Coastal Texas Protection and Restoration Feasibility Study

Final Feasibility Report

Appendix D-22:

Cost Engineering Report

Clear Lake Gate System and Pump Station

Dickinson Bay Gate System and Pump Station

Galveston Ring Barrier System

Offatts Bayou Closure

August 2021

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COASTAL TEXAS PROTECTION AND RESTORATION FEASIBILITY STUDY
COST APPENDIX

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1. CONSTRUCTION COST NARRATIVE

1.1 Introduction

This report provides the background information for cost estimates developed in support of the Coastal Texas Protection and Restoration Feasibility Study. The following documentation includes information to support the development of an MCACES cost estimate for structural components of the project at three locations:

1. Clear Lake Facility (Gate, Floodwall, Pump Station)
2. Dickinson Bay (Gate, Floodwall, Pump Station)
3. Galveston Island (Pump Station, Stormwater Conduit)
4. Offats Bayou (Gate)

1.2 Site Descriptions

1.2.1 Clear Lake Facility

The primary structure at the proposed Clear Lake Facility is a pump station with a design capacity of 46,500 cubic feet per second (cfs). This would require installing thirty-one pumps that each have a capacity of 1,500-cfs. The pump station structure would also require flood walls extending from both ends to provide the level of protection required for the overall project. Lastly, a new floodgate system would be installed in the navigable waterway. A site layout for Clear Lake is provided in Attachment 1.

1.2.2 Dickinson Bay Facility

The primary structure at the proposed Dickinson Bay Facility is a pump station with a design capacity of 19,500 cubic feet per second (cfs). This would require installing thirteen pumps that each have a capacity of 1,500-cfs. The pump station structure would also require flood walls extending from both ends to provide the level of protection required for the overall project. Lastly, a new floodgate system would be installed in the navigable waterway. A site layout for Dickinson Bay is provided in Attachment 2.

1.2.3 Galveston Island Facility

There are a total of four facilities throughout this site location. The first structure at the proposed Galveston Island Facility is a pump station with a design capacity of 4,500 cubic feet per second (cfs). This would require installing nine pumps that each have a capacity of 500-cfs. The second structure is a pump station with a design capacity of 1,500-cfs. This would require installing three pumps that each have a capacity of 500-cfs. The third and fourth structure is a pump station that both have a design capacity of 5,000-cfs. This would require installing ten pumps that each have a capacity of 500-cfs at both facilities. Lastly, a stormwater conduit system would be installed at all four facilities. A site layout for Galveston Island is provided in Attachment 3.

1.2.4 Offats Bayou

This site consists of a 125-ft sector gate structure. A list of features for this facility was provided by the USACE, Galveston District for use in this estimate.

1.3 Purpose

The purpose of this work is to develop MCACES cost estimates – consistent to the level of design – for the listed components of the project. The costs within this document are not for budgetary purposes and are subject to change.

1.4 Design Features

Features include those components necessary to fully implement the proposed facilities. The design features at the sites have been designed to differing levels, and thus the quantities and costs have been developed based on these levels as well.

1.4.1 10 Percent Design Features

Some features of this cost estimate have been previously developed under a separate task. These quantities have been estimated based on approximately 10 percent design plans. The following features have been estimated to this level.

- Clear Lake Facility and Dickinson Bay Facility
    - T-walls
    - Floodwalls
    - Pump Station
    - Fuel Tank Foundations
    - Cofferdam
    - Discharge Piping
    - Sector Gate
    - Bulkhead Storage Platform
    - Sector Gate Monolith
    - Sector Gate Bulkhead
    - Pump Station Mechanical
    - Sector Gate Mechanical
    - Pump Station and Sector Gate Electrical
- Galveston Island Facility
    - Pump Station
    - Fuel Tank Foundations
    - Pump Station Mechanical
    - Pump Station Electrical
    - Stormwater Conduit

The detailed assumptions and quantity take-offs for the above features at Clear Lake are provided in Attachment 4. The detailed assumptions and quantity take-offs for Dickinson Bay are provided in Attachment 5. The detailed assumptions and quantity take-offs for Galveston Island are provided in Attachment 6.

1.4.2 Rough Order of Magnitude (ROM) Quantities

There are other project features, not currently designed but required to fully complete the proposed facilities. These features have had quantities developed as part of this effort and are not shown in the 10 percent design plans referenced previously. The following features had ROM quantities calculated and the quantity assumptions and take-offs are provided in Attachment 7.

- Clear Lake Facility and Dickinson Bay Facility
    - Utility and pipeline relocations
    - Site access, roadways and bridges
    - Excavation and dredging quantities
    - Riprap protection
    - Navigation approach walls
    - Changes to Clear Lake design due to Highway 146 buffer area

These features are based on preliminary, planning-level conceptual design information, and common engineering practices. Many investigations and studies remain to be completed in order to better quantify these items. As such, these quantities are subject to change as the project progresses and are solely intended for a preliminary estimate of potential costs for use in future risk assessments for this project. A brief discussion of the development of each of the ROM quantities is provided below.

1.4.2.1 Utility and Pipeline Relocations

Utility and pipeline location files were provided by the USACE, Galveston District. These shapefiles were overlaid on the site plans. Any pipelines that intersected the project footprint were assumed to be relocated. The demolition length was generally considered the length across the project footprint, and the relocation length was estimated as twice the demolished length.

1.4.2.2 Site Access, Roadways and Bridges

Site access and roadways were determined using the plan view for the project location. An access roadway was assumed to be placed as shown in the quantity calculation page. Bridges were assumed to be constructed over waterways where land-based equipment was assumed to require access. Access roads and bridges are not currently assumed to be required at Dickinson Bay.

1.4.2.3 Excavation and Dredging

The ROM dredging quantities account for the dredging required at the inlet to the pump stations and the outlet to the discharge pipes. The dredging quantities used NOAA data and charts to obtain estimated floor elevations below the water level (NOAA). Assumed depths and other assumptions are provided in the quantity attachments. The excavation ROM quantities account for the excavation required for the land-based placement of the discharge piping.

1.4.2.4 Riprap Protection

Riprap is assumed to be required for two of the project features at both Clear Lake and Dickinson Bay Facilities. The first is for the T-walls. It is assumed that a 3-ft section of riprap would be placed for 100-ft on both sides of the wall. The other feature requiring riprap are the sector gates. It is assumed that riprap would be placed upstream/downstream of the four proposed guidewalls leading into/out of the sector gate channel.

A detailed analysis of stone sizing and scour analysis has not been performed as part of this analysis. The completion of this type of analysis would likely lead to a change in quantity and cost for the riprap features.

1.4.2.5 Navigation Approach Walls

The quantities for the navigation walls assumed 4 walls each 120-ft long, one wall for each side of both approaches to the sector gate structure. Each approach wall is assumed to consist of twelve pile clusters, 120-ft of fender system, and two dolphin structures. The navigation approach walls are assumed to be the same exact structures between the CClear Lake and Dickinson Bay Facilities.

1.4.2.6 Changes to Clear Lake Design Due to Highway146 Buffer Area

The Highway 146 Buffer Area is currently assumed to require moving the proposed Clear Lake pump station 100-ft from its current location. For estimating purposes, the only feature of the design that is assumed to change is the length of the discharge pipes. For each discharge pipeline an additional 100-ft was added from the 10 percent design quantity calculations.

1.4.3 USACE Provided Quantities

The Offats Bayou Facility quantities have been provided by the USACE, Galveston District. No changes to the quantities were made during the development of this estimate. The quantity and cost summary are provided in Attachment 8.

1.5 Construction Schedule

Tentative construction schedules have been developed for each of the four project sites. The schedules assume the sites are stand alone contracts that are not dependent on any other project features. The schedules have primarily been developed in order to calculate job office overhead markups for each contract. The construction schedules are provided in Attachment 9, and the total durations for each contract are as follows:

- Clear Lake 78 months
- Dickinson Bay 44 months
- Galveston Island 40 months
- Offats Bayou 21 months

1.6 Acquisition Plan

The cost estimate currently assumes that each of the different project locations would be let out under separate contracts. The contracting plan also assumes that subcontractors would be required for dewatering, concrete placement, pile driving, structural steel, electrical and mechanical work. The prime contractors are assumed to be responsible for all the preparatory work and placing all associated site work as well as overseeing the subcontractors' work. The estimate assumes the project would be let out in an unrestricted bid process and is expected to have a competitive bidding market. No small business contracts are assumed due to the overall size of the project.

1.7 Project Construction and Cost Methodology

1.7.1 Mobilization/Demobilization

Mobilization and demobilization costs account for the transportation of all construction equipment and personnel to and from the project site. All equipment and labor are assumed to be available in the greater Houston/Galveston region. Costs for this item also includes tug and barge mobilization.

1.7.2 Staging and Site Access

The cost estimate includes the installation of access roads, assumed to be fully paved, and the placement of bridge across waterways to connect site access points. The unit costs for the bridges were taken from Texas Department of Transportation average unit cost tables[1].

1.7.2.1 Borrow/Disposal Areas and Materials

Borrow materials are assumed to be available in the greater Galveston/Houston region. Any borrow material required is assumed to be transported into the project site.

Any excess earthen material is assumed to be hauled off-site by the contractor to a disposal location. The estimate assumes a 25-mile haul distance for disposal of all excess materials.

1.7.3 Construction Methodology Clear Lake and Dickinson Bay

Both the Clear Lake and Dickinson Bay sites have the same construction components assumed to be installed, just with differing quantities. Therefore, the following is a brief discussion of the proposed construction elements used in the development of the cost estimate for each feature at the pump station sites.

1.7.3.1 T-Walls (Type 1 and 2)

The construction cost for the T-walls accounts for full installation of the walls. These walls would be installed via land-based equipment. The costs include excavating with the use of hydraulic excavators. Rows of 3, 24-in battered steel pipe piles, and a sheet pile cutoff wall would then be installed (see Figure 1). The reinforced concrete base slab and wall would be cast-in-place next, followed by compacted backfill using the previously excavated material.

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[1] https://www.txdot.gov/inside-txdot/forms-publications/consultants-contractors/publications/bridge.html

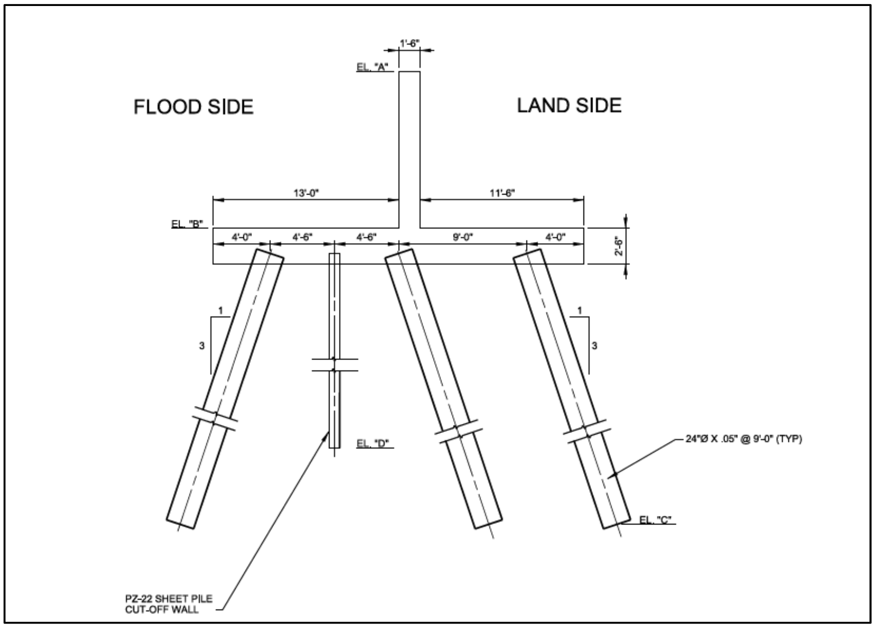


Figure 1 – Sample T-wall Cross Section

1.7.3.2 Floodwall

Unlike the T-walls which are constructed in-the-dry on land, the floodwall will be constructed in-the-wet. This construction cost item accounts for the full installation of the floodwall via barge mounted equipment. The cost for the floodwall includes installation of 42-in concrete piles, 18-in steel pipe piles, and 6-in square concrete piles (see Figure 2). A reinforced concrete pile cap would be installed on top of the piles to complete the wall.

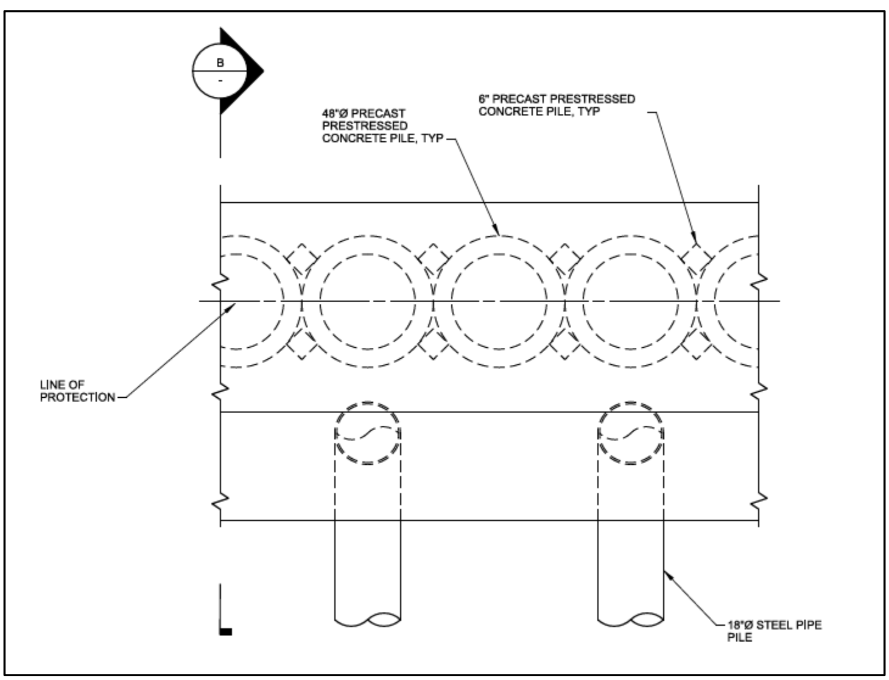


Figure 2 – Sample Floodwall Plan View

1.7.3.3 Pump Station - Structure

The foundation area of the pump stations will be coffered off with steel sheet piles and excavated in the wet. A tremie slab would be placed on top of a gravel layer within the coffered area. Next, 24-in pipe piles would be installed, followed by the placement of reinforced concrete slab and walls for the substructure. The pump station superstructure would then be poured, with a steel frame roof system installed above (see Figure 3). The pump station (substructure, pumps, superstructure) is based on the West Closure Complex pump station. A safe house facility would be constructed on site as well.

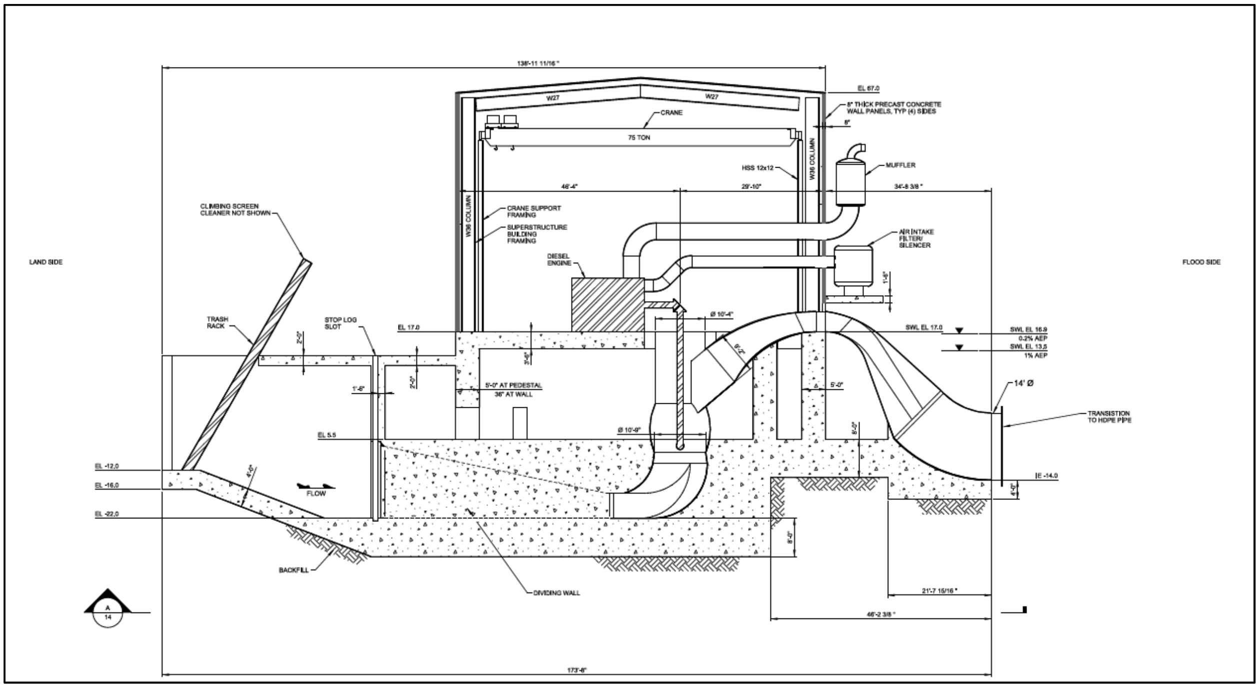


Figure 3 – Sample Pump Station Cross Section

1.7.3.4 Pump Station - Fuel Tank Foundations

The foundations for the fuel tanks would be constructed in the dry. The foundation would be constructed of reinforced concrete placed on top of 24-in battered pipe piles.

1.7.3.5 Pump Station - Discharge Pipes

The discharge pipes are assumed to be 14-ft Spirolite Pipe. The estimate assumes approximately half the pipe length would be installed via land-based equipment, with common excavation to install. The other half of the pipe would be installed using barge mounted equipment. The placement of the pipes in the water also require precast concrete collars. Price quotes for the pipe and collars were obtained, see Attachment 10 for the pricing backup information.

1.7.3.6 Pump Station - Mechanical and Electrical Items

The primary component in the mechanical list for the pump stations are the actual pumps themselves. A cost quote was obtained for the 1,500-cfs pumps, and other mechanical equipment. A full list of mechanical equipment and pricing sources is provided in Attachment 10.

The electrical components were primarily estimated using the MCACES Cost Book database.

1.7.3.7 Pump Station - Dredging

Dredging costs are currently included in the cost estimate and are estimated using a cost book item. However, costs are anticipated to be updated with estimated unit prices from CEDEP once provided by the USACE, Galveston District.

1.7.3.8 Sector Gates

The sector gates are to be constructed of steel members with UHMW fenders attached. The unit cost for the gate fabrication was taken from the IHNC GIWW Sector Gate and Maintenance Bulkheads Project.

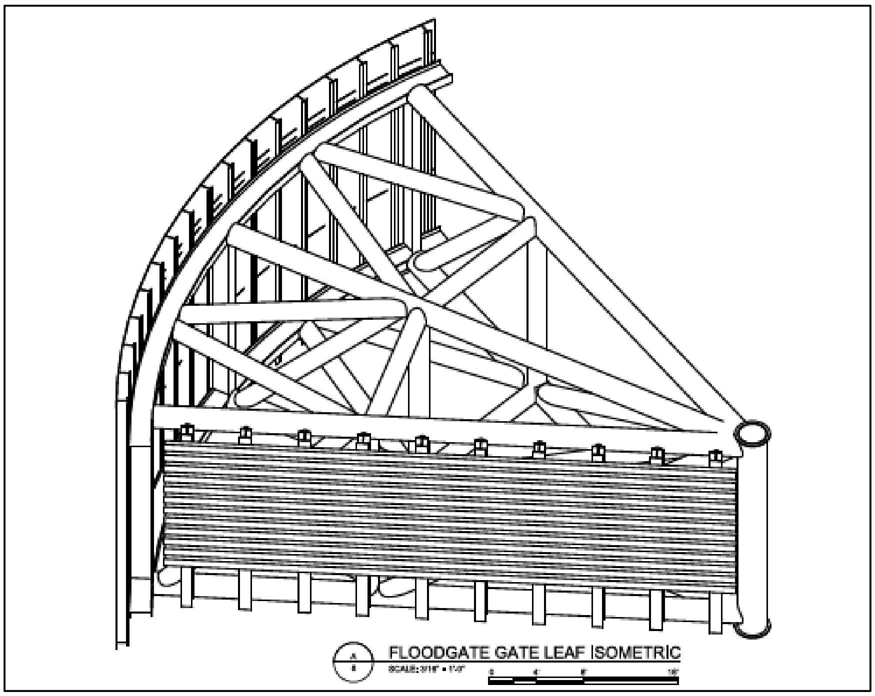


Figure 4 – Sample Sector Gate Drawing

1.7.3.9 Sector Gate – Bulkhead Storage Platform

The bulkhead storage platform would consist of a concrete platform placed on top of a 24-in pipe pile foundation. The platform is assumed to be constructed in the dry.

1.7.3.10 Sector Gate – Monoliths

The concrete monoliths would be constructed within a sheet pile cofferdam. Some excavation would be required, followed by the installation of a tremie slab to help with seepage. The concrete monolith structure would then be poured, and a control building would be constructed on each of the monoliths.

1.7.3.11 Sector Gate – Maintenance Bulkheads

The maintenance bulkheads would be fabricated from steel. The bulkhead unit price was taken from the IHNC GIWW Sector Gate and Maintenance Bulkheads Project.

1.7.3.12 Sector Gate – Mechanical Items

The mechanical items for the sector gate consist of the hinge and pintel, and the machinery and operating equipment. The hinge and pintel would be steel fabricated items. The unit price for the hinge and pintel, as well as the required operating equipment, were taken from the Inner Harbor Navigation Canal Hurricane Protection Project.

1.7.3.13 Sector Gates – Navigation Approach Walls

The navigation approach walls are assumed to be 120-ft long each and are based on the approach walls at Harvey Canal Sector Gate Complex. They are assumed to consist of pile clusters, dolphin structures, and a fender system. The unit prices for these structures was taken from the Harvey Canal Project.

1.7.3.14 Sector Gates - Electrical Items

The electrical components were primarily estimated using the MCACES Cost Book database.

1.7.3.15 Sector Gates – Riprap

Riprap is assumed to be placed upstream/downstream of each of the four navigation approach walls. The riprap is assumed to be placed via barge mounted equipment.

1.7.4 Cost Methodology Galveston Island

The Galveston Island pump station sites have similar construction components compared to the Clear Lake and Dickinson Bay sites, just with differing quantities. The following is a brief discussion of the proposed construction elements used in the development of the cost estimate for each feature at the pump station sites.

1.7.4.1 Pump Station – Structure

The foundation area of the pump stations will be coffered off with steel sheet piles and excavated in the wet. A tremie slab would be placed on top of a gravel layer within the coffered area. Next, 24-in pipe piles would be installed, followed by the placement of reinforced concrete slab and walls for the substructure. The pump station superstructure would then be poured, with a steel frame roof system installed above (see Figure 3). The pump station (substructure, pumps, superstructure) is based on the West Closure Complex pump station.

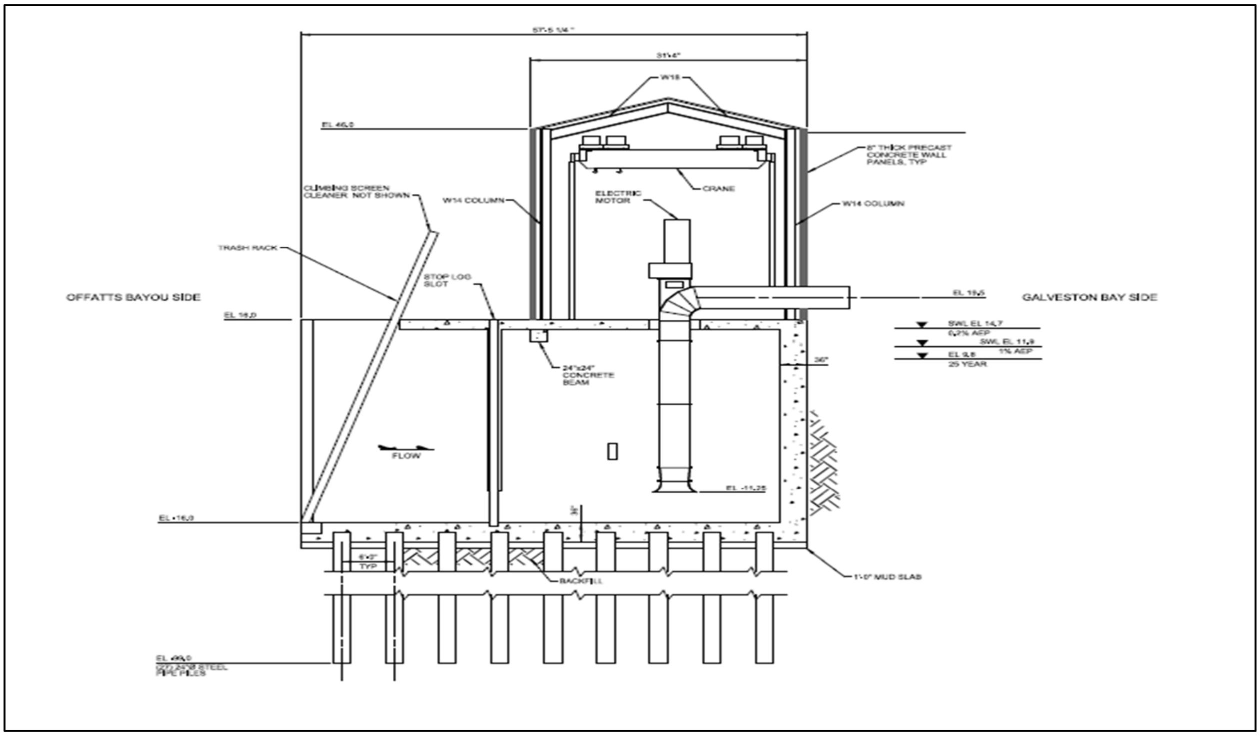


Figure 5 – Sample Pump Station Cross Section

1.7.4.2 Pump Station - Fuel Tank Foundations

The foundations for the fuel tanks would be constructed in the dry. The foundation would be constructed of reinforced concrete placed on top of 24-in battered pipe piles.

1.7.4.3 Pump Station - Mechanical and Electrical Items

The primary component in the mechanical list for the pump stations are the actual pumps themselves. A full list of mechanical equipment and pricing sources is provided in Attachment 10.

The electrical components were primarily estimated using the MCACES Cost Book database.

1.7.4.4 Stormwater Conduit

The stormwater conduits are currently assumed to be constructed beneath existing roadways. The estimate assumes full demolition of the roadways, with replacement at the end of construction. The required excavation would include the use of temporary sheet pile shoring on both sides of the trench. A gravel layer would be installed underneath the proposed reinforced, cast-in-place concrete conduits.

1.7.5 Cost Methodology Offats Bayou

As referenced previously, the quantities for Offats Bayou were provided by the USACE Galveston District. The quantity list provided quantities for key features, but also provided total costs for other elements per a lump sum quantity (see Attachment 8). For all items where a detailed quantity was provided, costs were estimated using similar methodologies and assumptions as referenced for the Clear Lake and Dickinson Bay facilities. But for lump sum items, where no quantity was provided, the listed cost from the USACE estimate was input into the MCACES. Therefore, the cost items developed for Offats Bayou are a combination of detailed unit cost development, and lump sum inputs.

1.8 Effective Dates for Labor, Equipment and Material Pricing

The labor, equipment and material pricing were developed using the MCACES 2016 English Unit Cost Library, the National Labor Library (per guidance from USACE, Galveston District), and the 2016 Equipment Library (Region VI) for the base cost estimate. The index pricing date has been prepared in February 2020 dollars.

The MCACES cost estimate has been updated with current quoted fuel prices of \$2.62/gal for off-road diesel, \$2.99/gal for on-road diesel and \$2.61/gal for gasoline in the Galveston area.

1.9 Estimated Production Rates

Much of the construction cost estimate was developed utilizing user defined crews and production rates. See Attachment 11 for the estimated production rates developed for this project.

1.10 Project Markups and Functional Costs

1.10.1 Escalation

No escalation has been included in the alternative estimates.

1.10.2 Preliminary Alternative Estimates Contingency

No contingency has been included in the MCACES estimate. It is assumed that the costs from this estimate will be incorporated into a cost and schedule risk analysis (CSRA) process, to be completed at a later date, for contingency development.

1.10.3 Real Estate Costs

No real estate costs are included in the MCACES estimate. Real estate required during construction and permanently will be defined by the USACE. Real estate costs for these sites are assumed to be developed by the USACE and incorporated into the full project.

1.10.4 Relocation Costs

Relocation costs have been included as part of the Non-Federal costs in the MCACES estimate. The relocations are assumed to include the removal and relocation of existing pipelines located at each of the sites.

1.10.5 Planning, Engineering and Design

No cost for planning, engineering and design is included in the MCACES estimate.

1.10.6 Construction Management

No cost for construction management is included in the MCACES estimate.

1.10.7 Operations and Maintenance (O&M)

Operations and maintenance (O&M) costs have been developed for each project site. The O&M estimates are conceptual level estimates and have been calculated for comparison purposes only. In order to estimate O&M costs for each site, general assumptions were developed to estimate costs spent for each O&M activity, as well as number of times each O&M activity would occur over an assumed 50 year project life. These costs and assumptions were developed in spreadsheet format, and the spreadsheet estimates are provided in Attachment 12. Table 1 shows the annual O&M cost for each project site.

Table 1 – Annual O&M Cost Summary

Project Site	Annual O&M
Clear Lake Facility	$5,165,000
Dickinson Bay Facility	$2,545,000
Galveston Island Pump Stations	$2,777,000
Offats Bayou Sector Gate	$178,000

1.10.8 Environmental Mitigation

No costs are currently included in the MCACES estimate for environmental mitigation. Per the scope of work for this effort, these costs are assumed to be developed by the USACE.

1.11 MCACES Construction Cost Estimate

The construction cost estimate was developed using MCACES 2nd Generation (MII) estimating software in accordance with guidance contained in ER 1110-2-1302, Civil Works Cost Engineering. Table 2 provides the total construction costs from the MCACES for each of the sites. See Attachment 11 for the MII output report.

Table 2 – MCACES Construction Cost Summary

MCACES Item Description	Construction Cost
Clear Lake Facility	$1,082,140,000
Dickinson Bay Facility	$496,581,000
Galveston Island Pump Stations	$409,842,000
Offats Bayou Sector Gate	$34,114,000
Total Cost	$2,022,677,000

2. REFERENCES

- NOAA Chart 11327, Upper Galveston Bay – Houston Ship Channel, Booklet Chart, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 2017.

- U.S. Army Corps of Engineers, 1993, *Engineering and Design Cost Engineering Policy and General Requirements, Engineering Regulation 1110-1-1300,* Department of the Army, Washington D.C., 26 March 1993.

- U.S. Army Corps of Engineers, 1999, *Engineering and Design For Civil Works Projects, Engineering Regulation 1110-2-1150,* Department of the Army, Washington D.C., 31 August 1999.

- U.S. Army Corps of Engineers, 2008a, *Civil Works Cost Engineering, Engineering Regulation 1110-2-1302,* Department of the Army, Washington D.C., 15 September 2008.

- U.S. Army Corps of Engineers, 2008b, *Construction Cost Estimating Guide For Civil Works, Engineering Technical Letter 1110-2-573,* Department of the Army, Washington D.C., 30 September 2008.

- U.S. Army Corps of Engineers, 2010, *Civil Works Construction Cost Index System, Engineering Manual 1110-2-1304,* Department of the Army, Washington D.C., 31 March 2014

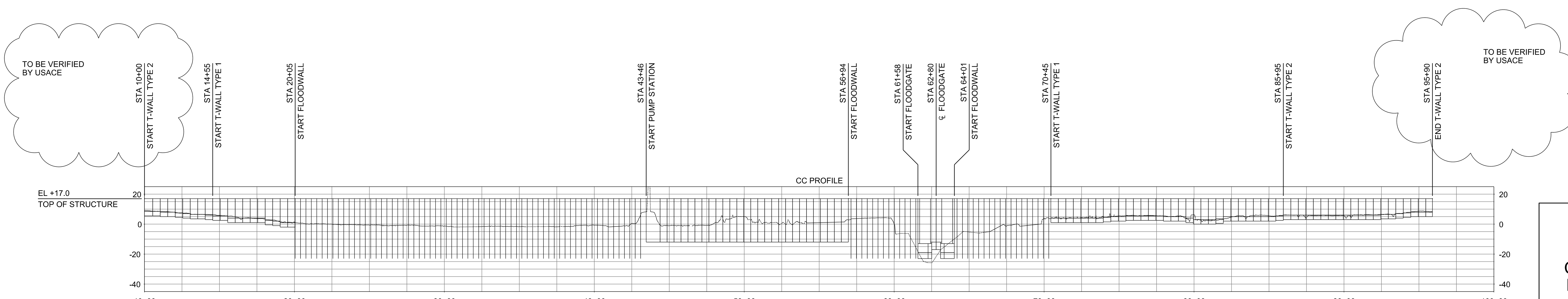
Attachment 1

Clear Lake Site Layout

CLEAR CREEK - GENERAL PLAN

SCALE: 1" = 400'

0 400' 800'



A
-
ELEVATION VIEW

SCALE: 1" = 400' HORIZONTAL, 1"=40' VERTICAL

0 400' 800'

CLEAR CREEK
GENERAL PLAN & ELEVATION

COASTAL TEXAS PROTECTION AND
RESTORATION FEASIBILITY STUDY

U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS

ENGINEERING APPENDIX
DATED:
NOVEMBER 9, 2018

TETRA TECH, INC.

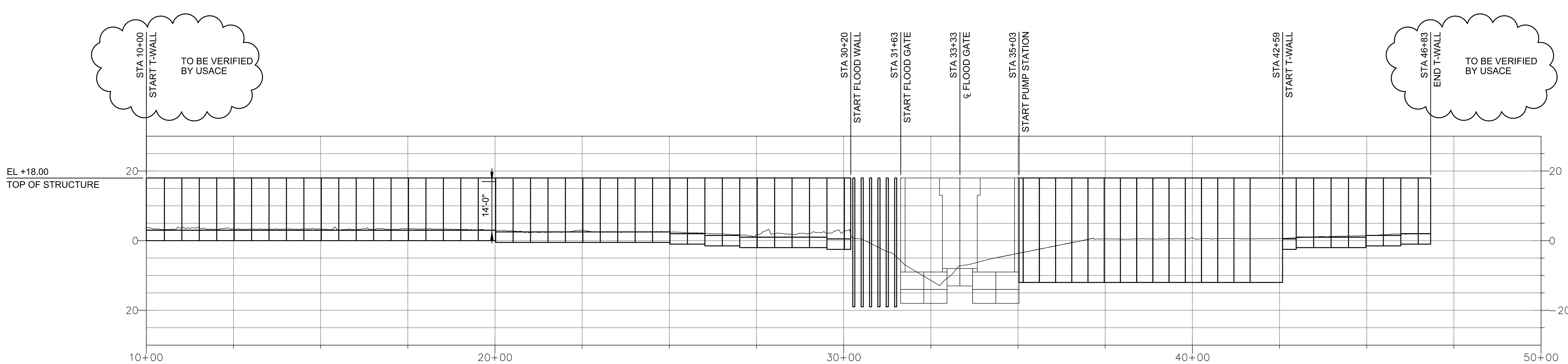
PLATE 1

Attachment 2

Dickinson Bay Site Layout

DICKINSON BAYOU - GENERAL PLAN

SCALE: 1" = 200'



ELEVATION VIEW

SCALE: 1" = 200'

DINKINSON BAYOU
GENERAL PLAN AND ELEVATION

COASTAL TEXAS PROTECTION AND RESTORATION FEASIBILITY STUDY

U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS

ENGINEERING APPENDIX
DATED:
NOVEMBER 9, 2018
TETRA TECH, INC.

Attachment 3

Galveston Island Site Layout

GALVESTON ISLAND - VICINITY PLAN

SCALE: 1" = 2000'

0 2000' 4000'

GALVESTON ISLAND
PUMP STATIONS
VICINITY PLAN

COASTAL TEXAS PROTECTION AND RESTORATION FEASIBILITY STUDY

U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS

ENGINEERING APPENDIX
DATED:
NOVEMBER 9, 2018

TETRA TECH, INC.

Attachment 4

Clear Lake 10 Percent Design Quantity Take-offs

TETRA TECH	Clear Creek T-Wall Quantities	Calculation No. CC-FW-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Clear Creek T-Wall Quantities				
Made By:	LN	**Date:** 07/23/18	**Chk'd By:** DS	**Date:**	08/17/18

Calc Body Pages	Appended Pages	Total Pages
12	0	12

Document code

Site	Feature	Discipline	Document type	Number
CC	FW	ST	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Lexee Navarre 8/22/18	Daniel Stuard 8/22/18	

TETRA TECH	**Clear Creek T-Wall Quantities**		**Calculation No.** **CC-FW-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LN	**Date:**	07/23/18	**Chk'd By:**	DS	**Date:**	08/17/18

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TETRA TECH	**Clear Creek T-Wall Quantities**	**Calculation No.** **CC-FW-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LN	**Date:**	07/23/18	**Chk'd By:**	DS	**Date:**	08/17/18

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for T-Walls.

APPROACH

Typical engineering means and methods for determining volumes and weights.

REFERENCES

References used during this calculation are as follows:

1) CC-FW-ST-CL-001
2) CC-FW-ST-CL-002
3) HSDRRS - DG with Revisions through June 2012

RESULTS / CONCLUSIONS

T-Wall 1:

Total Dry Excavation:	8867	yd^3			
Total Fill:	2800	yd^3			
Total # of Battered Pipe Piles:	700	(All piles have tension connections)			
Total 24" Diam. X 0.5" Steel Battered Pipe Pile:	44825	ft	**or**	2815	tons
Total PZ-22 Steel Sheet Pile:	22575	ft^2	**or**	248	tons
Total Concrete:	8244	yd^3			

T-Wall 2:

Total Dry Excavation:	4900	yd^3			
Total Fill:	1410	yd^3			
Total # of Battered Pipe Piles:	483	(All piles have tension connections)			
Total 24" Diam. X 0.5" Steel Battered Pipe Pile:	29932	ft	**or**	1880	tons
Total PZ-22 Steel Sheet Pile:	15588	ft^2	**or**	171	tons
Total Concrete:	4377	yd^3			

Combined Total:

Total Dry Excavation:	13767	yd^3			
Total Fill:	4210	yd^3			
Total # of Battered Pipe Piles:	1183	(All piles have tension connections)			
Total 24" Diam. X 0.5" Steel Battered Pipe Pile:	74757	ft	**or**	4695	tons
Total PZ-22 Steel Sheet Pile:	38163	ft^2	**or**	420	tons
Total Concrete:	12621	yd^3			

Job No.:	100-RCE-18-09-1					**Page:**	4
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LN	**Date:**	07/23/18	**Chk'd By:**	DS	**Date:**	08/17/18

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) A minimum PZ-22 hot rolled sheet piling shall be utilized for seepage cut-off. (HSDRRS)
2) Sheet pile tip shall extend a minimum of 10 feet beneath the T-Wall base. (HSDRRS)
3) Material Properties:
    - Concrete, f'c = 4000 psi
    - Reinforcement = ASTM A615 Grade 60
    - Pipe Piles = ASTM A252 Grade 3
    - Sheet Piles = ASTM A328
4) Costs of reinforcement is included in reinforced concrete unit cost.
5) All piles have tension connections.

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Start and end locations.
2) T-wall geometry.
3) Material types.

CALCULATIONS

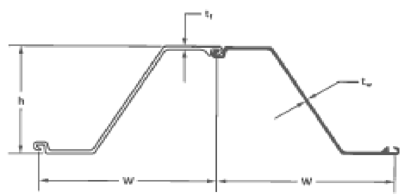
Start on next page.

Job No.:	100-RCE-18-09-1					**Page:**	5
Project:	Coastal Texas Protection and Restoration						
Description:	General References and Figures						
Made By:	LN	**Date:**	07/23/18	**Chk'd By:**	DS	**Date:**	08/17/18

General References and Figures

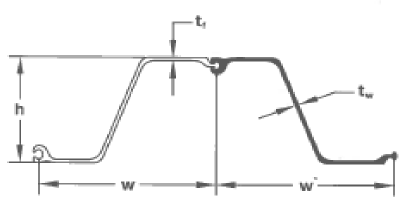
NZ/PZ

NZ/PZ Hot Rolled Steel Sheet Pile



NZ

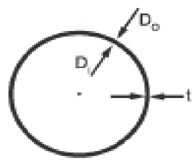
SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Web (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
NZ 19	27.56 700	16.14 410.0	0.375 9.5	0.375 9.5	7.04 148.9	55 81.85	23.95 116.93	35.08 1886	41.33 2222	233.1 38659	6.18 1.88	1.35 1.35
NZ 20	27.56 700	16.16 410.5	0.394 10.0	0.394 10.0	7.29 154.4	57 84.83	24.82 121.18	36.24 1948	42.80 2301	292.8 39984	6.18 1.88	1.35 1.35
NZ 21	27.56 700	16.20 411.5	0.433 11.0	0.433 11.0	7.80 165.2	61 90.78	26.56 129.68	38.69 2080	45.85 2465	313.4 42797	6.18 1.88	1.35 1.35
NZ 26	27.56 700	17.32 440.0	0.500 12.7	0.500 12.7	9.08 192.3	71 105.66	30.92 150.94	48.50 2608	57.01 3065	419.9 57340	6.49 1.98	1.41 1.41



PZ

SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Wall (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
PZ 22	22.0 559	9.0 229	0.375 9.50	0.375 9.50	6.47 136.9	40.3 60.0	22.0 107.4	18.1 973	21.79 1171.4	84.38 11500	4.48 1.37	1.22 1.22
PZ 27	18.0 457	12.0 305	0.375 9.50	0.375 9.50	7.94 168.1	40.5 60.3	27.0 131.8	30.2 1620	36.49 1961.9	184.20 25200	4.48 1.37	1.49 1.49
PZ 35	22.6 575	14.9 378	0.600 15.21	0.500 12.67	10.29 217.8	66.0 98.2	35.0 170.9	48.5 2608	57.17 3073.5	361.22 49300	5.37 1.64	1.42 1.42
PZ 40	19.7 500	16.1 409	0.600 15.21	0.500 12.67	11.77 249.1	65.6 97.6	40.0 195.3	60.7 3263	71.92 3866.7	490.85 67000	5.37 1.64	1.64 1.64

Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = 10.69*t*(D_o-t)
D_o (in) - outside diameter
t (in) - thickness of pipe

Pipe Weight (kg/m) = 0.0247*t*(D_o-t)
D_o (mm) - outside diameter
t (mm) - thickness of pipe

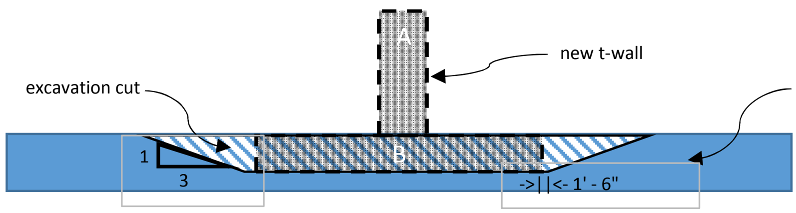
PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

Quantities for T-Wall 1

Start Station for T-Wall:	14+55	&	70+45
End Station for T-Wall:	20+05	&	85+95
Total Length of Wall:	2100.0 ft		

Figure 1:



EXCAVATION FOR T-WALL 1:

Base Excavation Width:	29.0	ft	**Cross Sectional Area:**	114.0	ft^2
Excavation Slope:	1:3	(V:H)	**Total Length of Wall:**	2100.0	ft
Excavation Depth:	3.0	ft			
Surface Excavation Width:	47.0	ft			

Volume of Excavation Cut: 8867 yd^3

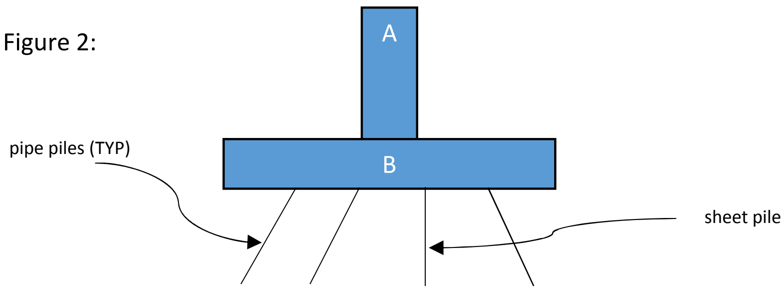
FILL FOR T-WALL 1:

After the T-Wall is placed, the remaining space of the initial excavation cut will need to be filled.
This value is just the initial cut minus the base of the T-Wall (Section B, see figure above).
See concrete section for each T-Wall for calculations of the wall base volumes.

Volume of Cut for T-Wall 1:	8866.7 yd^3
Volume of Base of T-Wall 1:	6066.7 yd^3

Volume of Fill for T-Wall 1: 2800 yd^3

Figure 2:



BATTERED PILES

Steel Pipe Piles with a spacing of 9 feet along the length of the wall. The minimum tip embedment is to be 60 feet plus 9 inches of embedment into concrete slab.

Pile Diameter:	24.0 in	**Batter:**	3:1 (V:H)
Pipe Thickness:	0.5 in	**Total Length of Wall:**	2100.0 ft
Pile Tip to Head Embedment:	60.75 ft	**Pile Spacing Along Wall:**	9.0 ft
Pipe Weight*:	125.61 lb/ft	**# of Pile Rows:**	3

*see general references attachments for reference of produced value

# of Piles	# of Pile Rows	Length (ft)	Total Length (ft)	Pipe Weight (lb/ft)	Weight (tons)
233	3	64.04	14941.76	125.61	938.42

TOTALS:	**# of Battered Piles:**	**700**
	Length:	**44825 ft**
	Weight:	**2815 tons**

SHEET PILE WALL

A PZ-22 hot rolled sheet piling shall be utilized for seepage cutoff with a depth of 10 feet of embedment plus 9 inches of embedment into the concrete slab.

Height of Wall: 10.75 ft
Length of Wall: 2100.0 ft
Weight of Wall*: 22.0 lb/ft^2

*see general references attachments for reference of produced value

# of Walls	Area (ft^2)	Weight of Wall (lb/ft^2)	Weight (tons)
1	22575.00	22.0	248.33

TOTALS:	**Area:**	**22575 ft^2**
	Weight:	**248 tons**

CONCRETE

Section*	Height (ft)	Width (ft)	Cross Sectional Area (ft^2)	Length (ft)	Volume (yd^3)
A	14.0	2.0	28.0	2100.0	2177.8
B	3.0	26.0	78.0	2100.0	6066.7

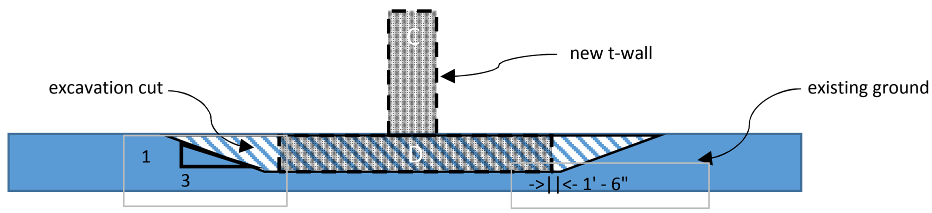
*see Figure 2 for sections

Total Concrete:	**8244 yd^3**

Quantities for T-Wall 2

Start Station for T-Wall:	10+00	&	85+95
End Station for T-Wall:	14+55	&	95+90
Total Length of Wall:	1450.0 ft		

Figure 3:



EXCAVATION FOR T-WALL 2:

Base Excavation Width:	29.0	ft	**Cross Sectional Area:**	91.3	ft^2
Excavation Slope:	1:3	(V:H)	**Total Length of Wall:**	1450.0	ft
Excavation Depth:	2.5	ft			
Surface Excavation Width:	44.0	ft			

Volume of Excavation Cut: 4900 yd^3

FILL FOR T-WALL 2:

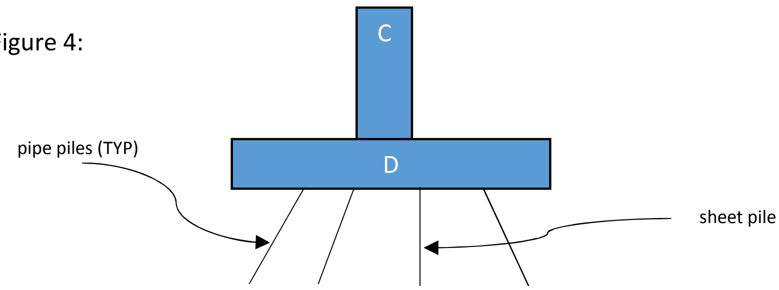
After the T-Wall is placed, the remaining space of the initial excavation cut will need to be filled.
This value is just the initial cut minus the base of the T-Wall (Section B, see figure above).
See concrete section for each T-Wall for calculations of the wall base volumes.

Volume of Cut for T-Wall 2:	4900.5 yd^3
Volume of Base of T-Wall 2:	3490.7 yd^3

Volume of Fill for T-Wall 2: 1410 yd^3

Job No.:	100-RCE-18-09-1					**Page:**	11
Project:	Coastal Texas Protection and Restoration						
Description:	Quantities for T-Wall 2						
Made By:	LN	**Date:**	07/23/18	**Chk'd By:**	DS	**Date:**	08/17/18

Figure 4:



BATTERED PILES

Steel Pipe Piles with a spacing of 9 feet along the length of the wall. The minimum tip embedment is to be 58 feet plus 9 inches of embedment into concrete slab.

Pile Diameter:	24.0 in	**Batter:**	3:1 (V:H)
Pipe Thickness:	0.5 in	**Total Length of Wall:**	1450.0 ft
Pile Tip to Head Embedment:	58.75 ft	**Pile Spacing Along Wall:**	9.0 ft
Pipe Weight*:	125.61 lb/ft	**# of Pile Rows:**	3

*see general references attachments for reference of produced value

# of Piles	# of Pile Rows	Length (ft)	Total Length (ft)	Pipe Weight (lb/ft)	Weight (tons)
161	3	61.93	9977.28	125.61	626.62

TOTALS:	**# of Battered Piles:**	**483**
	Length:	**29932 ft**
	Weight:	**1880 tons**

SHEET PILE WALL

A PZ-22 hot rolled sheet piling shall be utilized for seepage cutoff with a depth of 10 feet of embedment plus 9 inches of overlap into the concrete slab.

Height of Wall: 10.75 ft
Length of Wall: 1450.0 ft
Weight of Wall*: 22.0 lb/ft^2
*see general references attachments for reference of produced value

# of Walls	Area (ft^2)	Weight of Wall (lb/ft^2)	Weight (tons)
1	15587.50	22.0	171.46

TOTALS:	**Area:**	**15588 ft^2**
	Weight:	**171 tons**

CONCRETE

Section*	Height (ft)	Width (ft)	Cross Sectional Area (ft^2)	Length (ft)	Volume (yd^3)
C	11.0	1.5	16.5	1450.0	886.1
D	2.5	26.0	65.0	1450.0	3490.7

*see Figure 4 for sections

Total Concrete: 4377 yd^3

TETRA TECH	Clear Creek Floodwall Material Take-off	Calculation No. CC-FW-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Clear Creek Floodwall Material Take-off				
Made By:	LRM	**Date:** 11/07/18	**Chk'd By:** JK	**Date:**	11/08/18

Calc Body Pages	Appended Pages	Total Pages
7		7

Document code

Site	Feature	Discipline	Document type	Number
CC	FW	ST	MT	002

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Leo Moyer 11/8/18 [signature]	Jason Kikuta 11/8/18 [signature]	

TETRA TECH	Clear Creek Floodwall Material Take-off	Calculation No. CC-FW-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LRM	**Date:**	11/07/18	**Chk'd By:**	JK	**Date:**	11/08/18

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Attachments	Number of Pages	Last Page Number

TETRA TECH	Clear Creek Floodwall Material Take-off	Calculation No. CC-FW-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LRM	**Date:**	11/07/18	**Chk'd By:**	JK	**Date:**	11/08/18

ISSUE BEING ADDRESSED

Material take-off for the Clear Creek floodwall.

APPROACH

Calculate a material take-off for a typical running foot of the flood wall, which consists of vertical soldier piles, batter piles, a concrete pile cap, and 6-inch square precast piles. For the pile cap, assume a nominal reinforcing ratio. Once the typical quantity per running foot is calculated, multiply it by the length of the flood wall.

REFERENCES

References used during this calculation are as follows:

1) Clear Creek Floodwall detail, plate 3

RESULTS / CONCLUSIONS

See last page for quantities

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) The 6-inch precast concrete piles are 50 feet long
2) The reinforcing ratio of the pile cap

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Additional appurtenances for the flood wall
2) The actual reinforcing quantities for the pile cap
3) Details for the pile connectors to the pile cap
4) Infill for the pile and grouting between the soldier piles and the square precast piles will be included at a later design phase.

CALCULATIONS

TETRA TECH	Clear Creek Floodwall Material Take-off		Calculation No. CC-FW-ST-MT-002
Job No.:	100-RCE-18-09-1	**Page:**	5
Project:	Coastal Texas Protection and Restoration		
Description:	Floodwall Reaches		
Made By:	LRM **Date:** 11/07/18	**Chk'd By:** JK	**Date:** 11/08/18

Floodwall Reaches

References

Plate 3, Floodwall detail

	Starting Station	Ending Station	Length (ft)
Reach 1	20+05	43+46	2341
Reach 2	59+94	61+58	164
Reach 3	64+01	70+45	644
Total			**3149**

Material Take-offs per Foot of Wall

Inputs

Typical concrete reinforcing ratio	rho	0.010	
Rebar weight		490	pcf

Material take-offs

Soldier piles (48-inch precast, prestressed concrete piles, LF)

Spacing		4	ft per each
Typical pile length	top EL	15.25	
	tip EL	-70.00	
		85.25	LF/each

Batter piles (18x0.625 inch steel pipe pile, LF)

Spacing		8	ft per each
Typical pile length	top EL	15.25	
	tip EL	-98.00	
	batter angle	3	V:1H
		120	LF/each (rounded up to nearest foot)

Infill piles (pairs of 6-inch square precast, prestressed piles, LF)

Spacing		4	ft per each pair
Typical pile length	top EL	15.25	
	tip EL	-34.75	
		100	LF/each pair (two piles)

Pile Cap (reinforced concrete, cubic yards)

Continuous for length of wall		
Cross sectional area	17.8	ft^2
Volume per length of wall	**0.657**	$yard^3$ per ft of wall

Rebar (tons)

Volume of rebar	0.178	ft^3 per ft of wall
Tons of rebar per ft of wall	**0.0435**	tons per ft of wall

TETRA TECH	Clear Creek Floodwall Material Take-off	Calculation No. CC-FW-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	7
Project:	Coastal Texas Protection and Restoration						
Description:	Quantities						
Made By:	LRM	**Date:**	11/07/18	**Chk'd By:**	JK	**Date:**	11/08/18

Quantities

Floodwall length 3149 ft

Material take-offs

Item	Spacing (per ft of wall)	Quantity (EA)	Quantity (unit)	Unit
48-inch precast, prestressed concrete piles	4	788	**67177**	**LF**
18x0.625 inch steel pipe pile	8	394	**47280**	**LF**
6-inch square precast, prestressed piles	4	788	**78800**	**LF**
Reinforced concrete	1	3149	**2070**	**$yard^3$**
Rebar	1	3149	**137**	**tons**

TETRA TECH	Clear Creek Pump Station Quantities	Calculation No. CC-PS-ST-MT-001

Job No.:	100-RCE-18-09-1				**Page:**	1
Project:	Coastal Texas Protection and Restoration					
Description:	Clear Creek Pump Station Quantites					
Made By:	MGH	**Date:** 11/06/18		**Chk'd By:** JK	**Date:**	11/07/18

Calc Body Pages	Appended Pages	Total Pages
14	2	16

Document code

Site	Feature	Discipline	Document type	Number
CC	PS	ST	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Lexee Navarre 7/24/2018	Carl Grompe 9/21/2018	
B	Michael Hough 10/30/2018	Jason Kikuta 11/7/2018	Updated for Revised PS Geometry and design

TETRA TECH	**Clear Creek Pump Station Quantities**	**Calculation No. CC-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1				**Page:**	2
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ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for Pump Station at Clear Creek.

APPROACH

Typical engineering means and methods.

REFERENCES

References used during this calculation are as follows:

1) Plate 13
2) Plate 14
3) Plate 15

RESULTS / CONCLUSIONS

PILES:

Total # of 24" Diam. X 5/8" Vertical Pipe Piles:	4682			
Total 24" Diam. X 5/8" Steel Pipe Pile:	374560 ft	**OR**	29248 tons	
Total PZ-22 Steel Sheet Pile:	30217.3 ft^2	**OR**	332 tons	

CONCRETE:

FOUNDATIONS:		
Total Concrete for Base Slab:	67657 yd^3	
Total Concrete for Mud Slab:	8700 yd^3	
Total:	76356 yd^3	
SUBSTRUCTURE:		
Total:	84231 yd^3	
SUPERSTRUCTURE:		
Total:	9294 yd^3	8" Thick Precast Concrete Wall Panels
TOTAL CONCRETE:	169882 yd^3	

STEEL:

SUPERSTRUCTURE:

Total Number of W36X231 Steel Columns:	136			
Length	6800	ft	**OR**	785 tons
Total Number of W27X235 Steel Roof Beams:	68			
Length	4556	ft	**OR**	535 tons
Total Number of W27X235 Steel Beams:	74			
Length	3404	ft	**OR**	400 tons

CRANE FRAME:

Total Number of Steel HHS 12x12x1/2 Columns:	136			
Length	6120	ft	**OR**	233 tons
Total Number of W18X192 Steel Top Rails:	74			
Length	3404	ft	**OR**	327 tons
Total Number of 30 lb/ft Crane Rails:	74			
Length	3404	ft	**OR**	51 tons
Total Number of Steel HHS 12x12x1/2 Beams:	370			
Length	17020	ft	**OR**	647 tons

TETRA TECH	Clear Creek Pump Station Quantities	Calculation No. CC-PS-ST-MT-001

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ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) Excavation is to be determined by others.
2) Number of pumps = 31
3) Material Properties:
   - Concrete for base slab, allowable f'c = 4000 psi
   - Concrete for mud slab, allowable f'c = 2500 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
   - Sheet Piles = ASTM A328
4) All piles have tension connections.

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Material types and properties.
2) Layout, elevations and dimensions of Pump Station.

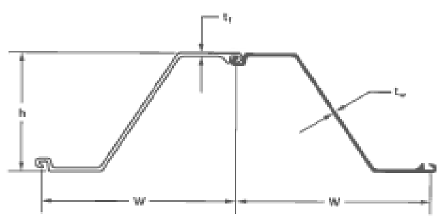
CALCULATIONS

Begin on next page.

General References and Figures

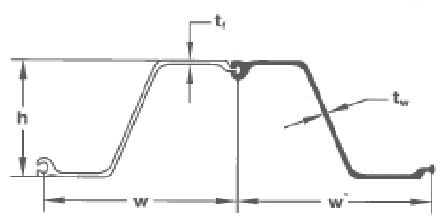
NZ/PZ

NZ/PZ Hot Rolled Steel Sheet Pile



NZ

SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Web (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
NZ 19	27.56 700	16.14 410.0	0.375 9.5	0.375 9.5	7.04 148.9	55 81.85	23.95 116.93	35.08 1886	41.33 2222	283.1 38659	6.18 1.88	1.35 1.35
NZ 20	27.56 700	16.16 410.5	0.394 10.0	0.394 10.0	7.29 154.4	57 84.83	24.82 121.18	36.24 1948	42.80 2301	292.8 39984	6.18 1.88	1.35 1.35
NZ 21	27.56 700	16.20 411.5	0.433 11.0	0.433 11.0	7.80 165.2	61 90.78	26.56 129.68	38.69 2080	45.85 2465	313.4 42797	6.18 1.88	1.35 1.35
NZ 26	27.56 700	17.32 440.0	0.500 12.7	0.500 12.7	9.08 192.3	71 105.66	30.92 150.94	48.50 2608	57.01 3065	419.9 57340	6.49 1.98	1.41 1.41



PZ

SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Wall (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
PZ 22	22.0 559	9.0 229	0.375 9.50	0.375 9.50	6.47 136.9	40.3 60.0	22.0 107.4	18.1 973	21.79 1171.4	84.38 11500	4.48 1.37	1.22 1.22
PZ 27	18.0 457	12.0 305	0.375 9.50	0.375 9.50	7.94 168.1	40.5 60.3	27.0 131.8	30.2 1620	36.49 1961.9	184.20 25200	4.48 1.37	1.49 1.49
PZ 35	22.6 575	14.9 378	0.600 15.21	0.500 12.67	10.29 217.8	66.0 98.2	35.0 170.9	48.5 2608	57.17 3073.5	361.22 49300	5.37 1.64	1.42 1.42
PZ 40	19.7 500	16.1 409	0.600 15.21	0.500 12.67	11.77 249.1	65.6 97.6	40.0 195.3	60.7 3263	71.92 3866.7	490.85 67000	5.37 1.64	1.64 1.64

TETRA TECH

Clear Creek Pump Station Quantities

Calculation No. CC-PS-ST-MT-001

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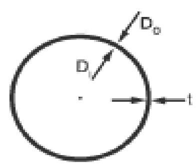
Made By:	MGH	**Date:**	11/06/18	**Chk'd By:**	JK	**Date:**	11/07/18

Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = 10.69*t*(D_o-t)
D_o (in) - outside diameter
t (in) - thickness of pipe

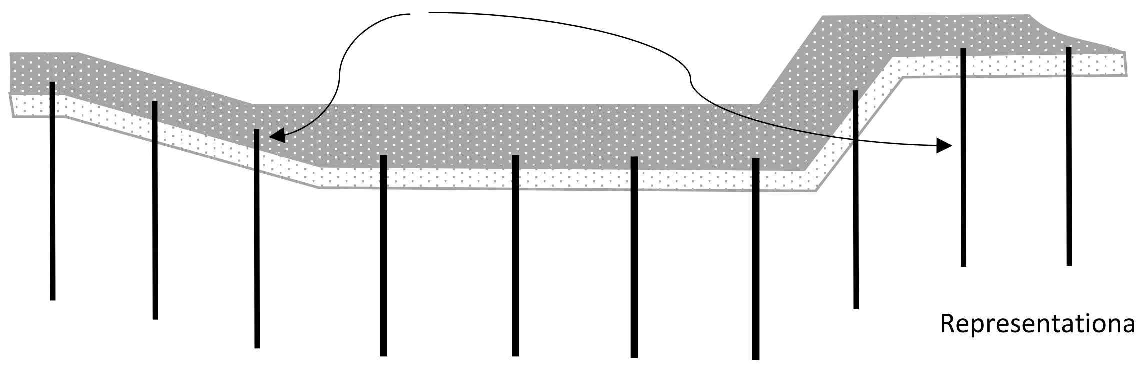
Pipe Weight (kg/m) = 0.0247*t*(D_o-t)
D_o (mm) - outside diameter
t (mm) - thickness of pipe

PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

Quantities for Pump Station Foundations

Figure 1:



PILES

Number of Piles 150
Number of Piles 32 At Safe House Enclosure Slab
Pile Diameter: 24 in
Pile Thickness: 5/8 in
Pile Weight: 156.17 lb/ft
*see general references attachments for reference of produced value

Piles	# of Piles per row	Rows	Pile Weight (lb/ft)	Start EL (ft)	End EL (ft)	Length (ft)	Weight (ton)	Total Length (ft)	Total Weight (ton)
Pumps	6	25	156.17	-16.0	-96.0	80.0	6.2	12000	937.0
Safe House	8	4	156.17	0.0	-80.0	80.0	6.2	2560	199.9

Piles (24" diam x 5/8")

Total # of Piles per Pump: 150
Total Length per Pump: 12000 ft
Total Weight per Pump: 937 tons

Total Number of Pumps: 31

Total # of Piles at Safe House Enclosure: 32
Total Length at Safe House: 2560 ft
Total Weight at safe house: 200 tons

TOTALS:

# of 24" diam x 5/8" Piles: 4682
Length of 24" diam x 5/8": 374560 ft
Weight of 24" diam x 5/8": 29248 tons

SHEET PILE

Note: It is assumed that the sheet pile wall used at WCC for seepage control will also be the same kind used at Clear Creek.
A PZ-22 hot rolled sheet piling shall be utilized for seepage cutoff.

Start EL of Sheet Pile Wall: -25.0 ft
End EL of Sheet Pile Wall: -46.0 ft
Height of Sheet Pile Wall: 21.0 ft
Weight of Sheet Pile Wall*: 22.0 lb/ft^2
Length of Sheet Pile Wall: 46.4 ft

*see general references attachments for reference of produced value

# of Walls	Area (ft^2)	Weight of Wall (lb/ft^2)	Weight (tons)
1	974.8	22.0	10.7

Total Number of Pumps: 31

Total Area per Pump: 975 ft^2
Total Weight per Pump: 11 tons

TOTALS:
Area: 30217 ft^2
Weight: 332 tons

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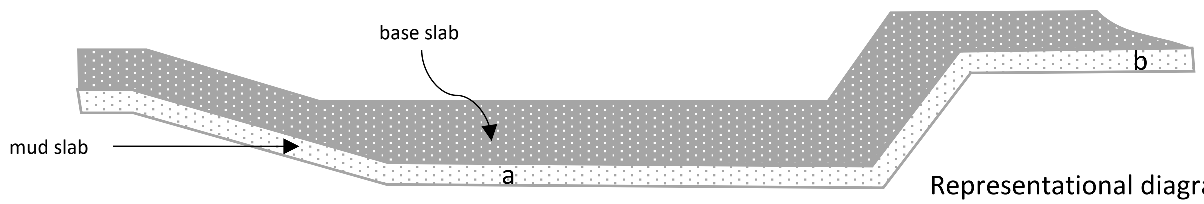
Made By:	MGH	**Date:**	11/06/18	**Chk'd By:**	JK	**Date:**	11/07/18

Figure 2:



Representational diagram

CONCRETE

FOUNDATION BASE SLAB:

F'c: 4,000 psi
Width of Slab: 46.4 ft

Total Volume of Concrete per Pump*: 2,182 yd^3
Total Number of Pumps: 31
Total Foundation Slab Concrete: 67657 yd^3

*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.

MUD SLAB:

Note: Please see attached SB-005 drawing for concrete sectioning. It is assumed that this pump station will also have a mud slab like West Closure Complex. Lengths of sections are estimates for the preliminary design phase.

F'c: 2,500 psi
Width of Slab: 46.4 ft **Slab Thickness:** 12.0 in

Section	Length (ft)	Thickness (in)	Cross Sectional Area (ft^2)	Width (ft)	Volume (yd^3)
a	156.0	12.00	156.00	46.4	268.19
b	21.0	12.00	21.00	16.0	12.44

Total Mud Slab Concrete per Pump: 281 yd^3
Total Number of Pumps: 31
Total Mud Slab Concrete: 8700 yd^3

TOTAL CONCRETE: 76356 yd^3

TETRA TECH	Clear Creek Pump Station Quantities	Calculation No. CC-PS-ST-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	11
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Description:	Pump Station Substructure Quantities						
Made By:	MGH	**Date:**	11/06/18	**Chk'd By:**	JK	**Date:**	11/07/18

Pump Station Substructure Quantities

CONCRETE

Total Volume of Concrete per Pump*:	2,665.8	yd^3	*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.
Total Number of Pumps:	31		
Total Volume of Concrete at Safe House*:	1,591.1	yd^3	

Total Concrete: 84231 yd^3

TETRA TECH	Clear Creek Pump Station Quantities	Calculation No. CC-PS-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	12
Project:	Coastal Texas Protection and Restoration				
Description:	Pump Station Superstructure Quantities				
Made By:	MGH	**Date:** 11/06/18	**Chk'd By:** JK	**Date:**	11/07/18

Pump Station Superstructure Quantities

PRECAST CONCRETE WALL PANELS

Total Volume of Concrete per Pump Bay*:	292	yd^3	*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.
Total Number of Pump Bays:	31		
Total Volume of Concrete at Safe House Enclosure*:	235	yd^3	

Total Concrete: 9294 yd^3

STEEL

COLUMNS:

The columns of the steel superstructure frame will be W36X231.

Weight:	231	lb/ft	
Height:	50	ft	
Number of Columns per Pump Bay:	4		
Total Number of Pump Bays:	31		
Number of Columns at Safe House Enclosure:	12		Per Plans

Total Number of W36X231 Steel Columns:	**136**	
Total Length of W36X231 Steel Columns:	**6800**	**ft**
Total Weight of W36X231 Steel Columns:	**785**	**tons**

LONGITUDINAL ROOF BEAMS (spanning length of pump bay):

The longitudinal roof beams of the steel superstructure frame will be W27X235.

Weight:	235	lb/ft	
Length:	67	ft	
Number of Roof Beams per Pump Bay:	2		
Total Number of Pump Bays:	31		
Number of Beams at Safe House Enclosure:	6		Per Plans

Total Number of W27X235 Steel Roof Beams:	**68**	
Total Length of W27X235 Steel Roof Beams:	**4556**	**ft**
Total Weight of W27X235 Steel Roof Beams:	**535**	**tons**

TRANSVERSE ROOF BEAMS (spanning width of pump bay):

The tansverse roof beams of the steel superstructure frame are W27X235.

Weight:	235	lb/ft	
Length:	46	ft	
Number of Roof Beams per Pump Bay:	2		
Total Number of Pump Bays:	31		
Number of Beams at Safe House Enclosure:	12		Per Plans

Total Number of W27X235 Steel Beams:	**74**	
Total Length of W27X235 Steel Roof Beams:	**3404**	**ft**
Total Weight of W27X235 Steel Roof Beams:	**400**	**tons**

Pump Station Crane Frame Quantities

STEEL

COLUMNS:

The columns of the steel crane frame are assumed to be HSS 12x12x1/2.

Weight:	76	lb/ft
Height:	45	ft
Number of Columns per Pump Bay:	4	
Total Number of Pump Bays:	31	
Number of Columns at Safe House Enclosure:	12	

Total Number of Steel HHS 12x12x1/2 Columns:	**136**	
Total Length of Steel HHS 12x12x1/2 Columns:	**6120**	**ft**
Total Weight of Steel HHS 12x12x1/2 Columns:	**233**	**tons**

TOP RAIL:

The top rail of the steel crane frame will be W18X192.

Weight:	192	lb/ft
Length:	46	ft
Number of Top Rails per Pump Bay:	2	
Total Number of Pump Bays:	31	
Number of Top Rails at Safe House Enclosure:	12	

Total Number of Top Rails:	**74**	
Total Length of Top Rails:	**3404**	**ft**
Total Weight of Top Rails:	**327**	**tons**

CRANE RAIL:

Added to the top rail will be a 30 lb/ft crane rail.

Weight:	30	lb/ft
Length:	46	ft
Number of Crane Rails per Pump Bay:	2	
Total Number of Pump Bays:	31	
Number of Crane Rails at Safe House Enclosure:	12	

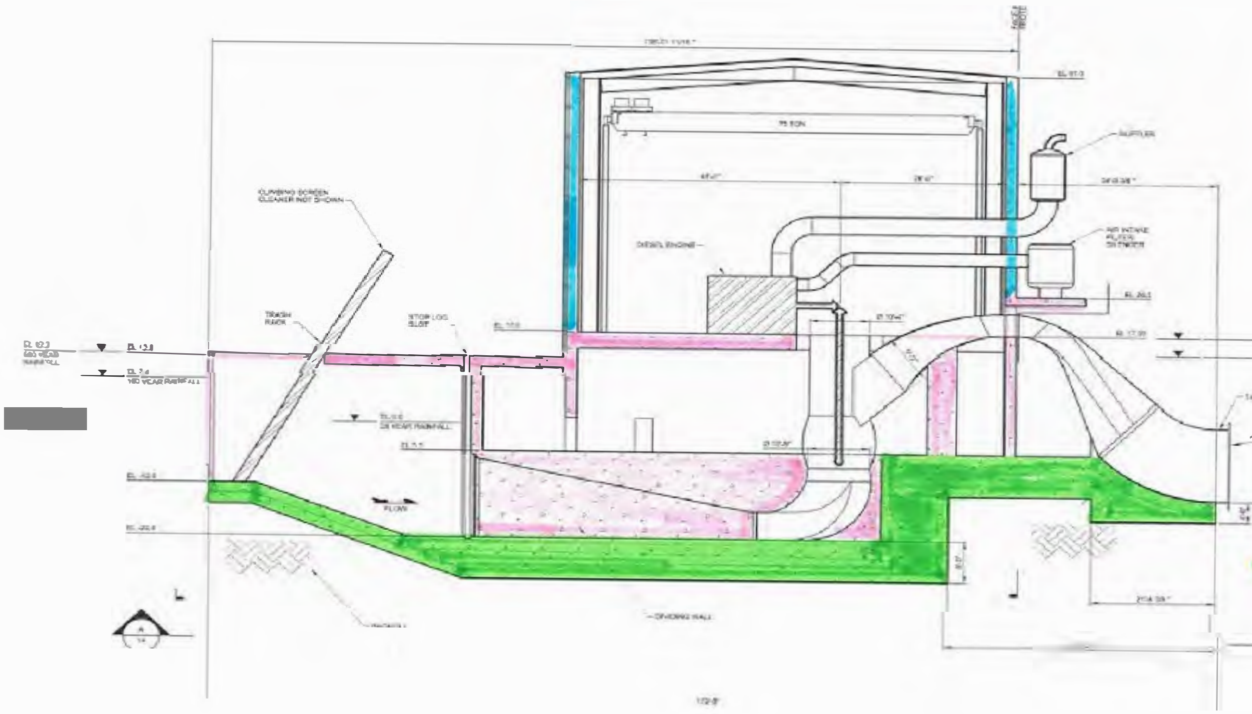
Total Number of Crane Rails:	**74**	
Total Length of Crane Rails:	**3404**	**ft**
Total Weight of Crane Rails:	**51**	**tons**

INFILL FRAMING:

The infill framing beams of the steel crane frame are assumed to be HSS 12x12x1/2.

Weight:	76	lb/ft	
Length:	46	ft	
Number of Infill Beams per Pump Bay:	10		5 each side
Total Number of Pump Bays:	31		
Number of Infill Beams at Safe House Enclosure:	60		

Total Number of Steel HHS 12x12x1/2 Beams:	**370**	
Total Length of Steel HHS 12x12x1/2 Beams:	**17020**	**ft**
Total Weight of Steel HHS 12x12x1/2 Beams:	**647**	**tons**



$7896\ ft^3 \times 31$

$+\ 6342\ ft^3$ (SH/CR)

$71977\ ft^3 \times 31$

$+\ 42960\ ft^3$ (SH/CR)

~~[illegible] ft~~$^3 \times 31$

$68927\ ft^3$

TETRA TECH	Clear Creek Fuel Tank Foundations Quantities	Calculation No. CC-PS-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Clear Creek Fuel Tank Foundations Quantities				
Made By:	LN	**Date:** 07/25/18	**Chk'd By:** DS	**Date:**	08/22/18

Calc Body Pages	Appended Pages	Total Pages
7	0	7

Document code

Site	Feature	Discipline	Document type	Number
CC	PS	ST	MT	002

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Lexee Navarre 8/22/18	Daniel Stuard 8/22/18	

TETRA TECH	Clear Creek Fuel Tank Foundations Quantities	Calculation No. CC-PS-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LN	**Date:**	07/25/18	**Chk'd By:**	DS	**Date:**	08/22/18

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Attachments	Number of Pages	Last Page Number

TETRA TECH	**Clear Creek Fuel Tank Foundations Quantities**	**Calculation No. CC-PS-ST-MT-002**

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LN	**Date:**	07/25/18	**Chk'd By:**	DS	**Date:**	08/22/18

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for fuel tank foundations.

APPROACH

Typical engineering means and methods for determining volumes and weights.

REFERENCES

References used during this calculation are as follows:

1) CC-PS-ST-CL-001
2) CC-PS-ME-CL-001

RESULTS / CONCLUSIONS

Total # of Pipe Piles:	112 (All piles have tension connections)			
Total 24" Diam. X 0.5" Steel Pipe Pile:	6692.0 ft	**or**	420.3 tons	
Total # of Pile Caps:	28			
Total Concrete per Cap:	13.3 yd^3			
Total Pile Cap Concrete:	373.3 yd^3			

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) Material Properties:
   - Concrete, f'c = 4000 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
2) Costs of reinforcement is included in reinforced concrete unit cost.
3) All piles have tension connections.
4) Total number of Tanks = 14

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

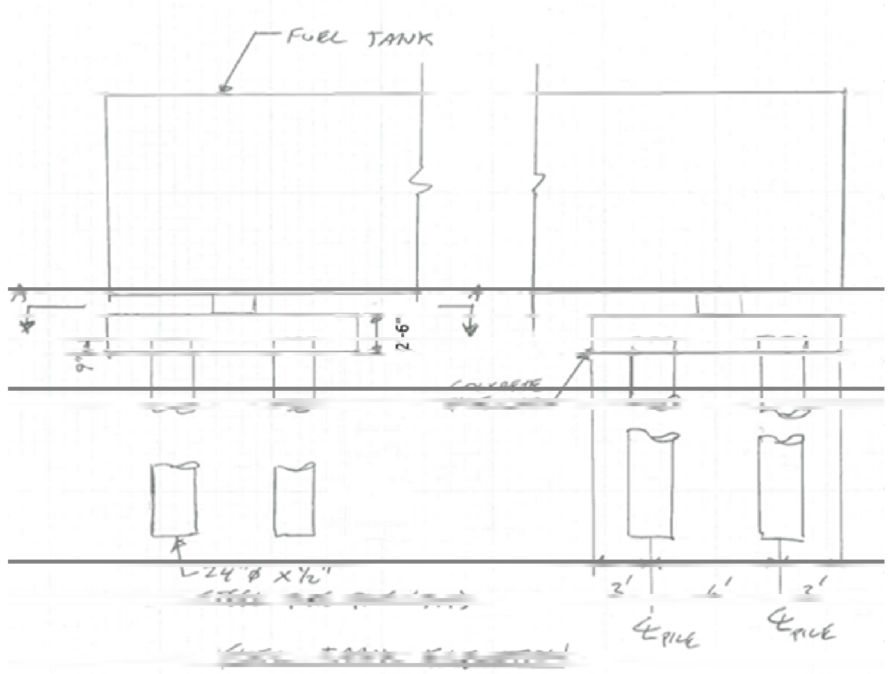
1) Materials and quantities as design progresses.

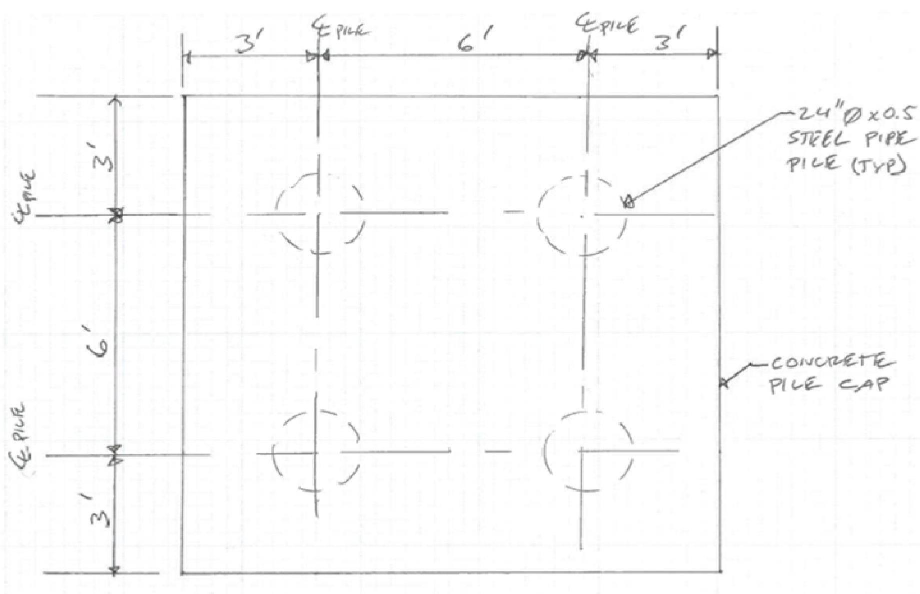
CALCULATIONS

Begin on next page.

TETRA TECH	**Clear Creek Fuel Tank Foundations Quantities**			**Calculation No. CC-PS-ST-MT-002**	
Job No.:	100-RCE-18-09-1			**Page:**	5
Project:	Coastal Texas Protection and Restoration				
Description:	General References and Figures				
Made By:	LN	**Date:** 07/25/18	**Chk'd By:** DS	**Date:**	08/22/18

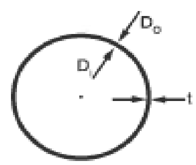
General References and Figures





FUEL TANK PILE CAP PLAN (A-A)

Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = 10.69*t*(D_o-t)
D_o (in) - outside diameter
t (in) - thickness of pipe

Pipe Weight (kg/m) = 0.0247*t*(D_o-t)
D_o (mm) - outside diameter
t (mm) - thickness of pipe

PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

Quantities for Fuel Tank Foundations

PILES

Steel Pipe Piles with a minimum tip embedment is to be 59 feet plus 9 inches of embedment into concrete slab.

Pile Diameter: 24.0 in

Pipe Thickness: 0.5 in

Pipe Weight*: 125.61 lb/ft

Pile Tip to Head Embedment: 59.75 ft

*see general references attachments for reference of produced value

Number of Caps per Tank: 2
Total Number of Tanks: 14
Total Number of Pile Caps: 28
Number of Piles per Cap: 4

Total Number of Piles: **112**
Total of Steel Pipe Piles: **6692.0 ft** **or** **420.3 tons**

CONCRETE:

PILE CAPS:

Thickness (ft)	Width (ft)	Cross Sectional Area (ft^2)	Length (ft)	Volume (yd^3)
2.5	12.0	30.0	12.0	13.3

Total Number of Pile Caps: 28 (see piles section)

Total Concrete: **373.33 yd^3**

TETRA TECH	Clear Creek Pump Station Cellular Cofferdam Quantities	Calculation No. CC-PS-ST-MT-003

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Coversheet				
Made By:	DAS	**Date:** 10/31/18	**Chk'd By:** JK	**Date:**	11/08/18

Calc Body Pages	Appended Pages	Total Pages
7	0	7

Document code

Site	Feature	Discipline	Document type	Number
CC	PS	ST	MT	003

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Dave Stensby Chris Gorsch for Dave Stensby 11.8.2018	Jason Kikuta 11/8/18	Submitted for Review

TETRA TECH	Clear Creek Pump Station Cellular Cofferdam Quantities	Calculation No. CC-PS-ST-MT-003

Job No.:	100-RCE-18-09-1			**Page:**	2
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	DAS	**Date:** 10/31/18	**Chk'd By:** JK	**Date:**	11/08/18

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TETRA TECH	Clear Creek Pump Station Cellular Cofferdam Quantities	Calculation No. CC-PS-ST-MT-003

Job No.:	100-RCE-18-09-1			**Page:**	3
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	DAS	**Date:** 10/31/18	**Chk'd By:** JK	**Date:**	11/08/18

ISSUE BEING ADDRESSED

The purpose of this calculation is to estimate the quantities necessary for sheet pile cellular cofferdams for the pumpstations. Limited geotechnical infomration is available at this time, so various assumptions will be made as to sizes of cofferdam components.

APPROACH

Typical engineering means and methods for determining volumes and weights.

Cellular cofferboxes were assumed, since the size of the cofferbox is very large and interior bracing would be problematic.

The foundations of the pumphouses are extend below the existing ground level and must be excavated in-the-wet. After the excavation, gravel layer will be placed to aid in drainage and a tremie slab will be placed. Then the excavation area will be dewatered for construction. The cofferdams must be designed to provide adequate strength and stability for each of these phases.

REFERENCES

1) USS Steel Sheet Pile Deisgn Manual, July 1984
2) Skyline Steel Technical Product Manual, 2013

RESULTS / CONCLUSIONS

Assumed Sheet Pile:	PS 31	
# of Sheets:	5,750	
Total Weight of Sheets:	9,550	Tons
Cellular Cofferdam Fill:	212,250	yd^3

TETRA TECH	**Clear Creek Pump Station** **Cellular Cofferdam Quantities**	**Calculation No.** **CC-PS-ST-MT-003**

Job No.:	100-RCE-18-09-1				**Page:**	4
Project:	Coastal Texas Protection and Restoration					
Description:						
Made By:	DAS	**Date:**	10/31/18	**Chk'd By:** JK	**Date:**	11/08/18

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

- These quantities are based on the associated structural calculations. Due to the limited amount of site information and design requirements available, a number of significant assumptions have been made. These are shown in the associated structural design calculations.

- Cofferdam Elevations & Dimesions:

	Elevations			Dimesions	
Top of Cofferdam:	5.0	ft	Sheet Pile:	PS 31	
Assumed Existing Ground:	-10.0	ft	Cofferdam Width:	50.0	ft
Btm of Excavation:	-34.0	ft	Clearance to Structure:	6.0	ft
Sheet pile tip:	-60.0	ft	Excavation Length:	1500.0	ft
			Excavation Width:	190.0	ft

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Final geotechnical information and recommendations
2) Detailed design of the cellular cofferdam
3) Pile type, size and layout.
4) Access requirements

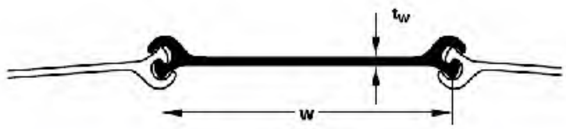
CALCULATIONS

See Next Page

GENERAL REFERENCES

Location of Clear Creek sector gate

Highway 146 bridge will be extended 100 feet to the west of the existing right of way.



PS

SECTION	Width (w) in (mm)	Web (t_w) in (mm)	Maximum Interlock Strength k/in (kN/m)	Minimum Cell Diameter* ft (m)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	Elastic Section Modulus in³/sheet (cm³/sheet)	Moment of Inertia in⁴/sheet (cm⁴/sheet)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² of wall (m²/m²)
PS 27.5	19.69 500	0.4 10.2	20 3500	30 9.14	8.09 171.2	45.1 67.1	27.5 134.3	3.3 54	5.3 221	3.65 1.11	1.11 1.11
PS 31	19.69 500	0.5 12.7	20 3500	30 9.14	9.12 193.0	50.9 75.7	31.0 151.4	3.3 54	5.3 221	3.65 1.11	1.11 1.11

Clear Creek Pump Station Cellular Cofferdam Quantities	Calculation No. CC-PS-ST-MT-003

Job No.:	100-RCE-18-09-1			**Page:**	7
Project:	Coastal Texas Protection and Restoration				
Description:	Cellular Cofferdam Quantities				
Made By:	DAS	**Date:** 10/31/18	**Chk'd By:** JK	**Date:**	11/08/18

Cellular Cofferdam Quantities

Excavation Dimensions		
Length	1500	ft
Width	190	ft

Centerline of sheetpile cells dimensions		
Cofferdam Width	50.0	ft
Clearance to Structure	6.0	ft
Length	1562	ft
Width	252	ft
Total Perimeter	**3628**	lineal feet

Sheet pile layout

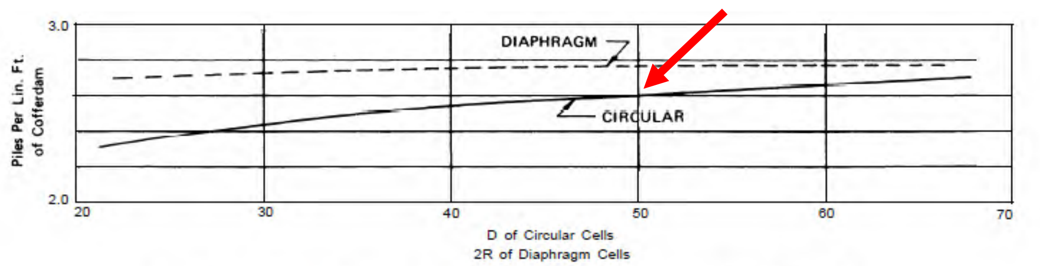
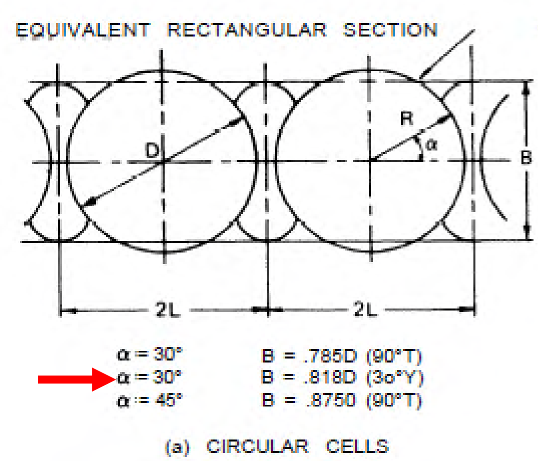


Fig. 64 - Piling required per linear foot of cofferdam (after TVA[36])

Length factor	2.6	from chart above
Total length of sheet piles	9432.8	lineal feet
Sheet pile top elevation	5	ft
Sheet pile tip elevation	-60	ft
Sheet pile length	65	ft
Sheet pile area	613,132	ft^2
Sheet pile weight / sq ft	31	psf
Total Sheet pile weight	19,007,092	pounds
	9,550	tons
Sheet length	19.69	inches
	1.64	feet
Number of piles	**5,750**	sheets

Cofferdam Fill

Top of Fill Elevation	5	ft
Bottom of fill	-10	
Width factor	0.81	from table
Width	40.5	ft
Total Fill volume	5,730,500	ft^3
	212,250	yds



TETRA TECH	Pump Station - Discharge pipes and supports	Calculation No. CC-PS-ST-MT-004

Job No.: 100-RCE-18-09-1 **Page:** 1
Project: Coastal Texas Protection and Restoration
Description: Pump Station - Discharge pipes and supports
Made By: SDG **Date:** Nov-07-2018 **Chk'd By:** LRM **Date:** 11/09/18

Calc Body Pages	Appended Pages	Total Pages
4	11	17

Document code

Site	Feature	Discipline	Document type	Number
CC	PS	ST	MT	004

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Sergio Gaitan 11/09/18 Hais Haesch for Sergio Gaitan	Leo Moyer 11/09/18 Hais Haesch for Leo Moyer	Initial for review

TETRA TECH	Pump Station - Discharge pipes and supports	Calculation No. CC-PS-ST-MT-004

Job No.:	100-RCE-18-09-1			**Page:**	2
Project:	Coastal Texas Protection and Restoration				
Description:	Clear Creek Pump Station - Discharge pipes and supports				
Made By:	SDG	**Date:** Nov-07-2018	**Chk'd By:** LRM	**Date:**	11/09/18

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TETRA TECH	**Pump Station - Discharge pipes and supports**	**Calculation No.** **CC-PS-ST-MT-004**

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:	Clear Creek Pump Station - Discharge pipes and supports						
Made By:	SDG	**Date:**	Nov-07-2018	**Chk'd By:**	LRM	**Date:**	11/09/18

ISSUE BEING ADDRESSED

Quantities are provided for the Spirolite discharge pipes

APPROACH

Quantities are based on the "sunk" approach for installing the pipes in the outfall channel.

REFERENCES

References used during this calculation are as follows:

1) ETL-1110-2-307 Flotation Stabilty Criteria

RESULTS / CONCLUSIONS

Clear Creek Bayou Pump Station

Spirolite pipe 14 ft diameter:	53,702	LF	Double closed cell type
Dry welding of Bell & Spigot joints	895	EA at 60 feet	
End elbows, FRP:	27	EA	Provide support H pile frame
Precast Concrete collars at 20' oc	2,685	EA	11.8 CY EA circumferential
Precast Concrete collars at 20' oc	31,683	CY	
Dredging Stage 1 to El -12:	572,832	CY	
Thalweg dredging Stage 2 to El -16:	111,384	CY	
Backfill 1 - gravel to El -5:	189,216	CY	
Backfill 2 - reuse dredged material to El +0:	188,955	CY	
Pressure relief air valve	27	EA	

Does not include property acquisition nor demolition of existing homes and structures.

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

The following assumptions can be considered when looking at the quantities and cost to provide and install these pipes, please refer to Plates in Engineering Appendix:

• Dredging can occur in 2 stages to minimize earthwork: initially down to El. -12 to obtain a constant depth throughout. Then a second dredging effort would be localized at the pipeline invert thalweg to bring the depth to -16.

• Collars are made of two half circular precast pieces bolted at the spring line to weigh down the pipes.

• Assuming a tidal range from +1 to -1, precast concrete collars can be installed at 20 ft spacing as the pipeline is launched into the water. The entire line would be launched assembled with collars by keeping

• Backfill operations can then proceed in two stages: First a gravel backfill around the pipes to a few feet above the spring line of the pipes to -5, to secure them against lateral forces, followed by hydraulic

• The elbow at the end turns the flow upward to dissipate energy and reduce erosion. The elbow would be supported off a pile supporting frame. The elbow would be made of solid double cell FRP wall material discharging at El +2. Riprap would surround the elbow to avoid local erosion.

• The Factor of Safety against buoyancy is 1.5 per ETL 1110-2-307 for normal operation.

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) No information on cost is available for 14 ft spirolite. A new mandrel would have to be custom made and only after knowing the total amount of linear feet of pipe, would IPF Plasson be able to cost this out. Having said that, a cost can be approximated by the calculated weight of the Closed Cell pipe in lbs per LF. Sixty-foot pipe sections would be welded in the dry and aligned for launching in the water. Bell and Spigot with extrusion welds are preferred.

2) As a cost comparison, Vari-Tech has provided 157" (13 ft) diameter pipes in the past at a cost of about $1,600/LF. This does not account for FOB delivery. The cost of field welding 100 joints of this pipe is about $600,000. Each FRP elbow can be supplied at a cost of about $35,000. This information needs to be confirmed for a 14 ft diameter pipe system.

3) The durability of the Spirolite material needs to be confirmed at 100 years and Vari-Tech may be able to provide supporting aging reports.

TETRA TECH	**Pump Station - Discharge pipes and supports**	**Calculation No. CC-PS-ST-MT-004**

Job No.:	100-RCE-18-09-1					**Page:**	6
Project:	Coastal Texas Protection and Restoration						
Description:	Clear Creek Pump Station - Discharge pipes and supports						
Made By:	SDG	**Date:**	Nov-07-2018	**Chk'd By:**	LRM	**Date:**	11/09/18

CALCULATIONS

CC	pipe lengths north to south
1	2197
2	2182
3	2168
4	2159
5	2137
6	2128
7	2124
8	2111
9	2112
10	2116
11	1946
12	1934
13	1925
14	1925
15	1919
16	1918
17	1900
18	1900
19	1904
20	1883
21	1876
22	1873
23	1872
24	1872
25	1875
26	1871
27	1875
Tota	53702

CALCULATIONS

Conceptual Design of Pump Stastions - Discharge Pipes - Anchoring Devices

Pipe Diameter

A 14 ft diameter pipeline serving each pump at 1500 cfs is first envisioned. The highest average pipe velocity would be about 10 fps. Currently, there are no fabricators of HDPE pipes for that large diameter in the U.S. It is possible that Malaysia could provide this large diameter, however I did not make a call. The largest produced in the USA is 11 ft diameter as provided by Spirolite. IPF Plasson-USA could consider the cost to fabricate a 14 ft mandrel if enough quantity is require

Main distributors of Sprirolite in the U.S. are Vari-tech LLC and ISCO. Vari-tech feels a 10 ft dia pipe is feasible if the pump requirements can support a 20-fps velocity and the associated friction losses. A 12 ft diameter pipe can also be envisioned; however, bends would require more robust lateral anchors. A lesser diameter pipe would result in savings on the pipe itself as it is sold by the lbs/LF of pipe. Savings can also be realized on the lesser amount of dredging.

For purposes of this design, a 14 ft pipe has been adopted going forward to keep the pumping head and requirements down as well as the cost to run the Pump Station in terms of kwh.

Pipe Material

HDPE spirolite can be either solid wall of various SDRs, open profile with exterior bids, or closed cell profile honeycomb design. Pipe pressures usually should stay to less than 25 ft of water head, which is realistic for this application. Joints are typically Bell & Spigot or Extruded melting by means of hot air. Welding is done in the dry and then pipe is floated into position. Segments are typically 60 ft long and are buoyant. The pipe cannot be curved beyond about 2 degrees (or about 700 ft radius), therefore it is not practical. Rather, several welded segments can be provided to suit each bend amount.

Two options were evaluated for installation of the pipes: A (preferred) fully submerged installation, and an option to have the pipes buoyant with the tides.

Submerged Design Option

It is preferable to "sink" the pipe to the bottom of the channel and this technique is used for many estuary-to-ocean applications. Precast concrete collars at 20 ft spacing are designed to permanently sink the pipes provided their spacing, water salinity, and pipe profile selected. Collars serve to overcome pipe material buoyancy and provide a safety factor in maintaining the pipes permanently sunk. Collars are made of two equal halves joined at the spring line by bolts. In order to increase the factor of safety during hurricane surge against lateral wave action, steel H-piles may need be provided at every bend.

In addition, it is possible to backfill the spaces between the pipes with the dredged material, providing less pipe surface to be exposed to wave action and a beneficial use for the dredged material. A 14 ft diameter alternative would be better installed by having localized dredging following the pipe invert as the segments are sank into place.

The Plastic Pipe Institute has information on the tie-down forces required for HDPE of different profiles and SDRs. Closed cell profiles are air tight and contribute to buoyancy. An important factor in selecting the level of submergence is for the crown of the pipe to be below the minimum low tide so as to minimize air from becoming trapped inside the pipe when the tide raises. A 1.5 safety factor has been used for calculating the ballast requirements against floatation. At the face/exit of the Pump Station, a small pressure relief air valve will have to be inevitably placed at the crown of the syphon just leaving the PS. This valve is included as part of the pump equipment.

Fatigue from tidal action is not an issue when the pipes are fully submerged, and the pipe circumferential wall stresses are minor when resisting the constant uplift in between concrete collars. This is also the case when storm surge arrives, because the pipe will remain further submerged. The pipe will however, need to be designed to resist stresses due to lateral submerged wave forces and uplift due to potential currents under the pipe. Fatigue from hurricane action is not significant due to its low frequency.

A check should be made for temperature stresses due to the brackish water being warmer at the top of the pipe vs below the pipe. The expansion coefficient for HDPE is about 1 inch per 10 degrees F per 100 LF of pipe.

Pipe Designed to be Byouyant with Tides

The main benefit of this alternative is to lessen the amount of dredging and backfill to otherwise sink the pipes. In this alternative, the pipes would float unstressed with the tides being restrained only by cable tie-downs to H-piles. Concrete collars would not be required, however there should be a bearing pad element designed and provided to lessen the concentrated stresses imparted by the cable during hurricanes. The cable would have guides attached to the bearing pad to maintain the pipes in a properly tethered position.

In this alternative, air relief valves are required to release air out of the pipes during a hurricane surge higher than the high tide. In this case, the cables are resisting the full uplift of the pipes plus the lateral wave forces acting on the pipe as well as any uplift from flowing water under the pipes.

The temperature check for this option is also required as the top of the pipe will always be exposed to the sun and the air temperature and UV rays.

Although this option appears to save on earthwork when compared with the submerged option, the submerged option results superior in terms of ability to withstand hurricane force waves and therefore durability. Cable tie-downs and H-pile anchors are also high maintenance items with a limited service life.

Quantities:

The following assumptions can be considered when looking at the quantities and cost to provide and install these pipes, please refer to Engineering Plates and quantity calculations:

- No information on cost is available for 14 ft spirolite. A new mandrel would have to be custom made and only after knowing the total amount of linear feet of pipe, would IPF Plasson be able to cost this out. Having said that, a cost can be approximated by the calculated weight of the Closed Cell pipe in lbs per LF. Forty-foot pipe sections would be welded in the dry and aligned for launching in the water. Bell and Spigot with extrusion welds are preferred.

- Dredging can occur in 2 stages to minimize earthwork: initially down to El. -12 to obtain a constant depth throughout. Pairs of H-piles spaced at 100 ft are then driven to locate the alignment of each pipe at the locations every 5th concrete collar. Then a second dredging effort would be localized at the pipeline invert thalweg to bring the depth to -16.

- Collars are made of two half circular precast pieces bolted at the spring line. During final design, a check needs to be made to assess the need to further anchor the pipes major bends and discrete locations to resist wave action. Locations like the discharge elbow will need to be secured and anchored to the ground.

- Assuming a tidal range from +1 to -1, precast concrete collars can be installed at 20 ft spacing as the pipeline is launched into the water. The entire line would be launched assembled with collars by keeping the pipe ends closed temporarily to obtain pipe buoyancy in route. Once the pipe is in correct alignment, the pipe ends can be removed, and the pipe alignment would be sunk down to a pre-dredged invert elevation of -16.

- Backfilled operations can then proceed in two stages: First a gravel backfill around the pipes to a few feet above the spring line of the pipes to secure them against lateral forces, followed by hydraulic backfilling using the native dredged materials to El. +1 or the prior original surrounding level.

- The elbow at the end turns the flow upward to dissipate energy and reduce erosion. The elbow would be supported off a pile supporting frame. The elbow would be made of solid double cell FRP wall material discharging at El +2. Riprap would surround the elbow to avoid local erosion.

- As a cost comparison, Vari-Tech has provided 157” (13 ft) diameter pipes in the past at a cost of about $1,600/LF. This does not account for FOB delivery. The cost of field welding 100 joints of this pipe is about $600,000. Each FRP elbow can be supplied at a cost of about $35,000 including anchoring platform.

- The durability of the Spirolite material has been estimted at 100 years and Vari-Tech can provide supporting aging reports

CALCULATIONS

Mr. Roger Setya
Tetra Tech
3445 N. Causeway Blvd., Suite 320,
Metairie, LA 70002

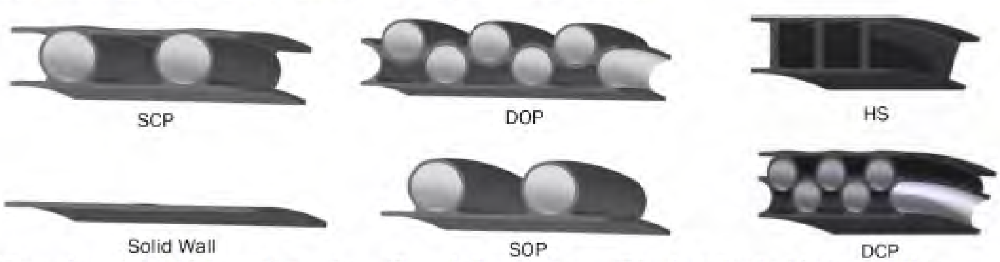
August 16, 2018

Re: Sergio D. Gaitan, P.E.,
VARI-TECH is happy to present the following information regarding spirolite for Marine applications. VARITECH is an organization that has aided in the proper installation of HDPE for over 35 years. With the technical staff ranging through PhD's, PE's and technical sales representatives. We've done projects all over the world throughout many industries. As previously discussed we have done numerous Marine and sub aqueous installations of polyethylene pipes from outfalls, intake, conduits and more.

Project recap:
As previously discussed on the telephone we are investigating the likelihood of upgrading our current line of 12 foot diameter to accommodate your job in Galveston Texas of 14 foot diameter polyethylene pipe. Much of the below pictures and discussion would be based off of previous projects we've done ranging throughout sizes up to the 10 foot diameter range. This will give a brief outline of ideas and details for installation. As this is figured to be iterative process as more details arise from your firm as well as our manufacture so will the tactics found below.

As we discussed I would propose installing the system as a static fixed pipeline. This is meant that the line is weighted or pinned in one location preferably under low tide location. By providing a line that is pinned or weighted properly line is constrained reducing its movement thereby reducing the ability of abrasion or dynamic forces acting on the pipe or its effects apparatuses such as pipe clamps or settles. This will not only make for a lower risk lifecycle to the pipe but also reduce maintenance costs on cables, beams or other members that would be used to allow free movement of the line.

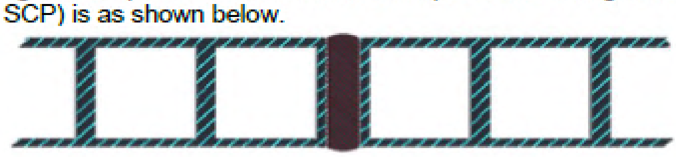
Pipe material:
The thought is to use the spirolite line to produce a watertight conduit of 14 foot inside diameter. A line will be constructed out of PE 4710 resin capable of being welded on the inside and out to handle tensile and bending of a full submergence application. The pipe profile has not yet been determined and may range from any of the profile shown below.



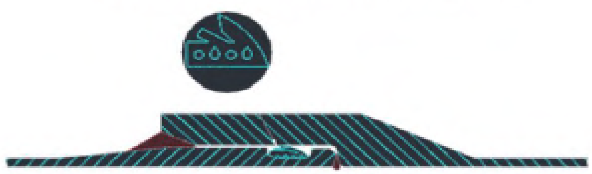
When choosing which configuration will work the best we will look at the inside layer(ID) to provide sufficient abrasion protection found from the organics and silts existing in the Galveston Bay. This layer will also aid in the structural stability for the installation process preventing against buckling during bending or tensile during deployment. The ribs of the pipe will add hoop stiffness which will help support the pipe and poor soil conditions and aid in the control of

deflection in sediment buildup around and on top of the pipe.

Connection methods:
The connection methods for spirolite would be a form of welding on the interior as well as the exterior. The bell and spicket may be utilized if they can be accommodated and tested in the 14 inch size. Bells and spicket's make for easy alignment during the welding process and creatively tight seal up to 25 feet head. An example of two configurations of welding close profile(HS or SCP) is as shown below.



Spirolite HS Thermal Welded Profile Ends



Spirolite Thermal Welded Bell and Spigot Joint

Each method utilizes extruded molten polyethylene to create a structural weld as well as leak tight seal. This is done utilizing extrusion welder or an automated extrusion welder as shown below.

Ballast blocks:

After the joint is completed ballast block would be installed on shore most preferably covering her overlapping the welded area. At this time we do not know the spacing or the size of the blocks as we are investigating the 14 foot upsize and the wall profile that would be used. Below is a standard concrete anchor which has typically been used on previous projects.

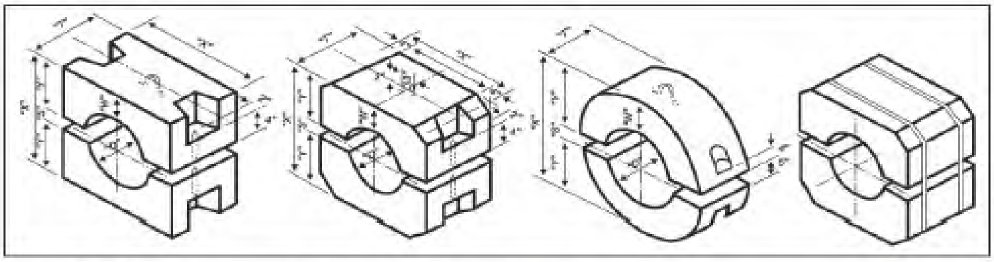


Figure A-3-1 Schematics of Concrete Ballast Designs

As previously discussed the weight of these blocks would be altered for this application. The 7" width would be much wider as well as the gap in between the weights. As previously discussed we will be working to give you a rough estimate on the overall size and placement of these blocks after we have worked with plasson to determine the feasibility of construction and anticipated wall configuration. For example of a previous project we've done, see the example of the 42 inch line deployed in New Jersey.

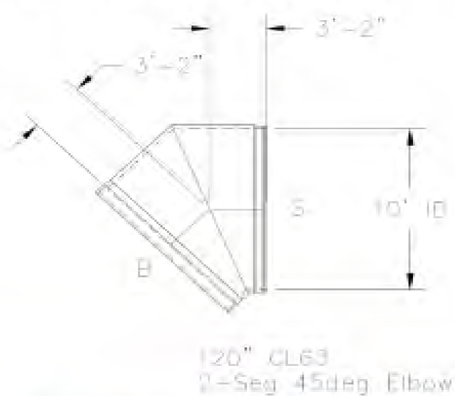
Deployment:

After each section is welding and ballast blocks are installed the pipe will be pushed out into the water being controlled by a boat or barge to help pull up in its intended location. Below is a picture of a large diameter spirolite line being deployed out into the waterway.

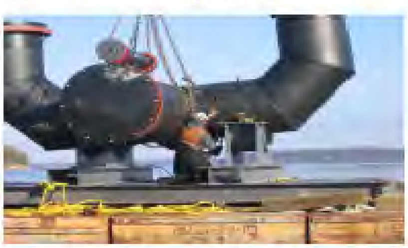
TETRA TECH	Pump Station - Discharge pipes and supports		Calculation No. CC-PS-ST-MT-004	
Job No.:	100-RCE-18-09-1		**Page:**	14
Project:	Coastal Texas Protection and Restoration			
Description:	CALCULATIONS			
Made By:	SDG	**Date:** Nov-07-2018	**Chk'd By:** LRM	**Date:** 11/09/18

Pipeline diffuser:

As we previously discussed if we can accommodate 14 foot diameter pipe with low enough velocities would be low enough to leave the line open ended with a 45. The 45 will be utilized to point up out of the sediment and allow for a free dispersion of particle discharge during pumping. To give you a rough magnitude size our typical 45 please see the below sketch of one of our 10 feet two segment elbows.



This elbow can be orientated vertically off the bottom and supported using an FRP fiberglass skid. Extension or pop could be added to gain your desired length to ensure it's up out of the sediment. Example of this can be seen below from one of our previous projects.



Closing remarks:

As we have found before with many Marine projects there are many different installation tactics for the actual sinking of the HDPE. The success of the tactic chosen depends on the knowledge of your project partners and the resources available to the installer. One of the major importance while taking on endeavor such as this is to qualify the rate team members to provide a proper and safe installation. As this project progresses VARI-TECH would be happy to aid your firm in the technical support of HDPE as well as help you find qualified contractors for technical installation questions as well as possible budgets if needed.

CALCULATIONS

SDG
Nov 9, 2018

Bouyancy on the pipes.

Wt. of a double cell Spirolite 13' ϕ = 644 lbs/LF
└ Varitech max available information w/ 5" wall thickness

Extrapolate wt. of 14' ϕ

$\frac{644}{\pi \cdot 13} = 15.78$ lb/LF circf.

$14 \cdot \pi \cdot 15.78 = \underline{693}$ lb/LF pipe ↓ Wstr

Consider a 6" thick Double cell 14' ϕ

Uplift based on displacement:

$U = \frac{6''}{12} \times \pi \times 14 \times 1' = 22$ sf. $\times 63$ lb/ft $= 1385$ lb/ft ↑

per ETC 1110-2-307

$F.S. = \frac{W_{str} + \text{Surcharge}}{U} = 1.5$
└ Normal operations

$1.5 = \frac{693 + S}{1385}$ ∴ $S = 1385$ lbs ↓

Volume of concrete $= \frac{1385}{(150-63)} = 15.91$ cf/LF pipe
× 20
318 cf of concrete/ring
÷ 27
11.8 cy of concrete/precast concrete ring

CALCULATIONS

SDG Nov 9 2018

EARTH WORK QTY: CLEAR CREEK P.S.

P.S. Discharge pipes
follow Dikinson Bayou approach.

Avg. ground EL. ~ 0.0 (some in shallow water, some in land to +3)

Avg length of pipes: 1,989 LF (see spreadsheet)
← 53702/27 pipes

Dredging:

Stage #1 to -12

$24' \times 12' \times 1{,}989'/27 = 24{,}752 \text{ cy} \times 27 \text{ pipes} = 572{,}832 \text{ cy}$

Stage #2 to -16

$(24+4)\frac{1}{2} \times 4 \times 1989/27 = 4125 \text{ cy/pipe} \times 27 = 111{,}384 \text{ cy}$

684,216 cy

Backfill

Stage #1: $4125 \text{ cy} + 24 \times 7 \times 1989/27 - \left[\frac{\pi}{4} \cdot 14^2 \times \frac{1989}{27} - \frac{25 \times 1989}{27}\right]$
to -5. $= 7{,}008 \text{ cy} \times 27 \text{ pipes} = \underline{189{,}216} \text{ cy}$ of gravel

stage #2
to ϕ : $24 \times 5 \times 1989/27 - 25 \times 1989/27 = 6{,}998 \text{ cy}$
$\times 27$ pipes

$\boxed{188\,955 \text{ cy}}$

TETRA TECH

Clear Creek Sector Gate Quantities

Calculation No.
CC-FG-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Coversheet				
Made By:	DAS	**Date:** 05/29/18	**Chk'd By:** DS	**Date:**	11/05/18

Calc Body Pages	Appended Pages	Total Pages
8	0	8

Document code

Site	Feature	Discipline	Document type	Number
CC	FG	ST	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Dave Stensby 11/14/18	Daniel Stuard 11/14/18	Submitted for Review
B			

TETRA TECH	**Clear Creek Sector Gate Quantity Calculations**		**Calculation No. CC-FG-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	DAS	**Date:**	05/29/18	**Chk'd By:**	DS	**Date:**	11/05/18

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Attachments	Number of Pages	Last Page Number

TETRA TECH	Clear Creek Sector Gate Quantity Calculations			Calculation No. CC-FG-ST-MT-001
Job No.:	100-RCE-18-09-1		**Page:**	3
Project:	Coastal Texas Protection and Restoration			
Description:				
Made By: DAS	**Date:** 05/29/18	**Chk'd By:** DS	**Date:**	11/05/18

ISSUE BEING ADDRESSED

This is a preliminary quantity takeoff for the sector gate. It is based on limited information regarding the site conditions and the feature requirements. These quantities will be updated in more detail as future design phases progress.

APPROACH

A solid model of the sector gate was prepared. Many quantities such as steel in the gate design are taken directly from that model. Fender quatities are calculated in the take off with the design assumptions listed.

REFERENCES

See associated structural calculations

RESULTS / CONCLUSIONS

Total Steel for Sector Gates:	188	tons	(both sector gates)
Total Weight of UHMW fenders	28400	lbs	(both sector gates)

TETRA TECH	Clear Creek Sector Gate Quantity Calculations			Calculation No. CC-FG-ST-MT-001
Job No.:	100-RCE-18-09-1		**Page:**	4
Project:	Coastal Texas Protection and Restoration			
Description:				
Made By:	DAS **Date:** 05/29/18	**Chk'd By:** DS	**Date:**	11/05/18

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

These quantities are based on the associated structural calculations. Due to the limited amount of site information and design requirements available, a number of significant assumptions have been made. These are shown in the associated structural design calculations.

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Water elevations and load cases to be evaluated.
2) Detailed design of gate and monolith.
3) Access requirements

CALCULATIONS

See Attached

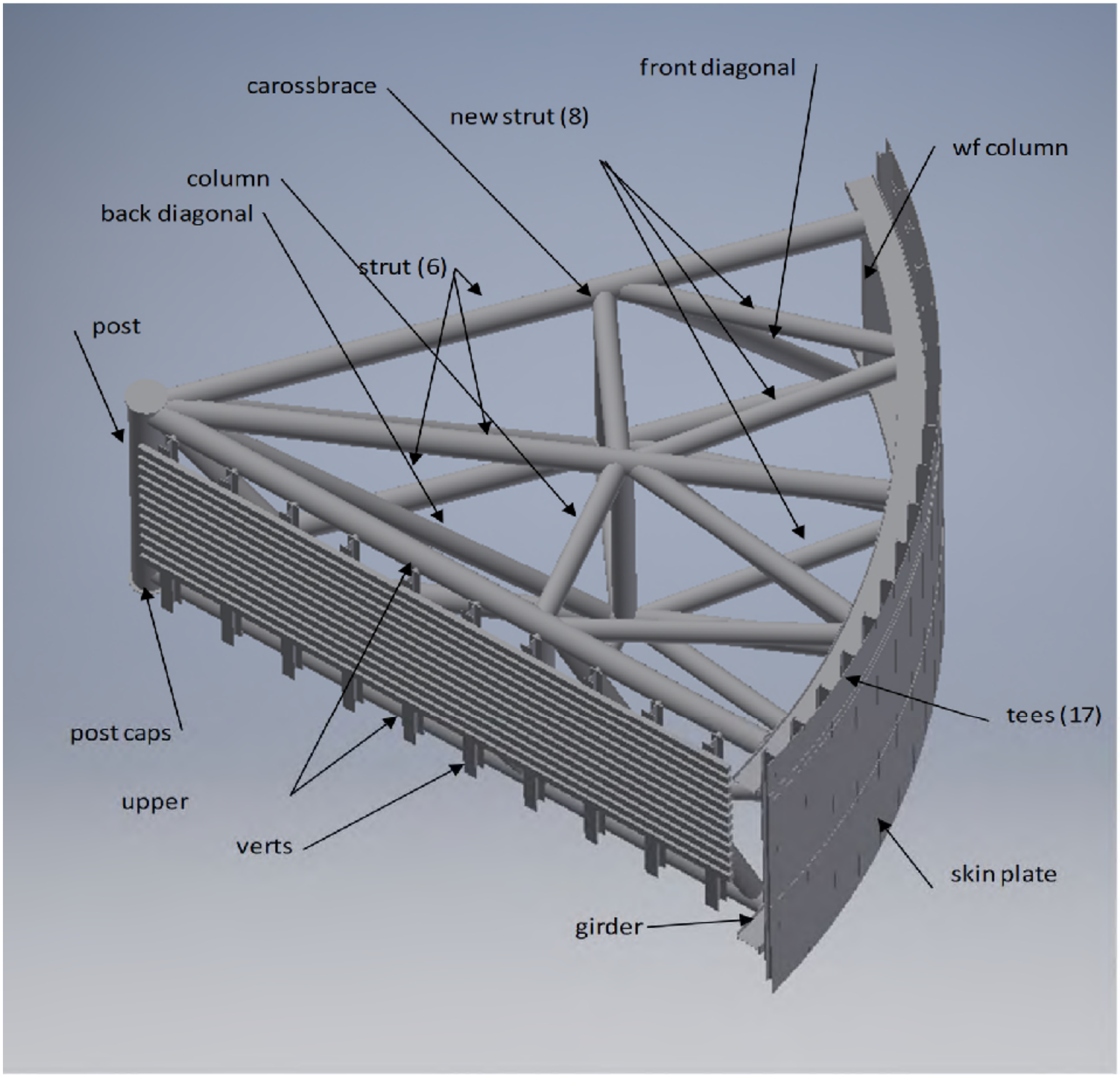
Sector Gate Steel Quantities

The sector gate quantities are taken from the solid model shown below.

The round sections are 0.5 inch wall pipe. The rest of the structure is rolled sections except for the skin plate.

The structure will be painted with a coal tar epoxy system.

Due to preliminary nature of the design, the weights have been increased to account for additional requirements such as walkways, etc.



front diagonal
carossbrace
new strut (8)
wf column
column
back diagonal
strut (6)
post
tees (17)
post caps
upper
verts
skin plate
girder

Quantities are taken from the solid model of the gate used for analysis.

Additional calcs are used to verify the results of some model components.
Quantities are for one gate. There are a total of two gates.

Item	component	quantity	material	Weight	Total Weight
		ea		lbs	lbs
1	skin plate	1	steel	33498	33498
2	tees	17	steel	1147.	19499
3	girder	2	steel	4887.	9774
4	post	1	steel	5394.	5394
5	strut	6	steel	6278.	37668
6	new strut	8	steel	1893.	15144
7	column	3	steel	1916.	5748
8	front diagonal	3	steel	2475.	7425
9	back diagonal	3	steel	3495.	10485
10	cross brace	4	steel	1351.	5404
11	wf column	3	steel	1519.	4557
12	post caps	2	steel	288.6	577.2
13	upper support	20	steel	18.69	373.8
14	vert	10	steel	1397.	13970

Total Steel Weight	169517	lbs
Allowanc for walkways, connections, etc.	10%	
Total steel Weight	186500	lbs
	94	tons
# gates	2	
Total Steel	188	tons

check skin plate					
height	348	in			
angle	60	deg			
	1.0472	radians			
radius	648	in			
length	678.58	inches			
thickness	0.5	inches			
vol	118074	in^3			
	68.33	ft^3			
density	490	pcf			
weight		33482 lbs			
weight from takeoff		33498	error:	-0.049%	ok

The fender system is comprised of 6 x 10 reinforced UHMW ('force bar') 'timbers'.

Quantity		
width	10	in
depth	6	in
area	0.4167	sq ft
length	45.7	ft
Density	62	pcf
Number of timber	12	
Total Weight	14200	lbs
# gates	2	
Total Weight	28400	lbs

TETRA TECH	Clear Creek Bulkhead Storage Platform Quantities	Calculation No. CC-FG-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Clear Creek Bulkhead Storage Platform Quantities				
Made By:	LN	**Date:** 07/25/18	**Chk'd By:** DS	**Date:**	08/22/18

Calc Body Pages	Appended Pages	Total Pages
7	0	7

Document code

Site	Feature	Discipline	Document type	Number
CC	FG	ST	MT	002

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Lexee Navarre 8/22/18 [signature]	Daniel Stuard 8/22/18 [signature]	

TETRA TECH	Clear Creek Bulkhead Storage Platform Quantities	Calculation No. CC-FG-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LN	**Date:**	07/25/18	**Chk'd By:**	DS	**Date:**	08/22/18

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Attachments	Number of Pages	Last Page Number

TETRA TECH	Clear Creek Bulkhead Storage Platform Quantities	Calculation No. CC-FG-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	3
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	LN	**Date:** 07/25/18	**Chk'd By:** DS	**Date:**	08/22/18

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for bulkhead storage platforms.

APPROACH

Typical engineering means and methods for determining volumes and weights.

REFERENCES

References used during this calculation are as follows:

1) CC-FG-ST-CL-002

RESULTS / CONCLUSIONS

Total # of Steel Pipe Piles:	8 (All piles have tension connections)			
Total 24" Diam. X 0.5" Steel Pipe Pile:	530.0 ft	**or**	33.3 tons	
Total Concrete:	105.8 yd^3			

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) Material Properties:
   - Concrete, f'c = 4000 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
2) Costs of reinforcement is included in reinforced concrete unit cost.
3) All piles have tension connections.

ITEMS TO BE VERIFIED

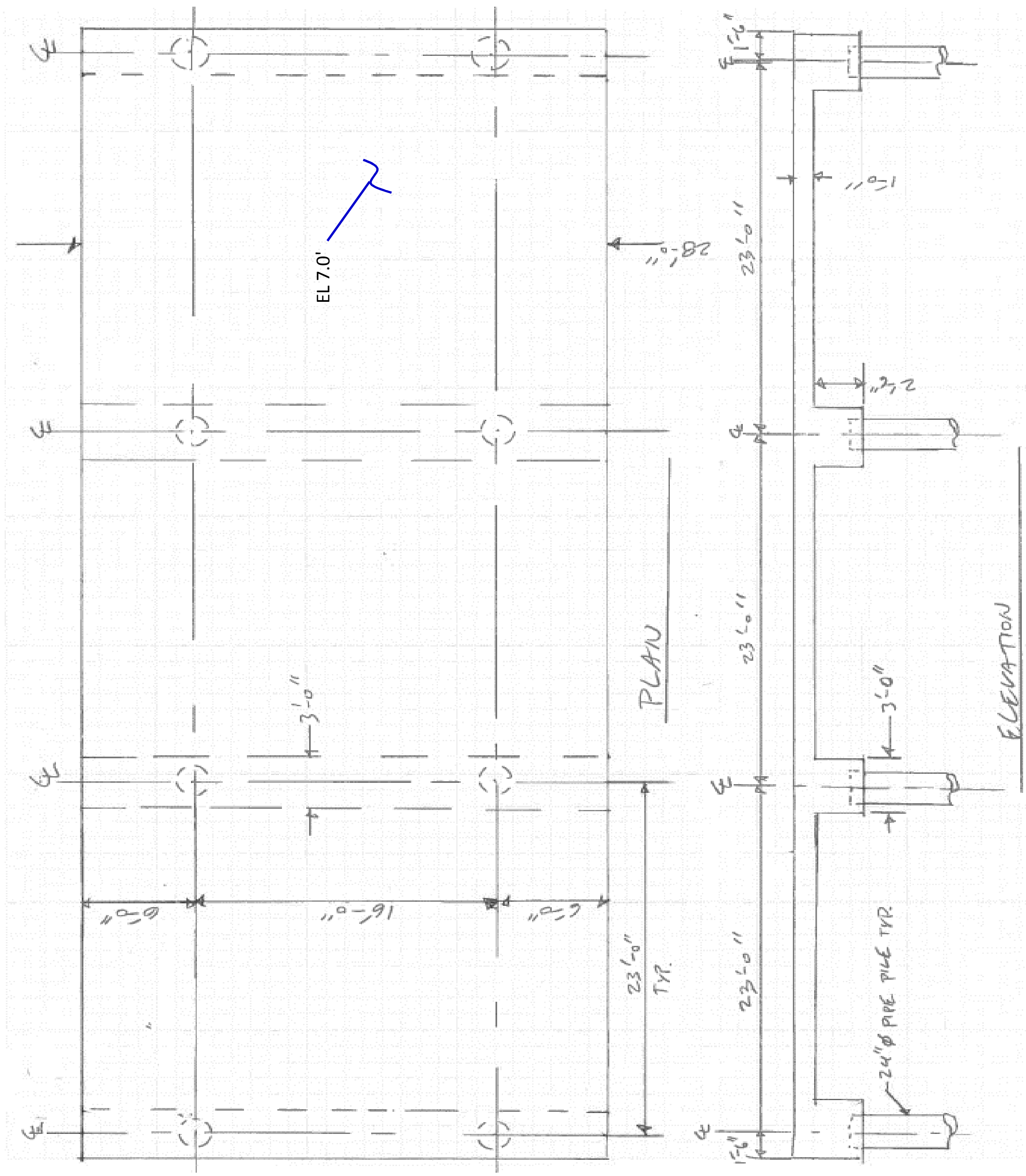
The following items are to be verified in a later design phase:

1) Materials and quantities as design progresses.

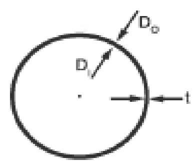
CALCULATIONS

Begin on next page.

General References and Figures



Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = 10.69*t*(D_o-t)
D_o (in) - outside diameter
t (in) - thickness of pipe

Pipe Weight (kg/m) = 0.0247*t*(D_o-t)
D_o (mm) - outside diameter
t (mm) - thickness of pipe

PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

Job No.:	100-RCE-18-09-1	**Page:**	7
Project:	Coastal Texas Protection and Restoration		
Description:	Quantities for Bulkhead Storage Platform		
Made By:	LN **Date:** 07/25/18	**Chk'd By:** DS	**Date:** 08/22/18

Quantities for Bulkhead Storage Platform

PILES

Pile Diameter:	24.0 in	**Head Elevation:**	4.25 ft
Pipe Thickness:	0.5 in	**Tip Elevation:**	-62.00 ft
Pipe Weight*:	125.61 lb/ft	**Pile Length:**	66.25 ft

*see general references attachments for reference of produced value

Number of Piles per Bent: 2
Number of Pile Bents: 4

Total Number of Piles:	**8**		
Total of Steel Pipe Piles:	**530.0 ft**	**or**	**33.3 tons**

CONCRETE:

DECK:

Thickness (ft)	Length (ft)	Cross Sectional Area (ft^2)	Width (ft)	Volume (yd^3)
1.0	72.0	72.0	28.0	74.7

Total Concrete for Deck: 74.7 yd^3

PILE BENTS:

Thickness (ft)	Width (ft)	Cross Sectional Area (ft^2)	Length (ft)	Volume (yd^3)
2.5	3.0	7.5	28.0	7.8

Number of Pile Bents: 4
Total Concrete for Bents: 31.1 yd^3

TOTAL CONCRETE: 105.8 yd^3

TETRA TECH	Clear Creek Monolith Quantities	Calculation No. CC-FG-ST-MT-003

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Coversheet				
Made By:	DS	**Date:** 11/05/18	**Chk'd By:** DAS	**Date:**	11/05/18

Calc Body Pages	Appended Pages	Total Pages
16	0	16

Document code

Site	Feature	Discipline	Document type	Number
CC	FG	ST	MT	003

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Daniel Stuard 11/06/18	Dave Stensby 11/06/18	Submitted for Review

TETRA TECH	Clear Creek Monolith Quantities	Calculation No. CC-FG-ST-MT-003

Job No.:	100-RCE-18-09-1			**Page:**	2
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	DS	**Date:** 11/05/18	**Chk'd By:** DAS	**Date:**	11/05/18

TABLE OF CONTENTS

Attachments	Number of Pages	Last Page Number

TETRA TECH	Clear Creek Monolith Quantities	Calculation No. CC-FG-ST-MT-003

Job No.:	100-RCE-18-09-1			**Page:**	3
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	DS	**Date:** 11/05/18	**Chk'd By:** DAS	**Date:**	11/05/18

ISSUE BEING ADDRESSED

This is a preliminary quantity takeoff for the sector gate. It is based on limited information regarding the site conditions and the feature requirements. These quantities will be updated in more detail as future design phases progress.

APPROACH

Typical engineering means and methods for determining volumes and weights.

REFERENCES

See associated structural calculations for the gate monolith and foundation

RESULTS / CONCLUSIONS

Excavation & Fill:

Total Wet Excavation:	3,161	yd^3
Total Wet Fill:	1,581	yd^3

Steel:

Total Steel for Sheet Piles and Shoring:	1,168	tons
Total Steel Pipe Piles:	273	
of which	154	are batted 3:1 (V:H) All piles have tension connections
Total Weight of Steel Pipe Piles:	1,427	tons
Total Steel:	2,595	tons

Tremie Concrete:

Total Tremie Concrete:	3,161	yd^3

Concrete:

Total Concrete for Fill of Steel Pipe Piles:	583	yd^3
Total Concrete for Base Slab:	3,952	yd^3
Total Concrete for Monolith Walls:	3,541	yd^3
Total:	8,076	yd^4

HPU / Control Building

Total # of HPU / Control Buildings:	2

TETRA TECH	**Clear Creek Monolith Quantities**		**Calculation No. CC-FG-ST-MT-003**
Job No.:	100-RCE-18-09-1	**Page:**	4
Project:	Coastal Texas Protection and Restoration		
Description:			
Made By: DS	**Date:** 11/05/18	**Chk'd By:** DAS	**Date:** 11/05/18

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

- These quantities are based on the associated structural calculations. Due to the limited amount of site information and design requirements available, a number of significant assumptions have been made. These are shown in the associated structural design calculations.
- Excavation only consideres excavation under the plan area of the structure, other excavation is to be determined by others. This excavation will be in the wet. The material will be soft sediment and clay and may be contaminated due to presence of chemical and petroleum pipelines in the area. Disposal area unknown.
- Fill and tremie to be placed within the closed cofferbox, in the wet.
- Structural Elevations:

Top of Structure:	17.0 ft	Pile Head:	-16.25 ft
Top of Base Slab / Sill:	-12.0 ft	Pile Tip:	-97.0 ft
Top of Tremie Slab:	-17.0 ft		
Top of Fill:	-21.0 ft		

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Water elevations and load cases to be evaluated.
2) Final geotechnical information and recommendations
3) Detailed design of gate and monolith.
4) Pile type, size and layout.
5) Pile load testing program.
6) Deflection criterial of HSDRRS is met
7) Access requirements

CALCULATIONS

See Next Page

GENERAL REFERENCES

Location of Clear Creek sector gate

Highway 146 bridge will be extended 100 feet to the west of the existing right of way.

