHPO) regarding the proposed project has occurred. A letter from the SHPO dated August 6, 2009 (Appendix E) indicates that the closure of Rollover Pass will have no adverse impacts on submerged historic resources. Further coordination with the SHPO regarding the proposed borrow area is ongoing.

3.11 RECREATION RESOURCES

Recreation resources within the project vicinity are primarily water dependent and include activities such as fishing, boating, and wildlife viewing. Rollover Pass and the East Bay area provide excellent fishing opportunities for a broad range of fish species including flounder, red drum, shark, speckled sea trout, and croaker. Over the years, Rollover Pass has become a nationally-recognized fishing destination visited by thousands of anglers annually.

3.12 AESTHETIC RESOURCES

Aesthetic resources are those natural and cultural features of the environment that elicit a pleasurable response in the observer, most notably through visual perception. Consequently, aesthetic resources are commonly referred to as visual resources, i.e., features that can be seen. Historically, the project vicinity offered views of the Gulf of Mexico beaches, the estuarine marshes and waters of Rollover and East Bays, and the small, coastal community of Gilchrist, Texas. Hurricane Ike in 2008 caused severe coastal erosion and property damage in the project vicinity. The Category 2 (at time of landfall) hurricane decimated the Gilchrist community and leveled nearly all of the residential and commercial structures. The Gulf and inshore natural environments still offer pleasurable views. The Hurricane dramatically altered the upland environment, removing most signs of human habitation except for building pads and roads. Property owners are slowly rebuilding, although a Federally-funded property buyout program will likely result in fewer permanent residents. These ongoing changes will permanently alter aesthetic resources in the vicinity of the proposed project.

3.13 COASTAL BARRIER RESOURCES

In 1982, Congress signed the Coastal Barrier Resources Act (CBRA) prohibiting Federal expenditures (direct or indirect) for development of designated undeveloped coastal barriers and their associated aquatic habitat, including wetlands, estuaries, and inlets. The three primary goals of CBRA include:

1. Minimize loss of human life by discouraging development in high risk areas
2. Reduce wasteful expenditure of Federal resources
3. Protect the natural resources associated with coastal barriers

The proposed project boundaries lie outside of any Coastal Barrier Resource System (CBRS) map unit. Two map units — T02A (High Island) and T03A (Bolivar Peninsula) — occur in the project area vicinity. CBRS unit T02A lies approximately 2.6 miles northeast of the project area. CBRS unit T03A lies approximately 2.7 miles southwest of the project area.

3.14 SOCIOECONOMICS

Tourism related to recreational fishing from the shorelines of Rollover Pass provides an important socioeconomic component of Gilchrist, Texas. Rollover Pass has become a nationally-recognized fishing hotspot with thousands of anglers visiting the Pass each year. Tourism associated with fishing and fishing-related activities likely serve as a primary source of income for businesses in the Gilchrist community. Hurricane Ike and its catastrophic impacts have undoubtedly resulted in a decrease in the amount of tourists visiting the Rollover Pass vicinity; however, the fishing resources of Rollover Pass and East Bay remain a primary attraction to the area.

3.15 ENVIRONMENTAL JUSTICE

In compliance with Executive Order 12898, Federal Action to Address Environmental Justice in Minority and Low-Income Populations, this EA includes an analysis to determine whether the proposed project will have a disproportionately adverse impact on minority or low-income population groups in the vicinity of the proposed project. Low-income persons include those persons whose household income is at or below the U.S. Department of Health and Human Services (HHS) poverty guidelines. The 2009 HHS poverty guideline for a single person is $10,830 and $22,050 for a family of four (HHS, 2009).

The U.S. Census Bureau (USCB) publishes population estimates between censuses based on the last decennial census (2000 in this case). Galveston County's 2008 population, based on USCB estimates, comprised 288,239 individuals living in 106,920 homes. The racial makeup of the county was 80.8% white, 14.4% African American, 2.8% Asian, 0.54% Native American, 0.1% Pacific Islander, and 1.3% from two or more races. Within these groups, approximately 21.5% of the population was of Hispanic descent (USCB, 2009a). The median household income for Galveston County in 2008 was $55,995 with 13.1% of individuals living below the poverty line (USCB, 2009b and 2009c).

The project area occurs in the community of Gilchrist, Texas within zip code 77617. Information from the 2000 census indicates that the Gilchrist population totals 508 individuals living in 251 homes. The racial makeup of Gilchrist is 96.1% white, 0.6% black, 0.4% Native American, 0.4% Asian, 0.8% other, and 1.8% from two or more races. Within those groups, individuals of Latin American descent comprise 1.8% of the population. The median household income for Gilchrist in 2000 (in 1999 dollars) was $30,114 with approximately 16.4% of individuals living below the poverty line (USCB, 2009d).

3.16 NAVIGATION

Rollover Pass lies adjacent to the GIWW, a channel maintained by the USACE Galveston District for commercial barge traffic. Recreational and commercial boaters also commonly use the GIWW, Rollover Bay, and East Bay for fishing, shrimping, wildlife viewing, and cruising. The Texas Game and Fish Commission, now TPWD, did not design the Pass as a navigable channel between the GIWW and the Gulf of Mexico. Due to strong currents and a weir system, Rollover Pass does not permit navigation of any vessels from the Gulf of Mexico to the inshore waters.

4.0 ENVIRONMENTAL EFFECTS

4.1 WETLANDS AND VEGETATION

4.1.1 No-Action

The No-Action alternative would not affect wetland habitats or vegetation.

4.1.2 Rollover Pass Closure (Preferred Alternative)

Rollover Pass closure would result in the direct filling of the artificial Pass itself, totaling 7.24 acres, and approximately 0.42 acre of a 0.45-acre tidal pool that occurs south of the State Highway 87 Bridge and east of the Pass (Figure 3). As described in Section 3.1, the tidal pool feature formed as a result of Hurricane Ike in 2008. Prior to the hurricane, upland features including houses and parking areas occupied the tidal pool site. The unvegetated tidal pool contains storm-generated debris and does not support a significant biological community. A review of aerial photographs from 2008 and 2009 in addition to visual observation in February 2010 suggest that the tidal pools are naturally filling in over time due to long- and cross-shore sand transport. Based on this information, the proposed fill activity expedites the natural filling process.

Additional project impacts include the loss of disturbed, low quality vegetation within the higher areas of the proposed borrow site (DMPA immediately north of the GIWW west of Rollover Pass). Corrigan Consulting, Inc. generally described elevations within the DMPA as 20 to 30 feet above sea level and vegetation communities as ruderal (Appendix B). Depending on the final borrow site elevations following spoil removal, the site may provide suitable conditions for recruitment of estuarine marsh species such as cordgrasses (*Spartina* spp.) that are abundant to the area.

Temporary disturbance to low marsh vegetation, primarily smooth cordgrass, would occur where the dredge pipeline crosses into the DMPA. The low marsh occurs as a narrow band in front of the articulated concrete mats that protect Goat Island's south shoreline. Intermittent stretches of unconsolidated shoreline occur within this low marsh community. As much as practicable, the contractor would lay the pipeline through areas devoid of marsh vegetation to minimize disturbance. A hearty and aggressive species, smooth cordgrass would likely recover quickly from unavoidable, project-related disturbance.

Results of Taylor Engineering's salinity modeling study indicate that closing Rollover Pass would moderately reduce salinities within Rollover Bay and would have a lesser effect on the eastern portion of East Bay. In the closed Pass condition, the model predicts equilibrated salinity concentrations that fall within the natural salinity tolerance range of the dominant, tidally-influenced vegetation communities currently occurring in the project vicinity. These results suggest that closing Rollover Pass would not have a significant impact on vegetation community structure in the project vicinity. Sections 3.6 and 4.6 of this EA provide a brief summary of the salinity modeling results. Appendix F contains Taylor Engineering's detailed modeling study report.

4.2 FISH AND WILDLIFE RESOURCES

4.2.1 No-Action

Under the No-Action alternative, the GIWW in the vicinity of Rollover Bay would continue to require annual maintenance dredging to maintain safe navigation depths. Each annual dredging event results in temporary, localized increases in turbidity and disturbance to fish and wildlife during dredging operations. These dredging events also result in short-term loss of non-motile benthic species within the dredging template.

4.2.2 Rollover Pass Closure (Preferred Alternative)

Dredging and material placement associated with Pass closure would temporarily affect water quality during construction. Dredging activities would produce short-term, localized increases in turbidity in the project area. However, these elevated turbidity levels should not significantly affect organisms inhabiting the project area. Given the naturally dynamic environmental characteristics of the estuary, organisms inhabiting the project area adapt well to reasonable environmental changes such as moderate increases in turbidity. Fish and other mobile species may temporarily leave the project area if turbidity becomes too great. Construction disturbance such as noise and equipment movement may also drive fish and wildlife from the project vicinity during construction. These species would likely relocate to other suitable habitats that are abundant to the area. Implementing best management practices (BMPs) and protective measures would minimize any potential adverse effects related to elevated turbidity. Prior to construction, the contractor would prepare and submit an environmental protection plan detailing the best management practices, protective measures, and a monitoring program that the contractor would implement during construction to minimize impacts to fish and wildlife.

Filling the Pass will result in the permanent loss of the benthic community within the Pass footprint. Subtidal sand and mud bottom habitat is abundant in the area and this loss is not expected to cause significant impacts to fish and wildlife that use the habitat for foraging and cover.

After closure, the Pass would no longer provide fish and aquatic organisms direct access to and from the Gulf of Mexico and the Galveston Bay estuary. These organisms would primarily rely on Galveston Inlet (Houston Ship Channel) and San Luis Pass for access to Galveston Bay. Since Rollover

Pass is a man-made inlet, closing the Pass would help restore a more natural hydrologic condition. Pass closure should not significantly affect life-history functions associated with estuarine conditions.

Closing Rollover Pass would alter the salinity regime in Rollover Bay and the eastern portion of East Bay. It would reduce inflows from the Gulf of Mexico, thus increasing the influence of freshwater inflows from Oyster Bayou and less saline waters farther west in East Bay. This change may have both positive and negative effects on fish and wildlife resources. This EA focuses on oysters, a representative keystone species in East Bay. Numerous past studies have documented oyster effects with respect to changes in salinity. This EA also discusses potential effects of salinity changes on a few representative recreational fish species as indicators of likely impacts.

Oyster reefs comprise a key ecological component of the Galveston Bay estuarine system. This habitat supports dense biological communities that are used by wide variety of wildlife resources (invertebrates, fishes, and birds). Oyster reefs in East Bay tend to occur in areas generally characterized by low- biomass benthic communities living in the muddy substrate, and serve as focal points for biological and ecological activity. Pattillo et al. (1995) provided a concise literature review of oyster reef ecology, documenting that:

- The distribution of oysters is profoundly influenced by salinity patterns which change either from natural or anthropogenic events.
- A variety of vertebrates and invertebrates heavily use oyster reefs as food sources and refuges from predation.
- Both high- and low-salinity events can have serious repercussions on the distribution of organisms that inhabit the oyster reef habitat. When salinity increases for long periods, high oyster mortality can result from increased numbers of stenohaline predators and parasites invading the reef.
- In response to higher salinities, the highest concentration of oyster reefs may shift over time to upper Bay areas.
- In the upper estuary, oysters and the organisms living on oyster reefs are much more susceptible to freshwater kills, runoff pollution, and siltation due to their proximity to sources of freshwater input. Periodic freshets are needed to control detrimental organisms invading the reef and to maintain health.
- Extended freshwater periods may cause oysters to perish from osmotic stress or starvation.

Pattillo et al. (1995) also note that the cumulative effects of even small changes in estuaries may affect the total system. The closure of Rollover Pass will eliminate at least one historic change and provide salinity conditions more favorable for oysters. Oyster densities in the East Bay project area are relatively low compared to oyster densities farther west in East Bay, and in parts of Galveston Bay and West Bay (Buzan et al. 2009). The interaction of available hard substrate and salinity may strongly influence the distribution of oysters in East Bay (Klinck et al. 2002) and their relative paucity in the project vicinity.

Freshwater inflows to Galveston Bay are positively correlated with oyster abundance (as measured by harvest quantities – Buzan et al. 2009). Dekshenieks et al. (2000) reported results of a modeling study simulating effects of environmental changes on oyster populations. The study found that:

> The simulated patterns suggest that several areas of Galveston Bay are capable of supporting viable oyster fisheries: central Galveston Bay, central East Bay, the Pelican Island Embayment, Dickinson Bay, lower Clear Lake, and the ship channel reaches off Dickinson Bay and lower Clear Lake. With the exception of the Pelican Island

Embayment, these regions, many of which are adjacent to or are part of the ship channel where mixing and water exchange are greater, are characterized by moderate to high flow rates and seston levels, as well as moderate salinities.

Increased oyster success correlated with periods of high freshwater inflows and decreases in salinity from 11 – 23 ppt to 3 – 15 ppt. The report also summarized other studies reporting most successful oyster recruitment within a salinity range of 17 – 24 ppt (Dekshenieks et al. 2000).

In a related article using the same model described in Dekshenieks (2000), Klinck et al. (2002) concluded that widening of the Houston Ship Channel would moderate (slightly increase) salinities and result in improved oyster habitat and abundance. They related this finding to the fact that the "hard substrate required for oyster growth" was not "in equilibrium" with the salinity conditions created by the existing ship channel in the 1990s. The study suggested that the proposed ship channel widening would expand the salinity gradient and create more favorable salinity conditions for oysters in areas with hard substrate, thus creating similar conditions when the oysters were more abundant.

Turner (2006) reached a different conclusion concerning major freshwater inputs and oyster abundance in estuaries of the Gulf of Mexico. He found that major increases in freshwater inputs (measured as annual riverine discharges) decreased oyster abundance (as measured by harvested amounts) and that major freshwater inputs were negatively correlated to oyster abundance. However, Oyster Bayou, the freshwater input to East Bay, is relatively small and would not likely exert the same level of influence as Turner considered in his analysis of major river estuaries.

Substrate in addition to high salinities may limit oyster production in East Bay and Rollover Bay. While the closure of Rollover Pass will not alter substrate availability, it will likely produce salinities at least slightly more amenable to the survival and growth of oysters in the affected area. Powell et al. (2003) noted "if a rule of thumb exists for oysters and freshwater inflow, it is that a reduction in freshwater inflow or an increase in saltwater intrusion will result in a reduction in oyster production because increased salinity increases the rate of oyster mortality from predation and disease."

Observations concerning the development of the fishery in Rollover Pass and analysis of size distributions of two species (Reid 1957 and Reid 1958, respectively) suggest that Pass opening and partial closure had relatively little influence on the fish community. Reid (1957) noted, "Rollover Pass was faunistically rich" (in 1956) and that …"fishing pressure was considerable…" This suggests that the existing fish populations in the Gulf of Mexico and East Bay found and used the Pass rather than gradually developing in response to construction of the Pass.

Reid (1958) also considered effects of the Pass on distribution of fish sizes. He found that across East Bay, size distributions of Atlantic croaker (*Micropogon undulatus*) and spot (*Leiostomus xanthurus)* shifted with the changes in salinity he recorded between 1954 and 1956. He concluded, "salinity *per se* is not the cause of the size distribution cline of the two species studied. This conclusion is based primarily on the fact that the original natural estuarine distribution pattern was maintained during two seasons in which the salinity gradient within the estuary was essentially reversed."

Glass et al. (2008) reported that southern flounder (*Paralichthys lethostigma*) juvenile numbers correlated to adjacency to passes. The article noted that the greater numbers of juveniles collected just offshore of Goat Island's north shore (compared to other locations they sampled) may have reflected the adjacency of two passes (Rollover Pass to the east and Galveston Inlet to the west). Thus, closure of Rollover Pass may reduce juvenile flounder populations to those more similar to other sampled areas (Galveston Bay, East Bay, and West Bay). However, they also concluded, "The observed differences in

density among Bays were correlated with salinity and proximity to inlets." Salinity reductions farther east in East Bay should have a beneficial effect on flounder recruitment.

Pattillo et al. (1995) provided a synoptic review of salinity requirements of selected Gulf of Mexico invertebrates and vertebrates. The study reported that southern flounder juveniles are adjusted to a wide range of salinity (2 – 25 ppt), as is Atlantic croaker (5 – 26 ppt), red drum (5 – 25 ppt), spot (10 – 20 ppt), sand seatrout (8 – 25 ppt), and a variety of other recreational and commercial species. Based on data from Pattillo et al. (1995), salinity changes due to Rollover Pass closure will not significantly impact juveniles of a wide variety of fish species. In some cases, species may benefit from the slightly reduced salinity regimes.

In summary, the salinity changes in East Bay and Rollover Bay following Pass closure should not adversely impact and may benefit fish and wildlife resources. Most estuarine species are adaptable to the highly dynamic environmental conditions exhibited within estuarine ecosystems.

4.3 ESSENTIAL FISH HABITAT

4.3.1 No-Action

Under the No-Action alternative, the need for annual maintenance dredging of the GIWW in the vicinity of Rollover Bay would continue. Each annual dredging event results in temporary, localized increases in turbidity in the vicinity of the borrow and placement sites during dredging operations. These dredging events also result in short-term loss of the benthic community within the dredging template.

4.3.2 Rollover Pass Closure (Preferred Alternative)

Dredging and material placement associated with Pass closure would temporarily affect water quality during construction. Dredging activities would produce short-term, localized increases in turbidity in the project area. However, these elevated turbidity levels should not significantly affect organisms inhabiting the project area. Given the naturally dynamic environment characteristic of the estuary, organisms inhabiting the project area adapt well to reasonable environmental changes such as moderate increases in turbidity. Fish and other mobile species may temporarily leave the project area if turbidity becomes too great. Construction disturbance such as noise and equipment movement may also drive fish and other species from the project vicinity during construction. These species would likely relocate to other suitable habitat that is abundant to the area. Implementing BMPs and protective measures would minimize any potential adverse effects related to elevated turbidity. Prior to construction the contractor would prepare and submit an environmental protection plan detailing the BMPs, protective measures, and monitoring program that the contractor would implement during construction to minimize impacts to water quality.

The results of Taylor Engineering's hydrodynamic and salinity modeling study (Appendix F) indicate that Pass closure would not significantly affect estuarine marsh essential fish habitat due to changes in salinity. The greatest salinity change would occur within Rollover Bay. The predicted salinities following Pass closure fall within the tolerance range of the dominant estuarine marsh species within the project area; therefore, the vegetation community structure should remain intact.

The project may result in creation of additional essential fish habitats, particularly within Rollover Bay. Reduced salinities within the Bay may promote development of additional oyster communities. In addition, closing Rollover Pass would reduce current velocities within Rollover Bay. Reduced current velocities may promote development of additional intertidal sand and mud flat essential fish habitat.

4.4 THREATENED AND ENDANGERED SPECIES

4.4.1 No-Action

The No-Action alternative may adversely affect threatened and endangered species by reducing the available nesting habitat for sea turtles and foraging and resting habitat for shorebirds such as the piping plover. Leaving the Pass open would continue to affect the natural longshore sediment transport in the area by intercepting and depositing sediments within Rollover and East Bays. This process effectively diminishes the natural sediment supply to downdrift beaches and accelerates erosion along the Bolivar Peninsula.

4.4.2 Rollover Pass Closure (Preferred Alternative)

The BA (Appendix D) provides a complete evaluation of the potential project-related impacts to Federally-listed threatened and endangered species. The BA concludes that the proposed project may effect, but is not likely to adversely affect the piping plover, Kemp's ridley sea turtle, and loggerhead sea turtle. The BA recommends protection and conservation measures to avoid and minimize potential impacts to these protected species. The GLO will implement all recommended species monitoring protocols in accordance with the permit special conditions.

4.5 WATER QUALITY

4.5.1 No-Action

Under the No-Action alternative, the need for annual maintenance dredging of the GIWW in the vicinity of Rollover Bay would remain. Each annual dredging event results in temporary, localized increases in turbidity during dredging operations in the vicinity of the borrow and placement sites.

4.5.2 Rollover Pass Closure (Preferred Alternative)

Construction of the proposed project would result in temporary, localized increases in turbidity during dredging operations in the immediate vicinity of the borrow and placement sites. Implementing BMPs and protective measures would minimize any potential adverse effects related to elevated turbidity. Prior to construction the contractor would prepare and submit an environmental protection plan detailing the BMPs, protective measures, and monitoring program that the contractor would implement during construction to minimize impacts to water quality. In the long-term, the proposed project would reduce the frequency of GIWW dredging events and associated water quality impacts.

Rollover Pass currently serves as the primary determinant of water quality in much or all of Rollover Bay. With the Pass closed, East Bay will provide the primary source of water to Rollover Bay and will serve as a primary determinant of water quality within the Bay. East Bay provided the same water quality determinant function for Rollover Bay prior to Pass opening in 1955.

4.6 WATER SALINITY

4.6.1 No-Action

Under the No-Action alternative, the Pass would remain open allowing highly saline Gulf of Mexico waters to enter Rollover and East Bays during flood tides. Although the barrier island in the vicinity of Rollover Pass historically breached during large, low frequency storm events, the daily tidal

exchange between the Gulf and Bay system has resulted in elevated, unnatural salinity conditions within Rollover Bay and portions of East Bay.

4.6.2 Rollover Pass Closure (Preferred Alternative)

Taylor Engineering, Inc. calibrated RMA2 and RMA4 models of Galveston and Rollover Bays based on the TxBLEND Model and tidal stage, current velocity, and salinity data collected by Taylor Engineering from July to September 2009. The models included Galveston Bay, Rollover Bay, portions of the GIWW, Galveston Inlet, Rollover Pass, a portion of the Gulf of Mexico and freshwater input from Buffalo Bayou, San Jacinto River, Cedar Bayou, and Trinity River. The model incorporated bathymetric survey data collect by Naismith Marine Services from August 6 – 21, 2009.

The RMA2 model provided a solution to the hydrodynamic conditions and the RMA4 model applied this solution to determine the circulation and mixing of saline water and freshwater throughout the system. The calibration adequately reproduced the measured tidal stage, current, and salinity data.

Taylor Engineering then modified the calibrated model to close Rollover Pass. Both the open Pass and the closed Pass models simulated three years of salinity variation through the system. To accomplish this simulation without excessively high computation costs, an analysis of the freshwater input and offshore tides determined four month-long periods that provided representative tide and freshwater flows. The study sequenced these month-long periods to simulate three years of hydrodynamic conditions for both the open and closed Pass condition. The transport model (RMA4) then applied this three-year simulation to estimate the variation of salinity in the systems over the three-year period. The year 3 simulation essentially duplicated the results of year 2 simulation, which indicates that the model had reached an equilibrium condition.

The Taylor Engineering study indicates that in the closed condition, the highest salinities would occur during the fall season. Average salinities during the fall would range from 25 – 27 ppt within Rollover Bay and the eastern portion of East Bay. The lowest salinity values occur during the spring season and range from 16 – 17 ppt.

Comparing salinities between the open and closed condition show that Pass closure would have the greatest effect within Rollover Bay. Seasonally-averaged salinity within Rollover Bay may decrease as much as 9 – 10 ppt from existing conditions during the summer, winter, and spring months, and should experience at least a 3 – 4 ppt drop in salinity throughout the year.

Within 2 miles of Rollover Bay, seasonally-averaged salinities may decrease up to 2 – 4 ppt during the winter through summer months, but may experience no change during the fall. Areas greater than five miles from Rollover Pass would likely experience very minor changes (less than 1 ppt).

Appendix F contains Taylor Engineering's detailed hydrodynamic and salinity modeling report.

Closure of Rollover Pass will reduce salinities in Rollover Bay and East Bay. Scientific studies performed immediately before and after construction of the Pass may provide valuable insight into the validity of Pass closure salinity changes modeled for this EA. Available historic data from the period of Pass construction (1954 – 1956) and current salinity data and modeling results provide a consistent picture of the expected salinity changes following Pass closure.

Reid (1955a, 1955b, and 1956; summarized in Reid, 1957 and Reid, 1958) analyzed chemical (salinity) and biological changes that occurred in response to opening Rollover Pass in 1955. He described salinity distributions in East Bay and Rollover Bay before construction of the Pass (1954), after

construction of the Pass (1955), and after partial closure of the Pass due to extensive erosion caused by the initial Pass opening (1956). Field data collection occurred in June of each study year. He concluded that before creation of the Pass, and during partial Pass closure, Galveston Bay served as the primary determinant of salinity. In 1955, "within four months following the opening of the Pass the salinity in nearly three-fourths of the Bay [East Bay] was under the influence of the Pass and that salinity had nearly doubled approximately one-fourth of the Bay…With complete blocking of the Pass salinity would be expected to revert to that of an undisturbed estuarine body." Reid provided the results of his extensive salinity measurements showing that 1954 salinities varied from "about 10 ppt in the upper [eastern-most] reaches of the Bay to approximately 20 ppt in the lower reaches." After the Pass opened in 1955, "the salinity in the upper area averaged almost 18 ppt grading to approximately 15 ppt in the lower [western-most] region." Salinities of 12 – 13 ppt in Rollover Bay before construction of the Pass increased to above 25 ppt in 1955 after the Pass opened.

Table 3 shows a comparison of Reid's reported salinity changes for the June sampling dates to Taylor Engineering's average of model results for April through May. The selected period of comparison — April through May — provides the most similar hydrologic and water quality conditions to Reid's data. With the Pass closed, model salinities decreased 0 – 3 ppt within East Bay. The greatest model salinity decreases in East Bay (from 19 to 16 ppt) occurred at the extreme eastern portion of the Bay (near the mouth of Oyster Bayou). Reid reported a wide range of salinities in East Bay before Pass construction; model results fall into the middle of Reid's range. Reid recorded open Pass salinities very similar to those reported by the Taylor Engineering model. Rollover Bay model salinities decreased between 4 and 10 ppt (a change from 21 – 28 ppt for the open condition to 16 – 17 ppt for the closed condition). Reid's measurements and Taylor Engineering's model reported similar salinities in Rollover Bay with the Pass open. Reid reported lower Rollover Bay salinities than those the model estimated for the closed condition.

Table 3 Summary of Salinity Sampling in June 1954 – 1956 (Reid 1958) and Taylor Engineering Salinity Modeling Results, Spring Season (April – May)

Data Source	**East Bay Pass Closed**	**East Bay Pass Open**	**Rollover Bay Pass Closed**	**Rollover Bay Pass Open**
Reid 1958	20 – 10 ppt	15 – 18 ppt	12 – 13 ppt	>25 ppt
Taylor Engineering, Inc. (Appendix F)	16 – 15 ppt	16 – 19 ppt	16 – 17 ppt	21 – 28 ppt

Note: Salinity ranges ordered from the east to west end of East Bay

Estimated salinity changes resulting from Pass closure may represent the most valuable component of the modeling effort. Reid's data and the model results show similar amounts of salinity change between the open and closed Pass conditions.

Notably, neither the Taylor Engineering model nor Reid's reports considered inherent variability of freshwater inputs to the system. The model used long-term freshwater input averages and did not account for short- or long-term variability in freshwater inputs. Reid did not report antecedent rainfall, which exerts a major influence on salinities measured at any single time. In addition, other changes to the larger Galveston Bay ecosystem (e.g., Houston Ship Channel expansions) have likely affected salinities in East Bay since the Reid studies. Recent sampling in East Bay (Glass et al., 2008) found salinity levels between 9 and 13 ppt from January – April 2005 for a location near the northernmost extension of Goat Island. Reid reported concentrations of about 15 ppt at that location in June 1954 (before Pass construction). Model salinities for the existing condition in that season (winter – spring) varied between 18 and 15 ppt at model calibration station 9, in East Bay north of Goat Island (Appendix F: Table 3.4).

Thus, the difference between the maximum and minimum salinities reported by Glass et al. and the model are quite similar.

4.7 AIR QUALITY

4.7.1 No-Action

The No-Action alternative would adversely affect long-term air quality by perpetuating the need for annual maintenance dredging within the GIWW in the vicinity of Rollover Bay. Each annual dredging event results in short-term impacts to air quality due to emissions associated with dredging equipment operation.

4.7.2 Rollover Pass Closure (Preferred Alternative)

Because the proposed project would occur within an area classified as a severe non-attainment area for ozone, a preliminary air conformity analysis (Appendix G) was performed to estimate the air quality impacts and determine whether the project requires a general conformity determination. The analysis used established criteria and focused on the construction and dredging requirements of Pass closure. The analysis applied established emission data collected from various EPA sources. The analysis considered equipment type, quantity, operating power, and duration, and accounted for both operation and idle conditions. The results of the preliminary air conformity analysis indicate that short-term construction emissions of volatile organic compounds (VOC) and nitrogen oxides (NOx), both ozone precursors, would amount to 5.6 and 98.2 tons per year, respectively. The VOC emissions fall below the *de minimis* threshold of 25 tons per year; however, the results indicate that NOx emissions would exceed the threshold level. Based on the analysis, the project requires a general conformity determination.

4.8 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

4.8.1 No-Action

The No-Action alternative would not have any effect on HTRW.

4.8.2 Rollover Pass Closure (Preferred Alternative)

The preliminary assessment of HTRW, comprising a State and Federal regulatory records search and review of historical aerial photographs, did not identify any facilities or sources of contamination that may affect the proposed project. The results of the preliminary assessment warrant no further HTRW investigation.

During construction, insignificant quantities of fuel and lubricants may leak from mechanical equipment; however, no adverse environmental impact is anticipated. Proper maintenance of mechanical equipment and implementing standard protective measures would help minimize fuel and oil leaks.

4.9 NOISE

4.9.1 No-Action

The No-Action alternative would adversely affect ambient noise conditions in the project area by perpetuating the need for annual maintenance dredging of the GIWW. Each year maintenance dredging operations remove approximately 200,000 cy of material for the GIWW in the vicinity of Rollover Bay. Rollover Pass serves as the primary conduit for sediments entering the GIWW near the Pass. For each

annual maintenance dredging event, temporary noise disturbances occur due to the presence heavy-duty dredging and construction equipment. Without Pass closure, these temporary noise disturbances would occur annually with each dredging event.

4.9.2 Rollover Pass Closure (Preferred Alternative)

The devastating effects of Hurricane Ike in 2008 substantially reduced the amount of noise receptors in the project vicinity. Very few residential or commercial structures remain.

Implementation of the proposed project would result in minor, short-term increases in ambient noise levels during the construction phase of the project. Primary sources of noise during construction include the hydraulic dredge, earth-moving equipment, barges, tug boats, booster pumps, and electric generators. Proper maintenance of construction equipment would help minimize noise level increases during the six to eight-month construction period.

Long-term, the proposed project would have beneficial effects on ambient noise levels by substantially reducing the required frequency for GIWW maintenance dredging. Currently, maintenance dredging occurs annually.

4.10 CULTURAL RESOURCES

4.10.1 No-Action

The No-Action alternative would not affect cultural resources.

4.10.2 Rollover Pass Closure (Preferred Alternative)

Coordination with the SHPO regarding the proposed project has occurred. A letter from the SHPO dated August 6, 2009 (Appendix E) indicates that the closure of Rollover Pass would have no adverse impacts on submerged historic resources. However, the SHPO requested further information regarding the proposed borrow area. Coordination with the SHPO regarding the proposed borrow area is ongoing.

4.11 RECREATION RESOURCES

4.11.1 No-Action

Adverse impacts related to the No-Action alternative may include the continued loss of beach width available for recreation due to accelerated erosion caused by Rollover Pass.

4.11.2 Rollover Pass Closure (Preferred Alternative)

Rollover Pass, a nationally-recognized fishing destination, provides recreational fishing opportunities that would no longer exist after project construction. To mitigate the lost recreational benefits, the GLO intends to construct additional recreational fishing amenities. Texas Senate Bill 2043 provides the legislative authority for this project and contains the following language regarding recreational impacts and mitigation:

> If the closing of a man-made Pass under this section results in a loss of public recreational opportunities, the commissioner shall develop, in consultation with the Parks and Wildlife Department and the county and, if applicable, the municipality in which the

Pass is located, and approve a plan to mitigate the loss. In developing the plan, the commissioner is strongly encouraged to assess the feasibility of installing fishing piers, boat ramps, and other facilities that provide public recreational opportunities. The plan must be presented to the public for comment before the commissioner approves it.

The GLO is committed to meeting the letter and spirit of the legislative mandate, including mitigation for loss of recreation resources. In developing the mitigation plan, the GLO is currently working with the citizens of Gilchrist, specifically the Gulf Coast Rod, Reel and Gun Club (GRRGC) and the Gilchrist Community Association (GCA), to identify suitable mitigation for recreational opportunities that will be lost due to the closure of Rollover Pass. Shoreline fishing comprises the main recreational opportunity at Rollover Pass. Options under consideration to provide access to waters of the Gulf of Mexico and East Bay include piers extending into the Gulf of Mexico and/or Rollover Bay; additional boat ramps, and shoreline access in suitable locations. Recreational facility designs will consider and insofar as possible incorporate components to provide easy access to handicapped individuals and the senior population.

Although the locations of these recreational amenities are subject to change, the GLO currently envisions potential recreational amenities located in the following areas:

- Gulf Pier – Within the current Rollover Pass opening to the Gulf of Mexico
- Bay Pier – Within the current Rollover Pass opening into Rollover Bay
- Bayside Boat Ramp – Directly east of the current Rollover Pass opening into Rollover Bay

The size and design of the potential Gulf Pier and Bay Pier have not been decided. However, the GLO currently sees both Piers constructed of concrete with removable or blow away decks, similar to Bob Hall Pier in Nueces County. The GLO also envisions each Pier extending between 1,000 and 1,500 feet in length.

The GLO is also planning on constructing proper parking and public assistance facilities, such as restrooms, near the potential recreational amenities site(s). If construction of the recreational amenities takes place in and around the Rollover Pass area, these parking and public assistance facilities will be placed on the currently paved adjacent lands to the Pass.

The GLO plans on coordinating with the TPWD in the near future to come up with more concrete recreational options and funding sources for these mitigation options. Once a more solidified set of recreational options in created, the GLO intends to distribute these options to the public and then hold a public meeting for all interested parties. From this meeting, the GLO hopes to find the most suitable recreational option(s) for all parties. This may mean constructing the recreational amenities outside of the immediate Rollover Pass area. Notably, the GLO will submit a separate Department of the Army permit application for the selected recreational mitigation option(s).

4.12 AESTHETIC RESOURCES

4.12.1 No-Action

The No-Action alternative would help perpetuate degraded aesthetics in the project vicinity by continuing to exacerbate erosion along the Bolivar Peninsula resulting in reduced beach width and natural habitat. In addition, keeping the Pass open would assure that maintenance dredging of the GIWW in the Rollover Bay vicinity continues annually. Annual maintenance dredging events result in temporary adverse impacts due to the presence and activity of earth-moving and dredging equipment during construction.

4.12.2 Rollover Pass Closure (Preferred Alternative)

Implementing the proposed project would result in short-term, localized impacts to aesthetics during project construction due to the presence and activity of earth-moving and dredging equipment. In the long-term, the project would result in aesthetic benefits by restoring the man-made Pass to a more natural condition, reducing erosion along the Bolivar Peninsula, and reducing the frequency of GIWW maintenance dredging.

4.13 SOCIOECONOMICS

4.13.1 No Action

Currently, the State of Texas spends approximately one million dollars annually to dredge the GIWW in the vicinity of Rollover Bay. Closing the Pass would substantially reduce the frequency and costs associated with GIWW maintenance dredging.

4.13.2 Rollover Pass Closure (Preferred Alternative)

Tourism for recreational fishing from the shorelines of Rollover Pass provides an important component of the socioeconomics of Gilchrist, Texas. Rollover Pass has become a nationally-recognized fishing hotspot with thousands of anglers visiting the Pass each year. Tourism associated with fishing and fishing-related activities likely serve as a primary source of income for businesses in the Gilchrist community. The proposed project would result in the loss of the Rollover Pass recreational fishing resource. This loss may have significant impacts on the Gilchrist economy. To mitigate the anticipated recreational resource and socioeconomic losses, the GLO may provide recreational amenities such as a fishing pier or boat ramp. The GLO will choose specific amenities based on consultation with the TPWD and local constituents. Texas Senate Bill 2043 provides the legislative authority for this project and contains the following language regarding recreational impacts and mitigation:

> If the closing of a man-made Pass under this section results in a loss of public recreational opportunities, the commissioner shall develop, in consultation with the Parks and Wildlife Department and the county and, if applicable, the municipality in which the Pass is located, and approve a plan to mitigate the loss. In developing the plan, the commissioner is strongly encouraged to assess the feasibility of installing fishing piers, boat ramps, and other facilities that provide public recreational opportunities. The plan must be presented to the public for comment before the commissioner approves it.

The GLO is committed to meeting the letter and spirit of the legislative mandate, including mitigation for loss of socioeconomic benefits of the Pass. Section 4.11.2 details potential mitigation options currently under consideration.

Pass closure would not significantly affect the potential for flooding due to changes in tidal amplitude, storm surge, or stormwater drainage. Rollover Pass constitutes a very small opening for energy transfer between the Gulf of Mexico and East Bay. Galveston Inlet dominates the control of water-based energy exchanges between the Gulf of Mexico and the Galveston Bay complex (including East Bay and Rollover Bay). Tidal amplitude in the Gulf of Mexico passing through Rollover Pass provides a minor influence on the tidal amplitude in Rollover Bay.

Closure of the Pass will result in tidal energy control emanating solely from Galveston Inlet. RMA2 modeling showed that closing Rollover Pass should have no significant effect on the tidal

amplitude in Rollover Bay or on locations between Rollover Bay and Galveston Inlet. The study did not model storm surge. However, storm surge amplitude should behave similarly to tide.

Pass closure will interrupt drainage, currently flowing from underground stormwater pipes into the Pass, from State Highway 87. The final Pass closure design will include a drainage plan incorporating stormwater management features that tie into the existing drainage pipes and continue the stormwater management functions of the existing drainage design. All designs and construction will meet Texas Department of Transportation design and performance standards. The project will result in no net alteration of stormwater runoff patterns or stormwater elevations in the general project area.

Hurricane Ike in 2008 caused severe coastal erosion and property damage in the project vicinity. The Category 2 (at time of landfall) hurricane decimated the Gilchrist community and leveled nearly all of the residential and commercial structures. Through a Federally-funded program, Galveston County is offering to purchase designated properties within coastal Galveston County communities including the Town of Gilchrist. This buyout program focuses on properties and areas that have a demonstrated high risk of damage and provides an economic alternative to those who wish to move to safer areas. The program will reduce the number of residents local to the Pass and thus will indirectly reduce the economic impact of Pass closure.

4.14 ENVIRONMENTAL JUSTICE

4.14.1 No Action

The No-Action alternative would not affect environmental justice.

4.14.2 Rollover Pass Closure (Preferred Alternative)

Available population data indicate that town of Gilchrist has a very low proportion of minority residents and the percentage of low-income residents closely compares to county-wide statistics. The proposed project should not disproportionately affect minority, low-income, or disadvantaged populations.

4.15 NAVIGATION

4.15.1 No Action

The No-Action alternative would perpetuate the need for annual maintenance dredging of the GIWW in the vicinity of Rollover Bay to maintain safe navigation depths.

4.15.2 Rollover Pass Closure (Preferred Alternative)

Implementing the proposed project would not result in significant adverse impacts to navigation along the GIWW. Short-term, minor impacts may occur due to the presence of dredging and barge traffic associated with project construction. The presence of construction vessels may result in slight inconveniences to other non-construction vessels passing through the construction vicinity. The contractor would submerge and secure the dredge pipeline across the GIWW channel and would follow protocols to ensure safe navigation and minimize any potential impact to navigation. In the long-term, the proposed project would improve navigation by reducing the amount of shoaling and dredging required within the GIWW.

4.16 COASTAL BARRIER RESOURCES

4.16.1 No Action

The No-Action alternative would adversely affect adjacent coastal barrier resources by allowing the manmade Pass to continue to exacerbate beach erosion along the Bolivar Peninsula. The Pass' flood dominant characteristics transport and deposit sediments into the Bay system and effectively diminish the natural sediment supply to the downdrift beaches. This process starves the beaches of the sand volume required to maintain natural beach conditions.

4.16.2 Rollover Pass Closure (Preferred Alternative)

The CBRA serves to minimize the loss of human life; wasteful expenditure of Federal funds; and damage to fishes, wildlife, and other resources associated with coastal barriers.

The proposed project boundaries lie outside any CBRS map unit. Two map units — T02A (High Island) and T03A (Bolivar Peninsula) — occur in the project area vicinity. CBRS unit T02A lies approximately 2.6 miles northeast of the project area. CBRS unit T03A lies approximately 2.7 miles southwest of the project area.

The proposed action, consistent with the intent of CBRA, would benefit adjacent coastal barrier resources by alleviating beach erosion along the Bolivar Peninsula and increasing the effectiveness of beach restoration projects in the area.

4.17 MITIGATION

The project proposes to permanently fill Rollover Pass (7.24 acres) and a 0.42-acre hurricane-generated tidal pool that occurs south of the State Highway 87 Bridge and east of the Pass (Figure 3). The Pass represents an artificial condition and the tidal pool has been naturally filling since its creation in 2008. The project proposes no mitigation for filling these features.

The project would result in unavoidable impacts to recreational resources by closing the Pass, a productive and popular fishing resource. The GLO would develop and implement a plan, in coordination with local stakeholders, to mitigate the fishing resource impacts. The plan may include the construction of bayside or gulfside public fishing piers, boat ramps, or other valuable fishing amenities. Section 4.11.2 describes the mitigation options currently under consideration.

4.18 CUMULATIVE IMPACTS

Council on Environmental Quality (CEQ) regulations for implementing the National Environmental Policy Act (NEPA) define cumulative impacts as those impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time. Impacts include both direct and indirect effects.

Past actions include the construction of the Rollover Pass in 1955 and annual GIWW dredging in the area of Rollover Bay with beach placement of dredged material. Current proposed actions include Pass closure. Future actions include GIWW maintenance dredging with beach placement every two years. Associated, significant cumulative impacts include:

- Decreases in recreational opportunities and fishing tourism

- Decreases in economic activity associated with recreational opportunities and tourism
- Decreased GIWW dredging and beach placement of dredged material (benefit)
- Possible increased development due to greater shoreline stability

Pass closure is projected to decrease the dredging frequency within the Rollover Bay reach of the GIWW by 50% (from annually to every 2 years). Decreased erosion along the Bolivar Peninsula will benefit sea turtle nesting habitat. Pass closure would reduce the need for beach nourishment, thus reducing environmental impacts related to beach nourishment activities. The GLO is committed to providing satisfactory and sufficient mitigation for decreases in recreational fishing opportunities and related tourism. The GLO will work with the Gilchrist community to identify and implement mutually-agreed solutions.

4.19 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

This EA, prepared in accordance with the CEQ regulations for implementing NEPA (40 CFR Parts 1500 – 1508) and USACE Regulation ER 200-2-2, Environmental Quality: Procedures for Implementing NEPA, intends to satisfy the requirements of all applicable environmental laws and regulations. The planning and implementation of the proposed project is consistent with the USACE Environmental Operating Principles. The following subsections list the applicable environmental laws and regulations that this EA considered and the compliance status.

4.19.1 National Environmental Policy Act of 1969, as amended

This EA, prepared in accordance with CEQ regulations, complies with the NEPA provisions. In accordance with the Act, this EA analyzed environmental, economic, and social consequences of the proposed project.

4.19.2 Endangered Species Act of 1973, as amended

This EA concludes that the proposed project would not cause permanent, adverse impacts to Federally-listed species or designated critical habitat. A BA is included in this document as Appendix D. The USACE will initiate consultation with the USFWS and NMFS regarding threatened and endangered species. This project complies with this Act.

4.19.3 Fish and Wildlife Coordination Act of 1958, as amended

The proposed project will be fully coordinated with the USFWS, NMFS, TPWD, and other appropriate State and Federal resource agencies. The USFWS and TPWD have been involved in project planning meetings and have provided comments. Continued coordination with these agencies will continue throughout the EA review process.

4.19.4 National Historic Preservation Act of 1966, as amended

Archival research and consultation with the SHPO were completed in accordance with the National Historic Preservation Act, as amended; the Archeological and Historic Preservation Act, as amended; and Executive Order 11593. Refer to Section 4.10 for the results of SHPO consultation. The project would not affect historic properties included in or eligible for inclusion in the National Register of Historic Places. The project complies with each of these Federal laws.

4.19.5 Clean Water Act of 1972, as amended

Appendix H of this EA includes a Section 404(b)(1) evaluation. A public notice will be issued to satisfy the requirements of Section 404 of the CWA. The TCEQ will review the proposed project for compliance with the State water quality standards, pursuant to the provisions of Section 401 of the CWA. This project complies with this Act.

4.19.6 Clean Air Act of 1972, as amended

The EPA established nationwide air quality standards to protect public health and welfare. The project locates within Galveston County. The EPA classifies Galveston County as a severe non-attainment area for the ozone NAAQS. The results of a preliminary air conformity analysis indicate that project-related emissions of VOC and NOx (ozone precursors) would amount to 5.6 and 98.2 tons per year, respectively. The VOC emissions fall below the de minimis threshold of 25 tons per year; however, the results indicate that the NOx emissions would exceed the threshold. Based on the analysis, the project requires a general conformity determination.

4.19.7 Coastal Zone Management Act of 1972

This Act requires that all land use changes in the project area occur in accordance with approved State coastal zone management programs. Any project that locates in or may affect land or water resources in the Texas coastal zone and either requires a Federal license or permit, is a direct activity of a Federal agency, or is Federally-funded, requires thorough review to document consistency with the Texas Coastal Management Program (TCMP). The proposed action occurs within the coastal boundary that the TCMP defines and is consistent with the goals and policies of the TCMP. Appendix I contains the coastal zone management consistency determination. This project complies with the intent of the Act.

4.19.8 Farmland Protection Policy Act of 1981

Congress enacted this Act to minimize the extent to which Federal programs contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses. Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses. Unique farmland is land other than prime farmland that is used for the production of specific high value food and fiber crops. The project area does not contain lands considered prime or unique farmlands, nor would the project affect any of these lands.

4.19.9 Coastal Barrier Resources Act and Coastal Barrier Improvement Act of 1990

The Coastal Barrier Resources Act (CBRA), enacted in 1982, designated various undeveloped coastal barriers as part of the John H. Chafee Coastal Barrier Resources System (CBRS). CBRA made designated areas ineligible for both direct and indirect Federal expenditures and financial assistance that might support development of fragile, high-risk, and ecologically sensitive coastal barriers.

The proposed project boundaries lie outside any CBRS map unit. Two map units — T02A (High Island) and T03A (Bolivar Peninsula) — occur in the project area vicinity. CBRS unit T02A lies approximately 2.6 miles northeast of the project area. CBRS unit T03A lies approximately 2.7 miles southwest of the project area.

The proposed action, consistent with the intent of CBRA, would benefit adjacent coastal barrier resources by alleviating beach erosion along the Bolivar Peninsula and increasing the effectiveness of beach restoration projects in the area.

4.19.10 Marine Protection, Research and Sanctuaries Act of 1972

This Act regulates the dumping of materials into ocean waters to prevent or strictly limit dumping of materials that would unreasonably degrade or endanger human health, welfare or amenities, marine environment, ecological system, or economic potentialities. The proposed project would not result in unreasonable degradation of the marine environment or endangerment of human health, welfare, or amenities. The proposed project complies with this Act.

4.19.11 Magnuson-Stevens Fishery Conservation and Management Act

Congress enacted amendments to the Magnuson-Stevens Fishery Conservation and Management Act in 1996 that established procedures for identifying EFH and required interagency coordination to further the conservation of Federally-managed fisheries. Rules published by the NMFS (50 CFR 600.805 through 600.930) specify that any Federal agency that authorizes, funds or undertakes, or proposes to authorize, fund or undertake an activity that could adversely affect EFH shall be subject to the consultation provisions of the Act. This EA concludes that the proposed project would not cause permanent, adverse impacts to EFH. The USACE will initiate consultation with the NMFS regarding Federally-managed fisheries and EFH. The proposed project complies with this Act.

4.19.12 E.O. 11990 Protection of Wetlands

This Executive Order requires Federal agencies to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance natural and beneficial values of wetlands in executing Federal projects. The proposed project will include measures to minimize temporary wetland disturbance during construction and will not result in permanent adverse impacts to wetlands. This project complies with the intent of this Order.

4.19.13 E.O. 11988 Flood Plain Management

This Executive Order directs Federal agencies to evaluate the potential effects of proposed actions on floodplains. Under the Order, Federal agencies should not undertake actions that directly or indirectly induce growth in floodplains unless there is no practical alternative. The proposed project locates within a floodplain; however, the project should not adversely affect nor induce growth within the floodplain.

4.19.14 E.O. 12898 Environmental Justice

This Executive Order directs Federal agencies to achieve environmental justice by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. This project would not have a disproportionate adverse impact on minority or low-income population groups within the project area.

5.0 COORDINATION WITH OTHERS

This project will include coordination with the following State and Federal agencies: U.S. Fish and Wildlife Service, National Marine Fisheries Service, Environmental Protection Agency, Texas Commission on Environmental Quality, Texas State Historic Preservation Office, and Texas Parks and Wildlife Department. In addition, coordination through circulation of the Draft EA will occur with various local and regional planning agencies, organizations, and interested citizens. The Final EA will

include comments on the Draft EA and responses. Appendix E will contain all pertinent correspondence letters as they become available.

6.0 CONCLUSIONS

The following conclusions summarize the findings of this EA, as detailed in Section 4.0 Environmental Effects.

- Permanent impacts to surface waters include filling the artificial Pass and a 0.42-acre tidal pool adjacent to the Pass. The tidal pool formed as result of Hurricane Ike and has partially filled in through natural processes since its creation in 2008.

- Temporary, minor impacts to upland and marsh vegetation would occur during construction. Salinity changes from Pass closure would not significantly affect tidally-influenced vegetation.

- Construction and dredging activities would result in minor impacts to fish and wildlife resources due to increased turbidity and construction disturbance. Pass closure may result in long-term natural community benefits due to salinity reductions within Rollover Bay and East Bay. Salinity reductions may increase oyster production.

- Short-term, minor impacts to EFH would occur during construction due to increased turbidity. Long-term benefits to EFH may include increased oyster production due to salinity reductions.

- The proposed project may affect, but is not likely to affect the piping plover, Kemp's ridley sea turtle, and loggerhead sea turtle.

- Minor water quality effects include temporary, localized increases in turbidity in the immediate vicinity of the project during construction.

- Salinity modeling results indicate that the greatest salinity changes would occur within Rollover Bay and eastern portion of East Bay. Salinities may decrease as much as 10 ppt within Rollover Bay and up to 4 ppt within portions of East Bay during some parts of the year. Overall, salinity changes should not result in significant adverse impacts to natural resources and may provide long-term benefits.

- The preliminary air conformity analysis indicates that short-term construction emissions of VOCs and NOx would amount to 5.6 and 98.2 tons per year, respectively. These results indicate that NOx emissions would exceed the 25 ton per year EPA threshold. The project requires a general conformity determination.

- The proposed project would not affect HTRW.

- Minor, short-term increases in ambient noise levels would occur during construction.

- Rollover Pass closure would not affect cultural resources near the Pass. Coordination with SHPO regarding the borrow area is ongoing.

- Filling the Pass would result in the loss of a significant fishing resource. This loss would adversely impact recreational resources and socioeconomics of the Town of Gilchrist. The GLO is committed to developing a plan in coordination with local stakeholders to mitigate for the lost recreation resource and related socioeconomic impacts.

- Pass closure would reduce GIWW dredging frequency and associated costs.

- Pass closure would not significantly affect the potential for flooding due to changes in tidal amplitude, storm surge, or stormwater drainage.

- Temporary, minor reductions in aesthetics would occur during project construction due to the presence of dredging and construction equipment.

- The proposed project would not significantly affect environmental justice.

- Temporary, minor effects to navigation may occur due to the presence of construction vessels.

- The proposed project may benefit adjacent CBRS units by reducing erosion along the Bolivar Peninsula.

- This EA identified no significant, adverse cumulative impacts to environmental resources associated with project implementation.

- The proposed project complies with Section 404 of the CWA and is consistent with TCMP.

7.0 REFERENCES

Berrigan,M., T. Candis, J. Cirino, R. Dugas, C. Dyer, J. Gray, T. Herrington, W. Keithly, R. Leard, J.R. Nelson, and M. Van Hoose. 1991. The Oyster Fishery of the Gulf of Mexico, United States: A Regional Management Plan. No. 24. Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi.

Buzan, D., W. Lee, J. Culbertson, N. Kuhn, and L. Robinson. 2009. Positive Relationship between Freshwater Inflow and Oyster Abundance in Galveston Bay, Texas Estuaries and Coasts 32:206–212

Dekshenieks M.M., E.E. Hofmann, J.M. Klinck, and E.N. Powell. 2000. Quantifying the Effects of Environmental Change on an Oyster Population: A Modeling Study. Estuaries Vol. 23, No. 5, p. 593–610 October 2000

EPA (U.S. Environmental Protection Agency). 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. EPA Publication No. 550/9-74-004. Washington, D.C.

EPA (U.S. Environmental Protection Agency). 1978. Protective Noise Levels: Condensed Version of EPA Levels Document. EPA Publication No. 550/9-79-100. Washington, D.C.

Glass, L.A., J.R. Rooker, R.T. Kraus, and G.J. Holt. 2008. Distribution, condition, and growth of newly settled southern flounder (*Paralichthys lethostigma*) in the Galveston Bay Estuary, TX. Journal of Sea Research 59 (2008) 259–268.

GMFMC (Gulf of Mexico Fishery Management Council). 1998. Generic Amendment for Addressing Essential Fish Habitat Requirements in the following Fishery Management Plans of the Gulf of Mexico: Shrimp Fishery of the Gulf of Mexico, United States Waters, Red Drum Fishery of the Gulf of Mexico, Reef Fish Fishery of the Gulf of Mexico, Coastal Migratory Pelagic Resource (Mackerels) in the Gulf of Mexico and South Atlantic, Stone Crab Fishery of the Gulf of Mexico. Spiny Lobster in the Gulf of Mexico and South Atlantic, Coral and Coral Reefs of the Gulf of Mexico. Tampa, FL.

HHS (U.S. Department of Health and Human Services). 2009. http://aspe.hhs.gov/poverty/09poverty.shtml. Accessed December 3, 2009.

Kennish, M.J. 2000. Estuary Restoration and Maintenance: The National Estuary Program. CRC Press, LLC. Boca Raton, FL.

Klinck J.M.,E.E. Hofmann, E.N. Powell; and M.M. Dekshenieks. 2002. Impact of Channelization on Oyster Production: A Hydrodynamic-Oyster Population Model for Galveston Bay, Texas Environmental Modeling and Assessment, Volume 7, Number 4, December 2002 , pp. 273-289(17)

Pattillo, M., L.P. Rozas, and R.J. Zimmerman. 1995. A Review of Salinity Requirements for Selected Invertebrates and Fishes of U.S. Gulf Of Mexico Estuaries. National Marine Fisheries Service Southeast Fisheries Science Center Galveston Laboratory. November 29, 1995.

Powell, E.N., J.M. Klinck, E.E. Hofmann, M.A. Mcmanus. 2003. Influence Of Water Allocation And Freshwater Inflow on Oyster Production: A Hydrodynamic–Oyster Population Model For Galveston Bay, Texas, USA. Environmental Management Vol. 31, No. 1, pp. 100–121.

Quast, W. D., M. A. Johns, D. E. Pitts, Jr., G. C. Matlock, and J. E. Clark. 1988. Texas oyster fishery management plan. Fisheries Management Plan Series Number 1. Texas Parks and Wildlife Department, Coastal Fisheries Branch, Austin, Texas, 228 pp.

Reid, G.K. 1955a. A summer study of the Biology and Ecology of East Bay, Texas, Part I. Texas Journal of Science. 7:316-343

Reid, G.K. 1955b. . A summer study of the Biology and Ecology of East Bay, Texas, Part I. Texas J. Science. 7:430-453.

Reid, G.K. 1956. Ecological Investigations of a Disturbed Texas Coastal Estuary. Texas Journal of Science 8:296-327.

Reid, G.K. 1957. Biological and Hydrographic Adjustment in a Disturbed Gulf Coast Estuary. Limnology and Oceanography 2(3):198-212.

Reid, G.K. 1958. Size Distribution of Fishes in a Texas Estuary. Copeia 3:225-231.

Turner, R.E. 2006. Will Lowering Estuarine Salinity Increase Gulf of Mexico Oyster Landings? Estuaries and Coasts Vol. 29, No. 3, p. 345–352 June 2006

USCB (U.S. Census Bureau). 2009a. http://factfinder.census.gov/servlet/QTTable?_bm=y&-context=qt&-qr_name=PEP_2008_EST_DP1PR&-qr_name=PEP_2008_EST_DP1&-ds_name=PEP_2008_EST&-CONTEXT=qt&-tree_id=808&-redoLog=true&-geo_id=05000US48167&-geo_id=NBSP&-search_results=01000US&-_lang=en. Accessed December 16, 2009.

USCB (U.S. Census Bureau). 2009b. http://factfinder.census.gov/servlet/STTable?_bm=y&-context=st&-qr_name=ACS_2008_3YR_G00_S1901&-ds_name=ACS_2008_3YR_G00_&-tree_id=3308&-redoLog=true&-_caller=geoselect&-geo_id=05000US48167&-format=&-_lang=en. Accessed December 16, 2009.

USCB (U.S. Census Bureau). 2009c. http://factfinder.census.gov/servlet/STTable?_bm=y&-context=st&-qr_name=ACS_2008_3YR_G00_S1701&-ds_name=ACS_2008_3YR_G00_&-tree_id=3308&-redoLog=true&-_caller=geoselect&-geo_id=05000US48167&-format=&-_lang=en. Accessed December 16, 2009.

USCB (U.S. Census Bureau). 2009d. http://factfinder.census.gov/servlet/SAFFFacts?_event=Search&geo_id=01000US&_geoContext=01000US&_street=&_county=&_cityTown=&_state=&_zip=77617&_lang=en&_sse=on&ActiveGeoDiv=geoSelect&_useEV=&pctxt=fph&pgsl=010&_submenuId=factsheet_1&ds_name=ACS_2008_3YR_SAFF&_ci_nbr=null&qr_name=null&reg=null%3Anull&_keyword=&_industry=&show_2003_tab=&redirect=Y. Accessed December 16, 2009.

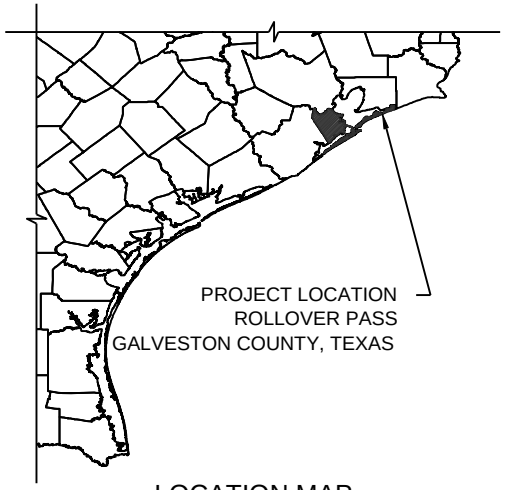
Wilson, C., L. Scotto, J. Scarpa, A. Volety, S. Laramore, and D. Haunert. 2005. Survey of Water Quality, Oyster Reproduction and Oyster Health Status in the St. Lucie Estuary. Journal of Shellfish Research 24:157-165.

FIGURES

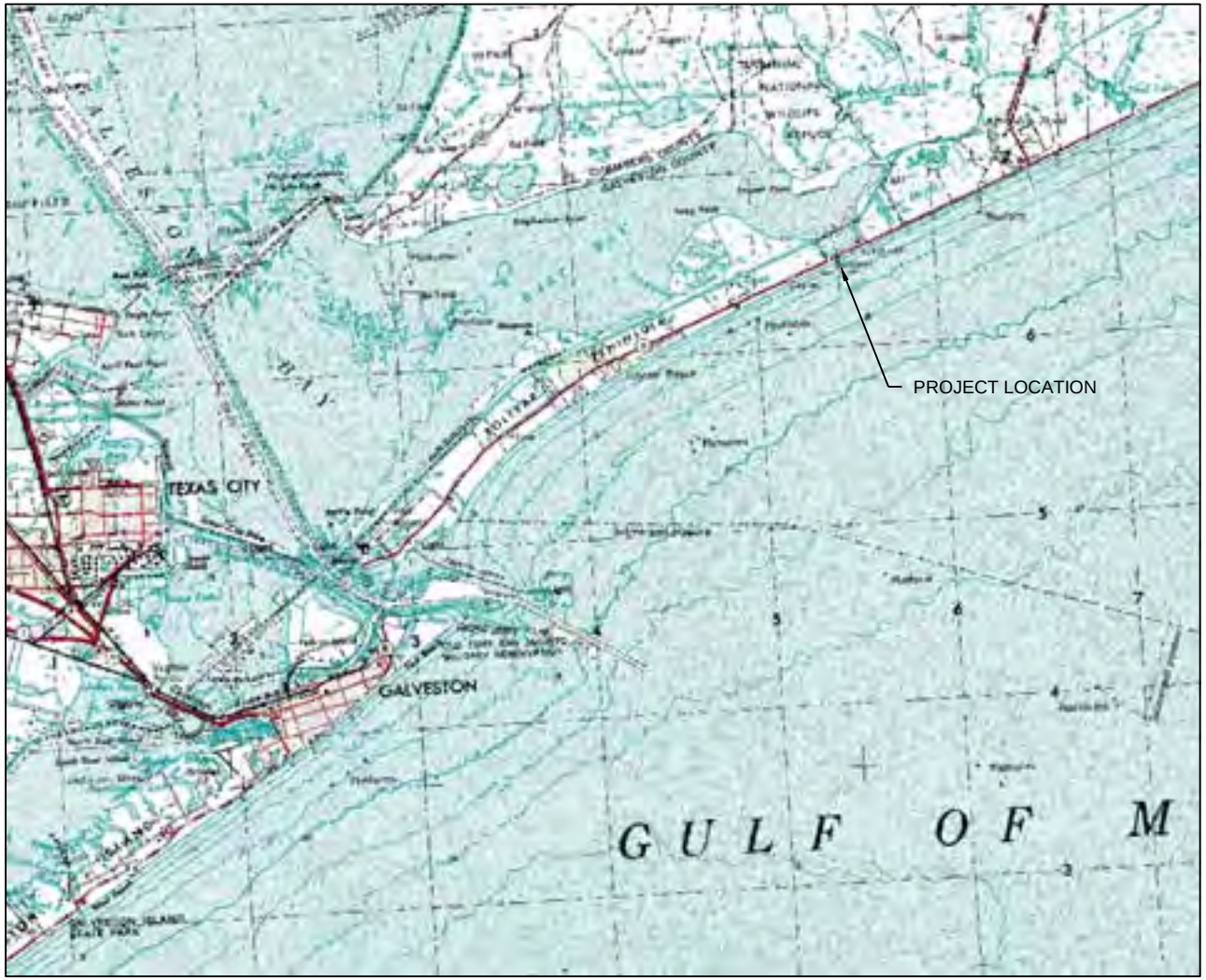
Rollover Pass Closure Project
Galveston County, Texas

ROLLOVER PASS CLOSURE PROJECT

GALVESTON COUNTY, TEXAS



LOCATION MAP
GULF COAST, TEXAS
NOT TO SCALE



VICINITY MAP
1"= 10,000'

DRAWING INDEX

1 COVER SHEET
2 OVERVIEW
3 KEY SHEET
4 ROLLOVER PASS CLOSURE PLAN AND PROFILE
5 ROLLOVER PASS CLOSURE PLAN AND PROFILE
6 ROLLOVER PASS CLOSURE PLAN AND PROFILE
7 PIPELINE ROUTE

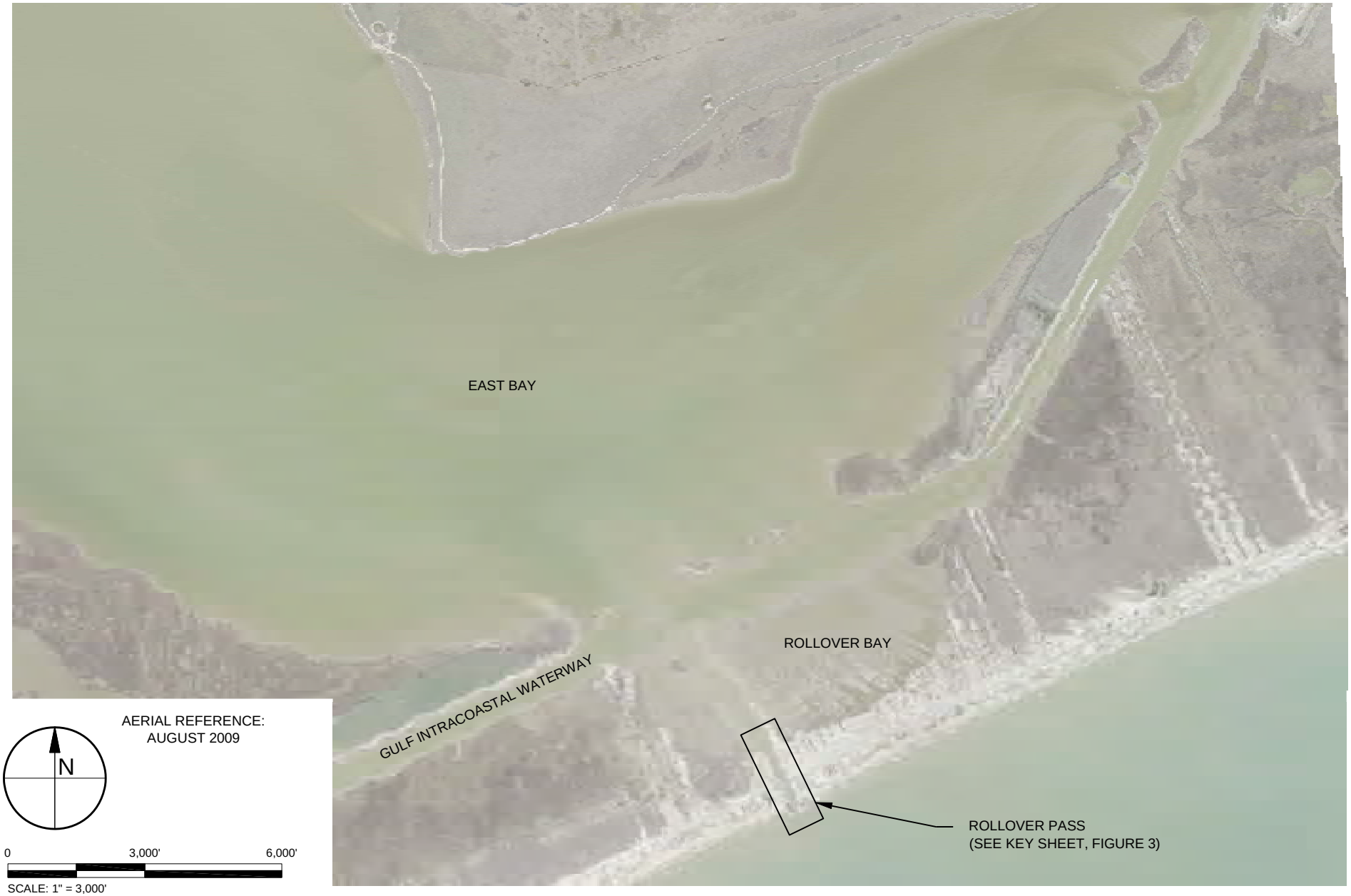
TAYLOR ENGINEERING INC.
10151 DEERWOOD PARK BLVD.
BLDG. 300, SUITE 300
JACKSONVILLE, FL 32256
CERTIFICATE OF AUTHORIZATION # 4815

FIGURE 1
COVER SHEET
ROLLOVER PASS CLOSURE PROJECT
GALVESTON COUNTY, TEXAS

PROJECT	C2009-063
DRAWN BY	AF
SHEET	1 of 7
DATE	FEB 2010

SEAL

ENG DATE

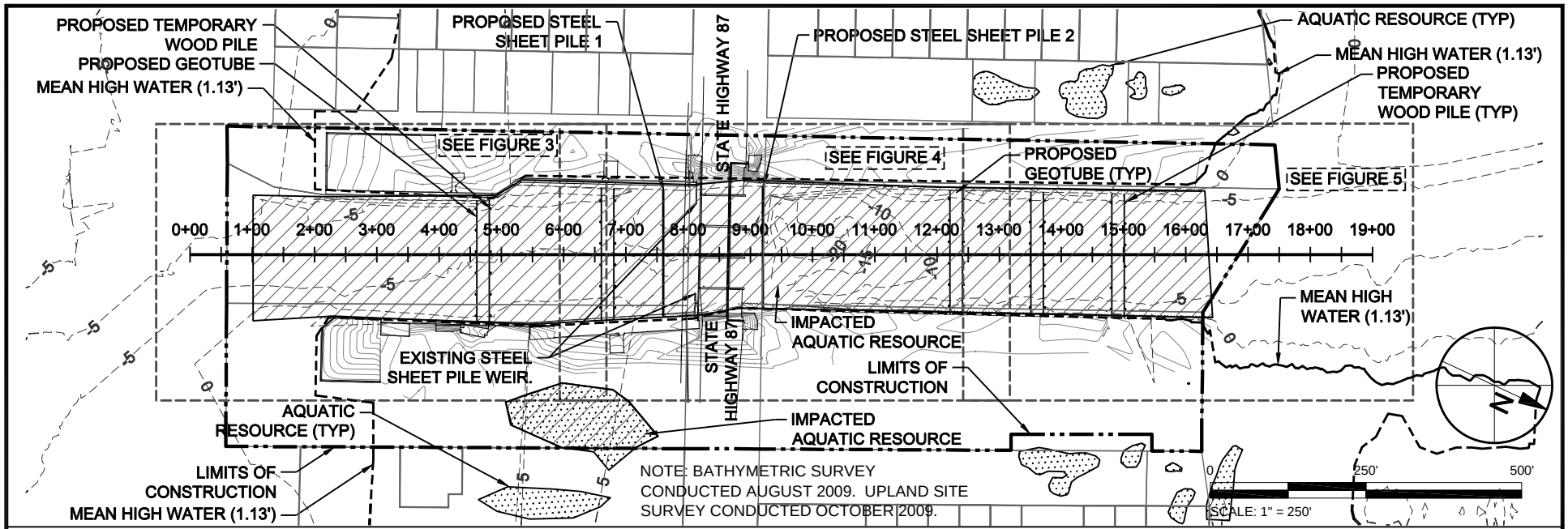


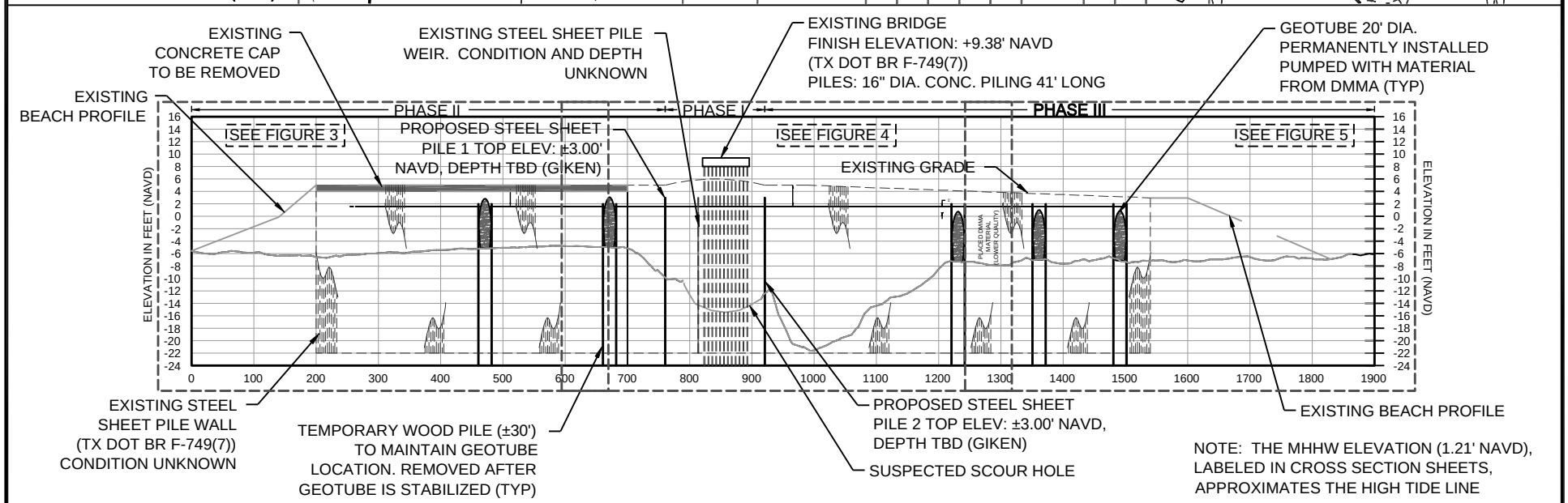
TAYLOR ENGINEERING INC.
10151 DEERWOOD PARK BLVD.
BLDG. 300, SUITE 300
JACKSONVILLE, FL 32256

FIGURE 2
OVERVIEW
ROLLOVER PASS CLOSURE PROJECT
GALVESTON COUNTY, TEXAS

PROJECT	C2009-063
DRAWN BY	AF
SHEET	2 of 7
DATE	FEB 2010

ANTON FLEWELLING X:\SYS\PROJECTS\C2009-063 ROLLOVER PASS CLOSURE\FIGURES\LETTERSIZE\C2009-063-F-OVERVIEW.DWG 2/12/2010 12:52:17 PM





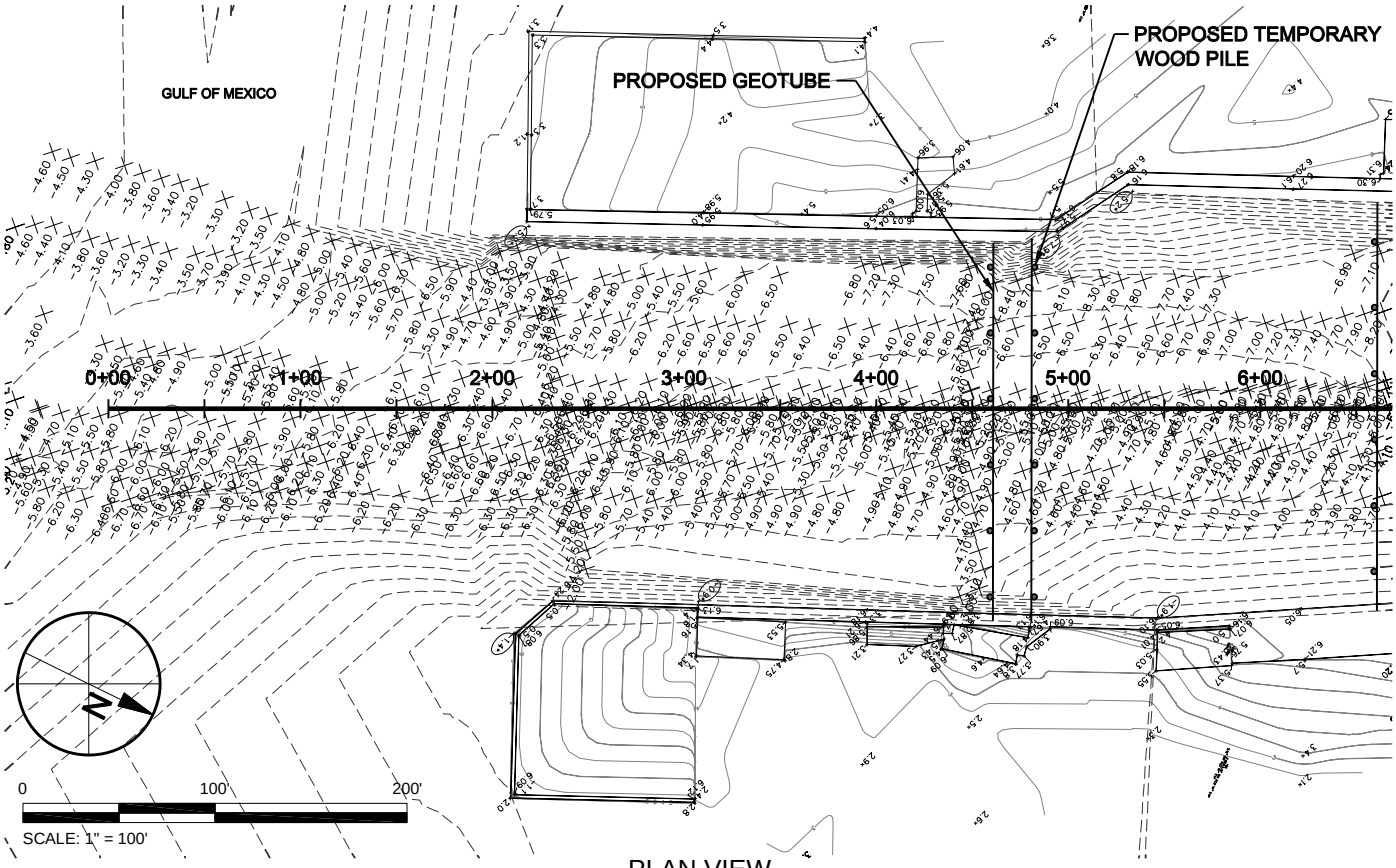
TAYLOR ENGINEERING INC.
10151 DEERWOOD PARK BLVD.
BLDG. 300, SUITE 300
JACKSONVILLE, FL 32256
CERTIFICATE OF AUTHORIZATION # 4815

FIGURE 3
KEY SHEET
ROLLOVER PASS CLOSURE PROJECT
GALVESTON COUNTY, TEXAS

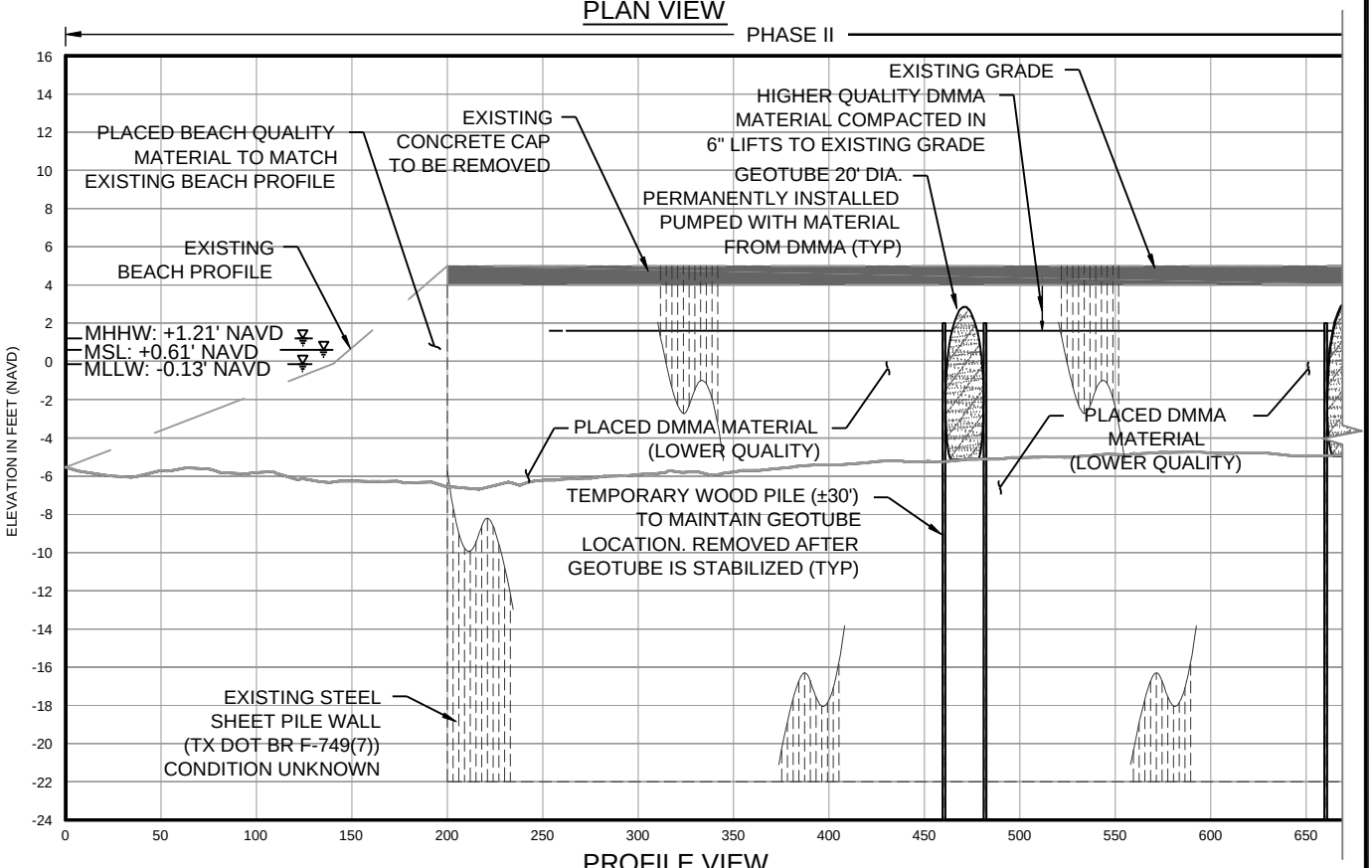
PROJECT	C2009-063
DRAWN BY	AF
SHEET	3 of 7
DATE	FEB 2010

SEAL
ENG DATE

ANTON FLEWELLING X:\SYS\PROJECTS\C2009-063 ROLLOVER PASS CLOSURE\FIGURES\LETTERSIZE\C2009-063-F-CLOSURE PLAN KEY.DWG 3/4/2010 11:10:54 AM