TETRA TECH	Clear Creek Monolith Quantities			Calculation No. CC-FG-ST-MT-003	
Job No.:	100-RCE-18-09-1			**Page:**	6
Project:	Coastal Texas Protection and Restoration				
Description:	GENERAL REFERENCES				
Made By:	DS	**Date:** 11/05/18	**Chk'd By:** DAS	**Date:**	11/05/18

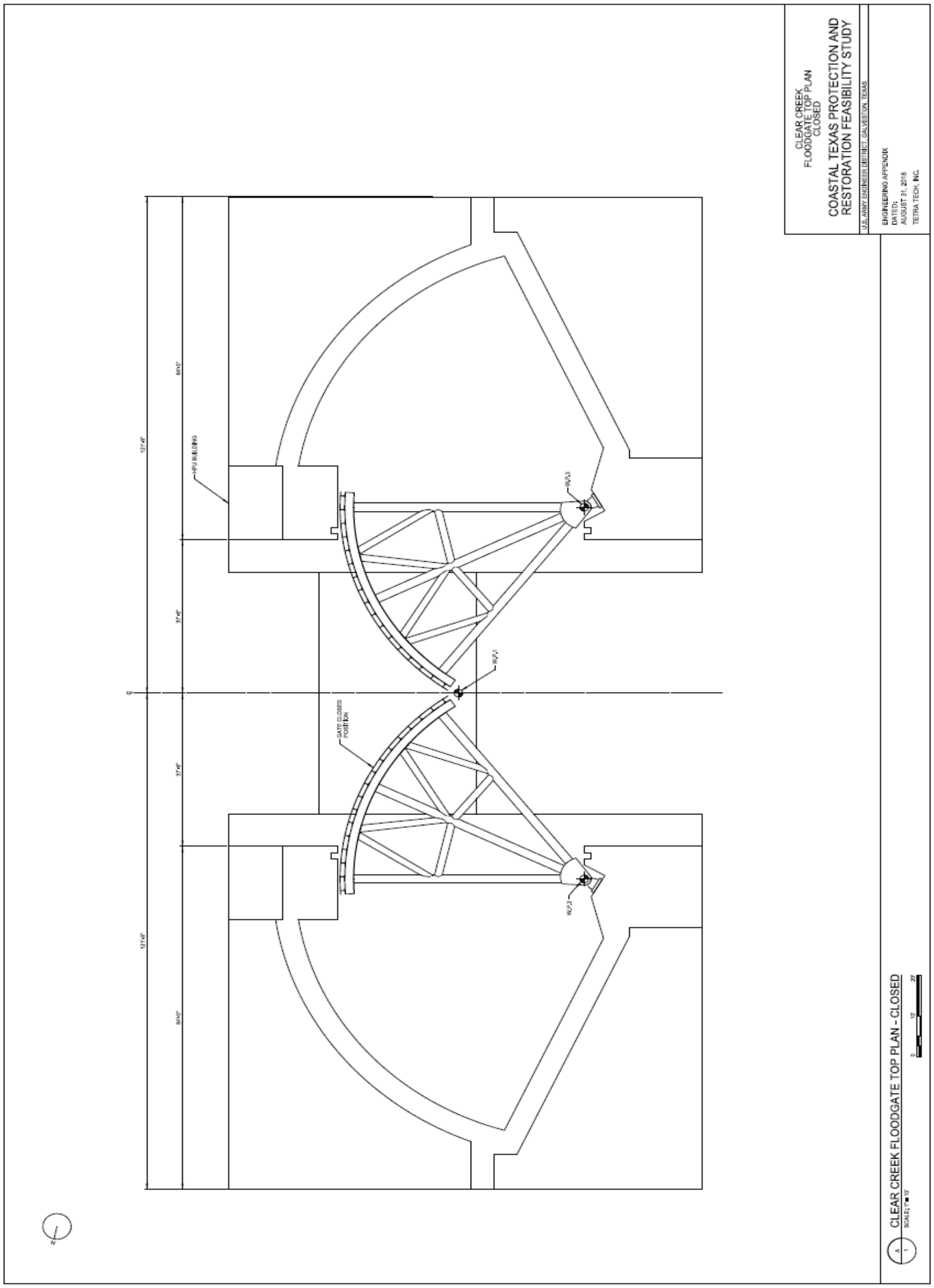
Location of existing underground pipelines at sector gate site.
We are directed to proceed as existing utilities will be removed by others.

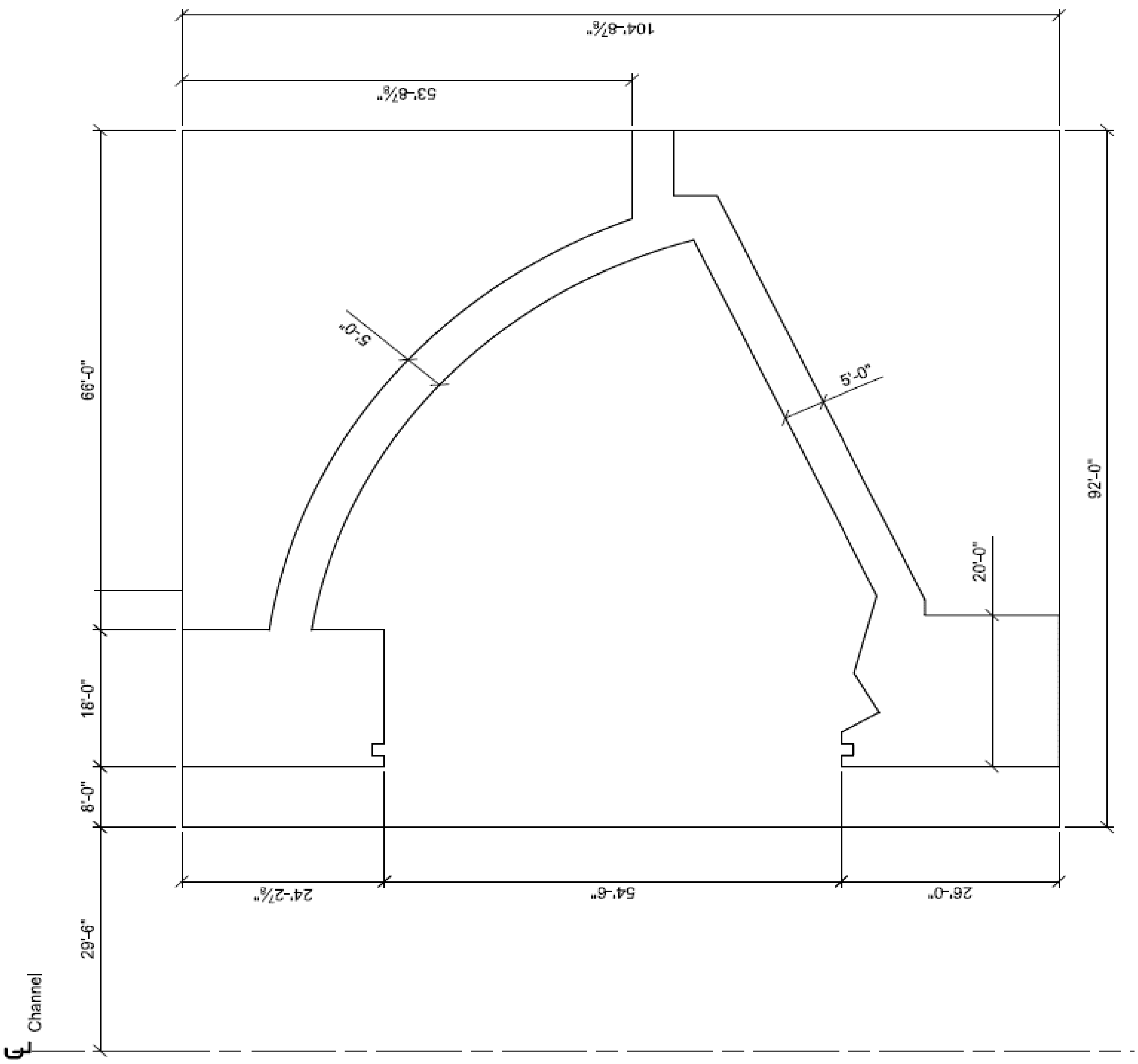
TETRA TECH

Clear Creek Monolith Quantities

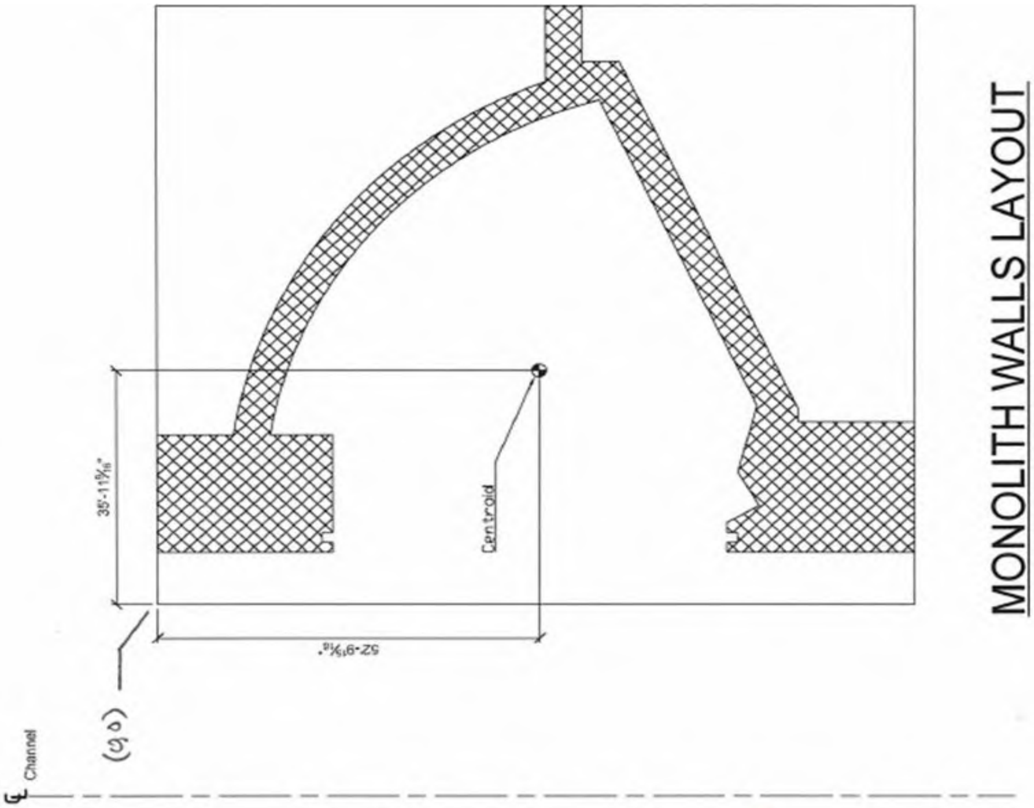
Calculation No.
CC-FG-ST-MT-003

Job No.:	100-RCE-18-09-1					**Page:**	7
Project:	Coastal Texas Protection and Restoration						
Description:	GENERAL REFERENCES						
Made By:	DS	**Date:**	11/05/18	**Chk'd By:**	DAS	**Date:**	11/05/18





104'-8⅞"
53'-8⅞"
5'-0"
5'-0"
66'-0"
92'-0"
20'-0"
18'-0"
8'-0"
24'-2⅞"
54'-6"
26'-0"
29'-6"
℄ Channel



Walls.mpr - Notepad

File Edit Format View Help

```
----------------   REGIONS   ----------------
Area:                    237384.9618
Perimeter:               5547.3686
Bounding box:         X: 96.0000  --  1104.0000
                      Y: -1256.8689  --  0.0000
Centroid:             X: 431.5440
                      Y: -633.3013
Moments of inertia:   X: 1.3530E+11
                      Y: 638458399995.1771
Product of inertia:  XY: -6.4822E+10
Radii of gyration:    X: 754.9605
                      Y: 518.6086
Principal moments and X-Y directions about centroid:
                      I: 19637432837.7658 along [0.0027 1.0000]
                      J: 40093244394.3111 along [-1.0000 0.0027]
```

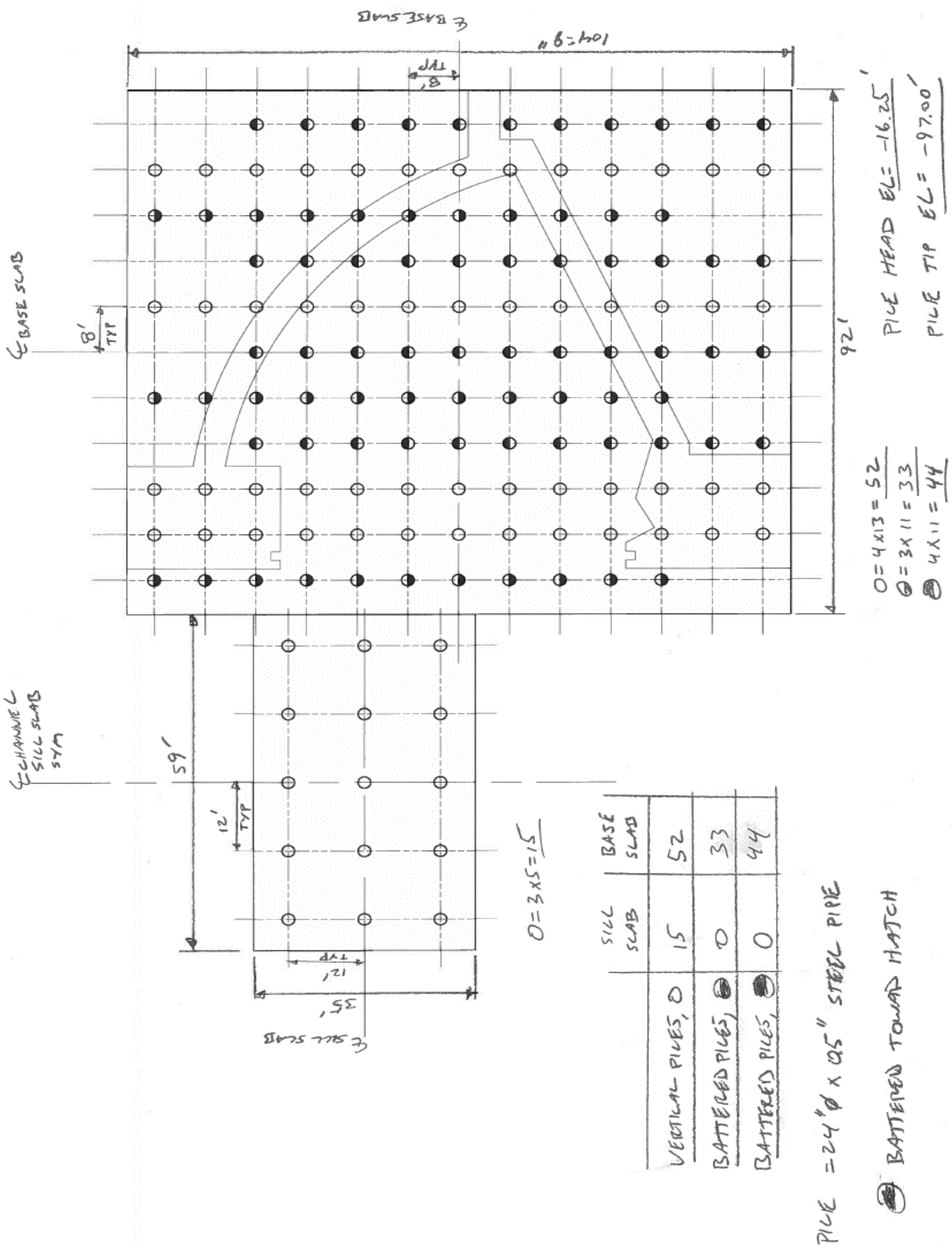
$A = 237385 \text{ in}^2 = \underline{1648.5 \text{ ft}^2}$

$\bar{X} = 633.3 \text{ in} = \underline{52.78'}$

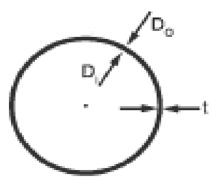
$\bar{Y} = 431.5 \text{ in} = \underline{35.96'}$

Note figure above is used only for Wall area

TETRA TECH	**Clear Creek Monolith Quantities**			**Calculation No.** CC-FG-ST-MT-003	
Job No.:	100-RCE-18-09-1			**Page:**	10
Project:	Coastal Texas Protection and Restoration				
Description:	GENERAL REFERENCES				
Made By:	DS	**Date:** 11/05/18	**Chk'd By:** DAS	**Date:**	11/05/18



Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = 10.69*t*(D_o-t)
D_o (in) - outside diameter
t (in) - thickness of pipe

Pipe Weight (kg/m) = 0.0247*t*(D_o-t)
D_o (mm) - outside diameter
t (mm) - thickness of pipe

PIPE WEIGHT lbs/ft (kg/m)														
Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42	111.58	139.04	166.86	194.60	221.82	248.95	276.44	303.84	330.72	384.67	438.29	544.52	597.14	

Job No.:	100-RCE-18-09-1					**Page:**	12
Project:	Coastal Texas Protection and Restoration						
Description:	Sector Gate Monolith Quantities						
Made By:	DAS	**Date:**	11/05/18	**Chk'd By:**	DAS	**Date:**	11/05/18

Sector Gate Monolith Quantities

EXCAVATION

- This excavation only consideres excavation under the plan area of the structure, other excavation is to be determined by others.
- This excavation will be in the wet. The material will be soft sediment and clay and may be contaminated due to presence of chemical and petroleum pipelines in the area.
- Disposal area unknown.
- Fill and Tremie to be placed within the closed cofferbox

Assumed Mud Line Elevation:	-19.0	ft
Elevation of Bottom of Tremie Slab:	-21.0	ft
Assumed Over Excavation:	2.0	ft
Depth of Excavation:	4.0	ft

Monolith Base Slab

Width:	92.00	ft
Length:	104.75	ft
Area:	9,637	ft^2
Excavation Volume / Monolith:	38,548	ft^3
# of Monoliths:	2	
Total Monolth Excavation:	77,096	ft^3

Sill Slab

Width:	59.00	ft
Length:	35.00	ft
Area:	2,065	ft^2
Excavation Volume:	8,260	ft^3

Volume of Excavation: 85,356 ft^3

Total Wet Excavation: 3161 yd^3

Fill

- Fill to be placed in the wet

Assumed Fill Depth: 2 ft

Monolith Base Slab

Area:	9,637	ft^2 (See above)
Fill Volume / Monolith:	19,274	ft^3
# of Monoliths:	2	
Total Monolth Excavation:	38,548	ft^3

Sill Slab

Area:	2,065	ft^2
Fill Volume:	4,130	ft^3

Volume of Fill: 42,678 ft^3

Total Wet Fill: 1581 yd^3

SHEET PILE COFFER BOX

Assumed Top of Sheet Pile Elevation:	10 ft	
Assumed Bottom of Sheet Pile Elevation:	-61 ft	(40ft below tremie slab)
Height of Sheet Pile:	71 ft	
Assumed Weight of Sheet Pile:	27 psf	
Assumed Weight of Sheet Pile:	1,917 lb/ft	

Monolith Base Slab		Sill Slab	
Width:	92.00 ft	Width:	59.00 ft
Length:	104.75 ft	Length:	35.00 ft
Perimeter:	393.5 ft	Perimeter:	188 ft
Sheet Pile Weight per Monolith:	754,340 lbs	Sheet Pile Weight:	360,396 lbs
# of Monoliths:	2		180.2 Tons
Total Weight for Monolths:	1,508,679 lbs		
	754.3 Tons		

Total Weight of Sheet Pile:	**935 tons**
Assumed Percent for Shoring:	25%
Total Steel Weight for Shoring:	**234 tons**
Total Steel for Sheet Piles and Shoring:	**1,168 tons**

Dewatering: **Lump Sum**

TETRA TECH	Clear Creek Monolith Quantities	Calculation No. CC-FG-ST-MT-003

Job No.:	100-RCE-18-09-1			**Page:**	14
Project:	Coastal Texas Protection and Restoration				
Description:	Sector Gate Monolith Quantities				
Made By:	DAS	**Date:** 11/05/18	**Chk'd By:** DAS	**Date:**	11/05/18

STEEL PIPE PILES

Pile: 24"x0.5" Steel Pipe Pile
Pile Weight: 125.6 lbs/ft (See Reference)

Top of Pile Elevation: -16.25 ft
Bottom of Sheet Pile Elevation: -97 ft
Vertical Pile Length: 80.75 ft

Batter: 3 :1 (V:H)
θ: 18.4 degrees
Battered Pile Length: 85.12 ft

Monolith Piles

	# of Piles	L / Pile ft	Total L ft
Vert. Piles	52	80.75	4,199.0
+Batt. Piles	33	85.12	2,808.9
-Batt Piles	44	85.12	3,745.2
Total:	**129**		**10,753.1**

Sill Slab Piles

	# of Piles	L / Pile ft	Total L ft
Vert. Piles	15	80.75	1,211.3

# of Monoliths: 2
Total # of Monolith Piles: 258
Monolith Piles Total Length: 21,506 ft

Total # of Batterd Piles: 154
Total # of Piles: 273 (All piles have tension connections)
Total Length of Piles: 22,717 ft
Pile Weight: 125.6 lbs/ft
Weight of Piles: 2,853,308 lbs

Total # of Piles:	**273**
Total Weight of Piles:	**1,427 tons**

FILL FOR PILE TOPS:

CONCRETE:

The preparation of the pile tops will be to fill the tops of the piles with concrete.

Pile Diameter: 24 in
Wall thickness: 0.5 in
Interior Pile Area: 415 in^2
2.9 ft^2
Length of Concrete Fill: 20 ft (assumed)
Volume of Concrete Fill: 57.7 ft^3
Total Number of Piles: 273 (see steel piles section)
Total Volume of Concrete: 15,753 ft^3

Total Fill Concrete:	**583 yd^3**

TETRA TECH	Clear Creek Monolith Quantities			Calculation No. CC-FG-ST-MT-003
Job No.:	100-RCE-18-09-1		**Page:**	15
Project:	Coastal Texas Protection and Restoration			
Description:	Sector Gate Monolith Quantities			
Made By:	DAS **Date:** 11/05/18	**Chk'd By:** DAS	**Date:**	11/05/18

TREMIE SLAB CONCRETE

Assumed Tremie Thickness: 4.0 ft

Monolith Base Slab			Sill Slab		
Width:	92.00	ft	Width:	59.00	ft
Length:	104.75	ft	Length:	35.00	ft
Area:	9,637	ft^2	Area:	2,065	ft^2
Tremie Slab Volume:	38,548	ft^3	Tremie Slab Volume:	8,260	ft^3
# of Monoliths:	2				
Total Monolth Tremie Slab:	77096	ft^3			

Total Volume of Tremie Slab: 85356 ft^3

Total Tremie Concrete: 3161 yd^3

BASE SLAB CONCRETE

Top of Base Slab Elevation: -12.0 ft

Top of Tremie Slab Elevation: -17.0 ft

Hight of Walls: 5.0 ft

Monolith Base Slab			Sill Slab		
Area:	9,637	ft^2 See above	Area:	2,065	ft^2
Base Slab Volume:	48,185	ft^3	Base Slab Volume:	10,325	ft^3
# of Monoliths:	2				
Total Monolth Tremie Slab:	96,370	ft^3			

Total Volume of Tremie Slab: 106,695 ft^3

Total Base Slab Concrete: 3952 yd^3

MONOLITH WALLS & THRUST BLOCK CONCRETE

Top of Monolith Elevation:	17.0	ft			
Top of Base Slab Elevation:	-12.0	ft	Plan Area of Walls:	1,649	ft^2
Hight of Walls:	29.0	ft	Volume of Walls:	47,807	ft^3

# of Monoliths: 2

Total Volume: 95,613.0 ft^3

Total Monolith Wall and Thrust Block Concrete: 3,541 yd^3

HPU / CONTROL BUILDING

HPU building is to be a prefabricated 18ftx12ft building

# of Monoliths: 2

HPU / Control Buildings:	**2**

TETRA TECH	Clear Creek Sector Gate Bulkhead Quantities	Calculation No. CC-FG-ST-MT-004

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Coversheet				
Made By:	DS	**Date:** 11/06/18	**Chk'd By:** DAS	**Date:**	11/7/16

Calc Body Pages	Appended Pages	Total Pages
7	0	7

Document code

Site	Feature	Discipline	Document type	Number
CC	FG	ST	MT	004

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Daniel Stuard 11/7/2018 Daniel Stuard	Dave Stensby 11/7/2018 Stephen [illegible] for Dave Stensby	Submitted for Review

TETRA TECH	**Clear Creek Sector Gate Quantity Calculations**	**Calculation No. CC-FG-ST-MT-004**

Job No.:	100-RCE-18-09-1				**Page:**	2
Project:	Coastal Texas Protection and Restoration					
Description:						
Made By:	DS	**Date:**	11/06/18	**Chk'd By:**	**Date:**	11/7/16

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Attachments	Number of Pages	Last Page Number

TETRA TECH	**Clear Creek Sector Gate Quantity Calculations**		**Calculation No. CC-FG-ST-MT-004**
Job No.:	100-RCE-18-09-1	**Page:**	3
Project:	Coastal Texas Protection and Restoration		
Description:			
Made By: DS	**Date:** 11/06/18	**Chk'd By:**	**Date:** 11/7/16

ISSUE BEING ADDRESSED

This is a preliminary quantity takeoff for the sector gate bulkheads. The gate and monolith design are based on limited information regarding the site conditions and the feature requirements. These quantities will be updated in more detail as future design phases progress.

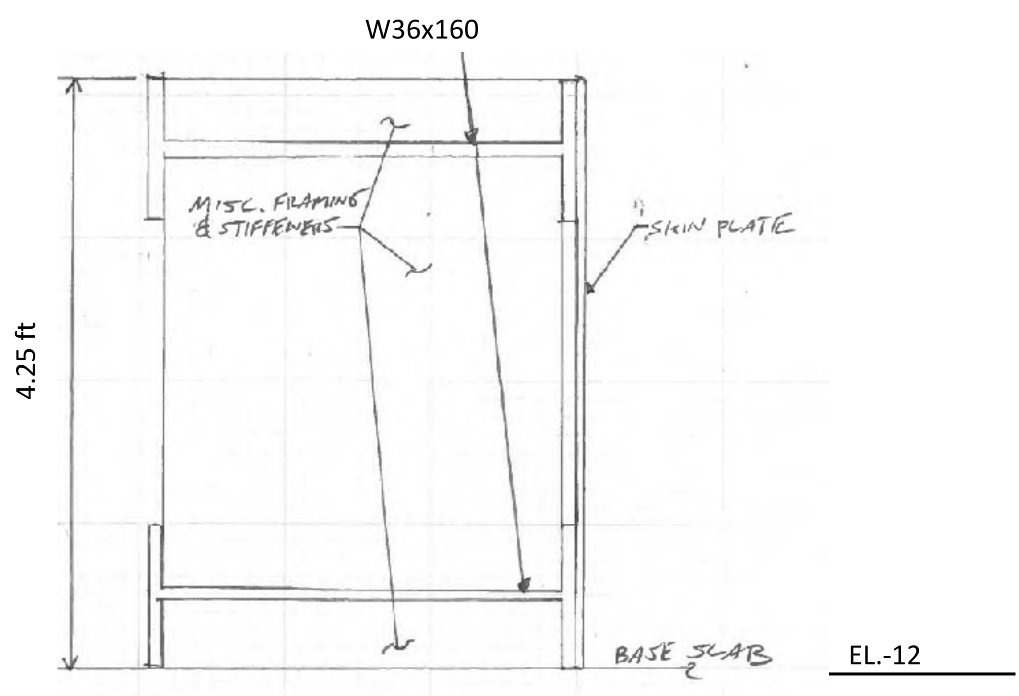
APPROACH

The bulkhead quantiles are estimated by assuming that the main members of the bulkheads are wide flange members with a 0.5" skin plate. Miscellaneous framing and stiffener weights are assumed as a percentage of the skin plate weight. The size and spacing of the main members are determined using typical engineering means and methods to determine demands and capacities.

REFERENCES

1) HSDRRS-DG with Revisions through June 2012
2) AISC 9th Edition

RESULTS / CONCLUSIONS



Bulkhead Weight:	13.5	tons each
Number of Bulkheads:	4	
Total Bulkhead Steel Weight:	54.0	tons

Job No.:	100-RCE-18-09-1			**Page:**	4
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	DS	**Date:**	11/06/18	**Chk'd By:**	**Date:** 11/7/16

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

- Design water elevation the maintenance case is : 5.00
- Apply 50% of the skin plate weight to account for misc. framing and stiffeners.
- Skin plate thickness of 0.5"
- Fy=50 ksi

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Water elevations and load cases to be evaluated.
2) Consistent with Detailed design of gate and monolith.
3) Bulkhead Design.

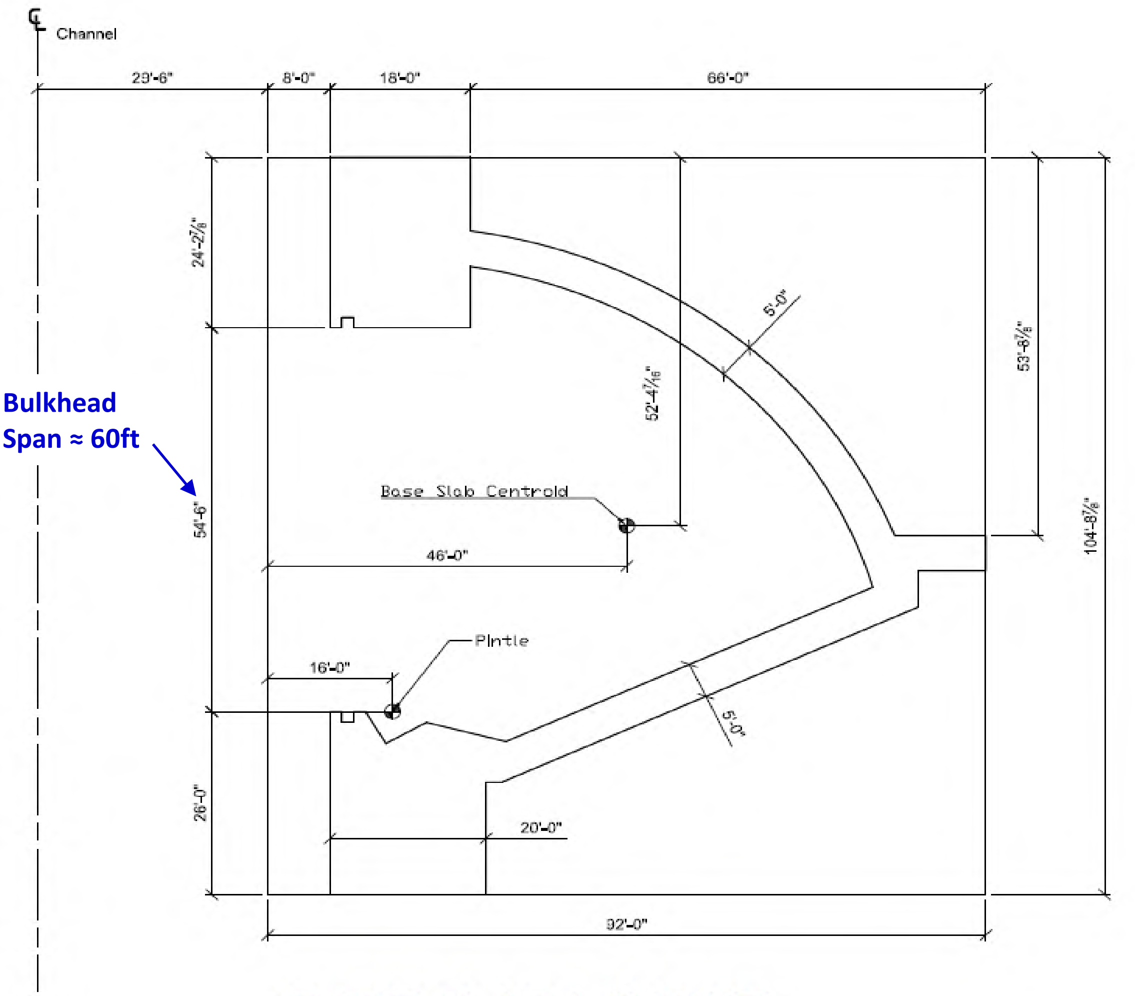
CALCULATIONS

See next page

Job No.:	100-RCE-18-09-1					**Page:**	5
Project:	Coastal Texas Protection and Restoration						
Description:	Base Slab Layout						
Made By:	DAS	**Date:**	11/06/18	**Chk'd By:**	DAS	**Date:**	11/7/16

Base Slab Layout

Bulkhead Span ≈ 60ft



BASE SLAB LAYOUT

Job No.:	100-RCE-18-09-1				**Page:**	6
Project:	Coastal Texas Protection and Restoration					
Description:	Bulkhead Quantities					
Made By:	DAS	**Date:** 11/06/18	**Chk'd By:**	DAS	**Date:**	11/7/16

Bulkhead Quantities

Bulkheads will be necessary to perform maintenance on the sector gates. The bulkheads will extend from the sill at -12 feet to El 5.0. Only one set of bulkheads will be provided, and can be used at either monolith.

GIRDERS:

Bulkhead Span:	60.0	feet	Sill EL.:	-12.00	ft
			WS EL.:	5.00	ft
Depth:	17	ft	Number of Bulkheads:	4	
Water Density:	64.0	pcf	Height of Each Bulkhead:	4.25	
Bottom Pressure:	1088	psf	Number of Girders per Bulkhead:	2	

Girder Tributary Width:	2.13	ft	
Girder Load, w:	2312	plf	
	2.31	klf	
Simple Span Moment:	1040	kip ft	wl^2 / 8
	12485	kip in	
fy:	50.0	ksi	
fb:	27.5	ksi	

(fb=0.66*fy*5/6 =AISC 9th Ed. with 5/6 reduction per HSDRRS)

S Required: **454** in^3

USE: W36x160

Web Depth:	36	in	Depth:	36	in	Sx:	542	in^3
Web Thickness:	0.65	in	Width:	12	in	Ix:	9760	in^4
Flange Thickness:	1.02	in						

TETRA TECH	**Clear Creek Sector Gate** **Bulkhead Quantities**	**Calculation No.** **CC-FG-ST-MT-004**

Job No.:	100-RCE-18-09-1					**Page:**	7
Project:	Coastal Texas Protection and Restoration						
Description:	Bulkhead Quantities						
Made By:	DAS	**Date:**	11/06/18	**Chk'd By:**	DAS	**Date:**	11/7/16

END CONNECTION:

Tibutary Length, L/2:	30.00	ft			
V:	69.4	kips			
fy:	50.0	ksi			
fv:	16.67	ksi	(fv=0.4*fy*5/6 =AISC 9th Ed. with 5/6 reduction per HSDRRS)		
Area Required:	4.2	in^2			
Depth of Web:	12.0	in (Cope end of Bulkhead)			
Thickness Required:	0.35	in	<	0.65 in	**OK**

DEFLECTION:

5/384*w*l^4/(E*I)

	I:	9760	in^4	(W36x150)
	E:	29000	ksi	
	Delta:	2.38	in	
L/x	x:	302	in	**OK**

STEEL

Girders:			Skin Plate:		
Weight:	160	plf	Thickness:	0.5	in
Length:	60	ft	Height:	4.25	ft
			Length:	60	ft
			Weight:	20.4	psf
			Area:	255	ft^2
Total Weight per Girder:	9600	lb	Total Weight per Skin Plate:	5206	lb
Number of Girders per Bulkhead:	2		Number of Skin Plates per Bulkhead:	1	
Total Weight of Girders:	19200	lb	Total Weight of Skin Plate:	5206	lb
			Additional Miscellaneous Framing per Bulkhead:	50%	of Skin Plate Weight
			Weight of Misc. Framing:	2603	lb
			Total Steel Weight per Bulkhead:	27009	lbs
				13.5	tons
			Number of Bulkheads:	4	
			Total Steel Weight:	**54.0**	**tons**

TETRA TECH	Pump Station Quantities	Calculation No. CC-PS-ME-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Pump Station Quantities				
Made By:	CTG	**Date:** 08/01/18	**Chk'd By:** XXX	**Date:** MM/DD/YY	

Calc Body Pages	Appended Pages	Total Pages
3	4	7

Document code

Site	Feature	Discipline	Document type	Number
CC	PS	ME	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	First, Last MM/DD/YY Carl Grompe 11/7/18 [signature]	First, Last MM/DD/YY Eric Fleckinger 11/7/18 [signature]	

TETRA TECH	**Pump Station Quantities**	**Calculation No. CC-PS-ME-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:	Pump Station Quantities						
Made By:	CTG	**Date:**	08/01/18	**Chk'd By:**	EOF	**Date:**	11/07/18

TABLE OF CONTENTS

ISSUE BEING ADDRESSED

Mechanical equipment quantity take-offs for preliminary cost estimate for Pump Station at Clear Creek.

APPROACH

Equipment falls into 2 categories, sets of equipment in every bay, and equipment unrelated to the number of bays

REFERENCES

References used during this calculation are as follows:

1) Mechanical drawings by Tetra Tech
2) WCC cross section
3) Patterson pump drawings from PCCP

RESULTS / CONCLUSIONS

See calculation sections

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) 5 days fuel storage

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1)

TETRA TECH	Pump Station Quantities	Calculation No. CC-PS-ME-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:	Pump Station Quantities						
Made By:	CTG	**Date:**	08/01/18	**Chk'd By:**	EOF	**Date:**	11/07/18

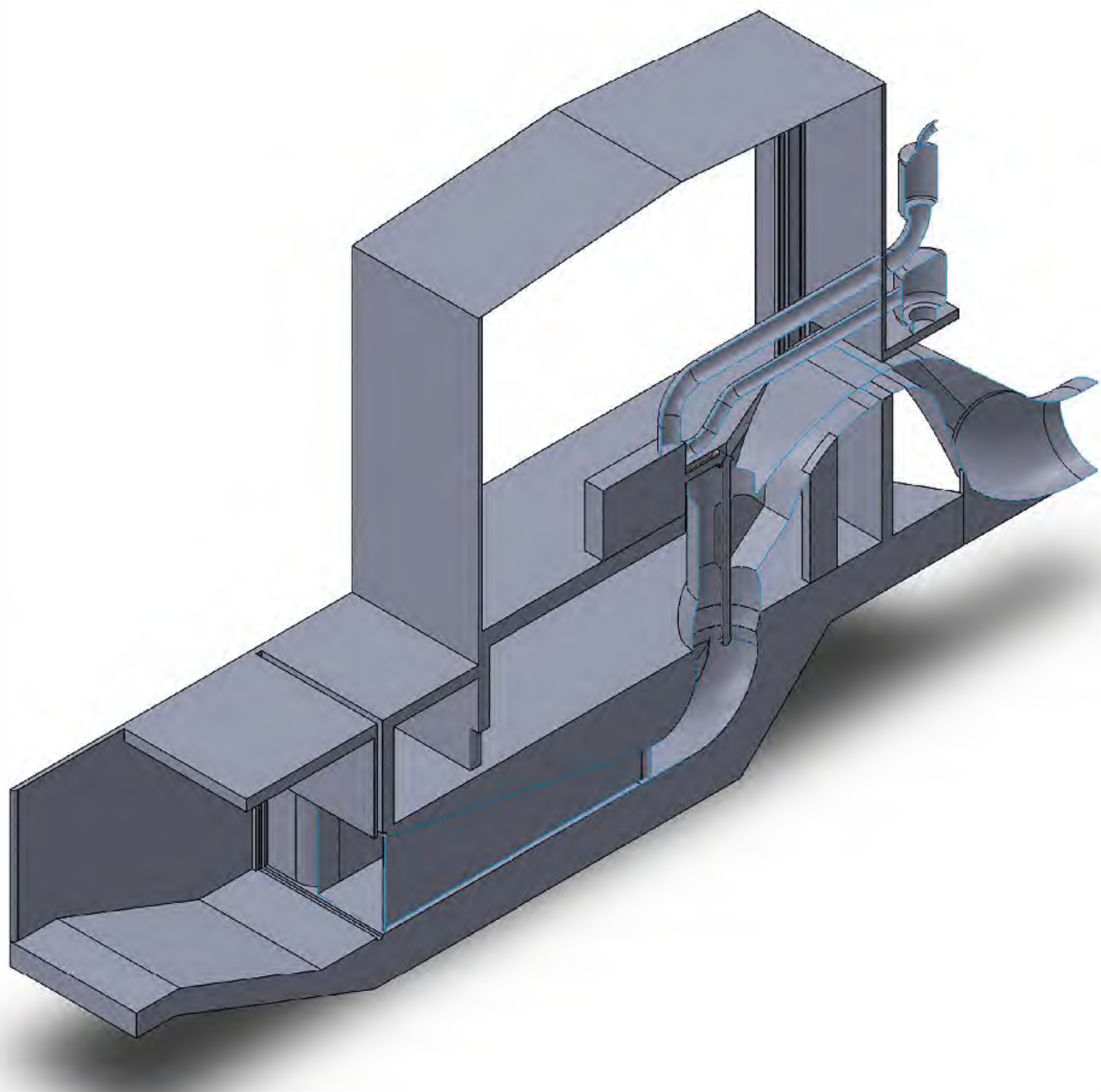
CALCULATIONS

Equipment in every bay

Number of Bays	31	
Trash rack	490	ft^2
Trash rake (climbing style)	1	
Formed suction intake (type 10 for Ø129")	1	
Vertical Pump (1500 cfs)	1	
Custom discharge piping	1	
Vacuume break	1	
hdpe discharge piping (Ø14', average length)	1975.8	ft
Angle gearbox/speed reducer	1	
Diesel engine (CAT 280-12-MC Marine)	1	
Cooling water supply lines (Ø 8")	131	ft
Cooling water pump	1	
Exhaust line	57	ft
Exhaust muffler	1	
Air intake line	42	ft
Air intake filter/silencer	1	
Day Tank (2000 gal)	1	
Double walled fuel pipe (Ø2" w/leak detection)	120	ft
Ventilation fan	1	

Other equipment

Sump stop log	695	ft^2
Stop log hoist	1	
Diesel Storage tanks (50,000 gal)	16	
Main fuel pumps	32	
Double walled fuel pipe (Ø4" w/leak detection)	2,786	ft
Double walled fuel pipe (Ø6" w/leak detection)	3,000	ft
Fuel conditioning (filter type or centrifuge type)	1	
Air Compressor	10	
Lube oil tank	13	
Bridge crane (capacity 75 tons)	2	
Trash conveyor	1210	ft
Fire protection system	1	

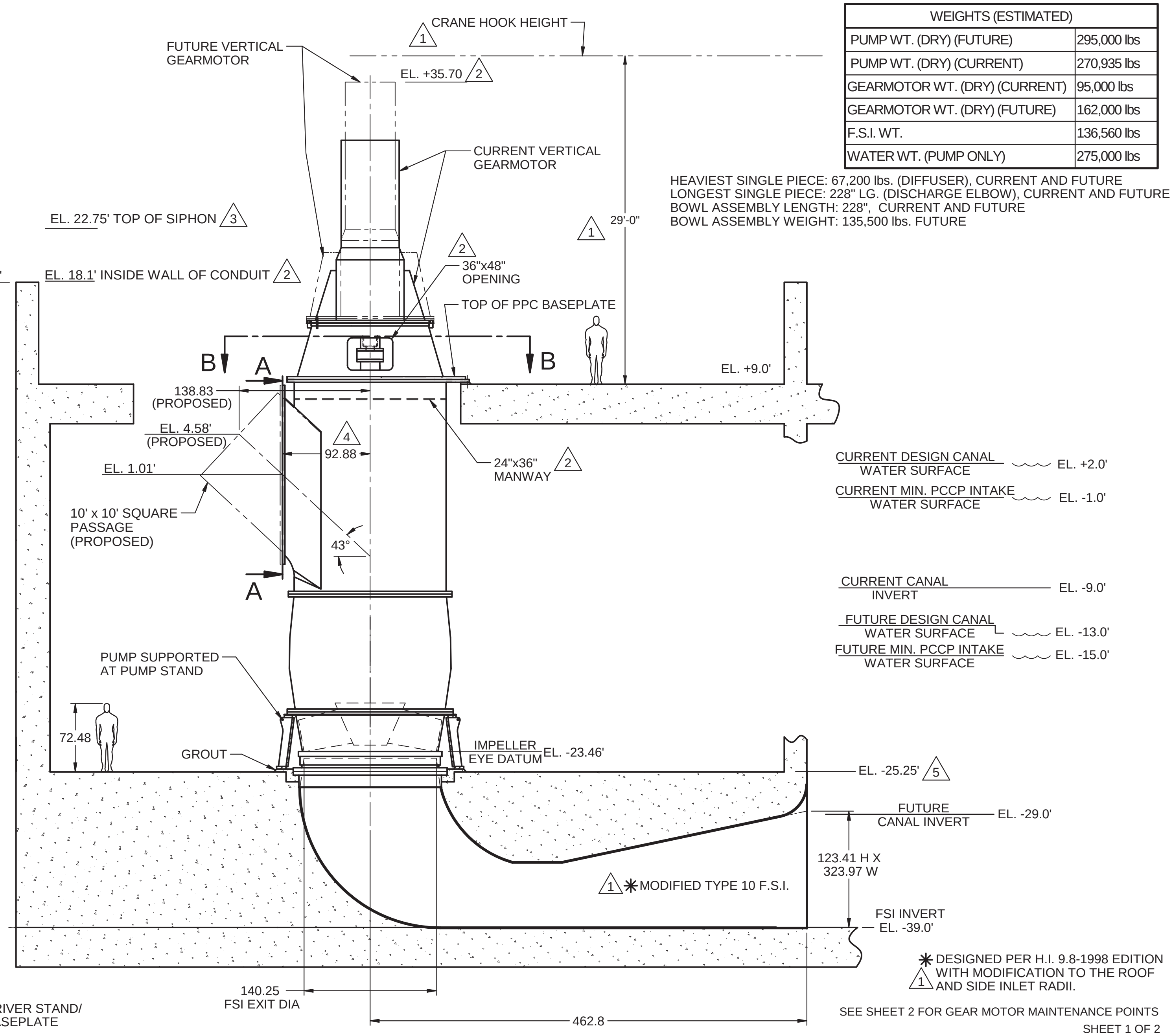


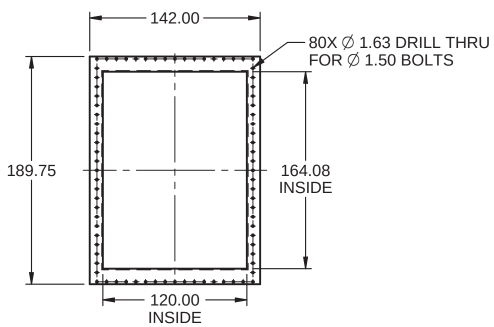
PRELIMINARY

PERMANENT CANAL CLOSURE
AND PUMPING
HURRICANE PROTECTION PROJECT
W912P8-12-C-0049
LONDON AVENUE

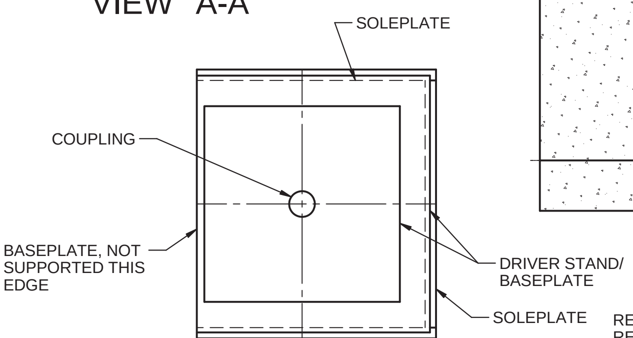
WEIGHTS (ESTIMATED)	
PUMP WT. (DRY) (FUTURE)	295,000 lbs
PUMP WT. (DRY) (CURRENT)	270,935 lbs
GEARMOTOR WT. (DRY) (CURRENT)	95,000 lbs
GEARMOTOR WT. (DRY) (FUTURE)	162,000 lbs
F.S.I. WT.	136,560 lbs
WATER WT. (PUMP ONLY)	275,000 lbs

HEAVIEST SINGLE PIECE: 67,200 lbs. (DIFFUSER), CURRENT AND FUTURE
LONGEST SINGLE PIECE: 228" LG. (DISCHARGE ELBOW), CURRENT AND FUTURE
BOWL ASSEMBLY LENGTH: 228", CURRENT AND FUTURE
BOWL ASSEMBLY WEIGHT: 135,500 lbs. FUTURE





VIEW "A-A"



VIEW "B-B"

NOTE:
SOLEPLATE IS ONLY ON 3
SIDES OF OPENING

✳ DESIGNED PER H.I. 9.8-1998 EDITION
1 WITH MODIFICATION TO THE ROOF
AND SIDE INLET RADII.

SEE SHEET 2 FOR GEAR MOTOR MAINTENANCE POINTS

SHEET 1 OF 2

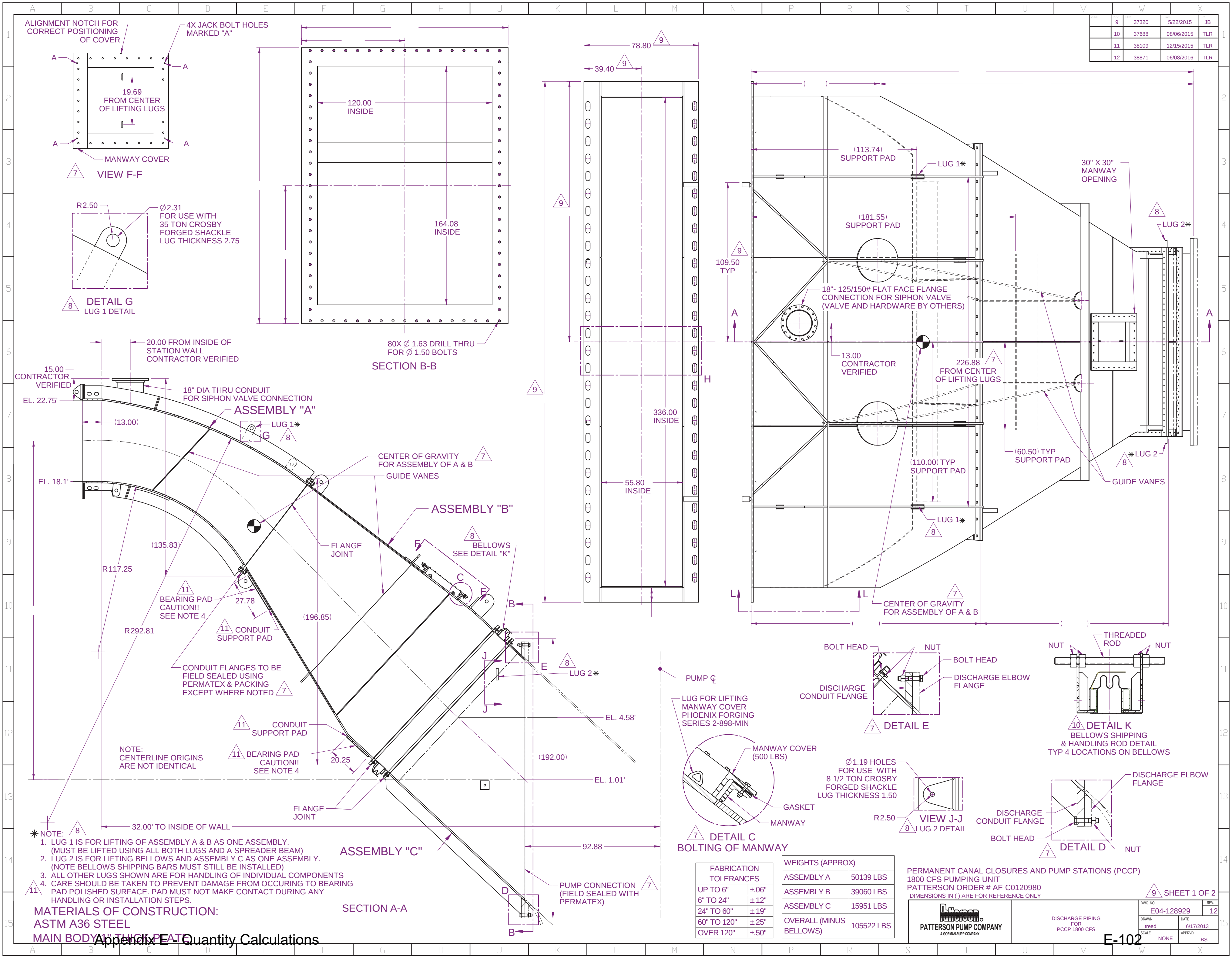
REV 1 ECR #34349 BY JCARSON ON 6-27-13
REV 2 ECR #34771 BY KMOODY ON 9-30-13
REV 3 ECR #35541 BY KMOODY ON 3-24-14
REV 4 ECR #35943 BY KMOODY ON 6-13-14
REV 5 ECR #36575 BY BNICHOLSON ON 10-15-14

PATTERSON PUMP COMPANY
A SUBSIDIARY OF THE GORMAN-RUPP COMPANY

OUTLINE DIMENSION
FOR 1800 CFS PUMP

DWG. NO.	REV.
C04-129127	5

DRAWN	DATE
kmoody	6/7/2013
SCALE	APPRVD.
NONE	EJC



	9	37320	5/22/2015	JB
	10	37688	08/06/2015	TLR
	11	38109	12/15/2015	TLR
	12	38871	06/08/2016	TLR

FABRICATION TOLERANCES	
UP TO 6"	±.06"
6" TO 24"	±.12"
24" TO 60"	±.19"
60" TO 120"	±.25"
OVER 120"	±.50"

WEIGHTS (APPROX)	
ASSEMBLY A	50139 LBS
ASSEMBLY B	39060 LBS
ASSEMBLY C	15951 LBS
OVERALL (MINUS BELLOWS)	105522 LBS

C280-12

Electronic Control System

PROPULSION ENGINE

RATINGS AND FUEL CONSUMPTION

	mhp	bhp	bkW	rpm	U.S. g/h	g/bkW-hr	EPA	IMO	EU
CS	4704	4640	3460	900	208	193.8	NC	II	NC
CS	5031	4962	3700	1000	210	199.2	T4C	III	NC
MC	5167	5096	3800	900	214	194.0	NC	II	NC
MC	5520	5444	4060	1000	217	198.8	T4C	III	NC

C280 fuel rate is at full load on the prop curve, BSFC is at full power condition.

SPECIFICATIONS

Vee 12, 4-Stroke-Cycle Diesel		
Aspiration	TTA	
Bore x Stroke	11.0 x 11.8 in	280 x 300 mm
Displacement	13,546 cu in	222 liter
Rotation (from flywheel end)	Counterclockwise or clockwise	
Engine dry weight (approx)	57,276 lb	25,980 kg

DIMENSIONS

	LE	H	WE
min.	182 in/4623 mm	134 in/3404 mm	80 in/2032 mm
max.	182 in/4623 mm	134 in/3404 mm	80 in/2032 mm

TETRA TECH	Clear Creek Sector gate Quantities	Calculation No. CC-FG-ME-MT-001

Job No.: 100-RCE-18-09-1		**Page:**	1
Project: Coastal Texas Protection and Restoration			
Description: Clear Creek Sector gate Quantities			
Made By: CTG	**Date:** 11/06/18	**Chk'd By:**	**Date:**

Calc Body Pages	Appended Pages	Total Pages
4	0	4

Document code

Site	Feature	Discipline	Document type	Number
CC	FG	ME	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Carl Groompe 11/7/18 Cgroompe	Enric Flickinger 11/7/18 [signature]	

TETRA TECH	Clear Creek Sector gate Quantities	Calculation No. CC-FG-ME-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:	Clear Creek Sector gate Quantities						
Made By:	CTG	**Date:**	11/06/18	**Chk'd By:**	EOF	**Date:**	11/07/18

TABLE OF CONTENTS

Attachments	Number of Pages	Last Page Number
N/A	-	-

ISSUE BEING ADDRESSED

Mechanical equipment quantity take-offs for preliminary cost estimate for Sector gate at Clear Creek.

APPROACH

Listed components are for 1 side only unless otherwise noted. Total of 2 sides

REFERENCES

References used during this calculation are as follows:

1) Mechanical drawings by Tetra Tech
2)

RESULTS / CONCLUSIONS

See calculation sections

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1)

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Design of hinge and pintle. Capacity of mechanical operator

Clear Creek Sector gate Quantities

Calculation No.
CC-FG-ME-MT-001

Job No.:	100-RCE-18-09-1	**Page:**	3
Project:	Coastal Texas Protection and Restoration		
Description:	Clear Creek Sector gate Quantities		
Made By:	CTG **Date:** 11/06/18	**Chk'd By:** EOF	**Date:** 11/07/18

CALCULATIONS

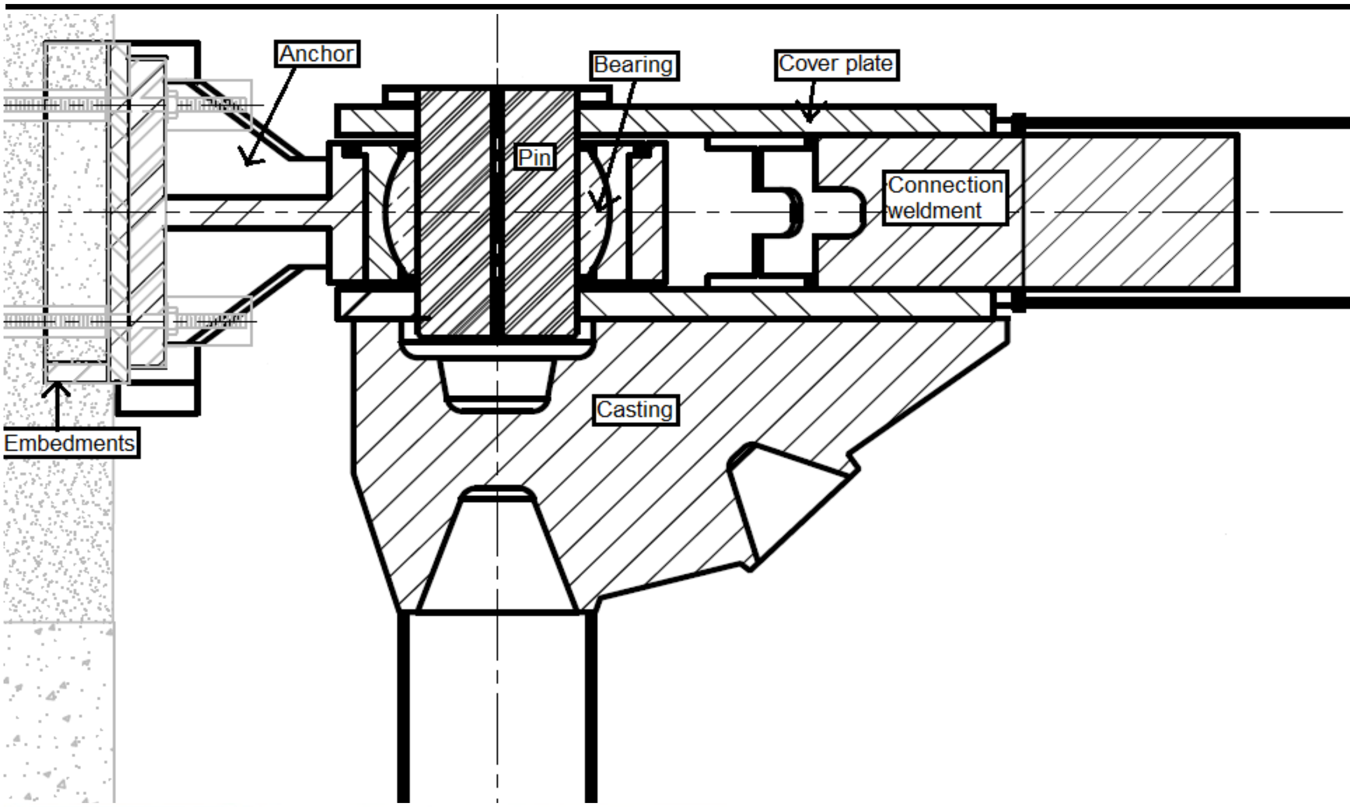
All quantities are for 1 side only. Total of 2 sides

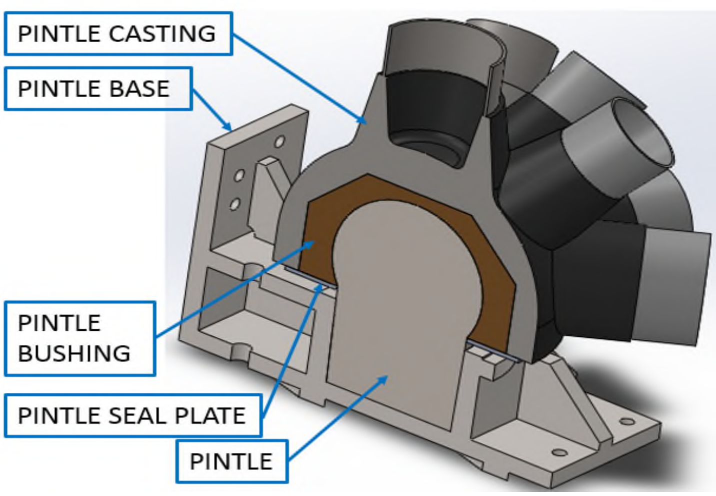
Item	Sub-item	Description	qty
Hinge		See CC-FG-ME-CL-001	
	Embedments	Permanantly installed in monolith	1
	Anchor weldment	Connects to embedments and contains bearing	1
	Casting	Forms connection to kingpost and diagonal members	1
	Connection weldment	Connects to each gate truss member	3
	Bearing	Spherical type	1
	Pin	Restrains bearing	1
	Keeper plate	Locks pin rotation	2
	Cover plate	Vertically constrains bearing	2
	Hardware		
Pintle		See CC-FG-ME-CL-011	
	Base	Connects to embedded anchors, contains pintle	1
	Pintle	Main bearing surface	1
	Bushing	Mating bearing surface, self lubricating	1
	Casting	Connects to kingpost and truss members	1
Operator		See CC-FG-ME-CL-021	
	Hydraulic motor	Bosh Rexroth Haaglunds w/ brake	1
	Movable skid	w/ hydraulic cylinder actuation	1
	HPU		1
	Pinion	Mounted to hydaulic motor, tranfers load to rack	1
	Rack	Mounted to skin plate, recieves operating load from pinion	1

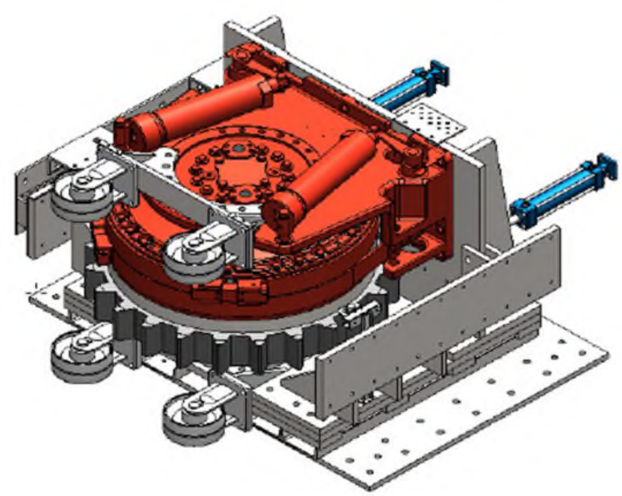
Clear Creek Sector gate Quantities

Calculation No. CC-FG-ME-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	4
Project:	Coastal Texas Protection and Restoration						
Description:	Clear Creek Sector gate Quantities						
Made By:	CTG	**Date:**	11/06/18	**Chk'd By:**	EOF	**Date:**	11/07/18







TETRA TECH — Calculation Cover Sheet

Job No.:	100-RCE-18-09-1
Project:	Coastal Texas Protection and Restoration
Title:	CC-PS-EE-MT-001
Design Topic:	Clear Creek Pump Station Electrical Quantities

Made By: JS **Date:** 08/17/18 **Chk'd By:** AJB **Date:** 08/20/18

Calc Body Pages	Appended Pages	Total Pages

Document code

Site	Feature	Discipline	Document type	Number
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A	Justin Serra 8/20/18	Albert Barnes 8/20/18	

TETRA TECH	Calculation Body				
Job No.:	100-RCE-18-09-1				
Project:	Coastal Texas Protection and Restoration				
Title:	CC-PS-EE-MT-001				
Design Topic:	Clear Creek Pump Station Electrical Quantities				
Made By:	JS	**Date:** 08/17/18	**Chk'd By:** AJB	**Date:**	08/20/18

CC-PS-EE-MT-001

1.0 ISSUE BEING ADDRESSED

2.0 APPROACH

Applying the National Electrical Code (NEC) and Unified facilities guide specifications Division 26 – Electrical

3.0 REFERENCES

References used for this estimate are as follows:

1) NFPA 70 - National Electrical Code - 2017
2) Design and Analysis of building electrical systems, John H. Matthews
3) Unified facilities guide specifications Division 26 - Electrical

4.0 RESULT SUMMARY/VERIFICATION

RESULTS / CONCLUSIONS

ITEMS TO BE VERIFIED

1) Number of pumps
2) Number of motors
3) Building size

5.0 ASSUMPTIONS

ASSUMPTIONS AND INPUTS

Assumptions made during this calculation are as follows

1) Large diesel powered motors will have a summed less than 10 HP worth of support motors.
2) Demand factors for electric motors and size of electric motors in sizing main service transformer
3) Pump Station layout of 8-15-2018 for distances and quantities of electrical equipment.

5.0 CALCULATIONS

Clear Creek Pump station has 31 diesel pumps. In each bay, a diesel pump occupies is approximately 50'x90'x60'. The pump station will have an additional 2 bays to contain the control room and living quarters for the pump station and pump station staff. The additional space is for the maintenance area and machine shop for the pump station. The pump station will be 1450' in length and a minimum width of 90'. Pump house equipment will be segregated to prevent one fault causing the loss of power and controls to the entire pump house. This will require multiple distribution power systems in the pump house.

TETRA TECH Calculation Body

Job No.:	100-RCE-18-09-1				
Project:	Coastal Texas Protection and Restoration				
Title:	CC-PS-EE-MT-001				
Design Topic:	Clear Creek Pump Station Electrical Quantities				
Made By:	JS	**Date:**	08/17/18 **Chk'd By:**	AJB	**Date:** 08/20/18

CC-PS-EE-MT-001

Item No.	Item Description	Quantity	Unit
ELECTRICAL ITEMS			
Clear Creek Pump House			
1	**TELEPHONE/COMMUNICATION SYSTEM**		
	a. Telephone Patch Panel	2	Ea
	b. Master Desk Telephone	2	Ea
	c. Combination Telephone/Intercom	20	Ea
	d. 1" RMC Conduit	3,000	Lf
	e. Telephone cable	5,000	Lf
	f. Cable Terminations	50	Ea
	PUMP STATION LIGHTS AND FIXTURES		
	a. High Bay Down Lighting	60	Ea
	b. Wall Lights	60	Ea
	c. Warning Light	10	Ea
	d. Warning Horn	4	Ea
	e. Mast Lights with 30' Mast	50	Ea
	f. Emergency Battery Lighting	25	Ea
	g. 3/4" RMC	8,000	CLF
	h. Lighting Connection Whips	150	Ea
	i. Ceiling Lights	40	Ea
	PUMP STATION VIDEO/CCTV SYSTEM		
	a. Video Camera	100	Ea
	b. Network Hub	20	Ea
	c. DVR	10	Ea
	d. 1" RMC	5,000	Lf
	e. Video Cable	5,000	Lf
	f. 2" RMC	1,500	Lf
	g. Fiber Optic Cable	1,500	Lf
	h. LCD television monitors, with audio, 8-inch	10	Ea
	i. Cable Terminations	200	Ea
	j. Monitoring Software	1	Ea
	FUEL STORAGE VIDEO/CCTV SYSTEM		
	a. Video Camera	15	Ea
	b. 3/4" RMC	5,000	Lf
	c. Video Cable	5,000	Lf
	d. 2" RMC	2,500	Lf
	e. Fiber Optic Cable	2,500	Lf
	f. Cable Terminations	200	Ea
	PUMP STATION FIRE ALARM AND DETECTION SYSTEM		
	a. Air Sampling (Ionization) Detector	60	Ea
	b. Thermal (Heat) Detector	60	Ea

	c. Smoke Detector	60	Ea
	d. Pull Station	20	Ea
	e. Bell	10	Ea
	f. Fire Alarm Control Panel	4	Ea
	g. Main Fire Alarm Control Panel	1	Ea
	h. Detector Cable	10,000	Lf
	i. Alarm Cable	3,000	Lf
	j. 8 Fiber Optic Cable	2,000	Lf
	k. 3/4" RMC for Routing Fire Alarm Cable	5,000	Lf
	l. 2" RMC for Routing Fiber Optic Cable	2,000	Lf
	m. Cable Terminations	200	Ea
	FUEL STORAGE FIRE ALARM AND DETECTION SYSTEM		
	a. Air Sampling (Ionization) Detector	30	Ea
	b. Thermal (Heat) Detector	30	Ea
	c. Smoke Detector	30	Ea
	d. Pull Station	20	Ea
	e. Bell	5	Ea
	f. Fire Alarm Control Panel	2	Ea
	g. Main Fire Alarm Control Panel	0	Ea
	h. Detector Cable	4,000	Lf
	i. Alarm Cable	0	Lf
	j. 8 Fiber Optic Cable	2,500	Lf
	k. 3/4" RMC for Routing Fire Alarm Cable	0	Lf
	l. 2" RMC for Routing Fiber Optic Cable	2,500	Lf
	m. Cable Terminations	100	Ea
	PUMP STATION CONTROLS AND SENSORS		
	a. Control Cabinet w/ PLC, power supply, processor, comm. Matrix, realys and network hub	10	Ea
	b. PLC Analog Inputs and Outputs	750	Ea
	c. PLC Digital Inputs and Ouputs	750	Ea
	d. Operators Control Cabinet w/ pushbuttons, switches, etc.	20	Ea
	e. Human/Machine Interface (HMI)	20	Ea
	f. Software for programming PLC and HMI	1	Ea
	g. 3/4" RMC	2,000	Lf
	h. 1" RMC	3,000	Lf
	i. 12 Pair Fiber Optic Cable	2,000	Lf
	j. 2" RMC for Fiber optic	2,000	
	k. Controls Panelboard, 120/240V/ 60A, 2d. ckt, w/20A ckt bkr	6	Ea
	l. Circuit Breakers, Various Sizes, 1-pole	80	Ea
	m. Cable Terminations	2,500	Ea
	n. Gearbox heaters	27	Ea
	FUEL STORAGE CONTROLS AND SENSORS		
	a. Control Cabinet w/ PLC, power supply, processor, comm. Matrix, realys and network hub	2	Ea

	b. PLC Analog Inputs and Outputs	200	Ea
	c. PLC Digital Inputs and Ouputs	200	Ea
	d. Operators Control Cabinet w/ pushbuttons, switches, etc.	4	Ea
	e. Human/Machine Interface (HMI)	4	Ea
	f. Software for programming PLC and HMI	0	Ea
	g. 3/4" RMC	2,000	Lf
	h. 1" RMC	0	Lf
	i. 2#14 AWG braided conductors	5,000	Lf
	j. Limit Switches	1	LOT
	k. Flow sensors	1	LOT
	l. Level sensors	1	LOT
	m. Valvue Actuators	1	LOT
	n. Leak Sensors	1	LOT
	o. Fuel Temp Sensors	1	LOT
	p. Relays	75	Ea
	INCOMING POWER		
	a. 35' Pole	10	Ea
	b. Overhead Conductors	2,500	Lf
	c. Pull Boxes	10	Ea
	d. Misc Hardware	1	LOT
	e. Cable Terminations	50	Ea
	PUMP STATION LIGHTING CONDUCTORS		
	a. #12 AWG Stranded Copper	10,000	Lf
	b. #10 AWG Stranded Copper	5,000	Ea
	c. #8 AWG Stranded Copper	1,000	Ea
	d. Pull Boxes	500	Ea
	e. Cable Terminations	500	Ea
	FUEL STORAGE LIGHTING		
	a. #12 AWG Stranded Copper	10,000	Lf
	b. #10 AWG Stranded Copper	5,000	Ea
	c. #8 AWG Stranded Copper	1,000	Ea
	d. Pull Boxes	200	Ea
	e. Cable Terminations	200	Ea
	f. Mast Lights with 30' Mast	20	Ea
	MOTOR CONTROL CENTER - MCCx25		
	a. MCC - Section	40	Ea
	b. Main Disconnect Circuit Breaker - MDCB	35	Ea
	c. Combination Starter	60	Ea
	d. Control Transformer	30	Ea
	e. Circuit Breaker	500	Lf
	f. 3-#12 AWG, 1 - #12 AWG	5000	Lf
	g. 3-#10 AWG, 1 - #10 AWG	5000	Lf
	h. 3-#8 AWG, 1 - #10 AWG	5000	

	PUMP STATION RECEPTACLES		
	a. 5-20R Receptacles	300	Ea
	b. #10 AWG Stranded Copper	10,000	Lf
	c. 100A 3P-5W NEMA-3R Power Outlet	40	Ea
	d. 4#1 AWG, 1#8 AWG EGC	1,000	Lf
	e. Pull Boxes	200	Ea
	f. Cable Terminations	200	Ea
	FUEL STORAGE RECEPTACLES		
	a. 5-20R Receptacles NEMA 4X	25	Ea
	b. #10 AWG Stranded Copper	2,000	Lf
	c. 100A 3P-5W NEMA-4X Power Outlet	4	Ea
	d. 4#1 AWG, 1#8 AWG EGC	1,000	Lf
	e. Pull Boxes	20	Ea
	f. Cable Terminations	20	Ea
	Automatic Transfer switches		
	a. Medium Voltage Automatic Transfer switches	0	Ea
	b. Low Voltage Automatic Transfer Switches	4	Ea
	c. Diconnect Switches	50	Ea
	d. Fused Disconnect Switches	4	
	Stand-by Generators		
	a. 1000kW Generator	4	Ea
	b. 250kW Generator	2	Ea
	c. Load Banks	6	Ea
	d. Control Panel	6	Ea
	Power Transformers		
	a. 1000kVA	3	Ea
	b. 50kVA	2	Ea
	c. 30kVA	2	Ea
	d. 15kVA	3	Ea
	Conductos		
	a. #14 AWG	10000	Lf
	b. #12 AWG	5000	Lf
	c. #10 AWG	3000	Lf
	d. #8 AWG	1500	Lf
	e. #6 AWG	0	Lf
	f. #4 AWG	1500	Lf
	g. #3 AWG	0	Lf
	h. #2 AWG	0	Lf
	i. #1 AWG	2000	Lf
	j. 1/0 AWG	1000	Lf
	k. 2/0 AWG	3000	Lf

	l. 3/0 AWG	0	Lf
	m. 4/0 Awg	1500	Lf
	n. 350 kmill	0	Lf
	o. 500 kmill	800	Lf
	Conduits and Conductors		
	a. 3/4" RMC	2500	Lf
	b. 1" RMC	2500	Lf
	c. 1 1/4" RMC	500	Lf
	d. 1 1/2" RMC	1000	Lf
	e. 2" RMC	2500	Lf
	f. 2 1/2" RMC	500	Lf
	g. 3" RMC	2500	Lf
	h. 4" RMC	0	Lf
	Motors		
	a. 1-hp, 3PH, 480VAC		Ea
	b. 2-hp, 3PH, 480VAC	2	Ea
	c. 5-hp, 3PH, 480VAC	60	Ea
	d. 10-hp, 3PH, 480VAC	2	Ea
	e. 20-hp, 3PH, 480VAC	103	Ea
	f. 30-hp, 3PH, 480VAC	0	Ea
	g. 50-hp, 3PH, 480VAC	0	Ea

TETRA TECH — Calculation Cover Sheet

Job No.:	100-RCE-18-09-1
Project:	Coastal Texas Protection and Restoration
Title:	CC-FG-EE-MT-002
Design Topic:	Clear Creek Floodgate Electrical Quantities

Made By: JS **Date:** 08/17/18 **Chk'd By:** AJB **Date:** 08/20/18

Calc Body Pages	Appended Pages	Total Pages

Document code

Site	Feature	Discipline	Document type	Number
CC	FG	EE	MT	002

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Discription
A	Justin Serve 8/20/18	Albert Barnes 8/20/18	

TETRA TECH **Calculation Body**

Job No.:	100-RCE-18-09-1
Project:	Coastal Texas Protection and Restoration
Title:	CC-FG-EE-MT-002
Design Topic:	Clear Creek Floodgate Electrical Quantities
Made By:	JS **Date:** 08/17/18 **Chk'd By:** AJB **Date:** 08/20/18

CC-FG-EE-MT-002

1.0 ISSUE BEING ADDRESSED

2.0 APPROACH

Applying the National Electrical Code (NEC) and Unified facilities guide specifications Division 26 – Electrical

3.0 REFERENCES

References used for this estimate are as follows:

1) NFPA 70 - National Electrical Code - 2017
2) Design and Analysis of building electrical systems, John H. Matthews
3) Unified facilities guide specifications Division 26 - Electrical

4.0 RESULT SUMMARY/VERIFICATION

RESULTS / CONCLUSIONS

ITEMS TO BE VERIFIED

1) Size of HPU units
2) Number of lights on site
3) Controls

5.0 ASSUMPTIONS

ASSUMPTIONS AND INPUTS

Assumptions made during this estimate are as follows:

1) Equipment size and available area in Floodgate building.
2) Demand factors for electric motors and size of electric motors in sizing main feeder.
3) Floodgate distance from Clear Creek Pump Station and location of Floodgate along the channel.

5.0 CALCULATIONS

Clear Creek Floodgate has a span of 75' with a gate house on each monolith. The Floodgate operation house contains the HMI station that controls the gates and the HPU unit that powers the floodgate. The MCC, Lighting Panel and the PLC cabinet distribute power to the motors, site lighting and control and sensors for the Floodgate. The Control Cabinet that houses the PLC and the Network Hub will communicate with the gate controls, video and voice communications and also with the control room inside the Clear Creek Pump Station Bunker.

Item No.	Item Description	Quantity	Unit
ELECTRICAL ITEMS			
Clear Creek Floodgate			
1	**TELEPHONE/COMMUNICATION SYSTEM**		
	a. Telephone Patch Panel	0	Ea
	b. Master Desk Telephone	0	Ea
	c. Combination Telephone/Intercom	2	Ea
	d. 1" MRC Conduit	1,500	Lf
	e. Telephone cable	1,500	Lf
	f. Cable Terminations	10	Ea
	FLOODGATE LIGHTS AND FIXTURES		
	a. High Bay Down Lighting	0	Ea
	b. Wall Lights	10	Ea
	c. Warning Light	2	Ea
	d. Warning Horn	1	Ea
	e. Mast Lights with 30' Mast	10	Ea
	f. Emergancy Battery Lighting	25	Ea
	g. 3/4" MRC	600	CLF
	h. Lighting Connection Whips	5	Ea
	i. Ceiling Lights	5	Ea
	j. Navigation Lights	10	Ea
	k. Solar Power'd hazard/Navigaiton Lights	10	Ea
	FLOODGATE VIDEO/CCTV SYSTEM		
	a. Video Camera	4	Ea
	b. Network Hub	1	Ea
	c. DVR	1	Ea
	d. 3/4" MRC	250	Lf
	e. Video Cable	300	Lf
	f. 2" MRC	1,500	Lf
	g. Fiber Optic Cable	1,500	Lf
	h. LCD television monitors, with audio, 8-inch	4	Ea
	i. Cable Terminations	10	Ea
	j. Monitoring Software	1	Ea
	FLOODGATE FIRE ALARM AND DETECTION SYSTEM		
	a. Air Sampling (Ionization) Detector	2	Ea
	b. Thermal (Heat) Detector	2	Ea
	c. Smoke Detector	2	Ea
	d. Pull Station	2	Ea
	e. Bell	2	Ea
	f. Fire Alarm Control Panel	2	Ea

	g. Main Fire Alarm Control Panel	0	Ea
	h. Detector Cable	1,500	Lf
	i. Alarm Cable	1,500	Lf
	j. 8 Fiber Optic Cable	0	Lf
	k. 3/4" MRC for Routing Fire Alarm Cable	1,500	Lf
	l. 1" MRC for Routing Fiber Optic Cable	0	Lf
	m. Cable Terminations	20	Ea
	FLOODGATE CONTROLS		
	a. Control Cabinet w/ PLC, power supply, processor, comm. Matrix, realys and network hub	2	Ea
	b. PLC Analog Inputs and Outputs	50	Ea
	c. PLC Digital Inputs and Ouputs	50	Ea
	d. Operators Control Cabinet w/ pushbuttons, switches, etc.	4	Ea
	e. Human/Machine Interface (HMI)	2	Ea
	f. Software for programming PLC and HMI	0	Ea
	g. 3/4" RMC	2,000	Lf
	h. 1" RMC	2,000	Lf
	i. 12 Pair Fiber Optic Cable	0	Lf
	j. Controls Panelboard, 120/240V/ 60A, 2d. ckt, w/20A ckt bkr	4	Ea
	k. Circuit Breakers, Various Sizes, 1-pole	40	Ea
	l. Cable Terminations	50	Ea
	INCOMING POWER		
	a. 3-#2/0 AWG, 1-#6 AWG	2,000	Lf
	b. 2" RMC Embedded Conduits	2,000	Lf
	c. Pull Boxes	20	Ea
	d. Misc Hardware	1	LOT
	e. Cable Terminations	50	Ea
	FLOODGATE LIGHTING CONDUCTORS		
	a. #12 AWG Stranded Copper	600	Lf
	b. #10 AWG Stranded Copper	200	Lf
	c. #8 AWG Stranded Copper	0	Lf
	d. Pull Boxes	20	Ea
	e. Cable Terminations	20	Ea
	MOTOR CONTROL CENTER - MCCx2		
	a. MCC - Section	4	Ea
	b. Main Disconnect Circuit Breaker - MDCB	2	Ea
	c. Combination Starter	8	Ea
	d. Control Transformer	2	Ea
	e. Circuit Breaker	40	Ea
	f. 3-#12 AWG, 1 - #12 AWG	600	Lf
	g. 3-#10 AWG, 1 - #10 AWG	600	Lf

	h. 3-#8 AWG, 1 - #10 AWG	0	Lf
	Automatic Transfer switches		
	a. Medium Voltage Automatic Transfer switches	0	Ea
	b. Low Voltage Automatic Transfer Switches	4	Ea
	c. Diconnect Switches	50	Ea
	d. Fused Disconnect Switches	4	Ea
	Power Transformers		
	a. 250kVA	1	Ea
	b. 50kVA	0	Ea
	c. 30kVA	1	Ea
	d. 15kVA	1	Ea
	Conductors		
	a. #14 AWG	2500	Lf
	b. #12 AWG	1500	Lf
	c. #10 AWG	1500	Lf
	d. #8 AWG	0	Lf
	e. #6 AWG	0	Lf
	f. #4 AWG	0	Lf
	g. #3 AWG	0	Lf
	h. #2 AWG	0	Lf
	i. #1 AWG	0	Lf
	j. 1/0 AWG	1500	Lf
	k. 2/0 AWG	0	Lf
	l. 3/0 AWG	0	Lf
	m. 4/0 Awg	0	Lf
	n. 350 kmill	0	Lf
	o. 500 kmill	0	Lf
	Conduits		
	a. 3/4" RMC	800	Lf
	b. 1" RMC	0	Lf
	c. 1 1/4" RMC	0	Lf
	d. 1 1/2" RMC	0	Lf
	e. 2" RMC	0	Lf
	f. 2 1/2" RMC	1500	Lf
	g. 3" RMC	0	Lf
	h. 4" RMC	0	Lf
	Motors		
	a. 1-hp, 3PH, 480VAC	0	Ea
	b. 2-hp, 3PH, 480VAC	0	Ea

	c. 5-hp, 3PH, 480VAC	0	Ea
	d. 10-hp, 3PH, 480VAC	2	Ea
	e. 20-hp, 3PH, 480VAC	4	Ea
	f. 30-hp, 3PH, 480VAC	0	Ea
	g. 50-hp, 3PH, 480VAC	0	Ea

Attachment 5

Dickinson Bay 10 Percent Design

Quantity Take-offs

TETRA TECH	Dickinson Bayou T-Wall Quantities	Calculation No. DB-FW-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Dickinson Bayou T-Wall Quantities				
Made By:	LN	**Date:** 07/29/18	**Chk'd By:** DS	**Date:**	09/21/18

Calc Body Pages	Appended Pages	Total Pages
12	0	12

Document code

Site	Feature	Discipline	Document type	Number
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A	Lexee Navarre 9/21/18	Daniel Stuard 9/21/18	

TETRA TECH	Dickinson Bayou T-Wall Quantities	Calculation No. DB-FW-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	2
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	LN	**Date:** 07/29/18	**Chk'd By:** DS	**Date:**	09/21/18

TABLE OF CONTENTS

Attachments	Number of Pages	Last Page Number

TETRA TECH	Dickinson Bayou T-Wall Quantities	Calculation No. DB-FW-ST-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LN	**Date:**	07/29/18	**Chk'd By:**	DS	**Date:**	09/21/18

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for T-Walls.

APPROACH

Typical engineering means and methods for determining volumes and weights.

REFERENCES

References used during this calculation are as follows:

1) CC-FW-ST-CL-001
2) CC-FW-ST-CL-002
3) HSDRRS - DG with Revisions through June 2012

RESULTS / CONCLUSIONS

T-Wall 1:

Total Dry Excavation:	5941 yd^3			
Total Fill:	1876 yd^3			
Total # of Battered Pipe Piles:	469 (All piles have tension connections)			
Total 24" Diam. X 0.5" Steel Battered Pipe Pile:	32505 ft	**or**	2041 tons	
Total PZ-22 Steel Sheet Pile:	15125 ft^2	**or**	166 tons	
Total Concrete:	6722 yd^3			

T-Wall 2:

Total Dry Excavation:	17604 yd^3		
Total Fill:	5064 yd^3		
Total # of Battered Pipe Piles:	1736 (All piles have tension connections)		
Total 24" Diam. X 0.5" Steel Battered Pipe Pile:	118509 ft	**or**	7443 tons
Total PZ-22 Steel Sheet Pile:	55997 ft^2	**or**	616 tons
Total Concrete:	18328 yd^3		

Combined Total:

Total Dry Excavation:	23545 yd^3		
Total Fill:	6940 yd^3		
Total # of Battered Pipe Piles:	2205 (All piles have tension connections)		
Total 24" Diam. X 0.5" Steel Battered Pipe Pile:	151014 ft	**or**	9484 tons
Total PZ-22 Steel Sheet Pile:	71122 ft^2	**or**	782 tons
Total Concrete:	25050 yd^3		

TETRA TECH	**Dickinson Bayou T-Wall Quantities**	**Calculation No. DB-FW-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	4
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LN	**Date:**	07/29/18	**Chk'd By:**	DS	**Date:**	09/21/18

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) A minimum PZ-22 hot rolled sheet piling shall be utilized for seepage cut-off. (HSDRRS)
2) Sheet pile tip shall extend a minimum of 10 feet beneath the T-Wall base. (HSDRRS)
3) Material Properties:
   - Concrete, f'c = 4000 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
   - Sheet Piles = ASTM A328
4) Costs of reinforcement is included in reinforced concrete unit cost.
5) All piles have tension connections.

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Start and end locations.
2) T-wall geometry.
3) Material Types

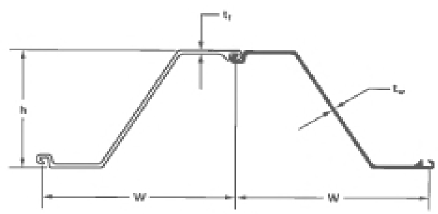
CALCULATIONS

Start on next page.

General References and Figures

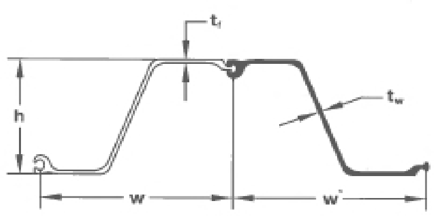
NZ/PZ

NZ/PZ Hot Rolled Steel Sheet Pile



NZ

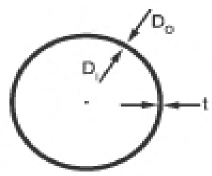
SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Web (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
NZ 19	27.56 700	16.14 410.0	0.375 9.5	0.375 9.5	7.04 148.9	55 81.85	23.95 116.93	35.08 1886	41.33 2222	233.1 38659	6.18 1.88	1.35 1.35
NZ 20	27.56 700	16.16 410.5	0.394 10.0	0.394 10.0	7.29 154.4	57 84.83	24.82 121.18	36.24 1948	42.80 2301	292.8 39984	6.18 1.88	1.35 1.35
NZ 21	27.56 700	16.20 411.5	0.433 11.0	0.433 11.0	7.80 165.2	61 90.78	26.56 129.68	38.69 2080	45.85 2465	313.4 42797	6.18 1.88	1.35 1.35
NZ 26	27.56 700	17.32 440.0	0.500 12.7	0.500 12.7	9.08 192.3	71 105.66	30.92 150.94	48.50 2608	57.01 3065	419.9 57340	6.49 1.98	1.41 1.41



PZ

SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Wall (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
PZ 22	22.0 559	9.0 229	0.375 9.50	0.375 9.50	6.47 136.9	40.3 60.0	22.0 107.4	18.1 973	21.79 1171.4	84.38 11500	4.48 1.37	1.22 1.22
PZ 27	18.0 457	12.0 305	0.375 9.50	0.375 9.50	7.94 168.1	40.5 60.3	27.0 131.8	30.2 1620	36.49 1961.9	184.20 25200	4.48 1.37	1.49 1.49
PZ 35	22.6 575	14.9 378	0.600 15.21	0.500 12.67	10.29 217.8	66.0 58.2	35.0 170.9	48.5 2608	57.17 3073.5	361.22 49300	5.37 1.64	1.42 1.42
PZ 40	19.7 500	16.1 409	0.600 15.21	0.500 12.67	11.77 249.1	65.6 57.6	40.0 195.3	60.7 3263	71.92 3866.7	490.85 67000	5.37 1.64	1.64 1.64

Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = 10.69*t*(D_o-t)
D_o (in) - outside diameter
t (in) - thickness of pipe

Pipe Weight (kg/m) = 0.0247*t*(D_o-t)
D_o (mm) - outside diameter
t (mm) - thickness of pipe

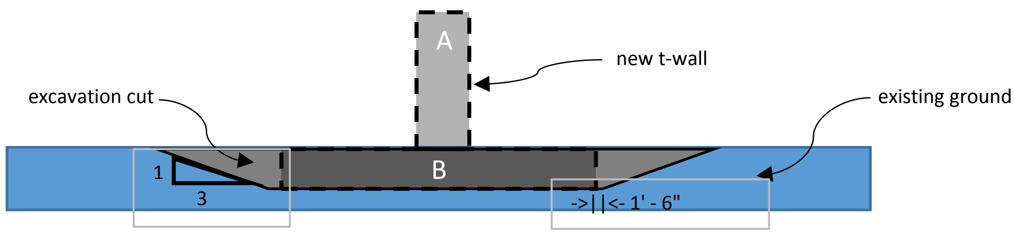
PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm) 0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

Quantities for T-Wall 1

Start Station for T-Wall:	39+57	&	62+12
End Station for T-Wall:	49+73	&	66+03
Total Length of Wall:	1407.0 ft		

Figure 1:



EXCAVATION FOR T-WALL 1:

Base Excavation Width:	29.0	ft	**Cross Sectional Area:**	114.0	ft^2
Excavation Slope:	1:3	(V:H)	**Total Length of Wall:**	1407.0	ft
Excavation Depth:	3.0	ft			
Surface Excavation Width:	47.0	ft			

Total Volume of Excavation Cut: 5941 yd^3

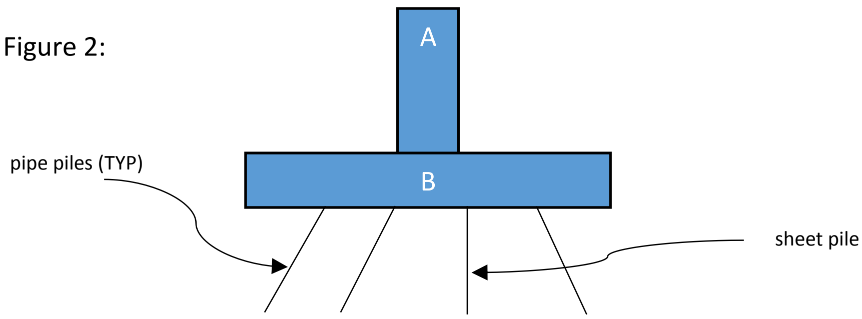
FILL FOR T-WALL 1:

After the T-Wall is placed, the remaining space of the initial excavation cut will need to be filled.
This value is just the initial cut minus the base of the T-Wall (Section B, see figure above).
See concrete section for T-Wall for calculations of the wall base volume.

Volume of Cut:	5940.7 yd^3
Volume of Base of T-Wall:	4064.7 yd^3

Total Volume of Fill: 1876 yd^3

Figure 2:



BATTERED PILES

Steel Pipe Piles with a spacing of 9 feet along the length of the wall. The minimum tip embedment is to be 65 feet plus 9 inches of embedment into concrete slab.

Pile Diameter:	24.0 in	**Batter:**	3:1 (V:H)
Pipe Thickness:	0.5 in	**Total Length of Wall:**	1407.0 ft
Pile Tip to Head Embedment:	65.75 ft	**Pile Spacing Along Wall:**	9.0 ft
Pipe Weight*:	125.61 lb/ft	**# of Pile Rows:**	3

*see general references attachments for reference of produced value

# of Piles	# of Pile Rows	Length (ft)	Total Length (ft)	Pipe Weight (lb/ft)	Weight (tons)
156	3	69.31	10834.93	125.61	680.49

TOTALS:	**# of Battered Piles:**	**469**
	Length:	**32505 ft**
	Weight:	**2041 tons**

TETRA TECH	**Dickinson Bayou T-Wall Quantities**	**Calculation No.** **DB-FW-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	9
Project:	Coastal Texas Protection and Restoration						
Description:	Quantities for T-Wall 1						
Made By:	LN	**Date:**	07/29/18	**Chk'd By:**	DS	**Date:**	09/21/18

SHEET PILE WALL

A PZ-22 hot rolled sheet piling shall be utilized for seepage cutoff with a depth of 10 feet of embedment plus 9 inches of embedment into the concrete slab.

Height of Wall: 10.75 ft
Length of Wall: 1407.0 ft
Weight of Wall*: 22.0 lb/ft^2

*see general references attachments for reference of produced value

# of Walls	Area (ft^2)	Weight of Wall (lb/ft^2)	Weight (tons)
1	15125.25	22.0	166.38

TOTALS:	**Area:**	**15125 ft^2**
	Weight:	**166 tons**

CONCRETE

Section*	Height (ft)	Width (ft)	Cross Sectional Area (ft^2)	Length (ft)	Volume (yd^3)
A	17.0	3.0	51.0	1407.0	2657.7
B	3.0	26.0	78.0	1407.0	4064.7

*see Figure 2 for sections

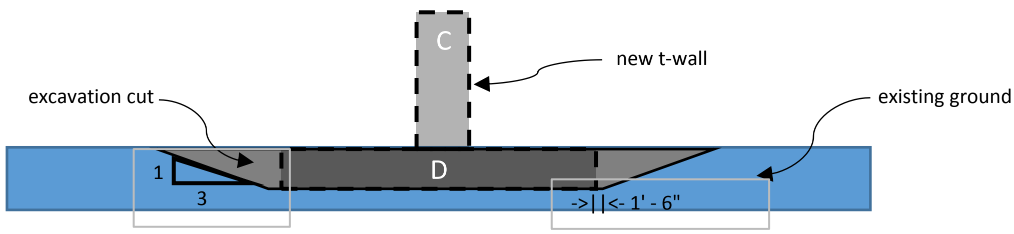
Total Concrete: 6722 yd^3

Job No.:	100-RCE-18-09-1					**Page:**	10
Project:	Coastal Texas Protection and Restoration						
Description:	Quantities for T-Wall 2						
Made By:	LN	**Date:**	07/29/18	**Chk'd By:**	DS	**Date:**	09/21/18

Quantities for T-Wall 2

Start Station for T-Wall:	10+00	&	66+03
End Station for T-Wall:	39+57	&	88+55
Total Length of Wall:	5209.0 ft		

Figure 1:



EXCAVATION FOR T-WALL 1:

Base Excavation Width:	29.0	ft	**Cross Sectional Area:**	91.3	ft^2
Excavation Slope:	1:3	(V:H)	**Total Length of Wall:**	5209.0	ft
Excavation Depth:	2.5	ft			
Surface Excavation Width:	44.0	ft			

Total Volume of Excavation Cut: 17604 yd^3

FILL FOR T-WALL 1:

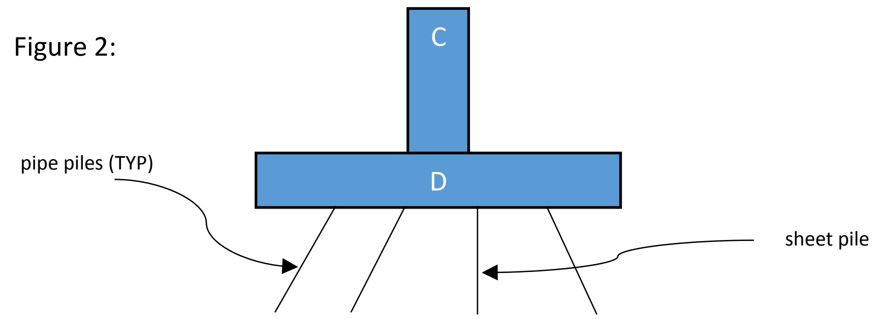
After the T-Wall is placed, the remaining space of the initial excavation cut will need to be filled.
This value is just the initial cut minus the base of the T-Wall (Section B, see figure above).
See concrete section for T-Wall for calculations of the wall base volume.

Volume of Cut:	17604.5 yd^3
Volume of Base of T-Wall:	12540.2 yd^3

Total Volume of Fill: 5064 yd^3

Job No.:	100-RCE-18-09-1			**Page:**	11
Project:	Coastal Texas Protection and Restoration				
Description:	Quantities for T-Wall 2				
Made By:	LN	**Date:** 07/29/18	**Chk'd By:** DS	**Date:**	09/21/18

Figure 2:



BATTERED PILES

Steel Pipe Piles with a spacing of 9 feet along the length of the wall. The minimum tip embedment is to be 64 feet plus 9 inches of embedment into concrete slab.

Pile Diameter:	24.0 in	**Batter:**	3:1 (V:H)
Pipe Thickness:	0.5 in	**Total Length of Wall:**	5209.0 ft
Pile Tip to Head Embedment:	64.75 ft	**Pile Spacing Along Wall:**	9.0 ft
Pipe Weight*:	125.61 lb/ft	**# of Pile Rows:**	3

*see general references attachments for reference of produced value

# of Piles	# of Pile Rows	Length (ft)	Total Length (ft)	Pipe Weight (lb/ft)	Weight (tons)
579	3	68.25	39503.03	125.61	2480.99

TOTALS:	**# of Battered Piles:**	**1736**
	Length:	**118509 ft**
	Weight:	**7443 tons**

SHEET PILE WALL

A PZ-22 hot rolled sheet piling shall be utilized for seepage cutoff with a depth of 10 feet of embedment plus 9 inches of embedment into the concrete slab.

Height of Wall:	10.75	ft
Length of Wall:	5209.0	ft
Weight of Wall*:	22.0	lb/ft^2

*see general references attachments for reference of produced value

# of Walls	Area (ft^2)	Weight of Wall (lb/ft^2)	Weight (tons)
1	55996.75	22.0	615.96

TOTALS:	**Area:**	**55997 ft^2**
	Weight:	**616 tons**

CONCRETE

Section*	Height (ft)	Width (ft)	Cross Sectional Area (ft^2)	Length (ft)	Volume (yd^3)
A	15.0	2.0	30.0	5209.0	5787.8
B	2.5	26.0	65.0	5209.0	12540.2

*see Figure 2 for sections

Total Concrete: 18328 yd^3

Dickinson Bayou Floodwall Material Take-off

TETRA TECH

Calculation No. DB-FW-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Dickinson Bayou Floodwall Material Take-off				
Made By:	LRM	**Date:** 11/08/18	**Chk'd By:** JK	**Date:**	11/08/18

Calc Body Pages	Appended Pages	Total Pages
7		7

Document code

Site	Feature	Discipline	Document type	Number
DB	FW	ST	MT	002

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Leo Moyer 11/8/18 [signature]	Jason Kikuta 11/8/18 [signature]	

TETRA TECH	Dickinson Bayou Floodwall Material Take-off	Calculation No. DB-FW-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	2
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	LRM	**Date:** 11/08/18	**Chk'd By:** JK	**Date:**	11/08/18

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Attachments	Number of Pages	Last Page Number

TETRA TECH	Dickinson Bayou Floodwall Material Take-off	Calculation No. DB-FW-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LRM	**Date:**	11/08/18	**Chk'd By:**	JK	**Date:**	11/08/18

ISSUE BEING ADDRESSED

Material take-off for the Dickinson Bayou floodwall.

APPROACH

Calculate a material take-off for a typical running foot of the floodwall, which consists of vertical soldier piles, batter piles, a concrete pile cap, and 6-inch square precast piles. For the pile cap, assume a nominal reinforcing ratio. Once the typical quantity per running foot is calculated, multiply it by the length of the flood wall.

REFERENCES

References used during this calculation are as follows:

1) Dicksinon Bayou Floodwall detail, plate 21

RESULTS / CONCLUSIONS

See last page for quantities

TETRA TECH	Dickinson Bayou Floodwall Material Take-off	Calculation No. DB-FW-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	4
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LRM	**Date:**	11/08/18	**Chk'd By:**	JK	**Date:**	11/08/18

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) The 6-inch precast concrete piles are 50 feet long
2) The reinforcing ratio of the pile cap

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Additional appurtenances for the flood wall
2) The actual reinforcing quantities for the pile cap
3) Details for the pile connectors to the pile cap
4) Infill for the pile and grouting between the soldier piles and the square precast piles will be included at a later design phase.

CALCULATIONS

TETRA TECH	Dickinson Bayou Floodwall Material Take-off	Calculation No. DB-FW-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	5
Project:	Coastal Texas Protection and Restoration						
Description:	Floodwall Reaches						
Made By:	LRM	**Date:**	11/08/18	**Chk'd By:**	JK	**Date:**	11/08/18

Floodwall Reaches

References

Plate 21, Floodwall detail

	Starting Station	Ending Station	Length (ft)
Reach 1	30+20	31+63	143
Total			**143**

Material Take-offs per Foot of Wall

Inputs

Typical concrete reinforcing ratio	rho	0.010	
Rebar weight		490	pcf

Material take-offs

Soldier piles (48-inch precast, prestressed concrete piles, LF)

Spacing		4	ft per each
Typical pile length	top EL	16.25	
	tip EL	-59.00	
		75.25	LF/each

Batter piles (18x0.625 inch steel pipe pile, LF)

Spacing		8	ft per each
Typical pile length	top EL	16.25	
	tip EL	-79.00	
	batter angle	3	V:1H
		101	LF/each (rounded up to nearest foot)

Infill piles (pairs of 6-inch square precast, prestressed piles, LF)

Spacing		4	ft per each pair
Typical pile length	top EL	16.25	
	tip EL	-33.75	
		100	LF/each pair (two piles)

Pile Cap (reinforced concrete, cubic yards)

Continuous for length of wall		
Cross sectional area	17.8	ft^2
Volume per length of wall	**0.657**	$yard^3$ per ft of wall

Rebar (tons)

Volume of rebar	0.178	ft^3 per ft of wall
Tons of rebar per ft of wall	**0.0435**	tons per ft of wall

TETRA TECH	**Dickinson Bayou Floodwall Material Take-off**	**Calculation No. DB-FW-ST-MT-002**

Job No.:	100-RCE-18-09-1					**Page:**	7
Project:	Coastal Texas Protection and Restoration						
Description:	Quantities						
Made By:	LRM	**Date:**	11/08/18	**Chk'd By:**	JK	**Date:**	11/08/18

Quantities

Floodwall length 143 ft

Material take-offs

Item	Spacing (per ft of wall)	Quantity (EA)	Quantity (unit)	Unit
48-inch precast, prestressed concrete piles	4	36	**2709**	**LF**
18x0.625 inch steel pipe pile	8	18	**1818**	**LF**
6-inch square precast, prestressed piles	4	36	**3600**	**LF**
Reinforced concrete	1	143	**94**	**yard^3**
Rebar	1	143	**7**	**tons**

TETRA TECH	Dickinson Bayou Pump Station Quantities	Calculation No. DB-PS-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Dickinson Bayou Pump Station Quantites				
Made By:	MGH	**Date:** 11/06/18	**Chk'd By:** JK	**Date:**	11/07/18

Calc Body Pages	Appended Pages	Total Pages
14	2	16

Document code

Site	Feature	Discipline	Document type	Number
DB	PS	ST	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Lexee Navarre 7/25/2018	Carl Grompe 9/21/2018	
B	Michael Hough 10/30/2018	Jason Kikuta 11/7/2018	Updated for Revised PS Geometry and design

TETRA TECH	**Dickinson Bayou Pump Station Quantities**		**Calculation No. DB-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1			**Page:**	2
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	MGH	**Date:** 11/06/18	**Chk'd By:** JK	**Date:**	11/07/18

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Attachments	Number of Pages	Last Page Number
Plate 13	1	14

TETRA TECH	Dickinson Bayou Pump Station Quantities	Calculation No. DB-PS-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	3
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	MGH	**Date:** 11/06/18	**Chk'd By:** JK	**Date:**	11/07/18

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for Pump Station at Dickinson Bayou.

APPROACH

Typical engineering means and methods.

REFERENCES

References used during this calculation are as follows:

1) Plate 13
2)
3)

RESULTS / CONCLUSIONS

PILES:

Total # of 24" Diam. X 5/8" Vertical Pipe Piles:	1982			
Total 24" Diam. X 5/8" Steel Pipe Pile:	158560 ft	**OR**	12381 tons	
Total PZ-22 Steel Sheet Pile:	12671.8 ft^2	**OR**	139 tons	

CONCRETE:

FOUNDATIONS:

Total Concrete for Base Slab:	28372 yd^3	
Total Concrete for Mud Slab:	3648 yd^3	
Total:	32020 yd^3	

SUBSTRUCTURE:

Total:	36247 yd^3	

SUPERSTRUCTURE:

Total:	4034 yd^3	8" Thick Precast Concrete Wall Panels
TOTAL CONCRETE:	72301 yd^3	

STEEL:

SUPERSTRUCTURE:

Total Number of W36X231 Steel Columns:	64		
Length	3200 ft	**OR**	370 tons
Total Number of W27X235 Steel Roof Beams:	32		
Length	2144 ft	**OR**	252 tons
Total Number of W27X235 Steel Beams:	38		
Length	1748 ft	**OR**	205 tons

CRANE FRAME:

Total Number of Steel HHS 12x12x1/2 Columns:	64		
Length	2880 ft	**OR**	109 tons
Total Number of W18X192 Steel Top Rails:	38		
Length	1748 ft	**OR**	168 tons
Total Number of 30 lb/ft Crane Rails:	38		
Length	1748 ft	**OR**	26 tons
Total Number of Steel HHS 12x12x1/2 Beams:	190		
Length	8740 ft	**OR**	332 tons

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) Excavation is to be determined by others.
2) Number of pumps = 13
3) Material Properties:
   - Concrete for base slab, allowable f'c = 4000 psi
   - Concrete for mud slab, allowable f'c = 2500 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
   - Sheet Piles = ASTM A328
4) All piles have tension connections.

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Material types and properties.
2) Layout, elevations and dimensions of Pump Station.

CALCULATIONS

Begin on next page.

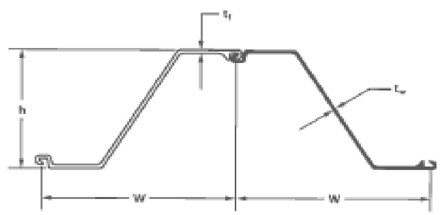
Tetra Tech	Dickinson Bayou Pump Station Quantities	Calculation No. DB-PS-ST-MT-001

Job No.:	100-RCE-18-09-1				**Page:**	6
Project:	Coastal Texas Protection and Restoration					
Description:	General References and Figures					
Made By:	MGH	**Date:** 11/06/18	**Chk'd By:**	JK	**Date:**	11/07/18

General References and Figures

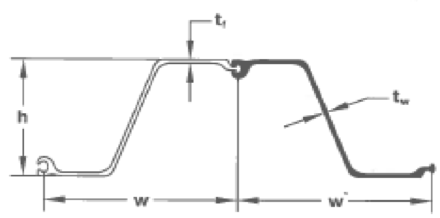
NZ/PZ

NZ/PZ Hot Rolled Steel Sheet Pile



NZ

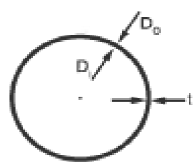
SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Web (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
NZ 19	27.56 700	16.14 410.0	0.375 9.5	0.375 9.5	7.04 148.9	55 81.85	23.95 116.93	35.08 1886	41.33 2222	233.1 38659	6.18 1.88	1.35 1.35
NZ 20	27.56 700	16.16 410.5	0.394 10.0	0.394 10.0	7.29 154.4	57 84.83	24.82 121.18	36.24 1948	42.80 2301	292.8 39984	6.18 1.88	1.35 1.35
NZ 21	27.56 700	16.20 411.5	0.433 11.0	0.433 11.0	7.80 165.2	61 90.78	26.56 129.68	38.69 2080	45.85 2465	313.4 42797	6.18 1.88	1.35 1.35
NZ 26	27.56 700	17.32 440.0	0.500 12.7	0.500 12.7	9.08 192.3	71 105.66	30.92 150.94	48.50 2608	57.01 3065	419.9 57340	6.49 1.98	1.41 1.41



PZ

SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Wall (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
PZ 22	22.0 559	9.0 229	0.375 9.50	0.375 9.50	6.47 136.9	40.3 60.0	22.0 107.4	18.1 973	21.79 1171.4	84.38 11500	4.48 1.37	1.22 1.22
PZ 27	18.0 457	12.0 305	0.375 9.50	0.375 9.50	7.94 168.1	40.5 60.3	27.0 131.8	30.2 1620	36.49 1961.9	184.20 25200	4.48 1.37	1.49 1.49
PZ 35	22.6 575	14.9 378	0.600 15.21	0.500 12.67	10.29 217.8	66.0 98.2	35.0 170.9	48.5 2608	57.17 3073.5	361.22 49300	5.37 1.64	1.42 1.42
PZ 40	19.7 500	16.1 409	0.600 15.21	0.500 12.67	11.77 249.1	65.6 97.6	40.0 195.3	60.7 3263	71.92 3866.7	490.85 67000	5.37 1.64	1.64 1.64

Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = $10.69 \cdot t \cdot (D_o - t)$
D_o (in) - outside diameter
t (in) - thickness of pipe

Pipe Weight (kg/m) = $0.0247 \cdot t \cdot (D_o - t)$
D_o (mm) - outside diameter
t (mm) - thickness of pipe

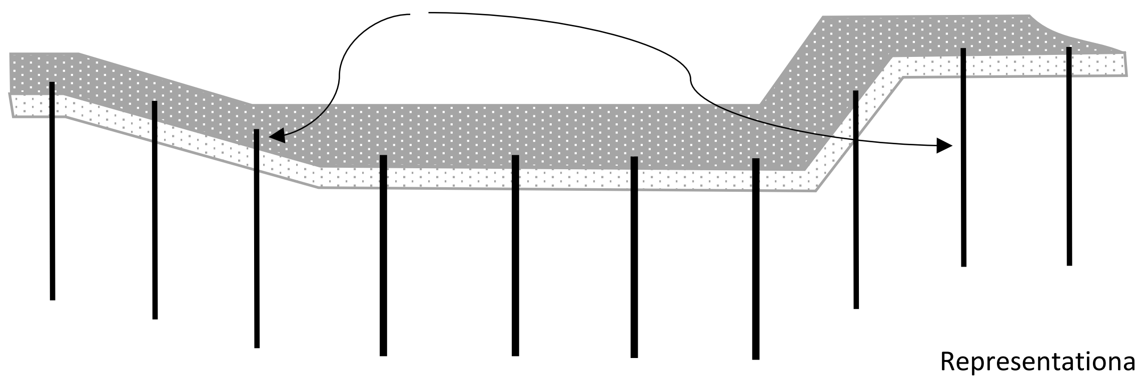
PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

Job No.:	100-RCE-18-09-1					**Page:**	8
Project:	Coastal Texas Protection and Restoration						
Description:	CC Quantities for Pump Station Foundations						
Made By:	MGH	**Date:**	11/06/18	**Chk'd By:**	JK	**Date:**	11/07/18

CC Quantities for Pump Station Foundations

Figure 1:



PILES

Number of Piles 150

Number of Piles 32 At Safe House Enclosure Slab

Pile Diameter: 24 in

Pile Thickness: 5/8 in

Pile Weight: 156.17 lb/ft

*see general references attachments for reference of produced value

Piles	# of Piles per row	Rows	Pile Weight (lb/ft)	Start EL (ft)	End EL (ft)	Length (ft)	Weight (ton)	Total Length (ft)	Total Weight (ton)
Pumps	6	25	156.17	-16.0	-96.0	80.0	6.2	12000	937.0
Safe House	8	4	156.17	0.0	-80.0	80.0	6.2	2560	199.9

TETRA TECH	Dickinson Bayou Pump Station Quantities	Calculation No. DB-PS-ST-MT-001

Job No.: 100-RCE-18-09-1 **Page:** 9

Project: Coastal Texas Protection and Restoration

Description: CC Quantities for Pump Station Foundations

Made By: MGH **Date:** 11/06/18 **Chk'd By:** JK **Date:** 11/07/18

Piles (24" diam x 5/8")

Total # of Piles per Pump: 150
Total Length per Pump: 12000 ft
Total Weight per Pump: 937 tons

Total Number of Pumps: 13

Total # of Piles at Safe House Enclosure: 32
Total Length at Safe House: 2560 ft
Total Weight at safe house: 200 tons

TOTALS:		
	# of 24" diam x 5/8" Piles:	**1982**
	Length of 24" diam x 5/8":	**158560 ft**
	Weight of 24" diam x 5/8":	**12381 tons**

SHEET PILE

Note: It is assumed that the sheet pile wall used at WCC for seepage control will also be the same kind used at Clear Creek.
A PZ-22 hot rolled sheet piling shall be utilized for seepage cutoff.

Start EL of Sheet Pile Wall: -25.0 ft **Weight of Sheet Pile Wall*:** 22.0 lb/ft^2
End EL of Sheet Pile Wall: -46.0 ft **Length of Sheet Pile Wall:** 46.4 ft
Height of Sheet Pile Wall: 21.0 ft

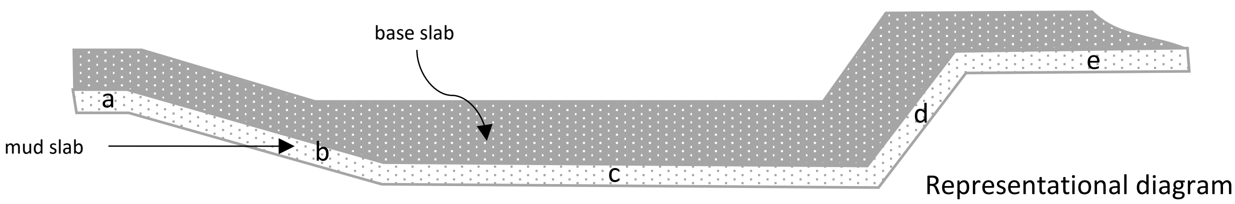
*see general references attachments for reference of produced value

# of Walls	Area (ft^2)	Weight of Wall (lb/ft^2)	Weight (tons)
1	974.8	22.0	10.7

Total Number of Pumps: 13 **Total Area per Pump:** 975 ft^2
Total Weight per Pump: 11 tons

TOTALS:		
	Area:	**12672 ft^2**
	Weight:	**139 tons**

Figure 2:



CONCRETE

FOUNDATION BASE SLAB:

F'c: 4,000 psi
Width of Slab: 46.4 ft

Total Volume of Concrete per Pump*: 2,182 yd^3
Total Number of Pumps: 13
Total Foundation Slab Concrete: 28372 yd^3

*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.

MUD SLAB:

Note: Please see attached SB-005 drawing for concrete sectioning. It is assumed that this pump station will also have a mud slab like West Closure Complex. Lengths of sections are estimates for the preliminary design phase.

F'c: 2,500 psi
Width of Slab: 46.4 ft **Slab Thickness:** 12.0 in

Section	Length (ft)	Thickness (in)	Cross Sectional Area (ft^2)	Width (ft)	Volume (yd^3)
a	156.0	12.00	156.00	46.4	268.19
b	21.0	12.00	21.00	16.0	12.44

Total Mud Slab Concrete per Pump: 281 yd^3
Total Number of Pumps: 13
Total Mud Slab Concrete: 3648 yd^3

TOTAL CONCRETE: 32020 yd^3

Job No.:	100-RCE-18-09-1					**Page:**	11
Project:	Coastal Texas Protection and Restoration						
Description:	Pump Station Substructure Quantities						
Made By:	MGH	**Date:**	11/06/18	**Chk'd By:**	JK	**Date:**	11/07/18

Pump Station Substructure Quantities

CONCRETE

Total Volume of Concrete per Pump*:	2,665.8	yd^3	*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.
Total Number of Pumps:	13		
Total Volume of Concrete at Safe House*:	1,591.1	yd^3	

Total Concrete: 36247 yd^3

Job No.:	100-RCE-18-09-1					**Page:**	12
Project:	Coastal Texas Protection and Restoration						
Description:	Pump Station Superstructure Quantities						
Made By:	MGH	**Date:**	11/06/18	**Chk'd By:**	JK	**Date:**	11/07/18

Pump Station Superstructure Quantities

PRECAST CONCRETE WALL PANELS

Total Volume of Concrete per Pump Bay*:	292	yd^3	*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.
Total Number of Pump Bays:	13		
Total Volume of Concrete at Safe House Enclosure*:	235	yd^3	

Total Concrete: 4034 yd^3

STEEL

COLUMNS:

The columns of the steel superstructure frame will be W36X231.

Weight:	231	lb/ft	
Height:	50	ft	
Number of Columns per Pump Bay:	4		
Total Number of Pump Bays:	13		
Number of Columns at Safe House Enclosure:	12		Per Plans

Total Number of W36X231 Steel Columns:	**64**	
Total Length of W36X231 Steel Columns:	**3200**	**ft**
Total Weight of W36X231 Steel Columns:	**370**	**tons**

TETRA TECH	Dickinson Bayou Pump Station Quantities	Calculation No. DB-PS-ST-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	13
Project:	Coastal Texas Protection and Restoration						
Description:	Pump Station Superstructure Quantities						
Made By:	MGH	**Date:**	11/06/18	**Chk'd By:**	JK	**Date:**	11/07/18

LONGITUDINAL ROOF BEAMS (spanning length of pump bay):

The longitudinal roof beams of the steel superstructure frame will be W27X235.

Weight:	235	lb/ft	
Length:	67	ft	
Number of Roof Beams per Pump Bay:	2		
Total Number of Pump Bays:	13		
Number of Beams at Safe House Enclosure:	6		Per Plans

Total Number of W27X235 Steel Roof Beams:	**32**	
Total Length of W27X235 Steel Roof Beams:	**2144**	**ft**
Total Weight of W27X235 Steel Roof Beams:	**252**	**tons**

TRANSVERSE ROOF BEAMS (spanning width of pump bay):

The tansverse roof beams of the steel superstructure frame are W27X235.

Weight:	235	lb/ft	
Length:	46	ft	
Number of Roof Beams per Pump Bay:	2		
Total Number of Pump Bays:	13		
Number of Beams at Safe House Enclosure:	12		Per Plans

Total Number of W27X235 Steel Beams:	**38**	
Total Length of W27X235 Steel Roof Beams:	**1748**	**ft**
Total Weight of W27X235 Steel Roof Beams:	**205**	**tons**

Pump Station Crane Frame Quantities

STEEL

COLUMNS:

The columns of the steel crane frame are assumed to be HSS 12x12x1/2.

Weight:	76	lb/ft
Height:	45	ft
Number of Columns per Pump Bay:	4	
Total Number of Pump Bays:	13	
Number of Columns at Safe House Enclosure:	12	

Total Number of Steel HHS 12x12x1/2 Columns:	**64**	
Total Length of Steel HHS 12x12x1/2 Columns:	**2880**	**ft**
Total Weight of Steel HHS 12x12x1/2 Columns:	**109**	**tons**

TOP RAIL:

The top rail of the steel crane frame will be W18X192.

Weight:	192	lb/ft
Length:	46	ft
Number of Top Rails per Pump Bay:	2	
Total Number of Pump Bays:	13	
Number of Top Rails at Safe House Enclosure:	12	

Total Number of Top Rails:	**38**	
Total Length of Top Rails:	**1748**	**ft**
Total Weight of Top Rails:	**168**	**tons**

CRANE RAIL:

Added to the top rail will be a 30 lb/ft crane rail.

Weight:	30	lb/ft	
Length:	46	ft	
Number of Crane Rails per Pump Bay:	2		
Total Number of Pump Bays:	13		
Number of Crane Rails at Safe House Enclosure:	12		

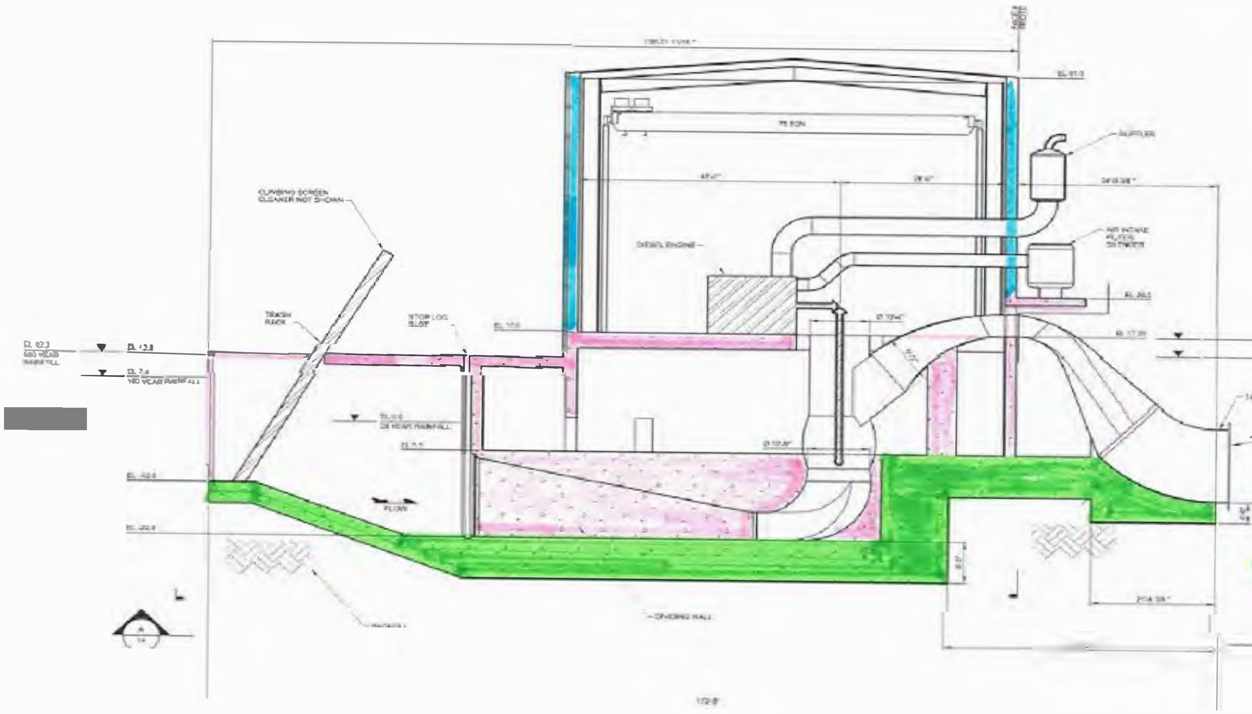
Total Number of Crane Rails:	**38**	
Total Length of Crane Rails:	**1748**	**ft**
Total Weight of Crane Rails:	**26**	**tons**

INFILL FRAMING:

The infill framing beams of the steel crane frame are assumed to be HSS 12x12x1/2.

Weight:	76	lb/ft	
Length:	46	ft	
Number of Infill Beams per Pump Bay:	10		5 each side
Total Number of Pump Bays:	13		
Number of Infill Beams at Safe House Enclosure:	60		

Total Number of Steel HHS 12x12x1/2 Beams:	**190**	
Total Length of Steel HHS 12x12x1/2 Beams:	**8740**	**ft**
Total Weight of Steel HHS 12x12x1/2 Beams:	**332**	**tons**



7890 ft³ × 31

+ 6342 ft³ (SH/CR)

71977 ft³ × 31

+ 42960 ft³ (SH/CR)

~~55640 ft³~~ × 31

68927 ft³

TETRA TECH	Dickinson Bayou Fuel Tank Foundations Quantities	Calculation No. DB-PS-ST-MT-002

Job No.:	100-RCE-18-09-1	**Page:**	1
Project:	Coastal Texas Protection and Restoration		
Description:	Dickinson Bayou Fuel Tank Foundations Quantities		
Made By:	LN **Date:** 07/25/18	**Chk'd By:** DS	**Date:** 08/17/18

Calc Body Pages	Appended Pages	Total Pages
7	0	7

Document code

Site	Feature	Discipline	Document type	Number
DB	PS	ST	MT	002

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Lexee Navarre 8/22/18 [signature]	Daniel Stuard 8/22/18 [signature]	

TETRA TECH	**Dickinson Bayou Fuel Tank Foundations Quantities**		**Calculation No.** **DB-PS-ST-MT-002**

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LN	**Date:**	07/25/18	**Chk'd By:**	DS	**Date:**	08/17/18

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TETRA TECH	Dickinson Bayou Fuel Tank Foundations Quantities	Calculation No. DB-PS-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	3
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	LN	**Date:** 07/25/18	**Chk'd By:** DS	**Date:**	08/17/18

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for T-Walls.

APPROACH

Typical engineering means and methods for determining volumes and weights.

REFERENCES

References used during this calculation are as follows:

1) DB-FG-ST-CL-002
2) DB-PS-ME-CL-001
3) DB-PS-ST-CL-001

RESULTS / CONCLUSIONS

Total # of Pipe Piles:	56 (All piles have tension connections)			
Total 24" Diam. X 0.5" Steel Pipe Pile:	3234.0 ft	**or**	203.1 tons	
Total # of Pile Caps:	14			
Total Concrete per Cap:	10.7 yd^3			
Pile Cap Concrete:	149.3 yd^3			

TETRA TECH	Dickinson Bayou Fuel Tank Foundations Quantities	Calculation No. DB-PS-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	4
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LN	**Date:**	07/25/18	**Chk'd By:**	DS	**Date:**	08/17/18

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) Material Properties:
   - Concrete, f'c = 4000 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
2) Costs of reinforcement is included in reinforced concrete unit cost.
3) All piles have tension connections.
4) Total number of Tanks = 7

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Materials and quantites as design progresses.

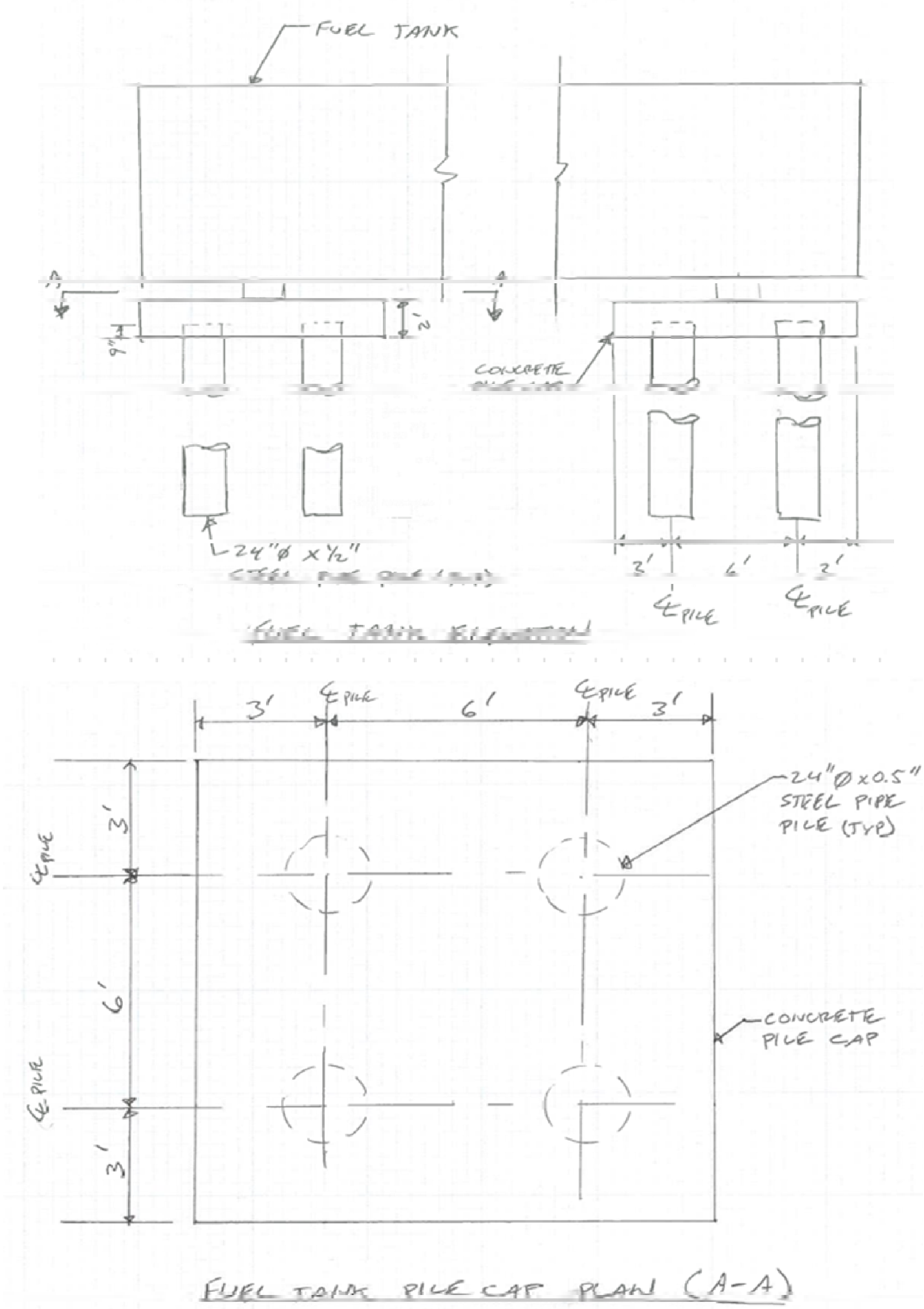
CALCULATIONS

Begin on next page.