PLAN VIEW



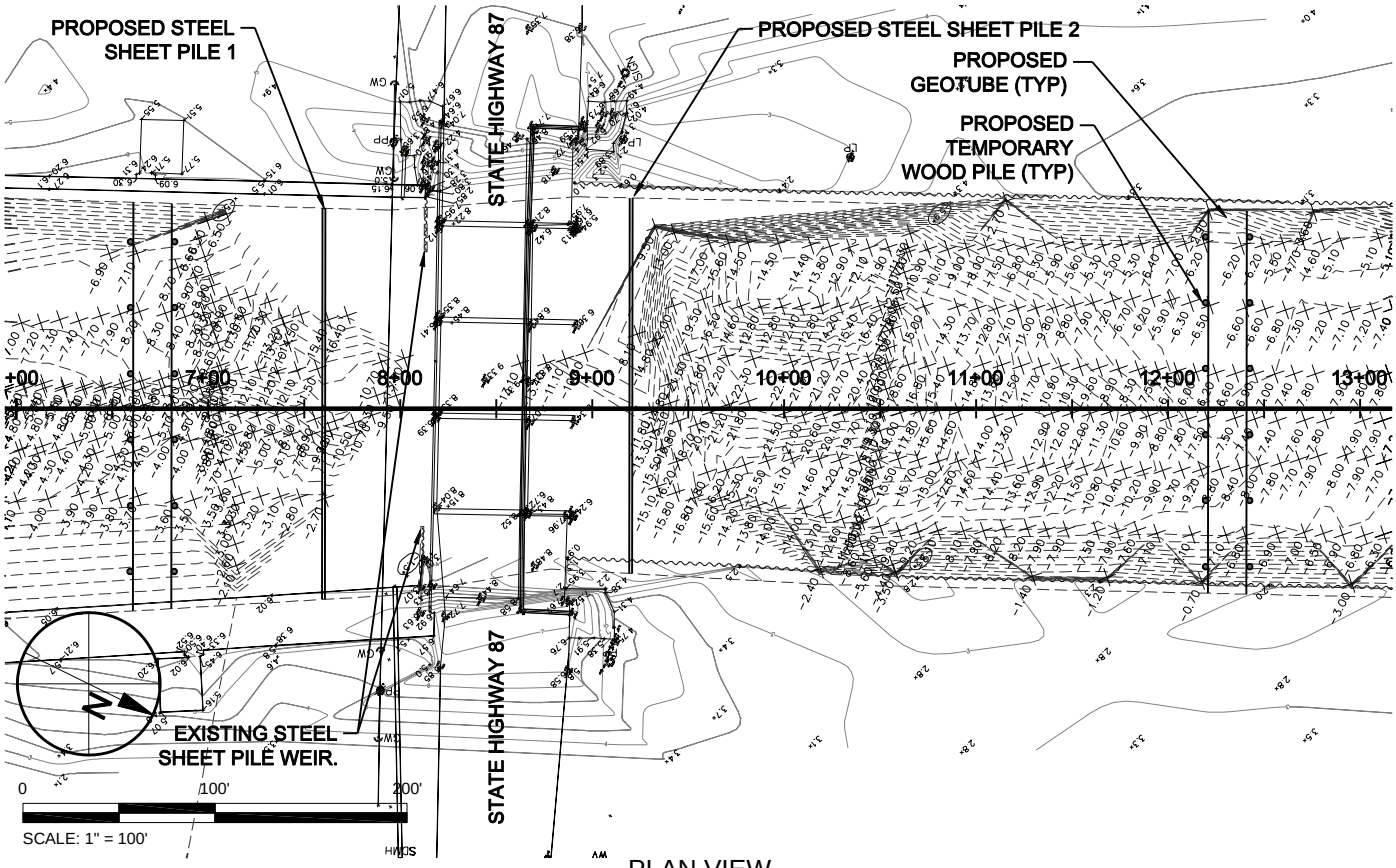
PROFILE VIEW

TAYLOR ENGINEERING INC.
10151 DEERWOOD PARK BLVD.
BLDG. 300, SUITE 300
JACKSONVILLE, FL 32256
CERTIFICATE OF AUTHORIZATION # 4815

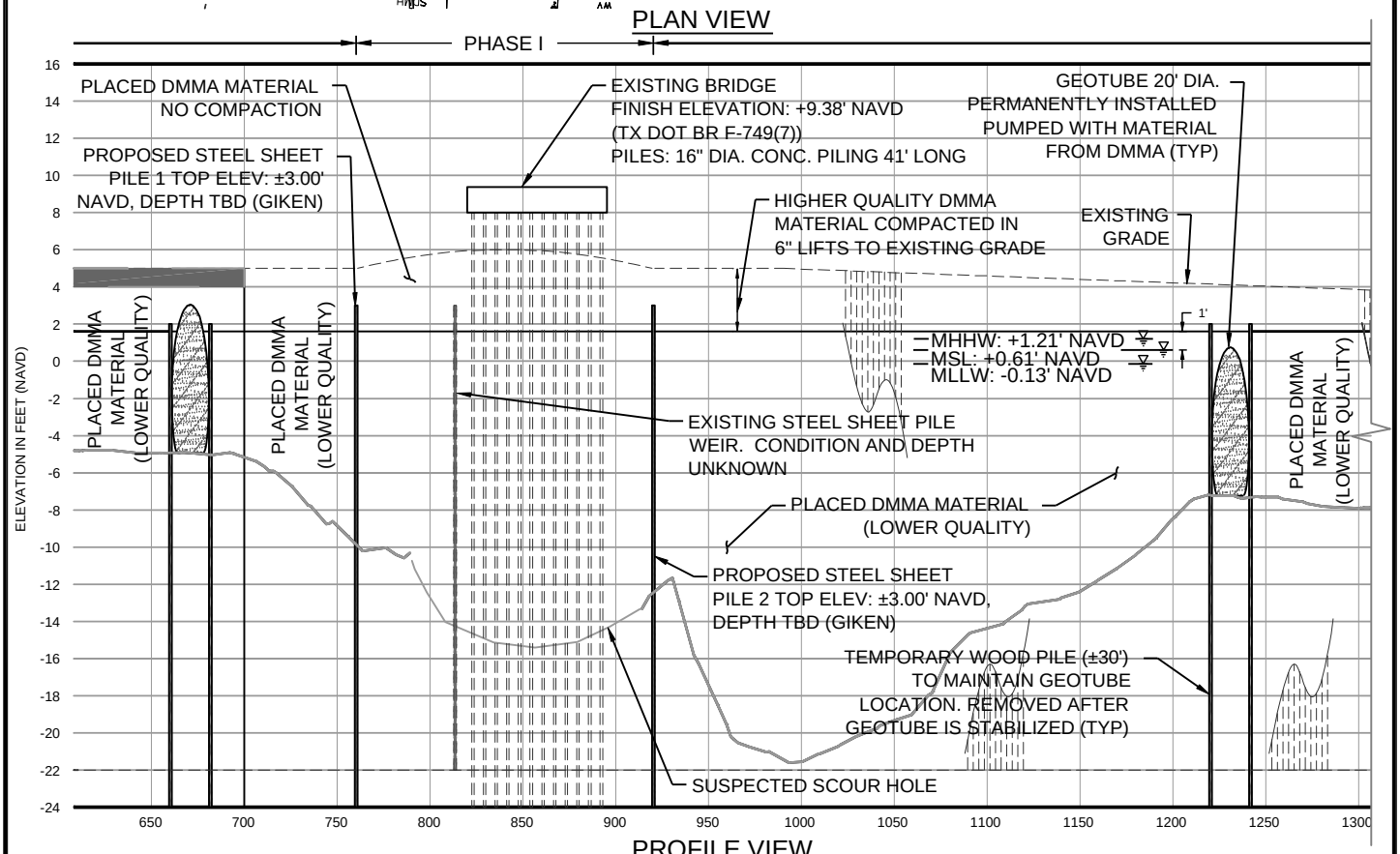
FIGURE 4
ROLLOVER PASS CLOSURE PLAN AND PROFILE
ROLLOVER PASS CLOSURE PROJECT
GALVESTON COUNTY, TEXAS

PROJECT	C2009-063
DRAWN BY	AF
SHEET	4 of 7
DATE	FEB 2010

ANTON FLEWELLING X:\SYS\PROJECTS\C2009-063 ROLLOVER PASS CLOSURE\FIGURES\LETTERSIZE\C2009-063-FLETTER-CLOSURE PLAN PROFILE.DWG 3/4/2010 11:02:09 AM



PLAN VIEW



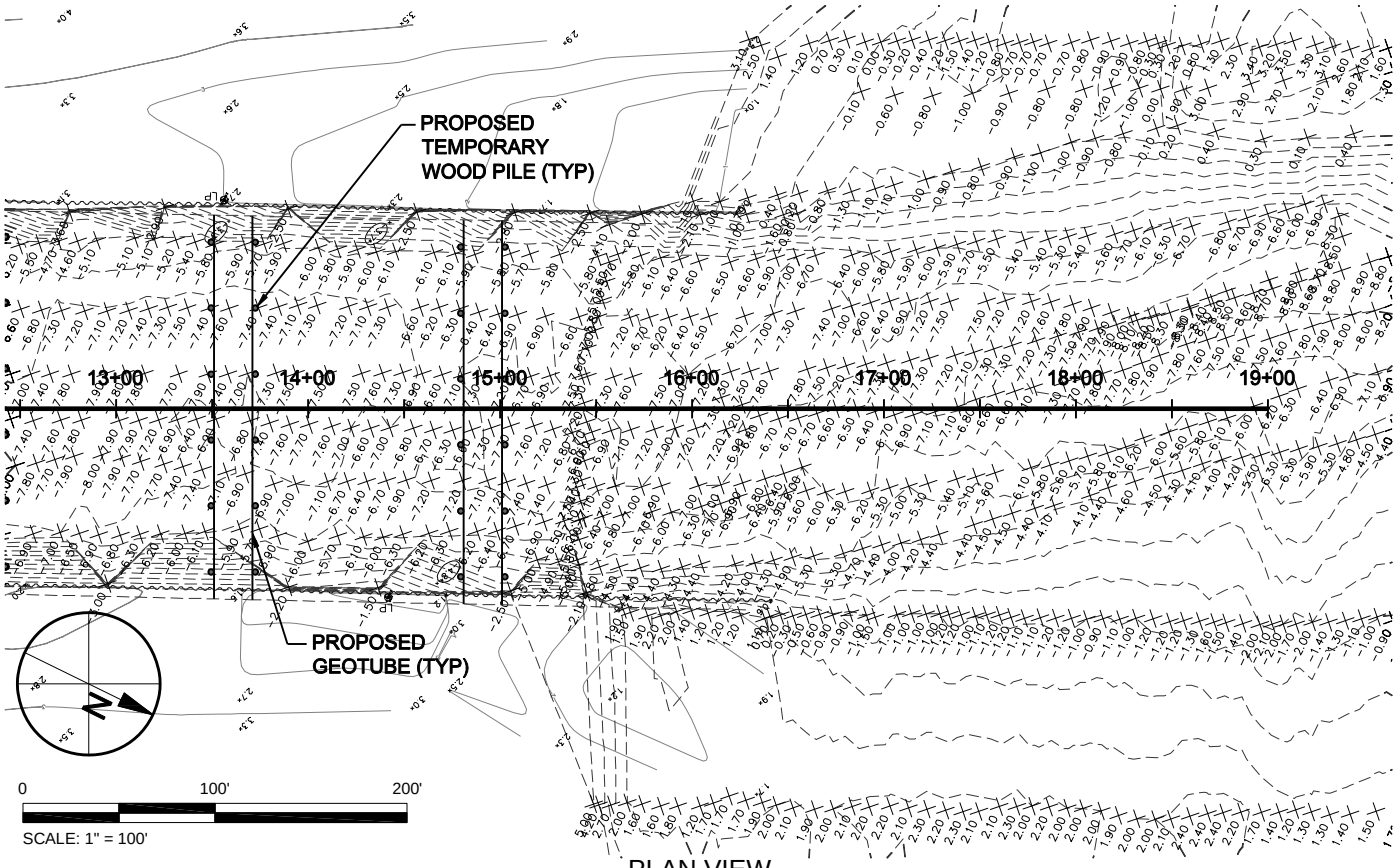
PROFILE VIEW

TAYLOR ENGINEERING INC.
10151 DEERWOOD PARK BLVD.
BLDG. 300, SUITE 300
JACKSONVILLE, FL 32256
CERTIFICATE OF AUTHORIZATION # 4815

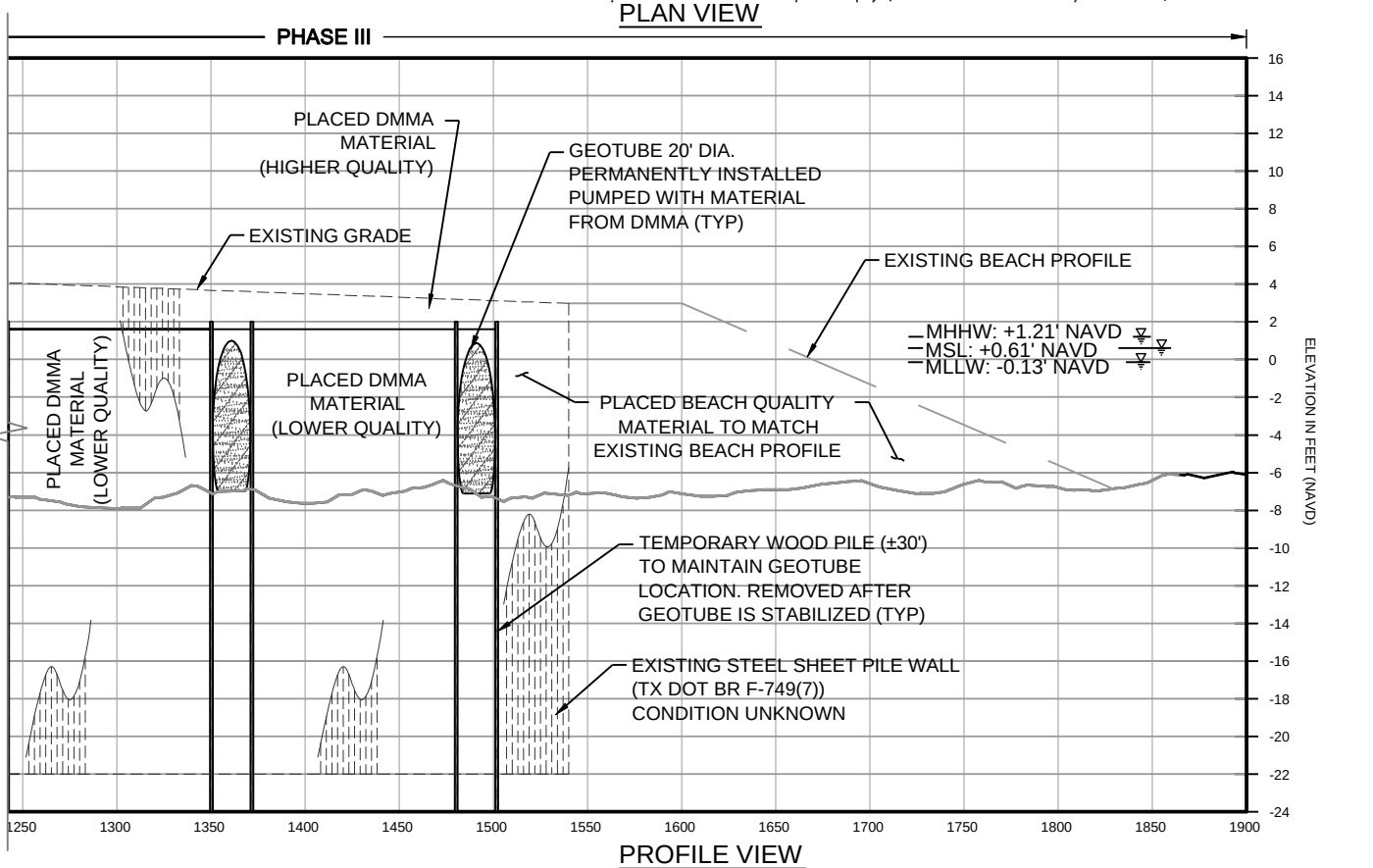
FIGURE 5
ROLLOVER PASS CLOSURE PLAN AND PROFILE
ROLLOVER PASS CLOSURE PROJECT
GALVESTON COUNTY, TEXAS

PROJECT	C2009-063
DRAWN BY	AF
SHEET	5 of 7
DATE	FEB 2010

ANTON FLEWELLING X:\SYS\PROJECTS\C2009-063 ROLLOVER PASS CLOSURE\FIGURES\LETTERSIZE\C2009-063-FLETTER-CLOSURE PLAN PROFILE.DWG 3/4/2010 11:05:13 AM



PLAN VIEW



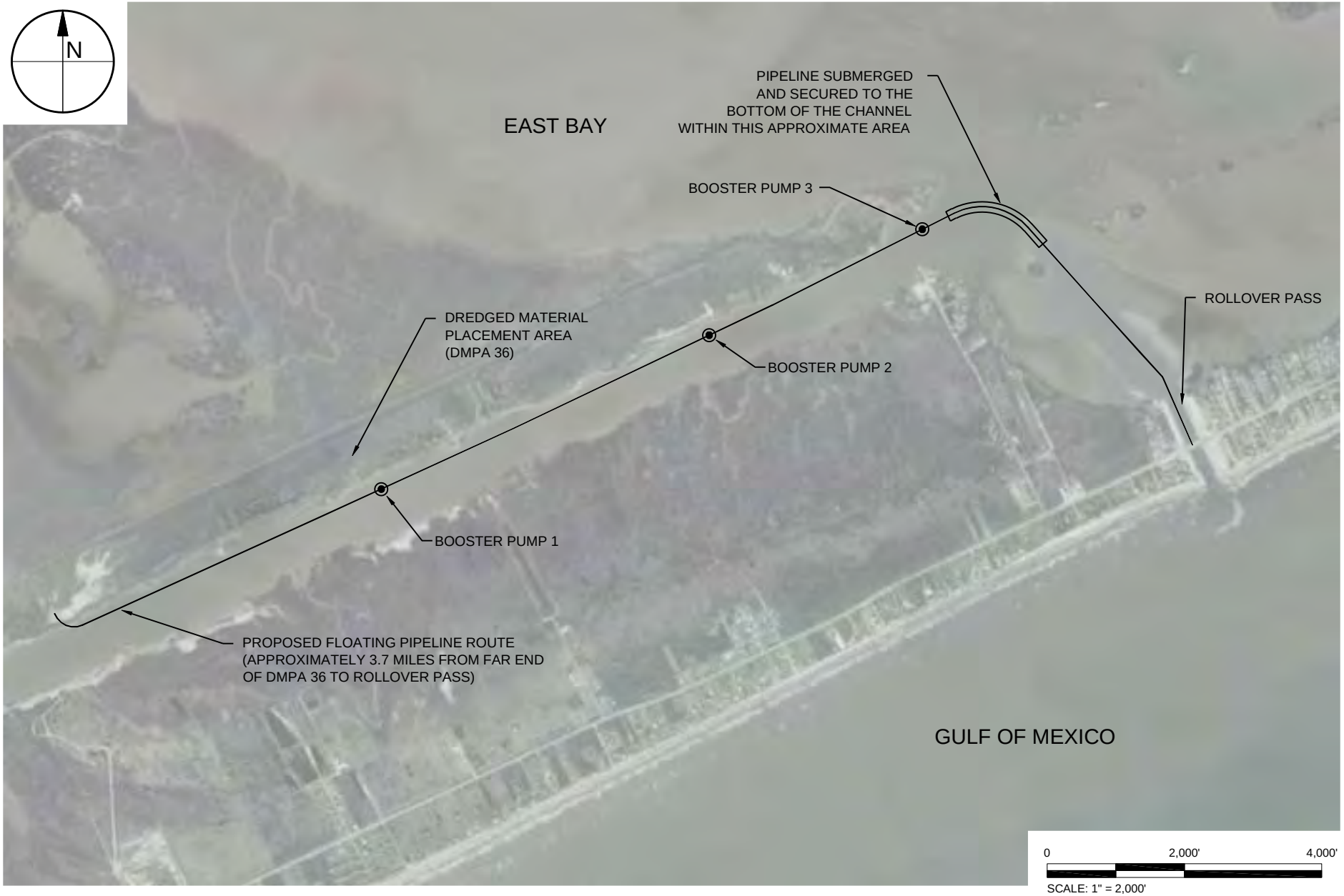
PROFILE VIEW

TAYLOR ENGINEERING INC.
10151 DEERWOOD PARK BLVD.
BLDG. 300, SUITE 300
JACKSONVILLE, FL 32256
CERTIFICATE OF AUTHORIZATION # 4815

FIGURE 6
ROLLOVER PASS CLOSURE PLAN AND PROFILE
ROLLOVER PASS CLOSURE PROJECT
GALVESTON COUNTY, TEXAS

PROJECT	C2009-063
DRAWN BY	AF
SHEET	6 of 7
DATE	FEB 2010

ANTON FLEWELLING X:\SYS\PROJECTS\C2009-063 ROLLOVER PASS CLOSURE\FIGURES\LETTERSIZE\C2009-063-FLETTER-CLOSURE PLAN PROFILE.DWG 3/4/2010 11:07:38 AM



ANTON FLEWELLING X:\SYS\PROJECTS\C2009-063 ROLLOVER PASS CLOSURE\FIGURES\LETTERSIZE\C2009-063-F-PIPEROUTE.DWG 2/12/2010 3:12:02 PM

TAYLOR ENGINEERING INC.
10151 DEERWOOD PARK BLVD.
BLDG. 300, SUITE 300
JACKSONVILLE, FL 32256
CERTIFICATE OF AUTHORIZATION # 4815

FIGURE 7
PIPELINE ROUTE
ROLLOVER PASS CLOSURE PROJECT
GALVESTON COUNTY, TEXAS

PROJECT	C2009-063
DRAWN BY	AF
SHEET	7 of 7
DATE	FEB 2010

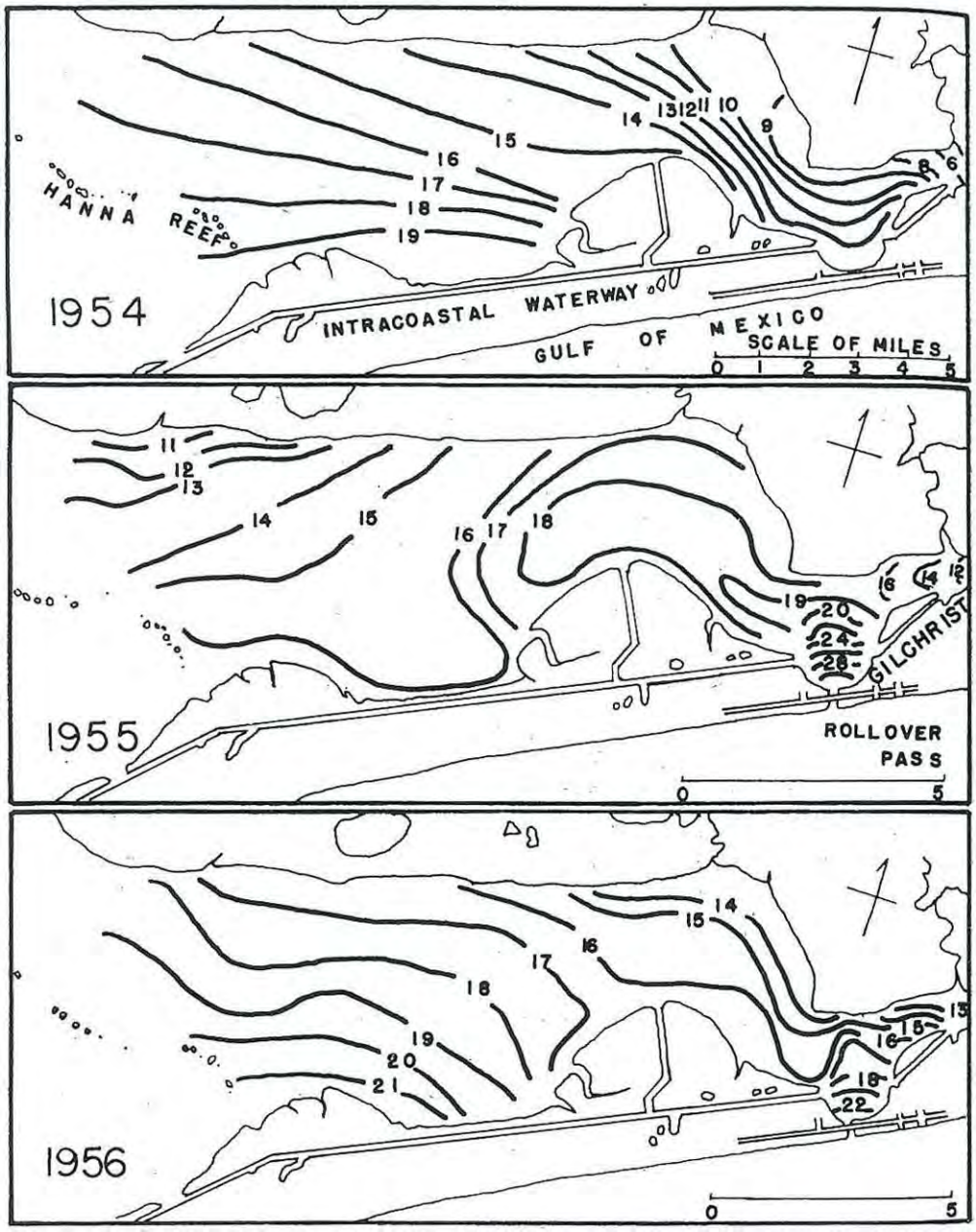


Figure 8 Salinity Distribution in East Bay, Texas from 1954 – 1956 as Reported in Reid (1958)

APPENDIX A

Analysis of Rollover Pass Impacts to Adjacent Beaches and the Littoral System
Galveston County, Texas
January 2010

Prepared by

Taylor Engineering, Inc.
10151 Deerwood Park Blvd
Building 300, Suite 300
Jacksonville, Florida 32256

Analysis of Rollover Pass Impacts to Adjacent Beaches and the Littoral System

Galveston County, TX

January 12, 2010

10151 Deerwood Park Blvd., Bldg. 300, Suite 300, Jacksonville, FL 32256
(904) 731-7040 ~ www.taylorengineering.com

Analysis of Rollover Pass Impacts to Adjacent Beaches and the Littoral System

Prepared for

Texas General Land Office

by

Taylor Engineering, Inc.
10151 Deerwood Park Blvd., Bldg. 300, Suite 300
Jacksonville, Florida 32256
(904) 731-7040

C2009-063

January 12, 2010

TABLE OF CONTENTS

1.0 INTRODUCTION **1**
2.0 ADVERSE IMPACTS **1**
2.1 Initial Effects **1**
2.2 Sediment Transport into Rollover Pass **2**
2.3 Beach Erosion **5**
3.0 1999 – 2008 SEDIMENT BUDGET **8**
3.1 Beach Volume Changes **8**
3.2 Longshore Sediment Transport Rates **8**
3.3 Sediment Transport into Rollover Pass **9**
3.4 Beach and Dune Nourishment and Dredging History **9**
3.5 Sediment Budget Results **9**
4.0 CONCLUSION **16**
REFERENCES **17**

LIST OF FIGURES

Figure 1 Observed Mean and Extreme Intracoastal Waterway Dredging Rates, Station 1700+00 to Station 2700+00, 1943–1980 (Source: Bales and Holley, 1989) 4
Figure 2 Cumulative Volume Dredged from Gulf Intracoastal Waterway, Station 1900+00 to Station 2450+00 (Source: Bales and Holley, 1989) 4
Figure 3 2008 Beach Contours near Rollover Pass (adapted from Galveston County, 2008) 7
Figure 4 Sediment Budget Cells 12
Figure 5 Sediment Budget Alternative 1 13
Figure 6 Sediment Budget Alternative 2 14

LIST OF TABLES

Table 1 Estimates of the Sediment Transport Rate into Rollover Pass 3
Table 2 1999 – 2008 Sediment Budget Nourishment Data and Dredging Volumes 11

1.0 INTRODUCTION

The Closure of Rollover Pass will immediately help reduce the rates of beach erosion along Bolivar Peninsula, reduce the required frequency and costs of Gulf Intracoastal Waterway (GIWW) maintenance dredging, and help improve the effectiveness of future beach restoration projects. The results of numerous studies — documenting the changes to the littoral system and their adverse impacts caused by Rollover Pass — from 1958 to the present support the above statement. This report summarizes the results of several past studies and introduces new data to demonstrate the Pass' adverse impacts and to support the stated project benefits. This report also develops a 1999 – 2008 sediment budget that summarizes beach volume changes and the sediment transport magnitudes and pathways, both natural and artificial, near Rollover Pass for the recent pre-Hurricane Ike period.

2.0 ADVERSE IMPACTS

Rollover Pass' adverse impacts on the coastal system began immediately after construction in 1955 and continue today. The impacts — namely, accelerated beach erosion and increased deposition in the GIWW — arise primarily from the Pass' flood-dominant characteristics that transport and deposit sediments into the Rollover and East Galveston bays and effectively diminish the natural sediment supply to the adjacent beaches. This process starves the beaches of the sand volume required to maintain the natural beach conditions; without this sand, erosion increases. Erosion also results from the trapping of littoral sediments against the Pass' updrift side and through ebb tidal effects. Similar to the above flood tidal process, the Pass' ebb tidal currents disrupt the natural longshore sediment transport by directing sediment offshore where they deposit in an ebb tidal shoal. Though the numerous studies disagree on impact quantities, the studies without exception acknowledge that Rollover Pass traps sediment that would normally reach the adjacent beaches, and consequently causes significant beach erosion and increases GIWW dredging requirements. The following sections discuss the initial effects of the Pass' construction, the trapping effect of the Pass' flood dominant characteristics, and beach erosion.

2.1 Initial Effects

The Texas Game and Fish Commission (now the Texas Parks and Wildlife Department) constructed Rollover Pass through a natural wash-over area, periodically breached during high tides and hurricanes, to improve local fishing conditions. The original Rollover Pass channel design included an 80-foot (ft) bottom width, an 8-ft depth, and sloping earthen sides throughout except for a steel sheet pile bulkhead along the southwest side. Unanticipated tidal currents through the Pass caused extensive erosion

as construction neared completion; the Gulf entrance widened to about 500 ft and the channel bottom scoured to a depth of 30 ft under the Highway 87 bridge. Immediate protection measures included additional pilings to protect the bridge abutments, groins along the northeast side of the Pass to stop erosion, and a protective cover of shell, broken concrete, stone and other rubble along all exposed banks (Prather and Sorensen, 1972). Subsequent erosion during unusually high tides in spring and summer of 1955 caused additional problems. The shoreline, extending approximately one mile southwest of the Pass, receded landward and undermined some houses, which were subsequently moved. Along the northeast side of the inlet; the Highway 87 bridge showed indications of possible scour damage. In November 1955, in an effort to stop erosion, a steel sheet pile wall, or sill, was constructed across the Pass 40 ft south of the bridge to close the Pass temporarily. Shortly thereafter, alternative piles of the sill were driven 2 ft below mean sea level to reopen a portion of the Pass. The Pass remained partially open until inlet stabilization measures were enacted in 1958 – 1959 based on U.S. Army Corps of Engineers (USACE, 1958) recommendations. Today, although the Pass remains open and various structural improvements have stabilized the inlet, chronic erosion problems still persist.

The beach and channel erosion that occurred immediately after construction of Rollover Pass demonstrate the Pass' significant sediment transport capability and its disruptive effect on the natural littoral system. The USACE, in 1958, authored the first of many reports aimed at correcting or managing the Pass' adverse impacts. The following sections cite relevant published data regarding the Pass' effects on the adjacent beaches and waterways.

2.2 Sediment Transport into Rollover Pass

Sediment transport directed into Rollover Pass represents the crux of the Pass' adverse impacts. Field measurements and analytical conclusions reported in several past studies (e.g., Bales and Holley [1985], Mason [1981], and Prather and Sorensen [1972]) document the flood-dominant characteristics of the Pass. The strong flood tidal currents intercept the natural longshore sediment transport and carry the sediment predominantly through the inlet into Rollover Bay and then into the deeper waters of the GIWW where the majority of sediment is deposited. This process directly increases adjacent beach erosion and the frequency and hence increases costs to the USACE to dredge the GIWW navigation channel in this area. Several studies have calculated the sediment transport rate into Rollover Pass. Although the estimates vary widely, the studies without exception agree that Rollover Pass adversely affects adjacent beach areas significantly by funneling sediments through the Pass into the adjacent Rollover Bay and GIWW areas.

Table 1 contains previously published estimates of sediment transport rates into Rollover Pass. The estimates, based on various calculation methods, range from 3,800 cy/yr to 290,000 cy/yr. Bales and Holley (1989) conducted a thorough analysis using three different methods. Bales and Holley acknowledged the limitations of all three calculation methods, and they considered the results based on longshore transport rates to be the least reliable due to the uncertainties in such rates and the results based on dredging records — "substantiated by limited direct measurements and by conditions in East Bay and Rollover Bay" — to be the most reliable. The dredging data presented in Bales and Holley document a dramatic increase in dredging requirements coinciding with the construction of Rollover Pass as shown in Figures 1 and 2. Notably, the Figure 2 data, which indicate a 290,000 cy/yr dredged-volume increase after Pass construction, include dredging volumes between GIWW stations 1900+00 and 2450+00. A more conservative estimate that includes only the portion of the GIWW within the confines of Rollover Bay indicates an 80,000 cy/yr increase in Rollover Pass dredging requirements (Bales and Holley, 1989).

Table 1 Estimates of the Sediment Transport Rate into Rollover Pass

Source	**Estimated Sediment Transport Rate (cy/yr)**	**Basis of Estimation**
USACE (1958)	18,000	Beach erosion rates
Bales and Holley (1989)	3,800 – 29,000	Percentage (i.e., 5 – 25%) of the longshore sediment transport rate
Bales and Holley (1989)	9,000 – 26,000	Beach erosion rates
Bales and Holley (1989)	240,000 – 290,000	GIWW dredging records
Bales and Holley (1989)	80,000	GIWW dredging records
Parchure (2000)	15,400	GIWW dredging records
Pacific International Engineering (2002)	>150,000	November 2000 – June 2001 bathymetric survey comparisons

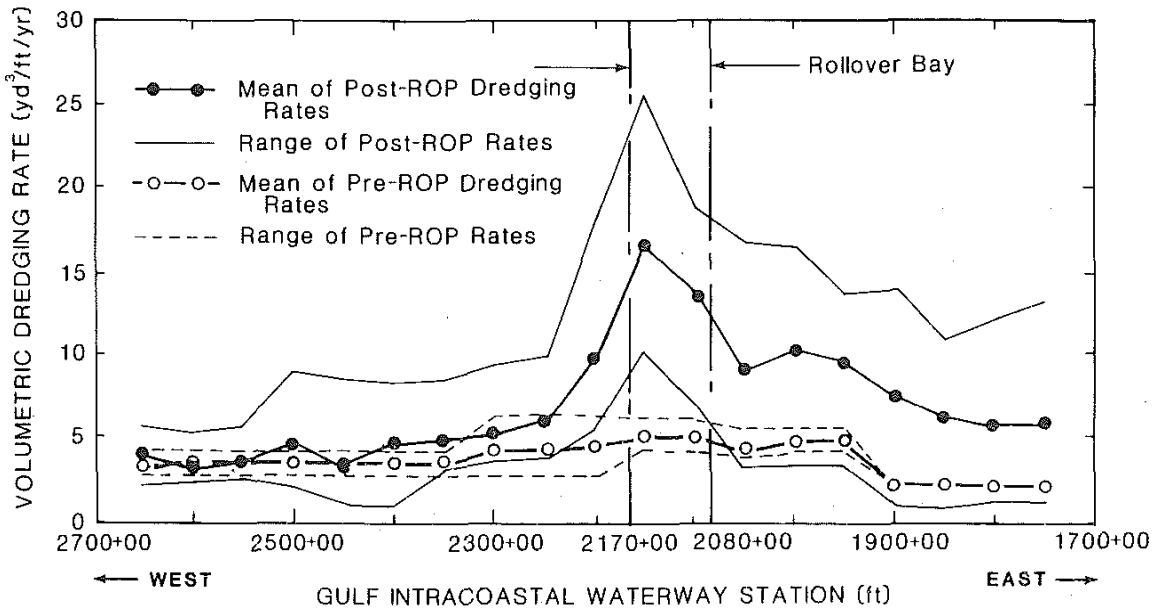


Figure 1 Observed Mean and Extreme Intracoastal Waterway Dredging Rates, Station 1700+00 to Station 2700+00, 1943–1980 (Source: Bales and Holley, 1989)

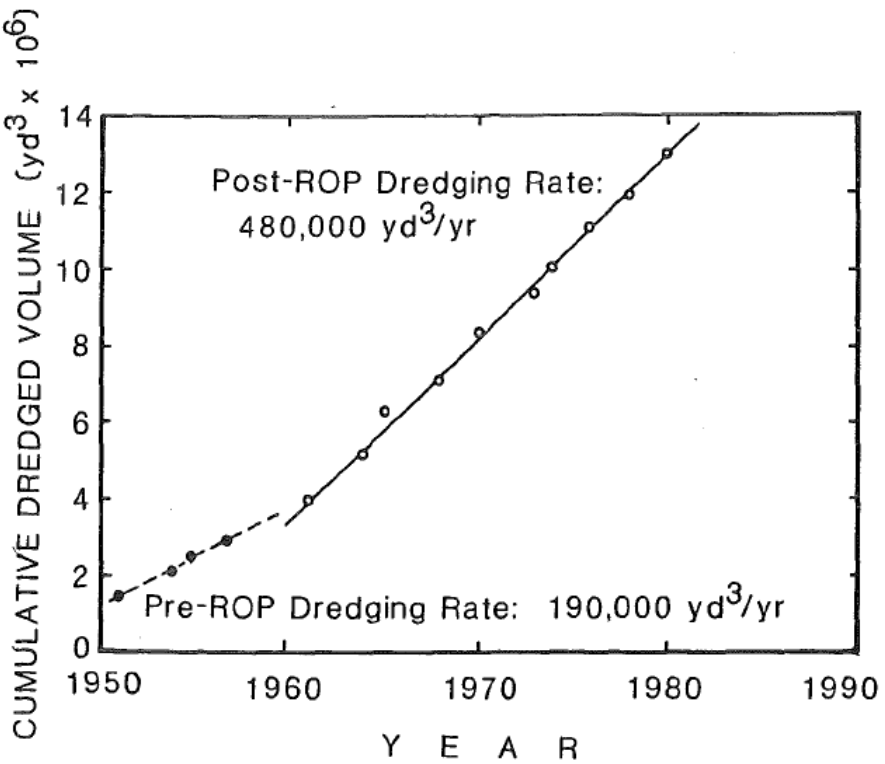


Figure 2 Cumulative Volume Dredged from Gulf Intracoastal Waterway, Station 1900+00 to Station 2450+00 (Source: Bales and Holley, 1989)

2.3 Beach Erosion

The beaches in the Rollover Pass vicinity would naturally experience background erosion absent the effects of Rollover Pass. However, as discussed above, Rollover Pass causes accelerated beach erosion by reducing the natural sediment supply to adjacent beaches. Numerous studies have documented such effects in terms of shoreline and beach volume change rates.

USACE (1958), as cited in Lockwood et al. (1974), calculated an average shoreline recession rate of 5 ft/yr from 1850 – 1956 (i.e., the data period selected by the study authors to represent pre-construction conditions). Subsequently, the USACE (as cited in Lockwood et al, 1974) documented an increased shoreline recession rate of 8.5 ft/yr from 1956 – 1974 within the first mile (5,280 feet) southwest of the Pass compared to a recession rate of 3 – 4 ft/yr over the next 10 miles (mi). In separate studies, Morton (1975) and the USACE, as cited in Mason (1981), found that shoreline recession rates varied between 15 – 25 ft/yr and between 7 – 14 ft/yr, respectively. Through analysis of beach profile changes, Mason (1981) estimated that Rollover Pass causes an additional 26,080 cy/yr of beach volume loss (i.e., erosion) over a 14,000-ft-long shoreline segment southwest of the Pass. Through analysis of aerial photographs of the beach within 6,900 ft of each side of the Pass, Bales and Holley (1989) estimated the Pass causes an additional 9,000 cy/yr of erosion within their study area southwest of the Pass. The above estimates clearly indicate that Rollover Pass has increased the shoreline recession and beach volume loss rates of the nearby beaches. Figure 3 illustrates the effect of adjacent erosion, indicated by the landward retreat of the beach contours (6.0 ft, 2.5-ft, and -2-ft contours shown) southwest of the Pass relative to the contours northeast of the Pass.

Recent studies by the USACE (2006) and Galveston County (2008) document beach changes without specifying the level of erosion caused by the Pass versus that caused by background conditions. The USACE (2006) calculated erosion rates of 42,500 cy/yr over an area extending 6,300 meters (m) (20,670 ft) southwest of the Pass and 36,000 cy/yr over an area extending 4,300 m (14,108 ft) northeast of the Pass. Galveston County (2008) analyzed 1999 – 2008 beach profile data to monitor beach changes associated with geotextile tube shore protection projects. The data, covering a 7-mile stretch of shoreline centered at the Pass, indicates the shoreline southwest of Rollover Pass receded 22.6 ft (2.5 ft/yr) on average and the northeast shoreline receded 4.5 ft (0.5 ft/yr). Though the above shoreline and volume changes do not specifically quantify the erosion caused by the Pass, the data clearly shows the southwestern (i.e. downdrift) beach suffers significantly more erosion than the northeastern beach.

Additionally, this erosion occurs despite the significant infusion of sand from beach and dune nourishment projects further discussed below.

Notably, the Bales and Holley and USACE (2006) volume change estimates originate from shoreline changes. Bales and Holley applied a sediment-volume conversion factor, developed by USACE (1984), of 0.7 cy per square foot of beach eroded to convert shoreline change to volume change. USACE calculated volumes changes by translating beach profiles (surveyed in 2002) by appropriate shoreline change distances (based on analysis of 1974, 1982, 1995 aerials and 2000 LIDAR topography by the University of Texas Bureau of Economic Geology). The USACE (2006) results correspond to conversion factors of 0.784 cy per square foot of beach eroded southwest of the Pass and 0.659 cy per square foot of beach eroded northeast of the Pass. The current study applied the conversion factors derived from USACE to the shoreline changes presented in Galveston County (2008) to calculate 1999 – 2008 beach volume changes extending 3.5 miles southwest and northeast of the Pass. The results indicate approximately 36,167 cy/yr of sand erode from the beach southwest of the Pass and 6,053 cy/yr erode northeast of the Pass within the monitoring area.

Figure 3 2008 Beach Contours near Rollover Pass (adapted from Galveston County, 2008)

3.0 1999 – 2008 SEDIMENT BUDGET

A sediment budget delineates sediment transport magnitudes and pathways and tallies sediment gains and losses within a specified domain. A 1999 – 2008 sediment budget for Rollover Pass provides an update to historic analyses cited above and helps evaluate the recent effects of the Pass. The sediment budget divides the Rollover Pass vicinity into three cells. These cells, illustrated in Figure 4, represent the beach extending 3.5 mi northeast of the Pass (cell 1), the beach extending 3.5 mi southwest of the Pass (cell 2), and the GIWW and Rollover Bay channel (cell 3). The following sections discuss the sediment budget input data — including beach volume changes, sediment transport rates, and beach nourishment and dredging data — and the sediment budget results.

3.1 Beach Volume Changes

As discussed above, Taylor Engineering calculated beach volume changes within cells 1 and 2. The volume estimates, based on shoreline change data reported in Galveston County (2008) and sediment volume conversion factors derived from USACE (2006) data, indicate erosion of 6,053 cy/yr in cell 1 and 36,167 cy/yr in cell 2. Notably, the conversion factors correspond to beach volume changes extending to -4 m (-13 ft) NAVD 88, the depth of closure as determined by the USACE (2006). Thus, the above erosion volumes theoretically represent volume changes to the same depth. Also of note, preferable volume changes based on direct comparison of beach profile surveys extending to the depth of closure are unavailable; however, the above estimates appear reasonable based on historic estimates similar in magnitude.

3.2 Longshore Sediment Transport Rates

Estimated in numerous studies, the longshore sediment transport rate near Rollover Pass is a critical component of the sediment budget. Bales and Holley (1989) reported previous estimates including 96,000 cy/yr (USACE, 1984), 75,000 cy/yr (Prather and Sorensen, 1972), 58,000 cy/yr (Mason 1981), and 54,000 cy/yr (Hall, 1976). All estimates represent a net southwesterly transport direction. The estimates of Mason and Hall include only wave-induced transport, whereas those of USACE and Prather and Sorensen include both wave and wind-current induced transport. Considering a separate USACE (1984) wind-induced transport estimate of 57,000 cy/yr, Bales and Holley (1989) present a possible 75,000 cy/yr – 115,000 cy/yr range of total longshore transport. In their study, the authors assume that addition of the independent wave- and wind-induced transport rates (i.e., addition of the 57,000 cy/yr wind-induced transport rate to the wave-induced rates estimated by Mason [1981] and Hall [1976])

reasonably represent the total rate. Recently, King (2007) applied numerical modeling techniques to simulate longshore sediment transport along Bolivar Peninsula. The sediment budget, which specifies the rate at the northeast boundary of cell 1, applies a transport rate of 91,600 cy/yr obtained from King.

3.3 Sediment Transport into Rollover Pass

As cited above, previous research led to a wide range of sediment transport estimates varying by an order of magnitude from 3,800 cy/yr to 290,000 cy/yr. This study selected a midrange of 80,000 cy/yr – 150,000 cy/yr based on data reported in Bales and Holley (1989) and PIE (2002). Notably, without any published data specifying the proportion of sand entering the inlet from the updrift and downdrift sides, this sediment budget assumes that 60% originates from the updrift beach. Notably, the 60% value corresponds to the southwesterly-directed proportion of gross sediment transport derived from King (2007). Numerical model results presented in King (2007) indicate gross sediment transport of roughly 650,000 cy/yr and net southwesterly sediment transport of roughly 133,500 cy/yr at the Pass. This data suggests the southwesterly-directed component of gross transport equals 391,750 cy/yr (or 60% of the gross transport) and the northeasterly-directed component equals 258,250 (or 40% of the gross transport).

3.4 Beach and Dune Nourishment and Dredging History

The sediment budget includes an average annual artificial placement of 64,675 cy/yr and 155,901 cy/yr of material onto the beaches northeast (cell 1) and southwest (cell 2) of Rollover Pass and removal of 185,668 cy/yr from the GIWW and Rollover Bay channel (cell 3) from 1999 – 2008. Taylor Engineering derived these quantities from annual beach and dune nourishment data (i.e., volumes, placement locations, and sand sources) from Galveston County (2008) and Texas General Land Office (personal communications) as presented in Table 2. Notably, cell 3 of the sediment budget corresponds to the reach associated with the dredging events documented in Table 2. Also, this analysis excludes a 2008 project that placed 134,700 cy southwest of the Pass; this nourishment event occurred after the 2008 survey used by Galveston County (2008) to determine shoreline changes.

3.5 Sediment Budget Results

Figures 5 and 6 illustrate alternative sediment budgets with differences that stem from different sediment transport rates entering the Pass. Alternative 1 (Figure 5) includes 80,000 cy/yr entering the Pass, and Alternative 2 (Figure 6) includes 150,000 cy/yr entering the Pass. Both alternatives specify the longshore transport rate (91,600 cy/yr) entering the domain cell 1 at the northeast boundary, the artificial transport (i.e. dredging and beach nourishment) magnitudes, and the proportions of transport entering the

Pass from updrift (60%) and downdrift (40%). All other transport rates — including transport into the GIWW from interior waters and longshore transport rates at the Pass (i.e. from cell to cell) and at the southwest domain boundary of cell 2— represent a balance of volumes such that the transport volume exiting a cell equals the sum of volumes entering the cell and volume changes within the cell. Both alternatives assume the net change within cell 3 equals zero (i.e., dredging rates equal deposition rates); thus, the sediment transport entering from interior bay waters equals the difference between the dredging rate and the sediment transport entering the Pass from offshore. Both alternatives assume zero offshore transport through the beach cell boundaries.

Comparison of Alternatives 1 and 2 provide insight into sediment transport as follows:

- Alternative 1 and Alternative 2 indicate that approximately 114,300 cy/yr and 72,300 cy/yr travel from the northeast beach cell (cell 1) to the southwest beach cell (cell 2). The greater transport into the Pass (Alternative 2), which diminishes sediment supply downdrift, accounts for the volume difference.

- Alternative 1 and Alternative 2 indicate that approximately 274,400 cy/yr and 204,400 cy/yr exit downdrift of the southwest beach cell (cell 2). Both estimates appear higher than previously estimated rates; the assumption of zero offshore transport and a possible underestimation of the transport into Rollover Bay could account for the higher than expected rates.

- Alternative 1 and Alternative 2 indicate 105,700 cy/yr and 35,700 cy/yr deposit into cell 3 via siltation from interior waters. The Alternative 1 estimate represents about 57% of the dredged volume. The Alternative 2 estimate represents about 19% of the dredged volume. Historic dredging records discussed above show evidence of increased deposition after construction of Rollover Pass, and several studies hypothesize that sediment transported from the beach rather than the bay region comprise the majority of deposited sediments. As such, the above results suggest that the 80,000 cy/yr transport of Alternative 1 underestimates the actual transport rate into the Pass.

Table 2 1999 – 2008 Sediment Budget Nourishment Data and Dredging Volumes

Year	Nourishment Type	Volume (cy)	Sand Source
Northeast Shoreline Nourishments (Cell 1)			
2000	Beach	300,000	Rollover Bay[3] (dredge placement)
2000	Dune	22,000[2]	Upland source (truck haul)
2001	Dune	17,800	Upland source (truck haul)
2003	Beach	104,000	GIWW (dredge placement)
2004	Beach	74,274	GIWW (dredge placement)
2005	Dune	64,000	Upland source (truck haul)
Total	-	582,074	-
1999 – 2008 annual average	-	64,675	-
Southwest Shoreline Nourishments (Cell 2)			
1999	Beach	175,000	GIWW (dredge placement)
2000	Beach	138,400	GIWW (dredge placement)
2000	Dune	22,000[2]	Upland source (truck haul)
2001	Beach	126,000	GIWW (dredge placement)
2001	Dune	6,600	Upland source (truck haul)
2002	Beach	119,000	GIWW (dredge placement)
2004	Beach	102,523	Upland source (truck haul)
2004	Dune	8,247	Upland source (truck haul)
2005	Beach	361,000	GIWW (dredge placement)
2005	Dune	71,000	Upland source (truck haul)
2006	Beach	87,737	GIWW (dredge placement)
2007	Beach	185,600	GIWW (dredge placement)
Total	-	1,403,107	-
1999 – 2008 annual average[1]	-	155,901	-
Dredging Volumes (Cell 3)			
1999 – 2008 Total[1]	-	1,371,011	GIWW
	-	300,000	Rollover Bay channel[3]
	-	1,671,011	Cell 3 total
1999 – 2008 annual average[1]	-	152,335	GIWW
		33,333	Rollover Bay channel[3]
		185,668	Cell 3 total

[1]The data excludes a 2008 nourishment of the southwest shoreline that placed 134,700 cy of GIWW dredged material; this event occurred after the 2008 survey that defines the sediment budget period.
[2]Event included placement of 44,000 cy southwest and northeast of the Pass, but the placement distribution is unknown to the study authors. Thus, the data presented above assumes equal distribution to both sides of the Pass.
[3]The 2000 dredging event removed sediment from the permitted borrow area located along the Rollover Bay channel.

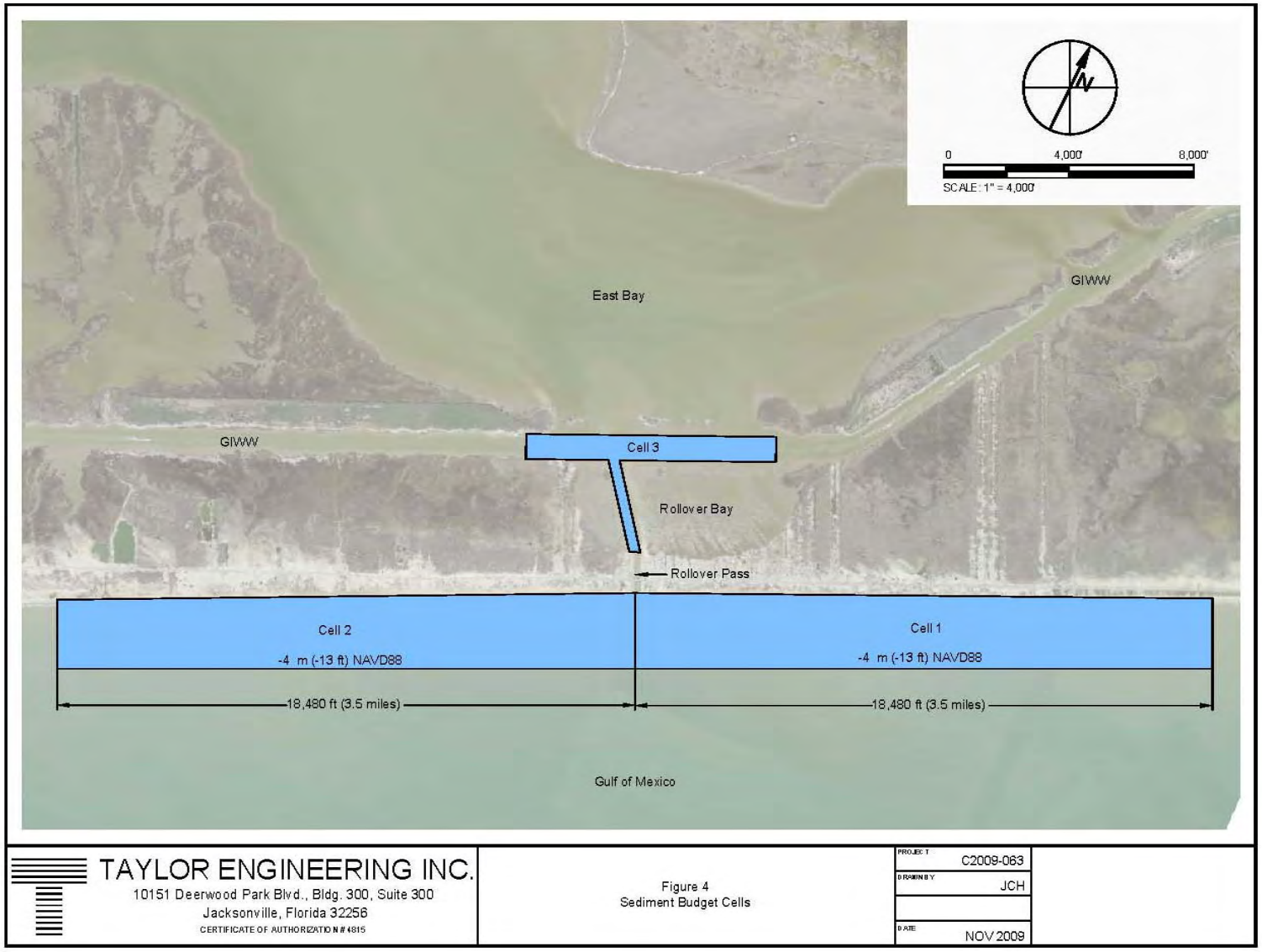


Figure 4 Sediment Budget Cells

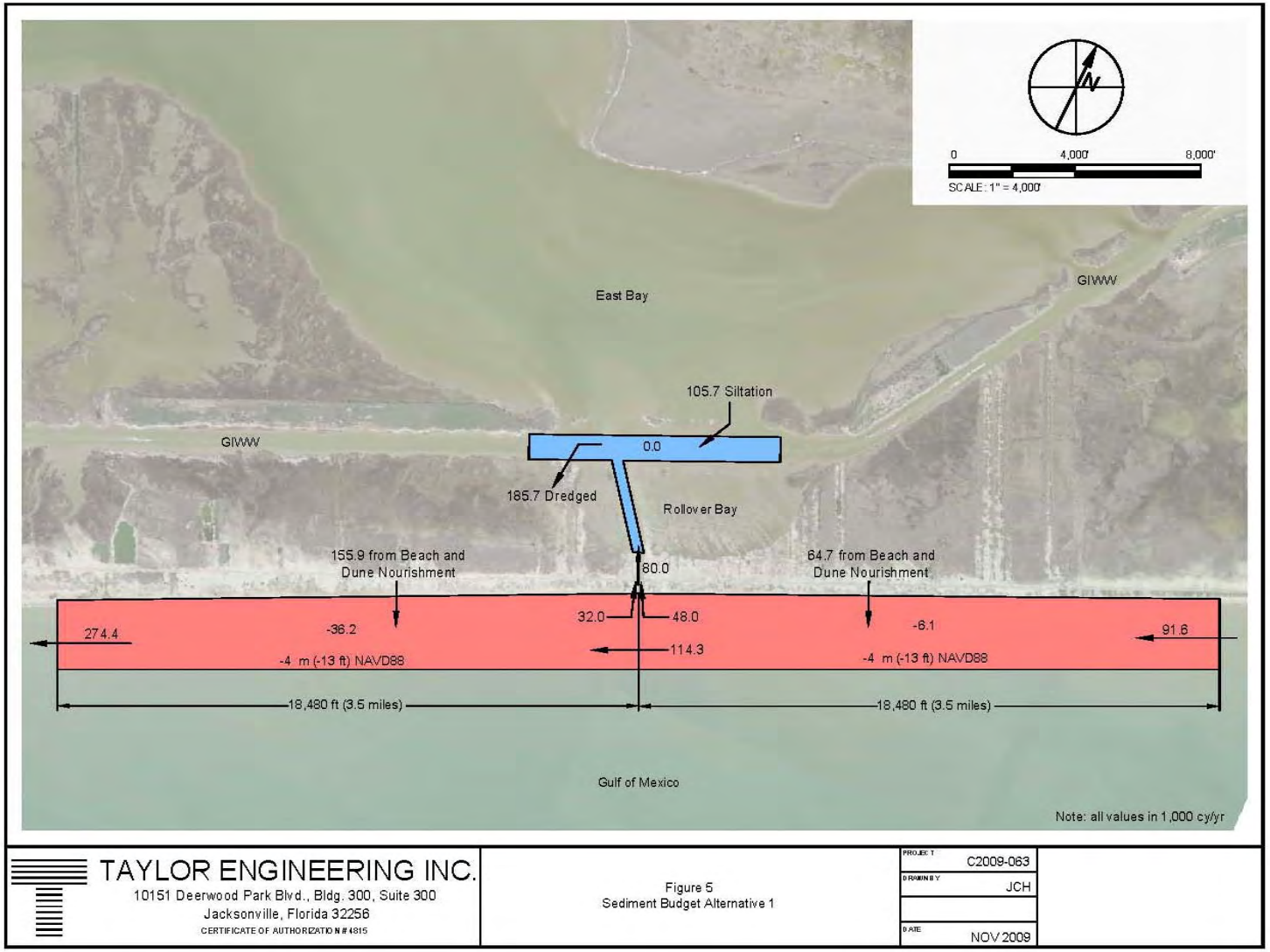


Figure 5 Sediment Budget Alternative 1

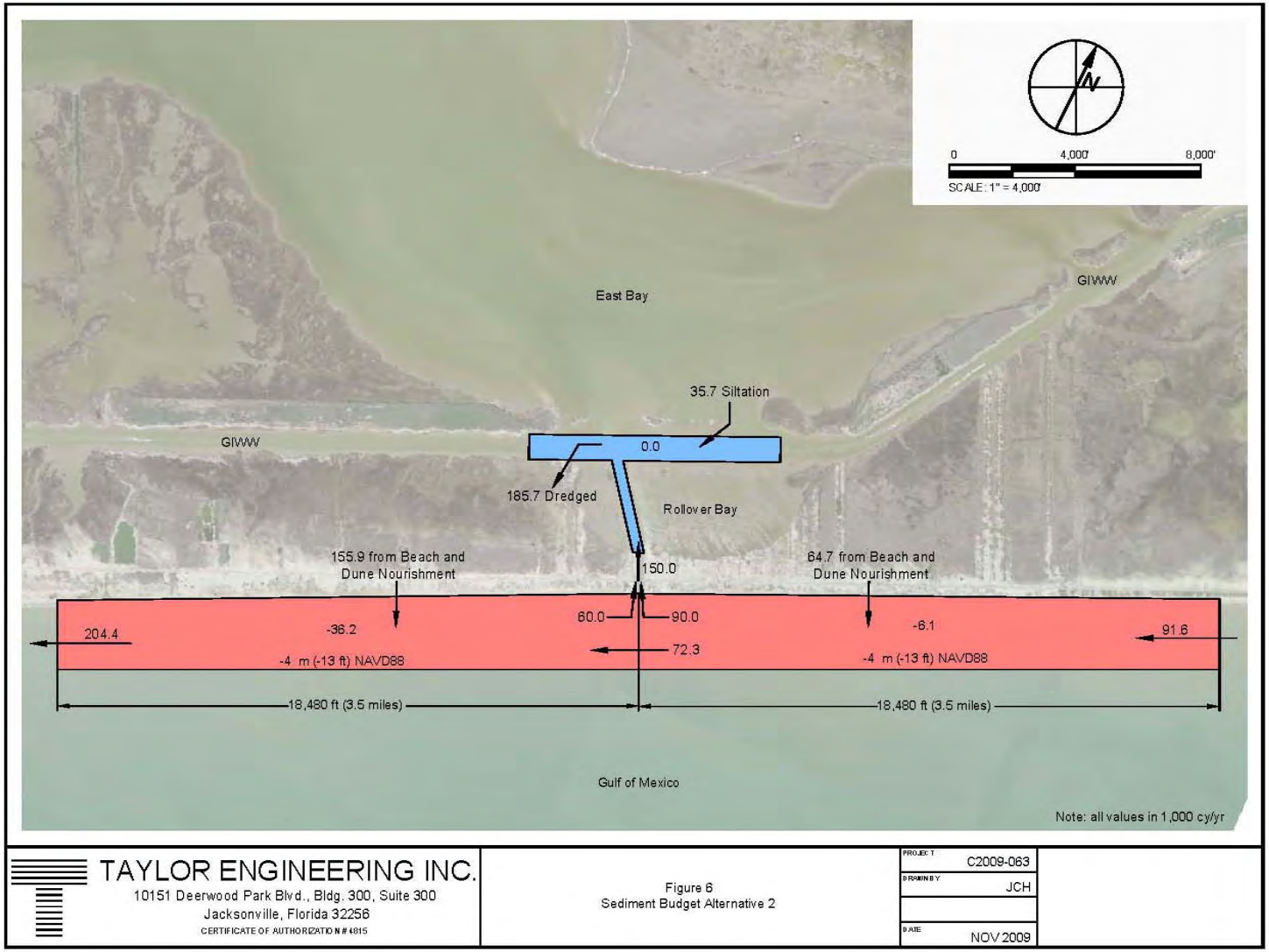


Figure 6 Sediment Budget Alternative 2

In summary, the sand transport rate into Rollover Pass remains debatable, but the sediment budget results suggest rates of 150,000 cy/yr or more are likely. Closing Rollover Pass would eliminate this sediment transport pathway and return the littoral system to a more natural state. In effect, the longshore transport will feed the beaches as naturally intended and alleviate the accelerated erosion rates caused by the Pass. Eliminating the sediment pathway into the Pass will also reduce deposition in the GIWW and Rollover Bay and help decrease the high dredging frequency currently required to maintain the GIWW. Additionally, future beach restoration projects, subject only to background erosion rates rather than the accelerated rates from the Pass, should perform more effectively.

4.0 CONCLUSION

This report cited numerous studies from 1958 to the present that indicate Rollover Pass causes significant erosion of the adjacent beaches and increases the frequency and, hence, costs to dredge the GIWW. Such adverse impacts arise primarily from the Pass' flood dominant characteristics that transport material from the natural littoral zone into the Pass interior. This report also developed an alternative 1999 – 2008 sediment budgets that summarize the beach volume changes and the sediment transport magnitudes and pathways, both natural and artificial, near Rollover Pass for the recent pre-Hurricane Ike period. The sediment budget alternatives suggest that a sediment transport rate of 150,000 cy/yr or more into Rollover Pass appears likely. Collectively, the results of this study justify closure of Rollover Pass to help reduce erosion of the adjacent beaches, reduce the required frequency and costs of GIWW maintenance dredging, and help improve the effectiveness of future beach restoration projects.

REFERENCES

Bales, J.D. and E.R. Holley. 1989. *Sand Transport in Texas Tidal Inlet*. Journal of Waterway, Port, Coastal, and Ocean Engineering, v. 115, no. 4, p. 427-443.

Bales, J.D. and E.R. Holley. 1985. *Evaluation of Existing Conditions and Possible Design Alternatives at Rollover Fish Pass, Texas.* Center for Research in Water Resources. Austin, Texas.

King, D.B. 2007. *Wave and Beach Processes Modeling for Sabine Pass to Galveston Bay, Texas, Shoreline Erosion Feasibility Study*. ERDC/CHL TR-07-6. Coastal and Hydraulics Laboratory, U. S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Lockwood, Andrews, and Newnam, Inc. 1974. *Localized Erosion at Rollover Fish Pass, Bolivar Peninsula, TX*. Galveston, Texas.

Mason, C. 1981. *Hydraulics and Stability of Five Texas Inlets*. Miscellaneous Report No. 81-1, U. S. Army Corps of Engineers Coastal Engineering Research Center, Fort Belvoir, Virginia.

Morang, A. 2006. *North Texas Sediment Budget, Sabine Pass to San Luis Pass.* ERDC/CHL TR-06-17, Coastal and Hydraulics Laboratory, U. S. Army Engineer Research and Development Center. Vicksburg. Mississippi.

Morton, R.A.. 1975. *Shoreline Changes Between Sabine Pass and Bolivar Roads*. Circular 75-6, Bureau of Economic Geology, University of Texas, Austin, Texas.

Pacific International Engineering. 2002. *Physical Processes, Engineering Analysis and Environmental Impacts.* Austin, Texas.

Parchure, T.M., Brown, B., and R.T. McAdory. 2000. *Design of Sediment Trap at Rollover Pass, Texas.* ERDC/CHL TR-00-23, Coastal and Hydraulics Laboratory, U. S. Army Engineer Research and Development Center. Vicksburg. Mississippi.

Prather, S.H. and R.M. Sorensen. 1972. *A Field Investigation of Rollover Fish Pass, Bolivar Peninsula, Texas.* Texas A&M University. Austin, Texas.

U.S. Army Corps of Engineers. 1958. *Report on Beach Erosion Control Cooperative Study of the Gulf Shore of Bolivar Peninsula, Texas (Erosion at Rollover Fish Pass).* Galveston, Texas.

APPENDIX B

Vegetative and Ecological Community Characterization Report
Rollover Pass Closure Studies
November 2009

Prepared by

Corrigan Consulting, Inc.
12000 Aerospace Avenue, Suite 450
Houston, Texas 77034

VEGETATIVE AND ECOLOGICAL COMMUNITY CHARACTERIZATION REPORT

ROLLOVER PASS CLOSURE STUDIES

Prepared for:

TAYLOR ENGINEERING, INC.
JACKSONVILLE, FLORIDA

November 2009

Prepared by:

CORRIGAN CONSULTING, INC.
an environmental consulting firm
12000 Aerospace Avenue, Suite 450
Houston, Texas 77034
(281) 922-4766

CCI Project No. 09-141

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Scope of Work 1
1.2 Project Summary 1
1.3 Project Area 1
2 METHODOLOGY 2
2.1 The Cowardin Classification System 2
2.2 Limitations 2
2.3 Survey Data 2
2.4 Data Analysis 2
3 RESULTS 4
3.1 Priority Area 1 – Rollover Bay 4
3.1.1 Rollover Bay East 4
3.1.2 Rollover Bay West 6
3.1.3 Rollover Pass 7
3.1.4 Intracoastal Waterway Islands 8
3.1.5 Inland Communities 9
3.1.6 Beach & Gulf Side of Rollover Pass 10
3.2 Priority Area 2 – Western Portion of Intracoastal Waterway 10
3.2.1 North Shore of Priority Area 2 10
3.2.2 South Shore of Priority Area 2 12
3.2.3 Goat Island 14
3.3 Priority Area 3 – Eastern Portion of Intracoastal Waterway 15
3.3.1 North Shore of Priority Area 3 15
3.3.2 South Shore of Priority Area 3 17
3.4 Priority Area 4 – North Shore of East Galveston Bay 17
4 DISCUSSION 18

1 INTRODUCTION

1.1 Scope of Work

Corrigan Consulting, Inc. was retained by Taylor Engineering, Inc. to prepare a Vegetative Mapping and Community Characterization Report to provide the Texas General Land Office (GLO) with an accurate vegetative and ecological resource data set including maps, vegetative community descriptions, a GIS data set, and a report of our findings. More specific descriptions of habitats and communities were also requested in the areas immediately adjacent to Rollover Pass and a proposed borrow area. In addition to this, a description of the vegetative components to the species level and a general assessment of the functional value of these resources was requested. This task is in support of an Environmental Assessment (EA) for the proposed closure of Rollover Pass in Crystal Beach, Texas.

1.2 Project Summary

Rollover Pass is located on the Bolivar Peninsula in Crystal Beach, Galveston County, Texas. Rollover Pass is approximately 200 feet in width and connects Galveston Bay with the Gulf of Mexico. In 2008, Rollover Pass and Crystal Beach as a whole was severely impacted from flooding and a storm surge exceeding 12 feet during Hurricane Ike.

Rollover Pass is a man-made channel that cuts through the Bolivar Peninsula and links the Gulf of Mexico with Rollover Bay and East Bay. The pass was opened in 1955 by the Texas Game and Fish Commission to increase bay water salinity, promote growth of submerged vegetation, and facilitate movement of marine fish to and from spawning and feeding areas in the bay.

In May 2007, the Texas Legislature passed legislation to close Rollover Pass. The pass has been identified as contributing to severe erosion on the beaches to the southwest because sediment moves into the pass instead of around it. Dredging by the Corps of Engineers to maintain the Intracoastal Waterway (ICWW) channel adjacent to the pass exceeds $1 million annually.

The GLO is currently preparing an EA to close Rollover Pass as a habitat restoration initiative. It is hypothesized that sedimentation will occur from water movement towards the newly closed area and create additional critical habitat for federally endangered species.

1.3 Project Area

The Project Area consists of approximately 50 square miles of East Galveston Bay from its terminus at the confluence of the ICWW and Oyster Bayou and extends west to the western-most tip of Goat Island. It includes the entire landward extent of Bolivar Peninsula between these two points as well as a portion of the northern shore of East Galveston Bay (Attachment A, Figure 1).

2 METHODOLOGY

2.1 The Cowardin Classification System

This project uses the Cowardin Classification System to uniquely identify wetland types within the Project Area. This system was developed by Lewis M. Cowardin for the US Fish and Wildlife Service (USFWS), and it is currently used by the USFWS to classify wetlands. Water regime is a primary evaluation metric of this system which uses a fairly complex hierarchical scheme that separates wetlands into two classifications: Coastal (marine) and Inland (non-marine) systems. Secondary alpha-numeric designations are assigned in order to derive a unique code for a number of habitats or community types. A chart used to classify communities is included in Attachment B of this report.

2.2 Limitations

As discussed in the previous section, classification of the various habitats and vegetative communities was achieved by employing the National Wetland Inventory's (NWI) Cowardin Classification System; the system chosen by the USFWS to differentiate wetlands for other terrestrial communities for the purposes of establishing a relatively efficient inventory tool. By categorizing wetlands using a metric water regime, which is the common denominator inherent to all wetlands, various communities can be identified as discrete entities. Upland communities, beyond their inherent lack of a water regime, are not so easily defined beyond the fact that they are uplands. Most, if not all upland communities within the Project Area are classified only as uplands with no specific designations assigned to them to indicate the presence of vegetative associations such as dunes, interdunal swales, or meadows. Additionally, groundtruthing and mapping signatures of the many reticulate palustrine wetland assemblages was deemed arbitrary and impractical; therefore, resources were focused towards the mostly estuarine communities associated with the proposed impact area.

2.3 Survey Data

CCI utilized a 2002 NWI Geographic Information System (GIS) layer (provided by Texas Natural Resource Information System) and compared the 2009 true color aerials (also provided by Taylor Engineering, Inc.) to determine obvious changes in the landscape due to erosion, effects from Hurricane Ike, and general land transformation over time in the Project Area. CCI then identified areas of concern to be field-verified during the field reconnaissance portion of the study.

2.4 Data Analysis

CCI employed a field crew to verify portions of the Project Area on October 13 and 14, 2009. Field verification was done both by boat and by automobile. The Project Area was divided into four Priority Areas. The Priority Areas were assigned with respect to their adjacency to Rollover Pass. Priority Area 1 included Rollover Pass and its surrounding islands and areas immediately adjacent. Priority Area 2 included the north and south shore of the western portion of the ICWW. Priority Area 3 included the north and south shore of the eastern portion of the ICWW. Priority Area 4 consisted of the entire north

shore of East Galveston Bay in the Project Area. The word “priority” implies no specific ranking of effort or importance of the different areas.

CCI-utilized maps and data provided by Taylor Engineering to field-verify areas of concern with respect to areas presumed to be markedly altered from 2002 to 2009, and with respect to notable habitats or differences in mapped vegetation and community types within the Project Area. Documentation in the form of photographs, notes, and GPS points were taken to identify changes in the landscape. In addition to this, any critical or essential habitats and unique ecosystems were also noted. Fauna was also noted as field work was done, and used to supplement the habitat characterization within the Project Area.

3 RESULTS

Results of the aerial mapping and field verification are presented here and in electronic format as ArcGIS Shapefiles, separated by Priority Area. An Overall Priority Area map (Attachment A, Figure 1) outlines the location and boundary of each of the four defined Priority Areas (Attachment A, Figures 2-5). Within each Priority Area, Cowardin wetland classifications are identified by color. In addition to this, dominant community types and other select features are labeled for clarity. Open water features were left uncolored.

An umbrella list of characteristic vegetation encountered within the Project Area is provided in Appendix C, Table 1. Additionally, a list of avifauna and invertebrate species encountered are included in Appendix C, Tables 2 and 3, respectively.

3.1 Priority Area 1 – Rollover Bay

Priority Area 1 is broken down into five separate areas for discussion that include: 1) Rollover Bay East, the portion of Rollover Bay to the east of Rollover Pass, 2) Rollover Bay West which include the portion of Rollover Bay west of Rollover pass, 3) Rollover Pass proper, 4) the islands and shoals located in the mouth of the bay that line either side of the ICWW, and 5) the inland communities in the vicinity of Rollover Pass (See Attachment A, Figure 2).

3.1.1 Rollover Bay East

Rollover Bay East (ROBE) is dominated by large expanses of intertidal mudflats (E2USM) that are exposed during low tide events. Depending upon the severity of the low tide, these exposed mudflats extend out from Bolivar Peninsula to the channel islands at the south bank of the ICWW and eastward until nearly the entire eastern portion of Rollover Bay is exposed (See Photo 1). These flats were at the time of field verification unvegetated, and with the exception of two discrete oyster beds (E2RF) located near the western end of ROBE, the mudflats were devoid of any perennial biotic communities (See Photo 2).

During surveys of this area, a large number of colonial shore birds including *Pelecanus occidentalis* (Brown pelican), *Pelecanus eryhtrorhynchos* (American white pelican), *Larus atricilla* (Laughing gull) and *Sterna maxima* (Royal tern) were observed roosting on more elevated stretches of the flats. Additionally, *Charadrius alexandrinus* (Snowy plover), *Charadrius wilsonia* (Wilson's plover), *Recurvirostra Americana* (American avocet), *Catotrophorus semipalmatus* (Willet), and *Himantopus mexicanus* (Black-necked stilt) were observed foraging in the shallow pools encumbered within the flats during these low tide events (See Photo 3). This particular expanse of mudflats appears to represent the single largest contiguous stretch of this habitat in the entire East Galveston Bay survey area and represents a significant portion of foraging habitat for migratory shore birds. However, due to the presence of persistent intertidal pools near the interface of the bay and the high marsh of Bolivar Peninsula, in addition to the lack of an intermediate marsh ecotone, the functions of this habitat beyond roosting and foraging appear to be somewhat diminished. A portion of Rollover Bay East east of the channel had been previously identified and permitted as a borrow area for beach renourishment. This area, with its extensive intertidal mudflats, constitutes critical

habitat for the federally endangered piping plover, and would likely no longer remain suitable as a borrow area.

Photo 1: Rollover Bay East exposed mud flat.

Photo 2: Rollover Bay East oyster reef.

Photo 3: Rollover Bay East birds resting and foraging.

3.1.2 Rollover Bay West

In contrast to ROBE, Rollover Bay West (ROBW) is substantially smaller in area and lacks the immense expanses of intertidal mudflats at low tide that are present to the east. The mudflats within ROBW are restricted to those intertidal areas adjacent to the bayside channel of Rollover Pass and associated with side-cast dredge spoil islands that will be discussed more in depth in Section 3.1.4. The majority of ROBW is a shallow, subtidal embayment (E2USM) with a western shore that is primarily buffered by intertidal marsh, and contains some upland areas associated with residential properties (See Photo 4).

Photo 4: Rollover Bay West shore and residential areas.

3.1.3 Rollover Pass

Rollover Pass consists of a dredged channel connecting East Galveston Bay to the Gulf of Mexico (Gulf). The Rollover Pass channel is deepwater habitat that facilitates tidal exchanges and the passage of fish and other marine fauna between the Gulf and East Bay. North of the ICWW at the intersection of the ICWW and Rollover Pass, intertidal islands composed of mainly oyster shells and unconsolidated sediments line the channel on either bank. These features appear to have resulted from the side-cast disposal of dredge material from periodic channel maintenance.

These areas are subtidal and provide roosting and foraging habitat for shore birds. These areas primarily consist of regularly and irregularly flooded intertidal flats. During surveys of this area, assemblages of several species of shore birds including Brown pelican, American white pelican, Laughing gull, Royal tern and *Platalea ajaja* (Roseate spoonbill) were observed (See Photo 5). The entire landward extent of the pass between Rollover Bay and the Gulf, as well as the mouth of the pass is armored. This portion of the pass is heavily frequented by sport fisherman.

Photo 5: Shorebirds resting and foraging in Rollover Pass.

3.1.4 Intracoastal Waterway Islands

The ICWW Islands consist of what appear to be exposed areas of side-cast dredge spoil, placed, ostensibly, to dissipate tidal energy across the channel and reduce accumulation of sediments. Additionally, these features provide the ancillary benefit of wildlife habitat. Estuarine unconsolidated shore areas make up a majority of the classification of these islands. Most of these areas are characterized by water regimes that are irregularly exposed (M), and thus are usually submerged. There are nine of these islands lining the north and south rim of the ICWW; five on the south side and four on the north side. Estuarine emergent wetlands located within these islands are considered either regularly flooded (N), or irregularly flooded (P).

There are five islands occurring along the south rim of the ICWW. Except for small portions of these islands that are vegetated, and experience periodic flooding, the islands along the south bank of the ICWW are irregularly exposed mudflats. These smoothly crowned portions have a tidal regime favorable to maintenance of perennial plant communities. Most are broadly rimmed, and in some cases, completely dominated by *Spartina alterniflora* (Smooth cordgrass).

Spoil islands one, two, and three appear to have the most favorable habitat along the south rim of the channel (See Photo 6). Each of these islands is rimmed with smooth cordgrass to some extent and the rounded crown of these islands facilitates a tidal regime sufficient to support intermediate marsh assemblages. The typical species observed were *Batis maritima* (Vidrillos), *Salicornia bigelovii* (Erect glasswort) *Heliotropium curassavicum* (Seaside heliotrope) and *Monanthochloe littoralis* (Shoregrass). Additionally, each of these islands contains, to varying degrees, some coverage of mudflat. While small, ranging in size from approximately 150 to 300 square feet, these areas exhibited high-quality habitat for shorebirds and may present favorable

breeding habitat for solitary species such as *Charadrius sp*. Numerous crab burrows appearing to harbor *Uca sp*. were observed, and, a brief exploration of the flotsam and jetsam revealed specimens of *Sesarma sp., Pagurus sp*., *Grammerus sp.,* and other similar crustaceans and amphipods. These islands appeared to have been particularly impacted by the deposition of household debris associated with the Hurricane Ike storm surge.

Photo 6: Spoil island with mudflat habitat rimmed with *Spartina alterniflora.*

3.1.5 Inland Communities

The inland communities within Priority Area 1 are dominated by land that has, over the years, been subject to anthropogenic manipulations and land uses. While this area was heavily impacted as a result of a direct hit from Hurricane Ike, field surveys identified very little alteration to existing landforms. Many homes and similar structures are no longer present; however, their foundations and access remain virtually intact. Much of this landscape is composed of high marsh (E2SS), sand dunes and interdunal swales with intervening areas of intermediate marsh (E2EM1P) and low marsh (E2EM1N) appearing sporadically, as tidal inputs permit.

The typical constituents observed in the high marsh areas included: *Spartina spartinae* (Gulf cordgrass), *Spartina patens* (Marshhay grass), *Haplopappus phyllocephalus* (Camphor daisy), *Iva frutescens* (Marsh elder), *Cyperus tenuis* (Flat sedge), *Baccharis halimifolia* (Baccharis), *Hydrocotyle bonariensis* (Largeleaf pennywort), *Chenopodium berlendieri* (Pit seed goose foot), *Zanthoxylum clava-hurculis* (Hercules' club), *Croton capitatus* (Wooly croton), and *Gaura villosa* (Wooly gaura), along with *Quercus virginiana* (Live oak), *Ilex vomitoria* (Yaupon), *Celtis laevigata* (Sugarberry), and *Tamarix gallica* (Salt cedar) in elevated areas that can support upland vegetation.

The reticulate intermediate and low marsh communities that are present, depending on their size and landscape position, included: *Distichlis spicata* (Green salt grass),

marshhay grass, seaside heliotrope, erect glasswort, shore grass and, smooth cordgrass when tidal flushing was consistent.

3.1.6 Beach & Gulf Side of Rollover Pass

The foreshore (intertidal zone) and backshore (above Mean High Water) zones of the Gulf appear to be the most heavily impacted communities within the survey area when comparing aerial imagery from 2004 with those taken in 2009. Significant scouring of the shoreline is evident. Much of the foreshore was eroded as a result of Hurricane Ike leaving this portion of the shoreline, as well as portions of the backshore as regularly flooded at high tide. Furthermore, as a result of the scouring, large portions of backshore remain inundated as high tides retreat. Many of these backshore areas remain inundated for prolonged periods and some appear to impound tidal inputs continuously. Incoming and outgoing tides partially flush these tidal pools through preferential flow ways. This condition appears to be consistent along within the entire project area and for the entire shoreline of Bolivar Peninsula well above Rollover Pass. Any dunes that were present prior to the storm are no longer present. Ecotonal vegetative assemblages occurring at the interface of the backshore and uplands are present and re-establishing. Typical constituents include *Sesuvium sessile* (Sea purslane), *Gaillardia pulchella* (Indian blanket), and marshhay grass.

3.2 Priority Area 2 – Western Portion of Intracoastal Waterway

Priority Area 2 includes the reach of the ICWW west from Rollover Bay to the western tip of Goat Island and contains the north and south shore of the ICWW, the entirety of Goat Island and the intervening communities between the south shore of the ICWW and the Gulf (Attachment A, Figure 3).

3.2.1 North Shore of Priority Area 2

Prior to the dredging of the ICWW, Goat Island and the portion of Bolivar Peninsula south of the existing channel were one contiguous complex of high marsh, low marsh, and tidal flats. It appears that historical dredging has resulted in a significant amount of dredge spoil on the north bank of the channel, which now makes up the south shore of Goat Island. Additionally, channels appear to have been dredged into interior areas of the islands and there is clear evidence that dredged material has been disposed in other areas, most noticeably in the northwest third of the island, creating areas of low and intermediate marsh. The north shore of the ICWW contains two large elevated Dredge Material Management Areas (DMMAs) that extend nearly the entire length of the shore line, an area approximately 30,000 feet long, 900 feet wide and elevated 20 to 30 feet above sea level. The two DMMAs are separated, roughly in the middle of the island, by a stretch of high marsh approximately 3,400 feet in length. This area of marsh is higher than corresponding marsh occurring along the south shore; it is likely this area has accepted dredged sediments in the past (See Photo 7).

The vegetation associated with the DMMAs, including their interior, dikes, and adjacent toes of slope would best be characterized as ruderal communities of maritime and palustrine assemblages (See Photo 8). The species observed in these area included: *Ambrosia psilostachya* (Western ragweed), marshhay cordgrass, smooth cordgrass, flatsedge, pit seed goose foot, wooly croton, baccharis, *Cuscuta cuspidate* (Dodder), camphor daisy, marsh elder, *Borrichea frutescens* (Sea oxeye daisy), and seaside

heliotrope. Salt cedar, live oak, yaupon, and sugarberry were clustered sporadically on higher land forms and along the toes of slope of the DMMAs.

Armoring consisting of articulated concrete mats is present along nearly the entire length of the north ICWW shore line. The exception to this is the intervening area between the western and eastern DMMA mentioned earlier. Below this amoring exists a narrow band of low marsh consisting mainly of smooth cordgrass with intermittent stretches of unconsolidated shoreline. (See Photo 9). Several monocultures, some relatively significant, of *Phragmites australis* (Common reed) were observed along the shoreline just above the annual high tide line (AHTL). Within the Priority Area 2, the northern shore of the ICWW had the most extensive, albeit intermittent, accumulations of this species.

Photo 7: High marsh located along the north bank of west ICWW.

Photo 8: Interior community associated with a DMMA.

Photo 9: Low marsh habitat along north shore of ICWW.

3.2.2 South Shore of Priority Area 2

The south shore of Priority Area 2 from the ICWW to the Gulf contains communities consistent with typical marsh assemblages. There was no obvious evidence of any DMMAs on the south shore. Existing data has this community characterized as primarily estuarine, intertidal wetlands. Some areas along the ICWW contained small

expanses of intertidal mudflats that are irregularly flooded (P) and typically exposed (E2US). Along these areas of mudflats, the presence of erect glasswort was dominant, along with a lining of smooth cordgrass immediately adjacent to the ICWW. South of these areas, a transition from unconsolidated shore to emergent wetlands was evident. These emergent wetlands contain instances of estuarine unconsolidated bottom and estuarine unconsolidated shore throughout Priority Area 2. In addition to the mud flats and intertidal pools, a number of large salt pans were observed in the intermediate marsh areas (E2EM2P, Figure 3). The areas were generally devoid and vegetation with the exception of erect glasswort, of which many individuals appeared to be stressed. Areas of stressed vegetation appear to coincide with elevated sediment concentrations of hydrogen sulfide that were detected in sediment samples collected from these areas (See Photo 10). As the landscape progresses southward towards the Gulf, areas of scrub-shrub wetlands and high marsh emerge, ultimately grading to uplands nearer to Highway 87 (E2SS). The large expanse of emergent wetlands with intertidal pools, mudflats, and salt pannes provide excellent habitat for shorebirds and other species (See Photo 11).

Photo 10: Salt panne east of Yacht Basin Road.

Photo 11: Mudflat along the south shore of the ICWW.

3.2.3 Goat Island

Goat Island consists of a pristine low marsh system that is made up of emergent wetlands (E2EM) dominated by primarily smooth cordgrass and green marsh grass (See Photos 12 & 13). Isolated stands of *Juncus romerianus* (Black needle rush) were also observed but would not be considered a dominant constituent. Mosaic areas of estuarine unconsolidated bottom and shore are present throughout the island. Typically, these areas consisted of mudflats and unvegetated shoreline. This area is excellent habitat for shorebirds and a number of foraging colonies of *Eudocimus albus* (White ibis) were observed.

Photo 12: Goat Island assemblage displaying *Juncus romerianus* and *Spartina patens*.

Photo 13: Goat Island assemblage displaying *Spartina alterniflora*.

3.3 Priority Area 3 – Eastern Portion of Intracoastal Waterway

Priority Area 3 encompasses of the eastern reach of the ICWW, east of Rollover Pass extending in a northeast direction to the terminus of East Galveston Bay. It includes two spoil islands comprising the north bank of the ICWW and includes the intervening terrestrial communities situated between the south bank of the ICWW and the Gulf (Attachment A, Figure 4).

3.3.1 North Shore of Priority Area 3

The north shore of Priority Area 3 (Figure 4) consists of two islands that appear to have been created by disposal of dredged spoil along this reach of the ICWW. The larger of the two islands contains a significant DMMA that occupies nearly two thirds of the island's total area (PEM). In the center of the DMMA, two large elevated lakes are surrounded by a palustrine fringe. No wildlife was observed in these areas; however, the area appears to provide some nominal habitat for resting or foraging birds. Most of the northern shoreline located along the ICWW is armored with concrete mats. A very narrow fringe of estuarine unconsolidated shore line between the armoring and the ICWW is present (E2US). A large and gradual ecotone transition is present on the easternmost portion of this island, where uplands associated with the elevated DMMA retrograde from ruderal assemblages to high marsh dominated by marshhay, eventually grading to a low marsh regime dominated by smooth cordgrass (See Photo 14). On the western and northern edges of this island, facing the bay, an ecotone transition is present to low marsh (E2EM), also dominated by smooth cordgrass.

No wildlife was observed. However, these marsh areas are regularly flooded, and provide favorable habitat for plant species.

A smaller island is located northeast of the large disposal island. This island is comprised of low and intermediate marsh, dominated by smooth cordgrass and other common constituents (E2EM). Additionally, monocultures of black needle rush were observed on the outer fringe of the island. The habitats associated with this island appear to be relatively pristine and untrammeled marsh habitat (See Photo 15).

Photo 14: Transition from DMMA area to high marsh.

Photo 15: Pristine emergent wetland northeast of DMMA island.

3.3.2 South Shore of Priority Area 3

The intervening terrestrial communities that lay between the south shore of ICWW and the Gulf predominantly consist of emergent estuarine wetlands that appear to be regularly flooded (N) or irregularly flooded (P). The exception to this is a small linear north-south residential development that runs the length of the marsh between the ICWW and Hwy 87. This enclave includes home sites situated along linear canals that appear to provide some level of deep water access to East Galveston Bay. As with is the case with similar areas, anthropogenic manipulations have created a mosaic of terrestrial and estuarine habitats, similar in makeup as those described earlier in the report. Beyond the development, this area is a large and relatively contiguous expanse of intermediate marsh (E2EM). This intermediate marsh being is similar to other habitats in the area contains a number of salt pans and irregularly exposed mudflats and represents excellent habitat for shorebirds and other species.

3.4 Priority Area 4 – North Shore of East Galveston Bay

The north shore of East Galveston Bay within the Project Area consists of a relatively pristine estuarine marsh landscape dominated by alternating patches of gulf cordgrass and smooth cordgrass in the irregularly exposed areas (M), with an abrupt shoreline transition to a high marsh habitat, dominated by gulf cordgrass and vidrillos (Attachment A, Figure 5; See Photo 16). The high marsh areas subsequently transition to palustrine scrub-shrub wetlands dominated by baccharis, gulf cordgrass, and sea oxeye daisy. The eastern portion of the north shore is part of the Anahuac Wildlife Refuge, and the shoreline associated with this area appears to be stabilized by strategically placed rock substrate outside (south) of the smooth cordgrass and marshhay grass assemblages that line the north coast. Small patches of salt cedar were encountered sporadically and were insignificant throughout the northern coast line.

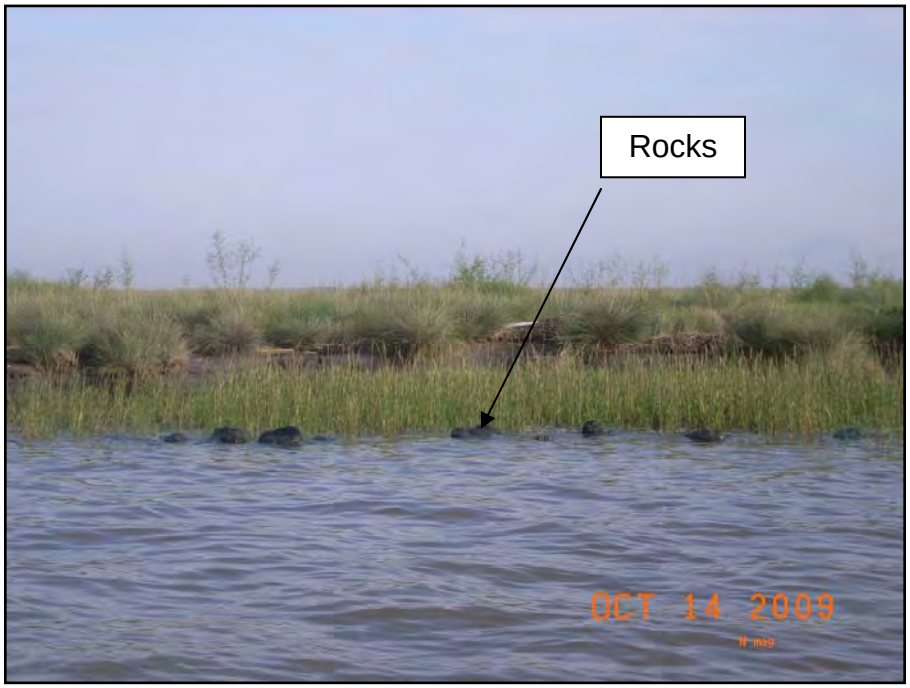


Photo 16: North shoreline of Priority Area 4.

4 DISCUSSION

The results of this survey have identified and further refined the vegetative communities in and around Rollover Bay and greater East Galveston Bay. These include: the ICWW channel islands, intertidal shorelines and mudflats of varying tidal regimes, broad expanses of intertidal marsh, both regularly and irregularly flooded systems and the intertidal pools, mudflats and salt pannes endemic to these habitats, as well as high marsh and uplands. While many of these areas were observed to maintain a near pristine condition, anthropogenic influences have altered many of the systems, often dramatically in some areas.

In evaluating these various communities, a few areas stand out as being particularly note worthy. One of these is the salt marsh of the eastern half of Goat Island. Below the toe of slope of the eastern DMMA there appears be very little in the way of manmade disturbance as the marsh extends out into the bay. Nourished by a network of natural channels and rivulets, this portion of marsh contains numerous intertidal mudflats that appear to contain some of the highest quality habitat in the area. *Littorina irrorata* (Marsh periwinkle) were observed at relatively high densities on the leaf blades of the smooth cordgrass and crab burrows (likely *Uca sp*.) were also numerous in portions of the mudflats. The low and intermediate marshes along the south bank of the ICWW below Goat Island also appeared to manifest similar habitat quality. In contrast to the northern bank of the ICWW, the south bank was unarmored and several significant expanses of intertidal mudflats were documented. As the intermediate marsh interfaced with high marsh, a number of intertidal salt pannes were documented at this ecotone. Numerous sightings of colonial shore birds were observed and documented in this area. There were signs of Hurricane Ike disturbance in the intermediate marsh including deposition of a passenger van partially submerged in sediment.

Of the channel islands, Spoil Islands Eight and Nine were noted as excellent habitat, each maintaining an assortment of habitats ranging from high marsh to low marsh and intertidal pool communities suitable to support foraging, roosting and breeding of modest populations of shore birds.

The mudflats in Rollover Bay west of Rollover Pass (E2USM) were the largest single expanse of contiguous mudflat mapped within the survey area. At the time of the investigation nearly the entirety of these flats were exposed and many numbers of shore bird species were observed utilizing this habitat. Two distinct accumulations of oysters were also observed within these flats, though at the time of the observations, it was unclear as to whether there were sufficient densities to identify either as an economically viable bed.

In general, the entire project area is a relatively stable system. While many communities have been significantly altered as a result of anthropogenic utilization, there still remain significant expanses of relatively pristine habitat, including ecologically valuable habitat that could potentially support threatened and endangered species. If the proposed action of closing Rollover Pass is implemented, the potential exists for some of the communities surrounding East Bay to change as a result of pass closure.

Shoreline accretion within Rollover Bay could increase as a result of the proposed Rollover Pass closure. Should this accretion result, it is likely that an increase in marsh habitat could occur. Furthermore, this has the potential of creating additional sandbar and mudflat habitat within Rollover Bay that could support additional threatened and endangered species. Finally, in addition to changes to vegetative communities, it is reasonable to assume that rates of recruitment to existing oyster reefs and establishment of new reefs may increase as a result of salinity dilution.

There were very few areas that were identified as having excessive accumulations of exotic and invasive species. Where present, exotic and invasive species consisted of salt cedar and common reed. Occurrences of these species were recorded along the north shore of the ICWW above the armoring and along the toes of slope of the DMMAs. Salt cedar was a common constituent of the high marsh and ruderal areas but was not observed to be present as monocultures, while in contrast, isolated assemblages of common reed were generally encountered as monocultures. Both Spoil Islands Eight and Nine had isolated occurrences of both species. However, neither was present as dominant species.

If an appreciable decrease (5-10 ppt) in aggregate salinity levels across all tidal regimes is realized as a result of the proposed Rollover Pass closure, mesohaline buffering, particularly in areas around the confluence of Oyster Bayou and the ICWW could be reduced leading to a shift towards an oligohaline condition. As a result, existing recruitment areas for common reed could increase. The area immediately adjacent to the mouth of Oyster Bayou could see the greatest reductions in aggregate salinity levels. Also, should finger canals off the ICWW, particularly those within Priority Area 3, see a reduction in salinity levels, it is anticipated that these areas may also see an increase in the recruitment of common reed.

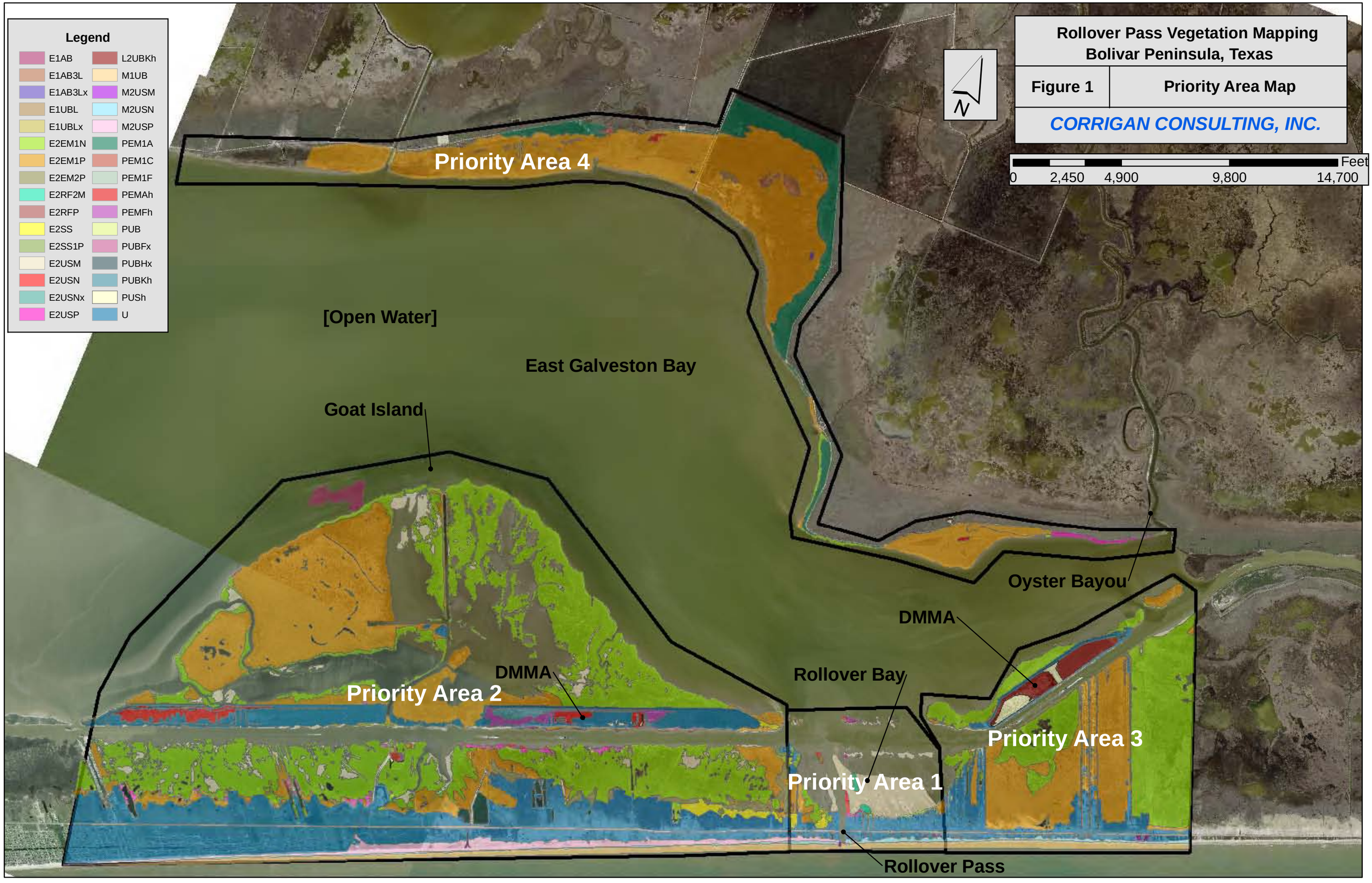
It is likely that much of the north shore of East Bay, west of Frozen Point, would remain relatively unchanged by the proposed Rollover Pass closure. This relatively narrow band of mesohaline to euhaline communities appears to be influenced by salinity from Galveston Bay as much as it is influenced by inputs through rollover pass. However, it is possible that areas east of Frozen Point could potentially undergo some vegetative community alterations as salinity decreases and conditions for recruitment from nearby palustrine communities becomes more favorable.

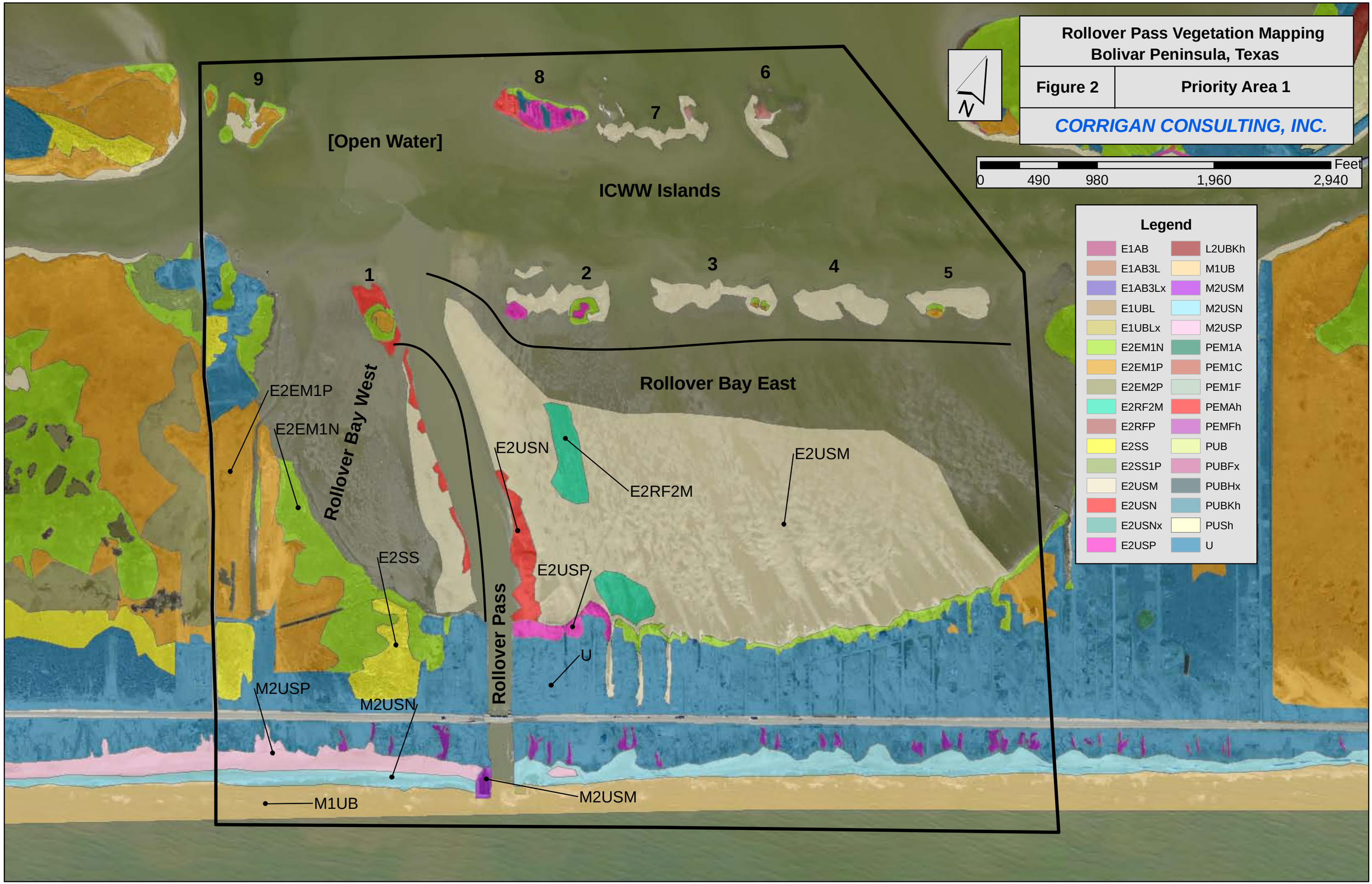
During the actual mapping of the vegetative communities the only areas that appeared to be significantly altered from the layer developed in 2002 was the shoreline of the Gulf. The shoreline, as expected, exhibited severe impacts as a result of the storm surge generated by Hurricane Ike which made landfall September 13, 2008. Comparisons of aerial imagery from 2004 and 2009 revealed a substantial loss of foreshore and backshore along the entire length of beach within the survey area. An estimated average of 250 feet of dunes and maritime meadow were lost as a result of the storm.

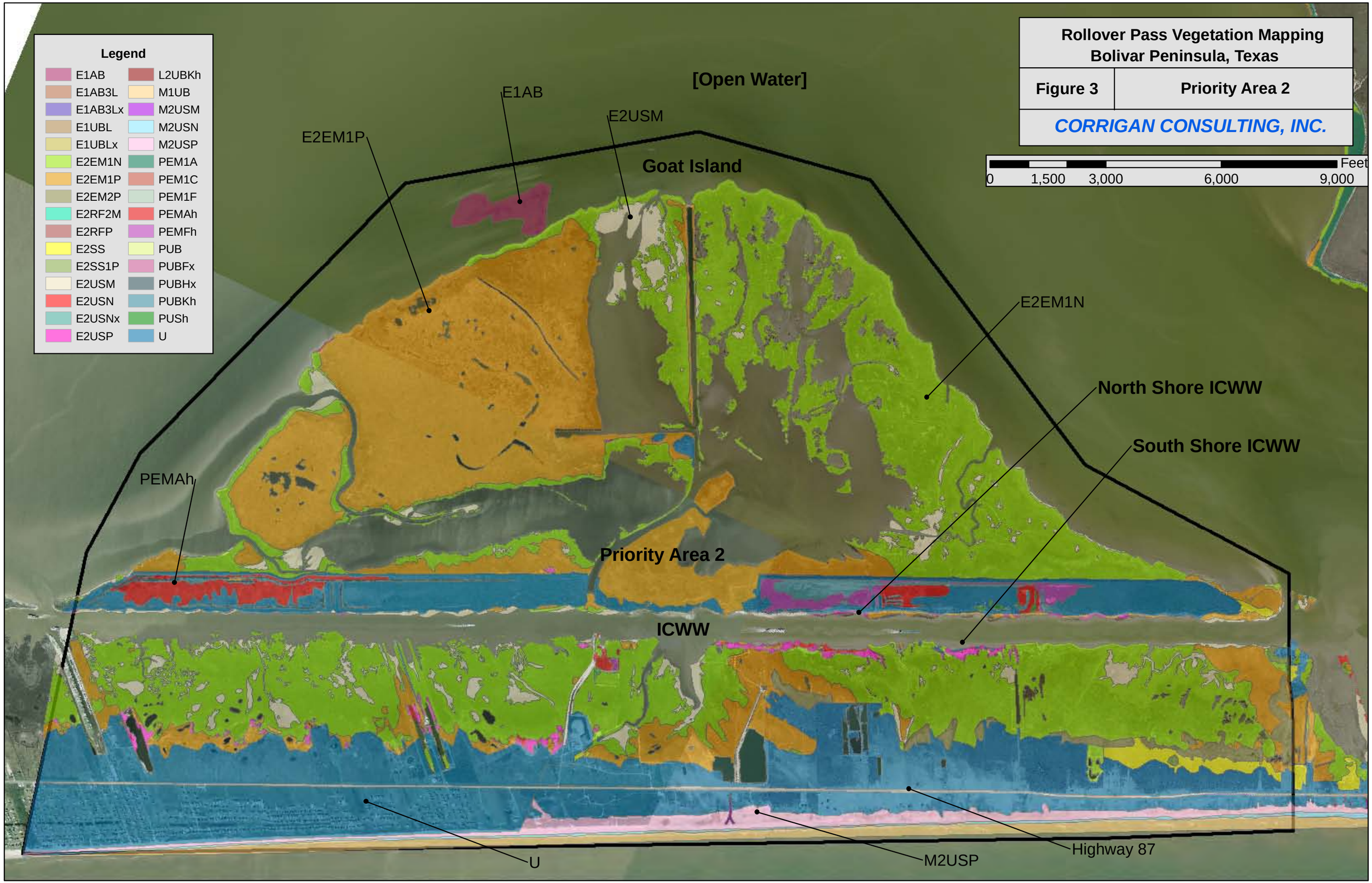
The loss of beach along the shore of the Gulf represents the most significant change that CCI noted and altered on ArcGIS Shapefiles. The shore has been dramatically altered due to natural disasters within Project Area since it was last mapped in 2002. Only a limited number of significant alterations were made to the 2002 mapping layer in other areas. Of these, the major refinements made were to the intertidal mudflats (E2USM) in Rollover Bay. These areas were expanded in the eastern side of the bay and dramatically reduced in the western side of the bay. Also, areas identified as salt pannes were separated from intermediate marsh (E2EM1P) and classified as E2EM2P. Beyond these changes, very few communities exhibited drastic alterations as a result of the storm. Other changes were minor in comparison and either further refined subtle changes or appended communities that may not have been completely mapped.

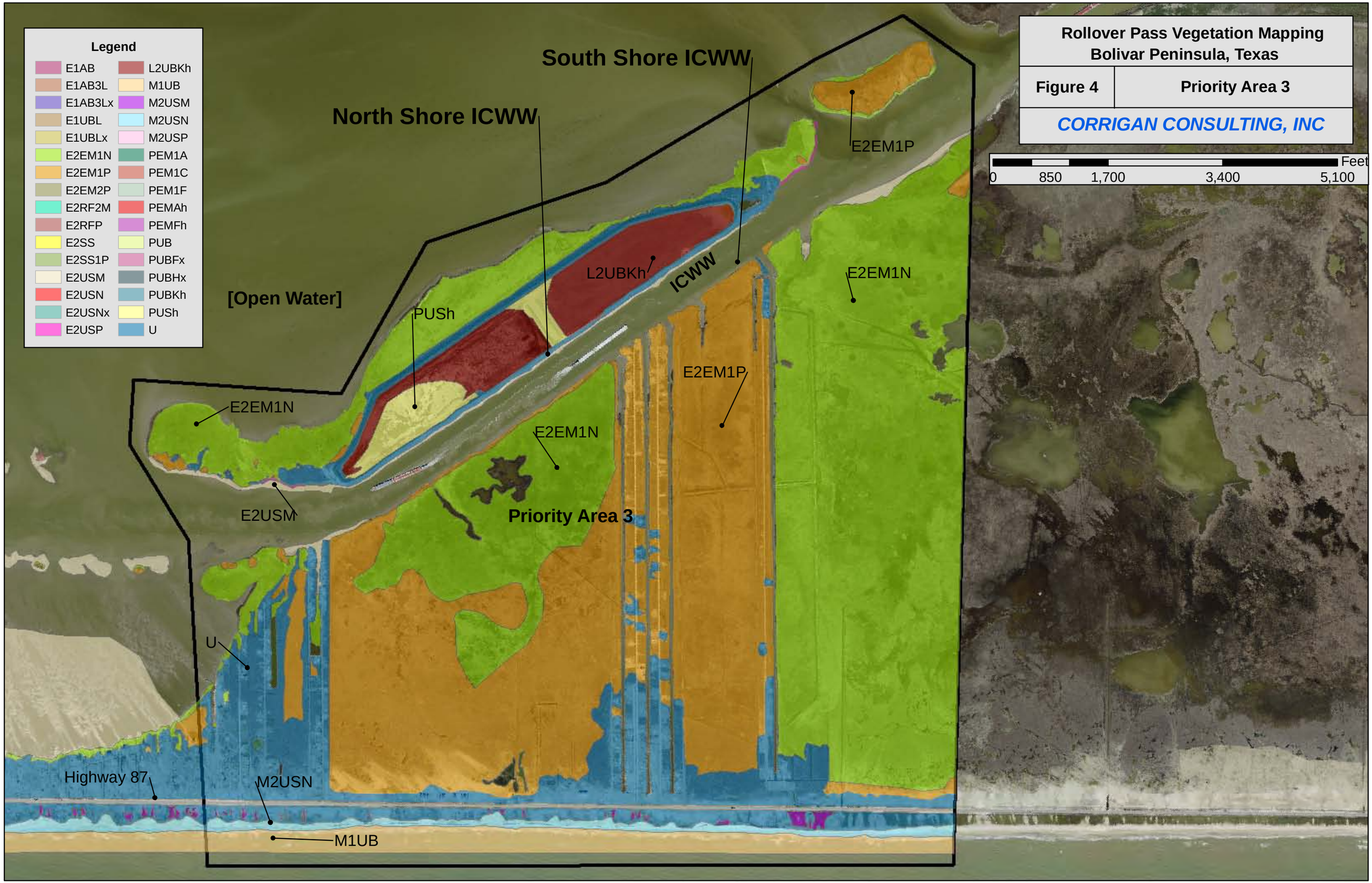
ATTACHMENT A

FIGURES


Rollover Pass Vegetation Mapping
Bolivar Peninsula, Texas
Figure 1
Priority Area Map
CORRIGAN CONSULTING, INC.
Legend
E1AB
E1AB3L
E1AB3Lx
E1UBL
E1UBLx
E2EM1N
E2EM1P
E2EM2P
E2RF2M
E2RFP
E2SS
E2SS1P
E2USM
E2USN
E2USNx
E2USP
L2UBKh
M1UB
M2USM
M2USN
M2USP
PEM1A
PEM1C
PEM1F
PEMAh
PEMFh
PUB
PUBFx
PUBHx
PUBKh
PUSh
U
N
Feet
0
2,450
4,900
9,800
14,700
Priority Area 4
[Open Water]
East Galveston Bay
Goat Island
Oyster Bayou
DMMA
Rollover Bay
DMMA
Priority Area 2
Priority Area 3
Priority Area 1
Rollover Pass


Rollover Pass Vegetation Mapping
Bolivar Peninsula, Texas
Figure 2
Priority Area 1
CORRIGAN CONSULTING, INC.
N
0
490
980
1,960
2,940
Feet
Legend
E1AB
E1AB3L
E1AB3Lx
E1UBL
E1UBLx
E2EM1N
E2EM1P
E2EM2P
E2RF2M
E2RFP
E2SS
E2SS1P
E2USM
E2USN
E2USNx
E2USP
L2UBKh
M1UB
M2USM
M2USN
M2USP
PEM1A
PEM1C
PEM1F
PEMAh
PEMFh
PUB
PUBFx
PUBHx
PUBKh
PUSh
U
[Open Water]
ICWW Islands
Rollover Bay West
Rollover Bay East
Rollover Pass
1
2
3
4
5
6
7
8
9
E2EM1P
E2EM1N
E2SS
E2USN
E2USP
E2RF2M
E2USM
U
M2USP
M2USN
M1UB
M2USM


Rollover Pass Vegetation Mapping
Bolivar Peninsula, Texas
Figure 3
Priority Area 2
CORRIGAN CONSULTING, INC.
Legend
E1AB
E1AB3L
E1AB3Lx
E1UBL
E1UBLx
E2EM1N
E2EM1P
E2EM2P
E2RF2M
E2RFP
E2SS
E2SS1P
E2USM
E2USN
E2USNx
E2USP
L2UBKh
M1UB
M2USM
M2USN
M2USP
PEM1A
PEM1C
PEM1F
PEMAh
PEMFh
PUB
PUBFx
PUBHx
PUBKh
PUSh
U
Feet
0
1,500
3,000
6,000
9,000
[Open Water]
E1AB
E2USM
E2EM1P
Goat Island
E2EM1N
North Shore ICWW
South Shore ICWW
PEMAh
Priority Area 2
ICWW
U
M2USP
Highway 87



Rollover Pass Vegetation Mapping
Bolivar Peninsula, Texas

Figure 4	Priority Area 3

CORRIGAN CONSULTING, INC

Rollover Pass Vegetation Mapping
Bolivar Peninsula, Texas

Figure 5	Priority Area 4

CORRIGAN CONSULTING, INC.

ATTACHMENT B

COWARDIN WETLAND CLASSIFICATIONS

WETLANDS AND DEEPWATER HABITATS CLASSIFICATION

System	M - Marine							
Subsystem	1 - Subtidal				2 - Intertidal			
Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	RF – Reef	AB – Aquatic Bed	RF – Reef	RS – Rocky Shore	US – Unconsolidated Shore
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud	1 Algal 3 Rooted Vascular	1 Coral 3 Worm	1 Algal 3 Rooted Vascular	1 Coral 3 Worm	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic

System	E - Estuarine											
Subsystem	1 - Subtidal				2 - Intertidal							
Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	RF – Reef	AB – Aquatic Bed	RF – Reef	SB – Streambed	RS – Rocky Shore	US – Unconsolidated Shore	EM – Emergent	SS – Scrub-Shrub	FO – Forested
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 3 Rooted Vascular 4 Floating Vascular	2 Mollusk 3 Worm	1 Algal 3 Rooted Vascular 4 Floating Vascular	2 Mollusk 3 Worm	1 Bedrock 2 Rubble 3 Cobble-Gravel 4 Sand 5 Mud 6 Organic	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Persistent 2 Non-persistent 5 *Phragmites australis*	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen

System	R - Riverine				
Subsystem	1 - Tidal	2 – Lower Perennial	3 – Upper Perennial	4* - Intermittent	5** – Unknown Perennial

Class	RB – Rock Bottom	UB – Unconsolidated Bottom	SB*** – Streambed	AB – Aquatic Bed	RS – Rocky Shore	US – Unconsolidated Shore	EM – Emergent
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble 3 Cobble-Gravel 4 Sand 5 Mud 6 Organic 7 Vegetated	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent

* **Intermittent** is limited to the **Streambed** Class
** **Unknown Perennial** is limited to **Unconsolidated Bottom**
*** **Streambed** is limited to **Tidal** and **Intermittent** Subsystems

Classification of Wetlands and Deepwater Habitats of the United States, Cowardin *et al*. 1979

WETLANDS AND DEEPWATER HABITATS CLASSIFICATION

System	L - Lacustrine										
Subsystem	1 - Limnetic			2 - Littoral							
Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	RS – Rocky Shore	US – Unconsolidated Shore	EM – Emergent		
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent		

System	P - Palustrine							
Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	US – Unconsolidated Shore	ML – Moss-Lichen	EM – Emergent	SS – Scrub-Shrub	FO – Forested
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	1 Moss 2 Lichen	1 Persistent 2 Nonpersistent 5 *Phragmites australis*	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen

MODIFIERS

In order to more adequately describe the wetland and deepwater habitats, one or more of the water regime, water chemistry, soil, or special modifiers may be applied at the class or lower level in the hierarchy. The farmed modifier may also be applied to the ecological system.

Water Regime			Special Modifiers	Water Chemistry			Soil
Nontidal	**Saltwater Tidal**	**Freshwater Tidal**		**Coastal Halinity**	**Inland Salinity**	**pH Modifiers for all Fresh Water**	
A Temporarily Flooded	L Subtidal	S Temporarily Flooded-Tidal	b Beaver	1 Hyperhaline	7 Hypersaline	a Acid	g Organic
B Saturated	M Irregularly Exposed	R Seasonally Flooded-Tidal	d Partly Drained/Ditched	2 Euhaline	8 Eusaline	t Circumneutral	n Mineral
C Seasonally Flooded	N Regularly Flooded	T Semipermanently Flooded-Tidal	f Farmed	3 Mixohaline (Brackish)	9 Mixosaline	I Alkaline	
E Seasonally Flooded/ Saturated	P Irregularly Flooded	V Permanently Flooded-Tidal	h Diked/Impounded	4 Polyhaline	0 Fresh		
F Semipermanently Flooded			r Artificial	5 Mesohaline			
G Intermittently Exposed			s Spoil	6 Oligohaline			
H Permanently Flooded			x Excavated	0 Fresh			
J Intermittently Flooded							
K Artificially Flooded							

ATTACHMENT C

SPECIES TABLES

Table 1: Representative Plant Species

Observed Habitat*	**Scientific Name**	**Common Name**	**Salinity****
H, U	*Ambrosia psilostachya*	Western ragweed	N/A
H, I, L	*Aster subulatus*	Saltmarsh aster	Mesohaline
H, I, U	*Baccharis halimifolia*	Eastern baccharis	Mesohaline
I	*Batis maritima*	Turtleweed	Polyhaline
H, U	*Berberis trifoliata*	Agarita	N/A
I	*Borrichia frutescens*	Sea oxeye daisy	Polyhaline
H, U	*Celtis laevigata*	Sugarberry	ND
H, U	*Chenopodium berlendieri*	Pitseed goosefoot	ND
H, U	*Croton capitatus*	Wooly croton	ND
H, U	*Cuscuta cuspidate*	Dodder	Oligohaline
H, I	*Cyperus tenuis*	Flatsedge	Oligohaline
I	*Distichlis spicata*	Greene saltgrass	Polyhaline
H,I, U	*Gaillardic pulchella*	Indian blanket	ND
H, U	*Gaura villosa*	Wooly gaura	ND
H, U	*Haplopappus phyllocephalus*	Camphor daisy	N/A
I	*Heliotropium currassavicum*	Seaside heliotrope	Polyhaline
H, I	*Hydrocotyle bonariensis*	Largeleaf pennywort	Mesohaline
H, U	*Ilex vomitoria*	Yaupon	ND
H, I	*Iva frutescens*	Marshelder	Mesohaline
H, I	*Lepidium austrinum*	Peppergrass	ND
H	*Maurandya cntirrhiniflora*	Vine snapdragon	ND
I,L	*Monanthochloe littoralis*	Shore grass	Mesohaline
H, I	*Panicum repens*	Torpedo grass	ND
H, U	*Phragmites australis*	Common reed	Mesohaline
H, U	*Quercus virginiana*	Live oak	ND
I	*Salicornia bigelovii*	Erect glasswort	Euhaline
H,I	*Seteria geniculata*	Bristle grass	Oligohaline
I	*Sesuvium maritimum*	Slender seapurslane	Mesohaline
H, I	*Sesuvium sessile*	Sea purslane	Mesohaline
H	*Solidago sempervirens*	Seaside goldenrod	Mesohaline
L	*Spartina alterniflora*	Smooth cordgrass	Euhaline
H, I, L	*Spartina patens*	Marshhay cordgrass	Mesohaline
H, I	*Spartina spartinae*	Gulf cordgrass	Polyhaline
H,I	*Sporobolus virginicus*	Seashore dropseed	Mesohaline
H, I	*Tamarix gallica*	Salt cedar	ND
H	*Typha lattifolia*	Cattail	Oligohaline
H, U	*Zanthoxylum clava-hurculis*	Hurcules' club	ND

***I = Intermediate Marsh; H = High Marsh; U = Upland**

****Oligohaline = 0.5-5ppt; Mesohaline = 5-18ppt; Polyhaline = 18-30ppt; Euhaline = 30-40ppt; N/A = Not applicable; ND = No data. Adapted from Stutzenbaker, C.D. 1999. Aquatic and Wetland Plants of the Western Gulf Coast**

Table 2: Representative Bird Species

Observed Habitat*	**Scientific Name**	**Common Name**	**Frequency of Occurrence**
I, H	*Ande alba*	Great egret	Common
I, H	*Andea herodias*	Great blue heron	Occasional
I, MF	*Catotrophorus semipulmatus*	Willet	Common
MF	*Charadrius melodus*	Piping plover	Not observed
MF	*Charadrius wilsonia*	Wilson plover	Rare
MF	*Chavadrius alexandrinus*	Snowy plover	Occasional
I, H	*Egretta thula*	Snowy egret	Common
I, MF	*Eudocimus albus*	White ibis	Common
MF	*Himantapus mexicanus*	Black-necked stilt	Common
MF	*Larus atricilla*	Laughing gull	Abundant
MF	*Pelecanus erythrorhynchos*	American white pelican	Abundant
MF	*Pelecanus occidentalis*	Brown pelican	Abundant
MF	*Platalec ajaja*	Roseate spoonbill	Occasional
MF	*Recurvirostra Americana*	American avocet	Occasional
MF	*Ryhnchops riser*	Black skimmer	Occasional
MF	*Sterna maxima*	Royal tern	Abundant

***I = Intermediate Marsh; H = High Marsh; MF = Mud Flat**

Table 3: Representative Invertebrate Species

Observed Habitat*	**Scientific Name**	**Common Name**
L	*Crassostrea virginica*	Eastern oyster
L	*Littorina irrorata*	Saltmarsh periwinkle
L	*Mucronatus sp.*	Amphipod
I, L	*Neopauope sp.*	Mud crab
L	*Pagurus annulipes*	Hermit crab
I, L	*Segarma sp.*	Wood crab
I, L	*Uca sp.*	Fiddler crab

***I = Intermediate Marsh; L = Low Marsh**

APPENDIX C

Wetland Delineation Report
Rollover Pass
Galveston County, Texas
February 2010

Prepared by

Corrigan Consulting, Inc.
12000 Aerospace Avenue, Suite 450
Houston, Texas 77034

CORRIGAN CONSULTING, INC.

12000 Aerospace Ave., Suite 450
Houston, Texas 77034
(281) 922-4766 • Fax (281) 922-4767

February 12, 2010

David L. Stites, Ph.D.
Director, Environmental Services
Taylor Engineering, Inc.
10151 Deerwood Park Blvd., Bldg. 300, Suite 300,
Jacksonville, FL 32256

Re: Wetland Delineation Report, Rollover Pass, 09-141, Task 6

Dear Mr. Stites,

On February 6, 2010 Corrigan Consulting, Inc. (CCI) met with David Stites of Taylor Engineering (Client) and Steve Walls of the US Army Corps of Engineers Galveston District (USACE) to assess the Rollover Pass project area for the presence of wetlands and other potential USACE jurisdictional areas. The limits of the investigation included an area approximately 200 feet wide along the western shore of Rollover Pass and an area approximately 300 feet wide along the eastern shore (Attachment A, Figure 1). The bounds of the survey area were based on field estimations of the maximum limits of the proposed project area to ensure that an adequate survey area was established. After reviewing the survey area with Mr. Walls, it was determined that several areas would likely fall under USACE jurisdiction. These areas were identified and their boundaries located using a sub-meter accurate Trimble Geo XT Geographic Positioning System (GPS) device. Within the survey area, three distinct communities were identified as likely or potentially jurisdictional under Section 404 of the Clean Water Act (CWA) and/or Section 10 of the Rivers and Harbors Act (RHA). These included three areas of intertidal marsh identified as Wetlands A, B, and C; eight depressions currently impounding water identified as Other Surface Waters (OSW) A-H, and two tidally flushed pools identified as Tidal Pools A and B (Attachment A, Figures 2, 3, 4). The constituent habitats of these features are discussed in detail within the following paragraphs. A map displaying NWI-mapped wetlands within and near the project area can be found in Attachment A, Figure 5. Attachment B includes field photographs.

The intertidal Wetlands A, B, and C were all located below the Annual High Tide Line (AHTL) and were composed of sparse, perennial, communities of smooth cord grass (*Spartina alterniflora*). Wetlands A and B were mapped as discrete communities while only the portion of Wetland C within the survey area was mapped. The substrate was observed and characterized as unconsolidated estuarine sediment underneath two to three inches of sand. As these areas occur below the observed AHTL they are assumed to be jurisdictional under the CWA or RHA.

Eight areas were identified above the AHTL and labeled as OSW. The eight mapped OSW features ranged in size from 247 square feet to 5,109 square feet. The depth of these features ranged from approximately six inches to two feet or more. While no features were observed to support established vegetative communities, each exhibited limited signs of prolonged

inundation manifested by the presence of significant accumulation of filamentous algae. Much of the vegetation observed was either dead or dormant and with the exception of a few notable species, namely marshhay grass (*Spartina patens*), coastal Bermuda grass (*Cynodon dactylon*), seashore dropseed (*Sporobolus virginicus*), and flat sedge (*Cyperus sp.*); therefore, a comprehensive list of dominant species could not be accurately compiled. An examination of the soils reveled recent disturbance and recent deposits of alleviated sand. The NRCS Soil Survey for Galveston County has the survey area mapped as Mustang Fine Sand Urban Complex (Attachment A, Figure 6). This soil is listed as a hydric soil on the National List of Hydric Soils. Hydrology was somewhat problematic to establish, however the accumulations of filamentous algae suggest prolonged inundation. It was unclear at the time of the investigation whether conditions during the growing season would sustain the levels of inundation or saturation at the limits observed. However, should these conditions persist into the growing season; it is likely these areas would maintain the requisite wetland characteristics as defined within the USACE Wetland Delineation Manual.

Tidal Pools A and B, located south of US Highway 87 and immediately east of Rollover Pass also appear to be resultant of the storm surge generated by Hurricane Ike. As with the aforementioned OSW, these storm-generated features lack established wetland vegetative assemblages. However, observed evidence of regular tidal flushing from the Gulf of Mexico as well as their position at or below the AHTL would indicate that the features are waters of the US and potentially subject to CWA and RHA.

Based upon interpretation of 2006 aerial imagery, it appears that both the OSW features and Tidal Pools were not present prior to the landfall of Hurricane Ike in September 2008. Furthermore, it was not readily apparent, at least with regards to the OSW, as to whether these features developed as a result of scouring associated with the storm landfall, or as a result of post Hurricane Ike salvage and clean-up operations. In an abundance of caution these features have been identified as areas to avoid for future project planning purposes. As for the wetland and waters of the US identified, it is recommended that all efforts be made to avoid impacts to these resources. Any impacts proposed would require authorization from the USACE as well as approved compensatory mitigation for all impacts.

Should you have any question regarding the information discussed within this report, please feel free to contact me or Rachel Schultz at (281) 922-4766.

Regards,

Rachel Schultz

for Scott Davis, PWS
Manager, Natural Resources

ATTACHMENT A

Figures

Wetland Map
Figure 1
Taylor Engineering
Rollover Pass
Bolivar Peninsula, Texas
CORRIGAN CONSULTING, INC.
Image Source: Houston-Galveston Area Council 2006
Wetland C
OSW E
OSW F
OSW G
OSW H
Wetland A
Wetland B
OSW A
OSW B
OSW C
OSW D
Tidal Pool A
Tidal Pool B
NORTH
Feet
0
100
200
400
600
Legend
Wetlands

Wetland Map: West	Taylor Engineering Rollover Pass Bolivar Peninsula, Texas
Figure 2	

CORRIGAN CONSULTING, INC.

Image Source: Houston-Galveston Area Council 2006

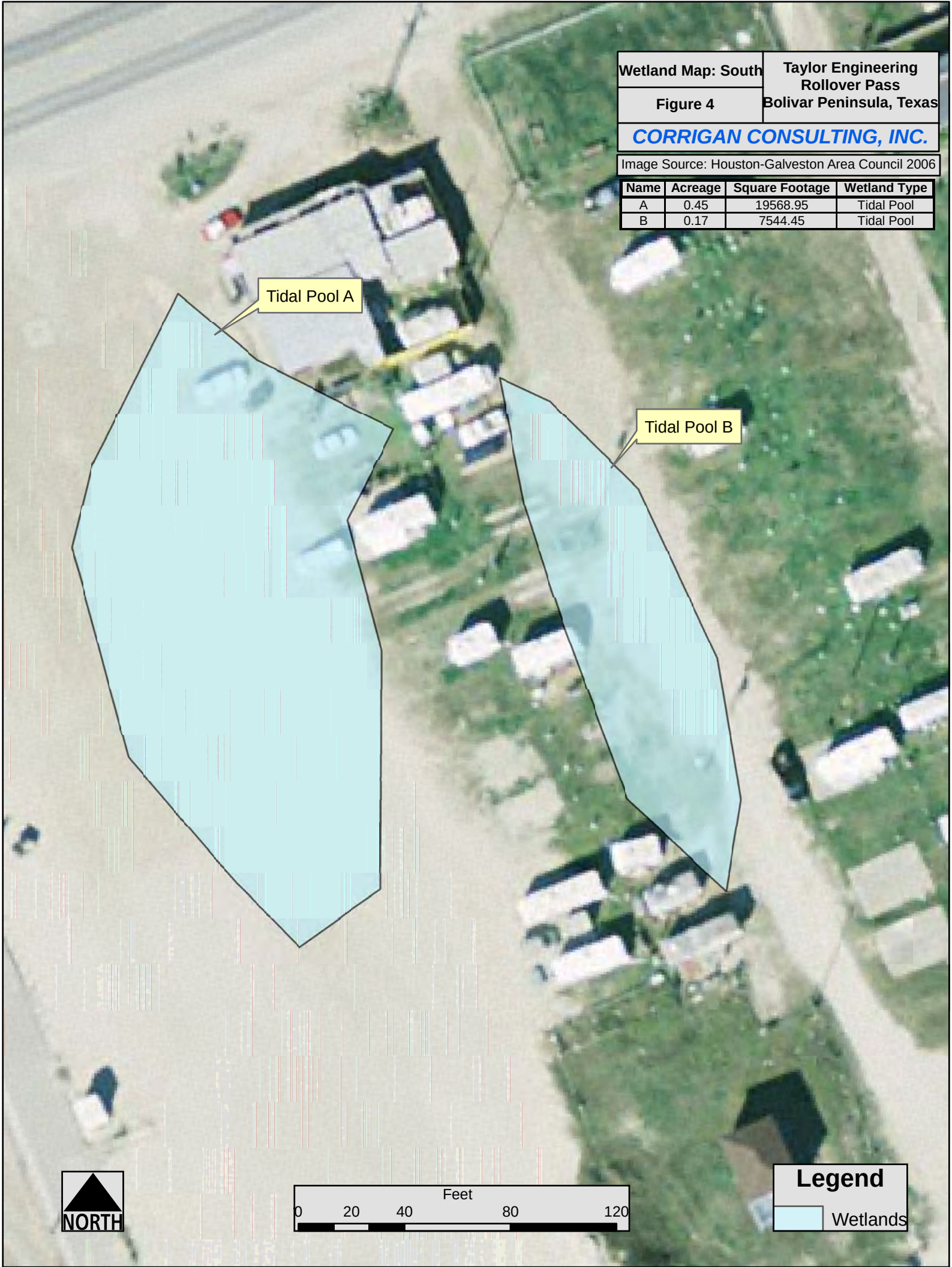
Name	Acreage	Square Footage	Wetland Type
A	<0.01	38.55	Wetland
B	<0.01	116.86	Wetland
A	0.01	401.98	OSW
B	0.02	887.11	OSW
C	0.11	4893.71	OSW
D	0.08	3434.60	OSW

Wetland Map: East	Taylor Engineering Rollover Pass Bolivar Peninsula, Texas
Figure 3	

CORRIGAN CONSULTING, INC.

Image Source: Houston-Galveston Area Council 2006

Name	Acreage	Square Footage	Wetland Type
C	0.08	3691.36	Wetland
E	0.03	1344.90	OSW
F	0.01	247.87	OSW
G	0.02	995.98	OSW
H	0.12	5109.37	OSW

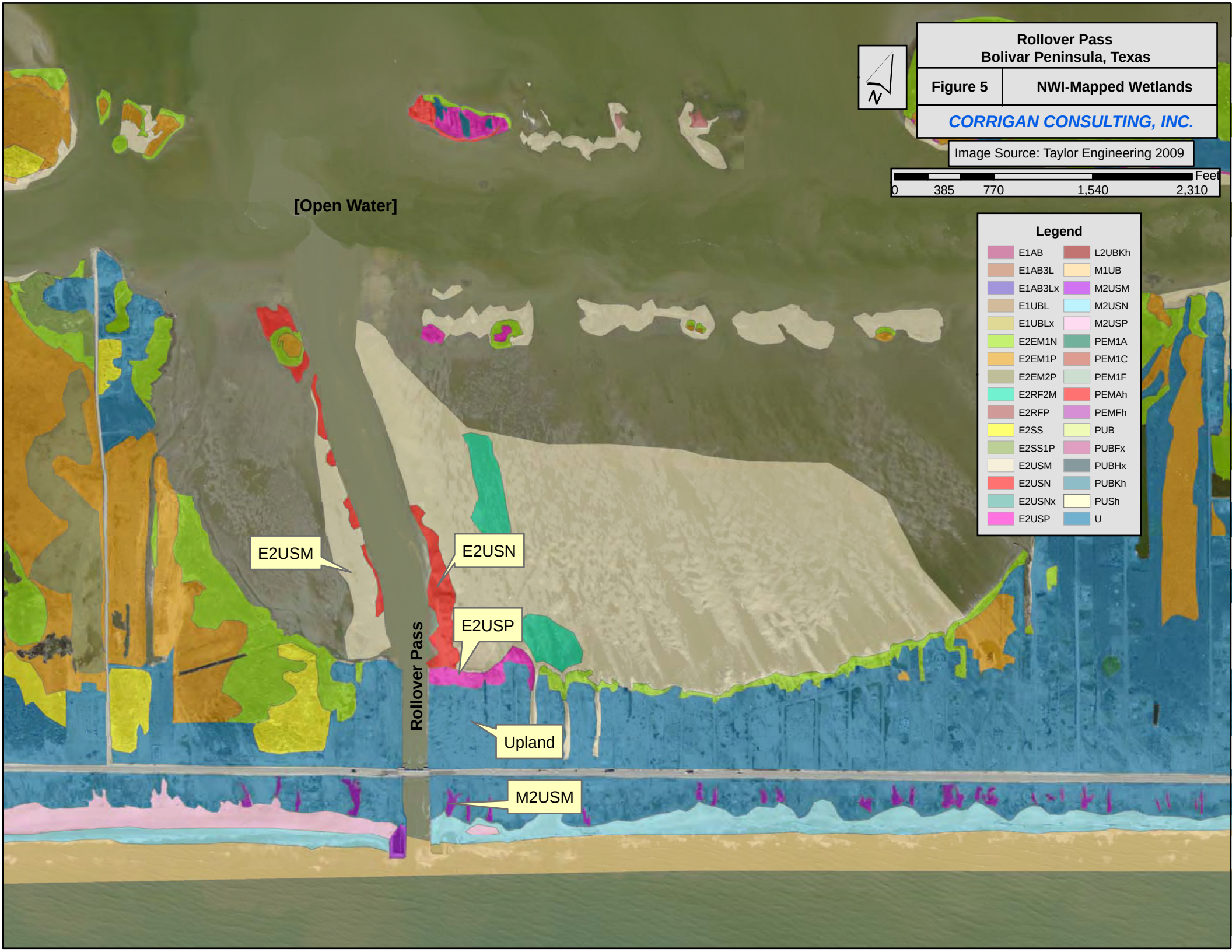


Wetland Map: South	Taylor Engineering Rollover Pass Bolivar Peninsula, Texas
Figure 4	

CORRIGAN CONSULTING, INC.

Image Source: Houston-Galveston Area Council 2006

Name	Acreage	Square Footage	Wetland Type
A	0.45	19568.95	Tidal Pool
B	0.17	7544.45	Tidal Pool


Rollover Pass
Bolivar Peninsula, Texas
Figure 5
NWI-Mapped Wetlands
CORRIGAN CONSULTING, INC.
Image Source: Taylor Engineering 2009
N
0
385
770
1,540
2,310
Feet
Legend
E1AB
E1AB3L
E1AB3Lx
E1UBL
E1UBLx
E2EM1N
E2EM1P
E2EM2P
E2RF2M
E2RFP
E2SS
E2SS1P
E2USM
E2USN
E2USNx
E2USP
L2UBKh
M1UB
M2USM
M2USN
M2USP
PEM1A
PEM1C
PEM1F
PEMAh
PEMFh
PUB
PUBFx
PUBHx
PUBKh
PUSh
U
[Open Water]
E2USM
E2USN
E2USP
Rollover Pass
Upland
M2USM

Soil Map	Taylor Engineering Rollover Pass Bolivar Peninsula, Texas
Figure 6	

CORRIGAN CONSULTING, INC.

Image Source: Houston-Galveston Area Council 2006

Soil Symbol	Soil Name
Bb	Beaches
Mn	Mustang fine sand
Mp	Mustang fine sand, saline
Mu	Mustang-Urban land complex
Vx	Veston loam, slightly saline-strongly saline complex
W	Water

ATTACHMENT B

Photographs

Photograph No. 1 – Taylor Engineering, Wetland Delineation, Rollover Pass.
Wetland A (CSD 2/6/10)

Photograph No. 2 – Taylor Engineering, Wetland Delineation, Rollover Pass.
Wetland B. (CSD 2/6/10)

Photograph No. 3 – Taylor Engineering, Wetland Delineation, Rollover Pass.
Other Surface Water A. (CSD 2/6/10)

Photograph No. 4 – Taylor Engineering, Wetland Delineation, Rollover Pass.
Other Surface Water B. (CSD 2/6/10)

Photograph No. 5 – Taylor Engineering, Wetland Delineation, Rollover Pass.
Other Surface Water C. (CSD 2/6/10)

Photograph No. 6 – Taylor Engineering, Wetland Delineation, Rollover Pass.
Other Surface Water D. (CSD 2/6/10)

Photograph No. 7 – Taylor Engineering, Wetland Delineation, Rollover Pass.
Wetland C. (CSD 2/6/10)

Photograph No. 8 – Taylor Engineering, Wetland Delineation, Rollover Pass.
Other Surface Water E. (CSD 2/6/10)

Photograph No. 9 – Taylor Engineering, Wetland Delineation, Rollover Pass.
Other Surface Water F. (CSD 2/6/10)

Photograph No. 10 – Taylor Engineering, Wetland Delineation, Rollover Pass.
Other Surface Water G. (CSD 2/6/10)

Photograph No. 11 – Taylor Engineering, Wetland Delineation, Rollover Pass.
Other Surface Water H. (CSD 2/6/10)

APPENDIX D

Biological Assessment
Rollover Pass Closure Project
Galveston County, Texas

BIOLOGICAL ASSESSMENT

FOR

ROLLOVER PASS CLOSURE PROJECT
GALVESTON COUNTY, TEXAS

MARCH 2010

1.0 INTRODUCTION

1.1 PURPOSE OF THE BIOLOGICAL ASSESSMENT

Preparation of this Biological Assessment (BA) fulfills the U.S. Army Corps of Engineers (USACE) requirements as outlined under Section 7(c) of the Endangered Species Act of 1973 (ESA), as amended. The proposed action entails the closure of Rollover Pass in Galveston County, Texas.

This BA will assist the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) in fulfilling their obligations under the ESA.

1.2 DESCRIPTION OF THE PROPOSED PROJECT

Rollover Pass, an artificial inlet created in 1955, lies on the Bolivar Peninsula in Galveston County, Texas about 30 km (19 miles) northeast of the Galveston Bay entrance. The Pass provides a tidal connection between the Gulf of Mexico and Rollover Bay in the southeastern portion of East Bay. The Texas Game and Fish Commission (now the Texas Parks and Wildlife Department) constructed Rollover Pass through a natural wash-over area, periodically breached during extreme high tides and hurricanes, to promote fish passage from the Gulf to the inshore waters and improve local fishing conditions. Since construction, Rollover Pass has had adverse effects on the coastal system including accelerated beach erosion, sediment deposition in the Gulf Intracoastal Waterway (GIWW), and increased salinity levels within the Bay.

The proposed action entails the closure of Rollover Pass to alleviate beach erosion along the Bolivar Peninsula, reduce the required frequency and costs of maintenance dredging the GIWW, increase the effectiveness of beach restoration projects, and restore the Bay waters to more natural water quality (salinity) conditions.

Project construction will occur in two primary locations, the dredge material source and the Pass closure location. The proposed project will use a hydraulic dredge connected to a floating pipeline to pump fill material from the borrow source to Rollover Pass. The project may use up to three potential fill sources including a nearby upland dredge material placement area (DMPA #36), the permitted Rollover Bay sand source (Galveston County, SWG 21755 and amendments), or the GIWW (from annual maintenance dredging) in the Rollover Pass vicinity. Material fill removal from the GIWW would coincide with annual maintenance dredging conducted by the U.S. Army Corps of Engineers (USACE). Heavy equipment will grade the infill to meet the elevations of adjacent lands. The specified construction methodology will use a combination of permanently installed steel sheet pile walls and geotextile bags to close the Pass. Implementing this methodology will minimize water quality impacts and structural impacts to the existing bridge and utilities. The existing State Highway 87 Bridge, maintained by the Texas Department of Transportation, and all utilities that currently cross Rollover Pass will remain intact.

Demolition and/or removal of the existing steel and concrete walls throughout the Pass will occur after the fill stabilizes.

Filling Rollover Pass will require approximately 6 months of construction, preceded by about one month of equipment mobilization and followed by approximately one month of demobilization. The project will progress in multiple steps, some of which will run concurrently. The remainder of this section details a typical construction process for the work environment and required construction activities. The selected contractor may find alternatives at different construction steps that create less environmental disturbance.

Project mobilization will proceed primarily over the water due to the size of the required equipment, the necessity to work across the channel from east to west on both north and south sides of the State Highway 87 Bridge, and the condition of the existing sheetpile walls that line the Pass. The majority of heavy equipment will operate from barges. Anchors or spuds (large pipes driven into the bottom) will hold the equipment barges in place.

For construction south of the State Highway 87 Bridge, the contractor will use tugboats or motorized barges to transport the large construction cranes and pile-driving equipment necessary to install pilings and geotubes at the project site. For construction north of the bridge, the contractor will transport equipment to the project site through the GIWW and Rollover Pass channel. A shallow-draft tugboat will push/pull the floating crane and piling-driving assembly. The contractor will likely use 20-30 foot workboats to shuttle workers between the shore and the crane platform, and perform other work tasks. Similar size boats will provide the platform to perform any necessary in-water monitoring work.

DMPA #36 north of the GIWW west of Rollover Bay will provide the primary source of material to fill the Pass. The contractor will create a slurry of the dredge material within the DMPA and transport, via hydraulic dredge, the material from the DMPA to Rollover Pass. A floating pipeline will extend from the DMPA east along the north side of the GIWW, except for a short submerged segment across the GIWW, and then south through Rollover Bay to the Pass. Floating pipeline allows easy inspection and maintenance compared to a pipeline secured to the bottom. The pumping distance along the proposed pipeline route will likely require 3 anchored booster pumps in addition to the main dredge platform. Spuds will anchor the dredge and booster pump platforms.

The contractor will likely assemble and anchor the floating pipeline along the GIWW in place. The remainder of pipeline assembly will occur in East Bay. The contactor will drag the assembled pipeline through Rollover Bay using a hawser, and workboats to control pipeline movement during transport. Once in place, anchors spaced about every 200 to 400 feet will hold the pipeline in the desired location. All equipment (dredge platform, booster pumps, and pipeline) will locate in waters with depths below the mean lower low water (MLLW) elevation. Flags, signs, and lights will provide the necessary warning information to protect boaters from colliding with the equipment.

Once mobilization is complete, construction may begin. Construction will start with installation of sheetpile on the Gulf side of the Highway 87 Bridge. The sheetpile wall will stop tidal exchange and will help reduce lateral pressure on the bridge pilings during construction. Installation of the bayside sheetpile will occur after completion of the gulfside wall. Following sheetpile installation, the contractor will install pilings east to west across the width of the Pass at several locations. These pilings will establish the geotube location. The geotubes will provide the means to contain the sand within a set of cells along the length of the Pass and allow the contractor to fill the Pass in stages. This approach will minimize turbidity in the surrounding waters. Once pile installation is complete, the contractor will place the geotubes and pump them full of seawater followed by dredged material. The final geotube elevation will lie well below the finished project elevation. The filled geotubes will effectively create individual

cells that the contractor will fill with dredged material. Material placement will commence at the bridge to fill the space in between the sheetpile and under the bridge. After filling this space, the contractor will proceed toward the adjacent water body (Gulf of Mexico or Rollover Bay). The contractor will continue filling the Pass at a speed that allows settling of fine materials and sufficient to maintain turbidity within acceptable limits. The contractor will use large earthmoving equipment to grade and compact the sediment during the construction process.

2.0 FEDERALLY-LISTED THREATENED AND ENDANGERED SPECIES

The project area lies within the coastal area of Galveston County, Texas. USFWS and the NMFS identified the threatened and endangered species listed in Table 1 as likely occurring in Galveston County. Of the species listed in Table 1, the piping plover and the five species of sea turtles are most likely to occur in the project vicinity. Due to lack of suitable habitat, known range limits, or presumed extinction (i.e. Eskimo curlew), the other species listed in Table 1 are not likely to occur in the project vicinity.

Table 1 Federally-Listed Threatened and Endangered Species Occurring in Galveston County, Texas

Common Name	**Scientific Name**	**Listing Status**	
		USFWS	**NMFS**
BIRDS			
Eskimo curlew	*Numenius borealis*	Endangered	-
Attwater's greater prairie-chicken	*Tympanuchus cupido attwateri*	Endangered	-
Piping plover	*Charadrius melodus*	Threatened	-
MAMMALS			
Blue whale	*Balaenoptera musculus*	-	Endangered
Finback whale	*Balaenoptera physalus*	-	Endangered
Humpback whale	*Megaptera novaeangliae*	-	Endangered
Sei whale	*Balaenoptera borealis*	-	Endangered
Sperm whale	*Physeter macrocephalus*	-	Endangered
REPTILES			
Green sea turtle	*Chelonia mydas*	Threatened	Threatened
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened	Threatened
FISH			
Smalltooth sawfish	*Pristis pectinata*	-	Endangered

Sources: (USFWS website: http://www.fws.gov/southwest/es/EndangeredSpecies/lists/ListSpecies.cfm accessed December 2009 and NOAA/NMFS website: http://sero.nmfs.noaa.gov/pr/pdf/Texas.pdf accessed December 2009)

2.1 PIPING PLOVER

The piping plover is a small shorebird approximately seven inches long with sand-colored plumage on their backs and crown with white underparts. Breeding birds have a single black band across the breast and bright orange legs. During the winter season, the birds lose the black band and the legs fade to pale yellow (USFWS, 2010).

An inhabitant of coastal beaches and tidal flats, the piping plover migrates along the Texas coast from fall through spring (Chapman, 1984; Haig, 1987). Piping plovers feed along moist, sandy beaches and in sand and mud flats around inlets and estuaries (Chapman, 1984). Their diet consists primarily of invertebrates such as polychaete worms, fly larvae, beetles, crustaceans, and mollusks (USFWS, 1996). Just over 5,000 piping plover breeding pairs exist today. Approximately 35 percent of the known piping plover population winters in Texas (TPWD, 2009a).

The primary causes of the piping plover decline include habitat alteration and destruction. Loss of sandy beaches, intertidal flats, and lakeshores due to recreational, residential, and commercial development have reduced the available habitat for the species (TPWD, 2009a).

In 1986, the USFWS listed piping plover populations as threatened and endangered. The Northern Great Plains and Atlantic Coast populations are threatened and the Great Lakes population is endangered. Wintering plovers along the Texas coast are threatened species.

In Texas, the USFWS has designated 37 piping plover critical habitat units along the coast from the Bolivar Peninsula on the upper Texas coast to the mouth of the Rio Grande on the south Texas coast. Three piping plover critical habitat units — TX-35, TX-36, and TX-37 — occur in the vicinity of the proposed project (Figure 1). Units TX-35 and TX-36 occur in the adjacent to Galveston Inlet near the entrance to the Gulf of Mexico. Unit TX-37 occurs north of Rollover Pass and includes Rollover Bay. The USFWS provides the following unit descriptions:

<u>TX-35: Big Reef. 47 ha (117 ac) in Galveston County</u>

This unit consists of beach and sand flats on the north, west, and east shore of Big Reef, down to mean lower low water (MLLW). South Jetty is not included. The area is currently managed by the City of Galveston. This unit includes the lands known as wind tidal flats that are infrequently inundated by seasonal winds.

<u>TX-36: Bolivar Flats. 160 ha (395 ac) in Galveston County</u>

This unit extends from the jetties on the southwest end of the Bolivar Peninsula to a point on the Gulf beach 1km (0.6 mi) north of Beacon Bayou. It includes 5.0 km (3 mi) of Gulf shoreline. The landward boundary is the line indicating the beginning of dense vegetation, and the gulfside boundary is MLLW. The area is leased from the TGLO by Houston Audubon Society and managed for its important avian resources. The upland areas are used for roosting by the piping plover. This unit includes lands known as wind tidal flats that are infrequently inundated by seasonal winds.

<u>Unit TX-37: Rollover Pass 6 ha (16 ac) in Galveston County</u>

This unit consists of Rollover Bay on the bayside of Bolivar Peninsula. The landward boundary is the line indicating the beginning of dense vegetation, and the bayside boundary is MLLW. It includes flats on State-owned land managed by the TGLO. This unit captures the intertidal complex of the Bay, and is bounded by the town of Gilchrist to the east and the Gulf beach of the Bolivar Peninsula to the

south. This unit includes lands known as wind tidal flats that are infrequently inundated by seasonal winds.

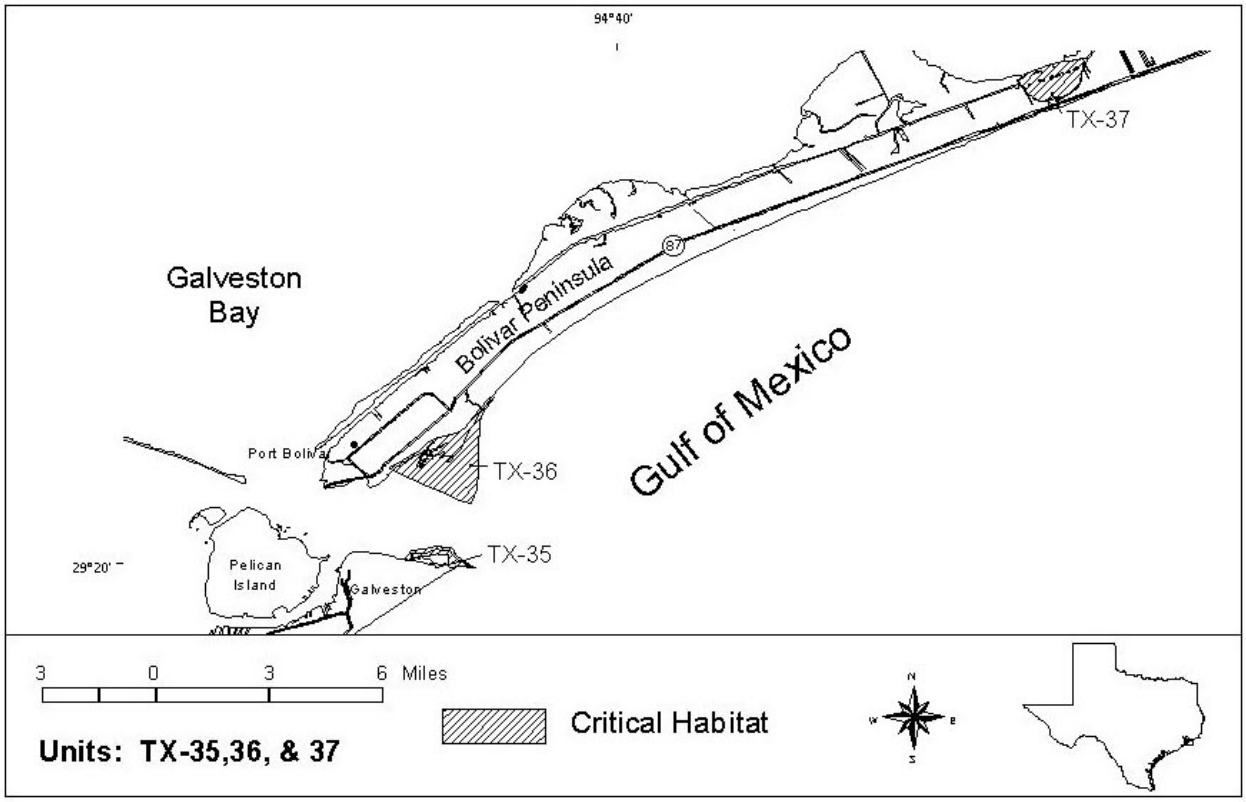


Figure 1 Piping Plover Critical Habitat Units on the Bolivar Peninsula

2.3 LOGGERHEAD SEA TURTLE

Named for their large heads that support powerful jaws, Loggerhead sea turtles have a slightly heart-shaped, reddish-brown carapace and pale yellow plastron. The neck and flippers are generally dull brown to reddish-brown. The average adult is approximately three feet long and weighs 250 pounds (NMFS, 2010a).

The loggerhead sea turtle occurs throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. The species may occur hundreds of miles offshore and in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. Adult females typically nest between the dune front and high tide line. Most nesting occurs at the western rims of the Atlantic and Indian Oceans. The densest nesting occurs along the Atlantic coast of South Florida and on Masirah Island, Oman. Adult loggerheads are known to make considerable migrations between foraging and nesting grounds. Post-hatchlings and young juveniles live an oceanic existence drifting with ocean currents and are commonly associated with sargassum rafts and open ocean drift lines. At some point, oceanic juveniles migrate to neritic waters and continue maturing until adulthood. The neritic zone provides crucial foraging habitat for juveniles, but also provides important foraging, inter-nesting, and migratory habitat for adults. Juvenile loggerheads commonly feed within the bays, sounds, and estuaries

along the Atlantic and Gulf coasts; however, adults infrequently use these inshore waters (NMFS, 2010a, USFWS, 2009a).

Loggerhead sea turtles are transient species along the Texas coast and in Texas bays and estuaries. Only minor nesting has occurred along the Gulf of Mexico coast. Since 1999, 29 documented loggerhead sea turtle nests have occurred along the Texas coast (D. Shaver, personal communication, January 8, 2010). All but one of those nests occurred between Mustang Island and South Padre Island. One nest occurred along the Bolivar Peninsula in 2008.

Threats to loggerhead sea turtle populations include loss or degradation of nesting habitat due to coastal development and beach armoring, disorientation from beachfront lighting, nest predation by native and introduced species, marine pollution and debris, disease, watercraft strikes, and incidental take due to dredging and fishing (NMFS, 2010a; USFWS, 2009a).

In 1978, the loggerhead sea turtle was listed under the ESA as a threatened species throughout its range.

2.2 GREEN SEA TURTLE

A large species, the green sea turtle grows to about four feet in length and can weigh up to 440 pounds. The green sea turtle has a heart-shaped shell, small head, and single-clawed flippers. Their smooth carapace (top shell) may consist of several colors including gray, green, brown, and yellow while the plastron (bottom shell) is generally yellowish-white (USFWS, 2009b).

The green turtle has a worldwide distribution in tropical and subtropical waters. After nest emergence, hatchlings move offshore where the feed on a variety of pelagic plants and animals. After several years, juvenile green sea turtles leave the pelagic habitat and travel to nearshore foraging grounds. Exclusively herbivorous, adults prefer shallow waters inside reefs, bays, and inlets, and are attracted to lagoons and shoals where seagrasses and algae commonly occur. Green sea turtles require beaches with a sloping platform and minimal disturbance for nesting and often make long distance migrations between feeding and nesting grounds (USFWS, 2009b). In the United States, most nesting occurs along the Atlantic coast of Florida. Green sea turtles occasionally nest along the Texas coast. From 1999-2009, 21 documented green sea turtle nests occurred along the Texas coast (D. Shaver, personal communication, January 8, 2010). All of the nests occurred on Padre Island.

Several factors have contributed to the decline of the green sea turtle. Commercial harvest for eggs and meat, disease (e.g. fibropapillomatosis), loss of nesting habitat due to coastal development and beach armoring, hatchling disorientation due to beach lighting, nest predation by native and introduced species, degradation of foraging habitat, marine pollution and debris, watercraft strikes, and incidental take from dredging and commercial fishing operations have all played a role in the species decline (TPWD, 2009b).

In 1978, the green sea turtle was listed under the ESA as an endangered species for breeding colonies in Florida and on the Pacific coast of Mexico, and as threatened for all others.

2.4 LEATHERBACK SEA TURTLE

The leatherback sea turtle is the largest sea turtle in the world. The adult leatherback can reach lengths up to eight feet and weigh 2,000 pounds. Their shell comprises a mosaic of small bones covered by firm, leathery skin with seven longitudinal ridges. The skin is predominantly black and the flippers are black with white margins (USFWS, 2009c).

The leatherback sea turtle is the deepest diving, most migratory and wide-ranging of all of the sea turtle species. Leatherback turtles are commonly known as pelagic species, but may also forage in coastal waters. Leatherbacks mate in waters adjacent to nesting beaches and along migratory corridors. Adult females require sandy nesting beaches backed with vegetation and sloped appropriately to minimize long crawls (USFWS, 2009c). Nesting grounds are located around the world. The largest nesting assemblages occur on the coasts of South America and West Africa. Once considered one of the the largest nesting colonies in the world, the Mexico leatherback nesting population now comprises less than one percent of its estimated size in 1980 (USFWS, 2009c). The U.S. Caribbean and southeast Florida support minor nesting colonies. After nesting, female leatherbacks migrate from tropical to more temperate latitudes, which support higher densities of jellyfish in the summer (NMFS, 2010b).

The leatherback turtle rarely occurs along the Texas coast. In an extremely rare occurrence, one leatherback turtle nested at the Padre Island National Seashore in 2008 (D. Shaver, personal communication, January 8, 2010). It was the first documented leatherback nest in Texas since the 1930s.

Several factors have contributed to the decline of the species including exploitation by humans for eggs and meat, incidental take associated with commercial fisheries, loss or degradation of nesting habitat from coastal development, hatchling disorientation from beachfront lighting, nest predation by native and introduced species, marine pollution and debris, and watercraft strikes (USFWS, 2009c).

In 1970, the leatherback sea turtle gained protection under the ESA as an endangered species throughout its range.

2.5 KEMP'S RIDLEY SEA TURTLE

The Kemp's ridley sea turtle, considered the smallest marine turtle in the world, grows to about two feet in length and weighs up to 100 pounds. The adult Kemp's ridely's oval, olive-gray carapace has five pairs of costal scutes. It has a triangular-shaped head and slightly hooked beak with large crushing surfaces (USFWS, 2009d).

Adult Kemp's ridley turtles occupy neritic habitats that typically contain muddy or sandy bottoms where prey species reside. Kemp's ridleys primarily feed on crabs, but occasionally eat fish, jellyfish, and mollusks. The range of the species includes the Gulf of Mexico coasts and the Atlantic coast of North America. Outside of nesting, the primary habitat for Kemp's ridleys include nearshore and inshore habitats of the northern Gulf of Mexico, especially Louisiana waters (USFWS, 2009d).

Most Kemp's ridleys nest on the coastal beaches of the Mexican states of Tamaulipas and Veracruz. Small numbers nest consistently along the Texas coast, primarily at Padre Island National Seashore (USFWS, 2009d). Between 1999 and 2009, a total of 807 recorded Kemp's ridley nests occurred along the Texas coast, with a record 197 nests in 2009 (D. Shaver, personal communication, January 8, 2010). The vast majority of the nests occurred along the Padre Island National Seashore. Ten nests during that time period occurred on Bolivar Peninsula beaches, six of which were recorded in 2008.

The principal causes for the species decline comprise human-related activities such as direct harvest of eggs and adults and incidental capture in commercial fishing gear (NMFS, 2010c).

Considered the most critically-endangered sea turtle species, the Kemp's ridley gained protection under the ESA in 1970 as an endangered species.

2.6 HAWKSBILL SEA TURTLE

A small to medium sized sea turtle, the hawksbill may reach up to three feet in length and weigh 300 pounds. Elongated and oval-shaped, the hawksbill carapace has tortoiseshell coloring ranging from dark to golden brown with mottles of orange, red, and/or black. The plastron is yellowish. The rear edge of the carapace is almost always serrated, except in older adults, and has overlapping scutes. Its elongated head that tapers to a point and beak-like mouth give the hawksbill its name (USFWS, 2009e).

The hawksbill inhabits the tropical and subtropical regions of the Atlantic, Pacific, and Indian Oceans. Hawksbill turtles use different habitats during different life stages, but most commonly associate with coral reefs. Post-hatchlings are believed to occupy pelagic environments taking shelter in floating algal mats and drift lines (NMFS, 2010d). After a few years in the pelagic zone, small juveniles migrate to the coastal foraging grounds. During this time their preferred feeding habitat changes from feeding primarily at the surface to feeding below the surface on animals typically associated with coral reefs (e.g. sponges, sea urchins, etc.). Hawksbills also occur around rocky outcrops and high energy shoals, which are also optimum sites for sponge growth. They inhabit mangrove-fringed bays and estuaries, particularly along the eastern shore of continents void of coral reefs (NMFS, 2010d).

Female hawksbills nest alone or in small numbers on scattered beaches throughout its range. Exceptions include the Gulf and Caribbean coasts of the Yucatan Peninsula, Mexico, where hawksbills nest on long expanses of beach in densities of 20-30 nests per kilometer (USFWS, 2009e).