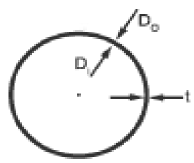
TETRA TECH	Dickinson Bayou Fuel Tank Foundations Quantities	Calculation No. DB-PS-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	5
Project:	Coastal Texas Protection and Restoration						
Description:	General References and Figures						
Made By:	LN	**Date:**	07/25/18	**Chk'd By:**	DS	**Date:**	08/17/18

General References and Figures



Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = 10.69*t*(D_o-t)
D_o (in) - outside diameter
t (in) - thickness of pipe

Pipe Weight (kg/m) = 0.0247*t*(D_o-t)
D_o (mm) - outside diameter
t (mm) - thickness of pipe

PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)												
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

TETRA TECH	Dickinson Bayou Fuel Tank Foundations Quantities	Calculation No. DB-PS-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	7
Project:	Coastal Texas Protection and Restoration						
Description:	Quantities for Fuel Tank Foundations						
Made By:	LN	**Date:**	07/25/18	**Chk'd By:**	DS	**Date:**	08/17/18

Quantities for Fuel Tank Foundations

PILES

Steel Pipe Piles with a spacing of 6 feet beneath the pile cap. The minimum tip embedment is to be 57 feet plus 9 inches of embedment into concrete slab.

Pile Diameter: 24.0 in
Pipe Thickness: 0.5 in
Pipe Weight*: 125.61 lb/ft
Pile Tip to Head Embedment: 57.75 ft

*see general references attachments for reference of produced value

Number of Caps per Tank: 2
Total Number of Tanks: 7
Total Number of Pile Caps: 14
Number of Piles per Cap: 4

Total Number of Piles: **56**
Total of Steel Pipe Piles: **3234.0 ft** **or** **203.1 tons**

CONCRETE:

PILE CAPS:

Thickness (ft)	Width (ft)	Cross Sectional Area (ft^2)	Length (ft)	Volume (yd^3)
2	12	24	12	10.7

Total Number of Pile Caps: 14 (see piles section)

Total Concrete: **149.33 yd^3**

TETRA TECH	Dickinson Bayou Pump Station Cellular Cofferdam Quantities	Calculation No. DB-PS-ST-MT-003

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Coversheet				
Made By:	DAS	**Date:** 10/31/18	**Chk'd By:** JK	**Date:**	11/08/18

Calc Body Pages	Appended Pages	Total Pages
7	0	7

Document code

Site	Feature	Discipline	Document type	Number
DB	PS	ST	MT	003

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Dave Stensby Chris Kossel for Dave Stensby 11.8.18	Jason Kikuta 11/8/18	Submitted for Review

TETRA TECH	Dickinson Bayou Pump Station Cellular Cofferdam Quantities	Calculation No. DB-PS-ST-MT-003

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	DAS	**Date:**	10/31/18	**Chk'd By:**	JK	**Date:**	11/08/18

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Attachments	Number of Pages	Last Page Number

TETRA TECH	Dickinson Bayou Pump Station Cellular Cofferdam Quantities	Calculation No. DB-PS-ST-MT-003

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	DAS	**Date:**	10/31/18	**Chk'd By:**	JK	**Date:**	11/08/18

ISSUE BEING ADDRESSED

The purpose of this calculation is to estimate the quantities necessary for sheet pile cellular cofferdams for the pumpstations. Limited geotechnical infomration is available at this time, so various assumptions will be made as to sizes of cofferdam components.

APPROACH

Typical engineering means and methods for determining volumes and weights.

Cellular cofferboxes were assumed, since the size of the cofferbox is very large and interior bracing would be problematic.

The foundations of the pumphouses are extend below the existing ground level and must be excavated in-the-wet. After the excavation, gravel layer will be placed to aid in drainage and a tremie slab will be placed. Then the excavation area will be dewatered for construction. The cofferdams must be designed to provide adequate strength and stability for each of these phases.

REFERENCES

1) USS Steel Sheet Pile Deisgn Manual, July 1984
2) Skyline Steel Technical Product Manual, 2013

RESULTS / CONCLUSIONS

Assumed Sheet Pile:	PS 31	
# of Sheets:	3,190	
Total Weight of Sheets:	5,300	Tons
Cellular Cofferdam Fill:	117,480	yd^3

TETRA TECH	**Dickinson Bayou Pump Station** **Cellular Cofferdam Quantities**	**Calculation No.** **DB-PS-ST-MT-003**

Job No.:	100-RCE-18-09-1					**Page:**	4
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	DAS	**Date:**	10/31/18	**Chk'd By:**	JK	**Date:**	11/08/18

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

- These quantities are based on the associated structural calculations. Due to the limited amount of site information and design requirements available, a number of significant assumptions have been made. These are shown in the associated structural design calculations.

- Cofferdam Elevations & Dimesions:

	Elevations			Dimesions	
Top of Cofferdam:	5.0	ft	Sheet Pile:	PS 31	
Assumed Existing Ground:	-10.0	ft	Cofferdam Width:	50.0	ft
Btm of Excavation:	-34.0	ft	Clearance to Structure:	6.0	ft
Sheet pile tip:	-60.0	ft	Excavation Length:	690.0	ft
			Excavation Width:	190.0	ft

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Final geotechnical information and recommendations
2) Detailed design of the cellular cofferdam
3) Pile type, size and layout.
4) Access requirements

CALCULATIONS

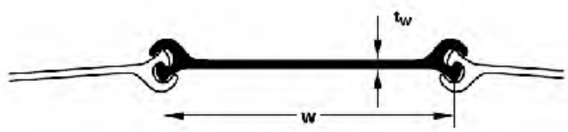
See Next Page

GENERAL REFERENCES

Location of Dickinson pumpstation and sector gates

TETRA TECH	Dickinson Bayou Pump Station Cellular Cofferdam Quantities	Calculation No. DB-PS-ST-MT-003

Job No.:	100-RCE-18-09-1			**Page:**	6
Project:	Coastal Texas Protection and Restoration				
Description:	GENERAL REFERENCES				
Made By:	DAS	**Date:** 10/31/18	**Chk'd By:** JK	**Date:**	11/08/18



PS

SECTION	Width (w) in (mm)	Web (t_w) in (mm)	Maximum Interlock Strength k/in (kN/m)	Minimum Cell Diameter* ft (m)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	Elastic Section Modulus in³/sheet (cm³/sheet)	Moment of Inertia in⁴/sheet (cm⁴/sheet)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² of wall (m²/m²)
PS 27.5	19.69 500	0.4 10.2	20 3500	30 9.14	8.09 171.2	45.1 67.1	27.5 134.3	3.3 54	5.3 221	3.65 1.11	1.11 1.11
PS 31	19.69 500	0.5 12.7	20 3500	30 9.14	9.12 193.0	50.9 75.7	31.0 151.4	3.3 54	5.3 221	3.65 1.11	1.11 1.11

Cellular Cofferdam Quantities

Excavation Dimensions		
Length	690	ft
Width	190	ft

Centerline of sheetpile cells dimensions		
Cofferdam Width	50.0	ft
Clearance to Structure	6.0	ft
Length	752	ft
Width	252	ft
Total Perimeter	**2008**	lineal feet

Sheet pile layout

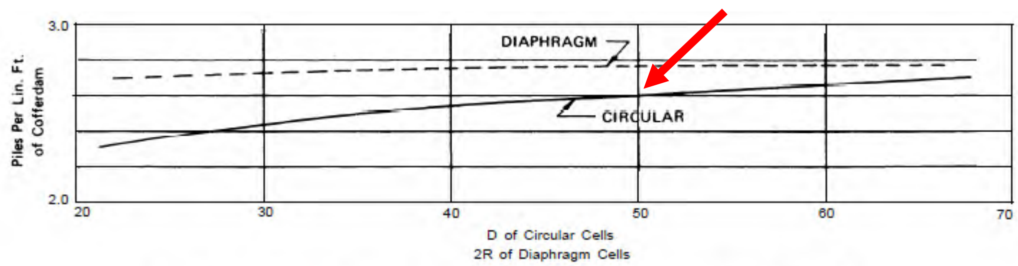
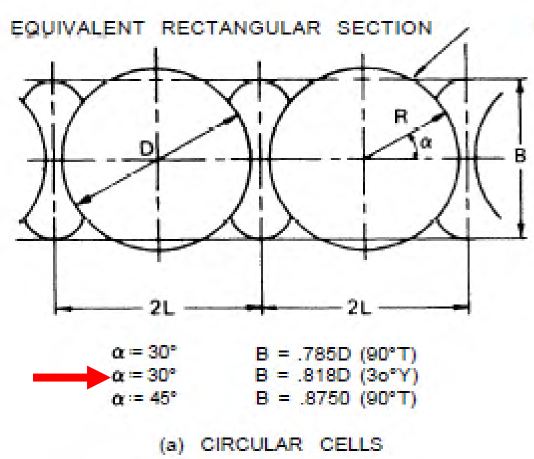


Fig. 64 - Piling required per linear foot of cofferdam (after TVA[36])

Length factor	2.6	from chart above
Total length of sheet piles	5220.8	lineal feet
Sheet pile top elevation	5	ft
Sheet pile tip elevation	-60	ft
Sheet pile length	65	ft
Sheet pile area	339,352	ft^2
Sheet pile weight / sq ft	31	psf
Total Sheet pile weight	10,519,912	pounds
	5,300	tons
Sheet length	19.69	inches
	1.64	feet
Number of piles	**3,190**	sheets

Cofferdam Fill

Top of Fill Elevation	5	ft
Bottom of fill	-10	
Width factor	0.81	from table
Width	40.5	ft
Total Fill volume	3,171,700	ft^3
	117,480	yds



TETRA TECH	Pump Station - Discharge Pipes and Supports	Calculation No. DB-PS-ST-MT-004

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Pump Station - Discharge Pipes and Supports ⍰				
Made By:	SDG	**Date:** Nov-07-2018	**Chk'd By:** LRM	**Date:**	11/09/18

Calc Body Pages	Appended Pages	Total Pages
4	11	16

Document code

Site	Feature	Discipline	Document type	Number
DB	PS	ST	MT	004

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Sergio Gaitan 11/09/18 Lois Loesch for Sergio Gaitan	Leo Moyer 11/09/18 Lois Loesch for Leo Moyer	Initial for review

	Pump Station - Discharge Pipes and Supports	Calculation No. DB-PS-ST-MT-004

Job No.:	100-RCE-18-09-1			**Page:**	2
Project:	Coastal Texas Protection and Restoration				
Description:	Dikinson Pump Station - Discharge pipes and supports				
Made By:	SDG	**Date:** lov-07-2018	**Chk'd By:** LRM	**Date:**	11/09/18

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TETRA TECH	Pump Station - Discharge Pipes and Supports	Calculation No. DB-PS-ST-MT-004

Job No.:	100-RCE-18-09-1				**Page:**	3
Project:	Coastal Texas Protection and Restoration					
Description:	Dikinson Pump Station - Discharge pipes and supports					
Made By:	SDG	**Date:** lov-07-2018	**Chk'd By:**	LRM	**Date:**	11/09/18

ISSUE BEING ADDRESSED

Quantities are provided for the Spirolite discharge pipes

APPROACH

Quantities are based on the "sunk" approach for installing the pipes in the outfall channel.

REFERENCES

References used during this calculation are as follows:

1) ETL-1110-2-307 Flotation Stabilty Criteria

RESULTS / CONCLUSIONS

Dickinson Bayou Pump Station

Spirolite pipe 14 ft diameter:	16,222	LF	Double closed Cell type
Dry welding of Bell & Spigot joints	270	EA at 60 feet	
End elbows, FRP:	13	EA	Provide support H pile frame
Precast Concrete collars at 20' oc	811	EA	11.8 CY EA circumferential
Precast Concrete collars at 20' oc	9,570	CY	
Dredging Stage 1 to El -12:	202,222	CY	
Thalweg dredging Stage 2 to El -16:	33,704	CY	
Backfill 1 - gravel to El -5:	57,366	CY	
Backfill 2 - reuse dredged material to El +2:	86,065	CY	
Pressure relief air valve	13	EA	

It does not account for property acquisition

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

The following assumptions can be considered when looking at the quantities and cost to provide and install these pipes, please refer to Plates in Engineering Appendix:

• Dredging can occur in 2 stages to minimize earthwork: initially down to El. -12 to obtain a constant depth throughout. Then a second dredging effort would be localized at the pipeline invert thalweg to bring the depth to -16.

• Collars are made of two half circular precast pieces bolted at the spring line to weigh down the pipes.

• Assuming a tidal range from +1 to -1, precast concrete collars can be installed at 20 ft spacing as the pipeline is launched into the water. The entire line would be launched assembled with collars by keeping the pipe ends closed temporarily to obtain pipe buoyancy in route. Once the pipe is in correct alignment, the pipe ends can be removed, and the pipe alignment would be sunk down to a pre-dredged invert elevation of -16.

• Backfill operations can then proceed in two stages: First a gravel backfill around the pipes to a few feet above the spring line of the pipes to -5, to secure them against lateral forces, followed by hydraulic backfilling using the native dredged materials to El. +2 or the prior original surrounding level.

• The elbow at the end turns the flow upward to dissipate energy and reduce erosion. The elbow would be supported off a pile supporting frame. The elbow would be made of solid double cell FRP wall material discharging at El +2. Riprap would surround the elbow to avoid local erosion.

• The Factor of Safety against buoyancy is 1.5 per ETL 1110-2-307 for normal operation.

TETRA TECH	Pump Station - Discharge Pipes and Supports	Calculation No. DB-PS-ST-MT-004

Job No.:	100-RCE-18-09-1				**Page:**	5
Project:	Coastal Texas Protection and Restoration					
Description:	Dikinson Pump Station - Discharge pipes and supports					
Made By:	SDG	**Date:** lov-07-2018	**Chk'd By:**	LRM	**Date:**	11/09/18

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) No information on cost is available for 14 ft spirolite. A new mandrel would have to be custom made and only after knowing the total amount of linear feet of pipe, would IPF Plasson be able to cost this out. Having said that, a cost can be approximated by the calculated weight of the Closed Cell pipe in lbs per LF. Sixty-foot pipe sections would be welded in the dry and aligned for launching in the water. Bell and Spigot with extrusion welds are preferred.

2) As a cost comparison, Vari-Tech has provided 157" (13 ft) diameter pipes in the past at a cost of about $1,600/LF. This does not account for FOB delivery. The cost of field welding 100 joints of this pipe is about $600,000. Each FRP elbow can be supplied at a cost of about $35,000. This information needs to be confirmed for a 14 ft diameter pipe system.

3) The durability of the Spirolite material needs to be confirmed at 100 years and Vari-Tech may be able to provide supporting aging reports.

CALCULATIONS

DB	pipe lengths north to south
1	1244
2	1238
3	1236
4	1231
5	1240
6	1237
7	1234
8	1244
9	1243
10	1268
11	1264
12	1260
13	1283
Total	16222

CALCULATIONS

Conceptual Design of Pump Stastions - Discharge Pipes - Anchoring Devices

Pipe Diameter

A 14 ft diameter pipeline serving each pump at 1500 cfs is first envisioned. The highest average pipe velocity would be about 10 fps. Currently, there are no fabricators of HDPE pipes for that large diameter in the U.S. It is possible that Malaysia could provide this large diameter, however I did not make a call. The largest produced in the USA is 11 ft diameter as provided by Spirolite. IPF Plasson-USA could consider the cost to fabricate a 14 ft mandrel if enough quantity is require

Main distributors of Sprirolite in the U.S. are Vari-tech LLC and ISCO. Vari-tech feels a 10 ft dia pipe is feasible if the pump requirements can support a 20-fps velocity and the associated friction losses. A 12 ft diameter pipe can also be envisioned; however, bends would require more robust lateral anchors. A lesser diameter pipe would result in savings on the pipe itself as it is sold by the lbs/LF of pipe. Savings can also be realized on the lesser amount of dredging.

For purposes of this design, a 14 ft pipe has been adopted going forward to keep the pumping head and requirements down as well as the cost to run the Pump Station in terms of kwh.

Pipe Material

HDPE spirolite can be either solid wall of various SDRs, open profile with exterior bids, or closed cell profile honeycomb design. Pipe pressures usually should stay to less than 25 ft of water head, which is realistic for this application. Joints are typically Bell & Spigot or Extruded melting by means of hot air. Welding is done in the dry and then pipe is floated into position. Segments are typically 60 ft long and are buoyant. The pipe cannot be curved beyond about 2 degrees (or about 700 ft radius), therefore it is not practical. Rather, several welded segments can be provided to suit each bend amount.

Two options were evaluated for installation of the pipes: A (preferred) fully submerged installation, and an option to have the pipes buoyant with the tides.

Submerged Design Option

It is preferable to "sink" the pipe to the bottom of the channel and this technique is used for many estuary-to-ocean applications. Precast concrete collars at 20 ft spacing are designed to permanently sink the pipes provided their spacing, water salinity, and pipe profile selected. Collars serve to overcome pipe material buoyancy and provide a safety factor in maintaining the pipes permanently sunk. Collars are made of two equal halves joined at the spring line by bolts. In order to increase the factor of safety during hurricane surge against lateral wave action, steel H-piles may need be provided at every bend.

In addition, it is possible to backfill the spaces between the pipes with the dredged material, providing less pipe surface to be exposed to wave action and a beneficial use for the dredged material. A 14 ft diameter alternative would be better installed by having localized dredging following the pipe invert as the segments are sank into place.

The Plastic Pipe Institute has information on the tie-down forces required for HDPE of different profiles and SDRs. Closed cell profiles are air tight and contribute to buoyancy. An important factor in selecting the level of submergence is for the crown of the pipe to be below the minimum low tide so as to minimize air from becoming trapped inside the pipe when the tide raises. A 1.5 safety factor has been used for calculating the ballast requirements against floatation. At the face/exit of the Pump Station, a small pressure relief air valve will have to be inevitably placed at the crown of the syphon just leaving the PS. This valve is included as part of the pump equipment.

Fatigue from tidal action is not an issue when the pipes are fully submerged, and the pipe circumferential wall stresses are minor when resisting the constant uplift in between concrete collars. This is also the case when storm surge arrives, because the pipe will remain further submerged. The pipe will however, need to be designed to resist stresses due to lateral submerged wave forces and uplift due to potential currents under the pipe. Fatigue from hurricane action is not significant due to its low frequency.

A check should be made for temperature stresses due to the brackish water being warmer at the top of the pipe vs below the pipe. The expansion coefficient for HDPE is about 1 inch per 10 degrees F per 100 LF of pipe.

Pipe Designed to be Byouyant with Tides

The main benefit of this alternative is to lessen the amount of dredging and backfill to otherwise sink the pipes. In this alternative, the pipes would float unstressed with the tides being restrained only by cable tie-downs to H-piles. Concrete collars would not be required, however there should be a bearing pad element designed and provided to lessen the concentrated stresses imparted by the cable during hurricanes. The cable would have guides attached to the bearing pad to maintain the pipes in a properly tethered position.

In this alternative, air relief valves are required to release air out of the pipes during a hurricane surge higher than the high tide. In this case, the cables are resisting the full uplift of the pipes plus the lateral wave forces acting on the pipe as well as any uplift from flowing water under the pipes.

The temperature check for this option is also required as the top of the pipe will always be exposed to the sun and the air temperature and UV rays.

Although this option appears to save on earthwork when compared with the submerged option, the submerged option results superior in terms of ability to withstand hurricane force waves and therefore durability. Cable tie-downs and H-pile anchors are also high maintenance items with a limited service life.

Quantities:

The following assumptions can be considered when looking at the quantities and cost to provide and install these pipes, please refer to Engineering Plates and quantity calculations:

- No information on cost is available for 14 ft spirolite. A new mandrel would have to be custom made and only after knowing the total amount of linear feet of pipe, would IPF Plasson be able to cost this out. Having said that, a cost can be approximated by the calculated weight of the Closed Cell pipe in lbs per LF. Forty-foot pipe sections would be welded in the dry and aligned for launching in the water. Bell and Spigot with extrusion welds are preferred.

- Dredging can occur in 2 stages to minimize earthwork: initially down to El. -12 to obtain a constant depth throughout. Pairs of H-piles spaced at 100 ft are then driven to locate the alignment of each pipe at the locations every 5th concrete collar. Then a second dredging effort would be localized at the pipeline invert thalweg to bring the depth to -16.

- Collars are made of two half circular precast pieces bolted at the spring line. During final design, a check needs to be made to assess the need to further anchor the pipes major bends and discrete locations to resist wave action. Locations like the discharge elbow will need to be secured and anchored to the ground.

- Assuming a tidal range from +1 to -1, precast concrete collars can be installed at 20 ft spacing as the pipeline is launched into the water. The entire line would be launched assembled with collars by keeping the pipe ends closed temporarily to obtain pipe buoyancy in route. Once the pipe is in correct alignment, the pipe ends can be removed, and the pipe alignment would be sunk down to a pre-dredged invert elevation of -16.

- Backfilled operations can then proceed in two stages: First a gravel backfill around the pipes to a few feet above the spring line of the pipes to secure them against lateral forces, followed by hydraulic backfilling using the native dredged materials to El. +1 or the prior original surrounding level.

- The elbow at the end turns the flow upward to dissipate energy and reduce erosion. The elbow would be supported off a pile supporting frame. The elbow would be made of solid double cell FRP wall material discharging at El +2. Riprap would surround the elbow to avoid local erosion.

- As a cost comparison, Vari-Tech has provided 157” (13 ft) diameter pipes in the past at a cost of about $1,600/LF. This does not account for FOB delivery. The cost of field welding 100 joints of this pipe is about $600,000. Each FRP elbow can be supplied at a cost of about $35,000 including anchoring platform.

- The durability of the Spirolite material has been estimted at 100 years and Vari-Tech can provide supporting aging reports

CALCULATIONS

Mr. Roger Setya
Tetra Tech
3445 N. Causeway Blvd., Suite 320,
Metairie, LA 70002

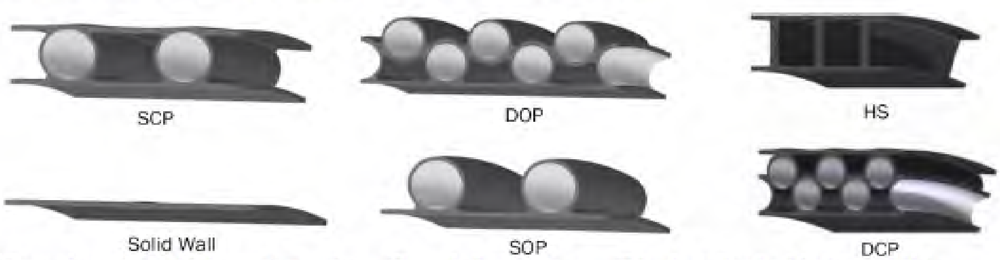
August 16, 2018

Re: Sergio D. Gaitan, P.E.,
VARI-TECH is happy to present the following information regarding spirolite for Marine applications. VARITECH is an organization that has aided in the proper installation of HDPE for over 35 years. With the technical staff ranging through PhD's, PE's and technical sales representatives. We've done projects all over the world throughout many industries. As previously discussed we have done numerous Marine and sub aqueous installations of polyethylene pipes from outfalls, intake, conduits and more.

Project recap:
As previously discussed on the telephone we are investigating the likelihood of upgrading our current line of 12 foot diameter to accommodate your job in Galveston Texas of 14 foot diameter polyethylene pipe. Much of the below pictures and discussion would be based off of previous projects we've done ranging throughout sizes up to the 10 foot diameter range. This will give a brief outline of ideas and details for installation. As this is figured to be iterative process as more details arise from your firm as well as our manufacture so will the tactics found below.

As we discussed I would propose installing the system as a static fixed pipeline. This is meant that the line is weighted or pinned in one location preferably under low tide location. By providing a line that is pinned or weighted properly line is constrained reducing its movement thereby reducing the ability of abrasion or dynamic forces acting on the pipe or its effects apparatuses such as pipe clamps or settles. This will not only make for a lower risk lifecycle to the pipe but also reduce maintenance costs on cables, beams or other members that would be used to allow free movement of the line.

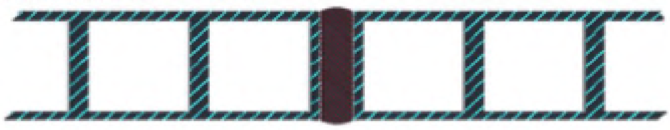
Pipe material:
The thought is to use the spirolite line to produce a watertight conduit of 14 foot inside diameter. A line will be constructed out of PE 4710 resin capable of being welded on the inside and out to handle tensile and bending of a full submergence application. The pipe profile has not yet been determined and may range from any of the profile shown below.



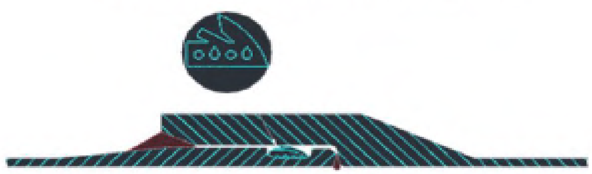
When choosing which configuration will work the best we will look at the inside layer(ID) to provide sufficient abrasion protection found from the organics and silts existing in the Galveston Bay. This layer will also aid in the structural stability for the installation process preventing against buckling during bending or tensile during deployment. The ribs of the pipe will add hoop stiffness which will help support the pipe and poor soil conditions and aid in the control of

deflection in sediment buildup around and on top of the pipe.

Connection methods:
The connection methods for spirolite would be a form of welding on the interior as well as the exterior. The bell and spicket may be utilized if they can be accommodated and tested in the 14 inch size. Bells and spicket's make for easy alignment during the welding process and creatively tight seal up to 25 feet head. An example of two configurations of welding close profile(HS or SCP) is as shown below.



Spirolite HS Thermal Welded Profile Ends



Spirolite Thermal Welded Bell and Spigot Joint

Each method utilizes extruded molten polyethylene to create a structural weld as well as leak tight seal. This is done utilizing extrusion welder or an automated extrusion welder as shown below.

Ballast blocks:

After the joint is completed ballast block would be installed on shore most preferably covering her overlapping the welded area. At this time we do not know the spacing or the size of the blocks as we are investigating the 14 foot upsize and the wall profile that would be used. Below is a standard concrete anchor which has typically been used on previous projects.

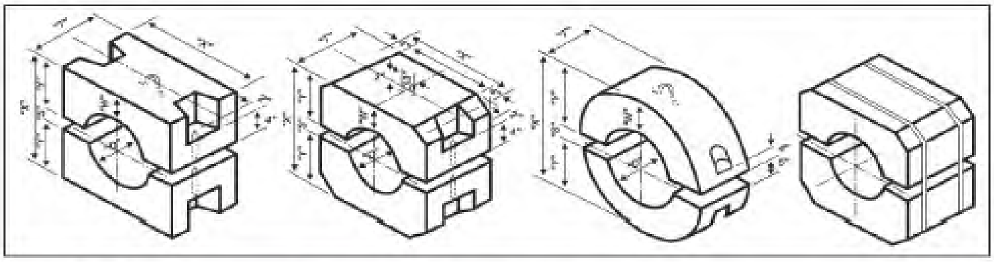


Figure A-3-1 Schematics of Concrete Ballast Designs

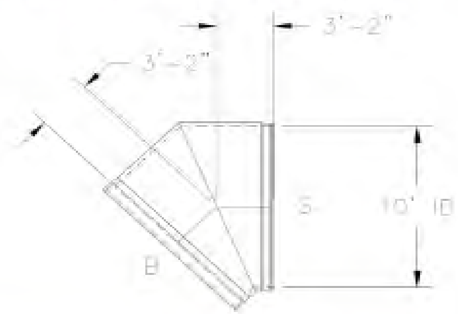
As previously discussed the weight of these blocks would be altered for this application. The 7" width would be much wider as well as the gap in between the weights. As previously discussed we will be working to give you a rough estimate on the overall size and placement of these blocks after we have worked with plasson to determine the feasibility of construction and anticipated wall configuration. For example of a previous project we've done, see the example of the 42 inch line deployed in New Jersey.

Deployment:

After each section is welding and ballast blocks are installed the pipe will be pushed out into the water being controlled by a boat or barge to help pull up in its intended location. Below is a picture of a large diameter spirolite line being deployed out into the waterway.

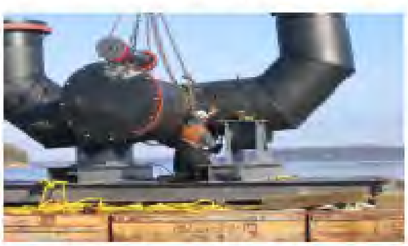
Pipeline diffuser:

As we previously discussed if we can accommodate 14 foot diameter pipe with low enough velocities would be low enough to leave the line open ended with a 45. The 45 will be utilized to point up out of the sediment and allow for a free dispersion of particle discharge during pumping. To give you a rough magnitude size our typical 45 please see the below sketch of one of our 10 feet two segment elbows.



120" CL63
2-Seg 45deg Elbow

This elbow can be orientated vertically off the bottom and supported using an FRP fiberglass skid. Extension or pop could be added to gain your desired length to ensure it's up out of the sediment. Example of this can be seen below from one of our previous projects.



Closing remarks:

As we have found before with many Marine projects there are many different installation tactics for the actual sinking of the HDPE. The success of the tactic chosen depends on the knowledge of your project partners and the resources available to the installer. One of the major importance while taking on endeavor such as this is to qualify the rate team members to provide a proper and safe installation. As this project progresses VARI-TECH would be happy to aid your firm in the technical support of HDPE as well as help you find qualified contractors for technical installation questions as well as possible budgets if needed.

SDG
Nov 9, 2018

Bouyancy on the pipes.

Wt. of a double cell Spirolite 13' ϕ = 644 lbs/LF
└ Varitech max available information w/ 5" wall thickness

Extrapolate wt. of 14' ϕ

$\frac{644}{\pi \cdot 13} = 15.78$ lb/LF circf.

$14 \cdot \pi \cdot 15.78 = \underline{693}$ lb/LF pipe ↓ Wstr

Consider a 6" thick Double cell 14' ϕ

Uplift based on displacement:

$U = \frac{6''}{12} \times \pi * 14 \times 1' = 22$ sf. $\times 63$ lb/ft $= 1385$ lb/ft ↑

per ETC 1110-2-307

$F.S. = \frac{\text{Wstr} + \text{Surcharge}}{U} = 1.5$
└ Normal operations

$1.5 = \frac{693 + S}{1385}$ ∴ $S = 1385$ lbs ↓

Volume of concrete $= \frac{1385}{(150-63)} = 15.91$ cf/LF pipe
× 20
318 cf of concrete/ring
÷ 27
11.8 CY of concrete/precast concrete ring

TETRA TECH	**Pump Station - Discharge pipes and supports**			**Calculation No. DB-PS-ST-MT-004**	
Job No.:	100-RCE-18-09-1			**Page:**	16
Project:	Coastal Texas Protection and Restoration				
Description:	CALCULATIONS				
Made By:	SDG	**Date:** Nov-07-2018	**Chk'd By:** LRM	**Date:**	11/09/18

CALCULATIONS

EARTHWORK QTY: DiKinson Bayou

SDG Nov 8 2018

P.S. Discharge Pipe

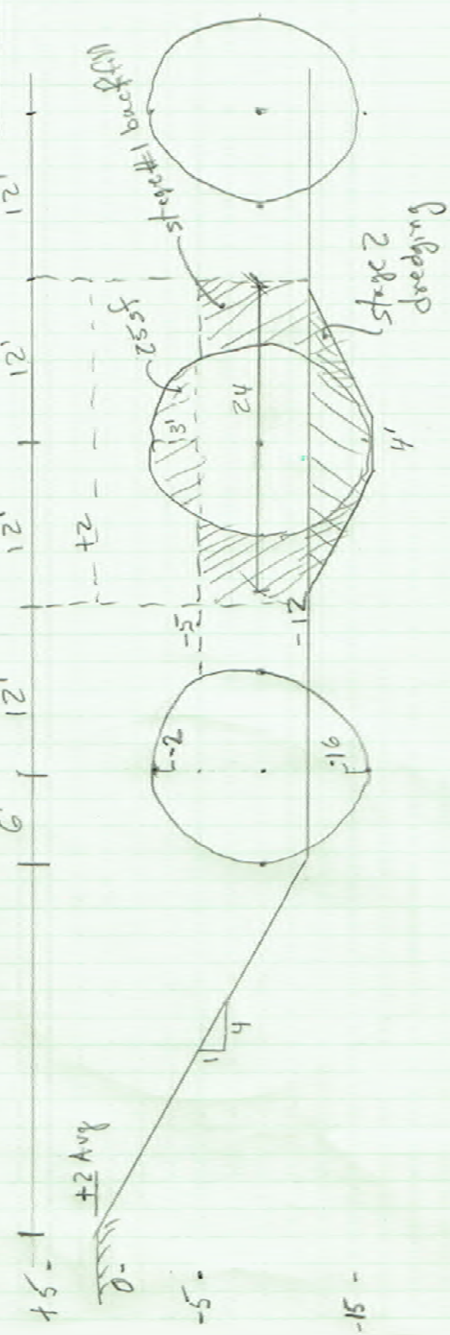
see spreadsheet = 16222/13

Dredging

Stage #1 to -12 = 24' x 14' x 1,250' /27 = 15,556 cy x 13 pipes = 202,222 cy
(width, depth, Avg. length)

Stage #2 to -16 = (24+4) $\frac{1}{2}$ * 4 x 1250 /27 = 2,600 cy x 13 = 33,704 cy

$\boxed{236{,}000 \text{ cy}}$



Backfill

Stage #1 - gravel bedding to -5: 2,600 cy/pipe + 24' x 7' x 1250/27 − $\left[\frac{\pi}{4} 14^2 \times \frac{1250}{27} - 25 \text{sf} \times \frac{1250}{27}\right]$ = 4413 cy

4413 x 13 pipes = $\boxed{57{,}366 \text{ cy}}$

stage #2 - Common hyd. backfill to +2 = 24 x 7 x 1250/27 − 25 x 1250/27 = 6620 cy

x 13 pipes = $\boxed{86{,}065 \text{ cy}}$

TETRA TECH

Dickinson Sector Gate Quantities

Calculation No. **DB-FG-ST-MT-001**

Job No.: 100-RCE-18-09-1 **Page:** 1
Project: Coastal Texas Protection and Restoration
Description: Coversheet
Made By: DAS **Date:** 05/29/18 **Chk'd By:** DS **Date:** 11/05/18

Calc Body Pages	Appended Pages	Total Pages
8	0	8

Document code

Site	Feature	Discipline	Document type	Number
DB	FG	ST	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Dave Stensby 11/14/18	Daniel Stuard 11/14/18	Submitted for Review
B			

TETRA TECH	**Dickinson Bayou Sector Gate Quantities**	**Calculation No.** **DB-FG-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	DAS	**Date:**	11/05/18	**Chk'd By:**	DS	**Date:**	11/05/18

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TETRA TECH	Dickinson Bayou Sector Gate Quantities			Calculation No. DB-FG-ST-MT-001
Job No.:	100-RCE-18-09-1		**Page:**	3
Project:	Coastal Texas Protection and Restoration			
Description:				
Made By:	DAS **Date:** 11/05/18	**Chk'd By:** DS	**Date:**	11/05/18

ISSUE BEING ADDRESSED

This is a preliminary quantity takeoff for the sector gate. It is based on limited information regarding the site conditions and the feature requirements. These quantities will be updated in more detail as future design phases progress.

APPROACH

A solid model of the sector gate was prepared. Many quantities such as steel in the gate design are taken directly from that model. Fender quatities are calculated in the take off with the design assumptions listed.

REFERENCES

See associated structural calculations

RESULTS / CONCLUSIONS

Total Steel for Sector Gates:	212 tons	(both sector gates)
Total Weight of UHMW fenders	38600 lbs	(both sector gates)

TETRA TECH	Dickinson Bayou Sector Gate Quantities					Calculation No. DB-FG-ST-MT-001	
Job No.:	100-RCE-18-09-1					**Page:**	4
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	DAS	**Date:**	11/05/18	**Chk'd By:**	DS	**Date:**	11/05/18

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

These quantities are based on the associated structural calculations. Due to the limited amount of site information and design requirements available, a number of significant assumptions have been made. These are shown in the associated structural design calculations.

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Water elevations and load cases to be evaluated.
2) Detailed design of gate and monolith.
3) Access requirements

CALCULATIONS

See Attached

TETRA TECH	**Dickinson Bayou Sector Gate Quantities**	**Calculation No. DB-FG-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	5
Project:	Coastal Texas Protection and Restoration						
Description:	Sector Gate Steel Quantities						
Made By:	DAS	**Date:**	11/05/18	**Chk'd By:**	DS	**Date:**	11/05/18

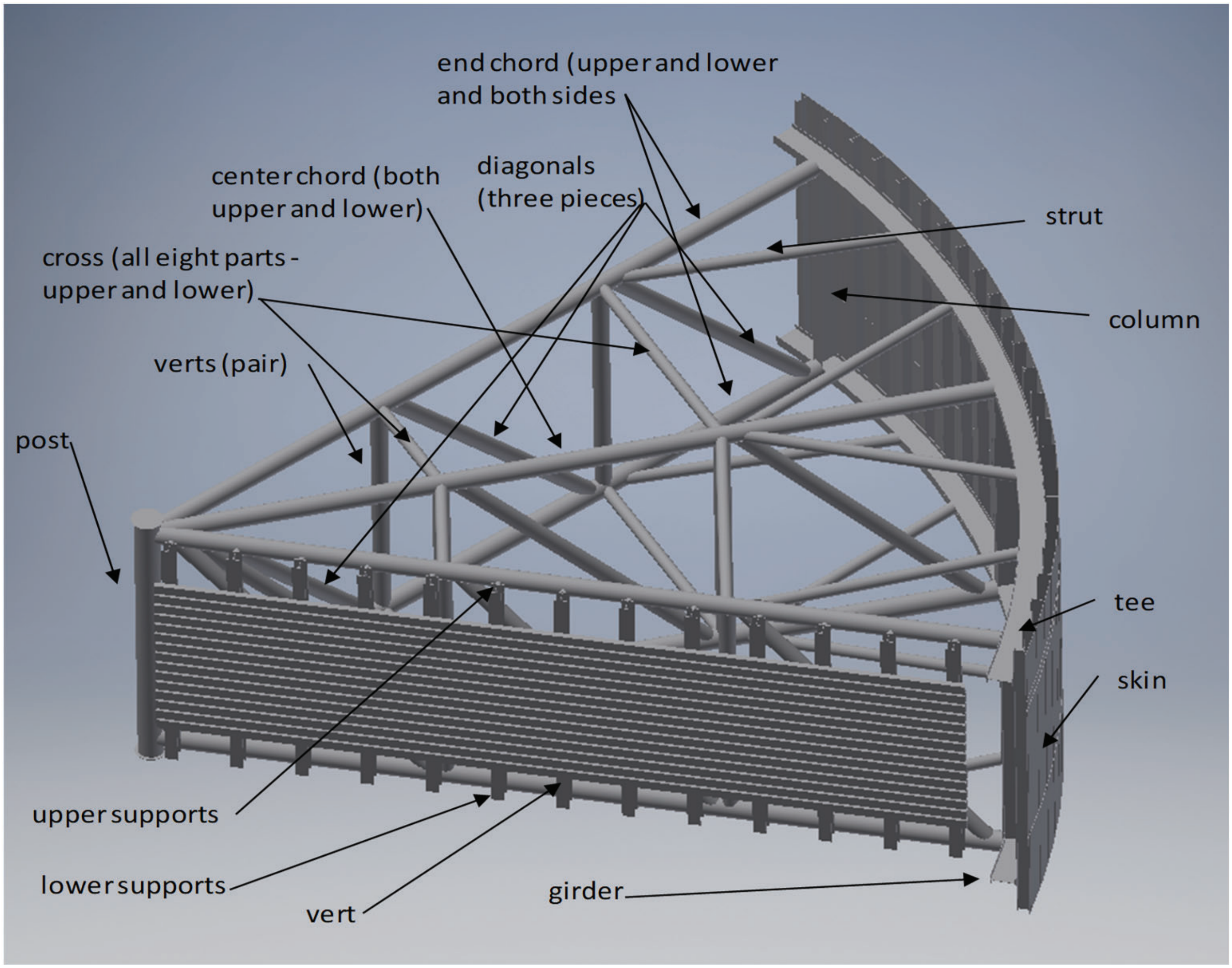
Sector Gate Steel Quantities

The sector gate quantities are taken from the solid model shown below.

The round sections are 0.5 inch wall pipe. The rest of the structure is rolled sections except for the skin plate.

The structure will be painted with a coal tar epoxy system.

Due to preliminary nature of the design, the weights have been increased to account for additional requirements such as walkways, etc.



end chord (upper and lower and both sides
center chord (both upper and lower)
diagonals (three pieces)
strut
cross (all eight parts - upper and lower)
column
verts (pair)
post
tee
skin
upper supports
lower supports
vert
girder

Quantities are taken from the solid model of the gate used for analysis.

Additional calcs are used to verify the results of some model components.
Quantities are for one gate. There are a total of two gates.

Component	Quant		Weight	Total Weight
	ea		lbs	lbs
Center Chord	1	steel	15981	15981
Post	1	steel	4049.	4049
verts	3	steel	3274.	9822
cross	1	steel	6696.	6696
diagonals	3	steel	6691.	20073
skin	1	steel	39439	39439
tee	24	steel	909.6	21830
girder	2	steel	5599.	11198
strut	8	steel	1236.	9888
column	3	steel	1612.	4836
End Chords	1	steel	28088	28088
upper support	13	steel	20.39	265.07
lower support	13	steel	18.76	243.88
vert	13	steel	1464.	19032

Total Steel Weight		191500	lbs
	Allowanc for walkways, connections, etc.	10%	
Total steel Weight		210700	lbs
		106	tons
	# gates	2	
	Total Steel	212	tons

check skin plate

height	324	in			
angle	60	deg			
	1.0472	radians			
radius	820	in			
length	858.7	inches			
thickness	0.5	inches			
vol	139110	in^2			
	80.503	ft^3			
density	490	pcf			
weight		39447 lbs			
weight from takeoff		39439	error:	0.019%	ok

The fender system is comprised of 6 x 10 reinforced UHMW ('force bar') 'timbers'.

Quantity

width	10	in
depth	6	in
area	0.4167	sq ft
length	62	ft
Density	62	pcf
Number of timbers	12	
Total Weight	19300	lbs
# gates	2	
Total Weight	38600	lbs

TETRA TECH	Dickinson Bayou Bulkhead Storage Platform Foundations Quantities	Calculation No. DB-FG-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Dickinson Bayou Bulkhead Storage Platform Foundations Quantities				
Made By:	LN	**Date:** 07/25/18	**Chk'd By:** DS	**Date:**	08/20/18

Calc Body Pages	Appended Pages	Total Pages
7	0	7

Document code

Site	Feature	Discipline	Document type	Number
DB	FG	ST	MT	002

Revision History

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A	Lexee Navarre 8/22/18	Daniel Stuard 8/22/18	

TETRA TECH	Dickinson Bayou Bulkhead Storage Platform Foundations Quantities	Calculation No. DB-FG-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	2
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	LN	**Date:** 07/25/18	**Chk'd By:** DS	**Date:**	08/20/18

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Attachments	Number of Pages	Last Page Number

TETRA TECH	Dickinson Bayou Bulkhead Storage Platform Foundations Quantities	Calculation No. DB-FG-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LN	**Date:**	07/25/18	**Chk'd By:**	DS	**Date:**	08/20/18

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for bulkhead storage platforms.

APPROACH

Typical engineering means and methods for determining volumes and weights.

REFERENCES

References used during this calculation are as follows:

1) DB-FG-ST-CL-002

RESULTS / CONCLUSIONS

Total # of Pipe Piles:	8	(All piles have tension connections)		
Total 24" Diam. X 0.5" Steel Pipe Pile:	546.0 ft	**or**	34.3	tons
Total Concrete:	105.8 yd^3			

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) Material Properties:
   - Concrete, f'c = 4000 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
2) Costs of reinforcement is included in reinforced concrete unit cost.
3) All piles have tension connections.

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

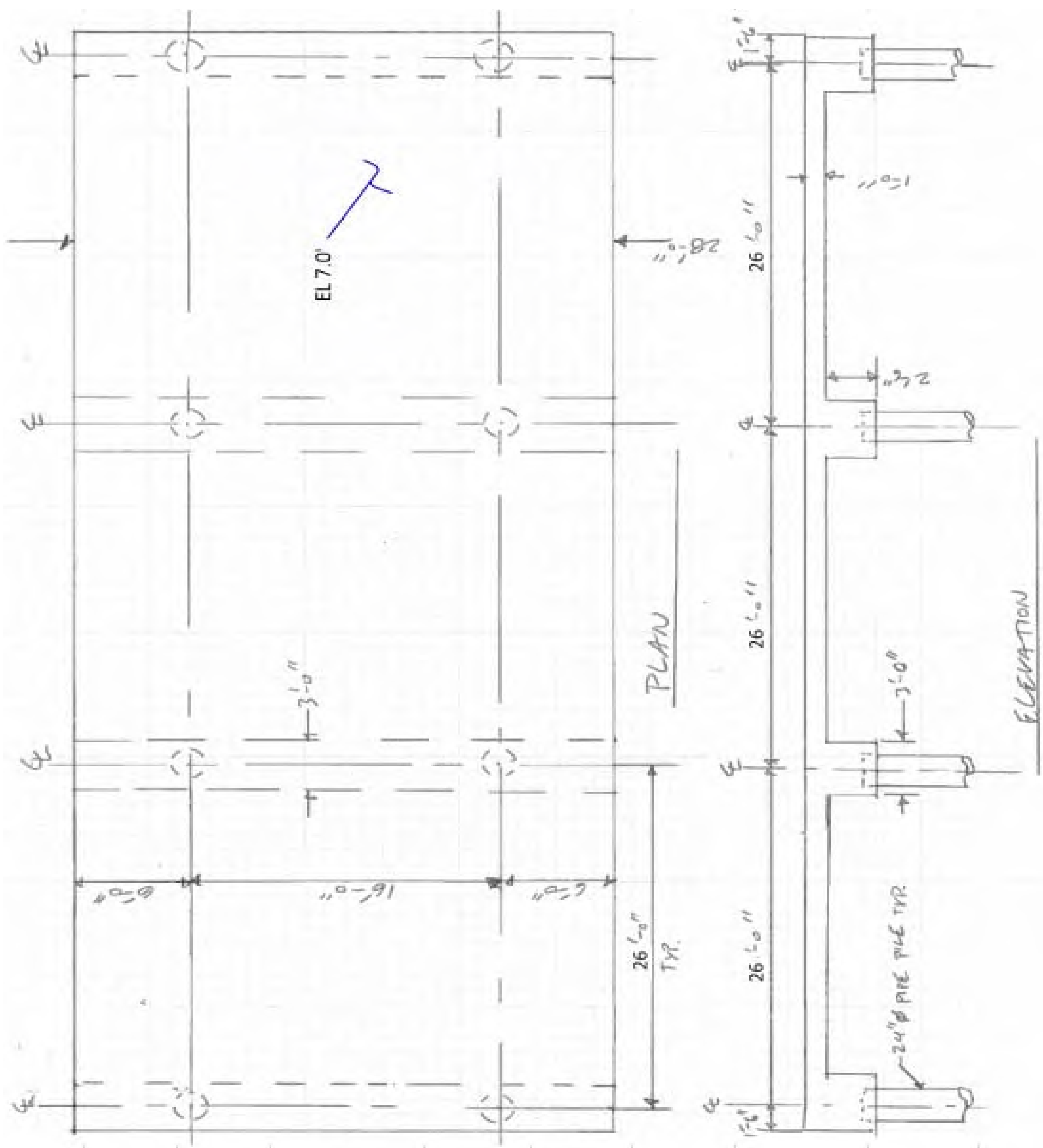
1) Materials and quantities as design progresses.

CALCULATIONS

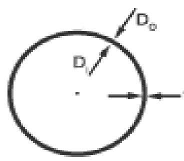
Begin on next page.

TETRA TECH	Dickinson Bayou Bulkhead Storage Platform Foundations Quantities			Calculation No. DB-FG-ST-MT-002	
Job No.:	100-RCE-18-09-1			**Page:**	5
Project:	Coastal Texas Protection and Restoration				
Description:	General References and Figures				
Made By:	LN	**Date:** 07/25/18	**Chk'd By:** DS	**Date:**	08/20/18

General References and Figures



Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = 10.69*t*(D_o-t)
D_o (in) - outside diameter
t (in) - thickness of pipe

Pipe Weight (kg/m) = 0.0247*t*(D_o-t)
D_o (mm) - outside diameter
t (mm) - thickness of pipe

PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

Quantities for Bulkhead Storage Platform

PILES

Pile Diameter:	24.0 in	**Pile Head EL:**	4.25 ft
Pipe Thickness:	0.5 in	**Pile Tip EL:**	-64.00 ft
Pipe Weight*:	125.61 lb/ft	**Pile Length:**	68.25 ft

*see general references attachments for reference of produced value

Number of Piles per Bent: 2
Number of Pile Bents: 4

Total Number of Piles:	**8**		
Total of Steel Pipe Piles:	**546.0 ft**	**or**	**34.3 tons**

CONCRETE:

DECK:

Thickness (ft)	Length (ft)	Cross Sectional Area (ft^2)	Width (ft)	Volume (yd^3)
1.0	72.0	72.0	28.0	74.7

Total Concrete for Deck: 74.7 yd^3

PILE BENTS:

Thickness (ft)	Width (ft)	Cross Sectional Area (ft^2)	Length (ft)	Volume (yd^3)
2.5	3.0	7.5	28.0	7.8

Number of Pile Bents: 4
Total Concrete for Bents: 31.1 yd^3

TOTAL CONCRETE: 105.8 yd^3

TETRA TECH	Dickinson Bayou Monolith Quantities	Calculation No. DB-FG-ST-MT-003

Job No.:	100-RCE-18-09-1			**Page:**	1
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Description:	Coversheet				
Made By:	DS	**Date:** 11/05/18	**Chk'd By:** DAS	**Date:**	11/06/18

Calc Body Pages	Appended Pages	Total Pages
16	0	16

Document code				
Site	**Feature**	**Discipline**	**Document type**	**Number**
DB	FG	ST	MT	003

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Daniel Stuard 11/06/18	Dave Stensby 11/06/18	Submitted For Review

TETRA TECH	Dickinson Bayou Monolith Quantities	Calculation No. DB-FG-ST-MT-003

Job No.:	100-RCE-18-09-1			**Page:**	2
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	DS	**Date:** 11/05/18	**Chk'd By:** DAS	**Date:**	11/06/18

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Description:				
Made By:	DS	**Date:** 11/05/18	**Chk'd By:** DAS	**Date:** 11/06/18

ISSUE BEING ADDRESSED

This is a preliminary quantity takeoff for the sector gate. It is based on limited information regarding the site conditions and the feature requirements. These quantities will be updated in more detail as future design phases progress.

APPROACH

Typical engineering means and methods for determining volumes and weights.

REFERENCES

See associated structural calculations for the gate monolith and foundation

RESULTS / CONCLUSIONS

Excavation & Fill:			
	Total Wet Excavation:	13,302	yd^3
	Total Wet Fill:	2,046	yd^3
Steel:			
	Total Steel for Sheet Piles and Shoring:	1,297	tons
	Total Steel Pipe Piles:	353	
	of which	192	are batted 3:1 (V:H) All piles have tension connections
	Total Weight of Steel Pipe Piles:	1,615	tons
	Total Steel:	2,912	tons
Tremie Concrete:			
	Total Tremie Concrete:	4,093	yd^3
Concrete:			
	Total Concrete for Fill of Steel Pipe Piles:	754	yd^3
	Total Concrete for Base Slab:	5,116	yd^3
	Total Concrete for Monolith Walls:	3,503	yd^3
	Total:	9,373	yd^4
HPU / Control Building			
	Total # of HPU / Control Buildings:	2	

TETRA TECH	Dickinson Bayou Monolith Quantities		Calculation No. DB-FG-ST-MT-003
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Description:			
Made By: DS	**Date:** 11/05/18	**Chk'd By:** DAS	**Date:** 11/06/18

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

- These quantities are based on the associated structural calculations. Due to the limited amount of site information and design requirements available, a number of significant assumptions have been made. These are shown in the associated structural design calculations.
- Excavation only consideres excavation under the plan area of the structure, other excavation is to be determined by others. This excavation will be in the wet. The material will be soft sediment and clay and may be contaminated due to presence of chemical and petroleum pipelines in the area. Disposal area unknown.
- Fill and tremie to be placed within the closed cofferbox, in the wet.
- Structural Elevations:

Top of Structure:	18.0	ft	Pile Head:	-13.25	ft
Top of Base Slab / Sill:	-9.0	ft	Pile Tip:	-84.0	ft
Top of Tremie Slab:	-14.0	ft			
Top of Fill:	-18.0	ft			

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Water elevations and load cases to be evaluated.
2) Final geotechnical information and recommendations
3) Detailed design of gate and monolith.
4) Pile type, size and layout.
5) Pile load testing program.
6) Deflection criterial of HSDRRS is met
7) Access requirements

CALCULATIONS

See Next Page

GENERAL REFERENCES

Location of Dickenson pump station and sector gates

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Location of existing underground pipelines at sector gate site.
We are directed to proceed as existing utilities will be removed by others.

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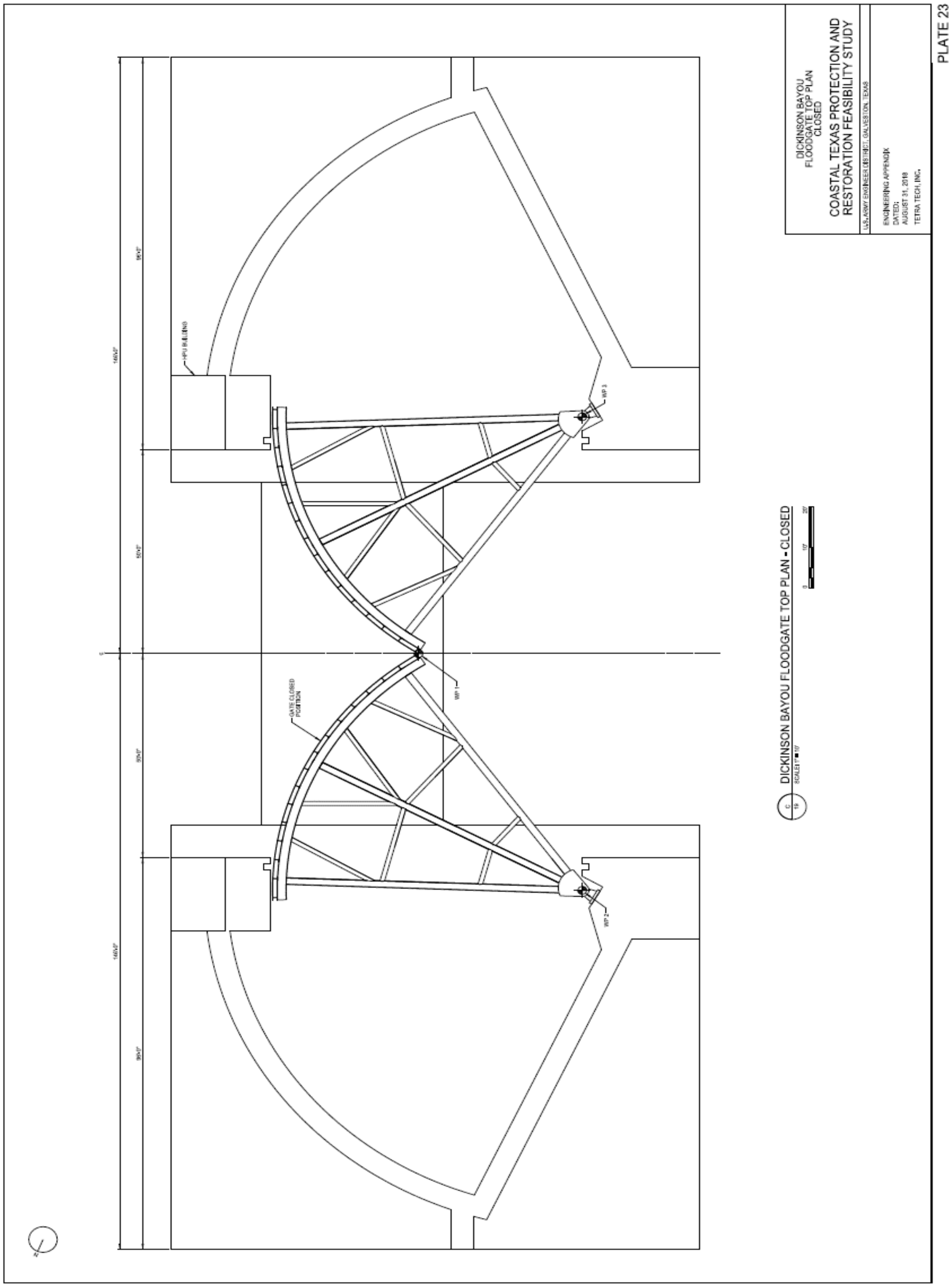
Description:	GENERAL REFERENCES					
Made By:	DS	**Date:**	11/05/18	**Chk'd By:** DAS	**Date:**	11/06/18



TETRA TECH	**Dickinson Bayou Monolith Quantities**			**Calculation No.** **DB-FG-ST-MT-003**
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Description:	GENERAL REFERENCES			
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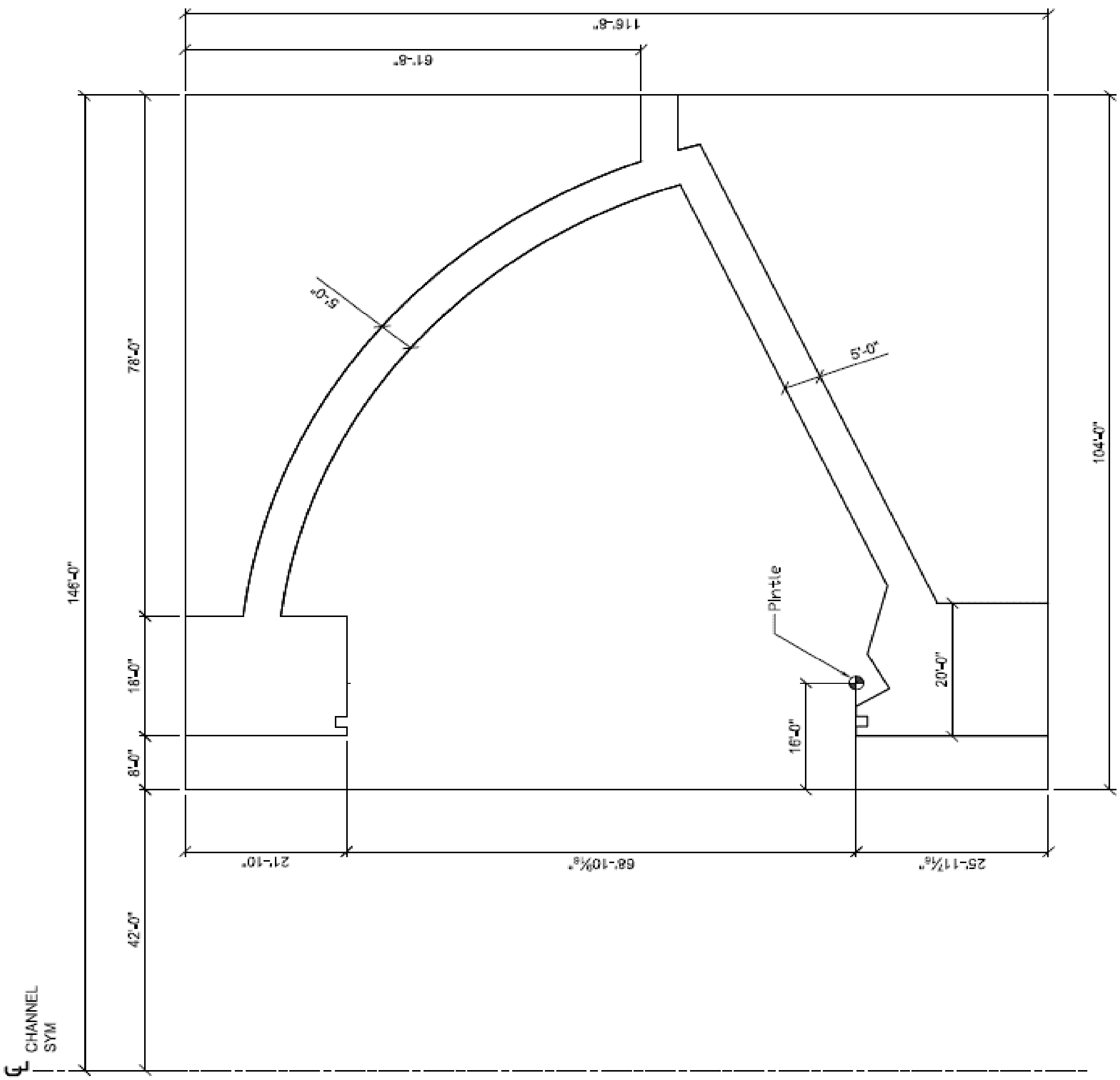

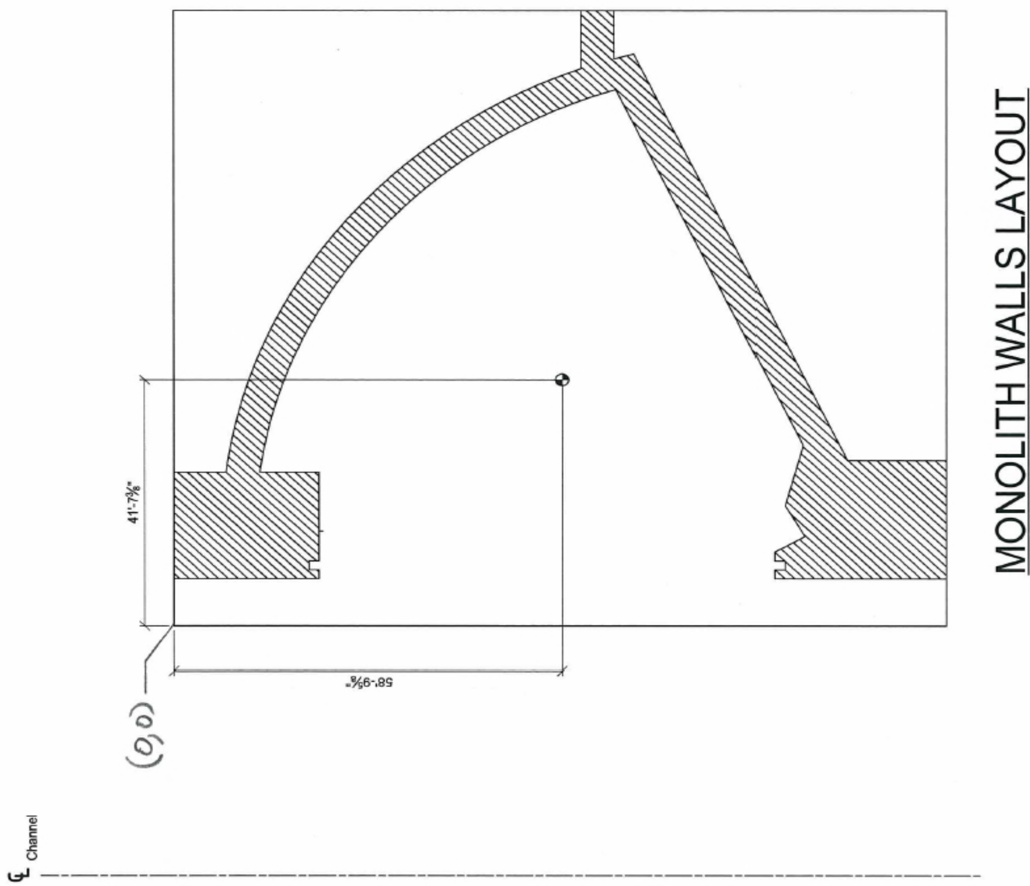

Note figure above is used only for Wall area

```
Walls.mpr - Notepad
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----------------  REGIONS  ----------------

Area:                    252211.30880 sq in
Perimeter:               6195.08869 in
Bounding box:         X: 96.00000  --  1248.00000 in
                      Y: -1400.00000  --  0.00000 in
Centroid:             X: 499.36429 in
                      Y: -705.65002 in
Moments of inertia:   X: 1.80887E+11 sq in sq in
                      Y: 9.22498E+10 sq in sq in
Product of inertia:  XY: 8.73366E+10 sq in sq in
Radii of gyration:    X: 846.87921 in
                      Y: 604.78427 in
Principal moments (sq in sq in) and X-Y directions about centroid:
                      I: 5.53912E+10 along [0.99826 -0.05893]
                      J: 2.92665E+10 along [0.05893 0.99826]
```

$A = 252211/144 = \underline{1751.5\ ft^2}$

$\bar{X} = 705.7/12 = \underline{58.8\ ft}$

$\bar{Y} = 499.4/12 = \underline{41.6\ ft}$

TETRA TECH	Dickinson Bayou Monolith Quantities	Calculation No. DB-FG-ST-MT-003

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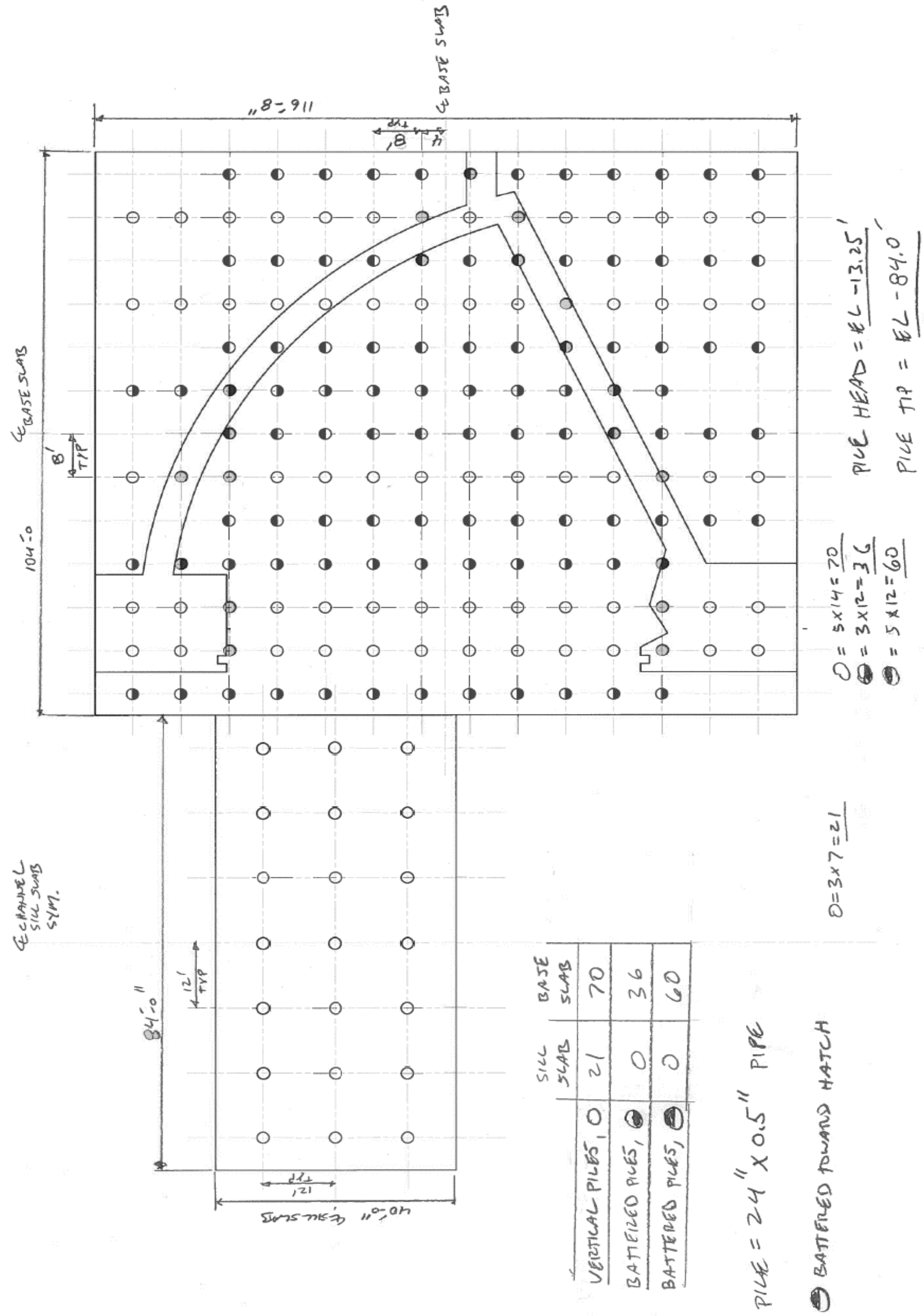
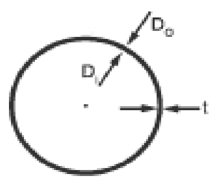


Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = 10.69*t*(D_o-t)
D_o (in) - outside diameter
t (in) - thickness of pipe

Pipe Weight (kg/m) = 0.0247*t*(D_o-t)
D_o (mm) - outside diameter
t (mm) - thickness of pipe

PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42	111.58	139.04	166.86	194.60	221.82	248.95	276.44	303.84	330.72	384.67	438.29	544.52	597.14	

TETRA TECH	Dickinson Bayou Monolith Quantities	Calculation No. DB-FG-ST-MT-003

Job No.:	100-RCE-18-09-1			**Page:**	12
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Description:	Sector Gate Monolith Quantities				
Made By:	DAS	**Date:** 11/05/18	**Chk'd By:** DAS	**Date:**	11/06/18

Sector Gate Monolith Quantities

EXCAVATION

- This excavation only consideres excavation under the plan area of the structure, other excavation is to be determined by others.
- This excavation will be in the wet. The material will be soft sediment and clay and may be contaminated due to presence of chemical and petroleum pipelines in the area.
- Disposal area unknown.
- Fill and Tremie to be placed within the closed cofferbox

Assumed Mud Line Elevation:	-7.0	ft
Elevation of Bottom of Tremie Slab:	-18.0	ft
Assumed Over Excavation:	2.0	ft
Depth of Excavation:	13.0	ft

Monolith Base Slab

Width:	104.00	ft
Length:	116.67	ft
Area:	12,133	ft^2
Excavation Volume / Monolith:	157,733	ft^3
# of Monoliths:	2	
Total Monolth Excavation:	315,467	ft^3

Sill Slab

Width:	84.00	ft
Length:	40.00	ft
Area:	3,360	ft^2
Excavation Volume:	43,680	ft^3

Volume of Excavation: 359,147 ft^3

Total Wet Excavation:	**13302 yd^3**

Fill

- Fill to be placed in the wet

Assumed Fill Depth: ed Fill Depth: 2 ft

Monolith Base Slab

Area:	12,133	ft^2 (See above)
Fill Volume / Monolith:	24,267	ft^3
# of Monoliths:	2	
Total Monolth Excavation:	48,533	ft^3

Sill Slab

Area:	3,360	ft^2
Fill Volume:	6,720	ft^3

Volume of Fill: 55,253 ft^3

Total Wet Fill:	**2046 yd^3**

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Description:	Sector Gate Monolith Quantities				
Made By:	DAS	**Date:** 11/05/18	**Chk'd By:** DAS	**Date:**	11/06/18

SHEET PILE COFFER BOX

Assumed Top of Sheet Pile Elevation:	10	ft	
Assumed Bottom of Sheet Pile Elevation:	-58	ft	(40ft below tremie slab)
Height of Sheet Pile:	68	ft	
Assumed Weight of Sheet Pile:	27	psf	
Assumed Weight of Sheet Pile:	1,836	lb/ft	

Monolith Base Slab

Width:	104.00	ft
Length:	116.67	ft
Perimeter:	441.3	ft
Sheet Pile Weight per Monolith:	810,288	lbs
# of Monoliths:	2	
Total Weight for Monolths:	1,620,576	lbs
	810.3	Tons

Sill Slab

Width:	84.00	ft
Length:	40.00	ft
Perimeter:	248	ft
Sheet Pile Weight:	455,328	lbs
	227.7	Tons

Total Weight of Sheet Pile:	**1,038**	**tons**
Assumed Percent for Shoring:	25%	
Total Steel Weight for Shoring:	**259**	**tons**

Total Steel for Sheet Piles and Shoring: 1,297 tons

Dewatering: **Lump Sum**

STEEL PIPE PILES

Pile: 24"x0.5" Steel Pipe Pile
Pile Weight: 125.6 lbs/ft (See Reference)

Top of Pile Elevation: -13.25 ft
Bottom of Sheet Pile Elevation: -84 ft
Vertical Pile Length: 70.75 ft

Batter: 3 :1 (V:H)
θ: 18.4 degrees
Battered Pile Length: 74.58 ft

Monolith Piles

	# of Piles	L / Pile ft	Total L ft
Vert. Piles	70	70.75	4,952.5
+Batt. Piles	36	74.58	2,684.8
-Batt Piles	60	74.58	4,474.6
Total:	**166**		**12,111.9**

Sill Slab Piles

	# of Piles	L / Pile ft	Total L ft
Vert. Piles	21	70.75	1,485.8

# of Monoliths: 2
Total # of Monolith Piles: 332
Monolith Piles Total Length: 24,224 ft

Total # of Batterd Piles: 192
Total # of Piles: 353 (All piles have tension connections)
Total Length of Piles: 25,710 ft
Pile Weight: 125.6 lbs/ft
Weight of Piles: 3,229,119 lbs

Total # of Piles:	**353**
Total Weight of Piles:	**1,615 tons**

FILL FOR PILE TOPS:

CONCRETE:

The preparation of the pile tops will be to fill the tops of the piles with concrete.

Pile Diameter: 24 in
Wall thickness: 0.5 in
Interior Pile Area: 415 in^2
2.9 ft^2
Length of Concrete Fill: 20 ft (assumed)
Volume of Concrete Fill: 57.7 ft^3
Total Number of Piles: 353 (see steel piles section)
Total Volume of Concrete: 20,370 ft^3

Total Fill Concrete:	**754 yd^3**

TETRA TECH	Dickinson Bayou Monolith Quantities	Calculation No. DB-FG-ST-MT-003

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Description:	Sector Gate Monolith Quantities						
Made By:	DAS	**Date:**	11/05/18	**Chk'd By:**	DAS	**Date:**	11/06/18

TREMIE SLAB CONCRETE

Assumed Tremie Thickness: 4.0 ft

Monolith Base Slab			Sill Slab		
Width:	104.00	ft	Width:	84.00	ft
Length:	116.67	ft	Length:	40.00	ft
Area:	12,133	ft^2	Area:	3,360	ft^2
Tremie Slab Volume:	48,533	ft^3	Tremie Slab Volume:	13,440	ft^3
# of Monoliths:	2				
Total Monolth Tremie Slab:	97066.667	ft^3			

Total Volume of Tremie Slab: 110507 ft^3

Total Tremie Concrete: 4093 yd^3

BASE SLAB CONCRETE

Top of Monolith Elevation: -9.0 ft
Top of Base Slab Elevation: -14.0 ft
Hight of Walls: 5.0 ft

Monolith Base Slab			Sill Slab		
Area:	12,133	ft^2 See above	Area:	3,360	ft^2
Base Slab Volume:	60,667	ft^3	Base Slab Volume:	16,800	ft^3
# of Monoliths:	2				
Total Monolth Tremie Slab:	121,333	ft^3			

Total Volume of Tremie Slab: 138,133 ft^3

Total Base Slab Concrete: 5116 yd^3

MONOLITH WALLS & THRUST BLOCK CONCRETE

Top of Monolith Elevation:	18.0	ft			
Top of Base Slab Elevation:	-9.0	ft	Plan Area of Walls:	1751.5	ft^2
Hight of Walls:	27.0	ft	Volume of Walls:	47,291	ft^3

# of Monoliths: 2
Total Volume: 94,581.0 ft^3

Total Monolith Wall and Thrust Block Concrete: 3,503 yd^3

HPU / CONTROL BUILDING

HPU building is to be a prefabricated 18ftx12ft building

# of Monoliths: 2

HPU / Control Buildings:	**2**

TETRA TECH

Dickinson Bayou Sector Gate Bulkhead Quantities

Calculation No. DB-FG-ST-MT-004

Job No.:	100-RCE-18-09-1	**Page:**	1
Project:	Coastal Texas Protection and Restoration		
Description:	Coversheet		
Made By: DS	**Date:** 11/06/18	**Chk'd By:** DAS	**Date:** 11/07/18

Calc Body Pages	Appended Pages	Total Pages
7	0	7

Document code

Site	Feature	Discipline	Document type	Number
DB	FG	ST	MT	004

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Daniel Stuard 11/07/18	Dave Stensby 11/07/18 for Dave Stensby	SUBMITTED FOR REVIEW

TETRA TECH	Clear Creek Sector Gate Quantity Calculations			Calculation No. DB-FG-ST-MT-004
Job No.:	100-RCE-18-09-1		**Page:**	2
Project:	Coastal Texas Protection and Restoration			
Description:				
Made By: DS	**Date:** 11/06/18	**Chk'd By:**	**Date:**	11/07/18

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Attachments	Number of Pages	Last Page Number

TETRA TECH	**Clear Creek Sector Gate Quantity Calculations**	**Calculation No. DB-FG-ST-MT-004**

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	DS	**Date:**	11/06/18	**Chk'd By:**		**Date:**	11/07/18

ISSUE BEING ADDRESSED

This is a preliminary quantity takeoff for the sector gate bulkheads. The gate and monolith design are based on limited information regarding the site conditions and the feature requirements. These quantities will be updated in more detail as future design phases progress.

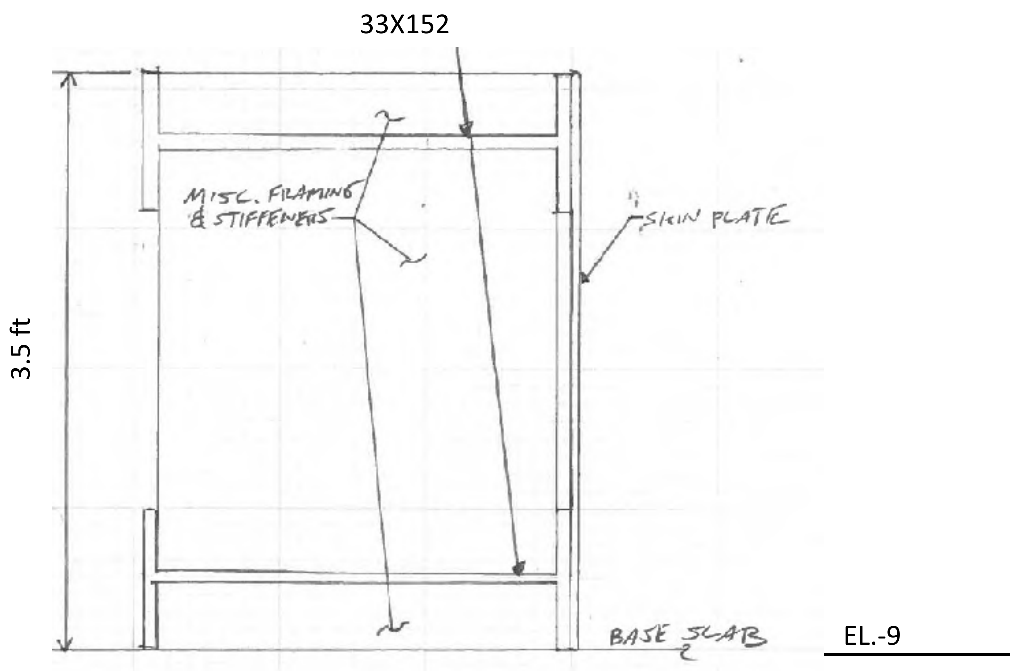
APPROACH

The bulkhead quantiles are estimated by assuming that the main members of the bulkheads are wide flange members with a 0.5" skin plate. Miscellaneous framing and stiffener weights are assumed as a percentage of the skin plate weight. The size and spacing of the main members are determined using typical engineering means and methods to determine demands and capacities.

REFERENCES

1) HSDRRS-DG with Revisions through June 2012
2) AISC 9th Edition

RESULTS / CONCLUSIONS



Bulkhead Weight:	14.4	tons each
Number of Bulkheads:	4	
Total Bulkhead Steel Weight:	57.6	tons

ASSUMPTIONS / INPUTS

TETRA TECH	Clear Creek Sector Gate Quantity Calculations		Calculation No. DB-FG-ST-MT-004
Job No.:	100-RCE-18-09-1	**Page:**	4
Project:	Coastal Texas Protection and Restoration		
Description:			
Made By: DS	**Date:** 11/06/18	**Chk'd By:**	**Date:** 11/07/18

Assumptions made during this calculation are as follows:

- Design water elevation the maintenance case is : 5.00
- Apply 50% of the skin plate weight to account for misc. framing and stiffeners.
- Skin plate thickness of 0.5"
- Fy=50 ksi

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Water elevations and load cases to be evaluated.
2) Consistent with Detailed design of gate and monolith.
3) Bulkhead Design.

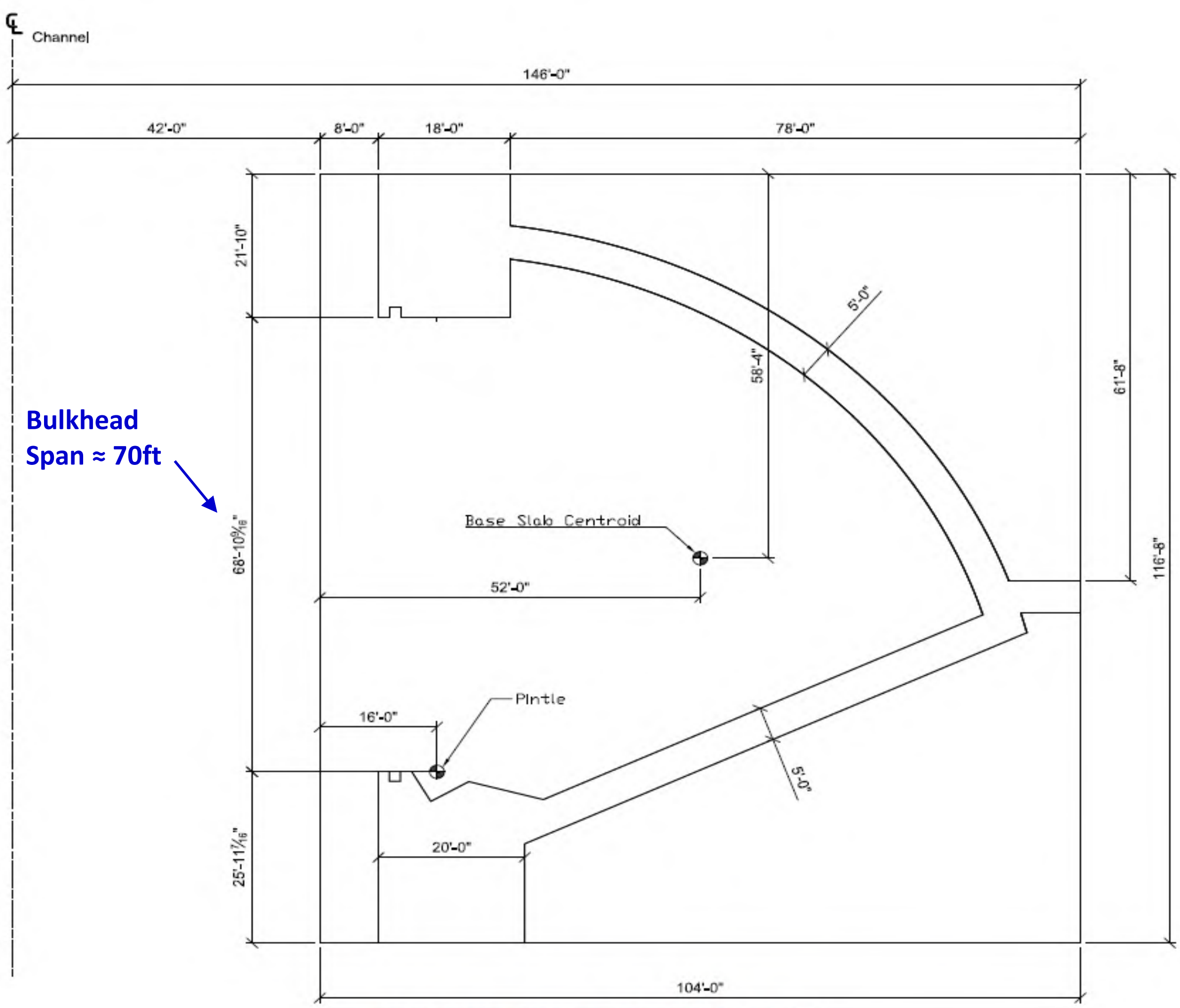
CALCULATIONS

See next page

TETRA TECH	**Dickinson Bayou Sector Gate Bulkhead Quantities**	**Calculation No. DB-FG-ST-MT-004**

Job No.:	100-RCE-18-09-1					**Page:**	5
Project:	Coastal Texas Protection and Restoration						
Description:	Base Slab Layout						
Made By:	DAS	**Date:**	11/06/18	**Chk'd By:**	DAS	**Date:**	11/07/18

Base Slab Layout



BASE SLAB LAYOUT

Job No.:	100-RCE-18-09-1			**Page:**	6
Project:	Coastal Texas Protection and Restoration				
Description:	Bulkhead Quantities				
Made By:	DAS	**Date:** 11/06/18	**Chk'd By:** DAS	**Date:**	11/07/18

Bulkhead Quantities

Bulkheads will be necessary to perform maintenance on the sector gates. The bulkheads will extend from the sill at -12 feet to El 5.0. Only one set of bulkheads will be provided, and can be used at either monolith.

GIRDERS:

Bulkhead Span: 70.0 feet

Sill EL.: -9.00 ft

WS EL.: 5.00 ft

Depth: 14 ft

Water Density: 64.0 pcf

Bottom Pressure: 896 psf

Number of Bulkheads: 4

Height of Each Bulkhead: 3.50

Number of Girders per Bulkhead: 2

Girder Tributary Width: 1.75 ft

Girder Load, w: 1568 plf
1.57 klf

Simple Span Moment: 960 kip ft   wl^2 / 8
11525 kip in

fy: 50.0 ksi

fb: 27.5 ksi

(fb=0.66*fy*5/6 =AISC 9th Ed. with 5/6 reduction per HSDRRS)

S Required: **419** in^3

USE: 33X152

Web Depth:	29.625 in	Depth:	33.5 in	Sx:	487 in^3
Web Thickness:	0.635 in	Width:	11.6 in	Ix:	8160 in^4
Flange Thickness:	1.06 in				

END CONNECTION:

Tibutary Length, L/2:	35.00	ft			
V:	54.9	kips			
fy:	50.0	ksi			
fv:	16.67	ksi	(fv=0.4*fy*5/6 =AISC 9th Ed. with 5/6 reduction per HSDRRS)		
Area Required:	3.3	in^2			
Depth of Web:	12.0	in (Cope end of Bulkhead)			
Thickness Required:	0.27	in	<	0.635 in	**OK**

DEFLECTION:

5/384*w*l^4/(E*I)

	I:	8160	in^4	(W36x150)
	E:	29000	ksi	
	Delta:	3.58	in	
L/x	x:	235	in	**OK**

STEEL

Girders:

Weight:	152	plf
Length:	70.0	ft
Total Weight per Girder:	10640	lb
Number of Girders per Bulkhead:	2	
Total Weight of Girders:	21280	lb

Skin Plate:

Thickness:	0.5	in
Height:	3.50	ft
Length:	70	ft
Weight:	20.4	psf
Area:	245	ft^2
Total Weight per Skin Plate:	5002	lb
Number of Skin Plates per Bulkhead:	1	
Total Weight of Skin Plate:	5002	lb
Additional Miscellaneous Framing per Bulkhead:	50%	of Skin Plate Weight
Weight of Misc. Framing:	2501	lb
Total Steel Weight per Bulkhead:	28783	lbs
	14.4	tons
Number of Bulkheads:	4	
Total Steel Weight:	**57.6**	**tons**

TETRA TECH	Dickinson Bayou Sector gate Quantities	Calculation No. DB-FG-ME-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Dickinson Bayou Sector gate Quantities				
Made By:	CTG	**Date:** 11/06/18	**Chk'd By:**		**Date:**

Calc Body Pages	Appended Pages	Total Pages
4	0	4

Document code

Site	Feature	Discipline	Document type	Number
DB	FG	ME	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Carl Grompe 11/8/18 Cgrompe	Eric Flickinger 11/12/18 [signature]	

TETRA TECH	Dickinson Bayou Sector gate Quantities	Calculation No. DB-FG-ME-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:	Dickinson Bayou Sector gate Quantities						
Made By:	CTG	**Date:**	11/06/18	**Chk'd By:**	EOF	**Date:**	11/08/18

TABLE OF CONTENTS

Attachments	Number of Pages	Last Page Number
N/A	-	-

ISSUE BEING ADDRESSED

Mechanical equipment quantity take-offs for preliminary cost estimate of Sector gate at Dickinson Bayou.

APPROACH

Listed components are for 1 side only unless otherwise noted. Total of 2 sides

REFERENCES

References used during this calculation are as follows:

1) Mechanical drawings by Tetra Tech
2)

RESULTS / CONCLUSIONS

See calculation sections

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1)

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Design of hinge and pintle. Capacity of mechanical operator

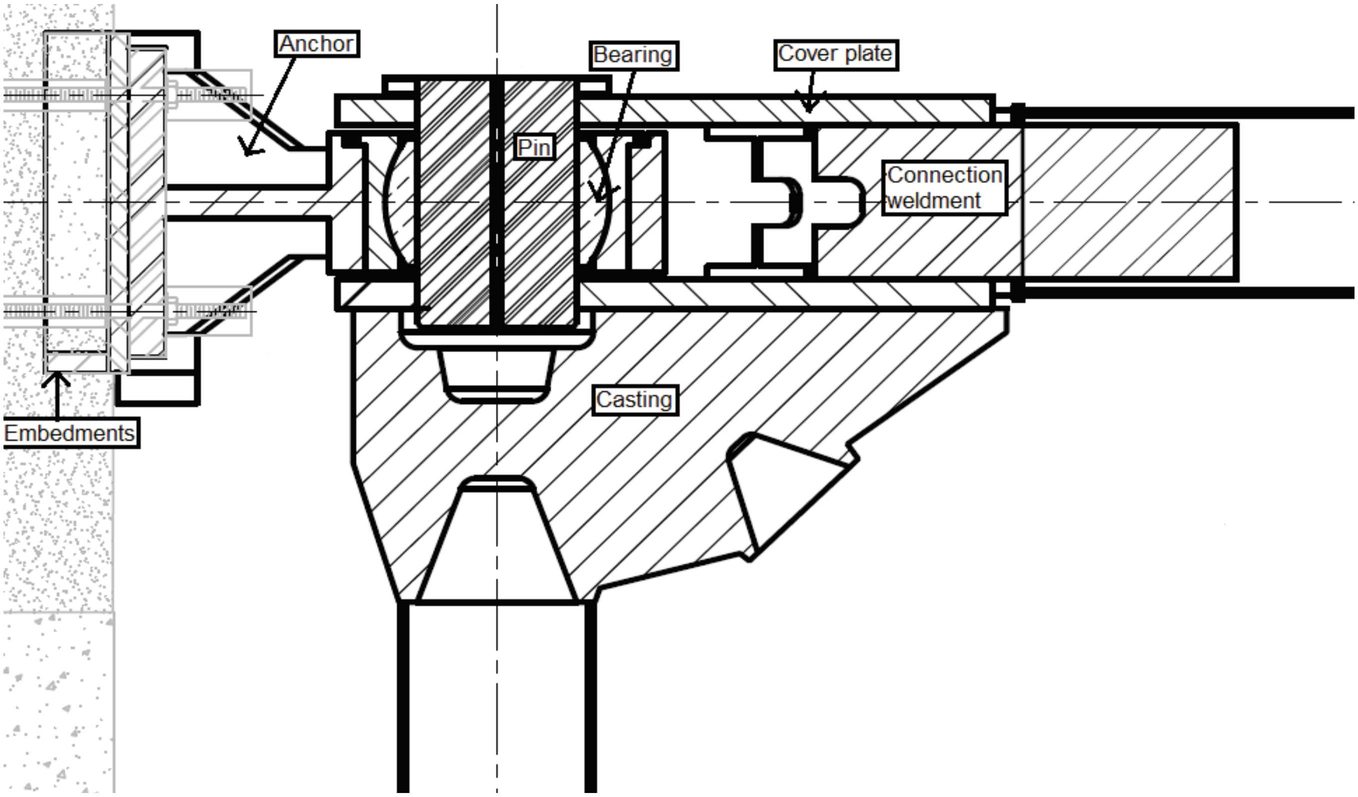
	Dickinson Bayou Sector gate Quantities	Calculation No. DB-FG-ME-MT-001

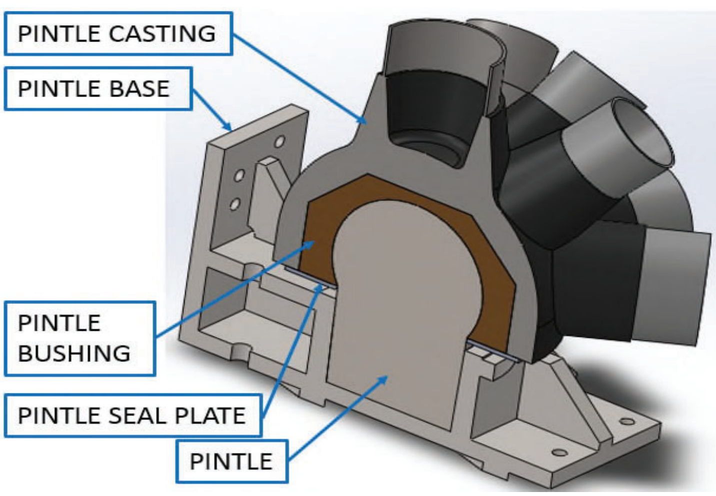
Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:	Dickinson Bayou Sector gate Quantities						
Made By:	CTG	**Date:**	11/06/18	**Chk'd By:**	EOF	**Date:**	11/08/18

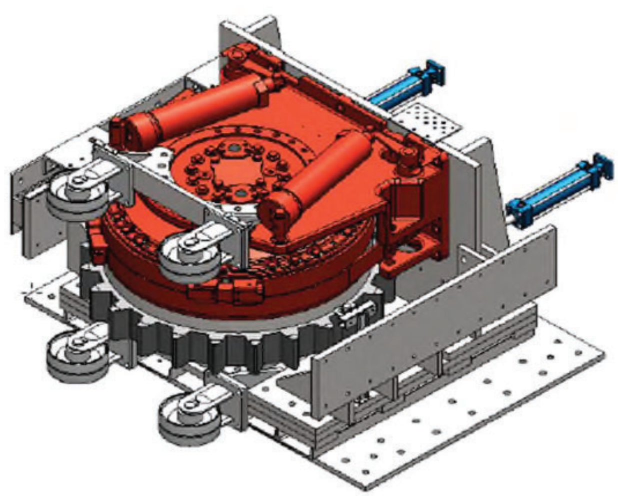
CALCULATIONS

All quantities are for 1 side only. Total of 2 sides

Item	Sub-item	Description	qty
Hinge		See DB-FG-ME-CL-001	
	Embedments	Permanantly installed in monolith	1
	Anchor weldment	Connects to embedments and contains bearing	1
	Casting	Forms connection to kingpost and diagonal members	1
	Connection weldment	Connects to each gate truss member	3
	Bearing	Spherical type	1
	Pin	Restrains bearing	1
	Keeper plate	Locks pin rotation	2
	Cover plate	Vertically constrains bearing	2
	Hardware		
Pintle		See DB-FG-ME-CL-011	
	Base	Connects to embedded anchors, contains pintle	1
	Pintle	Main bearing surface	1
	Bushing	Mating bearing surface, self lubricating	1
	Casting	Connects to kingpost and truss members	1
Operator		See DB-FG-ME-CL-021	
	Hydraulic motor	Bosch Rexroth Haaglunds w/ brake	1
	Movable skid	w/ hydraulic cylinder actuation	1
	HPU		1
	Pinion	Mounted to hydaulic motor, tranfers load to rack	1
	Rack	Mounted to skin plate, recieves operating load from pinion	1


Anchor
Bearing
Cover plate
Pin
Connection weldment
Casting
Embedments


PINTLE CASTING
PINTLE BASE
PINTLE BUSHING
PINTLE SEAL PLATE
PINTLE



TETRA TECH	Pump Station Quantities	Calculation No. DB-PS-ME-MT-001

Job No.:	100-RCE-18-09-1	**Page:**	1
Project:	Coastal Texas Protection and Restoration		
Description:	Pump Station Quantities		
Made By:	CTG **Date:** 08/30/18	**Chk'd By:**	**Date:**

Calc Body Pages	Appended Pages	Total Pages
3	4	7

Document code

Site	Feature	Discipline	Document type	Number
DB	PS	ME	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Carl Gronger 11/8/18 Cgronger	Eric Flickinger 11/8/18 [signature]	

DB-PS-ME-MT-001 Pump station quantities Cover

TETRA TECH	Pump Station Quantities	Calculation No. DB-PS-ME-MT-001

Job No.: 100-RCE-18-09-1 **Page:** 2
Project: Coastal Texas Protection and Restoration
Description: Pump Station Quantities
Made By: CTG **Date:** 08/30/18 **Chk'd By:** EOF **Date:** 11/08/18

TABLE OF CONTENTS

ISSUE BEING ADDRESSED

Mechanical equipment quantity take-offs for preliminary cost estimate for Pump Station at Dickenson Bayou.

APPROACH

Equipment falls into 2 categories, sets of equipment in every bay, and equipment unrelated to the number of bays

REFERENCES

References used during this calculation are as follows:

1) Mechanical drawings by Tetra Tech
2) WCC cross section
3) Patterson pump drawings from PCCP

RESULTS / CONCLUSIONS

See calculation sections

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) 5 days fuel storage

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1)

Pump Station Quantities

TETRA TECH

Calculation No. DB-PS-ME-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:	Pump Station Quantities						
Made By:	CTG	**Date:**	08/30/18	**Chk'd By:**	EOF	**Date:**	11/08/18

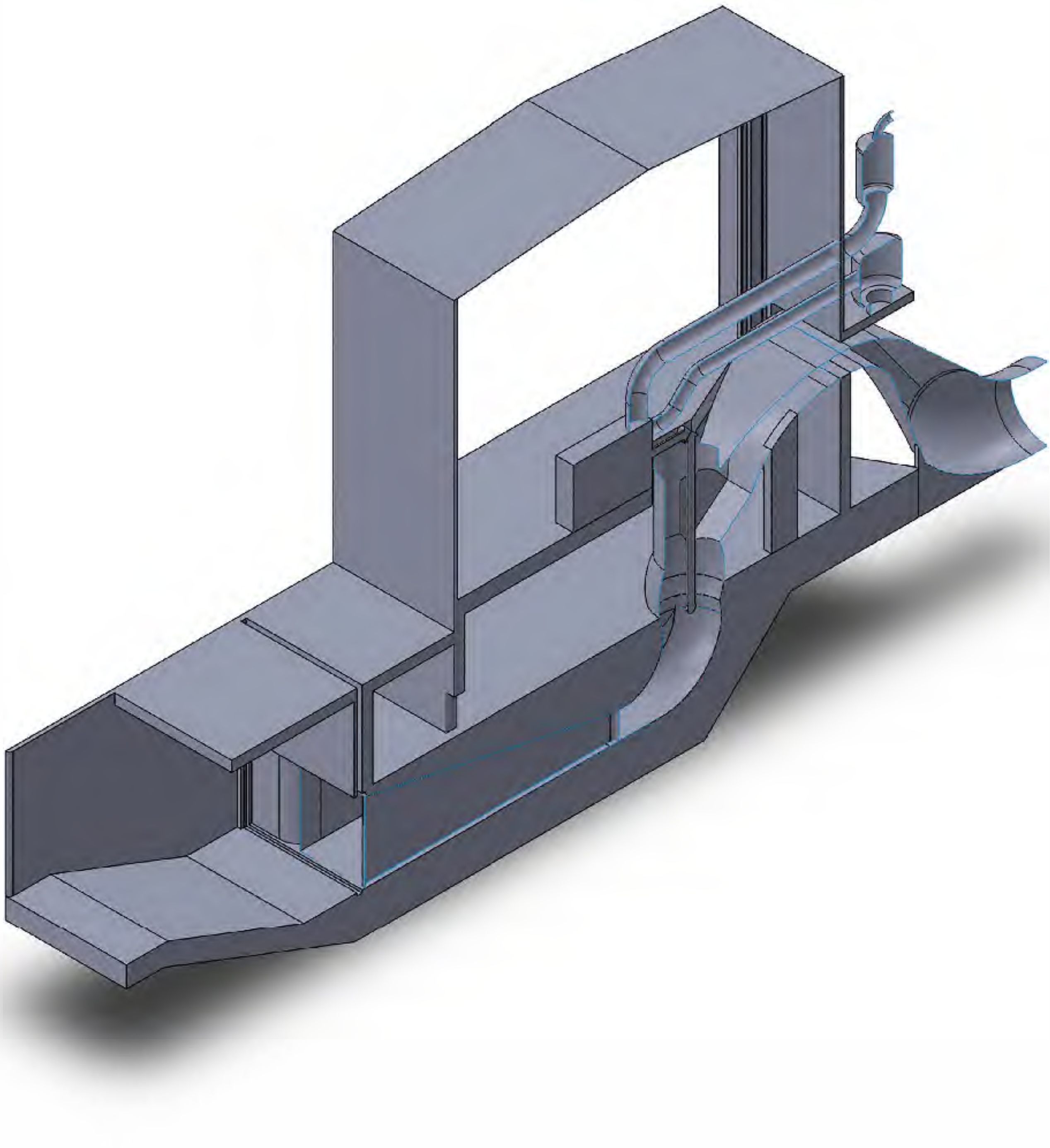
CALCULATIONS

Equipment in every bay

Number of Bays	13	
Trash rack	557	ft^2
Trash rake (climbing style)	1	
Formed suction intake (type 10 for Ø129")	1	
Vertical Pump (1500 cfs)	1	
Custom discharge piping	1	
Vacuume break	1	
hdpe discharge piping (Ø14', average length)	1315.9	ft
Angle gearbox/speed reducer	1	
Diesel engine (CAT 280-12-MC Marine)	1	
Cooling water supply lines (Ø 8")	131	ft
Cooling water pump	1	
Exhaust line	57	ft
Exhaust muffler	1	
Air intake line	42	ft
Air intake filter/silencer	1	
Day Tank (2000 gal)	1	
Double walled fuel pipe (Ø2" w/leak detection)	120	ft
Ventilation fan	1	

Other equipment

Sump stop log	695	ft^2
Stop log hoist	1	
Diesel Storage tanks (50,000 gal)	8	
Main fuel pumps	16	
Double walled fuel pipe (Ø4" w/leak detection)	1114	ft
Double walled fuel pipe (Ø6" w/leak detection)	600	ft
Fuel conditioning (filter type or centrifuge type)	1	
Air Compressor	4	
Lube oil tank	7	
Bridge crane (capacity 75 tons)	1	
Trash conveyor	637.5	ft
Fire protection system	1	

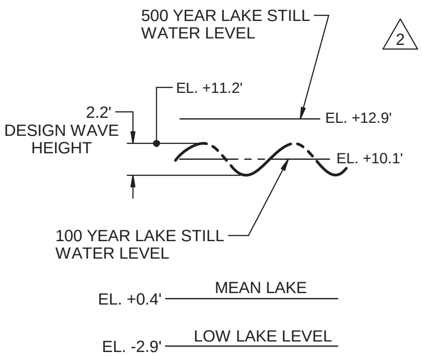


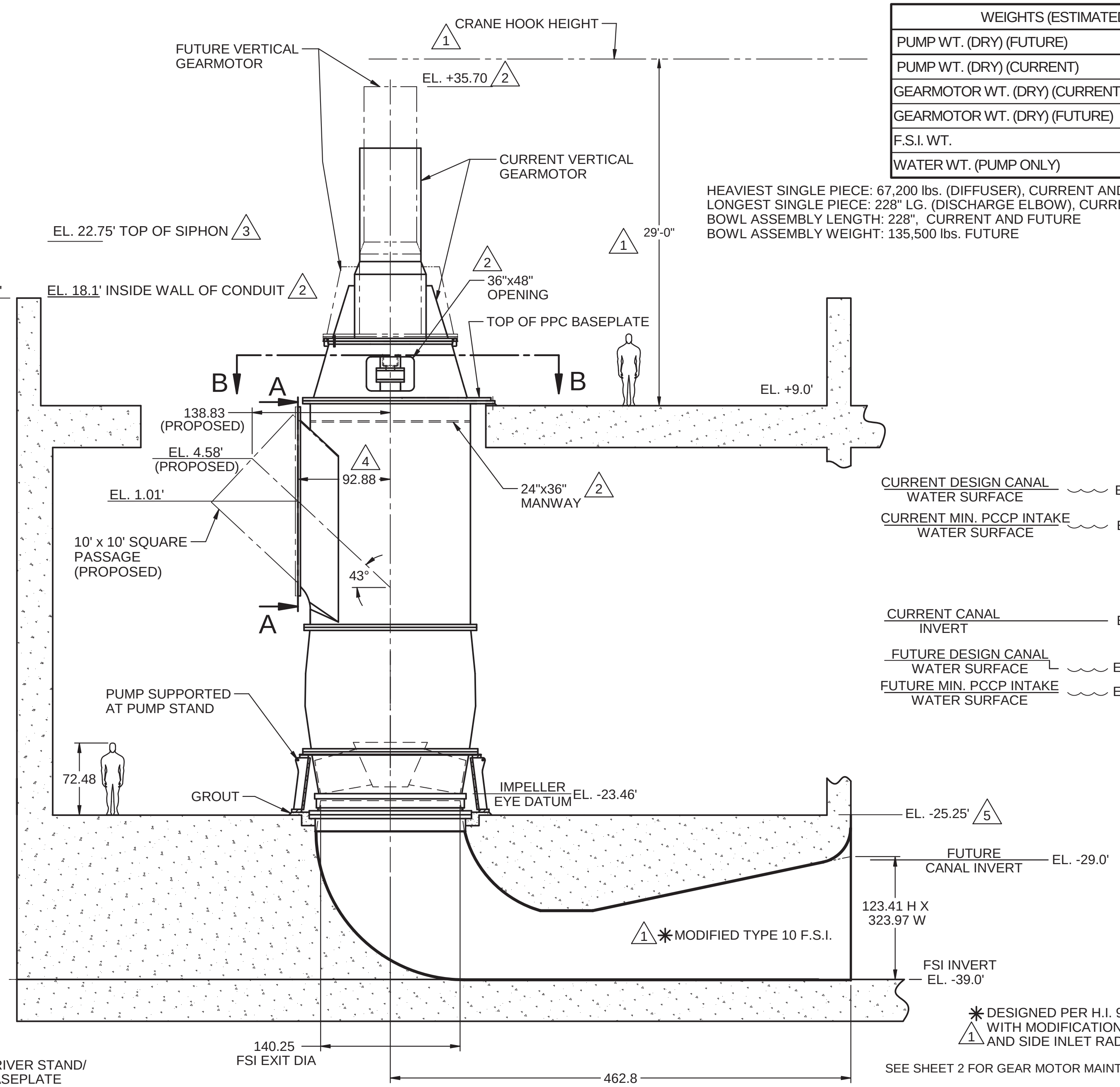
PRELIMINARY

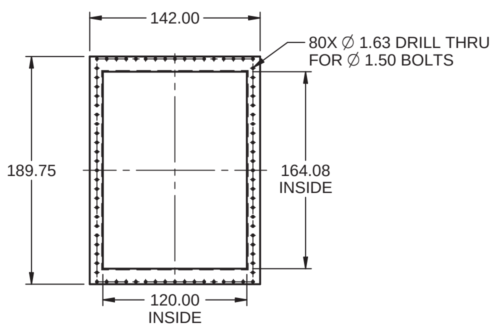
PERMANENT CANAL CLOSURE
AND PUMPING
HURRICANE PROTECTION PROJECT
W912P8-12-C-0049
LONDON AVENUE

WEIGHTS (ESTIMATED)	
PUMP WT. (DRY) (FUTURE)	295,000 lbs
PUMP WT. (DRY) (CURRENT)	270,935 lbs
GEARMOTOR WT. (DRY) (CURRENT)	95,000 lbs
GEARMOTOR WT. (DRY) (FUTURE)	162,000 lbs
F.S.I. WT.	136,560 lbs
WATER WT. (PUMP ONLY)	275,000 lbs

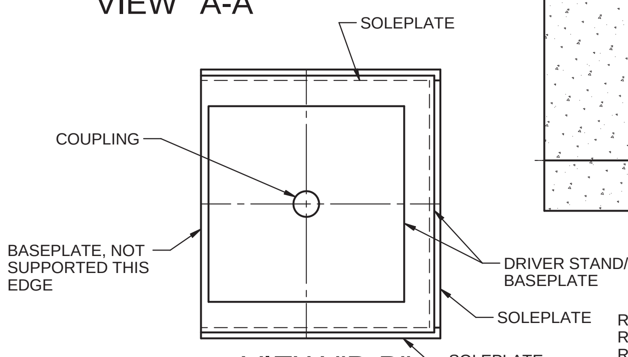
HEAVIEST SINGLE PIECE: 67,200 lbs. (DIFFUSER), CURRENT AND FUTURE
LONGEST SINGLE PIECE: 228" LG. (DISCHARGE ELBOW), CURRENT AND FUTURE
BOWL ASSEMBLY LENGTH: 228", CURRENT AND FUTURE
BOWL ASSEMBLY WEIGHT: 135,500 lbs. FUTURE







VIEW "A-A"



VIEW "B-B"

NOTE:
SOLEPLATE IS ONLY ON 3 SIDES OF OPENING

✱ DESIGNED PER H.I. 9.8-1998 EDITION WITH MODIFICATION TO THE ROOF AND SIDE INLET RADII.

SEE SHEET 2 FOR GEAR MOTOR MAINTENANCE POINTS

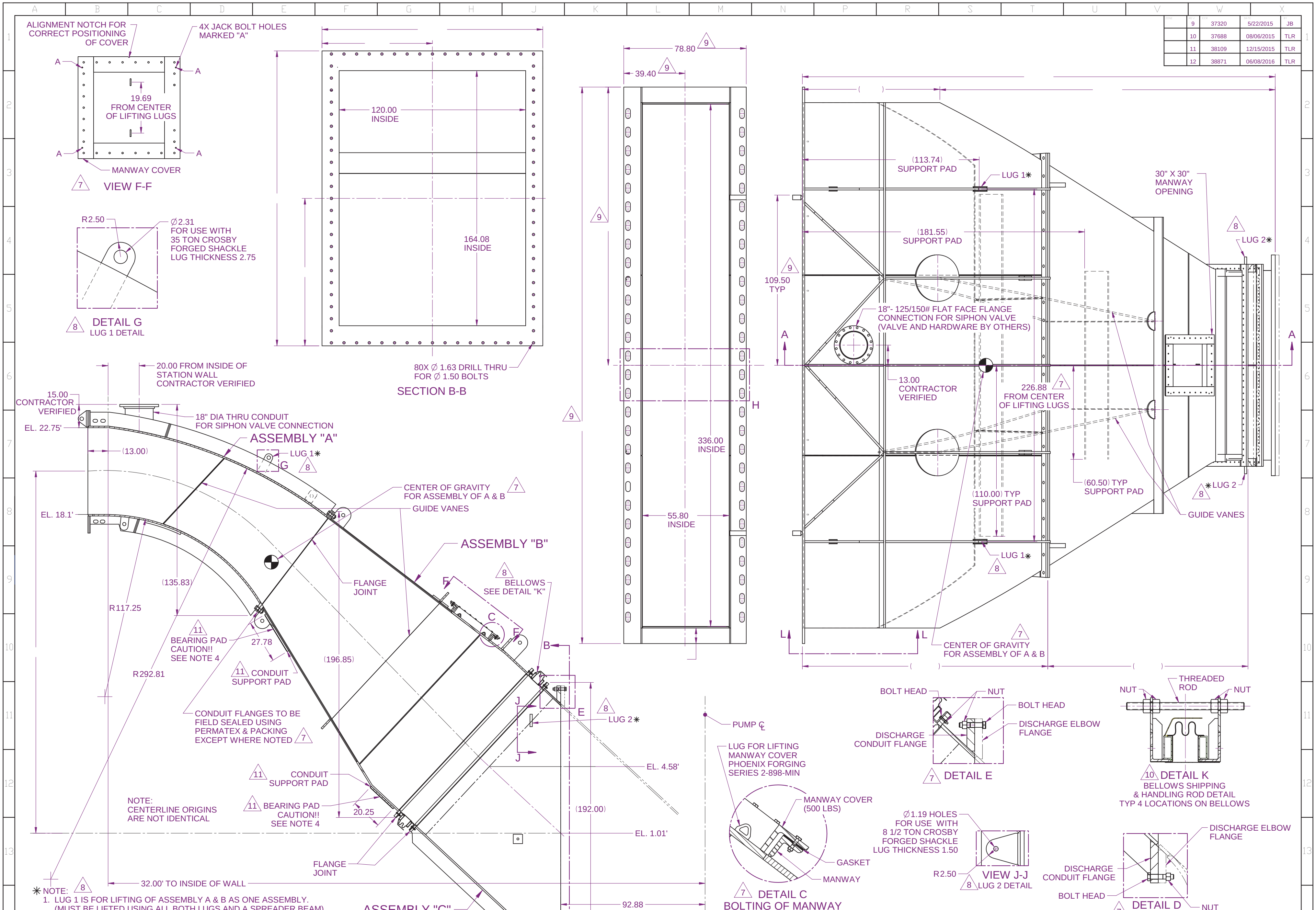
SHEET 1 OF 2

REV 1 ECR #34349 BY JCARSON ON 6-27-13
REV 2 ECR #34771 BY KMOODY ON 9-30-13
REV 3 ECR #35541 BY KMOODY ON 3-24-14
REV 4 ECR #35943 BY KMOODY ON 6-13-14
REV 5 ECR #36575 BY BNICHOLSON ON 10-15-14

PATTERSON PUMP COMPANY
A SUBSIDIARY OF THE GORMAN-RUPP COMPANY

OUTLINE DIMENSION
FOR 1800 CFS PUMP

DWG. NO.	REV.
C04-129127	5
DRAWN: kmoody	DATE: 6/7/2013
SCALE: NONE	APPRVD.: EJC



✳ NOTE:
1. LUG 1 IS FOR LIFTING OF ASSEMBLY A & B AS ONE ASSEMBLY. (MUST BE LIFTED USING ALL BOTH LUGS AND A SPREADER BEAM)
2. LUG 2 IS FOR LIFTING BELLOWS AND ASSEMBLY C AS ONE ASSEMBLY. (NOTE BELLOWS SHIPPING BARS MUST STILL BE INSTALLED)
3. ALL OTHER LUGS SHOWN ARE FOR HANDLING OF INDIVIDUAL COMPONENTS
4. CARE SHOULD BE TAKEN TO PREVENT DAMAGE FROM OCCURING TO BEARING PAD POLISHED SURFACE. PAD MUST NOT MAKE CONTACT DURING ANY HANDLING OR INSTALLATION STEPS.

MATERIALS OF CONSTRUCTION:
ASTM A36 STEEL
MAIN BODY 1" THICK PLATE

9	37320	5/22/2015	JB
10	37688	08/06/2015	TLR
11	38109	12/15/2015	TLR
12	38871	06/08/2016	TLR

FABRICATION TOLERANCES	
UP TO 6"	±.06"
6" TO 24"	±.12"
24" TO 60"	±.19"
60" TO 120"	±.25"
OVER 120"	±.50"

WEIGHTS (APPROX)	
ASSEMBLY A	50139 LBS
ASSEMBLY B	39060 LBS
ASSEMBLY C	15951 LBS
OVERALL (MINUS BELLOWS)	105522 LBS

PERMANENT CANAL CLOSURES AND PUMP STATIONS (PCCP)
1800 CFS PUMPING UNIT
PATTERSON ORDER # AF-C0120980
DIMENSIONS IN ( ) ARE FOR REFERENCE ONLY

SHEET 1 OF 2

PATTERSON PUMP COMPANY
A GORMAN-RUPP COMPANY

DISCHARGE PIPING FOR PCCP 1800 CFS

DWG. NO.	REV.
E04-128929	12

DRAWN	DATE	SCALE	APPRVD.
treed	6/17/2013	NONE	BS

C280-12

Electronic Control System

PROPULSION ENGINE

RATINGS AND FUEL CONSUMPTION

	mhp	bhp	bkW	rpm	U.S. g/h	g/bkW-hr	EPA	IMO	EU
CS	4704	4640	3460	900	208	193.8	NC	II	NC
CS	5031	4962	3700	1000	210	199.2	T4C	III	NC
MC	5167	5096	3800	900	214	194.0	NC	II	NC
MC	5520	5444	4060	1000	217	198.8	T4C	III	NC

C280 fuel rate is at full load on the prop curve, BSFC is at full power condition.

SPECIFICATIONS

Vee 12, 4-Stroke-Cycle Diesel		
Aspiration	TTA	
Bore x Stroke	11.0 x 11.8 in	280 x 300 mm
Displacement	13,546 cu in	222 liter
Rotation (from flywheel end)	Counterclockwise or clockwise	
Engine dry weight (approx)	57,276 lb	25,980 kg

DIMENSIONS

	LE	H	WE
min.	182 in/4623 mm	134 in/3404 mm	80 in/2032 mm
max.	182 in/4623 mm	134 in/3404 mm	80 in/2032 mm

TETRA TECH

Calculation Cover Sheet

Job No.:	100-RCE-18-09-1
Project:	Coastal Texas Protection and Restoration
Title:	DB-PS-EE-MT-001
Design Topic:	Dickenson Bayou Electrical Quantities Calculations

Made By:	JS	**Date:**	08/17/18	**Chk'd By:**	AJB	**Date:**	08/20/18

Calc Body Pages	Appended Pages	Total Pages

Document code

Site	Feature	Discipline	Document type	Number
DB	PS	EE	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Discription
A	Justin Serre 6/20/18	Albert Barnes 8/20/18	

TETRA TECH Calculation Body

Job No.:	100-RCE-18-09-1				
Project:	Coastal Texas Protection and Restoration				
Title:	DP-PS-EQ-CL				
Design Topic:	Dickenson Bayou Pump Station Electrical Quantities				
Made By:	JS	**Date:**	08/17/18 **Chk'd By:** AJB	**Date:**	08/20/18

DB-PS-EE-MT-001

1.0 ISSUE BEING ADDRESSED

2.0 APPROACH

Applying the National Electrical Code (NEC) and Unified facilities guide specifications Division 26 – Electrical

3.0 REFERENCES

References used for this estimate are as follows:

1) NFPA 70 - National Electrical Code - 2017
2) Design and Analysis of building electrical systems, John H. Matthews
3) Unified facilities guide specifications Division 26 - Electrical

4.0 RESULT SUMMARY/VERIFICATION

RESULTS / CONCLUSIONS

ITEMS TO BE VERIFIED

1) Number of pumps
2) Number of motors
3) Building size

5.0 ASSUMPTIONS

ASSUMPTIONS AND INPUTS

Assumptions made during this calculation are as follows:

1) Large diesel powered motors will have a summed less than 10 HP worth of support motors.
2) Demand factors for electric motors and size of electric motors in sizing main service transformer
3) Pump Station layout of 8-15-2018 for distances and quantities of electrical equipment.

5.0 CALCULATIONS

Dickeson Bayou Pump station has 14 diesel pumps. In each bay, a diesel pump occupies is approximately 50'x90'x60'. The pump station will have an additional 2 bays to contain the control room and living quarters for the pump station and pump station staff. The additional space is for the maintenance area and machine shop for the pump station. The pump station will be 750' in length and a minimum width of 90'. Pump house equipment will be segregated to prevent one fault causing the loss of power and controls to the entire pump house. This will require multiple distribution power systems in the pump house.

TETRA TECH **Calculation Body**

Job No.:	100-RCE-18-09-1				
Project:	Coastal Texas Protection and Restoration				
Title:	DP-PS-EQ-CL				
Design Topic:	Dickenson Bayou Pump Station Electrical Quantities				
Made By:	JS	**Date:**	08/17/18	**Chk'd By:** AJB	**Date:** 08/20/18

DB-PS-EE-MT-001

Item No.	Item Description	Quantity	Unit
ELECTRICAL ITEMS			
DICKESON BAYOU PUMP STAITON			
1	**TELEPHONE/COMMUNICATION SYSTEM**		
	a. Telephone Patch Panel	1	Ea
	b. Master Desk Telephone	2	Ea
	c. Combination Telephone/Intercom	20	Ea
	d. 1" RMC Conduit	3,000	Lf
	e. Telephone cable	5,000	Lf
	f. Cable Terminations	50	Ea
	PUMP STATION LIGHTS AND FIXTURES		
	a. High Bay Down Lighting	80	Ea
	b. Wall Lights	60	Ea
	c. Warning Light	10	Ea
	d. Warning Horn	4	Ea
	e. Mast Lights with 30' Mast	25	Ea
	f. Emergancy Battery Lighting	25	Ea
	g. 3/4" RMC	5,000	CLF
	h. Lighting Connection Whips	150	Ea
	i. Ceiling Lights	120	Ea
	PUMP STATION VIDEO/CC TV SYSTEM		
	a. Video Camera	30	Ea
	b. Network Hub	6	Ea
	c. DVR	4	Ea
	d. 3/4" RMC	5,000	Lf
	e. Video Cable	5,000	Lf
	f. 2" RMC	1,500	Lf
	g. Fiber Optic Cable	1,500	Lf
	h. LCD television monitors, with audio, 8-inch	10	Ea
	i. Cable Terminations	200	Ea
	j. Monitoring Software	1	Ea
	FUEL STORAGE VIDEO/CC TV SYSTEM		
	a. Video Camera	30	Ea
	b. 3/4" RMC	5,000	Lf
	c. Video Cable	5,000	Lf
	d. 2" RMC	1,500	Lf
	e. Fiber Optic Cable	1,500	Lf
	f. Cable Terminations	50	Ea
	PUMP STATION FIRE ALARM AND DETECTION SYSTEM		
	a. Air Sampling (Ionization) Detector	50	Ea

	b. Thermal (Heat) Detector	50	Ea
	c. Smoke Detector	50	Ea
	d. Pull Station	20	Ea
	e. Bell	10	Ea
	f. Fire Alarm Control Panel	4	Ea
	g. Main Fire Alarm Control Panel	1	Ea
	h. Detector Cable	15,000	Lf
	i. Alarm Cable	3,000	Lf
	j. 8 Fiber Optic Cable	300	Lf
	k. 3/4" RMC for Routing Fire Alarm Cable	5,000	Lf
	l. 1" RMC for Routing Fiber Optic Cable	300	Lf
	m. Cable Terminations	200	Ea
	n. Fire Pump	20	Ea
	FUEL STORAGE FIRE ALARM AND DETECTION SYSTEM		
	a. Air Sampling (Ionization) Detector	50	Ea
	b. Thermal (Heat) Detector	50	Ea
	c. Smoke Detector	0	Ea
	d. Pull Station	20	Ea
	e. Bell	5	Ea
	f. Fire Alarm Control Panel	2	Ea
	g. Main Fire Alarm Control Panel	0	Ea
	h. Detector Cable	0	Lf
	i. Alarm Cable	0	Lf
	j. 8 Fiber Optic Cable	2,000	Lf
	k. 3/4" RMC for Routing Fire Alarm Cable	0	Lf
	l. 1" RMC for Routing Fiber Optic Cable	0	Lf
	m. Cable Terminations	50	Ea
	n. Fire Pump	10	Ea
	PUMP STATION CONTROLS		
	a. Control Cabinet w/ PLC, power supply, processor, comm. Matrix, realys and network hub	7	Ea
	b. PLC Analog Inputs and Outputs	400	Ea
	c. PLC Digital Inputs and Ouputs	400	Ea
	d. Operators Control Cabinet w/ pushbuttons, switches, etc.	20	Ea
	e. Human/Machine Interface (HMI)	7	Ea
	f. Software for programming PLC and HMI	1	Ea
	g. 3/4" RMC	2,000	Lf
	h. 1" RMC	3,000	Lf
	i. 12 Pair Fiber Optic Cable	5,000	Lf
	j. Controls Panelboard, 120/240V/ 60A, 2d. ckt, w/20A ckt bkr	6	Ea
	k. Circuit Breakers, Various Sizes, 1-pole	80	Ea
	l. Cable Terminations	2,500	Ea
	m. Gearbox heaters	15	Ea

Item No.	Item Description	Quantity	Unit
	a. MCC - Section	55	Ea
	b. MDCB	60	Ea
	c. Combination Starter	60	Ea
	d. Control Transformer	10	Ea
	e. Circuit Breaker	200	Ea
	f. 3-#12 AWG, 1 - #12 AWG	5000	Lf
	g. 3-#10 AWG, 1 - #10 AWG	5000	Lf
	h. 3-#8 AWG, 1 - #10 AWG	5000	Lf
	PUMP STATION RECEPTACLES		
	a. 5-20R Receptacles	300	Ea
	b. #10 AWG Stranded Copper	10,000	Lf
	c. 100A 3P-5W NEMA-3R Power Outlet	20	Ea
	d. 4#1 AWG, 1#8 AWG EGC	1,000	Lf
	e. Pull Boxes	200	Ea
	f. Cable Terminations	500	Ea
	FUEL STORAGE RECEPTACLES		
	a. 5-20R Receptacles NEMA 4X	25	Ea
	b. #10 AWG Stranded Copper	2,000	Lf
	c. 100A 3P-5W NEMA-4X Power Outlet	4	Ea
	d. 4#1 AWG, 1#8 AWG EGC	1,000	Lf
	e. Pull Boxes	20	Ea
	f. Cable Terminations	50	Ea
	Automatic Transfer Switches		
	a. Medium Voltage Automatic Transfer switches	0	Ea
	b. Low Voltage Automatic Transfer Switches	4	Ea
	c. Diconnect Switches	50	Ea
	d. Fused Disconnect Switches	4	Ea
	Stand-by Generators		
	a. 2000kW Generator	2	Ea
	b. 250kW Generator	2	Ea
	c. Load Banks	2	Ea
	d. Control Panel	1	Ea
	Power Transformers		
	a. 2000kVA	1	Ea
	b. 50kVA	2	Ea
	c. 30kVA	2	Ea
	d. 15kVA	3	Ea
	Conductos		

Item No.	Item Description	Quantity	Unit
	a. #14 AWG	10000	Lf
	b. #12 AWG	5000	Lf
	c. #10 AWG	3000	Lf
	d. #8 AWG	1500	Lf
	e. #6 AWG	1500	Lf
	f. #4 AWG	1500	Lf
	g. #3 AWG	0	Lf
	h. #2 AWG	0	Lf
	i. #1 AWG	2000	Lf
	j. 1/0 AWG	1000	Lf
	k. 2/0 AWG	1000	Lf
	l. 3/0 AWG	5000	Lf
	m. 4/0 Awg	1500	Lf
	n. 350 kmill	0	Lf
	0. 500 kmill	800	Lf
	Conduits and Conductors		
	a. 3/4" RMC	2500	Lf
	b. 1" RMC	2500	Lf
	c. 1 1/4" RMC	500	Lf
	d. 1 1/2" RMC	1000	Lf
	e. 2" RMC	2500	Lf
	f. 2 1/2" RMC	500	Lf
	g. 3" RMC	2500	Lf
	h. 4" RMC	0	Lf
	Motors		
	a. 1-hp, 3PH, 480VAC	0	Ea
	b. 2-hp, 3PH, 480VAC	2	Ea
	c. 5-hp, 3PH, 480VAC	60	Ea
	d. 10-hp, 3PH, 480VAC	2	Ea
	e. 20-hp, 3PH, 480VAC	103	Ea
	f. 30-hp, 3PH, 480VAC	0	Ea
	g. 50-hp, 3PH, 480VAC	0	Ea

TETRA TECH

Calculation Cover Sheet

Job No.:	100-RCE-18-09-1
Project:	Coastal Texas Protection and Restoration Feasibility Study
Title:	DB-FG-EE-MT-002
Design Topic:	Dickenson Bayou Floodgate Electrical Quantities

Made By:	JS	**Date:**	08/17/18	**Chk'd By:**	AJB	**Date:**	08/20/18

Calc Body Pages	Appended Pages	Total Pages

Document code

Site	Feature	Discipline	Document type	Number
DB	FG	EE	MT	002

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Discription
A	Justin Serra 8/20/18	Albert Barnes 8/20/18	

TETRA TECH	**Calculation Body**

Job No.:	100-RCE-18-09-1				
Project:	Coastal Texas Protection and Restoration				
Title:	DB-FG-EQ-CL				
Design Top	DICKINSON BAYOU FLOODGATE ELECTRICAL QUANTITIES				
Made By: JS	**Date:**	08/17/18	**Chk'd By:** AJB	**Date:**	08/20/18

DB-FG-EE-MT-

1.0 ISSUE BEING ADDRESSED

2.0 APPROACH

Applying the National Electrical Code (NEC) and Unified facilities guide specifications Division 26 – Electrical

3.0 REFERENCES

References used for this Estimate are as follows:

1) NFPA 70 - National Electrical Code - 2017
2) Design and Analysis of building electrical systems, John H. Matthews
3) Unified facilities guide specificaitons Division 26 - Electrical

4.0 RESULT SUMMARY/VERIFICATION

RESULTS / CONCLUSIONS

ITEMS TO BE VERIFIED

1) Size of HPU units
2) Number of lights on site
3) Controls

5.0 ASSUMPTIONS

ASSUMPTIONS AND INPUTS

Assumptions made during this calculation are as follows

1) Equipment size and available area in Floodgate building.

2) Demand factors for electric motors and size of electric motors in sizing main feeder.
3) Floodgate distance from Clear Creek Pump Station and location of Floodgate along the channel.

5.0 CALCULATIONS

Dickenson Bayou Floodgate has a span of 100' with a gate house on each monolith. The Floodgate operation house contains the HMI station that controls the gates and the HPU unit that powers the floodgate. The MCC, Lighting Panel and the PLC cabinet distribute power to the motors, site lighting and control and sensors for the Floodgate. The Control Cabinet that houses the PLC and the Network Hub will communicate with the gate controls, video and voice communications and also with the control room inside the Clear Creek Pump Station

Bunker.

Item No.	Item Description	Quantity	Unit
ELECTRICAL ITEMS			
DICKENSON BAYOU FLOODGATE			
1	**TELEPHONE/COMMUNICATION SYSTEM**		
	a. Telephone Patch Panel	0	Ea
	b. Master Desk Telephone	0	Ea
	c. Combination Telephone/Intercom	2	Ea
	d. 1" RMC Conduit	1,500	Lf
	e. Telephone cable	1,500	Lf
	f. Cable Terminations	10	Ea
	FLOODGATE LIGHTS AND FIXTURES		
	a. High Bay Down Lighting	0	Ea
	b. Wall Lights	10	Ea
	c. Warning Light	2	Ea
	d. Warning Horn	1	Ea
	e. Mast Lights with 30' Mast	10	Ea
	f. Emergancy Battery Lighting	25	Ea
	g. 3/4" RMC	600	CLF
	h. Lighting Connection Whips	5	Ea
	i. Ceiling Lights	5	Ea
	j. Navigation Lights	6	Ea
	k. Solar Power/Navigaiton Lights	10	Ea
	FLOODGATE VIDEO/CCTV SYSTEM		
	a. Video Camera	4	Ea
	b. Network Hub	1	Ea
	c. DVR	1	Ea
	d. 3/4" RMC	250	Lf
	e. Video Cable	300	Lf
	f. 2" RMC	1,500	Lf
	g. Fiber Optic Cable	0	Lf
	h. LCD television monitors, with audio, 8-inch	4	Ea
	i. Cable Terminations	50	Ea
	j. Monitoring Software	1	Ea
	FLOODGATE FIRE ALARM AND DETECTION SYSTEM		
	a. Air Sampling (Ionization) Detector	2	Ea
	b. Thermal (Heat) Detector	2	Ea
	c. Smoke Detector	2	Ea
	d. Pull Station	2	Ea
	e. Bell	2	Ea
	f. Fire Alarm Control Panel	2	Ea
	g. Main Fire Alarm Control Panel	0	Ea

	h. Detector Cable	100	Lf
	i. Alarm Cable	100	Lf
	j. 8 Fiber Optic Cable	0	Lf
	k. 3/4" RMC for Routing Fire Alarm Cable	1,500	Lf
	l. 1" RMC for Routing Fiber Optic Cable	0	Lf
	m. Cable Terminations	100	Ea
	FLOODGATE CONTROLS		
	a. Control Cabinet w/ PLC, power supply, processor, comm. Matrix, realys and network hub	2	Ea
	b. PLC Analog Inputs and Outputs	50	Ea
	c. PLC Digital Inputs and Ouputs	50	Ea
	d. Operators Control Cabinet w/ pushbuttons, switches, etc.	4	Ea
	e. Human/Machine Interface (HMI)	2	Ea
	f. Software for programming PLC and HMI	0	Ea
	g. 3/4" RMC	2,000	Lf
	h. 1" RMC	2,000	Lf
	i. 12 Pair Fiber Optic Cable	0	Lf
	j. Controls Panelboard, 120/240V/ 60A, 2d. ckt, w/20A ckt bkr	4	Ea
	k. Circuit Breakers, Various Sizes, 1-pole	40	Ea
	l. Cable Terminations	50	Ea
	INCOMING POWER		
	a. 3-#2/0 AWG, 1-#6 AWG	2,000	Ea
	b. 2" RMC Embedded Conduits	2,000	Lf
	c. Pull Boxes	20	Ea
	d. Misc Hardware	1	LOT
	e. Cable Terminations	50	Ea
	FLOODGATE LIGHTING CONDUCTORS		
	a. #12 AWG Stranded Copper	600	Lf
	b. #10 AWG Stranded Copper	200	Lf
	c. #8 AWG Stranded Copper	0	Ea
	d. Pull Boxes	20	Ea
	e. Cable Terminations	100	Ea
		a	
	MOTOR CONTROL CENTER - MCCx2		
	a. MCC - Section	4	Ea
	b. Main Disconnect Circuit Breaker - MDCB	2	Ea
	c. Combination Starter	8	Ea
	d. Control Transformer	2	Ea
	e. Circuit Breaker	40	Ea
	f. 3-#12 AWG, 1 - #12 AWG	600	Lf
	g. 3-#10 AWG, 1 - #10 AWG	600	Lf

	h. 3-#8 AWG, 1 - #10 AWG	0	Lf
	Automatic Transfer switches		
	a. Medium Voltage Automatic Transfer switches	0	Ea
	b. Low Voltage Automatic Transfer Switches	4	Ea
	c. Diconnect Switches	50	Ea
	d. Fused Disconnect Switches	4	Ea
	Power Transformers		
	a. 250kVA	1	Ea
	b. 50kVA	0	Ea
	c. 30kVA	2	Ea
	d. 15kVA	2	Ea
	Conductos		
	a. #14 AWG	2500	Lf
	b. #12 AWG	1500	Lf
	c. #10 AWG	1500	Lf
	d. #8 AWG	1500	Lf
	e. #6 AWG	0	Lf
	f. #4 AWG	0	Lf
	g. #3 AWG	0	Lf
	h. #2 AWG	0	Lf
	i. #1 AWG	0	Lf
	j. 1/0 AWG	1500	Lf
	k. 2/0 AWG	0	Lf
	l. 3/0 AWG	0	Lf
	m. 4/0 Awg	0	Lf
	n. 350 kmill	0	Lf
	0. 500 kmill	0	Lf
	Conduits and Conductors		
	a. 3/4" RMC	800	Lf
	b. 1" RMC	250	Lf
	c. 1 1/4" RMC	0	Lf
	d. 1 1/2" RMC	0	Lf
	e. 2" RMC	1500	Lf
	f. 2 1/2" RMC	0	Lf
	g. 3" RMC	0	Lf
	h. 4" RMC	0	Lf
	Motors		
	a. 1-hp, 3PH, 480VAC	0	Ea
	b. 2-hp, 3PH, 480VAC	0	Ea
	c. 5-hp, 3PH, 480VAC	2	Ea
	d. 10-hp, 3PH, 480VAC	2	Ea

	e. 20-hp, 3PH, 480VAC	4	Ea
	f. 30-hp, 3PH, 480VAC	0	Ea
	g. 50-hp, 3PH, 480VAC	0	Ea

Attachment 6

Galveston Island 10 Percent Design

Quantity Take-offs

MOTT MACDONALD

Galveston Island Revised Pump Station Sizes

Coastal Texas Restoration and Protection Feasibility Study

Presentation Summary

- Revised 100 year, 90% CI WSE with 0.0’ used to calculate overtopping per USACE direction.
    - Resulting overtopping rates were calculated along the revised alignment

- Hydrologic model used to size pump stations for new overtopping rates.

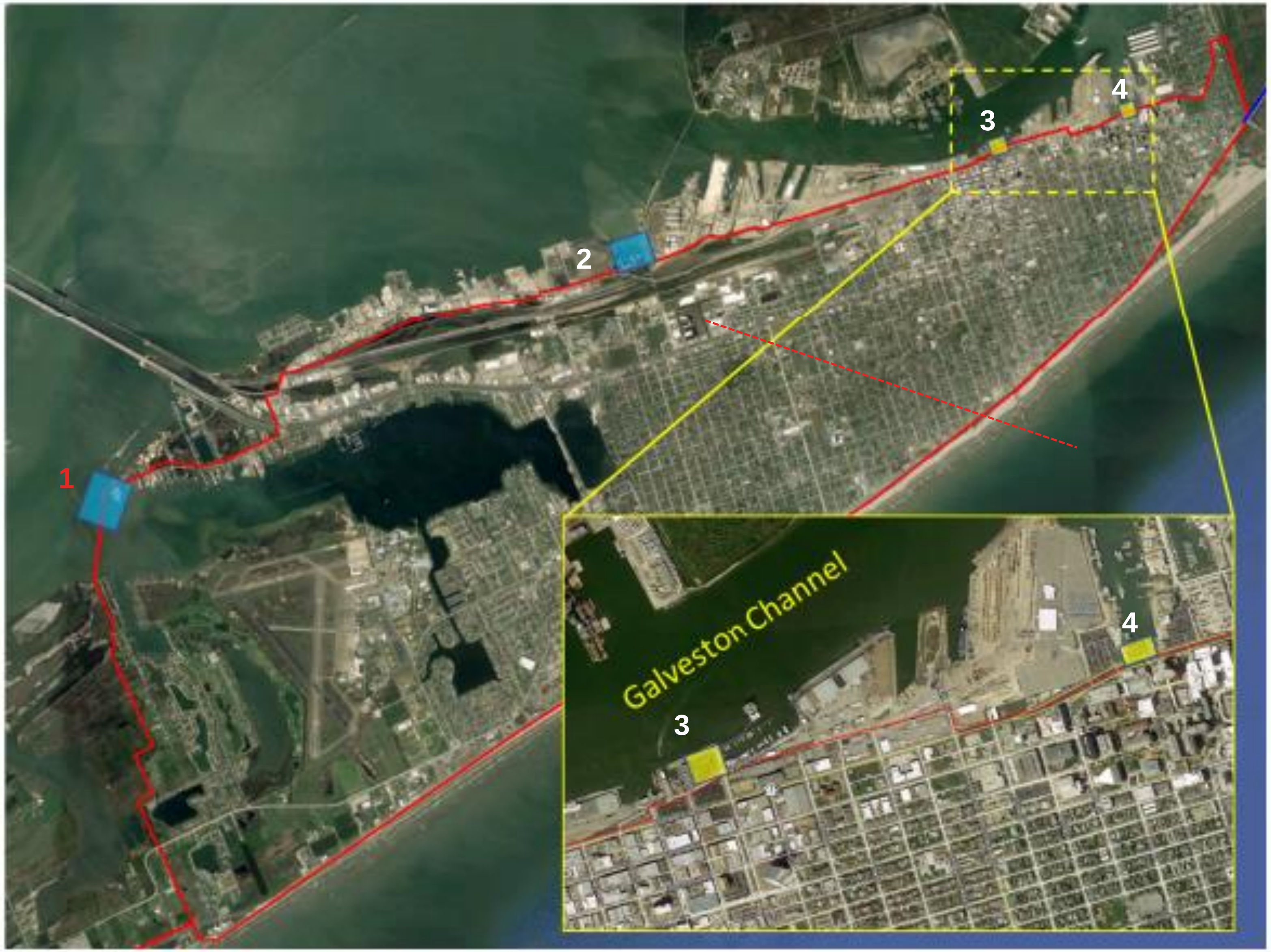
- Revised pump station and conduit sizes summarized in this presentation

Previous vs. Revised Alignment

Map

- USACE has revised the alignment of the Galveston Ring Barrier.
- Overtopping rates (cfs/lf) were calculated along 7 different segments of the **new alignment.**
- **Hydrologic modeling was done using the old alignment, previous pump station locations, and previous model per Amendment 6.**

Galveston: Pump Station Locations



- Four Pump stations, with same location as previous design were used in the modeling.

- Updated pump sizes for each pump station shown here are summarized on the next slide.
    - Conduit sizes are also summarized on the following slide.

Results Summary

- Pump Site 1 (Offatts Bayou)
  - Increase in pump size
  - Increase in channel cross section
- Pump Site 2
  - No increase
- Pump Site 3
  - Increase in pump size
  - Increase in channel cross section
- Pump Site 4
  - Increase in pump size
- No changes were made to conveyance channel locations, lengths, depths, slopes, or elevations

Parameter	**Required Pump and Conduit**
Pump Site 1 – Offat's Pump	**4,500 cfs**
Broadway Ave. Conveyance channel	32' wide x 13' high 416 sf
Pump Site 2 - Pump	**1,500 cfs**
Pump Site 2 - Conveyance channel	20' wide X 10' high 200 sf
Pump Site 3 - Pump	**5,000 cfs**
Pump Site 3 - Conveyance Channel	30' wide x 10' high 300 sf
Pump Site 4 - Pump	**5,000 cfs**
Pump Site 4 - Conveyance Channel	25' wide x 10' high 250 sf

TETRA TECH **Galveston Island Pump Stations**

Calculation No. GI-PS-ME-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	
Project:	Coastal Texas Protection and Restoration				
Description:	Galveston Island Pump Station Mechanical Quantity and Cost Estimates				
Made By:	NRT	**Date:** 02/20/20	**Chk'd By:** EOF	**Date:** 02/20/20	

Calc Body Pages	Appended Pages	Total Pages
3	0	3

Document code

Site	Feature	Discipline	Document type	Number
GI	PS	ME	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Nathan Tobin 2/20/2020 NRT	Eric Flickinger 2/20/20	

Galveston Island Pump Stations Mechanical Cost Estimation List

32 Pumphouse "units" total

Item	Qty.	Model	Individual Cost	Total Cost	Comments
Pump/Engine/Gearbox Package	32	Custom	$4,166,000.00	$133,312,000	Representative estimates 50-70% reduction when design data is received (Cost estimated by dividing quote for 1500 cfs pump by 3)
Jacket Water Tank	12	250 gal. Capacity Tank supplying 4 engines (3 Drivers + Generator)	$6,000.00	$72,000	3 per Pump Station
Auxiliary Jacket Water Pumps	39	Goulds Model 53BF1J9A0 Centrifugal Pump 5HP	$2,000.00	$78,000	*1 per engine If recommended by engine manufufacturer
Start Air Compressor	10	Bauer B22.5 Medium Pressure Compressor - 28-69 Bar (25-30 needed for diesel start)/ AtlasCopco LT 7-30 30 bar,17 cfm 5.5 hp motor	$41,000.00	$410,000	*2 recommended by USACE, using larger models and bottles can provide for more smaller engines, reducing amount needed- assume 2 per every 5 pump engines
Start Air Bottle	14	Awaiting quote from Atlas Copco Distributor	$10,000.00	$140,000	*must have capacity for 2 consecutive starts per engine without recharging - 1 for each compressor, + one emergency gen bottle in each station
Fuel Oil Purifier	56			$0	*2 per settler. To reach necessary flowrate as pass through before day tank, must match transfer pump gpm.
Fuel Oil Pumps	39	Scot DU SC3320 long coupled centrifugal fuel pump 1HP	$900.00	$35,100	*one per engine
F.O. Transfer Pump	56	Scot DU SC3320 long coupled centrifugal fuel pump 1HP	$900.00	$50,400	*2 per Settler
Fuel Oil Day Tank	39	700 Gallon Tank for 8.8 Hours operation	$5,000.00	$195,000	*Estimate- one per engine
Fuel Oil Settling Tank	28	28 10,000 Gal Tanks total	$31,250.00	$875,000	
Prelube Pump	39	*Small size of prelube pump probably renders cost negligible		$0	*If recommended by engine manufufacturer
Lube Oil Purifier	8	Alfa Laval OCM 17 GPM	$15,000.00	$120,000	*2 per Station ESTIMATE
Lube Oil Tank	4	500 Gal L.O. Tank	$5,000.00	$20,000	*With Immersion Heaters - One per Station
Lube Oil Cooler	39	Assume Submerged Pipe	$5,000.00	$195,000	*Estimate- one per engine
50-ton Overhead Crane	4		$80,000.00	$320,000	
Control Room HVAC Package Unit	4	Goodman 3 Ton 14 SEER Horizontal AC package unit	$2,080.00	$8,320	*Assume one control room per group of pumps
Fixed Fire Protection System	4	*Assume one per pump group. Gaseous/Liquid/Foam based		$0	
Emergency Diesel Generator	7	Caterpillar C32 Genset	$250,000.00	$1,750,000	2 per Station, except for Station 2, which only needs one due to smaller size
Stop Logs/ Roller Gate	32	Custom	$100,000.00	$3,200,000	
Trash Rack, Rake Assembly	32	Estimated $105,480 for the rack, $100,000 for Rake	$205,480.00	$6,575,360	
Exhaust Fan	16	4 50,000 cfm fans per 4 engine block	$6,000.00	$96,000	*Sized to accomplish 3 minute air change recommended for engine rooms
Sump Blower	32	6.7 Regenerative Blower 3 Phase, 230/460 Voltage, 2" (F)NPT Inlet Size	$2,135.00	$68,320	*Per USACE EM 1110-2-3105 9-5b
Submersible Nonclog Sump Pump	32	Goulds Model 3887BHF Submersible Sewage Pump 460V, 222 GPMmax, 80ft head	$1,596.00	$51,072	*Should be able to pass 2.5" solids

Air Start Valve	39	Amot 4123 Air Start valve 35 bar electric actuated	$2,000.00	$78,000	*eliminates the need for control air
Air Dryer	10		$4,200.00	$42,000	2 to each pair of S.A. Compressors

Estimated Pump Station Subtotal:	**$147,691,572.0**
Estimated Worst Case Pump/Driver Grand Total:	**$147,691,572.0**
Adjusted Estimate assuming 50% reduction in Pump/Driver Cost	**$81,035,572.0**
Adjusted Estimate assuming 70% reduction in Pump/Driver Cost	**$54,373,172.0**

TETRA TECH	Galveston Island #1 Pump Station Quantities	Calculation No. GI1-PS-ST-MT-001

Job No.: 100-RCE-18-09-1 **Page:** 1
Project: Coastal Texas Protection and Restoration
Description: Galveston Island Pump Station #1 Quantities
Made By: RSK **Date:** 02/06/20 **Chk'd By:** NRT **Date:** 02/10/20

Calc Body Pages	Appended Pages	Total Pages
14	2	16

Document code

Site	Feature	Discipline	Document type	Number
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A	Lexee Navarre 7/31/2018	Carl Grompe 9/21/2018	
B	Michael Hough 11/6/2018	Jason Kikuta 11/7/2018	Revised for updated geometry and design
C	Robert Kramer 2/6/2020 Robert Kramer	Nathan Tobin 2/10/2020 NT	Revised for updated general arrangement and pumping capacity

TETRA TECH	**Galveston Island #1 Pump Station Quantities**	**Calculation No. GI1-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:	Revision Summary						
Made By:	RSK	**Date:**	02/06/20	**Chk'd By:**	NRT	**Date:**	43871

Revision Summary

Revision Summary

Reason for Revision: USACE provided new SWL elevations following new storm analysis. For pump station 1, this resulted in a pump station with a pumping capacity of 4500 cfs, similar to the original PS3 except that there is no transition structure required into Offats Bayou. An additional reduction in the height of the substructure by 9.41 ft was required to maintain the optimal FSI invert elevation. The quantities have been updated to reflect these changes.

Symbols:

t_{11}: thickness of wall 11 — L_{11}: Length of wall 11

t_{10}: thickness of wall 10 — L_{10}: Length of wall 10

t_7: thickness of wall 7 — w_7: Width of wall 7

t_2: thickness of wall 2 — w_2: Width of wall 2

Diffuser Area Ratio: The New Diffuser Plan Area / Old Diffuser Area

Source for Revisions:

Original Galveston Island #3 Pump Station Concrete Walls Structural Calculations dated 11/2018
Old Concrete Estimates provided by cross-section attachments on page 17 and page 18

Revised Inputs:
* All revised inputs are in **red bold print** within calculation package

Revised Item	Location	Original Number	Updated Number	Updates to Number
Total Volume of Concrete for Precast Concrete Wall Pannels per Pump Bay	Substructure Quantities	651 yd^3	**582yd^3**	Decreased wall height for walls labelled 2,3,10 and 11
Pump Station Foundation	Foundation Quantities	270 yd^3	**269 yd^3**	Decreased Length of Slab
Intake Foundation Slab	Foundation Quantities	232 yd^3	**0 yd^3**	Eliminated Volume
Intake Diffuser Substructure	Substructure Quantities	331.9 yd^3	**0 yd^3**	Eliminated Volume

TETRA TECH	Galveston Island #1 Pump Station Quantities	Calculation No. GI1-PS-ST-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	RSK	**Date:**	02/06/20	**Chk'd By:**	NRT	**Date:**	02/10/20

TABLE OF CONTENTS

TETRA TECH	**Galveston Island #1 Pump Station Quantities**	**Calculation No.** **GI1-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1				**Page:**	5
Project:	Coastal Texas Protection and Restoration					
Description:						
Made By:	RSK	**Date:** 02/06/20		**Chk'd By:** NRT	**Date:**	02/10/20

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for Pump Station at Galveston Island Site #1

APPROACH

Typical engineering means and methods.

REFERENCES

References used during this calculation are as follows:

1) Plate 47 and 48 as noted

RESULTS / CONCLUSIONS

PILES:

Total # of 24" Diam. X 5/8" Vertical Pipe Piles:	680				
Total 24" Diam. X 5/8" Steel Pipe Pile:	63796	ft	**OR**	4982	tons
Total PZ-22 Steel Sheet Pile:	8772.75	ft^2	**OR**	97	tons

CONCRETE:

FOUNDATIONS:			
Total Concrete for Base Slab:	**2421**	yd^3	
Total Concrete for Mud Slab:	637	yd^3	
Total:	**3058**	yd^3	
SUBSTRUCTURE:			
Total:	**6270**	yd^3	
SUPERSTRUCTURE:			
Total:	577	yd^3	8" Thick Precast Concrete Wall Panels
TOTAL CONCRETE:	**9905**	yd^3	

STEEL:

SUPERSTRUCTURE:

Total Number of W27x194 Steel Columns:	48			
Length	2040 ft	**OR**	198	tons
Total Number of W18X143 Steel Roof Beams:	24			
Length	948 ft	**OR**	68	tons
Total Number of W18X143 Steel Roof Beams:	30			
Length	600 ft	**OR**	43	tons

CRANE FRAME:

Total Number of Steel HHS 12x12x1/2 Columns:	48			
Length	1800 ft	**OR**	68	tons
Total Number of W18X192 Steel Top Rails:	30			
Length	600 ft	**OR**	58	tons
Total Number of 30 lb/ft Crane Rails:	30			
Length	600 ft	**OR**	9	tons
Total Number of Steel HHS 12x12x1/2 Beams:	150			
Length	3000 ft	**OR**	114	tons

TETRA TECH	**Galveston Island #1 Pump Station Quantities**	**Calculation No.** **GI1-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	7
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	RSK	**Date:**	02/06/20	**Chk'd By:**	NRT	**Date:**	02/10/20

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) Excavation is to be determined by others.
2) Number of pumps = 9
3) Material Properties:
   - Concrete for base slab, allowable f'c = 4000 psi
   - Concrete for mud slab, allowable f'c = 2500 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
   - Sheet Piles = ASTM A328
4) All piles have tension connections.

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Material types and properties.
2) Layout, elevations and dimensions of Pump Station.

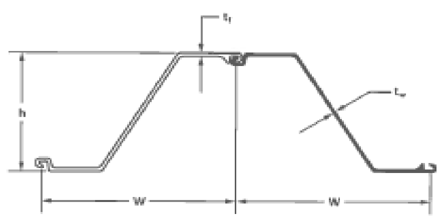
CALCULATIONS

Begin on next page.

General References and Figures

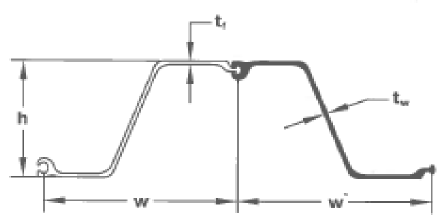
NZ/PZ

NZ/PZ Hot Rolled Steel Sheet Pile



NZ

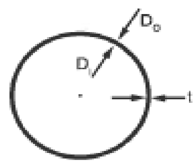
SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Web (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
NZ 19	27.56 700	16.14 410.0	0.375 9.5	0.375 9.5	7.04 148.9	55 81.85	23.95 116.93	35.08 1886	41.33 2222	283.1 38659	6.18 1.88	1.35 1.35
NZ 20	27.56 700	16.16 410.5	0.394 10.0	0.394 10.0	7.29 154.4	57 84.83	24.82 121.18	36.24 1948	42.80 2301	292.8 39984	6.18 1.88	1.35 1.35
NZ 21	27.56 700	16.20 411.5	0.433 11.0	0.433 11.0	7.80 165.2	61 90.78	26.56 129.68	38.69 2080	45.85 2465	313.4 42797	6.18 1.88	1.35 1.35
NZ 26	27.56 700	17.32 440.0	0.500 12.7	0.500 12.7	9.08 192.3	71 105.66	30.92 150.94	48.50 2608	57.01 3065	419.9 57340	6.49 1.98	1.41 1.41



PZ

SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Wall (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
PZ 22	22.0 559	9.0 229	0.375 9.50	0.375 9.50	6.47 136.9	40.3 60.0	22.0 107.4	18.1 973	21.79 1171.4	84.38 11500	4.48 1.37	1.22 1.22
PZ 27	18.0 457	12.0 305	0.375 9.50	0.375 9.50	7.94 168.1	40.5 60.3	27.0 131.8	30.2 1620	36.49 1961.9	184.20 25200	4.48 1.37	1.49 1.49
PZ 35	22.6 575	14.9 378	0.600 15.21	0.500 12.67	10.29 217.8	66.0 58.2	35.0 170.9	48.5 2608	57.17 3073.5	361.22 49300	5.37 1.64	1.42 1.42
PZ 40	19.7 500	16.1 409	0.600 15.21	0.500 12.67	11.77 249.1	65.6 57.6	40.0 195.3	60.7 3263	71.92 3866.7	490.85 67000	5.37 1.64	1.64 1.64

Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = 10.69*t*(D_o-t)
D_o (in) - outside diameter
t (in) - thickness of pipe

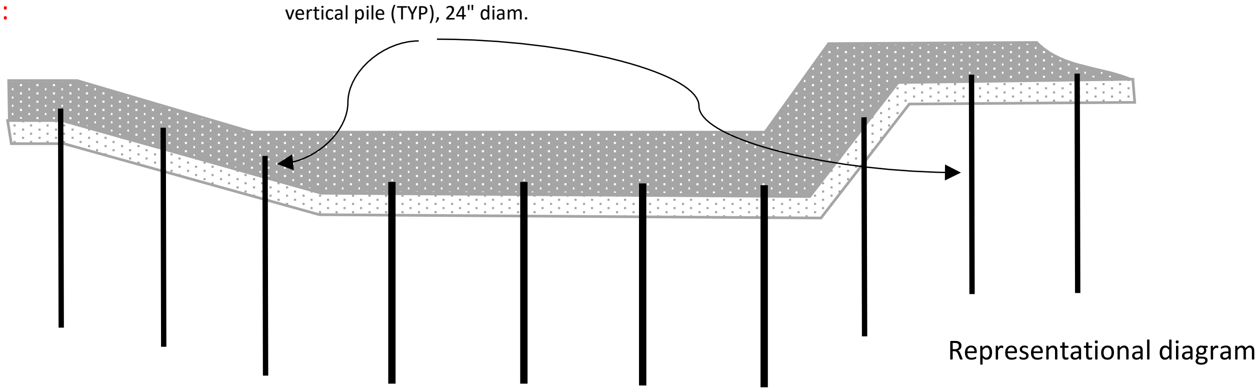
Pipe Weight (kg/m) = 0.0247*t*(D_o-t)
D_o (mm) - outside diameter
t (mm) - thickness of pipe

PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

Quantities for Pump Station Foundations

Figure 1:



PILES

Number of Piles 72 At Pumps
Number of Piles 32 At Safe House Enclosure Slab
Pile Diameter: 24 in
Pile Thickness: 5/8 in
Pile Weight: 156.17 lb/ft
*see general references attachments for reference of produced value

Piles	# of Piles per row	Rows	Pile Weight (lb/ft)	Start EL (ft)	End EL (ft)	Length (ft)	Weight (ton)	Total Length (ft)	Total Weight (ton)
Pumps	3	24	156.17	-14.0	-108.5	94.5	7.4	6804	531.3
Safe House	8	4	156.17	0.0	-80.0	80.0	6.2	2560	199.9

TETRA TECH	Galveston Island #1 Pump Station Quantities	Calculation No. GI1-PS-ST-MT-001

Job No.: 100-RCE-18-09-1 **Page:** 11
Project: Coastal Texas Protection and Restoration
Description: Quantities for Pump Station Foundations
Made By: RSK **Date:** 02/06/20 **Chk'd By:** NRT **Date:** 02/10/20

Piles (24" diam x 5/8")

Total # of Piles per Pump: 72
Total Length per Pump: 6804 ft
Total Weight per Pump: 531 tons

Total Number of Pumps: 9

Total # of Piles at Safe House Enclosure: 32
Total Length at Safe House: 2560 ft
Total Weight at safe house: 200 tons

TOTALS:
# of 24" diam x 5/8" Piles: **680**
Length of 24" diam x 5/8": **63796 ft**
Weight of 24" diam x 5/8": **4982 tons**

SHEET PILE

Note: It is assumed that the sheet pile wall used at WCC for seepage control will also be the same kind used at Clear Creek.
A PZ-22 hot rolled sheet piling shall be utilized for seepage cutoff.

Start EL of Sheet Pile Wall: -25.0 ft
End EL of Sheet Pile Wall: -46.0 ft
Height of Sheet Pile Wall: 21.0 ft
Weight of Sheet Pile Wall*: 22.0 lb/ft^2
Length of Sheet Pile Wall: 46.4 ft

*see general references attachments for reference of produced value

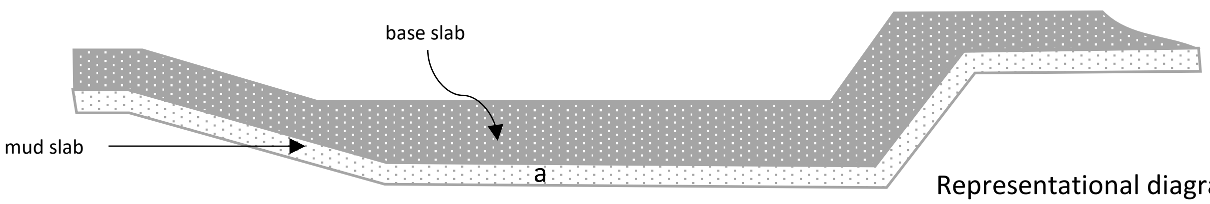
# of Walls	Area (ft^2)	Weight of Wall (lb/ft^2)	Weight (tons)
1	974.8	22.0	10.7

Total Number of Pumps: 9

Total Area per Pump: 975 ft^2
Total Weight per Pump: 11 tons

TOTALS:
Area: **8773 ft^2**
Weight: **97 tons**

Figure 2:



Representational diagram

CONCRETE

FOUNDATION BASE SLAB:

F'c: 4,000 psi
Width of Slab: 20.0 ft

Total Volume of Concrete per Pump*: 269 yd^3
Total Number of Pumps: 9
Intake Foundation Slab: 0 yd^3
Total Foundation Slab Concrete: 2421 yd^3

*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.

MUD SLAB:

Note: Please see attached Plate 48 drawing for concrete sectioning. It is assumed that this pump station will also have a mud slab like West Closure Complex. Lengths of sections are estimates for the preliminary design phase.

F'c: 2,500 psi
Width of Slab: 20.0 ft **Slab Thickness:** 12.0 in

Section	Length (ft)	Thickness (in)	Cross Sectional Area (ft^2)	Width (ft)	Volume (yd^3)	
a	95.5	12.00	95.50	20.0	70.74	Per Model

Total Mud Slab Concrete per Pump: 71 yd^3
Total Number of Pumps: 9
Total Mud Slab Concrete: 637 yd^3

TOTAL CONCRETE: 3058 yd^3

TETRA TECH	**Galveston Island #1 Pump Station Quantities**	**Calculation No. GI1-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	13
Project:	Coastal Texas Protection and Restoration						
Description:	Pump Station Substructure Quantities						
Made By:	RSK	**Date:**	02/06/20	**Chk'd By:**	NRT	**Date:**	02/10/20

Pump Station Substructure Quantities

CONCRETE

Total Volume of Concrete per Pump*:	**582.0**	yd^3	*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.
Total Number of Pumps:	9		
Total Volume of Concrete at Safe House*:	1,032.1	yd^3	
Total Volume of Concrete at Intake Diffuser*:	**0.0**	yd^3	

Total Concrete: 6270 yd^3

TETRA TECH	Galveston Island #1 Pump Station Quantities	Calculation No. GI1-PS-ST-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	14
Project:	Coastal Texas Protection and Restoration						
Description:	Pump Station Superstructure Quantities						
Made By:	RSK	**Date:**	02/06/20	**Chk'd By:**	NRT	**Date:**	02/10/20

Pump Station Superstructure Quantities

PRECAST CONCRETE WALL PANELS

Total Volume of Concrete per Pump Bay*:	45	yd^3	*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.
Total Number of Pump Bays:	9		
Total Volume of Concrete at Safe House Enclosure*:	169	yd^3	

Total Concrete:	**576.7 yd^3**

STEEL

COLUMNS:

The columns of the steel superstructure frame will be W27X194.

Weight:	194	lb/ft	
Height:	42.5	ft	
Number of Columns per Pump Bay:	4		
Total Number of Pump Bays:	9		
Number of Columns at Safe House Enclosure:	12		Per Plans

Total Number of W27x194 Steel Columns:	**48**	
Total Length of W27x194 Steel Columns:	**2040**	**ft**
Total Weight of W27x194 Steel Columns:	**198**	**tons**

LONGITUDINAL ROOF BEAMS (spanning length of pump bay):

The longitudinal roof beams of the steel superstructure frame will be W18X143.

Weight:	143	lb/ft	
Length:	39.5	ft	
Number of Roof Beams per Pump Bay:	2		
Total Number of Pump Bays:	9		
Number of Beams at Safe House Enclosure:	6		Per Plans

Total Number of W18X143 Steel Roof Beams:	**24**	
Total Length of W18X143 Steel Roof Beams:	**948**	**ft**
Total Weight of W18X143 Steel Roof Beams:	**68**	**tons**

TRANSVERSE ROOF BEAMS (spanning width of pump bay):

The tansverse roof beams of the steel superstructure frame are W18X143.

Weight:	143	lb/ft	
Length:	20	ft	
Number of Roof Beams per Pump Bay:	2		
Total Number of Pump Bays:	9		
Number of Beams at Safe House Enclosure:	12		Per Plans

Total Number of W18X143 Steel Roof Beams:	**30**	
Total Length of W18X143 Steel Roof Beams:	**600**	**ft**
Total Weight of W18X143 Steel Roof Beams:	**43**	**tons**

TETRA TECH	Galveston Island #1 Pump Station Quantities	Calculation No. GI1-PS-ST-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	16
Project:	Coastal Texas Protection and Restoration						
Description:	Pump Station Crane Frame Quantities						
Made By:	RSK	**Date:**	02/06/20	**Chk'd By:**	NRT	**Date:**	02/10/20

Pump Station Crane Frame Quantities

STEEL

COLUMNS:

The columns of the steel crane frame are assumed to be HSS 12x12x1/2.

Weight:	76	lb/ft
Height:	37.5	ft
Number of Columns per Pump Bay:	4	
Total Number of Pump Bays:	9	
Number of Columns at Safe House Enclosure:	12	

Total Number of Steel HHS 12x12x1/2 Columns:	**48**	
Total Length of Steel HHS 12x12x1/2 Columns:	**1800**	**ft**
Total Weight of Steel HHS 12x12x1/2 Columns:	**68**	**tons**

TOP RAIL:

The top rail of the steel crane frame will be W18X192.

Weight:	192	lb/ft
Length:	20	ft
Number of Top Rails per Pump Bay:	2	
Total Number of Pump Bays:	9	
Number of Top Rails at Safe House Enclosure:	12	

Total Number of Top Rails:	**30**	
Total Length of Top Rails:	**600**	**ft**
Total Weight of Top Rails:	**58**	**tons**

CRANE RAIL:

Added to the top rail will be a 30 lb/ft crane rail.

Weight:	30	lb/ft
Length:	20	ft
Number of Crane Rails per Pump Bay:	2	
Total Number of Pump Bays:	9	
Number of Crane Rails at Safe House Enclosure:	12	

Total Number of Crane Rails:	**30**	
Total Length of Crane Rails:	**600**	**ft**
Total Weight of Crane Rails:	**9**	**tons**

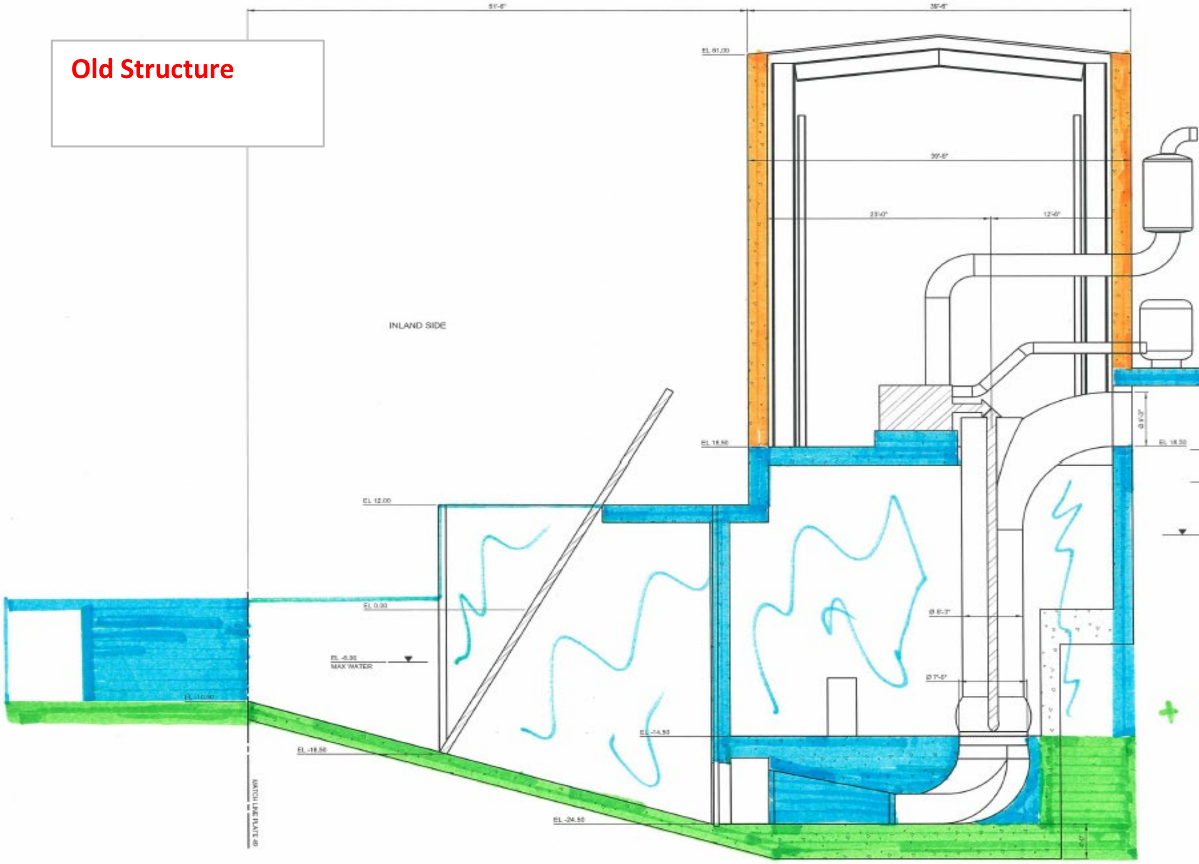
INFILL FRAMING:

The infill framing beams of the steel crane frame are assumed to be HSS 12x12x1/2.

Weight:	76	lb/ft	
Length:	20	ft	
Number of Infill Beams per Pump Bay:	10		5 each side
Total Number of Pump Bays:	9		
Number of Infill Beams at Safe House Enclosure:	60		

Total Number of Steel HHS 12x12x1/2 Beams:	**150**	
Total Length of Steel HHS 12x12x1/2 Beams:	**3000**	**ft**
Total Weight of Steel HHS 12x12x1/2 Beams:	**114**	**tons**

Old Structure



1,222 ft³ × 9

\+ 4,573 ft³

17,537

~~16,438~~ ft³ × 9

\+ 78,380 ft³

\+ 27,868 ft³

7,301 ft³ × 9

\+ 57,471 ft³

GALVESTON ISLAND 3 PUMP STATION
SECTION 1

COASTAL TEXAS PROTECTION AN
RESTORATION FEASIBILITY STUD'

U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS

# of Pumps: 8

Note: All Volumes based on Cale's 2nd version minus substructure volume changes (−9.41')

– Numbered wall Dimensions from Galveston Island #1 Pump Station concrete Walls Structural calculations

W_2 = width of bay = 20'

Total Volume of Conc. per Pump:

$$17{,}577\ ft^3 - 9.41'(t_{11}L_{11} + t_2W_2 + t_{10}L_{10} + t_3W_3)$$

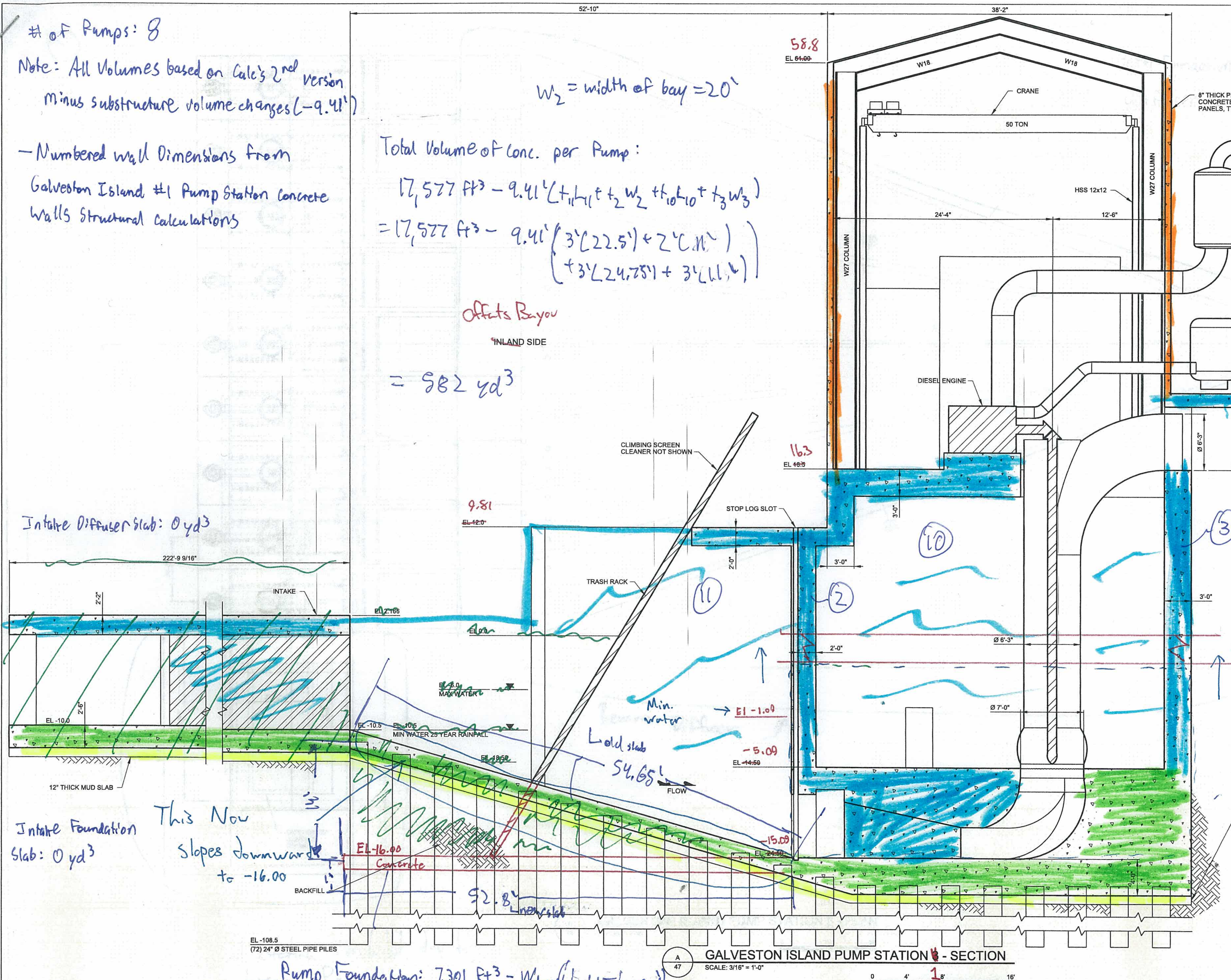
$$= 17{,}577\ ft^3 - 9.41'\left(3'(22.5') + 2'(11') + 3'(24.75') + 3'(11.6')\right)$$

$= 582\ yd^3$

Safehouse Super structure: $4{,}573\ ft^3 = 169\ yd^3$

Pump Superstructure: $1{,}222\ ft^3 = 45\ yd^3$/pump

Offatts Bayou



Intake Diffuser Slab: $0\ yd^3$

Safehouse substructure: $27{,}868\ ft^3 = 1{,}032\ yd^3$

Remove 9.41 ft of height from the structure, Shifting bottom (FSI) portion upward

Intake Foundation Slab: $0\ yd^3$

This Now Slopes downward to −16.00

NOTES:

1. ALL PILES ARE 24" Ø STEEL PIPE PILES.
2. MUD SLAB IS 2500 PSI LEAN CONCRETE, 12" THICKNESS.

A 47 GALVESTON ISLAND PUMP STATION 1 - SECTION

SCALE: 3/16" = 1'-0"

0 4' 8' 16'

Pump Foundation: $7301\ ft^3 - W_{bay}(L_{old} - L_{new})$

$= 7301\ ft^3 - 20'(54.65' - 52.8') = 7264\ ft^3 = 269\ yd^3$

GALVESTON ISLAND 3 PUMP STATION SECTION 1

COASTAL TEXAS PROTECTION AND RESTORATION FEASIBILITY STUDY

U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS

ENGINEERING APPENDIX
DATED:
NOVEMBER 9, 2018
TETRA TECH, INC.

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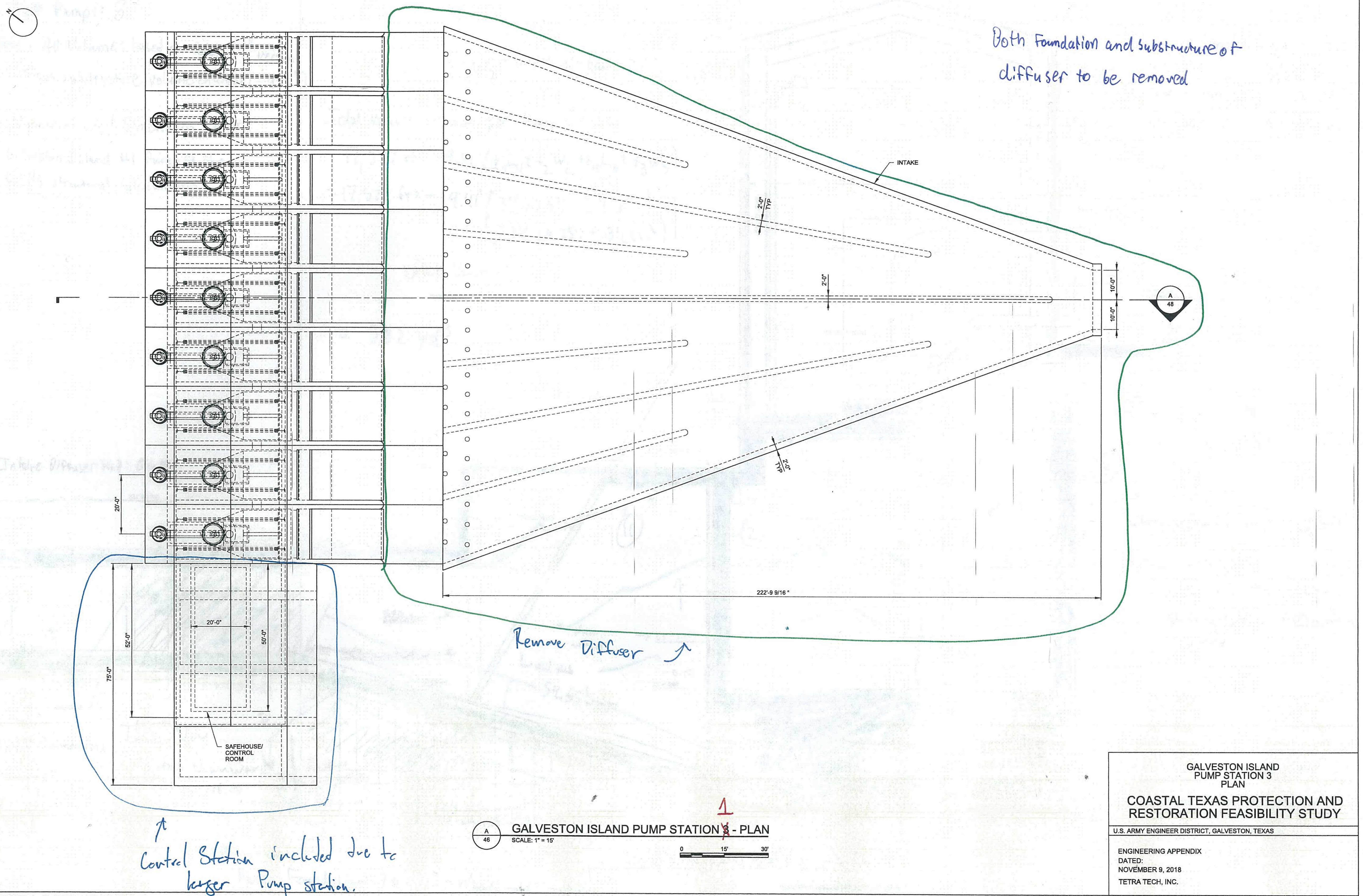
Checked by EOF Pump Station 1 update - Rev 2/5/20 NRT



A
46

GALVESTON ISLAND PUMP STATION ~~3~~ 1 - PLAN

SCALE: 1" = 15'

0 15' 30'

GALVESTON ISLAND
PUMP STATION 3
PLAN

COASTAL TEXAS PROTECTION AND RESTORATION FEASIBILITY STUDY

U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS

ENGINEERING APPENDIX
DATED:
NOVEMBER 9, 2018

TETRA TECH, INC.

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Jeff.Lee1 10:59:36 AM 11/8/2018

TETRA TECH Calculation Cover Sheet

Job No.:	100-RCE-18-09-1				
Project:	Coastal Texas Protection and Restoration				
Title:	GI1-PS-EE-MT-001				
Design Topic:	Galveston Island Pump Station 1 Electrical Quantities				
Made By:	JS	**Date:** 02/14/20	**Chk'd By:** AJB	**Date:**	02/19/20

Calc Body Pages	Appended Pages	Total Pages

Document code

Site	Feature	Discipline	Document type	Number
GI1	PS	EE	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Discription
A	JUSTIN SERRA 08/17/2018	ALBERT BARNES 08/20/2018	
B	JUSTIN SERRA 02/14/2020 Justin Serra	ALBERT BARNES 02/19/2020 Albert Barnes	Revise to reflect pump station increase to 4500 cfs

TETRA TECH **Calculation Body**

Job No.:	100-RCE-18-09-1						
Project:	Coastal Texas Protection and Restoration						
Title:	GI1-PS-EE-MT-001						
Design Top	Galveston Island Pump Station 1 Electrical Quantities						
Made By:	JS	**Date:**	02/14/20	**Chk'd By:**	AJB	**Date:**	02/19/20

GI1-PS-EE-MT-001

1.0 ISSUE BEING ADDRESSED

2.0 APPROACH

Applying the National Electrical Code (NEC) and Unified facilities guide specifications division26 - electric of the USACE

3.0 REFERENCES

References used during this calculation are as follows:

1) NFPA 70 - National Electrical Code - 2017
2) Design and Analysis of building electrical systems, John H. Matthews
3) Unified facilities guide specificaitons division 26 - Electrical

4.0 RESULT SUMMARY/VERIFICATION

RESULTS / CONCLUSIONS

ITEMS TO BE VERIFIED

1) Number of pumps
2) Number of motors
3) Building size

5.0 ASSUMPTIONS

ASSUMPTIONS AND INPUTS

Assumptions made during this calculation are as follows

1) 9 500cfs diesel motors
2) Demand factors for electric motors and size of electric motors in sizing main service transformer
3) 3 diesel generators
4) Pump Station layout of 8-15-2018 for distances and quantities of electrical equipment.
5) Adequate power is available within 250 feet of pump station location

5.0 CALCULATIONS

Galveston Island Pump Station has three diesel generators. The pump station will have a single generator to supply back up power to electric pump to provide compressed air to start deisel motors. Two diesel generators to provide power to the rest of the pump house systems, controls, lights and operations area of the pump house. The pump station generator will have a 5 day supply of fuel for the generator to provide uninterrupted power.

TETRA TECH

Calculation Body

Job No.:	100-RCE-18-09-1						
Project:	Coastal Texas Protection and Restoration						
Title:	GI1-PS-EE-MT-001						
Design Top	Galveston Island Pump Station 1 Electrical Quantities						
Made By:	JS	**Date:**	02/14/20	**Chk'd By:**	AJB	**Date:**	02/19/20

GI1-PS-EE-MT-001

Item No.	Item Description	Quantity	Unit
ELECTRICAL ITEMS			
Galveston Island Pump Station 1			
1	**TELEPHONE/COMMUNICATION SYSTEM**		
	a. Telephone Patch Panel	1	Ea
	b. Master Desk Telephone	1	Ea
	c. Combination Telephone/Intercom	5	Ea
	d. 1" RMC Conduit	200	Lf
	e. Telephone cable	200	Lf
	f. Cable Terminations	20	Ea
	PUMP STATION LIGHTS AND FIXTURES		
	a. High Bay Down Lighting	20	Ea
	b. Wall Lights	20	Ea
	c. Warning Light	20	Ea
	d. Warning Horn	2	Ea
	e. Mast Lights with 30' Mast	10	Ea
	f. Emergancy Battery Lighting	30	Ea
	g. 3/4" RMC	3,000	CLF
	h. Lighting Connection Whips	40	Ea
	i. Ceiling Lights	20	Ea
	PUMP STATION VIDEO/CCTV SYSTEM		
	a. Video Camera	10	Ea
	b. Network Hub	2	Ea
	c. DVR	2	Ea
	d. 1" RMC	500	Lf
	e. Video Cable	500	Lf
	f. 2" RMC	0	Lf
	g. Fiber Optic Cable	0	Lf
	h. LCD television monitors, with audio, 8-inch	2	Ea
	i. Cable Terminations	50	Ea
	j. Monitoring Software	1	Ea
	FUEL STORAGE VIDEO/CCTV SYSTEM		
	a. Video Camera	2	Ea
	b. 3/4" RMC	1,000	Lf
	c. Video Cable	1,000	Lf
	d. 2" RMC	0	Lf
	e. Fiber Optic Cable	0	Lf
	f. Cable Terminations	50	Ea
	PUMP STATION FIRE ALARM AND DETECTION SYSTEM		
	a. Air Sampling (Ionization) Detector	6	Ea
	b. Thermal (Heat) Detector	6	Ea

	c. Smoke Detector	6	Ea
	d. Pull Station	4	Ea
	e. Bell	2	Ea
	f. Fire Alarm Control Panel	2	Ea
	g. Main Fire Alarm Control Panel	1	Ea
	h. Detector Cable	300	Lf
	i. Alarm Cable	300	Lf
	j. 8 Fiber Optic Cable	0	Lf
	k. 3/4" RMC for Routing Fire Alarm Cable	300	Lf
	l. 2" RMC for Routing Fiber Optic Cable	0	Lf
	m. Cable Terminations	20	Ea
	FUEL STORAGE FIRE ALARM AND DETECTION SYSTEM		
	a. Air Sampling (Ionization) Detector	2	Ea
	b. Thermal (Heat) Detector	2	Ea
	c. Smoke Detector	2	Ea
	d. Pull Station	2	Ea
	e. Bell	1	Ea
	f. Fire Alarm Control Panel	1	Ea
	g. Main Fire Alarm Control Panel	0	Ea
	h. Detector Cable	500	Lf
	i. Alarm Cable	500	Lf
	j. 8 Fiber Optic Cable	0	Lf
	k. 3/4" RMC for Routing Fire Alarm Cable	500	Lf
	l. 2" RMC for Routing Fiber Optic Cable	0	Lf
	m. Cable Terminations	20	Ea
	PUMP STATION CONTROLS AND SENSORS		
	a. Control Cabinet w/ PLC, power supply, processor, comm. Matrix, realys and network hub	3	Ea
	b. PLC Analog Inputs and Outputs	100	Ea
	c. PLC Digital Inputs and Ouputs	100	Ea
	d. Operators Control Cabinet w/ pushbuttons, switches, etc.	4	Ea
	e. Human/Machine Interface (HMI)	6	Ea
	f. Software for programming PLC and HMI	1	Ea
	g. 3/4" RMC	500	Lf
	h. 1" RMC	250	Lf
	i. 12 Pair Fiber Optic Cable	0	Lf
	j. 2" RMC for Fiber optic	0	Lf
	k. Controls Panelboard, 120/240V/ 60A, 2d. ckt, w/20A ckt bkr	4	Ea
	l. Circuit Breakers, Various Sizes, 1-pole	100	Ea
	m. Cable Terminations	200	Ea
	n. Gearbox heaters	4	Ea
	FUEL STORAGE CONTROLS AND SENSORS		
	a. Control Cabinet w/ PLC, power supply, processor, comm. Matrix, realys and network hub	1	Ea

	b. PLC Analog Inputs and Outputs	100	Ea
	c. PLC Digital Inputs and Ouputs	100	Ea
	d. Operators Control Cabinet w/ pushbuttons, switches, etc.	1	LOT
	e. Human/Machine Interface (HMI)	2	Ea
	f. Software for programming PLC and HMI	0	Ea
	g. 3/4" RMC	300	Lf
	h. 1" RMC	300	Lf
	i. 2#14 AWG braided conductors	500	Lf
	j. Limit Switches	20	Ea
	k. Flow sensors	10	Ea
	l. Level sensors	10	Ea
	m. Valvue Actuators	20	Ea
	n. Leak Sensors	10	Ea
	o. Fuel Temp Sensors	10	Ea
	p. Relays	20	Ea
	INCOMING POWER		
	a. 35' Pole	3	Ea
	b. Overhead Conductors	250	Lf
	c. Pull Boxes	5	Ea
	d. Misc Hardware	1	LOT
	e. Cable Terminations	10	Ea
	PUMP STATION LIGHTING CONDUCTORS		
	a. #12 AWG Stranded Copper	2,500	Lf
	b. #10 AWG Stranded Copper	2,500	Lf
	c. #8 AWG Stranded Copper	1,000	Lf
	d. Pull Boxes	1,000	Ea
	e. Cable Terminations	2,500	Ea
	FUEL STORAGE LIGHTING		
	a. #12 AWG Stranded Copper	0	Lf
	b. #10 AWG Stranded Copper	200	Lf
	c. #8 AWG Stranded Copper	200	Lf
	d. Pull Boxes	20	Ea
	e. Cable Terminations	50	Ea
	f. Mast Lights with 30' Mast	6	Ea
	MOTOR CONTROL CENTER - MCCx12		
	a. MCC - Section	24	Ea
	b. Main Disconnect Circuit Breaker - MDCB	12	Ea
	c. Combination Starter	20	Ea
	d. Control Transformer	4	Ea
	e. Circuit Breaker	100	Lf
	f. 3-#12 AWG, 1 - #12 AWG	1000	Lf
	g. 3-#10 AWG, 1 - #10 AWG	1000	Lf
	h. 3-#8 AWG, 1 - #10 AWG	500	Lf

	PUMP STATION RECEPTACLES		
	a. 5-20R Receptacles	40	Ea
	b. #10 AWG Stranded Copper	500	Lf
	c. 100A 3P-5W NEMA-3R Power Outlet	6	Ea
	d. 4#1 AWG, 1#8 AWG EGC	2,000	Lf
	e. Pull Boxes	12	Ea
	f. Cable Terminations	50	Ea
	FUEL STORAGE RECEPTACLES		
	a. 5-20R Receptacles NEMA 4X	20	Ea
	b. #10 AWG Stranded Copper	250	Lf
	c. 100A 3P-5W NEMA-4X Power Outlet	2	Ea
	d. 4#1 AWG, 1#8 AWG EGC	500	Lf
	e. Pull Boxes	6	Ea
	f. Cable Terminations	20	Ea
	Automatic Transfer switches		
	a. Medium Voltage Automatic Transfer switches	0	Ea
	b. Low Voltage Automatic Transfer Switches	9	Ea
	c. Diconnect Switches	20	Ea
	d. Fused Disconnect Switches	2	Ea
	Stand-by Generators		
	a. 1000kW Generator	1	Ea
	b. 250kW Generator	2	Ea
	c.100kW Generator	0	Ea
	d. Load Banks	3	Ea
	e. Control Panel	3	Ea
	Power Transformers		
	a. 1000kVA	1	Ea
	b. 50kVA	0	Ea
	c. 30kVA	5	Ea
	d. 15kVA	5	Ea
	Conductors		
	a. #14 AWG	4000	Lf
	b. #12 AWG	2500	Lf
	c. #10 AWG	2500	Lf
	d. #8 AWG	2000	Lf
	e. #6 AWG	2000	Lf
	f. #4 AWG	1000	Lf
	g. #3 AWG	0	Lf
	h. #2 AWG	0	Lf
	i. #1 AWG	1000	Lf
	j. 1/0 AWG	1000	Lf

	k. 2/0 AWG	0	Lf
	l. 3/0 AWG	0	Lf
	m. 4/0 Awg	2000	Lf
	n. 350 kmill	0	Lf
	o. 500 kmill	0	Lf
	Conduits		
	a. 3/4" RMC	3000	Lf
	b. 1" RMC	2000	Lf
	c. 1 1/4" RMC	0	Lf
	d. 1 1/2" RMC	500	Lf
	e. 2" RMC	2000	Lf
	f. 2 1/2" RMC	0	Lf
	g. 3" RMC	500	Lf
	h. 4" RMC	300	Lf
	Motors		
	a. 1-hp, 3PH, 480VAC	0	Ea
	b. 2-hp, 3PH, 480VAC	10	Ea
	c. 5-hp, 3PH, 480VAC	0	Ea
	d. 10-hp, 3PH, 480VAC	10	Ea
	e. 20-hp, 3PH, 480VAC	10	Ea
	f. 30-hp, 3PH, 480VAC	0	Ea
	g. 50-hp, 3PH, 480VAC	2	Ea

TETRA TECH	Galveston Island 1 Pump Station Quantities		Calculation No. GI1-PS-ME-MT-001
Job No.:	100-RCE-18-09-1	**Page:**	1
Project:	Coastal Texas Protection and Restoration		
Description:	Galveston Island 1 Pump Station Quantities		
Made By: NRT	**Date:** 02/11/20	**Chk'd By:** LAL	**Date:** 02/13/20

Calc Body Pages	Appended Pages	Total Pages
3	3	6

Document code

Site	Feature	Discipline	Document type	Number
GI1	PS	ME	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Carl Grompe 08/02/2018	Eric Flickinger 11/08/2018	
B	Nathan Tobin 02/11/2020 NT	Lois Loesch 02/13/2020	Revised to reflect updated 4500 cfs pumping capacity

TETRA TECH	**Galveston Island 1 Pump Station Quantities**	**Calculation No.** **GI1-PS-ME-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	NRT	**Date:**	02/11/20	**Chk'd By:**	LAL	**Date:**	02/13/20

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ISSUE BEING ADDRESSED

Mechanical equipment quantity take-offs for preliminary cost estimate for Pump Station at Galveston Island 1.

APPROACH

Equipment falls into 2 categories, sets of equipment in every bay, and equipment unrelated to the number of bays

REFERENCES

References used during this calculation are as follows:

1) Mechanical drawings by Tetra Tech
2) WCC cross section
3) Patterson pump drawings from PCCP

RESULTS / CONCLUSIONS

See calculation sections

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) 5 days fuel storage

TETRA TECH	**Galveston Island 1 Pump Station Quantities**	**Calculation No.** GI1-PS-ME-MT-001	

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	NRT	**Date:**	02/11/20	**Chk'd By:**	LAL	**Date:**	02/13/20

CALCULATIONS

Equipment in every bay

Number of Bays	9	
Trash Rack	884	ft^2
Trash rake (climbing style)	1	
Formed suction intake (type 10 for Ø84")	1	
Vertical Pump (500 cfs)	1	
Custom discharge piping	1	
Vacuum break	1	
Angle gearbox/speed reducer	1	
Diesel engine (CAT 32-C[1] Marine)	1	
Exhaust line	38	ft
Exhaust muffler	1	
Air intake line	22	ft
Air intake filter/silencer	1	
Day Tank (700 gal)	1	
Double walled fuel pipe (Ø1.5" w/leak detection)	40	ft
Ventilation fan	1	

Other equipment

Sump stop log	60	ft^2
Stop log hoist	1	
Diesel Storage tanks (10,000 gal)	8	
Main fuel pumps	16	
Double walled fuel pipe (Ø3" w/leak detection)	520	ft
Fuel conditioning (filter type or centrifuge type)	1	
Air Compressor	3	
Lube oil tank	1	
Bridge crane (capacity 50 tons)	2	
Trash conveyor	255	ft
Fire protection system	1	

TETRA TECH	Galveston Island 1 Fuel Tank Foundations Quantities	Calculation No. GI1-PS-ST-MT-002

Job No.: 100-RCE-18-09-1 **Page:** 1

Project: Coastal Texas Protection and Restoration

Description: Galveston Island 1 Fuel Tank Foundations Quantities

Made By: NRT **Date:** 02/10/20 **Chk'd By:** LAL **Date:** 02/13/20

Calc Body Pages	Appended Pages	Total Pages
7	0	7

Document code

Site	Feature	Discipline	Document type	Number
GI1	PS	ST	MT	002

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Lexee Navarre 09/21/2018	Daniel Stuard 09/21/2018	
B	Nathan Tobin 02/10/2020 NRT	Lois Loesch 02/13/2020 Lois Loesch	Updated to reflect increased pumping capacity

TETRA TECH	**Galveston Island 1 Fuel Tank Foundations Quantities**	**Calculation No.** **GI1-PS-ST-MT-002**

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	NRT	**Date:**	02/10/20	**Chk'd By:**	LAL	**Date:**	02/13/20

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Attachments	Number of Pages	Last Page Number

TETRA TECH	Galveston Island 1 Fuel Tank Foundations Quantities	Calculation No. GI1-PS-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	NRT	**Date:**	02/10/20	**Chk'd By:**	LAL	**Date:**	02/13/20

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for fuel tank foundations.
New pumping station capacity will be 4500 cfs.

APPROACH

Typical engineering means and methods for determining volumes and weights.

REFERENCES

References used during this calculation are as follows:

1) GI1-PS-ST-CL-001
2) GI1-PS-ME-CL-001

RESULTS / CONCLUSIONS

Total # of Pipe Piles:	72	(All piles have tension connections)			
Total 24" Diam. X 0.5" Steel Pipe Pile:	4014.0	ft	**or**	252.1	tons
Total # of Pile Caps:	18				
Total Concrete per Cap:	13.3	yd^3			
Pile Cap Concrete:	240.0	yd^3			

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) Material Properties:
   - Concrete, f'c = 4000 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
2) Costs of reinforcement is included in reinforced concrete unit cost.
3) All piles have tension connections.
4) Total number of Tanks = 9

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

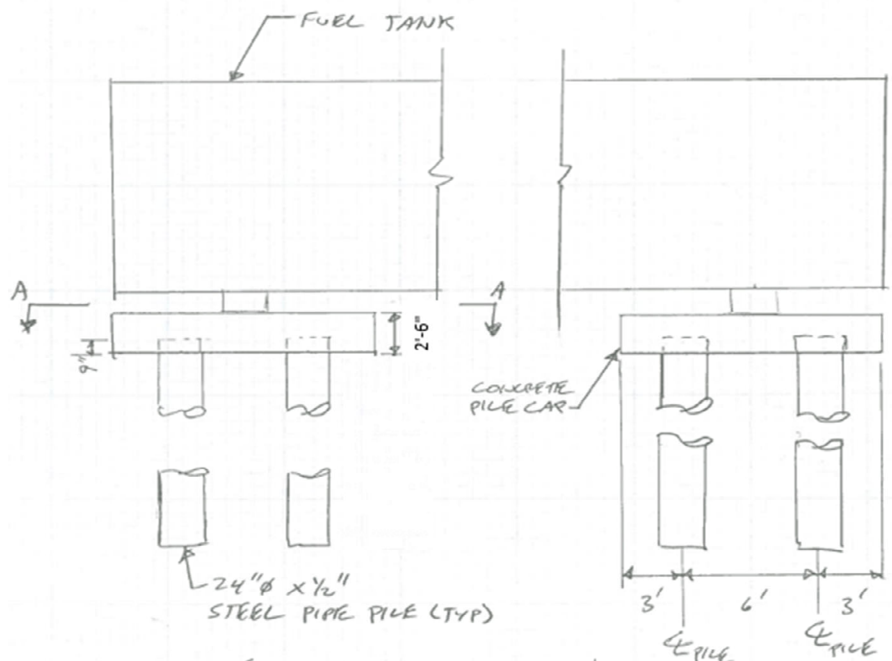
1) Materials and quantites as design progresses.

CALCULATIONS

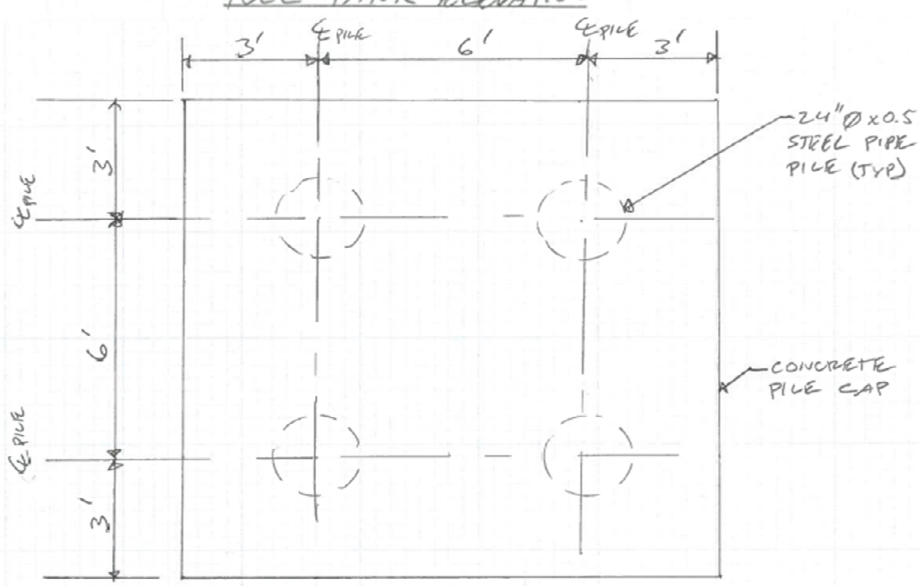
Begin on next page.

Made By:	NRT	**Date:**	02/10/20	**Chk'd By:**	LAL	**Date:**	02/13/20

General References and Figures



FUEL TANK ELEVATION

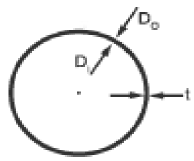


FUEL TANK PILE CAP PLAN (A-A)

TETRA TECH	Galveston Island 1 Fuel Tank Foundations Quantities	Calculation No. GI1-PS-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	6
Project:	Coastal Texas Protection and Restoration						
Description:	General References and Figures						
Made By:	NRT	**Date:**	02/10/20	**Chk'd By:**	LAL	**Date:**	02/13/20

Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = $10.69*t*(D_o-t)$
D_o (in) - outside diameter
t (in) - thickness of pipe

Pipe Weight (kg/m) = $0.0247*t*(D_o-t)$
D_o (mm) - outside diameter
t (mm) - thickness of pipe

PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)												
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

TETRA TECH	Galveston Island 1 Fuel Tank Foundations Quantities	Calculation No. GI1-PS-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	7
Project:	Coastal Texas Protection and Restoration						
Description:	Quantities for Fuel Tank Foundations						
Made By:	NRT	**Date:**	02/10/20	**Chk'd By:**	LAL	**Date:**	02/13/20

Quantities for Fuel Tank Foundations

PILES

The minimum tip embedment is to be 55 feet plus 9 inches of embedment into concrete slab.

Pile Diameter: 24.0 in
Pipe Thickness: 0.5 in
Pipe Weight*: 125.61 lb/ft
Pile Tip to Head Embedment: 55.75 ft

*see general references attachments for reference of produced value

Number of Caps per Tank: 2
Total Number of Tanks: 9
Total Number of Pile Caps: 18
Number of Piles per Cap: 4

Total Number of Piles: **72**
Total of Steel Pipe Piles: **4014.0 ft** **or** **252.1 tons**

CONCRETE:

PILE CAPS:

Thickness (ft)	Width (ft)	Cross Sectional Area (ft^2)	Length (ft)	Volume (yd^3)
2.5	12	30	12	13.3

Total Number of Pile Caps: 18 (see piles section)

Total Concrete: **240 yd^3**

TETRA TECH	Galveston Island #2 Pump Station Quantities	Calculation No. GI2-PS-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Galveston Island Pump Station #2 Quantites				
Made By:	RSK	**Date:** 02/05/20	**Chk'd By:** LAL	**Date:**	02/10/20

Calc Body Pages	Appended Pages	Total Pages
14	2	16

Document code

Site	Feature	Discipline	Document type	Number
GI2	PS	ST	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Lexee Navarre 7/31/2018	Carl Grompe 9/21/2018	
B	Michael Hough 11/6/2018	Jason Kikuta 11/7/2018	Revised for updated geometry and design
C	Robert Kramer 2/5/2020 Robert Kramer	Lois Loesch 2/10/2020 Lois Loesch	Revised for updated water surface elevations

TETRA TECH	Galveston Island #2 Pump Station Quantities	Calculation No. GI2-PS-ST-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:	Revision Summary						
Made By:	RSK	**Date:**	02/05/20	**Chk'd By:**	LAL	**Date:**	02/10/20

Revision Summary

Revision Summary

Reason for Revision: USACE provided new SWL elevations following new storm analysis. For pump station 2, this resulted in a jump in stormwater elevation from El 12 to EL 13.4. To meet this new demand, the pump house substructure and superstructure were raised 1.4'. This led to updated concrete quantities. There is no change to the pump station capacity.

Symbols:

t_{11}: thickness of wall 11 — L_{11}: Length of wall 11

t_{10}: thickness of wall 10 — L_{10}: Length of wall 10

t_7: thickness of wall 7 — w_7: Width of wall 7

t_2: thickness of wall 2 — w_2: Width of wall 2

Source for Revisions:

Galveston Island #2 Pump Station Concrete Walls Structural Calculations
Galveston Island #2 Intake Structure Concrete Walls Structural Calculations

Revised Inputs:
* All revised inputs are in **red bold print** within calculation package

Revised Item	Location	Original Number	Updated Number	Updates to Number
Total Volume of Concrete for Precast Concrete Wall Pannels per Pump Bay*:	Substructure Quantities	603.8 yd^3	**619 yd^3**	Increased wall height for walls labelled 2, 7, 10 and 11
Total Volume of Intake Structure	Substructure Quantities	332 yd^3	**413.6 yd^3**	Increased wall height for walls labelled 1 and 2

TETRA TECH	Galveston Island #2 Pump Station Quantities	Calculation No. GI2-PS-ST-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	RSK	**Date:**	02/05/20	**Chk'd By:**	LAL	**Date:**	02/10/20

TABLE OF CONTENTS

TETRA TECH	Galveston Island #2 Pump Station Quantities	Calculation No. GI2-PS-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	4
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	RSK	**Date:** 02/05/20	**Chk'd By:** LAL	**Date:**	02/10/20

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for Pump Station #2 at Galveston Island.

New water levels are:

100 yr. - 11.32 ft (use 11.3 ft)

500 yr. - 16.36 ft (use 16.9 ft.)

Assumes 2.1 ft. RSLR

APPROACH

Typical engineering means and methods.

REFERENCES

References used during this calculation are as follows:

1) Plate 43 - as noted
2) Plate 42

RESULTS / CONCLUSIONS

PILES:

Total # of 24" Diam. X 5/8" Vertical Pipe Piles:	248			
Total 24" Diam. X 5/8" Steel Pipe Pile:	19840 ft	**OR**	1549 tons	
Total PZ-22 Steel Sheet Pile:	2924.25 ft^2	**OR**	32 tons	

CONCRETE:

FOUNDATIONS:		
Total Concrete for Base Slab:	1062 yd^3	
Total Concrete for Mud Slab:	212 yd^3	
Total:	1275 yd^3	
SUBSTRUCTURE:		
Total:	**3254** yd^3	
SUPERSTRUCTURE:		
Total:	305 yd^3	8" Thick Precast Concrete Wall Panels
TOTAL CONCRETE:	**4834** yd^3	

STEEL:

SUPERSTRUCTURE:

Total Number of W27x194 Steel Columns:	24			
Length	1020	ft	**OR**	99 tons
Total Number of W18X143 Steel Roof Beams:	12			
Length	474	ft	**OR**	34 tons
Total Number of W18X143 Steel Roof Beams:	18			
Length	360	ft	**OR**	26 tons

CRANE FRAME:

Total Number of Steel HHS 12x12x1/2 Columns:	24			
Length	900	ft	**OR**	34 tons
Total Number of W18X192 Steel Top Rails:	18			
Length	360	ft	**OR**	35 tons
Total Number of 30 lb/ft Crane Rails:	18			
Length	360	ft	**OR**	5 tons
Total Number of Steel HHS 12x12x1/2 Beams:	90			
Length	1800	ft	**OR**	68 tons

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) Excavation is to be determined by others.
2) Number of pumps = 3
3) Material Properties:
   - Concrete for base slab, allowable f'c = 4000 psi
   - Concrete for mud slab, allowable f'c = 2500 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
   - Sheet Piles = ASTM A328
4) All piles have tension connections.

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Material types and properties.
2) Layout, elevations and dimensions of Pump Station.

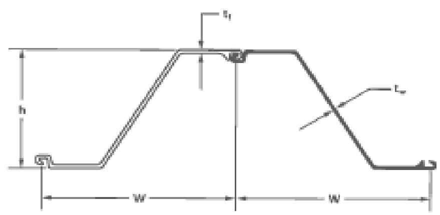
CALCULATIONS

Begin on next page.

General References and Figures

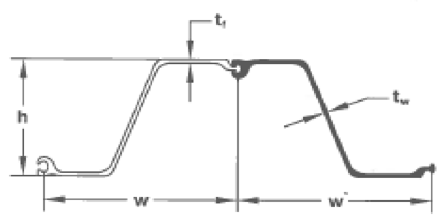
NZ/PZ

NZ/PZ Hot Rolled Steel Sheet Pile



NZ

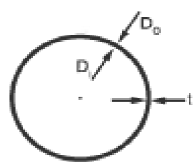
SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS: Flange (t_f) in (mm)	THICKNESS: Web (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT: Pile lb/ft (kg/m)	WEIGHT: Wall lb/ft² (kg/m²)	SECTION MODULUS: Elastic in³/ft (cm³/m)	SECTION MODULUS: Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA: Both Sides ft²/ft of single (m²/m)	COATING AREA: Wall Surface ft²/ft² (m²/m²)
NZ 19	27.56 700	16.14 410.0	0.375 9.5	0.375 9.5	7.04 148.9	55 81.85	23.95 116.93	35.08 1886	41.33 2222	283.1 38659	6.18 1.88	1.35 1.35
NZ 20	27.56 700	16.16 410.5	0.394 10.0	0.394 10.0	7.29 154.4	57 84.83	24.82 121.18	36.24 1948	42.80 2301	292.8 39984	6.18 1.88	1.35 1.35
NZ 21	27.56 700	16.20 411.5	0.433 11.0	0.433 11.0	7.80 165.2	61 90.78	26.56 129.68	38.69 2080	45.85 2465	313.4 42797	6.18 1.88	1.35 1.35
NZ 26	27.56 700	17.32 440.0	0.500 12.7	0.500 12.7	9.08 192.3	71 105.66	30.92 150.94	48.50 2608	57.01 3065	419.9 57340	6.49 1.98	1.41 1.41



PZ

SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS: Flange (t_f) in (mm)	THICKNESS: Wall (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT: Pile lb/ft (kg/m)	WEIGHT: Wall lb/ft² (kg/m²)	SECTION MODULUS: Elastic in³/ft (cm³/m)	SECTION MODULUS: Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA: Both Sides ft²/ft of single (m²/m)	COATING AREA: Wall Surface ft²/ft² (m²/m²)
PZ 22	22.0 559	9.0 229	0.375 9.50	0.375 9.50	6.47 136.9	40.3 60.0	22.0 107.4	18.1 973	21.79 1171.4	84.38 11500	4.48 1.37	1.22 1.22
PZ 27	18.0 457	12.0 305	0.375 9.50	0.375 9.50	7.94 168.1	40.5 60.3	27.0 131.8	30.2 1620	36.49 1961.9	184.20 25200	4.48 1.37	1.49 1.49
PZ 35	22.6 575	14.9 378	0.600 15.21	0.500 12.67	10.29 217.8	66.0 98.2	35.0 170.9	48.5 2608	57.17 3073.5	361.22 49300	5.37 1.64	1.42 1.42
PZ 40	19.7 500	16.1 409	0.600 15.21	0.500 12.67	11.77 249.1	65.6 97.6	40.0 195.3	60.7 3263	71.92 3866.7	490.85 67000	5.37 1.64	1.64 1.64

Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = 10.69*t*(D_o-t)
D_o (in) - outside diameter
t (in) - thickness of pipe

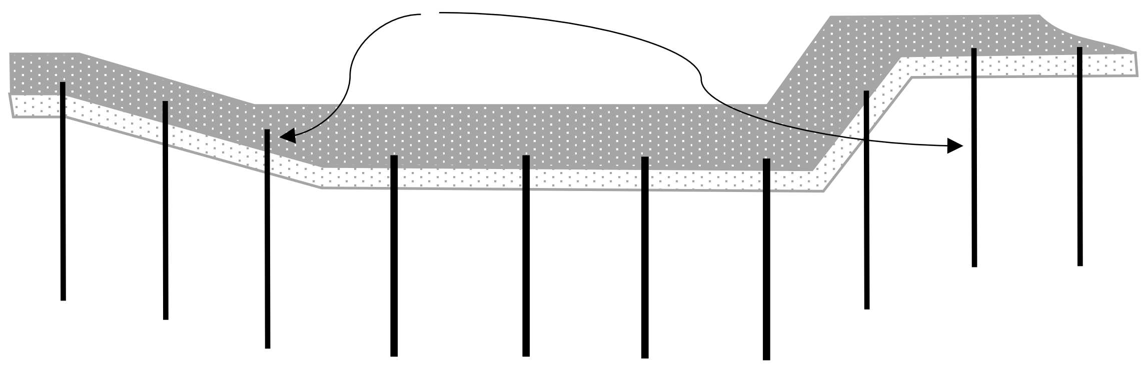
Pipe Weight (kg/m) = 0.0247*t*(D_o-t)
D_o (mm) - outside diameter
t (mm) - thickness of pipe

PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	**Wall Thickness (t) in** (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

Quantities for Pump Station Foundations

Figure 1:



PILES

Number of Piles 72 At Pumps

Number of Piles 32 At Safe House Enclosure Slab

Pile Diameter: 24 in

Pile Thickness: 5/8 in

Pile Weight: 156.17 lb/ft

*see general references attachments for reference of produced value

Piles	# of Piles per row	Rows	Pile Weight (lb/ft)	Start EL (ft)	End EL (ft)	Length (ft)	Weight (ton)	Total Length (ft)	Total Weight (ton)
Pumps	3	24	156.17	-10.0	-90.0	80.0	6.2	5760	449.8
Safe House	8	4	156.17	0.0	-80.0	80.0	6.2	2560	199.9

Piles (24" diam x 5/8")

Total # of Piles per Pump: 72
Total Length per Pump: 5760 ft
Total Weight per Pump: 450 tons

Total Number of Pumps: 3

Total # of Piles at Safe House Enclosure: 32
Total Length at Safe House: 2560 ft
Total Weight at safe house: 200 tons

TOTALS:	**# of 24" diam x 5/8" Piles:**	**248**
	Length of 24" diam x 5/8":	**19840 ft**
	Weight of 24" diam x 5/8":	**1549 tons**

SHEET PILE

Note: It is assumed that the sheet pile wall used at WCC for seepage control will also be the same kind used at Clear Creek.
A PZ-22 hot rolled sheet piling shall be utilized for seepage cutoff.

Start EL of Sheet Pile Wall: -25.0 ft
End EL of Sheet Pile Wall: -46.0 ft
Height of Sheet Pile Wall: 21.0 ft

Weight of Sheet Pile Wall*: 22.0 lb/ft^2
Length of Sheet Pile Wall: 46.4 ft

*see general references attachments for reference of produced value

# of Walls	Area (ft^2)	Weight of Wall (lb/ft^2)	Weight (tons)
1	974.8	22.0	10.7

Total Number of Pumps: 3

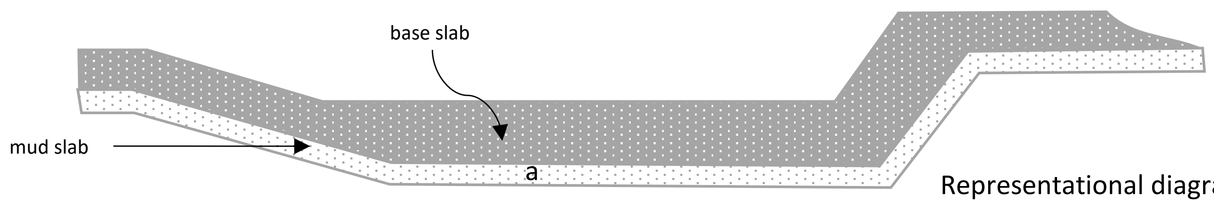
Total Area per Pump: 975 ft^2
Total Weight per Pump: 11 tons

TOTALS:	**Area:**	**2924 ft^2**
	Weight:	**32 tons**

TETRA TECH	**Galveston Island #2 Pump Station Quantities**	**Calculation No. GI2-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1			**Page:**	11
Project:	Coastal Texas Protection and Restoration				
Description:	Quantities for Pump Station Foundations				
Made By:	RSK	**Date:** 02/05/20	**Chk'd By:**	LAL	**Date:** 02/10/20

Figure 2:



Representational diagram

CONCRETE

FOUNDATION BASE SLAB:

F'c: 4,000 psi
Width of Slab: 20.0 ft

Total Volume of Concrete per Pump*: 277 yd^3
Total Number of Pumps: 3
Intake Slab: 232
Total Foundation Slab Concrete: 1062 yd^3

*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.

MUD SLAB:

Note: Please see attached Plate 43 drawing for concrete sectioning. It is assumed that this pump station will also have a mud slab like West Closure Complex. Lengths of sections are estimates for the preliminary design phase.

F'c: 2,500 psi
Width of Slab: 20.0 ft **Slab Thickness:** 12.0 in

Section	Length (ft)	Thickness (in)	Cross Sectional Area (ft^2)	Width (ft)	Volume (yd^3)	
a	95.5	12.00	95.50	20.0	70.74	Per Model

Total Mud Slab Concrete per Pump: 71 yd^3
Total Number of Pumps: 3
Total Mud Slab Concrete: 212 yd^3

TOTAL CONCRETE: 1275 yd^3

TETRA TECH	Galveston Island #2 Pump Station Quantities		Calculation No. GI2-PS-ST-MT-001
Job No.:	100-RCE-18-09-1	**Page:**	12
Project:	Coastal Texas Protection and Restoration		
Description:	Pump Station Substructure Quantities		
Made By:	RSK **Date:** 02/05/20	**Chk'd By:** LAL	**Date:** 02/10/20

Pump Station Substructure Quantities

CONCRETE

Total Volume of Concrete per Pump*:	**619.2**	yd^3	*Note: this value was obtained from a solid model developed for the design of this pump station, see attached. *Note: This value was also modified due to the pumphouse height being increased by 1.4' to meet new expected SWL
Total Number of Pumps:	3		
Total Volume of Concrete at Safe House*:	983.0	yd^3	
Total Volume of Concrete at Intake Diffuser*:	**413.6**	yd^3	
Total Concrete:	**3254**	**yd^3**	

Galveston Island #2 Pump Station Quantities

TETRA TECH

Calculation No. GI2-PS-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	13
Project:	Coastal Texas Protection and Restoration				
Description:	Pump Station Superstructure Quantities				
Made By:	RSK	**Date:** 02/05/20	**Chk'd By:** LAL	**Date:**	02/10/20

Pump Station Superstructure Quantities

PRECAST CONCRETE WALL PANELS

Total Volume of Concrete per Pump Bay*:	45	yd^3	*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.
Total Number of Pump Bays:	3		
Total Volume of Concrete at Safe House Enclosure*:	169	yd^3	

Total Concrete: 305 yd^3

STEEL

COLUMNS:

The columns of the steel superstructure frame will be W27X194.

Weight:	194	lb/ft	
Height:	42.5	ft	
Number of Columns per Pump Bay:	4		
Total Number of Pump Bays:	3		
Number of Columns at Safe House Enclosure:	12		Per Plans

Total Number of W27x194 Steel Columns:	**24**	
Total Length of W27x194 Steel Columns:	**1020**	**ft**
Total Weight of W27x194 Steel Columns:	**99**	**tons**

TETRA TECH	Galveston Island #2 Pump Station Quantities	Calculation No. GI2-PS-ST-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	14
Project:	Coastal Texas Protection and Restoration						
Description:	Pump Station Superstructure Quantities						
Made By:	RSK	**Date:**	02/05/20	**Chk'd By:**	LAL	**Date:**	02/10/20

LONGITUDINAL ROOF BEAMS (spanning length of pump bay):

The longitudinal roof beams of the steel superstructure frame will be W18X143.

Weight:	143	lb/ft	
Length:	39.5	ft	
Number of Roof Beams per Pump Bay:	2		
Total Number of Pump Bays:	3		
Number of Beams at Safe House Enclosure:	6		Per Plans

Total Number of W18X143 Steel Roof Beams:	**12**	
Total Length of W18X143 Steel Roof Beams:	**474**	**ft**
Total Weight of W18X143 Steel Roof Beams:	**34**	**tons**

TRANSVERSE ROOF BEAMS (spanning width of pump bay):

The tansverse roof beams of the steel superstructure frame are W18X143.

Weight:	143	lb/ft	
Length:	20	ft	
Number of Roof Beams per Pump Bay:	2		
Total Number of Pump Bays:	3		
Number of Beams at Safe House Enclosure:	12		Per Plans

Total Number of W18X143 Steel Roof Beams:	**18**	
Total Length of W18X143 Steel Roof Beams:	**360**	**ft**
Total Weight of W18X143 Steel Roof Beams:	**26**	**tons**

TETRA TECH	Galveston Island #2 Pump Station Quantities	Calculation No. GI2-PS-ST-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	15
Project:	Coastal Texas Protection and Restoration						
Description:	Pump Station Crane Frame Quantities						
Made By:	RSK	**Date:**	02/05/20	**Chk'd By:**	LAL	**Date:**	02/10/20

Pump Station Crane Frame Quantities

STEEL

COLUMNS:

The columns of the steel crane frame are assumed to be HSS 12x12x1/2.

Weight:	76	lb/ft
Height:	37.5	ft
Number of Columns per Pump Bay:	4	
Total Number of Pump Bays:	3	
Number of Columns at Safe House Enclosure:	12	

Total Number of Steel HHS 12x12x1/2 Columns:	**24**	
Total Length of Steel HHS 12x12x1/2 Columns:	**900**	**ft**
Total Weight of Steel HHS 12x12x1/2 Columns:	**34**	**tons**

TOP RAIL:

The top rail of the steel crane frame will be W18X192.

Weight:	192	lb/ft
Length:	20	ft
Number of Top Rails per Pump Bay:	2	
Total Number of Pump Bays:	3	
Number of Top Rails at Safe House Enclosure:	12	

Total Number of Top Rails:	**18**	
Total Length of Top Rails:	**360**	**ft**
Total Weight of Top Rails:	**35**	**tons**

CRANE RAIL:

Added to the top rail will be a 30 lb/ft crane rail.

Weight:	30	lb/ft
Length:	20	ft
Number of Crane Rails per Pump Bay:	2	
Total Number of Pump Bays:	3	
Number of Crane Rails at Safe House Enclosure:	12	

Total Number of Crane Rails:	**18**	
Total Length of Crane Rails:	**360**	**ft**
Total Weight of Crane Rails:	**5**	**tons**

INFILL FRAMING:

The infill framing beams of the steel crane frame are assumed to be HSS 12x12x1/2.

Weight:	76	lb/ft	
Length:	20	ft	
Number of Infill Beams per Pump Bay:	10		5 each side
Total Number of Pump Bays:	3		
Number of Infill Beams at Safe House Enclosure:	60		

Total Number of Steel HHS 12x12x1/2 Beams:	**90**	
Total Length of Steel HHS 12x12x1/2 Beams:	**1800**	**ft**
Total Weight of Steel HHS 12x12x1/2 Beams:	**68**	**tons**

Superstructure:

Safehouse: 159 yd³ (Based on Solid Works Model)

Superstructure Conc. per Bay: 45 yd³ (Based on Solid Works Model)

Substructure:

Safehouse: 983 yd³ (Based on Solid Works Model)

Intake Structure:

$V_{intake_0} = 8961\ ft^3$

$L_{w_1} = 55\ ft$ $t_{w_1} = 1.5\ ft$

$L_{w_2} = 41.25\ ft$ $t_{w_2} = 1.5\ ft$

# of Wall 1's = 2 # of Wall 2's = 1

(Based on Galveston Island Pump Station #2 Intake structure Conc. Wall)

Increase in wall Height: 1.4 ft (Updated Drawings 2/5/20)

$$V_{intake_f} = V_{initial_{intake}} + \Delta H(2L_{w_1} \cdot t_{w_1} + L_{w_2} \cdot t_{w_2})$$

$$= 8961\ ft^3 + 1.4\ ft(2(55\ ft)(1.5\ ft) + 41.25\ ft(1.5\ ft))$$

$$= 9278\ ft^3 = \underline{344\ yd^3}$$

Pumphouse:

# of Pumps: 3

$V_{PH_{initial}}$: 16,303 ft³

$t_{11} = 3'$ $L_{11} = 29.8'$

$t_7 = 2'$ $L_7 = 20'$

$t_{10} = 3'$ $L_{10} = 42.75'$

$t_2 = 2'$ $L_2 = 20'$

(Based on Galveston Island Pump Station #3 Concrete Walls Structural Calculations)

Increase in wall Height: 1.4 ft (Updated Drawings 2/5/20)

$$V_{PH_{final}} = V_{PH_{initial}} + \Delta H(t_{11}L_{11} + t_7L_7 + t_{10}L_{10} + t_2L_2) =$$

$$= 16,303\ ft^3 + 1.4'(3'(29.8') + 2'(20') + 3'(42.75') + 2'(20'))$$

$$= 16,719.71\ ft^3 = \underline{619\ yd^3}$$ per pump

TETRA TECH

Job Number ______
Vol./Sheet ______ of ______

Contract/Client: Galveston
Phase/Subject: Galveston Island Pump Station 2
Design Topic: Concrete Quantities — Page 18
Made By: RSK Date: 2/6/19 Checked By: ______ Date: ______

Foundation:

Intake slab: 232 yd^3

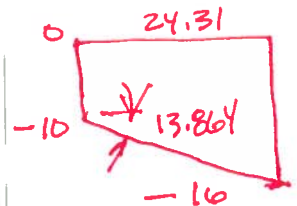
Pump Foundation: 277 yd^3 per pump

Mud slab: 71 yd^3 per pump

(Based on Solid Works Model)

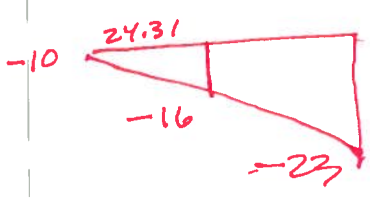
LAL 2/10/20

End walls

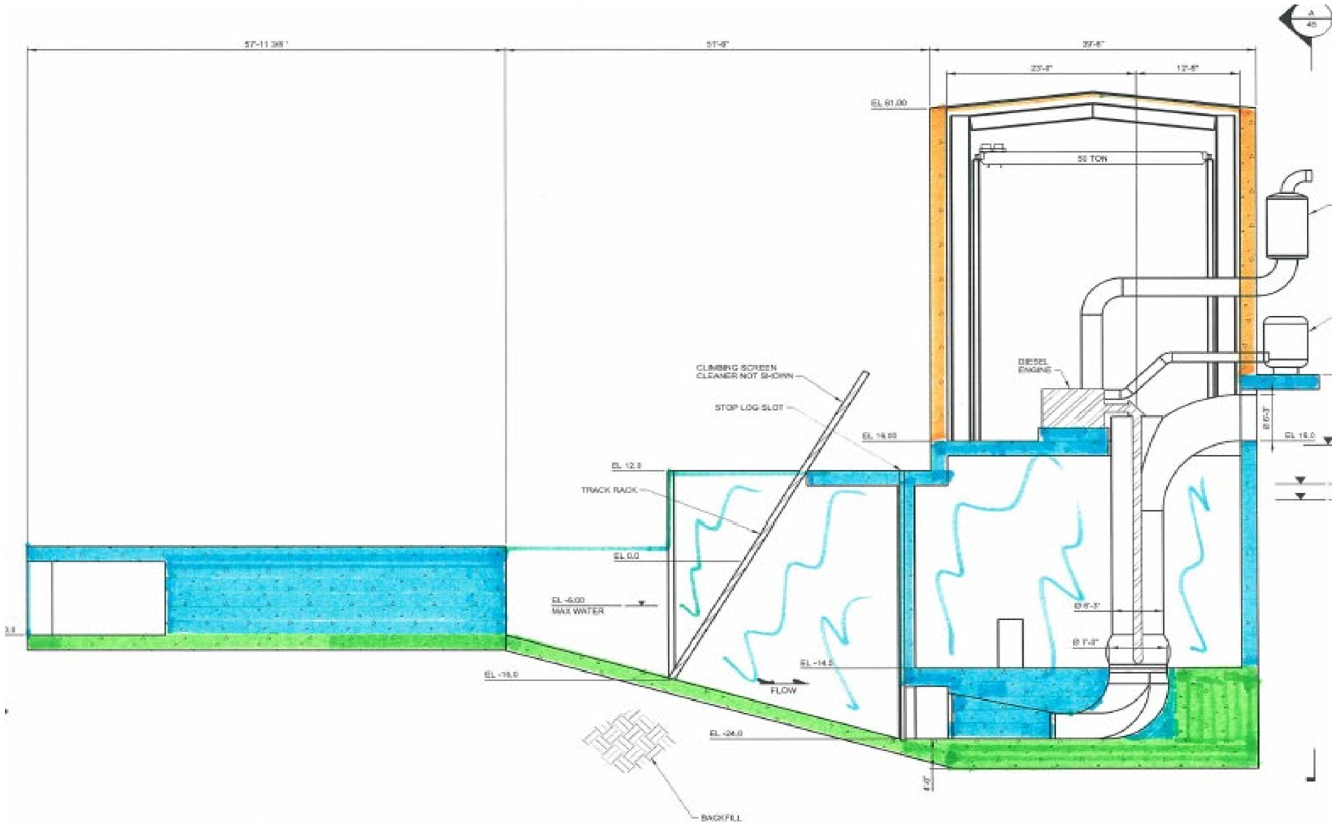


$V = \underbrace{2}_{\text{2 walls}} \times 3FT \times \left[(10 \times 24.31) + \frac{24.31}{2}(6) \right] \times \frac{1}{27}$

$= 70.2\ CY$



$\tan(13.864) = 13/L \rightarrow L = 52.67\ FT$

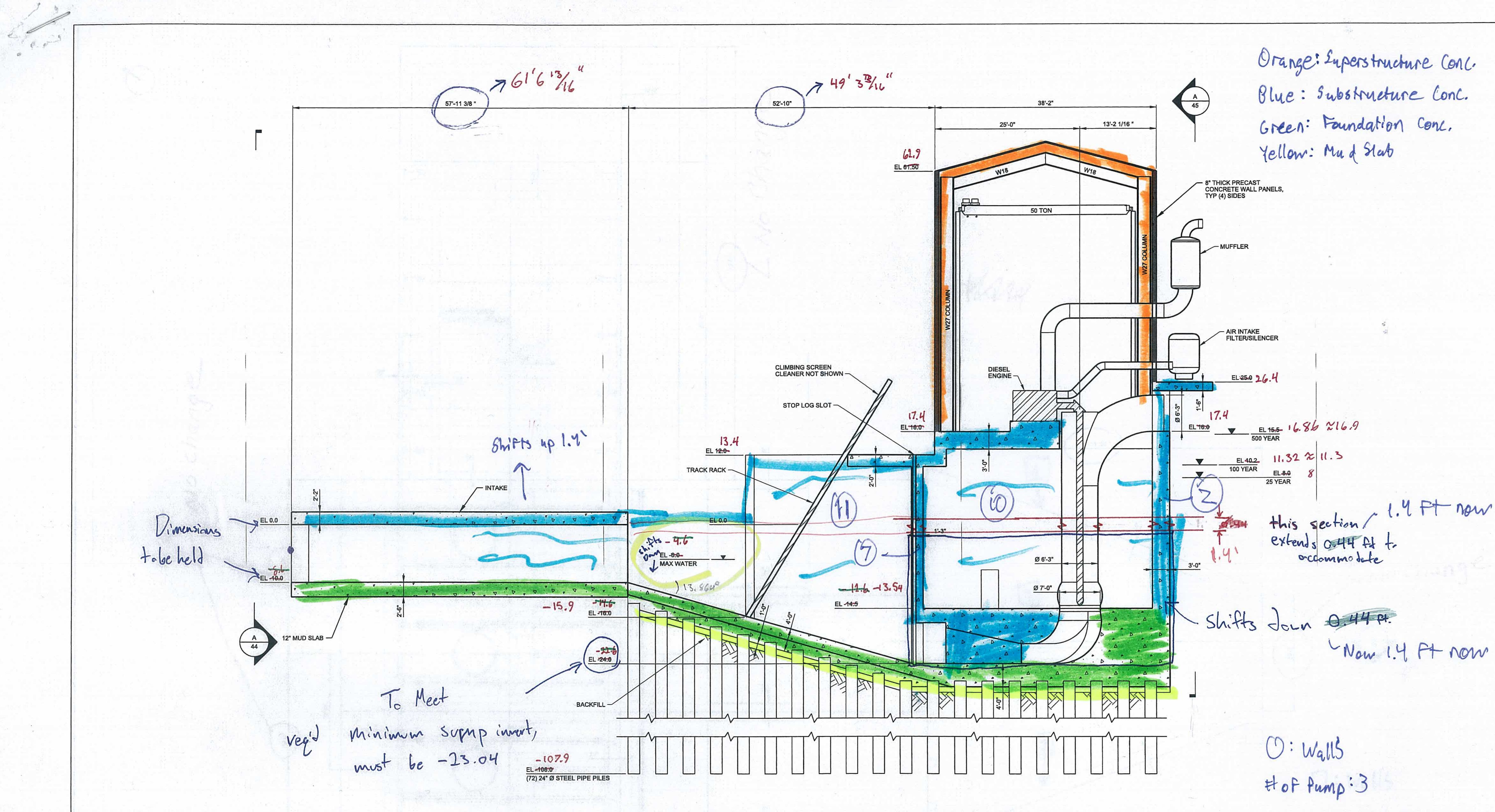


Old Concrete Volume Summary

1,141 ft^3 ×3
+ 4,573 ft^3

16,303
~~13,363~~ ft^3 ×3
+ 8961 ft^3
+ 26,542 ft^3

7,475 ft^3 ×3
+ 6,262 ft^3



A
42
GALVESTON ISLAND PUMP STATION 2 - SECTION
SCALE: 1/8" = 1'-0"

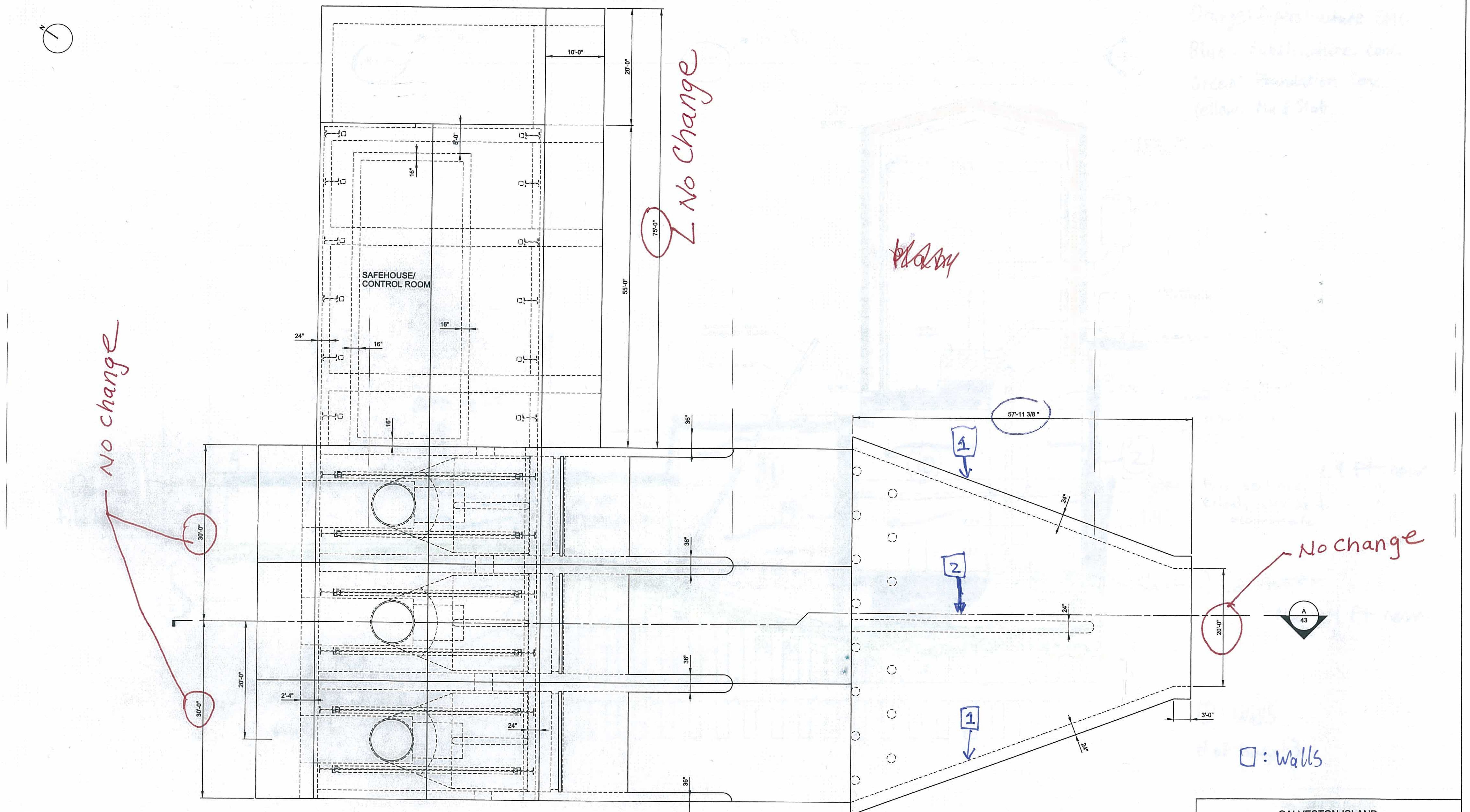
0 4' 8' 16'

GALVESTON ISLAND
PUMP STATION 2
SECTION

COASTAL TEXAS PROTECTION AND RESTORATION FEASIBILITY STUDY

U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS

ENGINEERING APPENDIX
DATED:
NOVEMBER 9, 2018
TETRA TECH, INC.



A
41
GALVESTON ISLAND PUMP STATION 2 - PLAN
SCALE: 1/8" = 1'-0"
0 4' 8' 16'

GALVESTON ISLAND
PUMP STATION 2
PLAN

COASTAL TEXAS PROTECTION AND
RESTORATION FEASIBILITY STUDY

U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS

ENGINEERING APPENDIX
DATED:
NOVEMBER 9, 2018
TETRA TECH, INC.

TETRA TECH **Calculation Cover Sheet**

Job No.:	100-RCE-18-09-1						
Project:	Coastal Texas Protection and Restoration						
Title:	GI2-PS-EE-MT-001						
Design Topic:	Galveston Island Pump Station 2 Electrical Quantities						
Made By:	JS	**Date:**	02/14/20	**Chk'd By:**	AJB	**Date:**	02/19/20

Calc Body Pages	Appended Pages	Total Pages

Document code

Site	Feature	Discipline	Document type	Number
GI2	PS	EE	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Discription
A	JUSTIN SERRA 08/17/2018	ALBERT BARNES 08/20/2018	
B	JUSTIN SERRA 02/14/2020 Justin Serra	ALBERT BARNES 02/19/2020 Albert Barnes	Confirm with pump station 1500 cfs

TETRA TECH **Calculation Body**

Job No.:	100-RCE-18-09-1
Project:	Coastal Texas Protection and Restoration
Title:	GI2-PS-EE-MT-001
Design Top	Galveston Island Pump Station 2 Electrical Quantities

Made By: JS **Date:** 02/14/20 **Chk'd By:** AJB **Date:** 02/19/20

GI2-PS-EE-MT-001

1.0 ISSUE BEING ADDRESSED

2.0 APPROACH

Applying the National Electrical Code (NEC) and Unified facilities guide specifications division26 - electric of the USACE

3.0 REFERENCES

References used during this calculation are as follows:

1) NFPA 70 - National Electrical Code - 2017
2) Design and Analysis of building electrical systems, John H. Matthews
3) Unified facilities guide specificaitons division 26 - Electrical

4.0 RESULT SUMMARY/VERIFICATION

RESULTS / CONCLUSIONS

ITEMS TO BE VERIFIED

1) Number of pumps
2) Number of motors
3) Building size

5.0 ASSUMPTIONS

ASSUMPTIONS AND INPUTS

Assumptions made during this calculation are as follows

1) Large diesel powered motors will have a summed less than 10 HP worth of support motors.
2) Demand factors for electric motors and size of electric motors in sizing main service transformer
3) Pump Station layout of 8-15-2018 for distances and quantities of electrical equipment.
4) Adequate power is available within 250 feet of pump station location

5.0 CALCULATIONS

Galveston Island Pump Station two has 3 diesel pumps. Each pump bay in the pump station is approximately 20'x70'x60'. The pump station will have an additional 2 bays to contain the control room and living quarters for the pump station and pump station staff. The additional space is for the maintenance area and machine shop for the pump station. The pump station length will be 100' in length and the addition of large clearance required for removal and replacement of equipment will result in the minimum width of 70'. The segregation of the pump house equipment to insure no one single fault resulting in the loss of power and function to the entire pump house requires

multiple separate distribution power systems in the pump house.

Item No.	Item Description	Quantity	Unit
ELECTRICAL ITEMS			
Galveston Island Pump Station 2			
1	**TELEPHONE/COMMUNICATION SYSTEM**		
	a. Telephone Patch Panel	1	Ea
	b. Master Desk Telephone	1	Ea
	c. Combination Telephone/Intercom	5	Ea
	d. 1" RMC Conduit	200	Lf
	e. Telephone cable	200	Lf
	f. Cable Terminations	20	Ea
	PUMP STATION LIGHTS AND FIXTURES		
	a. High Bay Down Lighting	6	Ea
	b. Wall Lights	10	Ea
	c. Warning Light	2	Ea
	d. Warning Horn	2	Ea
	e. Mast Lights with 30' Mast	6	Ea
	f. Emergancy Battery Lighting	6	Ea
	g. 3/4" RMC	500	CLF
	h. Lighting Connection Whips	40	Ea
	i. Ceiling Lights	20	Ea
	PUMP STATION VIDEO/CCTV SYSTEM		
	a. Video Camera	10	Ea
	b. Network Hub	2	Ea
	c. DVR	2	Ea
	d. 1" RMC	500	Lf
	e. Video Cable	500	Lf
	f. 2" RMC	0	Lf
	g. Fiber Optic Cable	0	Lf
	h. LCD television monitors, with audio, 8-inch	2	Ea
	i. Cable Terminations	50	Ea
	j. Monitoring Software	1	Ea
	FUEL STORAGE VIDEO/CCTV SYSTEM		
	a. Video Camera	2	Ea
	b. 3/4" RMC	1,000	Lf
	c. Video Cable	1,000	Lf
	d. 2" RMC	0	Lf
	e. Fiber Optic Cable	0	Lf
	f. Cable Terminations	50	Ea
	PUMP STATION FIRE ALARM AND DETECTION SYSTEM		
	a. Air Sampling (Ionization) Detector	6	Ea
	b. Thermal (Heat) Detector	6	Ea

	c. Smoke Detector	6	Ea
	d. Pull Station	4	Ea
	e. Bell	2	Ea
	f. Fire Alarm Control Panel	2	Ea
	g. Main Fire Alarm Control Panel	1	Ea
	h. Detector Cable	300	Lf
	i. Alarm Cable	300	Lf
	j. 8 Fiber Optic Cable	0	Lf
	k. 3/4" RMC for Routing Fire Alarm Cable	300	Lf
	l. 2" RMC for Routing Fiber Optic Cable	0	Lf
	m. Cable Terminations	100	Ea
	n. Fire Pump	4	Ea
	FUEL STORAGE FIRE ALARM AND DETECTION SYSTEM		
	a. Air Sampling (Ionization) Detector	2	Ea
	b. Thermal (Heat) Detector	2	Ea
	c. Smoke Detector	2	Ea
	d. Pull Station	2	Ea
	e. Bell	1	Ea
	f. Fire Alarm Control Panel	1	Ea
	g. Main Fire Alarm Control Panel	0	Ea
	h. Detector Cable	500	Lf
	i. Alarm Cable	500	Lf
	j. 8 Fiber Optic Cable	0	Lf
	k. 3/4" RMC for Routing Fire Alarm Cable	500	Lf
	l. 2" RMC for Routing Fiber Optic Cable	0	Lf
	m. Cable Terminations	50	Ea
	n. Fire Pump	4	Ea
	PUMP STATION CONTROLS AND SENSORS		
	a. Control Cabinet w/ PLC, power supply, processor, comm. Matrix, realys and network hub	3	Ea
	b. PLC Analog Inputs and Outputs	100	Ea
	c. PLC Digital Inputs and Ouputs	100	Ea
	d. Operators Control Cabinet w/ pushbuttons, switches, etc.	4	Ea
	e. Human/Machine Interface (HMI)	6	Ea
	f. Software for programming PLC and HMI	1	Ea
	g. 3/4" RMC	500	Lf
	h. 1" RMC	250	Lf
	i. 12 Pair Fiber Optic Cable	0	Lf
	j. 2" RMC for Fiber optic	0	Lf
	k. Controls Panelboard, 120/240V/ 60A, 2d. ckt, w/20A ckt bkr	4	Ea
	l. Circuit Breakers, Various Sizes, 1-pole	100	Ea
	m. Cable Terminations	200	Ea
	n. Gearbox heaters	4	Ea
	FUEL STORAGE CONTROLS AND SENSORS		

	a. Control Cabinet w/ PLC, power supply, processor, comm. Matrix, realys and network hub	1	Ea
	b. PLC Analog Inputs and Outputs	100	Ea
	c. PLC Digital Inputs and Ouputs	100	Ea
	d. Operators Control Cabinet w/ pushbuttons, switches, etc.	1	LOT
	e. Human/Machine Interface (HMI)	2	Ea
	f. Software for programming PLC and HMI	0	Ea
	g. 3/4" RMC	300	Lf
	h. 1" RMC	300	Lf
	i. 2#14 AWG braided conductors	500	Lf
	j. Limit Switches	25	Ea
	k. Flow sensors	50	Ea
	l. Level sensors	50	Ea
	m. Valvue Actuators	50	Ea
	n. Leak Sensors	50	Ea
	o. Fuel Temp Sensors	50	Ea
	p. Relays	20	Ea
	INCOMING POWER		
	a. 35' Pole	3	Ea
	b. Overhead Conductors	250	Lf
	c. Pull Boxes	5	Ea
	d. Misc Hardware	1	LOT
	e. Cable Terminations	10	Ea
	PUMP STATION LIGHTING CONDUCTORS		
	a. #12 AWG Stranded Copper	300	Lf
	b. #10 AWG Stranded Copper	300	Lf
	c. #8 AWG Stranded Copper	0	Lf
	d. Pull Boxes	30	Ea
	e. Cable Terminations	50	Ea
	FUEL STORAGE LIGHTING		
	a. #12 AWG Stranded Copper	0	Lf
	b. #10 AWG Stranded Copper	200	Lf
	c. #8 AWG Stranded Copper	200	Lf
	d. Pull Boxes	20	Ea
	e. Cable Terminations	30	Ea
	f. Mast Lights with 30' Mast	6	Ea
	MOTOR CONTROL CENTER - MCCx10		
	a. MCC - Section	20	Ea
	b. Main Disconnect Circuit Breater - MDCB	12	Ea
	c. Combination Starter	20	Ea
	d. Control Transformer	4	Ea
	e. Circuit Breaker	100	Lf
	f. 3-#12 AWG, 1 - #12 AWG	500	Lf

	g. 3-#10 AWG, 1 - #10 AWG	500	Lf
	h. 3-#8 AWG, 1 - #10 AWG	250	Lf
	PUMP STATION RECEPTACLES		
	a. 5-20R Receptacles	40	Ea
	b. #10 AWG Stranded Copper	500	Lf
	c. 100A 3P-5W NEMA-3R Power Outlet	6	Ea
	d. 4#1 AWG, 1#8 AWG EGC	2,000	Lf
	e. Pull Boxes	12	Ea
	f. Cable Terminations	50	Ea
	FUEL STORAGE RECEPTACLES		
	a. 5-20R Receptacles NEMA 4X	20	Ea
	b. #10 AWG Stranded Copper	250	Lf
	c. 100A 3P-5W NEMA-4X Power Outlet	2	Ea
	d. 4#1 AWG, 1#8 AWG EGC	500	Lf
	e. Pull Boxes	6	Ea
	f. Cable Terminations	20	Ea
	Automatic Transfer switches		
	a. Medium Voltage Automatic Transfer switches	0	Ea
	b. Low Voltage Automatic Transfer Switches	3	Ea
	c. Diconnect Switches	20	Ea
	d. Fused Disconnect Switches	2	Ea
	Stand-by Generators		
	a. 250kW Generator	1	Ea
	b. 500kW Generator	2	Ea
	c. Load Banks	1	Ea
	d. Control Panel	2	Ea
	Power Transformers		
	a. 2000kVA	1	Ea
	b. 50kVA	0	Ea
	c. 30kVA	1	Ea
	d. 15kVA	2	Ea
	Conductors		
	a. #14 AWG	4000	Lf
	b. #12 AWG	500	Lf
	c. #10 AWG	500	Lf
	d. #8 AWG	500	Lf
	e. #6 AWG	0	Lf
	f. #4 AWG	1000	Lf
	g. #3 AWG	0	Lf
	h. #2 AWG	0	Lf
	i. #1 AWG	1000	Lf

	j. 1/0 AWG	1000	Lf
	k. 2/0 AWG	0	Lf
	l. 3/0 AWG	0	Lf
	m. 4/0 Awg	250	Lf
	n. 350 kmill	0	Lf
	o. 500 kmill	0	Lf
	Conduits		
	a. 3/4" RMC	1000	Lf
	b. 1" RMC	1000	Lf
	c. 1 1/4" RMC	0	Lf
	d. 1 1/2" RMC	0	Lf
	e. 2" RMC	1000	Lf
	f. 2 1/2" RMC	0	Lf
	g. 3" RMC	500	Lf
	h. 4" RMC	300	Lf
	Motors		
	a. 1-hp, 3PH, 480VAC	0	Ea
	b. 2-hp, 3PH, 480VAC	10	Ea
	c. 5-hp, 3PH, 480VAC	0	Ea
	d. 10-hp, 3PH, 480VAC	10	Ea
	e. 20-hp, 3PH, 480VAC	10	Ea
	f. 30-hp, 3PH, 480VAC	0	Ea
	g. 50-hp, 3PH, 480VAC	0	Ea

TETRA TECH	Galverton Island 2 Pump Station Quantities	Calculation No. GI2-PS-ME-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Galverton Island 2 Pump Station Quantities				
Made By:	CTG	**Date:** 11/01/18	**Chk'd By:**	**Date:**	

Calc Body Pages	Appended Pages	Total Pages
3	5	8

Document code

Site	Feature	Discipline	Document type	Number
GI2	PS	ME	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Carl Gwompe 11/8/18 [signature]	Eric Flickinger 11/8/18 [signature]	

TETRA TECH	Galverton Island 2 Pump Station Quantities	Calculation No. GI2-PS-ME-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	CTG	**Date:**	11/01/18	**Chk'd By:**	EOF	**Date:**	11/08/18

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ISSUE BEING ADDRESSED

Mechanical equipment quantity take-offs for preliminary cost estimate for Pump Station at Galveston Island 1.

APPROACH

Equipment falls into 2 categories, sets of equipment in every bay, and equipment unrelated to the number of bays

REFERENCES

References used during this calculation are as follows:

1) Mechanical drawings by Tetra Tech
2) WCC cross section
3) Patterson pump drawings from PCCP

RESULTS / CONCLUSIONS

See calculation sections

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) 5 days fuel storage

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1)

TETRA TECH	Galverton Island 2 Pump Station Quantities	Calculation No. GI2-PS-ME-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	3
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	CTG	**Date:** 11/01/18	**Chk'd By:** EOF	**Date:**	11/08/18

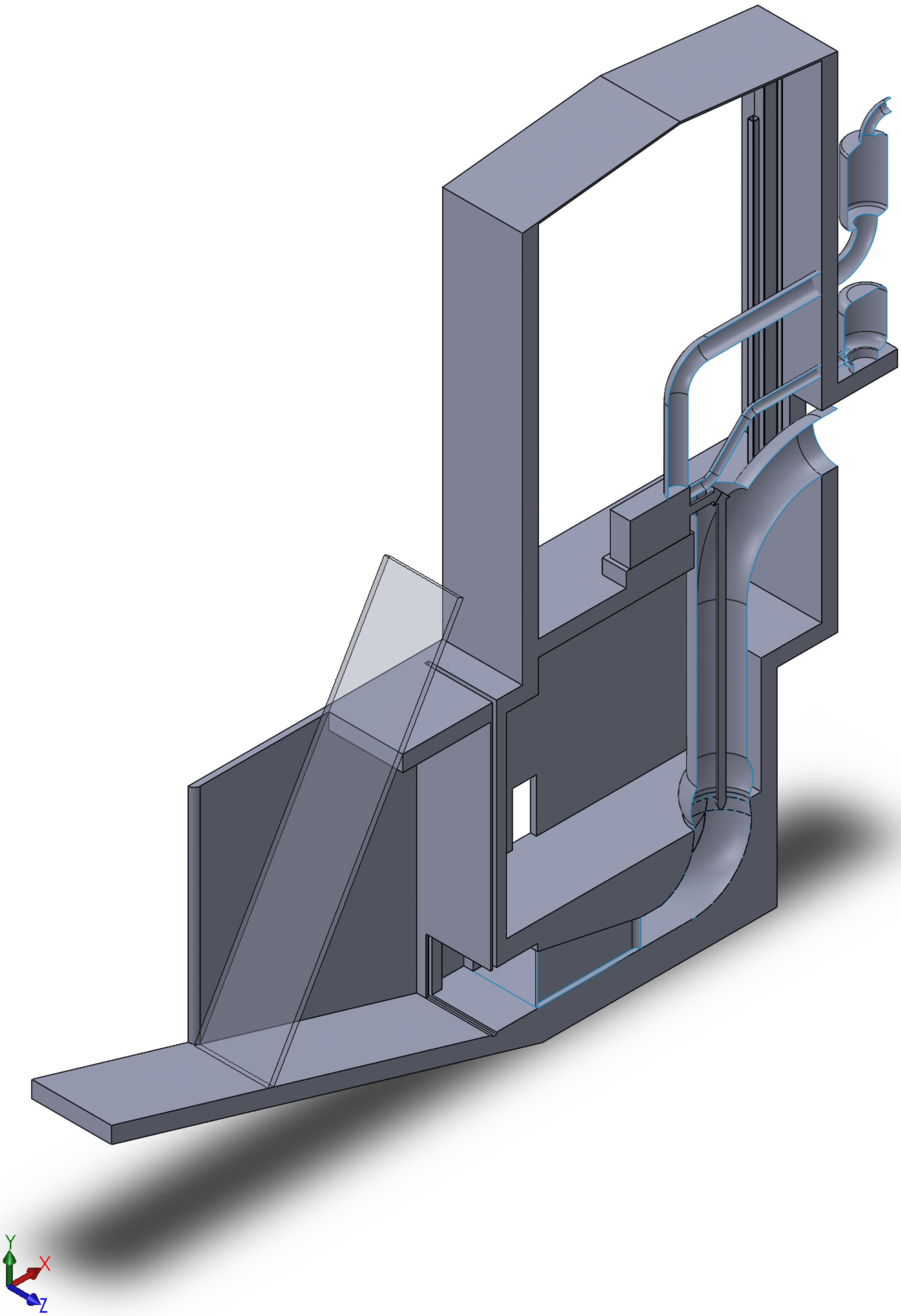
CALCULATIONS

Equipment in every bay

Number of Bays	3	
Trash rack	884	ft^2
Trash rake (climbing style)	1	
Formed suction intake (type 10 for Ø84")	1	
Vertical Pump (500 cfs)	1	
Custom discharge piping	1	
Vacuume break	1	
Angle gearbox/speed reducer	1	
Diesel engine (CAT 32-C[1] Marine)	1	
Cooling water supply lines (Ø 6")	128	ft
Cooling water pump	1	
Exhaust line	38	ft
Exhaust muffler	1	
Air intake line	22	ft
Air intake filter/silencer	1	
Day Tank (700 gal)	1	
Double walled fuel pipe (Ø1.5" w/leak detection)	40	ft
Ventilation fan	1	

Other equipment

Sump stop log	60	ft^2
Stop log hoist	1	
Diesel Storage tanks (10,000 gal)	3	
Main fuel pumps	6	
Double walled fuel pipe (Ø3" w/leak detection)	280	ft
Fuel conditioning (filter type or centrifuge type)	1	
Air Compressor	1	
Lube oil tank	1	
Bridge crane (capacity 50 tons)	2	
Trash conveyor	135	ft
Fire protection system	1	



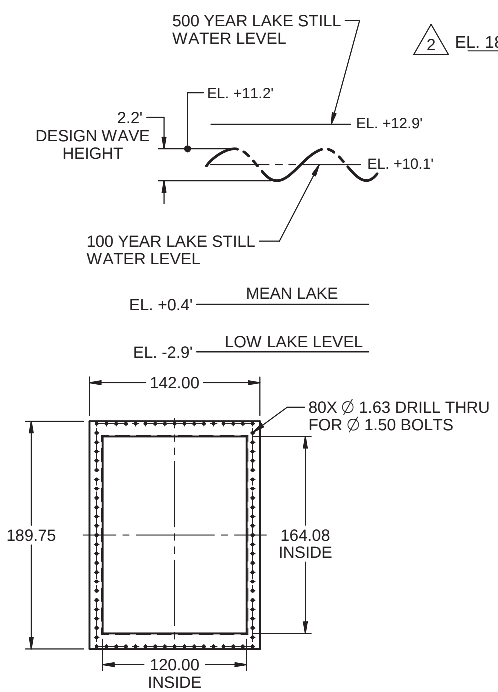
Y
X
Z

PRELIMINARY

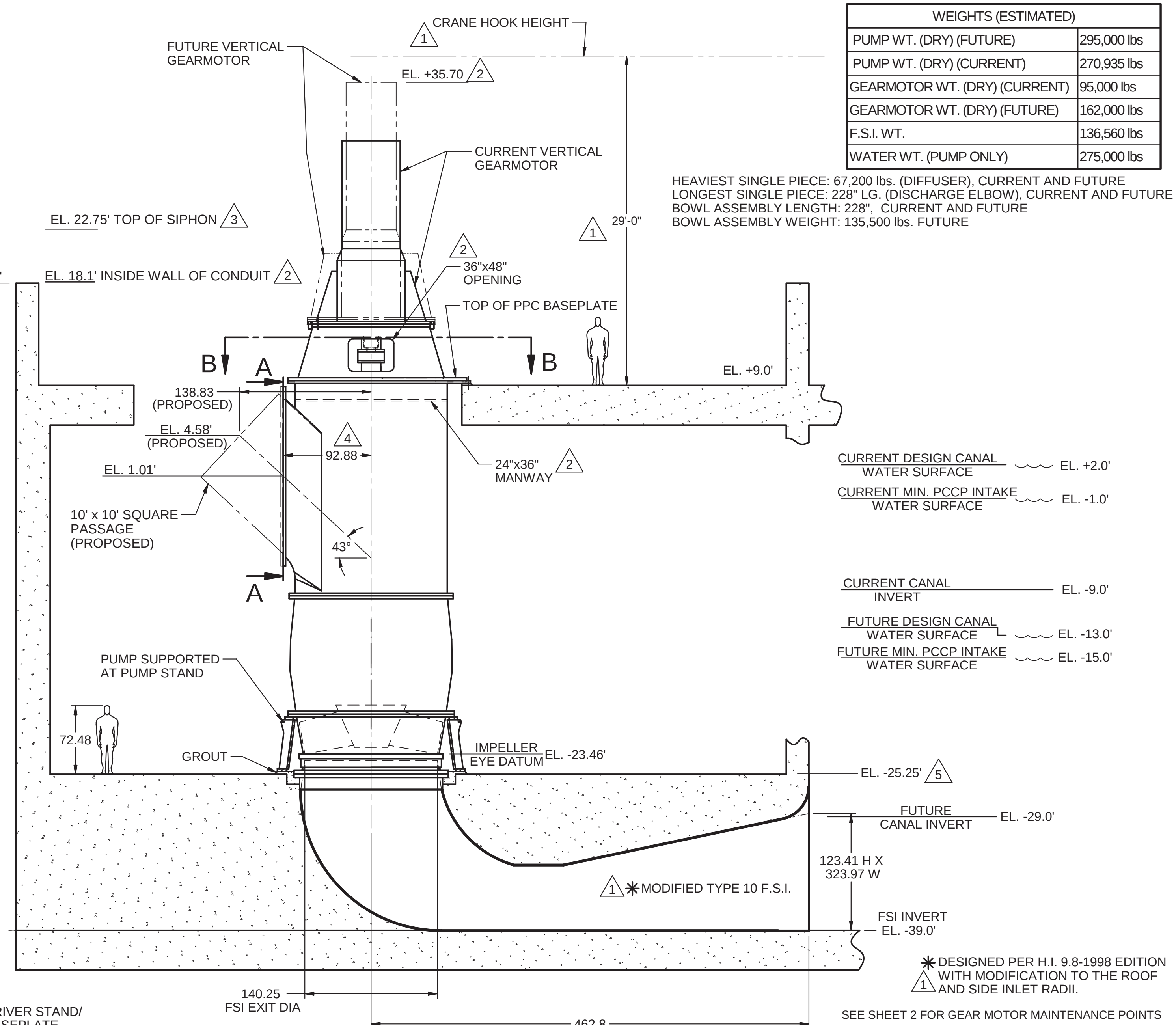
PERMANENT CANAL CLOSURE
AND PUMPING
HURRICANE PROTECTION PROJECT
W912P8-12-C-0049
LONDON AVENUE

WEIGHTS (ESTIMATED)	
PUMP WT. (DRY) (FUTURE)	295,000 lbs
PUMP WT. (DRY) (CURRENT)	270,935 lbs
GEARMOTOR WT. (DRY) (CURRENT)	95,000 lbs
GEARMOTOR WT. (DRY) (FUTURE)	162,000 lbs
F.S.I. WT.	136,560 lbs
WATER WT. (PUMP ONLY)	275,000 lbs

HEAVIEST SINGLE PIECE: 67,200 lbs. (DIFFUSER), CURRENT AND FUTURE
LONGEST SINGLE PIECE: 228" LG. (DISCHARGE ELBOW), CURRENT AND FUTURE
BOWL ASSEMBLY LENGTH: 228", CURRENT AND FUTURE
BOWL ASSEMBLY WEIGHT: 135,500 lbs. FUTURE



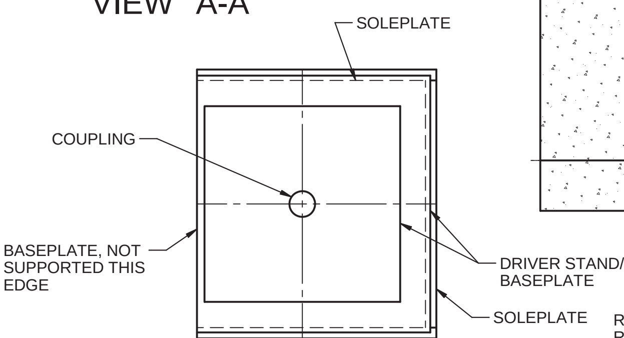
VIEW "A-A"



✳ DESIGNED PER H.I. 9.8-1998 EDITION WITH MODIFICATION TO THE ROOF AND SIDE INLET RADII.