Although very rare, Florida and Texas are the only U.S. states that hawksbill sightings occur with any regularity. Most sightings involve post-hatchlings and juveniles and are associated with stone jetties. Adult hawksbills are extremely rare in Texas. Hildebrand (1983) suggested that hawksbills occurring in Texas are waifs. Nesting data indicate that no hawksbill nesting occurred along the Texas coast from 1999–2009 (D. Shaver, personal communication, January 8, 2010).

Historically, the human exploitation for the tortoiseshell trade was the primary cause of the species' decline. This threat still exists while illegal trade continues. Other contributing threats include coral reef habitat loss, loss of nesting habitat due to coastal development, marine pollution and debris, and excessive nest predation (USFWS, 2009e).

In 1970, the hawksbill sea turtle was listed under the ESA as an endangered species throughout its range.

3.0 EFFECTS OF THE PROPOSED ACTION

The following subsections present effect determinations for each species and provide avoidance, minimization, and conservation recommendations that support the effect determinations. Based on the ESA, the effect determinations use the following language:

- *No effect* – The proposed action will not affect the federally-listed species or critical habitat.

- *May affect, but not likely to adversely affect* – The project may affect listed species and/or critical habitat; however, the effects are expected to be discountable, insignificant, or completely beneficial.

- *Likely to adversely affect* – Adverse effects to listed species and/or critical habitat may occur as a direct result of the proposed action or its interrelated or independent actions, and the effect is not discountable, insignificant, or completely beneficial. Under this determination,

an additional determination is made whether the action is likely to jeopardize the continued survival and eventual recovery of the species.

3.1 EFFECTS ON THE PIPING PLOVER

The project occurs in the immediate vicinity of piping plover critical habitat unit TX-37. As described in Section 2.1 above, the unit consists of the intertidal areas of Rollover Bay. The project will not directly impact these critical habitat areas. However, the project may result in temporary disturbance to resting and foraging piping plovers using intertidal habitats within the project vicinity. Highly mobile species, piping plovers occurring near the project area during construction would easily relocate to adjacent suitable habitat that is abundant in Rollover Bay and adjacent spoil islands. The project may result in long-term benefits by reducing the current velocities within Rollover Bay. Reduced current velocities may promote the development of additional intertidal sand and mud flats, desirable habitat for the piping plover.

Effect Determination: *May affect, but not likely to adversely affect*

3.1.1 Avoidance, Minimization and Conservation Measures

Limiting construction areas to deeper, subtidal waters (areas with bottom elevations below mean lower low water) within Rollover Bay and the GIWW will avoid direct impacts to critical habitat. Placement of the dredge pipeline and booster pumps will occur at the greatest distance as practicable from piping plover habitat. Construction vessels and personnel will to use the deeper channels for access to and from the construction site as to minimize potential disturbance. The contractor shall instruct all personnel associated with the project of the potential presence of the piping plover and the need to protect the species. The contractor shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing piping plovers, which are protected under the Endangered Species Act of 1973.

3.2 THE LOGGERHEAD SEA TURTLE

Historical data shows that loggerhead turtles very rarely nest (one documented nest from 1999-2009) on Bolivar Peninsula beaches (D. Shaver, personal communication, 2010). In addition, beach erosion, primarily due to Hurricane Ike in 2008, has severely reduced viable nesting habitat on the Bolivar Peninsula. However, the potential exists for loggerhead turtles to nest in the vicinity of the project area. Swimming and foraging loggerheads may also occur within the estuarine waters of Rollover Bay, East Bay, and the GIWW. Accordingly, the proposed action should incorporate the appropriate protection measures to minimize any potential impact to both swimming and nesting loggerhead sea turtles.

In the long-term, the proposed action will likely benefit nesting loggerhead sea turtles and reduce potential adverse impact to swimming turtles during annual GIWW dredging events. Closing Rollover Pass will help alleviate beach erosion along the Bolivar Peninsula, reduce the frequency of maintenance dredging of the GIWW, and increase the effectiveness of beach restoration projects. Currently, the Pass disrupts the natural movement of sand along the beach by intercepting sand that, in turn, deposits within the Bay system. The proposed project will help conserve the existing turtle nesting habitat by restoring the natural longshore sediment transport processes that provide sand to downdrift beaches. Closing the Pass will add approximately 300 linear feet of beach habitat that sea turtles may use for nesting. Reducing the frequency of GIWW maintenance dredging events will reduce the potential for vessel strike and incidental take associated with annual dredging activities.

Effect Determination: *May affect, but not likely to adversely affect*

3.2.1 Avoidance, Minimization and Conservation Measures

Recommended protection measures for nesting sea turtles include the following:

- The contractor shall instruct all personnel associated with the project of the potential presence of these species and the need to protect nesting sea turtles.

- The contractor shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles, which are protected under the Endangered Species Act of 1973.

- The contractor shall hire a trained sea turtle specialist to conduct daily sea turtle nest monitoring. Monitoring duties shall include identifying, recording, and mapping sea turtle nests and false crawls. All sea turtle nests shall be staked in the field for protection. If appropriate, sea turtle nest shall be relocated to a protected area out of harm's way.

- To the extent practicable, project materials and equipment shall be staged in areas to minimize any potential impact to nesting sea turtles.

- The number of vehicles transiting from the staging areas to the project sites shall be kept to a minimum. All vehicles shall use the same pathway whenever possible and vehicle access shall be confined to the immediate needs of the proposed project.

- Placed dredged and fill material on the beach shall be similar in size, texture, and color to the natural beach sediment. Placed dredged material shall be maintained at a natural, gradual slope as to not impede or obstruct nesting sea turtles. At the end of each construction day, the contractor shall smooth out ruts in the beach.

- Use of construction lighting at night shall be minimized to the greatest extent practicable. Shielding, as appropriate, shall be used to minimize any potential adverse effect to nesting sea turtles.

Recommended protection measures for swimming sea turtles include the following:

- The contractor shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with sea turtles. All construction personnel are responsible for observing water-related activities for the presence of sea turtles.

- The contractor shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles, which are protected under the Endangered Species Act of 1973.

- Siltation barriers shall be made of material in which a sea turtle cannot become entangled, be properly secured, and be regularly monitored to avoid sea turtle entrapment.

- All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

- If a sea turtle is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle. Operation of any mechanical construction equipment shall cease immediately if a sea turtle is seen within a 50-ft radius of the equipment. Activities shall not resume until the protected species has departed the project area of its own volition.

- Any collision with and/or injury to a sea turtle shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division and the local authorized sea turtle stranding/rescue organization.

3.3 EFFECTS ON THE GREEN SEA TURTLE

Due to lack of available food resources (submerged aquatic vegetation, algae, etc.) and preferred foraging habitat within the project vicinity, the green sea turtle is unlikely to occur in the project area. This BA concludes that the project will not affect the species.

Effect Determination: *No effect*

3.4 EFFECTS ON THE LEATHERBACK SEA TURTLE

Primarily a pelagic species, the leatherback sea turtle is highly unlikely to occur in the project vicinity. This BA concludes that the project will not affect the species.

Effect Determination: *No effect*

3.5 EFFECTS ON THE KEMP'S RIDELY SEA TURTLE

Of all five of the sea turtle species, the Kemp's ridley turtle is the most frequent nester along Texas beaches. However, nesting rarely occurs on Bolivar Peninsula beaches (ten documented nests from 1999-2009). In addition, beach erosion, primarily due to Hurricane Ike in 2008, has severely reduced viable nesting habitat on the Bolivar Peninsula. However, the potential exists for Kemp's ridley turtles to nest in the vicinity of the project area. Swimming and foraging Kemp's ridley turtles may also occur within the estuarine waters of Rollover Bay, East Bay, and the GIWW. Accordingly, the proposed action should incorporate the appropriate protection measures to minimize any potential impact to both swimming and nesting Kemp's ridley sea turtles.

In the long-term, the proposed action will likely benefit nesting Kemp's ridley sea turtles and reduce potential adverse impact to swimming turtles during annual GIWW dredging events. Closing Rollover Pass will help alleviate beach erosion along the Bolivar Peninsula, reduce the frequency of maintenance dredging of the GIWW, and increase the effectiveness of beach restoration projects. Currently, the Pass disrupts the natural movement of sand along the beach by intercepting sand that, in turn, deposits within the Bay system. The proposed project will help conserve the existing turtle nesting habitat by restoring the natural longshore sediment transport processes that provide sand to downdrift beaches. Closing the Pass will add approximately 300 linear feet of beach habitat that sea turtles may use for nesting. Reducing the frequency of GIWW maintenance dredging events will reduce the potential for vessel strike and incidental take associated with annual dredging activities.

Effect Determination: *May affect, but not likely to adversely affect*

3.5.1 Avoidance, Minimization, and Conservation Measures

Recommended protection measures for nesting sea turtles include the following:

- The contractor shall instruct all personnel associated with the project of the potential presence of these species and the need to protect nesting sea turtles.

- The contractor shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles, which are protected under the Endangered Species Act of 1973.

- The contractor shall hire a trained sea turtle specialist to conduct daily sea turtle nest monitoring. Monitoring duties shall include identifying, recording, and mapping sea turtle nests and false crawls. All sea turtle nests shall be staked in the field for protection. If appropriate, sea turtle nest shall be relocated to a protected area out of harm's way.

- To the extent practicable, project materials and equipment shall be staged in areas to minimize any potential impact to nesting sea turtles.

- The number of vehicles transiting from the staging areas to the project sites shall be kept to a minimum. All vehicles shall use the same pathway whenever possible and vehicle access shall be confined to the immediate needs of the proposed project.

- Placed dredged and fill material on the beach shall be similar in size, texture, and color to the natural beach sediment. Placed dredged material shall be maintained at a natural, gradual slope as to not impede or obstruct nesting sea turtles. At the end of each construction day, the contractor shall smooth out ruts in the beach.

- Use of construction lighting at night shall be minimized to the greatest extent practicable. Shielding, as appropriate, shall be used to minimize any potential adverse effect to nesting sea turtles.

Recommended protection measures for swimming sea turtles include the following:

- The contractor shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with sea turtles. All construction personnel are responsible for observing water-related activities for the presence of sea turtles.

- The contractor shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles, which are protected under the Endangered Species Act of 1973.

- Siltation barriers shall be made of material in which a sea turtle cannot become entangled, be properly secured, and be regularly monitored to avoid sea turtle entrapment.

- All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

- If a sea turtle is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle. Operation of any mechanical construction equipment shall cease immediately if a sea turtle is seen within a 50-ft radius of the equipment. Activities shall not resume until the protected species has departed the project area of its own volition.

- Any collision with and/or injury to a sea turtle shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division and the local authorized sea turtle stranding/rescue organization.

3.6 EFFECTS ON THE HAWKSBILL SEA TURTLE

The hawksbill sea turtle very rarely occurs along the Texas coast. Due to lack of preferred foraging habitat (coral reefs, rocky areas, stone jetties, etc.), the hawksbill turtle is highly unlikely to occur in the project vicinity. This BA concludes that the project will not affect the species.

Effect Determination: *No effect*

4.0 CONCLUSIONS

The Rollover Pass Closure Project will not affect the green, leatherback, or hawksbill sea turtles. The project may affect, but is not likely to adversely affect the piping plover, Kemp's ridley sea turtle, and loggerhead sea turtle. This BA proposes protection and conservation measures to avoid and minimize potential impacts to these species.

5.0 REFERENCES

Chapman, B.R. 1984. Seasonal abundance and habitat-use patterns of coastal bird populations on Padre and Mustang Island barrier beaches. National Coastal Ecosystems Team, USFWS, FWS/OBS-83/31.

Haig, S.M. 1987. Winter distribution and status of piping plovers on the Gulf of Mexico. Presented at the Canadian Wildlife Service Symposium on Prairie Endangered Species.

Hildebrand, H. 1983. Random notes on sea turtles in the western Gulf of Mexico. Proceedings Western Gulf of Mexico Sea Turtle Workshop. Texas A&M University. College Station, Texas. TAMU-SG-84-105.

NMFS. 2010a. Loggerhead Turtle. http://www.nmfs.noaa.gov/pr/species/turtles/loggerhead.htm. Accessed December 21, 2009.

NMFS. 2010b. Leatherback Turtle. http://www.nmfs.noaa.gov/pr/species/turtles/leatherback.htm. Accessed December 21, 2009.

NMFS. 2010c. Kemp's Ridley Turtle. http://www.nmfs.noaa.gov/pr/species/turtles/kempsridley.htm. Accessed December 21, 2009.

NMFS. 2010d. Hawksbill Turtle. http://www.nmfs.noaa.gov/pr/species/turtles/hawksbill.htm. Accessed December 21, 2009.

TPWD. 2009a. Piping Plover. http://www.tpwd.state.tx.us/huntwild/wild/species/piplover. Accessed December 21, 2009.

TPWD. 2009b. Green Sea Turtle. http://www.tpwd.state.tx.us/huntwild/wild/species/greentur. Accessed December 21, 2009.

USFWS. 1996. Piping Plover (Charadrius melodus), Atlantic Coast Population, Revised Recovery Plan. Hadley, Massachusetts. 258 pp.

USFWS. 2009a. Loggerhead Sea Turtle. http://www.fws.gov/northflorida/seaturtles/turtle%20factsheets/loggerhead-sea-turtle.htm. Accessed December 21, 2009.

USFWS. 2009b. Green Sea Turtle. http://www.fws.gov/northflorida/seaturtles/turtle%20factsheets/green-sea-turtle.htm. Accessed December 21, 2009.

USFWS. 2009c. Leatherback Sea Turtle. http://www.fws.gov/northflorida/seaturtles/turtle%20factsheets /leatherback-sea-turtle.htm. Accessed December 21, 2009.

USFWS. 2009d. Kemp's Ridley Sea Turtle. http://www.fws.gov/northflorida/seaturtles/turtle%20factsheets /kemps-ridley-sea-turtle.htm. Accessed December 21, 2009.

USFWS. 2009e. Hawksbill Sea Turtle. http://www.fws.gov/northflorida/seaturtles/turtle%20factsheets/hawksbill-sea-turtle.htm. Accessed December 21, 2009.

USFWS. 2010. Piping Plover. http://www.fws.gov/plover/facts.html. Accessed December 21, 2009.

APPENDIX E

Pertinent Correspondence

Coastal Coordination Council

P.O. Box 12873 ♦ Austin, Texas 78711-2873 ♦ (800) 998-4GLO ♦ FAX (512) 475-0680

Chairman

Jerry Patterson
Texas Land Commissioner

♦

Members

Karen Hixon
Parks & Wildlife Commission of Texas

Jose Dodier
Texas State Soil & Water Conservation Board

Edward G. Vaughan
Texas Water Development Board

Ned Holmes
Texas Transportation Commission

Elizabeth Jones
Railroad Commission of Texas

H. S. Buddy Garcia
Texas Commission on Environmental Quality

Robert R. Stickney
Sea Grant College Program

Robert "Bob" Jones
Coastal Resident Representative

Jerry Mohn
Coastal Business Representative

George Deshotels
Coastal Government Representative

Bob McCan
Agriculture Representative

♦

Tammy Brooks
Council Secretary

Jesse Solis, Jr.
Permit Service Center
Corpus Christi
1-866-894-3578

Permit Service Center
Galveston
1-866-894-7664

August 19, 2009

Ms. Kayleigh Rust
Texas General Land Office
Coastal Resources
PO Box 12873
Austin Texas 78711-2873

Re: NEPA Review Request for FEMA 404 HGMP (DR-1791-TX)
Application for the Closure of Rollover Pass

Dear Ms. Rust:

Based on information provided to the Texas Coastal Management Program on the above project, it has been determined that it will likely not have adverse impacts on coastal natural resource areas (CNRAs) in the coastal zone. However, siting and construction should avoid and minimize impacts to CNRAs. If a U. S. Army Corps of Engineers permit is required, it will be subject to consistency review under the Texas Coastal Management Program.

If you have any questions or concerns, please contact me at (512) 463-9212 or at tammy.brooks@glo.state.tx.us.

Sincerely,

Tammy S. Brooks
Coastal Coordination Council Secretary
Consistency Review Coordinator
Texas General Land Office

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
101 South Main
Temple, TX 76501-7602

August 17, 2009

Ms. Kayleigh Rust
Natural Resource Specialist
Texas General Land Office
P. O. Box 12873
Austin, TX 78711-2873

Dear Ms. Rust:

We have reviewed the project information pertaining to the application to the Texas Governor's Division of Emergency Management (DEM) for Federal Emergency Management Agency (FEMA) 404 Hazard Mitigation Grant Program (HMGP) funds for the closure of Rollover Pass on Bolivar Peninsula.

This project should have no significant adverse impact on the environment or natural resources in the area. We do not require any permits, easements, or approvals for activities such as this.

Thank you for the opportunity to review this proposed project.

Sincerely,

For DONALD W. GOHMERT
State Conservationist

RECEIVED
AUG 20 2009
GENERAL LAND OFFICE

TEXAS HISTORICAL COMMISSION
real places telling real stories

RECEIVED
AUG 11 2009
GENERAL LAND OFFICE

August 6, 2009

Ms. Kayleigh Rust
Natural Resource Specialist
Coastal Protection Division
Texas General Land Office
1700 North Congress Ave.
Austin, TX 78701

Re: Project review under Section 106 of the National Historic Preservation Act of 1966 and the Antiquities Code of Texas
Closure of Rollover Pass, Galveston County
GLO

Dear Ms. Rust

Thank you for your correspondence describing the above referenced project. This letter serves as comment on the proposed federal undertaking from the State Historic Preservation Officer, the Executive Director of the Texas Historical Commission. As the state agency responsible for administering the Antiquities Code of Texas, these comments also provide recommendations on compliance with state antiquities laws and regulations.

The review staff, led by State Marine Archeologist Steven D. Hoyt, has completed its review. The closure of Rollover Pass will have no adverse impact on submerged historic resources in the area. However, the vicinity of the pass, both in the Gulf and in East Bay, is considered high probability for the presence of historic shipwrecks. The illustrations provided give only an "approximate location of borrow area." We need to see a more accurate location of where the borrow area will be before we can determine if a marine archeological survey is needed in that area. Considerable survey has already been completed in the bay by the US Army Corps of Engineers, Galveston District. Your borrow area may fall within that previous survey and already be cleared for cultural resource purposes or you may be able to adjust you borrow area to fall within the previously surveyed area. Please provide the additional information on the location of the borrow area so that we may appropriately review the project impacts.

We look forward to further consultation with your office and hope to maintain a partnership that will foster effective historic preservation. Thank you for your cooperation in this federal and state review process, and for your efforts to preserve the irreplaceable heritage of Texas. **If you have any questions concerning our review or if we can be of further assistance, please contact Steve Hoyt at 512/927-7882.**

Sincerely,

for
Mark Wolfe, State Historic Preservation Officer

APPENDIX F

The Effects of Rollover Pass Closure on Hydrodynamics and Salinity
Galveston County, Texas
January 2010

Prepared by

Taylor Engineering, Inc.
10151 Deerwood Park Blvd
Building 300, Suite 300
Jacksonville, Florida 32256

AYLOR ENGINEERING, INC.

The Effects of Rollover Pass Closure on Hydrodynamics and Salinity

Galveston County, TX

January 2010

The Effects of Rollover Pass Closure on Hydrodynamics and Salinity

Prepared for

Texas General Land Office

by

Taylor Engineering, Inc.
10151 Deerwood Park Blvd., Bldg. 300, Suite 300
Jacksonville, Florida 32256
(904) 731-7040

C2009-063

January 2010

TABLE OF CONTENTS

LIST OF FIGURES ii
LIST OF TABLES iii
1.0 INTRODUCTION 1
2.0 STUDY AREA, MODELING PROCEDURES, AND CALIBRATION 2
2.1 Overview 2
2.2 Study Area and Model Domain 3
2.3 Hydrodynamic Model Calibration Data Collection and Tidal Characteristics 6
2.4 Hydrodynamic Model Parameters and Boundary Conditions 8
2.5 Hydrodynamic Model Calibration Results 10
2.6 Transport Model Calibration Data, Parameters and Boundary Conditions 23
2.7 Transport Model Calibration Results 24
3.0 LONG-TERM MODELING OF THE CLOSURE OF ROLLOVER PASS 33
3.1 Methodology Overview and Boundary Conditions 33
3.2 Model Procedure 36
3.3 Model Results 39
4.0 SUMMARY 67
REFERENCES 68
APPENDIX A Salinity Variation with Time Plots

LIST OF FIGURES

Figure 2.1 Model Domain 4
Figure 2.2 Extent of New Bathymetric Survey Data near Rollover Pass 5
Figure 2.3 Mesh and Bathymetry near Rollover Pass 6
Figure 2.4 Model Calibration Points 7
Figure 2.5 Hydrodynamic Model Boundary Condition Points 9
Figure 2.6 Sample Model Calibration Results at Tide Station 1 11
Figure 2.7 Sample Model Calibration Results at Tide Station 2 12
Figure 2.8 Sample Model Calibration Results at Tide Station 3 13
Figure 2.9 Model Calibration Results at Velocity Station 1, Data Period 1 15
Figure 2.10 Model Calibration Results at Velocity Station 1, Data Period 2 16
Figure 2.11 Model Calibration Results at Velocity Station 2, Data Period 1 17
Figure 2.12 Model Calibration Results at Velocity Station 2, Data Period 2 18
Figure 2.13 Model Calibration Results at Velocity Station 3, Data Period 1 19
Figure 2.14 Model Calibration Results at Velocity Station 3, Data Period 2 20
Figure 2.15 Model Calibration Results at Velocity Station 4, Data Period 1 21
Figure 2.16 Model Calibration Results at Velocity Station 4, Data Period 2 22
Figure 2.17 Salinity Data Collection Stations 23
Figure 2.18 Transport Model Calibration Results, Salinity Station 1 25
Figure 2.19 Transport Model Calibration Results, Salinity Station 2 26
Figure 2.20 Transport Model Calibration Results, Salinity Station 3 27
Figure 2.21 Transport Model Calibration Results, Salinity Station 4 28
Figure 2.22 Transport Model Calibration Results, Salinity Station 5 29
Figure 2.23 Transport Model Calibration Results, Salinity Station 6 30
Figure 2.24 Transport Model Calibration Results, Salinity Station 7 31
Figure 2.25 Transport Model Calibration Results, Salinity Station 8 32
Figure 3.1 Representative Annual Daily Stream Flow Statistics at Model Input Location 34
Figure 3.2 Representative Annual Total Daily Stream Flow and Constant Model Input Stream Flow 35
Figure 3.3 Model Tide Input vs. Measured Mean, High, and Low Tide Levels 37
Figure 3.4 Model Tide Input vs. Measured Mean, High, and Low Tide Levels 38
Figure 3.5 Winter Circulation in Rollover and East Bay with Rollover Pass Open 40
Figure 3.6 Winter Circulation in Rollover and East Bay with Rollover Pass Closed 40
Figure 3.7 Production Run Salinity Sample Points 42

Figure 3.8 Salinity Variation with Time, Station 4, Year 1 43
Figure 3.9 Salinity Variation with Time, Station 4, Year 2 44
Figure 3.10 Salinity Variation with Time, Station 4, Year 3 45
Figure 3.11 Salinity Variation with Time, Station 3, Year 1 46
Figure 3.12 Salinity Variation with Time, Station 3, Year 2 47
Figure 3.13 Salinity Variation with Time, Station 3, Year 3 48
Figure 3.14 Salinity Variation with Time, Station 11, Year 1 49
Figure 3.15 Salinity Variation with Time, Station 11, Year 2 50
Figure 3.16 Salinity Variation with Time, Station 11, Year 3 51
Figure 3.17 Average Salinity Contours, Rollover Pass Open, Summer Year 2 55
Figure 3.18 Average Salinity Contours, Rollover Pass Closed, Summer Year 2 56
Figure 3.19 Average Salinity Contours, Rollover Pass Open, Fall Year 2 57
Figure 3.20 Average Salinity Contours, Rollover Pass Closed, Fall Year 2 58
Figure 3.21 Average Salinity Contours, Rollover Pass Open, Winter Year 2 59
Figure 3.22 Average Salinity Contours, Rollover Pass Closed, Winter Year 2 60
Figure 3.23 Average Salinity Contours, Rollover Pass Open, Spring Year 2 61
Figure 3.24 Average Salinity Contours, Rollover Pass Closed, Spring Year 2 62
Figure 3.25 Contours of Average Salinity Change, Summer Year 2 63
Figure 3.26 Contours of Average Salinity Change, Fall Year 2 64
Figure 3.27 Contours of Average Salinity Change, Winter Year 2 65
Figure 3.28 Contours of Average Salinity Change, Spring Year 2 66

LIST OF TABLES

Table 2.1 NOAA Tide Data 8
Table 2.2 Error Measurement Formulas 10
Table 2.3 Tide Station Error Measurement Summary 14
Table 2.4 Velocity Station Mean Velocity Comparison, Data Period 1 14
Table 2.5 Velocity Station Mean Velocity Comparison, Data Period 2 14
Table 2.6 Salinity Station Mean Salinity Comparison 24
Table 3.1 Model Stream Flow Input 36
Table 3.2 Simulation Periods and Corresponding Hydrodynamic Simulations 39
Table 3.3 Summer and Fall Salinity Values 52
Table 3.4 Winter and Spring Salinity Values 53

1.0 INTRODUCTION

Rollover Pass, an artificial inlet created in 1955 to enhance recreational fishing opportunities, lies on the Bolivar Peninsula in Galveston County, Texas about 30 km (19 miles) northeast of the Galveston Bay entrance. The Pass, which provides a tidal connection between the Gulf of Mexico and Rollover Bay in the southeastern portion of East Bay, causes beach erosion, increases the frequency and, hence, costs to dredge the Gulf Intracoastal Waterway (GIWW), and increases the salinity levels within interior waters. The proposed Rollover Pass Closure project will alleviate the above adverse impacts and return the project site to a more natural state by completely infilling the pass from the Gulf to the bay shoreline.

The Texas General Land Office (GLO) requested Taylor Engineering, Inc. to evaluate the potential affects of the closure of Rollover Pass on inland water hydraulics and salinity. This report discusses a numerical modeling effort conducting by Taylor Engineering to analyze such affects of Pass closure. Following this brief introduction, Chapter 2 describes the general modeling procedures, the study area, and the model calibration. Chapter 3 presents the study methodology and model results. Chapter 4 contains a brief summary of the study's findings.

2.0 STUDY AREA, MODELING PROCEDURES, AND CALIBRATION

2.1 Overview

The study area lies on the northwestern side of the Gulf of Mexico and includes Rollover Pass, Rollover Bay, and Galveston Bay. Galveston Inlet and Rollover Pass connect the bays directly to the Gulf. Tides in the Gulf of Mexico generate tidal currents through these connections which exchange water between the bays and the Gulf. The tidal currents draw highly saline water into the bays from the Gulf of Mexico and expel saline water mixed with freshwater from the bays. Additionally, tidally controlled water level changes generate currents internal to the bays. These currents mix saline water from the Gulf with freshwater continuously entering the system through rivers and bayous. This study examines the affects of closing Rollover Pass, the primary conduit for water interchange, on the salinity concentration of waters in Rollover Bay and Galveston Bay.

Tidal and river circulations in and around inlets, rivers, and bays control the introduction and mixing of saline ocean waters with freshwater from streams and rivers. Hydrodynamic models provide engineers a means to describe and study these circulations. Such models simulate flow by solving the governing equations for the fluid dynamic processes at a given location under specific water level and flow boundary conditions.

This study employed two U.S. Army Corps of Engineers (USACE) two-dimensional finite element models (RMA2 and RMA4) to determine water conditions which would result from closing Rollover Pass. RMA2 computes water surface elevations and horizontal velocity components in two-dimensional flow fields based on tidal or riverine flow data. RMA4 applies the hydrodynamic solution from RMA2 to simulate the advection-diffusion transport process of saline and freshwater through the system.

Resource Management Associates, Inc. of Davis, California developed the hydrodynamic model RMA2 in 1973. Continuing modification and improvement by researchers at the USACE Waterways Experiment Station (WES) has resulted in a robust, well-established model. RMA2 solves the two-dimensional transient, depth-averaged, fluid dynamic governing equations in a finite element scheme with specifications for roughness coefficients to describe bed friction, turbulent exchange coefficients for turbulence closure, and both flow and free surface boundary conditions. Additional capabilities include treatments for wetting and drying, Coriolis acceleration, wind stress, dynamic bed friction assignment by depth, Peclet number definition of turbulent exchange coefficients, and one-dimensional storage and flow structures.

RMA4, another Resource Management Associates program modified and improved by researchers at WES, applies the hydrodynamic solutions from RMA2 to simulate depth-averaged advection-diffusion transport processes. RMA4 can simulate the fate of constituents as conservative or non-conservative with a first order decay. Successful applications include investigating the physical processes of migration and mixing of a soluble substance in reservoirs, rivers, bays, estuaries, and coastal zones; defining horizontal salinity distributions; tracing temperature effects from power plants; calculating residence times of harbors or basins; optimizing the placement of outfalls; identifying potential critical areas for oil spills or other contaminant spread; evaluating turbidity plume extent; and monitoring other water quality criterion within game and fish habitats.

The RMA2 model, calibrated with especially collected tidal stage and tidal velocity data, provides the hydrodynamic solution for the RMA4 model. The RMA4 model, calibrated with salinity data collected coincident with the tide data, estimates the salinity of the bays.

2.2 Study Area and Model Domain

Figure 2.1 shows the extent of the model domain. As noted, Galveston Inlet and Rollover Pass connect the bays directly to the Gulf of Mexico and provide the source of saline water in the bays. Trinity River provides 60 – 70% of the freshwater entering the study area with Buffalo Bayou, San Jacinto River, and Cedar Bayou providing the majority of the remaining freshwater input to the system.

The model domain applied in this study derives from the TxBLEND (Matsumoto et al., 2005). Taylor Engineering converted this model to RMA2, added details of Rollover Bay, and updated Rollover and East Bays with bathymetric data collected by Naismith Marine Services from August 6 to 21, 2009 (Figure 2.2). Figure 2.3 shows the bathymetry and model mesh in Rollover and East Bay, near Rollover Pass.

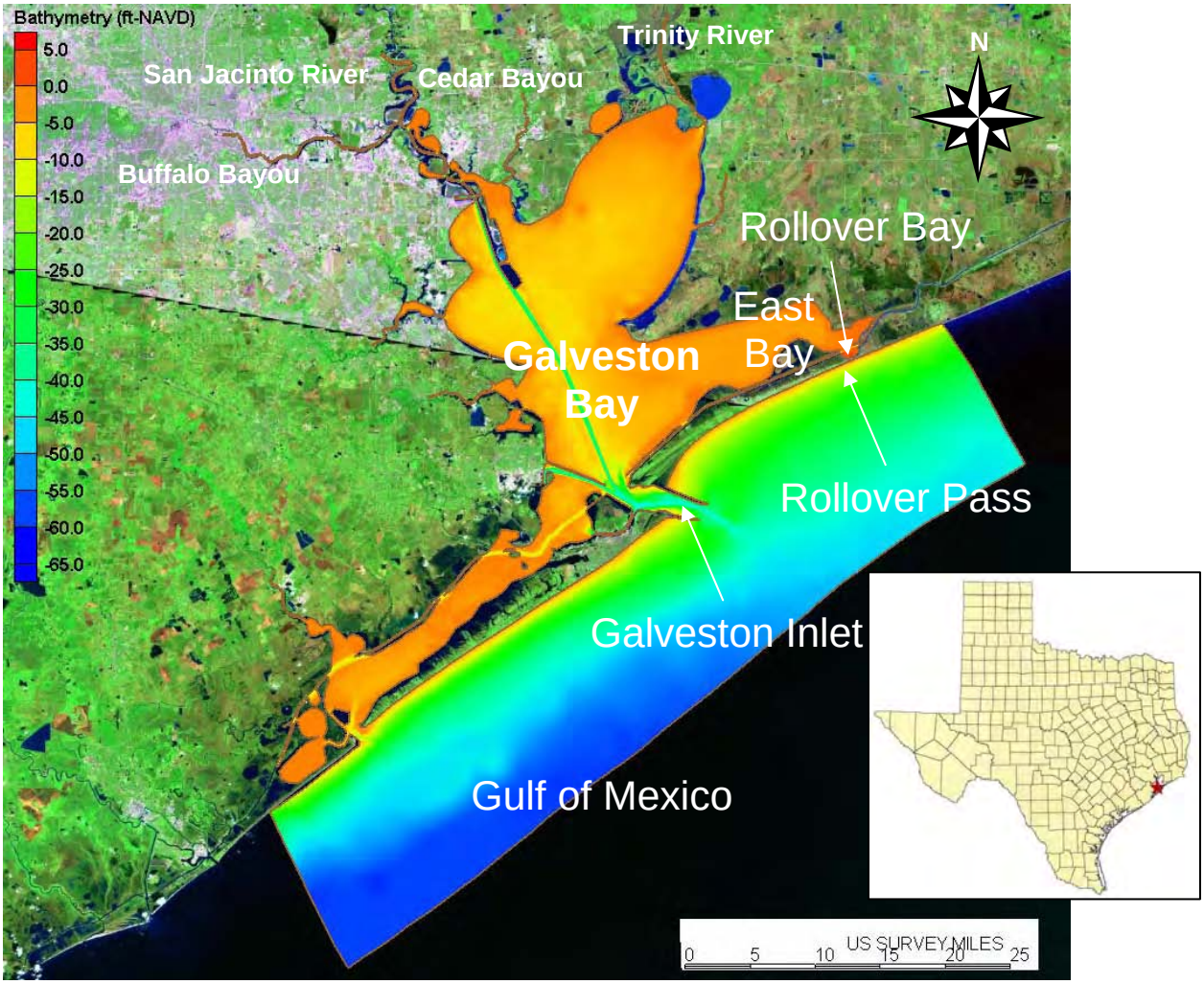


Figure 2.1 Model Domain

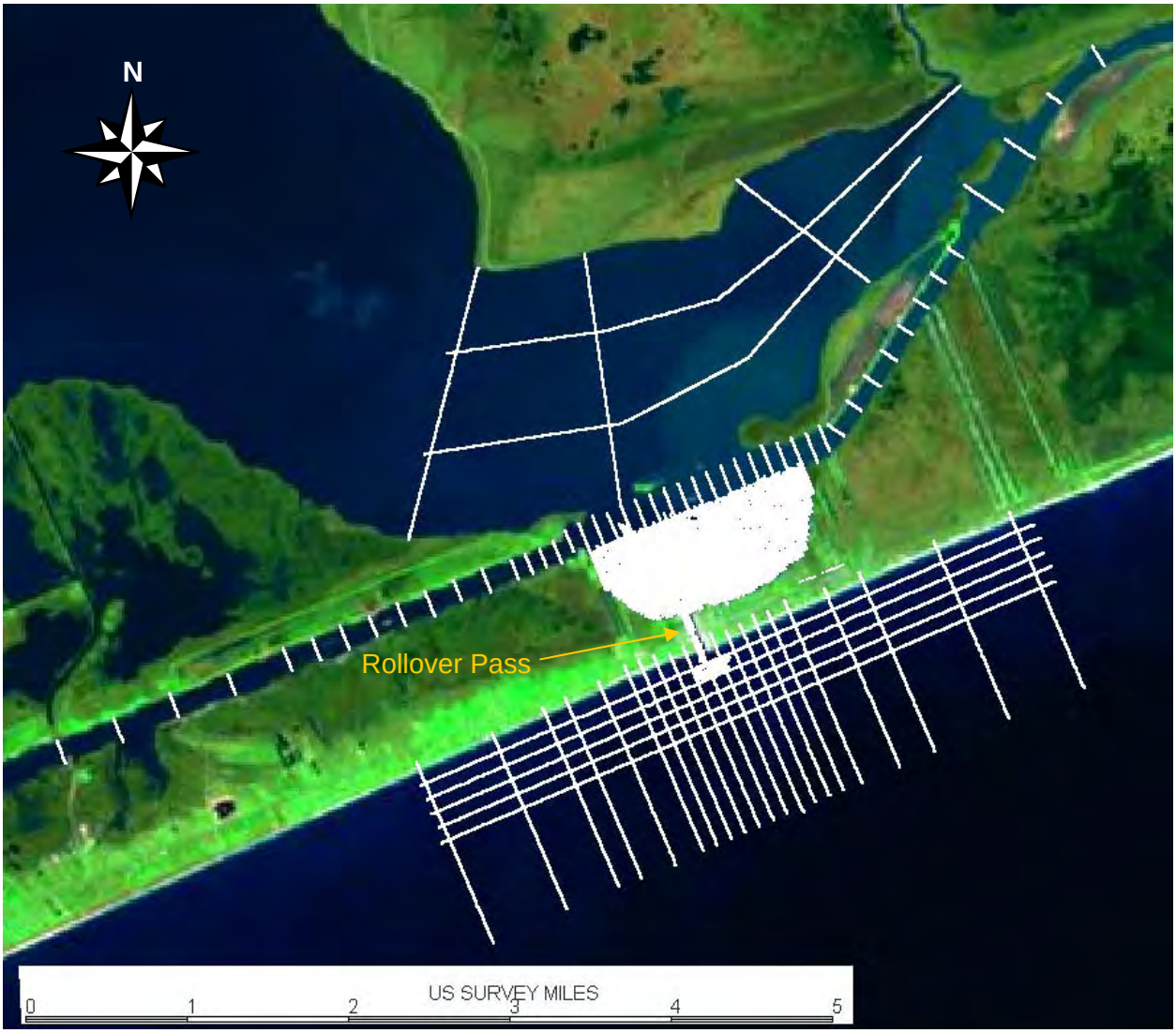


Figure 2.2 Extent of New Bathymetric Survey Data near Rollover Pass

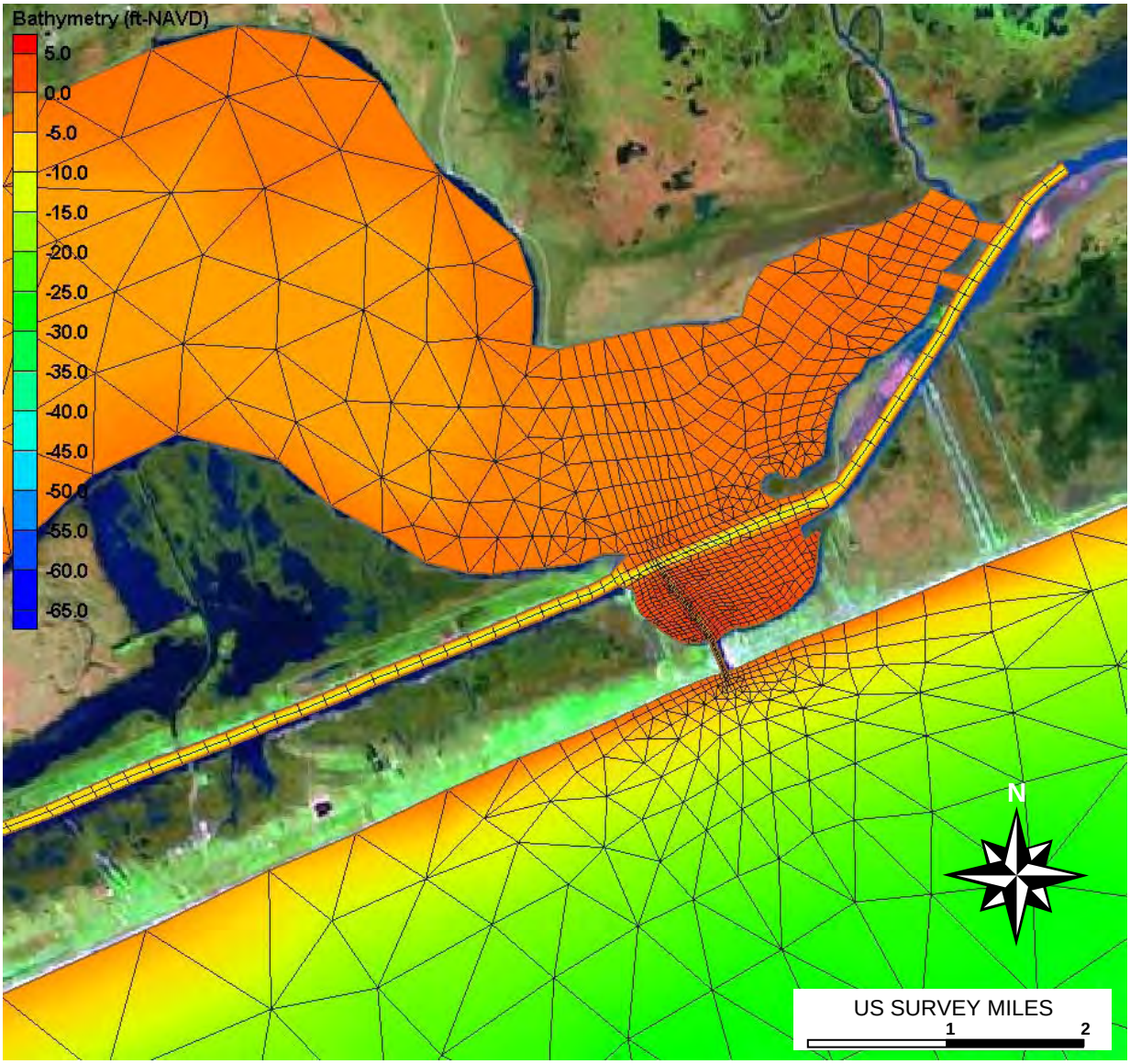


Figure 2.3 Mesh and Bathymetry near Rollover Pass

2.3 Hydrodynamic Model Calibration Data Collection and Tidal Characteristics

Gauges at six stations located in the project area (Figure 2.4) provided tidal stage and velocity data. Two stations provided only tidal stage data, three stations provided only velocity data, and one station in Rollover Pass provided both tidal stage and velocity data. One additional station in the Gulf Intracoastal Waterway east of the project area provided tidal stage data for model boundary conditions. The tide gauges supplied continuous water level data from July 28 to September 3, 2009. Taylor Engineering collected velocity data over the water column with an Acoustic Doppler Current Profiler (ADCP) during discrete intervals (lasting at least five minutes) on July 29 and September 3, 2009. This data provided the required information for hydrodynamic model calibration.

Figure 2.4 Model Calibration Points

Notably, collected salinity data only covers the late summer, early fall period. Time constrains did not allow data collection over an extended period. To predict the absolute value of salinity with any accuracy over several years requires calibration with salinity data for each season. Therefore, the model may not accurately predict absolute salinity values, but should reliably predict relative salinity between simulations with the Pass open and closed.

National Oceanic and Atmospheric Administration (NOAA) stations 8771510 at Galveston Pleasure Pier and 8770971 Rollover Pass provided long-term tidal stage information. Table 2.1 summarizes the tidal data from these stations.

Table 2.1 NOAA Tide Data

Tide Data	STA 8771510, Galveston Pleasure Pier (ft-NAVD)	STA 8770971, Rollover Pass (ft-NAVD)
Mean Higher High Water (MHHW)	1.43	1.21
Mean High Water (MHW)	1.24	1.13
Mean Tide Level (MTL)	0.51	0.61
Mean Sea Level (MSL)	0.50	0.61
Mean Low Water (MLW)	-0.22	0.03
Mean Lower Low Water (MLLW)	-0.61	-0.13
Mean Tide Range (ft) (MHW – MLW)	1.46	1.10
Diurnal Tide Range (ft) (MHHW – MLLW)	2.04	1.34

2.4 Hydrodynamic Model Parameters and Boundary Conditions

A Manning's roughness coefficient (Manning's *n*) value ranging from 0.015 to 0.035 provided the bed friction boundary condition within the model. The USACE recommends $n = 0.02 – 0.025$ for sand channels and 0.075 – 0.150 for winding or overgrown channels (Donnell et al., 2005); Chow (1959) recommends $n = 0.035$ for rivers, and the U.S. Geological Survey (USGS) recommends $n = 0.012 – 0.026$ (Arcement and Schneider, 1989).

A turbulent exchange coefficient value of 30 – 70 lb-sec/ft^2 controlled the turbulence closure for the hydrodynamic model. This value falls within the 20 – 100 lb-sec/ft^2 range the model developers recommend for flow in tidal estuaries (Donnell et al., 2005).

The model calibration applied time-varying free surface water level boundary conditions from July 28 to September 3, 2009 offshore and on the Intracoastal Waterway east of the area of interest. NOAA tide measurements from Galveston Pleasure Pier provided the offshore water level boundary

conditions for the model while measured tide data in the Intracoastal Waterway provided the water level boundary at that site.

USGS stream flow data from July to September 2009 provided freshwater input discharge data for model calibration. Taylor Engineering compiled the daily mean stream flow data for Trinity River, Cedar Bayou, San Jacinto River, and Buffalo Bayou for the calibration period and applied the data as time-varying freshwater input flows to the hydrodynamic model. An absence of data for Oyster Bayou precluded their inclusion in the model; however, because Trinity River contributes 60 – 70% of the freshwater to the system, the absence of Oyster Bayou freshwater input should have no significant affect on the study. Figure 2.5 indicates the boundary input locations for the time-varying freshwater input flows and water level boundary conditions.

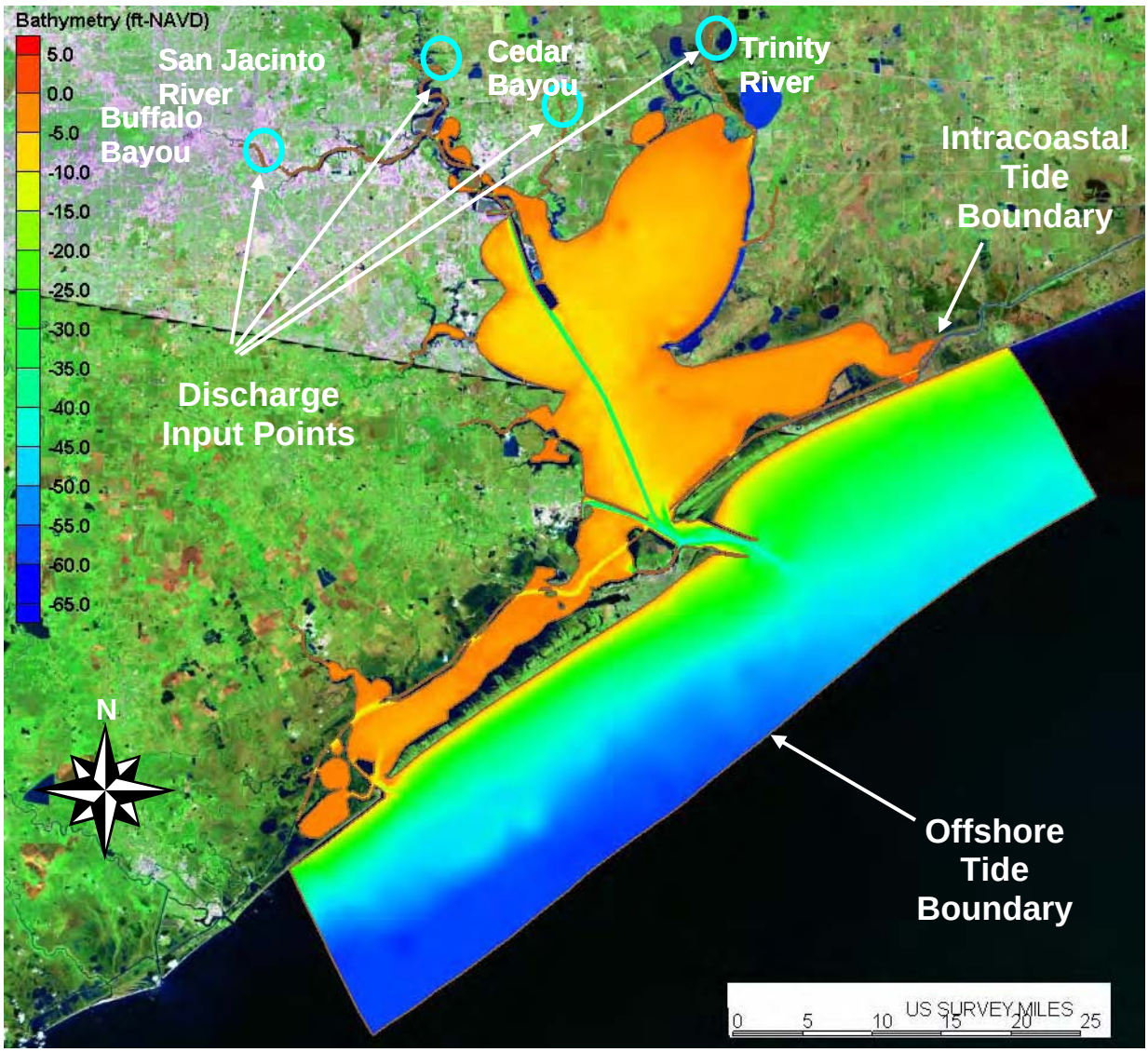


Figure 2.5 Hydrodynamic Model Boundary Condition Points

2.5 Hydrodynamic Model Calibration Results

A model's calibration demonstrates its capability to reproduce observed hydrodynamic conditions. The correlation coefficient (the ratio of the covariance of two data sets to the product of the variance of the data sets) provides a statistical measure of the correspondence of two data sets. Two coincident data sets have a correlation coefficient of 1.0 (i.e., the data sets match), while correlation coefficients approaching zero indicate less correspondence between the data sets.

The mean error (E = the average of the difference of between two data sets) provides another measure of the difference of two data sets. A positive value for the mean error indicates that the model overestimates the measured data, while a negative value indicates the model underestimates the data.

Finally, the root-mean-square error (E_{rms} = the square-root of the average of the square of the difference of between two data sets) indicates the absolute error of the compared data sets. Table 2.2 gives the formulas for each of the error measurements. In Table 2.2, x = measured data, y = model data, N = total number of data points, σ_x^2 = variance of the measured data, σ_y^2 = variance of the model data, and σ_{xy}^2 = covariance of the measured and model data.

Table 2.2 Error Measurement Formulas

	Symbol	**Formula**
Correlation coefficient	r^2	$r^2 = \frac{\sigma_{xy}^2}{\sigma_x^2 \sigma_y^2}$
Mean Error	E	$E = \frac{\sum_1^N (y - x)}{N}$
Root-Mean-Square Error	E_{rms}	$E_{rms} = \sqrt{\frac{\sum_1^N (y - x)^2}{N}}$

Figures 2.6 – 2.8 compare the modeled tidal stage with the measured tidal stage data at the three tide stations shown in Figure 2.4. The figures show only a representative portion of the complete model calibration period from July 28 to September 3, 2009; however, the indicated correlation coefficient (r^2) applies to the entire calibration period. Table 2.3 summarizes the tidal stage error measurements for each tide station over this period. Figures 2.6 – 2.8 and Table 2.3 indicate reasonable agreement between the modeled and measured tide water levels.

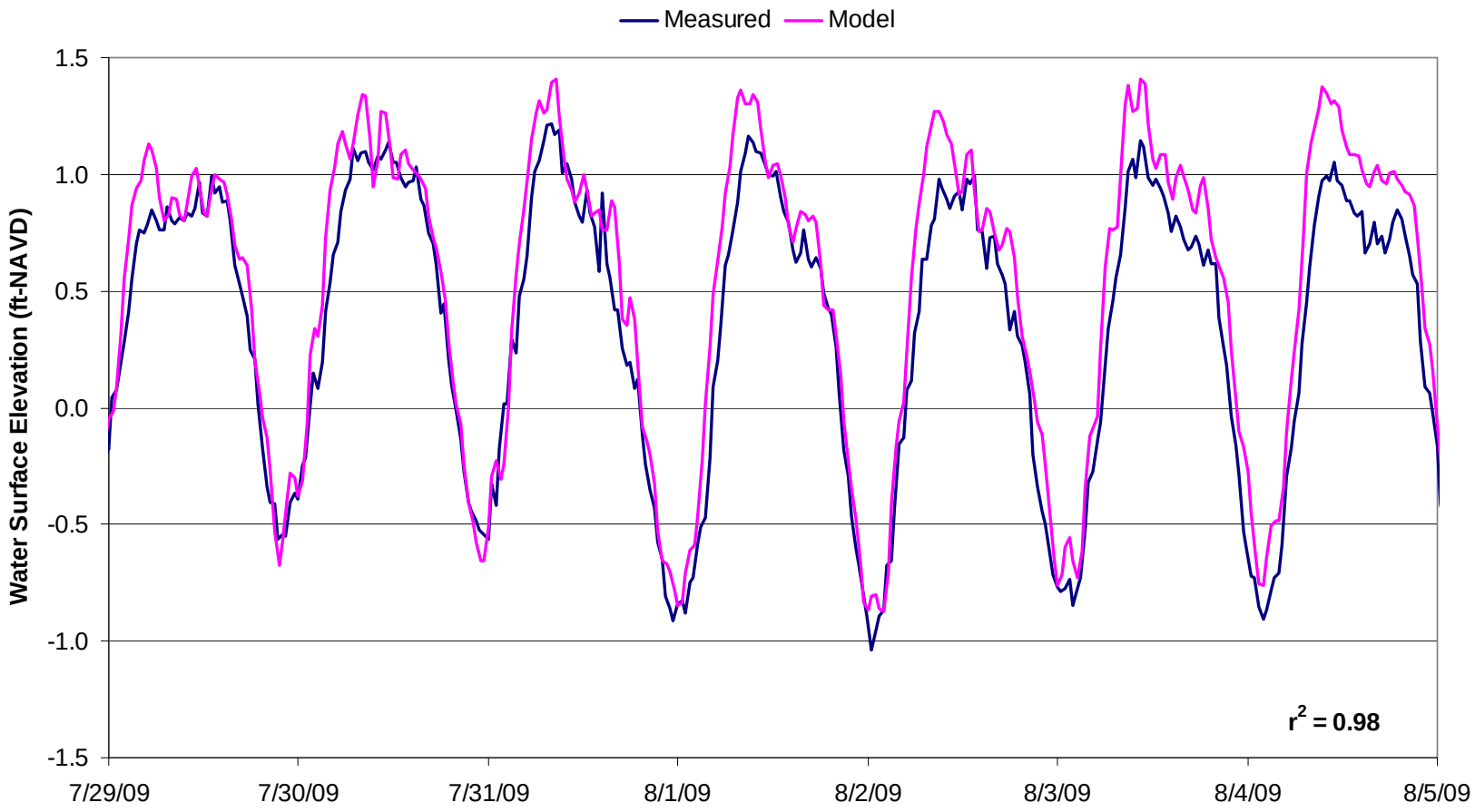


Figure 2.6 Sample Model Calibration Results at Tide Station 1

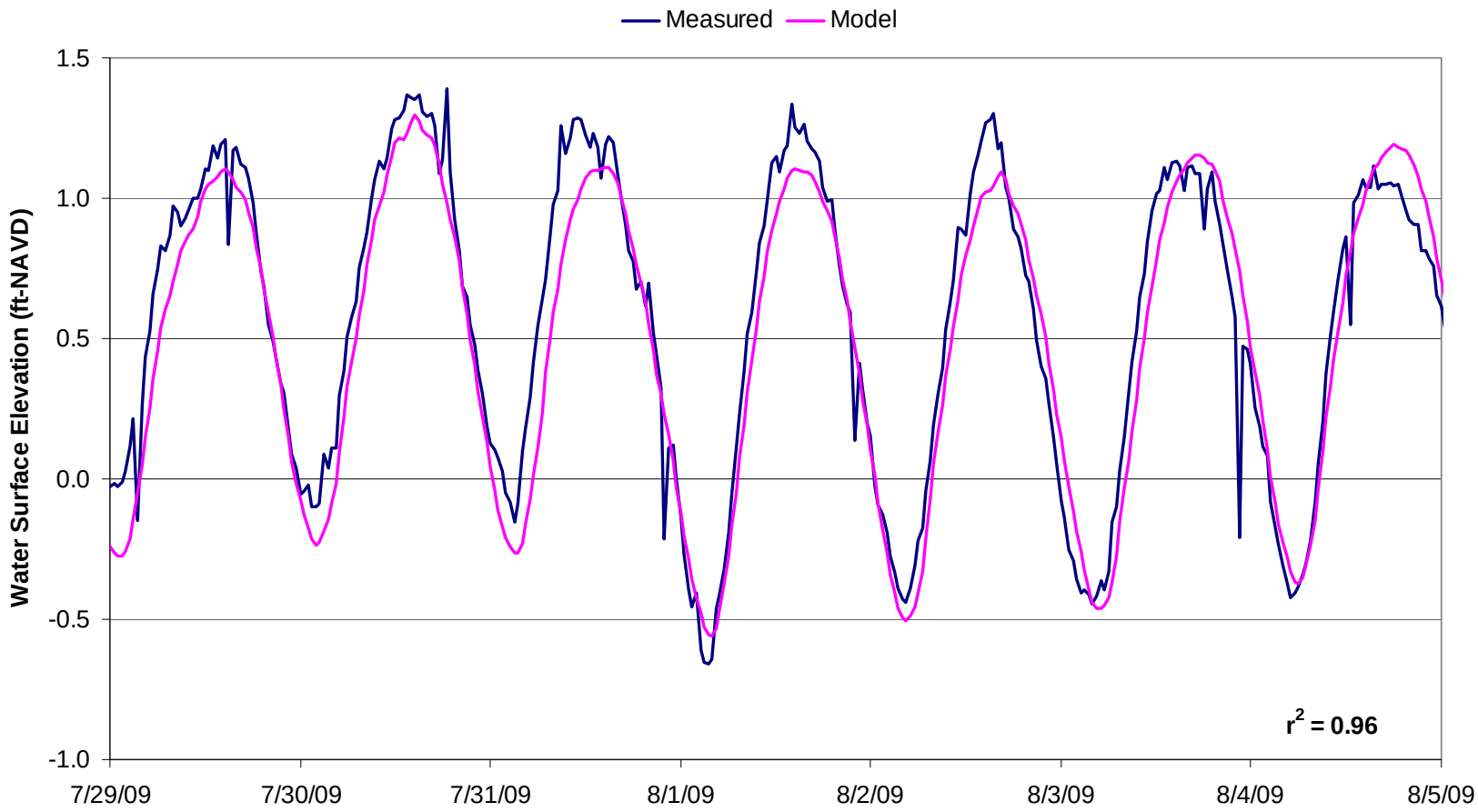


Figure 2.7 Sample Model Calibration Results at Tide Station 2

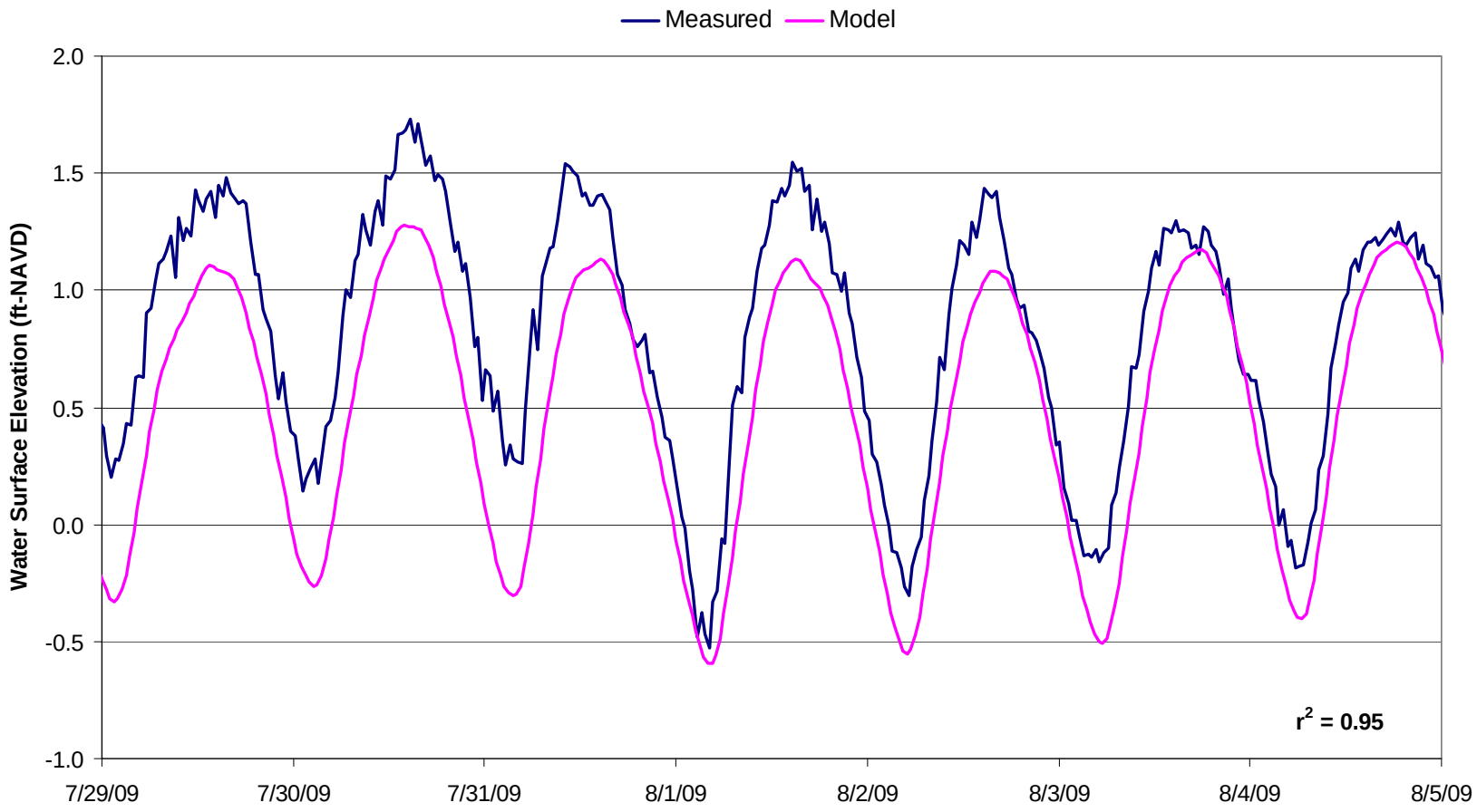


Figure 2.8 Sample Model Calibration Results at Tide Station 3

Table 2.3 Tide Station Error Measurement Summary

	Tide Station 1	**Tide Station 2**	**Tide Station 3**
Correlation coefficient	0.98	0.96	0.95
Mean Error	0.27	0.04	-0.15
Root-Mean-Square Error	0.30	0.16	0.23

Figures 2.9 – 2.16 show plots of the measured velocities against the RMA2 model depth-averaged velocities. The figures show two periods for each of the four velocity stations — one in July 2009 and one in September 2009. Each figure displays the continuous model output and discrete point values for the measured data. The ADCP recorded velocity profiles over the water column. Analysis of the measured data converted the ADCP data to depth-averaged velocities. During the velocity data collection, field personnel noted high wind conditions which may have caused velocity variations the model failed to capture. The effect of wind on the water surface layer was notable in several data sets, particularly the July readings at Station 4.

The discrete nature of the velocity measurements (i.e., non-continuous data) precludes the computation of the error estimates obtained for the tidal stage data. Tables 2.4 and 2.5 compare the average measured and modeled velocities at each location for the two data collection periods. The figures and table show adequate agreement between depth-averaged model velocities and ADCP velocities converted to depth-averaged velocities. Notably, the velocity stations in Rollover Pass and Rollover Bay — locations with the most up-to-date bathymetric data — showed the closest agreement.

Table 2.4 Velocity Station Mean Velocity Comparison, Data Period 1

	Velocity Station 1	**Velocity Station 2**	**Velocity Station 3**	**Velocity Station 4**
Measured Mean Velocity (ft/s)	1.75	1.21	0.60	0.69
Modeled Mean Velocity (ft/s)	1.99	1.18	0.62	0.42
Difference (ft/s)	+0.24	-0.03	+0.02	-0.27

Table 2.5 Velocity Station Mean Velocity Comparison, Data Period 2

	Velocity Station 1	**Velocity Station 2**	**Velocity Station 3**	**Velocity Station 4**
Measured Mean Velocity (ft/s)	0.75	0.38	0.17	0.29
Modeled Mean Velocity (ft/s)	0.87	0.27	0.93	0.26
Difference (ft/s)	+0.12	-0.11	+0.76	-0.03

Overall, the comparison of measured and model data indicate that the model satisfactorily reflects the physical processes in the study area.

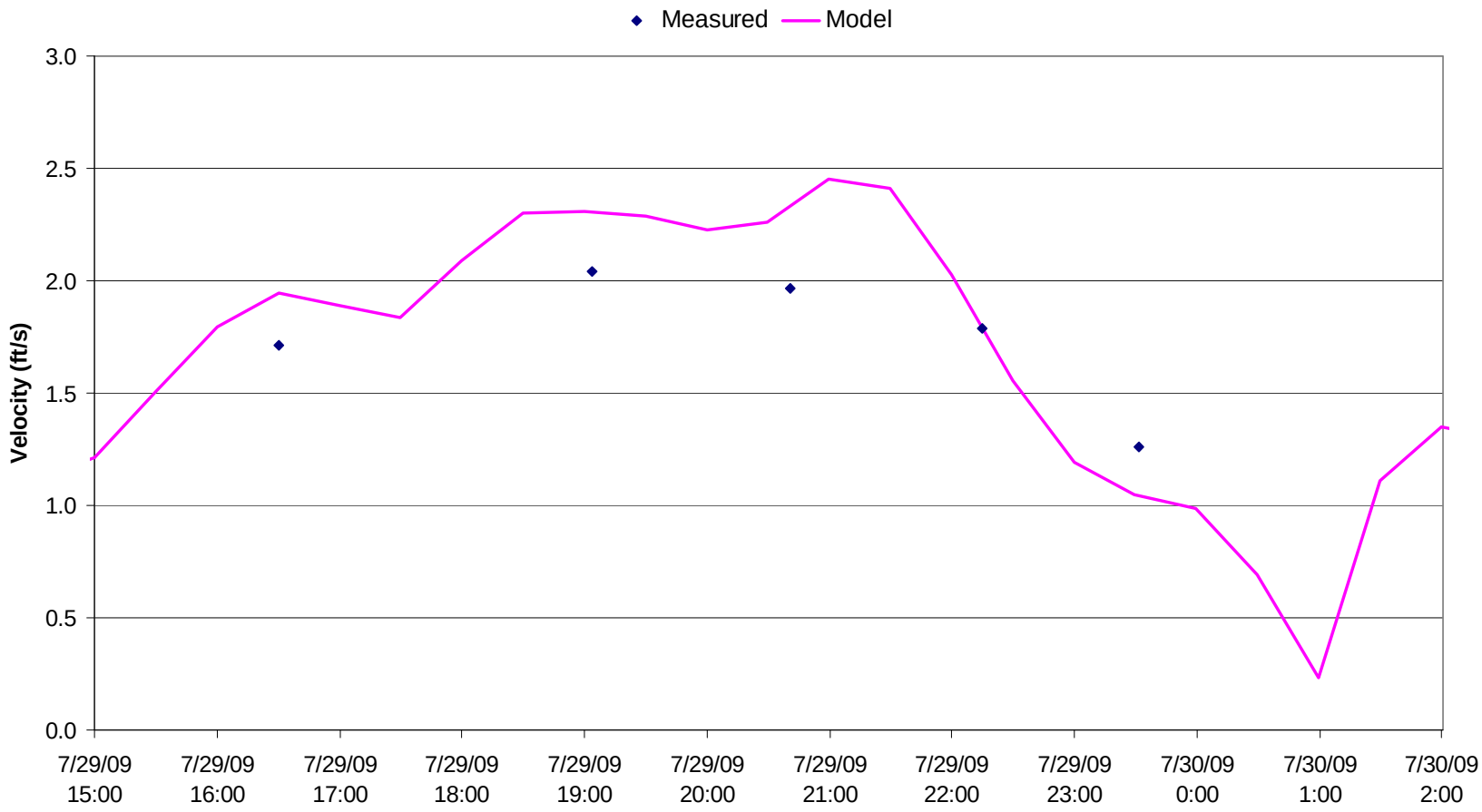


Figure 2.9 Model Calibration Results at Velocity Station 1, Data Period 1

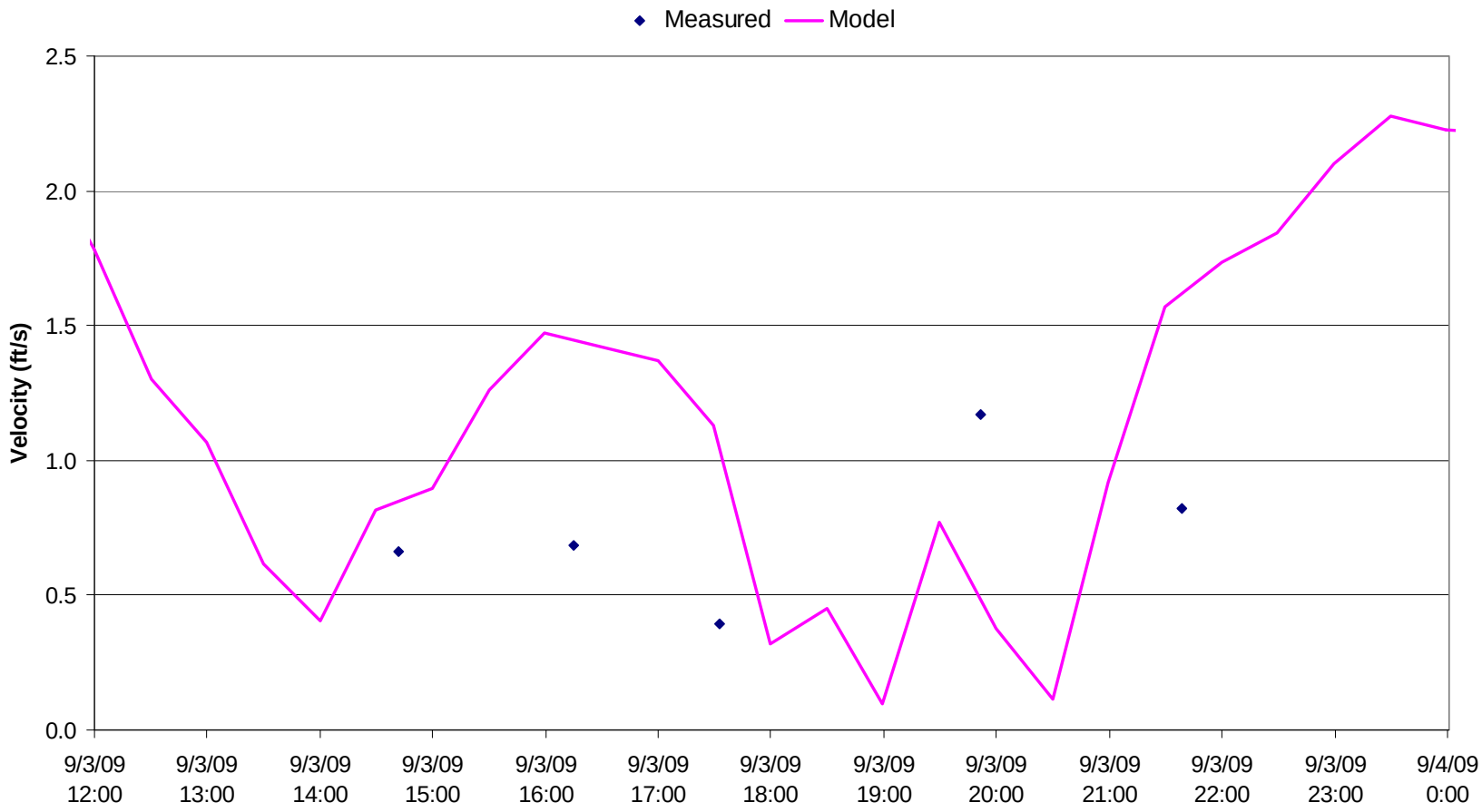


Figure 2.10 Model Calibration Results at Velocity Station 1, Data Period 2

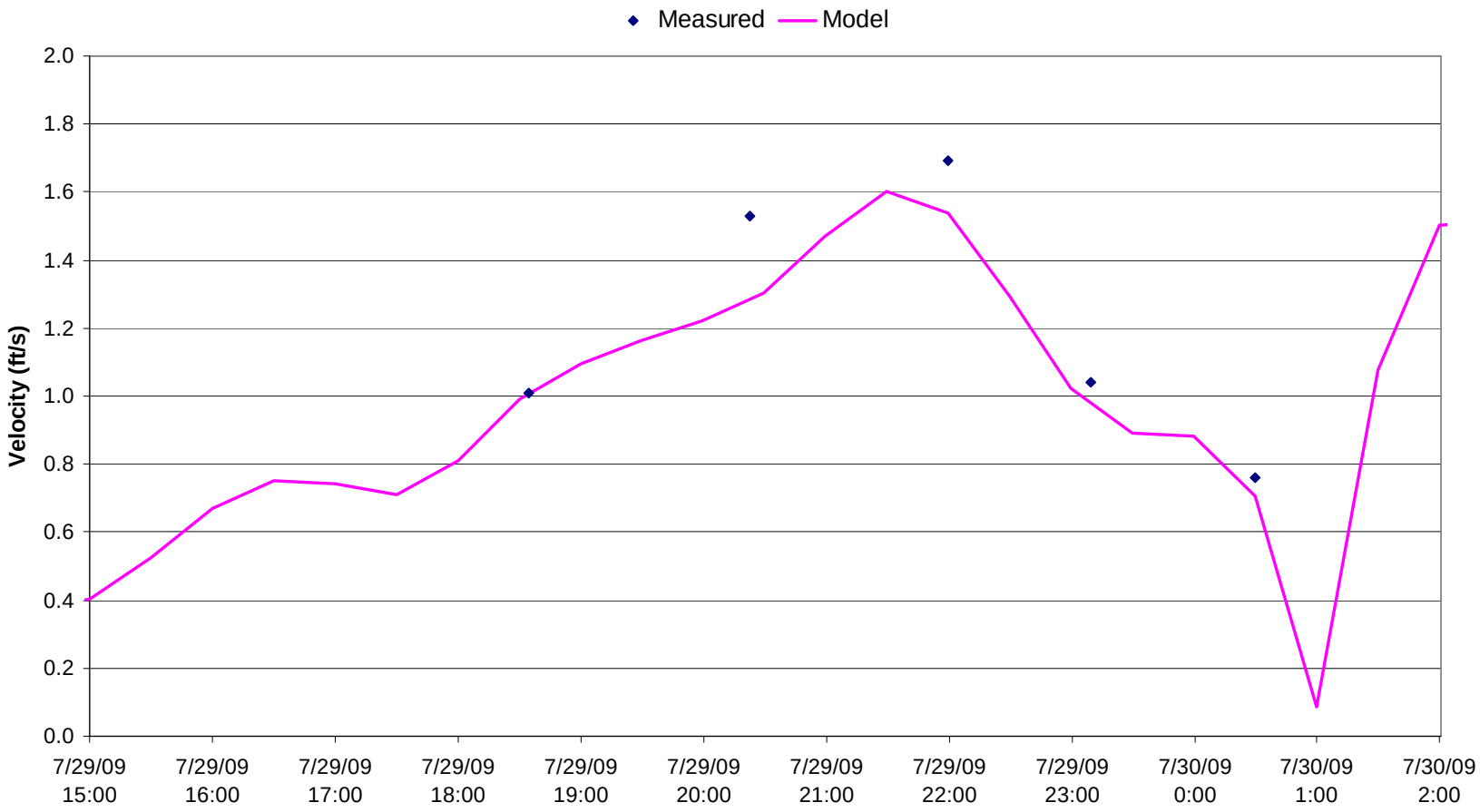


Figure 2.11 Model Calibration Results at Velocity Station 2, Data Period 1

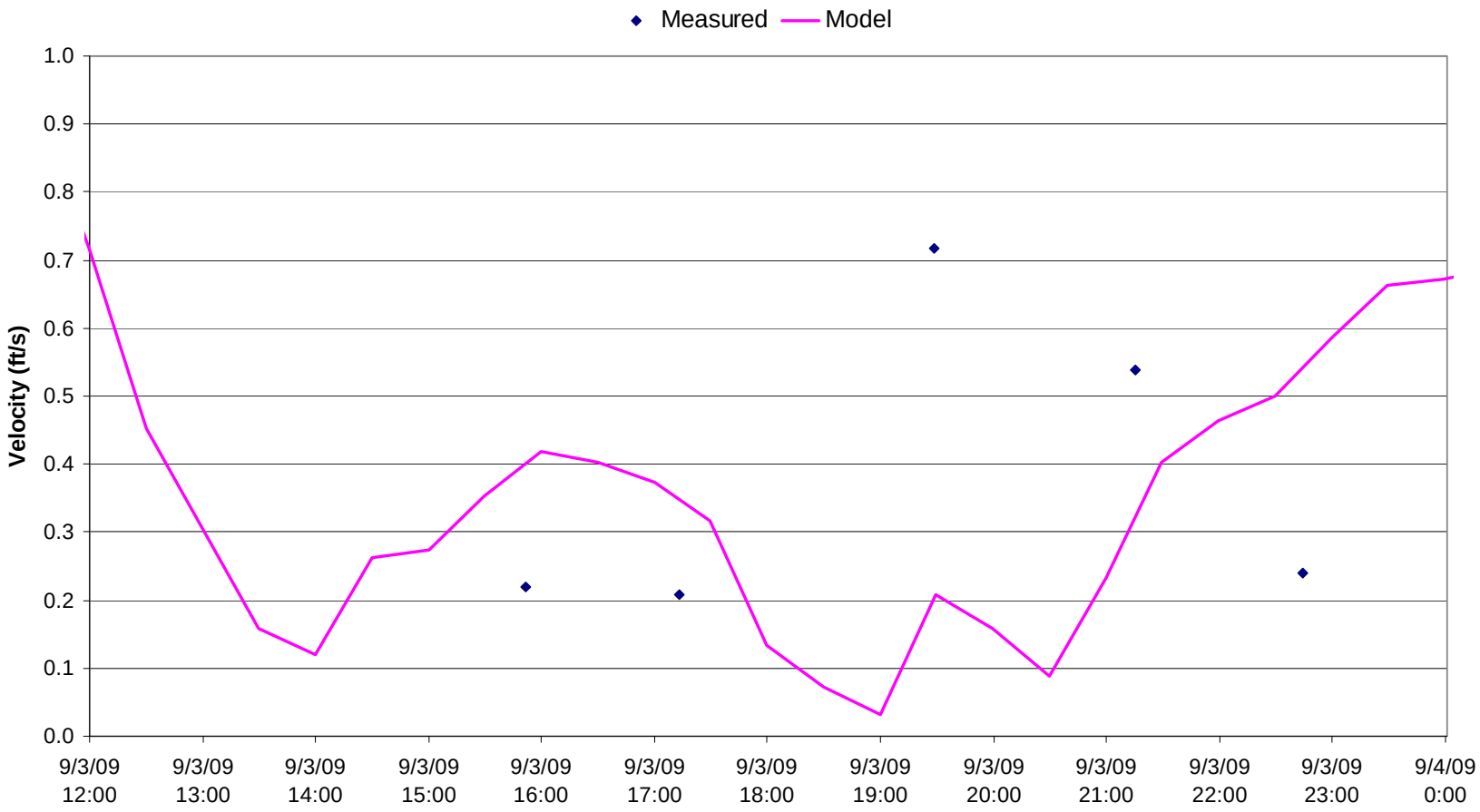


Figure 2.12 Model Calibration Results at Velocity Station 2, Data Period 2

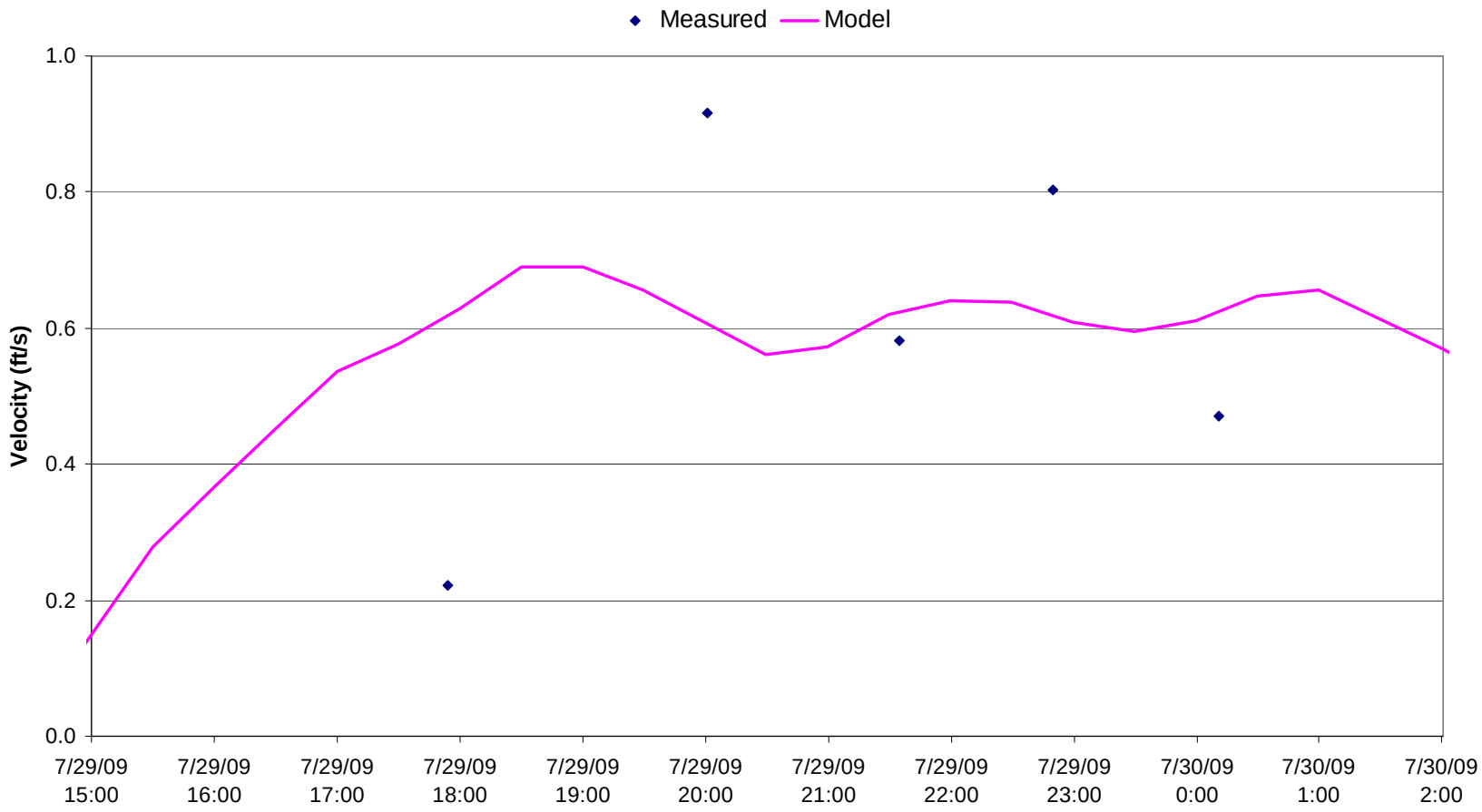


Figure 2.13 Model Calibration Results at Velocity Station 3, Data Period 1

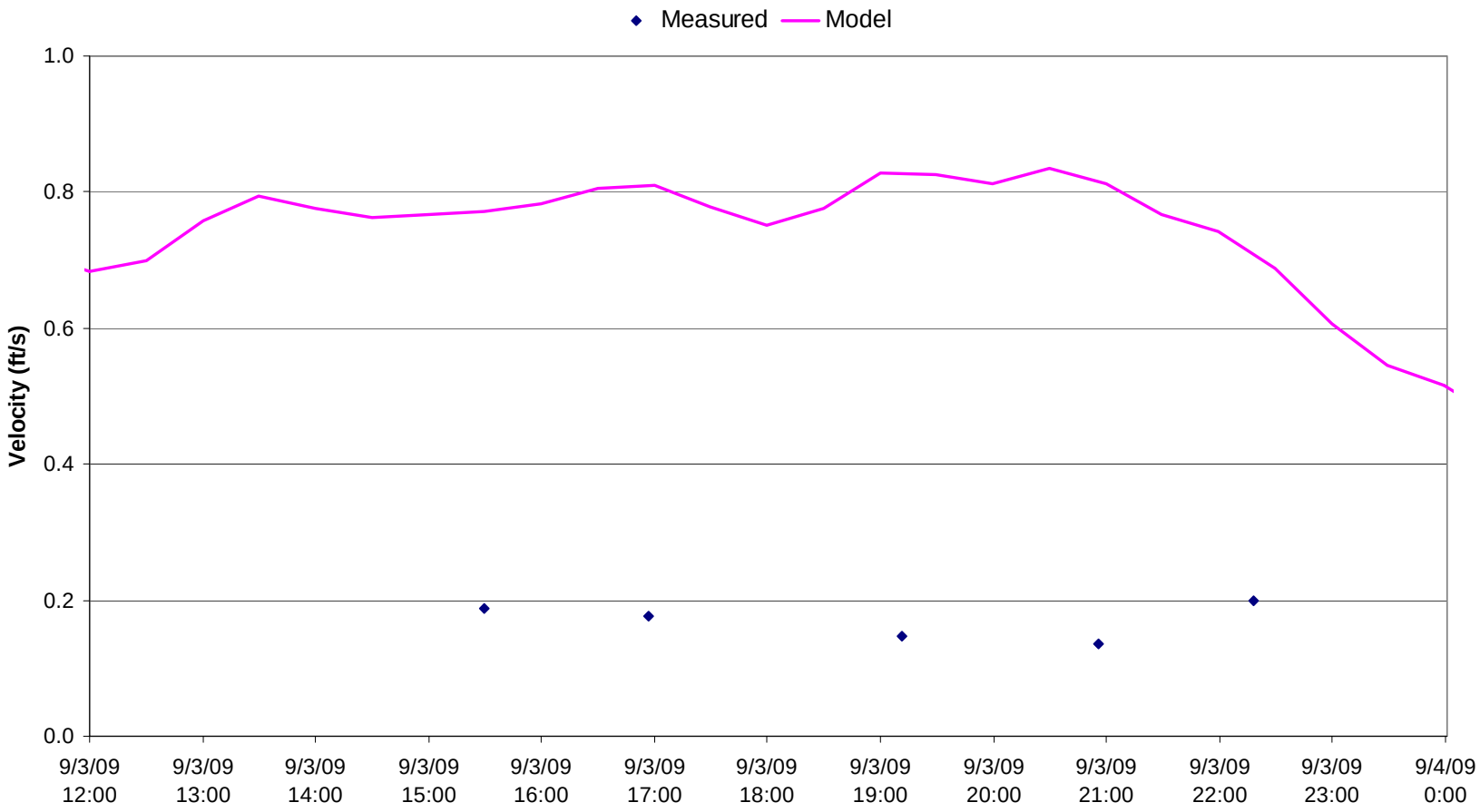


Figure 2.14 Model Calibration Results at Velocity Station 3, Data Period 2

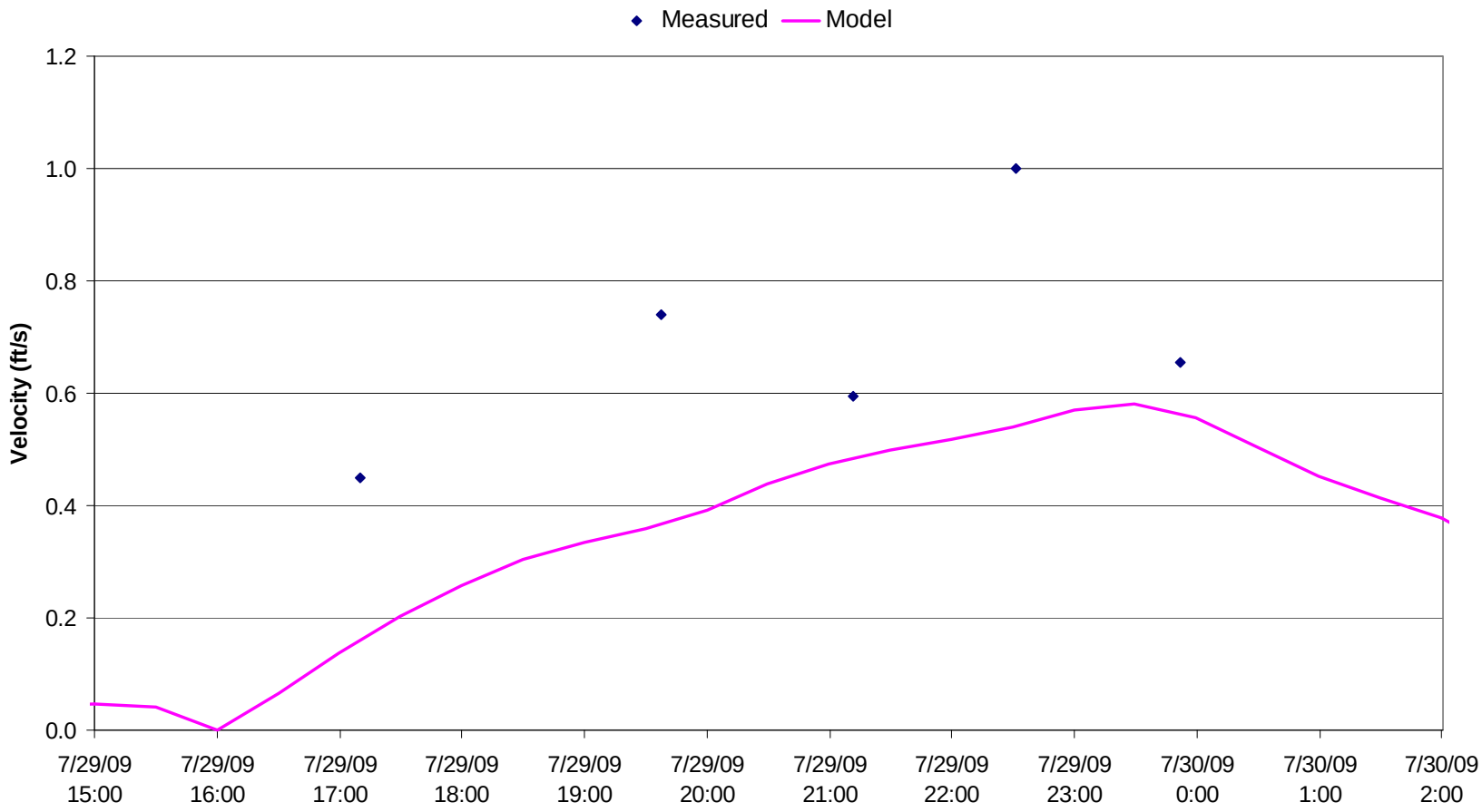


Figure 2.15 Model Calibration Results at Velocity Station 4, Data Period 1

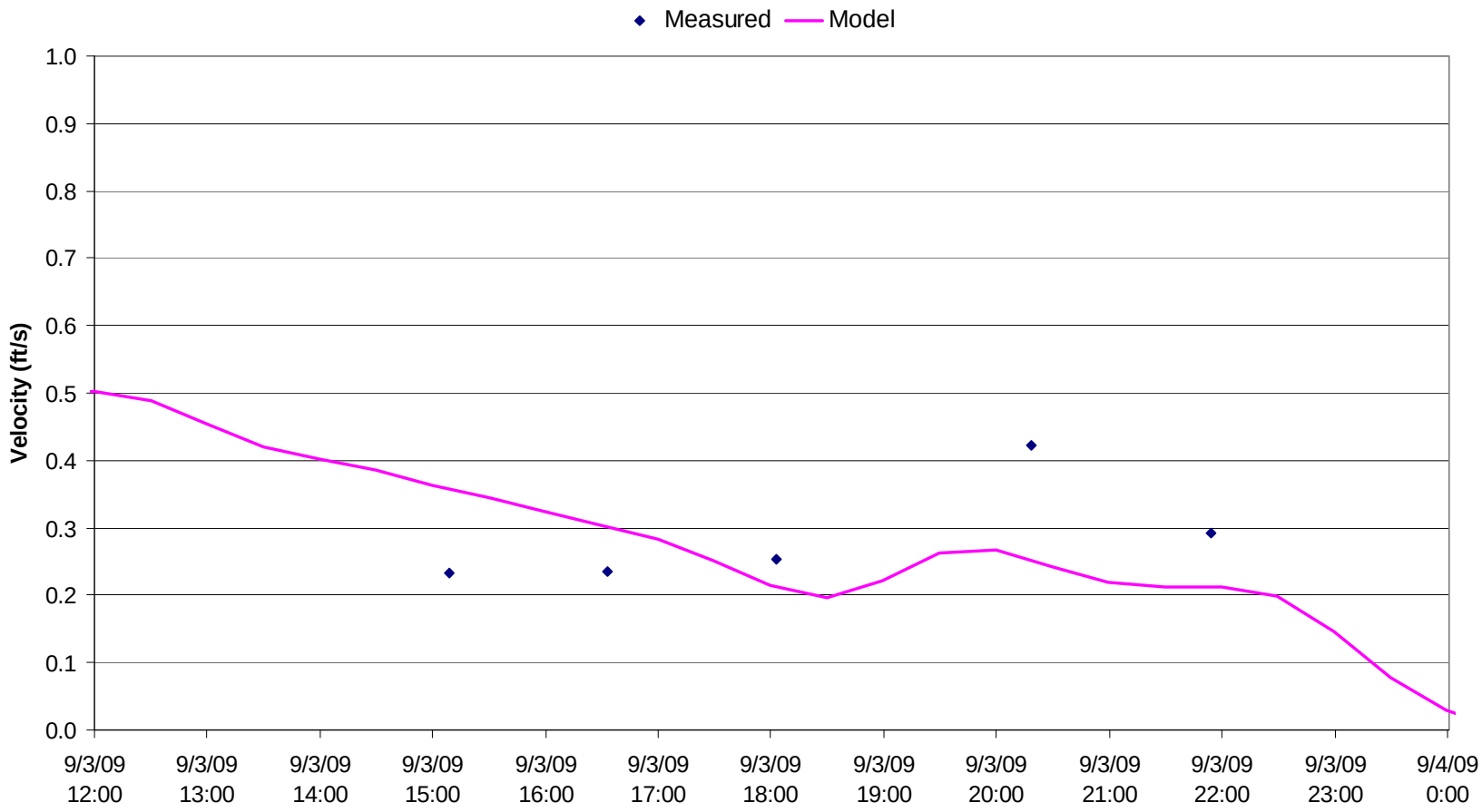


Figure 2.16 Model Calibration Results at Velocity Station 4, Data Period 2

2.6 Transport Model Calibration Data, Parameters and Boundary Conditions

Taylor Engineering collected salinity data on August 4, 5, 12, and 13, 2009 at the eight locations shown in Figure 2.17. As with the velocity data, salinity data reflect discrete time periods and depths over the water column at the various locations. Analysis of the data provided depth-averaged values.