SEE SHEET 2 FOR GEAR MOTOR MAINTENANCE POINTS

SHEET 1 OF 2



VIEW "B-B"

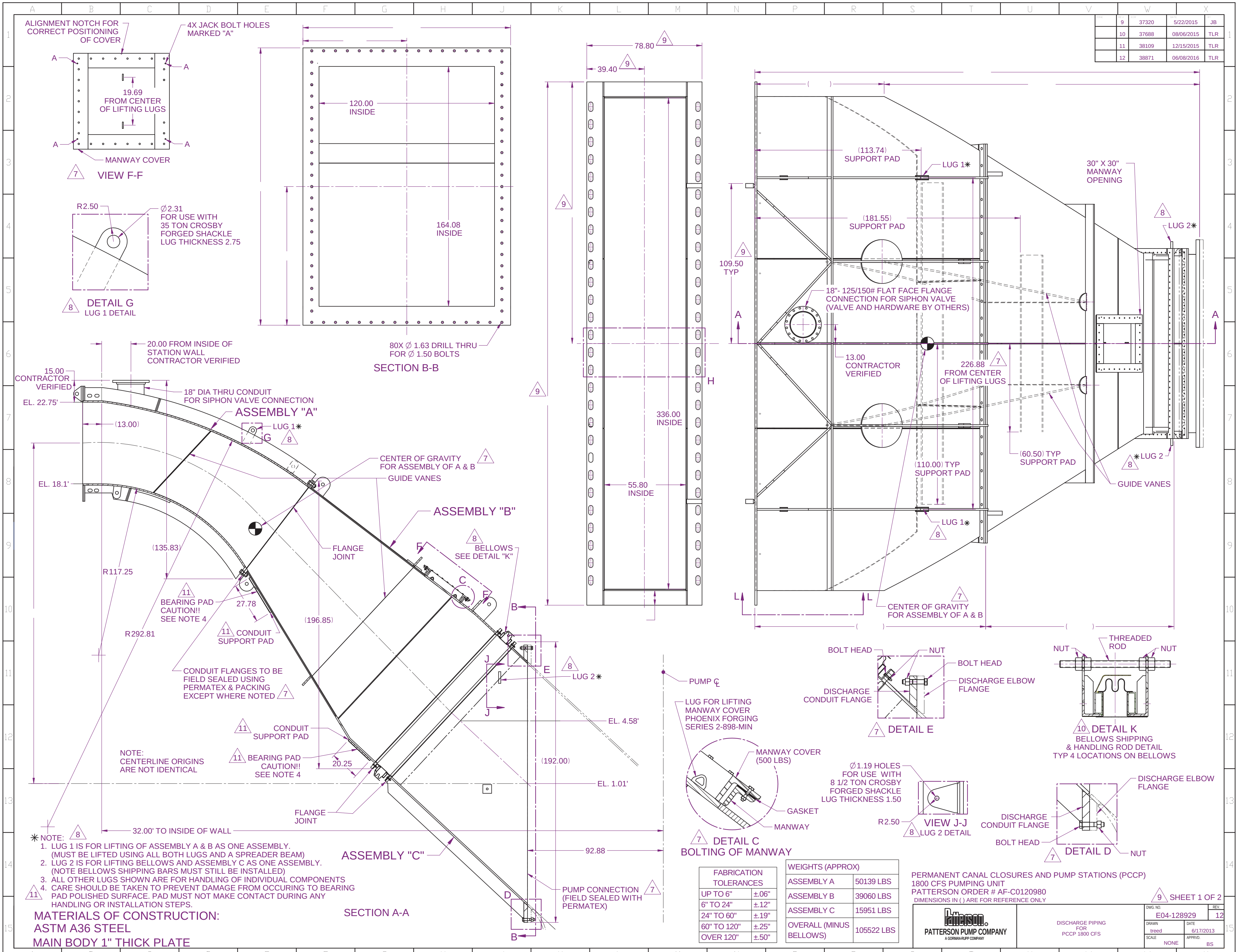
NOTE:
SOLEPLATE IS ONLY ON 3 SIDES OF OPENING

REV 1 ECR #34349 BY JCARSON ON 6-27-13
REV 2 ECR #34771 BY KMOODY ON 9-30-13
REV 3 ECR #35541 BY KMOODY ON 3-24-14
REV 4 ECR #35943 BY KMOODY ON 6-13-14
REV 5 ECR #36575 BY BNICHOLSON ON 10-15-14

PATTERSON PUMP COMPANY
A SUBSIDIARY OF THE GORMAN-RUPP COMPANY

OUTLINE DIMENSION FOR 1800 CFS PUMP

DWG. NO. C04-129127	REV. 5
DRAWN kmoody	DATE 6/7/2013
SCALE NONE	APPRVD. EJC



✳ NOTE:
1. LUG 1 IS FOR LIFTING OF ASSEMBLY A & B AS ONE ASSEMBLY. (MUST BE LIFTED USING ALL BOTH LUGS AND A SPREADER BEAM)
2. LUG 2 IS FOR LIFTING BELLOWS AND ASSEMBLY C AS ONE ASSEMBLY. (NOTE BELLOWS SHIPPING BARS MUST STILL BE INSTALLED)
3. ALL OTHER LUGS SHOWN ARE FOR HANDLING OF INDIVIDUAL COMPONENTS
4. CARE SHOULD BE TAKEN TO PREVENT DAMAGE FROM OCCURING TO BEARING PAD POLISHED SURFACE. PAD MUST NOT MAKE CONTACT DURING ANY HANDLING OR INSTALLATION STEPS.

MATERIALS OF CONSTRUCTION:
ASTM A36 STEEL
MAIN BODY 1" THICK PLATE

9	37320	5/22/2015	JB
10	37688	08/06/2015	TLR
11	38109	12/15/2015	TLR
12	38871	06/08/2016	TLR

FABRICATION TOLERANCES	
UP TO 6"	±.06"
6" TO 24"	±.12"
24" TO 60"	±.19"
60" TO 120"	±.25"
OVER 120"	±.50"

WEIGHTS (APPROX)	
ASSEMBLY A	50139 LBS
ASSEMBLY B	39060 LBS
ASSEMBLY C	15951 LBS
OVERALL (MINUS BELLOWS)	105522 LBS

PERMANENT CANAL CLOSURES AND PUMP STATIONS (PCCP)
1800 CFS PUMPING UNIT
PATTERSON ORDER # AF-C0120980
DIMENSIONS IN ( ) ARE REFERENCE ONLY

SHEET 1 OF 2

PATTERSON PUMP COMPANY
A GORMAN-RUPP COMPANY

DISCHARGE PIPING FOR PCCP 1800 CFS

DWG. NO. E04-128929 REV. 12
DRAWN treed DATE 6/17/2013
SCALE NONE APPRVD. BS

C32

PROPULSION ENGINE (Commercial Applications)

(continued)

RATINGS AND FUEL CONSUMPTION

U.S. EPA Tier 3 and IMO Tier II

	mhp	bhp	bkW	rpm	U.S. g/h	g/bkW-hr	EPA	IMO	EU
A[1]	760	750	559	1600-1800	37.5	213.2	T3C	II	IW
A[1]	811	800	597	1600-1800	40.3	214.6	T3C	II	IW

U.S. EPA Tier 4 and IMO Tier III

	mhp	bhp	bkW	rpm	U.S. g/h	g/bkW-hr	EPA	IMO	EU
A[1]	1014	1000	746	1600-1800	49.6	210.9	T4C	III	IW
B[1]	1217	1200	895	1800-2100	59.1	209.8	T4C	III	IW
C[1]	1319	1300	970	1800-2100	64.3	210.7	T4C	III	IW
C[1]	1470	1450	1081	2050-2150	73.4	215.6	T4C	III	IW

[1] *Wide Operating Speed Range (WOSR)*

Heat Exchanger (32°C Sea Water Temp), Keel Cooled (52°C SCAC Temp)

[2] *Sea Water Aftercooled*

[4] *Contact your local dealer for availability on U.S. EPA Tier 4 and IMO III ratings.*

(continued)

C32

PROPULSION ENGINE (Commercial Applications)

(continued)

SPECIFICATIONS

Vee 12, 4-Stroke-Cycle Diesel		
Aspiration	TTA	
Bore x Stroke	5.71 x 6.38 in	145 x 162 mm
Displacement	1659 cu in	32.1 liter
Rotation (from flywheel end)	Counterclockwise	
Engine dry weight (approx)	6950 - 7160 lb	3152 - 3248 kg

DIMENSIONS

	LE	H	WE
min.	83.5 in/2121 mm	60.9 in/1547 mm	60.17 in/1528 mm
max.	89.9 in/2284 mm	62.5 in/1587 mm	60.17 in/1528 mm

TETRA TECH	Galveston Island 2 Fuel Tank Foundations Quantities	Calculation No. GI2-PS-ST-MT-002

Job No.: 100-RCE-18-09-1 **Page:** 1
Project: Coastal Texas Protection and Restoration
Description: Galveston Island 2 Fuel Tank Foundations Quantities
Made By: LN **Date:** 07/25/18 **Chk'd By:** DS **Date:** 09/21/18

Calc Body Pages	Appended Pages	Total Pages
7	0	7

Document code

Site	Feature	Discipline	Document type	Number
GI2	PS	ST	MT	002

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Lexee Navarre Lexee Navarre 9/21/18	Daniel Stuard Daniel Stuard 9/21/18	

TETRA TECH	**Galveston Island 2 Fuel Tank Foundations Quantities**	**Calculation No. GI2-PS-ST-MT-002**

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LN	**Date:**	07/25/18	**Chk'd By:**	DS	**Date:**	09/21/18

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Attachments	Number of Pages	Last Page Number

TETRA TECH	**Galveston Island 2 Fuel Tank Foundations Quantities**	**Calculation No. GI2-PS-ST-MT-002**

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LN	**Date:**	07/25/18	**Chk'd By:**	DS	**Date:**	09/21/18

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for fuel tank foundations.

APPROACH

Typical engineering means and methods for determining volumes and weights.

REFERENCES

References used during this calculation are as follows:

1) GI2-PS-ST-CL-001
2) GI2-PS-ME-CL-001

RESULTS / CONCLUSIONS

Total # of Pipe Piles:	32	(All piles have tension connections)		
Total 24" Diam. X 0.5" Steel Pipe Pile:	1784.0	ft	**or**	112.0 tons
Total # of Pile Caps:	8			
Total Concrete per Cap:	13.3	yd^3		
Pile Cap Concrete:	106.7	yd^3		

TETRA TECH	**Galveston Island 2 Fuel Tank Foundations Quantities**	**Calculation No. GI2-PS-ST-MT-002**

Job No.:	100-RCE-18-09-1					**Page:**	4
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	LN	**Date:**	07/25/18	**Chk'd By:**	DS	**Date:**	09/21/18

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) Material Properties:
   - Concrete, f'c = 4000 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
2) Costs of reinforcement is included in reinforced concrete unit cost.
3) All piles have tension connections.
4) Total number of Tanks = 4

ITEMS TO BE VERIFIED

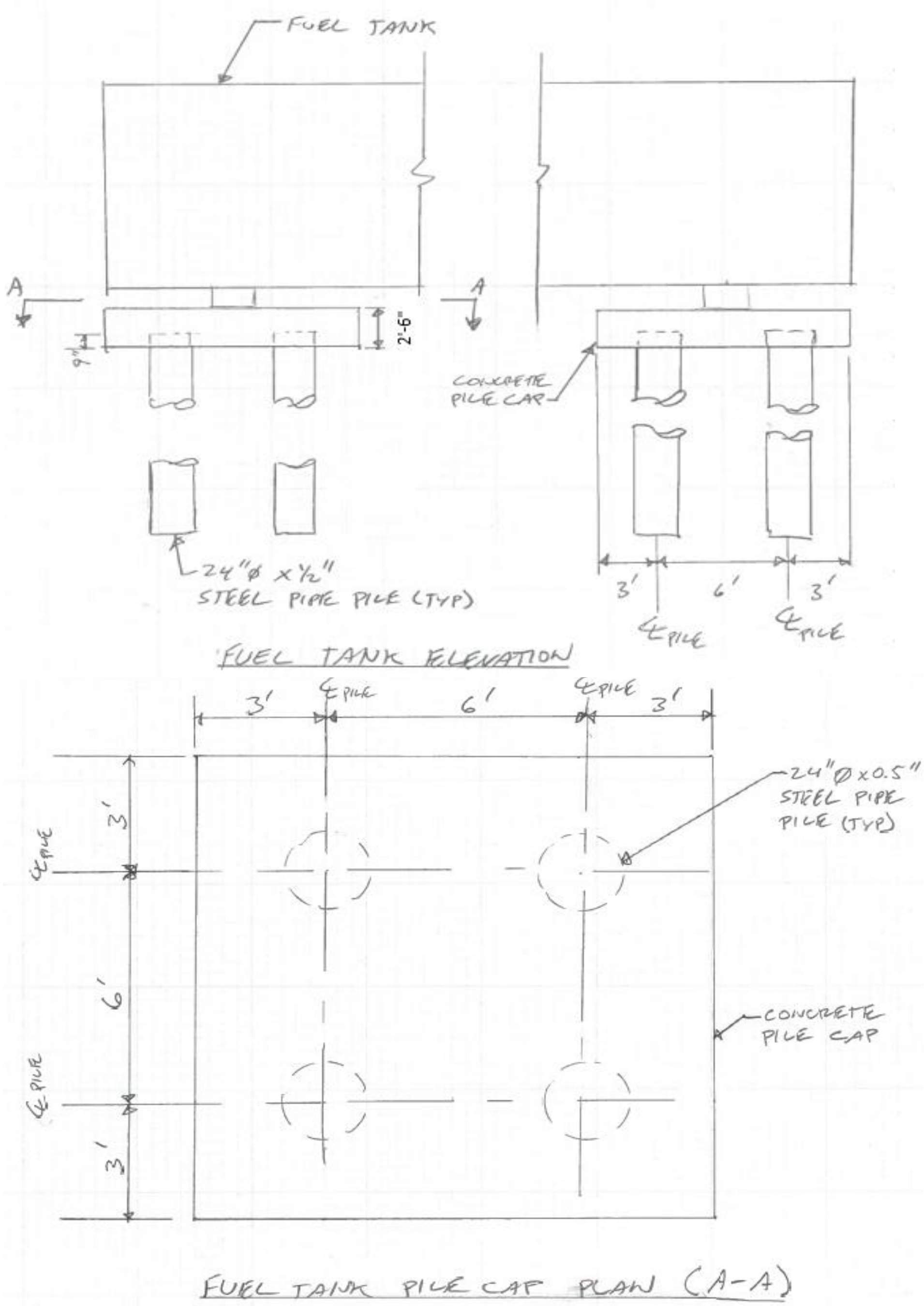
The following items are to be verified in a later design phase:

1) Materials and quantites as design progresses.

CALCULATIONS

Begin on next page.

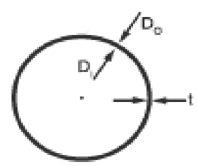
General References and Figures



TETRA TECH	Galveston Island 2 Fuel Tank Foundations Quantities	Calculation No. GI2-PS-ST-MT-002

Job No.:	100-RCE-18-09-1				**Page:**	6
Project:	Coastal Texas Protection and Restoration					
Description:	General References and Figures					
Made By:	LN	**Date:** 07/25/18	**Chk'd By:**	DS	**Date:**	09/21/18

Rolled and Welded Pipe



APPROXIMATE VALUES
Pipe Weight (lbs/ft) = 10.69*t*(D_o-t) D_o (in) - outside diameter t (in) - thickness of pipe
Pipe Weight (kg/m) = 0.0247*t*(D_o-t) D_o (mm) - outside diameter t (mm) - thickness of pipe

PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)												
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

TETRA TECH	Galveston Island 2 Fuel Tank Foundations Quantities	Calculation No. GI2-PS-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	7
Project:	Coastal Texas Protection and Restoration				
Description:	Quantities for Fuel Tank Foundations				
Made By:	LN	**Date:** 07/25/18	**Chk'd By:** DS	**Date:**	09/21/18

Quantities for Fuel Tank Foundations

PILES

The minimum tip embedment is to be 55 feet plus 9 inches of embedment into concrete slab.

Pile Diameter: 24.0 in
Pipe Thickness: 0.5 in
Pipe Weight*: 125.61 lb/ft
Pile Tip to Head Embedment: 55.75 ft

*see general references attachments for reference of produced value

Number of Caps per Tank: 2
Total Number of Tanks: 4
Total Number of Pile Caps: 8
Number of Piles per Cap: 4

Total Number of Piles: **32**
Total of Steel Pipe Piles: **1784.0 ft** **or** **112.0 tons**

CONCRETE:

PILE CAPS:

Thickness (ft)	Width (ft)	Cross Sectional Area (ft^2)	Length (ft)	Volume (yd^3)
2.5	12	30	12	13.3

Total Number of Pile Caps: 8 (see piles section)

Total Concrete: **106.67 yd^3**

TETRA TECH	Galveston Island #3 Pump Station Quantities	Calculation No. GI3-PS-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Galveston Island Pump Station #3 Quantites				
Made By:	RSK	**Date:** 02/05/20	**Chk'd By:** NRT	**Date:**	02/11/20

Calc Body Pages	Appended Pages	Total Pages
14	2	16

Document code

Site	Feature	Discipline	Document type	Number
GI3	PS	ST	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Lexee Navarre 7/31/2018	Carl Grompe 9/21/2018	
B	Michael Hough 11/6/2018	Jason Kikuta 11/7/2018	Revised for updated geometry and design
C	Robert Kramer 2/6/2020 Robert Kramer	Nathan Tobin 02/11/2020 NT	Revised for updated water surface elevations and new pump demands

Galveston Island #3 Pump Station Quantities	Calculation No. GI3-PS-ST-MT-001

TETRA TECH

Job No.: 100-RCE-18-09-1 **Page:** 2
Project: Coastal Texas Protection and Restoration
Description: Revision Summary
Made By: RSK **Date:** 02/05/20 **Chk'd By:** NRT **Date:** 02/11/20

Revision Summary

Revision Summary

Reason for Revision: USACE provided new SWL elevations following new storm analysis. For pump station 3, this resulted in a jump in water intake thus requiring an increase in pumps from 9 to 10. The stormwater elevation for each pump dropped from El 12 to EL 10 due to the additional pump decreasing the average SWL between all 10 pumps. This allowed the pump superstructures and substructures to drop 2' each. The concrete quantities were thus updated.

Symbols:

t_{11}: thickness of wall 11 L_{11}: Length of wall 11
t_{10}: thickness of wall 10 L_{10}: Length of wall 10
t_7: thickness of wall 7 w_7: Width of wall 7
t_2: thickness of wall 2 w_2: Width of wall 2

Diffuser Area Ratio: The New Diffuser Plan Area / Old Diffuser Area

Source for Revisions:

Galveston Island #3 Pump Station Concrete Walls Structural Calculations
Old Concrete Estimates provided by cross-section attachments on page 17 and page 18

Revised Inputs:
* All revised inputs are in **red bold print** within calculation package

Revised Item	Location	Original Number	Updated Number	Updates to Number
Number of Pumps	TOC & Description, Foundation, Substructure and Superstructure Quantities	9	**10**	N/A
Total Volume of Concrete for Precast Concrete Wall Pannels per Pump Bay	Substructure Quantities	649 yd^3	**627 yd^3**	Decreased wall height for walls labelled 2,7,10 and 11
Intake Foundation Slab Volume	Foundation Quantities	2129 yd^3	**2397 yd^3**	Increased CS Area for Slab
Intake Diffuser Substructure Volume	Substructure Quantities	2903 yd^3	**3199 yd^3**	Increased CS Area for Slab via ratio between Old and New Diffuser CS

TETRA TECH	Galveston Island #3 Pump Station Quantities	Calculation No. GI3-PS-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	3
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	RSK	**Date:** 02/05/20	**Chk'd By:** NRT	**Date:**	02/11/20

TABLE OF CONTENTS

TETRA TECH	Galveston Island #3 Pump Station Quantities	Calculation No. GI3-PS-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	4
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	RSK	**Date:** 02/05/20	**Chk'd By:** NRT	**Date:**	02/11/20

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for Pump Station at Clear Creek.

APPROACH

Typical engineering means and methods.

REFERENCES

References used during this calculation are as follows:

1) Plate 48

RESULTS / CONCLUSIONS

PILES:

Total # of 24" Diam. X 5/8" Vertical Pipe Piles:	752			
Total 24" Diam. X 5/8" Steel Pipe Pile:	70600 ft	**OR**	5513 tons	
Total PZ-22 Steel Sheet Pile:	9747.5 ft^2	**OR**	107 tons	

CONCRETE:

FOUNDATIONS:

Total Concrete for Base Slab:	5101 yd^3	
Total Concrete for Mud Slab:	707 yd^3	
Total:	5808 yd^3	

SUBSTRUCTURE:

Total:	10506 yd^3	

SUPERSTRUCTURE:

Total:	622 yd^3	8" Thick Precast Concrete Wall Panels
TOTAL CONCRETE:	16936 yd^3	

TETRA TECH	Galveston Island #3 Pump Station Quantities	Calculation No. GI3-PS-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	5
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	RSK	**Date:** 02/05/20	**Chk'd By:** NRT	**Date:**	02/11/20

STEEL:

SUPERSTRUCTURE:

Total Number of W27x194 Steel Columns:	52		
Length	2210 ft	**OR**	214 tons
Total Number of W18X143 Steel Roof Beams:	26		
Length	1027 ft	**OR**	73 tons
Total Number of W18X143 Steel Roof Beams:	32		
Length	640 ft	**OR**	46 tons

CRANE FRAME:

Total Number of Steel HHS 12x12x1/2 Columns:	52		
Length	1950 ft	**OR**	74 tons
Total Number of W18X192 Steel Top Rails:	32		
Length	640 ft	**OR**	61 tons
Total Number of 30 lb/ft Crane Rails:	32		
Length	640 ft	**OR**	10 tons
Total Number of Steel HHS 12x12x1/2 Beams:	160		
Length	3200 ft	**OR**	122 tons

TETRA TECH	**Galveston Island #3 Pump Station Quantities**	**Calculation No. GI3-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	6
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	RSK	**Date:**	02/05/20	**Chk'd By:**	NRT	**Date:**	02/11/20

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) Excavation is to be determined by others.
2) Number of pumps = **10**
3) Material Properties:
   - Concrete for base slab, allowable f'c = 4000 psi
   - Concrete for mud slab, allowable f'c = 2500 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
   - Sheet Piles = ASTM A328
4) All piles have tension connections.

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Material types and properties.
2) Layout, elevations and dimensions of Pump Station.

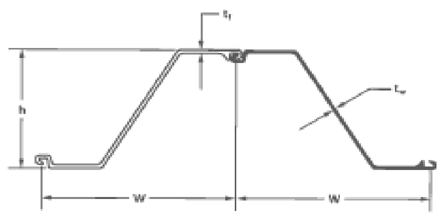
CALCULATIONS

Begin on next page.

General References and Figures

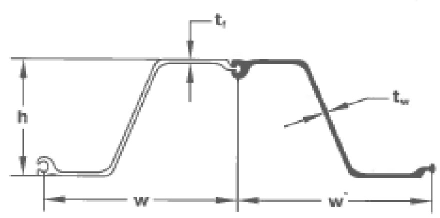
NZ/PZ

NZ/PZ Hot Rolled Steel Sheet Pile



NZ

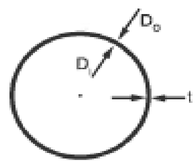
SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Web (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
NZ 19	27.56 700	16.14 410.0	0.375 9.5	0.375 9.5	7.04 148.9	55 81.85	23.95 116.93	35.08 1886	41.33 2222	233.1 38659	6.18 1.88	1.35 1.35
NZ 20	27.56 700	16.16 410.5	0.394 10.0	0.394 10.0	7.29 154.4	57 84.83	24.82 121.18	36.24 1948	42.80 2301	292.8 39984	6.18 1.88	1.35 1.35
NZ 21	27.56 700	16.20 411.5	0.433 11.0	0.433 11.0	7.80 165.2	61 90.78	26.56 129.68	38.69 2080	45.85 2465	313.4 42797	6.18 1.88	1.35 1.35
NZ 26	27.56 700	17.32 440.0	0.500 12.7	0.500 12.7	9.08 192.3	71 105.66	30.92 150.94	48.50 2608	57.01 3065	419.9 57340	6.49 1.98	1.41 1.41



PZ

SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Wall (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
PZ 22	22.0 559	9.0 229	0.375 9.50	0.375 9.50	6.47 136.9	40.3 60.0	22.0 107.4	18.1 973	21.79 1171.4	84.38 11500	4.48 1.37	1.22 1.22
PZ 27	18.0 457	12.0 305	0.375 9.50	0.375 9.50	7.94 168.1	40.5 60.3	27.0 131.8	30.2 1620	36.49 1961.9	184.20 25200	4.48 1.37	1.49 1.49
PZ 35	22.6 575	14.9 378	0.600 15.21	0.500 12.67	10.29 217.8	66.0 98.2	35.0 170.9	48.5 2608	57.17 3073.5	361.22 49300	5.37 1.64	1.42 1.42
PZ 40	19.7 500	16.1 409	0.600 15.21	0.500 12.67	11.77 249.1	65.6 97.6	40.0 195.3	60.7 3263	71.92 3866.7	490.85 67000	5.37 1.64	1.64 1.64

Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = $10.69 * t * (D_o - t)$
D_o (in) - outside diameter
t (in) - thickness of pipe

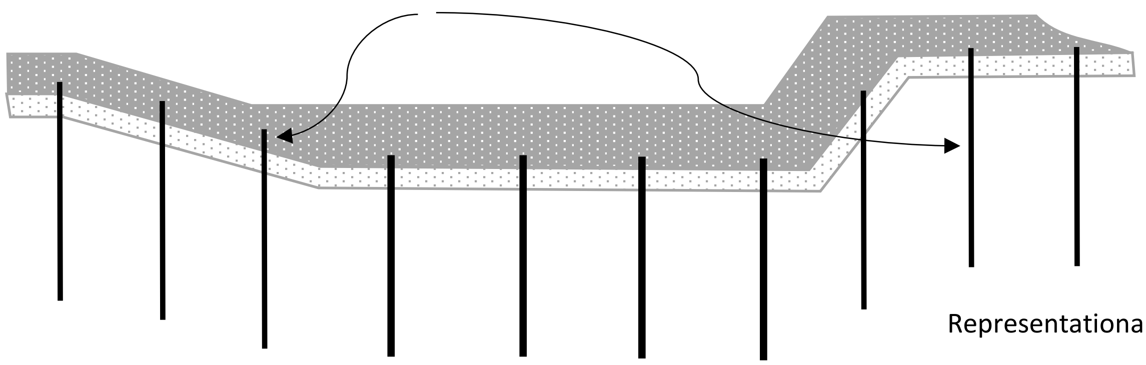
Pipe Weight (kg/m) = $0.0247 * t * (D_o - t)$
D_o (mm) - outside diameter
t (mm) - thickness of pipe

PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

Quantities for Pump Station Foundations

Figure 1:



PILES

Number of Piles 72 At Pumps

Number of Piles 32 At Safe House Enclosure Slab

Pile Diameter: 24 in

Pile Thickness: 5/8 in

Pile Weight: 156.17 lb/ft

*see general references attachments for reference of produced value

Piles	# of Piles per row	Rows	Pile Weight (lb/ft)	Start EL (ft)	End EL (ft)	Length (ft)	Weight (ton)	Total Length (ft)	Total Weight (ton)
Pumps	3	24	156.17	-14.0	-108.5	94.5	7.4	6804	531.3
Safe House	8	4	156.17	0.0	-80.0	80.0	6.2	2560	199.9

TETRA TECH	Galveston Island #3 Pump Station Quantities	Calculation No. GI3-PS-ST-MT-001

Job No.: 100-RCE-18-09-1 **Page:** 10

Project: Coastal Texas Protection and Restoration

Description: Quantities for Pump Station Foundations

Made By: RSK **Date:** 02/05/20 **Chk'd By:** NRT **Date:** 02/11/20

Piles (24" diam x 5/8")

Total # of Piles per Pump: 72
Total Length per Pump: 6804 ft
Total Weight per Pump: 531 tons

Total Number of Pumps: **10**

Total # of Piles at Safe House Enclosure: 32
Total Length at Safe House: 2560 ft
Total Weight at safe house: 200 tons

TOTALS:
# of 24" diam x 5/8" Piles: **752**
Length of 24" diam x 5/8": **70600 ft**
Weight of 24" diam x 5/8": **5513 tons**

SHEET PILE

Note: It is assumed that the sheet pile wall used at WCC for seepage control will also be the same kind used at Clear Creek.
A PZ-22 hot rolled sheet piling shall be utilized for seepage cutoff.

Start EL of Sheet Pile Wall: -25.0 ft
End EL of Sheet Pile Wall: -46.0 ft
Height of Sheet Pile Wall: 21.0 ft
Weight of Sheet Pile Wall*: 22.0 lb/ft^2
Length of Sheet Pile Wall: 46.4 ft

*see general references attachments for reference of produced value

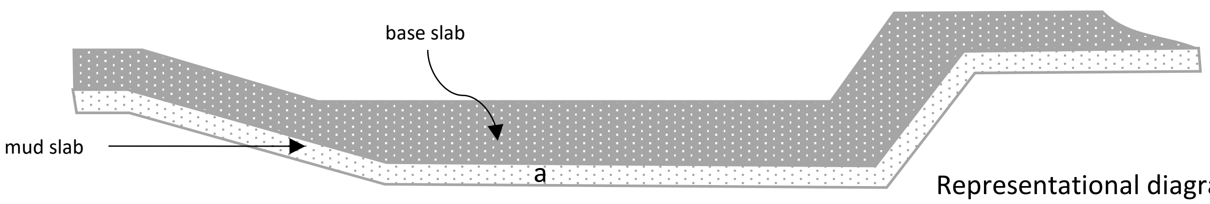
# of Walls	Area (ft^2)	Weight of Wall (lb/ft^2)	Weight (tons)
1	974.8	22.0	10.7

Total Number of Pumps: **10**

Total Area per Pump: 975 ft^2
Total Weight per Pump: 11 tons

TOTALS:
Area: **9748 ft^2**
Weight: **107 tons**

Figure 2:



Representational diagram

CONCRETE

FOUNDATION BASE SLAB:

F'c: 4,000 psi
Width of Slab: 20.0 ft

Total Volume of Concrete per Pump*: 270 yd^3
Total Number of Pumps: **10**
Intake Foundation Slab: **2397** yd^3
Total Foundation Slab Concrete: **5101** yd^3

*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.

MUD SLAB:

Note: Please see attached Plate 48 drawing for concrete sectioning. It is assumed that this pump station will also have a mud slab like West Closure Complex. Lengths of sections are estimates for the preliminary design phase.

F'c: 2,500 psi
Width of Slab: 20.0 ft
Slab Thickness: 12.0 in

Section	Length (ft)	Thickness (in)	Cross Sectional Area (ft^2)	Width (ft)	Volume (yd^3)	
a	95.5	12.00	95.50	20.0	70.74	Per Model

Total Mud Slab Concrete per Pump: 71 yd^3
Total Number of Pumps: **10**
Total Mud Slab Concrete: **707** yd^3

TOTAL CONCRETE: 5808 yd^3

Pump Station Substructure Quantities

CONCRETE

Total Volume of Concrete per Pump*:	**627.5**	yd^3	*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.
Total Number of Pumps:	**10**		
Total Volume of Concrete at Safe House*:	1,032.1	yd^3	
Total Volume of Concrete at Intake Diffuser*:	**3,199.0**	yd^3	

Total Concrete: **10506** **yd^3**

TETRA TECH	Galveston Island #3 Pump Station Quantities	Calculation No. GI3-PS-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	13
Project:	Coastal Texas Protection and Restoration				
Description:	Pump Station Superstructure Quantities				
Made By:	RSK	**Date:** 02/05/20	**Chk'd By:** NRT	**Date:**	02/11/20

Pump Station Superstructure Quantities

PRECAST CONCRETE WALL PANELS

Total Volume of Concrete per Pump Bay*:	45	yd^3	*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.
Total Number of Pump Bays:	10		
Total Volume of Concrete at Safe House Enclosure*:	169	yd^3	

Total Concrete: 622 yd^3

STEEL

COLUMNS:

The columns of the steel superstructure frame will be W27X194.

Weight:	194	lb/ft	
Height:	42.5	ft	
Number of Columns per Pump Bay:	4		
Total Number of Pump Bays:	10		
Number of Columns at Safe House Enclosure:	12		Per Plans

Total Number of W27x194 Steel Columns:	**52**	
Total Length of W27x194 Steel Columns:	**2210**	**ft**
Total Weight of W27x194 Steel Columns:	**214**	**tons**

LONGITUDINAL ROOF BEAMS (spanning length of pump bay):

The longitudinal roof beams of the steel superstructure frame will be W18X143.

Weight:	143	lb/ft	
Length:	39.5	ft	
Number of Roof Beams per Pump Bay:	2		
Total Number of Pump Bays:	**10**		
Number of Beams at Safe House Enclosure:	6		Per Plans

Total Number of W18X143 Steel Roof Beams:	**26**	
Total Length of W18X143 Steel Roof Beams:	**1027**	**ft**
Total Weight of W18X143 Steel Roof Beams:	**73**	**tons**

TRANSVERSE ROOF BEAMS (spanning width of pump bay):

The tansverse roof beams of the steel superstructure frame are W18X143.

Weight:	143	lb/ft	
Length:	20	ft	
Number of Roof Beams per Pump Bay:	2		
Total Number of Pump Bays:	**10**		
Number of Beams at Safe House Enclosure:	12		Per Plans

Total Number of W18X143 Steel Roof Beams:	**32**	
Total Length of W18X143 Steel Roof Beams:	**640**	**ft**
Total Weight of W18X143 Steel Roof Beams:	**46**	**tons**

TETRA TECH	**Galveston Island #3 Pump Station Quantities**	**Calculation No. GI3-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	15
Project:	Coastal Texas Protection and Restoration						
Description:	Pump Station Crane Frame Quantities						
Made By:	RSK	**Date:**	02/05/20	**Chk'd By:**	NRT	**Date:**	02/11/20

Pump Station Crane Frame Quantities

STEEL

COLUMNS:

The columns of the steel crane frame are assumed to be HSS 12x12x1/2.

Weight:	76	lb/ft
Height:	37.5	ft
Number of Columns per Pump Bay:	4	
Total Number of Pump Bays:	**10**	
Number of Columns at Safe House Enclosure:	12	

Total Number of Steel HHS 12x12x1/2 Columns:	**52**	
Total Length of Steel HHS 12x12x1/2 Columns:	**1950**	**ft**
Total Weight of Steel HHS 12x12x1/2 Columns:	**74**	**tons**

TOP RAIL:

The top rail of the steel crane frame will be W18X192.

Weight:	192	lb/ft
Length:	20	ft
Number of Top Rails per Pump Bay:	2	
Total Number of Pump Bays:	**10**	
Number of Top Rails at Safe House Enclosure:	12	

Total Number of Top Rails:	**32**	
Total Length of Top Rails:	**640**	**ft**
Total Weight of Top Rails:	**61**	**tons**

CRANE RAIL:

Added to the top rail will be a 30 lb/ft crane rail.

Weight:	30	lb/ft
Length:	20	ft
Number of Crane Rails per Pump Bay:	2	
Total Number of Pump Bays:	**10**	
Number of Crane Rails at Safe House Enclosure:	12	

Total Number of Crane Rails:	**32**	
Total Length of Crane Rails:	**640**	**ft**
Total Weight of Crane Rails:	**10**	**tons**

INFILL FRAMING:

The infill framing beams of the steel crane frame are assumed to be HSS 12x12x1/2.

Weight:	76	lb/ft	
Length:	20	ft	
Number of Infill Beams per Pump Bay:	10		5 each side
Total Number of Pump Bays:	**10**		
Number of Infill Beams at Safe House Enclosure:	60		

Total Number of Steel HHS 12x12x1/2 Beams:	**160**	
Total Length of Steel HHS 12x12x1/2 Beams:	**3200**	**ft**
Total Weight of Steel HHS 12x12x1/2 Beams:	**122**	**tons**

Superstructure: (Not Changing)

Safe house: $169\ yd^3$ (Based on Solid Works Model)

Superstructure Conc per Pump: $45\ yd^3$ (Based on Solid Works Model)

# of Pumps = 10

Substructure:

Safe house: $1{,}032.1\ yd^3$ (Based on Solid Works Model) (Not Changing)

Intake Structure:

$$V_{intake_i} = 2903\ yd^3$$

Original Intake Structure Plan Area:

$L = 222.80'$ $W_{pump} = 20'$ original # of pumps: 9

$W_{io} = 20\ ft$ $W_{oo} = W_{pump}\# = 20'(9) = 180'$ (Based on Updated Drawing)

$$A_o = 222.80'\left(\frac{20+180'}{2}\right) = 22{,}280\ ft^2$$

New Intake Structure Plan Area

$L = 222.80'$ $W_{pump} = 20'$ # pump = 10 (Based on Updated Drawing)

$W_{in} = 25'$ $W_{on} = W\ pump\# = 20'(10) = 200'$

$$A_n = 222.80'\left(\frac{25'+200'}{2}\right) = 25{,}065\ ft^2$$

New / Old Ratio = $A_n / A_o = 25{,}065\ ft^2 / 22{,}280\ ft^2 = 1.125$

$t_{intake\ structure} = 2.17' =$

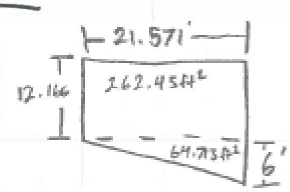
$$V_{intake_{new}} = V_{intake_i} - t_{intake}A_o + t_{intake}A_n$$

$$= 2903\ yd^3 - \left(\frac{2.17'(22{,}280\ ft^2)}{27}\right) + \frac{2.17(25{,}065\ ft^2)}{27}$$

$$= \underline{3{,}127\ yd^3}$$

Endwalls

$$\frac{14'}{52.833'-2.5'} = \frac{6'}{x} \qquad x = 21.571$$



Total Area: $327.143\ ft^2$

$V = 3ft \cdot 327.143\ ft^2$

$= 981.429\ ft^3$

$= 36.35\ yd^3$

2x endwalls → $\boxed{72.7\ yd^3}$

Substructure:

Pumphouse

old # of pumps: 9

new # of pumps: 10

$V_{PH\,initial} = 17,577\ ft^3$ (Based on Solid Works Model

Decrease in wall Height: $-2.0'$ (Updated Drawings 2/6)

$t_{11} = 3'$ $L_{11} = 29.8'$

$t_7 = 2'$ $L_7 = 20'$

$t_{10} = 3'$ $L_{10} = 42.75'$

$t_2 = 2'$ $L_2 = 20'$

(Based on Galveston Island Pump Station #3 Concrete Walls Structural Calcs)

$$V_{PH\,Final} = V_{PH\,initial} + \Delta H (t_{11}L_{11} + t_7 L_7 + t_{10}L_{10} + t_2 L_2)$$

$$= 17,577\ ft^3 - 2'(3'(29.8') + 2'(20') + 3'(42.75') + 2'(20'))$$

$$= 16,941\ ft^3 = \underline{627.46\ yd^3} \text{ per pump}$$

Foundation:

Pumphouse Foundation: 220 yd^3 per pump (Based on Solid Works Model) No Change

Mud Slab: 71 yd^3 per pump (Based on Solid Works Model) No Change

Intake Structure:

$t = 2.6'$ (Based on Drawings 2/6)

$V_{intake\,old} = 2129\ yd^3$ (Based on Solid Works)

$V_{intake\,new} = V_{intake\,old} - tA_o + tA_n$ (A_o & A_n From Substructure)

$$= 2129\ yd^3 - \frac{2.6'(22,280\ ft^2)}{27} + \frac{2.6'(25,065\ ft^2)}{27}$$

$$= \underline{2,397\ yd^3}$$

TETRA TECH

Job Number ____________

Vol./Sheet ________ of ________

Contract/Client ____________

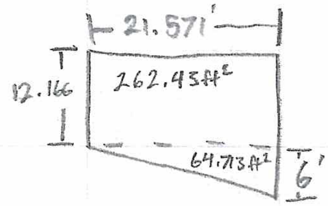
Phase/Subject ____________

Design Topic ____________

Made By ________ Date ________ Checked By ________ Date ________

Endwalls

$$\frac{14'}{52.833' - 2.5'} = \frac{6'}{x} \qquad x = 21.571$$



Total Area: $327.143\,ft^2$

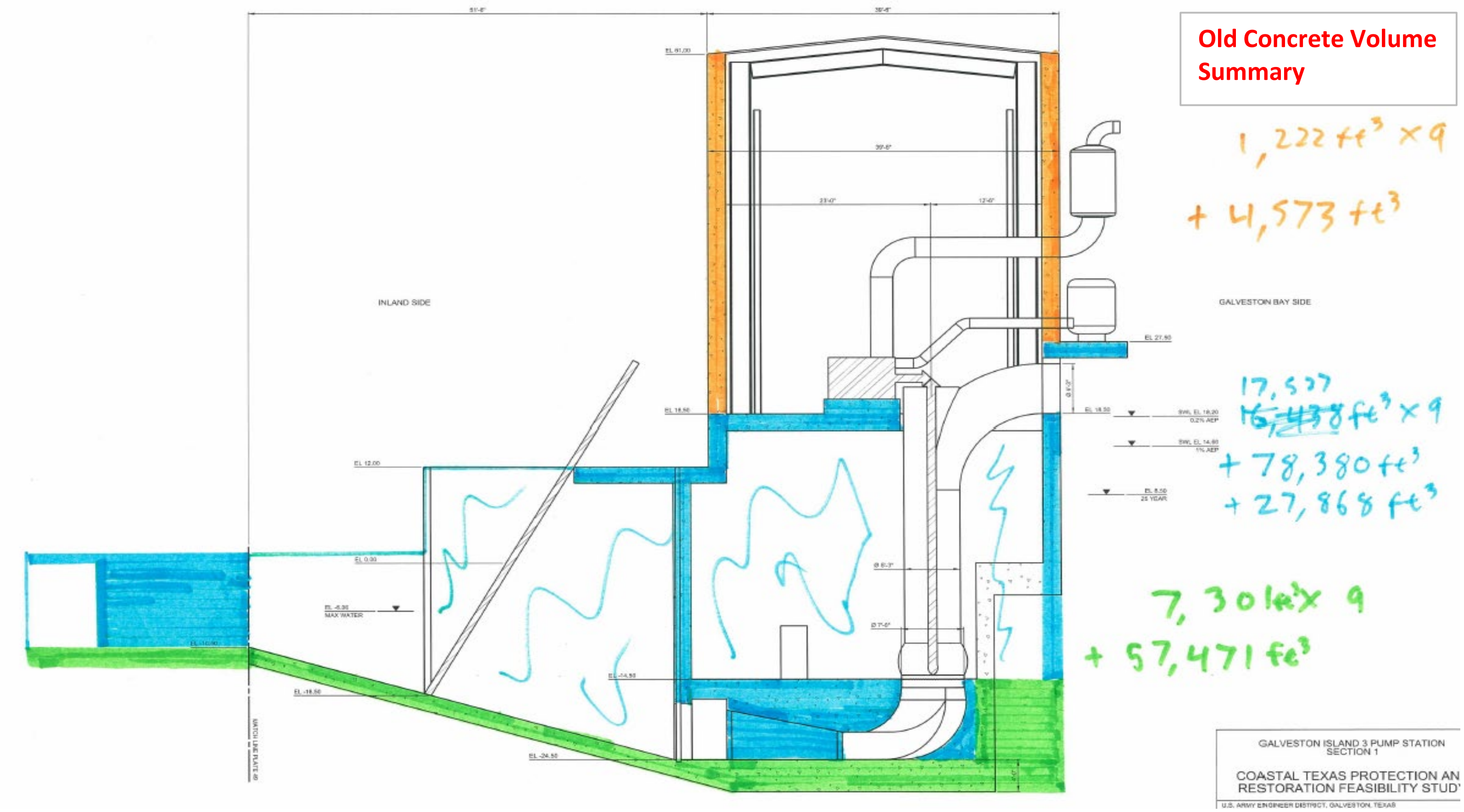
$V = 3ft \cdot 327.143\,ft^2$

$= 981.429\,ft^3$

$= 36.35\,yd^3$

2xendwalls $\rightarrow \boxed{72.7\,yd^3}$

Old Concrete Volume Summary



New Structure

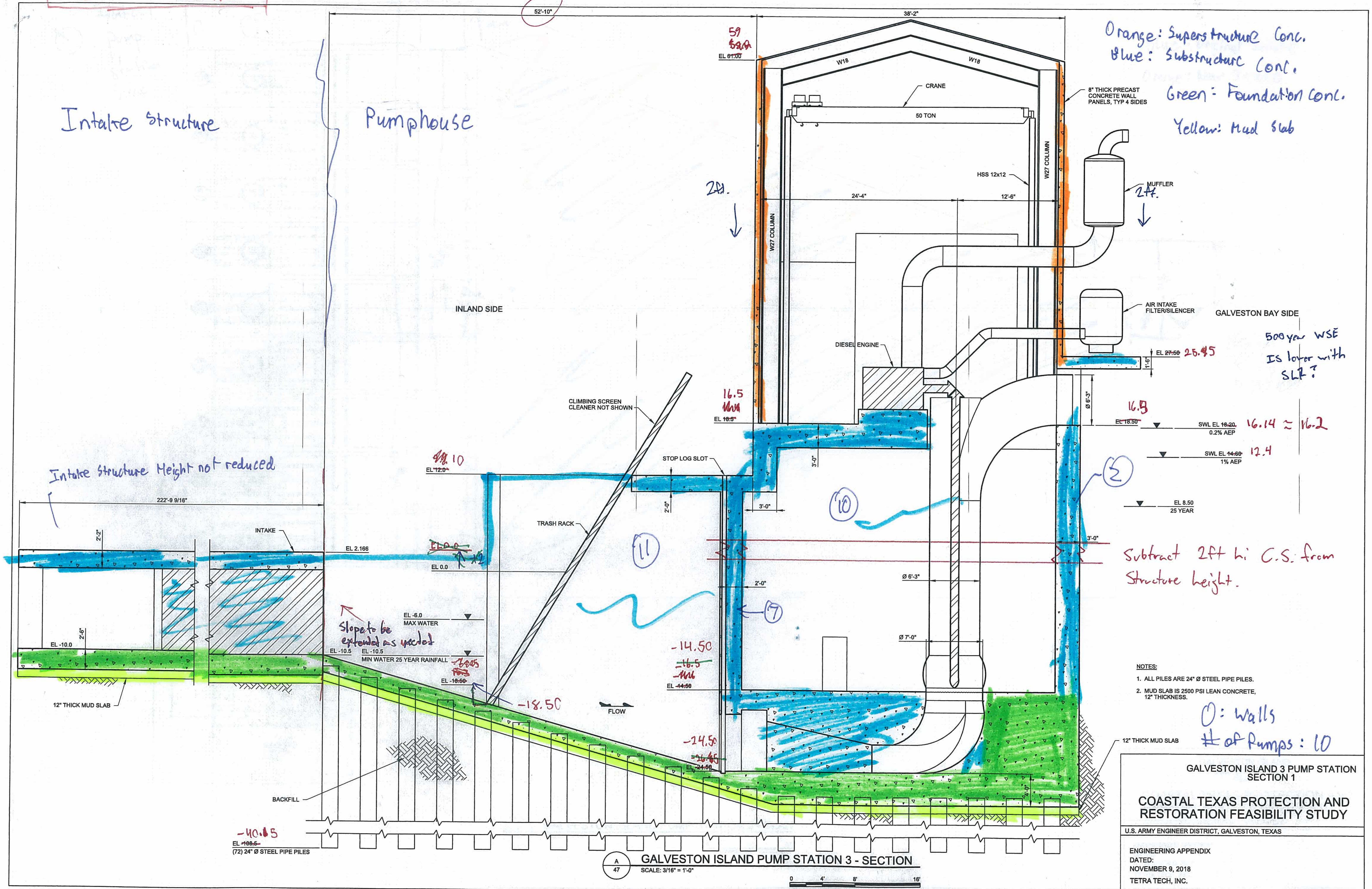


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PLATE 48

→ WSE Update
Checked By EOF

TETRA TECH — Calculation Cover Sheet

Job No.:	100-RCE-18-09-1				
Project:	Coastal Texas Protection and Restoration				
Title:	GI3-PS-EE-MT-001				
Design Topic:	Galviston Island Pump Station 3 Electrical Quantities				
Made By:	JS	**Date:** 02/14/20	**Chk'd By:** AJB	**Date:**	02/19/20

Calc Body Pages	Appended Pages	Total Pages

Document code

Site	Feature	Discipline	Document type	Number
GI3	PS	EE	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Discription
A	JUSTIN SERRA 08/17/2018	ALBERT BARNES 08/20/2018	
B	JUSTIN SERRA 02/14/2020 Justin Serra	ALBERT BARNES 02/19/2020 Albert Barnes	Revise to reflect pump station increase to 5000 cfs

TETRA TECH **Calculation Body**

Job No.:	100-RCE-18-09-1
Project:	Coastal Texas Protection and Restoration
Title:	GI3-PS-EE-MT-001
Design Top	Galviston Island Pump Station 3 Electrical Quantities

Made By: JS **Date:** 02/14/20 **Chk'd By:** AJB **Date:** 02/19/20

GI3-PS-EE-MT-001

1.0 ISSUE BEING ADDRESSED

2.0 APPROACH

Applying the National Electrical Code (NEC) and Unified facilities guide specifications division 26 - electric of the USACE

3.0 REFERENCES

References used during this calculation are as follows:

1) NFPA 70 - National Electrical Code - 2017
2) Design and Analysis of building electrical systems, John H. Matthews
3) Unified facilities guide specificaitons division 26 - Electrical

4.0 RESULT SUMMARY/VERIFICATION

RESULTS / CONCLUSIONS

ITEMS TO BE VERIFIED

1) Number of pumps
2) Number of motors
3) Building size

5.0 ASSUMPTIONS

ASSUMPTIONS AND INPUTS

Assumptions made during this calculation are as follows

1) Large diesel powered motors will have a summed less than 10 HP worth of support motors.
2) Demand factors for electric motors and size of electric motors in sizing main service transformer
3) Pump Station layout of 8-15-2018 for distances and quantities of electrical equipment.
4) Adequate power is available within 250 feet of pump station location

5.0 CALCULATIONS

Galveston Island Pump Station three has 10 diesel pumps. Each pump bay in the pump station is approximately 20'x70'x60'. The pump station will have an additional 2 bays to contain the control room and living quarters for the pump station and pump station staff. The additional space is for the maintenance area and machine shop for the pump station. The pump station length will be 220' in length and the addition of large clearance required for removal and replacement of equipment will result in the minimum width of 70'. The segregation of the pump house equipment to insure no one single fault resulting in the loss of power and function to the entire pump house requires

multiple separate distribution power systems in the pump house.

Item No.	Item Description	Quantity	Unit
ELECTRICAL ITEMS			
Galveston Island Pump Station 3			
1	**TELEPHONE/COMMUNICATION SYSTEM**		
	a. Telephone Patch Panel	1	Ea
	b. Master Desk Telephone	1	Ea
	c. Combination Telephone/Intercom	5	Ea
	d. 1" RMC Conduit	200	Lf
	e. Telephone cable	200	Lf
	f. Cable Terminations	20	Ea
	PUMP STATION LIGHTS AND FIXTURES		
	a. High Bay Down Lighting	20	Ea
	b. Wall Lights	20	Ea
	c. Warning Light	20	Ea
	d. Warning Horn	2	Ea
	e. Mast Lights with 30' Mast	10	Ea
	f. Emergancy Battery Lighting	30	Ea
	g. 3/4" RMC	3,000	CLF
	h. Lighting Connection Whips	40	Ea
	i. Ceiling Lights	20	Ea
	PUMP STATION VIDEO/CCTV SYSTEM		
	a. Video Camera	10	Ea
	b. Network Hub	2	Ea
	c. DVR	2	Ea
	d. 1" RMC	500	Lf
	e. Video Cable	500	Lf
	f. 2" RMC	0	Lf
	g. Fiber Optic Cable	0	Lf
	h. LCD television monitors, with audio, 8-inch	2	Ea
	i. Cable Terminations	50	Ea
	j. Monitoring Software	1	Ea
	FUEL STORAGE VIDEO/CCTV SYSTEM		
	a. Video Camera	2	Ea
	b. 3/4" RMC	1,000	Lf
	c. Video Cable	1,000	Lf
	d. 2" RMC	0	Lf
	e. Fiber Optic Cable	0	Lf
	f. Cable Terminations	50	Ea
	PUMP STATION FIRE ALARM AND DETECTION SYSTEM		
	a. Air Sampling (Ionization) Detector	6	Ea
	b. Thermal (Heat) Detector	6	Ea

	c. Smoke Detector	6	Ea
	d. Pull Station	4	Ea
	e. Bell	2	Ea
	f. Fire Alarm Control Panel	2	Ea
	g. Main Fire Alarm Control Panel	1	Ea
	h. Detector Cable	300	Lf
	i. Alarm Cable	300	Lf
	j. 8 Fiber Optic Cable	0	Lf
	k. 3/4" RMC for Routing Fire Alarm Cable	300	Lf
	l. 2" RMC for Routing Fiber Optic Cable	0	Lf
	m. Cable Terminations	20	Ea
	FUEL STORAGE FIRE ALARM AND DETECTION SYSTEM		
	a. Air Sampling (Ionization) Detector	2	Ea
	b. Thermal (Heat) Detector	2	Ea
	c. Smoke Detector	2	Ea
	d. Pull Station	2	Ea
	e. Bell	1	Ea
	f. Fire Alarm Control Panel	1	Ea
	g. Main Fire Alarm Control Panel	0	Ea
	h. Detector Cable	500	Lf
	i. Alarm Cable	500	Lf
	j. 8 Fiber Optic Cable	0	Lf
	k. 3/4" RMC for Routing Fire Alarm Cable	500	Lf
	l. 2" RMC for Routing Fiber Optic Cable	0	Lf
	m. Cable Terminations	20	Ea
	PUMP STATION CONTROLS AND SENSORS		
	a. Control Cabinet w/ PLC, power supply, processor, comm. Matrix, realys and network hub	3	Ea
	b. PLC Analog Inputs and Outputs	100	Ea
	c. PLC Digital Inputs and Ouputs	100	Ea
	d. Operators Control Cabinet w/ pushbuttons, switches, etc.	4	Ea
	e. Human/Machine Interface (HMI)	6	Ea
	f. Software for programming PLC and HMI	1	Ea
	g. 3/4" RMC	500	Lf
	h. 1" RMC	250	Lf
	i. 12 Pair Fiber Optic Cable	0	Lf
	j. 2" RMC for Fiber optic	0	Lf
	k. Controls Panelboard, 120/240V/ 60A, 2d. ckt, w/20A ckt bkr	4	Ea
	l. Circuit Breakers, Various Sizes, 1-pole	100	Ea
	m. Cable Terminations	200	Ea
	n. Gearbox heaters	4	Ea
	FUEL STORAGE CONTROLS AND SENSORS		
	a. Control Cabinet w/ PLC, power supply, processor, comm. Matrix, realys and network hub	1	Ea

	b. PLC Analog Inputs and Outputs	100	Ea
	c. PLC Digital Inputs and Ouputs	100	Ea
	d. Operators Control Cabinet w/ pushbuttons, switches, etc.	1	LOT
	e. Human/Machine Interface (HMI)	2	Ea
	f. Software for programming PLC and HMI	0	Ea
	g. 3/4" RMC	300	Lf
	h. 1" RMC	300	Lf
	i. 2#14 AWG braided conductors	500	Lf
	j. Limit Switches	20	Ea
	k. Flow sensors	10	Ea
	l. Level sensors	10	Ea
	m. Valvue Actuators	20	Ea
	n. Leak Sensors	10	Ea
	o. Fuel Temp Sensors	10	Ea
	p. Relays	20	Ea
	INCOMING POWER		
	a. 35' Pole	3	Ea
	b. Overhead Conductors	250	Lf
	c. Pull Boxes	5	Ea
	d. Misc Hardware	1	LOT
	e. Cable Terminations	10	Ea
	PUMP STATION LIGHTING CONDUCTORS		
	a. #12 AWG Stranded Copper	2,500	Lf
	b. #10 AWG Stranded Copper	2,500	Lf
	c. #8 AWG Stranded Copper	1,000	Lf
	d. Pull Boxes	1,000	Ea
	e. Cable Terminations	2,500	Ea
	FUEL STORAGE LIGHTING		
	a. #12 AWG Stranded Copper	0	Lf
	b. #10 AWG Stranded Copper	200	Lf
	c. #8 AWG Stranded Copper	200	Lf
	d. Pull Boxes	20	Ea
	e. Cable Terminations	50	Ea
	f. Mast Lights with 30' Mast	6	Ea
	MOTOR CONTROL CENTER - MCCx12		
	a. MCC - Section	24	Ea
	b. Main Disconnect Circuit Breaker - MDCB	12	Ea
	c. Combination Starter	20	Ea
	d. Control Transformer	4	Ea
	e. Circuit Breaker	100	Lf
	f. 3-#12 AWG, 1 - #12 AWG	1000	Lf
	g. 3-#10 AWG, 1 - #10 AWG	1000	Lf
	h. 3-#8 AWG, 1 - #10 AWG	500	Lf

	PUMP STATION RECEPTACLES		
	a. 5-20R Receptacles	40	Ea
	b. #10 AWG Stranded Copper	500	Lf
	c. 100A 3P-5W NEMA-3R Power Outlet	6	Ea
	d. 4#1 AWG, 1#8 AWG EGC	2,000	Lf
	e. Pull Boxes	12	Ea
	f. Cable Terminations	50	Ea
	FUEL STORAGE RECEPTACLES		
	a. 5-20R Receptacles NEMA 4X	20	Ea
	b. #10 AWG Stranded Copper	250	Lf
	c. 100A 3P-5W NEMA-4X Power Outlet	2	Ea
	d. 4#1 AWG, 1#8 AWG EGC	500	Lf
	e. Pull Boxes	6	Ea
	f. Cable Terminations	20	Ea
	Automatic Transfer switches		
	a. Medium Voltage Automatic Transfer switches	0	Ea
	b. Low Voltage Automatic Transfer Switches	3	Ea
	c. Diconnect Switches	20	Ea
	d. Fused Disconnect Switches	2	Ea
	Stand-by Generators		
	a. 1000kW Generator	2	Ea
	b. 250kW Generator	1	Ea
	c.100kW Generator	3	Ea
	d. Load Banks	5	Ea
	e. Control Panel	3	Ea
	Power Transformers		
	a. 1000kVA	1	Ea
	b. 50kVA	0	Ea
	c. 30kVA	1	Ea
	d. 15kVA	2	Ea
	Conductors		
	a. #14 AWG	4000	Lf
	b. #12 AWG	2500	Lf
	c. #10 AWG	2500	Lf
	d. #8 AWG	2000	Lf
	e. #6 AWG	2000	Lf
	f. #4 AWG	1000	Lf
	g. #3 AWG	0	Lf
	h. #2 AWG	0	Lf
	i. #1 AWG	1000	Lf
	j. 1/0 AWG	1000	Lf

	k. 2/0 AWG	0	Lf
	l. 3/0 AWG	0	Lf
	m. 4/0 Awg	2000	Lf
	n. 350 kmill	0	Lf
	o. 500 kmill	0	Lf
	Conduits		
	a. 3/4" RMC	3000	Lf
	b. 1" RMC	2000	Lf
	c. 1 1/4" RMC	0	Lf
	d. 1 1/2" RMC	500	Lf
	e. 2" RMC	2000	Lf
	f. 2 1/2" RMC	0	Lf
	g. 3" RMC	500	Lf
	h. 4" RMC	300	Lf
	Motors		
	a. 1-hp, 3PH, 480VAC	0	Ea
	b. 2-hp, 3PH, 480VAC	10	Ea
	c. 5-hp, 3PH, 480VAC	0	Ea
	d. 10-hp, 3PH, 480VAC	10	Ea
	e. 20-hp, 3PH, 480VAC	10	Ea
	f. 30-hp, 3PH, 480VAC	0	Ea
	g. 50-hp, 3PH, 480VAC	2	Ea

TETRA TECH	Galveston Island 3 Pump Station Quantities	Calculation No. GI3-PS-ME-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Galveston Island 3 Pump Station Quantities				
Made By:	NRT	**Date:** 02/12/20	**Chk'd By:** LAL	**Date:**	02/13/20

Calc Body Pages	Appended Pages	Total Pages
3	5	8

Document code

Site	Feature	Discipline	Document type	Number
GI3	PS	ME	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Carl Grompe 11/8/2018	Eric Flickinger 11/8/2018	
B	Nathan Tobin 02/12/2020 NTT	Lois Loesch 02/13/2020 Lois Loesch	Revised to reflect pump station capacity increase to 5000 cfs

TETRA TECH	**Galveston Island 3 Pump Station Quantities**	**Calculation No.** **GI3-PS-ME-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	NRT	**Date:**	02/12/20	**Chk'd By:**	LAL	**Date:**	02/13/20

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ISSUE BEING ADDRESSED

Mechanical equipment quantity take-offs for preliminary cost estimate for Pump Station at Galveston Island 3.

APPROACH

Equipment falls into 2 categories, sets of equipment in every bay, and equipment unrelated to the number of bays

REFERENCES

References used during this calculation are as follows:

1) Mechanical drawings by Tetra Tech
2) WCC cross section
3) Patterson pump drawings from PCCP

RESULTS / CONCLUSIONS

See calculation sections

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) 5 days fuel storage

TETRA TECH	Galveston Island 3 Pump Station Quantities	Calculation No. GI3-PS-ME-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	NRT	**Date:**	02/12/20	**Chk'd By:**	LAL	**Date:**	02/13/20

CALCULATIONS

Equipment in every bay

Number of Bays	10	
Trash Rack	884	ft^2
Trash rake (climbing style)	1	
Formed suction intake (type 10 for Ø84")	1	
Vertical Pump (500 cfs)	1	
Custom discharge piping	1	
Vacuum break	1	
Angle gearbox/speed reducer	1	
Diesel engine (CAT 32-C[1] Marine)	1	
Cooling water supply lines (Ø 6")	133	ft
Cooling water pump	1	
Exhaust line	38	ft
Exhaust muffler	1	
Air intake line	22	ft
Air intake filter/silencer	1	
Day Tank (700 gal)	1	
Double walled fuel pipe (Ø1.5" w/leak detection)	40	ft
Ventilation fan	1	

Other equipment

Sump stop log	60	ft^2
Stop log hoist	1	
Diesel Storage tanks (10,000 gal)	9	
Main fuel pumps	18	
Double walled fuel pipe (Ø3" w/leak detection)	520	ft
Fuel conditioning (filter type or centrifuge type)	1	
Air Compressor	3	
Lube oil tank	1	
Bridge crane (capacity 50 tons)	2	
Trash conveyor	255	ft
Fire protection system	1	

TETRA TECH

Galveston Island 3 Fuel Tank Foundations Quantities

Calculation No. GI3-PS-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Galveston Island 3 Fuel Tank Foundations Quantities				
Made By:	NRT	**Date:** 02/10/20	**Chk'd By:** LAL	**Date:**	02/13/20

Calc Body Pages	Appended Pages	Total Pages
7	0	7

Document code

Site	Feature	Discipline	Document type	Number
GI3	PS	ST	MT	002

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Lexee Navarre 9/12/2018	Daniel Stuard 9/21/2018	
B	Nathan Tobin 2/10/2020 NTr	Lois Loesch 2/13/2020 Lois Loesch	Updated to reflect increased pumping capacity

TETRA TECH	Galveston Island 3 Fuel Tank Foundations Quantities	Calculation No. GI3-PS-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	NRT	**Date:**	02/10/20	**Chk'd By:**	LAL	**Date:**	02/13/20

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Attachments	Number of Pages	Last Page Number

TETRA TECH	Galveston Island 3 Fuel Tank Foundations Quantities	Calculation No. GI3-PS-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	3
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	NRT	**Date:** 02/10/20	**Chk'd By:** LAL	**Date:**	02/13/20

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for fuel tank foundations.
Pump station capacity increased to 5000 cfs.

APPROACH

Typical engineering means and methods for determining volumes and weights.

REFERENCES

References used during this calculation are as follows:

1) GI3-PS-ST-CL-001
2) GI3-PS-ME-CL-001

RESULTS / CONCLUSIONS

Total # of Pipe Piles:	80	(All piles have tension connections)			
Total 24" Diam. X 0.5" Steel Pipe Pile:	4460.0	ft	**or**	280.1	tons
Total # of Pile Caps:	20				
Total Concrete per Cap:	13.3	yd^3			
Pile Cap Concrete:	266.7	yd^3			

TETRA TECH	Galveston Island 3 Fuel Tank Foundations Quantities	Calculation No. GI3-PS-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	4
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	NRT	**Date:**	02/10/20	**Chk'd By:**	LAL	**Date:**	02/13/20

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) Material Properties:
   - Concrete, f'c = 4000 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
2) Costs of reinforcement is included in reinforced concrete unit cost.
3) All piles have tension connections.
4) Total number of Tanks = 10

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Materials and quantites as design progresses.

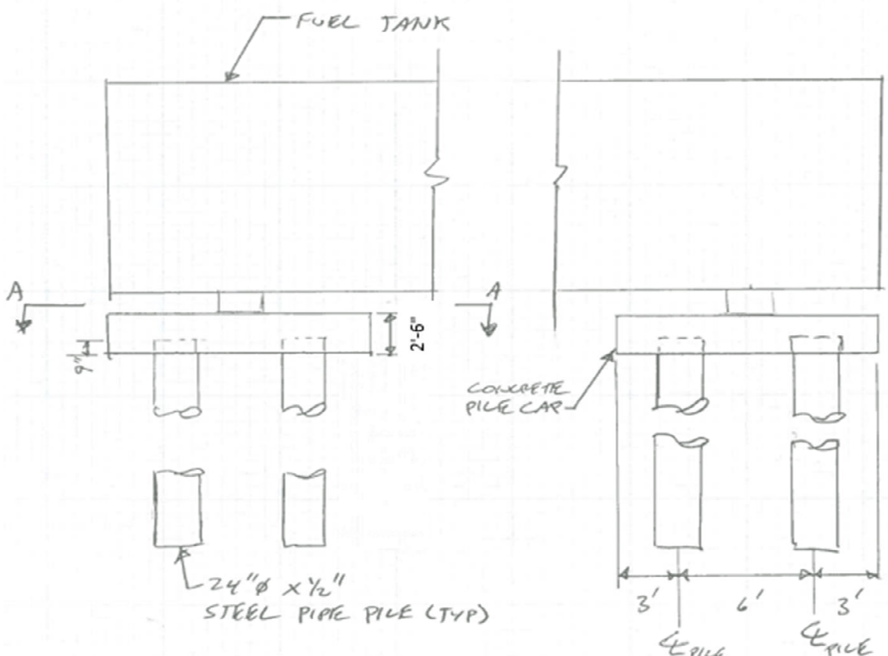
CALCULATIONS

Begin on next page.

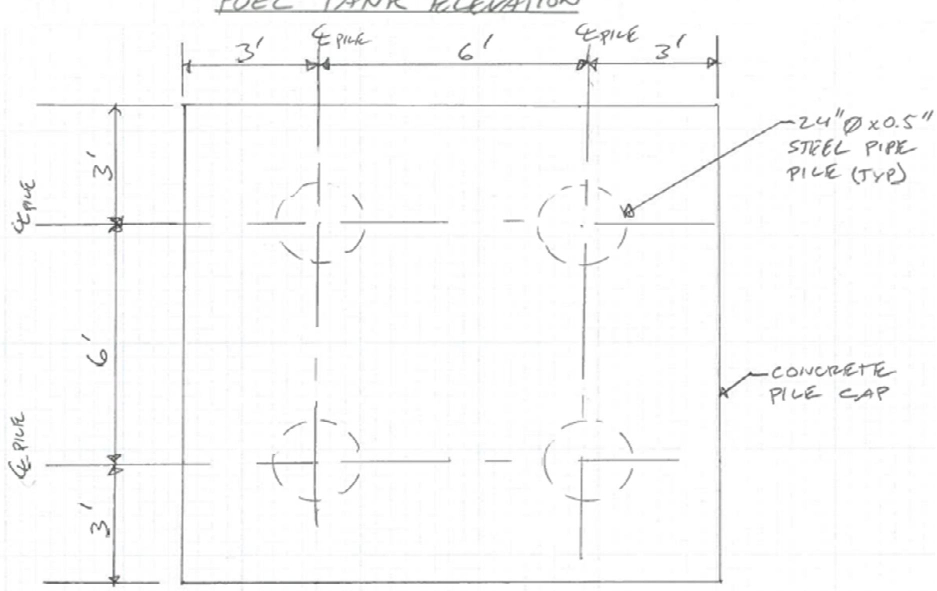
TETRA TECH	**Galveston Island 3 Fuel Tank Foundations Quantities**	**Calculation No.** **GI3-PS-ST-MT-002**

Job No.:	100-RCE-18-09-1					**Page:**	5
Project:	Coastal Texas Protection and Restoration						
Description:	General References and Figures						
Made By:	NRT	**Date:**	02/10/20	**Chk'd By:**	LAL	**Date:**	02/13/20

General References and Figures

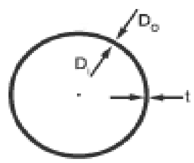


FUEL TANK ELEVATION



FUEL TANK PILE CAP PLAN (A-A)

Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = $10.69 * t * (D_o - t)$
D_o (in) - outside diameter
t (in) - thickness of pipe

Pipe Weight (kg/m) = $0.0247 * t * (D_o - t)$
D_o (mm) - outside diameter
t (mm) - thickness of pipe

PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

Tetra Tech	Galveston Island 3 Fuel Tank Foundations Quantities	Calculation No. GI3-PS-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	7
Project:	Coastal Texas Protection and Restoration				
Description:	Quantities for Fuel Tank Foundations				
Made By:	NRT	**Date:** 02/10/20	**Chk'd By:** LAL	**Date:**	02/13/20

Quantities for Fuel Tank Foundations

PILES

The minimum tip embedment is to be 55 feet plus 9 inches of embedment into concrete slab.

Pile Diameter: 24.0 in
Pipe Thickness: 0.5 in
Pipe Weight*: 125.61 lb/ft
Pile Tip to Head Embedment: 55.75 ft

*see general references attachments for reference of produced value

Number of Caps per Tank: 2
Total Number of Tanks: 10
Total Number of Pile Caps: 20
Number of Piles per Cap: 4

Total Number of Piles: **80**
Total of Steel Pipe Piles: **4460.0 ft** **or** **280.1 tons**

CONCRETE:

PILE CAPS:

Thickness (ft)	Width (ft)	Cross Sectional Area (ft^2)	Length (ft)	Volume (yd^3)
2.5	12	30	12	13.3

Total Number of Pile Caps: 20 (see piles section)

Total Concrete: **266.67 yd^3**

TETRA TECH

Galveston Island #4 Pump Station Quantities

Calculation No. GI4-PS-ST-MT-001

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Galveston Island Pump Station #4 Quantites				
Made By:	RSK	**Date:** 02/06/20	**Chk'd By:** NRT	**Date:**	02/11/20

Calc Body Pages	Appended Pages	Total Pages
14	2	16

Document code

Site	Feature	Discipline	Document type	Number
GI4	PS	ST	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Lexee Navarre 7/31/2018	Carl Grompe 9/21/2018	
B	Michael Hough 11/6/2018	Jason Kikuta 11/7/2018	Revised for updated geometry and design
C	Robert Kramer 2/6/2020 Robert Kramer	Nathan Tobin 02/11/2020 NT	Revised for updated water surface elevations

TETRA TECH	**Galveston Island #4 Pump Station Quantities**		**Calculation No. GI4-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:	Revision Summary						
Made By:	RSK	**Date:**	02/06/20	**Chk'd By:**	NRT	**Date:**	02/11/20

Revision Summary

Revision Summary

Reason for Revision: USACE provided new SWL elevations and required pump capacities following new storm analysis. At pump station 4 the result of this analysis was an increase in the required pump capacity, increasing the number of pumps from 3 to 10. Per USACE, the stormwater elevation for each pump also dropped from SWL 500 El 18.2 to EL 16.1 and SWL100 El 14.6 to El 12.4. This allowed the pump superstructures to be lowered 2.1' each. The concrete quantities were updated to reflect the removed materials.

Symbols:

t_{11}: thickness of wall 11 — L_{11}: Length of wall 11

t_{10}: thickness of wall 10 — L_{10}: Length of wall 10

t_7: thickness of wall 7 — w_7: Width of wall 7

t_2: thickness of wall 2 — w_2: Width of wall 2

Diffuser Area Ratio: The New Diffuser Plan Area / Old Diffuser Area

Source for Revisions:

Galveston Island #4 Pump Station Concrete Walls Structural Calculations
Galveston Island #4 Intake Structure Concrete Walls Structural Calculations

Revised Inputs:

* All revised inputs are in **red bold print** within calculation package

Revised Item	Location	Original Number	Updated Number	Updates to Number
Number of Pumps	TOC & Description, Foundation, Substructure and Superstructure Quantities	3	**10**	N/A
Total Volume of Concrete for Precast Concrete Wall Panels per Pump Bay	Substructure Quantities	603.8 yd^3	**581 yd^3**	Decreased wall height for walls labelled 2,7,10 and 11
Intake Foundation Slab	Foundation Quantities	232 yd^3	**2338 yd^3**	Increased CS Area for Slab
Intake Diffuser Substructure	Substructure Quantities	331.9 yd^3	**2717 yd^3**	Increased CS Area for Slab and decreased wall heights

TETRA TECH	**Galveston Island #4 Pump Station Quantities**	**Calculation No. GI4-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	RSK	**Date:**	02/06/20	**Chk'd By:**	NRT	**Date:**	02/11/20

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TETRA TECH	**Galveston Island #4 Pump Station Quantities**	**Calculation No. GI4-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1			**Page:**	4
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	RSK	**Date:** 02/06/20	**Chk'd By:** NRT	**Date:**	02/11/20

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for Pump Station at Galveston Island Site #4

APPROACH

Typical engineering means and methods.

REFERENCES

References used during this calculation are as follows:

1) Plate 51 - as noted
2) Plate 52

RESULTS / CONCLUSIONS

PILES:

Total # of 24" Diam. X 5/8" Vertical Pipe Piles:	752			
Total 24" Diam. X 5/8" Steel Pipe Pile:	60160 ft	**OR**	4698 tons	
Total PZ-22 Steel Sheet Pile:	9747.5 ft^2	**OR**	107 tons	

CONCRETE:

FOUNDATIONS:

Total Concrete for Base Slab:	**5107** yd^3	
Total Concrete for Mud Slab:	707 yd^3	
Total:	**5814** yd^3	

SUBSTRUCTURE:

Total:	**9510** yd^3	

SUPERSTRUCTURE:

Total:	622 yd^3	8" Thick Precast Concrete Wall Panels
TOTAL CONCRETE:	**15946** yd^3	

TETRA TECH	**Galveston Island #4 Pump Station Quantities**	**Calculation No. GI4-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	5
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	RSK	**Date:**	02/06/20	**Chk'd By:**	NRT	**Date:**	02/11/20

STEEL:

SUPERSTRUCTURE:

Total Number of W27x194 Steel Columns:	52		
Length	2210 ft	**OR**	214 tons
Total Number of W18X143 Steel Roof Beams:	26		
Length	1027 ft	**OR**	73 tons
Total Number of W18X143 Steel Roof Beams:	32		
Length	640 ft	**OR**	46 tons

CRANE FRAME:

Total Number of Steel HHS 12x12x1/2 Columns:	52		
Length	1950 ft	**OR**	74 tons
Total Number of W18X192 Steel Top Rails:	32		
Length	640 ft	**OR**	61 tons
Total Number of 30 lb/ft Crane Rails:	32		
Length	640 ft	**OR**	10 tons
Total Number of Steel HHS 12x12x1/2 Beams:	160		
Length	3200 ft	**OR**	122 tons

TETRA TECH	**Galveston Island #4 Pump Station Quantities**	**Calculation No.** **GI4-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	6
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	RSK	**Date:**	02/06/20	**Chk'd By:**	NRT	**Date:**	02/11/20

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) Excavation is to be determined by others.
2) Number of pumps = **10**
3) Material Properties:
   - Concrete for base slab, allowable f'c = 4000 psi
   - Concrete for mud slab, allowable f'c = 2500 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
   - Sheet Piles = ASTM A328
4) All piles have tension connections.

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) Material types and properties.
2) Layout, elevations and dimensions of Pump Station.

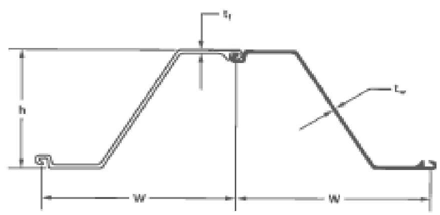
CALCULATIONS

Begin on next page.

General References and Figures

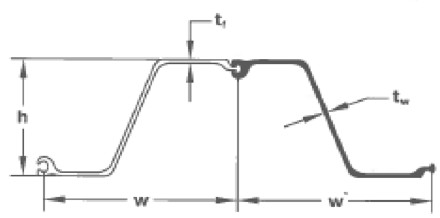
NZ/PZ

NZ/PZ Hot Rolled Steel Sheet Pile



NZ

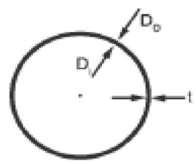
SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Web (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
NZ 19	27.56 700	16.14 410.0	0.375 9.5	0.375 9.5	7.04 148.9	55 81.85	23.95 116.93	35.08 1886	41.33 2222	283.1 38659	6.18 1.88	1.35 1.35
NZ 20	27.56 700	16.16 410.5	0.394 10.0	0.394 10.0	7.29 154.4	57 84.83	24.82 121.18	36.24 1948	42.80 2301	292.8 39984	6.18 1.88	1.35 1.35
NZ 21	27.56 700	16.20 411.5	0.433 11.0	0.433 11.0	7.80 165.2	61 90.78	26.56 129.68	38.69 2080	45.85 2465	313.4 42797	6.18 1.88	1.35 1.35
NZ 26	27.56 700	17.32 440.0	0.500 12.7	0.500 12.7	9.08 192.3	71 105.66	30.92 150.94	48.50 2608	57.01 3065	419.9 57340	6.49 1.98	1.41 1.41



PZ

SECTION	Width (w) in (mm)	Height (h) in (mm)	THICKNESS Flange (t_f) in (mm)	THICKNESS Wall (t_w) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft of single (m²/m)	COATING AREA Wall Surface ft²/ft² (m²/m²)
PZ 22	22.0 559	9.0 229	0.375 9.50	0.375 9.50	6.47 136.9	40.3 60.0	$\boxed{22.0 \; 107.4}$	18.1 973	21.79 1171.4	84.38 11500	4.48 1.37	1.22 1.22
PZ 27	18.0 457	12.0 305	0.375 9.50	0.375 9.50	7.94 168.1	40.5 60.3	27.0 131.8	30.2 1620	36.49 1961.9	184.20 25200	4.48 1.37	1.49 1.49
PZ 35	22.6 575	14.9 378	0.600 15.21	0.500 12.67	10.29 217.8	66.0 98.2	35.0 170.9	48.5 2608	57.17 3073.5	361.22 49300	5.37 1.64	1.42 1.42
PZ 40	19.7 500	16.1 409	0.600 15.21	0.500 12.67	11.77 249.1	65.6 97.6	40.0 195.3	60.7 3263	71.92 3866.7	490.85 67000	5.37 1.64	1.64 1.64

Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = 10.69*t*(D_o-t)
D_o (in) - outside diameter
t (in) - thickness of pipe

Pipe Weight (kg/m) = 0.0247*t*(D_o-t)
D_o (mm) - outside diameter
t (mm) - thickness of pipe

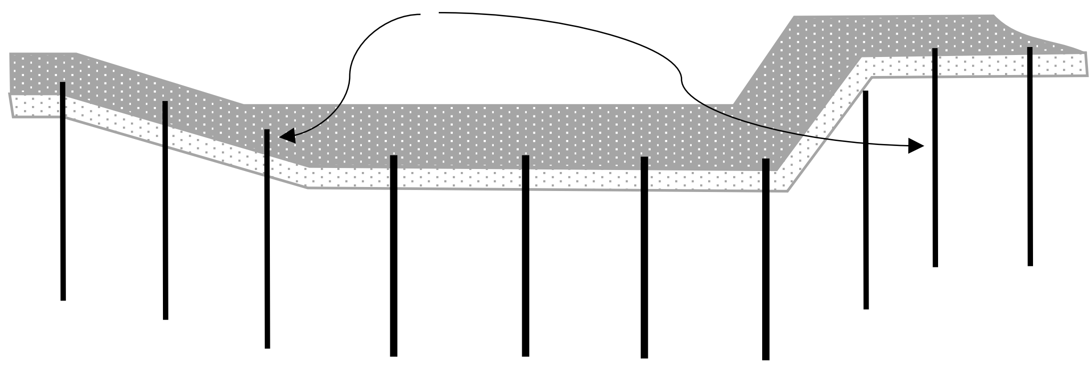
PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

Job No.:	100-RCE-18-09-1					**Page:**	9
Project:	Coastal Texas Protection and Restoration						
Description:	Quantities for Pump Station Foundations						
Made By:	RSK	**Date:**	02/06/20	**Chk'd By:**	NRT	**Date:**	02/11/20

Quantities for Pump Station Foundations

Figure 1:



PILES

Number of Piles 72 At Pumps
Number of Piles 32 At Safe House Enclosure Slab
Pile Diameter: 24 in
Pile Thickness: 5/8 in
Pile Weight: 156.17 lb/ft
*see general references attachments for reference of produced value

Piles	# of Piles per row	Rows	Pile Weight (lb/ft)	Start EL (ft)	End EL (ft)	Length (ft)	Weight (ton)	Total Length (ft)	Total Weight (ton)
Pumps	3	24	156.17	-10.0	-90.0	80.0	6.2	5760	449.8
Safe House	8	4	156.17	0.0	-80.0	80.0	6.2	2560	199.9

TETRA TECH

Galveston Island #4 Pump Station Quantities

Calculation No. GI4-PS-ST-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	10
Project:	Coastal Texas Protection and Restoration						
Description:	Quantities for Pump Station Foundations						
Made By:	RSK	**Date:**	02/06/20	**Chk'd By:**	NRT	**Date:**	02/11/20

Piles (24" diam x 5/8")

Total # of Piles per Pump: 72
Total Length per Pump: 5760 ft
Total Weight per Pump: 450 tons

Total Number of Pumps: **10**

Total # of Piles at Safe House Enclosure: 32
Total Length at Safe House: 2560 ft
Total Weight at safe house: 200 tons

TOTALS:
# of 24" diam x 5/8" Piles: **752**
Length of 24" diam x 5/8": **60160 ft**
Weight of 24" diam x 5/8": **4698 tons**

SHEET PILE

Note: It is assumed that the sheet pile wall used at WCC for seepage control will also be the same kind used at Clear Creek.
A PZ-22 hot rolled sheet piling shall be utilized for seepage cutoff.

Start EL of Sheet Pile Wall: -25.0 ft
End EL of Sheet Pile Wall: -46.0 ft
Height of Sheet Pile Wall: 21.0 ft
'eight of Sheet Pile Wall*: 22.0 lb/ft^2
Length of Sheet Pile Wall: 46.4 ft

*see general references attachments for reference of produced value

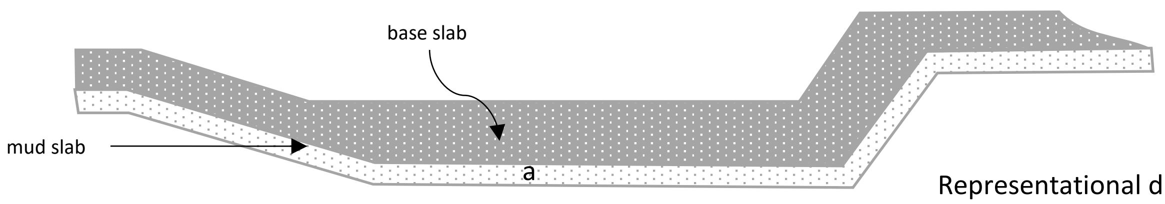
# of Walls	Area (ft^2)	Weight of Wall (lb/ft^2)	Weight (tons)
1	974.8	22.0	10.7

Total Number of Pumps: **10**

Total Area per Pump: 975 ft^2
Total Weight per Pump: 11 tons

TOTALS:
Area: **9748 ft^2**
Weight: **107 tons**

Figure 2:



Representational diagram

CONCRETE

FOUNDATION BASE SLAB:

F'c: 4,000 psi
Width of Slab: 20.0 ft

Total Volume of Concrete per Pump*: 277 yd^3
Total Number of Pumps: 10
Intake Slab: 2338
Total Foundation Slab Concrete: 5107 yd^3

*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.

MUD SLAB:

Note: Please see attached Plate 43 drawing for concrete sectioning. It is assumed that this pump station will also have a mud slab like West Closure Complex. Lengths of sections are estimates for the preliminary design phase.

F'c: 2,500 psi
Width of Slab: 20.0 ft **Slab Thickness:** 12.0 in

Section	Length (ft)	Thickness (in)	Cross Sectional Area (ft^2)	Width (ft)	Volume (yd^3)	
a	95.5	12.00	95.50	20.0	70.74	Per Model

Total Mud Slab Concrete per Pump: 71 yd^3
Total Number of Pumps: 10
Total Mud Slab Concrete: 707 yd^3

TOTAL CONCRETE: 5814 yd^3

TETRA TECH	Galveston Island #4 Pump Station Quantities	Calculation No. GI4-PS-ST-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	12
Project:	Coastal Texas Protection and Restoration						
Description:	Pump Station Substructure Quantities						
Made By:	RSK	**Date:**	02/06/20	**Chk'd By:**	NRT	**Date:**	02/11/20

Pump Station Substructure Quantities

CONCRETE

Total Volume of Concrete per Pump*:	**581.0**	yd^3	*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.
Total Number of Pumps:	**10**		
Total Volume of Concrete at Safe House*:	983.0	yd^3	
Total Volume of Concrete at Intake Diffuser*:	**2,717.0**	yd^3	

Total Concrete:	**9510**	**yd^3**

TETRA TECH	**Galveston Island #4 Pump Station Quantities**	**Calculation No. GI4-PS-ST-MT-001**

Job No.:	100-RCE-18-09-1			**Page:**	13
Project:	Coastal Texas Protection and Restoration				
Description:	Pump Station Superstructure Quantities				
Made By:	RSK	**Date:** 02/06/20	**Chk'd By:** NRT	**Date:**	02/11/20

Pump Station Superstructure Quantities

PRECAST CONCRETE WALL PANELS

Total Volume of Concrete per Pump Bay*:	45	yd^3	*Note: this value was obtained from a solid model developed for the design of this pump station, see attached.
Total Number of Pump Bays:	**10**		
Total Volume of Concrete at Safe House Enclosure*:	169	yd^3	

Total Concrete:	**622**	**yd^3**

STEEL

COLUMNS:
The columns of the steel superstructure frame will be W27X194.

Weight:	194	lb/ft	
Height:	42.5	ft	
Number of Columns per Pump Bay:	4		
Total Number of Pump Bays:	**10**		
Number of Columns at Safe House Enclosure:	12		Per Plans

Total Number of W27x194 Steel Columns:	**52**	
Total Length of W27x194 Steel Columns:	**2210**	**ft**
Total Weight of W27x194 Steel Columns:	**214**	**tons**

TETRA TECH	Galveston Island #4 Pump Station Quantities	Calculation No. GI4-PS-ST-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	14
Project:	Coastal Texas Protection and Restoration						
Description:	Pump Station Superstructure Quantities						
Made By:	RSK	**Date:**	02/06/20	**Chk'd By:**	NRT	**Date:**	02/11/20

LONGITUDINAL ROOF BEAMS (spanning length of pump bay):

The longitudinal roof beams of the steel superstructure frame will be W18X143.

Weight:	143	lb/ft	
Length:	39.5	ft	
Number of Roof Beams per Pump Bay:	2		
Total Number of Pump Bays:	10		
Number of Beams at Safe House Enclosure:	6		Per Plans

Total Number of W18X143 Steel Roof Beams:	**26**	
Total Length of W18X143 Steel Roof Beams:	**1027**	**ft**
Total Weight of W18X143 Steel Roof Beams:	**73**	**tons**

TRANSVERSE ROOF BEAMS (spanning width of pump bay):

The tansverse roof beams of the steel superstructure frame are W18X143.

Weight:	143	lb/ft	
Length:	20	ft	
Number of Roof Beams per Pump Bay:	2		
Total Number of Pump Bays:	10		
Number of Beams at Safe House Enclosure:	12		Per Plans

Total Number of W18X143 Steel Roof Beams:	**32**	
Total Length of W18X143 Steel Roof Beams:	**640**	**ft**
Total Weight of W18X143 Steel Roof Beams:	**46**	**tons**

Pump Station Crane Frame Quantities

STEEL

COLUMNS:

The columns of the steel crane frame are assumed to be HSS 12x12x1/2.

Weight:	76	lb/ft
Height:	37.5	ft
Number of Columns per Pump Bay:	4	
Total Number of Pump Bays:	10	
Number of Columns at Safe House Enclosure:	12	

Total Number of Steel HHS 12x12x1/2 Columns:	**52**	
Total Length of Steel HHS 12x12x1/2 Columns:	**1950**	**ft**
Total Weight of Steel HHS 12x12x1/2 Columns:	**74**	**tons**

TOP RAIL:

The top rail of the steel crane frame will be W18X192.

Weight:	192	lb/ft
Length:	20	ft
Number of Top Rails per Pump Bay:	2	
Total Number of Pump Bays:	10	
Number of Top Rails at Safe House Enclosure:	12	

Total Number of Top Rails:	**32**	
Total Length of Top Rails:	**640**	**ft**
Total Weight of Top Rails:	**61**	**tons**

CRANE RAIL:

Added to the top rail will be a 30 lb/ft crane rail.

Weight:	30	lb/ft
Length:	20	ft
Number of Crane Rails per Pump Bay:	2	
Total Number of Pump Bays:	10	
Number of Crane Rails at Safe House Enclosure:	12	

Total Number of Crane Rails:	**32**	
Total Length of Crane Rails:	**640**	**ft**
Total Weight of Crane Rails:	**10**	**tons**

INFILL FRAMING:

The infill framing beams of the steel crane frame are assumed to be HSS 12x12x1/2.

Weight:	76	lb/ft	
Length:	20	ft	
Number of Infill Beams per Pump Bay:	10		5 each side
Total Number of Pump Bays:	10		
Number of Infill Beams at Safe House Enclosure:	60		

Total Number of Steel HHS 12x12x1/2 Beams:	**160**	
Total Length of Steel HHS 12x12x1/2 Beams:	**3200**	**ft**
Total Weight of Steel HHS 12x12x1/2 Beams:	**122**	**tons**

TETRA TECH

Job Number

Vol./Sheet ____ of ____

Contract/Client: Galveston

Phase/Subject: Galveston Island Pumpstation 4

Design Topic: Concrete Quantities

Made By: RSK Date: 2/6/20 Checked By: ____ Date: ____

<u>Superstructure:</u> Not Changing

Safe house: $169\ yd^3$ (Based on Solid Works)

\# of Pumps: 10 (Based on PS 3 + 1 extra pump

Pumps: $45\ yd^3$ (Based on Solid Works

<u>Substructure:</u>

<u>Safehouse:</u> $983\ yd^3$ (Based on Model) (Not Changing)

<u>Intake Structure:</u>

$V_{intake} = 331.9\ yd^3$ (Based on Model)

Original Intake Plan Area

$L_{io} = 58'$ $w_{io} = 20'$ $w_{oo} = 60'$ (Old sta 4 plan)

$A_o = L_o \left(\frac{w_{io} + w_{oo}}{2} \right) = 58' \left(\frac{20' + 60'}{2} \right)$

$= 2320\ ft^2$

New Intake Plan Area:

$L_n = 222.75'$ $w_{in} = 25'$ $w_{on} = 200'$ (PS 3 Plan + 1 Pump)

$A_n = L_n \left(\frac{w_{in} + w_{on}}{2} \right) = 222.75' \left(\frac{25' + 200'}{2} \right) = 25{,}060\ ft^2$

$t_{intake\ structure} = 2.17'$ $\Delta H = -2.1'$

Change in Wall Height:

$H_{1o} = 10'$ $Lw_{1o} = 55'$ $tw_1 = 1.5'$

$H_{2o} = 10'$ $Lw_{2o} = 41.25'$ $tw_2 = 1.5'$

\# of wall 1's = 1 \# of wall 2's = 2

(Galveston Island PS #2 Intake Structure Conc. Wall)

\# of wall 1's: 2 $Lw_{1n} = 221.1'$ $tw_{1n} = 1.5'$ (Galveston Island PS #3 Intake Structure Conc. Wall)

$H_{1o} = 10'$

$H_{2o} = 10'$ \# of wall 2's: 3 $Lw_{2n} = 206.1'$ $tw_{2n} = 1.5'$

$H_{3o} = 10'$ \# of wall 3's: 4 $Lw_{3n} = 55'$ $tw_{3n} = 1.5'$ (Intake Structure Conc. wall #2)

TETRA TECH

Job Number

Vol./Sheet of

Contract/Client

Phase/Subject

Design Topic

Made By Date Checked By Date

Substructure:

$$V_{intake_{Final}} = V_{intake\,initial} - t_i A_0 + t_i A_n - 1(L_{w_{10}}) t_{w_1} - 2(L_{w_{20}}) t_{w_2} + 2 L_{w_{1n}}^{CH-AH} t_{w_{1n}} + 3 L_{w_{2n}}^{CH-AH} t_{w_{2n}} + 4 L_{w_{4n}}^{CH-AH} t_{w_{4n}}$$

$$= 331.9\,yd^3 - \frac{2.17'(2320\,ft^2)}{27} + \frac{2.17(25{,}060\,ft^2)}{27'}$$

$$- \frac{10\,55'(1.5')}{27} - \frac{2(41.25')(1.5')(16')}{27'} + \frac{221.1'(7.4')(1.5')(2)}{27'}$$

$$+ \frac{(3)\,206.1'(7.4')(1.5')}{27} + \frac{(4)\,55'(7.4')(1.5')}{27'}$$

$$= \underline{2645\ yd^3}$$

Pumps:

\# of Pumps = 10

$V_{p\,initial} = 603.8\,yd^3$

$t_{11} = 3'$ $L_{11} = 29.8'$

$t_7 = 2'$ $L_7 = 20'$

$t_{10} = 3'$ $L_{10} = 42.75'$

$t_2 = 2'$ $L_2 = 20'$

(PS 3 Concrete Wall Structural Calcs)

Decrease in Wall Height: 2.1'

$$V_{p\,Final} = V_{p\,initial} + \Delta H (t_{11} L_{11} + t_7 L_7 + t_{10} L_{10} + t_2 L_2)$$

$$= 603.8\,yd^3 - \frac{2.1'\left(3'(29.8') + 2(20') + 3'(42.75') + 2'(20')\right)}{27}$$

$$= 581\ yd^3$$

TETRA TECH

Job Number

Vol./Sheet of

Contract/Client

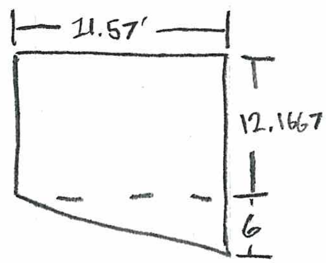
Phase/Subject

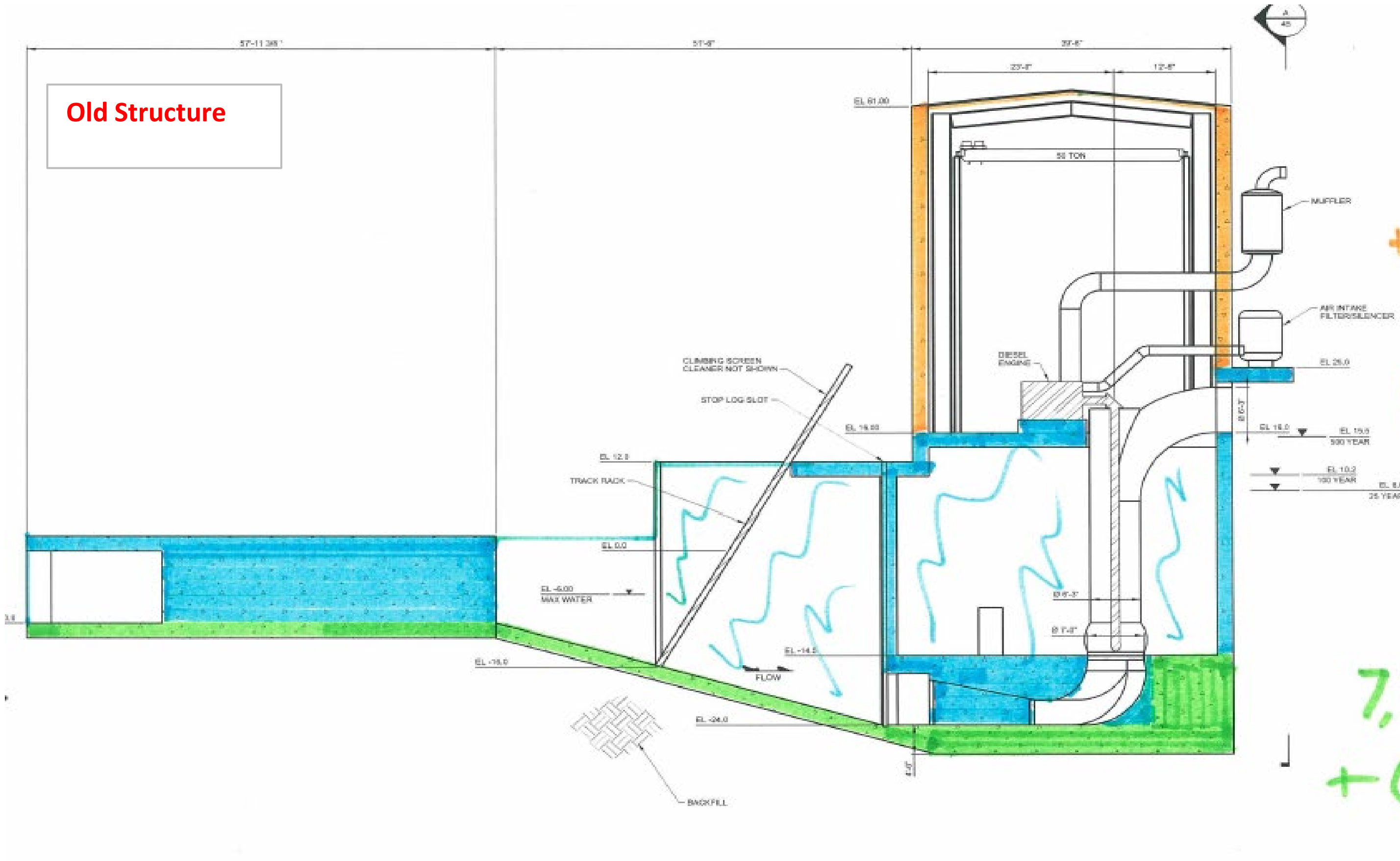
Design Topic

Made By Date Checked By Date

Endwalls

$$\frac{14'}{50.33'} = \frac{6}{x} \rightarrow x = 21.57'$$

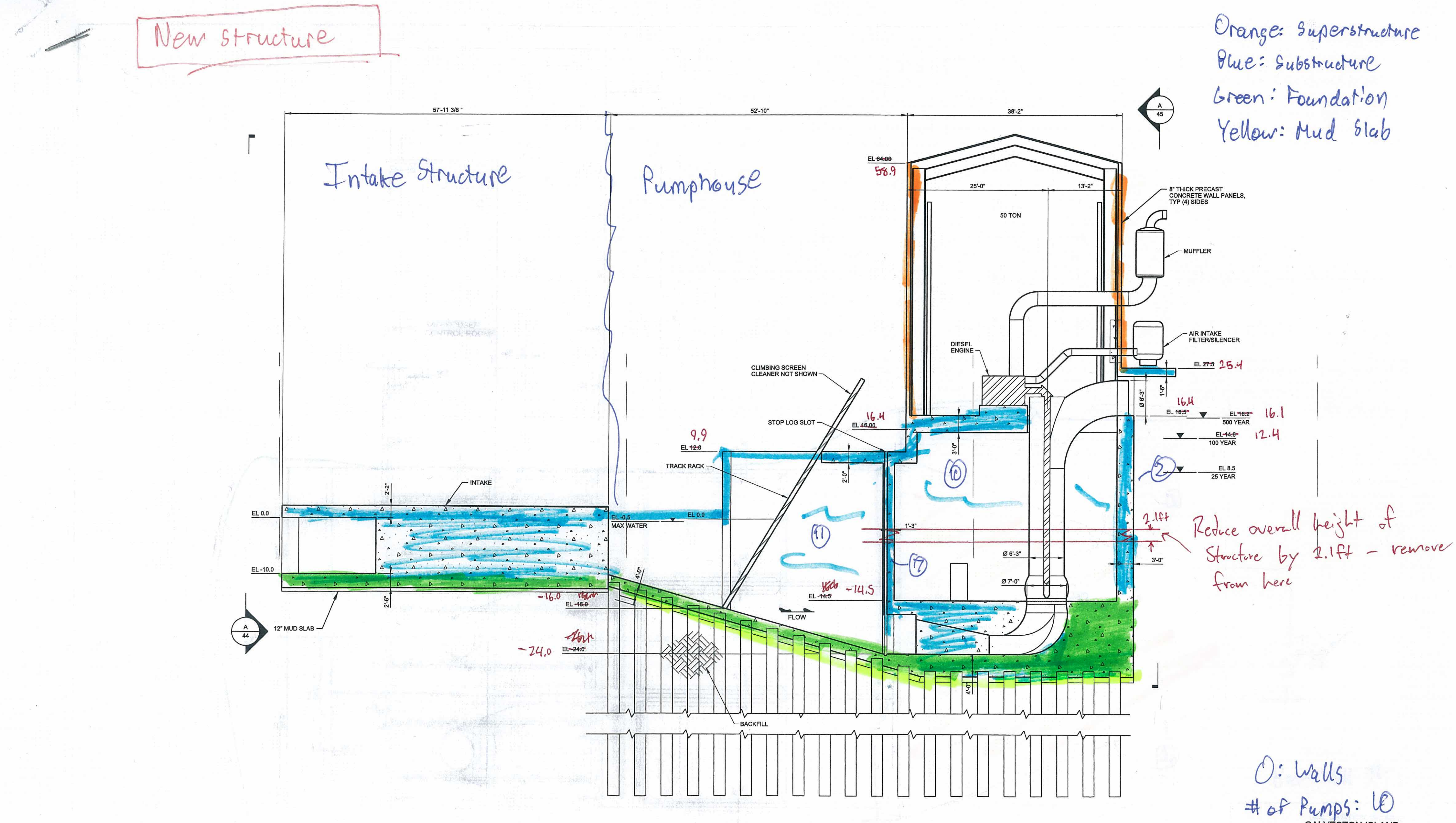




1,141 ft^3 ×3
+ 4,573 ft^3

16,303
~~13,363~~ ft^3 ×3
+ 8961 ft^3
+ 26,542 ft^3

7,475 ft^3 ×3
+ 6,262 ft^3



A 51 GALVESTON ISLAND PUMP STATION 4 - SECTION

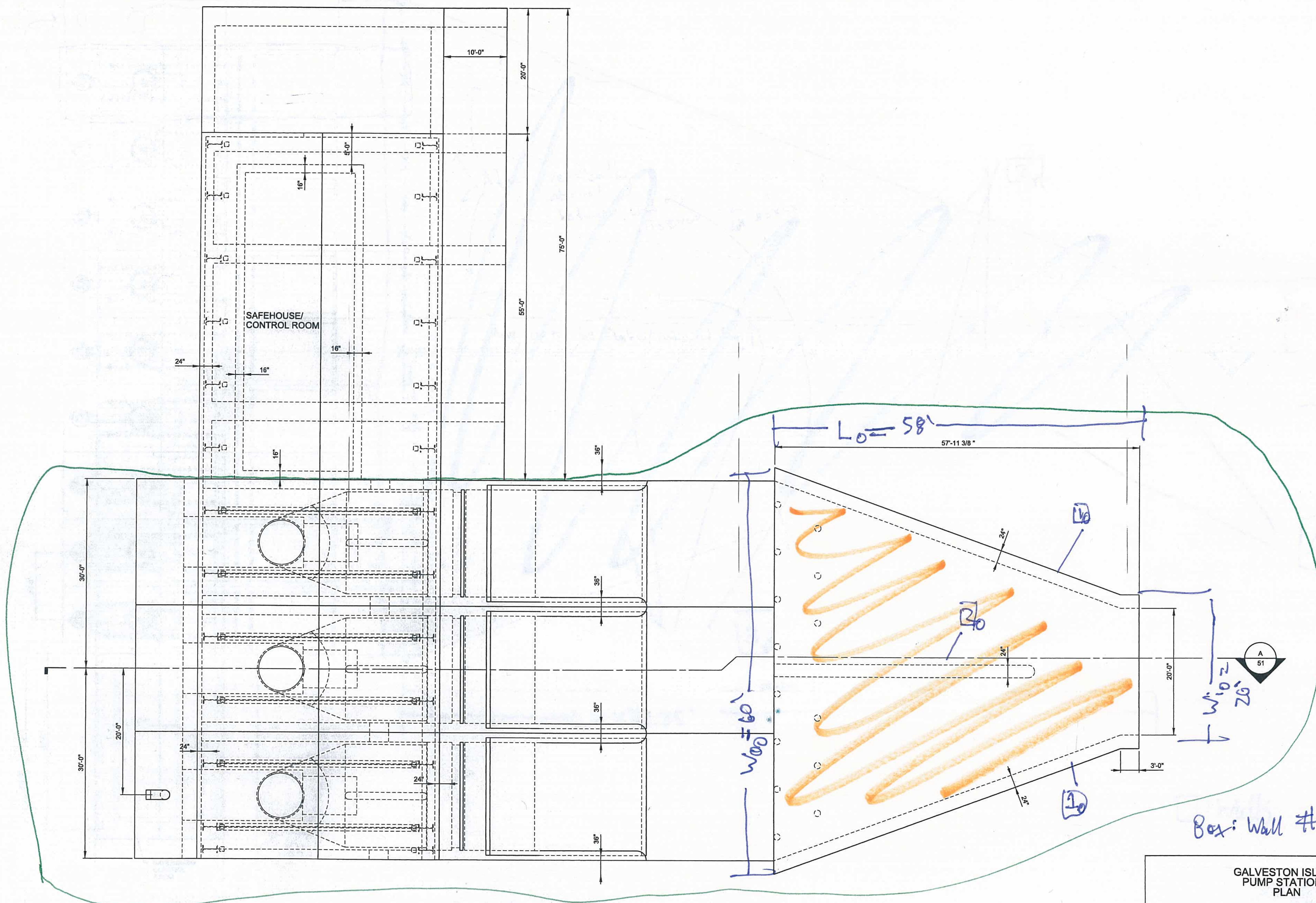
SCALE: 1/8" = 1'-0"

L:\2018\18-09 (RCE) - Ike Dike\CAD\Sheets\PLATE 52.dgn
vince.rouse 6:35:35 PM 11/7/2018

Checked by EOF

Revised 2/6/20 NRT

PLATE 52



GALVESTON ISLAND PUMP STATION 4 - PLAN

SCALE: 1/8" = 1'-0"

A 50

0 4' 8' 16'

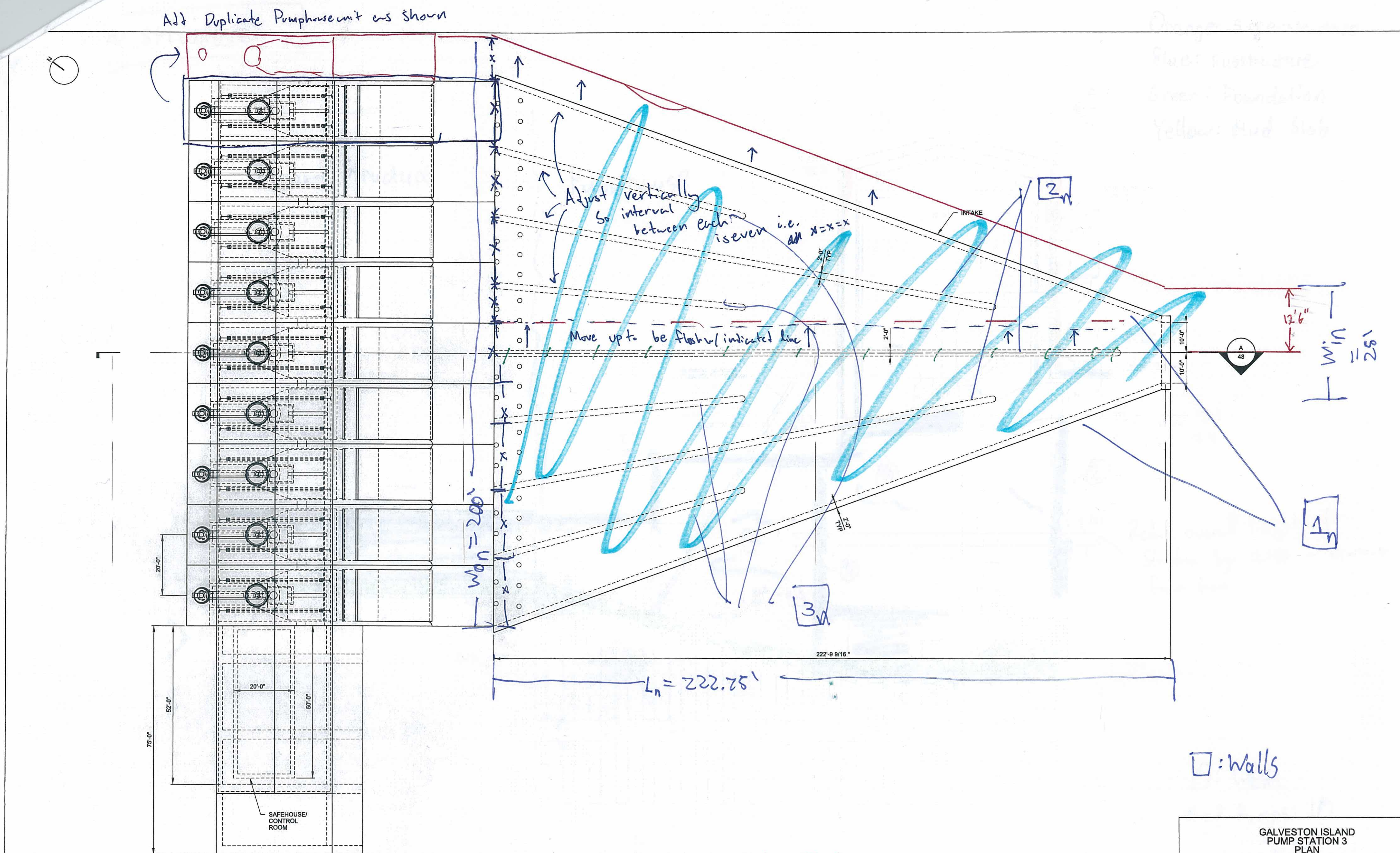
Remove & Replace w/ copy of updated 10-Pump bank on plate 47 attached

GALVESTON ISLAND
PUMP STATION 4
PLAN

COASTAL TEXAS PROTECTION AND RESTORATION FEASIBILITY STUDY

U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS

ENGINEERING APPENDIX
DATED:
NOVEMBER 9, 2018
TETRA TECH, INC.



A 46 GALVESTON ISLAND PUMP STATION 3 - PLAN
SCALE: 1" = 15'
0 15' 30'

GALVESTON ISLAND
PUMP STATION 3
PLAN

COASTAL TEXAS PROTECTION AND RESTORATION FEASIBILITY STUDY

U.S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS

ENGINEERING APPENDIX
DATED:
NOVEMBER 9, 2018
TETRA TECH, INC.

TETRA TECH

Calculation Cover Sheet

Job No.:	100-RCE-18-09-1					
Project:	Coastal Texas Protection and Restoration					
Title:	GI4-PS-EE-MT-001					
Design Topic:	Galveston Island Pump Station 4 Electrical Quantities					
Made By:	JS	**Date:**	02/14/20	**Chk'd By:**	AJB	**Date:** 02/19/20

Calc Body Pages	Appended Pages	Total Pages

Document code

Site	Feature	Discipline	Document type	Number
GI	PS	EE	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Discription
A	JUSTIN SERRA 08/17/2018	ALBERT BARNES 08/20/2018	
B	JUSTIN SERRA 02/14/2020 Justin Serra	ALBERT BARNES 02/19/2020 Albert Barnes	Revise to reflect pump station increase to 5000 cfs

TETRA TECH **Calculation Body**

Job No.:	100-RCE-18-09-1
Project:	Coastal Texas Protection and Restoration
Title:	GI4-PS-EE-MT-001
Design To	Galveston Island Pump Station 4 Electrical Quantities

Made By: JS **Date:** 02/14/20 **Chk'd By:** AJB **Date:** 02/19/20

GI-PS-EE-MT-001

1.0 ISSUE BEING ADDRESSED

2.0 APPROACH

Applying the National Electrical Code (NEC) and Unified facilities guide specifications division26 - electric of the USACE

3.0 REFERENCES

References used during this calculation are as follows:

1) NFPA 70 - National Electrical Code - 2017
2) Design and Analysis of building electrical systems, John H. Matthews
3) Unified facilities guide specificaitons division 26 - Electrical

4.0 RESULT SUMMARY/VERIFICATION

RESULTS / CONCLUSIONS

ITEMS TO BE VERIFIED

1) Number of pumps
2) Number of motors
3) Building size

5.0 ASSUMPTIONS

ASSUMPTIONS AND INPUTS

Assumptions made during this calculation are as follows

1) Large diesel powered motors will have a summed less than 10 HP worth of support motors.
2) Demand factors for electric motors and size of electric motors in sizing main service transformer
3) Pump Station layout of 8-15-2018 for distances and quantities of electrical equipment.
4) Adequate power is available within 250 feet of pump station location

5.0 CALCULATIONS

Galveston Island Pump Station four has 10 diesel pumps. Each pump bay in the pump station is approximately 20'x70'x60'. The pump station will have an additional 2 bays to contain the control room and living quarters for the pump station and pump station staff. The additional space is for the maintenance area and machine shop for the pump station. The pump station length will be 100' in length and the addition of large clearance required for removal and replacement of equipment will result in the minimum width of 70'. The segregation of the pump house equipment to insure no one single fault resulting in the loss of power and function to the entire pump house requires

multiple separate distribution power systems in the pump house.

Item No.	Item Description	Quantity	Unit
ELECTRICAL ITEMS			
Galveston Island Pump Station 4			
1	**TELEPHONE/COMMUNICATION SYSTEM**		
	a. Telephone Patch Panel	1	Ea
	b. Master Desk Telephone	1	Ea
	c. Combination Telephone/Intercom	5	Ea
	d. 1" RMC Conduit	200	Lf
	e. Telephone cable	200	Lf
	f. Cable Terminations	20	Ea
	PUMP STATION LIGHTS AND FIXTURES		
	a. High Bay Down Lighting	20	Ea
	b. Wall Lights	20	Ea
	c. Warning Light	20	Ea
	d. Warning Horn	2	Ea
	e. Mast Lights with 30' Mast	10	Ea
	f. Emergancy Battery Lighting	30	Ea
	g. 3/4" RMC	3,000	CLF
	h. Lighting Connection Whips	40	Ea
	i. Ceiling Lights	20	Ea
	PUMP STATION VIDEO/CCTV SYSTEM		
	a. Video Camera	10	Ea
	b. Network Hub	2	Ea
	c. DVR	2	Ea
	d. 1" RMC	500	Lf
	e. Video Cable	500	Lf
	f. 2" RMC	0	Lf
	g. Fiber Optic Cable	0	Lf
	h. LCD television monitors, with audio, 8-inch	2	Ea
	i. Cable Terminations	50	Ea
	j. Monitoring Software	1	Ea
	FUEL STORAGE VIDEO/CCTV SYSTEM		
	a. Video Camera	2	Ea
	b. 3/4" RMC	1,000	Lf
	c. Video Cable	1,000	Lf
	d. 2" RMC	0	Lf
	e. Fiber Optic Cable	0	Lf
	f. Cable Terminations	50	Ea
	PUMP STATION FIRE ALARM AND DETECTION SYSTEM		
	a. Air Sampling (Ionization) Detector	6	Ea
	b. Thermal (Heat) Detector	6	Ea

	c. Smoke Detector	6	Ea
	d. Pull Station	4	Ea
	e. Bell	2	Ea
	f. Fire Alarm Control Panel	2	Ea
	g. Main Fire Alarm Control Panel	1	Ea
	h. Detector Cable	300	Lf
	i. Alarm Cable	300	Lf
	j. 8 Fiber Optic Cable	0	Lf
	k. 3/4" RMC for Routing Fire Alarm Cable	300	Lf
	l. 2" RMC for Routing Fiber Optic Cable	0	Lf
	m. Cable Terminations	20	Ea
	FUEL STORAGE FIRE ALARM AND DETECTION SYSTEM		
	a. Air Sampling (Ionization) Detector	2	Ea
	b. Thermal (Heat) Detector	2	Ea
	c. Smoke Detector	2	Ea
	d. Pull Station	2	Ea
	e. Bell	1	Ea
	f. Fire Alarm Control Panel	1	Ea
	g. Main Fire Alarm Control Panel	0	Ea
	h. Detector Cable	500	Lf
	i. Alarm Cable	500	Lf
	j. 8 Fiber Optic Cable	0	Lf
	k. 3/4" RMC for Routing Fire Alarm Cable	500	Lf
	l. 2" RMC for Routing Fiber Optic Cable	0	Lf
	m. Cable Terminations	20	Ea
	PUMP STATION CONTROLS AND SENSORS		
	a. Control Cabinet w/ PLC, power supply, processor, comm. Matrix, realys and network hub	3	Ea
	b. PLC Analog Inputs and Outputs	100	Ea
	c. PLC Digital Inputs and Ouputs	100	Ea
	d. Operators Control Cabinet w/ pushbuttons, switches, etc.	4	Ea
	e. Human/Machine Interface (HMI)	6	Ea
	f. Software for programming PLC and HMI	1	Ea
	g. 3/4" RMC	500	Lf
	h. 1" RMC	250	Lf
	i. 12 Pair Fiber Optic Cable	0	Lf
	j. 2" RMC for Fiber optic	0	Lf
	k. Controls Panelboard, 120/240V/ 60A, 2d. ckt, w/20A ckt bkr	4	Ea
	l. Circuit Breakers, Various Sizes, 1-pole	100	Ea
	m. Cable Terminations	200	Ea
	n. Gearbox heaters	4	Ea
	FUEL STORAGE CONTROLS AND SENSORS		
	a. Control Cabinet w/ PLC, power supply, processor, comm. Matrix, realys and network hub	1	Ea

	b. PLC Analog Inputs and Outputs	100	Ea
	c. PLC Digital Inputs and Ouputs	100	Ea
	d. Operators Control Cabinet w/ pushbuttons, switches, etc.	1	LOT
	e. Human/Machine Interface (HMI)	2	Ea
	f. Software for programming PLC and HMI	0	Ea
	g. 3/4" RMC	300	Lf
	h. 1" RMC	300	Lf
	i. 2#14 AWG braided conductors	500	Lf
	j. Limit Switches	20	Ea
	k. Flow sensors	10	Ea
	l. Level sensors	10	Ea
	m. Valvue Actuators	20	Ea
	n. Leak Sensors	10	Ea
	o. Fuel Temp Sensors	10	Ea
	p. Relays	20	Ea
	INCOMING POWER		
	a. 35' Pole	3	Ea
	b. Overhead Conductors	250	Lf
	c. Pull Boxes	5	Ea
	d. Misc Hardware	1	LOT
	e. Cable Terminations	10	Ea
	PUMP STATION LIGHTING CONDUCTORS		
	a. #12 AWG Stranded Copper	2,500	Lf
	b. #10 AWG Stranded Copper	2,500	Lf
	c. #8 AWG Stranded Copper	1,000	Lf
	d. Pull Boxes	1,000	Ea
	e. Cable Terminations	2,500	Ea
	FUEL STORAGE LIGHTING		
	a. #12 AWG Stranded Copper	0	Lf
	b. #10 AWG Stranded Copper	200	Lf
	c. #8 AWG Stranded Copper	200	Lf
	d. Pull Boxes	20	Ea
	e. Cable Terminations	50	Ea
	f. Mast Lights with 30' Mast	6	Ea
	MOTOR CONTROL CENTER - MCCx12		
	a. MCC - Section	24	Ea
	b. Main Disconnect Circuit Breaker - MDCB	12	Ea
	c. Combination Starter	20	Ea
	d. Control Transformer	4	Ea
	e. Circuit Breaker	100	Lf
	f. 3-#12 AWG, 1 - #12 AWG	1000	Lf
	g. 3-#10 AWG, 1 - #10 AWG	1000	Lf
	h. 3-#8 AWG, 1 - #10 AWG	500	Lf

	PUMP STATION RECEPTACLES		
	a. 5-20R Receptacles	40	Ea
	b. #10 AWG Stranded Copper	500	Lf
	c. 100A 3P-5W NEMA-3R Power Outlet	6	Ea
	d. 4#1 AWG, 1#8 AWG EGC	2,000	Lf
	e. Pull Boxes	12	Ea
	f. Cable Terminations	50	Ea
	FUEL STORAGE RECEPTACLES		
	a. 5-20R Receptacles NEMA 4X	20	Ea
	b. #10 AWG Stranded Copper	250	Lf
	c. 100A 3P-5W NEMA-4X Power Outlet	2	Ea
	d. 4#1 AWG, 1#8 AWG EGC	500	Lf
	e. Pull Boxes	6	Ea
	f. Cable Terminations	20	Ea
	Automatic Transfer switches		
	a. Medium Voltage Automatic Transfer switches	0	Ea
	b. Low Voltage Automatic Transfer Switches	3	Ea
	c. Diconnect Switches	20	Ea
	d. Fused Disconnect Switches	2	Ea
	Stand-by Generators		
	a. 1000kW Generator	2	Ea
	b. 250kW Generator	1	Ea
	c.100kW Generator	3	Ea
	d. Load Banks	5	Ea
	e. Control Panel	3	Ea
	Power Transformers		
	a. 1000kVA	1	Ea
	b. 50kVA	0	Ea
	c. 30kVA	1	Ea
	d. 15kVA	2	Ea
	Conductors		
	a. #14 AWG	4000	Lf
	b. #12 AWG	2500	Lf
	c. #10 AWG	2500	Lf
	d. #8 AWG	2000	Lf
	e. #6 AWG	2000	Lf
	f. #4 AWG	1000	Lf
	g. #3 AWG	0	Lf
	h. #2 AWG	0	Lf
	i. #1 AWG	1000	Lf
	j. 1/0 AWG	1000	Lf
	k. 2/0 AWG	0	Lf

	l. 3/0 AWG	0	Lf
	m. 4/0 Awg	2000	Lf
	n. 350 kmill	0	Lf
	o. 500 kmill	0	Lf
	Conduits		
	a. 3/4" RMC	3000	Lf
	b. 1" RMC	2000	Lf
	c. 1 1/4" RMC	0	Lf
	d. 1 1/2" RMC	500	Lf
	e. 2" RMC	2000	Lf
	f. 2 1/2" RMC	0	Lf
	g. 3" RMC	500	Lf
	h. 4" RMC	300	Lf
	Motors		
	a. 1-hp, 3PH, 480VAC	0	Ea
	b. 2-hp, 3PH, 480VAC	10	Ea
	c. 5-hp, 3PH, 480VAC	0	Ea
	d. 10-hp, 3PH, 480VAC	10	Ea
	e. 20-hp, 3PH, 480VAC	10	Ea
	f. 30-hp, 3PH, 480VAC	0	Ea
	g. 50-hp, 3PH, 480VAC	2	Ea

TETRA TECH	Galveston Island 4 Pump Station Quantities	Calculation No. GI4-PS-ME-MT-001

Job No.:	100-RCE-18-09-1	**Page:**	1
Project:	Coastal Texas Protection and Restoration		
Description:	Galveston Island 4 Pump Station Quantities		
Made By:	NRT **Date:** 02/12/20	**Chk'd By:** LAL	**Date:** 02/13/20

Calc Body Pages	Appended Pages	Total Pages
3	5	8

Document code

Site	Feature	Discipline	Document type	Number
GI4	PS	ME	MT	001

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Carl Grompe 11/08/2018	Eric Flickinger 11/08/2018	
B	Nathan Tobin 02/12/2020 NT	Lois Loesch 02/13/2020 Lois Loesch	Revised to reflect increase in pump station capacity from 1500 to 5000

TETRA TECH	**Galveston Island 4 Pump Station Quantities**	**Calculation No. GI4-PS-ME-MT-001**

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	NRT	**Date:**	02/12/20	**Chk'd By:**	LAL	**Date:**	02/13/20

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ISSUE BEING ADDRESSED

Mechanical equipment quantity take-offs for preliminary cost estimate for Pump Station at Galveston Island 4.

APPROACH

Equipment falls into 2 categories, sets of equipment in every bay, and equipment unrelated to the number of bays

REFERENCES

References used during this calculation are as follows:

1) Mechanical drawings by Tetra Tech
2) WCC cross section
3) Patterson pump drawings from PCCP

RESULTS / CONCLUSIONS

See calculation sections

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) 5 days fuel storage

TETRA TECH	Galveston Island 4 Pump Station Quantities	Calculation No. GI4-PS-ME-MT-001

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	NRT	**Date:**	02/12/20	**Chk'd By:**	LAL	**Date:**	02/13/20

CALCULATIONS

Equipment in every bay

Number of Bays	10	
Trash rack	884	ft^2
Trash rake (climbing style)	1	
Formed suction intake (type 10 for Ø84")	1	
Vertical Pump (500 cfs)	1	
Custom discharge piping	1	
Vacuum break	1	
Angle gearbox/speed reducer	1	
Diesel engine (CAT 32-C[1] Marine)	1	
Cooling water supply lines (Ø 6")	133	ft
Cooling water pump	1	
Exhaust line	38	ft
Exhaust muffler	1	
Air intake line	22	ft
Air intake filter/silencer	1	
Day Tank (700 gal)	1	
Double walled fuel pipe (Ø1.5" w/leak detection)	40	ft
Ventilation fan	1	

Other equipment

Sump stop log	60	ft^2
Stop log hoist	1	
Diesel Storage tanks (10,000 gal)	9	
Main fuel pumps	18	
Double walled fuel pipe (Ø3" w/leak detection)	520	ft
Fuel conditioning (filter type or centrifuge type)	1	
Air Compressor	3	
Lube oil tank	1	
Bridge crane (capacity 50 tons)	2	
Trash conveyor	255	ft
Fire protection system	1	

TETRA TECH	Galveston Island 4 Fuel Tank Foundations Quantities	Calculation No. GI4-PS-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Galveston Island 4 Fuel Tank Foundations Quantities				
Made By:	NRT	**Date:** 02/10/20	**Chk'd By:** LAL	**Date:**	02/13/20

Calc Body Pages	Appended Pages	Total Pages
7	0	7

Document code

Site	Feature	Discipline	Document type	Number
GI4	PS	ST	MT	002

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Lexee Navarre 09/21/2018	Daniel Stuard 09/21/2018	
B	Nathan Tobin 02/10/2020 NT	Lois Loesch 02/13/2020 Lois Loesch	Updated to reflect increased pumping capacity

TETRA TECH	Galveston Island 4 Fuel Tank Foundations Quantities	Calculation No. GI4-PS-ST-MT-002

Job No.:	100-RCE-18-09-1			**Page:**	2
Project:	Coastal Texas Protection and Restoration				
Description:					
Made By:	NRT	**Date:** 02/10/20	**Chk'd By:** LAL	**Date:**	02/13/20

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Attachments	Number of Pages	Last Page Number

TETRA TECH	Galveston Island 4 Fuel Tank Foundations Quantities	Calculation No. GI4-PS-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	NRT	**Date:**	02/10/20	**Chk'd By:**	LAL	**Date:**	02/13/20

ISSUE BEING ADDRESSED

Quantity take-offs for preliminary cost estimate for fuel tank foundations.

APPROACH

Typical engineering means and methods for determining volumes and weights.

Pump station capacity increased to 5000 cfs.

REFERENCES

References used during this calculation are as follows:

1) GI4-PS-ST-CL-001
2) GI4-PS-ME-CL-001

RESULTS / CONCLUSIONS

Total # of Pipe Piles:	80	(All piles have tension connections)		
Total 24" Diam. X 0.5" Steel Pipe Pile:	4460.0	ft	**or**	280.1 tons
Total # of Pile Caps:	20			
Total Concrete per Cap:	13.3	yd^3		
Pile Cap Concrete:	266.7	yd^3		

TETRA TECH	Galveston Island 4 Fuel Tank Foundations Quantities	Calculation No. GI4-PS-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	4
Project:	Coastal Texas Protection and Restoration						
Description:							
Made By:	NRT	**Date:**	02/10/20	**Chk'd By:**	LAL	**Date:**	02/13/20

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

1) Material Properties:
   - Concrete, f'c = 4000 psi
   - Reinforcement = ASTM A615 Grade 60
   - Pipe Piles = ASTM A252 Grade 3
2) Costs of reinforcement is included in reinforced concrete unit cost.
3) All piles have tension connections.
4) Total number of Tanks = 10

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

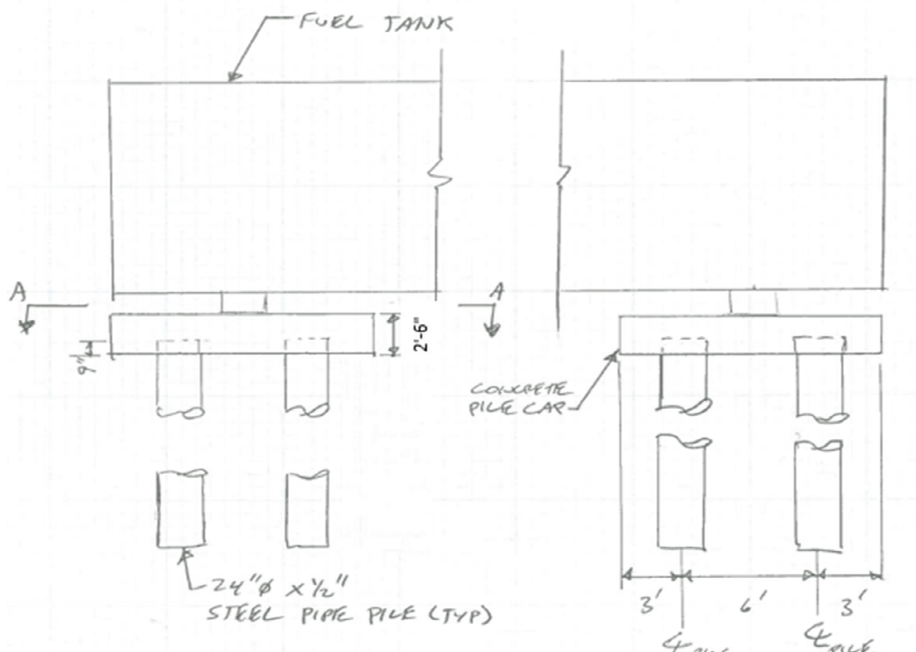
1) Materials and quantites as design progresses.