Peclet number control automatically assigned the model diffusion coefficient for the transport model with a Peclet number equal to 20 throughout the model. The earliest measured data provided the initial salinity values throughout the system.

Figure 2.17 Salinity Data Collection Stations

2.7 Transport Model Calibration Results

Figures 2.18 – 2.25 compare the modeled and measured salinity results. The figures show reasonable agreement between the modeled and the measured salinity. The data set contains 59 data points recorded between August 4 and 13, 2009. The model produced salinities within 2 parts per thousand (ppt) for 52 of the 59 measured data points or 88%. All model results fall within about 8 ppt of the measured data. Table 2.6 shows the mean measured salinity, mean modeled salinity, and the difference between the modeled and measured means at each station over the collection period. On average, the mean model and measured salinities differed by only 1 – 2 ppt.

Table 2.6 Salinity Station Mean Salinity Comparison

	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**
Measured Mean Salinity (ppt)	25	24	26	30	27	30	33	37
Modeled Mean Salinity (ppt)	26	25	28	30	26	31	32	36
Difference (ppt)	+1	+1	+2	0	-1	+1	-1	-1

Overall, the comparison of measured salinity and model output indicate that the transport model satisfactorily reflects the processes in the study area.

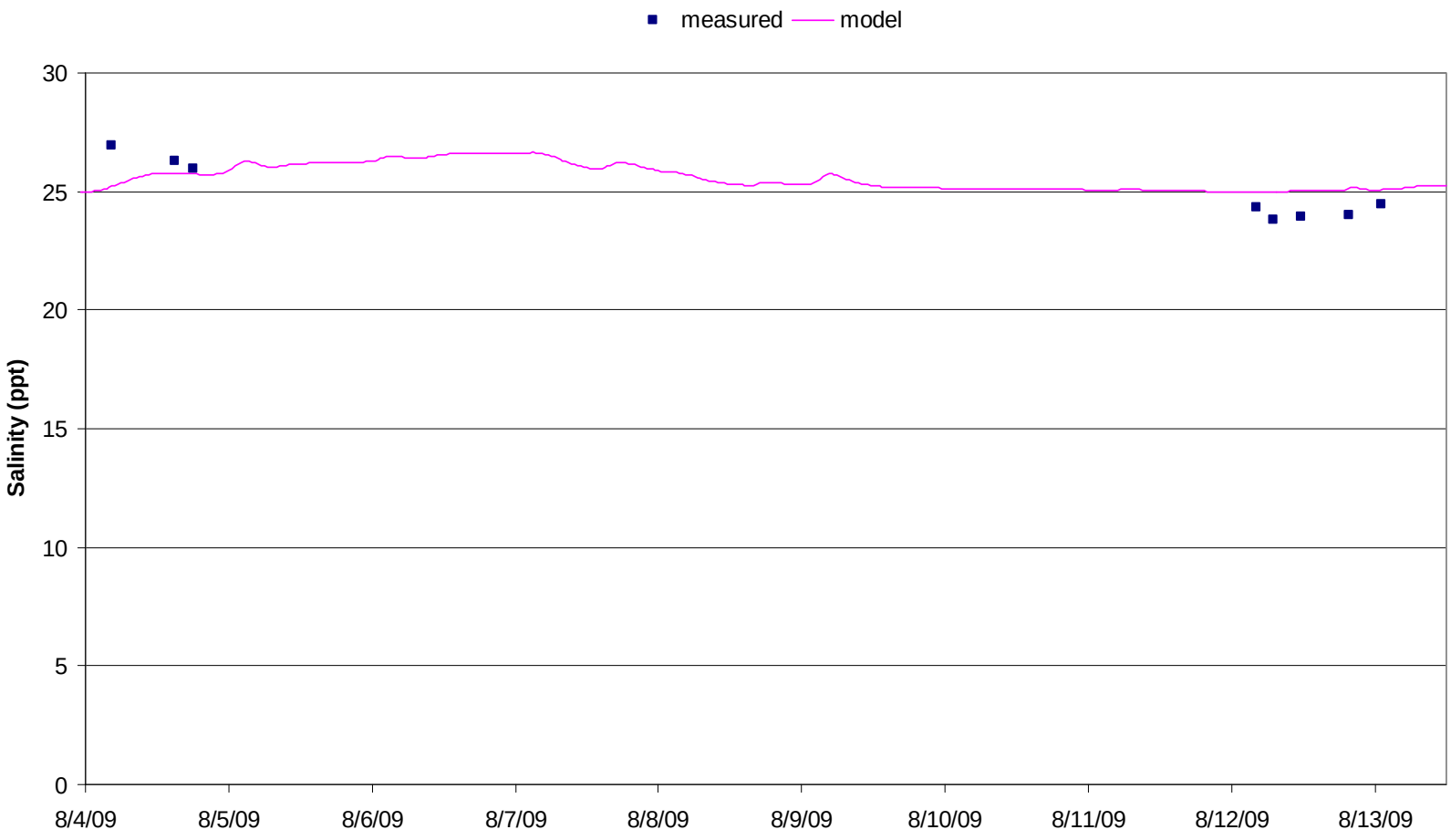


Figure 2.18 Transport Model Calibration Results, Salinity Station 1

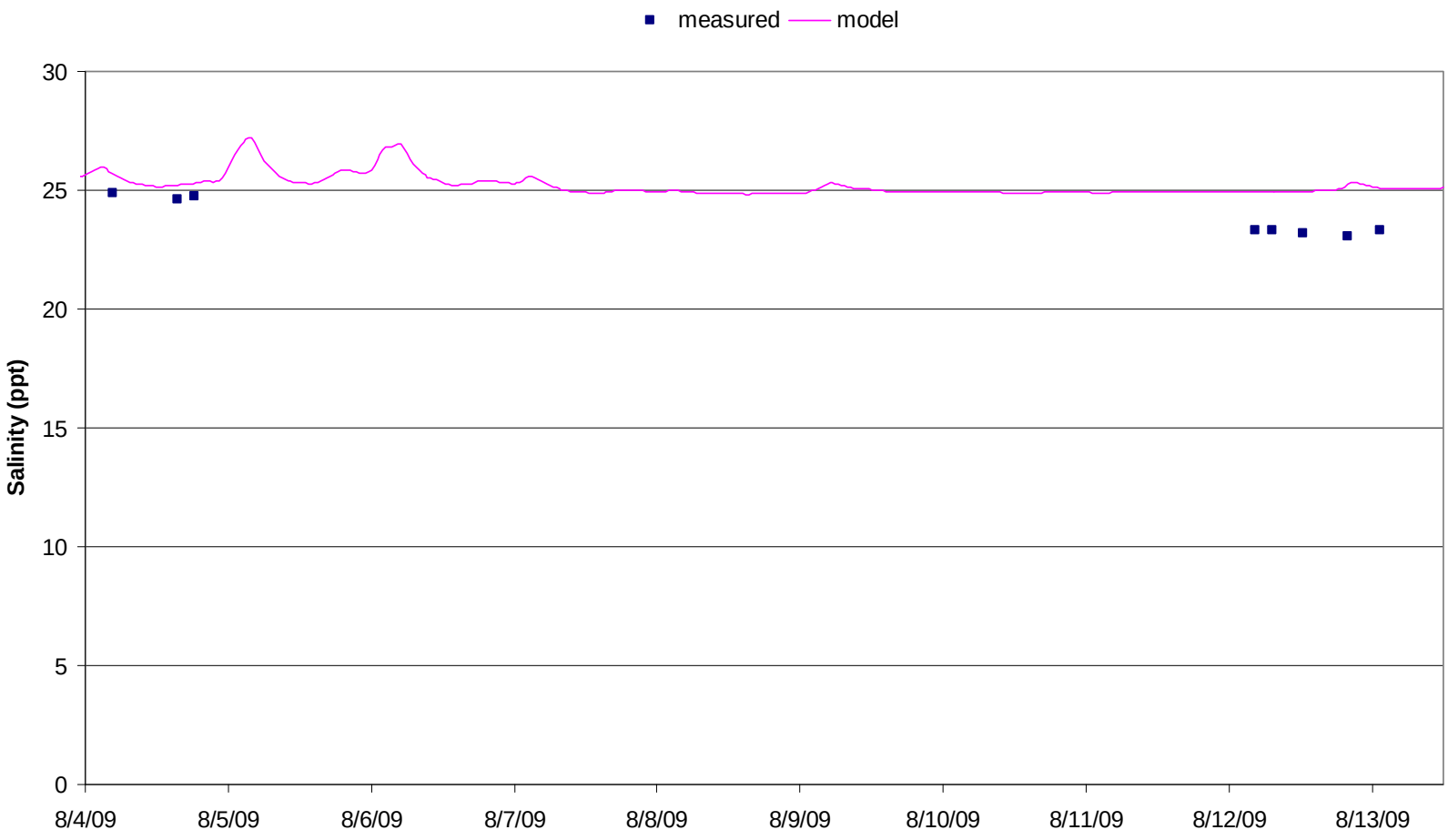


Figure 2.19 Transport Model Calibration Results, Salinity Station 2

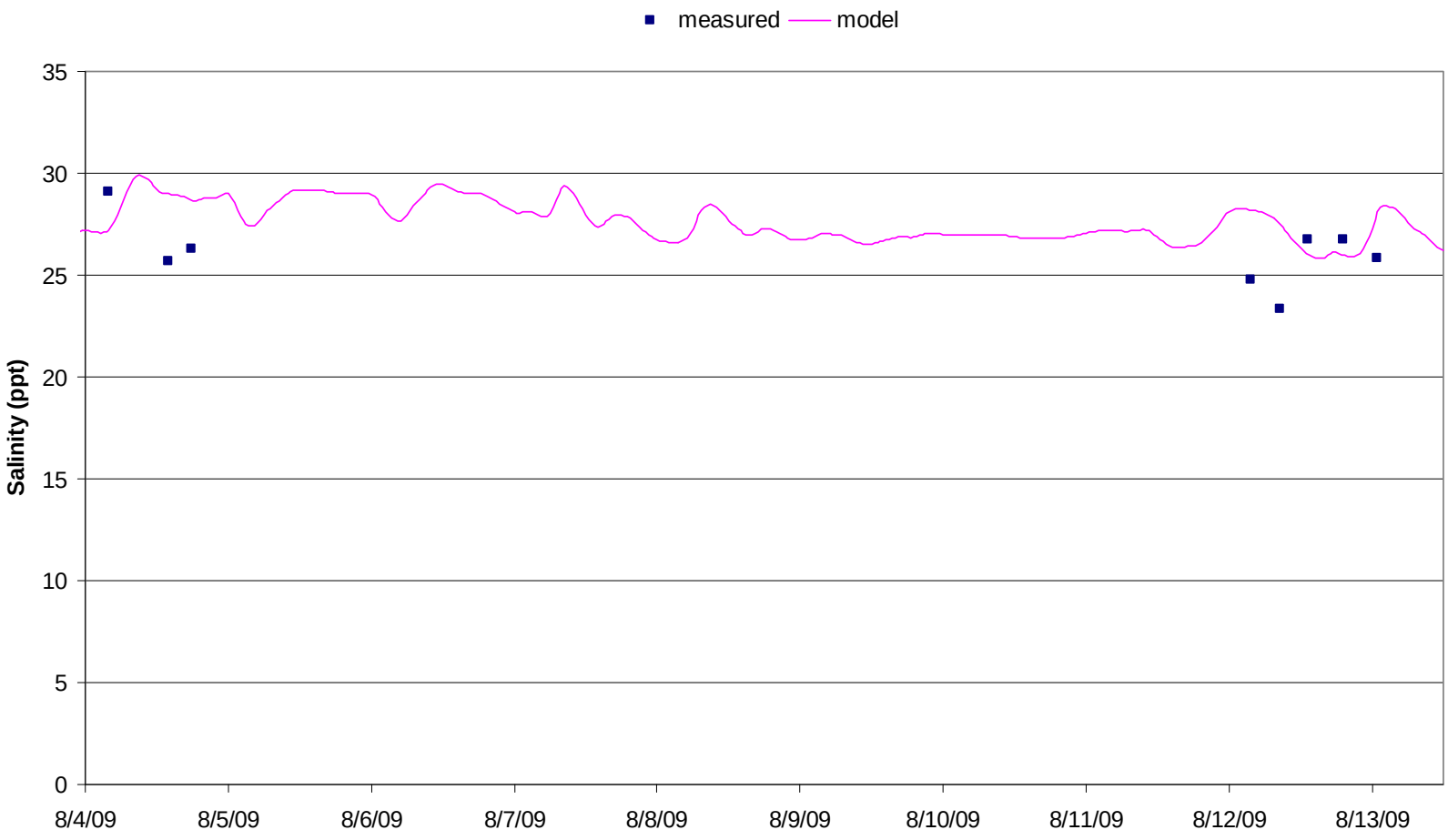


Figure 2.20 Transport Model Calibration Results, Salinity Station 3

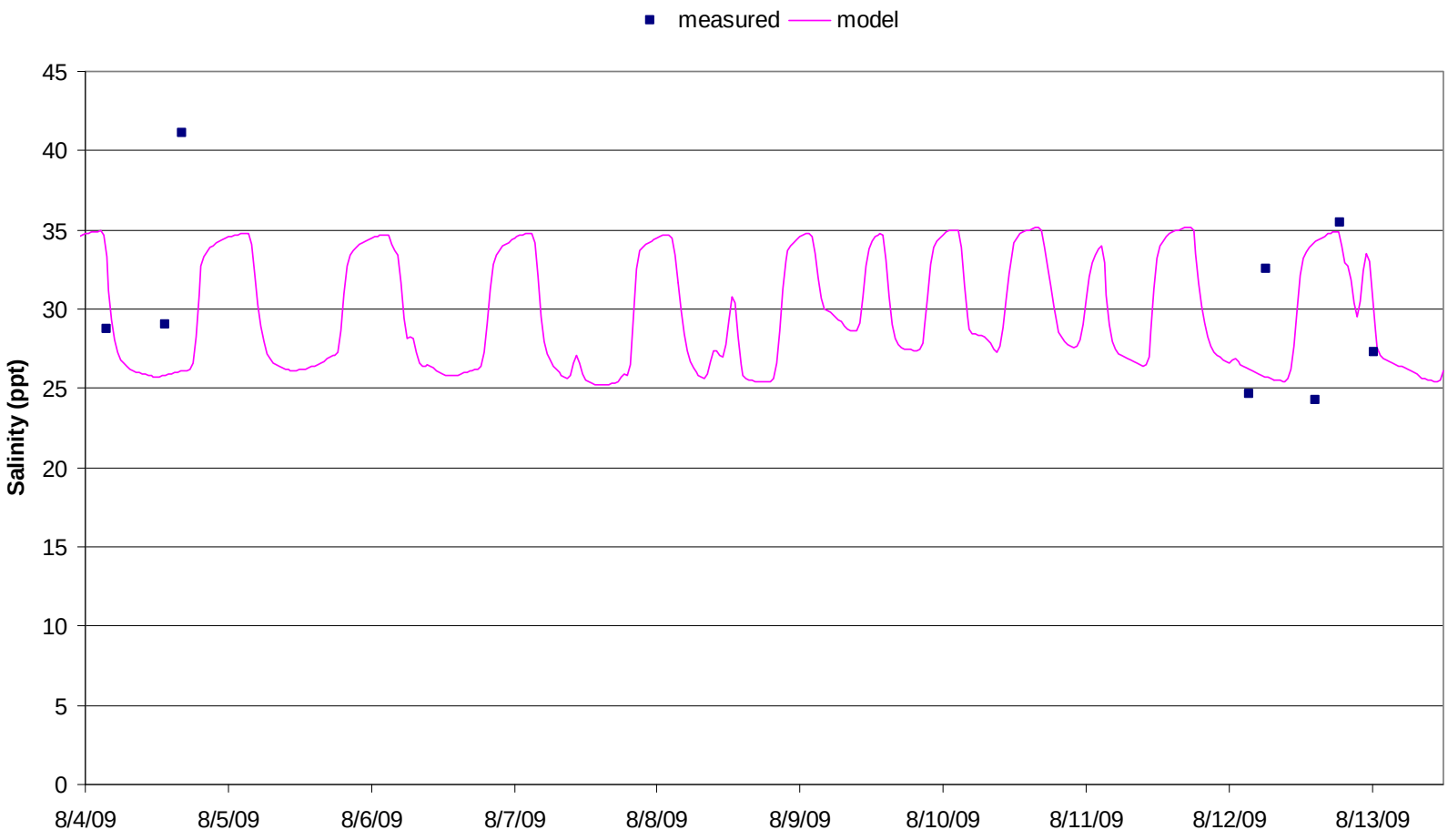


Figure 2.21 Transport Model Calibration Results, Salinity Station 4

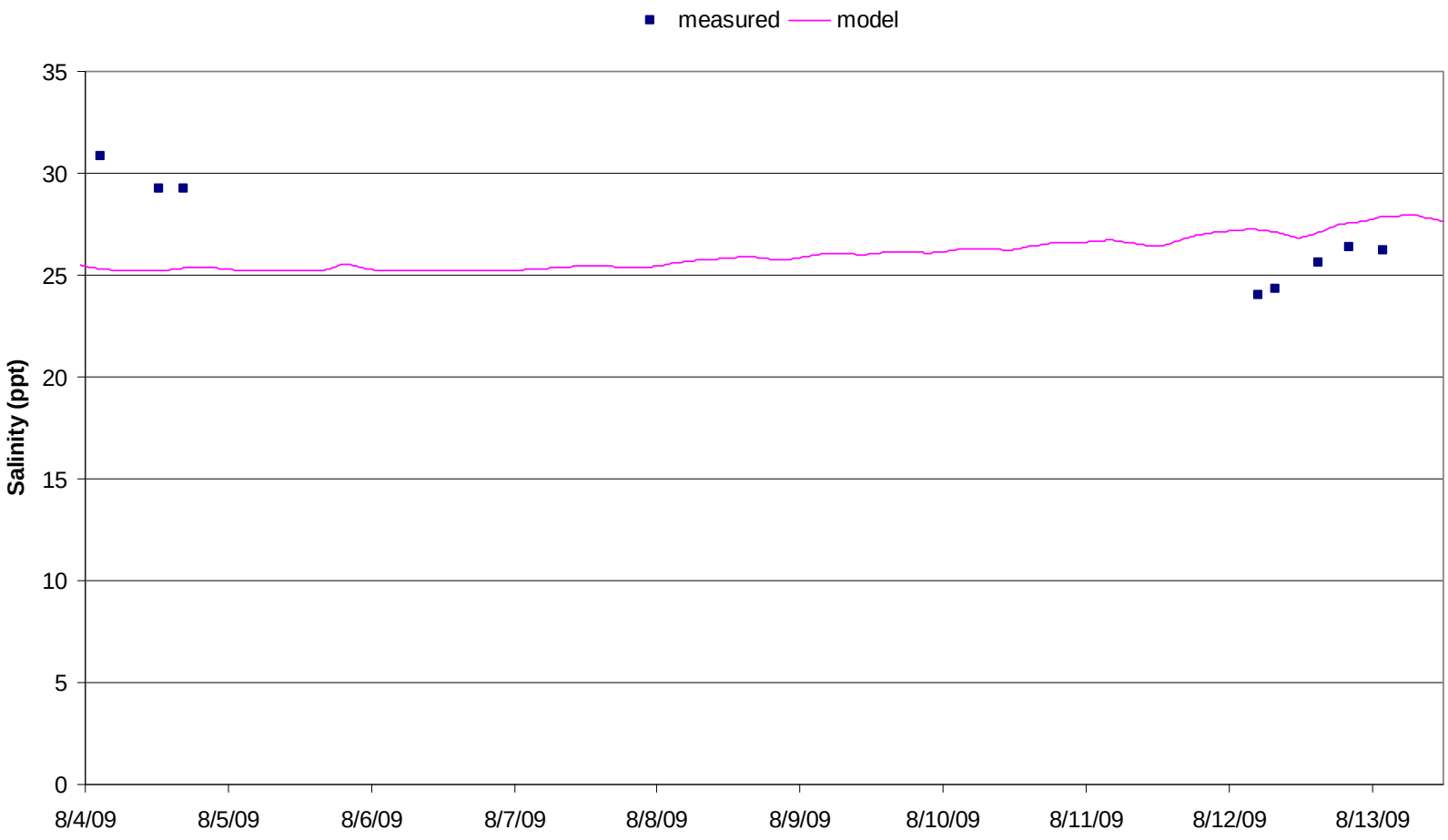


Figure 2.22 Transport Model Calibration Results, Salinity Station 5

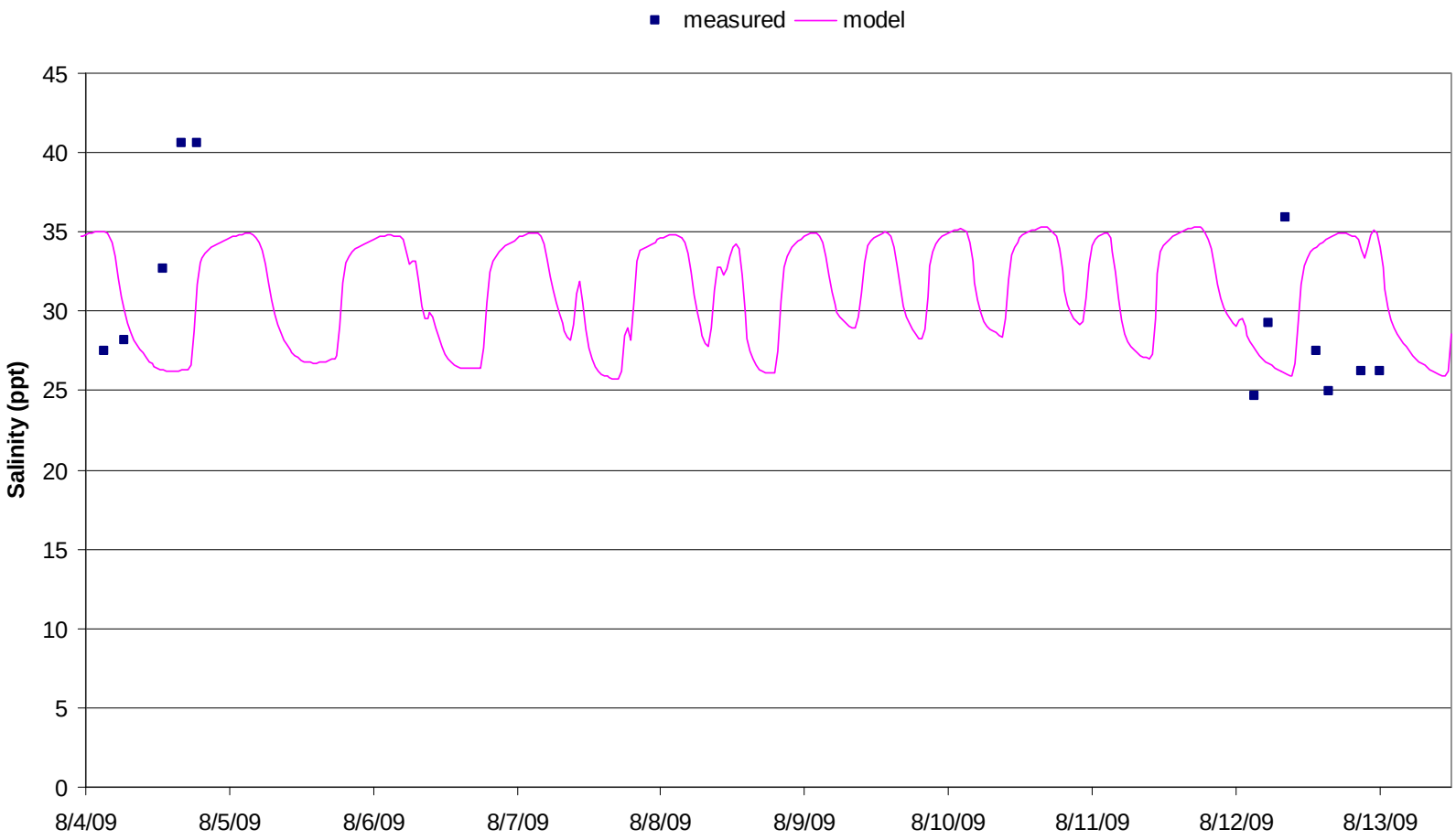


Figure 2.23 Transport Model Calibration Results, Salinity Station 6

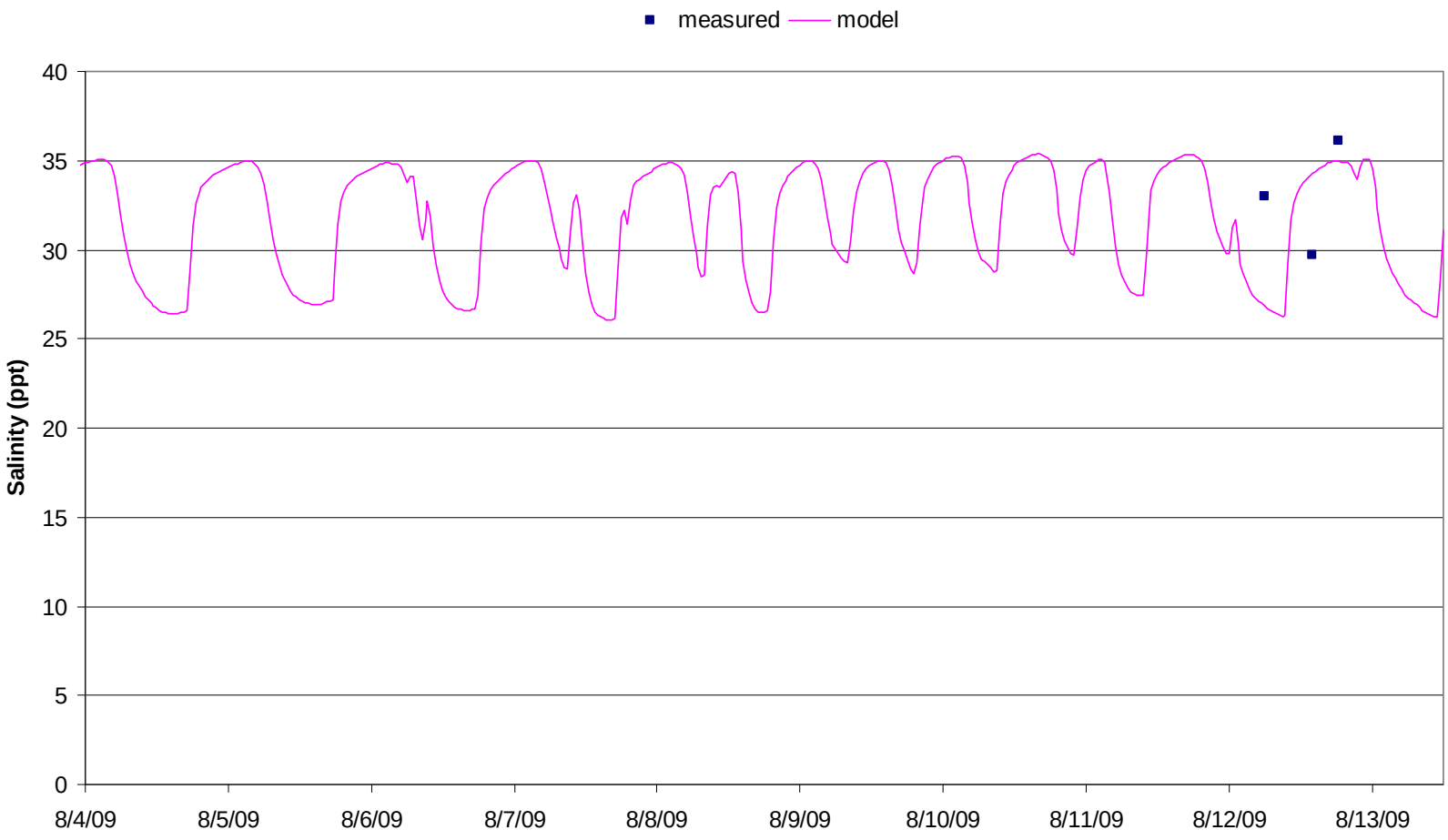


Figure 2.24 Transport Model Calibration Results, Salinity Station 7

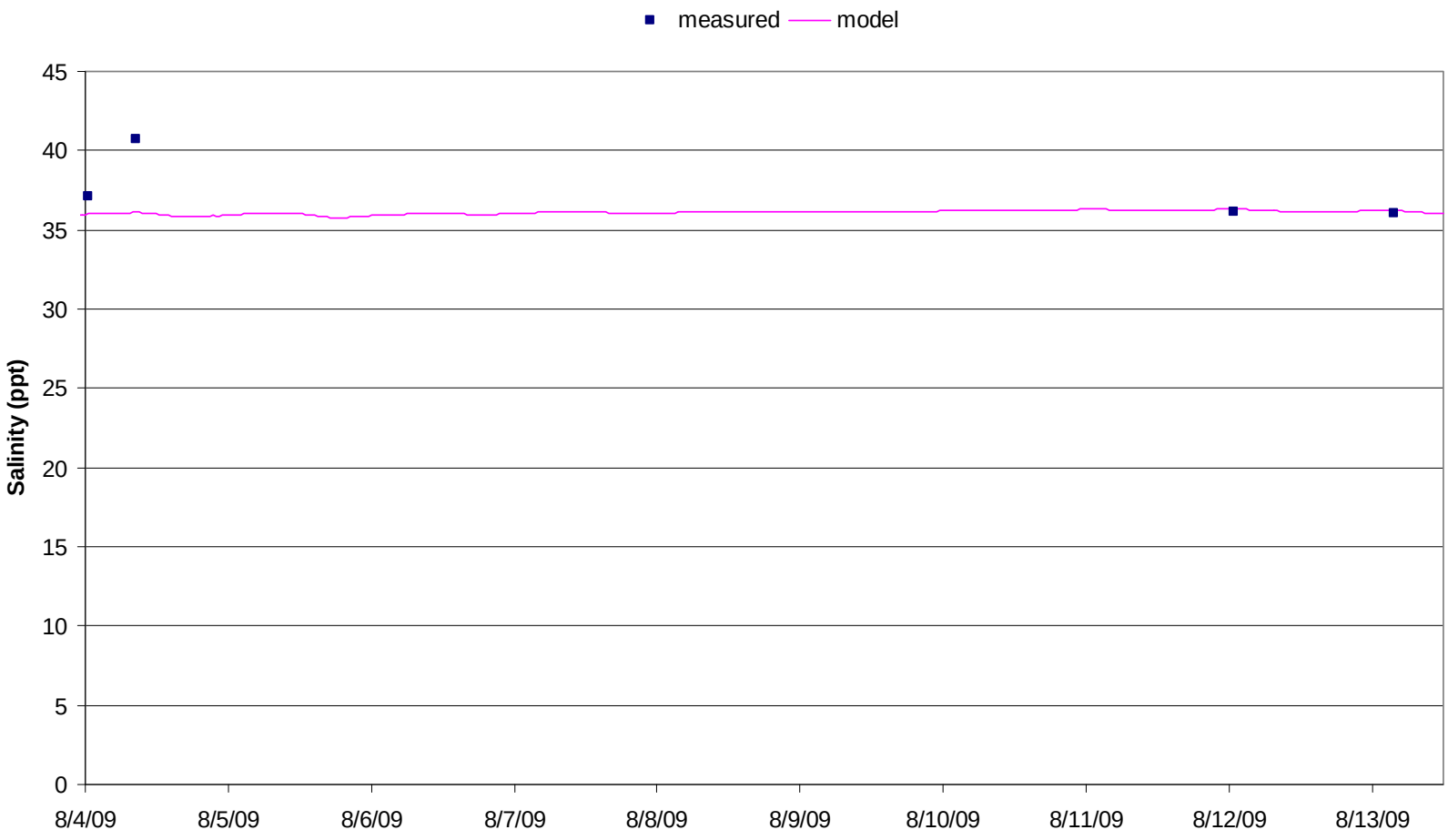


Figure 2.25 Transport Model Calibration Results, Salinity Station 8

3.0 LONG-TERM MODELING OF THE CLOSURE OF ROLLOVER PASS

3.1 Methodology Overview and Boundary Conditions

This study examines the effect of closing Rollover Pass on salinity in Rollover, East, and Galveston Bays. To accomplish this, the study needs to simulate salinity in the system over several years for the existing and proposed physical conditions of the study area (i.e., Rollover Pass open and Rollover Pass closed).

Hydrodynamic models such as RMA2 generally command very high computational costs — in the form of prohibitively long model run times and large solution file sizes — to simulate extended time periods (i.e., multiple years). These high computational costs make such long-term hydrodynamic simulations impractical without the use of expensive high performance computing facilities running multi-processor clusters and parallelized hydrodynamic and transport models.

However, an analysis of historic (1936 – 2009) daily stream flow records indicated generally consistent seasonal variations in the freshwater entering the bays. This analysis suggested that representative month-long hydrodynamic simulations with seasonally varying freshwater input would provide a computationally cost-effective method to simulate long-term hydrodynamic conditions. The less computationally expensive transport model (RMA4) can draw on the hydrodynamic model solutions representing the appropriate season and provide a numerical description of salinity transport processes spanning several years.

Analysis of the stream flow records at Trinity River, Cedar Bayou, San Jacinto River, and Buffalo Bayou from 1936 to 2009 showed seasonally varying stream flow values roughly corresponding to spring, summer, fall, and winter. As noted in Chapter 2, no data exists for Oyster Bayou. Figure 3.1 combines stream flow data from 1936 to 2009 and shows the average daily stream flow statistics over a representative year. Figure 3.2 compares the total stream flow statistics to representative constant seasonal flows applied as model boundary conditions. Table 3.1 lists the model input stream flow values and the period of the stream flow record analyzed at each input location.

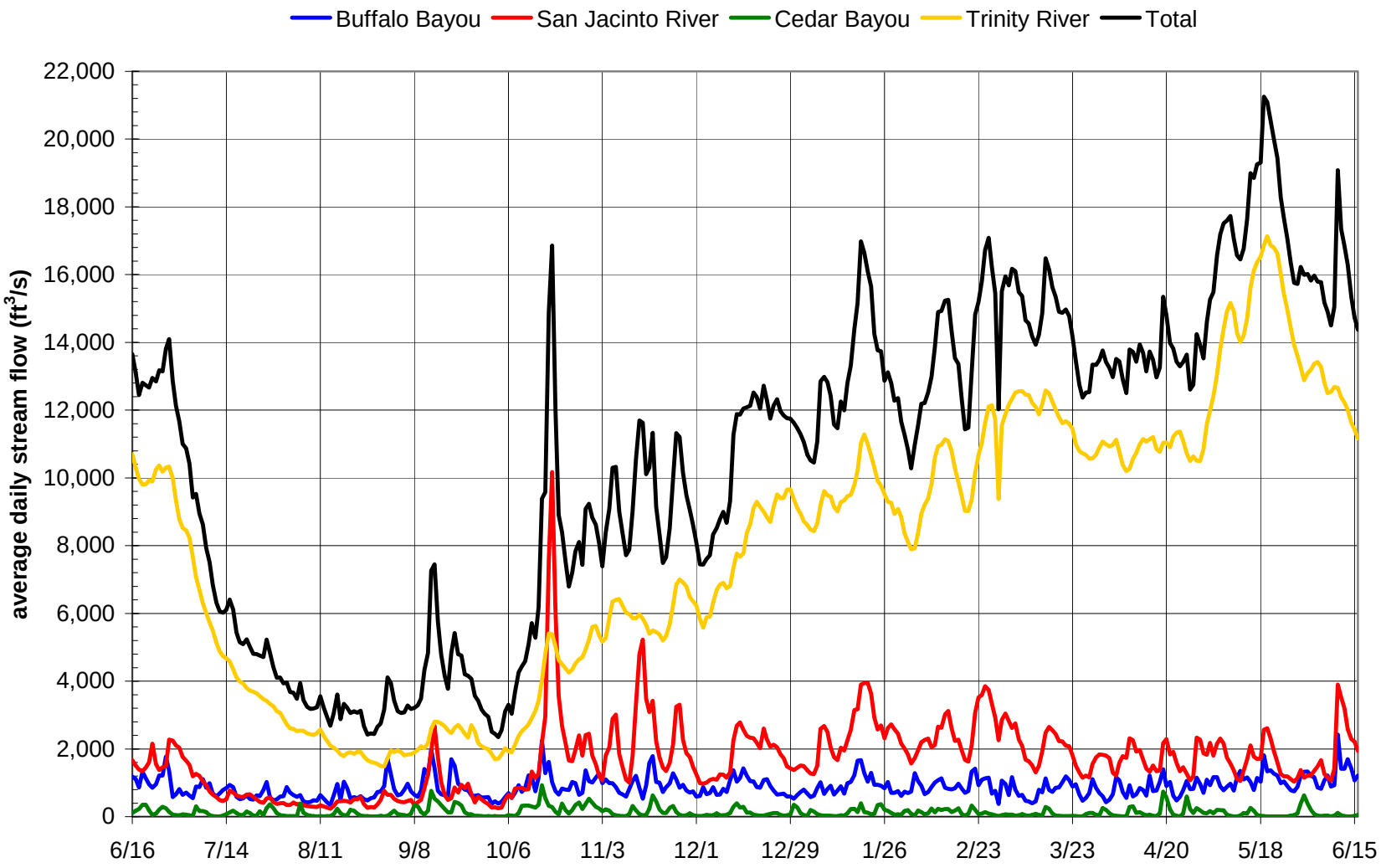


Figure 3.1 Representative Annual Daily Stream Flow Statistics at Model Input Location

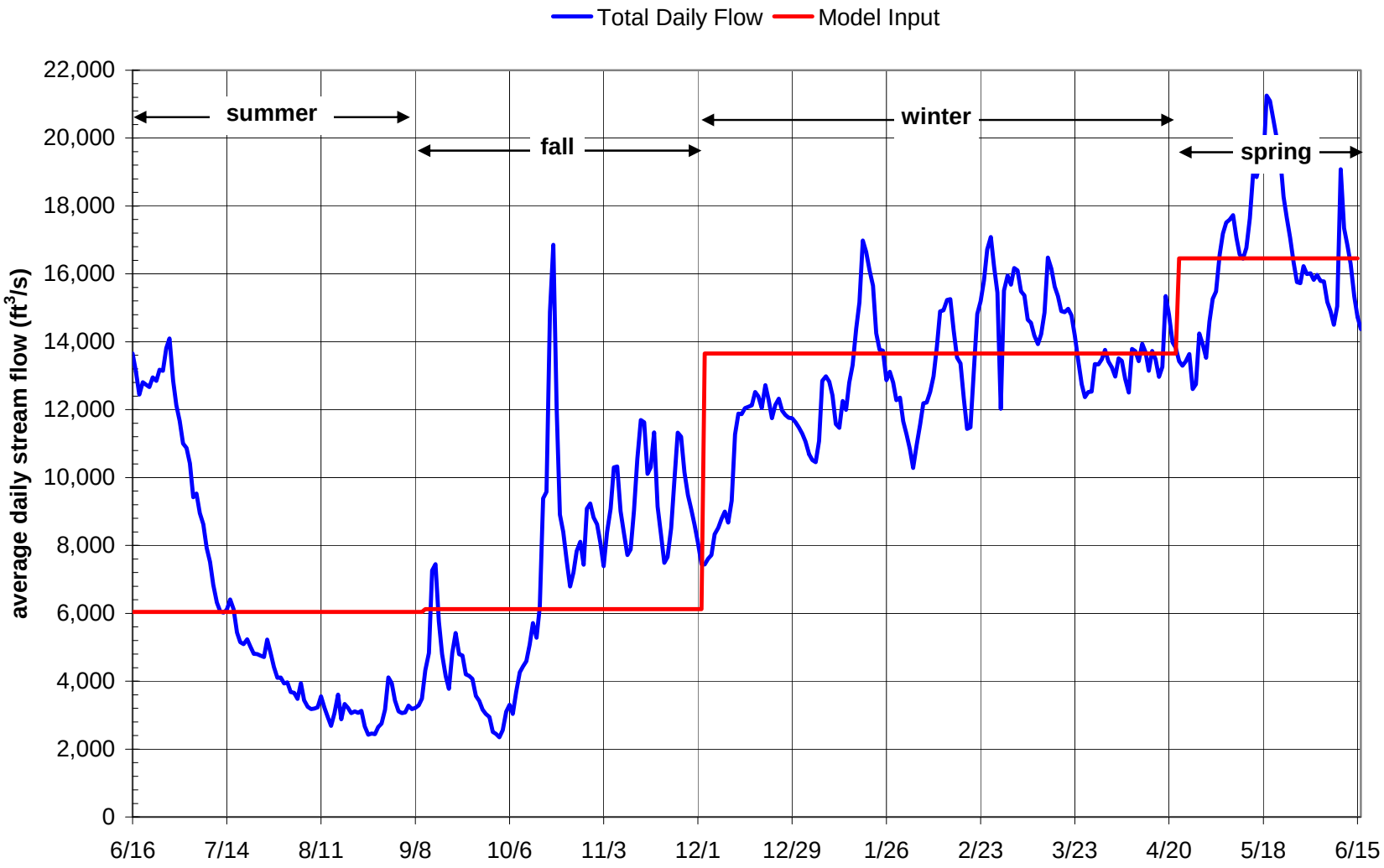


Figure 3.2 Representative Annual Total Daily Stream Flow and Constant Model Input Stream Flow

Table 3.1 Model Stream Flow Input

Input Location	Winter Flow (cfs)	Spring Flow (cfs)	Summer Flow (cfs)	Fall Flow (cfs)	Record Period
Trinity River	10,500	13,507	4,427	3,347	1936 – 2009
Cedar Bayou	114	105	102	232	2001 – 2009
San Jacinto River	2,189	1,747	755	1,611	1939 – 2009
Buffalo Bayou	855	1,098	755	932	1936 – 2009
Total	13,658	16,457	6,039	6,122	–

Similarly, an analysis of the tidal record at Galveston Pleasure Pier from 2004 to 2009 developed representative tidal characteristics for each season. Figure 3.3 shows the weekly mean, high, and low water levels from the analysis period plotted against the model input water level. Figure 3.4 compares the month-long (28-day) model input tide boundary conditions applied to each season. Figure 3.3 shows that the representative tide follows the general pattern of mean high and low tide over the typical year. Additionally, the model input tide captures the higher mean tide levels seen in the late summer through fall months. Figure 3.4 shows that the representative 28-day periods capture typical spring and neap tides, and successive model periods do not introduce large discontinuities into the model water levels. Notably, a reduced tide range accompanies the higher mean tide levels in the late summer through fall months.

3.2 Model Procedure

The hydrodynamic simulations developed in this study consisted of four seasonally representative one-month (28-day) simulations on each of the two model domains (Rollover Pass open and Rollover Pass closed). Each simulation applied time varying tidal inputs (Figures 3.3 and 3.4) and constant freshwater inputs (Figure 3.2) to model a full lunar cycle (28 days) and yield a solution representative of a given season.

Properly sequenced, the month-long seasonal simulations generate representative hydrodynamic conditions over multiple years. The transport model applied these hydrodynamic conditions to determine the circulation and mixing of saline water and freshwater throughout the system. The transport model applied a constant offshore boundary salinity of 37 ppt and 0 ppt at the stream flow input locations throughout the simulation. This boundary derived from the measured data collected from July – September 2009.

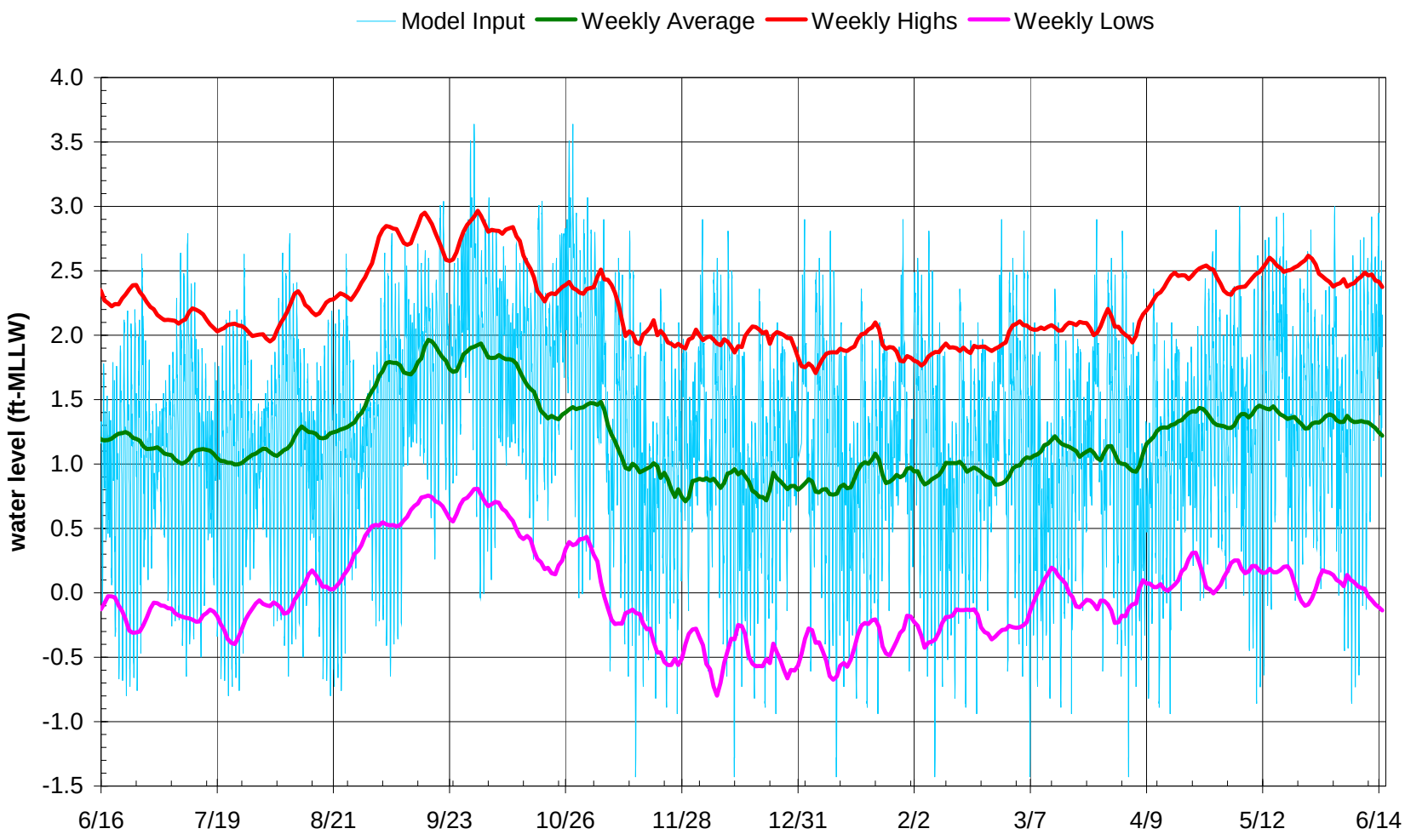


Figure 3.3 Model Tide Input vs. Measured Mean, High, and Low Tide Levels

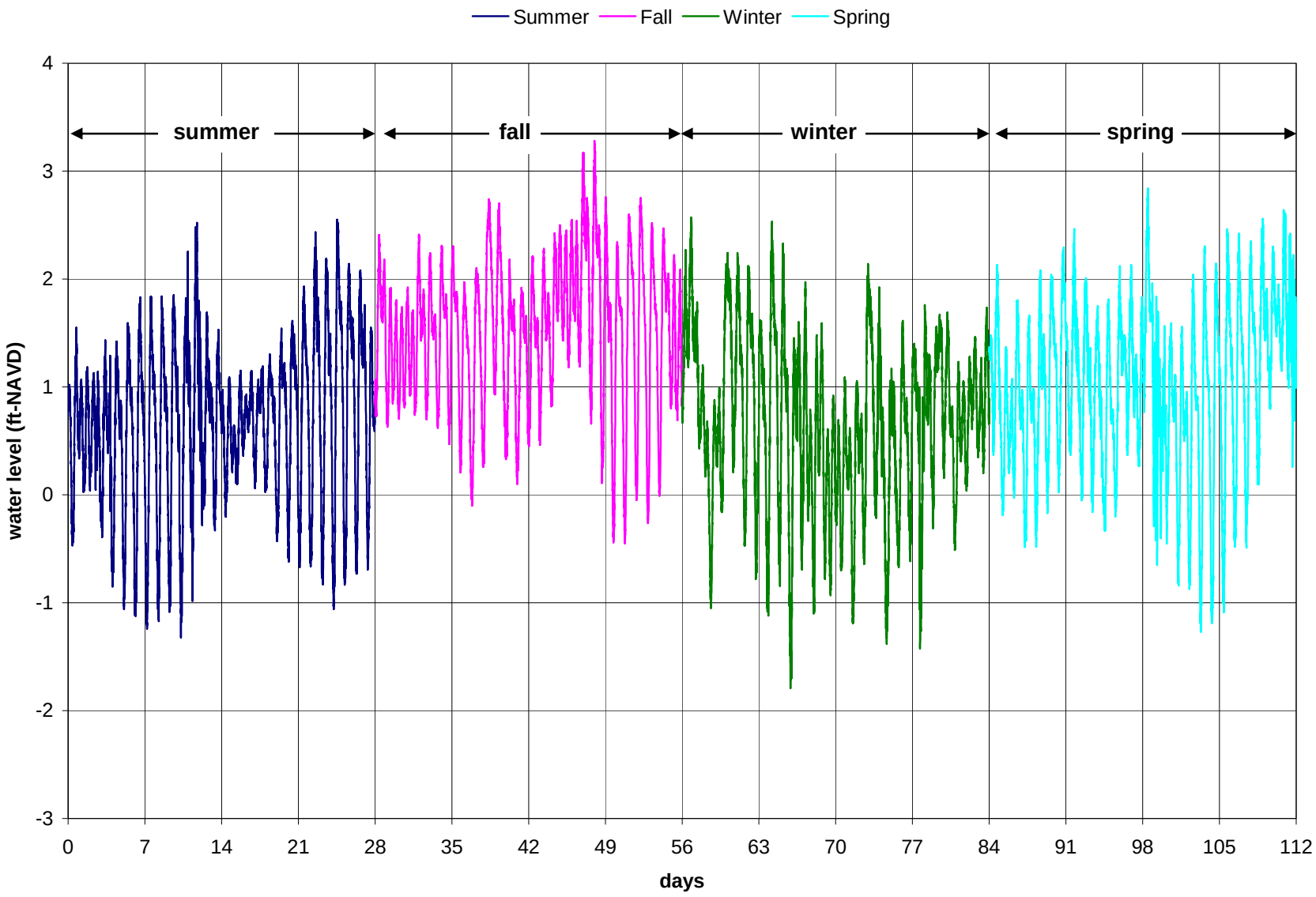


Figure 3.4 Model Tide Input vs. Measured Mean, High, and Low Tide Levels

Table 3.2 lists the one-month seasonal simulations applied for each calendar period. Notably, each hydrodynamic simulation covers 28 days with a full year requiring thirteen 28-day months.

Table 3.2 Simulation Periods and Corresponding Hydrodynamic Simulations

Calendar Period	Number of 28-day Calendar Months	Hydrodynamic Simulation (One-month Tide and Stream Flow Conditions)
June – August	3	Summer
September – November	3	Fall
December – March	5	Winter
April – May	2	Spring

The transport model applied the initial salinity conditions of July 2009 from the calibration model to establish the initial salinity throughout the system. An initial "spin-up" simulation period of one-month (28-day) applied the summer hydrodynamic solution to the transport model and allowed the salinity throughout the model to stabilize before beginning the model production runs. Following this spin-up period, control programs scheduled the appropriate seasonal hydrodynamic solution files as input to the transport model as described in Table 3.2. The final transport model solution describes the salinity throughout the system with Rollover Pass open and closed over a typical three-year period. The model does not include episodic events such as hurricanes or other storms.

Both the Rollover Pass open and closed models applied exactly the same boundary conditions throughout the simulation. The study assumes that closing Rollover Pass would not change the model parameters determined during the calibration process (i.e., bed roughness and eddy viscosity). The application of consistent conditions (i.e., bed roughness, eddy viscosity, stream flow, tide, boundary salinity) to both models should counter any unaccounted variability in boundary data (e.g., offshore salinity). The comparison of the models should remain consistent regardless of actual boundary conditions.

3.3 Model Results

Figures 3.5 and 3.6 show circulation patterns in Rollover and East Bays during typical winter tides and freshwater stream flows with Rollover Pass open and closed. The figures indicate that closing Rollover Pass reduces the flows along the channel in Rollover Bay, but does not appreciably affect the circulation in the rest of the Bay.

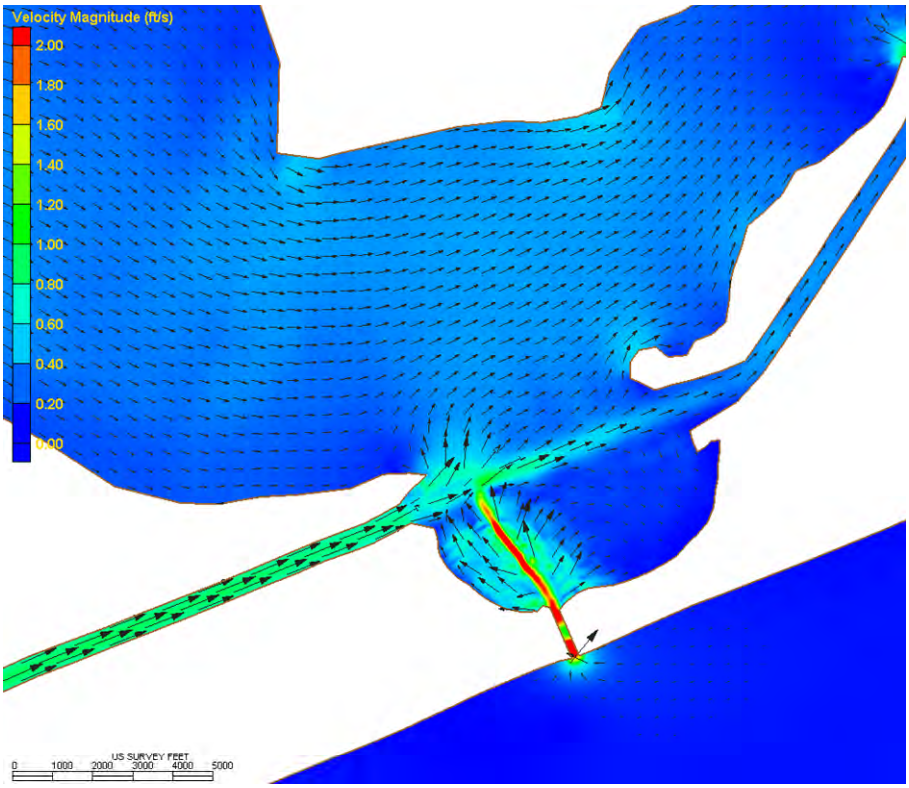


Figure 3.5 Winter Circulation in Rollover and East Bay with Rollover Pass Open

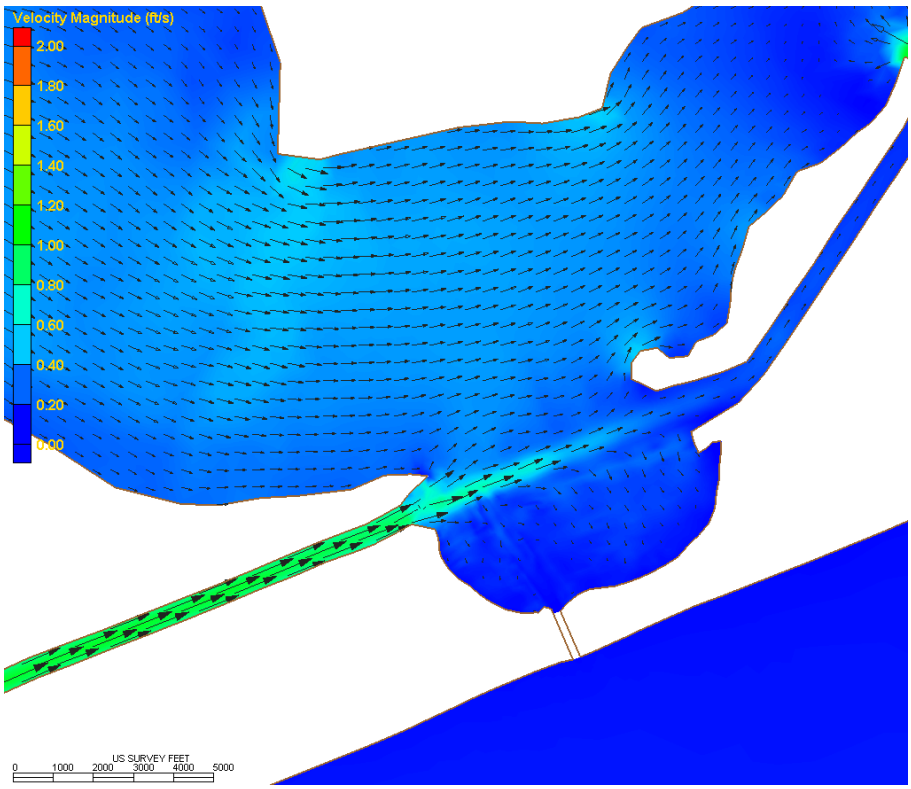


Figure 3.6 Winter Circulation in Rollover and East Bay with Rollover Pass Closed

The transport model determined the salinity at each model grid point at half-hour intervals over three years. Post-simulation analysis of the model results examined time-varying salinity data at various stations (Figure 3.7) near Rollover Pass and determined seasonal average salinity throughout the model domain.

Figures 3.8 – 3.16 show the time-varying salinity results for each of the three simulation years at three typical sample stations (Stations 4, 3, and 11). Appendix A contains similar plots for each station shown in Figure 3.5. Each plot compares the salinity for Rollover Pass the open and closed condition over the given simulation year and also plots the total freshwater input to the model during each season. Plot annotations indicate the average, maximum, and minimum salinity in ppt for each season with Rollover Pass open and closed.

High salinities at the start of Year 1 derive from the initial salinity conditions applied to the models. These initial conditions reflect salinity levels more representative of the end of the summer season rather than the beginning. The models eliminate this effect by the end of the Year 1 fall season.

Comparison of the plots at each sample station demonstrates that simulation Year 3 essentially duplicates Year 2, and the model reached an equilibrium condition after the first simulation year. Simulations beyond Year 3 should show no appreciable change. Tables 3.3 and 3.4 list maximum, average, minimum salinity with the Pass open and closed by season for simulation Year 2 at all sample stations (Figure 3.7).