CALCULATIONS

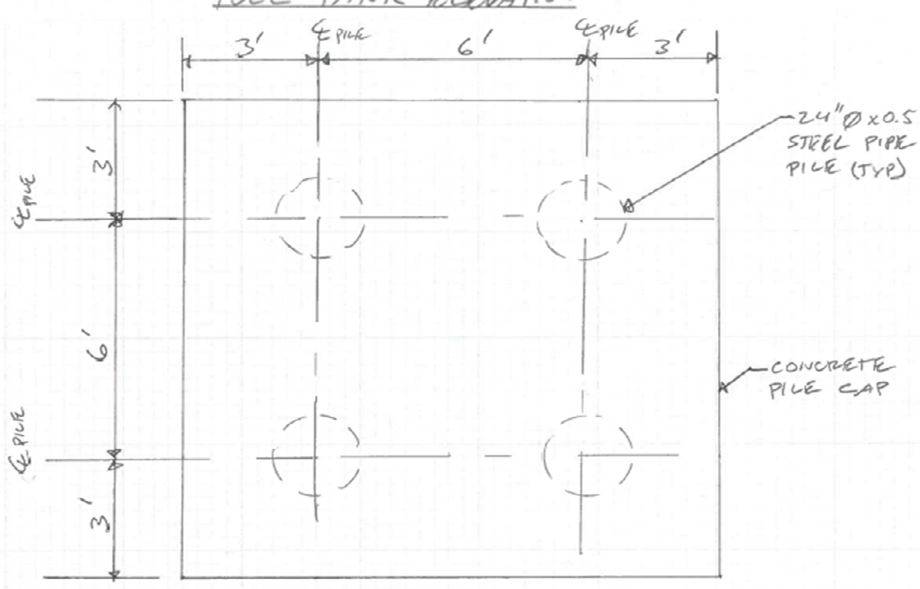
Begin on next page.

Job No.:	100-RCE-18-09-1					**Page:**	5
Project:	Coastal Texas Protection and Restoration						
Description:	General References and Figures						
Made By:	NRT	**Date:**	02/10/20	**Chk'd By:**	LAL	**Date:**	02/13/20

General References and Figures

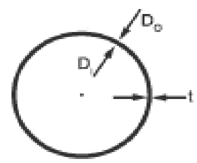


FUEL TANK ELEVATION



FUEL TANK PILE CAP PLAN (A-A)

Rolled and Welded Pipe



APPROXIMATE VALUES

Pipe Weight (lbs/ft) = $10.69 * t * (D_o - t)$
D_o (in) - outside diameter
t (in) - thickness of pipe

Pipe Weight (kg/m) = $0.0247 * t * (D_o - t)$
D_o (mm) - outside diameter
t (mm) - thickness of pipe

PIPE WEIGHT lbs/ft (kg/m)

Outside Diameter (D_o) in (mm)	Wall Thickness (t) in (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35			
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03		
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

TETRA TECH	Galveston Island 4 Fuel Tank Foundations Quantities	Calculation No. GI4-PS-ST-MT-002

Job No.: 100-RCE-18-09-1 **Page:** 7

Project: Coastal Texas Protection and Restoration

Description: Quantities for Fuel Tank Foundations

Made By: NRT **Date:** 02/10/20 **Chk'd By:** LAL **Date:** 02/13/20

Quantities for Fuel Tank Foundations

PILES

The minimum tip embedment is to be 55 feet plus 9 inches of embedment into concrete slab.

Pile Diameter: 24.0 in **Pipe Weight*:** 125.61 lb/ft

Pipe Thickness: 0.5 in **Pile Tip to Head Embedment:** 55.75 ft

*see general references attachments for reference of produced value

Number of Caps per Tank: 2

Total Number of Tanks: 10

Total Number of Pile Caps: 20

Number of Piles per Cap: 4

Total Number of Piles: 80

Total of Steel Pipe Piles: 4460.0 ft or 280.1 tons

CONCRETE:

PILE CAPS:

Thickness (ft)	Width (ft)	Cross Sectional Area (ft^2)	Length (ft)	Volume (yd^3)
2.5	12	30	12	13.3

Total Number of Pile Caps: 20 (see piles section)

Total Concrete: 266.67 yd^3

MOTT MACDONALD

Prepared by DR
Checked by ZS
Date: 2/03/2020

PROJECT: TEXAS COASTAL PROTECTION AND RESTORATION PROJECT
GALVESTON - STORMWATER COLLECTIONS NETWORK FOR PUMP STATIONS

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNITS
	Earth Excavation Greater than 14 Feet in Depth	833,244	C.Y.
	For 32' x 13" Concrete Box Culver with 18" Thickness	9,540	L.F.
	For 20' x 10" Concrete Box Culver with 18" Thickness	5,670	L.F.
	For 30' x 10" Concrete Box Culver with 18" Thickness	9,024	L.F.
	For 25' x 10" Concrete Box Culver with 18" Thickness	3,011	L.F.
	For Pavement Restoration	127,345	S.Y.
	For Backfill	454,632	C.Y.
	For Disposal	378,611	C.Y.
	10'X35' JUNCTION STRUCTRE	9	UNITS
	10'X25' JUNCTION STRUCTRE	8	UNITS
	10'X30' JUNCTION STRUCTRE	4	UNITS
	25'X25' JUNCTION STRUCTRE	1	UNITS
	30'X30' JUNCTION STRUCTRE	1	UNITS
	35'X35' JUNCTION STRUCTRE	4	UNITS

Assumptions:
Pipe Wall Thickness = 1.5'
Pipe to Trench Wall Distance = 5'
1' Bedding Depth Added to Trench depth

Attachment 7

Rough Order of Magnitude (ROM)

Quantity Take-offs

			Job No.	100-RCE-18-01	
Contract/Client	**Texas General Land Office**				
Phase/Subject	**Coastal Texas Protection and Restoration Feasibilty Study**				
Design Topic	**Utility Length - Clear Creek Pump Station**				
Made By	EO	Date	10/17/2019	Checked By	SKV	Date	12/5/2019

Total Relocation Length

Gas	70,762	ft
Petroleum	45,820	ft
Unknown	12,030	ft
Abandoned	6,960	ft
	135,572	**ft**

Object ID ***705***
Type of Utility **Gas** Propylene Chem - Liquid
Diameter 4 **in**

Length to Land 3465 **ft**

Relocation Length 6930 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***3684***
Type of Utility **Gas** Ethylene - Gas
Diameter 6 **in**

Length to Land 4800 **ft**

Relocation Length 9600 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***5173***
Type of Utility **Gas** Propylene - Liquid
Diameter 6 **in**

Length to Land 4150 **ft**

Relocation Length 8300 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***3400***
Type of Utility **Gas** Crude Hyrogen - Gas
Diameter 6 **in**

Length to Land 4145 **ft**

Relocation Length 8290 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***418***
Type of Utility **Gas** Propylene - Liquid
Diameter 8 **in**

Length to Land 3500 **ft**

Relocation Length 7000 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***5122***
Type of Utility **Gas** Ethylene - Liquid
Diameter 8 **in**

Length to Land 4050 **ft**

			Job No.	100-RCE-18-01	
Contract/Client	**Texas General Land Office**				
Phase/Subject	**Coastal Texas Protection and Restoration Feasibilty Study**				
Design Topic	**Utility Length - Clear Creek Pump Station**				
Made By	EO	Date	10/17/2019	Checked By	SKV	Date	12/5/2019

Relocation Length 8100 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***5814***
Type of Utility **Gas** Propylene - Liquid
Diameter 8.63 **in**

Length to Land 3665 **ft**

Relocation Length 7330 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***3437***
Type of Utility **Gas** Propylene - Liquid
Diameter 10 **in**

Length to Land 4200 **ft**

Relocation Length 8400 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***6625***
Type of Utility **Gas** Nitrogen - Liquid
Diameter 10.75 **in**

Length to Land 3406 **ft**

Relocation Length 6812 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***1320***
Type of Utility **Petroleum** Propylene Dilute - Liquid
Diameter 6.63 **in**

Length to Land 4135 **ft**

Relocation Length 8270 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***8606***
Type of Utility **Petroleum** Highly Volatile Liquid - Liquid
Diameter 8 **in**

Length to Land 4050 **ft**

Relocation Length 8100 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***8608***
Type of Utility **Petroleum** Highly Volatile Liquid - Liquid
Diameter 8 **in**

					Job No.	100-RCE-18-01	
Contract/Client	**Texas General Land Office**						
Phase/Subject	**Coastal Texas Protection and Restoration Feasibilty Study**						
Design Topic	**Utility Length - Clear Creek Pump Station**						
Made By	EO	Date	10/17/2019	Checked By	SKV	Date	12/5/2019

Length to Land 4150 **ft**

Relocation Length 8300 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***4150***
Type of Utility **Petroleum** Liquid Petroleum Gas - Liquid
Diameter 10 **in**

Length to Land 3665 **ft**

Relocation Length 7330 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***4143***
Type of Utility **Petroleum** Liquid Petroleum Gas - Liquid
Diameter 12 **in**

Length to Land 4080 **ft**

Relocation Length 8160 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***2172***
Type of Utility **Petroleum** Pipeline - Petroleum Products
Diameter Unknown **in**

Length to Land 1930 **ft**

Relocation Length 3860 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***2033***
Type of Utility **Petroleum** Pipeline - Hazardous Material (Exxon Mobil Oil)
Diameter Unknown **in**

Length to Land 900 **ft**

Relocation Length 1800 **ft**
(Assuming Relocation length twice the length to land distance)

Object ID ***2176***
Type of Utility **Unknown** Pipeline- Hazardous Material
Diameter 10 **in**

Length to Land 1870 **ft**

Relocation Length 3740 **ft**
(Assuming Relocation length twice the length to land distance)

				Job No.	100-RCE-18-01		
Contract/Client	**Texas General Land Office**						
Phase/Subject	**Coastal Texas Protection and Restoration Feasibilty Study**						
Design Topic	**Utility Length - Clear Creek Pump Station**						
Made By	EO	Date	10/17/2019	Checked By	SKV	Date	12/5/2019

Object ID	***3844***	
Type of Utility	**Unknown**	Magellan Pipeline Company - Liquid
Diameter	18	**in**
Length to Land	4145	**ft**
Relocation Length	8290	**ft**

(Assuming Relocation length twice the length to land distance)

Object ID	***9092***	
Type of Utility	**Abandoned**	Empty Liquid - Liquid
Diameter	8.63	**in**
Length to Land	3480	**ft**
Relocation Length	6960	**ft**

(Assuming Relocation length twice the length to land distance)

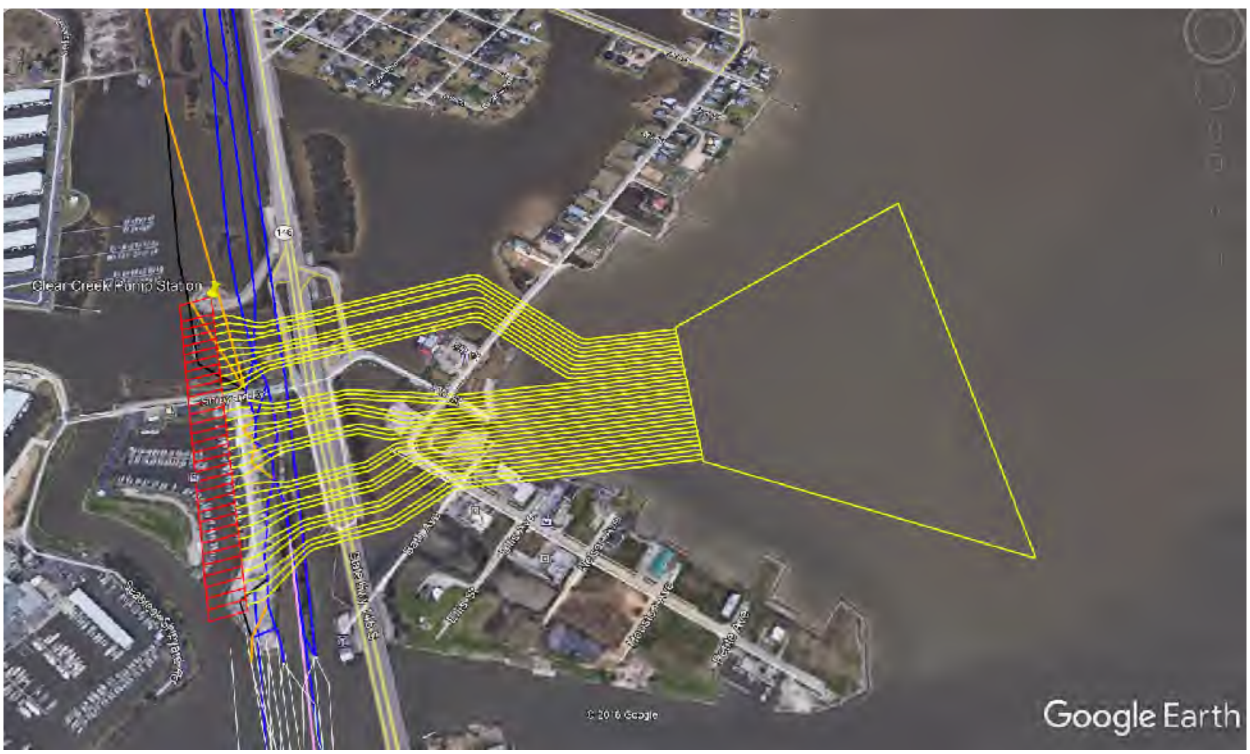


Figure 1: Clear Creek Pump Station Aerial

		Job No.	100-RCE-18-01

Contract/Client	**Texas General Land Office**						
Phase/Subject	**Coastal Texas Protection and Restoration Feasibilty Study**						
Design Topic	**Utility Length - Dickinson Bayou Pump Station**						
Made By	EO	Date	10/17/2019	Checked By		Date	12/5/2019

Total Relocation Length

Gas	6,920	ft
Petroleum	6,270	ft
Unknown	3,940	ft
Abandoned	530	ft
	17,660	**ft**

Object ID	***1276***	
Type of Utility	Gas	Propylene Chem - Liquid
Diameter	4	in
Length to Land	265	ft
Relocation Length	530	ft

(Assuming Relocation length twice the length to land distance)

Object ID	***525***	
Type of Utility	Gas	Propylene - Liquid
Diameter	8	in
Length to Land	265	ft
Relocation Length	530	ft

(Assuming Relocation length twice the length to land distance)

Object ID	***5500***	
Type of Utility	Gas	Ethylene - Liquid
Diameter	8	in
Length to Land	1300	ft
Relocation Length	2600	ft

(Assuming Relocation length twice the length to land distance)

Object ID	***6052***	
Type of Utility	Gas	Propylene - Liquid
Diameter	8.63	in
Length to Land	1630	ft
Relocation Length	3260	ft

(Assuming Relocation length twice the length to land distance)

Object ID	***8605***	
Type of Utility	Petroleum	Highly Volatile Liquid - Liquid
Diameter	8	in
Length to Land	265	ft
Relocation Length	530	ft

(Assuming Relocation length twice the length to land distance)

Object ID	***6514***	
Type of Utility	Petroleum	Diesel, Fuel Oil - Liquid
Diameter	10.75	in
Length to Land	265	ft
Relocation Length	530	ft

(Assuming Relocation length twice the length to land distance)

Object ID	***4142***	
Type of Utility	Petroleum	Liquid Petroleum Gas - Liquid
Diameter	12	in
Length to Land	265	ft
Relocation Length	530	

(Assuming Relocation length twice the length to land distance)

Object ID	***917***

					Job No.	100-RCE-18-01	
Contract/Client	**Texas General Land Office**						
Phase/Subject	**Coastal Texas Protection and Restoration Feasibilty Study**						
Design Topic	**Utility Length - Dickinson Bayou Pump Station**						
Made By	EO	Date	10/17/2019	Checked By		Date	12/5/2019

Type of Utility	Petroleum	Pipeline - Petroleum Products
Diameter	Unknown	in
Length to Land	990	ft
Relocation Length	1980	ft
(Assuming Relocation length twice the length to land distance)		
Object ID	***926***	
Type of Utility	Petroleum	Pipeline - Petroleum Products
Diameter	Unknown	in
Length to Land	739	ft
Relocation Length	1478	ft
(Assuming Relocation length twice the length to land distance)		
Object ID	***1903***	
Type of Utility	Petroleum	Pipeline - Oil
Diameter	Unknown	in
Length to Land	611	ft
Relocation Length	1222	ft
(Assuming Relocation length twice the length to land distance)		
Object ID	***3843***	
Type of Utility	Unknown	Magellan Pipeline - Liquid
Diameter	18	in
Length to Land	1300	ft
Relocation Length	2600	ft
(Assuming Relocation length twice the length to land distance)		
Object ID	***918***	
Type of Utility	Unknown	Pipeline - Hazardous Material
Diameter	Unknown	in

				Job No.		100-RCE-18-01	
Contract/Client	**Texas General Land Office**						
Phase/Subject	**Coastal Texas Protection and Restoration Feasibilty Study**						
Design Topic	**Utility Length - Dickinson Bayou Pump Station**						
Made By	EO	Date	10/17/2019	Checked By		Date	12/5/2019

Length to Land 670 ft

Relocation Length 1340 ft
(Assuming Relocation length twice the length to land distance)

Object ID	***9566***	
Type of Utility	Abandoned	Empty Liquid - Liquid
Diameter	8.63 in	

Length to Land 265 ft

Relocation Length 530 ft
(Assuming Relocation length twice the length to land distance)

Figure 2. Dickinson Bayou Pump Station Aerial

Project:	Coastal Texas Protection and Restoration Feasibility Study						
Job No.	*100-RCE-18-09*						
Description:	Clear Creek Access Road						
Computed:	*RSK*	**Date:**	*11-Nov-19*	**Checked:**	*NRT*	**Date:**	*11-Dec-19*

Cover Sheet

1 CALCULATION ADDRESSES THE FOLLOWING:

Cost Takeoff and Methodolgy for Cost Takeoff for Clear Creek Access Road

2 APPROACH

1. Determined Length of Total Length of Access Road using Clear Creek General Plan from Appendix A of Coastal Texas Protection and Restoration Feasibility Study plates

3 REFERENCES

Reference 1: Appendix A - Coastal Texas Protection and Restoration Feasibilty Study'

4 ASSUMPTIONS / INPUTS

2 Lanes required
Can support typical TXDOT truck load

5 COMPUTATIONS
See attached

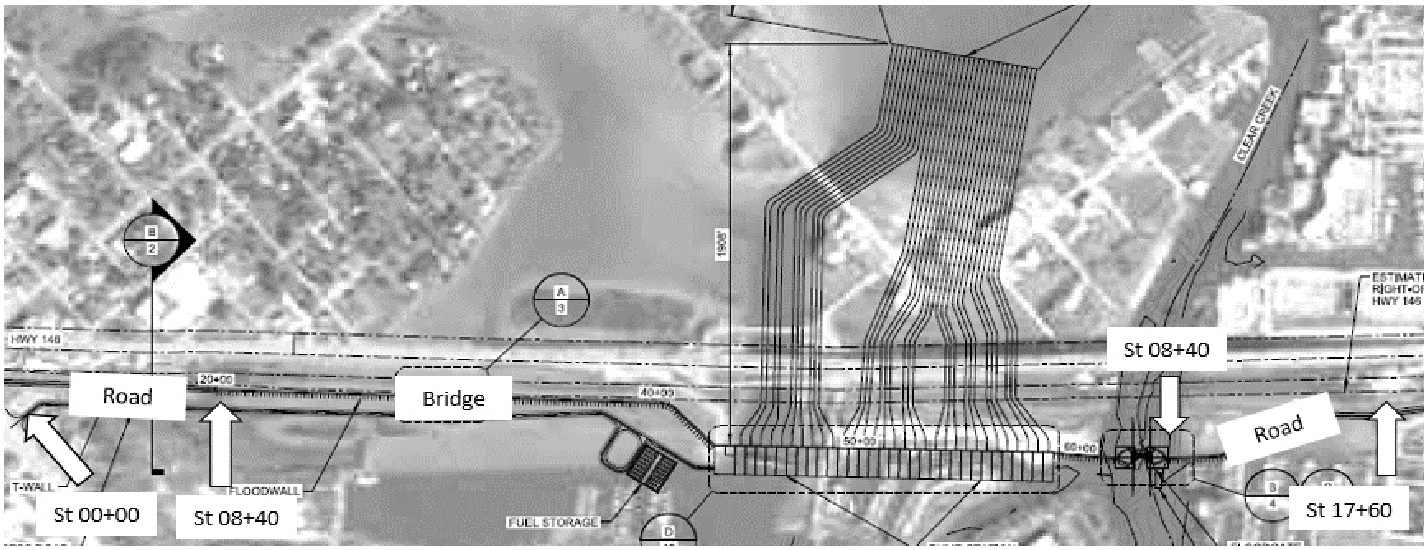
6 RESULTS/CONCLUSIONS

Total Roadway Area:	56,320	ft^2

Project:	Coastal Texas Protection and Restoration Feasibility Study					
Job No.	100-RCE-18-09					
Description:	Clear Creek Access Road					
	- Quantity Takeoff					
Computed:	*RSK*	**Date:** *11-Nov-19*	**Backchecked:**	*NRT*	**Date:**	*11-Dec-19*

Quantity Takeoff

Requirements:



Reference 1

Begin Station:	0+00		End Station:	17+60
Road Length:	1,760.00	ft		
Lane Requirements:	2	(Assume eash lane is 12' in width with 4' shoulders)		
Roadway Width:	32	(Matches Standard Bridge Road Width)		
Square Footage for Road	56,320.00	ft^2		

Project:	Ike Dike
Job No.	*100-RCE-18-09*
Description:	Clear Creek Bridge

Computed:	*RSK*	**Date:**	*1-Nov-19*	**Checked:**	*DS*	**Date:**	*1-Nov-19*

Cover Sheet

1 CALCULATION ADDRESSES THE FOLLOWING:

Cost Takeoff and Methodolgy for Cost Takeoff for Clear Creek Access Road Bridge

2 APPROACH

1. Determined Length of Total Length of Bridge using Clear Creek General Plan from Appendix A of Coastal Texas Protection and Resotraion Feasibility Study plates
2. Determine cost on a per span basis for modular scaling
3. Cost takeoff performed with only structural components considered with reference to TxDoT FY18 Average Cost

3 REFERENCES

Reference 1: Appendix A - Coastal Texas Protection and Restoration Feasibilty Study'
Reference 2: TxDOT Unit Costs 2018
Reference 3: TxDOT Unit Costs 2013
Reference 4: TxDOT Bridge Facts 2010
Reference 5: TxDOT Bridge Detailing Guide (August 2018)
Reference 6: TxDOT I Girders, Recommended Span Lengths for LRFD
Reference 7: TxDOT Bridge Project Development Manual 2018

4 ASSUMPTIONS / INPUTS

Cost estimates are based on TxDoT low bid for on-system bridge projects
2 Lanes required
Concrete bridge as it is the most cost efficient per square foot
120 foot typical spans in accordance with TXDOT provided examples and are a reasonable girder size
Can support typical TXDOT truck load

5 COMPUTATIONS
See attached

6 RESULTS/CONCLUSIONS

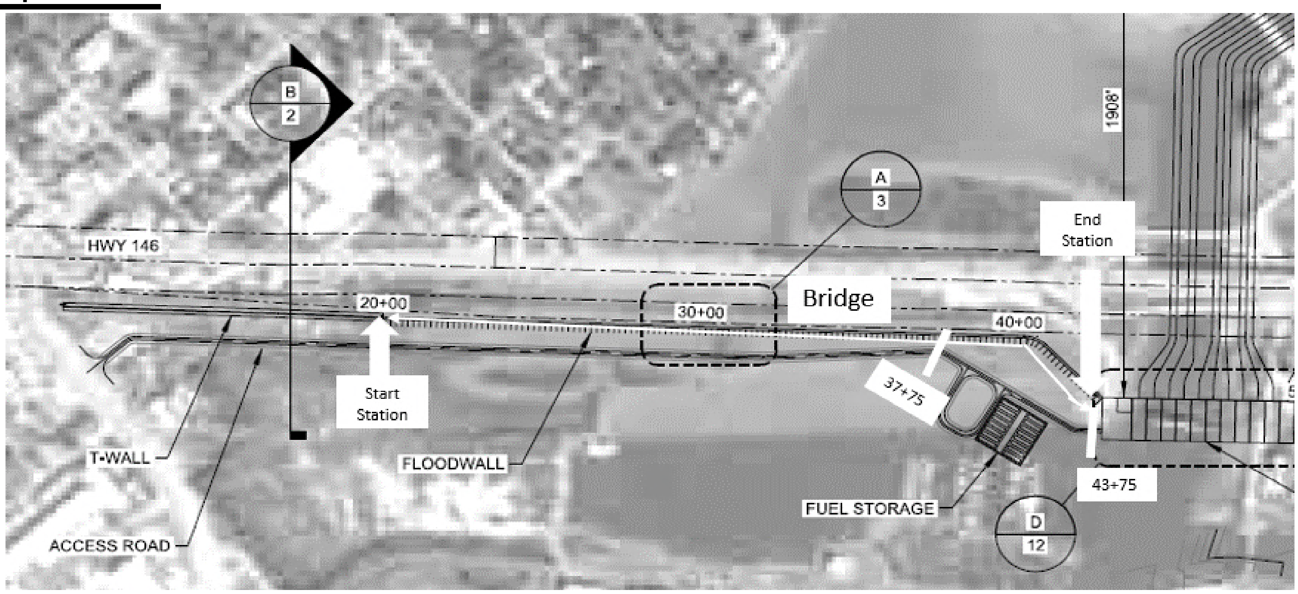
Cost per 120' Span (Substructure and SuperStructure Only):	$	264,384
Total Cost (Substructure and SuperStructure Only):	$	5,287,680

Project:	Coastal Texas Protection and Restoration Feasibility Study
Job No.	100-RCE-18-09
Description:	Clear Creek Bridge - Cost Takeoff

Computed: *RSK* **Date:** *1-Nov-19* **Backchecked:** *DS* **Date:** *1-Nov-19*

Cost Takeoff

Requirements:



Reference 1

Begin Station:	20+00	End Station:	43+75
Bridge Length:	2,375.00	ft	
Type of Bridge:	Girder Prestressed "I" Texas Shape (FY 18 Average Unit Cost)		
	Note:	Girder Prestressed "I" Texas Shape Bridge Selected as it was the only bridge provided that was concrete and recommended for spans greater than 1,000 ft	
Bridge Code:	GPITX	(FY 18 Average Unit Cost)	
Lane Requirements:	2	(Assume eash lane is 12' in width with 4' shoulders)	
Roadway Width:	32	(Matches Standard Roadway Width from Section 5 of Chapter 8 of TxDoT Bridge Detailing Guide)	
Bridge Width:	34	(TxDot Bridge Detailing Guide Figure A-6)	
Recommended Span Length:	120	(TxDOT Bridge Detailing Guide Figure A-5)	
Recommended I Girder:	TX54	Economical Span Limit is 125 ft for member (TX54's ESP closest to 120' rec. span) according to TxDOT's I Girders, Recommended Span Lengths for LRFD	
Square Footage per Span	4,080.00		

Project:	Ike Dike
Job No.	100-RCE-18-09
Description:	Clear Creek Bridge - Cost Takeoff

Computed: *RSK* **Date:** *1-Nov-19* **Backchecked:** *DS* **Date:** *1-Nov-19*

Cost Takeoff

Cost Takeoff:

Notes:

* Cost estimates are based on low bid structure costs (Reference 3)
* Low bid structure costs include only strucutral work items for deck (including bridge rail), super structure, substrucutre. Items for approach roadway , traffic control, environment controls and other bid items are not included (Reference3)
* Costs are based on on-system bridges, vehicular bridges owned and maintained by the state on the TxDOT highway system (Reference 4)
* See Bridge Project Development Manual for excluded from Bridge Estimate (Reference 7)

TxDoT On-System Bridge Cost per SF:	64.80	(TxDoT FY 18 Average Unit Cost Table) (On-system definition provided in TxDot 2010 Bridge Facts)
Square Footage per Span:	4,080.00	(32' Width x 120' Length)
Cost per Span:	**$ 264,384**	
# of Spans:	20.00	(2375'/120' = 19.8 ~ 20 spans)
Structural Cost:	**$5,287,680**	

FY 18 Average Unit Cost

State FY 2018 Low Bid Average for New and Replaced Bridges with DCIS Estimate													average	Total Number
Length, LF	20-50		51-100		101-200		201-400		401-1000		>1000			
Type	#	$/SF	#	$/SF	#	$/SF	#	$/SF	#	$/SF	#	$/SF	$/SF	#
CLV	50	75.4	10	89.2	4	59.0							**76.2**	64
GP-BX			15	136.3	3	98.9	2	77.5					**106.6**	20
GPDSB	2	114.3	1	278.1									**203.0**	3
GPITX			18	104.3	31	80.2	104	65.1	39	56.4	18	64.8	**63.8**	210
GP-U							3	76.3					**76.3**	3
GPXBX			1	98.9	1	85.1							**89.4**	2
GS-I					2	141.2			4	113.4	1	160.3	**122.2**	7
GS-I RR							1	738.0					**738.0**	1
GS-TR											1	168.8	**168.8**	1
PCSB	16	129.7	15	120.4	12	89.4	3	73.9	1	65.7			**95.0**	47
SLAB			1	167.0									**167.0**	1
All Types Total													71.5	359

Legend:

CLV - Bridge Class Culvert

GP-BX - Girder Prestressed "Box" Beam

GPDSB - Girder Prestressed Decked Slab Beam

GPITX - Girder Prestressed "I" Texas Shape

GP-U - Girder Prestressed "U" Beam

GPXBX - Girder Prestressed "X Box"

GS-I - Girder Steel "I" Beam

GS-I RR - Girder Steel "I" Beam carrying RR

GS-TR - Girder Steel Trapezoidal

PCSB - Prestressed Concrete Slab Beam

SLAB – CIP slab

Note: # is a number of whole or portions of a bridge of a certain type. In this case 359 portions represent 352 bridges.

Reference 2

State FY 2018 Low Bid Average for New and Replaced Bridges with DCIS Estimate, cont.

Length, LF	20-50				51-100				101-200				201-400				401-1000				>1000				
	On		Off		On		Off		On		Off		On		Off		On		Off		On		Off		Type
Type	#	$/SF	#	$/SF	#	$/SF	#	$/SF	#	$/SF	#	$/SF	#	$/SF	#	$/SF	#	$/SF	#	$/SF	#	$/SF	#	$/SF	
CLV	47	72.5	5	133.7	6	86.53	2	126.6	4	59.0															CLV
GP-BX					3	149.5	12	131.4	2	65.0	1	99.6	1	70.8	1	90.3									GP-BX
GPDSB			2	114.3	5	81.7	13	123.8																	GPDSB
GPITX					6	68.7	12	130.2	24	65.0	7	106.3	103	64.7	1	78.1	39	56.4			18	64.8			GPITX
GP-U													3	76.3											GP-U
GPXBX					1	98.9			1	85.1															GPXBX
GS-I									2	141.2							4	113.4			1	160.3			GS-I
GS-I RR													1	738.0											GS-I RR
GS-TR																					1	168.8			GS-TR
PCSB	1	104.8	15	132.2	4	129.9	11	116.9	6	83.0	6	108.0	3	73.9			1	65.7							PCSB
SLAB							1	167.0																	SLAB

Type	average $/SF			Area								Cost						Number					
	On	Off	Total	On			Off			Total	%Total	On		Off		Total	Total	On		Off		Total	Total
	$/SF	$/SF	$/SF	SF	avg SF	%	SF	avg SF	%	SF	%	$	%	$	%	$	%	#	%	#	%	#	%
CLV	73.6	131.8	**76.2**	289,616	5,081	95.4	13,958	1,994	4.6	303,574	4.1	21,306,721	92.1	1,839,029	7.9	23,145,750	4.1	57	89.1	7	10.9	64	16.1
GP-BX	91.8	119.5	**106.6**	28,344	4,724	46.6	32,455	2,318	53.4	60,799	0.8	2,601,624	40.1	3,878,834	59.9	6,480,458	1.1	6	30.0	14	70.0	20	5.0
GPDSB		203.0	**203.0**	0	0	0.0	5,671	1,890	100.0	5,671	0.1	0	0.0	1,151,195	100.0	1,151,195	0.2		0.0	3	100.0	3	0.8
GPITX	63.3	110.0	**63.8**	6,228,384	32,954	98.9	67,703	3,224	1.1	6,296,087	84.7	394,198,702	98.1	7,444,421	1.9	401,643,123	70.6	189	90.0	21	10.0	210	52.8
GP-U	76.2		**76.2**	41,611	13,870	100	0	0	0.0	41,611	0.6	3,172,779	100.0	0	0.0	3,172,779	0.6	3	100.0	0	0.0	3	0.8
GPXBX	89.4		**89.4**	13,970	6,985	100	0	0	0.0	13,970	0.2	1,248,843	100.0	0	0.0	1,248,843	0.2	2	100.0	0	0.0	2	0.5
GS-I	122.2		**122.2**	298,582	42,655	100	0	0	0.0	298,582	4.0	36,485,765	100.0	0	0.0	36,485,765	6.4	7	100.0	0	0.0	7	1.8
GS-I RR	738.0		**738.0**	5,413	5,413	100	0	0	0.0	5,413	0.1	3,995,117	100.0	0	0.0	3,995,117	0.7	1	100.0	0	0.0	1	0.3
GS-TR	168.8		**168.8**	209,285	209,285	100	0	0	0.0	209,285	2.8	35,319,698	100.0	0	0.0	35,319,698	6.2	1	100.0	0	0.0	1	0.3
PCSB	81.9	118.6	**95.0**	124,491	8,299	64.3	69,053	2,158	35.7	193,543	2.6	10,196,442	55.5	8,188,830	44.5	18,385,272	3.2	15	31.9	32	68.1	47	11.8
SLAB		167.0	**167.0**	0	0	0.0	1,950	1,950	100.0	1,950	0.6	0	0.0	325,639	100.0	325,638	0.1	0	0.0	1	100.0	1	0.3
ALL*	70.2	120.9	**71.5**	7,239,696		100.0	188,840		100.0	7,430,486	100.0	508,525,691	100.0	22,827,948	100.0	531,353,638	100.0	281	100.0	78	100.0	359	100.0
All-CLV	70.1	118.7	**71.3**	6,950,080		96.0	176,832		92.6	7,126,912	95.9	487,218,970	95.8	20,988,919	91.9	508,207,888	95.6	224	79.7	71	91.0	295	82.2
CLV	73.6	131.8	**76.2**	289,616		4.0	13,958		7.4	303,574	4.1	21,306,721	4.2	1,839,029	8.1	23,145,750	4.4	57	20.3	7	9.0	64	17.8
ALL	70.2	95.8	71.5	7,047,725		95	380,812		5			494,560,776	93	36,467,226	7			281	78	77	22		
All-CLV	70.1	118.2	71.3	6,950,080		94	174,882		2	7,430,486		487,218,970	92	20,663,282	4	$531,353,638		224	62	71	20	359	
CLV	73.6	131.8	72.4	97,644		1	205,930		3			7,341,806	1	15,803,944	3			57	16	7	2		

is a number of whole or portions of a bridge of certain type. In this case 359 portions represent 352 bridges.

FY 2013 Average % Breakdown of Overall Project Costs for Bridges

System	*Structure %*	*Mobilization %*	*Removal %*	*Approach, etc. %*
Off-System Span Bridges	63.6%	10.1%	3.9%	22.4%
Off-System Culverts	41.5%	8.0%	3.5%	47.0%
On-System Span Bridges	49.6%	8.6%	3.5%	38.3%
On-System Culverts	47.7%	7.2%	3.2%	41.9%

FY 2013 Average Unit Cost

System	*Structure Type*	*Number Bridges*	*Deck Area (sq.ft.)*	*Low Bid Structure Cost**	*Average Unit Cost*** (\$/sq.ft.)*
Off-System Culvert					
	Culverts	16	23,367	$ 2,645,113	$ 113.20
Off-System Span					
	Concrete Girder "Pan" (CG-PN)	0	-	$ -	
	Girder Prestressed "Box" Beam (GP-BX)	14	26,469	$ 2,743,989	$ 103.67
	Girder Prestressed Decked Slab Beam (GPDSB)	2	3,120	$ 303,485	$ 97.27
	Girder Prestressed "I" Beam (GPI)	7	49,315	$ 2,340,499	$ 47.46
	Girder Prestressed "I" Beam "Texas Shape" (GPITX)	24	169,441	$ 11,448,548	$ 67.57
	Prestressed Concrete Slab Beam (PCSB)	51	86,079	$ 7,912,522	$ 91.92
	Concrete Slab (SLAB)	1	1,989	$ 181,266	$ 91.13
	Girder Prestressed "T" Beam (GP-T)	0	-	$ -	-
	Girder Steel "I" Beam (GS-I)	1	41,303	$ 3,058,691	$ 74.05
Off-System Span Totals					
	Off Span Totals	100	377,715	$ 27,989,000	$ 74.10
On-System Culvert					
	Culverts	38	186,886	$ 12,471,791	$ 66.73
On-System Span					
	Girder Prestressed "Box" Beam (GP-BX)	17	146,340	$ 12,746,825	$ 87.10
	Girder Prestressed "I" Beam (GP-I)	40	980,850	$ 71,821,041	$ 73.22
	Girder Prestressed "I" Beam "Texas Shape" (GPITX)	112	2,733,820	$ 176,359,094	$ 64.51
	Girder Prestressed "U" Beam (GP-U)	40	2,045,834	$ 105,578,993	$ 51.61
	Girder Prestressed Segmental (GPSEG)	0	-	$ -	$ -
	Prestressed Concrete Slab Beam (PCSB)	47	332,152	$ 22,946,748	$ 69.09
	Concrete Slab (SLAB)	3	19,923	$ 1,412,044	$ 70.87
	Concrete Girder Pan Form (CG-PN)	1	5,293	$ 61,039	$ 11.53
	Girder Steel "I" Beam (GS-I)	8	231,946	$ 29,262,460	$ 126.16
	Girder Steel Trapezoidal (GS-TR)	16	767,558	$ 117,676,246	$ 153.31
	Structural Steel Truss (STRTR)	0	-	$ -	-
On-System Span Totals					
	On Span Totals	284	7,263,715	$ 537,864,491	$ 74.05

**Low bid structure costs include only structural work items for deck (including bridge rail), superstructure, and substructure. Items for approach roadway, traffic control, environmental controls, and other bid items are not included.*

***The accumulation of the low bid structure cost for the year is divided by the accumlation of the deck area to arrive at the approximate average unit cost.*

Reference 3

BRIDGE TERMS AND DEFINITIONS

Definition of Bridge: An on-system or off-system structure, including supports, erected over a depression or an obstruction such as water, a highway, or a railway; having a roadway or track for carrying traffic or other moving loads; and having an opening measured along the center of the roadway of more than 20 feet between faces of abutments, spring lines of arches, or extreme ends of the openings for multiple box culverts or multiple pipes that are 60 inches or more in diameter and that have a clear distance between openings of less than half of the smallest pipe diameter.

Highway Bridge Program: The Highway Bridge Program (HBP) is a federal-aid program that provides funding to enable states to improve the condition of their highway bridges through replacement, rehabilitation, and systematic preventive maintenance.

Structurally Deficient and Functionally Obsolete: The terms "structurally deficient" and "functionally obsolete" are used by the Federal Highway Administration to designate bridges eligible for federal funding. Bridges classified as structurally deficient or functionally obsolete are not unsafe. A structurally deficient bridge is one with routine maintenance concerns that do not pose a safety risk or one that is frequently flooded. To remain open to traffic, structurally deficient bridges are often posted with reduced weight limits that restrict the gross weight of vehicles using the bridges. Classification as functionally obsolete means the bridge met current design standards when built, but over time has become obsolete due to an increase in traffic volume. Functionally obsolete bridges are those that do not have adequate lane widths, shoulder widths or vertical clearance to serve current traffic demands or are occasionally flooded.

Sub-standard-for-Load-Only: The term "sub-standard-for-load-only" is used by TxDOT to designate bridges in relatively good condition that do not have specific maintenance concerns, but do have a load-carrying capacity less than the state legal limit for public roadways. Sub-standard-for-load-only bridges are posted with reduced weight limits. These bridges are not classified as structurally deficient or functionally obsolete under FHWA definitions.

On-System Bridge: A vehicular bridge owned and maintained by the state on the TxDOT-designated highway system.

Off-System Bridge: A vehicular bridge owned and maintained by a county, city, or other local or regional governmental unit, and not on the TxDOT-designated highway system.

Historic Bridge: A bridge listed on or eligible to be listed on the National Register of Historic Places.

FY 2010 BRIDGE STATISTICS

	Number	Sq. ft. (Deck)
Statewide	51,557	465,814,726
On-system	33,679	390,145,630
Off-system	17,878	75,669,096
Structurally deficient	1,553	8,495,910
On-system	305	6,286,340
Off-system	1,248	2,209,570
Functionally obsolete	7,433	75,505,190
On-system	3,471	53,003,410
Off-system	3,962	22,501,780
Sub-standard-for-load-only	1,151	1,734,772
On-system	94	359,955
Off-system	1,057	1,374,817

Number of international bridges

There are twenty-four vehicular international bridges along the Texas and Mexico border.

Number of bridges over waterways

Statewide	42,863
On-system	25,594
Off-system	17,269

Number of steel-truss type bridges

Statewide	221
On-system	39
Off-system	182

Number of suspension-type bridges

Statewide	4
On-system	0
Off-system	2 open to traffic 2 closed to traffic

Average bridge construction cost per square foot of deck area

The average structure unit cost during fiscal year 2010 for constructing bridge structures was:

- On-system span-type bridge: $52.97 per sq. ft.
- On-system culvert: $39.60 per sq. ft.
- Off-system span-type bridge: $58.52 per sq. ft.
- Off-system culvert: $58.80 per sq. ft.

Asset value of bridges

The historical cost of capitalized on-system state bridges is $18.8 billion with accumulated depreciation totaling $10.5 billion. TxDOT's policy is to capitalize only those bridges and improvements with a cost of at least $500,000.

Average age of Texas bridges

On-system years – 43 years
Off-system years – 31 years

FY 2010 CONTRACT STATISTICS

Existing bridges let to contract for replacement or rehabilitation, FY2010	
On-system	275
Value of contracts	$320.4M
Off-system	155
Value of contracts	$60.1M
New-location bridges let to contract, FY2010	
On-system	169
Value of contracts	$385.3M
Off-system	26
Value of contracts	$34.9M

GENERAL INFORMATION

Highest Bridge

The Rainbow Bridge (SH 87) near Port Arthur has 176.9 feet of clearance between the bridge and the water.

Longest Bridges

The longest bridge on the National Bridge Inventory is the Pharr/Reynosa Bridge over the Rio Grande River. It is 15,770 feet long. This off-system bridge is partially owned by Mexico.

The longest on-system bridge is the Sabine River/Toledo Bend Bridge on SH 21. It is 13,196 feet long. This on-system bridge is partially owned by the State of Louisiana.

The longest on-system bridge fully owned by the State of Texas is IH 45 Southbound crossing IH 30, US 75, and the DART Rail Line in Dallas. It is 13,192 feet long.

The longest on-system bridge fully owned by the State of Texas and spanning a body of water is the Queen Isabella Memorial Bridge at South Padre Island. It is 12,510 feet long.

Bridge with Longest Span

The main span of the Fred Hartman Bridge (SH 146) over the Houston Ship Channel is 1,250 feet long. The bridge is owned by the State of Texas.

Oldest Bridges

The oldest on-system bridge is FM 51 over Town Creek in Parker County, built in 1911. There are numerous off-system bridges dating back to 1900.

Reference 4

Section 5
Parameters and Tolerances

Normal layout parameters are as follows:

Columns and Drilled Shafts

- 1' - drilled shaft and piling length increments
- 1' - column height increments

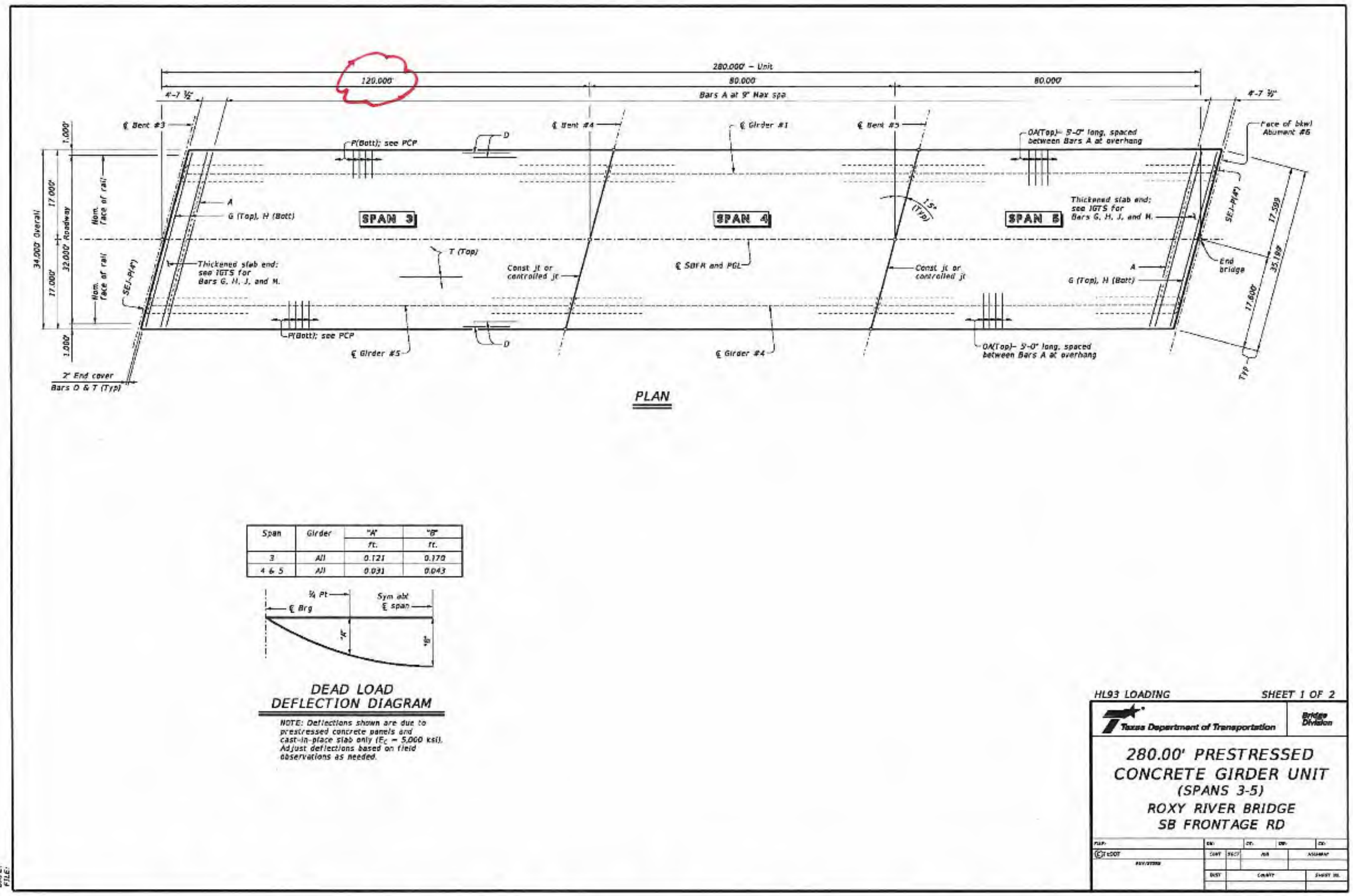
Roadway Width

- 24'-0" - standard roadway width
- 28'-0" - standard roadway width
- 30'-0" - standard roadway width
- 32'-0" - standard roadway width
- 38'-0" - standard roadway width
- 40'-0" - standard roadway width
- 44'-0" - standard roadway width

Miscellaneous

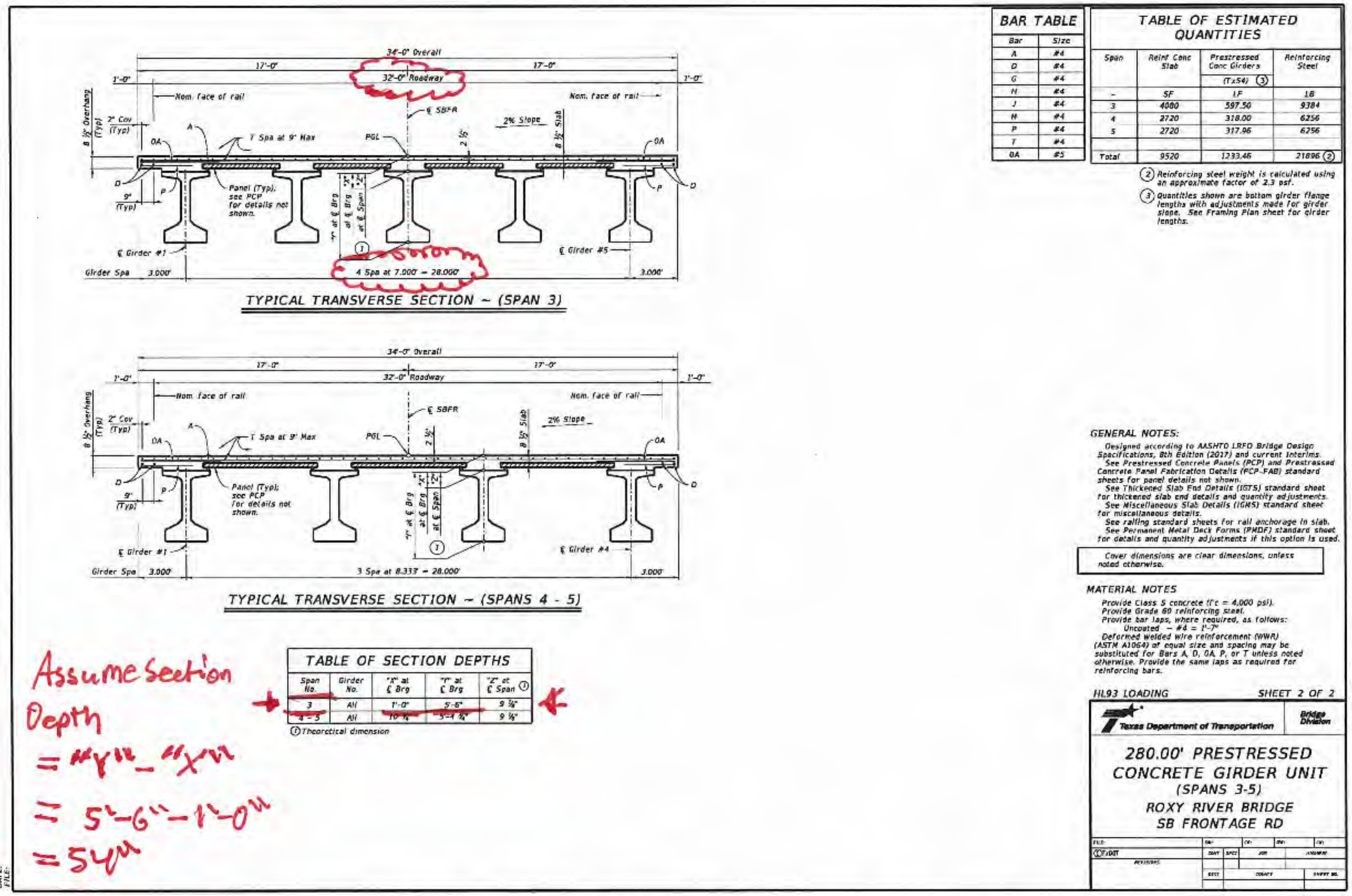
- 1'-0" - nominal face of rail from edge of slab
- 4" or 5" - sealed expansion joint

Reference 5



Span	Girder	"A" ft.	"B" ft.
3	All	0.121	0.170
4 & 5	All	0.031	0.043

Figure A–5. Example, 15º Skew Prestressed Concrete Girder Unit 15º, Sheet 1 of 2. Online users can click here to view this illustration in PDF.



BAR TABLE

Bar	Size
A	#4
D	#4
G	#4
H	#4
J	#4
M	#4
P	#4
T	#4
OA	#5

TABLE OF ESTIMATED QUANTITIES

Span	Reinf Conc Slab	Prestressed Conc Girders (Tx54) (3)	Reinforcing Steel
–	SF	LF	LB
3	4080	597.50	9384
4	2720	318.00	6256
5	2720	317.96	6256
Total	9520	1233.46	21896 (2)

(2) Reinforcing steel weight is calculated using an approximate factor of 2.3 psf.

(3) Quantities shown are bottom girder flange lengths with adjustments made for girder slope. See Framing Plan sheet for girder lengths.

TABLE OF SECTION DEPTHS

Span No.	Girder No.	"X" at € Brg	"Y" at € Brg	"Z" at € Span (1)
3	All	1'-0"	5'-6"	9 ⅝"
4 - 5	All	10 ¾"	5'-4 ¾"	9 ⅝"

(1) Theoretical dimension

GENERAL NOTES:

Designed according to AASHTO LRFD Bridge Design Specifications, 8th Edition (2017) and current Interims.

See Prestressed Concrete Panels (PCP) and Prestressed Concrete Panel Fabrication Details (PCP-FAB) standard sheets for panel details not shown.

See Thickened Slab End Details (IGTS) standard sheet for thickened slab end details and quantity adjustments.

See Miscellaneous Slab Details (IGMS) standard sheet for miscellaneous details.

See railing standard sheets for rail anchorage in slab.

See Permanent Metal Deck Forms (PMDF) standard sheet for details and quantity adjustments if this option is used.

Cover dimensions are clear dimensions, unless noted otherwise.

MATERIAL NOTES

Provide Class S concrete (f'c = 4,000 psi).
Provide Grade 60 reinforcing steel.
Provide bar laps, where required, as follows:
Uncoated – #4 = 1'-7"

Deformed welded wire reinforcement (WWR) (ASTM A1064) of equal size and spacing may be substituted for Bars A, D, OA, P, or T unless noted otherwise. Provide the same laps as required for reinforcing bars.

HL93 LOADING SHEET 2 OF 2

Texas Department of Transportation — Bridge Division

280.00' PRESTRESSED CONCRETE GIRDER UNIT (SPANS 3-5)
ROXY RIVER BRIDGE
SB FRONTAGE RD

Figure A–6. Example, 15° Skew Prestressed Concrete Girder Unit, Sheet 2 of 2. Online users can click here to view this illustration in PDF.

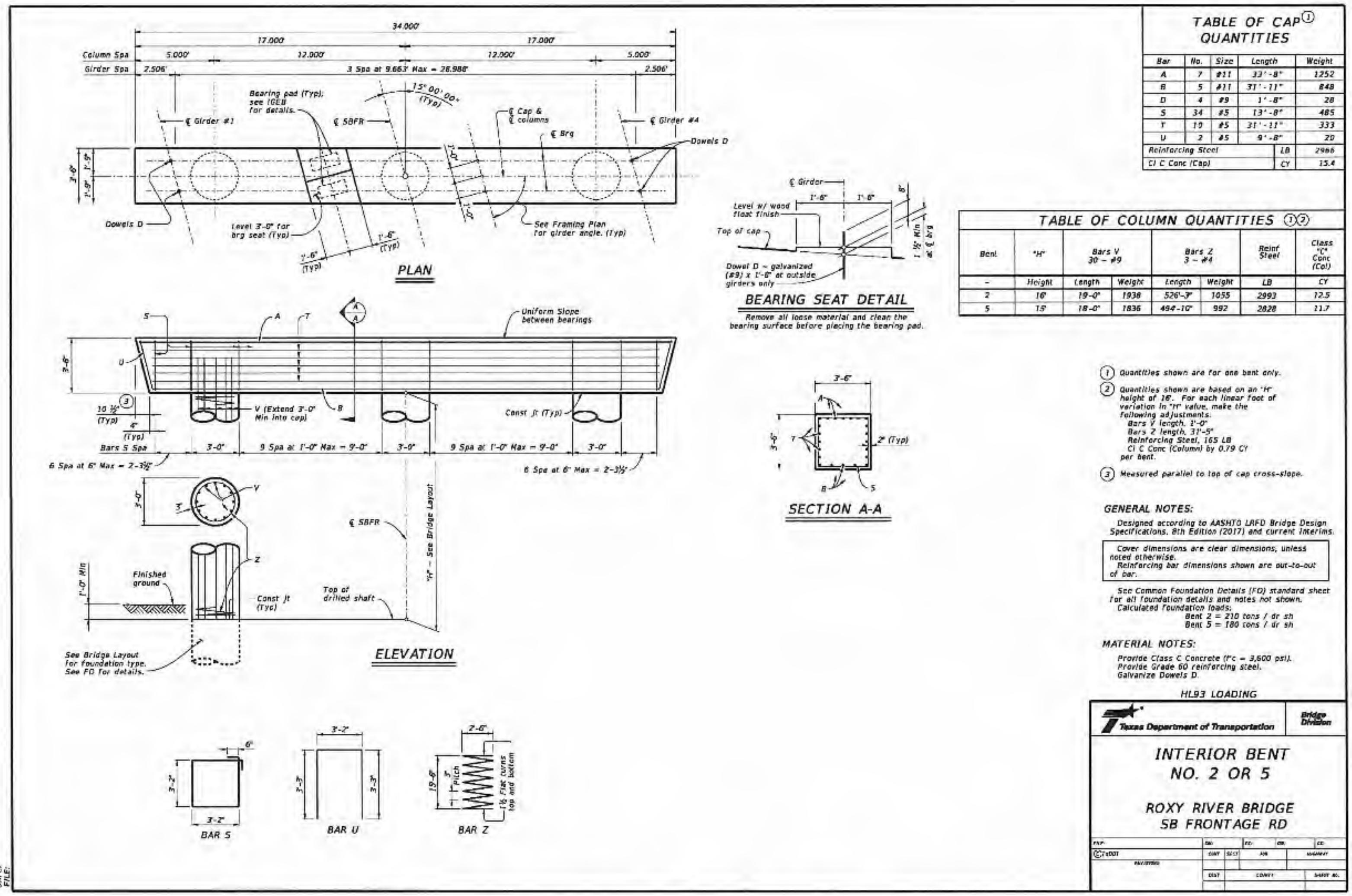


TABLE OF CAP QUANTITIES ①

Bar	No.	Size	Length	Weight
A	7	#11	33'-8"	1252
B	5	#11	31'-11"	848
D	4	#9	1'-8"	28
S	34	#5	13'-8"	485
T	10	#5	31'-11"	333
U	2	#5	9'-8"	20
Reinforcing Steel			LB	2966
Cl C Conc (Cap)			CY	15.4

TABLE OF COLUMN QUANTITIES ①②

Bent	"H"	Bars V 30 – #9		Bars Z 3 – #4		Reinf Steel	Class "C" Conc (Col)
–	Height	Length	Weight	Length	Weight	LB	CY
2	16'	19'-0"	1938	526'-3"	1055	2993	12.5
5	15'	18'-0"	1836	494'-10"	992	2828	11.7

Figure A–80. Example, 15° Skew Interior Bent (Type Tx54 Girders). Online users can click here to view this illustration in PDF.

I Girders, Recommended Span Lengths for LRFD

Beam Type	Beam Depth	[1]Approx Structure Depth	Use
TX28	28 in.	38 in.	Economical span limit is 70 ft. Spans should not exceed 80 ft.
TX34	34 in.	44 in.	Economical span limit is 80 ft. Spans should not exceed 95 ft.
TX40	40 in.	50 in.	Economical span limit is 95 ft. Spans should not exceed 105 ft.
TX46	46 in.	56 in.	Economical span limit is 105 ft. Spans should not exceed 120 ft.
TX54	54 in.	64 in.	Economical span limit is 125 ft. Spans should not exceed 140 ft.
TX62	62 in.	72 in.	Economical limt is 135ft. Spans should not exceed 150 ft.
TX70	70 in.	80 in.	Economical limt is 145 ft. Spans should not exceed 150 ft due to handling constraints.

[1]Approx Structure depth is Beam Depth plus 8" minimum slab plus 2" estimated haunch.

Reference 6

Roadway Items Excluded from Bridge Item Estimate

To calculate the unit cost of a bridge project accurately, the bid items need to be divided in the appropriate manner. FHWA's memorandum (HIBS-30) dated February 9, 2016, provides the proper breakout of bridge items from roadway items. Below are the roadway items that should be excluded from the bridge item estimate.

Do not include the following items in the bridge item section of the estimate:

- Mobilization
- Demolition of existing structure (Item 496)
- Bridge approach slabs (only include in the bridge items if the approach slab is integral with the abutment)
- Stream channel work such as riprap, slope paving
- Earthwork relating to channel excavation
- Clearing and grubbing
- Retaining walls not attached to, or not for the protection of, the abutments
- Guardrail transitions to bridges
- Maintenance and protection of traffic
- Detour costs
- Signing and marking
- Lighting
- Electrical Conduit
- Inlet frames and grates
- Field office
- Construction engineering items
- Training
- Right-of-way
- Utility relocations
- Contingencies

Include the following item with the bridge items section of the estimate:

- Riprap if needed for abutment protection *only*

The most current federal requirements can be found on the Bridge Division internal Project Development web page at http://crossroads/org/brg/PD/index.htm

Reference 7

		Job No.	100-RCE-18-01
Contract/Client	**USACE**		
Phase/Subject	**Clear Creek & Dickinson Bayou Pump Station - Quantities**		
Design Topic	**Dredging and Excavation Volumes Summary**		
Made By	EO	Date	10/9/2019
Checked By	SKV	Date	12/5/2019

Final Dredging Volumes	**UOM**	**Quantity**
Clear Creek	CY	1,532,461
Dickinson Bayou	CY	383,268

Final Excavation Volumes	**UOM**	**Quantity**
Clear Creek	CY	615,519
Dickinson Bayou	CY	239,223

		Job No.	100-RCE-18-01

Contract/Client	**USACE**						
Phase/Subject	**Clear Creek Pump Station - Quantities**						
Design Topic	**Dredging Volume**						
Made By	AG	Date	10/9/2019	Checked By	SKV	Date	12/5/2019

Determine the dredging volume using Cad:
P:\Watr\T18-09-1 Ike Dike\CAD\Design\Clear Crk Dredging

MLLW = -0.034
Water Depth is taken from NOAA Upper Galveston Bay Houston Ship Channel, NOAA Chart 11327

Average Depth is approximately= 1

Existing Ground Elevation = -1.034

Invert of Pump Station Pipe = -14
Assume an additional 1' depth = -15

Depth from ground to bottom of dredging = 13.966 ft

Area 1 Bottom= 265,496 sf (assumes a 10' buffer)
Area 1 Top= 439,545 sf
(this assumes a 4:1 slope to ground Elevation)

Area 2 Bottom= 2,035,252 sf (assumes a 10' buffer)
Area 2 Top= 2,486,775 sf
(this assumes a 4:1 slope to ground Elevation)

Pump Intake Area Bottom= 247,165 sf (assumes a 10' buffer)
Pump Intake Area 2 Top= 451,079 sf
(this assumes a 4:1 slope to ground Elevation)

<u>Area 1</u>
Dredge Volume= 182,344 CY

<u>Area 2</u>
Dredge Volume= 1,169,530 CY

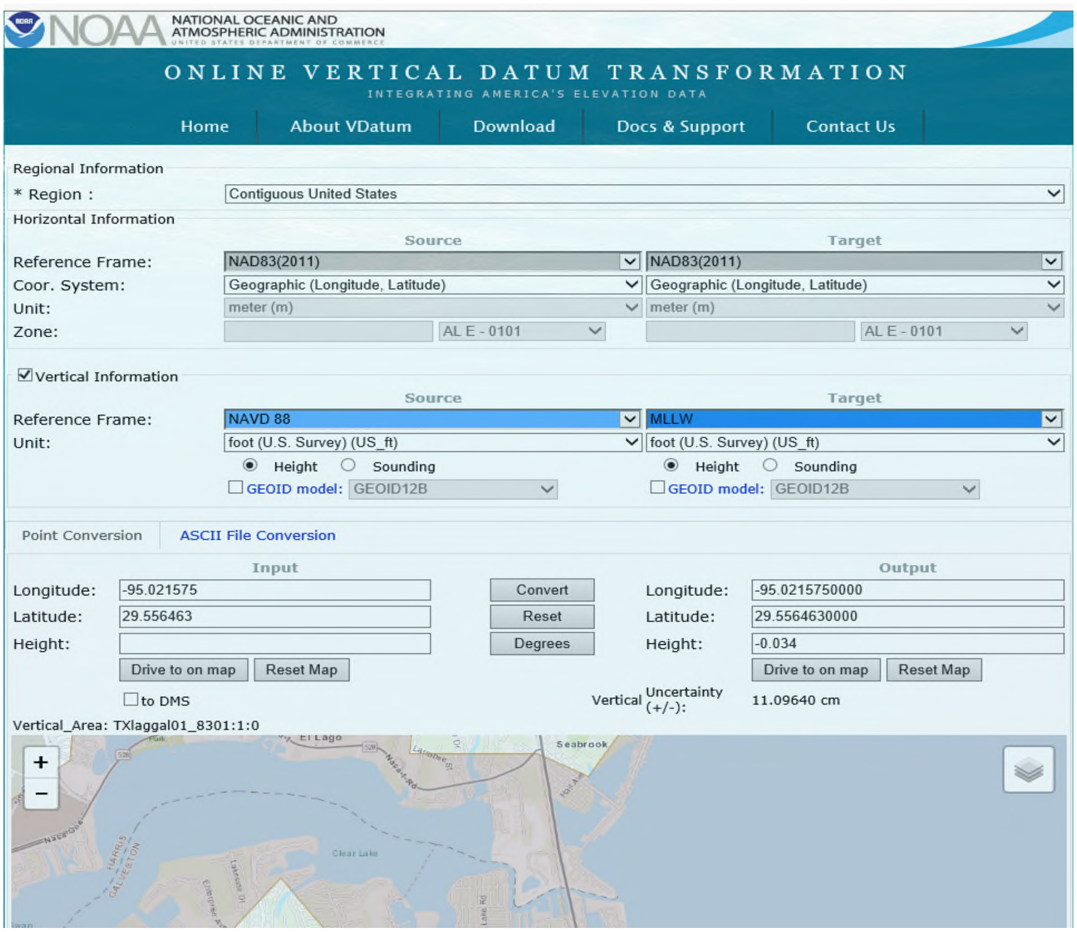
<u>Pump Intake Area</u>
Dredge Volume= 180,587 CY

Total Dredge Volume =	**1,532,461 CY**

Job No. 100-RCE-18-01

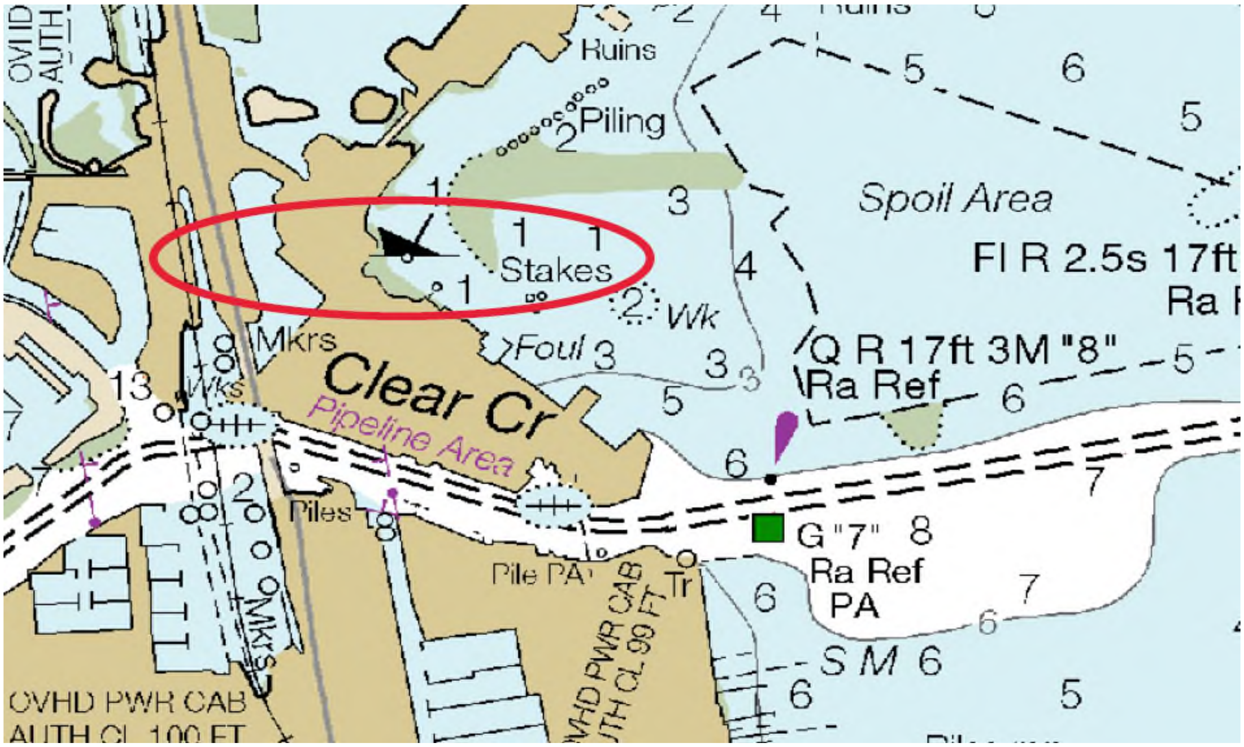
Contract/Client	USACE						
Phase/Subject	Clear Creek Pump Station - Quantities						
Design Topic	Dredging Volume						
Made By	AG	Date	10/9/2019	Checked By	SKV	Date	12/5/2019

MLLW Determined from NOAA for NAVD88 to MLLW Conversion:



				Job No.	100-RCE-18-01		
Contract/Client	**USACE**						
Phase/Subject	**Clear Creek Pump Station - Quantities**						
Design Topic	**Dredging Volume**						
Made By	AG	Date	10/9/2019	Checked By	SKV	Date	12/5/2019

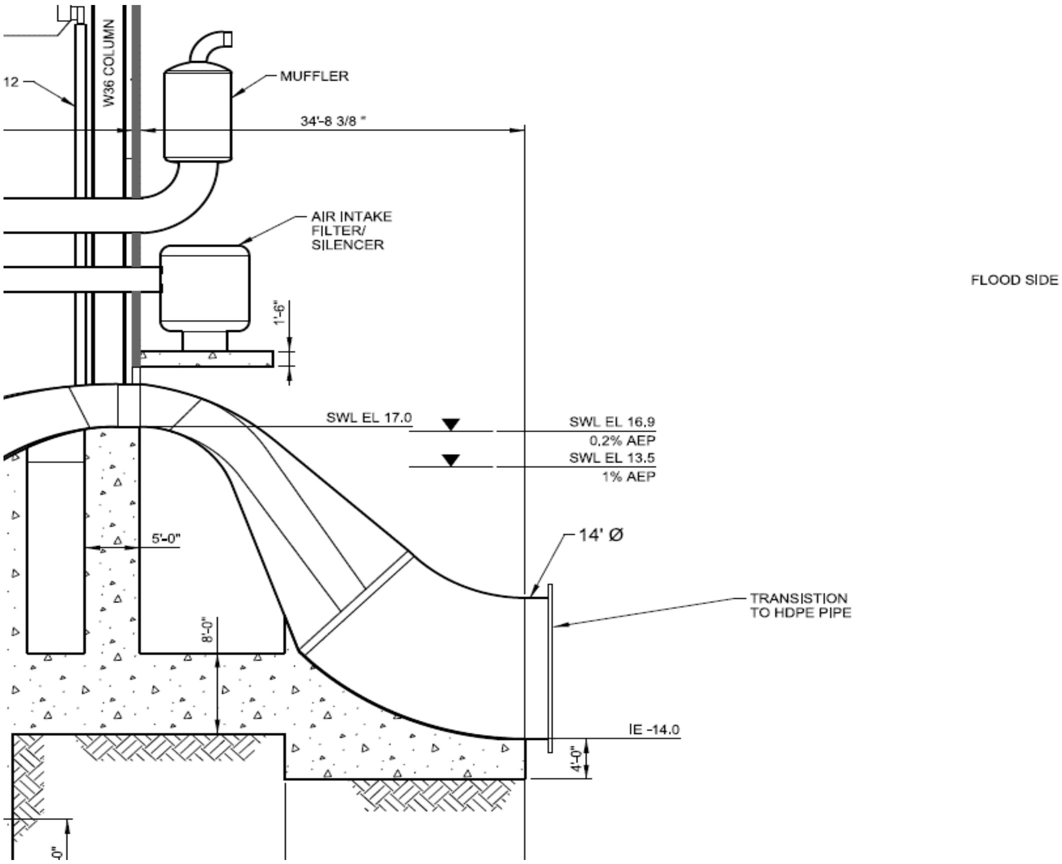
NOAA Boating Depth:



Job No. 100-RCE-18-01

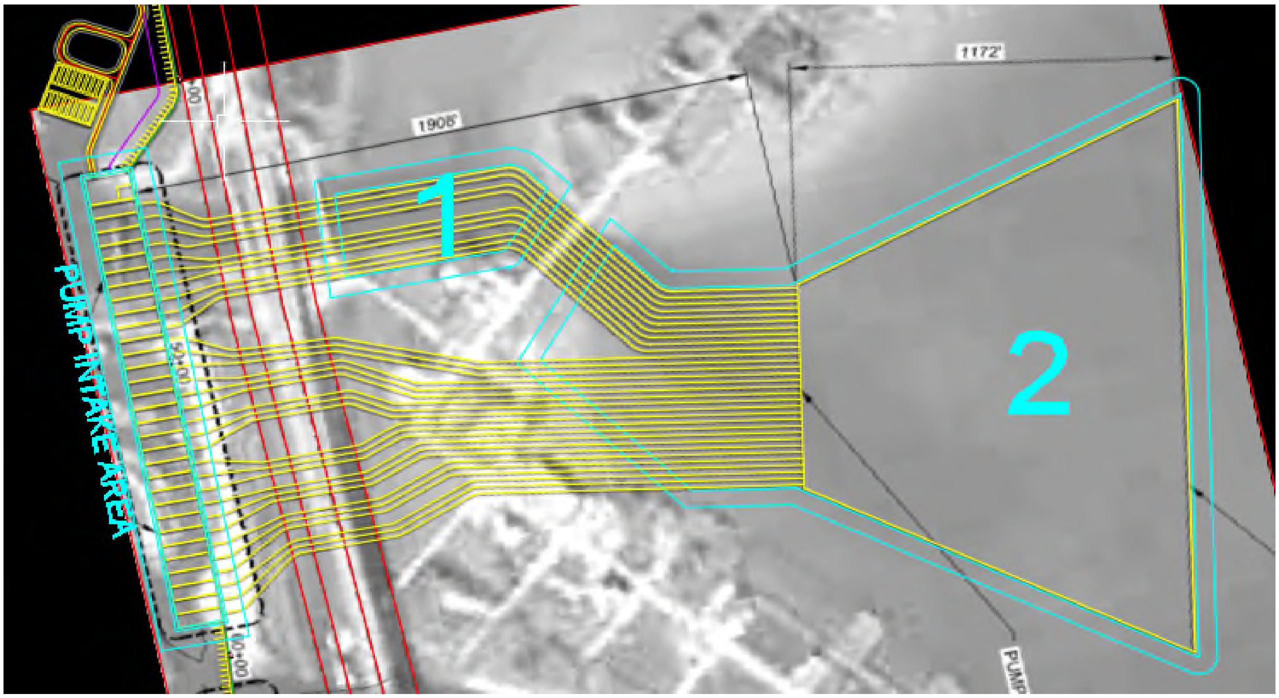
Contract/Client	**USACE**					
Phase/Subject	**Clear Creek Pump Station - Quantities**					
Design Topic	**Dredging Volume**					
Made By	AG	Date	10/9/2019	Checked By	SKV	Date 12/5/2019

Pump Station Outlet Pipe Profile:



				Job No.	100-RCE-18-01
Contract/Client	**USACE**				
Phase/Subject	**Clear Creek Pump Station - Quantities**				
Design Topic	**Dredging Volume**				
Made By	AG	Date	10/9/2019	Checked By	SKV Date 12/5/2019

Plan View of Dredging Locations:



			Job No.	100-RCE-18-01	
Contract/Client	**USACE**				
Phase/Subject	**Dickinson Pump Station - Quantities**				
Design Topic	**Dredging Volume**				
Made By	AG	Date	10/9/2019	Checked By	SKV	Date	########

Determine the dredging volume using Cad:
P:\Watr\T18-09-1 Ike Dike\CAD\Design\Dickinson Dredging

MLLW = -0.062
Water Depth is taken from NOAA Upper Galveston Bay Houston Ship Channel, NOAA Chart 11327

Average Depth is approximately= 2 ft.

Existing Ground Elevation = -2.062 ft.

Invert of Pump Station Pipe = -14
Assume an additional 1' depth = -15

Depth from ground to bottom of dredging = 12.938 ft

Area 1 (west of HWY 146) Bottom= 277,056 sf (assumes a 10' buffer)
Area 1 (west of HWY 146) Top= 400,723 sf
(this assumes a 4:1 slope to ground Elevation)

Area 2 (east of HWY 146) Bottom= 382,185 sf (assumes a 10' buffer)
Area 2 (east of HWY 146) Top= 323,982 sf
(this assumes a 4:1 slope to ground Elevation)

Pump Intake Area 2 Bottom= 76,093 sf (assumes a 10' buffer)
Pump Intake Area 2 Top= 139,625 sf
(this assumes a 4:1 slope to ground Elevation)

Area 1
Dredge Volume= 162,391 CY

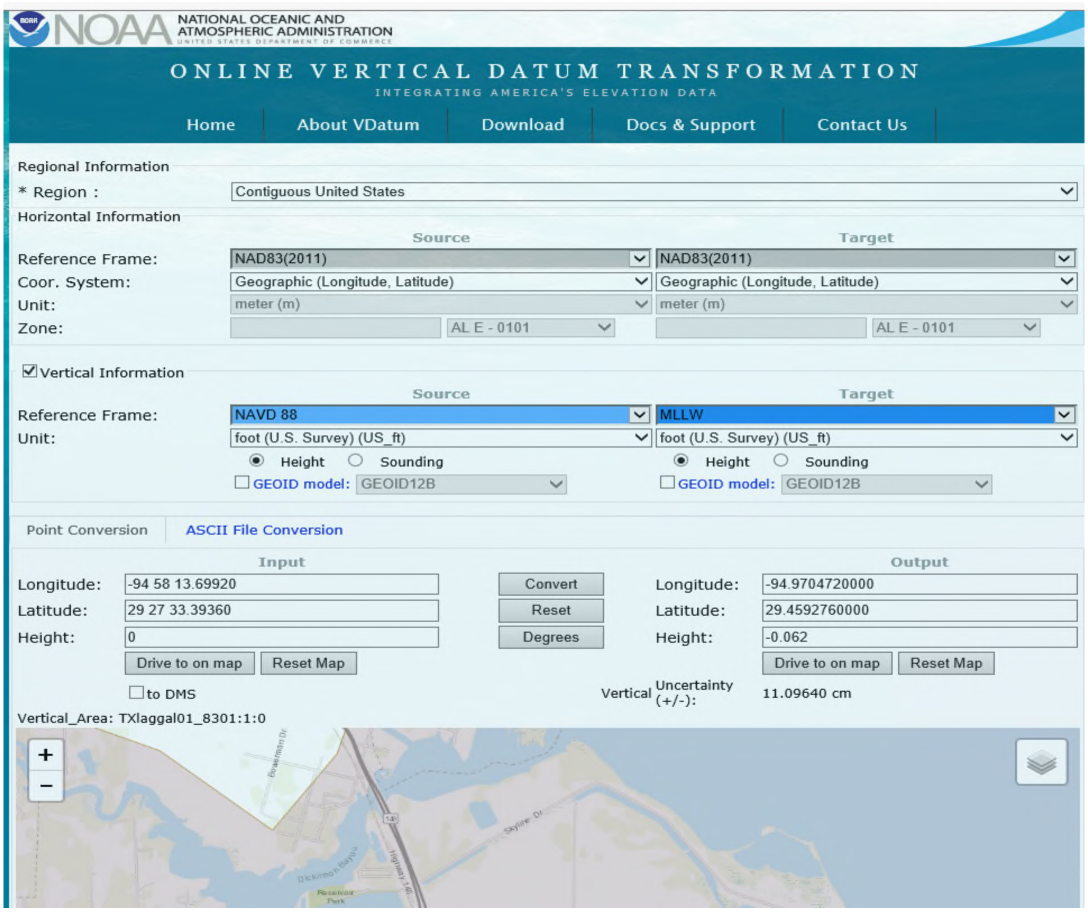
Area 2
Dredge Volume= 169,192 CY

Pump Intake Area
Dredge Volume= 51,684 CY

Total Dredge Volume = 383,268 CY

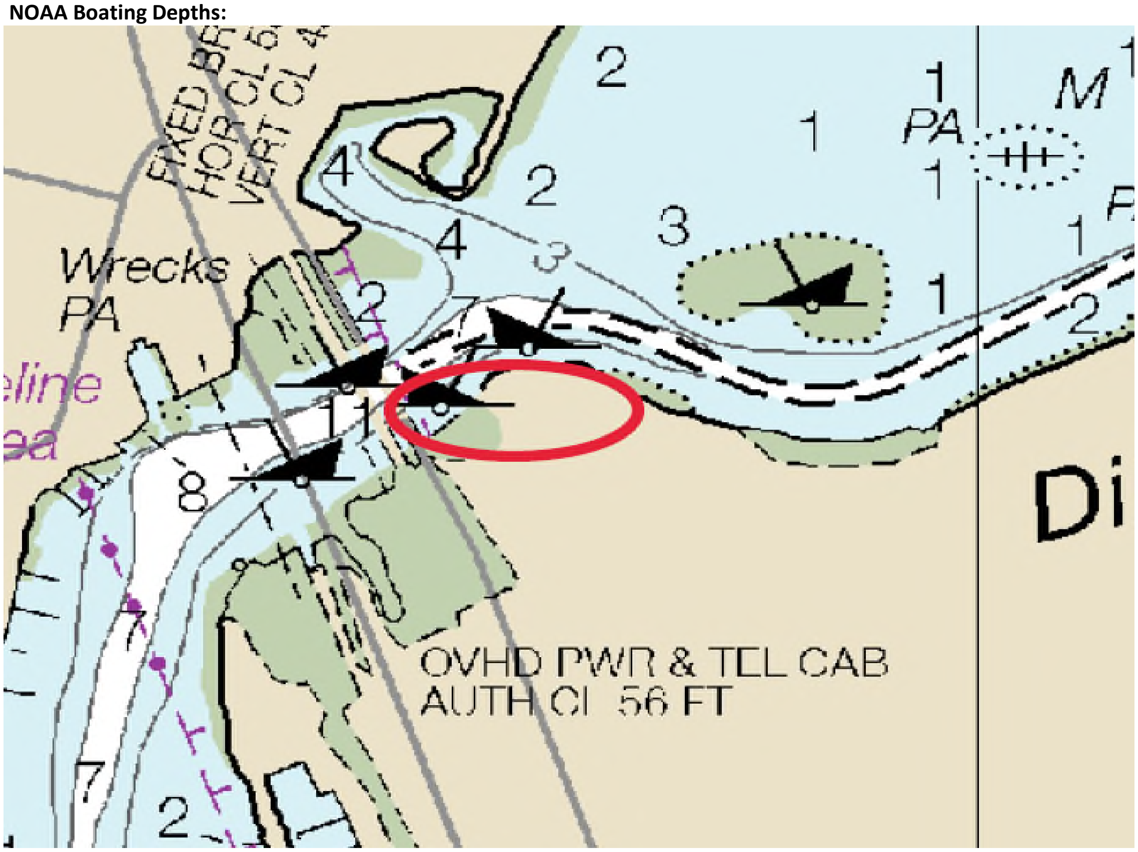
				Job No.	100-RCE-18-01		
Contract/Client	**USACE**						
Phase/Subject	**Dickinson Pump Station - Quantities**						
Design Topic	**Dredging Volume**						
Made By	AG	Date	10/9/2019	Checked By	SKV	Date	########

MLLW Determined from NOAA for NAVD88 to MLLW Conversion:



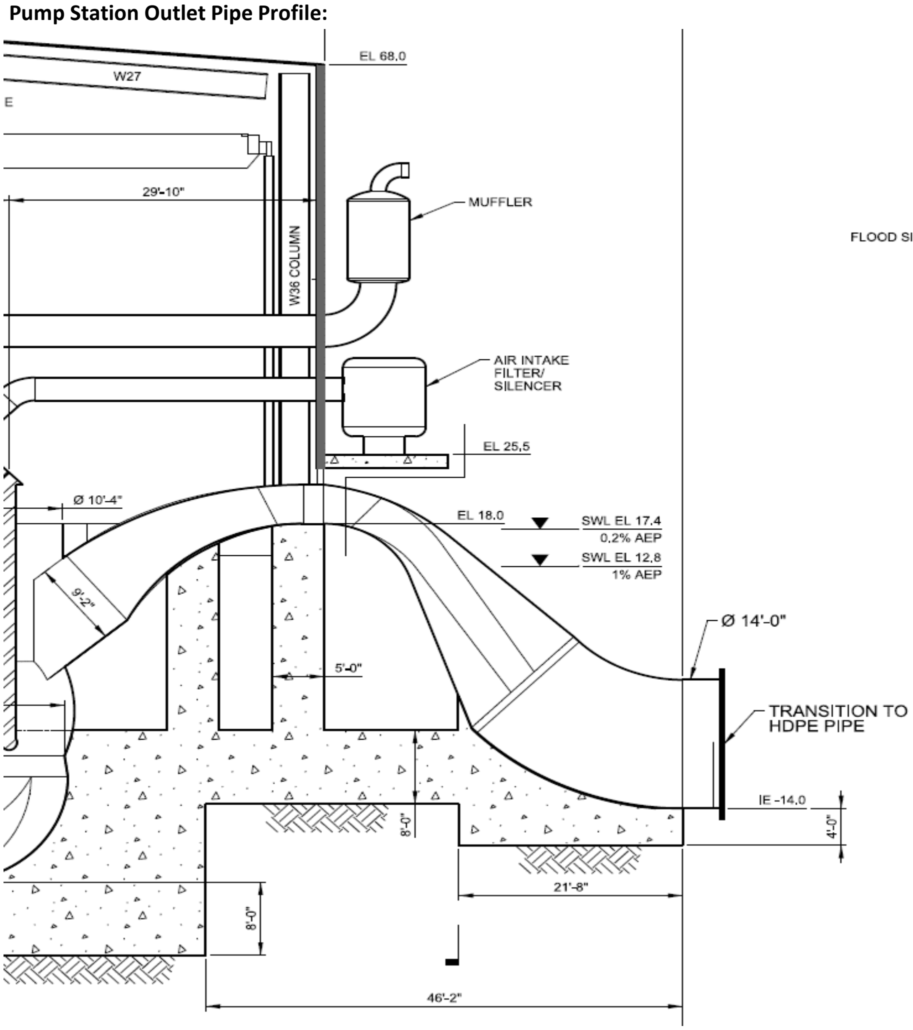
				Job No.		100-RCE-18-01	
Contract/Client	**USACE**						
Phase/Subject	**Dickinson Pump Station - Quantities**						
Design Topic	**Dredging Volume**						
Made By	AG	Date	10/9/2019	Checked By	SKV	Date	########

NOAA Boating Depths:



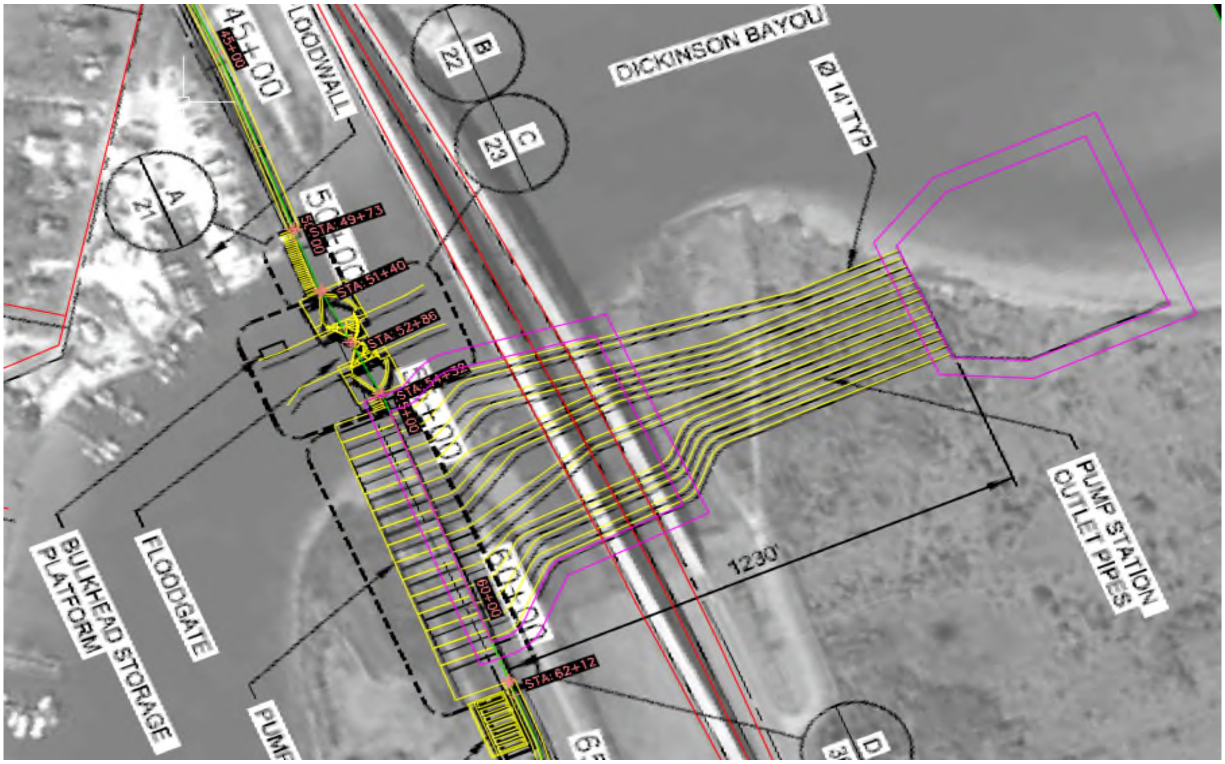
				Job No.	100-RCE-18-01		
Contract/Client	**USACE**						
Phase/Subject	**Dickinson Pump Station - Quantities**						
Design Topic	**Dredging Volume**						
Made By	AG	Date	10/9/2019	Checked By	SKV	Date	########

Pump Station Outlet Pipe Profile:



				Job No.	100-RCE-18-01		
Contract/Client	**USACE**						
Phase/Subject	**Dickinson Pump Station - Quantities**						
Design Topic	**Dredging Volume**						
Made By	AG	Date	10/9/2019	Checked By	SKV	Date	########

Plan View of Dredging Locations:



			Job No.	100-RCE-18-01	
Contract/Client	**USACE**				
Phase/Subject	**Clear Creek Pump Station - Quantities**				
Design Topic	**Excavation Volume**				
Made By	AG	Date	10/9/2019	Checked By SKV	Date ########

Determine the excavation volume using Cad:
P:\Watr\T18-09-1 Ike Dike\CAD\Design\Dickinson Dredging

Average Depth is approximately= 3 ft. (Google Earth Elevation)

Invert of Pump Station Pipe = -14
Assume an additional 1' depth = -15

Depth from ground to bottom of dredging = 18 ft

Area "A" (west of HWY 146) Bottom= 770,765 sf (assumes a 10' buffer)
Area "A" (west of HWY 146) Top= 930,842 sf
(this assumes a 2:1 slope to ground Elevation)

<u>Area "A"</u>
Excavation Volume= 567,202 CY

Area "B" (west of HWY 146) Bottom= 66,108 sf (assumes a 10' buffer)
Area "B" (west of HWY 146) Top= 78,841 sf
(this assumes a 2:1 slope to ground Elevation)

<u>Area "B"</u>
Excavation Volume= 48,316 CY

Total Excavation Volume = 615,519 CY

		Job No.	100-RCE-18-01	
Contract/Client	**USACE**			
Phase/Subject	**Dickinson Pump Station - Quantities**			
Design Topic	**Excavation Volume**			
Made By	AG	Date 10/9/2019	Checked By SKV	Date 12/5/2019

Determine the excavation volume using Cad:
P:\Watr\T18-09-1 Ike Dike\CAD\Design\Dickinson Dredging

Average Depth is approximately= 5 ft. (Google Earth Elevation)

Invert of Pump Station Pipe = -14
Assume an additional 1' depth = -15

Depth from ground to bottom of dredging = 20 ft

Area 1 (west of HWY 146) Bottom= 275,650 sf (assumes a 10' buffer)
Area 1 (west of HWY 146) Top= 370,251 sf
(this assumes a 2:1 slope to ground Elevation)

Area 1
Excavation Volume= 239,223 CY

Total Excavation Volume =	**239,223 CY**

		Job No.	100-RCE-18-01
Contract/Client	**Texas General Land Office**		
Phase/Subject	**Clear Creek & Dickinson Bayou Pump Station - Quantities**		
Design Topic	**Riprap Volumes Summary**		
Made By	EO	Date	10/31/2019
Checked By	SKV	Date	12/5/2019

Final Riprap Volumes	UOM	Quantity
Clear Creek	CY	74,689
Dickinson Bayou	CY	6,800

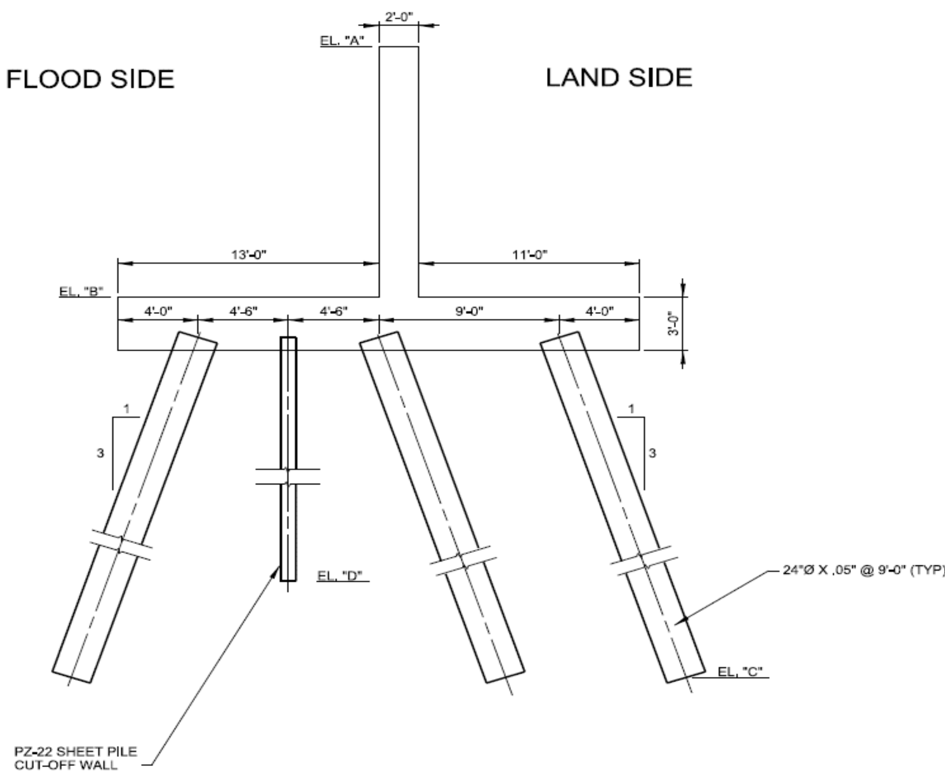
		Job No.	100-RCE-18-01

Contract/Client	**Texas General Land Office**					
Phase/Subject	**Clear Creek - Quantities**					
Design Topic	**Riprap Volume for T-Walls and Bank Protection**					
Made By	AG	Date	10/31/2019	Checked By	SKV	Date 12/5/2019

T- Wall Length = 3263 ft. <== from CAD

Assume riprap is 3' thick.
Riprap will be placed at bottom of the bay at 100' from landside and floodside face of the T-Walls.

Volume =	72,511	CY



LOCATION	TYPE	"A"	"B"	"C"	"D"
STA 10+00 TO STA 14+55	2	17.0	6.0	-51.5	-6.5
STA 14+55 TO STA 20+05	1	17.0	3.0	-60.0	-10.0
STA 70+45 TO STA 85+95	1	17.0	3.0	-60.0	-10.0
STA 85+95 TO STA 95+90	2	17.0	6.0	-51.5	-6.5

Job No. 100-RCE-18-01

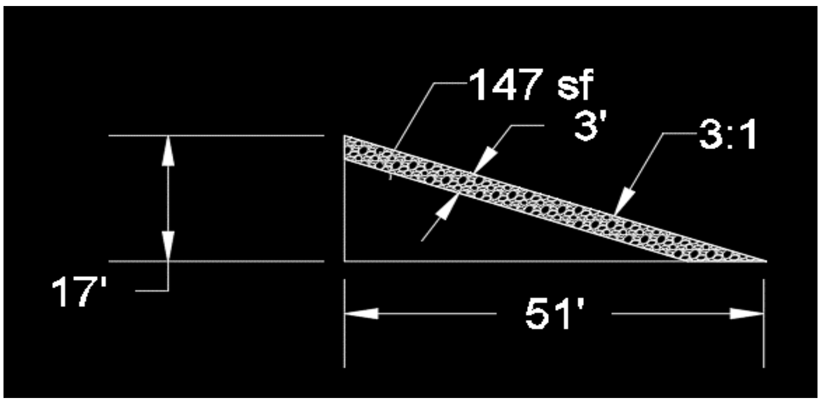
Contract/Client	**Texas General Land Office**
Phase/Subject	**Clear Creek - Quantities**
Design Topic	**Riprap Volume for T-Walls and Bank Protection**
Made By	AG
Date	10/31/2019
Checked By	SKV
Date	12/5/2019

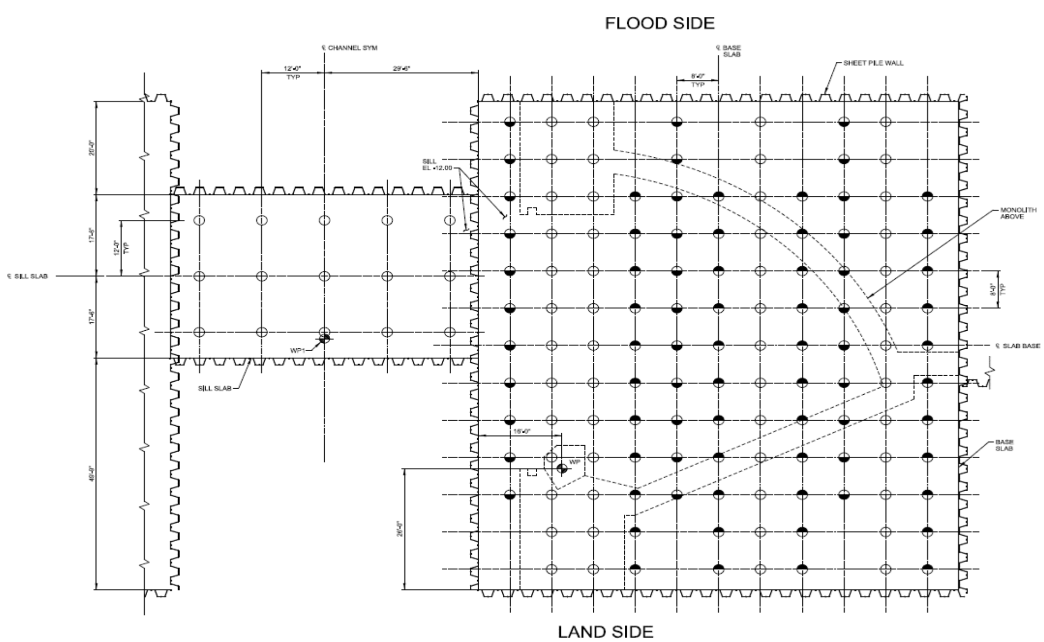
Floodgate Navigation Channel Riprap Volume:

Assume 100' of bank protection from the end of the sheetpile= 400 ft.
Assume vertical sheetpile walls at 17' high.
Riprap would be placed at 3:1 slope within the water.

Area of 3' thick riprap = 147
Volume of wedge= 2,178 CY

Total Riprap Volume= 74,689 CY



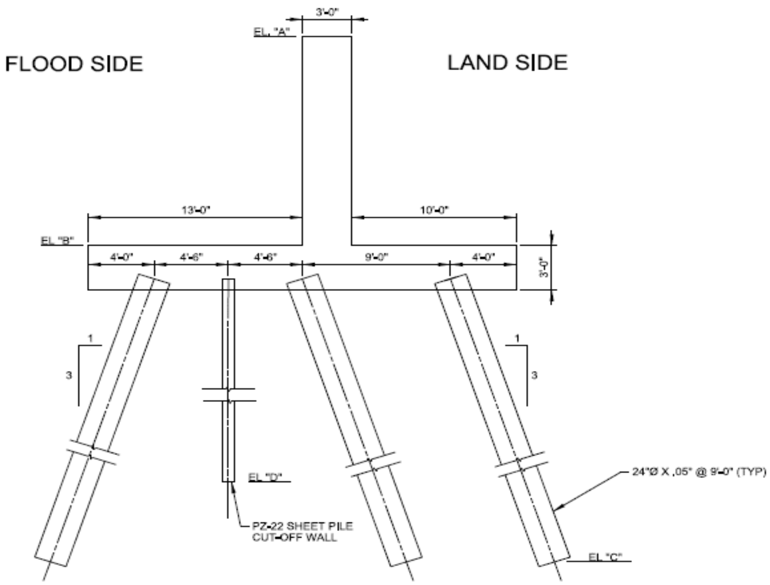


Job No.	100-RCE-18-01
Contract/Client	**Texas General Land Office**
Phase/Subject	**Dickinson Bayou - Quantities**
Design Topic	**Riprap Volume for T-Walls and Bank Protection**
Made By	AG Date 10/31/2019 Checked By SKV Date 12/5/2019

T- Wall Length = 202 ft. <== From CAD

Assume riprap is 3' thick.
Riprap will be placed at bottom of the bay at 100' from landside and floodside face of the T-Walls.

Volume = 4,489 CY



LOCATION	TYPE	"A"	"B"	"C"	"D"
STA 10+00 TO STA 39+57	1	18.0	1.0	-67.0	-12.0
STA 39+57 TO STA 49+73	2	18.0	3.0	-63.0	-9.5
STA 62+12 TO STA 66+03	2	18.0	3.0	-63.0	-9.5
STA 66+03 TO STA 88+55	1	18.0	1.0	-67.0	-12.0

Job No. 100-RCE-18-01

Contract/Client	**Texas General Land Office**
Phase/Subject	**Dickinson Bayou - Quantities**
Design Topic	**Riprap Volume for T-Walls and Bank Protection**

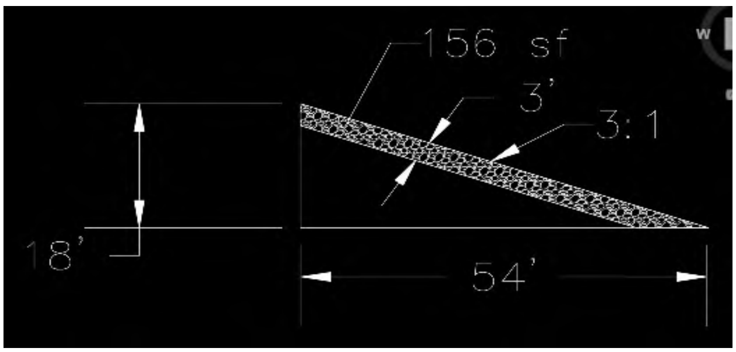
Made By AG Date 10/31/2019 Checked By SKV Date 12/5/2019

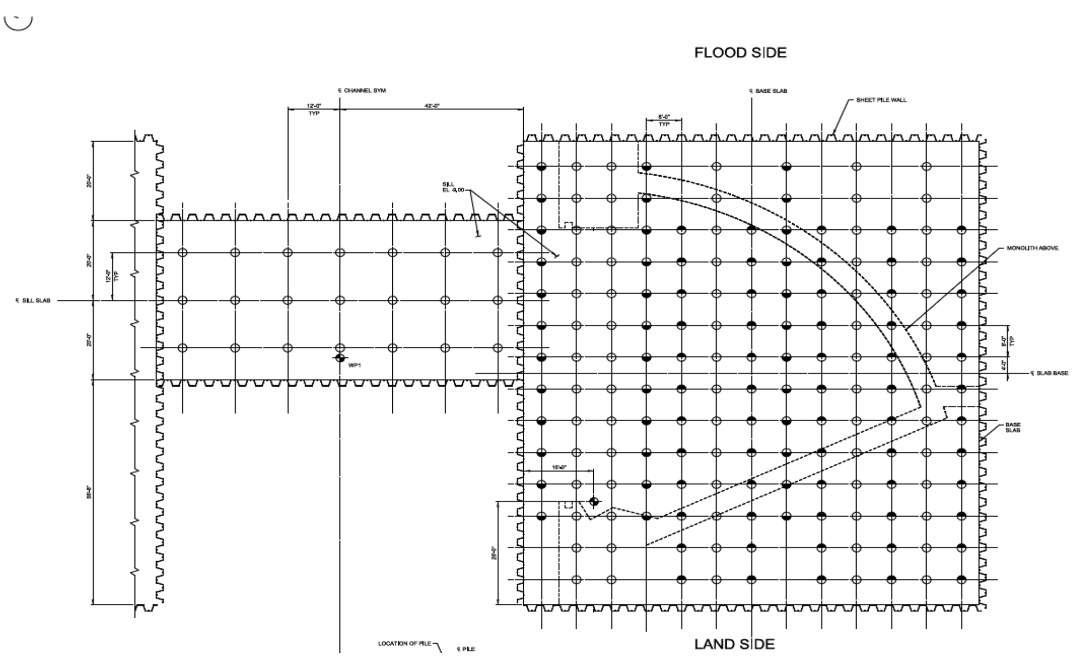
Floodgate Navigation Channel Riprap Volume:

Assume 100' of bank protection from the end of the sheetpile= 400 ft.
Assume vertical sheetpile walls at 18' high.
Riprap would be placed at 3:1 slope within the water.

Area of 3' thick riprap = 156
Volume of wedge= 2,311 CY

Total Riprap Volume= 6,800 CY





TETRA TECH

CALCULATIONS

Project:	Coastal Texas Protection & Restoration
Job No.	100-WTR-18-09-1
Description:	Dickinson Bayou Navigation Approach Walls
	- Dickinson Bayou Quantity Takeoff

Computed: *RSK* **Date:** *21-Oct-19* **Checked:** *DS* **Date:** *21-Oct-19*

Dickinson Bayou Quantity Takeoff

Dickinson Bayou Navigation Approach Wall Quantity Summary

Component: **Timber Materials for Dickinson Bayou Approach Walls**

Item	Length per Item (LF)	Total Length for Clear Creek (LF)
12" x 12" Composite Marine Timber	20.0	4,320
12" x 12" Select Structural Southern Pine Timbers (Treated)	20.0	960
6" x 10" Select Structural Southern Pine Timbers (Treated)	16.0	3,072
10" x 10" Select Structural Southern Pine Timbers (Treated)	13.0	2,496
8" x 8" Select Structural Southern Pine Timbers (Treated)	17.0	1,632
8" x 12" Splice Block	2.5	600
13" Dia Min Southern Pine Pole	16.5	792

Component: **Timber Piles for Dickinson Bayou Approach Walls**

Timber Piles	Length per Pile (LF)	Total Length for Clear Creek (LF)
13" Min Dia Southern Pine or Douglas Fir (Vertical and ASTMD25 Treated)	75	3,600
13" Min Dia Southern Pine or Douglas Fir (Battered and ASTMD25 Treated)	75	3,600

Component: **7 - Pile Cluster Dolphin Piles**

Timber Piles	Length per Pile (LF)	Total Length for Clear Creek (LF)
13" Ø Reinforced Composite Marine Timber Piles Battered 12:1 (V:H)	60	2,880
13" Ø Reinforced Composite Marine Timber Piles Vertical	60	480

Component: **Galvanized Wire Rope**

Galvanized Wire Rope	Total Length for Clear Creek (LF)
5/8" Ø Galvanized Wire Rope, Staple Each Turn to Pile	2,052.51

TETRA TECH

CALCULATIONS

Project:	Coastal Texas Protection & Restoration
Job No.	100-WTR-18-09-1
Description:	Dickinson Bayou Navigation Approach Walls
	- Dickinson Bayou Quantity Takeoff

Computed: *RSK* **Date:** *21-Oct-19* **Checked:** *DS* **Date:** *21-Oct-19*

Dickinson Bayou Quantity Takeoff

Dickinson Bayou Navigation Approach Wall Quantities

Notes:

* 4 approach walls are needed for Dickinson Bayou's Sector Gates, 2 for Bay Side and 2 for Inlet Side
* Each approach wall is assumed to be 120' in length with 2 dolphins at the ends of each wall
* The quantities are taken per 10' and then multiplied by the number of segments to get the total quantities per a wall
* The guidewalls were assumed to be similar to the Brazos Lock Gate's Guidewalls
* The dolphins were assumed to be similar to the Harvey Canal Sector Gates's dolphins

Component: **10' Section of Approach Wall**

Number of Segments per Guidewall: 12.00
Number of Guidewalls for Clear Creek: 4.00

Item	Length per Segment (LF)	Each	Number of Each Segment	Levels per Segment	Total Length for One Segment (LF)	Total Length per a Guidewall (LF)	Total Length for Clear Creek (LF)
12" x 12" Composite Marine Timber Fenders	10.00	1	1	9	90.00	1,080.00	4,320.00
12" x 12" Select Structural Southern Pine Timbers (Treated)	10.00	1	1	2	20.00	240.00	960.00
6" x 10" Select Structural Southern Pine Timbers (Treated)	16.00	2	1	2	64.00	768.00	3,072.00
10" x 10" Select Structural Southern Pine Timbers (Treated)	13.00	2	1	2	52.00	624.00	2,496.00
8" x 8" Select Structural Southern Pine Timbers (Treated)	17.00	2	1	1	34.00	408.00	1,632.00
8" x 12" Splice Block	2.50	5	1	1	12.50	150.00	600.00
13" Dia Min Southern Pine Pole	16.50	1	1	1	16.50	198.00	792.00

TETRA TECH

CALCULATIONS

Project:	Coastal Texas Protection & Restoration
Job No.	100-WTR-18-09-1
Description:	Dickinson Bayou Navigation Approach Walls
	- Dickinson Bayou Quantity Takeoff

Computed: *RSK* **Date:** *21-Oct-19* **Checked:** *DS* **Date:** *21-Oct-19*

Dickinson Bayou Quantity Takeoff

Component: **10' Section of Approach Wall**

Timber Piles	Length (LF)	Number of Sections per Segment	Total Length for One Segment (LF)	Total Length per a Guidewall (LF)	Total Length for Clear Creek (LF)
13" Min Dia Southern Pine or Douglas Fir (Vertical and ASTMD25 Treated)	75	1	75.00	900	3,600.00
13" Min Dia Southern Pine or Douglas Fir (Battered and ASTMD25 Treated)	75	1	75.00	900	3,600.00

TETRA TECH

CALCULATIONS

Project:	Coastal Texas Protection & Restoration						
Job No.	100-WTR-18-09-1						
Description:	Dickinson Bayou Navigation Approach Walls						
	- Dickinson Bayou Quantity Takeoff						
Computed:	*RSK*	**Date:**	*21-Oct-19*	**Checked:**	*DS*	**Date:**	*21-Oct-19*

Dickinson Bayou Quantity Takeoff

Component: **7 - Pile Cluster Dolphin**

Timber Piles

Timber Piles	Length (LF)	Number of Sections per Segment	Total Length for One Segment (LF)
13" Ø Reinforced Composite Marine Timber Piles Battered 12:1 (V:H)	60	6	360.00
13" Ø Reinforced Composite Marine Timber Piles Vertical	60	1	60.00
		Grand Total (per 10' Section):	420.00

Number of Dolphins per Guidewall: 2.00
Grand Total per Guidewall: 840.00 LF

Number of Guidewalls for Clear Creek: 4.00
Grand Total for Clear Creek: 3,360.00 LF

Galvanized Wire Rope

Notes:
* Diameter of top of dolphin determined by adding the diameter of three piles (13" Ø ea.)
  * 13" x3 =39"
* Piles Battered at 1/12 (H:V) so for every foot decrease in elevation, two inches were added to the dolphin's diameter (1" x2 as both end piles were battered)
  * 5' Elevation change from top of dolphin to bottom chord = 5" x2 widening
  * Total Dia = (39")+5"*2 = 49" = 4'-1"
*Use bottom chord diameter for both chords to be conservative

Rope	Diameter for Dolphin at Bottom Chord	# of Turns	Length	Number of Cords per Dolphin	Total LF for One Segment
5/8" Ø Galvanized Wire Rope, Staple Each Turn to Pile	4.08	10	128.28	2	256.56

Number of Dolphins per Guidewall: 2.00
Grand Total per Guidewall: 513.13 LF

Number of Guidewalls for Clear Creek: 4.00
Grand Total for Clear Creek: 2,052.51 LF

Attachment 8

Offats Bayou Quantities and Costs

Texas Costal 125' Sector Gate

BID SCHEDULE

Sector Gate 01

Top of Gate	13.5
Top of Sill	-15
Bottom of Slab	-23

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	Estimated Amount
0001	24" x 1/2" Steel Pile Piles	32,580.00	LF		
0002	CIP Strutural Concrete (Sector Gate Monolith)	12,789.29	CY		
0003	Sector Gate Leafs	344.00	TONS		
0004	Cofferdam	1.00	LS		4,946,829.54
0005	Steel Sheet Pile, PZC -13	2,672.00	SF	36.04	96,286.32
0006	Timber Pile Clusters	4.00	EA	16,350.00	65,400.00
0007	Embankment	2,299.00	CY	42.41	97,500.59
0008	Riprap	5,593.00	TONS	82.25	460,046.62
0009	Clearing and Grubbing	1.90	ACRE	9,870.42	18,753.80
0010	Access Road	1.00	LS		195,288.94
0011	Control /Generator Buildings	1.00	LS		142,852.61
0012	Installation and Testing of Sector Gate	1.00	LS		2,300,331.99
0013	Needle Girders	1.00	LS		19,696.84
0014	Guide Walls	1.00	LS		203,145.00
0015	Gate Operating Machinery	1.00	LS		1,007,401.65
0016	Electrical - Entergy Sevice Fee	1.00	LS		110,269.87
0017	Electrical - Miscellaneous	1.00	LS		4,231,958.51

Attachment 9

Tentative Construction Schedule

Texas Coastal Protection
Clear Creek Facility
Tentative Construction Schedule

Thu 12/19/19

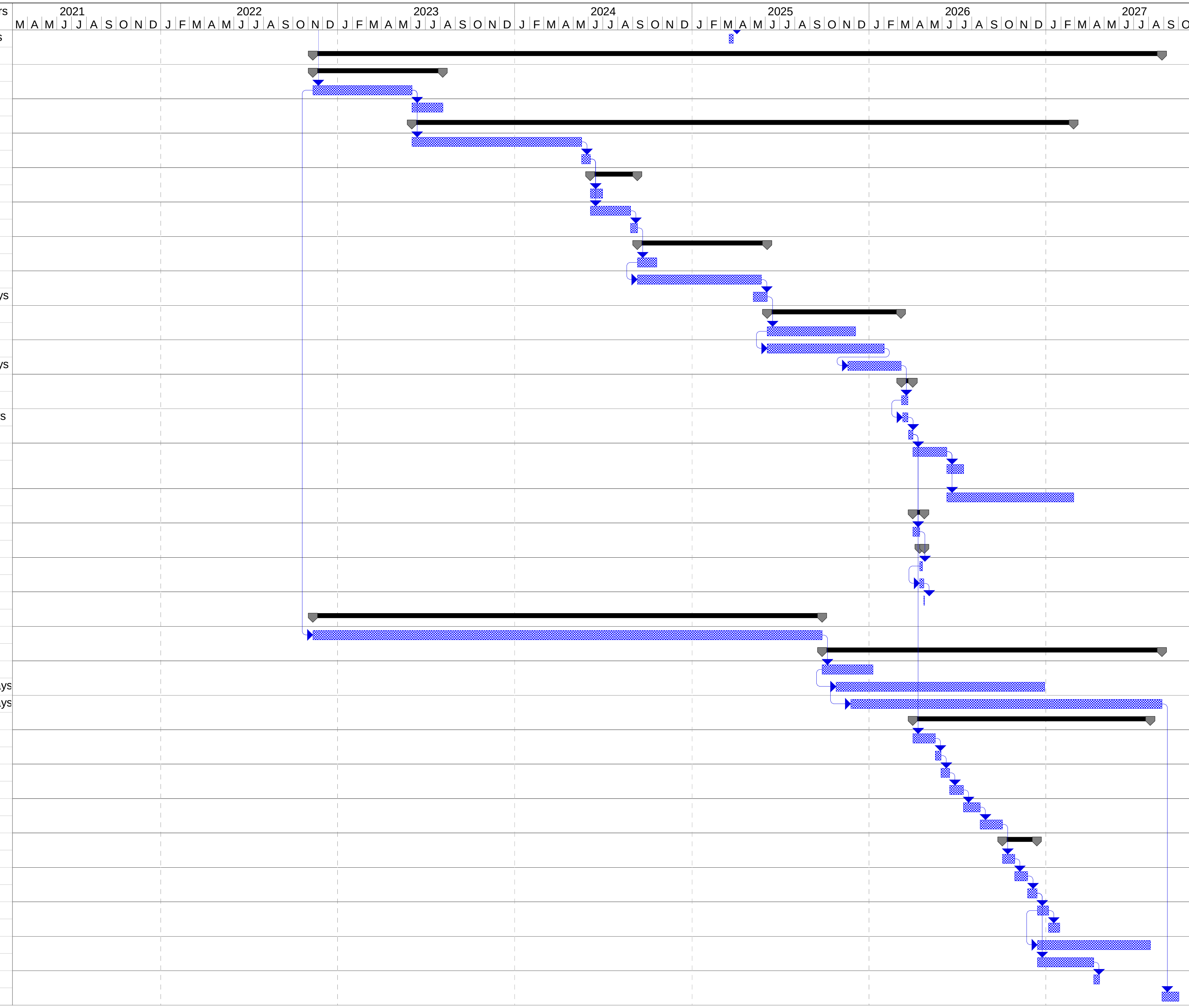
ID	Task Name	Duration	Start	Finish	Predecessors
1	**TEXAS COASTAL PROTECTION STUDY**	**2036 days**	**Thu 4/1/21**	**Fri 10/1/27**	
2	**Clear Creek Facility**	**2036 days**	**Thu 4/1/21**	**Fri 10/1/27**	
3	Notice to Proceed	0 days	Thu 4/1/21	Thu 4/1/21	
4	Mobilization	45 days	Thu 4/1/21	Sat 5/22/21	3
5	**Utility Relocations**	**460 days**	**Mon 5/24/21**	**Thu 11/10/22**	
6	**Pipeline Relocations**	**460 days**	**Mon 5/24/21**	**Thu 11/10/22**	
7	4" Gas Line	55 days	Mon 5/24/21	Mon 7/26/21	4
8	6" Gas Line	70 days	Mon 5/24/21	Thu 8/12/21	4
9	6" Gas Line	65 days	Mon 5/24/21	Fri 8/6/21	4
10	6" Gas Line	65 days	Tue 7/27/21	Sat 10/9/21	7
11	8" Gas Line	70 days	Sat 8/7/21	Wed 10/27/21	9
12	8" Gas Line	75 days	Fri 8/13/21	Mon 11/8/21	8
13	9" Gas Line	70 days	Mon 10/11/21	Thu 12/30/21	10
14	10" Gas Line	80 days	Thu 10/28/21	Fri 1/28/22	11
15	11" Gas Line	95 days	Tue 11/9/21	Sat 2/26/22	12
16	7" Petroleum Line	60 days	Fri 12/31/21	Thu 3/10/22	13
17	8" Petroleum Line	75 days	Sat 1/29/22	Tue 4/26/22	14
18	8" Petroleum Line	80 days	Mon 2/28/22	Tue 5/31/22	15
19	10" Petroleum Line	70 days	Fri 3/11/22	Tue 5/31/22	16
20	12" Petroleum Line	115 days	Wed 4/27/22	Wed 9/7/22	17
21	Unknown - Assumes 8"	40 days	Wed 6/1/22	Sat 7/16/22	18
22	Unknown - Assumes 8"	20 days	Wed 6/1/22	Thu 6/23/22	19
23	18" Line	120 days	Fri 6/24/22	Thu 11/10/22	22
24	9" Abandoned	10 days	Mon 7/18/22	Thu 7/28/22	21
25	**Walls**	**743 days**	**Fri 11/11/22**	**Wed 3/26/25**	
26	**T-Wall (Type 1)**	**250 days**	**Fri 11/11/22**	**Tue 8/29/23**	
27	Excavation	10 days	Fri 11/11/22	Tue 11/22/22	23
28	24" Steel Pipe Pile, Battered	86 days	Wed 11/23/22	Thu 3/2/23	27
29	Steel Sheet Pile, PZ-22	19 days	Fri 3/3/23	Fri 3/24/23	28
30	**Concrete Footing**	**95 days**	**Sat 3/25/23**	**Thu 7/13/23**	
31	Formwork	25 days	Sat 3/25/23	Sat 4/22/23	29
32	Reinforcing Steel	90 days	Sat 3/25/23	Fri 7/7/23	29
33	Placement	20 days	Wed 6/21/23	Thu 7/13/23	32FS-15 days
34	**Concrete Wall**	**35 days**	**Fri 7/14/23**	**Wed 8/23/23**	
35	Formwork	25 days	Fri 7/14/23	Fri 8/11/23	33
36	Reinforcing Steel	25 days	Thu 7/20/23	Thu 8/17/23	35SS+5 days
37	Placement	10 days	Sat 8/12/23	Wed 8/23/23	36FS-5 days
38	Fill and Compact	5 days	Thu 8/24/23	Tue 8/29/23	37
39	**T-Wall (Type 2)**	**168 days**	**Wed 8/30/23**	**Tue 3/12/24**	
40	Excavation	5 days	Wed 8/30/23	Mon 9/4/23	38
41	24" Steel Pipe Pile, Battered	83 days	Tue 9/5/23	Sat 12/9/23	40
42	Steel Sheet Pile, PZ-22	13 days	Mon 12/11/23	Mon 12/25/23	41
43	**Concrete Footing**	**50 days**	**Tue 12/26/23**	**Wed 2/21/24**	
44	Formwork	8 days	Tue 12/26/23	Wed 1/3/24	42
45	Reinforcing Steel	50 days	Tue 12/26/23	Wed 2/21/24	42
46	Placement	10 days	Mon 2/5/24	Thu 2/15/24	45FS-15 days
47	**Concrete Wall**	**19 days**	**Fri 2/16/24**	**Fri 3/8/24**	
48	Formwork	12 days	Fri 2/16/24	Thu 2/29/24	46
49	Reinforcing Steel	12 days	Thu 2/22/24	Wed 3/6/24	48SS+5 days
50	Placement	7 days	Fri 3/1/24	Fri 3/8/24	49FS-5 days
51	Fill and Compact	3 days	Sat 3/9/24	Tue 3/12/24	50
52	**Floodwall**	**325 days**	**Wed 3/13/24**	**Wed 3/26/25**	
53	42" Cylindrical Pile	150 days	Wed 3/13/24	Tue 9/3/24	51
54	18" Steel Pipe Pile	75 days	Wed 9/4/24	Fri 11/29/24	53
55	6" Square Concrete Pile	55 days	Sat 11/30/24	Sat 2/1/25	54
56	**Concrete Pile Cap**	**45 days**	**Mon 2/3/25**	**Wed 3/26/25**	
57	Formwork	25 days	Mon 2/3/25	Mon 3/3/25	55
58	Reinforcing Steel	37 days	Sat 2/8/25	Sat 3/22/25	57SS+5 days

Task	Summary	External MileTask	Inactive Summary	Manual Summary Rollup	Finish-only
Split	Project Summary	Inactive Task	Manual Task	Manual Summary	Progress
Milestone	External Tasks	Inactive Milestone	Duration-only	Start-only	Split

Texas Coastal Protection
Clear Creek Facility
Tentative Construction Schedule

Thu 12/19/19

ID	Task Name	Duration	Start	Finish	Predecessors
59	Placement	8 days	Tue 3/18/25	Wed 3/26/25	58FS-5 days
60	**Pumping Plant**	**1501 days**	**Fri 11/11/22**	**Fri 8/27/27**	
61	**Sheet Pile Cofferdam**	**230 days**	**Fri 11/11/22**	**Sat 8/5/23**	
62	Steel Sheet Pile, PS-31	175 days	Fri 11/11/22	Fri 6/2/23	23
63	Cofferdam Fill	55 days	Sat 6/3/23	Sat 8/5/23	62
64	**Pump Station Structure**	**1170 days**	**Sat 6/3/23**	**Fri 2/26/27**	
65	24" Steel Pipe Piles	300 days	Sat 6/3/23	Fri 5/17/24	62
66	Steel Sheet Pile	15 days	Sat 5/18/24	Tue 6/4/24	65
67	**Concrete Mud Slab**	**83 days**	**Wed 6/5/24**	**Mon 9/9/24**	
68	Formwork	22 days	Wed 6/5/24	Sat 6/29/24	66
69	Reinforcing Steel	71 days	Wed 6/5/24	Mon 8/26/24	66
70	Concrete Placement	12 days	Tue 8/27/24	Mon 9/9/24	69
71	**Concrete Base Slab**	**230 days**	**Tue 9/10/24**	**Wed 6/4/25**	
72	Formwork	35 days	Tue 9/10/24	Sat 10/19/24	70
73	Reinforcing Steel	220 days	Tue 9/10/24	Fri 5/23/25	72SS
74	Concrete Placement	25 days	Wed 5/7/25	Wed 6/4/25	73FS-15 days
75	**Concrete Substructure**	**237 days**	**Thu 6/5/25**	**Sat 3/7/26**	
76	Formwork	156 days	Thu 6/5/25	Wed 12/3/25	74
77	Reinforcing Steel	207 days	Thu 6/5/25	Sat 1/31/26	76SS
78	Concrete Placement	95 days	Tue 11/18/25	Sat 3/7/26	77FS-65 days
79	**Concrete Safehouse**	**20 days**	**Mon 3/9/26**	**Tue 3/31/26**	
80	Formwork	12 days	Mon 3/9/26	Sat 3/21/26	78
81	Reinforcing Steel	10 days	Wed 3/11/26	Sat 3/21/26	80SS+2 days
82	Concrete Placement	8 days	Mon 3/23/26	Tue 3/31/26	81
83	Precast Wall Panels	60 days	Wed 4/1/26	Tue 6/9/26	82
84	Steel Columns, Roof Beams and Crane Frame	30 days	Wed 6/10/26	Tue 7/14/26	83
85	Mechanical and Electrical Components	225 days	Wed 6/10/26	Fri 2/26/27	83
86	**Fuel Tank Foundations**	**21 days**	**Wed 4/1/26**	**Fri 4/24/26**	
87	24" Steel Pipe Piles, Battered	12 days	Wed 4/1/26	Tue 4/14/26	82
88	**Concrete Pile Cap**	**9 days**	**Wed 4/15/26**	**Fri 4/24/26**	
89	Formwork	5 days	Wed 4/15/26	Mon 4/20/26	87
90	Reinforcing Steel	8 days	Wed 4/15/26	Thu 4/23/26	89SS
91	Concrete Placement	1 day	Fri 4/24/26	Fri 4/24/26	90
92	**Dredging**	**900 days**	**Fri 11/11/22**	**Thu 9/25/25**	
93	Mechanical Dredging	900 days	Fri 11/11/22	Thu 9/25/25	62SS
94	**Discharge Pipes**	**601 days**	**Fri 9/26/25**	**Fri 8/27/27**	
95	Excavation	90 days	Fri 9/26/25	Thu 1/8/26	93
96	Discharge Pipes, Land Placement	368 days	Sat 10/25/25	Mon 12/28/26	95SS+25 days
97	Discharge Pipes, Barge Placement	551 days	Mon 11/24/25	Fri 8/27/27	96SS+25 days
98	**Sector Gate**	**420 days**	**Wed 4/1/26**	**Tue 8/3/27**	
99	Steel Sheet Piles	40 days	Wed 4/1/26	Sat 5/16/26	82
100	Mechanical Dredging	10 days	Mon 5/18/26	Thu 5/28/26	99
101	24" Steel Pipe Piles	15 days	Fri 5/29/26	Mon 6/15/26	100
102	24" Steel Pipe Piles, Battered	24 days	Tue 6/16/26	Mon 7/13/26	101
103	Tremie Concrete	30 days	Tue 7/14/26	Mon 8/17/26	102
104	Concrete Base Slab	40 days	Tue 8/18/26	Fri 10/2/26	103
105	**Concrete Monolith Walls and Thrust Blocks**	**61 days**	**Sat 10/3/26**	**Sat 12/12/26**	
106	Formwork	21 days	Sat 10/3/26	Tue 10/27/26	104
107	Reinforcing Steel	23 days	Wed 10/28/26	Mon 11/23/26	106
108	Concrete Placement	17 days	Tue 11/24/26	Sat 12/12/26	107
109	Control Building	20 days	Mon 12/14/26	Tue 1/5/27	108
110	Sector Gate Steel Installation	20 days	Wed 1/6/27	Thu 1/28/27	109
111	Mechanical and Electrical Components	200 days	Mon 12/14/26	Tue 8/3/27	109SS
112	Navigation Approach Walls	100 days	Mon 12/14/26	Thu 4/8/27	108
113	Riprap Placement	10 days	Fri 4/9/27	Tue 4/20/27	112
114	Demobilization	30 days	Sat 8/28/27	Fri 10/1/27	97