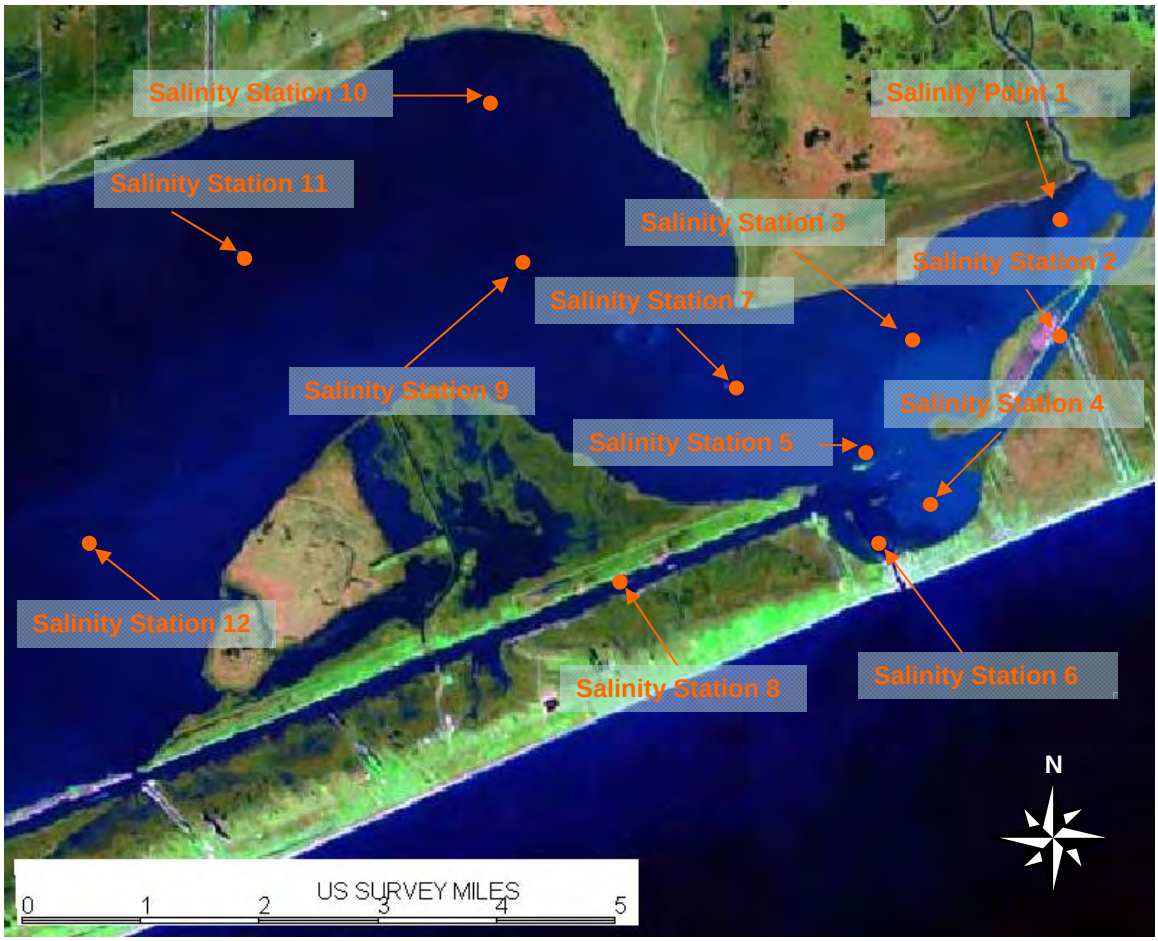


Figure 3.7 Production Run Salinity Sample Points

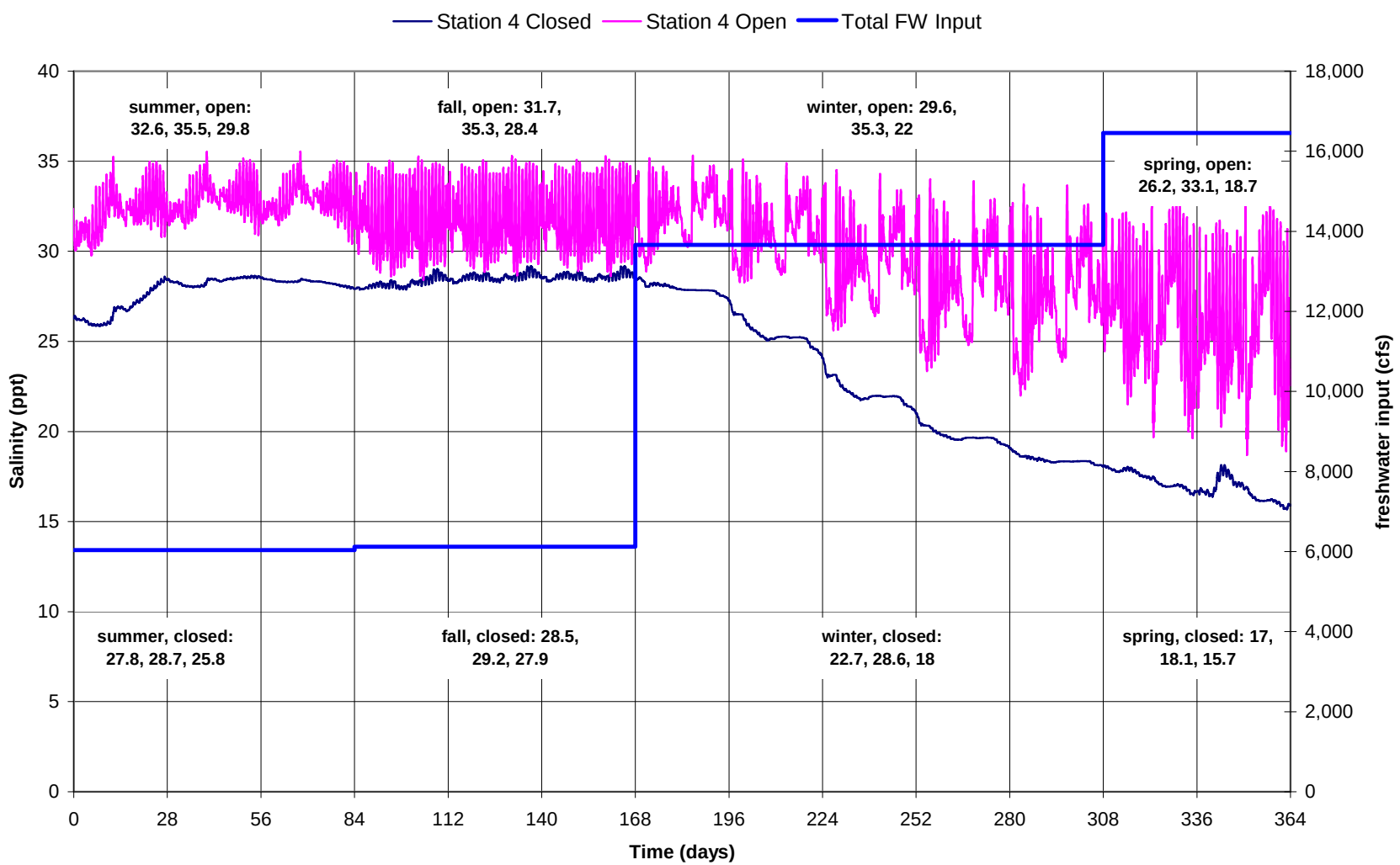


Figure 3.8 Salinity Variation with Time, Station 4, Year 1

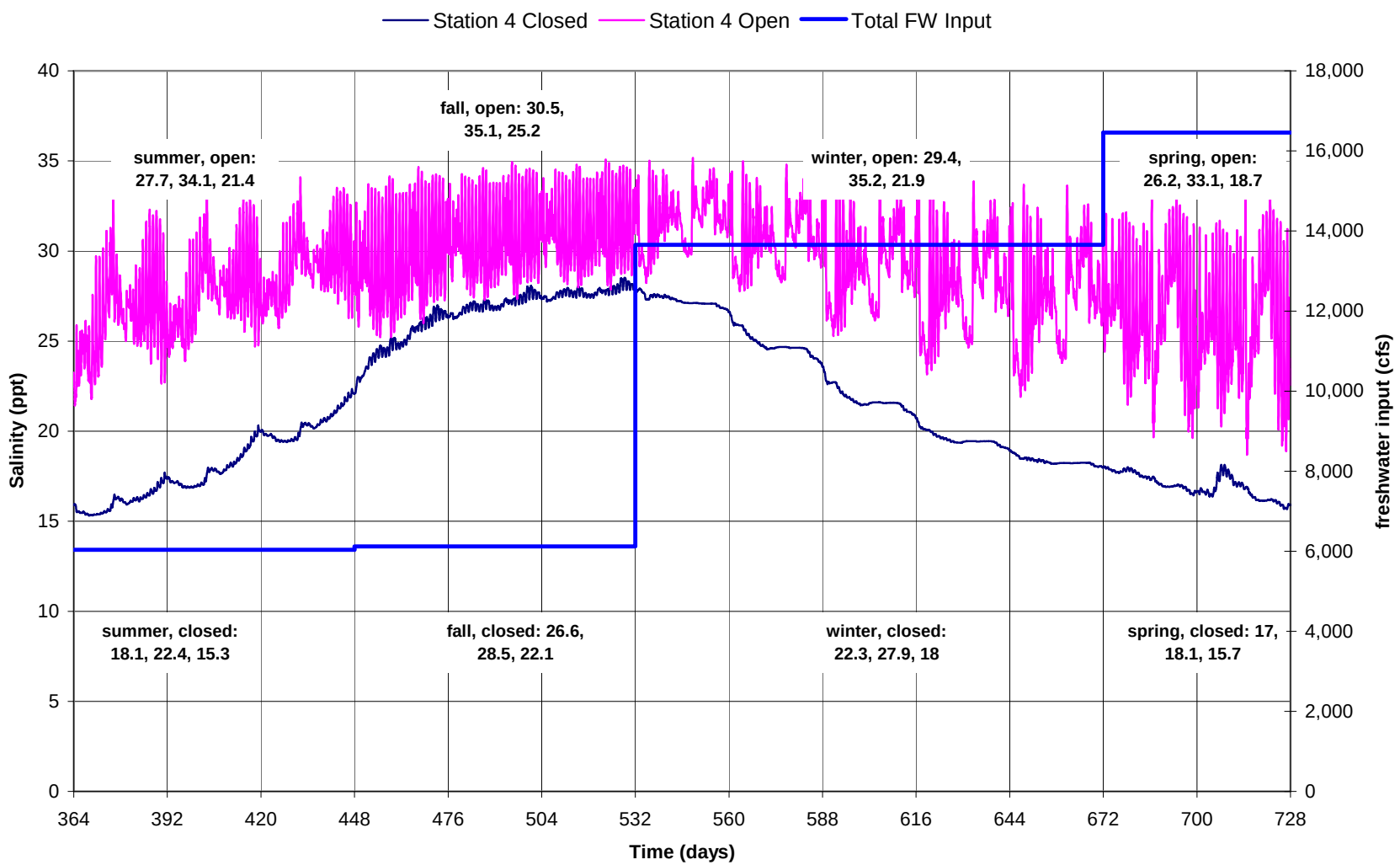


Figure 3.9 Salinity Variation with Time, Station 4, Year 2

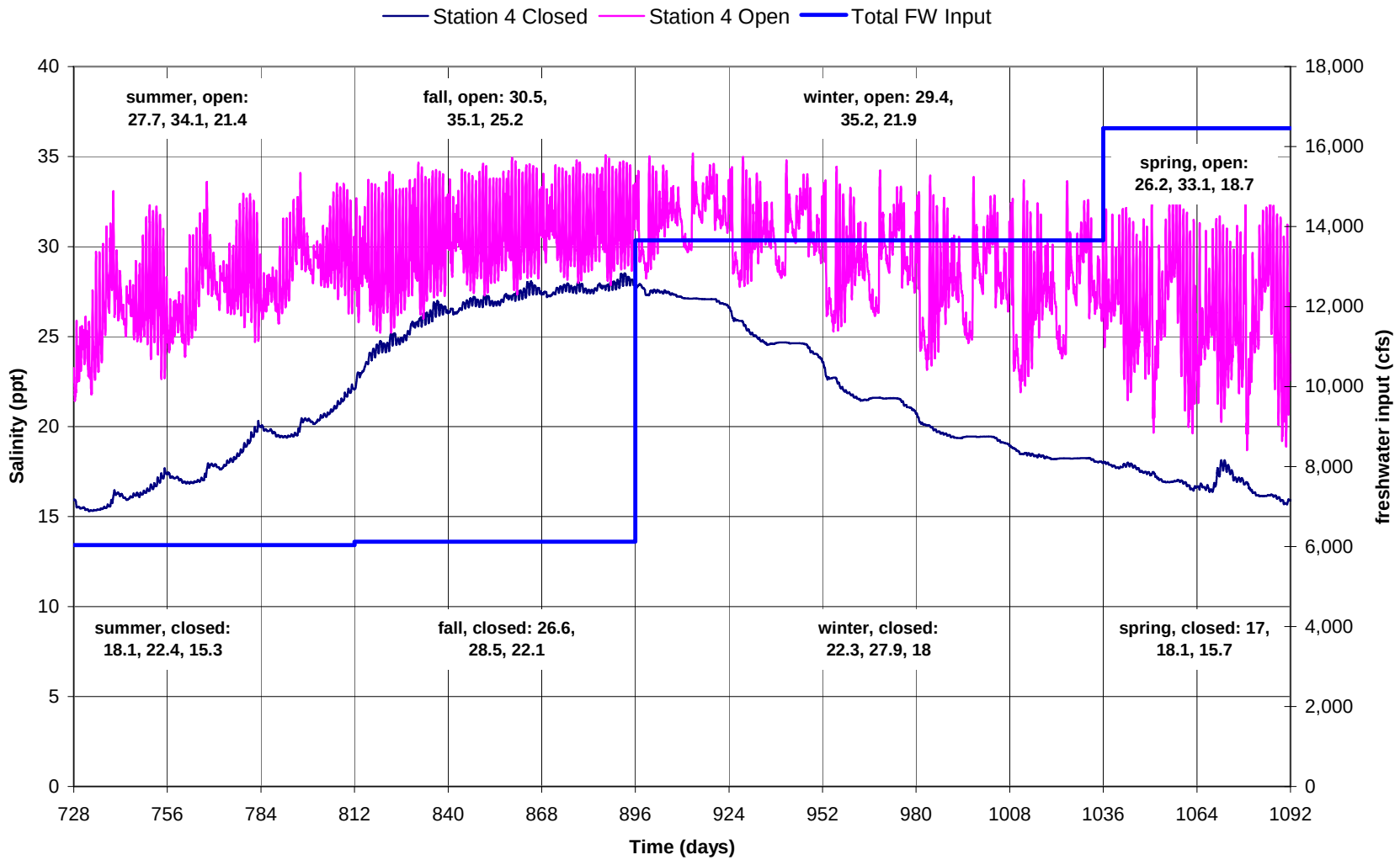


Figure 3.10 Salinity Variation with Time, Station 4, Year 3

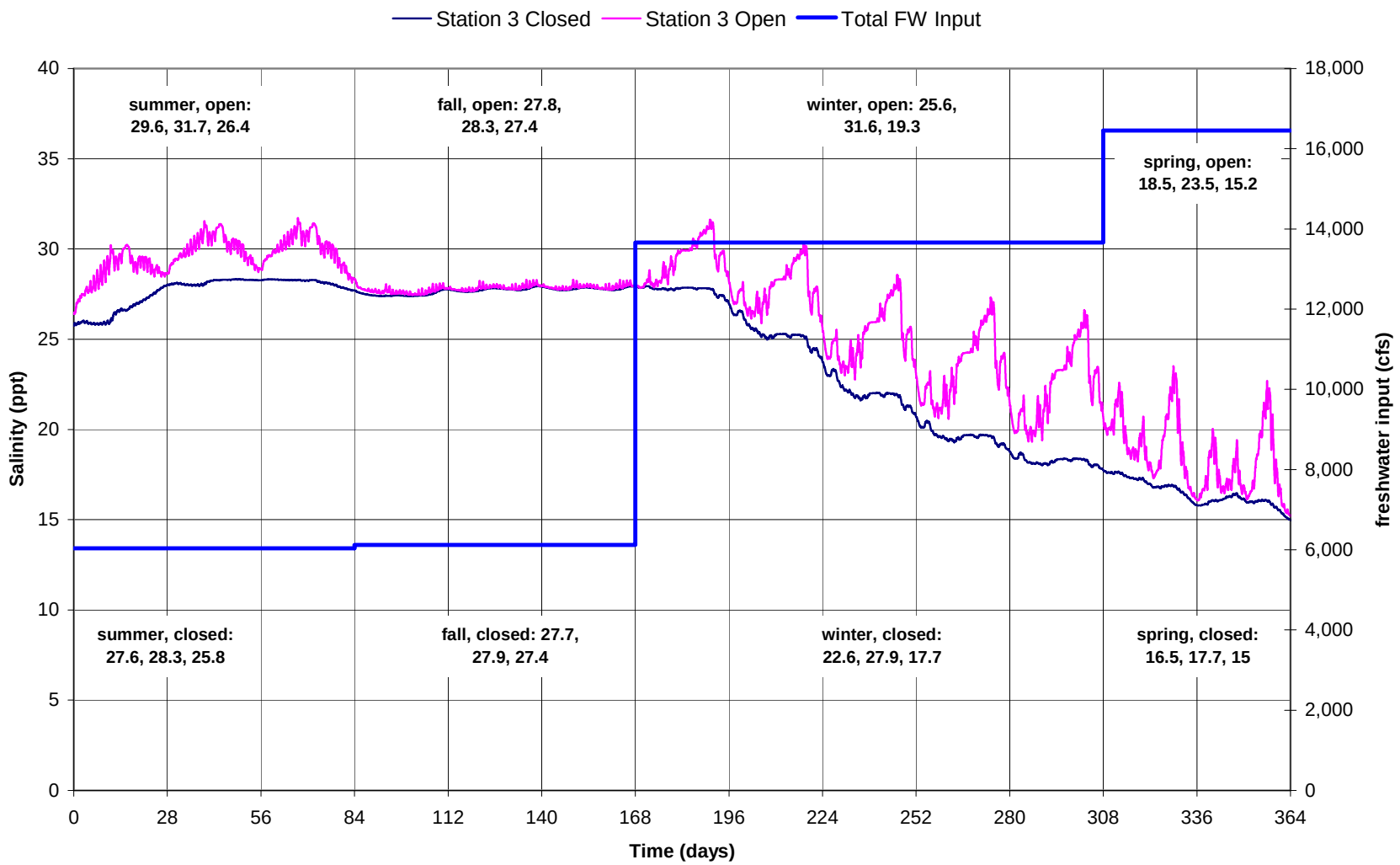


Figure 3.11 Salinity Variation with Time, Station 3, Year 1

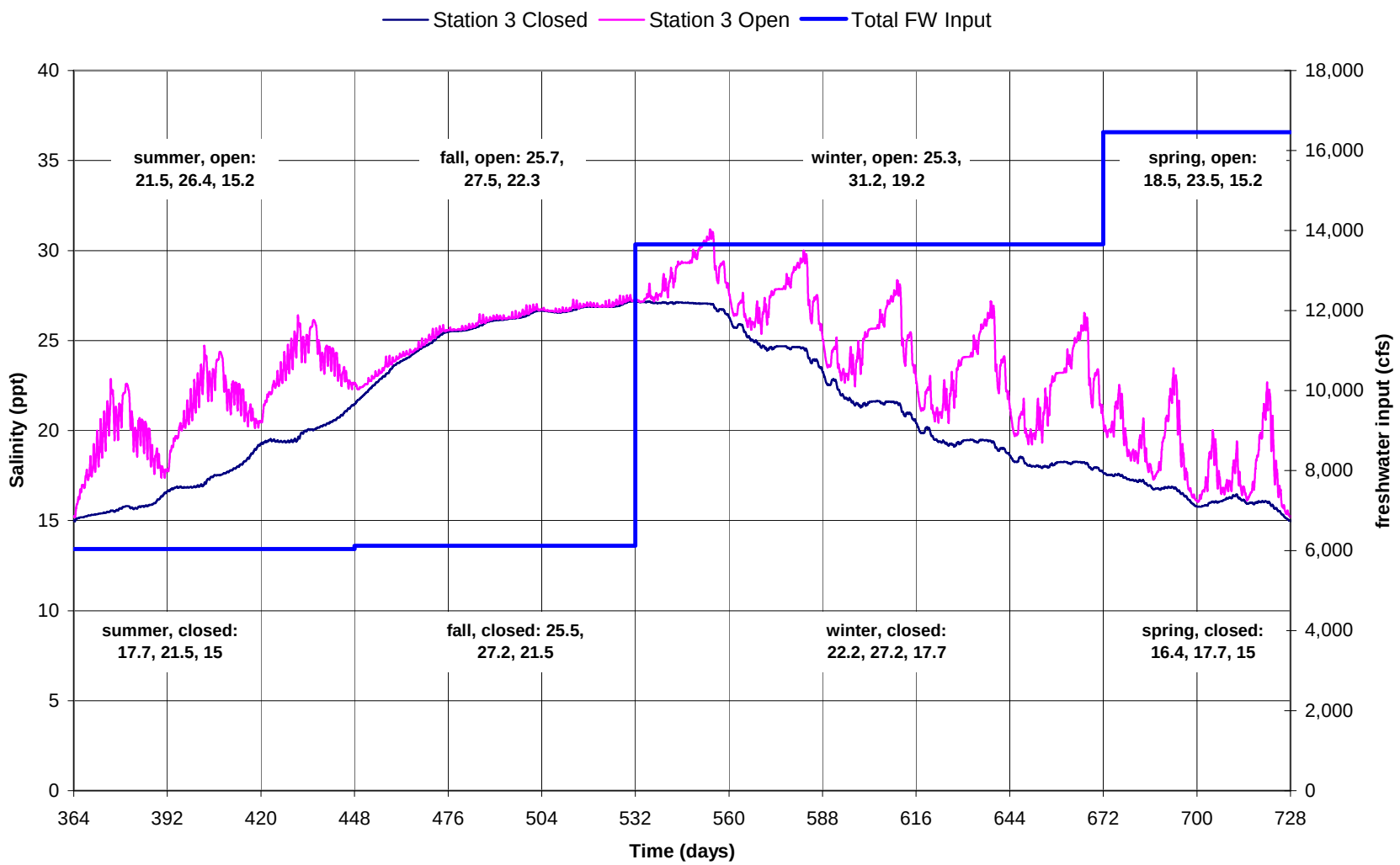


Figure 3.12 Salinity Variation with Time, Station 3, Year 2

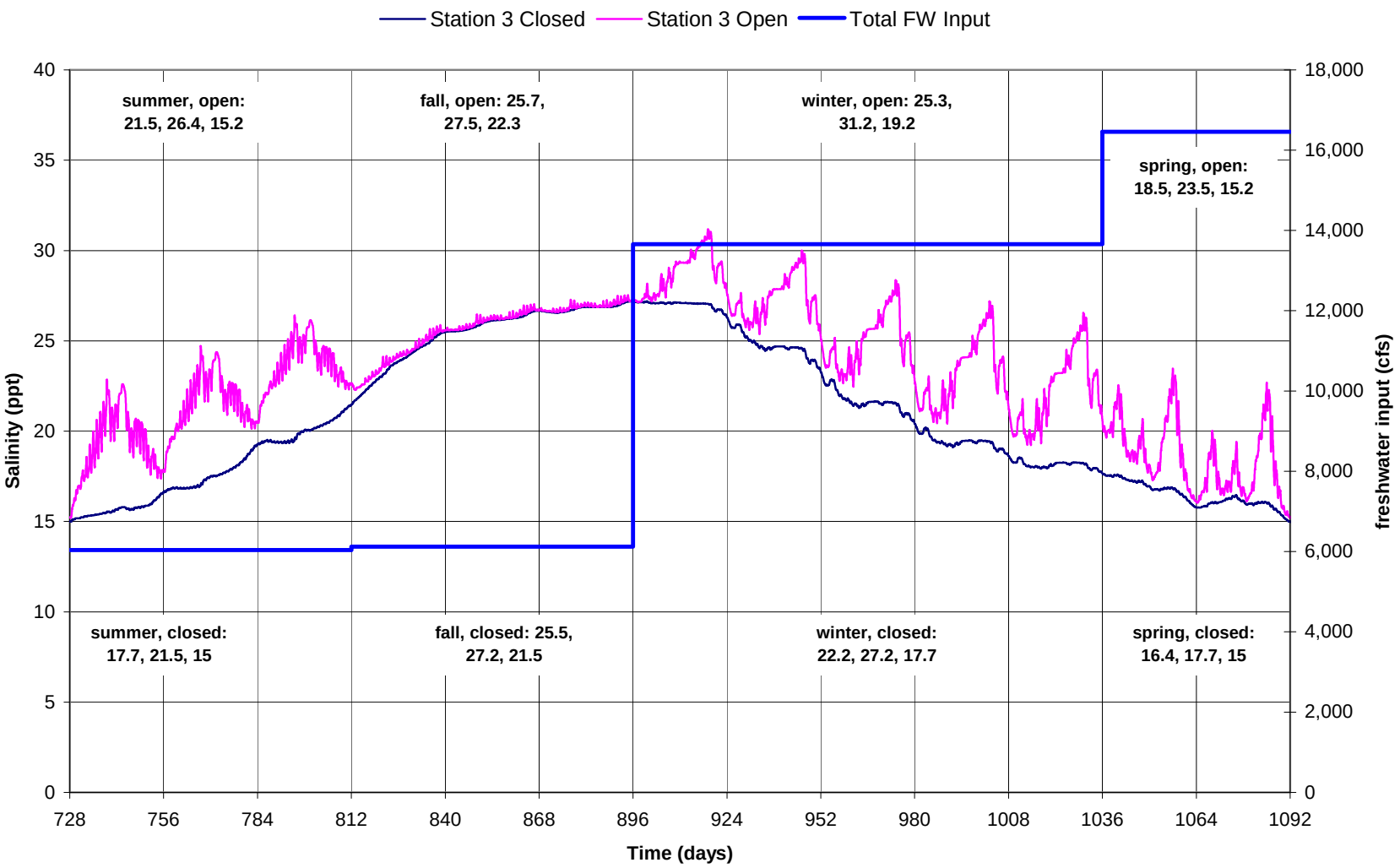


Figure 3.13 Salinity Variation with Time, Station 3, Year 3

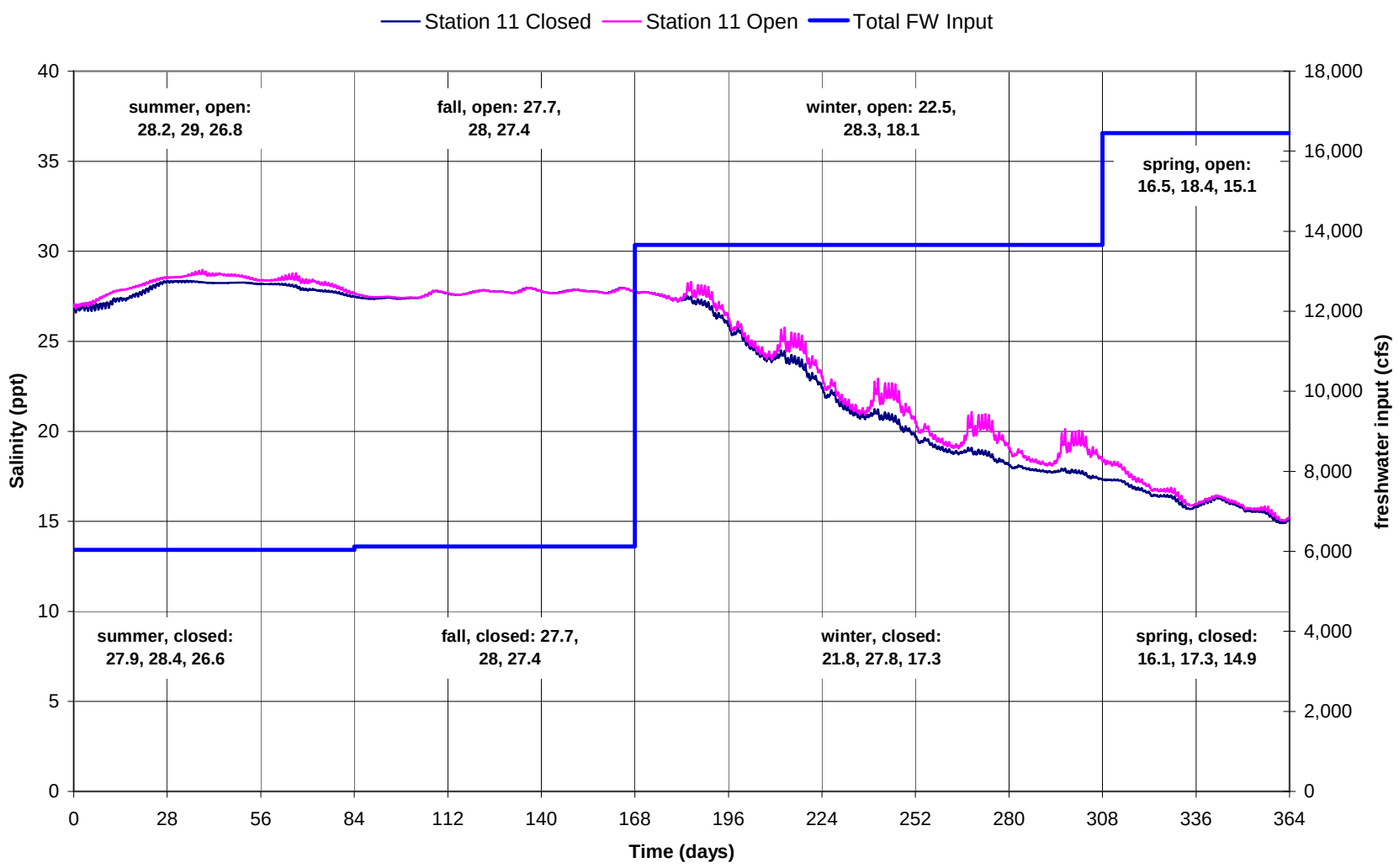


Figure 3.14 Salinity Variation with Time, Station 11, Year 1

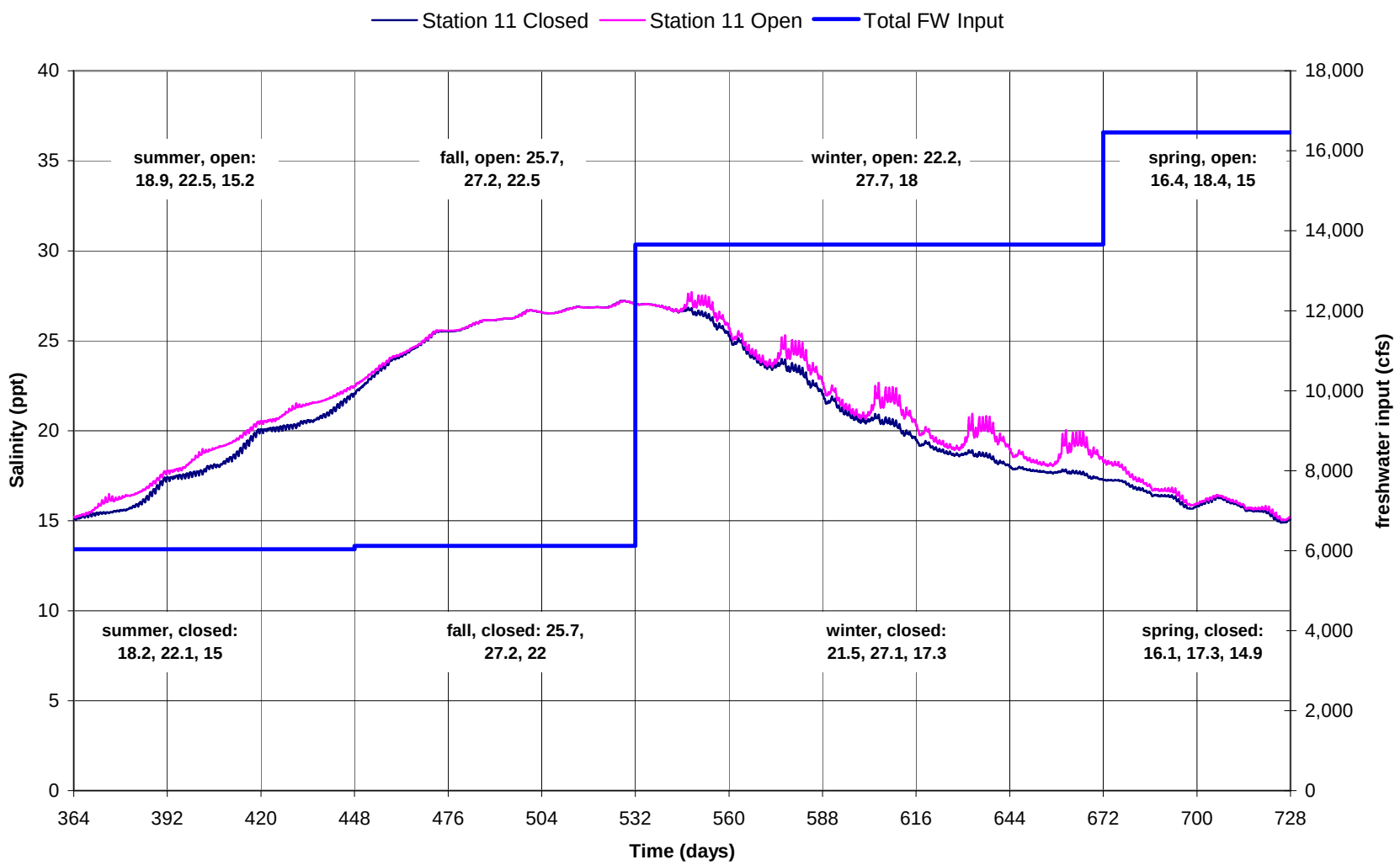


Figure 3.15 Salinity Variation with Time, Station 11, Year 2

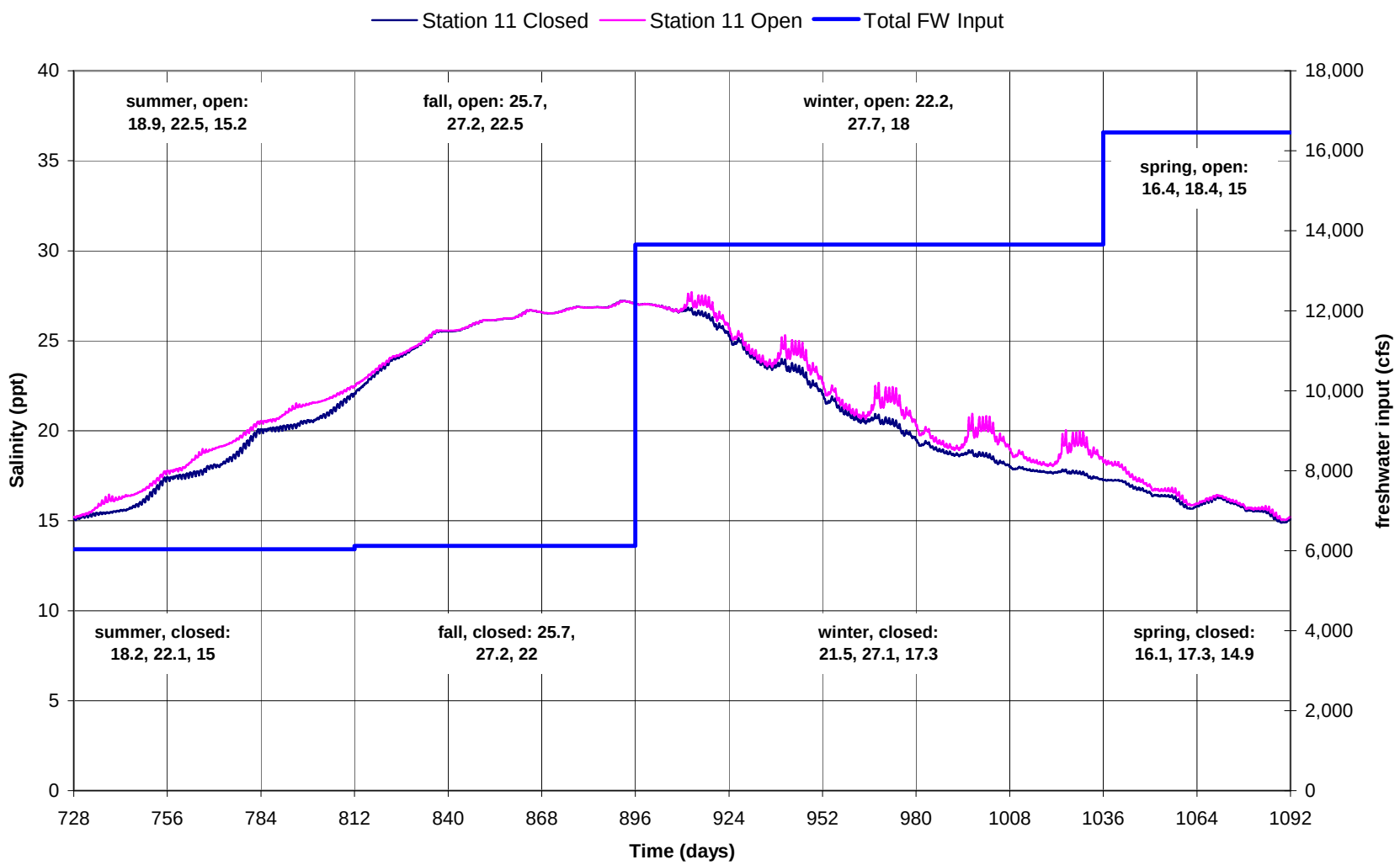


Figure 3.16 Salinity Variation with Time, Station 11, Year 3

Table 3.3 Summer and Fall Salinity Values

Station	Pass Condition	Summer, Year 2			Fall, Year 2		
		Maximum Salinity (ppt)	**Average Salinity (ppt)**	**Minimum Salinity (ppt)**	**Maximum Salinity (ppt)**	**Average Salinity (ppt)**	**Minimum Salinity (ppt)**
1	Open	26.7	21.9	15.4	27.6	25.8	22.3
	Closed	21.5	17.7	15	27.2	25.5	21.4
2	Open	31	23.4	16.3	32.2	27.8	23.3
	Closed	22.1	17.9	15.2	27.9	26.1	21.9
3	Open	26.4	21.5	15.2	27.5	25.7	22.3
	Closed	21.5	17.7	15	27.2	25.5	21.5
4	Open	34.1	27.7	21.4	35.1	30.5	25.2
	Closed	22.4	18.1	15.3	28.5	26.6	22.1
5	Open	31.5	23.9	15.4	30.5	26.4	22.3
	Closed	21.9	18	15.1	27.4	25.7	21.8
6	Open	35	28.3	17.1	35.5	30.9	23.4
	Closed	22.4	18.3	15.5	28.7	27	22.3
7	Open	25.5	20.2	15.1	27.2	25.6	22.2
	Closed	21.6	17.8	15	27.2	25.5	21.5
8	Open	26.5	21.4	16.8	29.7	27.7	24.2
	Closed	24	20	15.8	29.7	27.6	24
9	Open	22.4	19.1	15.1	27.2	25.7	22.3
	Closed	21.8	17.9	15	27.2	25.6	21.7
10	Open	22.3	18.9	15.1	27.2	25.6	22.3
	Closed	21.7	18	15	27.2	25.6	21.7
11	Open	22.5	18.9	15.2	27.2	25.7	22.5
	Closed	22.1	18.2	15	27.2	25.7	22
12	Open	22.7	19	15.4	27.3	25.9	22.7
	Closed	22.4	18.6	15.3	27.3	25.8	22.4

Table 3.4 Winter and Spring Salinity Values

Station	Pass Condition	Winter, Year 2			Spring, Year 2		
		Maximum Salinity (ppt)	Average Salinity (ppt)	Minimum Salinity (ppt)	Maximum Salinity (ppt)	Average Salinity (ppt)	Minimum Salinity (ppt)
1	Open	31.1	25.8	19.9	23.8	19.3	15.4
	Closed	27.2	22.3	17.8	17.8	16.6	15
2	Open	32.9	26.8	20.6	29.4	21.7	16.4
	Closed	27.5	22.3	17.9	17.9	16.7	15.4
3	Open	31.2	25.3	19.2	23.5	18.5	15.2
	Closed	27.2	22.2	17.7	17.7	16.4	15
4	Open	35.2	29.4	21.9	33.1	26.2	18.7
	Closed	27.9	22.3	18	18.1	17	15.7
5	Open	33.6	26.4	19	29.5	20.1	15.3
	Closed	27.5	22.2	17.7	17.7	16.6	15.1
6	Open	35.8	30.3	19.6	34.3	26.1	16.4
	Closed	28.2	22.4	18.1	18.5	17.2	15.9
7	Open	30.6	24.3	18.5	21	17.2	15.1
	Closed	27.2	22.1	17.6	17.5	16.3	15
8	Open	31.1	24.5	19.1	22.2	18.3	16.1
	Closed	28.5	22.3	18.1	20.6	17.8	15.9
9	Open	29	23.1	18.3	19	16.7	15.1
	Closed	27.1	21.8	17.4	17.4	16.2	14.9
10	Open	28.3	22.9	18.3	19	16.7	15.1
	Closed	27.1	21.8	17.4	17.4	16.2	14.9
11	Open	27.7	22.2	18	18.4	16.4	15
	Closed	27.1	21.5	17.3	17.3	16.1	14.9
12	Open	27	21.6	17.8	17.9	16.3	15
	Closed	27	21.1	17.2	17.2	16.1	14.8

A seasonal rise and fall of salinity evidenced in all plots corresponds to the fall increase in mean water levels shown in Figure 3.3. Higher offshore water levels combine with low freshwater input to increase salinity within the system. Salinity falls when water levels return to their normal winter-spring-summer levels and freshwater inputs rise during the winter and spring. Lower freshwater inputs in summer cause salinities to rise — slowly during summer and more rapidly when high water levels return in fall.

Figures 3.11 – 3.16 exhibit an episodic — several times monthly — rise and fall in salinity with Rollover Pass open at Stations 3 and 11 from winter through summer. Low salinities at these stations nearly reach the Pass closed salinity levels during these episodes. These patterns reflect salinity oscillations at Station 4 (Figures 3.8 – 3.10) near Rollover Pass, and follow the monthly spring-neap tide sequence illustrated in Figure 3.4. As spring tide approaches, more saline water enters the bays and salinity rises. As spring tide approaches less saline water enters the bays and salinity falls under the influence of freshwater input from the rivers and bayous. Higher mean tide levels and smaller tidal ranges during fall months (Figure 3.4) suppress this pattern at Stations 3 and 11.

The response of Stations 3 and 11 indicates the closure of Rollover Pass should not appreciably affect salinity levels outside of Rollover Bay during the fall months — when the area experiences no salinity oscillations. During the winter through summer months, closure of the Pass eliminates the monthly salinity fluctuations and stabilizes salinity near Pass open low levels.

Tables 3.3 and 3.4 indicate the largest change in seasonally-averaged salinity occurs in summer. Closing the Pass reduces seasonally-averaged salinity up to 10 ppt near the Pass (Station 6) and less than 2 ppt about four miles from the Pass (Station 7). Peak salinity drops 16 ppt near the Pass and less than 4 ppt about four miles from the Pass.

Figures 3.17 – 3.24 plot contours of the seasonally-averaged salinity in Rollover Pass and East Bay for simulation Year 2. The figures show seasonally-averaged salinity contours with the Pass open, followed by contours with the Pass closed for each season. Figures 3.25 – 3.28 show contours of change in salinity (Pass closed minus Pass open) for each season. As noted in Chapter 2, the model calibration excluded multi-seasonal data comparisons and, thus, may not accurately predict absolute salinity values (Figures 3.17 – 3.24) but should reliably predict relative changes in salinity due to closing Rollover Pass (Figures 3.25 – 3.28).

Figures 3.25 – 3.28 indicate seasonally-averaged salinity changes due to closing the Pass increase with proximity to the Pass. Closing the Pass minimally affects seasonally-averaged salinity (less than 2 ppt change) beyond five miles from the Pass. In Rollover Bay, seasonally-averaged salinity may drop as much as 8 – 12 ppt during spring, summer, and fall and about 5 ppt during winter.

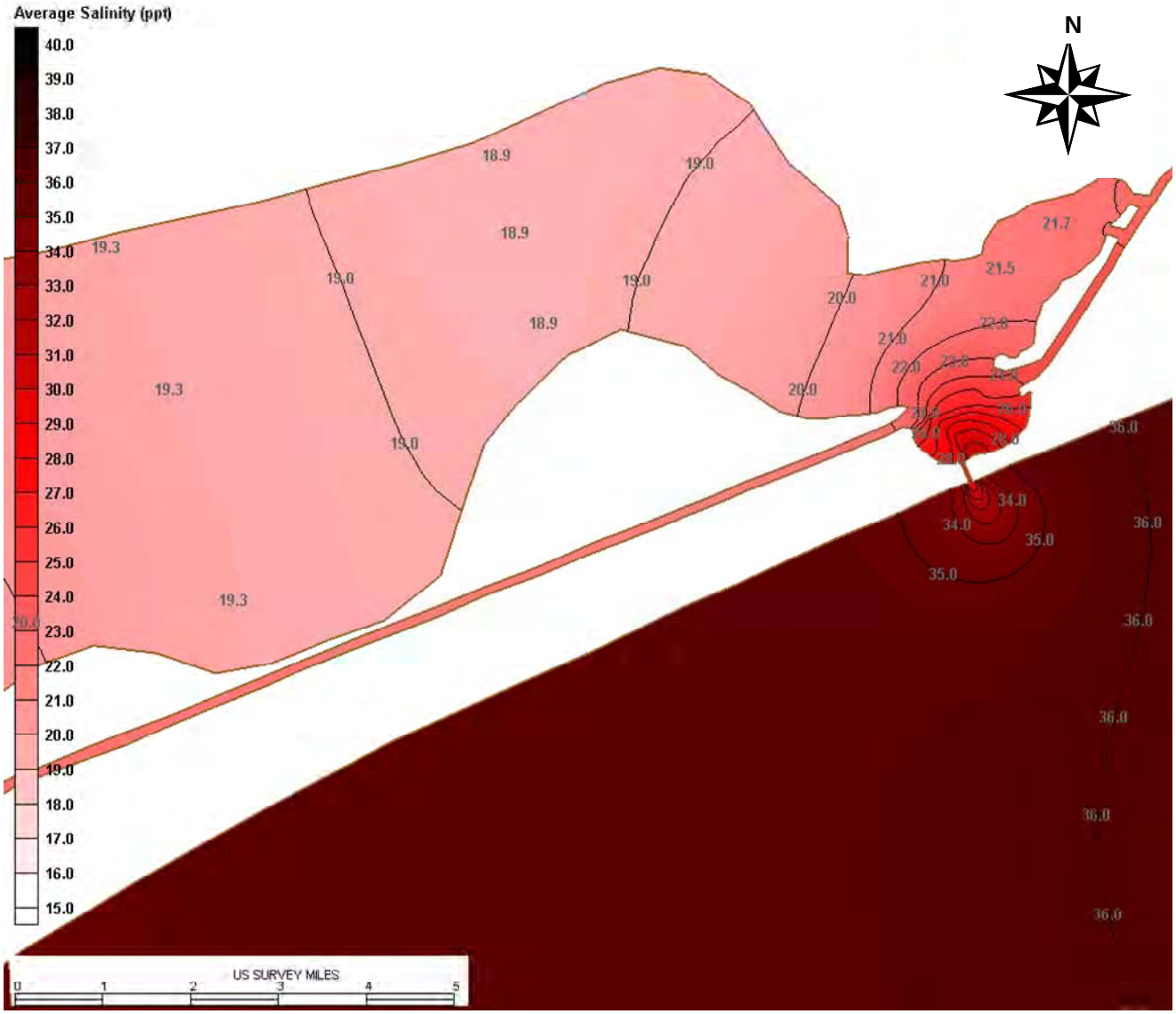


Figure 3.17 Average Salinity Contours, Rollover Pass Open, Summer Year 2

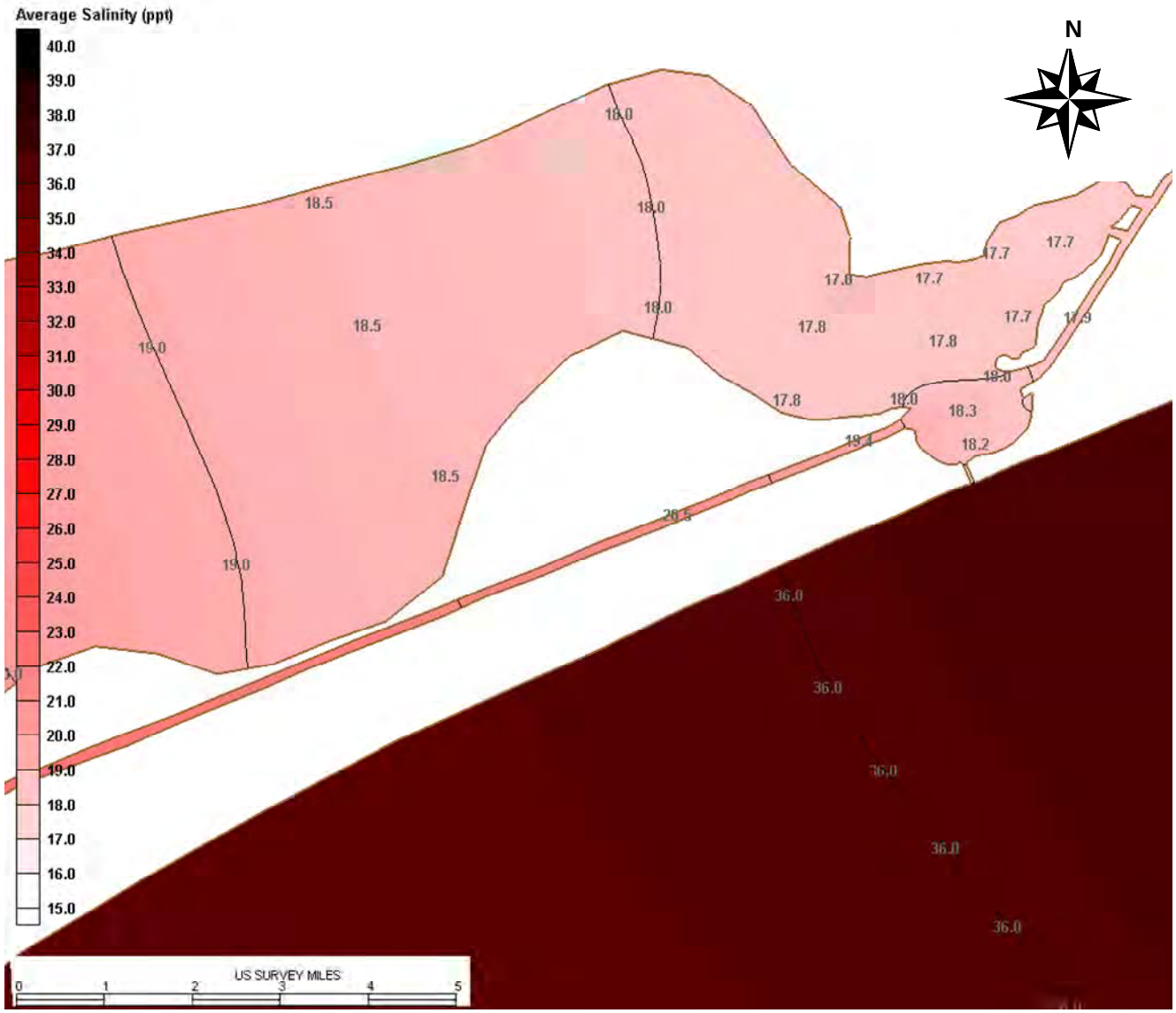


Figure 3.18 Average Salinity Contours, Rollover Pass Closed, Summer Year 2

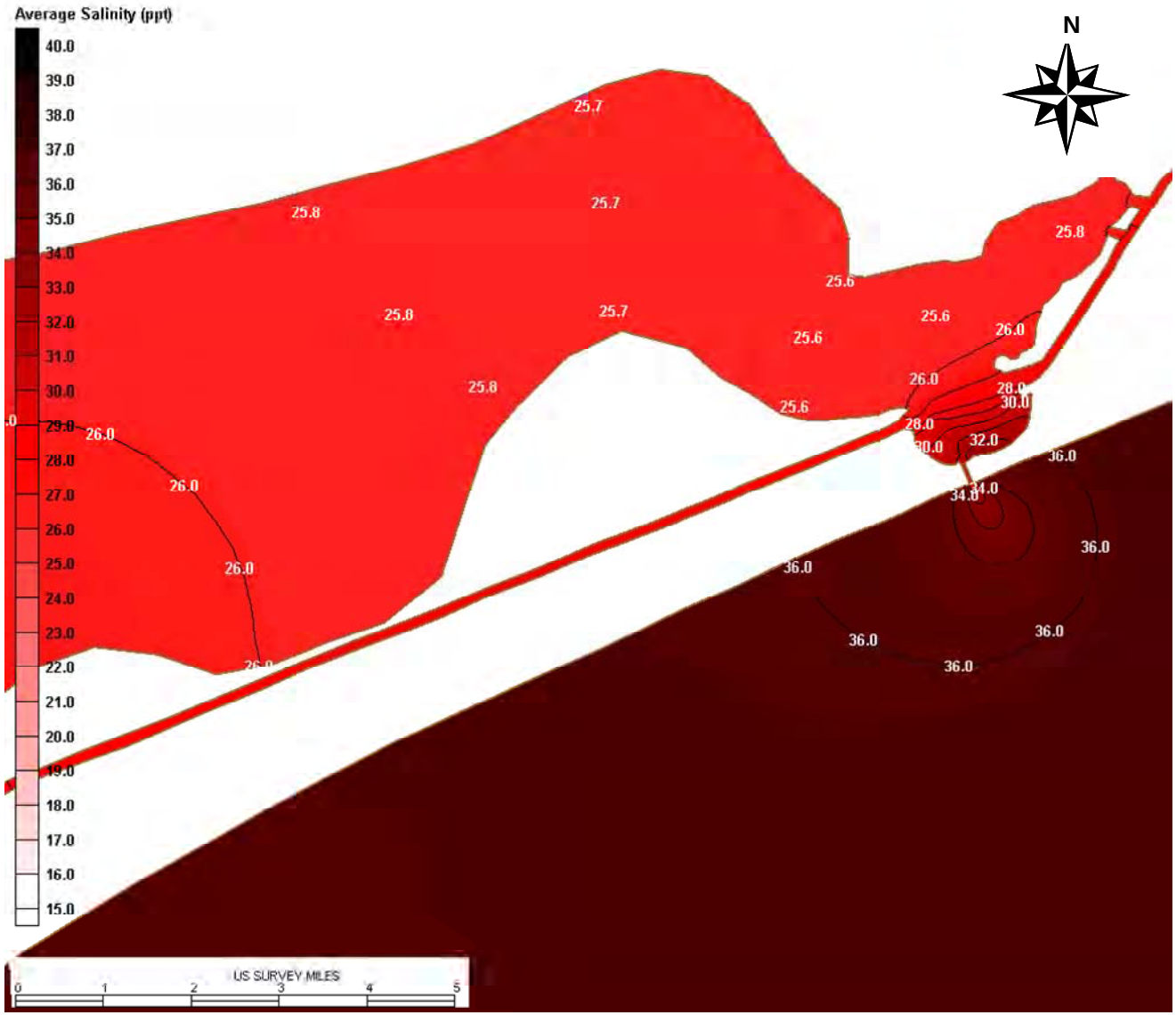


Figure 3.19 Average Salinity Contours, Rollover Pass Open, Fall Year 2

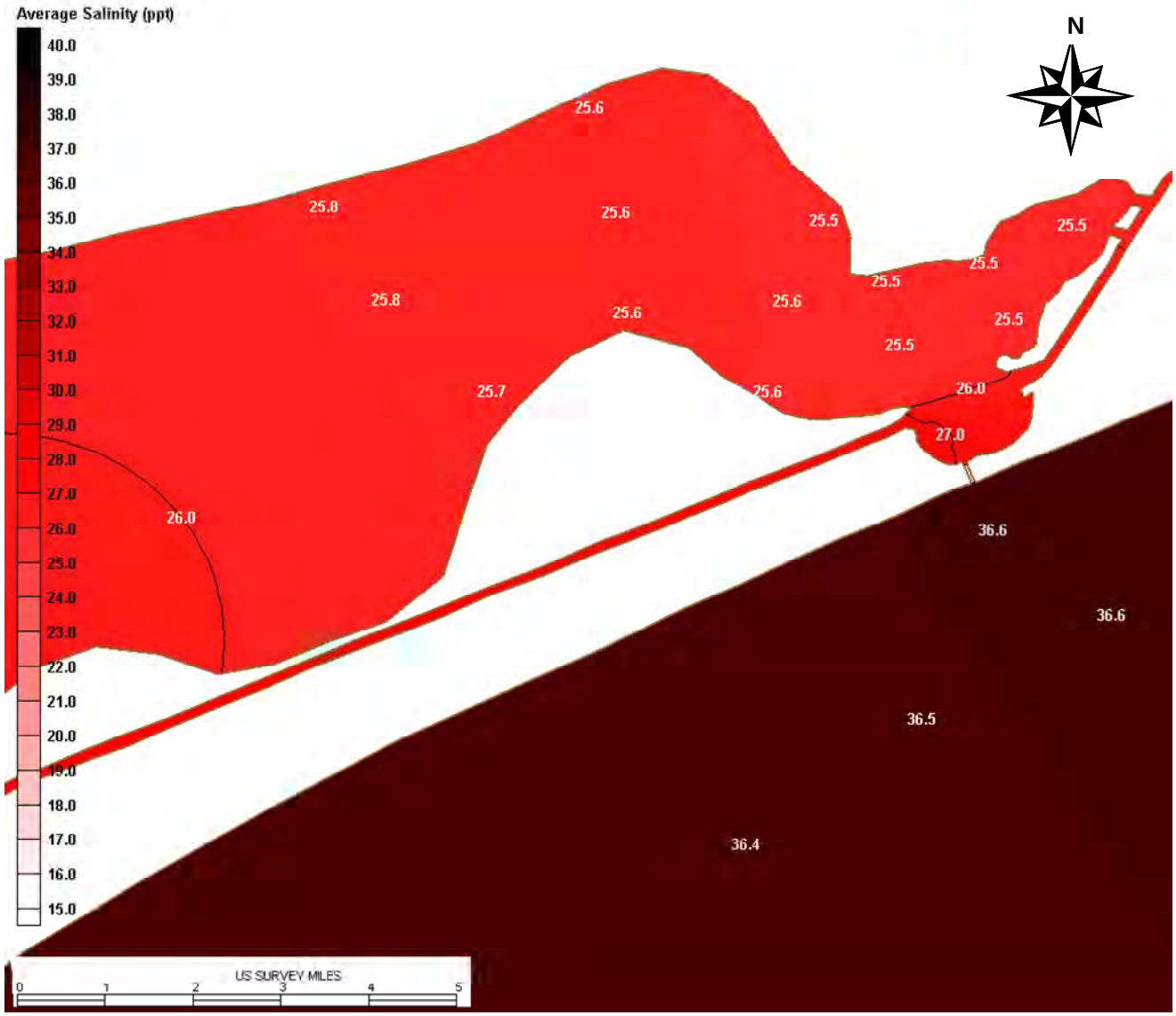


Figure 3.20 Average Salinity Contours, Rollover Pass Closed, Fall Year 2

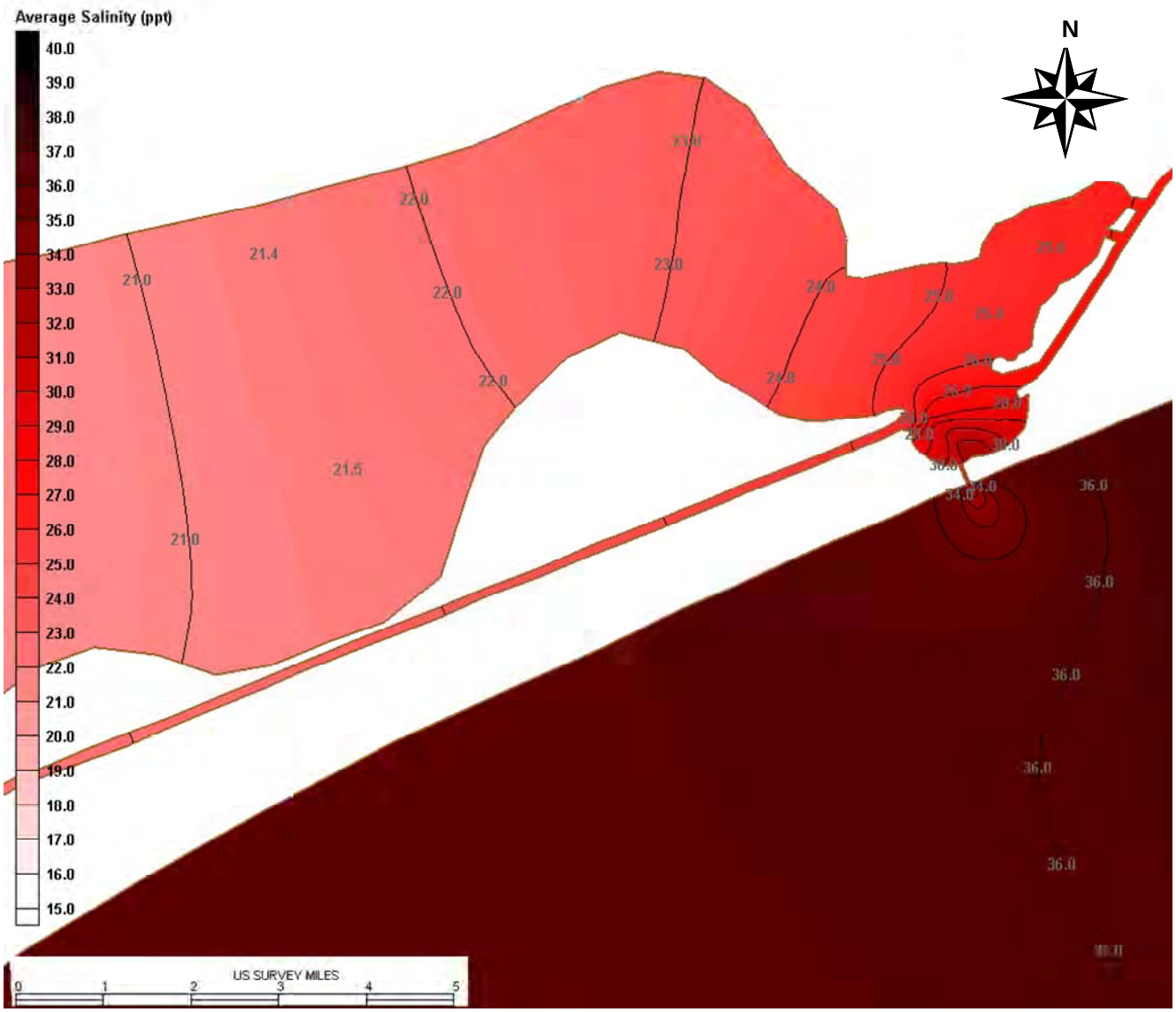


Figure 3.21 Average Salinity Contours, Rollover Pass Open, Winter Year 2

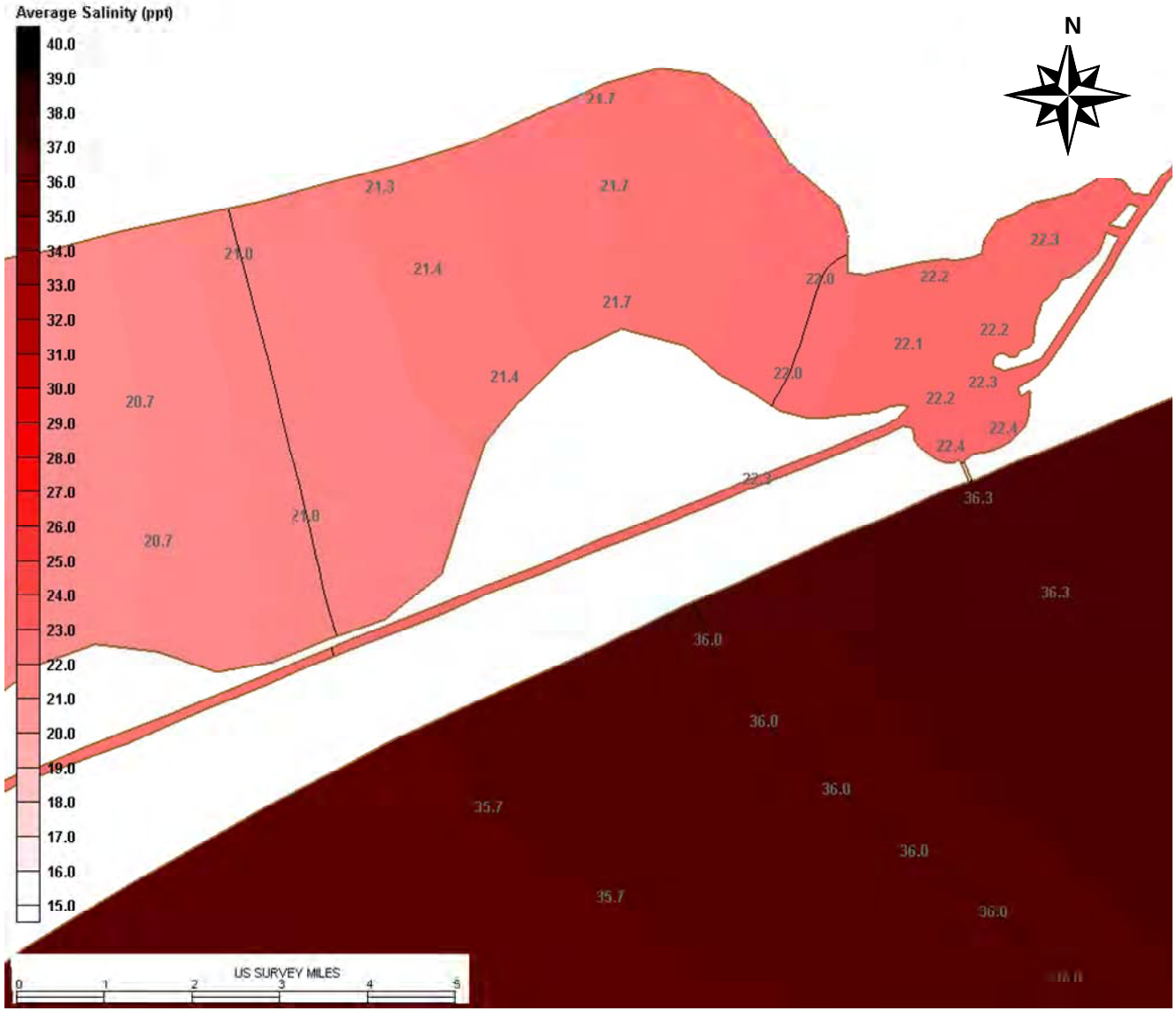


Figure 3.22 Average Salinity Contours, Rollover Pass Closed, Winter Year 2

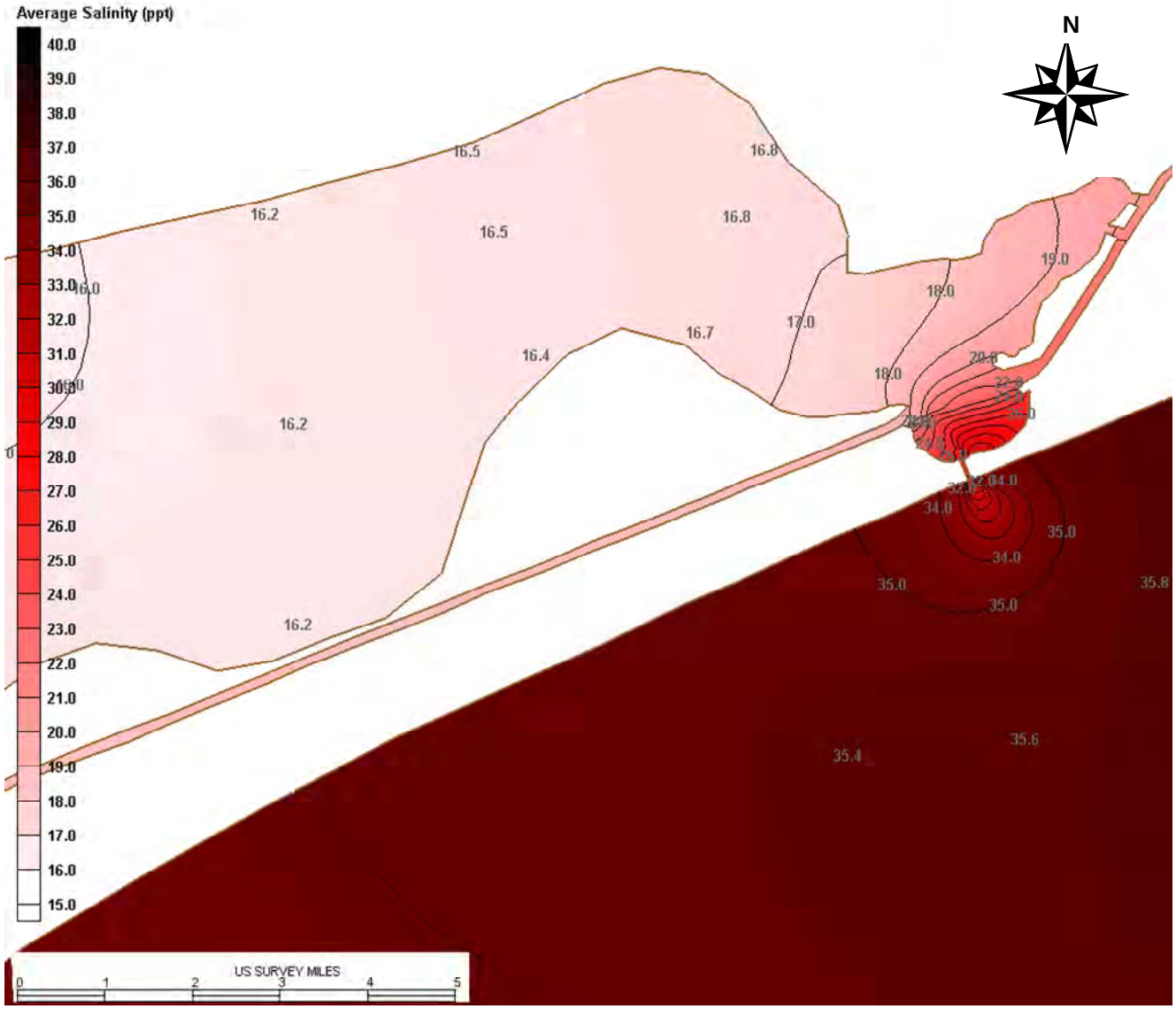


Figure 3.23 Average Salinity Contours, Rollover Pass Open, Spring Year 2

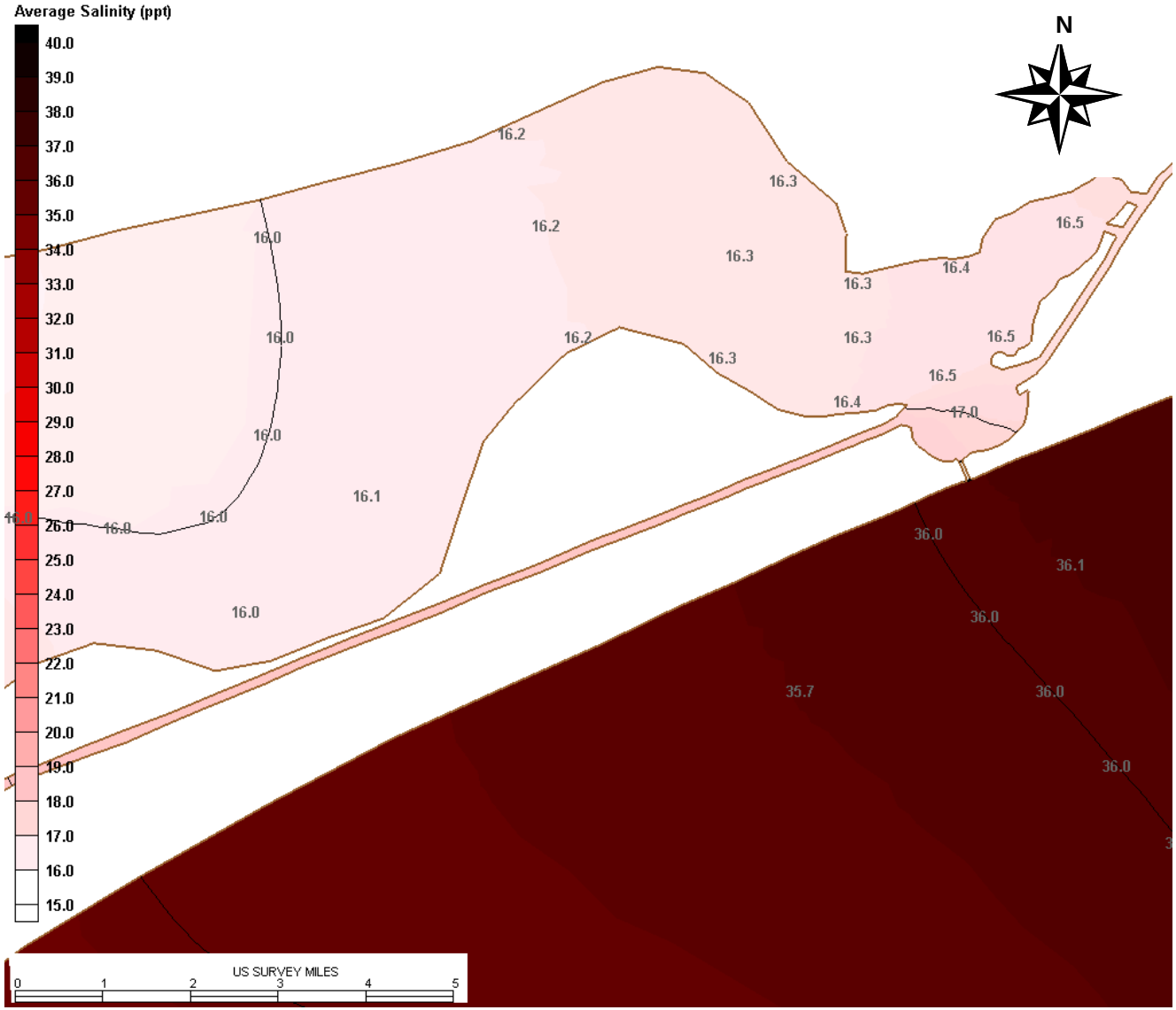


Figure 3.24 Average Salinity Contours, Rollover Pass Closed, Spring Year 2

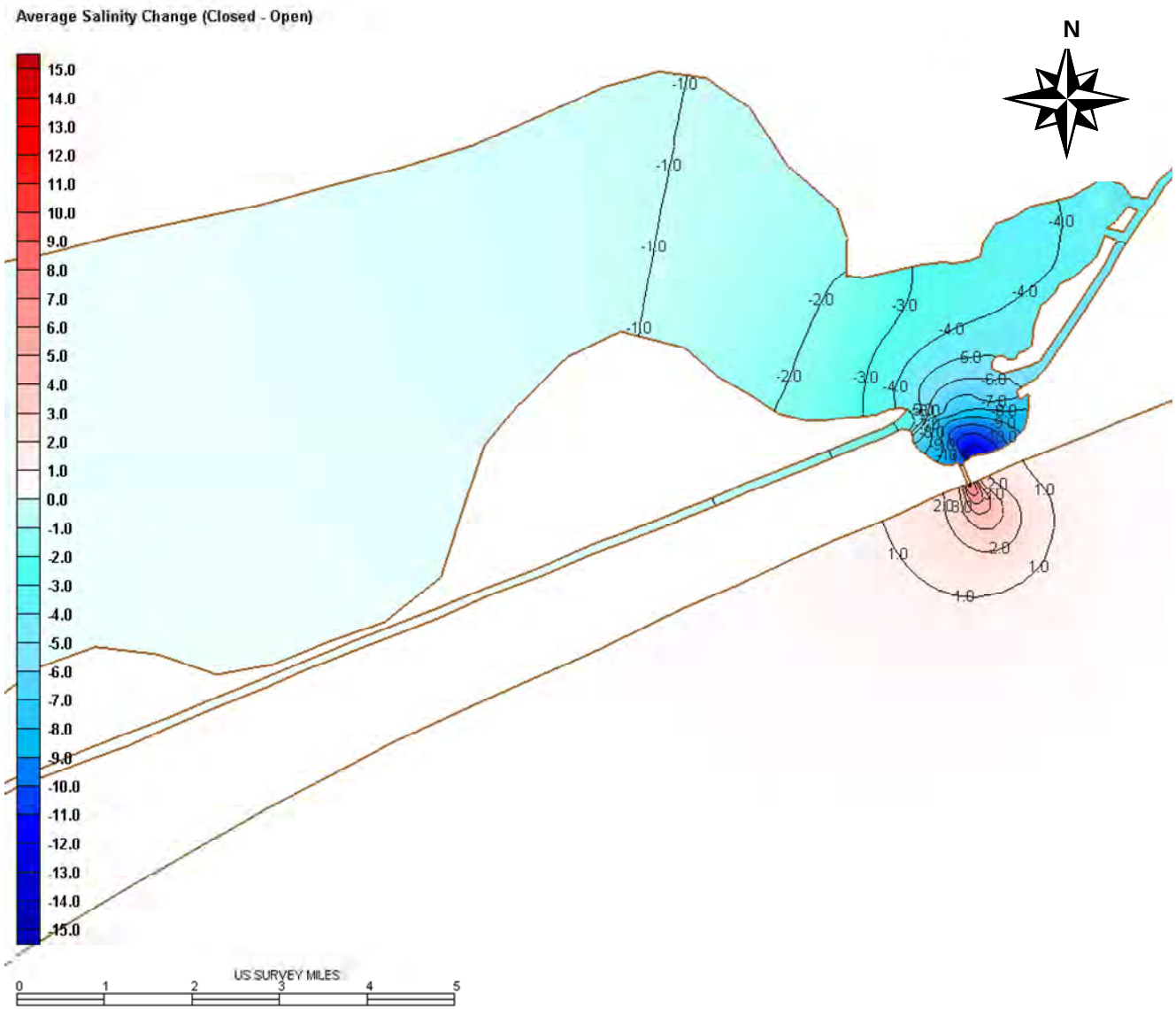


Figure 3.25 Contours of Average Salinity Change, Summer Year 2

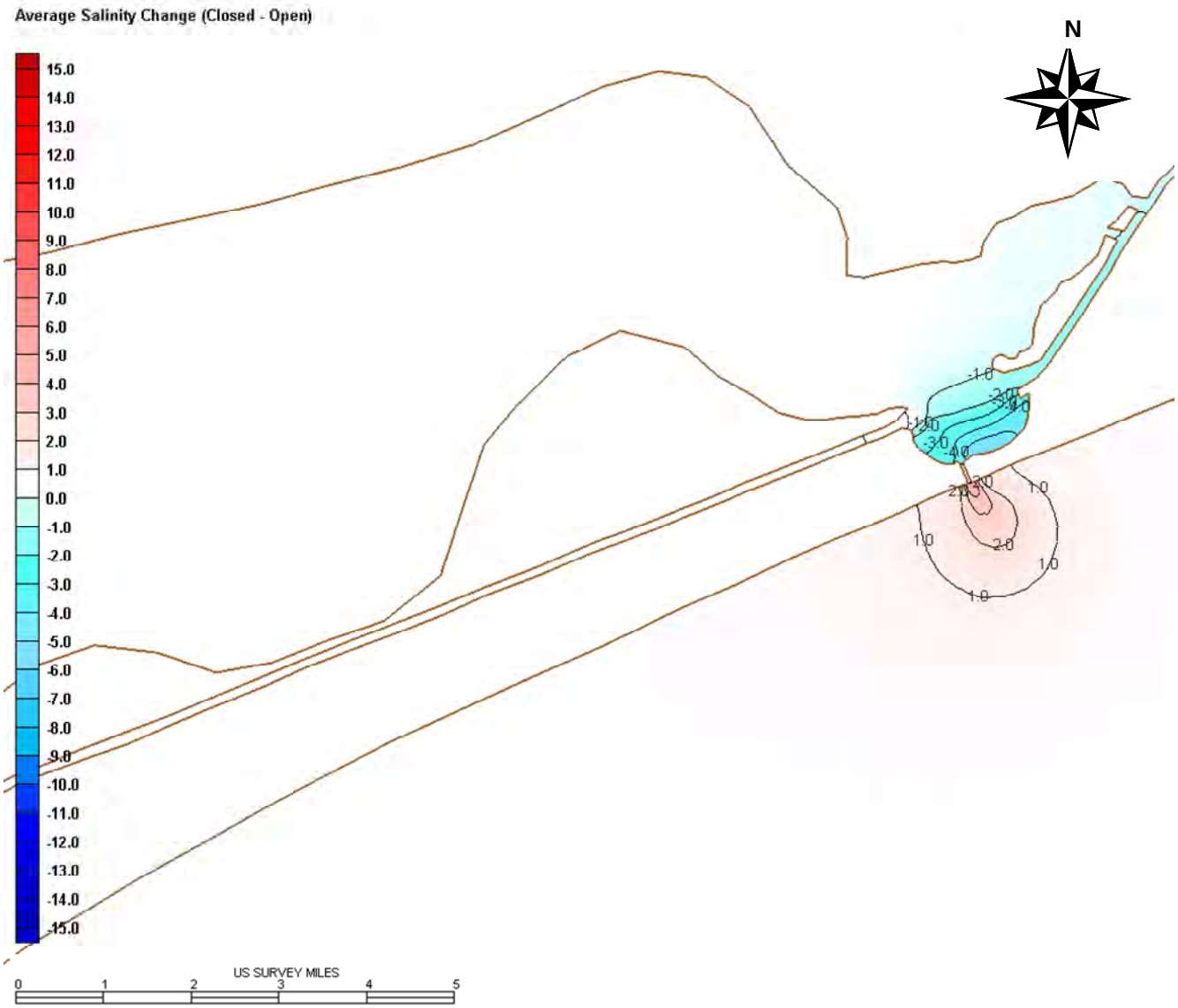


Figure 3.26 Contours of Average Salinity Change, Fall Year 2

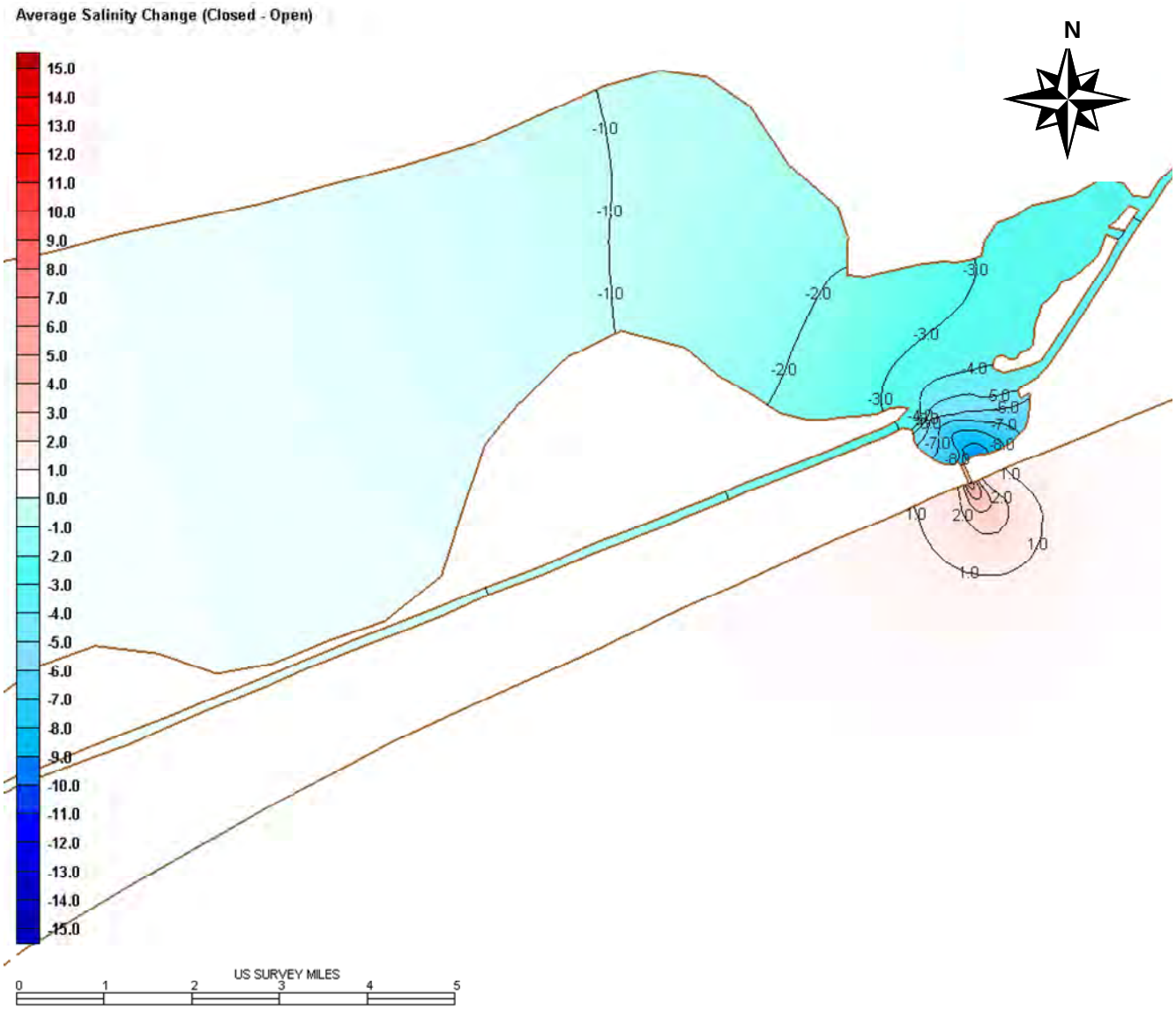


Figure 3.27 Contours of Average Salinity Change, Winter Year 2

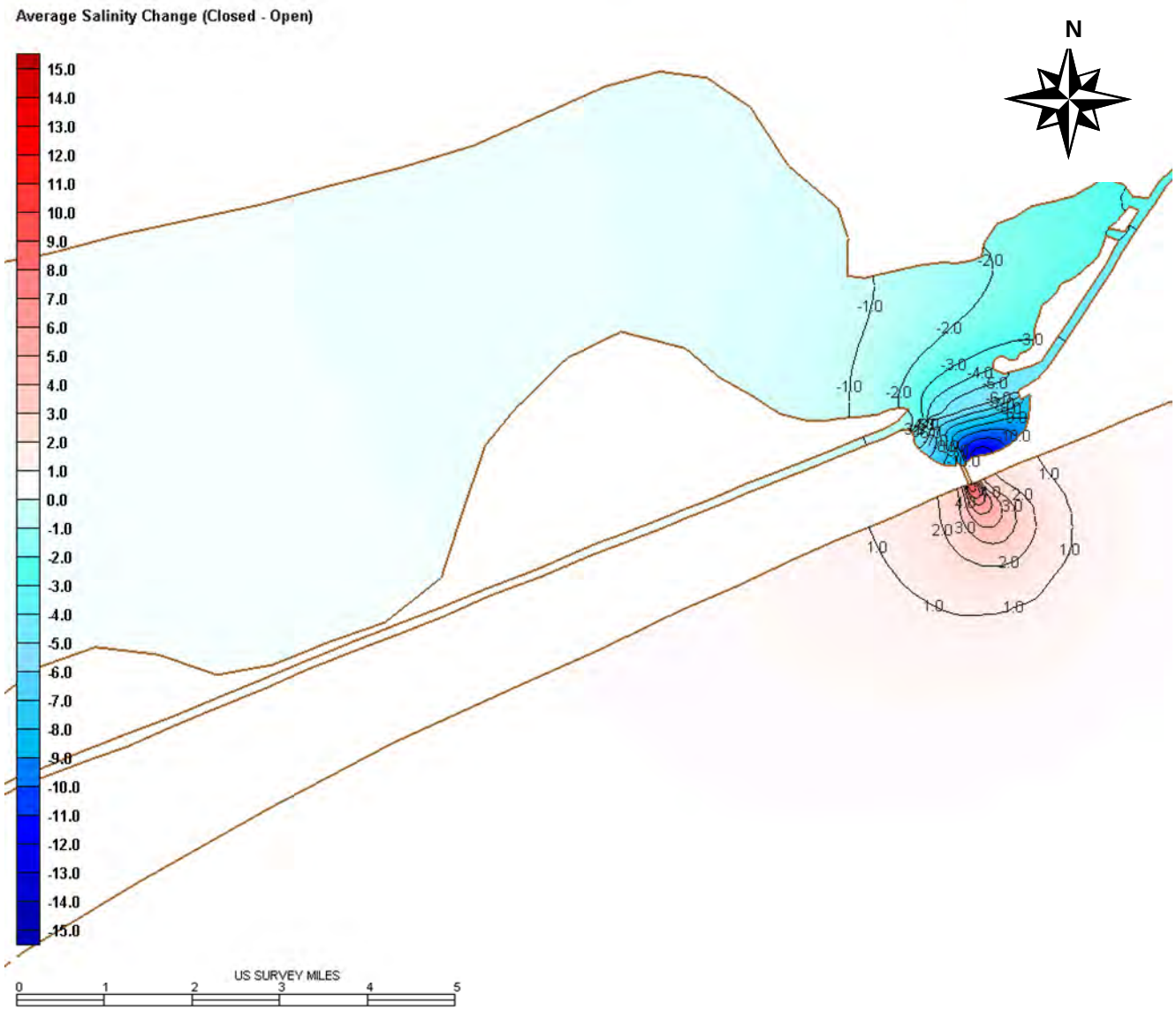


Figure 3.28 Contours of Average Salinity Change, Spring Year 2

4.0 SUMMARY

Overall, the effects on salinity of closing Rollover Pass appear greatest within Rollover Bay. Seasonally-averaged salinity in the Bay may drop as much as 9 – 10 ppt from existing conditions during most of the year. Rollover Bay should experience at least a 3 – 4 ppt drop in seasonally-averaged salinity throughout the year.

Within two miles of Rollover Bay, seasonally-averaged salinity may drop up to 2 – 4 ppt, but may experience no change from existing conditions during some portions of the typical year. Areas more than five – six miles from Rollover Pass should experience minimal changes (less than 2 ppt) in seasonally-averaged salinity.

REFERENCES

Arcement, G.J. and Schneider, V.R. 1989. *Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains*, United States Geological Survey Water-Supply Paper 2339 (WSP2339).

Chow, V. T. 1959. *Open-Channel Hydraulics.* McGraw-Hill, Inc. New York.

Donnell, Barbara P., Letter, Joseph V., MacAnaaly, William H., and Thomas, William A. 2005. *Users Guide to RMA2 Version 4.5*. U.S. Army, Engineer Research and Development Center, Waterways Experiment Station, Coastal and Hydraulics Laboratory. Vicksburg, MS.

Donnell, Barbara P., Letter Joseph V. 2003. *Users Guide to RMA4 Version 4.5*. U.S. Army, Engineer Research and Development Center, Waterways Experiment Station, Coastal and Hydraulics Laboratory. Vicksburg, MS.

Matsumoto, J., Powell, G.L., Brock, D.A., and Paternostro, C. 2005. *Effects of Structures and Practices on the Circulation and Salinity Patterns of Galveston Bay, Texas.* Report to the Texas Water Development Board, Austin, Texas, February, 2005.

APPENDIX A

Salinity Variation with Time Plots

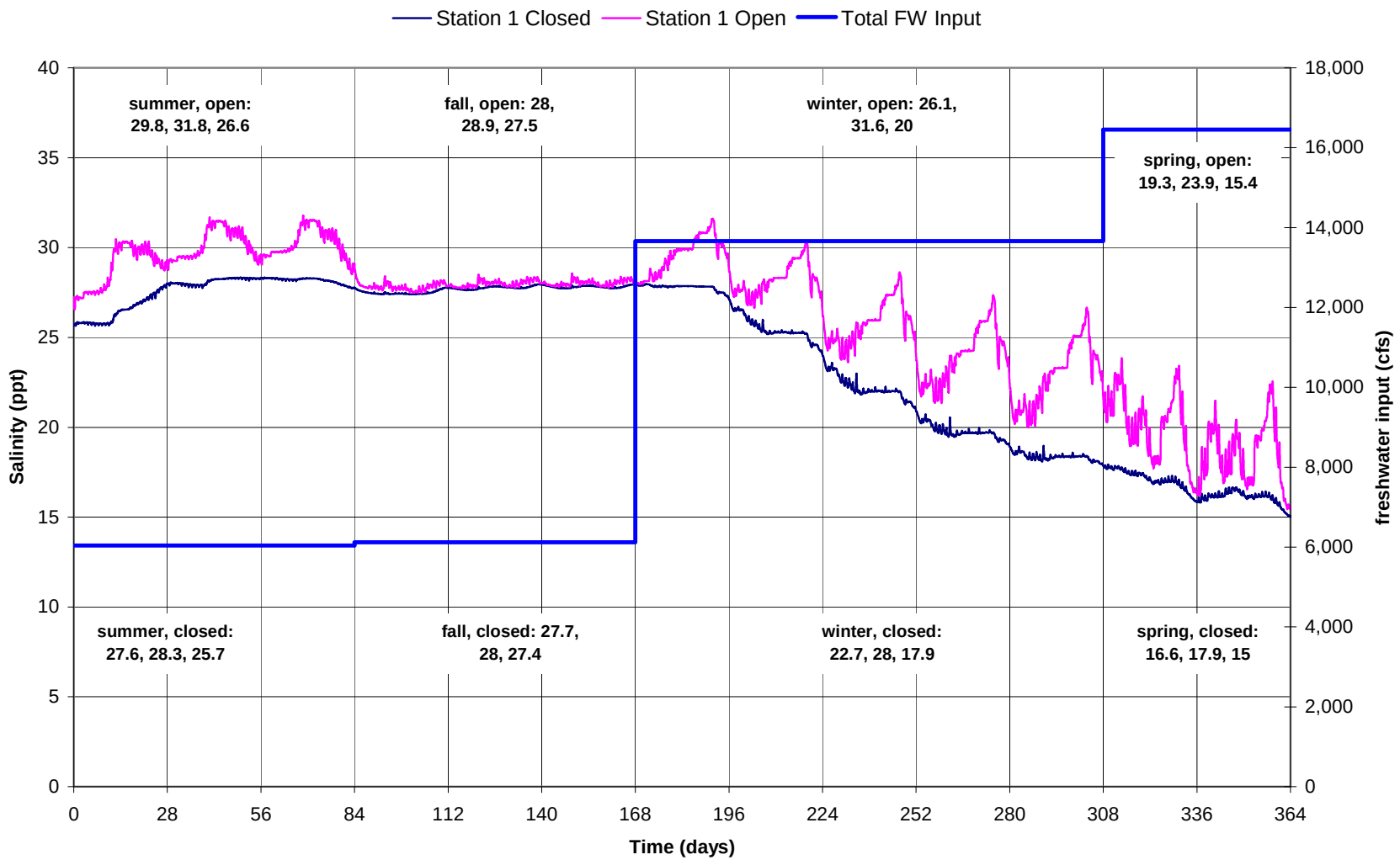


Figure A1 Salinity Variation with Time, Station 1, Year 1

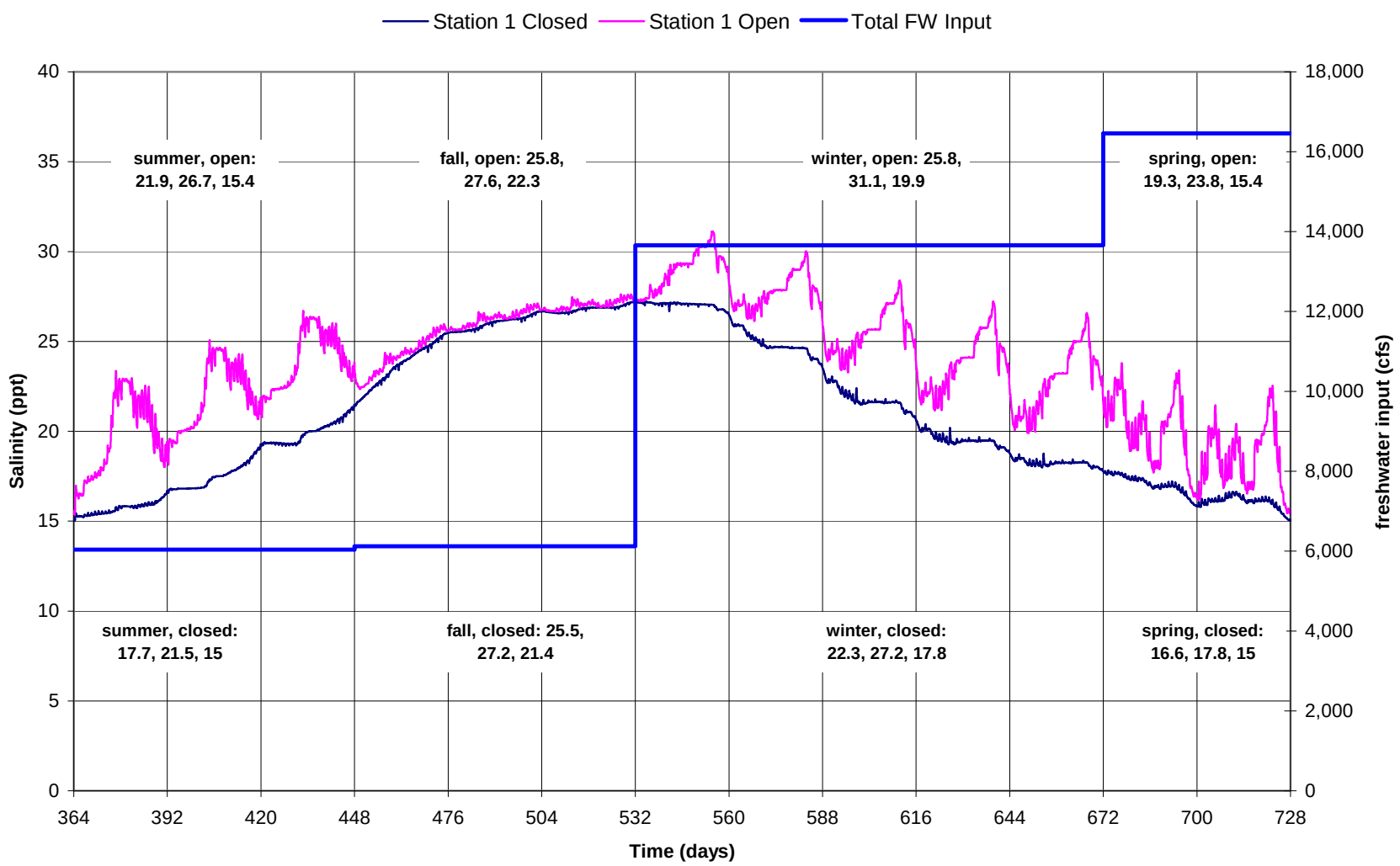


Figure A2 Salinity Variation with Time, Station 1, Year 2

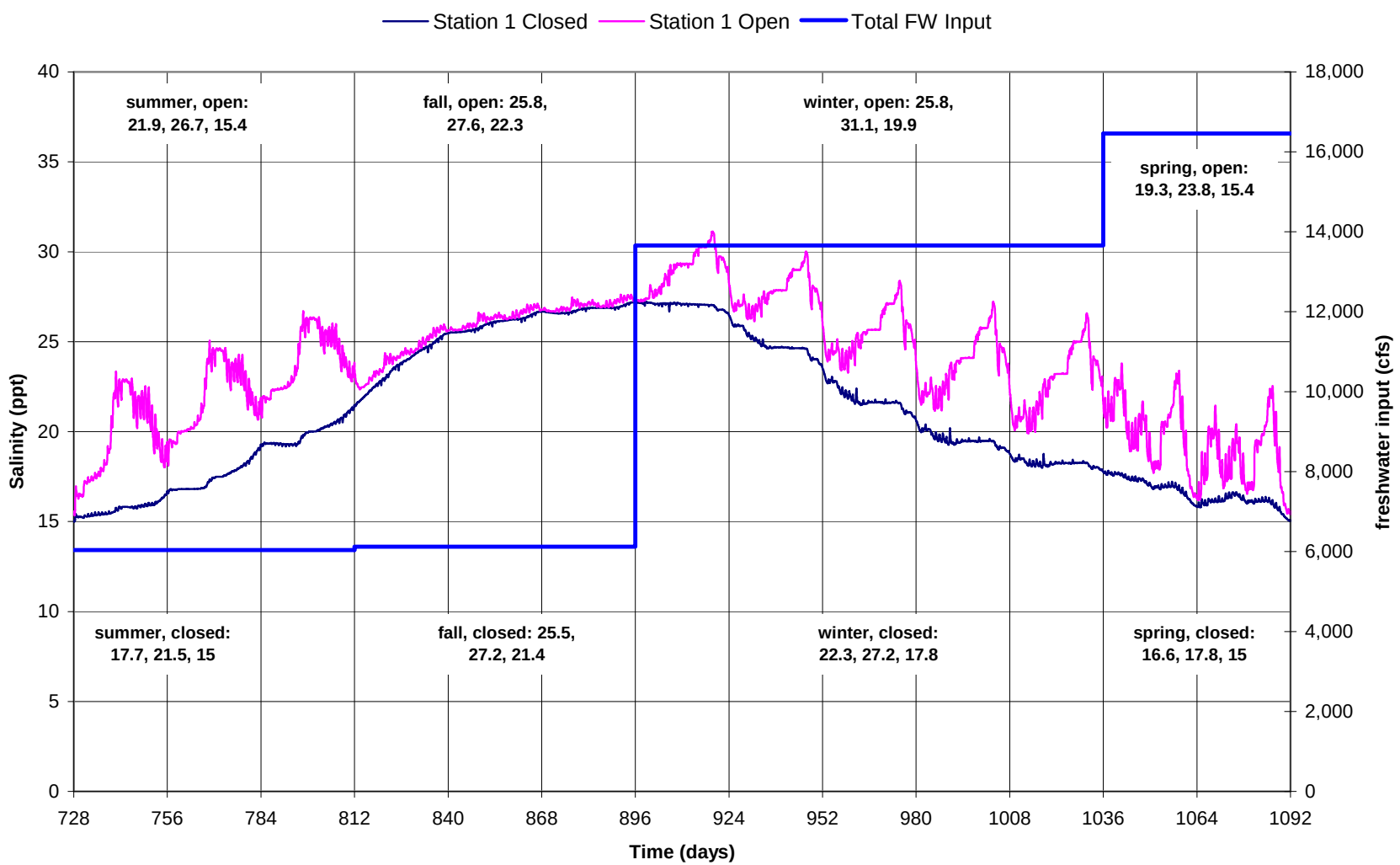


Figure A3 Salinity Variation with Time, Station 1, Year 3

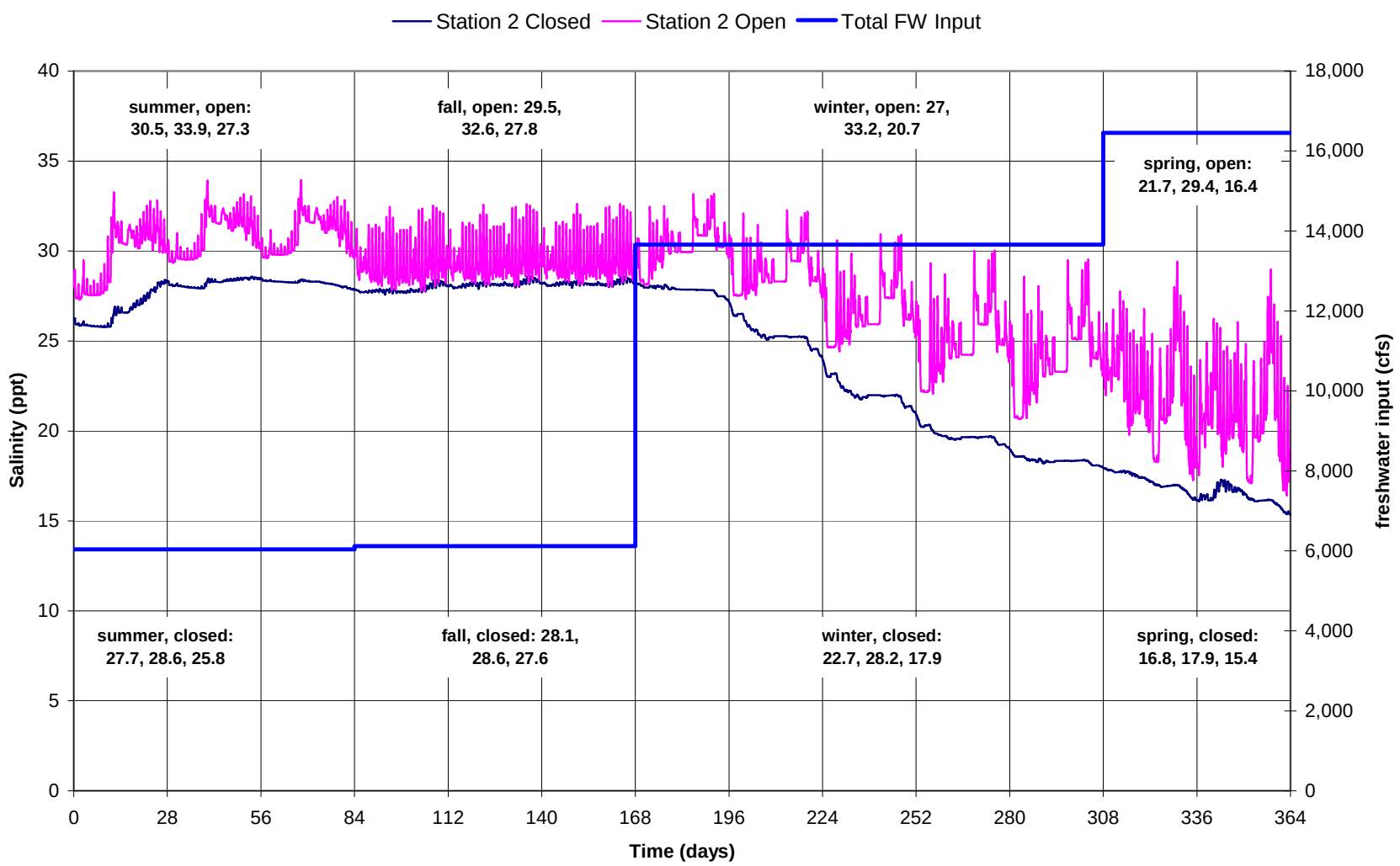


Figure A4 Salinity Variation with Time, Station 2, Year 1

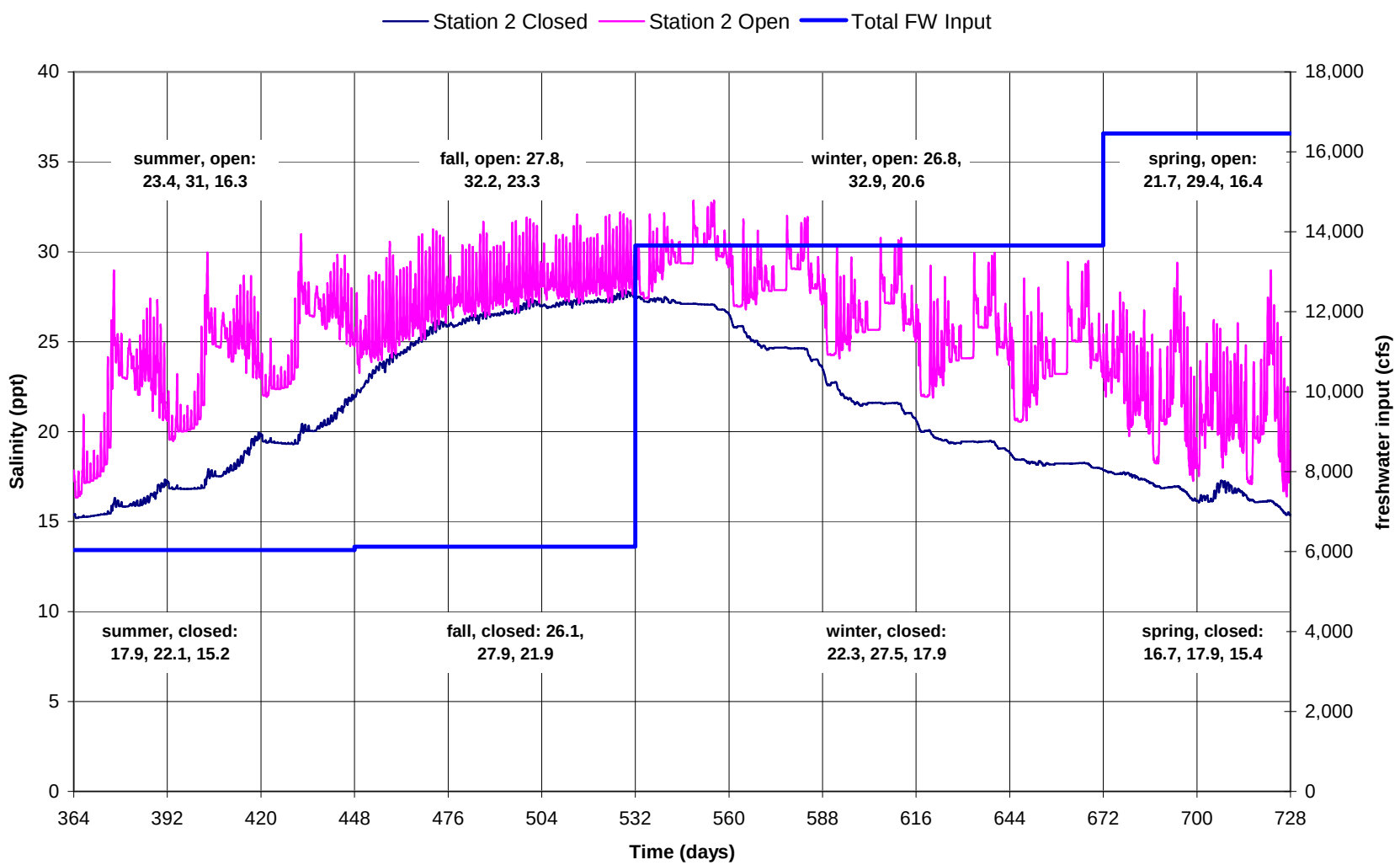


Figure A5 Salinity Variation with Time, Station 2, Year 2

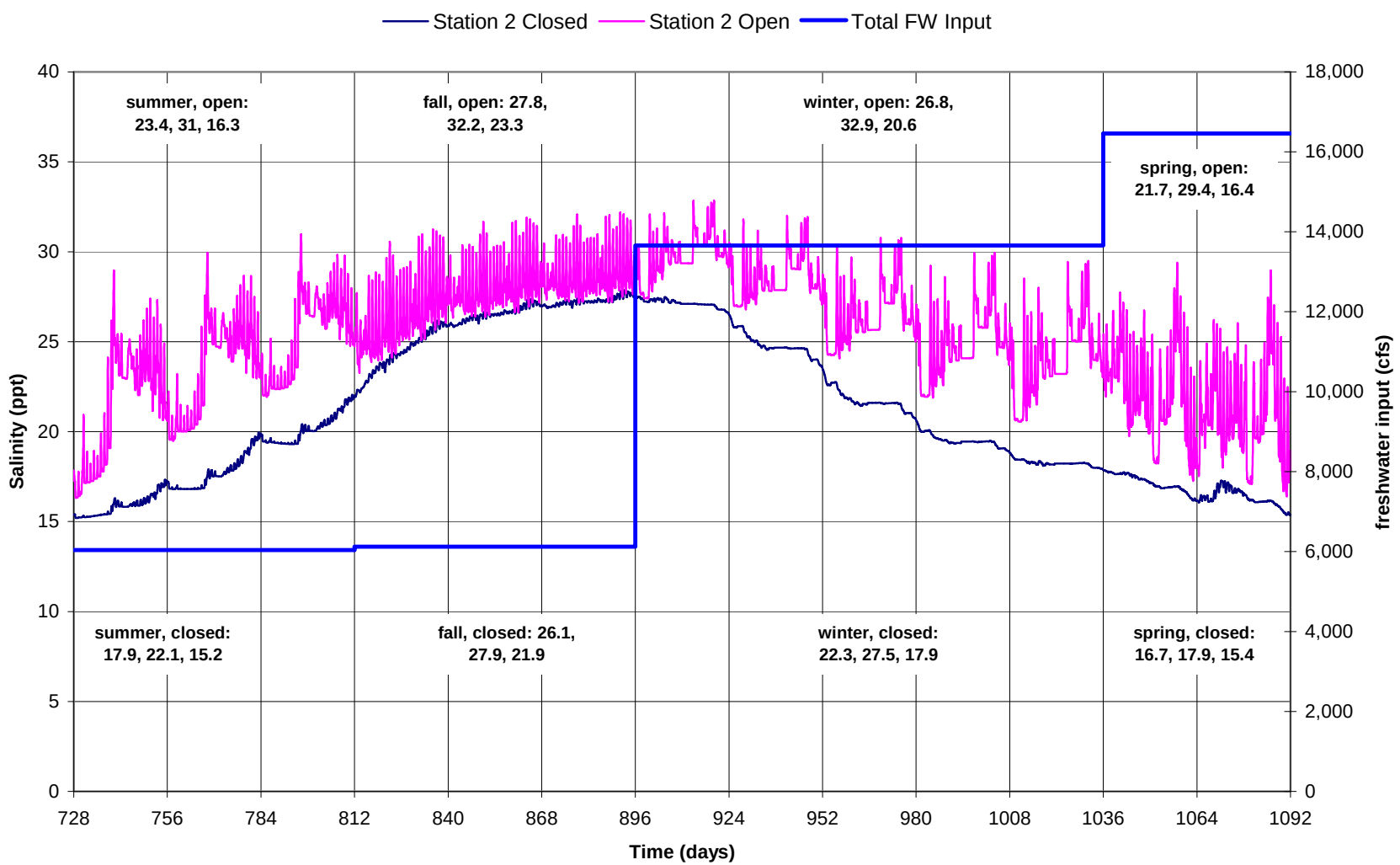


Figure A6 Salinity Variation with Time, Station 2, Year 3

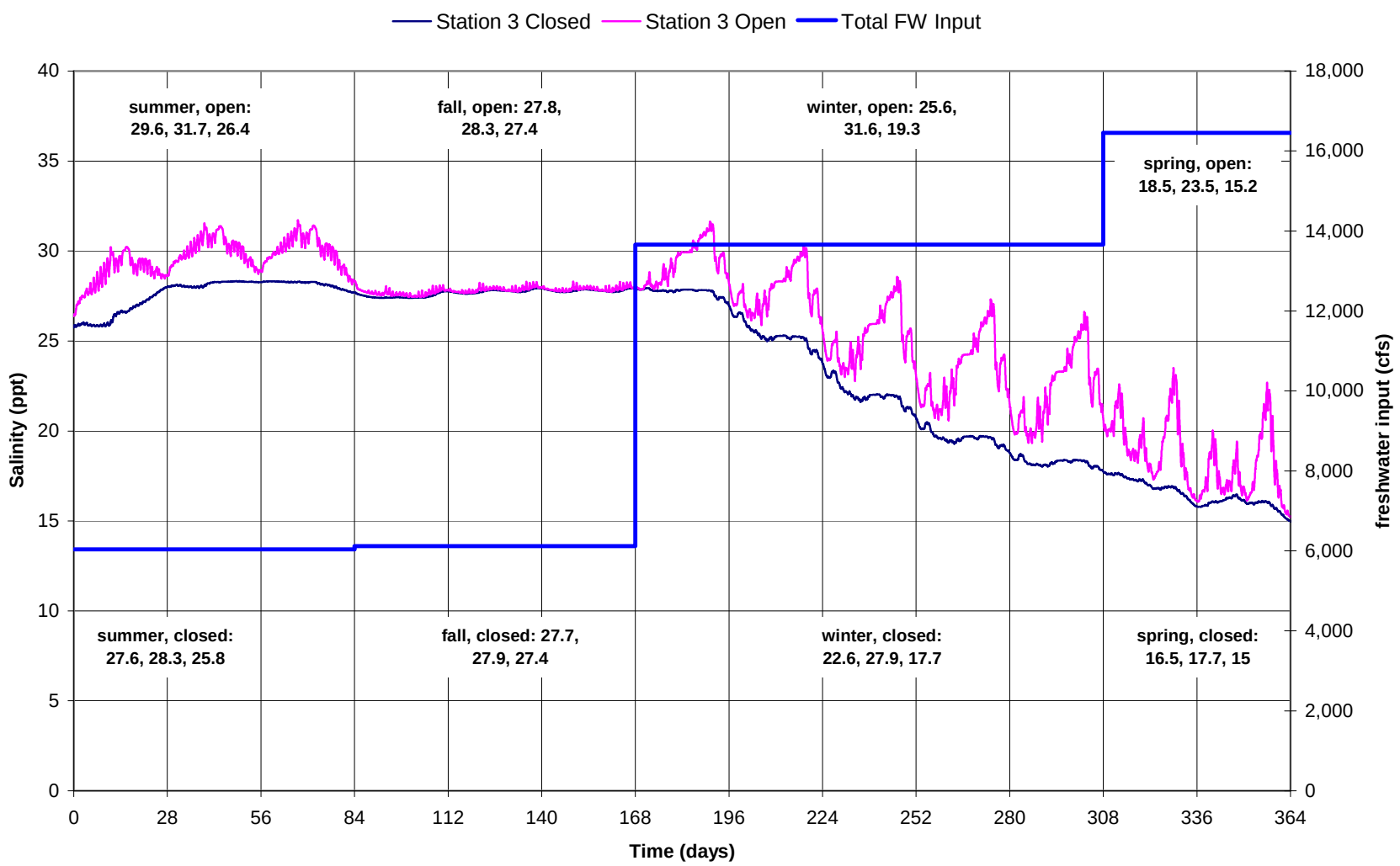


Figure A7 Salinity Variation with Time, Station 3, Year 1

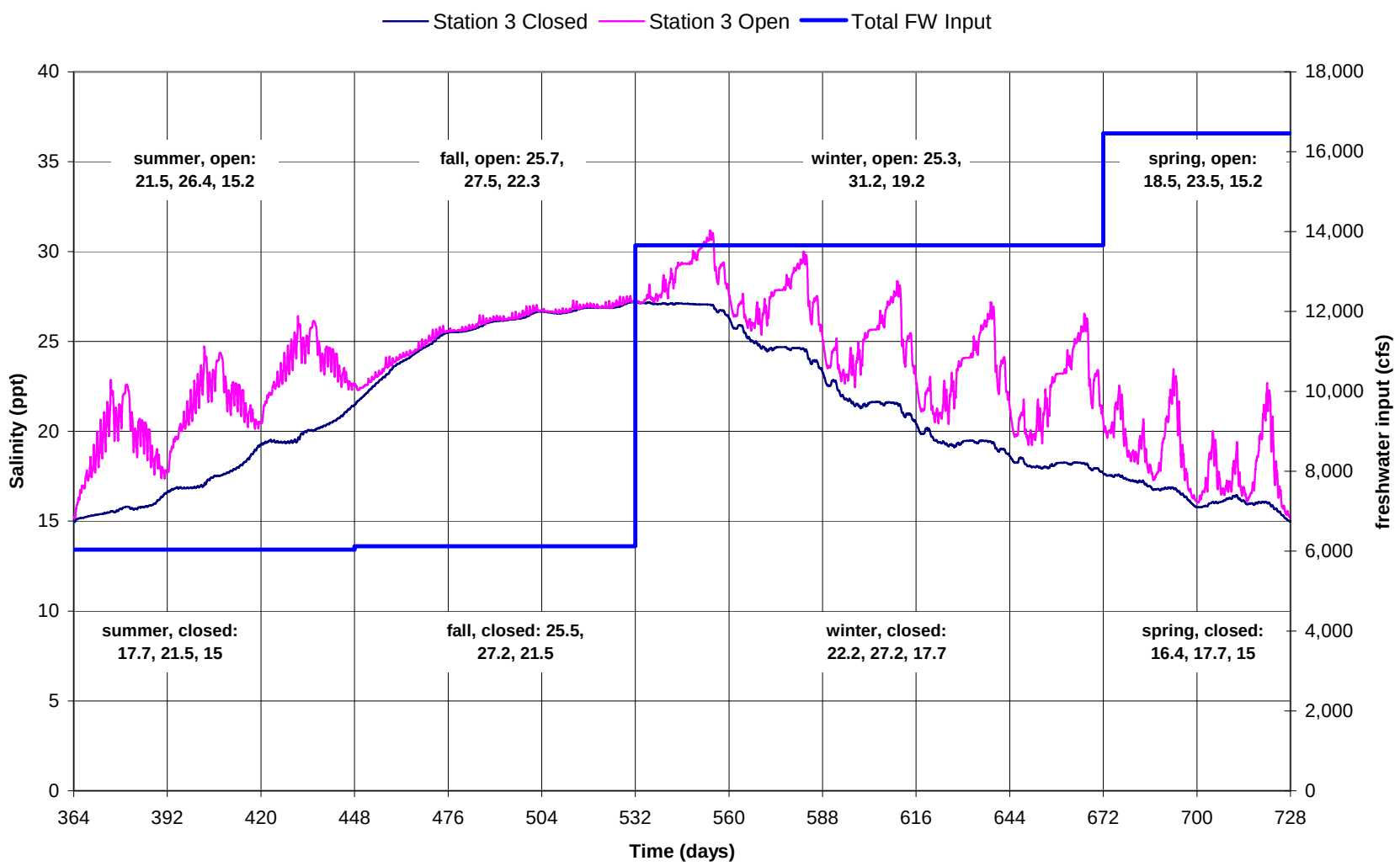


Figure A8 Salinity Variation with Time, Station 3, Year 2

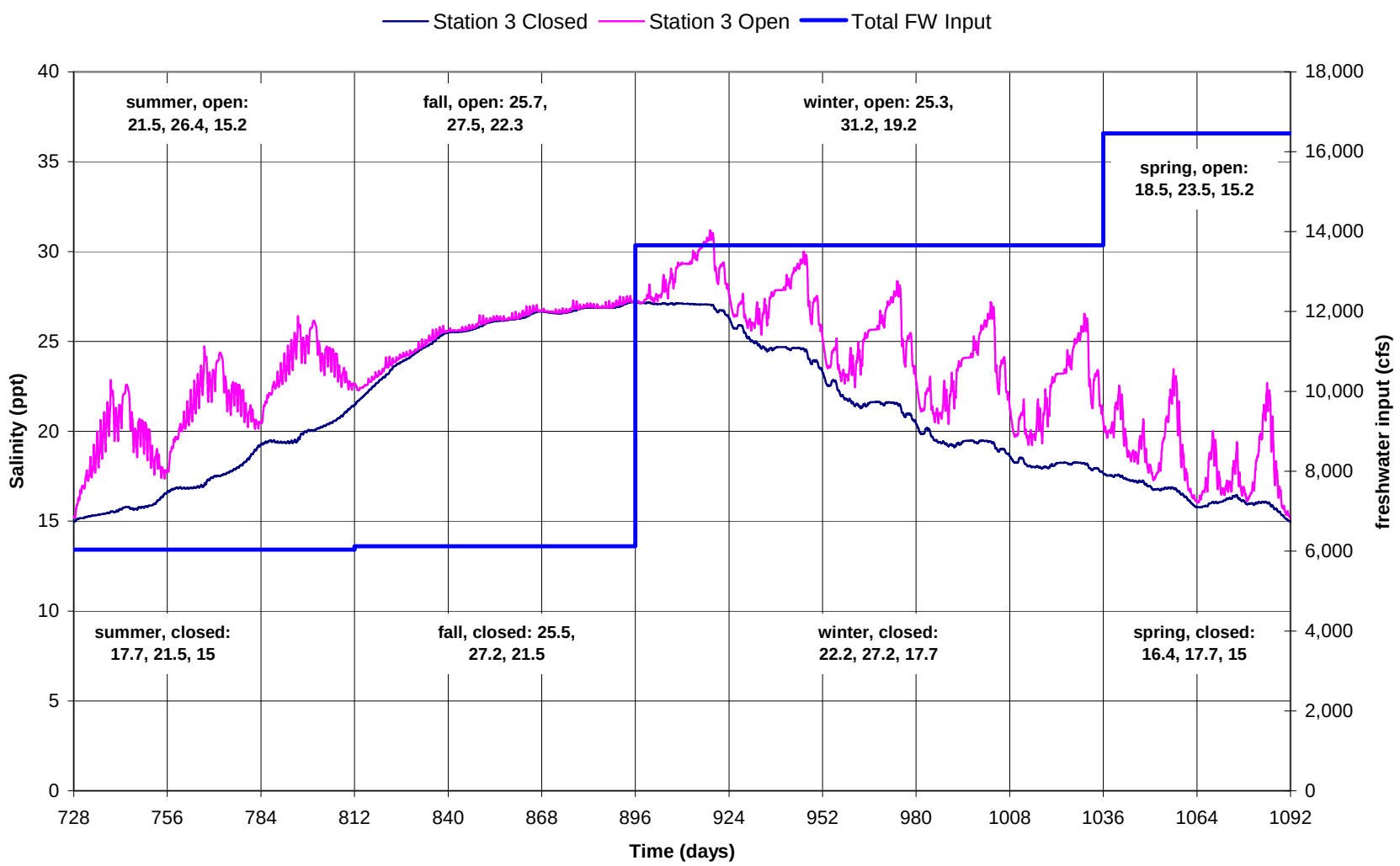


Figure A9 Salinity Variation with Time, Station 3, Year 3

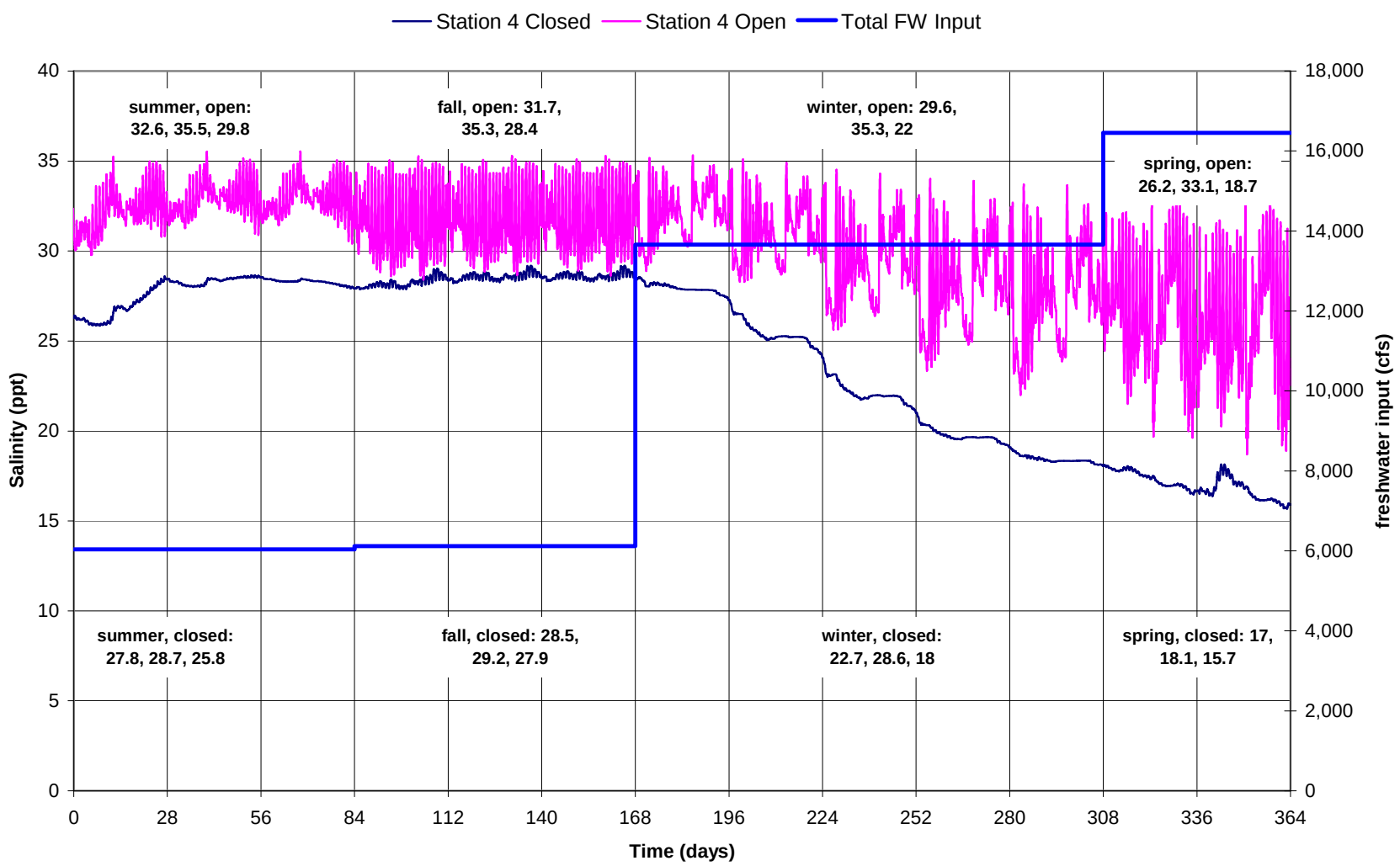


Figure A10 Salinity Variation with Time, Station 4, Year 1

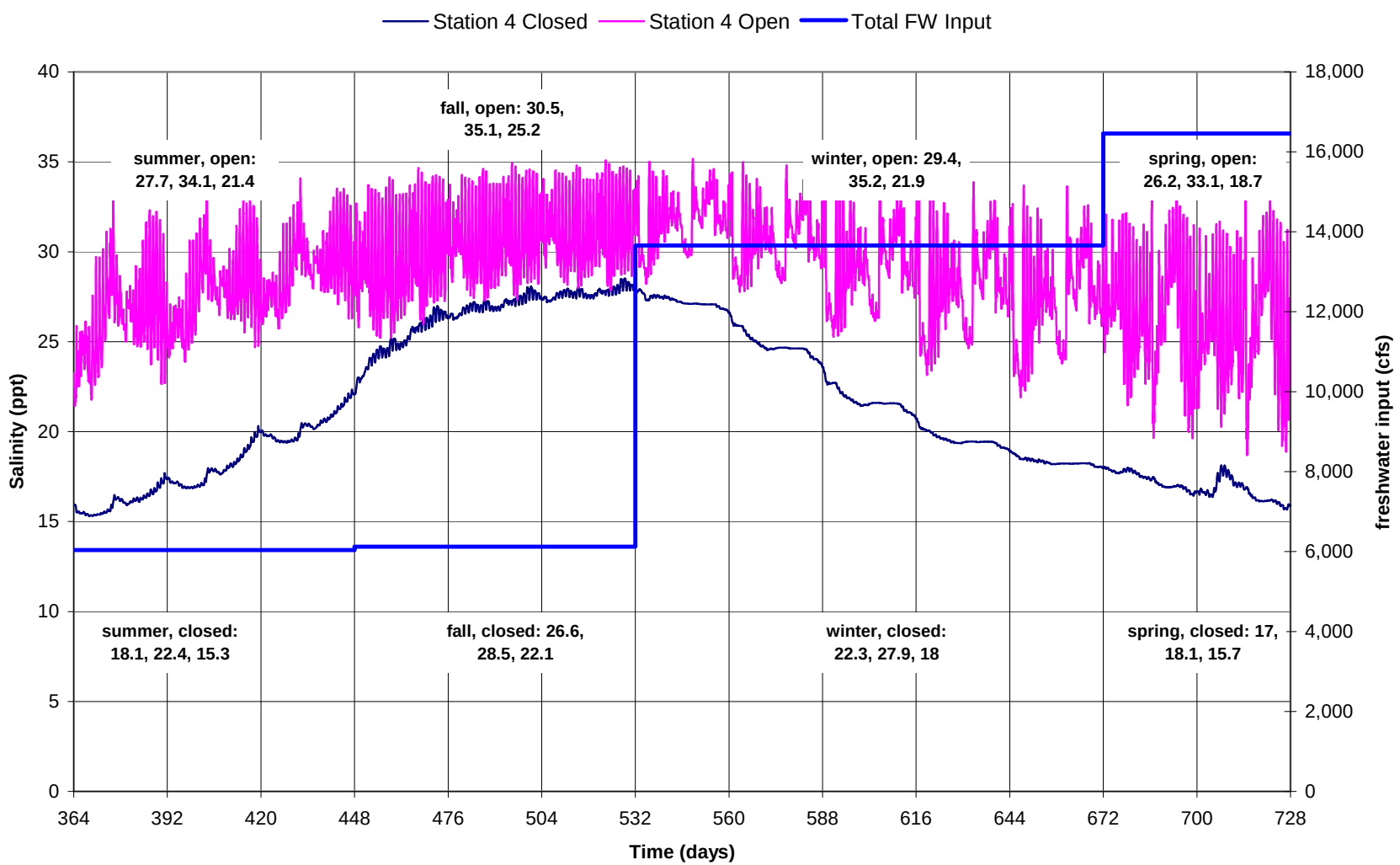


Figure A11 Salinity Variation with Time, Station 4, Year 2

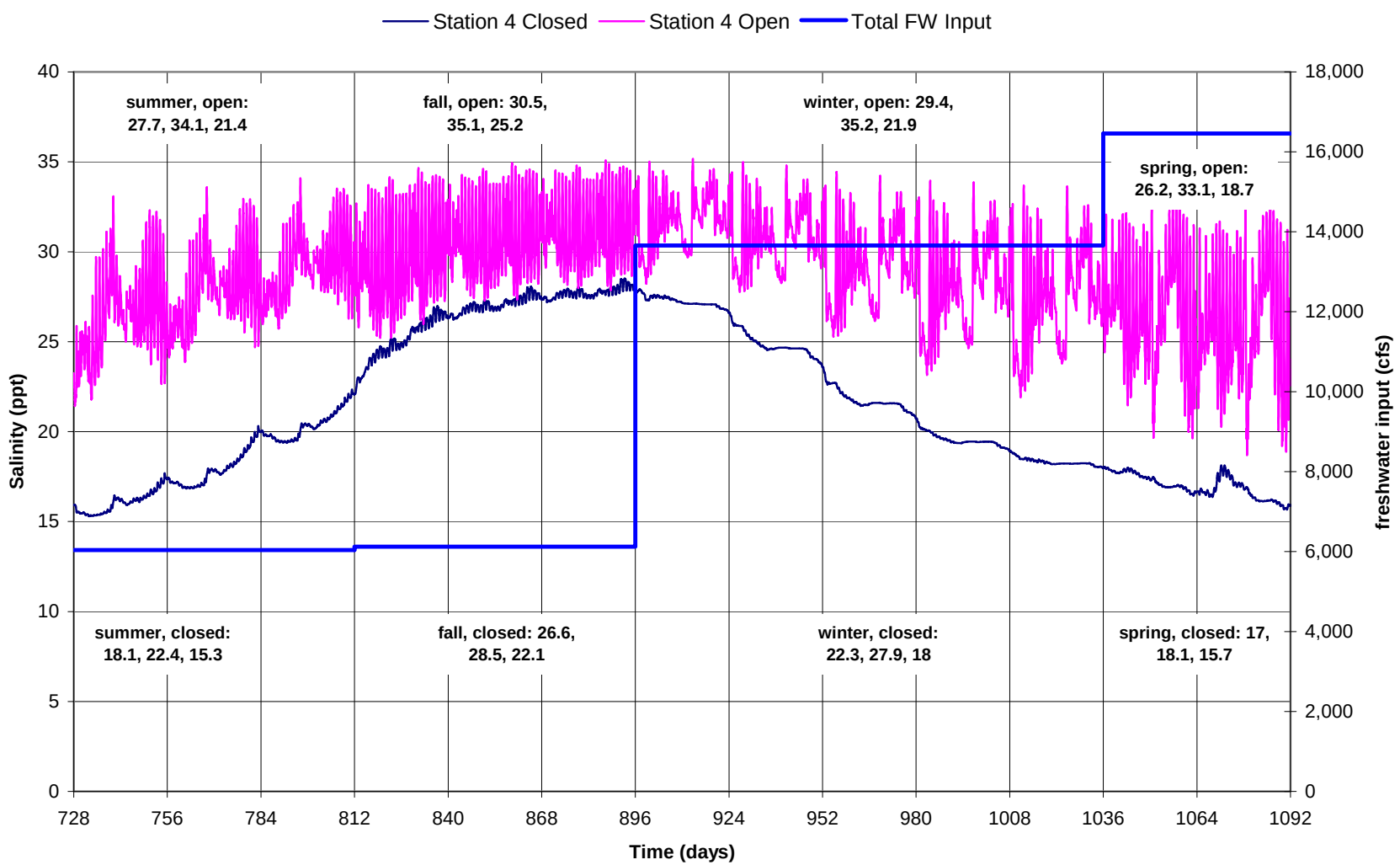


Figure A12 Salinity Variation with Time, Station 4, Year 3

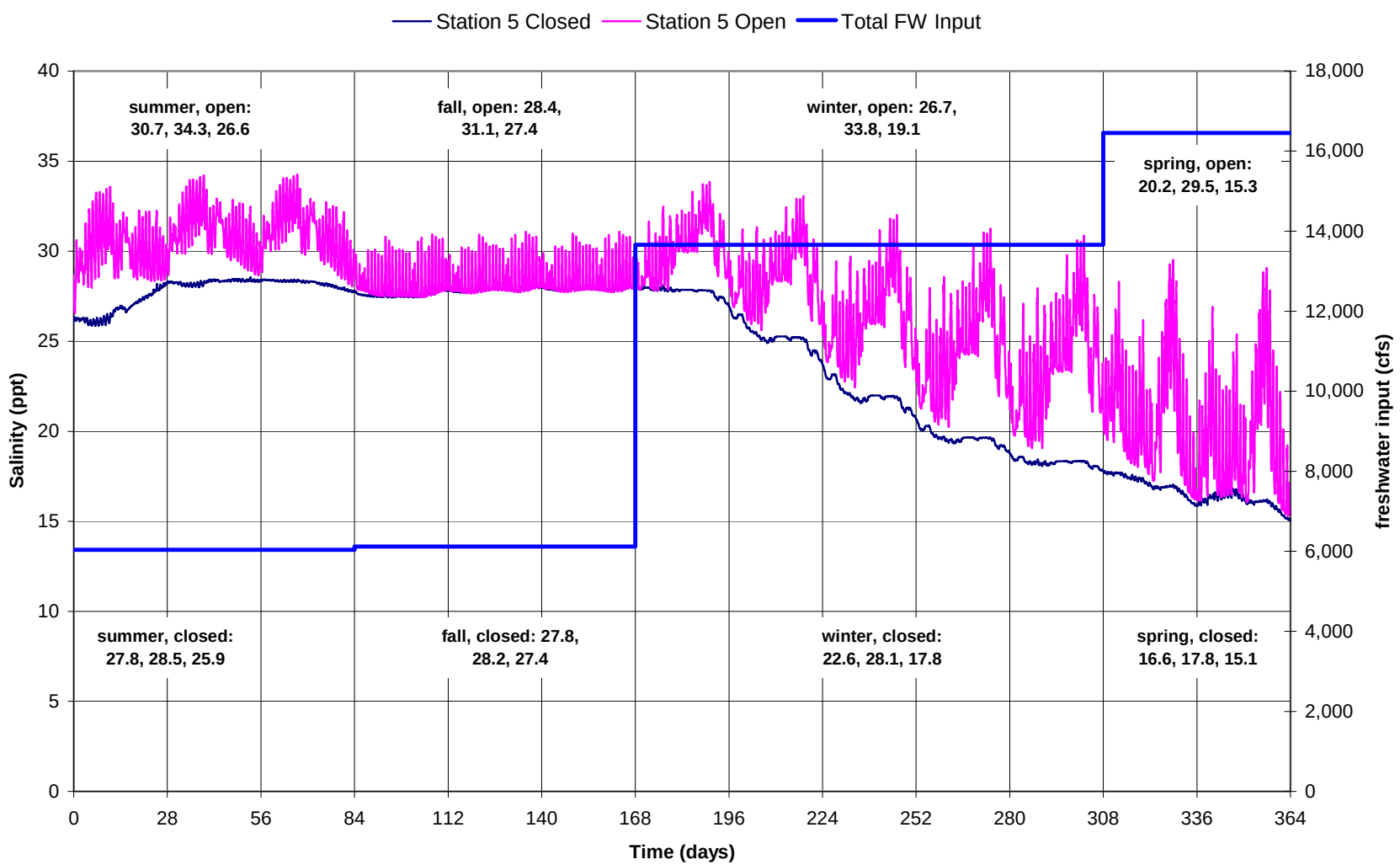


Figure A13 Salinity Variation with Time, Station 5, Year 1

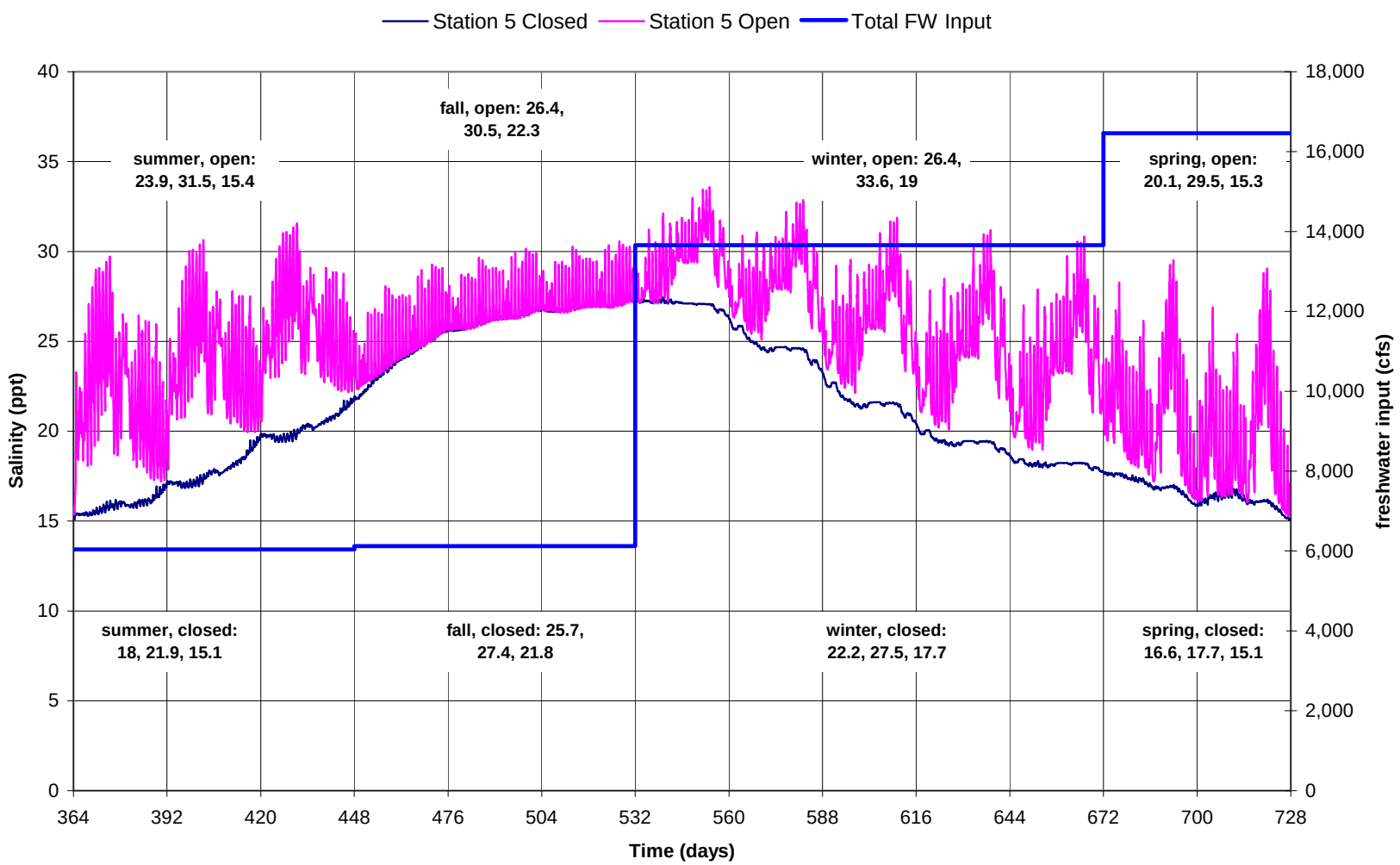


Figure A14 Salinity Variation with Time, Station 5, Year 2

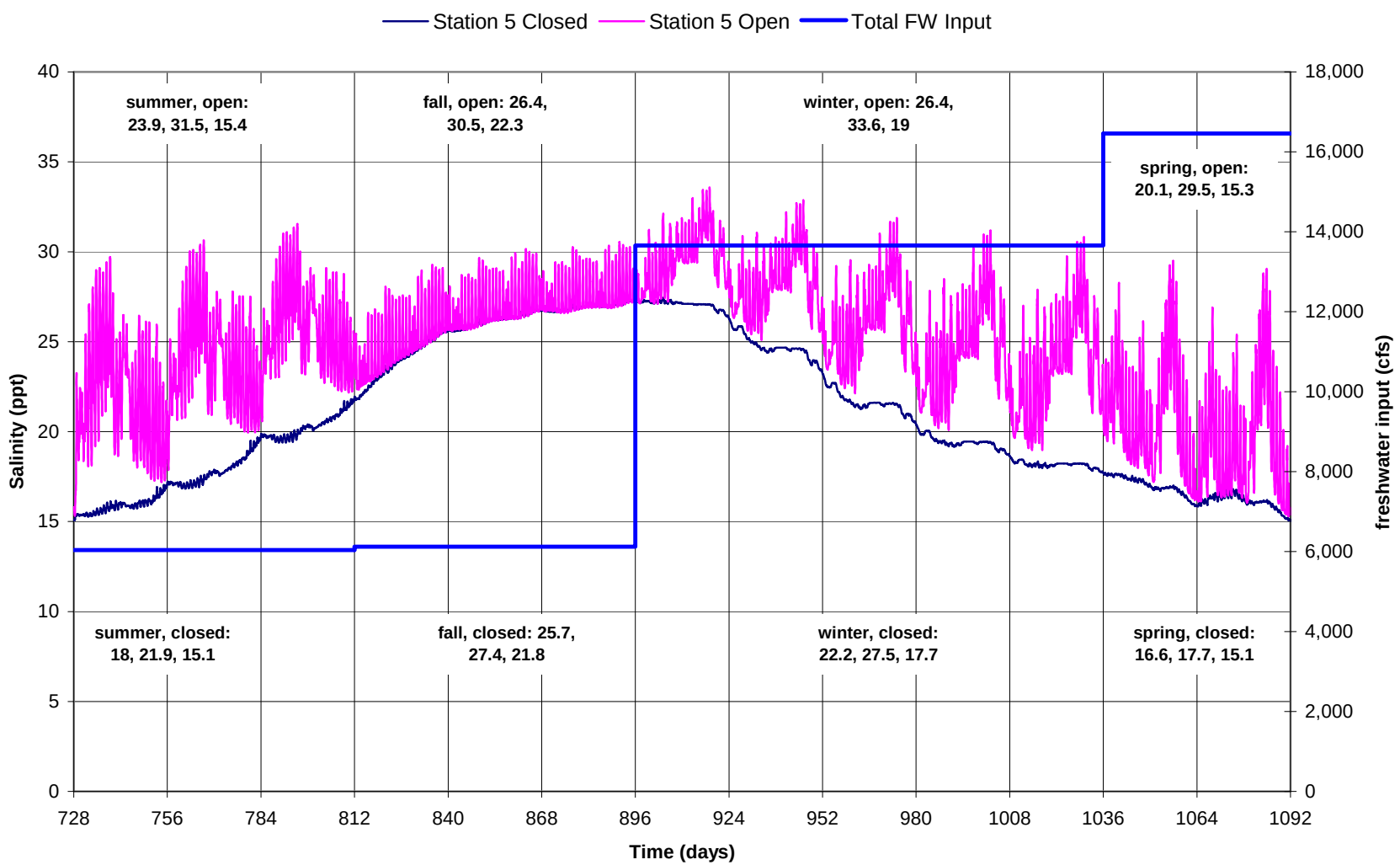


Figure A15 Salinity Variation with Time, Station 5, Year 3

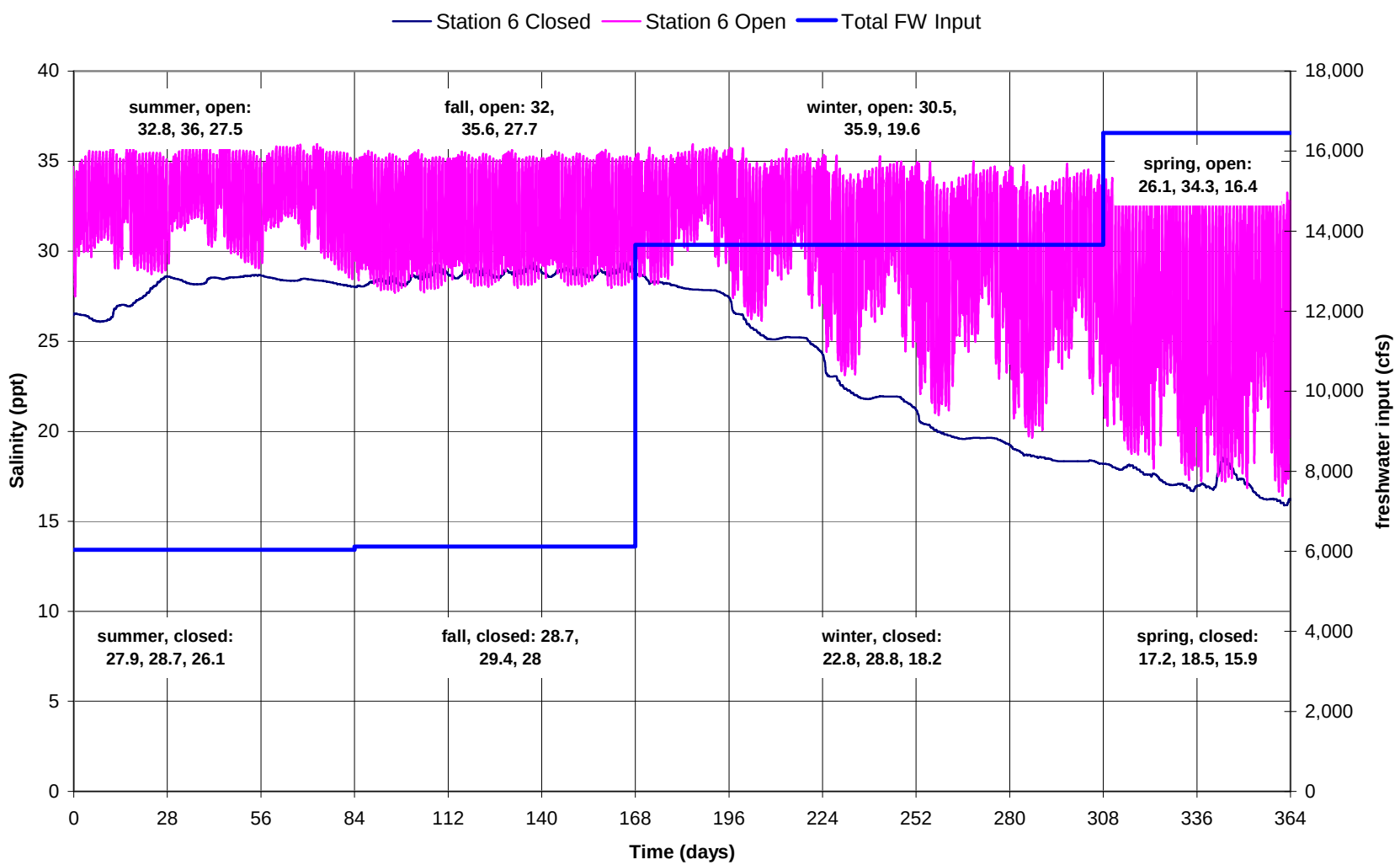


Figure A16 Salinity Variation with Time, Station 6, Year 1

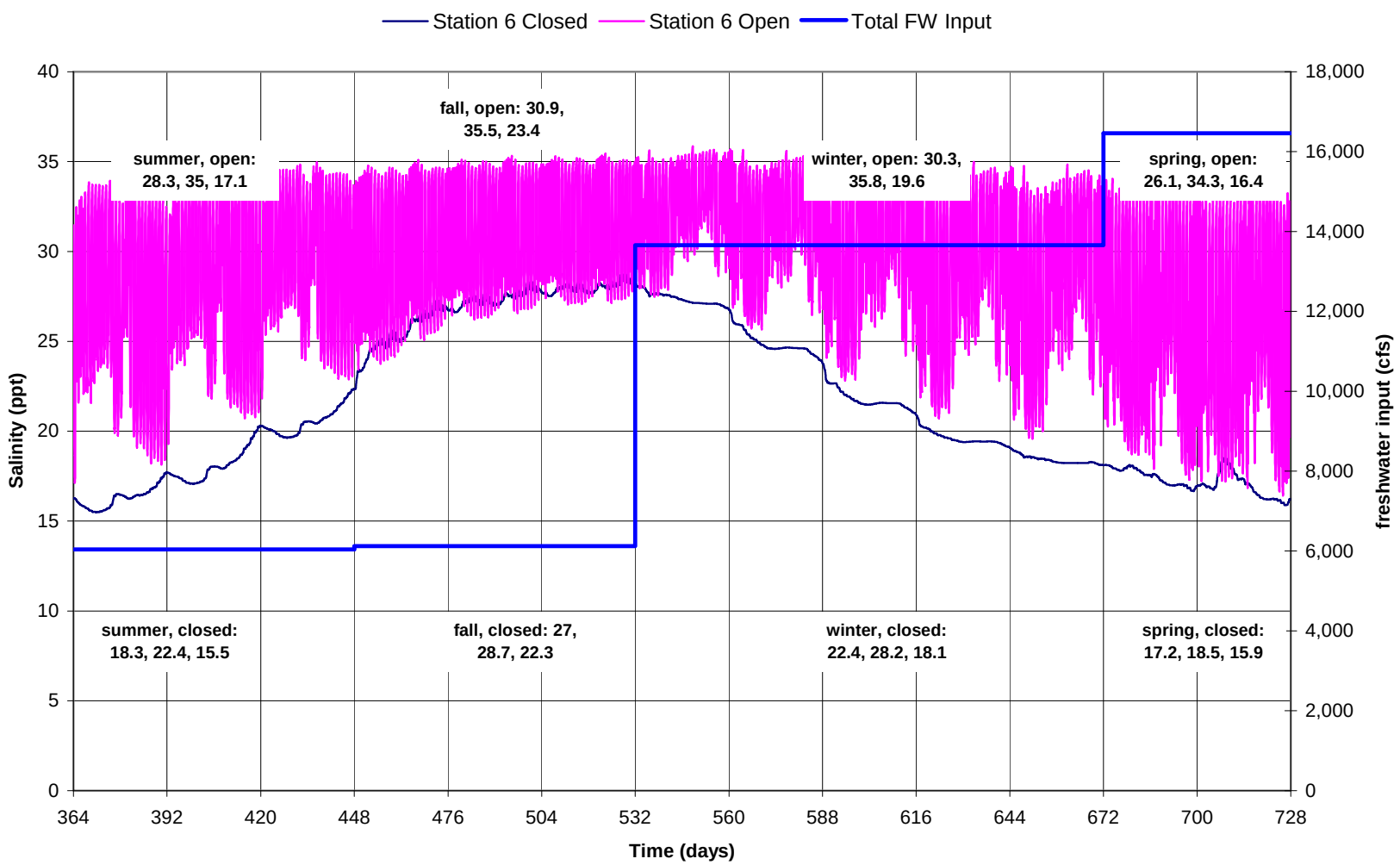


Figure A17 Salinity Variation with Time, Station 6, Year 2

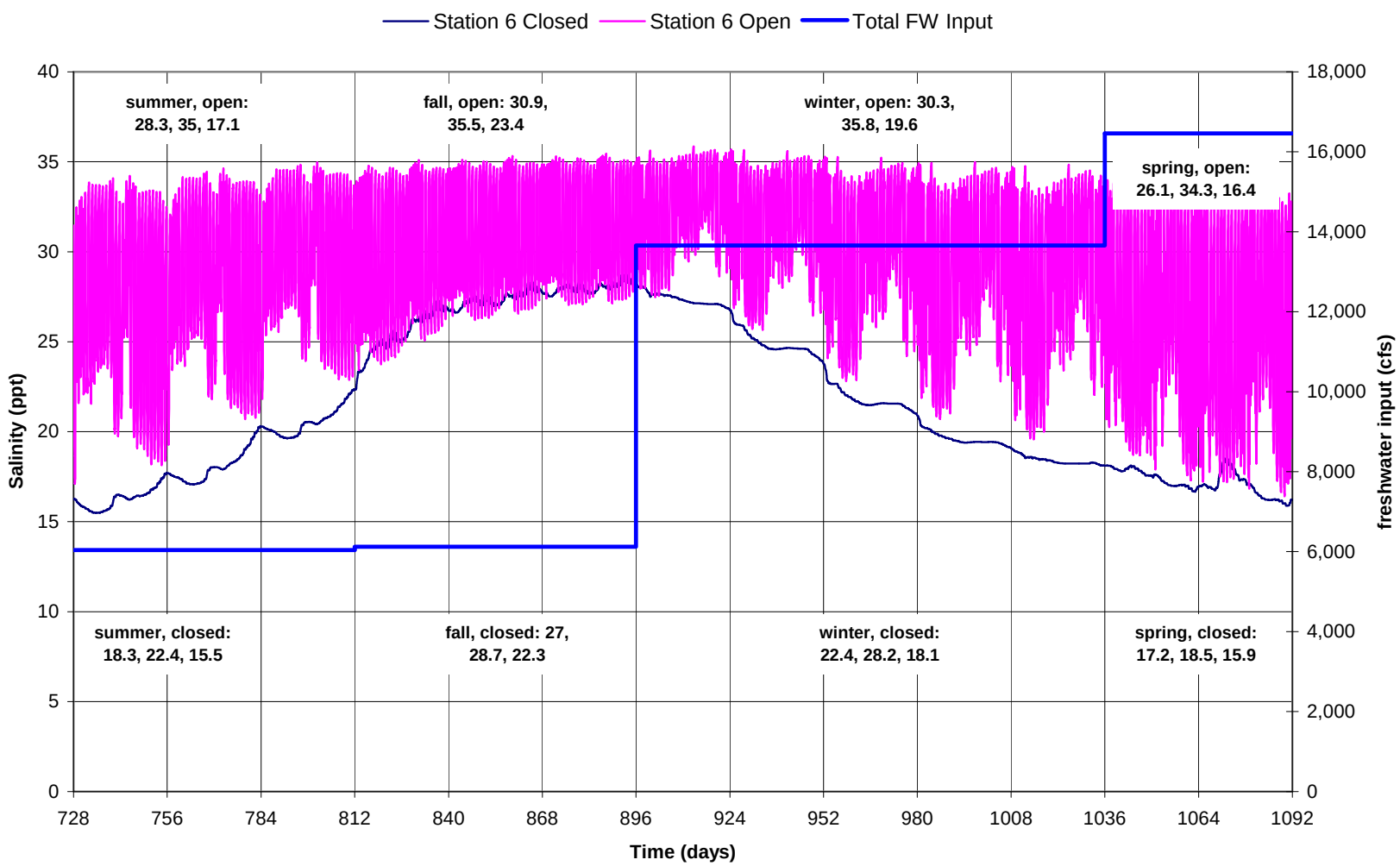


Figure A18 Salinity Variation with Time, Station 6, Year 3

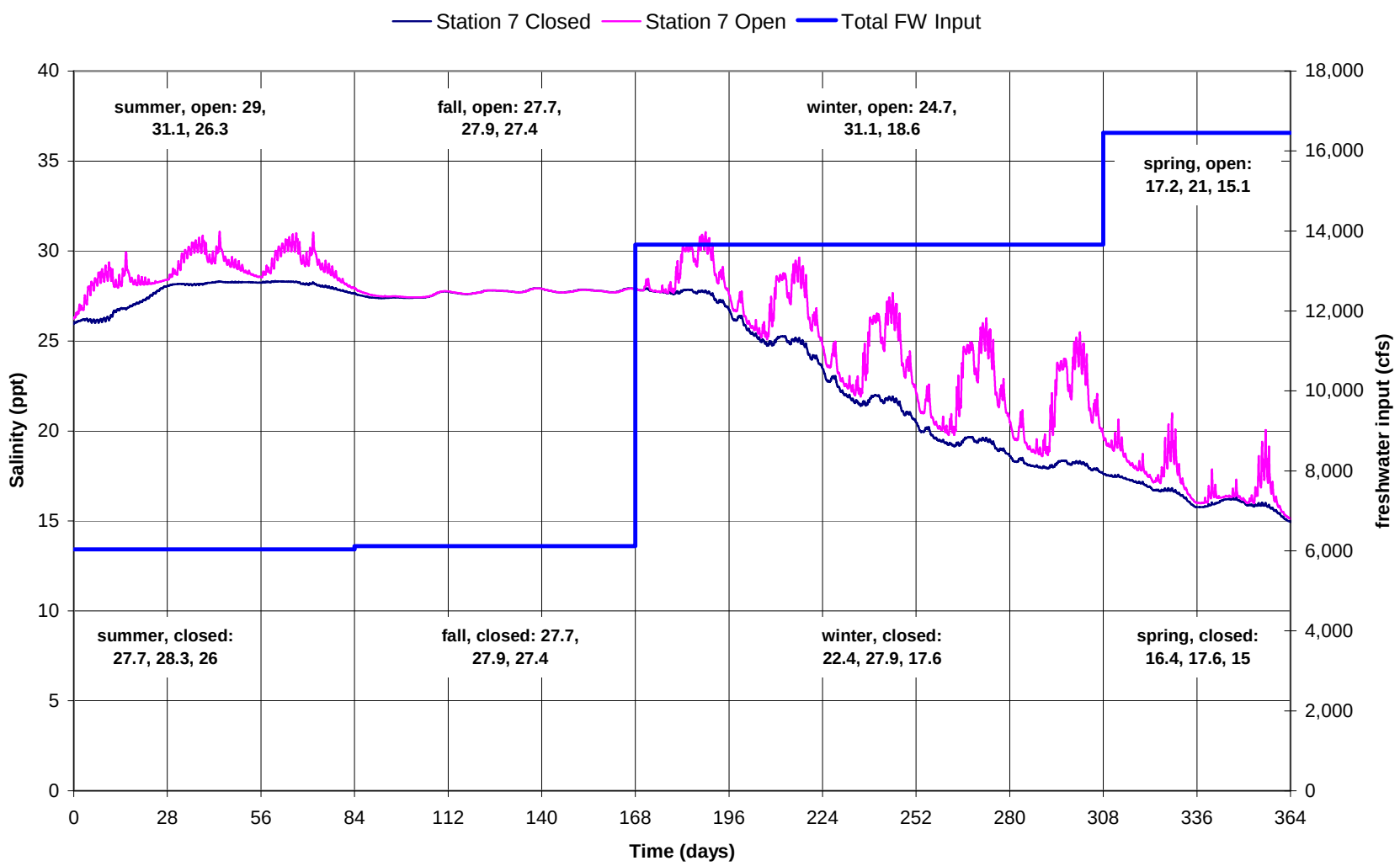


Figure A19 Salinity Variation with Time, Station 7, Year 1

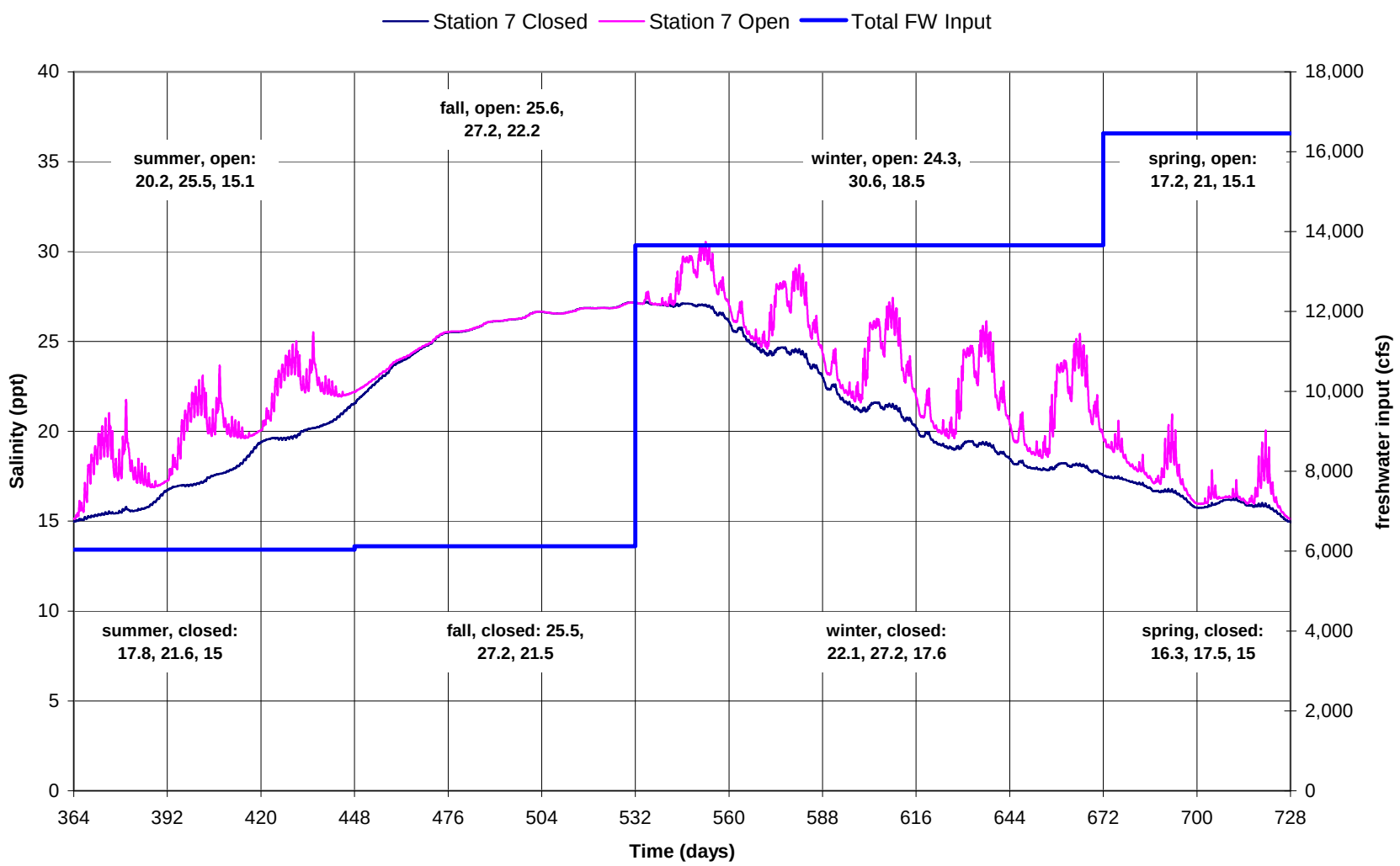


Figure A20 Salinity Variation with Time, Station 7, Year 2

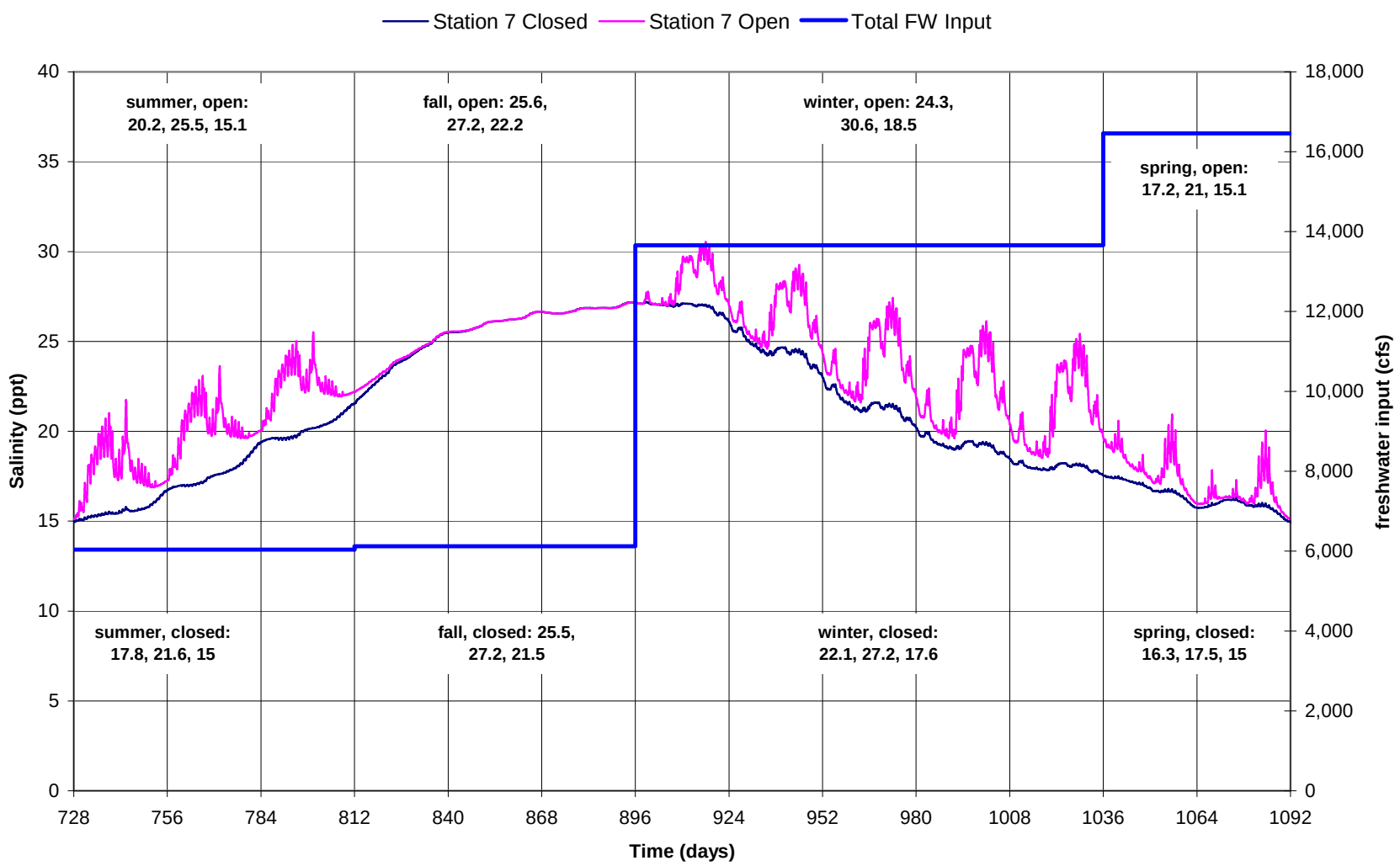


Figure A21 Salinity Variation with Time, Station 7, Year 3

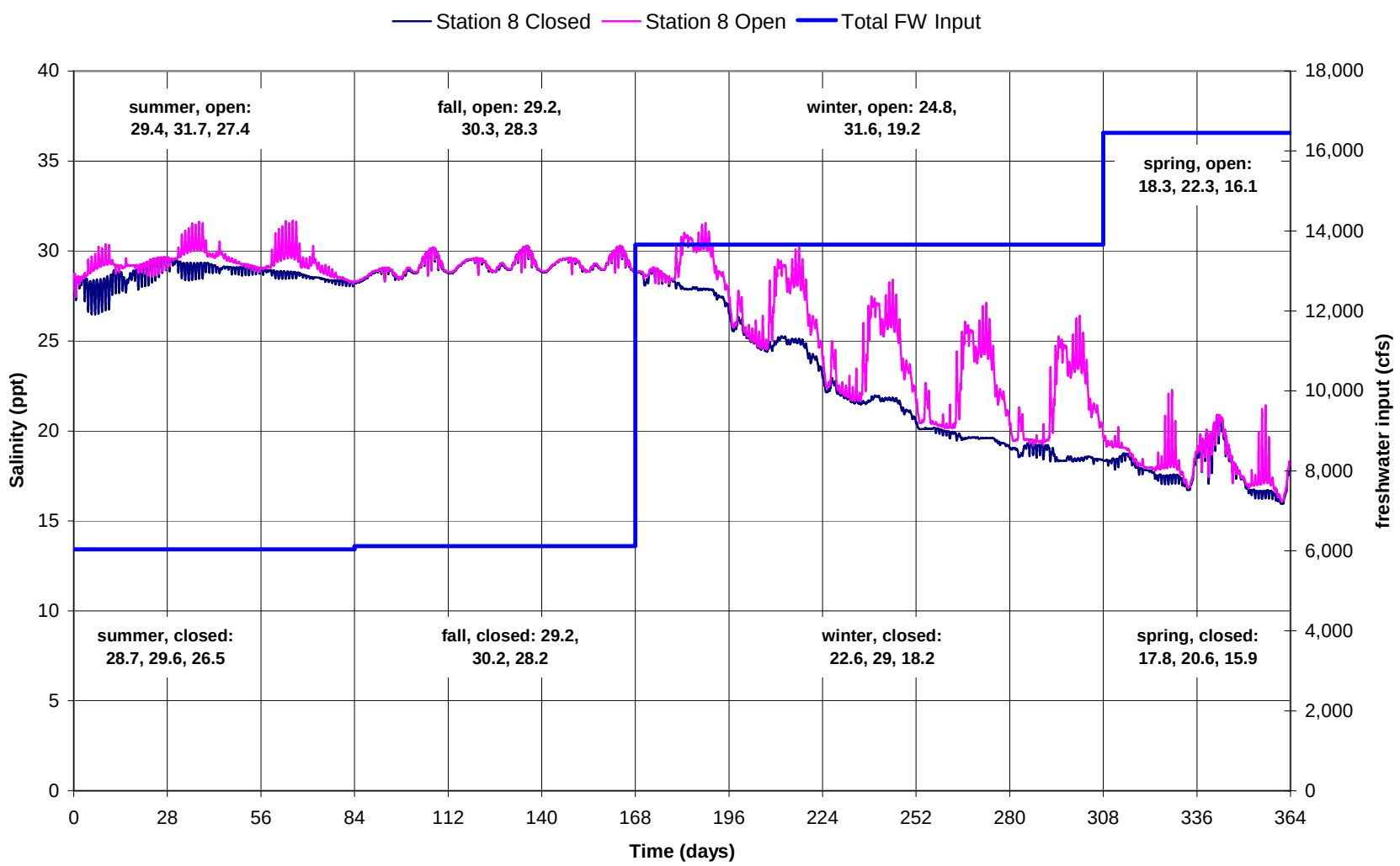


Figure A22 Salinity Variation with Time, Station 8, Year 1

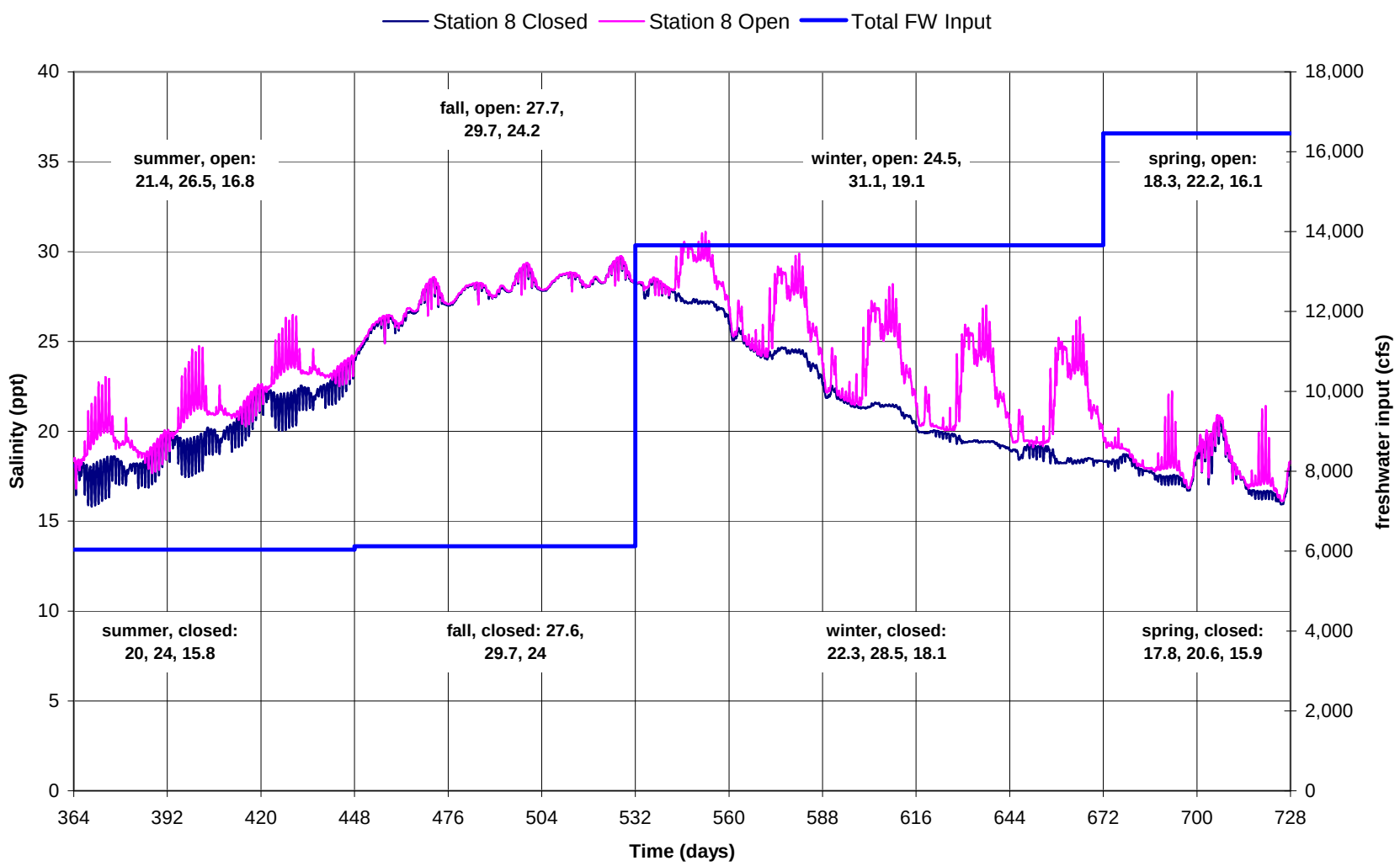


Figure A23 Salinity Variation with Time, Station 8, Year 2

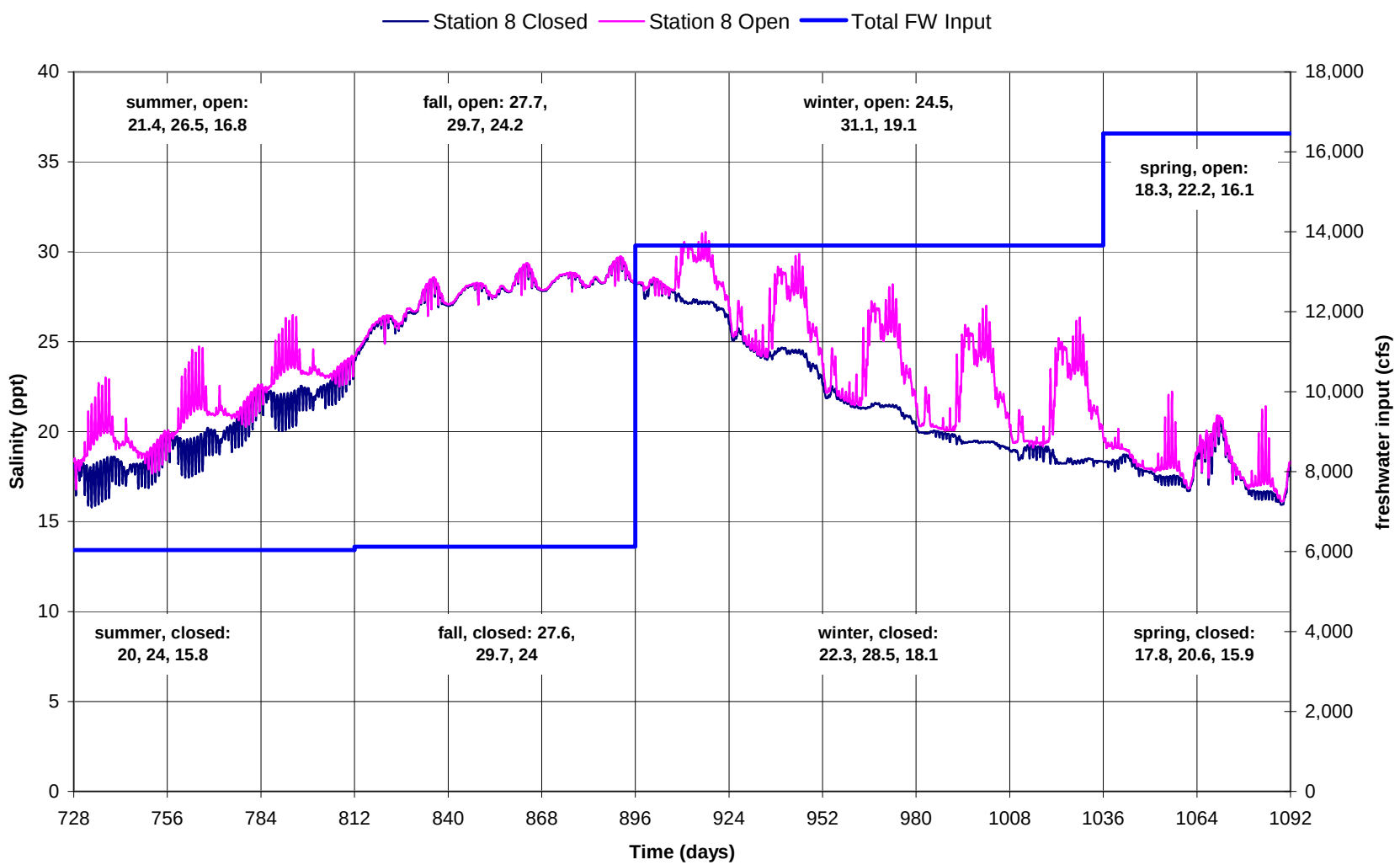


Figure A24 Salinity Variation with Time, Station 8, Year 3

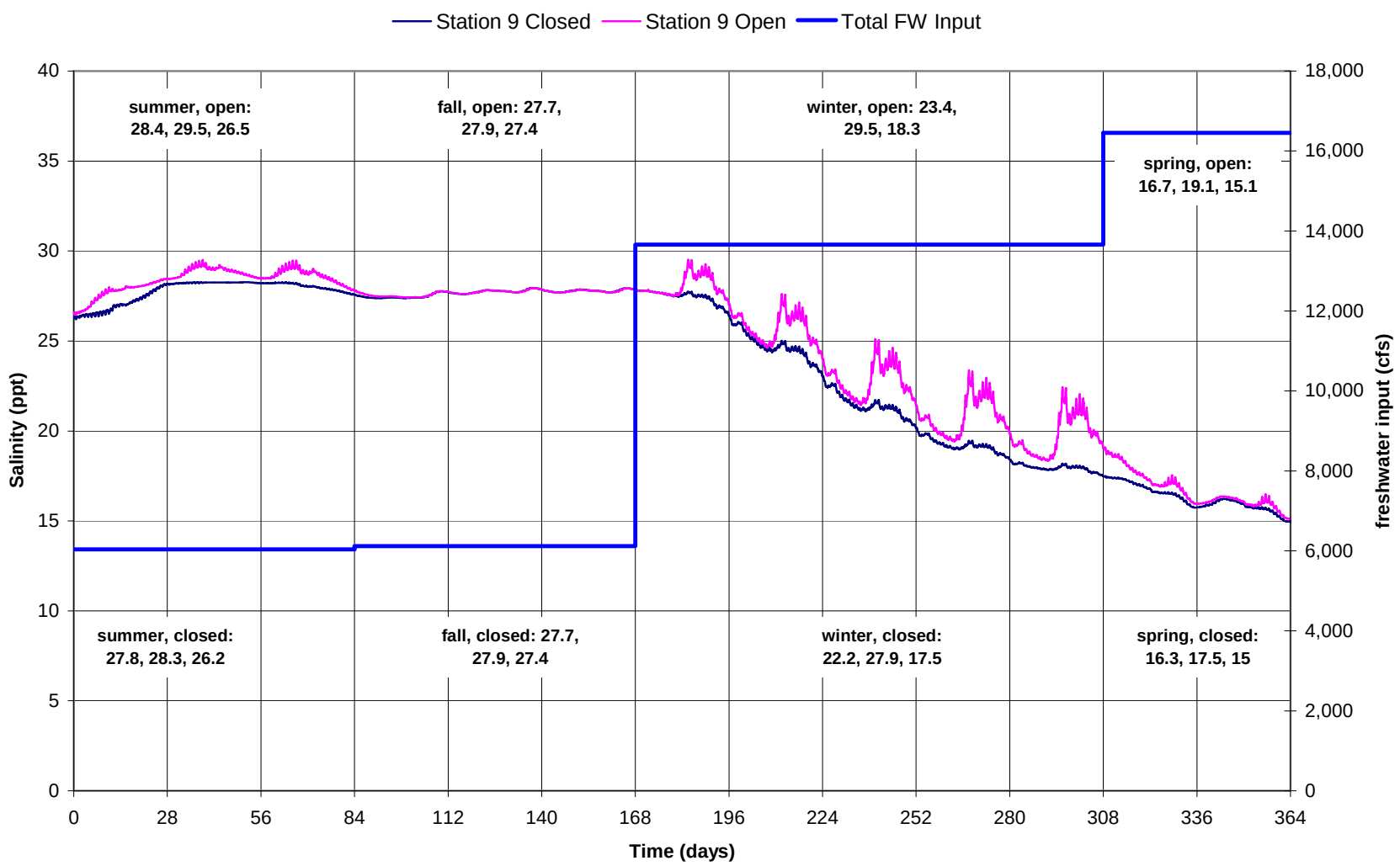


Figure A25 Salinity Variation with Time, Station 9, Year 1

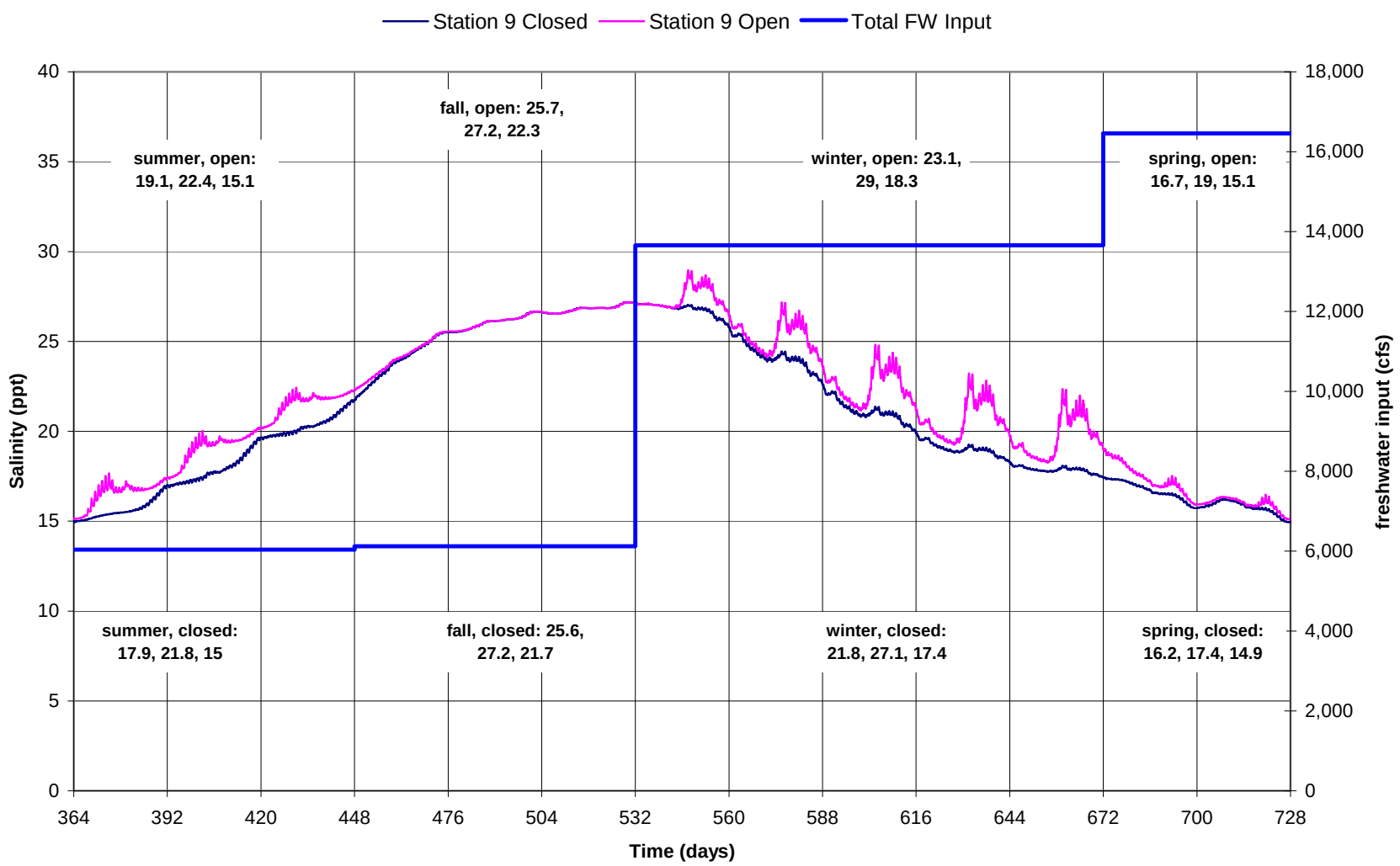


Figure A26 Salinity Variation with Time, Station 9, Year 2

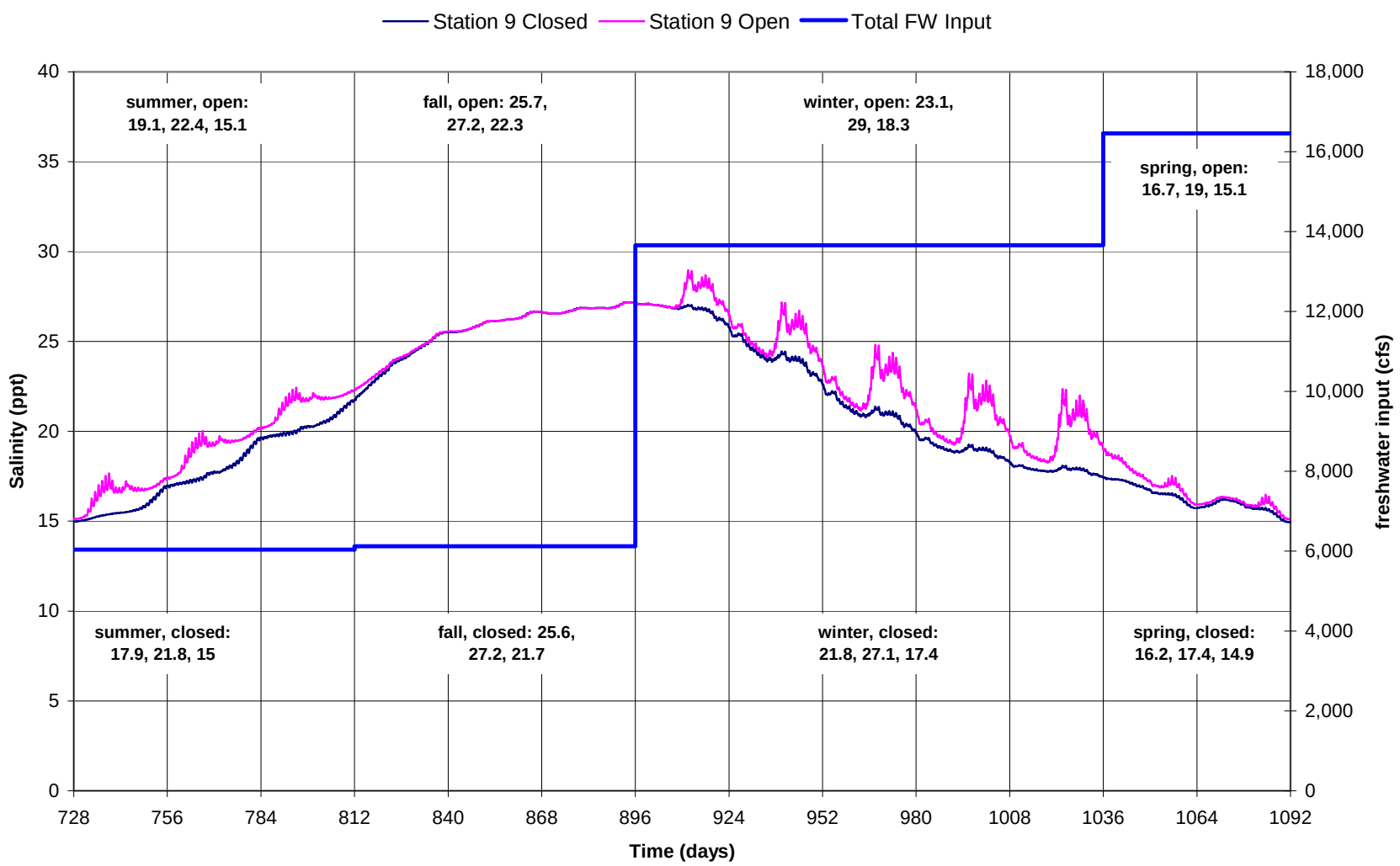


Figure A27 Salinity Variation with Time, Station 9, Year 3

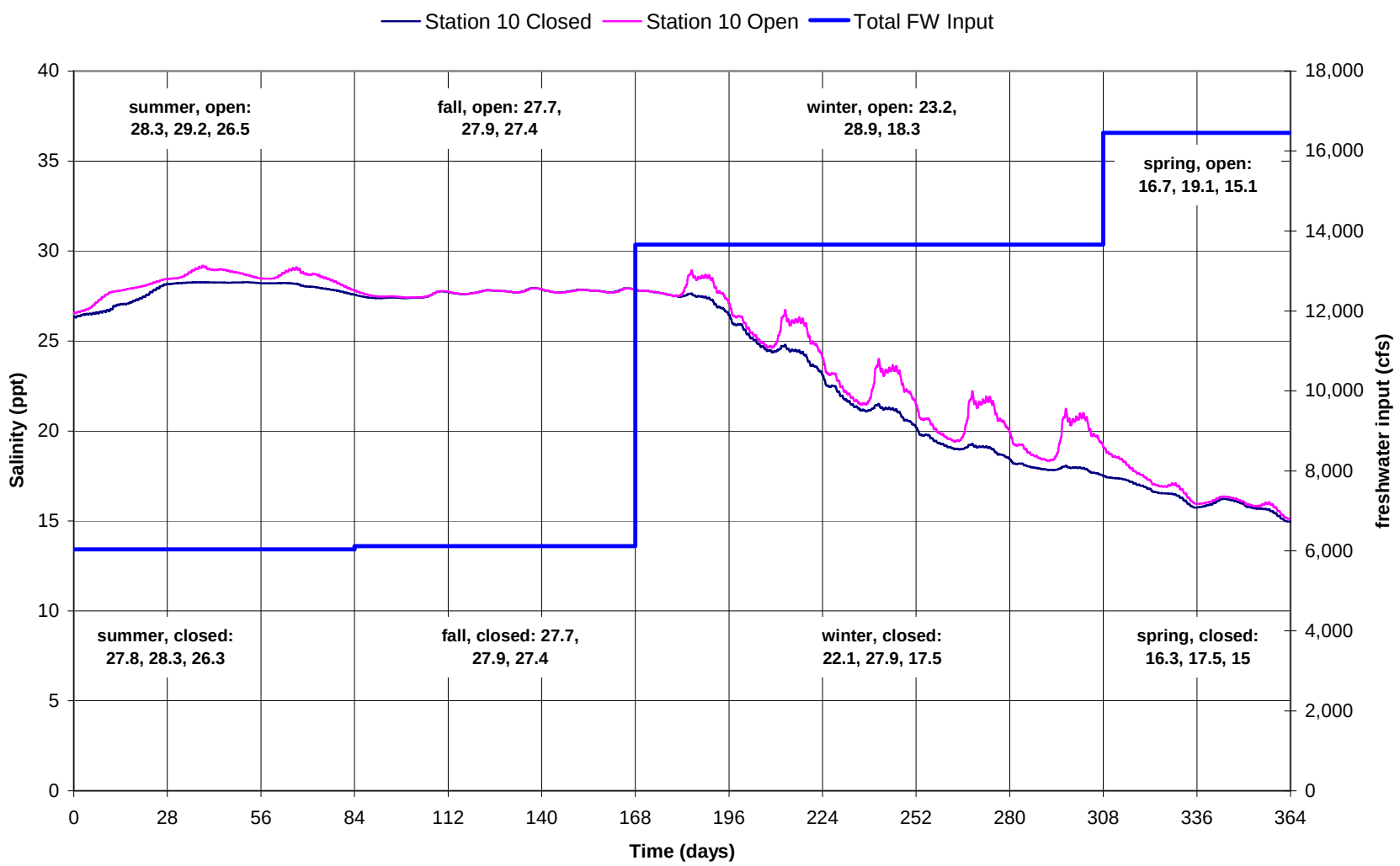


Figure A28 Salinity Variation with Time, Station 10, Year 1

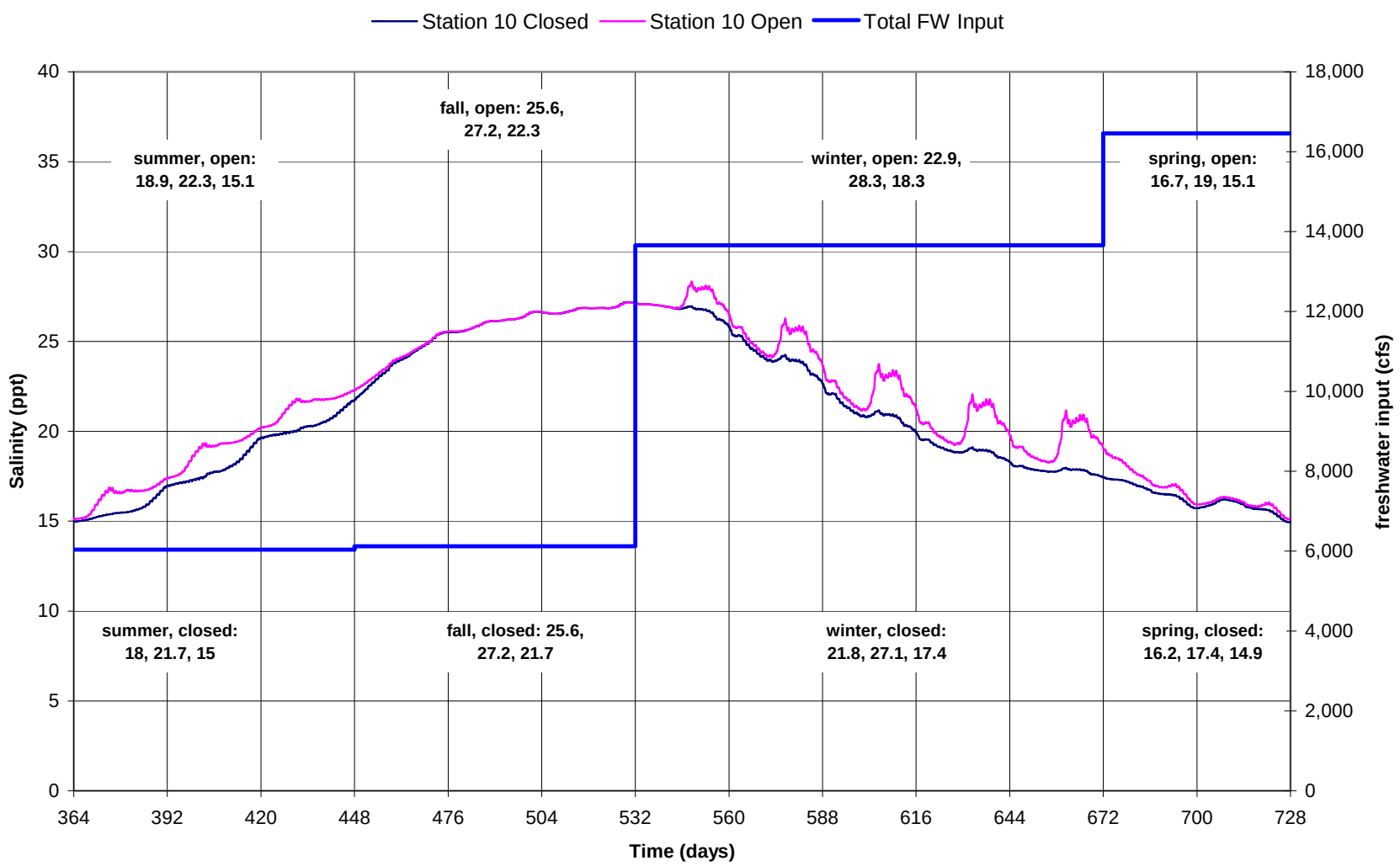


Figure A29 Salinity Variation with Time, Station 10, Year 2

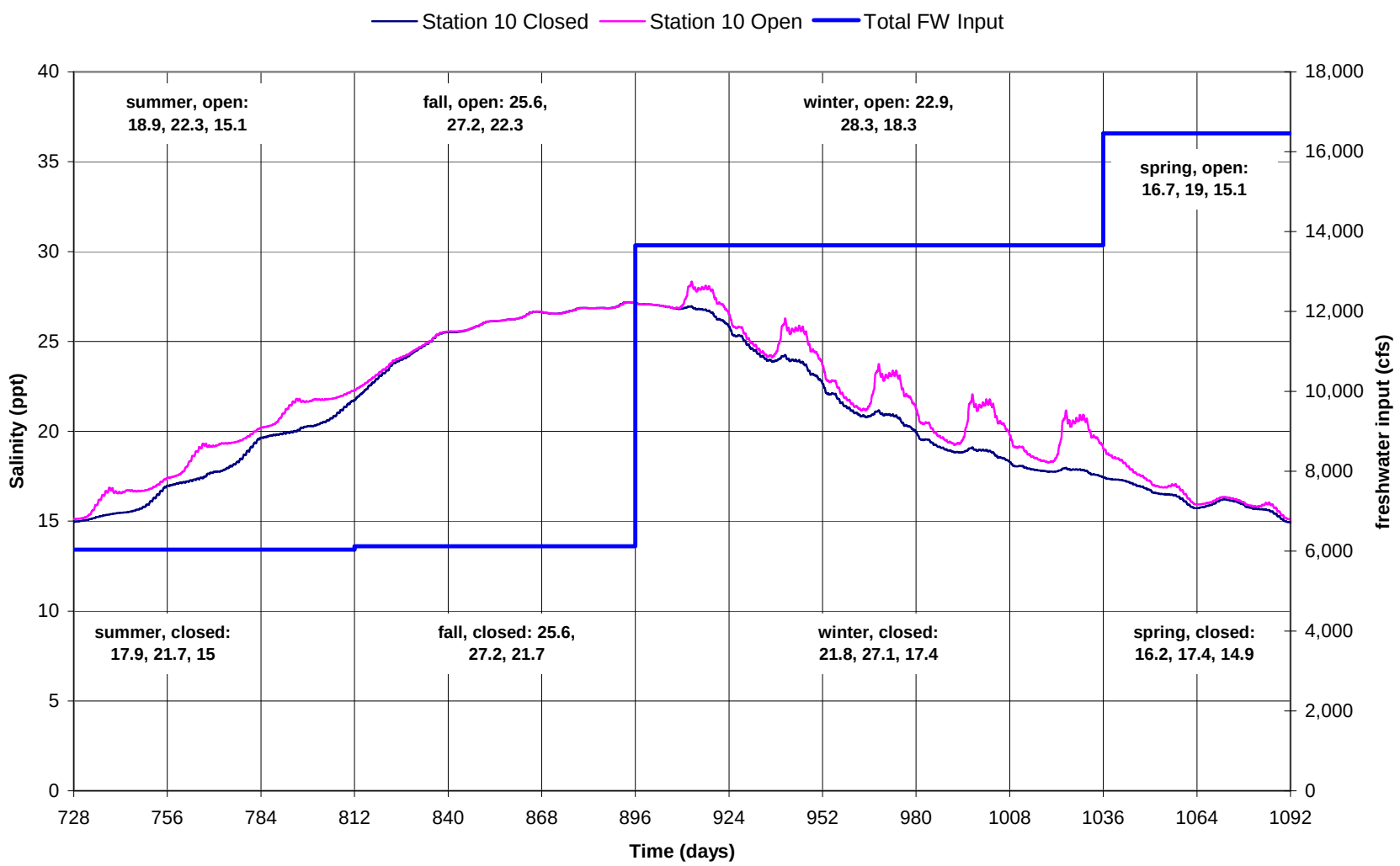


Figure A30 Salinity Variation with Time, Station 10, Year 3

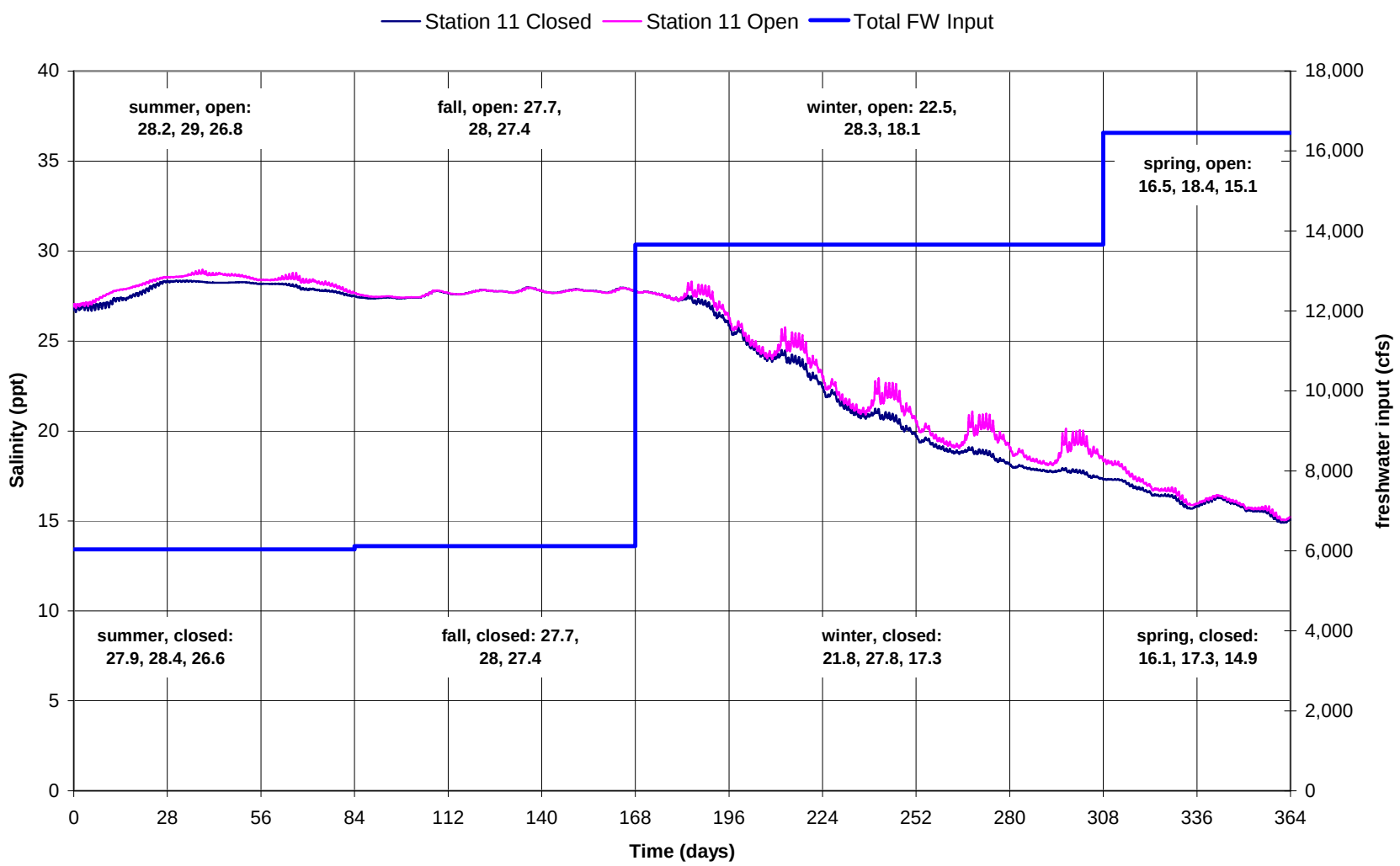


Figure A31 Salinity Variation with Time, Station 11, Year 1

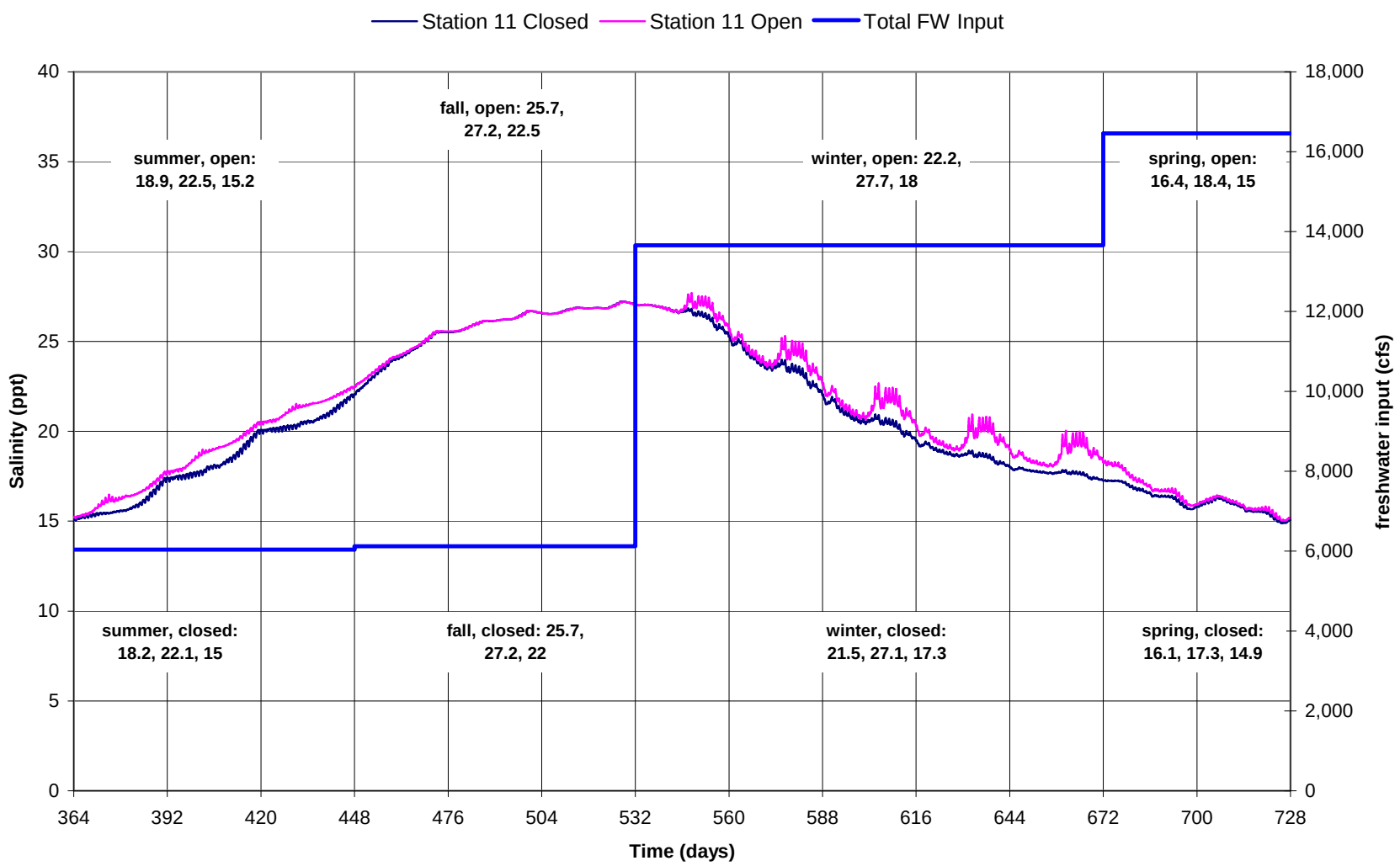


Figure A32 Salinity Variation with Time, Station 11, Year 2

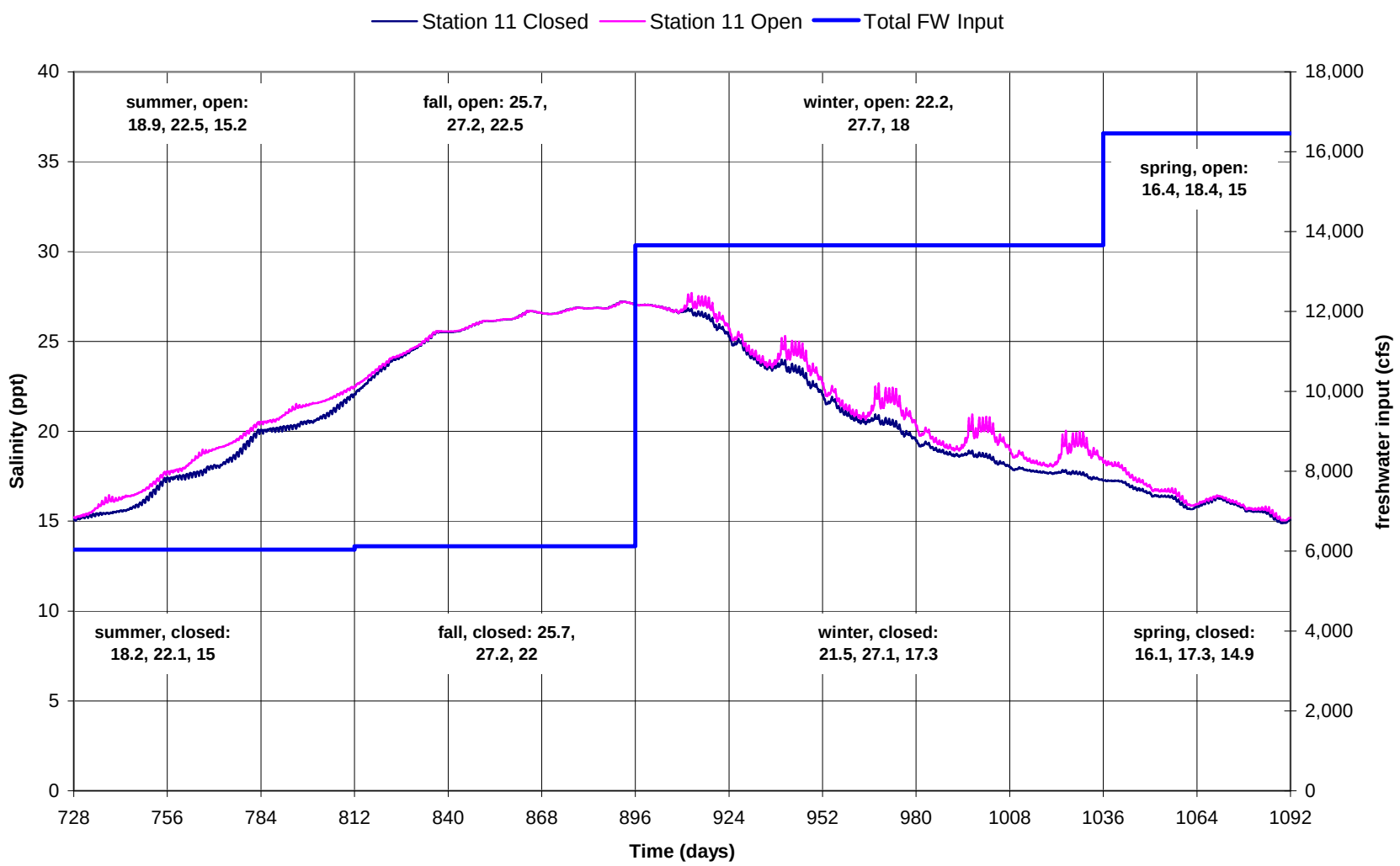


Figure A33 Salinity Variation with Time, Station 11, Year 3

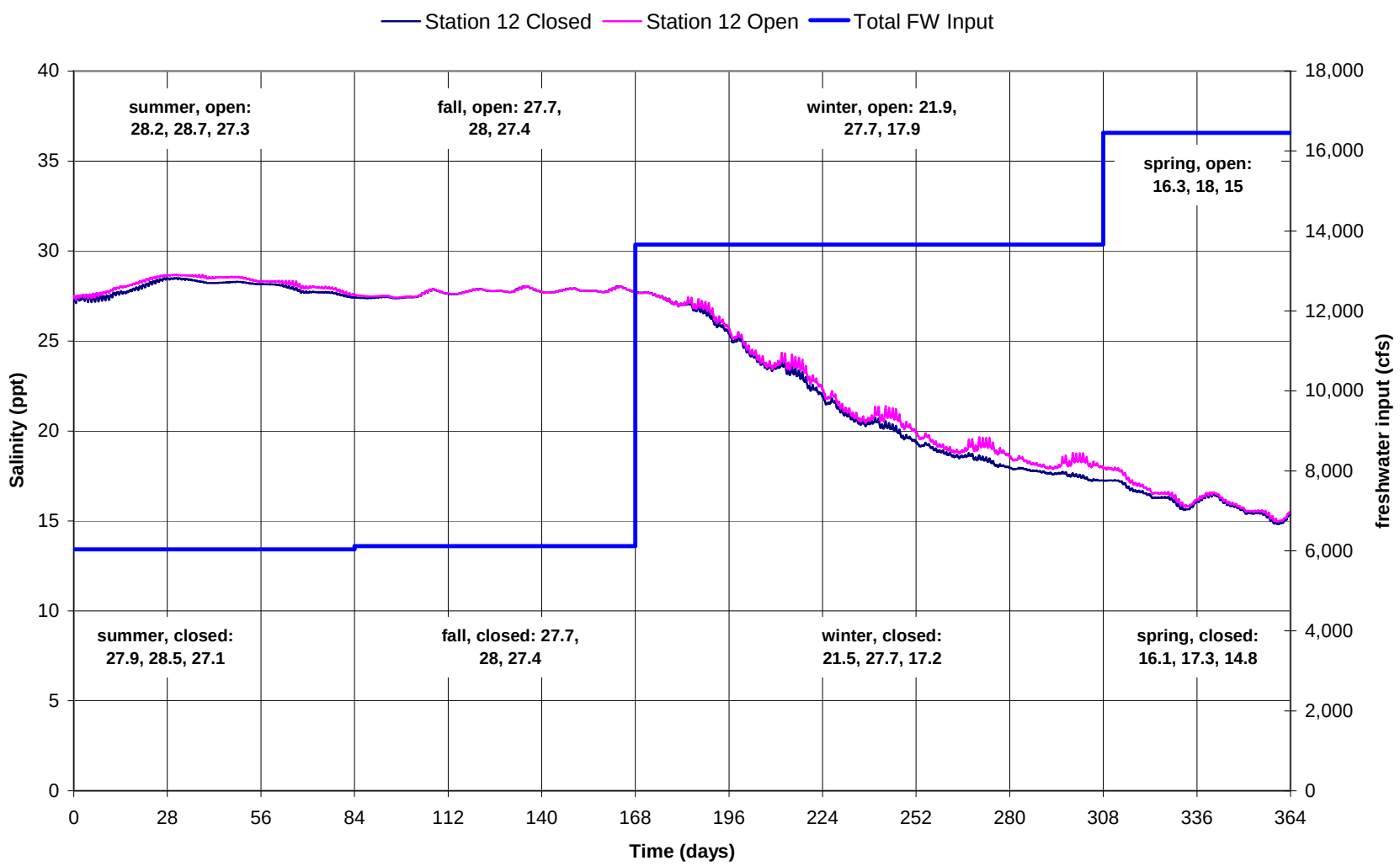


Figure A34 Salinity Variation with Time, Station 12, Year 1

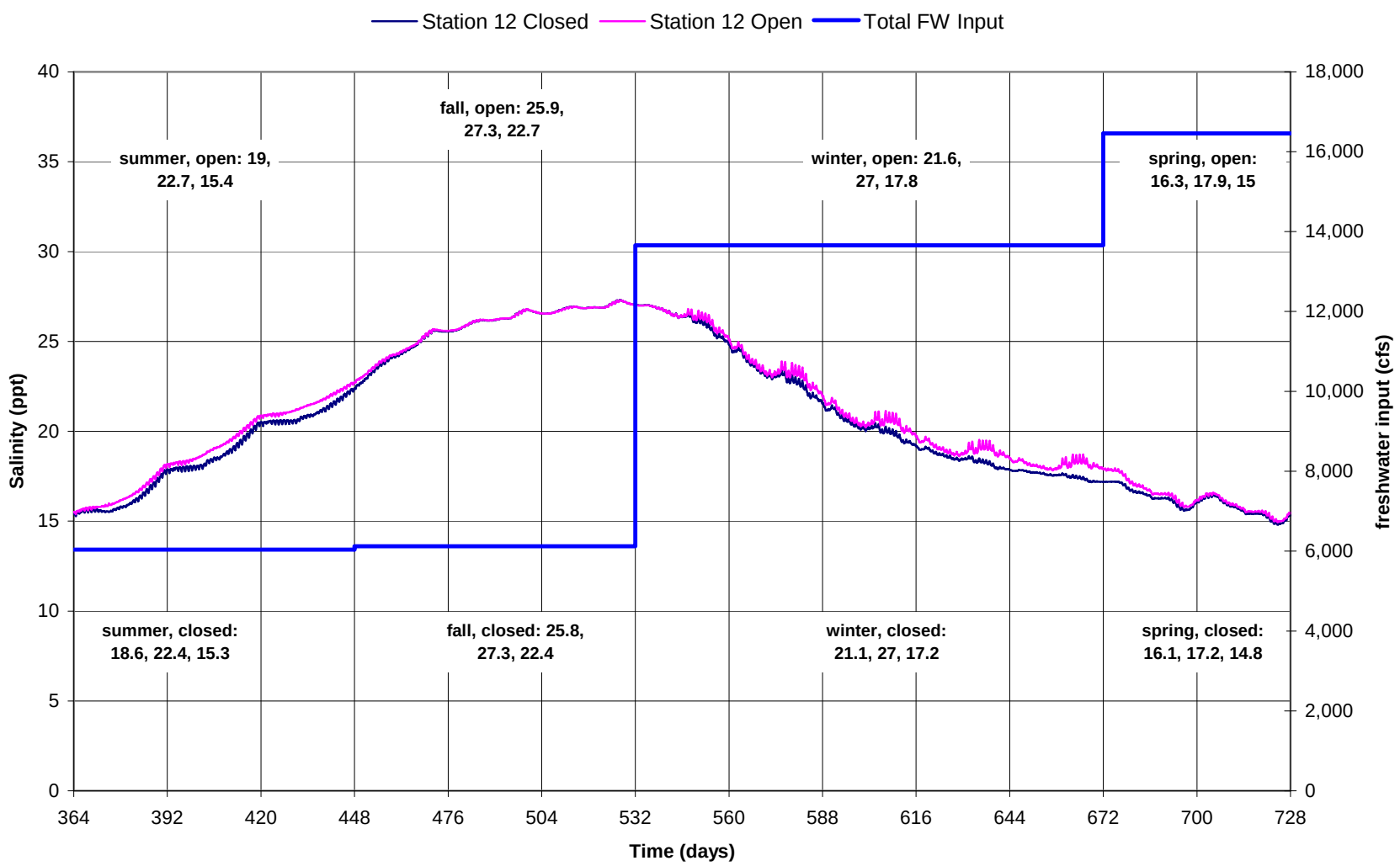


Figure A35 Salinity Variation with Time, Station 12, Year 2

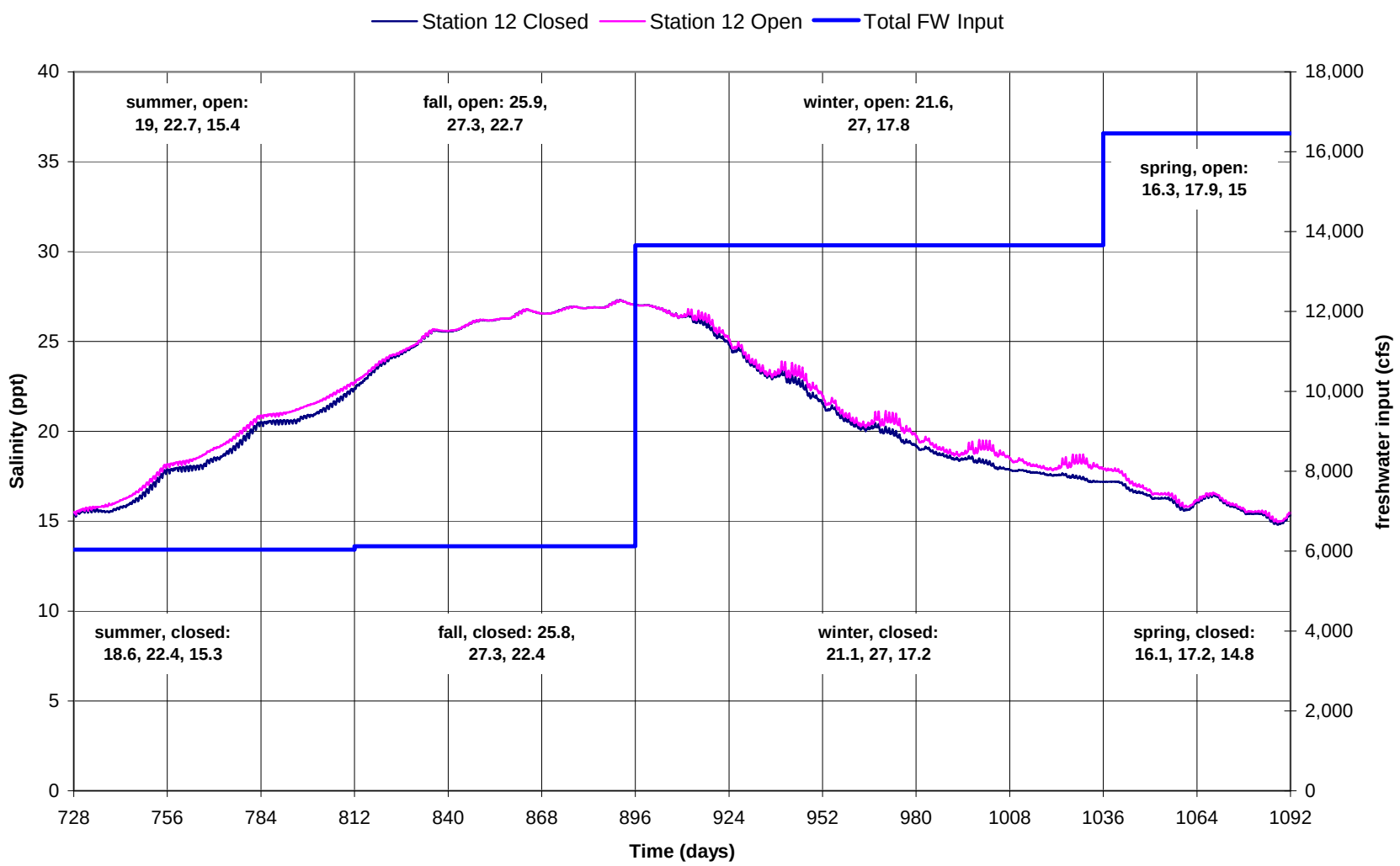


Figure A36 Salinity Variation with Time, Station 12, Year 3

APPENDIX G

Preliminary Air Conformity Analysis
Rollover Pass Closure Project
Galveston County, Texas
January 2010

Prepared by

Taylor Engineering, Inc.
10151 Deerwood Park Blvd
Building 300, Suite 300
Jacksonville, Florida 32256

PRELIMINARY AIR CONFORMITY ANALYSIS

ROLLOVER PASS CLOSURE PROJECT
GALVESTON COUNTY, TEXAS
JANUARY 2010

INTRODUCTION

The proposed project is located in Galveston County, one of the eight counties that comprise the Houston-Galveston-Brazoria Intrastate Air Quality Control Region (HGB). The Texas Commission on Environmental Quality (TCEQ) classifies the HGB as a severe non-attainment area for ozone under the 8-hour National Ambient Air Quality Standard (NAAQS) for ozone (TCEQ, 2009).

Taylor Engineering conducted a preliminary analysis of air contaminant emissions to determine if the Rollover Pass Closure Project will generate nitrogen oxide (NO_x) and volatile organic compound (VOC) emissions (ozone precursors) above *de minimus* levels specified in the general conformity rules, established by the Clean Air Act (CAA), for the HGA. The CAA established *de minimus* levels of 25 tons per year each for NO_x and VOCs for severe non-attainment areas such as the HGA. If potential emissions exceed the *de minimus* levels for either NO_x or VOCs, the CAA requires a General Conformity Determination for the project.

METHODOLOGY

Taylor Engineering based its assumptions and equipment schedules on its experience with dredged material discharge operations and earthwork construction projects that contained similar construction elements as the Rollover Pass Closure Project. This analysis assumes the total project duration will approach eight months. During the first two months the contractor will mobilize to the site, establish erosion control measures, set-up dredging pipeline and booster pumps, and drive the steel sheetpile and timber piles required for the project. During months three and four the contractor will pump dredged material from Dredged Material Placement Area (DMPA) 36 to the Gulf of Mexico side of Rollover Pass and compact and grade the material. During months five and six, the contractor will pump material to the East Bay side of Rollover Pass and begin placing beach sand on both side of the Pass to tie into the existing grades. The final two months will allow the contractor to demolish the existing steel sheetpile, establish vegetation, perform project punch out and clean up, and demobilize from the site. Table 1 lists the engineer's opinion of the equipment required, estimated operating and idle power, equipment activity description, and total estimated operating and idle time for each type of equipment. Notably, the operating and idle time include a 20% contingency to account for general project uncertainties that may arise during construction.

Table 1
Texas GLO - Rollover Pass Closure Study, Phase II
Engineer's Estimate of Equipment Operating Time

Quantity	Equipment Description	Equipment Activity	Estimated Operating Power (HP)	Estimated Operating Time (hrs)	Estimated Idle Power (HP)	Estimated Idle Time (hrs)
1	Hydraulic Dredge	Pumps dredged material from the dredged material placement area (DMPA) to Rollover Pass	3,400	520	2,400	180
3	Booster Pumps	Pumps placed along dredge pipeline route to move material from the DMMA to Rollover Pass	3,000	1,560	2,000	540
2	Front End Loaders	Move dredged material within the DMMA to the hydraulic dredge	260	1,040	125	360
1	Track-mounted Crane	Drive steel sheetpile and timber piles	350	160	175	50
2	Combination Backhoe	Provides general material moving and hauling at Rollover Pass closure site	150	1,300	100	320
1	Support Tug Boat	Provides movement operations for working barges and general support for construction operations	3,000	800	2,000	480
1	Dump Truck	Moves demolition debris to an on-site or off-site location	350	50	175	5
2	Generators	Provides power at the Rollover Pass closure site	1,000	2,500	-	-

Taylor Engineering obtained emission factors for the dredging and other equipment from the U.S. Environmental Protection Agency's (EPA) *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression Ignition* (April 2004) document. Appendix A of the EPA document provides zero-hour, steady-state emission factors, transient adjustments factors, and deterioration factors for nonroad compression ignition engines. We assumed the contractor's average equipment age would approach 10 years; therefore, we evaluated each equipment type as Tier 1 technology. This approach is consistent with the above-referenced document. To determine the final emission factor for each type of equipment we used the following formula:

$$EF_{adj(HC,CO,NOx)} = EF_{SS} \times TAF \times DF$$

$$where:$$

$$EF_{adj(HC,CO,NOx)} = final\ emission\ factor$$

$$EF_{SS} = zero-hour, steady-state\ emissions\ factor$$

$$TAF = transient\ adjustment\ factor$$

$$DF = deterioration\ factor$$

To report the hydrocarbon emissions as volatile organic compounds (VOC), Taylor Engineering used the following equation for diesel engines as defined in the EPA's *Conversion Factors for Hydrocarbon Emission Components* (December 2005):

$$\frac{VOC}{THC} = 1.053$$

$$where:$$

$$VOC = volatile\ organic\ compound$$

$$THC = total\ hydrocarbons$$

SUMMARY OF EMISSIONS/GENERAL CONFORMITY THRESHOLDS

The CAA established *de minimus* levels of 25 tons per year (tpy) each for NO_x and VOCs for severe non-attainment areas such as the HGA. If project operations result in air emissions of less than 25 tpy for both of these air contaminants, the project does not require a General Conformity Determination to demonstrate that such actions conform to the State Implementation Plan (SIP). Tables 2 – 4 summarize the total project emissions for NO_x and VOCs.

Table 2
Texas GLO - Rollover Pass Closure Study, Phase II
Engineer's Estimate of Operating Emissions

Quantity	Equipment Description	Estimated Operating Power (HP)	Estimated Operating Time (hrs)	Zero-Hour, Steady-State Emission Factors (g/hp-hr)		Transient Adjustment Factor (unitless)		Deterioration Factor (unitless)		Adjusted Emissions Factors (g/hp-hr)		Total Emissions (Tons)	
				HC	NOx	HC	NOx	HC	NOx	HC	NOx	VOC1	NOx
1	Hydraulic Dredge	3,400	520	0.2861	6.1525	1.05	0.95	1.02	1.01	0.306	5.92	0.6	11.5
3	Booster Pumps	3,000	1,560	0.2861	6.1525	1.00	1.00	1.02	1.01	0.291	6.23	1.6	32.1
2	Front End Loaders	260	1,040	0.3085	5.5772	2.29	1.10	1.02	1.01	0.719	6.21	0.2	1.9
1	Track-mounted Crane	350	160	0.2025	6.0153	1.00	1.00	1.02	1.01	0.207	6.10	0.0	0.4
2	Combination Backhoe	150	1,300	0.3384	5.6523	2.29	1.10	1.02	1.01	0.789	6.29	0.2	1.4
1	Support Tug Boat	3,000	800	0.2861	6.1525	1.00	1.00	1.00	1.00	0.287	6.17	0.8	16.3
1	Dump Truck	350	50	0.2025	6.0153	1.05	0.95	1.05	1.03	0.223	5.90	0.0	0.1
2	Generators	1,000	2,500	0.2861	6.1525	1.00	1.00	1.02	1.01	0.291	6.23	0.8	17.2
Total Operating Emissions												**4.3**	**80.9**

Footnotes:

1 HC converted to VOC in accordance with EPA Conversion Factors for Hydrocarbon Emission Components

Table 3
Texas GLO - Rollover Pass Closure Study, Phase II
Engineer's Estimate of Idle Emissions

Quantity	Equipment Description	Estimated Idle Power (HP)	Estimated Idle Time (hrs)	Zero-Hour, Steady-State Emission Factors (g/hp-hr)		Transient Adjustment Factor (unitless)		Deterioration Factor (unitless)		Adjusted Emissions Factors (g/hp-hr)		Total Emissions (Tons)	
				HC	NOx	HC	NOx	HC	NOx	HC	NOx	VOC1	NOx
1	Hydraulic Dredge	2,400	180	0.2861	6.1525	1.05	0.95	1.02	1.01	0.306	5.92	0.2	2.8
3	Booster Pumps	2,000	540	0.2861	6.1525	1.00	1.00	1.02	1.01	0.291	6.23	0.4	7.4
2	Front End Loaders	125	360	0.3384	5.6523	2.29	1.10	1.02	1.01	0.789	6.29	0.0	0.3
1	Track-mounted Crane	175	50	0.3384	5.6523	1.00	1.00	1.02	1.01	0.346	5.73	0.0	0.1
2	Combination Backhoe	100	320	0.3384	5.6523	2.29	1.10	1.02	1.01	0.789	6.29	0.0	0.2
1	Support Tug Boat	2,000	480	0.2861	6.1525	1.00	1.00	1.00	1.00	0.287	6.17	0.3	6.5
1	Dump Truck	175	5	0.3384	5.6523	1.05	0.95	1.05	1.03	0.373	5.55	0.0	0.0
2	Generators	-	-	-	-	-	-	-	-	-	-	-	-
Total Operating Emissions												**0.9**	**17.4**

Footnotes:

1 HC converted to VOC in accordance with EPA Conversion Factors for Hydrocarbon Emission Components

Table 4
Texas GLO - Rollover Pass Closure Study, Phase II
Engineer's Summary of Total Emissions Estimate

	VOC	NOx
Operating Emissions	4.3	80.9
Idle Emissions	0.9	17.4
Total Emissions	5.2	98.2
Severe Attainment Zone Conformity Threshold (Tons/Year)	25	25
Exceeds Threshold (y/n)	No	**Yes**

As shown in Table 4, the estimated emissions for VOCs fall below *de minimus* levels of 25 tons per year. However; the estimated emissions for NO_x exceed *de minimus* levels; therefore this project will require a General Conformity Determination to demonstrate that such actions conform to the State Implementation Plan (SIP).

REFERENCES

TCEQ (Texas Commission on Environmental Quality). 2009. Interoffice Memorandum; Docket No.: 2009-0802-SIP

EPA. 2005. Conversion Factors for Hydrocarbon Emission Components (EPA420-R-05-015 December 2005 NR-002c)

EPA. 2004. Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression-Ignition (EPA420-P-04-009 April 2009 NR-009c)

EPA. 2002. Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling (EPA420-P-02-014 December 2002 NR-005b)

EPA. 2005. Nonroad Engine Population Estimates (EPA420-R-05-022 December 2005 NR-006d)

APPENDIX H

Section 404(b)(1) Evaluation

EVALUATION OF SECTION 404(b)(1) GUIDELINES (SHORT FORM)

ROLLOVER PASS CLOSURE PROJECT
GALVESTON COUNTY, TEXAS

	Yes	No*
1. Review of Compliance (230.10(a)-(d))		
A review of the proposed project indicates that:		
a. The placement represents the least environmentally damaging practicable alternative and, if in a special aquatic site, the activity associated with the placement must have direct access or proximity to, or be located in the aquatic ecosystem, to fulfill its basic purpose (if no, see Section 2 and information gathered for EA alternative).	**X**	
b. The activity does not appear to:		
1) Violate applicable state water quality standards or effluent standards prohibited under Section 307 of the Clean Water Act	**X**	
2) Jeopardize the existence of Federally-listed endangered or threatened species or their habitat; and	**X**	
3) Violate requirements of any Federally-designated marine sanctuary (if no, see Section 2b and check responses from resource and water quality certifying agencies).	**X**	
c. The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values (if no, see values, Section 2)	**X**	
d. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem.	**X**	

	Not Applicable	Not Significant	Significant*
2. Technical Evaluation Factors (Subparts C-F) (where a "Significant" Category is checked, add explanation below)			
a. Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C)			
1) Substrate impacts		**X**	
2) Suspended particulates/turbidity impacts		**X**	
3) Water column impacts		**X**	
4) Alteration of current patterns and water circulation		**X**	
5) Alteration of normal water fluctuation/hydroperiod		**X**	
6) Alteration of salinity gradients			**X**
b. Biological Characteristics of the Aquatic Ecosystem (Subpart D)			
1) Effect on threatened/endangered species and their habitat		**X**	
2) Effect on the aquatic food web		**X**	
3) Effect of other wildlife (mammals, birds, reptiles, and amphibians)		**X**	
c. Special Aquatic Sites (Subpart E)			
1) Sanctuaries and refuges	**X**		
2) Wetlands		**X**	
3) Mud flats		**X**	
4) Vegetated shallows		**X**	
5) Coral reefs	**X**		
6) Riffle and pool complexes	**X**		

	Not Applicable	Not Significant	Significant*
2. Technical Evaluation Factors (Subparts C-F) (where a "Significant" Category is checked, add explanation below)			
d. Human Use Characteristics			
1) Effects on municipal and private water supplies	**X**		
2) Recreational and commercial fisheries impacts			**X**
3) Effects of water-related recreation		**X**	
4) Aesthetic impacts		**X**	
5) Effects of parks, national and historical monuments, national seashores, wilderness areas, research sites, and similar preserves	**X**		

	Yes
3. Evaluation of Dredged or Fill Material (Subpart G)	
a. The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material (check only those appropriate)	
1) Physical characteristics	**X**
2) Hydrography in relation to known or anticipated sources of contamination	
3) Results from previous testing of the material or similar material in the vicinity of the project	
4) Known, significant sources of persistent pesticides from land runoff or percolation	**X**
5) Spill records for petroleum products designated (Section 311 or Clean Water Act) hazardous substances	**X**
6) Other public records of significant introduction of contaminants from industries, municipalities, or other sources	**X**
7) Known existence of substantial material deposits of substances which could be released in harmful quantities to the aquatic environment by man-induced discharge activities	
b. An evaluation of the appropriate information in 3a above indicates that there is reason to believe the proposed dredged or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and placement sites and not likely to degrade the placement sites, or the material meets the testing exclusion criteria.	

List appropriate references:

	Yes
4. Placement Site Delineation	
a. The following factors as appropriate, have been considered in evaluating the placement site:	
1) Depth of water at the placement site	**X**
2) Current velocity, direction, and variability at the placement site	**X**
3) Degree of turbulence	**X**
4) Water column stratification	
5) Discharge vessel speed and direction	
6) Rate of discharge	**X**
7) Fill material characteristics (constituents, amount, and type of material, settling velocities)	**X**
8) Number of discharges per unit of time	**X**
9) Other factors affecting rates and patterns of mixing (specify)	
b. An evaluation of the appropriate factors in 4a above indicates that the placement site and/or size of mixing zone are acceptable	**X**

	Yes	No
5. Actions to Minimize Adverse Effects (Subpart H)		
All appropriate and practicable steps have been taken, through application of recommendations of 230.70-230.77 to ensure minimal adverse effects of the proposed discharge.	**X**	

List actions taken:

	Yes	No*
6. Factual Determination (230.11)		
A review of appropriate information as identified in items 2-5 above indicates that there is minimal potential for short- or long-term environmental effects of the proposed discharge as related to:		
a. Physical substrate at the placement site (review Sections 2a, 3, 4, and 5 above)	**X**	
b. Water circulation, fluctuation and salinity (review Sections 2a, 3, 4, and 5)	**X**	
c. Suspended particulates/turbidity (review Sections 2a, 3, 4, and 5)	**X**	
d. Contaminant availability (review Sections 2a, 3, and 4)	**X**	
e. Aquatic ecosystem structure and function (review Sections 2b, 2c, 3, and 5)	**X**	
f. Placement site (review Sections 2, 4, and 5)	**X**	
g. Cumulative impacts on the aquatic ecosystem	**X**	
h. Secondary impacts on the aquatic ecosystem	**X**	

7. Evaluation Responsibility
a. This evaluation was prepared by: Position:

	Yes
8. Findings	
a. The proposed placement site for discharge of dredged or fill material complies with Section 404(b)(1) guidelines	**X**
b. The proposed placement site for discharge of dredged or fill material complies with the Section 404(b)(1) guidelines with the inclusion of the following conditions.	

List of conditions:

	Yes
c. The proposed placement site for discharge of dredged or fill material does not comply with the Section 404(b)(1) guidelines for the following reason(s):	
1) There is a less damaging practicable alternative	
2) The proposed discharge will result in significant degradation of the aquatic ecosystem	
3) The proposed discharge does not include all practicable and appropriate measures to minimize potential harm to the aquatic ecosystem	

_____ Date	_____

NOTES:

* A negative, significant, or unknown response indicates that the permit application may not be in compliance with the Section 404(b)(1) guidelines.

Negative responses to three or more of the compliance criteria at the preliminary stage indicate that the proposed projects may not be evaluated using this “short form” procedure. Care should be used in assessing pertinent portions of the technical information of items 2a-e before completing the final review of compliance.