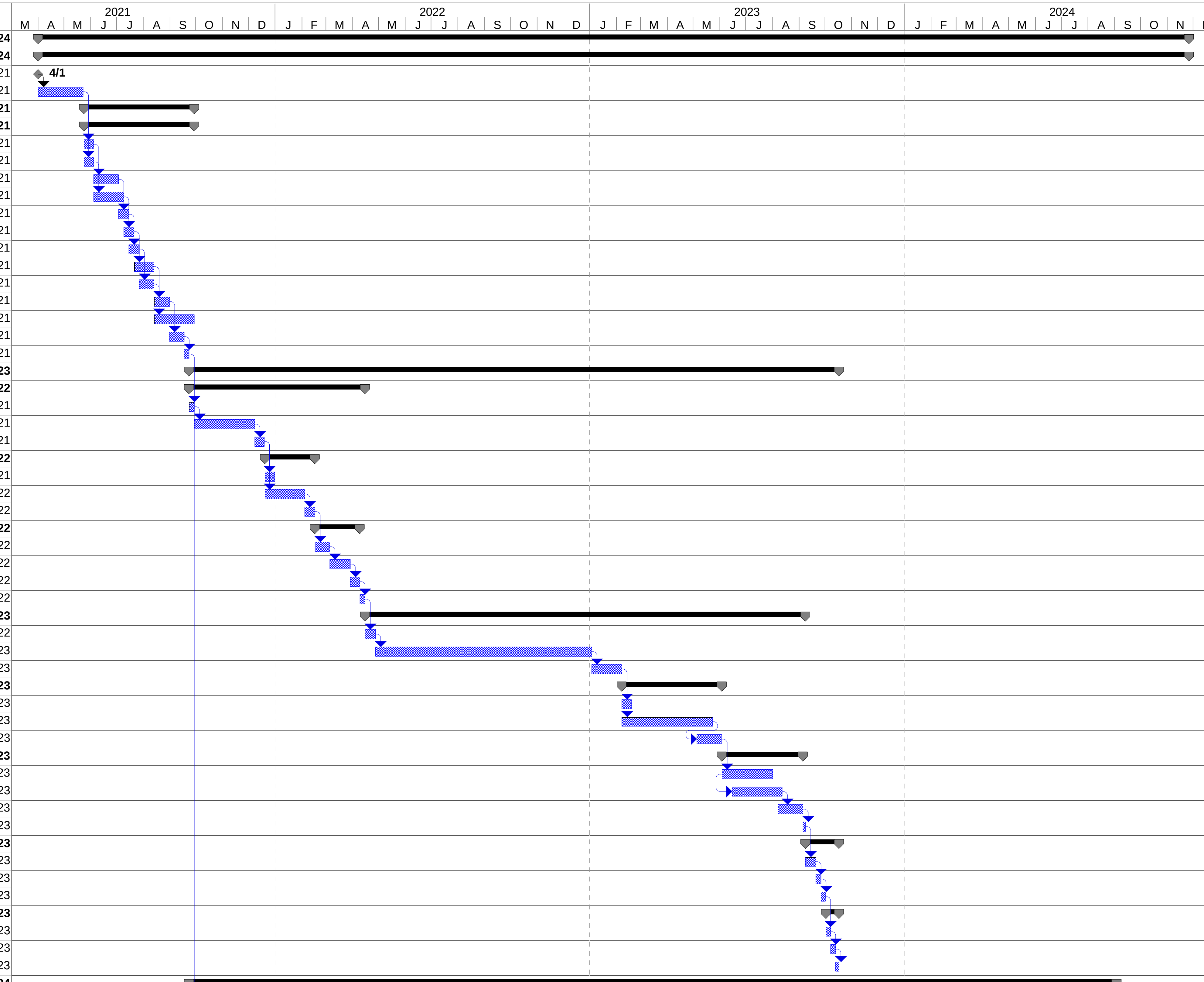


Task	Summary	External MileTask	Inactive Summary	Manual Summary Rollup	Finish-only
Split	Project Summary	Inactive Task	Manual Task	Manual Summary	Progress
Milestone	External Tasks	Inactive Milestone	Duration-only	Start-only	Split

Thu 12/19/19

Texas Coastal Protection
Dickinson Bayou Facility
Tentative Construction Schedule

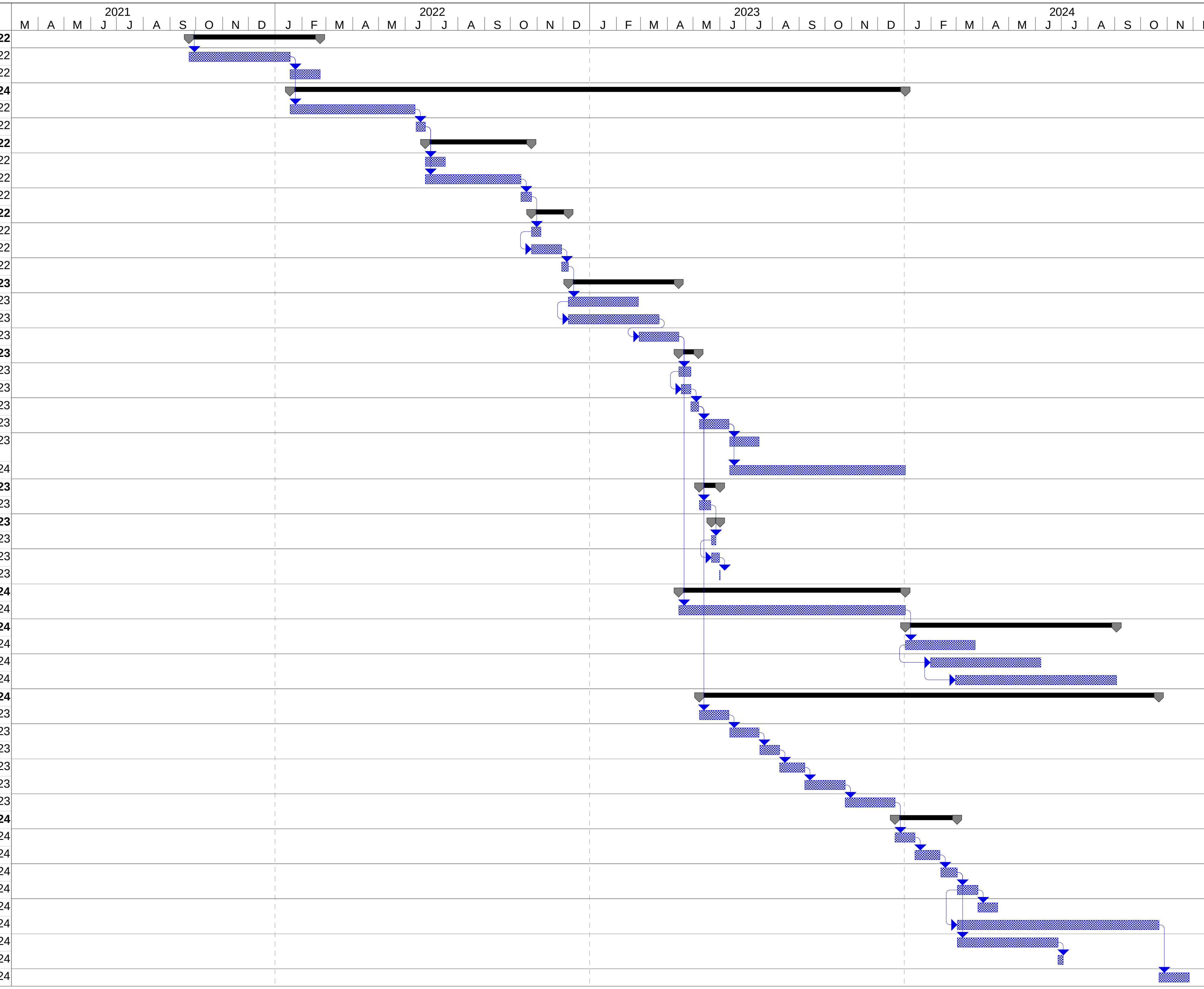
ID	Task Name	Duration	Start	Finish
1	**TEXAS COASTAL PROTECTION STUDY**	**1144 days**	**Thu 4/1/21**	**Mon 11/25/24**
2	**Dickinson Bayou Facility**	**1144 days**	**Thu 4/1/21**	**Mon 11/25/24**
3	Notice to Proceed	0 days	Thu 4/1/21	Thu 4/1/21
4	Mobilization	45 days	Thu 4/1/21	Sat 5/22/21
5	**Utility Relocations**	**110 days**	**Mon 5/24/21**	**Tue 9/28/21**
6	**Pipeline Relocations**	**110 days**	**Mon 5/24/21**	**Tue 9/28/21**
7	4" Gas Line	10 days	Mon 5/24/21	Thu 6/3/21
8	6" Gas Line	10 days	Mon 5/24/21	Thu 6/3/21
9	6" Gas Line	25 days	Fri 6/4/21	Fri 7/2/21
10	6" Gas Line	30 days	Fri 6/4/21	Thu 7/8/21
11	8" Gas Line	10 days	Sat 7/3/21	Wed 7/14/21
12	8" Gas Line	10 days	Fri 7/9/21	Tue 7/20/21
13	9" Gas Line	10 days	Thu 7/15/21	Mon 7/26/21
14	10" Gas Line	20 days	Wed 7/21/21	Thu 8/12/21
15	11" Gas Line	15 days	Tue 7/27/21	Thu 8/12/21
16	7" Petroleum Line	15 days	Fri 8/13/21	Mon 8/30/21
17	8" Petroleum Line	40 days	Fri 8/13/21	Tue 9/28/21
18	8" Petroleum Line	15 days	Tue 8/31/21	Thu 9/16/21
19	10" Petroleum Line	5 days	Fri 9/17/21	Wed 9/22/21
20	**Walls**	**646 days**	**Thu 9/23/21**	**Mon 10/16/23**
21	**T-Wall (Type 1)**	**175 days**	**Thu 9/23/21**	**Thu 4/14/22**
22	Excavation	5 days	Thu 9/23/21	Tue 9/28/21
23	24" Steel Pipe Pile, Battered	60 days	Wed 9/29/21	Tue 12/7/21
24	Steel Sheet Pile, PZ-22	10 days	Wed 12/8/21	Sat 12/18/21
25	**Concrete Footing**	**50 days**	**Mon 12/20/21**	**Tue 2/15/22**
26	Formwork	10 days	Mon 12/20/21	Thu 12/30/21
27	Reinforcing Steel	40 days	Mon 12/20/21	Thu 2/3/22
28	Placement	10 days	Fri 2/4/22	Tue 2/15/22
29	**Concrete Wall**	**45 days**	**Wed 2/16/22**	**Fri 4/8/22**
30	Formwork	15 days	Wed 2/16/22	Fri 3/4/22
31	Reinforcing Steel	20 days	Sat 3/5/22	Mon 3/28/22
32	Placement	10 days	Tue 3/29/22	Fri 4/8/22
33	Fill and Compact	5 days	Sat 4/9/22	Thu 4/14/22
34	**T-Wall (Type 2)**	**438 days**	**Fri 4/15/22**	**Thu 9/7/23**
35	Excavation	10 days	Fri 4/15/22	Tue 4/26/22
36	24" Steel Pipe Pile, Battered	215 days	Wed 4/27/22	Mon 1/2/23
37	Steel Sheet Pile, PZ-22	30 days	Tue 1/3/23	Mon 2/6/23
38	**Concrete Footing**	**100 days**	**Tue 2/7/23**	**Fri 6/2/23**
39	Formwork	10 days	Tue 2/7/23	Fri 2/17/23
40	Reinforcing Steel	90 days	Tue 2/7/23	Mon 5/22/23
41	Placement	25 days	Fri 5/5/23	Fri 6/2/23
42	**Concrete Wall**	**80 days**	**Sat 6/3/23**	**Mon 9/4/23**
43	Formwork	50 days	Sat 6/3/23	Mon 7/31/23
44	Reinforcing Steel	50 days	Thu 6/15/23	Fri 8/11/23
45	Placement	25 days	Mon 8/7/23	Mon 9/4/23
46	Fill and Compact	3 days	Tue 9/5/23	Thu 9/7/23
47	**Floodwall**	**33 days**	**Fri 9/8/23**	**Mon 10/16/23**
48	42" Cylindrical Pile	10 days	Fri 9/8/23	Tue 9/19/23
49	18" Steel Pipe Pile	5 days	Wed 9/20/23	Mon 9/25/23
50	6" Square Concrete Pile	5 days	Tue 9/26/23	Sat 9/30/23
51	**Concrete Pile Cap**	**13 days**	**Mon 10/2/23**	**Mon 10/16/23**
52	Formwork	5 days	Mon 10/2/23	Fri 10/6/23
53	Reinforcing Steel	5 days	Sat 10/7/23	Thu 10/12/23
54	Placement	3 days	Fri 10/13/23	Mon 10/16/23
55	**Pumping Plant**	**922 days**	**Thu 9/23/21**	**Mon 9/2/24**



Task		Summary		External MileTask		Inactive Summary		Manual Summary Rollup		Finish-only	
Split		Project Summary		Inactive Task		Manual Task		Manual Summary		Progress	
Milestone		External Tasks		Inactive Milestone		Duration-only		Start-only		Split	

Texas Coastal Protection
Dickinson Bayou Facility
Tentative Construction Schedule

ID	Task Name	Duration	Start	Finish
56	**Sheet Pile Cofferdam**	**130 days**	**Thu 9/23/21**	**Mon 2/21/22**
57	Steel Sheet Pile, PS-31	100 days	Thu 9/23/21	Mon 1/17/22
58	Cofferdam Fill	30 days	Tue 1/18/22	Mon 2/21/22
59	**Pump Station Structure**	**612 days**	**Tue 1/18/22**	**Mon 1/1/24**
60	24" Steel Pipe Piles	125 days	Tue 1/18/22	Sat 6/11/22
61	Steel Sheet Pile	10 days	Mon 6/13/22	Thu 6/23/22
62	**Concrete Mud Slab**	**105 days**	**Fri 6/24/22**	**Mon 10/24/22**
63	Formwork	20 days	Fri 6/24/22	Sat 7/16/22
64	Reinforcing Steel	95 days	Fri 6/24/22	Wed 10/12/22
65	Concrete Placement	10 days	Thu 10/13/22	Mon 10/24/22
66	**Concrete Base Slab**	**37 days**	**Tue 10/25/22**	**Tue 12/6/22**
67	Formwork	10 days	Tue 10/25/22	Fri 11/4/22
68	Reinforcing Steel	30 days	Tue 10/25/22	Mon 11/28/22
69	Concrete Placement	7 days	Tue 11/29/22	Tue 12/6/22
70	**Concrete Substructure**	**110 days**	**Wed 12/7/22**	**Thu 4/13/23**
71	Formwork	70 days	Wed 12/7/22	Sat 2/25/23
72	Reinforcing Steel	90 days	Wed 12/7/22	Tue 3/21/23
73	Concrete Placement	40 days	Mon 2/27/23	Thu 4/13/23
74	**Concrete Safehouse**	**20 days**	**Fri 4/14/23**	**Sat 5/6/23**
75	Formwork	12 days	Fri 4/14/23	Thu 4/27/23
76	Reinforcing Steel	10 days	Mon 4/17/23	Thu 4/27/23
77	Concrete Placement	8 days	Fri 4/28/23	Sat 5/6/23
78	Precast Wall Panels	30 days	Mon 5/8/23	Sat 6/10/23
79	Steel Columns, Roof Beams and Crane Frame	30 days	Mon 6/12/23	Sat 7/15/23
80	Mechanical and Electrical Components	175 days	Mon 6/12/23	Mon 1/1/24
81	**Fuel Tank Foundations**	**21 days**	**Mon 5/8/23**	**Wed 5/31/23**
82	24" Steel Pipe Piles, Battered	12 days	Mon 5/8/23	Sat 5/20/23
83	**Concrete Pile Cap**	**9 days**	**Mon 5/22/23**	**Wed 5/31/23**
84	Formwork	5 days	Mon 5/22/23	Fri 5/26/23
85	Reinforcing Steel	8 days	Mon 5/22/23	Tue 5/30/23
86	Concrete Placement	1 day	Wed 5/31/23	Wed 5/31/23
87	**Dredging**	**225 days**	**Fri 4/14/23**	**Mon 1/1/24**
88	Mechanical Dredging	225 days	Fri 4/14/23	Mon 1/1/24
89	**Discharge Pipes**	**210 days**	**Tue 1/2/24**	**Mon 9/2/24**
90	Excavation	70 days	Tue 1/2/24	Fri 3/22/24
91	Discharge Pipes, Land Placement	110 days	Wed 1/31/24	Thu 6/6/24
92	Discharge Pipes, Barge Placement	160 days	Thu 2/29/24	Mon 9/2/24
93	**Sector Gate**	**457 days**	**Mon 5/8/23**	**Mon 10/21/24**
94	Steel Sheet Piles	30 days	Mon 5/8/23	Sat 6/10/23
95	Mechanical Dredging	30 days	Mon 6/12/23	Sat 7/15/23
96	24" Steel Pipe Piles	20 days	Mon 7/17/23	Tue 8/8/23
97	24" Steel Pipe Piles, Battered	25 days	Wed 8/9/23	Wed 9/6/23
98	Tremie Concrete	40 days	Thu 9/7/23	Mon 10/23/23
99	Concrete Base Slab	50 days	Tue 10/24/23	Wed 12/20/23
100	**Concrete Monolith Walls and Thrust Blocks**	**62 days**	**Thu 12/21/23**	**Fri 3/1/24**
101	Formwork	20 days	Thu 12/21/23	Fri 1/12/24
102	Reinforcing Steel	25 days	Sat 1/13/24	Sat 2/10/24
103	Concrete Placement	17 days	Mon 2/12/24	Fri 3/1/24
104	Control Building	20 days	Sat 3/2/24	Mon 3/25/24
105	Sector Gate Steel Installation	20 days	Tue 3/26/24	Wed 4/17/24
106	Mechanical and Electrical Components	200 days	Sat 3/2/24	Mon 10/21/24
107	Navigation Approach Walls	100 days	Sat 3/2/24	Wed 6/26/24
108	Riprap Placement	5 days	Thu 6/27/24	Tue 7/2/24
109	Demobilization	30 days	Tue 10/22/24	Mon 11/25/24

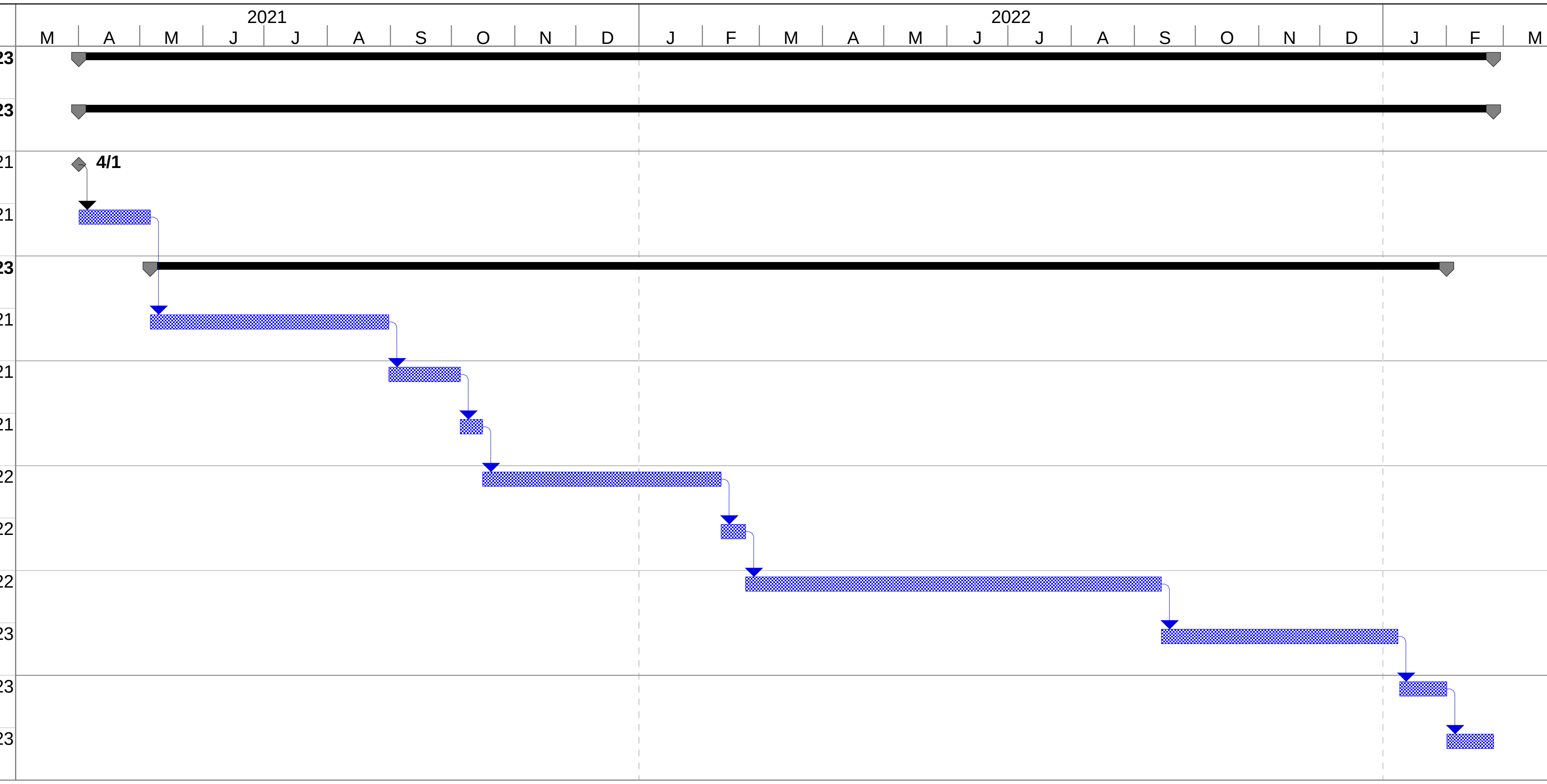


Task · Split · Milestone · Summary · Project Summary · External Tasks · External MileTask · Inactive Task · Inactive Milestone · Inactive Summary · Manual Task · Duration-only · Manual Summary Rollup · Manual Summary · Start-only · Finish-only · Progress · Split

Thu 12/19/19

Texas Coastal Protection
Clear Creek Facility
Tentative Construction Schedule

ID	Task Name	Duration	Start	Finish
1	**TEXAS COASTAL PROTECTION STUDY**	**595 days**	**Thu 4/1/21**	**Thu 2/23/23**
2	**Offats Bayou Facility**	**595 days**	**Thu 4/1/21**	**Thu 2/23/23**
3	Notice to Proceed	0 days	Thu 4/1/21	Thu 4/1/21
4	Mobilization	30 days	Thu 4/1/21	Wed 5/5/21
5	**Sector Gate**	**545 days**	**Thu 5/6/21**	**Tue 1/31/23**
6	Cofferdam	100 days	Thu 5/6/21	Mon 8/30/21
7	24" Steel Pipe Piles	30 days	Tue 8/31/21	Mon 10/4/21
8	Steel Sheet Pile	10 days	Tue 10/5/21	Fri 10/15/21
9	CIP Structural Concrete	100 days	Sat 10/16/21	Wed 2/9/22
10	Control / Generator Building	10 days	Thu 2/10/22	Mon 2/21/22
11	Operating Machinery and Electrical	175 days	Tue 2/22/22	Tue 9/13/22
12	Guide Walls	100 days	Wed 9/14/22	Sat 1/7/23
13	Emankment and Riprap	20 days	Mon 1/9/23	Tue 1/31/23
14	Demobilization	20 days	Wed 2/1/23	Thu 2/23/23

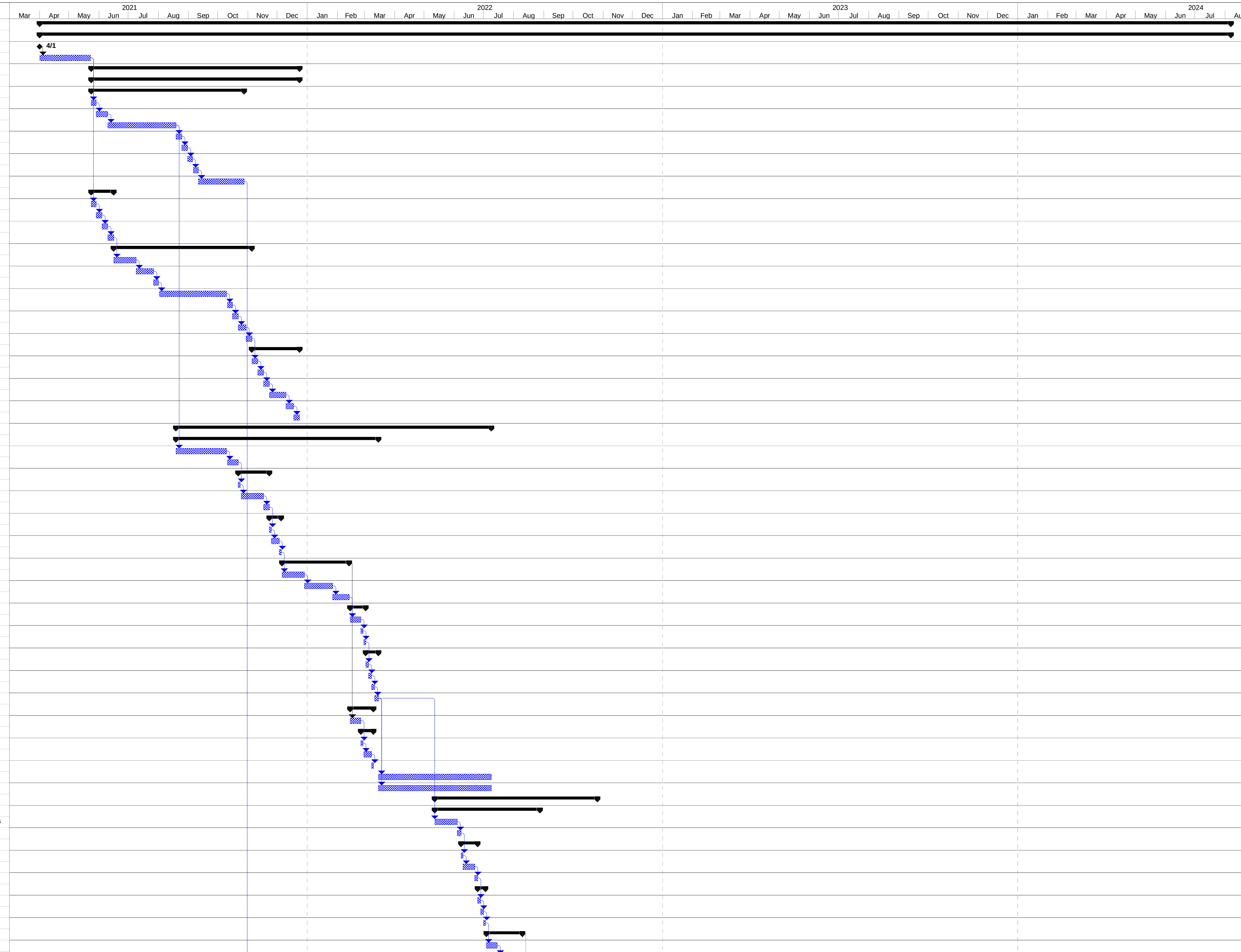


Task	Summary	External MileTask	Inactive Summary	Manual Summary Rollup	Finish-only
Split	Project Summary	Inactive Task	Manual Task	Manual Summary	Progress
Milestone	External Tasks	Inactive Milestone	Duration-only	Start-only	Split

Texas Coastal Protection
Galveston Island Facility
Tentative Construction Schedule

Mon 2/24/20

ID	Task Name	Duration	Start	Finish	Predecessors
1	**TEXAS COASTAL PROTECTION STUDY**	**1049 days**	**Thu 4/1/21**	**Tue 8/6/24**	
2	**Galveston Island Facility**	**1049 days**	**Thu 4/1/21**	**Tue 8/6/24**	
3	Notice to Proceed	0 days	Thu 4/1/21	Thu 4/1/21	
4	Mobilization	45 days	Thu 4/1/21	Sat 5/22/21	3
5	**Utility Relocations**	**184 days**	**Mon 5/24/21**	**Thu 12/23/21**	
6	**Pipeline Relocations**	**184 days**	**Mon 5/24/21**	**Thu 12/23/21**	
7	**Pumping Plant 1**	**135 days**	**Mon 5/24/21**	**Wed 10/27/21**	
8	1" PVC Waterline	5 days	Mon 5/24/21	Fri 5/28/21	4
9	12" AC Water Line	10 days	Sat 5/29/21	Wed 6/9/21	8
10	18" CI Water Line	60 days	Thu 6/10/21	Wed 8/18/21	9
11	20" DI Water Line	5 days	Thu 8/19/21	Tue 8/24/21	10
12	18" PVC Sewer Line	5 days	Wed 8/25/21	Mon 8/30/21	11
13	8" Clay Sewer Line	5 days	Tue 8/31/21	Sat 9/4/21	12
14	36" Storm Drain	5 days	Mon 9/6/21	Fri 9/10/21	13
15	Box Culverts	40 days	Sat 9/11/21	Wed 10/27/21	14
16	**Pumping Plant 2**	**20 days**	**Mon 5/24/21**	**Tue 6/15/21**	
17	30" PVC Water Line	5 days	Mon 5/24/21	Fri 5/28/21	4
18	12" CI Water Line	5 days	Sat 5/29/21	Thu 6/3/21	17
19	20" HDPE Water Line	5 days	Fri 6/4/21	Wed 6/9/21	18
20	Box Culverts	5 days	Thu 6/10/21	Tue 6/15/21	19
21	**Pumping Plant 3**	**122 days**	**Wed 6/16/21**	**Thu 11/4/21**	
22	8" PVC Water Line	20 days	Wed 6/16/21	Thu 7/8/21	20
23	12" CI Water Line	15 days	Fri 7/9/21	Mon 7/26/21	22
24	20" DI Water Line	5 days	Tue 7/27/21	Sat 7/31/21	23
25	30" Clay Sewer Line	60 days	Mon 8/2/21	Sat 10/9/21	24
26	24" CI Sewer Line	5 days	Mon 10/11/21	Fri 10/15/21	25
27	42" PVC Sewer Line	5 days	Sat 10/16/21	Thu 10/21/21	26
28	42" Storm Drain	7 days	Fri 10/22/21	Fri 10/29/21	27
29	Box Culverts	5 days	Sat 10/30/21	Thu 11/4/21	28
30	**Pumping Plant 4**	**42 days**	**Fri 11/5/21**	**Thu 12/23/21**	
31	6" PVC Water Line	5 days	Fri 11/5/21	Wed 11/10/21	29
32	6" CI Water Line	5 days	Thu 11/11/21	Tue 11/16/21	31
33	12" AC Water Line	5 days	Wed 11/17/21	Mon 11/22/21	32
34	12" Clay Sewer Line	15 days	Tue 11/23/21	Thu 12/9/21	33
35	36" Storm Drain	7 days	Fri 12/10/21	Fri 12/17/21	34
36	Box Culverts	5 days	Sat 12/18/21	Thu 12/23/21	35
37	**Pumping Plant 1**	**278 days**	**Thu 8/19/21**	**Fri 7/8/22**	
38	**Pump Station Structure**	**178 days**	**Thu 8/19/21**	**Mon 3/14/22**	
39	24" Steel Pipe Piles	45 days	Thu 8/19/21	Sat 10/9/21	10
40	Steel Sheet Pile	10 days	Mon 10/11/21	Thu 10/21/21	39
41	**Concrete Base Slab**	**27 days**	**Fri 10/22/21**	**Mon 11/22/21**	
42	Formwork	2 days	Fri 10/22/21	Sat 10/23/21	40
43	Reinforcing Steel	20 days	Mon 10/25/21	Tue 11/16/21	42
44	Concrete Placement	5 days	Wed 11/17/21	Mon 11/22/21	43
45	**Concrete Mud Slab**	**11 days**	**Tue 11/23/21**	**Sat 12/4/21**	
46	Formwork	2 days	Tue 11/23/21	Wed 11/24/21	44
47	Reinforcing Steel	7 days	Thu 11/25/21	Thu 12/2/21	46
48	Concrete Placement	2 days	Fri 12/3/21	Sat 12/4/21	47
49	**Concrete Substructure**	**60 days**	**Mon 12/6/21**	**Sat 2/12/22**	
50	Formwork	20 days	Mon 12/6/21	Tue 12/28/21	48
51	Reinforcing Steel	25 days	Wed 12/29/21	Wed 1/26/22	50
52	Concrete Placement	15 days	Thu 1/27/22	Sat 2/12/22	51
53	**Superstructure**	**14 days**	**Mon 2/14/22**	**Tue 3/1/22**	
54	Precast Wall Panels	10 days	Mon 2/14/22	Thu 2/24/22	52
55	Steel Columns	2 days	Fri 2/25/22	Sat 2/26/22	54
56	Roof Beams	2 days	Mon 2/28/22	Tue 3/1/22	55
57	**Crane Frame**	**11 days**	**Wed 3/2/22**	**Mon 3/14/22**	
58	Steel Columns	3 days	Wed 3/2/22	Fri 3/4/22	56
59	Top Rail	2 days	Sat 3/5/22	Mon 3/7/22	58
60	Crane Rails	3 days	Tue 3/8/22	Thu 3/10/22	59
61	Infill Framing	3 days	Fri 3/11/22	Mon 3/14/22	60
62	**Fuel Tank Foundations**	**21 days**	**Mon 2/14/22**	**Wed 3/9/22**	
63	24" Steel Pipe Piles, Battered	10 days	Mon 2/14/22	Thu 2/24/22	49
64	**Concrete Pile Cap**	**11 days**	**Fri 2/25/22**	**Wed 3/9/22**	
65	Formwork	2 days	Fri 2/25/22	Sat 2/26/22	63
66	Reinforcing Steel	7 days	Mon 2/28/22	Mon 3/7/22	65
67	Concrete Placement	2 days	Tue 3/8/22	Wed 3/9/22	66
68	Mechanical Items	100 days	Tue 3/15/22	Fri 7/8/22	61
69	Electrical Items	100 days	Tue 3/15/22	Fri 7/8/22	61
70	**Pumping Plant 2**	**143 days**	**Thu 5/12/22**	**Tue 10/25/22**	
71	**Pump Station Structure**	**93 days**	**Thu 5/12/22**	**Sat 8/27/22**	
72	24" Steel Pipe Piles	20 days	Thu 5/12/22	Fri 6/3/22	61FS+50 days
73	Steel Sheet Pile	3 days	Sat 6/4/22	Tue 6/7/22	72
74	**Concrete Base Slab**	**15 days**	**Wed 6/8/22**	**Fri 6/24/22**	
75	Formwork	2 days	Wed 6/8/22	Thu 6/9/22	73
76	Reinforcing Steel	10 days	Fri 6/10/22	Tue 6/21/22	75
77	Concrete Placement	3 days	Wed 6/22/22	Fri 6/24/22	76
78	**Concrete Mud Slab**	**7 days**	**Sat 6/25/22**	**Sat 7/2/22**	
79	Formwork	2 days	Sat 6/25/22	Mon 6/27/22	77
80	Reinforcing Steel	3 days	Tue 6/28/22	Thu 6/30/22	79
81	Concrete Placement	2 days	Fri 7/1/22	Sat 7/2/22	80
82	**Concrete Substructure**	**32 days**	**Mon 7/4/22**	**Tue 8/9/22**	
83	Formwork	10 days	Mon 7/4/22	Thu 7/14/22	81
84	Reinforcing Steel	12 days	Fri 7/15/22	Thu 7/28/22	83

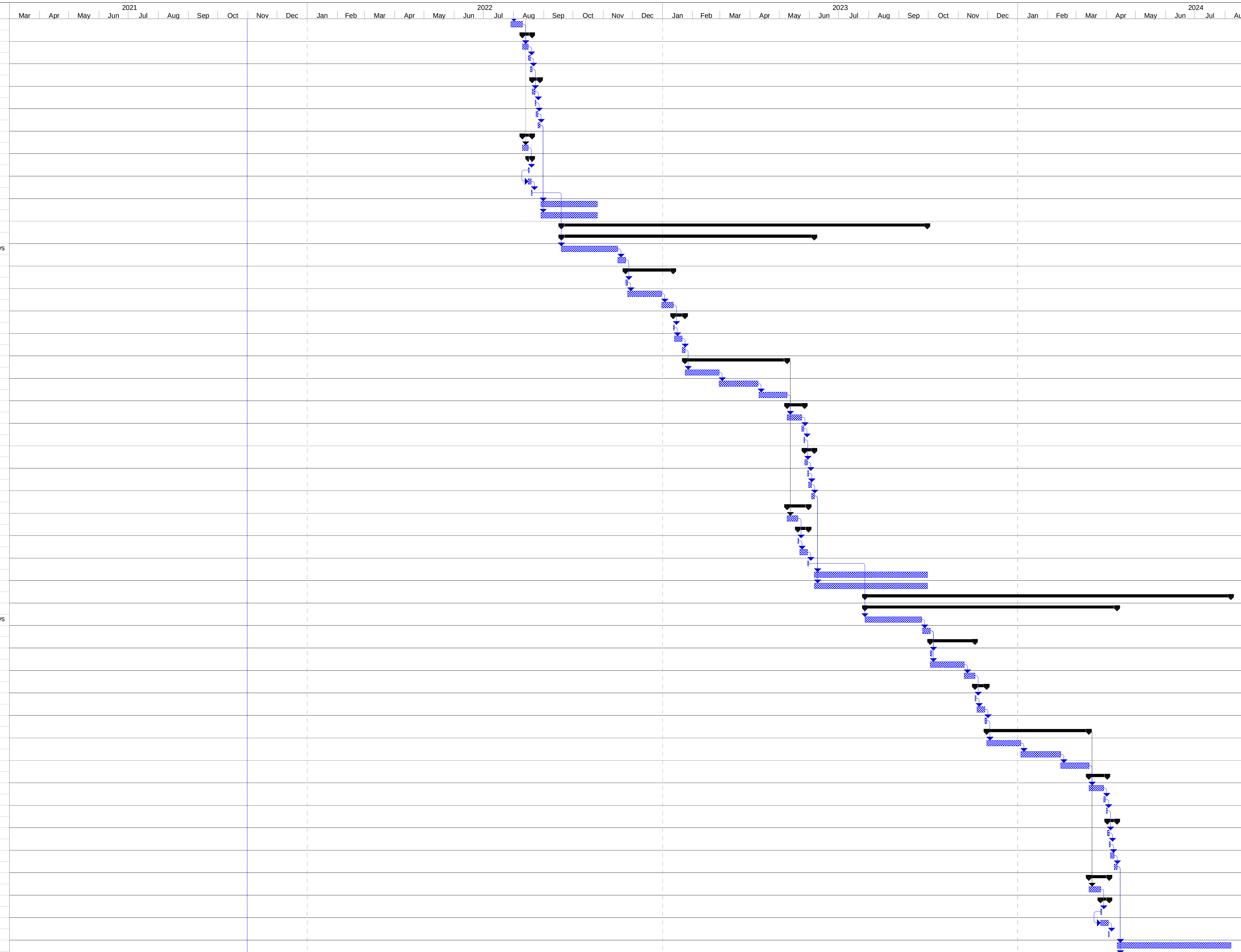


Task | Split | Milestone | Summary | Project Summary | External Tasks | External MileTask | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Progress | Split

Mon 2/24/20

Texas Coastal Protection
Galveston Island Facility
Tentative Construction Schedule

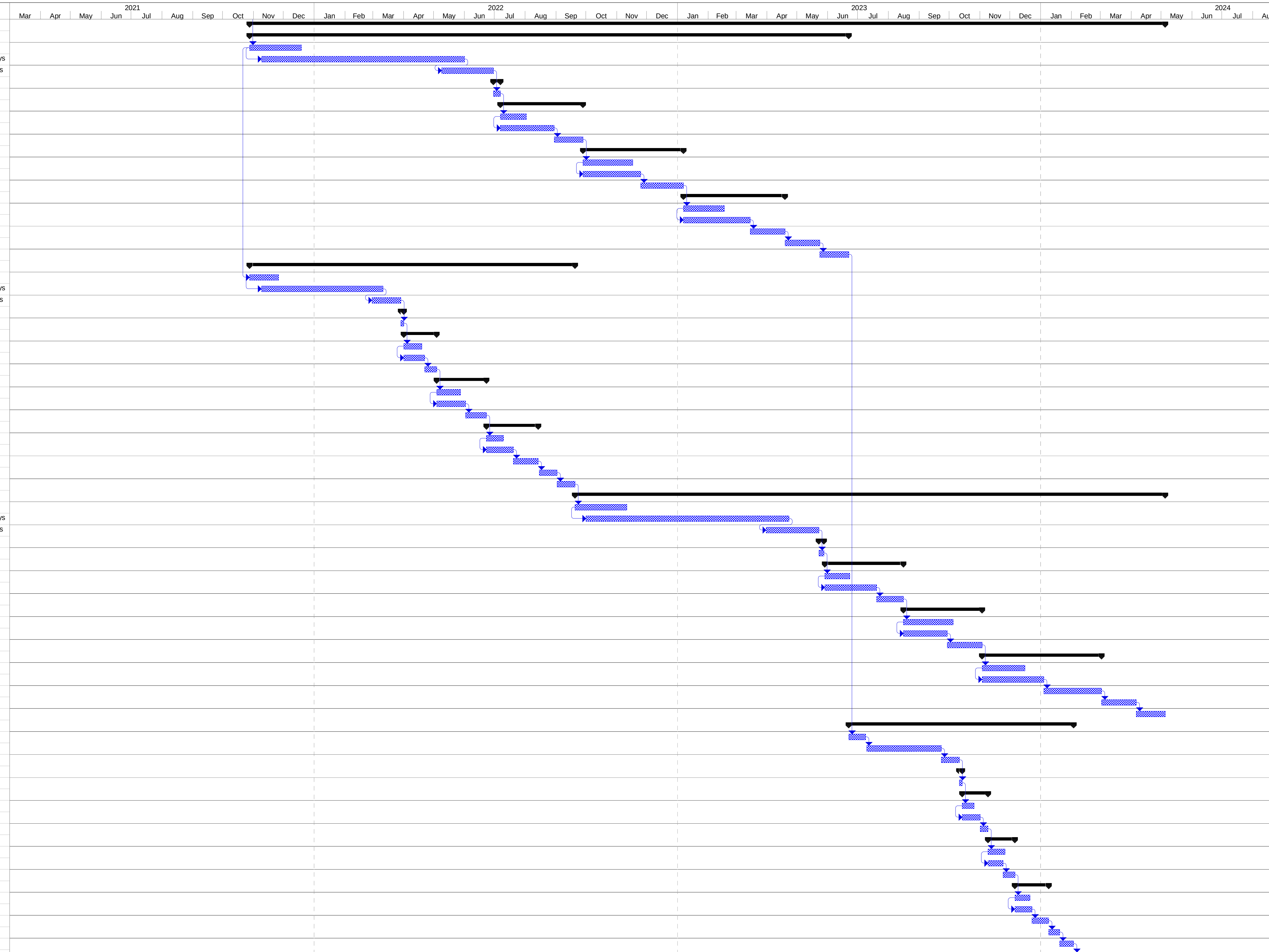
ID	Task Name	Duration	Start	Finish	Predecessors
85	Concrete Placement	10 days	Fri 7/29/22	Tue 8/9/22	84
86	**Superstructure**	**9 days**	**Wed 8/10/22**	**Fri 8/19/22**	
87	Precast Wall Panels	5 days	Wed 8/10/22	Mon 8/15/22	85
88	Steel Columns	2 days	Tue 8/16/22	Wed 8/17/22	87
89	Roof Beams	2 days	Thu 8/18/22	Fri 8/19/22	88
90	**Crane Frame**	**7 days**	**Sat 8/20/22**	**Sat 8/27/22**	
91	Steel Columns	2 days	Sat 8/20/22	Mon 8/22/22	89
92	Top Rail	1 day	Tue 8/23/22	Tue 8/23/22	91
93	Crane Rails	2 days	Wed 8/24/22	Thu 8/25/22	92
94	Infill Framing	2 days	Fri 8/26/22	Sat 8/27/22	93
95	**Fuel Tank Foundations**	**9 days**	**Wed 8/10/22**	**Fri 8/19/22**	
96	24" Steel Pipe Piles, Battered	5 days	Wed 8/10/22	Mon 8/15/22	82
97	**Concrete Pile Cap**	**4 days**	**Tue 8/16/22**	**Fri 8/19/22**	
98	Formwork	1 day	Tue 8/16/22	Tue 8/16/22	96
99	Reinforcing Steel	3 days	Tue 8/16/22	Thu 8/18/22	98SS
100	Concrete Placement	1 day	Fri 8/19/22	Fri 8/19/22	99
101	Mechanical Items	50 days	Mon 8/29/22	Tue 10/25/22	94
102	Electrical Items	50 days	Mon 8/29/22	Tue 10/25/22	94
103	**Pumping Plant 3**	**323 days**	**Mon 9/19/22**	**Fri 9/29/23**	
104	**Pump Station Structure**	**223 days**	**Mon 9/19/22**	**Mon 6/5/23**	
105	24" Steel Pipe Piles	50 days	Mon 9/19/22	Tue 11/15/22	100FS+25 days
106	Steel Sheet Pile	7 days	Wed 11/16/22	Wed 11/23/22	105
107	**Concrete Base Slab**	**42 days**	**Thu 11/24/22**	**Wed 1/11/23**	
108	Formwork	2 days	Thu 11/24/22	Fri 11/25/22	106
109	Reinforcing Steel	30 days	Sat 11/26/22	Fri 12/30/22	108
110	Concrete Placement	10 days	Sat 12/31/22	Wed 1/11/23	109
111	**Concrete Mud Slab**	**10 days**	**Thu 1/12/23**	**Mon 1/23/23**	
112	Formwork	1 day	Thu 1/12/23	Thu 1/12/23	110
113	Reinforcing Steel	7 days	Fri 1/13/23	Fri 1/20/23	112
114	Concrete Placement	2 days	Sat 1/21/23	Mon 1/23/23	113
115	**Concrete Substructure**	**90 days**	**Tue 1/24/23**	**Mon 5/8/23**	
116	Formwork	30 days	Tue 1/24/23	Mon 2/27/23	114
117	Reinforcing Steel	35 days	Tue 2/28/23	Sat 4/8/23	116
118	Concrete Placement	25 days	Mon 4/10/23	Mon 5/8/23	117
119	**Superstructure**	**16 days**	**Tue 5/9/23**	**Fri 5/26/23**	
120	Precast Wall Panels	13 days	Tue 5/9/23	Tue 5/23/23	118
121	Steel Columns	2 days	Wed 5/24/23	Thu 5/25/23	120
122	Roof Beams	1 day	Fri 5/26/23	Fri 5/26/23	121
123	**Crane Frame**	**8 days**	**Sat 5/27/23**	**Mon 6/5/23**	
124	Steel Columns	2 days	Sat 5/27/23	Mon 5/29/23	122
125	Top Rail	1 day	Tue 5/30/23	Tue 5/30/23	124
126	Crane Rails	3 days	Wed 5/31/23	Fri 6/2/23	125
127	Infill Framing	2 days	Sat 6/3/23	Mon 6/5/23	126
128	**Fuel Tank Foundations**	**19 days**	**Tue 5/9/23**	**Tue 5/30/23**	
129	24" Steel Pipe Piles, Battered	10 days	Tue 5/9/23	Fri 5/19/23	115
130	**Concrete Pile Cap**	**9 days**	**Sat 5/20/23**	**Tue 5/30/23**	
131	Formwork	1 day	Sat 5/20/23	Sat 5/20/23	129
132	Reinforcing Steel	7 days	Mon 5/22/23	Mon 5/29/23	131
133	Concrete Placement	1 day	Tue 5/30/23	Tue 5/30/23	132
134	Mechanical Items	100 days	Tue 6/6/23	Fri 9/29/23	127
135	Electrical Items	100 days	Tue 6/6/23	Fri 9/29/23	127
136	**Pumping Plant 4**	**322 days**	**Fri 7/28/23**	**Tue 8/6/24**	
137	**Pump Station Structure**	**222 days**	**Fri 7/28/23**	**Thu 4/11/24**	
138	24" Steel Pipe Piles	50 days	Fri 7/28/23	Sat 9/23/23	133FS+50 days
139	Steel Sheet Pile	7 days	Mon 9/25/23	Mon 10/2/23	138
140	**Concrete Base Slab**	**40 days**	**Tue 10/3/23**	**Fri 11/17/23**	
141	Formwork	2 days	Tue 10/3/23	Wed 10/4/23	139
142	Reinforcing Steel	30 days	Tue 10/3/23	Mon 11/6/23	139
143	Concrete Placement	10 days	Tue 11/7/23	Fri 11/17/23	142
144	**Concrete Mud Slab**	**10 days**	**Sat 11/18/23**	**Wed 11/29/23**	
145	Formwork	1 day	Sat 11/18/23	Sat 11/18/23	143
146	Reinforcing Steel	7 days	Mon 11/20/23	Mon 11/27/23	145
147	Concrete Placement	2 days	Tue 11/28/23	Wed 11/29/23	146
148	**Concrete Substructure**	**90 days**	**Thu 11/30/23**	**Wed 3/13/24**	
149	Formwork	30 days	Thu 11/30/23	Wed 1/3/24	147
150	Reinforcing Steel	35 days	Thu 1/4/24	Tue 2/13/24	149
151	Concrete Placement	25 days	Wed 2/14/24	Wed 3/13/24	150
152	**Superstructure**	**16 days**	**Thu 3/14/24**	**Mon 4/1/24**	
153	Precast Wall Panels	13 days	Thu 3/14/24	Thu 3/28/24	151
154	Steel Columns	2 days	Fri 3/29/24	Sat 3/30/24	153
155	Roof Beams	1 day	Mon 4/1/24	Mon 4/1/24	154
156	**Crane Frame**	**9 days**	**Tue 4/2/24**	**Thu 4/11/24**	
157	Steel Columns	2 days	Tue 4/2/24	Wed 4/3/24	155
158	Top Rail	1 day	Thu 4/4/24	Thu 4/4/24	157
159	Crane Rails	3 days	Fri 4/5/24	Mon 4/8/24	158
160	Infill Framing	3 days	Tue 4/9/24	Thu 4/11/24	159
161	**Fuel Tank Foundations**	**18 days**	**Thu 3/14/24**	**Wed 4/3/24**	
162	24" Steel Pipe Piles, Battered	10 days	Thu 3/14/24	Mon 3/25/24	148
163	**Concrete Pile Cap**	**8 days**	**Tue 3/26/24**	**Wed 4/3/24**	
164	Formwork	1 day	Tue 3/26/24	Tue 3/26/24	162
165	Reinforcing Steel	7 days	Tue 3/26/24	Tue 4/2/24	164SS
166	Concrete Placement	1 day	Wed 4/3/24	Wed 4/3/24	165
167	Mechanical Items	100 days	Fri 4/12/24	Tue 8/6/24	160
168	Electrical Items	100 days	Fri 4/12/24	Tue 8/6/24	160



Task, Split, Milestone, Summary, Project Summary, External Tasks, External MileTask, Inactive Task, Inactive Milestone, Inactive Summary, Manual Task, Duration-only, Manual Summary Rollup, Manual Summary, Start-only, Finish-only, Progress, Split

Texas Coastal Protection
Galveston Island Facility
Tentative Construction Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
169	**Stormwater Conduit**	**789 days**	**Thu 10/28/21**	**Sat 5/4/24**	
170	**32' x 13' Drainage Conduit**	**516 days**	**Thu 10/28/21**	**Wed 6/21/23**	
171	Road Demolition	45 days	Thu 10/28/21	Sat 12/18/21	15
172	Sheet Pile Installation	175 days	Tue 11/9/21	Tue 5/31/22	171SS+10 days
173	Excavation	45 days	Mon 5/9/22	Wed 6/29/22	172FS-20 days
174	**Aggregate Base**	**6 days**	**Thu 6/30/22**	**Wed 7/6/22**	
175	Aggregate Base	6 days	Thu 6/30/22	Wed 7/6/22	173
176	**Reinforced Concrete Slab**	**71 days**	**Thu 7/7/22**	**Tue 9/27/22**	
177	Formwork	22 days	Thu 7/7/22	Mon 8/1/22	175
178	Reinforcing Steel	46 days	Thu 7/7/22	Mon 8/29/22	177SS
179	Concrete Placement	25 days	Tue 8/30/22	Tue 9/27/22	178
180	**Reinforced Concrete Walls**	**87 days**	**Wed 9/28/22**	**Fri 1/6/23**	
181	Formwork	43 days	Wed 9/28/22	Wed 11/16/22	179
182	Reinforcing Steel	50 days	Wed 9/28/22	Thu 11/24/22	181SS
183	Concrete Placement	37 days	Fri 11/25/22	Fri 1/6/23	182
184	**Reinforced Concrete Elevated Slab**	**87 days**	**Sat 1/7/23**	**Tue 4/18/23**	
185	Formwork	35 days	Sat 1/7/23	Thu 2/16/23	183
186	Reinforcing Steel	57 days	Sat 1/7/23	Tue 3/14/23	185SS
187	Concrete Placement	30 days	Wed 3/15/23	Tue 4/18/23	186
188	Backfill	30 days	Wed 4/19/23	Tue 5/23/23	187
189	Road Reconstruction	25 days	Wed 5/24/23	Wed 6/21/23	188
190	**20' x 10' Drainage Conduit**	**280 days**	**Thu 10/28/21**	**Mon 9/19/22**	
191	Road Demolition	25 days	Thu 10/28/21	Thu 11/25/21	171SS
192	Sheet Pile Installation	105 days	Tue 11/9/21	Thu 3/10/22	191SS+10 days
193	Excavation	25 days	Mon 2/28/22	Mon 3/28/22	192FS-10 days
194	**Aggregate Base**	**3 days**	**Tue 3/29/22**	**Thu 3/31/22**	
195	Aggregate Base	3 days	Tue 3/29/22	Thu 3/31/22	193
196	**Reinforced Concrete Slab**	**28 days**	**Fri 4/1/22**	**Tue 5/3/22**	
197	Formwork	15 days	Fri 4/1/22	Mon 4/18/22	195
198	Reinforcing Steel	18 days	Fri 4/1/22	Thu 4/21/22	197SS
199	Concrete Placement	10 days	Fri 4/22/22	Tue 5/3/22	198
200	**Reinforced Concrete Walls**	**43 days**	**Wed 5/4/22**	**Wed 6/22/22**	
201	Formwork	21 days	Wed 5/4/22	Fri 5/27/22	199
202	Reinforcing Steel	25 days	Wed 5/4/22	Wed 6/1/22	201SS
203	Concrete Placement	18 days	Thu 6/2/22	Wed 6/22/22	202
204	**Reinforced Concrete Elevated Slab**	**45 days**	**Thu 6/23/22**	**Sat 8/13/22**	
205	Formwork	15 days	Thu 6/23/22	Sat 7/9/22	203
206	Reinforcing Steel	23 days	Thu 6/23/22	Tue 7/19/22	205SS
207	Concrete Placement	22 days	Wed 7/20/22	Sat 8/13/22	206
208	Backfill	16 days	Mon 8/15/22	Thu 9/1/22	207
209	Road Reconstruction	15 days	Fri 9/2/22	Mon 9/19/22	208
210	**30' x 10' Drainage Conduit**	**509 days**	**Tue 9/20/22**	**Sat 5/4/24**	
211	Road Demolition	45 days	Tue 9/20/22	Thu 11/10/22	209
212	Sheet Pile Installation	175 days	Sat 10/1/22	Sat 4/22/23	211SS+10 days
213	Excavation	45 days	Fri 3/31/23	Mon 5/22/23	212FS-20 days
214	**Aggregate Base**	**5 days**	**Tue 5/23/23**	**Sat 5/27/23**	
215	Aggregate Base	5 days	Tue 5/23/23	Sat 5/27/23	213
216	**Reinforced Concrete Slab**	**68 days**	**Mon 5/29/23**	**Tue 8/15/23**	
217	Formwork	22 days	Mon 5/29/23	Thu 6/22/23	215
218	Reinforcing Steel	45 days	Mon 5/29/23	Wed 7/19/23	217SS
219	Concrete Placement	23 days	Thu 7/20/23	Tue 8/15/23	218
220	**Reinforced Concrete Walls**	**68 days**	**Wed 8/16/23**	**Thu 11/2/23**	
221	Formwork	43 days	Wed 8/16/23	Wed 10/4/23	219
222	Reinforcing Steel	38 days	Wed 8/16/23	Thu 9/28/23	221SS
223	Concrete Placement	30 days	Fri 9/29/23	Thu 11/2/23	222
224	**Reinforced Concrete Elevated Slab**	**103 days**	**Fri 11/3/23**	**Fri 3/1/24**	
225	Formwork	37 days	Fri 11/3/23	Fri 12/15/23	223
226	Reinforcing Steel	53 days	Fri 11/3/23	Wed 1/3/24	225SS
227	Concrete Placement	50 days	Thu 1/4/24	Fri 3/1/24	226
228	Backfill	30 days	Sat 3/2/24	Fri 4/5/24	227
229	Road Reconstruction	25 days	Sat 4/6/24	Sat 5/4/24	228
230	**25' x 10' Drainage Conduit**	**194 days**	**Thu 6/22/23**	**Fri 2/2/24**	
231	Road Demolition	15 days	Thu 6/22/23	Sat 7/8/23	189
232	Sheet Pile Installation	65 days	Mon 7/10/23	Fri 9/22/23	231
233	Excavation	15 days	Sat 9/23/23	Tue 10/10/23	232
234	**Aggregate Base**	**3 days**	**Wed 10/11/23**	**Fri 10/13/23**	
235	Aggregate Base	3 days	Wed 10/11/23	Fri 10/13/23	233
236	**Reinforced Concrete Slab**	**22 days**	**Sat 10/14/23**	**Wed 11/8/23**	
237	Formwork	10 days	Sat 10/14/23	Wed 10/25/23	235
238	Reinforcing Steel	15 days	Sat 10/14/23	Tue 10/31/23	237SS
239	Concrete Placement	7 days	Wed 11/1/23	Wed 11/8/23	238
240	**Reinforced Concrete Walls**	**23 days**	**Thu 11/9/23**	**Tue 12/5/23**	
241	Formwork	15 days	Thu 11/9/23	Sat 11/25/23	239
242	Reinforcing Steel	13 days	Thu 11/9/23	Thu 11/23/23	241SS
243	Concrete Placement	10 days	Fri 11/24/23	Tue 12/5/23	242
244	**Reinforced Concrete Elevated Slab**	**29 days**	**Wed 12/6/23**	**Mon 1/8/24**	
245	Formwork	13 days	Wed 12/6/23	Wed 12/20/23	243
246	Reinforcing Steel	15 days	Wed 12/6/23	Fri 12/22/23	245SS
247	Concrete Placement	14 days	Sat 12/23/23	Mon 1/8/24	246
248	Backfill	10 days	Tue 1/9/24	Fri 1/19/24	247
249	Road Reconstruction	12 days	Sat 1/20/24	Fri 2/2/24	248
250	Demobilization	30 days	Sat 2/3/24	Fri 3/8/24	249



Task	Milestone	Project Summary	External MileTask	Inactive Milestone	Manual Task	Manual Summary Rollup	Start-only	Progress	
Split	Summary	External Tasks	Inactive Task	Inactive Summary	Duration-only	Manual Summary	Finish-only	Split	

Attachment 10

Unit Price Supporting Documents

Tetra Tech Clear Creek/Dickinson Bayou Pump Station Mechanical Cost Estimation List

Pump Station Costs: Clear Creek

Item	Qty.	Model	Individual Cost	Total Cost	Comments	Source
Pump/Engine/Gearbox Package	24	Custom, quoted by Patterson Pump with 4000 HP Caterpillar Engine	$12,498,000.00	$299,952,000	(Representative estimates 50-70% reduction in cost when design data is received)	Budgetary estimate from Patterson Pump encompassing 4000 hp Diesel Engine, Gearbox, and Pump
Jacket Water Tank	8	500 gal. Capacity Tank supplying 4 engines (3 Drivers + Generator)	$12,000.00	$96,000		Budgetary estimate from Niles Tank for JS-048-084 Insulated Tank
Auxiliary Jacket Water Pumps	32	Goulds Model 53BF1J9A0 Centrifugal Pump 5HP	$2,000.00	$64,000	*If recommended by engine manufacturer	Price available from Anderson Process website, a Gould distributor
Start Air Compressor	16	Bauer B22.5 Medium Pressure Compressor - 28-69 Bar (25-30 needed for diesel start)	$42,339.00	$677,424	*2 recommended by USACE	Budgetary quote from Bauer Compressor
Start Air Bottle	16		$11,850.00	$189,600	*must have capacity for 2 consecutive starts per engine without recharging	Atlas Copco Marine Start Air Receiver Quote - 11/18/19
Fuel Oil Purifier	24	100 GPM CAT 370-8570 Bulk Fuel Filter -Can fill 1200 gallon tank in 12 minutes		$0	before day tank, must match transfer pump gpm. Still awaiting quote	Cost assumed relatively small
Fuel Oil Pumps	32	Scot DU SC3320 long coupled centrifugal fuel pump 3HP	$1,394.00	$44,608	*one per engine	Price available from Dultmeier website, a Scot Pump distributor
F.O. Transfer Pump	24	Scot DU SC3320 long coupled centrifugal fuel pump 3HP	$1,394.00	$33,456	*2 per Settler	Price available from Dultmeier website, a Scot Pump distributor
Fuel Oil Day Tank	32	1200 Gallon Tank for 8.8 Hours operation (Ref. CAT 3516E) (1000 for CAT 3512)	$5,834.03	$186,689	*1 for each engine	Cost assumed similar to quoted 2000 gallon tank by Hamilton Tank
Fuel Oil Settling Tank	12	18 40,000 Gal Tanks total	$125,226.20	$1,502,714		Budgetary quote from Highland Tank
Prelube Pump	32	*Small size of prelube pump probably renders cost negligible		$0	*If recommended by engine manufufacturer	Cost either negligible or built into engine
Lube Oil Purifier	8	Alfa Laval OCM 17 GPM (each engine holds 211 Gal. L.O.)		$0	*2 per L.O. Tank	Due to the complexity of centrifugal separators, could be a significant cost - New inquiry in with Alfa Laval
Lube Oil Tank	4	2000 Gal L.O. Tank holds enough to completely change oil in 8 engines (3516) or 500 gal for 3512	$5,834.03	$23,336	*With Immersion Heaters	Budgetary quote from Hamilton Tank
Lube Oil Cooler	32	Assume Submerged Pipe	$5,000.00	$160,000	*Estimate- one per engine	Estimated cost
50-ton Overhead Crane	4		$80,000.00	$320,000		Estimate based on similar resale cranes
Control Room HVAC Package Unit	2	Goodman 3 Ton 14 SEER Horizontal AC package unit	$2,080.00	$4,160	*Assume one control room per group of pumps	Price available from ACWholesalers website
Fixed Fire Protection System	2	*Assume one per pump group. Gaseous/Liquid/Foam based		$0		Too many unknowns for good estimate
Emergency Diesel Generator	8	Caterpillar C32 Genset	$308,507.00	$2,468,056	all diesel engine support pumps+ compressors,fans,dryers running to support maximum pump output (Estimate: 1 DG	NC Power Systems (local CAT dealer) quote - 11/18/19
Stop Logs/ Roller Gate	24	*awaiting WCC information		$0		Still awaiting West Closure Complex details for reference, as these are custom-made
Trash Rack	24	*awaiting WCC information		$0		Still awaiting West Closure Complex details for reference, as these are custom-made
Trash Rake	24	*awaiting WCC information		$0		Still awaiting West Closure Complex details for reference, as these are custom-made
Exhaust Fan	24	4 Canarm Panel Mount 54 inch 50,330 cfm belt drive fans per 4 engine block	$6,447.63	$154,743	*Sized to accomplish 3 minute air change recommended for engine rooms	Price Available from Industrial Fans Direct website
Sump Blower	24	6.7 Regenerative Blower 3 Phase, 230/460 Voltage, 2" (F)NPT Inlet Size	$2,135.00	$51,240	*Per USACE EM 1110-2-3105 9-5b	Price available from Grainger website
Submersible Nonclog Sump Pump	24	Goulds Model 3887BHF Submersible Sewage Pump 460V, 222 GPMmax, 80ft head	$1,596.00	$38,304	*Should be able to pass 2.5" solids	Price available from Anderson Process website, a Gould distributor
Air Start Valve	32	Amot 4123 Air Start valve 35 bar electric actuated	$2,000.00	$64,000	*eliminates the need for control air	Estimate - cost relatively small
Air Dryer	16		$4,200.00	$67,200	2 to each pair of S.A. Compressors	Price available from Ultrafilter website.
					Estimated Pump Station Subtotal:	**$306,097,531**

Pump Station Costs: Dickinson Bayou

Item	**Qty.**	**Model**	**Individual Cost**	**Total Cost**	**Comments**	**Source**
Pump/Engine/Gearbox Package	12	Custom, quoted by Patterson Pump with 4000 HP Caterpillar Engine	$12,498,000.00	$149,976,000		Budgetary estimate from Patterson Pump encompassing Engine, Gearbox, and Pump
Jacket Water Tank	4	500 gal. Capacity Tank supplying 4 engines (3 Drivers + Generator)	$12,000.00	$48,000		Budgetary estimate from Niles Tank for JS-048-084 Insulated Tank
Auxiliary Jacket Water Pumps	16	Goulds Model 53BF1J9A0 Centrifugal Pump 5HP	$2,000.00	$32,000		Price available from Anderson Process website, a Gould distributor
Start Air Compressor	8	Bauer B22.5 Medium Pressure Compressor - 28-69 Bar (25-30 needed for diesel start)/ AtlasCopco LT 7-30 30 bar,17 cfm 5.5 hp motor	$42,339.00	$338,712		Budgetary quote from Bauer Compressor
Start Air Bottle	8		$11,850.00	$94,800		Atlas Copco Marine Start Air Receiver Quote - 11/18/19
Fuel Oil Purifier	12	100 GPM CAT 370-8570 Bulk Fuel Filter -Can fill 1200 gallon tank in 12 minutes (2 per station)	$0.00	$0		Cost assumed relatively small
Fuel Oil Pumps	16	Scot DU SC3320 long coupled centrifugal fuel pump 3HP	$1,394.00	$22,304		Price available from Dultmeier website, a Scot Pump distributor
F.O. Transfer Pump	12	Scot DU SC3320 long coupled centrifugal fuel pump 3HP	$1,394.00	$16,728		Price available from Dultmeier website, a Scot Pump distributor
Fuel Oil Day Tank	16	1200 Gallon Tank for 8.8 Hours operation (Ref. CAT 3516E) (1000 for CAT 3512)	$5,834.03	$93,344		Cost assumed similar to quoted 2000 gallon tank by Hamilton Tank
Fuel Oil Settling Tank	6	18 40,000 Gal Tanks	$125,226.20	$751,357		Budgetary quote from Highland Tank
Prelube Pump	16	*Small size of prelube pump probably renders cost negligible	$0.00	$0		Cost either negligible or built into engine
Lube Oil Purifier	4	Alfa Laval OCM 17 GPM (each engine holds 211 Gal. L.O.)	$0.00	$0		Due to the complexity of centrifugal separators, could be a significant cost - New inquiry in with Alfa Laval
Lube Oil Tank	2	2000 Gal L.O. Tank holds enough to completely change oil in 8 engines (3516) or 500 gal for 3512	$5,834.03	$11,668		Budgetary quote from Hamilton Tank
Lube Oil Cooler	16	Assume Submerged Pipe	$5,000.00	$80,000		Estimated cost
50-ton Overhead Crane	2		$80,000.00	$160,000		Estimate based on similar resale cranes
Control Room HVAC Package Unit	1	Goodman 3 Ton 14 SEER Horizontal AC package unit	$2,080.00	$2,080		Price available from ACWholesalers website
Fixed Fire Protection System	1	*Assume one per pump group. Gaseous/Liquid/Foam based	$0.00	$0		Too many unknowns for good estimate
Emergency Diesel Generator	4	Caterpillar C32 Genset	$308,507.00	$1,234,028		NC Power Systems (local CAT dealer) quote - 11/18/19
Stop Logs/ Roller Gate	12	*awaiting WCC information	$0.00	$0		Still awaiting West Closure Complex details for reference, as these are custom-made
Trash Rack	12	*awaiting WCC information	$0.00	$0		Still awaiting West Closure Complex details for reference, as these are custom-made
Trash Rake	12	*awaiting WCC information	$0.00	$0		Still awaiting West Closure Complex details for reference, as these are custom-made
Exhaust Fan	12	4 50,000 cfm fans per 4 engine block to accomplish 3 minute air change recommended for engine rooms	$6,447.63	$77,372		Price Available from Industrial Fans Direct website
Sump Blower	12	6.7 Regenerative Blower 3 Phase, 230/460 Voltage, 2" (F)NPT Inlet Size	$2,135.00	$25,620		Price available from Grainger website
Submersible Nonclog Sump Pump	12	Goulds Model 3887BHF Submersible Sewage Pump 460V, 222 GPMmax, 80ft head	$1,596.00	$19,152		Price available from Anderson Process website, a Gould distributor
Air Start Valve	16	Amot 4123 Air Start valve 35 bar electric actuated	$2,000.00	$32,000		Estimate - cost relatively small
Air Dryer	8		$4,200.00	$33,600		Price available from Ultrafilter website.
					Estimated Pump Station Subtotal:	**$153,048,765**

Sector Gate Mechanical						
Sector Gate Machinery and Installation				$5,485,103.00		Referencing IHNC Sector Gate Fabrication costs (100% IHNC DDR - 2016-05-25) - Costs represent all operating machinery costs associated with one complete sector gate assembly (both leafs)
Hinge and Pintle Casting				$678,842.00		Referencing IHNC Sector Gate Fabrication costs (100% IHNC DDR - 2016-05-25) - Costs represent all operating machinery costs associated with one complete sector gate assembly (both leafs)
					Estimated Sector Gate Subtotal:	**$6,163,945.00**
					Estimated Worst Case Pump/Driver Grand Total:	**$465,310,240.9**
					Adjusted Estimate assuming 50% reduction in Pump/Driver Cost	**$162,285,475.6**
					Adjusted Estimate assuming 70% reduction in Pump/Driver Cost	**$102,295,075.6**

Galveston Island Pump Stations Mechanical Cost Estimation List

32 Pumphouse "units" total

Item	Qty.	PS 1	PS 2	PS 3	PS 4	Model	Individual Cost	Total Cost	Comments
Pump/Engine/Gearbox Package	32	9	3	10	10	Custom	$4,166,000.00	$133,312,000	(INCLUDES PROP PUMP AND IS WORST CASE COST ESTIMATE PER PATTERSON PUMP - Representative estimates 50-70% reduction when design data is received) (Cost estimated by dividing quote for 1500 cfs pump by 3)
Jacket Water Tank	12	3	1	4	4	250 gal. Capacity Tank supplying 4 engines (3 Drivers + Generator)	$6,000.00	$72,000	3 per Pump Station
Auxiliary Jacket Water Pumps	39	11	2	13	13	Goulds Model 53BF1J9A0 Centrifugal Pump 5HP	$2,000.00	$78,000	*1 per engine If recommended by engine manufufacturer
Start Air Compressor	10	3	1	3	3	Bauer B22.5 Medium Pressure Compressor - 28-69 Bar (25-30 needed for diesel start)/ AtlasCopco LT 7-30 30 bar,17 cfm 5.5 hp motor	$41,000.00	$410,000	*2 recommended by USACE, using larger models and bottles can provide for more smaller engines, reducing amount needed- a:
Start Air Bottle	14	3	1	5	5	Awaiting quote from Atlas Copco Distributor	$10,000.00	$140,000	*must have capacity for 2 consecutive starts per engine without recharging - 1 for each compressor, + one emergency gen bottl
Fuel Oil Purifier	56	16	4	18	18	100 GPM CAT 370-8570 Bulk Fuel Filter -Can fill 1200 gallon tank in 12 minutes (2 per station) OR 200 GPM Skimoil"TFP 3000" - Can refill day tank in 6 minutes OR Alfa Laval MMB 44 GPM - 27min (separator style, runs in cycles).		$0	*2 per settler. To reach necessary flowrate as pass through before day tank, must match transfer pump gpm. Still awaiting quote
Fuel Oil Pumps	39	11	2	13	13	Scot DU SC3320 long coupled centrifugal fuel pump 1HP	$900.00	$35,100	*one per engine
F.O. Transfer Pump	56	16	4	18	18	Scot DU SC3320 long coupled centrifugal fuel pump 1HP	$900.00	$50,400	*2 per Settler
Fuel Oil Day Tank	39	11	2	13	13	700 Gallon Tank for 8.8 Hours operation	$5,000.00	$195,000	*Estimate- one per engine
Fuel Oil Settling Tank	28	9	1	9	9	28 10,000 Gal Tanks total	$31,250.00	$875,000	
Prelube Pump	39	11	2	13	13	*Small size of prelube pump probably renders cost negligible		$0	*If recommended by engine manufufacturer
Lube Oil Purifier	8	2	2	2	2	Alfa Laval OCM 17 GPM	$15,000.00	$120,000	*2 per Station ESTIMATE
Lube Oil Tank	4	1	1	1	1	500 Gal L.O. Tank	$5,000.00	$20,000	*With Immersion Heaters - One per Station
Lube Oil Cooler	39	11	2	13	13	Assume Submerged Pipe	$5,000.00	$195,000	*Estimate- one per engine
50-ton Overhead Crane	4	1	1	1	1		$80,000.00	$320,000	
Control Room HVAC Package Unit	4	1	1	1	1	Goodman 3 Ton 14 SEER Horizontal AC package unit	$2,080.00	$8,320	*Assume one control room per group of pumps
Fixed Fire Protection System	4	1	1	1	1	*Assume one per pump group. Gaseous/Liquid/Foam based		$0	
Emergency Diesel Generator	7	2	1	2	2	Caterpillar C32 Genset	$250,000.00	$1,750,000	2 per Station, except for Station 2, which only needs one due to smaller size
Stop Logs/ Roller Gate	32	9	3	10	10	Custom	$100,000.00	$3,200,000	
Trash Rack, Rake Assembly	32	9	3	10	10	Estimated $105,480 for the rack, $100,000 for Rake	$205,480.00	$6,575,360	
Exhaust Fan	16	4	4	4	4	4 50,000 cfm fans per 4 engine block	$6,000.00	$96,000	*Sized to accomplish 3 minute air change recommended for engine rooms
Sump Blower	32	9	3	10	10	6.7 Regenerative Blower 3 Phase, 230/460 Voltage, 2" (F)NPT Inlet Size	$2,135.00	$68,320	*Per USACE EM 1110-2-3105 9-5b
Submersible Nonclog Sump Pump	32	9	3	10	10	Goulds Model 3887BHF Submersible Sewage Pump 460V, 222 GPMmax, 80ft head	$1,596.00	$51,072	*Should be able to pass 2.5" solids
Air Start Valve	39	11	2	13	13	Amot 4123 Air Start valve 35 bar electric actuated	$2,000.00	$78,000	*eliminates the need for control air
Air Dryer	10	3	1	3	3		$4,200.00	$42,000	2 to each pair of S.A. Compressors

Estimated Pump Station Subtotal:	**$147,691,572.0**
Estimated Worst Case Pump/Driver Grand Total:	**$147,691,572.0**
Adjusted Estimate assuming 50% reduction in Pump/Driver Cost	**$81,035,572.0**
Adjusted Estimate assuming 70% reduction in Pump/Driver Cost	**$54,373,172.0**

Prestressed Concrete Pile Cost and Backup

Table of Contents

Stuard, Daniel

From: Dylan Watts <Dwatts@gcprestress.com>
Sent: Thursday, October 17, 2019 8:38 AM
To: Stuard, Daniel
Subject: 13046 - COASTAL TEXAS PROTECTION & RESTORATION FLOOD WALL - GALVESTON, TX
Attachments: Proposal.PDF; Proposal GENERAL TERMS AND CONDITIONS - GULF COAST PRESTRESS.pdf

Please see attached proposal. Let us know if you have any questions.

PROPOSAL - CONTRACT

Gulf Coast Pre-Stress Partners Ltd.
P.O. Box 825
Pass Christian, MS 39571
PHONE: 228-452-9486 FAX: 228-452-9495

TO: DANIEL STUARD

PROJECT: COASTAL TEXAS PROTECTION & RESTORATION FLOOD WALL
GALVESTON, TX

DATE: 10/17/2019 **PROPOSAL NO:** 13046

PLANS & SPECIFICATONS BY:

BID DATE: #Error **TIME:** 10:38:17 AM

ITEM NUMBER	APPROXIMATE QUANTITY	UNIT	DESCRIPTION	PRICE
	68,816.00	LF	42" CYLINDER PILE - Product and Haul	$218.43 /
	78,800.00	LF	16" SQ PILE - Product and Haul	$61.47 /
	78,800.00	LF	12" SQ PILE - Product and Haul (ALTERNATE OPTION)	$34.87 /

NOTE: PRICES ARE BASED ON THE CURRENT "STEEL MILL PUBLISHED BASE PRICE".
OUT PRICES MAY INCREASE ALONG WITH THIS BASE PRICE.

** BUDGETARY PRICING **

PRICES ARE F.O.B. BARGES....JOBSITE

THE ABOVE PRICES ARE "ALL OR NONE". SELLER WILL NOT EXCEPT AN ORDER FOR THE GIRDERS WITHOUT AN ORDER FOR THE PILE.

GCP IS A PCI CERTIFIED PLANT AND WILL USE ITS OWN QUALITY CONTROL DEPARTMENT FOR QUALITY ASSURANCE AND TESTING. IF ANY INDEPENDENT TESTING LAB SERVICES AREREQUIRED, BUYER MUST SELECT SAID SERVICES AND PAY ALL COST FOR SAME.

PILE LENGTHS ON CONTRACT DRAWINGS ARE ORDER LENGTHS. ABOVE PRICES ARE BASED ON THESE LENGTHS AND QUANTITIES. ANY CHANGES TO THE SAME MAY REQUIRE A PRICE CHANGE.

NO TEST PILES REQUESTED.

PILE PRICING DOES NOT INCLUDE ANY ADMIXTURES ASSISTING WITH SEVERE OR AGGRESSIVE PROJECT AND/OR SOIL CONDITIONS.

PRICES DO NOT INCLUDE ANY REBAR CAST INTO THE PILE, SPECIAL INSERTS, EPOXY, GROUT, DOWEL HOLES, TENSION CONNECTORS, STRAND ANCHORAGES, SILICA FUME OR CORROSION INHIBITOR IN THE CONCRETE MIX. NOT SPECIFICALLY NOTED HEREIN.

PRICES DO NOT INCLUDE PILE SHOES SPECIAL FINISHES OR COATINGS, OR ANY OTHER ITEMS NOT SPECIFICALLY NOTED HEREIN.

SPUN CAST CYLINDER PILE PRODUCTION WILL SPECIFICALLY FOLLOW GCP'S QUALITY CONTROL MANUAL, TO INCLUDE BUT NOT LIMITED TO PRODUCTION, QUALITY CONTROL, CURING AND REPAIR PROCEDURES.

GROUT FOR CYLINDER PILE WILL BE NEAT CEMENT AND WATER

12" PILE BARGES WILL BE LOADED WITH 300 PILES PER BARGE

16" PILE BARGES WILL BE LOADED WITH 170 PILES PER BARGE.

42" CYLINDER PILE BARGES WILL BE LOADED WITH 30 PILE PER BARGE. 2 STACKS OF 15.

TAXES SEE BELOW:

TAXES: The above prices do not include any applicable federal, state, or local sales taxes or other taxes except as specifically stated above, and will be increased to the extent of such taxes.

PAYMENT: In accordance with paragraph 9 on reverse side hereof.

EXPIRATION: If this proposal is not accepted within 15 days from date, or bid date, if applicable, it is subject to a possible price revision or cancellation at option of Seller.

ACCEPTANCE: This proposal is made on the basis that if accepted it shall become a contract incorporating all of the terms printed on the reverse side hereof. If buyer accepts this proposal, but prefers to use his own contract form, it is understood that this proposal and all of its terms shall automatically become a part of said contract.

The above proposal is hereby accepted subject to all the conditions stated above and on the reverse side hereof, which the signer has read and acknowledges:

Firm: ______________________________

By: ____________________ Date: ________________

Respectfully submitted,

Gulf Coast Pre-Stress Partners Ltd.

By: ______________________________

Dylan Watts

If accepted, return one signed copy to Gulf Coast Pre-Stress Partners Ltd., and retain duplicate for your records.

PROPOSAL - CONTRACT

Gulf Coast Pre-Stress Partners Ltd.
P.O. Box 825
Pass Christian, MS 39571
PHONE: 228-452-9486 FAX: 228-452-9495

TO: DANIEL STUARD

PROJECT: COASTAL TEXAS PROTECTION & RESTORATION FLOOD WALL
GALVESTON, TX

DATE: 10/17/2019 **PROPOSAL NO: 13046**

PLANS & SPECIFICATONS BY:

BID DATE: #Error **TIME:** 10:38:17 AM

ALL DELIVERIES WILL BE MADE IN (10) TRIPS WITH (4) BARGES PER TRIP. BUYER WILL HAVE (11) MONTHS TO OFFLOAD ALL PILE. AFTERWHICH, BUYER WILL BE CHARGED $525 / DAY PER BARGE IN CIRCULATION.

SELLER WILL HAVE (8) BARGES IN ROTATION.

ALL BARGES ARE UNDER THE CARE, CUSTODY AND CONTROL OF BUYER ONCE BARGES ARE DROPPED OFF.

BUYER WILL HAVE 24 HRS OF STANDBY TIME FOR TUGBOAT AT JOBSITE. AFTERWHICH, BUYER WILL BE CHARED $400 PER HOUR FOR STAND BY TIME.

TAXES SEE BELOW:

TAXES: The above prices do not include any applicable federal, state, or local sales taxes or other taxes except as specifically stated above, and will be increased to the extent of such taxes.

PAYMENT: In accordance with paragraph 9 on reverse side hereof.

EXPIRATION: If this proposal is not accepted within 15 days from date, or bid date, if applicable, it is subject to a possible price revision or cancellation at option of Seller.

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The above proposal is hereby accepted subject to all the conditions stated above and on the reverse side hereof, which the signer has read and acknowledges:

Firm: ____

By: _________________________ Date:___________________

Respectfully submitted,

Gulf Coast Pre-Stress Partners Ltd.

By: ____

Dylan Watts

If accepted, return one signed copy to Gulf Coast Pre-Stress Partners Ltd., and retain duplicate for your records.

GENERAL TERMS AND CONDITIONS

Manufacture and Design:

1. Precast and/or prestressed products covered by this proposal-contract are to be manufactured in accordance with current codes and criteria of the PRE-STRESSED CONCRETE INSTITUTE, the AMERICAN CONCRETE INSTITUTE, and/or other applicable specifications.

2. The Seller will furnish all shop drawings necessary for manufacture and erection of his product. Manufacture of the products will not be started until Seller's shop drawings have been approved by Buyer. Seller may make written requests to Buyer for information measurements he deems necessary and Buyer agrees to furnish such information and measurements and assume complete responsibility for the accuracy of same.

3. Products covered by this contract are to be custom manufactured in conformity with Buyers plan and specifications and are not returnable nor is this contract cancelable by the Buyer for any reason without Sellers written consent.

4. All material and workmanship during manufacture of products are available for Buyers inspection at Sellers plant. If Buyer desires to exercise the privilege of plant inspection, he shall notify Seller immediately after proposal is accepted.

Delivery and Erection:

5. Seller will make every reasonable effort to make delivery within the agreed time, but shall not be liable for any loss, damage, or delay due to strikes, fires, accidents, storms, wars, delays of carriers, or any other cause beyond Sellers control.

6. Buyer shall be responsible for keeping seller informed with a reasonable degree of accuracy the prospective date that products will be required in order that manufacturing can be properly scheduled. Buyer shall advice Seller in writing the specific tentative date that delivery and erection of the products is desired **TEN DAYS** in advance thereof, and shall reconfirm the specific delivery and erection date **FOUR DAYS** in advance thereof. These advance notices are essential to the seller in efficiently scheduling delivery equipment and erection crews.

7. If product covered by this contract are purchased on an FOB jobsite basis, such as shall be defined to mean deliver to the nearest point the structure, to which, in seller's opinion, loaded hauling equipment can proceed under its own power. Unloading shall be by Buyer at his expense. Buyer will be allowed an hour free time per truck and/or trailer for unloading and shall be charged $80.00 per hour per truck and/or trailer for unloading time more than one hour. "Loaded hauling equipment" shall be defined as: truck and/or trailer combination, also tug and/or barge combination, the latter having a 7 ½' minimum draft. Seller will inform Buyer of a four-hour window barges will be delivered. A buyer representative must be present at time of Sellers delivery to examine all barges for undesirable conditions as well as sign delivery tickets. If Buyer does not have a representative onsite, buyer will be charged the standard tugboat rate until representative arrives. See reverse side hereof for special demurrage and for time for tug and/or barge.

8. If the products covered by this contact are purchased on FOB jobsite basis with erection advisor furnished by Seller, this means that Seller will furnish a qualified and experienced advisor at jobsite as necessary during actual erection of Sellers products to offer advice and answer questions regarding normal product handling and erection techniques. Sellers erection advisor will NOT act in a supervisory capacity. Seller assumes no responsibility for any losses or damages due to inadequacies of design or mechanical failure of Buyers erection equipment and rigging or due to errors or lack of experience of Buyers erection personnel.

Payment:

9. Payment terms, unless otherwise specifically stated on this proposal, are as follows: when one continuous delivery is involved, payment is due upon receipt of invoice and past due after 30 days. Interest at the rate of 1½ % PER MONTH (18% annual rate) will be charges on the unpaid balance of all past due accounts, all times computed from the date of invoice. However, when the project involves more than one continuous delivery period and extends over one week, buyer will be invoiced at the end of each week or at any prior date requested by Buyer, for products delivered during the week payable on the same terms as above. However, further, if Buyer does not accept delivery of products within 60 days of completion of manufacture in accordance with the agreed schedule, then Buyer will be invoiced for manufactured, but undelivered products, payable on the same terms above.

10. If surety bond is required in connection with this contract, the cost of premium shall be paid by Buyer in addition to the amount of products.

11. Title of all products shall remain with Seller until paid in full.

12. Reasonable doubt of Buyers financial responsibility shall entitle Seller to stop manufacture, decline shipment, or stop material in transit without liability, until Buyer shall have paid for all material or satisfied Seller of his financial responsibility.

13. In the event it is necessary for the Seller to collect all or part of the money due to the Seller under this contract, through an attorney, whether by reference or collection or by suit, the Buyer agrees to pay all reasonable attorneys fee and all costs and expenses of collections.

14. No back charge of any nature will be honored, paid for, assumed, or deducted from the contract amount unless advance approval is given in writing by the manager or authorized representative of Gulf Coast PreStress, Partners.

Stuard, Daniel

From: Stuard, Daniel
Sent: Tuesday, October 15, 2019 2:53 PM
To: Dylan Watts
Subject: RE: Coastal Texas Protection and Restoration - Flood Wall

Dylan,
Thanks for reviewing my request so quickly. In response to your questions:

- Using and pile length of 88' for the spun cast piles is fine
- Yes, 16" for the square prestressed piles.

Thanks

Daniel A Stuard, PE | Structural Project Engineer
Direct **+1 (425) 732-5642** | Business **+1 (425) 635-1000** | Daniel.Stuard@tetratech.com

Tetra Tech | Complex World, Clear Solutions™
400 112th Ave. NE, Suite 300, Bellevue, WA 98004 | tetratech.com

---

From: Dylan Watts <Dwatts@gcprestress.com>
Sent: Tuesday, October 15, 2019 2:24 PM
To: Stuard, Daniel <Daniel.Stuard@tetratech.com>
Subject: RE: Coastal Texas Protection and Restoration - Flood Wall

Daniel,

Thank you for the request. Due to our system only being able to cast in 8' and 16' sections, we will have to go 88' on the cylinder piles. For the square piles you said 6". I am guessing you meant 16" Pile?

Thanks,

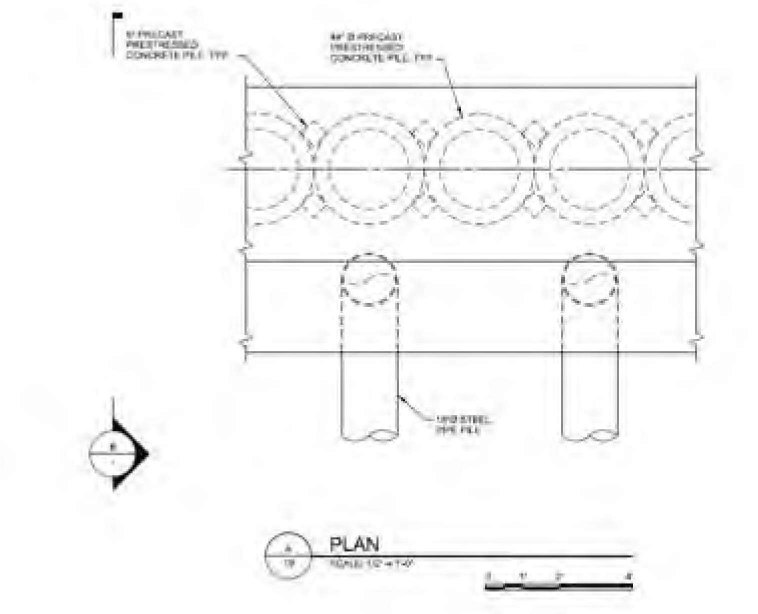
Dylan T. Watts
Estimator
Sales Department
494 North Market Street
Pass Christian, Mississippi 39571
Office (228) 452-9486
Cell (601) 337-1719
Fax (228) 452-9495
http://www.gcprestress.com

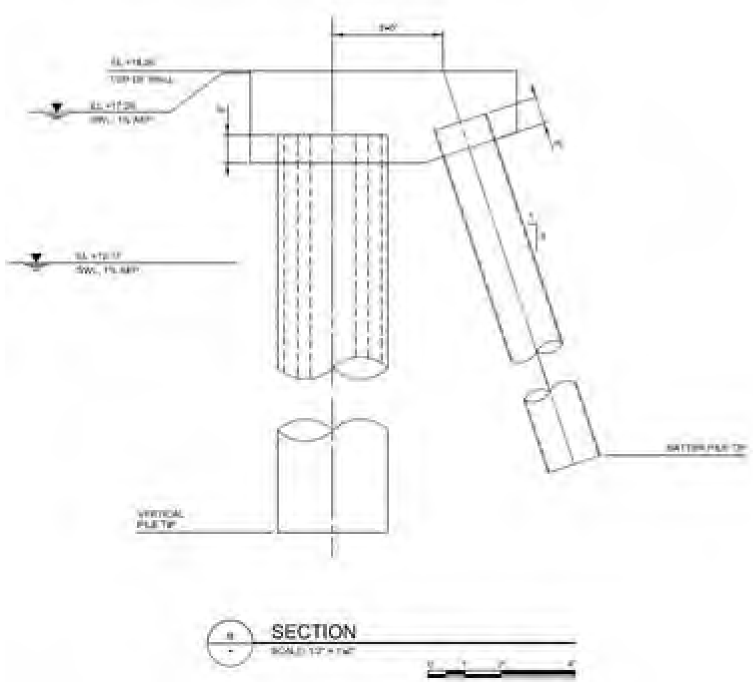
From: Stuard, Daniel <Daniel.Stuard@tetratech.com>
Sent: Tuesday, October 15, 2019 1:45 PM
To: Dylan Watts <Dwatts@gcprestress.com>
Subject: Coastal Texas Protection and Restoration - Flood Wall

Hi Dylan,
I spoke with you on the phone earlier today about receiving a budgetary level cost estimate for spun cast piles. I have provided some specific project information below:

- Project / Location: Coastal Texas Protection and Restoration / Galveston Texas
- Pile Size, Length & Total Quantity: 42" diameter with 16 tendons, 86 feet long with a total quantity of 67,200 LF.
- Delivery Method: Barge
- Use: The intended use for the piles to is form a flood barrier similar to that the IHNC Lake Borgne Surge Barrier and will be located adjacent to pump stations and gate structures also part of the project. I have provided a representative figure below.
- In addition to the spun cast piles, please also provide a budgetary cost estimate for the 6 inch square precast prestressed piles. These piles are 50 feet long and have a total quantity of 78,800 linear feet. These piles will be used to provide a seal between the spun cast piles and therefor construction loading is expected to control. At this stage, please assume the minimum prestress required for typical lifting and handling. Like the spun cast piles, please use a delivery location of Galveston Texas via barge.

As we discussed on the phone, the target date for the estimate is this Thursday Oct. 17. Please let me know if any additional information is required. Thanks,





Daniel A Stuard, PE | Structural Project Engineer
Direct **+1 (425) 732-5642** | Business **+1 (425) 635-1000** | Daniel.Stuard@tetratech.com

Tetra Tech | Complex World, Clear Solutions™
400 112th Ave. NE, Suite 300, Bellevue, WA 98004 | tetratech.com

communication by anyone other than the intended recipient is strictly prohibited and may be unlawful. If you are not the intended recipient, please notify the sender by replying to this message and then delete it from your system.

TETRA TECH, INC.

PHONE LOG

CLIENT:	Mott MacDonald/GLO
JOB TITLE:	Coastal Texas Protection and Restoration
PROJECT NO.:	100-RCE-18-09-1
SUBJECT:	Precast Prestressed Concrete Piles
CONVERSATION DATE:	Oct. 15th, 2019
PREPARED BY:	Daniel Stuard
CONVERSATIONALISTS:	Representative of Gulf Coast Pre-stress Partners (GCP)and Daniel Stuard of Tetra Tech

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This phone log summarizes the items discussed or issues resolved during the phone conversation to the best of the writer's ability.

Dylan Watts, a sales representative from Nucor Skyline (Houston, TX) was spoken with and was able to provide the following information. The phone number for GPC is (228) 452-9486 and Dylan's email is dwatts@gcprestress.com. The representative requested that an email be sent with project/pile information. It was discussed that the target date to receive the cost estimate via email is Thursday Oct. 17,2019. Provided project details are listed below:

- Project / Location: Coastal Texas Protection and Restoration / Galveston Texas
- Pile Size, Length & Total Quantity: 42" diameter with 16 tendons, 86 feet long with a total quantity of 67,200 LF.
- Delivery Method: Barge
- Use: The intended use for the piles to is form a flood barrier similar to that the IHNC Lake Borgne Surge Barrier and will be located adjacent to pump stations and gate structures also part of the project. I have provided a representative figure below.
- In addition to the spun cast piles, please also provide a budgetary cost estimate for the 6 inch square precast prestressed piles. These piles are 50 feet long and have a total quantity of 78,800 linear feet. These piles will be used to provide a seal between the spun cast piles and therefor construction loading is expected to control. At this stage, please assume the minimum prestress required for typical lifting and handling. Like the spun cast piles, please use a delivery location of Galveston Texas via barge.
- As we discussed on the phone, the target date for the estimate is this Thursday Oct. 17. Please let me know if any additional information is required. Thanks,

Vertical Pile Design Check

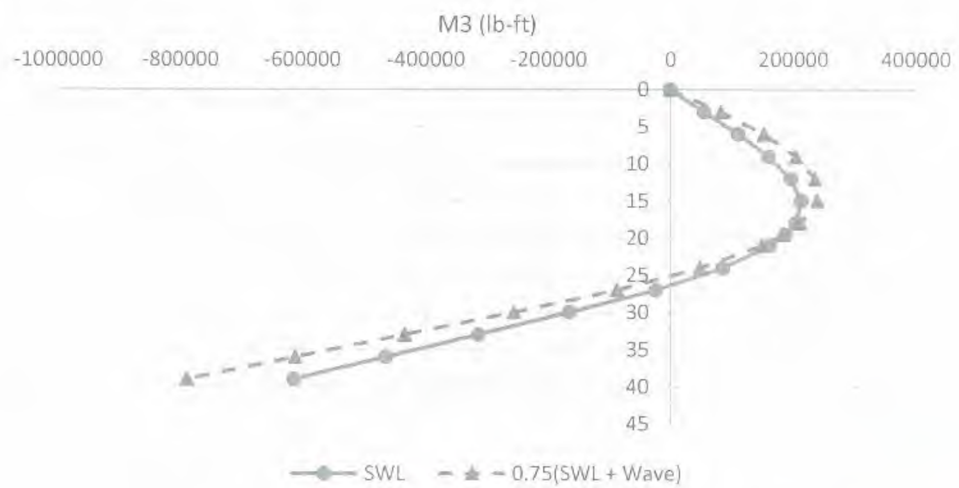
Assumptions

The braced point occurs ten feet below the mudline per IBC 2015 18.10.2

The peak positive negative occurs in a location that is considered to be fully braced

Shear is negligible

Pile Forces (from SAP2000 model)



Note: SWL + Wave case reduced to account for overstress factor

Max Negative Moment -788649 lb-ft $(788650/1000) \times 12 = 9,463$ K-IN

Note: Peak negative moment will be reduced when soil springs are accounted for. For this phase, only check positive moment.

Max Positive Moment 239814 lb-ft → 2,877 K-IN

Axial Load 87828 lb

Factored Loads

Load Factor		1.00	(service load check)
Axial load	P	87828 lb	← COMP. OR TENSION?
Moment FACTORED LOADS		239814 lb-ft	
	M	**2877773 lb-in**	

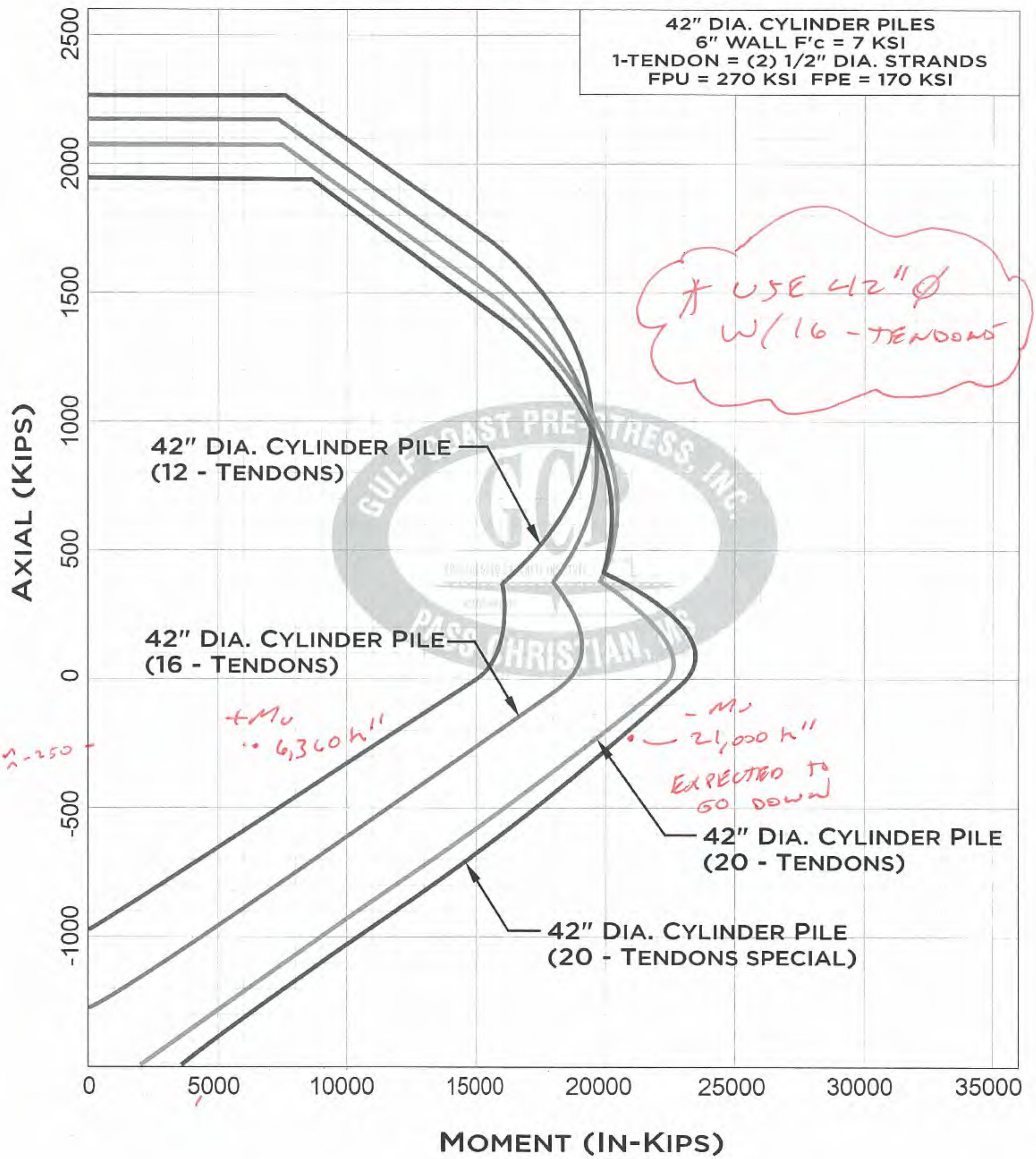
L.F. HF

$1.7 \times 1.3 \times 9,463 = 20,913$ k-'' ← EXPECTED TO BE REDUCED IN LATER DESIGN

$1.7 \times 1.3 \times 2,877 = 6,358$ k-''

$1.7 \times 1.65 \times 87.8 = 246.3$ k

Ultimate Strength Design



TETRA TECH	Clear Creek Floodwall Material Take-off	Calculation No. CC-FW-ST-MT-002

Job No.:	100-RCE-18-09-1					**Page:**	7
Project:	Coastal Texas Protection and Restoration						
Description:	Quantities						
Made By:	LRM	**Date:**	11/07/18	**Chk'd By:**	JK	**Date:**	11/08/18

Quantities

Floodwall length 3149 ft

Material take-offs

Item		Spacing (per ft of wall)	Quantity (EA)	Quantity (unit) Unit	
48-inch precast, prestressed concrete piles	86' EA	4	788	**67177 LF**	→ 67,200
18x0.625 inch steel pipe pile		8	394	**47280 LF**	
6-inch square precast, prestressed piles	50' EA	4	788	**78800 LF**	
Reinforced concrete		1	3149	**2070 yard³**	
Rebar		1	3149	**137 tons**	

SAY 16" □

42" ϕ W/ 16 TENDONS

- IN THE WET CONSTRUCTION, ASSUME DELIVERY VIA BARGE TO GALVESTON ISLAND.

Sector Gate & Bulkhead Fabrication with Delivery

Table of Contents

Title: Coastal Texas Protection and Restoration
Subject: Cost Estimate - Special Steel Fabrication Unit Costs
Made By: DS Date: 11/15/19 Checked By: RSK Date: 10/15/19

Objective:

Determine fabrication unit costs for the Clear Creek and Dickinson Bayou Sector Gates and Maintenance Bulkheads.

Approach:

Use costs and weights from the IHNC GIWW Sector Gate and Maintenance Bulkheads. Fabrication costs for IHNC are provided in the IHNC Design Documentation Report (2016)and weights are provided in the submitted design calculations (2010).

Assumptions:

The DDR, which was written sometime after construction, does not specify what year the fabrication costs are from. It is conservative to assume that the fabrication costs are from 2010 and installation costs are from 2011. The king post fabrication costs will be included in the total gate costs and the hinge and pintle are not included in the unit cost of the gate as they are castings and not structural steel fabrication. Delivery of the sector gate was provided by the fabricator via barge and is therefore included in the fabrication costs. It is assumed that the gate was installation was included with the install of the mechanical equipment.

Unit costs of the Bayou Bienvenue Lift Gate are provided for comparison.

Conclusions:

	Cost $/Pound
Sector Gate:	10.76
Maintenance Bulkheads:	9.22
Lift Gate:	10.49

Costs are assumed to be in 2010 dollars and includes delivery via barge, see above

Calculations:

GIWW Sector Gate

- *King Post weight is assumed to be included in gate framing weight
- Weight of 1 leaf = 1,223,415 lbs (2 Leafs required)

	Cost $	Weight lbs	Cost/Pound $/lb
Sector Gate:	23,745,357	2,446,830	9.70
King Post:	2,580,633	*	
Total:	26,325,990	2,446,830	10.76

Cost / Pound: **10.76** $/lb

GIWW Maintenance Bulkheads

- Weight of 1 Bulkhead Truss = 160,000 lbs (8 Leafs required)

	Cost $	Weight lbs	Cost/Pound $/lb
Bulkhead:	11,799,147	1,280,000	9.22

Cost / Pound: **9.22** $/lb

BB Lift Gate

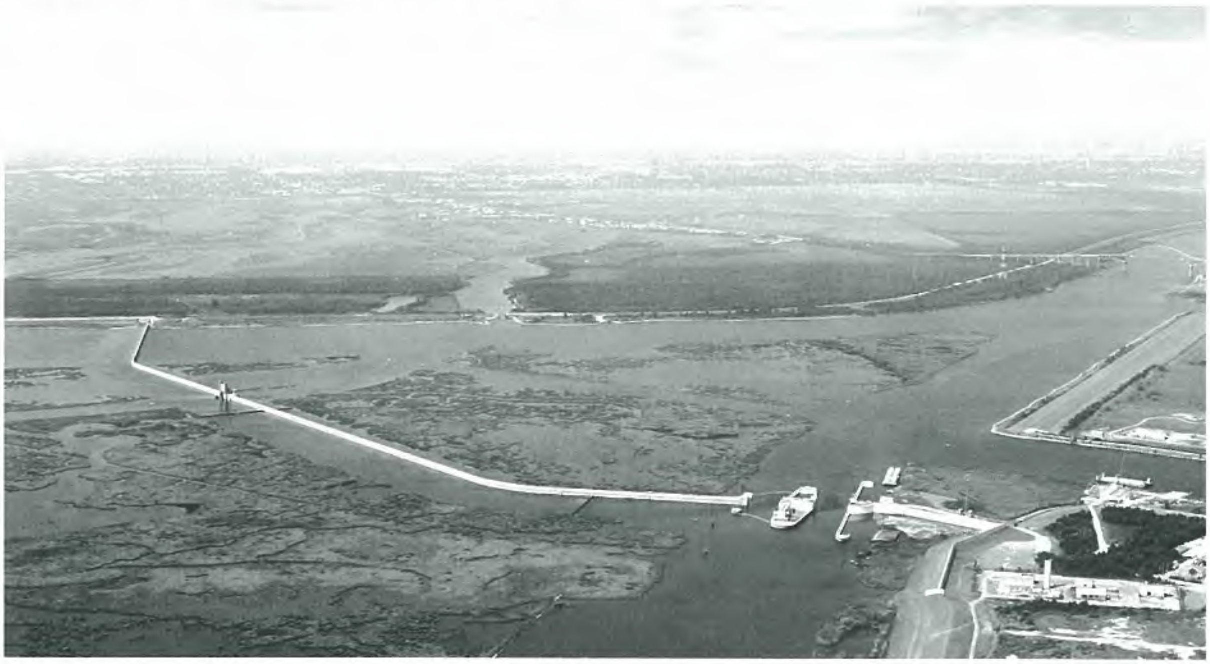
- Total Weight= 123.24 tons

	Cost $	Weight lbs	Cost/Pound $/lb
Lift Gate:	2,584,362	246,480	10.49

Cost / Pound: **10.49** $/lb

US Army Corps of Engineers
New Orleans District

INNER HARBOR NAVIGATION CANAL (IHNC) HURRICANE PROTECTION PROJECT



DESIGN DOCUMENTATION REPORT – 100 PERCENT SUBMITTAL

LAKE PONTCHARTRAIN AND VICINITY
ORLEANS AND ST BERNARD PARISH, LA

CONTRACT NO.: W912P8-10-D-0060
TASK ORDER: 0010

JUNE 2016

JV INCA Gerwick

1.7.8 COMMISSIONING

The Contractor prepared a Commissioning Plan for the entire project. This plan conveyed and/or provided the design's intended operation, a commissioning organization (both Contractor and Government), a schedule of commissioning activities, documentation procedures, operating parameters, qualification of required personnel, performance criteria, start up procedures, and user inputs. The Commissioning Plan was a living document that was updated periodically as the design and construction progressed. ER 1110-345-723 "System Commissioning Procedures" was available as guidance for the preparation and activation of Commissioning. The Government had a Commissioning Manager assigned to this project as part of the quality assurance program. The initial Commissioning Plan was submitted at the 30 Percent Submittal and updated as the design and construction progresses. A commissioning plan for the Advance Measures was also prepared to address the intended operation and maintenance requirements that will precede the completion of the permanent project.

The Commissioning Plan was not included with the Government furnished information.

1.8 COST ESTIMATE

During the design and construction of this project, the Contractor was fully cognizant of the effect of the design on the Operation and Maintenance Cost of the final structures and barriers that are to be placed. The nonfederal sponsor was responsible to pay all O&M costs of the project. Every effort was made to minimize operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) costs for the final project. Reference ER 1110-2-8159 Life Cycle Design and Performance.

Final construction costs broken down by project feature are provided in the table below. Construction costs are per email correspondence with the Corps of Engineers.

Table 1-16: IHNC Cost by Feature

Feature Description	Amount
Floodwall	\$739,710,000
GIWW	\$381,332,000
BB	\$78,806,000
North T-Wall	\$25,076,000
South T-Wall	\$25,736,000
Summary	\$1,250,660,000

Additional documentation furnished by the Government included partial cost breakdowns of the project features included in the Narrative Completion Report. These costs are summarized in the tables below. The original contract amount is provided alongside the final value, which includes change orders. Note that not all sub-features are included in tables for GIWW and BB and the costs are not equal to the feature costs provided in Table 1-16.

Table 1-17: GIWW Cost by Selected Subfeature

Feature Description	Awarded Contract Value	Final Contract Value
Dredging, Dikes, and Fill	$4,070,190	$3,603,938
Bypass Gate Monolith Construction	$29,082,490	$34,214,806
Sector Gate Fabrication	$23,447,811	$23,745,357 + 2580633 = 26,325,990
Sector Gate Piles	$15,296,939	$15,594,484
Bulkhead Fabrication	$9,142,486	$11,799,147
King Post Fabrication	$2,317,251	$2,580,633 (ADDED TO GATE)
King Post Casting	$461,590	$678,842
Sector Gate Pile Driving	$4,448,424	$4,448,424
Sector Gate Monolith Construction	$36,977,382	$42,676,115
Sector Gate Mechanical and Installation	$4,182,100	$5,485,103

Table 1-18: Bayou Bienvenue Cost by Selected Subfeature

Feature Description	Awarded Contract Value	Final Contract Value
Vertical Lift Gate Leaf Fabrication	$1,701,975	$2,584,362
BB Towers	$2,094,054	$2,750,794
BB Gate Sill and Monolith	$2,000,000	$28,767,964
BB Control House	$969,296	$990,080
BB Bridge and Tower Fabrication	$2,906,113	$6,163,250

Table 1-19: Additional Subfeature Costs

Feature Description	Awarded Contract Value	Final Contract Value
North Shore Complex	$9,618,200	$11,815,779
Access Closure Wall	$2,560,000	$2,633,174
MRGO Fill	$8,189,357	$10,472,518
South Vehicle Access	$5,804,638	$9,498,820
Scour Stone	$26,900,051	$38,027,641
Approach Walls	$21,063,415	$35,540,074

Inner Harbor Navigation Canal
Hurricane Risk Reduction

100-Percent Design for GIWW Buoyant Gate

WBS No. 131527.1.04.01.34.50.99

Submitted to:

Shaw E&I

May 21, 2010

Submitted by:

INCA Engineers, Inc.

Prepared by: **Daniel W. Hartford, P.E.**
James M. Costello, P.E.

Approved by: **Daniel W. Hartford, P.E.**
Engineer of Record

STATE OF LOUISIANA
DANIEL W. HARTFORD
License No. [illegible]
5/21/2010
PROFESSIONAL ENGINEER

Prepared for:

U.S. Army Corps of Engineers
Hurricane Protection Office

INCA ENGINEERS, INC.

Job Number 07-039B
Sheet No.

Contract/Client	USACE New Orleans District
Phase/Subject	GIWW Sector Gate
Design Topic	Steel Quantities - Summary
Made By CW	Date 1/6/2010
Checked By	Date

Quantities shown are per one gate. Total 2 gates are required.

All round HSS members shall be line pipe, API Specification 5L, Grade X52, Class B.
Wide flange members shall be ASTM A992, Gr. 50. All other shapes and plate shall be ASTM A572, Gr 50.
Handrail pipe shall be A53 Gr. B, Fy = 35 ksi. All grating shall be galvanized steel.

Quantity Summary

Steel Weight

Gate Frame	523255 lbs	
Buoyancy Tank	283170 lbs	
Fender	101284 lbs	
Bridge	113659 lbs	
Walkway	19484 lbs	
Skin Plate	153660 lbs	
Ladder Access	28902 lbs	
Pintle Casting	0 lbs	(This item is included in Mechanical Quantity)
Hinge Casting	0 lbs	(This item is included in Mechanical Quantity)
	1223415 lbs	

Total Weight Per Leaf = 1223000 lbs

TOTAL GATE = 2,446,830 LBS

Inner Harbor Navigation Canal
Hurricane Risk Reduction Project

100% Sealed Submittal
GIWW Flood Level Bulkhead and Maintenance Bulkhead 4
December 17, 2009 4
WBS 02.10.50.10.99 and 02.10.60.05.99

Prepared by:

Linfield, Hunter and Junius, Inc.

STATE OF LOUISIANA
ANTHONY F. GOODGION
REG. No. 24466
REGISTERED
PROFESSIONAL ENGINEER
12/17/09
CIVIL ENGINEERING

Submitted to:

U.S. Army Corps of Engineers
Hurricane Protection Office

Quantities			
GIWW Bulkheads			
100% Quantities - December 7, 2009			
IHNC Flood Level / Maintenance Bulkheads			
100% Quantities - December 17, 2009			
		Weight	
		Lbs	
Truss Units (8)	**Use**	160,000	**Lbs - Each Truss (8 Required)**
Total Estimated Steel =		1,280,000	**Pounds**
See Calculations p. 7-1 through 7-3 for Supporting Calculations			

	Project	Date	
JV INCA Gerwick	IHNC Hurricane Protection Project	6/11/10	
	Subject Rev 0 Released for Construction		Nelson

Structural – Bayou Bienvenue Floodgate (Vertical Lift Gate)

Table of Contents

JV NCA Gerwick	Project IHNC Hurricane Protection Project	Date 6/11/10	
	Subject Rev 0 Released for Construction		Nelson

2.6 Material Quantities

BY	J.Hemeter	11/11/2009	IHNC LIFTGATE	SHEET	1
CHKD			MATERIALS TAKEOFF	JOB NO.	20080111-27

Stiffened Skin Plate

Type	Shape	Size	Weight(tons)
PLATE		5/8"	15.80
PLATE		1/2"	7.72
	HSS	4.5 x 0.237	0.14
	HSS	6.625 x 0.432	8.02
	HSS	8.625 x 0.5	2.93
	HSS	12.750 x 0.500	5.41
	HSS	12.750 x 0.625	4.75
	HSS	12.750 x 0.875	5.22
	HSS	16.000 x 0.750	12.60
	HSS	16.000 x 1.000	15.13
	HSS	16.000 x 1.250	5.91
	HSS	8.000 x 4.000 x 0.500	1.12
	HSS	8.000 x 6.000 x 0.500	15.32
	PLGD	PLG1 Tw=1.5"	9.52
	PLGD	PLG2 Tw=2.5"	13.00
	Channel	C8 x 11.5	0.35
	HSS	1.9 x 0.145	0.27
	ANGLE	L2x2x1/4	0.03
		TOTAL STEEL WT=	123.24 TONS

CHECK
2.15
1.79
8.58
2.61
15.13 ✓

← TOTAL GATE

**NOTE-THE SACS MODEL RESULTS HAS A TOTAL WEIGHT OF 138TONS. THIS DIFFERENCE IS DUE TO:
#1) A LOAD FACTOR OF 1.08 IS APPLIED TO THE DEAD WEIGHT
#2) THE ENTIRE SKIN PLATE IS MODELED AS 5/8" THICK PLATE.
IF A 1.08 FACTOR IS APPLIED TO THIS MTO AND ALL OF THE SKIN PLATE IS TAKEN AS 5/8" THICK
THE WEIGHT BECOMES 136TONS. THE DIFFERENCE IS 1.5% AND IS ACCEPTABLE

Truss @ (+)22'-0"

Type	Shape	Size	Weight(psf,plf)	Length(ft)	Weight(lbs)	Weight(tons)
	HSS	4.5 x 0.237	10.78		0.00	0.00
	HSS	6.625 x 0.432	28.6		0.00	0.00
	HSS	8.625 x 0.5	43.4		0.00	0.00
	HSS	12.750 x 0.500	65.48	41.32	2705.63	1.35
	HSS	12.750 x 0.625	81	58.65	4750.65	2.38
	HSS	12.750 x 0.875	111.1		0.00	0.00
	HSS	16.000 x 0.750	122.27	84.67	10352.60	5.18
	HSS	16.000 x 1.000	160.4	26.83	4303.85	2.15
	HSS	16.000 x 1.250	197.1		0.00	0.00
	HSS	8.000 x 4.000 x 0.500	37.43		0.00	0.00
	HSS	8.000 x 6.000 x 0.500	41.91		0.00	0.00
	PLGD	PLG1 Tw=1.5"	559.8		0.00	0.00
	PLGD	PLG2 Tw=2.5"	746.5		0.00	0.00

Truss @ (+)13'-0"

Type	Shape	Size	Weight(psf,plf)	Length(ft)	Weight(lbs)	Weight(tons)
	HSS	4.5 x 0.237	10.78		0.00	0.00
	HSS	6.625 x 0.432	28.6		0.00	0.00
	HSS	8.625 x 0.5	43.4		0.00	0.00
	HSS	12.750 x 0.500	65.48	41.32	2705.63	1.35
	HSS	12.750 x 0.625	81	58.65	4750.65	2.38
	HSS	12.750 x 0.875	111.1		0.00	0.00
	HSS	16.000 x 0.750	122.27	84.67	10352.60	5.18
	HSS	16.000 x 1.000	160.4	22.33	3581.73	1.79
	HSS	16.000 x 1.250	197.1		0.00	0.00
	HSS	8.000 x 4.000 x 0.500	37.43		0.00	0.00
	HSS	8.000 x 6.000 x 0.500	41.91		0.00	0.00
	PLGD	PLG1 Tw=1.5"	559.8		0.00	0.00
	PLGD	PLG2 Tw=2.5"	746.5		0.00	0.00

JV NCA Gerwick	Project IHNC Hurricane Protection Project	Date 6/11/10	
	Subject Rev 0 Released for Construction		Nelson

Truss @ (+)4'-0"

Type	Shape	Size	Weight(psf,plf)	Length(ft)	Weight(lbs)	Weight(tons)
	HSS	4.5 x 0.237	10.78		0.00	0.00
	HSS	6.625 x 0.432	28.6		0.00	0.00
	HSS	8.625 x 0.5	43.4		0.00	0.00
	HSS	12.750 x 0.500	65.48	41.32	2705.63	1.35
	HSS	12.750 x 0.625	81		0.00	0.00
	HSS	12.750 x 0.875	111.1	58.65	6516.02	3.26
	HSS	16.000 x 0.750	122.27		0.00	0.00
	HSS	16.000 x 1.000	160.4	107.00	17162.80	8.58
	HSS	16.000 x 1.250	197.1		0.00	0.00
	HSS	8.000 x 4.000 x 0.500	37.43		0.00	0.00
	HSS	8.000 x 6.000 x 0.500	41.91		0.00	0.00
	PLGD	PLG1 Tw=1.5"	559.8		0.00	0.00
	PLGD	PLG2 Tw=2.5"	746.5		0.00	0.00

Truss @ (-)5'-0"

Type	Shape	Size	Weight(psf,plf)	Length(ft)	Weight(lbs)	Weight(tons)
	HSS	4.5 x 0.237	10.78		0.00	0.00
	HSS	6.625 x 0.432	28.6		0.00	0.00
	HSS	8.625 x 0.5	43.4		0.00	0.00
	HSS	12.750 x 0.500	65.48	41.32	2705.63	1.35
	HSS	12.750 x 0.625	81		0.00	0.00
	HSS	12.750 x 0.875	111.1	23.32	2590.85	1.30
	HSS	16.000 x 0.750	122.27	36.83	4503.20	2.25
	HSS	16.000 x 1.000	160.4	32.49	5211.40	2.61
	HSS	16.000 x 1.250	197.1	60.00	11826.00	5.91
	HSS	8.000 x 4.000 x 0.500	37.43		0.00	0.00
	HSS	8.000 x 6.000 x 0.500	41.91		0.00	0.00
	PLGD	PLG1 Tw=1.5"	559.8		0.00	0.00
	PLGD	PLG2 Tw=2.5"	746.5		0.00	0.00

Elevation Front Truss

Type	Shape	Size	Weight(psf,plf)	Length(ft)	Weight(lbs)	Weight(tons)
	HSS	4.5 x 0.237	10.78		0.00	0.00
	HSS	6.625 x 0.432	28.6	242.17	6926.06	3.46
	HSS	8.625 x 0.5	43.4	135.00	5859.00	2.93
	HSS	12.750 x 0.500	65.48		0.00	0.00
	HSS	12.750 x 0.625	81		0.00	0.00
	HSS	12.750 x 0.875	111.1	6.00	666.60	0.33
	HSS	16.000 x 0.750	122.27		0.00	0.00
	HSS	16.000 x 1.000	160.4		0.00	0.00
	HSS	16.000 x 1.250	197.1		0.00	0.00
	HSS	8.000 x 4.000 x 0.500	37.43		0.00	0.00
	HSS	8.000 x 6.000 x 0.500	41.91		0.00	0.00
	PLGD	PLG1 Tw=1.5"	559.8	34.00	19033.20	9.52
	PLGD	PLG2 Tw=2.5"	746.5	34.83	26000.60	13.00

JV INCA Gerwick	Project IHNC Hurricane Protection Project	Date 6/11/10	
	Subject Rev 0 Released for Construction		Nelson

Section C

Type	Shape	Size	Weight(psf,plf)	Length(ft)	Weight(lbs)	Weight(tons)
	HSS	4.5 x 0.237	10.78		0.00	0.00
	HSS	6.625 x 0.432	28.6	162.25	4640.35	2.32
	HSS	8.625 x 0.5	43.4		0.00	0.00
	HSS	12.750 x 0.500	65.48		0.00	0.00
	HSS	12.750 x 0.625	81		0.00	0.00
	HSS	12.750 x 0.875	111.1		0.00	0.00
	HSS	16.000 x 0.750	122.27		0.00	0.00
	HSS	16.000 x 1.000	160.4		0.00	0.00
	HSS	16.000 x 1.250	197.1		0.00	0.00
	HSS	8.000 x 4.000 x 0.500	37.43		0.00	0.00
	HSS	8.000 x 6.000 x 0.500	41.91		0.00	0.00
	PLGD	PLG1 Tw=1.5"	559.8		0.00	0.00
	PLGD	PLG2 Tw=2.5"	746.5		0.00	0.00

Elevation Back Truss

Type	Shape	Size	Weight(psf,plf)	Length(ft)	Weight(lbs)	Weight(tons)
	HSS	4.5 x 0.237	10.78		0.00	0.00
	HSS	6.625 x 0.432	28.6	156.36	4471.90	2.24
	HSS	8.625 x 0.5	43.4		0.00	0.00
	HSS	12.750 x 0.500	65.48		0.00	0.00
	HSS	12.750 x 0.625	81		0.00	0.00
	HSS	12.750 x 0.875	111.1	6.00	666.60	0.33
	HSS	16.000 x 0.750	122.27		0.00	0.00
	HSS	16.000 x 1.000	160.4		0.00	0.00
	HSS	16.000 x 1.250	197.1		0.00	0.00
	HSS	8.000 x 4.000 x 0.500	37.43		0.00	0.00
	HSS	8.000 x 6.000 x 0.500	41.91		0.00	0.00
	PLGD	PLG1 Tw=1.5"	559.8		0.00	0.00
	PLGD	PLG2 Tw=2.5"	746.5		0.00	0.00

Stiffened Skin Plate

Type	Shape	Size	Weight(psf,plf)	Length(ft)	Weight(lbs)	Weight(tons)
	HSS	4.5 x 0.237	10.78		0.00	0.00
	HSS	6.625 x 0.432	28.6		0.00	0.00
	HSS	8.625 x 0.5	43.4		0.00	0.00
	HSS	12.750 x 0.500	65.48		0.00	0.00
	HSS	12.750 x 0.625	81		0.00	0.00
	HSS	12.750 x 0.875	111.1		0.00	0.00
	HSS	16.000 x 0.750	122.27		0.00	0.00
	HSS	16.000 x 1.000	160.4		0.00	0.00
	HSS	16.000 x 1.250	197.1		0.00	0.00
	HSS	8.000 x 4.000 x 0.500	37.43	60.00	2245.80	1.12
	HSS	8.000 x 6.000 x 0.500	41.91	731.00	30636.21	15.32
	PLGD	PLG1 Tw=1.5"	559.8		0.00	0.00
	PLGD	PLG2 Tw=2.5"	746.5		0.00	0.00
PLATE		5/8"	25.52	1238.44	31604.99	15.80
PLATE		1/2"	20.42	756.00	15437.52	7.72

Stiffened Skin Plate

Type	Shape	Size	Weight(psf,plf)	Length(ft)	Weight(lbs)	Weight(tons)
	Channel	C8 x 11.5	11.5	60.68	697.82	0.35
	HSS	1.9 x 0.145	2.55	209.72	534.79	0.27
	HSS	4.5 x 0.237	10.78	26.00	280.28	0.14
	ANGLE	L2x2x1/4	3.19	18.31	58.41	0.03

Steel Pipe Piles and Sheet Piles

Table of Contents

Stuard, Daniel

From: Davidson, Jeremy [SKYUS] <jeremy.davidson@nucorskyline.com>
Sent: Wednesday, October 16, 2019 8:29 AM
To: Stuard, Daniel
Subject: FW: Budgetary Pricing - Galveston, TX

⚠ **CAUTION:** This email originated from an external sender. Verify the source before opening links or attachments. ⚠

Daniel,

Here are some budgetary numbers for your project. Prices are **budgetary**, based on today's current market pricing. Prices are subject to change based on increases related to changes in market conditions, including but not limited to tariffs, mill increases, and freight increases. Material is priced based on truck delivery to the jobsite.

Spiral Weld Pipe – 24" OD x .500" WT; ASTM A252 Gr.3; Bare = **$1500/ton delivered to Galveston**

PZ-22 Sheet Piling; ASTM A572 Gr.50; Bare = **$1375/ton delivered to Galveston**

PS-31 Flat Sheet Piling; ASTM A572 Gr.50; Bare = **$1400/ton delivered to Galveston**

Let me know if you have any questions.

Regards,

Jeremy Davidson
Sales

Nucor Skyline
1120 NASA Parkway, Suite 225 • Houston, TX 77058
Phone: 281.992.4000
Cell: 832-584-8988
Fax: 281.335.8321
Jeremy.Davidson@nucorskyline.com

NUCOR

TETRA TECH, INC.

PHONE LOG

CLIENT:	Mott MacDonald/GLO
JOB TITLE:	Coastal Texas Protection and Restoration
PROJECT NO.:	100-RCE-18-09-1
SUBJECT:	Steel Pipe Piles & Steel Sheet Piles
CONVERSATION DATE:	Oct. 14th, 2019
PREPARED BY:	Daniel Stuard
CONVERSATIONALISTS:	Representative of Nucor Skyline and Daniel Stuard of Tetra Tech

---

This phone log summarizes the items discussed or issues resolved during the phone conversation to the best of the writer's ability.

Jeremy Davison, a sales representative from Nucor Skyline (Houston, TX) was spoken with and was able to provide the following information. The phone number for Nucor Skyline (Houston, TX) is (281) 992-4000. The representative provided the following price quotes and information regarding the steel pipe piles and steel sheet piles and will follow up with an email by mid-day Oct. 15,2019.

- Steel Pipe Piles:
  - Pipe piles are of similar size, per conversation cost will not vary significantly across sizes. Use 24" Dia. x 0.5".
  - Not coated, A252, Grade 3.
  - 11,000 tons is about 460-500 trucks. (assume lengths of pipe are 50-60ft)
  - $1,000/ton (at mill) for pipe piles and does not change much based on section size. (+$50/ton for 48in Dia. x 1")
  - Barge delivery may be able to cut delivery by half.
- Sheet piles
  - PZ22 not coated
  - PS31 (flat not coated for cellular cofferdam)

Project:	Galveston - Clear Creek
Job No.	100-WTR-18-09
Description:	0
	- Clear Creek Quantity Takeoff
Computed:	*RSK* **Date:** *12-Oct-19* **Checked:** *XXX* **Date:** *XXXX*

Clear Creek Quantity Takeoff

Component: **Steel Pipe Piles**

Size	Average Wt/ft	# of Piles	Total Length	Total Weight	Location	Notes
Ø x t (in x in)	(lb/ft)	N/A	ft	Tons	**N/A**	**N/A**
24 x 0.5	125.60	8.00	530.00	33.30	Bulkhead Storage Platform	All have tension connections
24 x 0.5	125.60	104.00	8,398	527.39	Monolith	*All have tension connections
24 x 0.5	125.60	154.00	13,108	823.21	Monolith	*All have tension connections *All 154 are batted 3:1 (V:H) w/ 85.12 ft batter length and at 18.4 degrees
24 x 0.5	125.60	15.00	1,211	76.07	Monolith's Sill Slab	*All have tension connections
24 x 0.5	125.60	700.00	44,828	2,815	T-Wall 1	*All are batted 3:1 (V:H) w/ 85.12 ft batter length
24 x 0.5	125.60	483.00	29,912	1,878	T-Wall 2	*All are batted 3:1 (V:H) w/ 85.12 ft batter length
24 x 0.5	125.60	112.00	6,692	420	Fuel Tank	
24x½ **24 x 0.5 Sub -Total**	125.60	1,576	104,680	6,574		
18X⅝ 18 x 0.625	125.60	394.00	47,280	2,969	Floodwall per Foot of Wall	*All are batted 3:1 (V:H) w/ 85.12 ft batter length
24x⅝ 24 x 0.625	156.17	150.00	12,000	937	Pump Station	
24 x 0.625	156.17	32.00	2,560	200	Safe House Enclosure Slab	
24 x 0.625 Sub - Total	156.17	182.00	14,560.00	1,136.92		

	# of Piles	Total Length	Total Weight
Sum (Total of all Piles):	2,152	166,520 FT	10,680 TONS

@ mill
≈ 4,000 /ton

±$50/TON

Project:	Galveston - Clear Creek
Job No.	100-WTR-18-09
Description:	0
	- Clear Creek Quantity Takeoff
Computed:	RSK Date: 12-Oct-19 Checked: XXX Date: XXXX

Clear Creek Quantity Takeoff

Component: **Steel Sheet Piling**

# of Sheets	Sheet Length	Wall Height	Average Wt/ft	Total Length	Total Weight	Location	Notes
-	ft	ft	(lb/ft)	ft	Tons	-	-
N/A	N/A	71.00	1,917.00	787	754.34	Monolith Base Slab's Coffer Box	
N/A	N/A	71.00	1,917.00	188	180.20	Sill Slab's Coffer	
572.73	3.67	10.75	236.50	2,100	248.33	T-Wall 1	* A PZ-22 hot rolled sheet piling shall be utilized for seepage cutoff with a depth of 10 feet of embedment plus 9 inches of embedment into the concrete slab * ASTM A328 grade
395.45	3.67	10.75	236.50	1,450	171.46	T-Wall 2	* A PZ-22 hot rolled sheet piling shall be utilized for seepage cutoff with a depth of 10 feet of embedment plus 9 inches of embedment into the concrete slab * ASTM A328 grade
31.00	46.40	21.00	462.00	1,438.4	332.27	Pump Station	*Pz-22 sheets *ASTM A328 grade
5,750	1.64	65.00	2,015.00	9,430	9,550.00	Cofferdam	* PS31 *Corresponds to 5,750 sheets * My calc requires only 9,504 tons

	Total Length	Total Weight
	ft	Tons
Sum (Total of all Piles):	15,393	11,237

Clear Creek Discharge Pipes and Collars

Table of Contents

Archived: Friday, October 18, 2019 2:33:17 PM
From: Bill Haines
Sent: Thursday, October 17, 2019 4:02:15 PM
To: Kramer, Rob
Cc: Frank Carioti; Dan Culican; Sam Carioti
Subject: RE: Budget Pricing for 13' Diameter Spirolite Pipe; Galveston Project
Sensitivity: Normal

\u9888 ? **CAUTION:** This email originated from an external sender. Verify the source before opening links or attachments. \u9888 ?