Negative response to one of the compliance criteria at the final stage indicates that the proposed project does not comply with the guidelines. If the economics of navigation and anchorage of Section 404(b)(2) are to be evaluated in the decision-making process, the “short form” evaluation process is inappropriate.

APPENDIX I

Coastal Zone Management Consistency Determination

COMPLIANCE WITH GOALS AND POLICIES
SECTION 501.25(a)-(f)

ROLLOVER PASS CLOSURE PROJECT
GALVESTON COUNTY, TEXAS

Section 501.25 Dredging and Dredged Material Disposal and Placement

(a) Dredging and the disposal and placement of dredged material shall avoid and otherwise minimize adverse effects to coastal waters, submerged lands, critical areas, coastal shore areas, and Gulf beaches to the greatest extent practicable. The policies of this subsection are supplemental to any further restrictions or requirements relating to the beach access and use rights of the public. In implementing this subsection, cumulative and secondary adverse effects of dredging and the disposal and placement of dredged material and the unique characteristics of affected sites shall be considered.

(1) Dredging and dredged material disposal and placement shall not cause or contribute, after consideration of dilution and dispersions to violation of any applicable surface water quality standards established under §501.21 of this title.

(2) Except as otherwise provided in paragraph (4) of this paragraph, adverse effects on critical areas from dredging and dredged material disposal or placement shall be avoided and otherwise minimized, and appropriate and practicable compensatory mitigation shall be required, in accordance with §501.23 of this title.

(3) Except as provided in paragraph (4) of this paragraph, dredging and the disposal and placement of dredged material shall not be authorized if:

(A) there is a practicable alternative that would have fewer adverse effects on coastal waters, submerged lands, critical areas, coastal shore areas, and Gulf beaches, so long as that alternative does not have other significant adverse effects;

(B) all appropriate and practicable steps have not been taken to minimize adverse effects on coastal waters, submerged lands, critical areas, coastal shore areas, and Gulf beaches; or

(C) significant degradation of critical areas under §501.23(a)(7)(E) of this title would result.

(4) A dredging or dredged material disposal or placement project that would be prohibited solely by application of paragraph (3) of this paragraph may be allowed if it is determined to be of overriding importance to the public and national interest in light of economic impacts on navigation and maintenance of commercially navigable waterways.

Compliance: No practicable alternative exists that would have fewer adverse effects on coastal waters, submerged lands, coastal shore areas, and Gulf beaches. Construction of the proposed project would result in temporary, localized increases in turbidity during dredging operations in the immediate vicinity of the borrow and placement sites. Implementing best management practices and protective measures (e.g. turbidity screens, energy dissipaters, etc.) would minimize any potential adverse effects related to elevated turbidity. Prior to construction the contractor

would prepare and submit an environmental protection plan detailing the BMPs, protective measures, and monitoring program that the contractor would implement during construction to minimize impacts to water quality. In the long-term, the proposed project would reduce the frequency of GIWW dredging events and associated water quality impacts. The project may also benefit critical areas by reducing salinities within Rollover Bay and East Bay and providing conditions more suitable for oyster reef development.

(b) Adverse effects from dredging and dredged material disposal and placement shall be minimized as required in subsection (a) of this section. Adverse effects can be minimized by employing the techniques in this paragraph where appropriate and practicable.

(1) Adverse effects from dredging and dredged material disposal and placement can be minimized by controlling the location and dimensions of the activity. Some of the ways to accomplish this include:

(A) locating and confining discharges to minimize smothering of organisms;

(B) locating and designing projects to avoid adverse disruption of water inundation patterns, water circulation, erosion and accretion processes, and other hydrodynamic processes;

(C) using existing or natural channels and basins instead of dredging new channels or basins, and discharging materials in areas that have been previously disturbed or used for disposal or placement of dredged material;

(D) limiting the dimensions of channels, basins, and disposal and placement sites to the minimum reasonably required to serve the project purpose, including allowing for reasonable overdredging of channels and basins, and taking into account the need for capacity to accommodate future expansion without causing additional adverse effects;

(E) discharging materials at sites where the substrate is composed of material similar to that being discharged;

(F) locating and designing discharges to minimize the extent of any plume and otherwise control dispersion of material; and

(G) avoiding the impoundment or drainage of critical areas.

Compliance: Construction activities will primarily occur within the existing, deeper channels of the GIWW and Rollover Pass. The proposed construction boundary only uses the space necessary to complete the project and the construction sequence was designed to minimize potential adverse effects (e.g. turbidity, wildlife disturbance, etc.). While some localized, minor impacts may occur, overall, the project will likely benefit the system by restoring more natural estuarine conditions.

(2) Dredging and disposal and placement of material to be dredged shall comply with applicable standards for sediment toxicity. Adverse effects from constituents contained in materials discharged can be minimized by treatment of or limitations on the material itself.

Some ways to accomplish this include:

(A) disposal or placement of dredged material in a manner that maintains physicochemical conditions at discharge sites and limits or reduces the potency and availability of pollutants;

(B) limiting the solid, liquid, and gaseous components of material discharged;

(C) adding treatment substances to the discharged material; and

(D) adding chemical flocculants to enhance the deposition of suspended particulates in confined disposal areas,

Compliance: Development of the Environmental Assessment included a preliminary assessment of hazardous, toxic, and radioactive waste. The assessment comprised a regulatory records search and review of historical aerial photographs of the project site. The assessment did not identify any facilities or sources of contamination that may affect the proposed project.

(3) Adverse effects from dredging and dredged material disposal or placement can be minimized through control of the materials discharged. Some ways of accomplishing this include:

(A) use of containment levees and sediment basins designed, constructed, and maintained to resist breaches, erosion, slumping, or leaching;

(B) use of lined containment areas to reduce leaching where leaching of chemical constituents from the material is expected to be a problem;

(C) capping in-place contaminated material or, selectively discharging the most contaminated material first and then capping it with the remaining material;

(D) properly containing discharged material and maintaining discharge sites to prevent point and nonpoint pollution; and

(E) timing the discharge to minimize adverse effects from unusually high water flows, wind, wave, and tidal actions.

Compliance: The construction methods and sequencing are designed to minimize potential adverse impacts (e.g. turbidity) to the aquatic system. Prior to construction the contractor would prepare and submit an environmental protection plan detailing the BMPs, protective measures, and monitoring program that the contractor would implement during construction to minimize impacts to water quality.

(4) Adverse effects from dredging and dredged material disposal or placement can be minimized by controlling the manner in which material is dispersed. Some ways of accomplishing this include:

(A) where environmentally desirable, distributing the material in a thin layer;

(B) orienting material to minimize undesirable obstruction of the water current or circulation patterns;

(C) using silt screens or other appropriate methods to confine suspended particulates or turbidity to a small area where settling or removal can occur;

(D) using currents and circulation patterns to mix, disperse, dilute, or otherwise control the discharge;

(E) minimizing turbidity by using a diffuser system or releasing material near the bottom;

(F) selecting sites or managing discharges to confine and minimize the release of suspended particulates and turbidity and maintain light penetration for organisms; and

(G) setting limits on the amount of material to be discharged per unit of time or volume of receiving waters.

Compliance: The contractor would implement best management practices (BMPs) and protective measures (e.g. turbidity screens, energy dissipaters, etc.) to minimize any potential adverse water quality effects (e.g. elevated turbidity).

(5) Adverse effects from dredging and dredged material disposal or placement operations can be minimized by adopting technology to the needs of each site. Some ways of accomplishing this include:

(A) using appropriate equipment, machinery, and operating techniques for access to sites and transport of material, including those designed to reduce damage to critical areas;

(B) having personnel on site adequately trained in avoidance and minimization techniques and requirements; and

(C) designing temporary and permanent access roads and channel spanning structures using culverts, open channels, and diversions that will pass both low and high water flows, accommodate fluctuating water levels, and maintain circulation and faunal movement.

Compliance: Development of the construction plan including methods and sequencing aimed to minimize environmental impacts to the greatest extent practicable. The contractor will educate construction personal regarding protected natural resources and techniques to and avoid and minimize impact. Prior to construction the contractor would prepare and submit an environmental protection plan detailing the BMPs, protective measures, and monitoring program that the contractor would implement during construction to minimize impacts to the environment.

(6) Adverse effects on plant and animal populations from dredging and dredged material disposal or placement can be minimized by:

(A) avoiding changes in water current and circulation patterns that would interfere with the movement of animals;

(B) selecting sites or managing discharges to prevent or avoid creating habitat conducive to the development of undesirable predators or species that have a competitive edge ecologically over indigenous plants or animals;

(C) avoiding sites having unique habitat or other values including habitat of endangered

species;

(D) using planning and construction practices to institute habitat development and restoration to produce a new or modified environmental state of higher ecological value by displacement of some or all of the existing environmental characteristics;

(E) using techniques that have been demonstrated to be effective in circumstances similar to those under consideration whenever possible and, when proposed development and restoration techniques have not yet advanced to the pilot demonstration stage, initiating their use on a small scale to allow corrective action if unanticipated adverse effects occur;

(F) timing dredging and dredged material disposal or placement activities to avoid spawning or migration seasons and other biologically critical time periods; and

(G) avoiding the destruction of remnant natural sites within areas already affected by development.

Compliance: The EA concluded that the project should not adversely affect vegetation, fish, or wildlife resources. The project will fill a man-made Pass that affects water circulation and salinity within Rollover Bay and East Bay. Filling the Pass may benefit fish and wildlife resources (e.g. oysters) by restoring salinity conditions that are more typical of the natural estuarine environment.

(7) Adverse effects on human use potential from dredging and dredged material disposal or placement can be minimized by:

(A) selecting sites and following procedures to prevent or minimize any potential damage to the aesthetically pleasing features of the site, particularly with respect to water quality;

(B) selecting sites which are not valuable as natural aquatic areas;

(C) timing dredging and dredged material disposal or placement activities to avoid the seasons or periods when human recreational activity associated with the site is most important; and

(D) selecting sites that will not increase incompatible human activity or require frequent dredge or fill maintenance activity in remote fish and wildlife areas.

Compliance: Rollover Pass, a nationally-recognized fishing destination, provides recreational fishing opportunities that would no longer exist after project construction. To mitigate the lost recreational benefits, the Texas General Land Office intends to construct additional recreational fishing amenities. Texas Senate Bill 2043 provides the legislative authority for this project and contains the following language regarding recreational impacts and mitigation:

> If the closing of a man-made Pass under this section results in a loss of public recreational opportunities, the commissioner shall develop, in consultation with the Parks and Wildlife Department and the county and, if applicable, the municipality in which the Pass is located, and approve a plan to mitigate the loss. In developing the plan, the commissioner is strongly encouraged to assess the

feasibility of installing fishing piers, boat ramps, and other facilities that provide public recreational opportunities. The plan must be presented to the public for comment before the commissioner approves it.

The General Land Office is committed to meeting the letter and spirit of the legislative mandate, including mitigation for loss of recreation.

(8) Adverse effects from new channels and basins can be minimized by locating them at sites:

(A) that ensure adequate flushing and avoid stagnant pockets; or

(B) that will create the fewest practicable adverse effects on CNRAs from additional infrastructure such as roads, bridges, causeways, piers, docks, wharves, transmission line crossings, and ancillary channels reasonably likely to be constructed as a result of the project; or

(C) with the least practicable risk that increased vessel traffic could result in navigation hazards, spills, or other forms of contamination which could adversely affect CNRAs;

(D) provided that, for any dredging of new channels or basins subject to the requirements of §501.15 of this title (relating to Policy for Major Actions), data and information on minimization of secondary adverse effects need not be produced or evaluated to comply with this subparagraph if such data and information is produced and evaluated in compliance with §501.15(b)(1) of this title (relating to Policy for Major Actions).

Compliance: The project proposes filling of an existing man-made Pass that is not used for navigation. The project would not create new channels, but would help restore the Pass to its natural condition.

(c) Disposal or placement of dredged material in existing contained dredge disposal sites identified and actively used as described in an environmental assessment or environmental impact statement issued prior to the effective date of this chapter shall be presumed to comply with the requirements of subsection (a) of this section unless modified in design, size, use, or function.

Compliance: This project does not propose dredged material placement within an existing contained dredged material disposal site.

(d) Dredged material from dredging projects in commercially navigable waterways is a potentially reusable resource and must be used beneficially in accordance with this policy.

(1) If the costs of the beneficial use of dredged material are reasonably comparable to the costs of disposal in a non-beneficial manner, the material shall be used beneficially.

Compliance: The proposed project will beneficially use dredged material from previous dredging events to fill Rollover Pass. The Pass has adversely impacted the coastal zone by accelerating erosion along the Bolivar Peninsula.

(2) If the costs of the beneficial use of dredged material are significantly greater than the costs of disposal in a non-beneficial manner, the material shall be used beneficially unless it is demonstrated that the costs of using the material beneficially are not reasonably

proportionate to the costs of the project and benefits that will result. Factors that shall be considered in determining whether the costs of the beneficial use are not reasonably proportionate to the benefits include, but are not limited to:

(A) environmental benefits, recreational benefits, flood or storm protection benefits, erosion prevention benefits, and economic development benefits;

(B) the proximity of the beneficial use site to the dredge site; and

(C) the quantity and quality of the dredged material and its suitability for beneficial use.

Compliance: The proposed project will beneficially use dredged material from previous dredging events to fill Rollover Pass. The Pass has adversely impacted the coastal zone by accelerating erosion along the Bolivar Peninsula.

(3) Examples of the beneficial use of dredged material include, but are not limited to:

(A) projects designed to reduce or minimize erosion or provide shoreline protection;

(B) projects designed to create or enhance public beaches or recreational areas;

(C) projects designed to benefit the sediment budget or littoral system;

(D) projects designed to improve or maintain terrestrial or aquatic wildlife habitat;

(E) projects designed to create new terrestrial or aquatic wildlife habitat, including the construction of marshlands, coastal wetlands, or other critical areas;

(F) projects designed and demonstrated to benefit benthic communities or aquatic vegetation;

(G) projects designed to create wildlife management areas, parks, airports, or other public facilities;

(H) projects designed to cap landfills or other waste disposal areas;

(I) projects designed to fill private property or upgrade agricultural land, if cost-effective public beneficial uses are not available; and

(J) projects designed to remediate past adverse impacts on the coastal zone.

(e) If dredged material cannot be used beneficially as provided in subsection (d)(2) of this section, to avoid and otherwise minimize adverse effects as required in subsection (a) of this section, preference will be given to the greatest extent practicable to disposal in:

(1) contained upland sites;

(2) other contained sites; and

(3) open water areas of relatively low productivity or low biological value.

(f) For new sites, dredged materials shall not be disposed of or placed directly on the boundaries of submerged lands or at such location so as to slump or migrate across the boundaries of submerged lands in the absence of an agreement between the affected public owner and the adjoining private owner or owners that defines the location of the boundary or boundaries affected by the deposition of the dredged material.

Compliance: This project will be fully coordinated with appropriate State and Federal agencies and other interested parties. Prior to construction, the GLO will satisfy all appropriate real estate requirements.