Rob:

I don't have any "rule of thumb" costs for the precast anchors. The weights on the solid wall option would be smaller as there is no air in the pipe wall to compensate for. As the deign progresses, we can assist your team in sizing and determining appropriate spacing for the weights(depending on deployment methods).

Bill Haines, P.E.
US General Manager
VARI-TECH LLC
58 Main St.
Topsfield, Ma. 01983
978-887-0272
978-887-8121(FAX)
978-621-8497(cell)
bhaines@varitech.com

From: Kramer, Rob <Rob.Kramer@tetratech.com>
Sent: Thursday, October 17, 2019 4:23 PM
To: Bill Haines <BHaines@varitech.com>
Subject: RE: Budget Pricing for 13' Diameter Spirolite Pipe; Galveston Project

Hi Bill,

Thank you for your prompt response in getting back to me with the costs for the pipe. I just left a message on your office phone about my thoughts with what you provided. The double cell and solid 5" wall pipes both appear to be good options that we will investigate. As for the concrete ballast blocks/collars, are you able to provide a rough estimate on the cost per an item? If not, that is fine as I can make some calls with some precast manufacturers in the project site area but if you can still determine the cost of that item, it would be greatly appreciated. I also will make sure our technical team reaches out to your team to discuss the appropriate pipe to use for our design when the time and stage of project comes. Please let me know if you have any other questions.

Thank you,
Rob

From: Bill Haines <BHaines@varitech.com>
Sent: Thursday, October 17, 2019 12:23 PM
To: Kramer, Rob <Rob.Kramer@tetratech.com>; Loesch, Lois <Lois.Loesch@tetratech.com>
Cc: Frank Carioti <FCarioti@varitech.com>; Dan Culican <DCulican@varitech.com>; Sam Carioti <SCarioti@varitech.com>
Subject: Budget Pricing for 13' Diameter Spirolite Pipe; Galveston Project

\u9888 ? **CAUTION:** This email originated from an external sender. Verify the source before opening links or attachments. \u9888 ?

Rob:

Attached please find information relative to the 100 year life for HDPE and our budget pricing for the 13' option. Please note that we have offered two options and the preferable option would depend on a number of variables including deployment methodology; bottom conditions and final trench/backfill/armoring configuration; concrete ballasting; etc.. When you move past the EIS stage it would be prudent for us to sit down and have a discussion with your technical team. Please call if you have any questions.

Bill Haines, P.E.
US General Manager
VARI-TECH LLC
58 Main St.
Topsfield, Ma. 01983
978-887-0272
978-887-8121(FAX)
978-621-8497(cell)
bhaines@varitech.com

VARI-TECH LLC

Phone (315) 622-1800 Fax (315) 622-1811

4545 **Wetzel Road**
Liverpool, NY 13090

Project: Galveston Bay
Customer: Tetra Tech
Contact: Rob Kramer, EIT
Date: 10/17/2018

VARI-TECH is proud to present the following documentation with regards to the Galveston Bay outfall project. As a brief introduction we are providing information on a 156" SPIROLITE HDPE high-density polyethylene piping system. Within this proposal we are providing options of two pipe wall profile configurations. One of those being the dual closed profile as listed and indicated in documentation provided to Tetra Tech on 8/23/2018 and the second being a solid 5" thick wall. VARI-TECH is offering options for these two, as their profiles lend benefits for performance optimization depending on the chosen site, hydraulic/bathymetric conditions and installation tactics.

- 156" I.D. controlled DCP(dual close profile) will offer the price of $1900 per/ft delivered

DCP

- 156" I.D. controlled solid wall pipe will offer the price of $3,800 per/ft delivered

Solid Wall

- Cost of an elbow and its supporting FRP frame for either option is approximately $45,000 delivered
- Cost of field welding 100 joints of pipe is in the order of $600,000

When it comes to the question of design lifespan of HDPE material it is noted for its ability to hold up in the harshest conditions. HDPE piping solutions have been selected from environments ranging from the coldest places as Alaska to alternate extremes such as locations around the equator. Chemical resistance is excellent and aids this material very well in landfills, chemical plants, superfund sites and of course ocean applications. For these reasons HDPE material has been recognized and tested for a **full pressure** lifespan of 100 years. With this being said many pipelines not operating at its full design limitations are expected to last much longer than the 100 years design lifespan published by AWWA C906 as attached.

On behalf of the VARI-TECH team we are looking forward to helping you through this challenging endeavor.

Dan Culican, M.E.M.
United States Engineering Manager
VARI-TECH ,LLC
Phone: 856-332-3918

Copy: Bill Haines, PE; Frank Carioti, PhD; Sam Carioti

Update on AWWA C906-12 **November 2013**

On July 30, 2013, the AWWA Executive Committee completed its comprehensive review of all the technical and procedural appeals and unanimously reaffirmed the C906-12 version that was previously approved by the AWWA Standards Council and the Polyolefin Pipe Committee. All procedural and technical challenges and appeals were found to be either without merit or were adequately addressed by the Committee. Since then, AWWA forwarded the proposed revision of C906 to ANSI for review, and the updated standard is expected to be published following completion of ANSI approval processes.

The intent of the revisions to the AWWA C906 standard is to enable users to take advantage of the enhanced performance properties of the newer class of PE4710 materials that increases the design and operating safety of water pipelines.

Specifically,

- No changes have been made to the safety factor. The safety factor for existing and high performance HDPE material under conditions specified in C906 continue to exceed 2.0.
- The Safety Factors (SF) for PE4710 relative to multiple conditions exceed 2.0 as demonstrated to the AWWA Executive Committee during the recent hearing, as summarized below:

	Factor
Hydrostatic design basis (1,600) relative to hydrostatic design stress (1,000 psi)	**Not applicable**
Yield stress (3,625 psi) relative to hydrostatic design stress (1,000 psi)	3.6
Predicted lifetime relative to desired service life (100 years)	> 10
Peak surge wave burst stress (~4,350 psi) relative to allowable pressure (2,000 psi) under occasional surge	2.2
Peak surge wave burst stress (~4,350 psi) relative to allowable pressure (1,500 psi) under recurring surge	2.9
Number of cycles to predicted failure relative to cycles under occasional surge (2,000 psi, 1 occasional surge/day for 100 years)	11.6
Number of cycles to predicted failure relative to cycles under recurring surge (1,500 psi, 55 recurrent surges/day for 100 years)	3.6 to 5.0

- The equivalent design factor in the highly regarded ISO Standard is higher than that proposed in AWWA C906-12: 0.8 for all grades of PE (PE80, PE100, PEX) vs. 0.63 for PVC-U.
- PE has the lowest failure rate among pipe materials (Iron, Ductile Iron, PVC, Asbestos Cement) per the UK WIR Water Main Failure database.
- In the UK, PE 100 (PE 4710) pipes are well established with higher design factor and highest market share of 65% (among steel, GRP, PVC, ductile iron, PE 80)
- In Germany, PE 100 (PE4710) pipes are also well established with higher design factor and highest market share of 47% (among steel, GRP, PVC, ductile iron, PE 80, concrete)
- According to TEPPFA - The European Plastic Pipe and Fittings Association - approximately 90% of all newly installed pipes (based on installed feet) are made from certified HDPE grades.
- The design factor for existing PE materials was not changed (it remains at 0.5).

- A newer class of high performance HDPE materials (like PE4710), with its own specific elevated requirements and design criteria is being added to the standard.
- This newer class of material and the corresponding design approach (which utilizes a 0.63 design factor in conjunction with other specific performance criteria) results in even GREATER performance safety in the end-use application.
- In 2008, AWWA approved and published a similar standard for HDPE (ANSI/AWWA C901) that included PE 4710 and included the 0.63 Design Factor for this newer class of high performance materials. The change in C906 is not unprecedented as demonstrated to the AWWA Executive Committee and as summarized below:
    - Eighteen Standards (ANSI/ASTM, CSA, API) similarly recognize the 0.63 design factor
    - Over 20-year history in Europe with PE 100/PE 4710 at even higher design stresses
    - AWWA C950-07 for fiberglass pressure pipe establishes a design factor 0.56
    - AWWA C200-05 for steel pipe does not establish a design factor; the design stress is specified by the purchaser.
- The current PE 3408 was introduced in the US and North America in 1979. PE 4710 was being produced under PE 3408; in 2004, the US industry introduced a subgroup within the existing PE3408 category and called it PE 4710; in Europe, PE4710/PE100 has been in use since 1990.

To provide members with additional background information on this issue, PPI is making the following documents available to its members:

1. Case studies
2. FAQs about PE Pipe in Water Distribution
3. PE 100 Pipe- The Precursor to PE 4710
4. Design and Safety Factors for PE4710 Materials Under the Proposed Revision
5. Response to Negative Regarding Design Factor on AWWA C906 Ballot
6. Letter to AWWA 263 Chair, John Fishburne
7. ASTM International: Long-Term Hydrostatic Strength and Design of Thermoplastic Piping Compounds

Archived: Friday, October 18, 2019 2:57:47 PM
From: Kramer, Rob
Sent: Tuesday, October 15, 2019 11:59:00 M
To: Frank Carioti
Cc: Bill Haines; Dan Culican; Sam Carioti; oesch, ois
Subject: RE: ari Tech C uote Re uest
Sensitivity: Normal

Hi Frank,

To follow up on our conversation earlier between Bill, you and I with regards to our TetraTech's project in and around Galveston, Te as, I talked to our project manager and one of our senior mechanical engineers to clarify some of your concerns and answer some of your questions.

First, I would like to clarify that I was mistaken with what stage we e actly are at in that we are still technically undergoing a feasibility study. When you talked to Sergio last August, we were developing a draft Environmental Impact Study (EIS). We are now at the stage of developing a finalized EIS for the Army Corps with the project being several years from being fully designed much less constructed. For this reason, there is not so much an urgency to nail down a preferred pipe as much as we are still just aiming for general cost estimates. For what it is worth, our mechanical engineer would like to stick with a 14' diameter pipe but him and our PM recognize the project must still go through several iterations before the pipes are fully finalized. This means that a 13' and maybe even a 10' diameter pipe could still be in contention for being utilized at the site.

Secondly, we are developing a finalized yet still basic cost estimate for this EIS. My PM gave me the go ahead to use the 13' diameter pipe and accompanying precast concrete ballast blocks/ collars for our cost estimates. That means if he makes things easier and quicker on your side, you need only to provide the cost and supporting aging reports for the 13' ID pipe and concrete blocks.

As for a discussion or call with our technical team, our PM recognizes and appreciates your concerns with the size, feasibility and cost of producing a 14' diameter pipe. However, she does not deem it necessary as of now. Rather, she would prefer to revisit the discussion and consult with your team once more parameters are established for the project. We will keep your suggestions of using a smaller diameter pipe in mind and under our consideration.

Finally, to reiterate what I said before, we would very much appreciate if you could provide a cost estimate for the 13' diameter Spirolite pipe and accompanying concrete blocks by Thursday. Please let me know if you have any concerns with what we are asking and I will be sure to either respond in a prompt manner or put you in contact with one of our more senior engineers.

Thank you,
Rob

Rob Kramer, EIT | Structural Design Engineer II
Direct **+1 (425) 732-5705** | Business **+1 (425) 635-1000** | Mobile **+1 (443) 745-0421**
Rob.Kramer@tetratech.com

From: Frank Carioti <FCarioti@varitech.com>
Sent: Tuesday, October 15, 2019 7:35 AM
To: Kramer, Rob <Rob.Kramer@tetratech.com>
Cc: Bill Haines <BHaines@varitech.com>; Dan Culican <DCulican@varitech.com>; Sam Carioti <SCarioti@varitech.com>
Subject: RE: Vari-Tech LLC uote Request

Good morning Robert,

es, I am available to talk with you after 1:00PM EST today. On the call with me will be our General Manager, Bill Haines, P.E. We would be happy to discuss this large diameter application with you and your team.

Frank

Frank V. Carioti, Ph.D.
Transformational Leader

VARI-TECH LLC
315-622-1800 Office Phone
315-391-7622 Cell Phone
http://www.varitech.com/ Web Page

From: Varitech Contact <varitech@varitech.com>
Sent: Monday, October 14, 2019 7:59 PM
To: VARI-TECH <varitech@varitech.com>
Subject: Vari-Tech LLC uote Request

Vari-Tech LLC Quote Request

Name	Robert Kramer
Company	TetraTech
Phone	425-732-5705
Address	
City	
State	
Zip	
Email	rob.kramer@tetratech.com
Description	Hello, Two of my colleagues at Tetra Tech, Mr. Roger Setya and Mr. Sergio Gaitan, contacted you last August to obtain a quote for a large scale Army Corps of Engineers coastal protection and restoration project in Galveston. We are trying to obtain new estimates for the cost of construction for our project. We are specifically interested in any further information you could provide with your capability to produce a 14ft diameter spirolite pipe. In addition, we are wondering if you include precast concrete collars, if it is possible to barge in the pipes due to their size and if you can confirm the durability of the material through aging reports or such. I figure this may not be enough information so please give me a call when you can and as soon as you can. I am based out of Seattle and am free to talk any time after 12:00 EST or 9:00 PST.

TETRA TECH, INC.

PHONE LOG

CLIENT:	Mott MacDonald/GLO
JOB TITLE:	Coastal Texas Protection and Restoration
PROJECT NO.:	100-RCE-18-09-1
SUBJECT:	Discharge Pipe and Precast Concrete Collars
CONVERSATION DATE:	Oct. 15th, 2019
PREPARED BY:	Robert Kramer
CONVERSATIONALISTS:	Frank Carioti, Transformational Lead, and Bill Haines, General Manager at Vari-Tech and Robert Kramer of Tetra Tech

---

This phone log summarizes the items discussed or issues resolved during the phone conversation to the best of the writer's ability.

Frank Carioti and Bill Haines, the transformational leader and the general manager at Vari-Tech (Liverpool, New York) were spoken to and able to provide the following information. The office phone number for Bill Haines is (315)-622-1800 while his cell phone number is (315)-391-7622.

The Vari-Tech representatives were unable to provide price quotes during the call due to the size of the 14' inside diameter (ID) pipe requested being outside of their current capabilities. That being considered, they offered to provide cost estimates for similar types of pipes offered at smaller sizes to give us a better understanding of the cost. Cost sheets for a 13' IN diameter pipe will be provided on a per linear foot basis. Accompanying precast concrete collar costs will be included with the pipe cost sheets as well as supporting aging reports to validate the durability of the Spirolite material being greater than 100 years. Vari-Tech will follow up with an email by Friday October 18th that contains the relevant cost and durability information while also formally requesting a meeting be had with the technical design team to discuss the feasibility in using a 14' diameter Spirolite pipe.

Vari-Tech's representatives voiced concerns with supplying a 14' diameter pipe which included the following:

- Largest pipe they have made is 13' ID
- Cost of Concrete Blocks/Collars significantly increase from 13' to 14' Diameter pipes
- Bigger Mandrels required to form 14' OD pipes

Vari-Tech mentioned that they have developed the methodology for producing a 14' diameter pipe yet could not provide a cost estimate. They estimated that the lead time from pumps to pipes was 30 to 40 weeks from past projects. After the call concluded, I consulted Lois Loesch and Eric Flickinger and determined it was best to only request the 13' diameter pipe costs and information while we would consider the 10’ diameter pipe option if the project’s design parameters changed. However, the 14’ diameter pipe is still the preferred option despite the limited data and information on how it will produce and perform.

TETRA TECH, INC.

PHONE LOG

CLIENT:	Mott MacDonald/GLO
JOB TITLE:	Coastal Texas Protection and Restoration
PROJECT NO.:	100-RCE-18-09-1
SUBJECT:	Discharge Pipe and Precast Concrete Collars
CONVERSATION DATE:	Oct. 16th, 2019
PREPARED BY:	Robert Kramer
CONVERSATIONALISTS:	Cesar Gallardo, Sales Representative at ISCO Industries and Robert Kramer of Tetra Tech

---

This phone log summarizes the items discussed or issues resolved during the phone conversation to the best of the writer's ability.

Cesar Gallardo, a sales representative at ISCO Industries, were spoken to and able to provide the following information. The office phone number for Cesar Gallardo is (360) 949-6227.

The ISCO sales representative was unable to provide price quotes for 14' Spirolite pipe or the corresponding concrete collars or even if they had the technology and history of producing such materials. However, he took note of what I had to say with regards to the project, the phase of the projects, the parameters for the pipe, the need for durability information and the need to know how shipping of the materials could and should be done. He offered to talk to his colleagues who are more familiar with that sector within the company. I gave him a deadline of getting back to me on the costs and related information by close of business on Thursday October 17th. He will email or call me when he determines if our request is within the company's current capabilities.

TETRA TECH, INC.

PHONE LOG

CLIENT:	Mott MacDonald/GLO
JOB TITLE:	Coastal Texas Protection and Restoration
PROJECT NO.:	100-RCE-18-09-1
SUBJECT:	Discharge Pipe and Precast Concrete Collars
CONVERSATION DATE:	Oct. 17th, 2019
PREPARED BY:	Robert Kramer
CONVERSATIONALISTS:	Ken Thielbar, Business Leader for Spirolite Products Group at IPF Plasson and Robert Kramer of Tetra Tech

---

This phone log summarizes the items discussed or issues resolved during the phone conversation to the best of the writer's ability.

Ken Thielbar, the Business Leader for the Spirolite Products Group at IPF Plasson was spoken to and able to provide the following information. His cell phone number is (713)-907-5296.

I was placed in contact with Ken through Cesar Gallardo, a sales representative with the pipe distributor, ISCO Industries. Ken had left work for the day. However, he was still able to field some questions and took note of what we needed. He had already heard of some of the project's demands through Cesar the previous day and 9 months prior through Vari-Tech, the other pipe distributor I contacted earlier in the week. I provided a more expansive layout of the project and what information we had including the diameter of pipe we wanted, the amount of total pipe (~60,000 ft) we needed for the Clear Creek site, the level of service that will be required of each pipe and pump (1,500 cfs) and our preferred method of construction (fully submerged). In addition, for the concrete collars, I provided the predicted amount of required precast concrete per collar (11.8 CY EA) and number of collars for 20 oc (2,685 EA).

Ken was not able to provide costs for the pipe per foot or concrete collars per item or confirm if they have ever produced a 14' diameter Spirolite pipe. He said he would check for their current capabilities in producing a pipe of that relative size. He mentioned his superior had experience with projects of this scope and type and could possibly provide rough estimates for the collar cost. One of his questions that I was not able to address was the depth of water that the pipe will be placed. He wanted the information to assist in determining construction costs. To assist him and his superior with the estimates, I emailed him several examples pictures and diagrams from our earlier quantity takeoff. I mentioned that the sooner they could get back with the estimates the better. He mentioned that the distribution center that would be closest to our project site was four hours north of Galveston in Corsicana, Texas. His rough estimate for the cost of shipping would be $4,000 per a truck load. Finally, we mentioned that we will contact each other early in the week of the 21st so I could hear what estimates they found for the collars and pipes.

From:	Cesar Gallardo
To:	Kramer, Rob
Subject:	Re: 14" DIAMETER HDPE PIPE - SPIROLITE
Date:	Friday, October 18, 2019 7:45:02 AM

CAUTION: This email originated from an external sender. Verify the source before opening links or attachments.

Hello Rob,

Excellent! I’m glad he was helpful. We have great relationships with our business partners and we are happy to hear this always.

I will circle back with you next week. Have a great weekend!

Cesar

Cesar Gallardo
Marine Group Sales
ISCO Industries, Inc.
Office: 502.614.3639<tel:502.614.3639>
Direct: 360.949.6227<tel:360.949.6227>
Email: cesar.gallardo@isco-pipe.com<mailto:cesar.gallardo@isco-pipe.com>
www.highlandfloats.com<http://www.highlandfloats.com/>

On Oct 17, 2019, at 4:40 PM, Kramer, Rob <Rob.Kramer@tetratech.com> wrote:

SENT BY AN EXTERNAL SENDER

Hi Cesar,

Thank you for putting me in contact with Ken. I called him albeit after he left work. He did pick up and we discussed some preliminary details of the project. He was of great help and will hopefully get back to me with some more estimates come sometime early next week once he is back at work tomorrow and able to talk to his boss.

Thank you,

Rob

From: Cesar Gallardo <Cesar.Gallardo@isco-pipe.com>
Sent: Thursday, October 17, 2019 2:33 PM
To: Kramer, Rob <Rob.Kramer@tetratech.com>
Subject: RE: 14' DIAMETER HDPE PIPE - SPIROLITE
Importance: High

CAUTION: This email originated from an external sender. Verify the source before opening links or attachments.

Good afternoon Rob,

After further conversations with my Team, and we all agree that in order to be able to provide to you the most accurate information possible we feel the best path forward would be to have you correspond directly with our manufacturing partner. I have included his contact information is below:

They will keep us in the loop so please reach out to him at your earliest convenience!
Cesar

Ken Thielbar
Business Leader Spirolite Products Group
Cell: 713-907-5296
Email: Ken Thielbar <ken.thielbar@plassonusa.com<mailto:ken.thielbar@plassonusa.com>>
Cesar Gallardo
Marine Group Sales / Business Development
www.highlandfloats.com<http://www.highlandfloats.com/>

ISCO Industries, Inc.
Corporate Office
100 Witherspoon Street 2West
Louisville, KY 40202
WA Direct: 360.949.6227
EFax: 502.568.4048
www.isco-pipe.com<http://www.isco-pipe.com/>
ISCO – Total Piping Solutions

From: Kramer, Rob <Rob.Kramer@tetratech.com<mailto:Rob.Kramer@tetratech.com>>
Sent: Thursday, October 17, 2019 12:27 PM
To: Cesar Gallardo <Cesar.Gallardo@isco-pipe.com<mailto:Cesar.Gallardo@isco-pipe.com>>
Subject: RE: 14' DIAMETER HDPE PIPE - SPIROLITE

SENT BY AN EXTERNAL SENDER

Hello Cesar,

I appreciate the update. For the pipe size, that is what I expected. If you can not fully determine the relevant information for a 14’ diameter pipe in a quick manner, the relevant information for the largest pipe you can produce or have produced before would suffice for now. As for the concrete and ballast blocks, we will contact the relevant vendors to determine the information. Thank you again for the prompt update and let me known if you have any other questions.

Thank you,
Rob

From: Cesar Gallardo <Cesar.Gallardo@isco-pipe.com<mailto:Cesar.Gallardo@isco-pipe.com>>
Sent: Thursday, October 17, 2019 11:45 AM
To: Kramer, Rob <Rob.Kramer@tetratech.com<mailto:Rob.Kramer@tetratech.com>>
Subject: RE: 14' DIAMETER HDPE PIPE - SPIROLITE

CAUTION: This email originated from an external sender. Verify the source before opening links or attachments.

Hello Rob,

I have the Team looking into the 14' diameter pipe and it's for sure less than your typical profile wall pipe size. We want to be able to provide to you the most accurate information possible and we may need more time to gather the information. We may find out that a slightly smaller diameter size may be more feasible, but we are still gathering information to make that determination.

In regards to the concrete collar/ballast blocks, we would need you to lean on a others that would have more expertise.

Just wanted to keep you updated.

Cesar Gallardo
Marine Group Sales / Business Development
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ISCO – Total Piping Solutions

From: Kramer, Rob <Rob.Kramer@tetratech.com<mailto:Rob.Kramer@tetratech.com>>
Sent: Wednesday, October 16, 2019 1:55 PM
To: Cesar Gallardo <Cesar.Gallardo@isco-pipe.com<mailto:Cesar.Gallardo@isco-pipe.com>>
Subject: RE: 14' DIAMETER HDPE PIPE - SPIROLITE

SENT BY AN EXTERNAL SENDER

Hi Cesar,

I apologize for the delay in me getting back to you. To follow up from our conversation earlier today, my name is Rob Kramer. I am a staff engineer at Tetratech in Bellevue, Washington. As I said on our phone call, we are currently doing a quantity and cost takeoff for our Army Corps project down in the Galveston, Texas area. The project is still in the Environmental Impact Study (EIS) phase which is in other words a feasibility study. We are still dealing with bigger picture items but for now what would be of use to you to know is that the pile will be used at three main project sites in the area. The pipes will serve as discharge pipes for pump stations next to large scale sector gate and flood wall facilities being built to control storm surge and rising sea levels.

We are in need of cost and durability information for 14' diameter Spirolite pipes. For reference, one of three sites will need approximately 53,700 feet of pipe. Our current thoughts are that the pipe will be dry welded and Bell and Spigot Joints installed fully submerged. The 14ft diameter pipe will be serving each pump at 1500 cfs. In addition, the current plan is to use concrete collars at 20' off center.

The cost, durability and other information we are specifically looking for are listed below:

* Does ISCO produce and sell 14’ diameter Spirolite pipe? If not, what is the closest size you produce?
* If you do not currently produce and sell 14’ diameter Spirolite pipe, how far are you in terms of time, scope and scale in producing one?
* Would it possible to truck the pipes to the site or do you recommend barging them in? Do you have manufacturing partners in the Houston/Galveston area that would help produce the pipes if need be?
* For the pipe you produce, what are its costs per foot? Does this cost account for FOB delivery or not?
* If possible, could you provide estimates for the cost of field welding each joint? The costs per a FRP elbow?
* If possible, could you provide estimates for the cost of a typical concrete collar/ballast block for the pipe?
* What is the maximum curvature (either in degrees or radius about) for the pipe that you can supply?
* Can you provide the pipe’s durability information through supporting aging reports?

The highlighted bullet points are the most pertinent and time sensitive questions so if need be, you can just search for answers to those questions.

As I mentioned earlier, our late deadline for determining costs is tomorrow at close of business. Please let me know by email or phone (425-732-5705) if you have questions or concerns.

Thank you,
Rob Kramer

Rob Kramer, EIT | Structural Design Engineer II
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From: Cesar Gallardo <Cesar.Gallardo@isco-pipe.com<mailto:Cesar.Gallardo@isco-pipe.com>>
Sent: Wednesday, October 16, 2019 1:38 PM
To: Kramer, Rob <Rob.Kramer@tetratech.com<mailto:Rob.Kramer@tetratech.com>>
Subject: 14' DIAMETER HDPE PIPE - SPIROLITE

CAUTION: This email originated from an external sender. Verify the source before opening links or attachments.

Rob,

Great talking to you this morning. I haven’t seen your email and just wanted to make sure I didn’t miss it.

Talk to you again soon,
Cesar

Cesar Gallardo
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Project:	Coastal Texas Protection & Restoration						
Job No.	100-WTR-18-09-1						
Description:	Clear Creek Navigation Approach Walls						
	- Clear Creek Quantity Takeoff						
Computed:	*RSK*	**Date:**	*12-Oct-19*	**Checked:**	*0*	**Date:**	*0-Jan-00*

Clear Creek Quantity Takeoff

Component: **Precast Concrete Collars**

Precast Concrete Collars at 20' oc:	2,685	EA	11.8 CY EA circumferential
Precast Concrete Collars at 20' oc:	31,683	CY	

* Collars are made of two half circular precast pieces bolted at the psring line to weight down the pipes

* Assuming a tidal range from +1 to -1, precast concrete collars can be installed at 20 ft spacing as the pipeline is launched into the water. The entire line would be launched assembled with collars by keeping the pipe ends closed temporarily to obtain pipe buoyancy in route.

* Pairs of H-piles spaced with every 5th concrete collar

Component: **Discharge Pipe (Spirolite)**

Diameter:	14.00	ft	
Length:	60,000	ft	
Dry Welding:	895	EA	at 60 feet
End Elbows:	27	EA	
Pressure Releif Air Valve:	27	EA	

TETRA TECH	Pump Station - Discharge pipes and supports	Calculation No. CC-PS-ST-MT-004

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Pump Station - Discharge pipes and supports				
Made By:	SDG	**Date:** Nov-07-2018	**Chk'd By:** LRM	**Date:**	11/09/18

Calc Body Pages	Appended Pages	Total Pages
4	11	15

Document code

Site	Feature	Discipline	Document type	Number
CC	PS	ST	MT	004

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Sergio Gaitan 11/09/18 Mario Koesch for Sergio Gaitan	Leo Moyer 11/09/18 Mario Koesch for Leo Moyer	Initial for review

TETRA TECH	Pump Station - Discharge pipes and supports	Calculation No. CC-PS-ST-MT-004

Job No.:	100-RCE-18-09-1					**Page:**	1
Project:	Coastal Texas Protection and Restoration						
Description:	Clear Creek Pump Station - Discharge pipes and supports						
Made By:	SDG	**Date:**	Nov-07-2018	**Chk'd By:**	LRM	**Date:**	11/09/18

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2) Large Diameter Estuary Installation - Vari-Tech	5	14
3) Buoyancy calculation	1	15
4) Earthwork quantities	1	16

TETRA TECH	**Pump Station - Discharge pipes and supports**		**Calculation No. CC-PS-ST-MT-004**	

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:	Clear Creek Pump Station - Discharge pipes and supports						
Made By:	SDG	**Date:**	Nov-07-2018	**Chk'd By:**	LRM	**Date:**	11/09/18

ISSUE BEING ADDRESSED

Quantities are provided for the Spirolite discharge pipes

APPROACH

Quantities are based on the "sunk" approach for installing the pipes in the outfall channel.

REFERENCES

References used during this calculation are as follows:

1) ETL-1110-2-307 Flotation Stabilty Criteria

RESULTS / CONCLUSIONS

Clear Creek Bayou Pump Station

Spirolite pipe 14 ft diameter:	53,702	LF	Double closed cell type
Dry welding of Bell & Spigot joints	895	EA at 60 feet	
End elbows, FRP:	27	EA	Provide support H pile frame
Precast Concrete collars at 20' oc	2,685	EA	11.8 CY EA circumferential
Precast Concrete collars at 20' oc	31,683	CY	
Dredging Stage 1 to El -12:	572,832	CY	
Thalweg dredging Stage 2 to El -16:	111,384	CY	
Backfill 1 - gravel to El -5:	189,216	CY	
Backfill 2 - reuse dredged material to El +0:	188,955	CY	
Pressure relief air valve	27	EA	

Does not include property acquisition nor demolition of existing homes and structures.

Job No.:	100-RCE-18-09-1					**Page:**	4
Project:	Coastal Texas Protection and Restoration						
Description:	Clear Creek Pump Station - Discharge pipes and supports						
Made By:	SDG	**Date:**	Nov-07-2018	**Chk'd By:**	LRM	**Date:**	11/09/18

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

The following assumptions can be considered when looking at the quantities and cost to provide and install these pipes, please refer to Plates in Engineering Appendix:

• Dredging can occur in 2 stages to minimize earthwork: initially down to El. -12 to obtain a constant depth throughout. Then a second dredging effort would be localized at the pipeline invert thalweg to bring the depth to -16.

• Collars are made of two half circular precast pieces bolted at the spring line to weigh down the pipes.

• Assuming a tidal range from +1 to -1, precast concrete collars can be installed at 20 ft spacing as the pipeline is launched into the water. The entire line would be launched assembled with collars by keeping

• Backfill operations can then proceed in two stages: First a gravel backfill around the pipes to a few feet above the spring line of the pipes to -5, to secure them against lateral forces, followed by hydraulic

• The elbow at the end turns the flow upward to dissipate energy and reduce erosion. The elbow would be supported off a pile supporting frame. The elbow would be made of solid double cell FRP wall material discharging at El +2. Riprap would surround the elbow to avoid local erosion.

• The Factor of Safety against buoyancy is 1.5 per ETL 1110-2-307 for normal operation.

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

1) No information on cost is available for 14 ft spirolite. A new mandrel would have to be custom made and only after knowing the total amount of linear feet of pipe, would IPF Plasson be able to cost this out. Having said that, a cost can be approximated by the calculated weight of the Closed Cell pipe in lbs per LF. Sixty-foot pipe sections would be welded in the dry and aligned for launching in the water. Bell and Spigot with extrusion welds are preferred.

2) As a cost comparison, Vari-Tech has provided 157” (13 ft) diameter pipes in the past at a cost of about $1,600/LF. This does not account for FOB delivery. The cost of field welding 100 joints of this pipe is about $600,000. Each FRP elbow can be supplied at a cost of about $35,000. This information needs to be confirmed for a 14 ft diameter pipe system.

3) The durability of the Spirolite material needs to be confirmed at 100 years and Vari-Tech may be able to provide supporting aging reports.

CALCULATIONS

CC	pipe lengths north to south
1	2197
2	2182
3	2168
4	2159
5	2137
6	2128
7	2124
8	2111
9	2112
10	2116
11	1946
12	1934
13	1925
14	1925
15	1919
16	1918
17	1900
18	1900
19	1904
20	1883
21	1876
22	1873
23	1872
24	1872
25	1875
26	1871
27	1875
Tota	53702

Conceptual Design of Pump Stastions - Discharge Pipes - Anchoring Devices

Pipe Diameter

A 14 ft diameter pipeline serving each pump at 1500 cfs is first envisioned. The highest average pipe velocity would be about 10 fps. Currently, there are no fabricators of HDPE pipes for that large diameter in the U.S. It is possible that Malaysia could provide this large diameter, however I did not make a call. The largest produced in the USA is 11 ft diameter as provided by Spirolite. IPF Plasson-USA could consider the cost to fabricate a 14 ft mandrel if enough quantity is require

Main distributors of Sprirolite in the U.S. are Vari-tech LLC and ISCO. Vari-tech feels a 10 ft dia pipe is feasible if the pump requirements can support a 20-fps velocity and the associated friction losses. A 12 ft diameter pipe can also be envisioned; however, bends would require more robust lateral anchors. A lesser diameter pipe would result in savings on the pipe itself as it is sold by the lbs/LF of pipe. Savings can also be realized on the lesser amount of dredging.

For purposes of this design, a 14 ft pipe has been adopted going forward to keep the pumping head and requirements down as well as the cost to run the Pump Station in terms of kwh.

Pipe Material

HDPE spirolite can be either solid wall of various SDRs, open profile with exterior bids, or closed cell profile honeycomb design. Pipe pressures usually should stay to less than 25 ft of water head, which is realistic for this application. Joints are typically Bell & Spigot or Extruded melting by means of hot air. Welding is done in the dry and then pipe is floated into position. Segments are typically 60 ft long and are buoyant. The pipe cannot be curved beyond about 2 degrees (or about 700 ft radius), therefore it is not practical. Rather, several welded segments can be provided to suit each bend amount.

Two options were evaluated for installation of the pipes: A (preferred) fully submerged installation, and an option to have the pipes buoyant with the tides.

Submerged Design Option

It is preferable to "sink" the pipe to the bottom of the channel and this technique is used for many estuary-to-ocean applications. Precast concrete collars at 20 ft spacing are designed to permanently sink the pipes provided their spacing, water salinity, and pipe profile selected. Collars serve to overcome pipe material buoyancy and provide a safety factor in maintaining the pipes permanently sunk. Collars are made of two equal halves joined at the spring line by bolts. In order to increase the factor of safety during hurricane surge against lateral wave action, steel H-piles may need be provided at every bend.

In addition, it is possible to backfill the spaces between the pipes with the dredged material, providing less pipe surface to be exposed to wave action and a beneficial use for the dredged material. A 14 ft diameter alternative would be better installed by having localized dredging following the pipe invert as the segments are sank into place.

The Plastic Pipe Institute has information on the tie-down forces required for HDPE of different profiles and SDRs. Closed cell profiles are air tight and contribute to buoyancy. An important factor in selecting the level of submergence is for the crown of the pipe to be below the minimum low tide so as to minimize air from becoming trapped inside the pipe when the tide raises. A 1.5 safety factor has been used for calculating the ballast requirements against floatation. At the face/exit of the Pump Station, a small pressure relief air valve will have to be inevitably placed at the crown of the syphon just leaving the PS. This valve is included as part of the pump equipment.

Fatigue from tidal action is not an issue when the pipes are fully submerged, and the pipe circumferential wall stresses are minor when resisting the constant uplift in between concrete collars. This is also the case when storm surge arrives, because the pipe will remain further submerged. The pipe will however, need to be designed to resist stresses due to lateral submerged wave forces and uplift due to potential currents under the pipe. Fatigue from hurricane action is not significant due to its low frequency.

A check should be made for temperature stresses due to the brackish water being warmer at the top of the pipe vs below the pipe. The expansion coefficient for HDPE is about 1 inch per 10 degrees F per 100 LF of pipe.

Pipe Designed to be Byouyant with Tides

The main benefit of this alternative is to lessen the amount of dredging and backfill to otherwise sink the pipes. In this alternative, the pipes would float unstressed with the tides being restrained only by cable tie-downs to H-piles. Concrete collars would not be required, however there should be a bearing pad element designed and provided to lessen the concentrated stresses imparted by the cable during hurricanes. The cable would have guides attached to the bearing pad to maintain the pipes in a properly tethered position.

In this alternative, air relief valves are required to release air out of the pipes during a hurricane surge higher than the high tide. In this case, the cables are resisting the full uplift of the pipes plus the lateral wave forces acting on the pipe as well as any uplift from flowing water under the pipes.

The temperature check for this option is also required as the top of the pipe will always be exposed to the sun and the air temperature and UV rays.

Although this option appears to save on earthwork when compared with the submerged option, the submerged option results superior in terms of ability to withstand hurricane force waves and therefore durability. Cable tie-downs and H-pile anchors are also high maintenance items with a limited service life.

Quantities:

The following assumptions can be considered when looking at the quantities and cost to provide and install these pipes, please refer to Engineering Plates and quantity calculations:

- No information on cost is available for 14 ft spirolite. A new mandrel would have to be custom made and only after knowing the total amount of linear feet of pipe, would IPF Plasson be able to cost this out. Having said that, a cost can be approximated by the calculated weight of the Closed Cell pipe in lbs per LF. Forty-foot pipe sections would be welded in the dry and aligned for launching in the water. Bell and Spigot with extrusion welds are preferred.

- Dredging can occur in 2 stages to minimize earthwork: initially down to El. -12 to obtain a constant depth throughout. Pairs of H-piles spaced at 100 ft are then driven to locate the alignment of each pipe at the locations every 5th concrete collar. Then a second dredging effort would be localized at the pipeline invert thalweg to bring the depth to -16.

- Collars are made of two half circular precast pieces bolted at the spring line. During final design, a check needs to be made to assess the need to further anchor the pipes major bends and discrete locations to resist wave action. Locations like the discharge elbow will need to be secured and anchored to the ground.

- Assuming a tidal range from +1 to -1, precast concrete collars can be installed at 20 ft spacing as the pipeline is launched into the water. The entire line would be launched assembled with collars by keeping the pipe ends closed temporarily to obtain pipe buoyancy in route. Once the pipe is in correct alignment, the pipe ends can be removed, and the pipe alignment would be sunk down to a pre-dredged invert elevation of -16.

- Backfilled operations can then proceed in two stages: First a gravel backfill around the pipes to a few feet above the spring line of the pipes to secure them against lateral forces, followed by hydraulic backfilling using the native dredged materials to El. +1 or the prior original surrounding level.

- The elbow at the end turns the flow upward to dissipate energy and reduce erosion. The elbow would be supported off a pile supporting frame. The elbow would be made of solid double cell FRP wall material discharging at El +2. Riprap would surround the elbow to avoid local erosion.

- As a cost comparison, Vari-Tech has provided 157” (13 ft) diameter pipes in the past at a cost of about $1,600/LF. This does not account for FOB delivery. The cost of field welding 100 joints of this pipe is about $600,000. Each FRP elbow can be supplied at a cost of about $35,000 including anchoring platform.

- The durability of the Spirolite material has been estimted at 100 years and Vari-Tech can provide supporting aging reports

CALCULATIONS

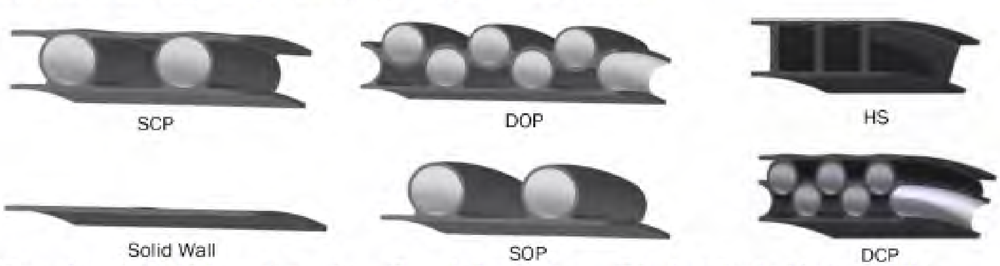
Mr. Roger Setya
Tetra Tech
3445 N. Causeway Blvd., Suite 320,
Metairie, LA 70002 August 16, 2018

Re: Sergio D. Gaitan, P.E.,
VARI-TECH is happy to present the following information regarding spirolite for Marine applications. VARITECH is an organization that has aided in the proper installation of HDPE for over 35 years. With the technical staff ranging through PhD's, PE's and technical sales representatives. We've done projects all over the world throughout many industries. As previously discussed we have done numerous Marine and sub aqueous installations of polyethylene pipes from outfalls, intake, conduits and more.

Project recap:
As previously discussed on the telephone we are investigating the likelihood of upgrading our current line of 12 foot diameter to accommodate your job in Galveston Texas of 14 foot diameter polyethylene pipe. Much of the below pictures and discussion would be based off of previous projects we've done ranging throughout sizes up to the 10 foot diameter range. This will give a brief outline of ideas and details for installation. As this is figured to be iterative process as more details arise from your firm as well as our manufacture so will the tactics found below.

As we discussed I would propose installing the system as a static fixed pipeline. This is meant that the line is weighted or pinned in one location preferably under low tide location. By providing a line that is pinned or weighted properly line is constrained reducing its movement thereby reducing the ability of abrasion or dynamic forces acting on the pipe or its effects apparatuses such as pipe clamps or settles. This will not only make for a lower risk lifecycle to the pipe but also reduce maintenance costs on cables, beams or other members that would be used to allow free movement of the line.

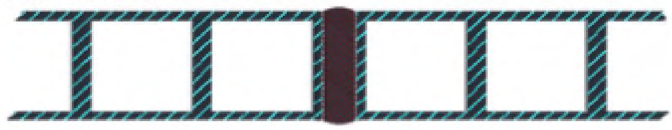
Pipe material:
The thought is to use the spirolite line to produce a watertight conduit of 14 foot inside diameter. A line will be constructed out of PE 4710 resin capable of being welded on the inside and out to handle tensile and bending of a full submergence application. The pipe profile has not yet been determined and may range from any of the profile shown below.



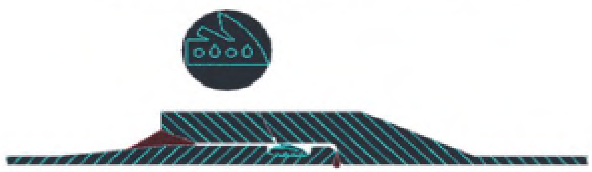
When choosing which configuration will work the best we will look at the inside layer(ID) to provide sufficient abrasion protection found from the organics and silts existing in the Galveston Bay. This layer will also aid in the structural stability for the installation process preventing against buckling during bending or tensile during deployment. The ribs of the pipe will add hoop stiffness which will help support the pipe and poor soil conditions and aid in the control of

deflection in sediment buildup around and on top of the pipe.

Connection methods:
The connection methods for spirolite would be a form of welding on the interior as well as the exterior. The bell and spicket may be utilized if they can be accommodated and tested in the 14 inch size. Bells and spicket's make for easy alignment during the welding process and creatively tight seal up to 25 feet head. An example of two configurations of welding close profile(HS or SCP) is as shown below.



Spirolite HS Thermal Welded Profile Ends



Spirolite Thermal Welded Bell and Spigot Joint

Each method utilizes extruded molten polyethylene to create a structural weld as well as leak tight seal. This is done utilizing extrusion welder or an automated extrusion welder as shown below.

Ballast blocks:

After the joint is completed ballast block would be installed on shore most preferably covering her overlapping the welded area. At this time we do not know the spacing or the size of the blocks as we are investigating the 14 foot upsize and the wall profile that would be used. Below is a standard concrete anchor which has typically been used on previous projects.

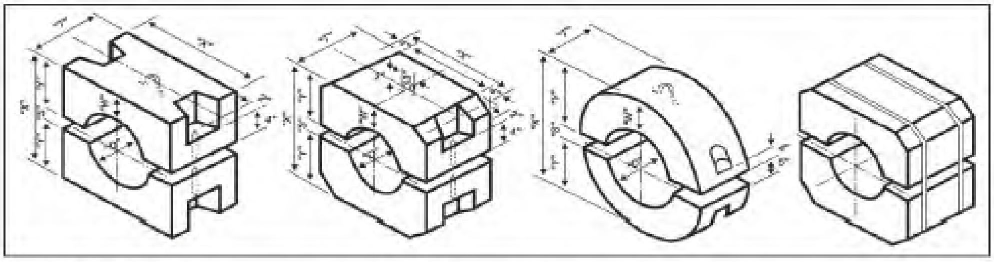


Figure A-3-1 Schematics of Concrete Ballast Designs

As previously discussed the weight of these blocks would be altered for this application. The 7" width would be much wider as well as the gap in between the weights. As previously discussed we will be working to give you a rough estimate on the overall size and placement of these blocks after we have worked with plasson to determine the feasibility of construction and anticipated wall configuration. For example of a previous project we've done, see the example of the 42 inch line deployed in New Jersey.

Deployment:

After each section is welding and ballast blocks are installed the pipe will be pushed out into the water being controlled by a boat or barge to help pull up in its intended location. Below is a picture of a large diameter spirolite line being deployed out into the waterway.

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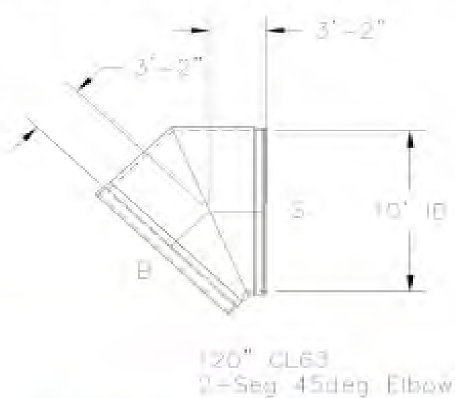
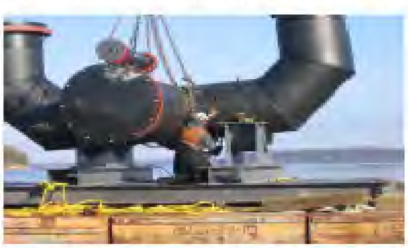
Pipeline diffuser:

As we previously discussed if we can accommodate 14 foot diameter pipe with low enough velocities would be low enough to leave the line open ended with a 45. The 45 will be utilized to point up out of the sediment and allow for a free dispersion of particle discharge during pumping. To give you a rough magnitude size our typical 45 please see the below sketch of one of our 10 feet two segment elbows.



This elbow can be orientated vertically off the bottom and supported using an FRP fiberglass skid. Extension or pop could be added to gain your desired length to ensure it's up out of the sediment. Example of this can be seen below from one of our previous projects.



Closing remarks:

As we have found before with many Marine projects there are many different installation tactics for the actual sinking of the HDPE. The success of the tactic chosen depends on the knowledge of your project partners and the resources available to the installer. One of the major importance while taking on endeavor such as this is to qualify the rate team members to provide a proper and safe installation. As this project progresses VARI-TECH would be happy to aid your firm in the technical support of HDPE as well as help you find qualified contractors for technical installation questions as well as possible budgets if needed.

CALCULATIONS

SDG
Nov 9, 2018

Bouyancy on the pipes.

Wt. of a double cell Spirolite 13' ϕ = 644 lbs/LF
└ Varitech max available information w/5" wall thickness

Extrapolate wt. of 14' ϕ

$\frac{644}{\pi \cdot 13} = 15.78$ lb/LF circf.

$14 \cdot \pi \cdot 15.78 = \underline{693}$ lb/LF pipe ↓ Wstr

Consider a 6" thick Double cell 14' ϕ

Uplift based on displacement:

$U = \frac{6''}{12} \times \pi * 14 \times 1' = 22$ sf. $\times 63$ lb/ft $= 1385$ lb/ft ↑

per ETC 1110-2-307

$$F.S. = \frac{W_{str} + \text{Surcharge}}{U} = 1.5$$
└ Normal operations

$1.5 = \frac{693 + S}{1385}$ ∴ $S = 1385$ lbs ↓

Volume of concrete $= \frac{1385}{(150 - 63)} = 15.91$ cf/LF pipe

× 20
318 cf of concrete/ring
÷ 27
11.8 CY of concrete/precast concrete ring

Tetra Tech	Pump Station - Discharge pipes and supports	Calculation No. CC-PS-ST-MT-004

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CALCULATIONS

SDG Nov 9 2018

EARTH WORK QTY: CLEAR CREEK P.S.

P.S. Discharge pipes

follow Dikinson Bayou approach.

Avg. ground EL. ~ 0.0 (some in shallow water, some in land to +3)

Avg length of pipes: 1,989 LF (see spreadsheet)

← 53702/27 pipes

Dredging:

Stage #1 to -12

24' x 12' x 1,989'/27 = 24,752 cy x 27 pipes = 572,832 cy

Stage #2 to -16

$(24+4)\frac{1}{2} \times 4 \times 1989/27 = 4125$ cy/pipe $\times 27 = 111{,}384$ cy

684,216 cy

Backfill

Stage #1: 4125 cy + 24 × 7 × 1989/27 − $\left[\frac{\pi}{4} \cdot 14^2 \times \frac{1989}{27} - \frac{25 \times 1989}{27}\right]$

to -5. = 7,008 cy × 27 pipes = 189,216 cy of gravel

stage #2

to Φ : 24 × 5 × 1989/27 − 25 × 1989/27 = 6,998 cy

× 27 pipes

$\boxed{188\,955 \text{ cy}}$

Clear Creek Precast Concrete Collar Quantity and Cost Estimates

Table of Contents

From: Kramer, Rob
To: Michael Luck
Subject: RE: Galveston Coastal Texas Restoration and Protection Project
Date: Friday, October 25, 2019 10:40:00 AM

Okay, that all makes sense. Yes, our contract should have a separate clause for offloading and handling the collars as well as other items shipped to the staging area. We anticipate having several cranes there to assist with that. That all being said, I think you covered everything we need for now with that estimate. Thank you again and we will be in contact if and when something comes up in relation to this project;.

Thank you,
Rob

From: Michael Luck [mailto:michael.luck@lockesolutions.com]
Sent: Friday, October 25, 2019 10:23 AM
To: Kramer, Rob <Rob.Kramer@tetratech.com>
Subject: RE: Galveston Coastal Texas Restoration and Protection Project

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That is one area that I think we can save lots of money – I put in for 1 truck per ½ a collar – in reality they only weigh around 24000 lbs so the odds of cutting down the weight a little more and getting both halves on a single truck is very high.
We are very close to Galveston. We ship there often. It's only 50-60 miles from our office

Other charges would be off loading at site – you would need a crane to handle – which I guess your contract that is installing the pipe would do that part.

Honestly – that's all I can think of – unless you are going to store them at a yard in Galveston before you install all the pipe

Michael Luck **** WE'VE MOVED! SEE OUR NEW ADDRESS BELOW AT 700 ALMEDA-GENOA ****

Vice President – Sales / Business Development |
Locke Solutions | 700 Almeda-Genoa Rd, Houston, TX 77047 |
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From: Kramer, Rob [mailto:Rob.Kramer@tetratech.com]
Sent: Friday, October 25, 2019 12:18 PM
To: Michael Luck
Subject: RE: Galveston Coastal Texas Restoration and Protection Project

Michael,

Thank you! We appreciate the quick turnaround as I realize we did not give you much lead time. As for the completeness of your estimate, it looks great for what we need now although more cost savings and a more refined design and estimate are always appreciated. We will be sure to keep you in the know as we refine our design and gather further information on the specs we must meet for the concrete collars and corresponding pipe. Finally, my only question with the estimate is with the standard flatbed load estimate and if it is for a roughly estimated flat fee to transport 6000 semi-circle concrete collars to Galveston or are there additional transportation fees not included in that line item?

Thank you,
Rob

From: Michael Luck [mailto:michael.luck@lockesolutions.com]
Sent: Friday, October 25, 2019 10:16 AM
To: Kramer, Rob <Rob.Kramer@tetratech.com>
Subject: RE: Galveston Coastal Texas Restoration and Protection Project

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Sorry
Didn't put in the correct quantity

Revised

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---

From: Kramer, Rob [mailto:Rob.Kramer@tetratech.com]
Sent: Thursday, October 24, 2019 3:46 PM
To: Michael Luck
Subject: RE: Galveston Coastal Texas Restoration and Protection Project

Michael,

Thank you for the update. That is fine. Could you possibly just give an estimate with the green epoxy applied to the rebar instead of the purple?

Thank you,
Rob

From: Michael Luck [mailto:michael.luck@lockesolutions.com]
Sent: Thursday, October 24, 2019 1:44 PM
To: Kramer, Rob <Rob.Kramer@tetratech.com>
Subject: RE: Galveston Coastal Texas Restoration and Protection Project

⚠ **CAUTION:** This email originated from an external sender. Verify the source before opening links or attachments. ⚠

Rob,
Am going to miss my target date.. still waiting on rebar cost… purple evidently is not common here. They are working on it

Michael Luck **** WE'VE MOVED! SEE OUR NEW ADDRESS BELOW AT 700 ALMEDA-GENOA ****

Vice President – Sales / Business Development |
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http://lockesolutions.com |

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From: Kramer, Rob [mailto:Rob.Kramer@tetratech.com]
Sent: Monday, October 21, 2019 5:21 PM
To: Michael.Luck@lockesolutions.com
Subject: Galveston Coastal Texas Restoration and Protection Project

Hi Michael,

My name is Rob Kramer, the staff engineer at Tetratech over in Bellevue, Washington, who called you today. I found your email on your company's website after I forgot to ask for it before we concluded our call. Anyways, I thought I would follow-up with an email to recap some of what I said and to answer some of your questions from our call. Here is an overall of what we are looking for:

- Project/Location: Coastal Texas Protection and Restoration / Galveston, Texas
- Project Phase: Environmental Impact Study (EIS)~ Feasibility Assessment's Quantity and Cost Takeoff, Design Finalization ~ 3-5 Years
- Two piece concrete collar that can support a 14' diameter Spirolite (corrugated plastic) pipe
- Estimated Cubic Yardage per Item = 11.8 CY
- One Project Site's Estimated Number of Collars (Two C Section Pieces per Collar) = 3,000 Collars
- One Project Site's Total Estimated Cubic Yardage of Precast Concrete = 35,400 CY
- Total Project's Estimated Number of Collars = 8,000 Collars
- Total Project's Total Estimated Cubic Yardage of Precast Concrete = 95,000 CY
- Total Length of Pipe for One Project Site: 60,000 feet
- Total Estimated Length of Pipe for Project: 140,000 feet

Reinforcement to be used for estimate: epoxy coated rebar (Purple Coating that meets ASTM A934/A934M requirements)

- Use: Weigh 14' Diameter Spirolite pipes down to ocean floor
- Collars are made of two half circular precast pieces bolted at the spring
- Precast concrete collars can be installed at 20 ft spacing as the pipeline is launched into the water. The entire line would be launched assembled with collars by keeping the pipe ends closed temporarily to obtain pipe buoyancy in route. Once the pipe is in correct alignment, the pipe ends can be removed, and the pipe alignment would be sunk down to a pre-dredged invert elevation of -16.
- Target Date for Estimate: Thursday Oct. 24th, 2019

In addition, I have attached some pictures and diagrams to assist you in determining an appropriate design. Some questions that I also forgot to ask are listed below:

- Could you provide an estimated delivery cost per item in addition to the material and manufacturing cost per collar?
- What would be the recommended delivery method?

Besides that information and those questions, please let me know if you need clarification with anything else in regards to the collars or project. Thank you and I look forward to hearing from you in the near future.

Thank you,
Rob

Locke Solutions
700 Almeda-Genoa Rd
Houston, TX 77047
Phone: (832) 804-7062
Fax: (832) 804-7071

QUOTE

Quote #: 19-8146 **Terms:** C.O.D.
Order Date: 10/23/2019

Customer Copy

Bill to: All Bidders
,

Delivery to: Tetratech - Galveston
,

Contact:
Phone : **Fax:**

Project Manager:
Phone : **Fax:**

Customer ID: ALL **PO:** **ShipVia:** **Sales Rep:** M Luck

Qty	Item	Description	Weight	Unit F/H	Unit Price	TX	Extension
Structure: ☐ **del**		**Foundation**		**Station:**			
6000	D100	Standard Flatbed Load	0				
							$3,900,000.00
Structure: ☐ **PH**		**Foundation**		**Station:**			
3000	MH902	220'' x 110'' x 23'' pipe hold down block w/ pipe block out, epoxy rebar, and SS all thread	72,947,910				
3000	MH902	220'' x 110'' x 23'' pipe hold down block w/ pipe block out, epoxy rebar A934, and SS all thread	72,947,910				
12000	S910	1-1/2" x 144" 304 SS all thread w/ 2 washer and 2 nuts	492,000				
							$78,000,000.00
		Total Weight	146,387,820				

Taxable	$81,900,000.00
Non-Taxable	$0.00
Sub Total	$81,900,000.00
Tax	$6,756,750.00
Total	$88,656,750.00

Pricing Includes Delivery of All Materials to Jobsite. Customer Responsible for Offloading Unless Noted Otherwise

Concrete Compressive Strengths at 28 Days to Exceed 5,500 PSI. Fresh Concrete Testing & Cylinder Breaks Performed by ACI Certified QC Tech.

The above does not include applicable federal, state, or local taxes. Taxes may be billed without receipt of tax exemption form. Price good for 30 days from date of this quote.

Payment Terms for Project Specific Engineered Products - 25% Due Upon Approved Drawings In Order to Start Production, 25% Due In Order to Release Shipment of Product, Balance Due Net 30 Upon Receipt of Product at Jobsite. The Products Listed in this Paragraph are Custom and Not Subject for Return or Cancellation Once Fabrication Has Begun.
Payment Terms for Standard Products - Net 30 Upon Receipt of Product at Jobsite.

Locke Solutions reserves the right to invoice for stored materials and/or to charge a storage fee for any and all items that do not show substantial shipping progress or prior arrangements being made.

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Project:	Coastal Texas Protection & Restoration						
Job No.	100-WTR-18-09-1						
Description:	Clear Creek Navigation Approach Walls						
	- Clear Creek Quantity Takeoff						
Computed:	*RSK*	**Date:**	*12-Oct-19*	**Checked:**	*0*	**Date:**	*0-Jan-00*

Clear Creek Quantity Takeoff

Component: **Precast Concrete Collars**

Precast Concrete Collars at 20' oc:	2,685	EA	11.8 CY EA circumferential
Precast Concrete Collars at 20' oc:	31,683	CY	

* Collars are made of two half circular precast pieces bolted at the psring line to weight down the pipes

* Assuming a tidal range from +1 to -1, precast concrete collars can be installed at 20 ft spacing as the pipeline is launched into the water. The entire line would be launched assembled with collars by keeping the pipe ends closed temporarily to obtain pipe buoyancy in route.

* Pairs of H-piles spaced with every 5th concrete collar

Component: **Discharge Pipe (Spirolite)**

Diameter:	14.00	ft	
Length:	60,000	ft	
Dry Welding:	895	EA	at 60 feet
End Elbows:	27	EA	
Pressure Releif Air Valve:	27	EA	

TETRA TECH	Pump Station - Discharge pipes and supports	Calculation No. CC-PS-ST-MT-004

Job No.:	100-RCE-18-09-1			**Page:**	1
Project:	Coastal Texas Protection and Restoration				
Description:	Pump Station - Discharge pipes and supports				
Made By:	SDG	**Date:** Nov-07-2018	**Chk'd By:** LRM	**Date:**	11/09/18

Calc Body Pages	Appended Pages	Total Pages
4	11	15

Document code

Site	Feature	Discipline	Document type	Number
CC	PS	ST	MT	004

Revision History

Rev #	Preparer (printed name, date and signature)	Reviewer (printed name, date and signature)	Revision Description
A	Sergio Gaitan 11/09/18 Hais Hoesch for Sergio Gaitan	Leo Moyer 11/09/18 Hais Hoesch for Leo Moyer	Initial for review

TETRA TECH	**Pump Station - Discharge pipes and supports**		**Calculation No.** **CC-PS-ST-MT-004**

Job No.:	100-RCE-18-09-1					**Page:**	2
Project:	Coastal Texas Protection and Restoration						
Description:	Clear Creek Pump Station - Discharge pipes and supports						
Made By:	SDG	**Date:**	Nov-07-2018	**Chk'd By:**	LRM	**Date:**	11/09/18

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REMOVE UNUSED LINES

TETRA TECH	**Pump Station - Discharge pipes and supports**	**Calculation No. CC-PS-ST-MT-004**

Job No.:	100-RCE-18-09-1					**Page:**	3
Project:	Coastal Texas Protection and Restoration						
Description:	Clear Creek Pump Station - Discharge pipes and supports						
Made By:	SDG	**Date:** Nov-07-2018		**Chk'd By:**	LRM	**Date:**	11/09/18

ISSUE BEING ADDRESSED

Quantities are provided for the Spirolite discharge pipes

APPROACH

Quantities are based on the "sunk" approach for installing the pipes in the outfall channel.

REFERENCES

References used during this calculation are as follows:

1) ETL-1110-2-307 Flotation Stabilty Criteria

RESULTS / CONCLUSIONS

Clear Creek Bayou Pump Station

Spirolite pipe 14 ft diameter:	53,702	LF	Double closed cell type
Dry welding of Bell & Spigot joints	895	EA at 60 feet	
End elbows, FRP:	27	EA	Provide support H pile frame
Precast Concrete collars at 20' oc	2,685	EA	11.8 CY EA circumferential
Precast Concrete collars at 20' oc	31,683	CY	
Dredging Stage 1 to El -12:	572,832	CY	
Thalweg dredging Stage 2 to El -16:	111,384	CY	
Backfill 1 - gravel to El -5:	189,216	CY	
Backfill 2 - reuse dredged material to El +0:	188,955	CY	
Pressure relief air valve	27	EA	

Does not include property acquisition nor demolition of existing homes and structures.

Job No.:	100-RCE-18-09-1					**Page:**	4
Project:	Coastal Texas Protection and Restoration						
Description:	Clear Creek Pump Station - Discharge pipes and supports						
Made By:	SDG	**Date:**	Nov-07-2018	**Chk'd By:**	LRM	**Date:**	11/09/18

ASSUMPTIONS / INPUTS

Assumptions made during this calculation are as follows:

The following assumptions can be considered when looking at the quantities and cost to provide and install these pipes, please refer to Plates in Engineering Appendix:

• Dredging can occur in 2 stages to minimize earthwork: initially down to El. -12 to obtain a constant depth throughout. Then a second dredging effort would be localized at the pipeline invert thalweg to bring the depth to -16.

• Collars are made of two half circular precast pieces bolted at the spring line to weigh down the pipes.

• Assuming a tidal range from +1 to -1, precast concrete collars can be installed at 20 ft spacing as the pipeline is launched into the water. The entire line would be launched assembled with collars by keeping

• Backfill operations can then proceed in two stages: First a gravel backfill around the pipes to a few feet above the spring line of the pipes to -5, to secure them against lateral forces, followed by hydraulic

• The elbow at the end turns the flow upward to dissipate energy and reduce erosion. The elbow would be supported off a pile supporting frame. The elbow would be made of solid double cell FRP wall material discharging at El +2. Riprap would surround the elbow to avoid local erosion.

• The Factor of Safety against buoyancy is 1.5 per ETL 1110-2-307 for normal operation.

ITEMS TO BE VERIFIED

The following items are to be verified in a later design phase:

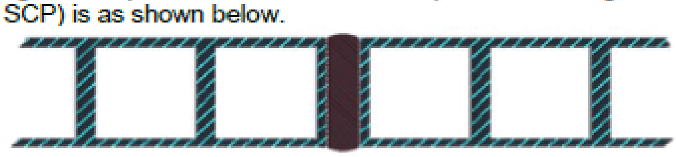
1) No information on cost is available for 14 ft spirolite. A new mandrel would have to be custom made and only after knowing the total amount of linear feet of pipe, would IPF Plasson be able to cost this out. Having said that, a cost can be approximated by the calculated weight of the Closed Cell pipe in lbs per LF. Sixty-foot pipe sections would be welded in the dry and aligned for launching in the water. Bell and Spigot with extrusion welds are preferred.

2) As a cost comparison, Vari-Tech has provided 157” (13 ft) diameter pipes in the past at a cost of about $1,600/LF. This does not account for FOB delivery. The cost of field welding 100 joints of this pipe is about $600,000. Each FRP elbow can be supplied at a cost of about $35,000. This information needs to be confirmed for a 14 ft diameter pipe system.

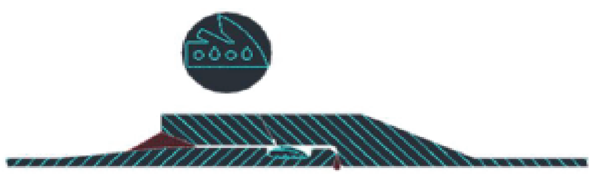
3) The durability of the Spirolite material needs to be confirmed at 100 years and Vari-Tech may be able to provide supporting aging reports.

deflection in sediment buildup around and on top of the pipe.

Connection methods:
The connection methods for spirolite would be a form of welding on the interior as well as the exterior. The bell and spicket may be utilized if they can be accommodated and tested in the 14 inch size. Bells and spicket's make for easy alignment during the welding process and creatively tight seal up to 25 feet head. An example of two configurations of welding close profile(HS or SCP) is as shown below.



Spirolite HS Thermal Welded Profile Ends



Spirolite Thermal Welded Bell and Spigot Joint

Each method utilizes extruded molten polyethylene to create a structural weld as well as leak tight seal. This is done utilizing extrusion welder or an automated extrusion welder as shown below.

Ballast blocks:

After the joint is completed ballast block would be installed on shore most preferably covering her overlapping the welded area. At this time we do not know the spacing or the size of the blocks as we are investigating the 14 foot upsize and the wall profile that would be used. Below is a standard concrete anchor which has typically been used on previous projects.

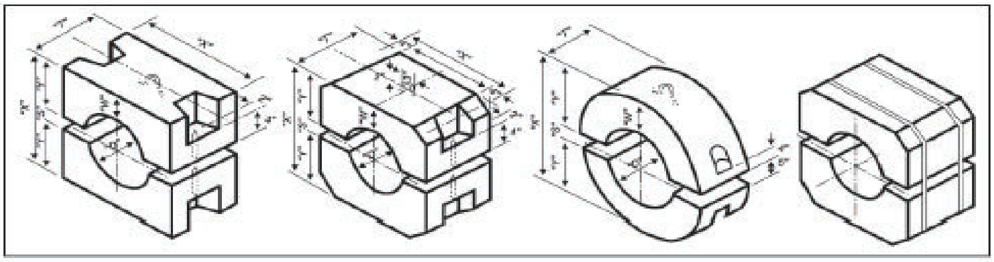


Figure A-3-1 Schematics of Concrete Ballast Designs

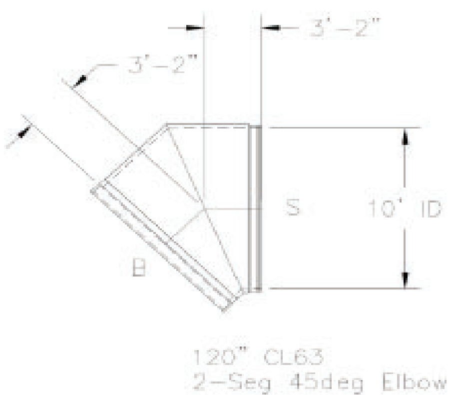
As previously discussed the weight of these blocks would be altered for this application. The 7" width would be much wider as well as the gap in between the weights. As previously discussed we will be working to give you a rough estimate on the overall size and placement of these blocks after we have worked with plasson to determine the feasibility of construction and anticipated wall configuration. For example of a previous project we've done, see the example of the 42 inch line deployed in New Jersey.

Deployment:

After each section is welding and ballast blocks are installed the pipe will be pushed out into the water being controlled by a boat or barge to help pull up in its intended location. Below is a picture of a large diameter spirolite line being deployed out into the waterway.

Pipeline diffuser:

As we previously discussed if we can accommodate 14 foot diameter pipe with low enough velocities would be low enough to leave the line open ended with a 45. The 45 will be utilized to point up out of the sediment and allow for a free dispersion of particle discharge during pumping. To give you a rough magnitude size our typical 45 please see the below sketch of one of our 10 feet two segment elbows.



This elbow can be orientated vertically off the bottom and supported using an FRP fiberglass skid. Extension or pop could be added to gain your desired length to ensure it's up out of the sediment. Example of this can be seen below from one of our previous projects.

Attachment 11

Estimated Production Rates

TITLE:	Coastal Texas Protetion and Restoration Study	
SUBJECT:	Output Rates for Earthwork	
MADE BY:	SKV	JOB NO.:
CHECKED BY:		DATE: 12/10/2019

FILL AND COMPACT FILL
[Front End Loader, Compactor]

CREW:	Z Fill and Compact Crew	5 crew members
PRODUCTION		
	3 cy bucket	
	0.85 % fill	
	50 min/hr	
	0.8 cycle/min	
Output	102.0 cy/crew hr	102 cy/crew hr →

EXCAVATE TO STOCKPILE
[2.5-cy Hydraul. Excav.]

CREW:	Z 2.5-cy Excavator Crew	4 crew members
PRODUCTION		
	2.5 cy bucket	
	0.85 % fill	
	50 min/hr	
	1 cycle/min	
Output	106.3 cy/crew hr	106 cy/crew hr →

PLACE COFFERDAM FILL
[Hydraul. Excavat.]

CREW:	Z Riprap Crew	2 crew members
PRODUCTION		
	2.5 cy bucket	
	0.85 % fill	
	55 min/hr	
	1.2 cycle/min	
Output	140.3 cy/crew hr	140 cy/crew hr →

EXCAVATE COFFERDAM FILL
[2.5-cy Excavator Crew]

CREW:	Z 2.5-cy Excavator Crew	4 crew members
PRODUCTION		
	2.5 cy bucket	
	0.85 % fill	
	50 min/hr	
	0.75 cycle/min	
Output	79.7 cy/crew hr	80 cy/crew hr →

TITLE:	Coastal Texas Protetion and Restoration Study		
SUBJECT:	Output Rates for Earthwork		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	12/10/2019

PLACE RIPRAP
[Hydraul. Excavat.]

CREW: Z Riprap Crew — 2 crew members

PRODUCTION

2.5	cy bucket
0.7	% fill
50	min/hr
0.4	cycle/min

Output 35.0 cy/crew hr → 35 cy/crew hr

TITLE:	Coastal Texas Protetion and Restoration Study		
SUBJECT:	Output Rates for Hauling Earth		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	12/10/2019

CSI TASK:

LOAD AND HAUL EXCESS EARTHEN MATERIAL
[25-miles, 16-cy truck]

CREW NAME: *Z Load and Haul Earth Crew* 15 crew members

OVERALL PRODUCTION RATE **140 cy/crew hr** →

LOADING

SUB-CREW: Loading Crew 2 crew members

PRODUCTION

2	cy bucket
0.85	% fill
55	min/hr
1.50	cycle/min

140 cy/crew hr — 140 cy/crew hr →

1.00 crews/equipment members to match overall production rate

1.00 total number of crews needed

HAUL TO DISPOSAL SITE

SUB-CREW: Truck Haul Crew 1 crew members

PRODUCTION

16	cy truck
0.95	% fill
6.8	min. for loading
25	mi. to disposal location
35	mph haul speed
3.4	min. dump time
55	min/hr

QUANTITY PER TRUCK 15.2 cy/truck

DURATION OF HAULING 1.75 hr

8.7 cy/hr →

13.00 Number of truck crews required to have little or no back up on route

TITLE:	Coastal Texas Protetion and Restoration Study	
SUBJECT:	Output Rates for Asphalt Hauling	
MADE BY:	SKV	JOB NO.:
CHECKED BY:		DATE: 12/10/2019

Sheet No. 1 of 2

CSI TASK:

LOAD AND HAUL EXCESS EARTHEN MATERIAL
[25-miles, 16-cy truck]

CREW NAME: *Z Load and Haul Earth Crew* 15 crew members

OVERALL PRODUCTION RATE **140 cy/crew hr** →

LOADING

SUB-CREW: Loading Crew 2 crew members

PRODUCTION

2	cy bucket
0.85	% fill
55	min/hr
1.50	cycle/min

140 cy/crew hr → 140 cy/crew hr

1.00 crews/equipment members to match overall production rate

1.00 total number of crews needed

Sheet No. 2 of 2

HAUL TO DISPOSAL SITE

SUB-CREW: Truck Haul Crew 1 crew members

PRODUCTION

16	cy truck
0.95	% fill
6.8	min. for loading
25	mi. to disposal location
35	mph haul speed
3.4	min. dump time
55	min/hr

QUANTITY PER TRUCK 15.2 cy/truck

DURATION OF HAULING 1.75 hr

8.7 cy/hr →

13.00 Number of truck crews required to have little or no back up on route

TITLE:	Coastal Texas Protetion and Restoration Study		
SUBJECT:	Output Rates for Gravel Hauling		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	12/10/2019

Sheet No. 1 of 2

CSI TASK:

LOAD AND HAUL EXCESS EARTHEN MATERIAL
[25-miles, 16-cy truck]

CREW NAME: *Z Load and Haul Earth Crew* 15 crew members

OVERALL PRODUCTION RATE **140 cy/crew hr** →

LOADING

SUB-CREW: Loading Crew 2 crew members

PRODUCTION

2	cy bucket
0.85	% fill
55	min/hr
1.50	cycle/min

140 cy/crew hr → 140 cy/crew hr

1.00 crews/equipment members to match overall production rate

1.00 total number of crews needed

Sheet No. 2 of 2

HAUL TO DISPOSAL SITE

SUB-CREW: Truck Haul Crew 1 crew members

PRODUCTION

16	cy truck
0.95	% fill
6.8	min. for loading
25	mi. to disposal location
35	mph haul speed
3.4	min. dump time
55	min/hr

QUANTITY PER TRUCK 15.2 cy/truck

DURATION OF HAULING 1.75 hr

8.7 cy/hr →

13.00 Number of truck crews required to have little or no back up on route

TITLE:	Coastal Texas Protetion and Restoration Study		
SUBJECT:	Output Rates for Discharge Pipe Placement		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	12/10/2019

14' DISCHARGE PIPE, LAND PLACEMENT

CREW:	Z Discharge Pipe Crew (Land)	5 crew members
PRODUCTION		
	8 ft of pipe	
	40 min/hr	
	180 min/cycle	
Output	1.8 ft/crew hr	1.8 ft/crew hr

14' DISCHARGE PIPE, BARGE PLACEMENT

CREW:	Z Discharge Pipe Crew (Barge)	9 crew members
PRODUCTION		
	8 ft of pipe	
	35 min/hr	
	360 min/cycle	
Output	0.8 ft/crew hr	0.8 ft/crew hr

TITLE:	Coastal Texas Protetion and Restoration Study		
SUBJECT:	Output Rates for Concrete Placement		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	12/10/2019

CONCRETE PLACEMENT BY BARGE

CREW: Z Concrete Placement Crew (Barge) — 9 crew members

PRODUCTION

1	cy of concrete
50	min/hr
0.15	cycle/min

Output 7.5 lbs/crew hr → 7.5 lbs/crew hr

TITLE:	Coastal Texas Protetion and Restoration Study		
SUBJECT:	Output Rates Steel Steel Pile Placement		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	12/10/2019

24" STEEL PIPE PILE, PLACEMENT
[Battered]

CREW: Z Pile Driving Crew — 8 crew members

PRODUCTION

1	vlf of pile
50	min/hr
0.7	cycle/min

Output 35.0 vlf/crew hr → 35.0 vlf/crew hr

STEEL SHEET PILE, INSTALLATION
[PZ-22]

CREW: Z Pile Driving Crew — 8 crew members

PRODUCTION

1	sf of sheet pile
50	min/hr
2.4	cycle/min

Output 120.0 sf/crew hr → 120.0 sf/crew hr

18" STEEL PIPE PILE, PLACEMENT
[Battered]

CREW: Z Pile Driving Crew — 8 crew members

PRODUCTION

1	vlf of pile
50	min/hr
0.8	cycle/min

Output 40.0 vlf/crew hr → 40.0 vlf/crew hr

6" SQUARE CONCRETE PILE, PLACEMENT

CREW: Z Pile Driving Crew — 8 crew members

PRODUCTION

1	vlf of pile
50	min/hr
1.8	cycle/min

Output 90.0 vlf/crew hr → 90.0 vlf/crew hr

TITLE:	Coastal Texas Protetion and Restoration Study		
SUBJECT:	Output Rates Steel Steel Pile Placement		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	12/10/2019

24" STEEL PIPE PILE, PLACEMENT

CREW: Z Pile Driving Crew — 8 crew members

PRODUCTION

1	vlf of pile
50	min/hr
0.8	cycle/min

Output 40.0 vlf/crew hr → 40.0 vlf/crew hr

42" CYLINDER PILE, PLACEMENT [Battered]

CREW: Z Pile Driving Crew — 8 crew members

PRODUCTION

1	vlf of pile
50	min/hr
0.5	cycle/min

Output 25.0 vlf/crew hr → 25.0 vlf/crew hr

STEEL SHEET PILE, INSTALLATION [PS-31]

CREW: Z Pile Driving Crew — 8 crew members

PRODUCTION

1	sf of sheet pile
50	min/hr
2.2	cycle/min

Output 110.0 sf/crew hr → 110.0 sf/crew hr

STEEL SHEET PILE, INSTALLATION [PZ-27]

CREW: Z Pile Driving Crew — 8 crew members

PRODUCTION

1	sf of sheet pile
50	min/hr
2.3	cycle/min

Output 115.0 sf/crew hr → 115.0 sf/crew hr

TITLE:	Coastal Texas Protetion and Restoration Study		
SUBJECT:	Output Rates Steel Steel Pile Placement		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	12/10/2019

STEEL SHEET PILE, INSTALLATION
[PZC-13]

CREW: Z Pile Driving Crew — 8 crew members

PRODUCTION

	1	sf of sheet pile
	50	min/hr
	2.4	cycle/min
Output	120.0	sf/crew hr

120.0 sf/crew hr

TITLE:	Coastal Texas Protetion and Restoration Study		
SUBJECT:	Output Rates for Sector Gate Steel Installation		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	12/10/2019

SECTOR GATE STEEL INSTALLATION

CREW: Z Sector Gate Steel Crew — 10 crew members

PRODUCTION

50 min/ton

Output — 1.200 ton/hr

TITLE:	Coastal Texas Protetion and Restoration Study		
SUBJECT:	Output Rates for Directional Drilling		
MADE BY:	SKV	JOB NO.:	
CHECKED BY:		DATE:	12/10/2019

DIRECTIONAL DRILLING
[3" - 6" Dia.]

CREW: Z 3"-6" Boring Crew — 3 crew members

PRODUCTION

12 min/lf

Output 5.0 lf/hr

DIRECTIONAL DRILLING
[8" - 12" Dia.]

CREW: Z 4"-12" Boring Crew — 3 crew members

PRODUCTION

30 min/lf

Output 2.0 lf/hr

DIRECTIONAL DRILLING
[14" - 18" Dia.]

CREW: Z 12"-18" Boring Crew — 3 crew members

PRODUCTION

40 min/lf

Output 1.5 lf/hr

Attachment 12

Estimated O&M Costs

Clear Creek - Estimated O&M Costs

Item No.	Item Description	Cost per Occurrence	No. of Occurences	50-yr Total Cost	Comments/Assummptions
1	**T-wall (Type 1)**				
a	Quarterly Inspections	$ 2,500.00	200	$ 500,000	Inspecting full length of wall for major/visible damage
b	Annual Inspetions	$ 15,000.00	50	$ 750,000	Detailed inspection of both sides of wall
c	Wall Survey	$ 30,000.00	5	$ 150,000	Assumes detail survey of wall every 10-yrs to check ffor horizontal and vertical movement
d	Concrete Repairs	$ 15,000.00	5	$ 75,000	Assumes patching and repairing concrete spalls and other damage every 10 years.
				$ 1,475,000	**Total Cost**
				$ 29,500	**Annual Cost**
2	**T-wall (Type 2)**				
a	Quarterly Inspections	$ 2,500.00	200	$ 500,000	Inspecting full length of wall for major/visible damage
b	Annual Inspections	$ 15,000.00	50	$ 750,000	Detailed inspection of both sides of wall
c	Wall Survey	$ 30,000.00	5	$ 150,000	Assumes detail survey of wall every 10-yrs to check ffor horizontal and vertical movement
d	Concrete Repairs	$ 15,000.00	5	$ 75,000	Assumes patching and repairing concrete spalls and other damage every 10 years.
				$ 1,475,000	**Total Cost**
				$ 29,500	**Annual Cost**
3	**T-wall (Type 3)**				
a	Annual Inspections	$ 25,000.00	50	$ 1,250,000	Inspecting wall for damage via boat
b	Wall Survey	$ 50,000.00	5	$ 250,000	Assumes detail survey of wall every 10-yrs to check ffor horizontal and vertical movement via boat crews
c	Concrete Repairs	$ 25,000.00	5	$ 125,000	Assumes patching and repairing concrete spalls and other damage every 10 years.
				$ 1,625,000	**Total Cost**
				$ 32,500	**Annual Cost**
4	**Pump Station**				
a	Quarterly Inspections	$ 5,000.00	200	$ 1,000,000	Inspecting facility for minor damage and issues
b	Annual Inspections	$ 25,000.00	50	$ 1,250,000	Detailed inspection of full pump station facility for damage/issues
c	Pump Rehabilitation	$ 2,000,000.00	20	$ 40,000,000	Assumes 20 major pump rehabilitations over the 50-year project life
d	Pump Replacement	$ 17,000,000.00	10	$ 170,000,000	Assumes 10 pumps requiring full replacement over duration of project life
e	Pump Station Minor Maintenance	$ 50,000.00	50	$ 2,500,000	Assumes minor maintenance to the pump facility on an annual basis.
f	Pump Testing	$ 100,000.00	50	$ 5,000,000	Assumes annual testing of pumps.
g	Electrical Equipment Repair	$ 50,000.00	50	$ 2,500,000	Accounts for typical maintenance and repairs made to electrical components on an annual basis.
h	Manpower to Operate/Maintain	$ 200,000.00	50	$ 10,000,000	Assumes 4 workers at $50,000 per year to be onsite for operation and maintenance purposes.
i	Power Costs	$ 200,000.00	50	$ 10,000,000	Estimate of utility fees for the site
j	Discharge Pipe Repairs	$ 1,000,000.00	5	$ 5,000,000	Assumes repair of 200-ft of discharge pipes every 5-years
				$ 247,250,000	**Total Cost**
				$ 4,945,000	**Annual Cost**
5	**Sector Gate**				
a	Quarterly Inspections	$ 5,000.00	200	$ 1,000,000	Inspecting facility for minor damage and issues
b	Annual Inspections	$ 20,000.00	50	$ 1,000,000	Detailed inspection of full pump station facility for damage/issues
c	Hinge and Pintel Maintenance	$ 20,000.00	10	$ 200,000	Assumes greasing and other maintenance activities once every 10 years.
d	Hinge and Pintel Replacement	$ 850,000.00	1	$ 850,000	Assumes replacing the hinge and pintel once over lifespan of project
e	Recoat Steel	$ 50,000.00	2	$ 100,000	Assumes recoating sector gates once every 25-years.
f	Major Steel Replacement	$ 1,000,000.00	1	$ 1,000,000	Assumes major repairs of the sector gate steel one time during the 50 year project life
g	Control Building Maintenance	$ 20,000.00	50	$ 1,000,000	Typical maintenance of control building's structure and equipment.
h	Bulkhead Maintenance	$ 250,000.00	5	$ 1,250,000	Assumes major repairs and blasting and painting of maintenance bulkhead every 10 years.
				$ 6,400,000	**Total Cost**
				$ 128,000	**Annual Cost**
				$ 258,225,000	**Total O&M Costs for Clear Creek Facility**
				$ 5,164,500	**Total Annual O&M Costs**

Dickinson Bayou - Estimated O&M Costs

Item No.	Item Description	Cost per Occurrence	No. of Occurences	50-yr Total Cost	Comments/Assummptions
1	**T-wall (Type 1)**				
a	Quarterly Inspections	$ 2,500.00	200	$ 500,000	Inspecting full length of wall for major/visible damage
b	Annual Inspetions	$ 15,000.00	50	$ 750,000	Detailed inspection of both sides of wall
c	Wall Survey	$ 30,000.00	5	$ 150,000	Assumes detail survey of wall every 10-yrs to check ffor horizontal and vertical movement
d	Concrete Repairs	$ 15,000.00	5	$ 75,000	Assumes patching and repairing concrete spalls and other damage every 10 years.
				$ 1,475,000	**Total Cost**
				$ 29,500	**Annual Cost**
2	**T-wall (Type 2)**				
a	Quarterly Inspections	$ 2,500.00	200	$ 500,000	Inspecting full length of wall for major/visible damage
b	Annual Inspections	$ 15,000.00	50	$ 750,000	Detailed inspection of both sides of wall
c	Wall Survey	$ 30,000.00	5	$ 150,000	Assumes detail survey of wall every 10-yrs to check ffor horizontal and vertical movement
d	Concrete Repairs	$ 15,000.00	5	$ 75,000	Assumes patching and repairing concrete spalls and other damage every 10 years.
				$ 1,475,000	**Total Cost**
				$ 29,500	**Annual Cost**
3	**T-wall (Type 3)**				
a	Annual Inspections	$ 25,000.00	50	$ 1,250,000	Inspecting wall for damage via boat
b	Wall Survey	$ 50,000.00	5	$ 250,000	Assumes detail survey of wall every 10-yrs to check ffor horizontal and vertical movement via boat crews
c	Concrete Repairs	$ 25,000.00	5	$ 125,000	Assumes patching and repairing concrete spalls and other damage every 10 years.
				$ 1,625,000	**Total Cost**
				$ 32,500	**Annual Cost**
4	**Pump Station**				
a	Quarterly Inspections	$ 5,000.00	200	$ 1,000,000	Inspecting facility for minor damage and issues
b	Annual Inspections	$ 25,000.00	50	$ 1,250,000	Detailed inspection of full pump station facility for damage/issues
c	Pump Rehabilitation	$ 2,000,000.00	8	$ 16,000,000	Assumes 8 major pump rehabilitations over the 50-year project life
d	Pump Replacement	$ 17,000,000.00	4	$ 68,000,000	Assumes 10 pumps requiring full replacement over duration of project life
e	Pump Station Minor Maintenance	$ 50,000.00	50	$ 2,500,000	Assumes minor maintenance to the pump facility on an annual basis.
f	Pump Testing	$ 100,000.00	50	$ 5,000,000	Assumes annual testing of pumps.
g	Electrical Equipment Repair	$ 50,000.00	50	$ 2,500,000	Accounts for typical maintenance and repairs made to electrical components on an annual basis.
h	Manpower to Operate/Maintain	$ 200,000.00	50	$ 10,000,000	Assumes 4 workers at $50,000 per year to be onsite for operation and maintenance purposes.
i	Power Costs	$ 100,000.00	50	$ 5,000,000	Estimate of utility fees for the site
j	Discharge Pipe Repairs	$ 1,000,000.00	5	$ 5,000,000	Assumes repair of 200-ft of discharge pipes every 5-years
				$ 116,250,000	**Total Cost**
				$ 2,325,000	**Annual Cost**
5	**Sector Gate**				
a	Quarterly Inspections	$ 5,000.00	200	$ 1,000,000	Inspecting facility for minor damage and issues
b	Annual Inspections	$ 20,000.00	50	$ 1,000,000	Detailed inspection of full pump station facility for damage/issues
c	Hinge and Pintel Maintenance	$ 20,000.00	10	$ 200,000	Assumes greasing and other maintenance activities once every 10 years.
d	Hinge and Pintel Replacement	$ 850,000.00	1	$ 850,000	Assumes replacing the hinge and pintel once over lifespan of project
e	Recoat Steel	$ 50,000.00	2	$ 100,000	Assumes recoating sector gates once every 25-years.
f	Major Steel Replacement	$ 1,000,000.00	1	$ 1,000,000	Assumes major repairs of the sector gate steel one time during the 50 year project life
g	Control Building Maintenance	$ 20,000.00	50	$ 1,000,000	Typical maintenance of control building's structure and equipment.
h	Bulkhead Maintenance	$ 250,000.00	5	$ 1,250,000	Assumes major repairs and blasting and painting of maintenance bulkhead every 10 years.
				$ 6,400,000	**Total Cost**
				$ 128,000	**Annual Cost**
				$ 127,225,000	**Total O&M Costs for Clear Creek Facility**
				$ 2,544,500	**Total Annual O&M Costs**

Galveston Island - Estimated O&M Costs

Item No.	Item Description	Cost per Occurrence	No. of Occurences	50-yr Total Cost	Comments/Assummptions
1	**Pump Station 1**				
a	Quarterly Inspections	$ 5,000.00	200	$ 1,000,000	Inspecting facility for minor damage and issues
b	Annual Inspections	$ 25,000.00	50	$ 1,250,000	Detailed inspection of full pump station facility for damage/issues
c	Pump Rehabilitation	$ 500,000.00	5	$ 2,500,000	Assumes 5 major pump rehabilitations over the 50-year project life
d	Pump Replacement	$ 5,100,000.00	3	$ 15,300,000	Assumes 3 pumps requiring full replacement over duration of project life
e	Pump Station Minor Maintenance	$ 25,000.00	50	$ 1,250,000	Assumes minor maintenance to the pump facility on an annual basis.
f	Pump Testing	$ 50,000.00	50	$ 2,500,000	Assumes annual testing of pumps.
g	Electrical Equipment Repair	$ 25,000.00	50	$ 1,250,000	Accounts for typical maintenance and repairs made to electrical components on an annual basis.
h	Manpower to Operate/Maintain	$ 100,000.00	50	$ 5,000,000	Assumes 4 workers at $50,000 per year to be onsite for operation and maintenance purposes, split between two pump sites.
i	Power Costs	$ 100,000.00	50	$ 5,000,000	Estimate of utility fees for the site
				$ 35,050,000	**Total Cost**
				$ 701,000	**Annual Cost**
2	**Pump Station 2**				
a	Quarterly Inspections	$ 5,000.00	200	$ 1,000,000	Inspecting facility for minor damage and issues
b	Annual Inspections	$ 15,000.00	50	$ 750,000	Detailed inspection of full pump station facility for damage/issues
c	Pump Rehabilitation	$ 500,000.00	1	$ 500,000	Assumes 1 major pump rehabilitations over the 50-year project life
d	Pump Replacement	$ 5,100,000.00	2	$ 10,200,000	Assumes 2 pumps requiring full replacement over duration of project life
e	Pump Station Minor Maintenance	$ 25,000.00	50	$ 1,250,000	Assumes minor maintenance to the pump facility on an annual basis.
f	Pump Testing	$ 20,000.00	50	$ 1,000,000	Assumes annual testing of pumps.
g	Electrical Equipment Repair	$ 10,000.00	50	$ 500,000	Accounts for typical maintenance and repairs made to electrical components on an annual basis.
h	Manpower to Operate/Maintain	$ 100,000.00	50	$ 5,000,000	Assumes 4 workers at $50,000 per year to be onsite for operation and maintenance purposes, split between two pump sites.
i	Power Costs	$ 50,000.00	50	$ 2,500,000	Estimate of utility fees for the site
				$ 22,700,000	**Total Cost**
				$ 454,000	**Annual Cost**
3	**Pump Station 3**				
a	Quarterly Inspections	$ 5,000.00	200	$ 1,000,000	Inspecting facility for minor damage and issues
b	Annual Inspections	$ 25,000.00	50	$ 1,250,000	Detailed inspection of full pump station facility for damage/issues
c	Pump Rehabilitation	$ 500,000.00	5	$ 2,500,000	Assumes 5 major pump rehabilitations over the 50-year project life
d	Pump Replacement	$ 5,100,000.00	3	$ 15,300,000	Assumes 3 pumps requiring full replacement over duration of project life
e	Pump Station Minor Maintenance	$ 25,000.00	50	$ 1,250,000	Assumes minor maintenance to the pump facility on an annual basis.
f	Pump Testing	$ 50,000.00	50	$ 2,500,000	Assumes annual testing of pumps.
g	Electrical Equipment Repair	$ 25,000.00	50	$ 1,250,000	Accounts for typical maintenance and repairs made to electrical components on an annual basis.
h	Manpower to Operate/Maintain	$ 100,000.00	50	$ 5,000,000	Assumes 4 workers at $50,000 per year to be onsite for operation and maintenance purposes, split between two pump sites.
i	Power Costs	$ 100,000.00	50	$ 5,000,000	Estimate of utility fees for the site
				$ 35,050,000	**Total Cost**
				$ 701,000	**Annual Cost**
4	**Pump Station 4**				
a	Quarterly Inspections	$ 5,000.00	200	$ 1,000,000	Inspecting facility for minor damage and issues
b	Annual Inspections	$ 25,000.00	50	$ 1,250,000	Detailed inspection of full pump station facility for damage/issues
c	Pump Rehabilitation	$ 500,000.00	5	$ 2,500,000	Assumes 5 major pump rehabilitations over the 50-year project life
d	Pump Replacement	$ 5,100,000.00	3	$ 15,300,000	Assumes 3 pumps requiring full replacement over duration of project life
e	Pump Station Minor Maintenance	$ 25,000.00	50	$ 1,250,000	Assumes minor maintenance to the pump facility on an annual basis.
f	Pump Testing	$ 50,000.00	50	$ 2,500,000	Assumes annual testing of pumps.
g	Electrical Equipment Repair	$ 25,000.00	50	$ 1,250,000	Accounts for typical maintenance and repairs made to electrical components on an annual basis.
h	Manpower to Operate/Maintain	$ 100,000.00	50	$ 5,000,000	Assumes 4 workers at $50,000 per year to be onsite for operation and maintenance purposes, split between two pump sites.
i	Power Costs	$ 100,000.00	50	$ 5,000,000	Estimate of utility fees for the site
				$ 35,050,000	**Total Cost**
				$ 701,000	**Annual Cost**
4	**Stormwater Conduit**				
a	Quarterly Inspections	$ 5,000.00	200	$ 1,000,000	Inspecting facility for minor damage and issues
b	Annual Inspections	$ 25,000.00	50	$ 1,250,000	Detailed inspection of full pump station facility for damage/issues
c	Conduit Minor Maintenance	$ 25,000.00	50	$ 1,250,000	Minor repairs and clean outs of conduit
d	Conduit Repairs to Concrete	$ 1,500,000.00	5	$ 7,500,000	Major concrete repairs and cleanouts after large storme events
				$ 11,000,000	**Total Cost**
				$ 220,000	**Annual Cost**
				$ 138,850,000	**Total O&M Costs for Galveston Island Facilites**
				$ 2,777,000	**Total Annual O&M Costs**

Offats Bayou - Estimated O&M Costs

Item No.	Item Description	Cost per Occurrence	No. of Occurences	50-yr Total Cost	Comments/Assummptions
5	**Sector Gate**				
a	Quarterly Inspections	$ 5,000.00	200	$ 1,000,000	Inspecting facility for minor damage and issues
b	Annual Inspections	$ 20,000.00	50	$ 1,000,000	Detailed inspection of full pump station facility for damage/issues
c	Hinge and Pintel Maintenance	$ 20,000.00	10	$ 200,000	Assumes greasing and other maintenance activities once every 10 years.
d	Hinge and Pintel Replacement	$ 850,000.00	1	$ 850,000	Assumes replacing the hinge and pintel once over lifespan of project
e	Recoat Steel	$ 50,000.00	2	$ 100,000	Assumes recoating sector gates once every 25-years.
f	Major Steel Replacement	$ 1,000,000.00	1	$ 1,000,000	Assumes major repairs of the sector gate steel one time during the 50 year project life
g	Control Building Maintenance	$ 20,000.00	50	$ 1,000,000	Typical maintenance of control building's structure and equipment.
h	Bulkhead Maintenance	$ 250,000.00	5	$ 1,250,000	Assumes major repairs and blasting and painting of maintenance bulkhead every 10 years.
i	Site Staffing	$ 50,000.00	50	$ 2,500,000	Assumes 2 employees ($50k/yr) being available half time to maintain and operate the facility.
				$ 8,900,000	**Total Cost**
				$ 178,000	**Annual Cost**

Attachment 13

MCACES Summary Report

Estimated by Tetra Tech, Inc.
Designed by Tetra Tech, Inc.
Prepared by Tetra Tech, Inc
Preparation Date 2/20/2020
Effective Date of Pricing 2/20/2020
Estimated Construction Time Days

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
Project Cost Summary Report			**2,022,674,905**	**2,022,674,905**	
Coastal Texas Protection	**1.00**	**LS**	**2,022,674,905**	**2,022,674,905**	
01 Contract 1 - Clear Creek	**1.00**	**LS**	**1,082,139,537**	**1,082,139,537**	
01 01 Non-Federal Costs	**1.00**	**LS**	**23,133,903**	**23,133,903**	
01 01 02 Relocations	**1.00**	**LS**	**23,133,903**	**23,133,903**	
			23,133,902.76	*23,133,902.76*	
01 01 02 01 Utility and Pipeline Relocations	**1.00**	**EA**	**23,133,903**	**23,133,903**	
			73.38	*73.38*	
01 01 02 01 01 4-in Gas Line	**6,930.00**	**LF**	**508,556**	**508,556**	
			28.92	*28.92*	
Demolition	**3,465.00**	**LF**	**100,191**	**100,191**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	
Pipe Removal	**3,465.00**	**LF**	**97,936**	**97,936**	
			58.93	*58.93*	
Reconstruction	**6,930.00**	**LF**	**408,365**	**408,365**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			58.60	*58.60*	
Pipe Placement	**6,930.00**	**LF**	**406,110**	**406,110**	
			95.44	*95.44*	
01 01 02 01 02 6-in Gas Line	**9,600.00**	**LF**	**916,225**	**916,225**	
			28.73	*28.73*	
Demolition	**4,800.00**	**LF**	**137,924**	**137,924**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	
Pipe Removal	**4,800.00**	**LF**	**135,669**	**135,669**	
			81.07	*81.07*	
Reconstruction	**9,600.00**	**LF**	**778,301**	**778,301**	
			2,255.06	*2,255.06*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			80.84	*80.84*	
Pipe Placement	**9,600.00**	**LF**	**776,046**	**776,046**	
			95.51	*95.51*	
01 01 02 01 03 6-in Gas Line	**8,300.00**	**LF**	**792,763**	**792,763**	
			28.81	*28.81*	
Demolition	**4,150.00**	**LF**	**119,552**	**119,552**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	
Pipe Removal	**4,150.00**	**LF**	**117,297**	**117,297**	
			81.11	*81.11*	
Reconstruction	**8,300.00**	**LF**	**673,211**	**673,211**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			80.84	*80.84*	
Pipe Placement	**8,300.00**	**LF**	**670,956**	**670,956**	
			95.51	*95.51*	
01 01 02 01 04 6-in Gas Line	**8,290.00**	**LF**	**791,814**	**791,814**	
			28.81	*28.81*	
Demolition	**4,145.00**	**LF**	**119,411**	**119,411**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	
Pipe Removal	**4,145.00**	**LF**	**117,156**	**117,156**	
			81.11	*81.11*	
Reconstruction	**8,290.00**	**LF**	**672,403**	**672,403**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			80.84	*80.84*	
Pipe Placement	**8,290.00**	**LF**	**670,148**	**670,148**	
			130.17	*130.17*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
01 01 02 01 05 8-in Gas Line	**7,000.00**	**LF**	**911,181**	**911,181**	
			28.91	*28.91*	
Demolition	**3,500.00**	**LF**	**101,180**	**101,180**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	
Pipe Removal	**3,500.00**	**LF**	**98,925**	**98,925**	
			115.71	*115.71*	
Reconstruction	**7,000.00**	**LF**	**810,001**	**810,001**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			115.39	*115.39*	
Pipe Placement	**7,000.00**	**LF**	**807,746**	**807,746**	
			130.08	*130.08*	
01 01 02 01 06 8-in Gas Line	**8,100.00**	**LF**	**1,053,658**	**1,053,658**	
			28.82	*28.82*	
Demolition	**4,050.00**	**LF**	**116,726**	**116,726**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	
Pipe Removal	**4,050.00**	**LF**	**114,471**	**114,471**	
			115.67	*115.67*	
Reconstruction	**8,100.00**	**LF**	**936,932**	**936,932**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			115.39	*115.39*	
Pipe Placement	**8,100.00**	**LF**	**934,677**	**934,677**	
			233.79	*233.79*	
01 01 02 01 07 9-in Gas Line	**7,330.00**	**LF**	**1,713,663**	**1,713,663**	
			28.88	*28.88*	
Demolition	**3,665.00**	**LF**	**105,844**	**105,844**	
			2,255.06	*2,255.06*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	
Pipe Removal	**3,665.00**	**LF**	**103,589**	**103,589**	
			219.35	*219.35*	
Reconstruction	**7,330.00**	**LF**	**1,607,819**	**1,607,819**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			219.04	*219.04*	
Pipe Placement	**7,330.00**	**LF**	**1,605,564**	**1,605,564**	
			233.71	*233.71*	
01 01 02 01 08 10-in Gas Line	**8,400.00**	**LF**	**1,963,157**	**1,963,157**	
			28.80	*28.80*	
Demolition	**4,200.00**	**LF**	**120,965**	**120,965**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	
Pipe Removal	**4,200.00**	**LF**	**118,710**	**118,710**	
			219.31	*219.31*	
Reconstruction	**8,400.00**	**LF**	**1,842,192**	**1,842,192**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			219.04	*219.04*	
Pipe Placement	**8,400.00**	**LF**	**1,839,937**	**1,839,937**	
			276.70	*276.70*	
01 01 02 01 09 11-in Gas Line	**6,812.00**	**LF**	**1,884,863**	**1,884,863**	
			32.56	*32.56*	
Demolition	**3,406.00**	**LF**	**110,883**	**110,883**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			31.89	*31.89*	
Pipe Removal	**3,406.00**	**LF**	**108,628**	**108,628**	
			260.42	*260.42*	

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Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
Reconstruction	**6,812.00**	**LF**	**1,773,980**	**1,773,980**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			260.09	*260.09*	
Pipe Placement	**6,812.00**	**LF**	**1,771,725**	**1,771,725**	
			130.07	*130.07*	
01 01 02 01 10 7-in Petroleum Line	**8,270.00**	**LF**	**1,075,677**	**1,075,677**	
			28.81	*28.81*	
Demolition	**4,135.00**	**LF**	**119,128**	**119,128**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	
Pipe Removal	**4,135.00**	**LF**	**116,873**	**116,873**	
			115.66	*115.66*	
Reconstruction	**8,270.00**	**LF**	**956,549**	**956,549**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			115.39	*115.39*	
Pipe Placement	**8,270.00**	**LF**	**954,294**	**954,294**	
			130.08	*130.08*	
01 01 02 01 11 8-in Petroleum Line	**8,100.00**	**LF**	**1,053,658**	**1,053,658**	
			28.82	*28.82*	
Demolition	**4,050.00**	**LF**	**116,726**	**116,726**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	
Pipe Removal	**4,050.00**	**LF**	**114,471**	**114,471**	
			115.67	*115.67*	
Reconstruction	**8,100.00**	**LF**	**936,932**	**936,932**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			115.39	*115.39*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
Pipe Placement	**8,100.00**	**LF**	**934,677**	**934,677**	
			130.07	*130.07*	
01 01 02 01 12 8-in Petroleum Line	**8,300.00**	**LF**	**1,079,563**	**1,079,563**	
			28.81	*28.81*	
Demolition	**4,150.00**	**LF**	**119,552**	**119,552**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	
Pipe Removal	**4,150.00**	**LF**	**117,297**	**117,297**	
			115.66	*115.66*	
Reconstruction	**8,300.00**	**LF**	**960,011**	**960,011**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			115.39	*115.39*	
Pipe Placement	**8,300.00**	**LF**	**957,756**	**957,756**	
			233.79	*233.79*	
01 01 02 01 13 10-in Petroleum Line	**7,330.00**	**LF**	**1,713,663**	**1,713,663**	
			28.88	*28.88*	
Demolition	**3,665.00**	**LF**	**105,844**	**105,844**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	
Pipe Removal	**3,665.00**	**LF**	**103,589**	**103,589**	
			219.35	*219.35*	
Reconstruction	**7,330.00**	**LF**	**1,607,819**	**1,607,819**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			219.04	*219.04*	
Pipe Placement	**7,330.00**	**LF**	**1,605,564**	**1,605,564**	
			276.59	*276.59*	
01 01 02 01 14 12-in Petroleum Line	**8,160.00**	**LF**	**2,256,959**	**2,256,959**	
			32.45	*32.45*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
Demolition	**4,080.00**	**LF**	**132,379**	**132,379**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			31.89	*31.89*	
Pipe Removal	**4,080.00**	**LF**	**130,124**	**130,124**	
			260.37	*260.37*	
Reconstruction	**8,160.00**	**LF**	**2,124,580**	**2,124,580**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			260.09	*260.09*	
Pipe Placement	**8,160.00**	**LF**	**2,122,325**	**2,122,325**	
			234.34	*234.34*	
01 01 02 01 15 Unknown	**3,860.00**	**LF**	**904,555**	**904,555**	
			29.43	*29.43*	
Demolition	**1,930.00**	**LF**	**56,805**	**56,805**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	
Pipe Removal	**1,930.00**	**LF**	**54,550**	**54,550**	
			219.62	*219.62*	
Reconstruction	**3,860.00**	**LF**	**847,750**	**847,750**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			219.04	*219.04*	
Pipe Placement	**3,860.00**	**LF**	**845,495**	**845,495**	
			235.68	*235.68*	
01 01 02 01 16 Unknown	**1,800.00**	**LF**	**424,220**	**424,220**	
			30.77	*30.77*	
Demolition	**900.00**	**LF**	**27,693**	**27,693**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
Pipe Removal	**900.00**	**LF**	**25,438**	**25,438**	
			220.29	*220.29*	
Reconstruction	**1,800.00**	**LF**	**396,527**	**396,527**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			219.04	*219.04*	
Pipe Placement	**1,800.00**	**LF**	**394,272**	**394,272**	
			481.20	*481.20*	
01 01 02 01 17 18-in	**8,290.00**	**LF**	**3,989,112**	**3,989,112**	
			48.38	*48.38*	
Demolition	**4,145.00**	**LF**	**200,550**	**200,550**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			47.84	*47.84*	
Pipe Removal	**4,145.00**	**LF**	**198,295**	**198,295**	
			457.00	*457.00*	
Reconstruction	**8,290.00**	**LF**	**3,788,562**	**3,788,562**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			456.73	*456.73*	
Pipe Placement	**8,290.00**	**LF**	**3,786,307**	**3,786,307**	
			28.91	*28.91*	
01 01 02 01 18 9-in Abandoned	**3,480.00**	**LF**	**100,615**	**100,615**	
			28.91	*28.91*	
Demolition	**3,480.00**	**LF**	**100,615**	**100,615**	
			2,255.06	*2,255.06*	
Earthwork	**1.00**	**EA**	**2,255**	**2,255**	
			28.26	*28.26*	
Pipe Removal	**3,480.00**	**LF**	**98,360**	**98,360**	
01 02 Federal Costs	**1.00**	**LS**	**1,059,005,634**	**1,059,005,634**	
01 02 11 Levees and Floodwalls	**1.00**	**LS**	**62,866,471**	**62,866,471**	
			7,624.24	*7,624.24*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
01 02 11 01 T-Wall	**3,550.00**	**LF**	**27,066,042**	**27,066,042**	
			5,706.96	*5,706.96*	
01 02 11 01 01 Type 1	**2,100.00**	**LF**	**11,984,608**	**11,984,608**	
			17.51	*17.51*	
01 02 11 01 01 01 Earthwork	**8,867.00**	**CY**	**155,272**	**155,272**	
			15.03	*15.03*	
01 02 11 01 01 01 01 Excavation	**8,867.00**	**CY**	**133,300**	**133,300**	
			7.85	*7.85*	
01 02 11 01 01 01 02 Fill	**2,800.00**	**CY**	**21,972**	**21,972**	
			9,453.24	*9,453.24*	
01 02 11 01 01 02 Battered Pipe Piles	**700.00**	**EA**	**6,617,267**	**6,617,267**	
			311.51	*311.51*	
01 02 11 01 01 03 Sheet Pile	**2,100.00**	**LF**	**654,180**	**654,180**	
			552.87	*552.87*	
01 02 11 01 01 04 Concrete	**8,244.00**	**CY**	**4,557,889**	**4,557,889**	
			512.38	*512.38*	
01 02 11 01 01 04 01 Footing	**6,067.00**	**CY**	**3,108,586**	**3,108,586**	
			665.43	*665.43*	
01 02 11 01 01 04 02 Wall	**2,178.00**	**CY**	**1,449,302**	**1,449,302**	
			5,107.88	*5,107.88*	
01 02 11 01 02 Type 2	**1,450.00**	**LF**	**7,406,430**	**7,406,430**	
			17.73	*17.73*	
01 02 11 01 02 01 Earthwork	**4,900.00**	**CY**	**86,860**	**86,860**	
			15.47	*15.47*	
01 02 11 01 02 01 01 Excavation	**4,900.00**	**CY**	**75,792**	**75,792**	
			7.85	*7.85*	
01 02 11 01 02 01 02 Fill	**1,410.00**	**CY**	**11,068**	**11,068**	
			9,678.69	*9,678.69*	
01 02 11 01 02 02 Battered Pipe Piles	**483.00**	**EA**	**4,674,807**	**4,674,807**	
			311.52	*311.52*	
01 02 11 01 02 03 Sheet Pile	**1,450.00**	**LF**	**451,710**	**451,710**	
			501.04	*501.04*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
01 02 11 01 02 04 Concrete	**4,377.00**	**CY**	**2,193,053**	**2,193,053**	
			473.12	*473.12*	
01 02 11 01 02 04 01 Footing	**3,491.00**	**CY**	**1,651,674**	**1,651,674**	
			611.04	*611.04*	
01 02 11 01 02 04 02 Wall	**886.00**	**CY**	**541,379**	**541,379**	
			105.85	*105.85*	
01 02 11 01 03 Riprap	**72,511.00**	**CY**	**7,675,004**	**7,675,004**	
			11,368.82	*11,368.82*	
01 02 11 02 Floodwall	**3,149.00**	**LF**	**35,800,429**	**35,800,429**	
			28,235.42	*28,235.42*	
01 02 11 02 01 48-inch Concrete Piles	**788.00**	**EA**	**22,249,510**	**22,249,510**	
			20,302.88	*20,302.88*	
01 02 11 02 02 Steel Pipe Piles	**394.00**	**EA**	**7,999,333**	**7,999,333**	
			4,188.94	*4,188.94*	
01 02 11 02 03 6-in Square Piles	**788.00**	**EA**	**3,300,888**	**3,300,888**	
			1,087.29	*1,087.29*	
01 02 11 02 04 Reinforced Concrete Pile Cap	**2,070.00**	**CY**	**2,250,698**	**2,250,698**	
01 02 13 Pumping Plant	**1.00**	**LS**	**967,449,658**	**967,449,658**	
01 02 13 00 Mob, Demob and Site Prep	**1.00**	**LS**	**8,218,631**	**8,218,631**	
01 02 11 03 01 Mobilization	**1.00**	**LS**	**975,613**	**975,613**	
01 02 11 03 02 Demobilization	**1.00**	**LS**	**806,176**	**806,176**	
			6,436,841.55	*6,436,841.55*	
01 02 11 03 03 Site Access	**1.00**	**EA**	**6,436,842**	**6,436,842**	
			4.91	*4.91*	
Access Road	**56,320.00**	**SF**	**276,761**	**276,761**	
			75.49	*75.49*	
Access Bridge	**81,600.00**	**SF**	**6,160,081**	**6,160,081**	
			925,775,350.83	*925,775,350.83*	
01 02 13 01 Clear Creek Pump Station	**1.00**	**EA**	**925,775,351**	**925,775,351**	
			185,122,211.22	*185,122,211.22*	
01 02 13 01 01 Pump Station Structure	**1.00**	**EA**	**185,122,211**	**185,122,211**	
			102,490,351.77	*102,490,351.77*	

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Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
01 02 13 01 01 01 Foundation	**1.00**	**EA**	**102,490,352**	**102,490,352**	
			14,780.64	*14,780.64*	
01 02 13 01 01 01 01 24-in Pipe Pile	**4,682.00**	**EA**	**69,202,933**	**69,202,933**	
			28.98	*28.98*	
01 02 13 01 01 01 02 Sheet Pile	**30,217.00**	**SF**	**875,630**	**875,630**	
			421.36	*421.36*	
01 02 13 01 01 01 03 Foundation Base Slab	**67,657.00**	**CY**	**28,508,005**	**28,508,005**	
			448.71	*448.71*	
01 02 13 01 01 01 04 Mud Slab	**8,700.00**	**CY**	**3,903,783**	**3,903,783**	
			53,476,193.62	*53,476,193.62*	
01 02 13 01 01 02 Substructure	**1.00**	**EA**	**53,476,194**	**53,476,194**	
			633.51	*633.51*	
01 02 13 01 01 02 01 Concrete Substructure	**82,640.00**	**CY**	**52,353,592**	**52,353,592**	
			705.59	*705.59*	
01 02 13 01 01 02 02 Concrete Safe House	**1,591.00**	**CY**	**1,122,601**	**1,122,601**	
			24,927,958.62	*24,927,958.62*	
01 02 13 01 01 03 Superstructure	**1.00**	**EA**	**24,927,959**	**24,927,959**	
			2,058.97	*2,058.97*	
01 02 13 01 01 03 01 Precast Wall Panels	**9,294.00**	**CY**	**19,136,099**	**19,136,099**	
			23,301.73	*23,301.73*	
01 02 13 01 01 03 02 Steel Columns	**136.00**	**EA**	**3,169,035**	**3,169,035**	
			18,470.60	*18,470.60*	
01 02 13 01 01 03 03 Roof Beams	**142.00**	**EA**	**2,622,825**	**2,622,825**	
			4,227,707.20	*4,227,707.20*	
01 02 13 01 01 04 Crane Frame	**1.00**	**EA**	**4,227,707**	**4,227,707**	
			6,966.41	*6,966.41*	
01 02 13 01 01 04 01 Steel Columns	**136.00**	**EA**	**947,432**	**947,432**	
			6,716.07	*6,716.07*	
01 02 13 01 01 04 02 Top Rail	**74.00**	**EA**	**496,989**	**496,989**	
			2,005.88	*2,005.88*	
01 02 13 01 01 04 03 Crane Rails	**74.00**	**EA**	**148,435**	**148,435**	
			7,121.22	*7,121.22*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
01 02 13 01 01 04 04 Infill Framing	**370.00**	**EA**	**2,634,851**	**2,634,851**	
			1,230,073.18	*1,230,073.18*	
01 02 13 01 02 Fuel Tank Foundations	**1.00**	**EA**	**1,230,073**	**1,230,073**	
			9,380.82	*9,380.82*	
01 02 13 01 02 01 Steel Pipe Piles	**112.00**	**EA**	**1,050,652**	**1,050,652**	
			481.02	*481.02*	
01 02 13 01 02 02 Concrete Pile Cap	**373.00**	**CY**	**179,421**	**179,421**	
			45,089,563.01	*45,089,563.01*	
01 02 13 01 03 Sheetpile Cofferdam	**1.00**	**EA**	**45,089,563**	**45,089,563**	
			32.33	*32.33*	
01 02 13 01 03 01 Steel Sheetpile	**613,132.00**	**SF**	**19,822,692**	**19,822,692**	
			110.77	*110.77*	
01 02 13 01 03 02 Cofferdam Fill	**212,250.00**	**CY**	**23,509,961**	**23,509,961**	
			82.12	*82.12*	
01 02 13 01 03 02 01 Fill Placement	**212,250.00**	**CY**	**17,430,428**	**17,430,428**	
			28.64	*28.64*	
01 02 13 01 03 02 02 Fill Removal	**212,250.00**	**CY**	**6,079,533**	**6,079,533**	
			146,409.10	*146,409.10*	
01 02 13 01 03 03 Dewater Pumping	**12.00**	**MO**	**1,756,909**	**1,756,909**	
			265,243,391.06	*265,243,391.06*	
01 02 13 01 04 Discharge Pipes	**1.00**	**EA**	**265,243,391**	**265,243,391**	
			4,493.23	*4,493.23*	
01 02 13 01 04 01 Discharge Pipes	**56,402.00**	**LF**	**253,426,999**	**253,426,999**	
			19.20	*19.20*	
01 02 13 01 04 02 Excavation	**615,519.00**	**CY**	**11,816,393**	**11,816,393**	
			418,945,518.66	*418,945,518.66*	
01 02 13 01 05 Mechanical Items	**1.00**	**EA**	**418,945,519**	**418,945,519**	
			17,069,955.81	*17,069,955.81*	
01 02 13 01 05 01 Pump, Engine and Gearbox	**24.00**	**EA**	**409,678,940**	**409,678,940**	
			18,017.12	*18,017.12*	
01 02 13 01 05 02 Jacket Water Tank	**8.00**	**EA**	**144,137**	**144,137**	
			4,384.00	*4,384.00*	

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Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
01 02 13 01 05 03 Auxiliary Jacket Water Pumps	**32.00**	**EA**	**140,288**	**140,288**	
			62,693.41	*62,693.41*	
01 02 13 01 05 04 Start Air Compressor	**16.00**	**EA**	**1,003,095**	**1,003,095**	
			30,581.00	*30,581.00*	
01 02 13 01 05 05 Start Air Bottle	**16.00**	**EA**	**489,296**	**489,296**	
			3,677.26	*3,677.26*	
01 02 13 01 05 06 Fuel Oil Purifier	**24.00**	**EA**	**88,254**	**88,254**	
			3,557.83	*3,557.83*	
01 02 13 01 05 07 Fuel Oil Pumps	**32.00**	**EA**	**113,851**	**113,851**	
			3,557.83	*3,557.83*	
01 02 13 01 05 08 Fuel Oil Transfer Pump	**24.00**	**EA**	**85,388**	**85,388**	
			9,612.30	*9,612.30*	
01 02 13 01 05 09 Fuel Oil Day Tank	**12.00**	**EA**	**115,348**	**115,348**	
			115,391.16	*115,391.16*	
01 02 13 01 05 10 Fuel Oil Settling Tank	**12.00**	**EA**	**1,384,694**	**1,384,694**	
			1,329.46	*1,329.46*	
01 02 13 01 05 11 Prelube Pump	**32.00**	**EA**	**42,543**	**42,543**	
			3,677.26	*3,677.26*	
01 02 13 01 05 12 Lube Oil Purifier	**8.00**	**EA**	**29,418**	**29,418**	
			9,612.30	*9,612.30*	
01 02 13 01 05 13 Lube Oil Tank	**4.00**	**EA**	**38,449**	**38,449**	
			5,736.17	*5,736.17*	
01 02 13 01 05 14 Lube Oil Cooler	**32.00**	**EA**	**183,557**	**183,557**	
			149,167.79	*149,167.79*	
01 02 13 01 05 15 Overhead Crane	**4.00**	**EA**	**596,671**	**596,671**	
			7,624.19	*7,624.19*	
01 02 13 01 05 16 Control Room HVAC Package Unit	**2.00**	**EA**	**15,248**	**15,248**	
			549,722.10	*549,722.10*	
01 02 13 01 05 17 Fixed Fire Protection System	**1.00**	**EA**	**549,722**	**549,722**	
			265,004.13	*265,004.13*	
01 02 13 01 05 18 Emergency Diesel Generator	**8.00**	**EA**	**2,120,033**	**2,120,033**	
			28,697.73	*28,697.73*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
01 02 13 01 05 19 Stop Logs / Roller Gate	**24.00**	**EA**	**688,746**	**688,746**	
			11,479.09	*11,479.09*	
01 02 13 01 05 20 Trash Rack	**24.00**	**EA**	**275,498**	**275,498**	
			34,082.82	*34,082.82*	
01 02 13 01 05 21 Trash Rake	**24.00**	**EA**	**817,988**	**817,988**	
			5,274.56	*5,274.56*	
01 02 13 01 05 22 Exhaust Fan	**24.00**	**EA**	**126,589**	**126,589**	
			3,234.53	*3,234.53*	
01 02 13 01 05 23 Sump Blower	**24.00**	**EA**	**77,629**	**77,629**	
			1,806.28	*1,806.28*	
01 02 13 01 05 24 Submersible Nonclog Sump Pump	**24.00**	**EA**	**43,351**	**43,351**	
			1,031.04	*1,031.04*	
01 02 13 01 05 25 Air Start Valve	**32.00**	**EA**	**32,993**	**32,993**	
			3,987.11	*3,987.11*	
01 02 13 01 05 26 Air Dryer	**16.00**	**EA**	**63,794**	**63,794**	
01 02 13 01 01 Electrical	**1.00**	**LS**	**10,144,594**	**10,144,594**	
01 02 13 01 01 01 Telephone/Communication System	**1.00**	**LS**	**91,821**	**91,821**	
01 02 13 01 01 02 Pump Station Lights and Fixtures	**1.00**	**LS**	**422,579**	**422,579**	
01 02 13 01 01 03 Pump Station Video/CCTV System	**1.00**	**LS**	**457,536**	**457,536**	
01 02 13 01 01 04 Fuel Storage Video/CCTV System	**1.00**	**LS**	**271,001**	**271,001**	
01 02 13 01 01 05 Pump Station Fire Alarm and Detection System	**1.00**	**LS**	**337,774**	**337,774**	
01 02 13 01 01 06 Fuel Storage Fire Alarm and Detection System	**1.00**	**LS**	**180,959**	**180,959**	
01 02 13 01 01 07 Pump Station Controls and Sensors	**1.00**	**LS**	**3,797,343**	**3,797,343**	
01 02 13 01 01 08 Fuel Storage Controls and Sensors	**1.00**	**LS**	**766,773**	**766,773**	
01 02 13 01 01 09 Incoming Power	**1.00**	**LS**	**59,647**	**59,647**	
01 02 13 01 01 10 Pump Station Lighting Conductors	**1.00**	**LS**	**205,512**	**205,512**	
01 02 13 01 01 11 Motor Control Center	**1.00**	**LS**	**1,139,686**	**1,139,686**	
			151,398.34	*151,398.34*	
01 02 13 01 01 12 Pump Station Receptacles	**1.00**	**EA**	**151,398**	**151,398**	
			38,384.93	*38,384.93*	
01 02 13 01 01 13 Fuel Storage Receptacles	**1.00**	**EA**	**38,385**	**38,385**	
01 02 13 01 01 14 Automatic Transfer Switches	**1.00**	**LS**	**164,179**	**164,179**	

Labor ID: NLS2016 EQ ID: EP16R06 Currency in US dollars TRACES MII Version 4.3

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			1,214,966.40	*1,214,966.40*	
01 02 13 01 01 15 Stand-by Generators	**1.00**	**EA**	**1,214,966**	**1,214,966**	
01 02 13 01 01 16 Power Transformers	**1.00**	**LS**	**164,881**	**164,881**	
01 02 13 01 01 17 Conductors	**1.00**	**LS**	**89,054**	**89,054**	
01 02 13 01 01 18 Conduits	**1.00**	**LS**	**271,568**	**271,568**	
01 02 13 01 01 19 Motors	**1.00**	**LS**	**319,530**	**319,530**	
			21.83	*21.83*	
01 02 13 02 Dredging	**1,532,461.00**	**CY**	**33,455,676**	**33,455,676**	
01 02 15 Floodway Control - Diversion Structure	**1.00**	**LS**	**28,689,505**	**28,689,505**	
			28,689,504.90	*28,689,504.90*	
01 02 15 01 Clear Creek Sector Gate	**1.00**	**EA**	**28,689,505**	**28,689,505**	
			5,320,808.47	*5,320,808.47*	
01 02 15 01 01 Sector Gate	**1.00**	**EA**	**5,320,808**	**5,320,808**	
			2,439,888.43	*2,439,888.43*	
01 02 15 01 01 01 Sector Gate Steel	**2.00**	**EA**	**4,879,777**	**4,879,777**	
			220,515.80	*220,515.80*	
01 02 15 01 01 02 UHMW Fenders	**2.00**	**EA**	**441,032**	**441,032**	
			130,943.56	*130,943.56*	
01 02 15 01 02 Bulkhead Storage Platform	**1.00**	**EA**	**130,944**	**130,944**	
			10,173.33	*10,173.33*	
01 02 15 01 02 01 Steel Pipe Piles	**8.00**	**EA**	**81,387**	**81,387**	
			468.40	*468.40*	
01 02 15 01 02 02 Concrete	**105.80**	**CY**	**49,557**	**49,557**	
			11,950,025.02	*11,950,025.02*	
01 02 15 01 03 Monoliths	**1.00**	**EA**	**11,950,025**	**11,950,025**	
			21.83	*21.83*	
01 02 15 01 03 01 Earthwork	**3,161.00**	**CY**	**69,009**	**69,009**	
			29.60	*29.60*	
01 02 15 01 03 02 Steel Sheet Piles	**69,225.00**	**SF**	**2,048,748**	**2,048,748**	
			15,041.51	*15,041.51*	
01 02 15 01 03 03 Steel Pipe Piles	**273.00**	**EA**	**4,106,331**	**4,106,331**	
			449.74	*449.74*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
01 02 15 01 03 04 Tremie Concrete	**3,161.00**	**CY**	**1,421,642**	**1,421,642**	
			530.43	*530.43*	
01 02 15 01 03 05 Concrete	**8,076.00**	**CY**	**4,283,762**	**4,283,762**	
			449.55	*449.55*	
05 02 04 01 03 04 01 Fill Pile Tops	**583.00**	**CY**	**262,086**	**262,086**	
			449.74	*449.74*	
05 02 04 01 03 04 02 Base Slab Concrete	**3,952.00**	**CY**	**1,777,359**	**1,777,359**	
			633.81	*633.81*	
05 02 04 01 03 04 03 Monolith Walls and Thrust Block	**3,541.00**	**CY**	**2,244,317**	**2,244,317**	
			10,266.72	*10,266.72*	
01 02 15 01 03 06 Control Building	**2.00**	**EA**	**20,533**	**20,533**	
			290,011.97	*290,011.97*	
01 02 15 01 04 Bulkheads	**4.00**	**EA**	**1,160,048**	**1,160,048**	
			7,242,716.66	*7,242,716.66*	
01 02 15 01 05 Mechanical Items	**1.00**	**EA**	**7,242,717**	**7,242,717**	
			852,640.52	*852,640.52*	
01 02 15 01 05 01 Hinge and Pintel	**1.00**	**EA**	**852,641**	**852,641**	
			6,390,076.14	*6,390,076.14*	
01 02 15 01 05 02 Machinery and Operating Equipment	**1.00**	**EA**	**6,390,076**	**6,390,076**	
			3,018.68	*3,018.68*	
01 02 15 01 06 Navigation Approach Walls	**480.00**	**LF**	**1,448,965**	**1,448,965**	
01 02 15 01 07 Electrical	**1.00**	**LS**	**1,142,638**	**1,142,638**	
01 02 15 01 07 01 Telephone/Communication System	**1.00**	**LS**	**29,532**	**29,532**	
01 02 15 01 07 02 Floodgate Lights and Fixtures	**1.00**	**LS**	**175,674**	**175,674**	
01 02 15 01 07 03 Floodgate Video/CCTV System	**1.00**	**LS**	**72,416**	**72,416**	
01 02 15 01 07 04 Floodgate Fire Alarm and Detection System	**1.00**	**LS**	**43,097**	**43,097**	
01 02 15 01 07 05 Floodgate Controls	**1.00**	**LS**	**319,468**	**319,468**	
01 02 15 01 07 06 Incoming Power	**1.00**	**LS**	**90,396**	**90,396**	
01 02 15 01 07 07 Floodgate Lighting Conductors	**1.00**	**LS**	**13,846**	**13,846**	
01 02 15 01 07 08 Motor Control Center	**1.00**	**LS**	**132,778**	**132,778**	
01 02 15 01 07 09 Automatic Transfer Switches	**1.00**	**LS**	**164,179**	**164,179**	
01 02 15 01 07 10 Power Transformers	**1.00**	**LS**	**34,726**	**34,726**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
01 02 15 01 07 11 Conductors	**1.00**	**LS**	**13,930**	**13,930**	
01 02 15 01 07 12 Conduits	**1.00**	**LS**	**40,806**	**40,806**	
01 02 15 01 07 13 Motors	**1.00**	**LS**	**11,790**	**11,790**	
			134.69	*134.69*	
01 02 15 01 08 Riprap	**2,178.00**	**CY**	**293,361**	**293,361**	
05 Contract 2 - Dickinson Bayou	**1.00**	**LS**	**496,580,495**	**496,580,495**	
05 01 Non-Federal Costs	**1.00**	**LS**	**4,329,346**	**4,329,346**	
05 01 01 Relocations	**1.00**	**LS**	**4,329,346**	**4,329,346**	
			4,329,346.38	*4,329,346.38*	
05 01 01 01 Utility and Pipeline Relocations	**1.00**	**EA**	**4,329,346**	**4,329,346**	
			84.21	*84.21*	
05 01 01 01 01 4-in Gas Line	**530.00**	**LF**	**44,634**	**44,634**	
			38.09	*38.09*	
Demolition	**265.00**	**LF**	**10,095**	**10,095**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			29.27	*29.27*	
Pipe Removal	**265.00**	**LF**	**7,758**	**7,758**	
			65.17	*65.17*	
Reconstruction	**530.00**	**LF**	**34,539**	**34,539**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			60.76	*60.76*	
Pipe Placement	**530.00**	**LF**	**32,202**	**32,202**	
			143.22	*143.22*	
05 01 01 01 02 8-in Gas Line	**530.00**	**LF**	**75,906**	**75,906**	
			38.09	*38.09*	
Demolition	**265.00**	**LF**	**10,095**	**10,095**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			29.27	*29.27*	
Pipe Removal	**265.00**	**LF**	**7,758**	**7,758**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			124.17	*124.17*	
Reconstruction	**530.00**	**LF**	**65,812**	**65,812**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			119.76	*119.76*	
Pipe Placement	**530.00**	**LF**	**63,475**	**63,475**	
			136.20	*136.20*	
05 01 01 01 03 8-in Gas Line	**2,600.00**	**LF**	**354,116**	**354,116**	
			31.07	*31.07*	
Demolition	**1,300.00**	**LF**	**40,393**	**40,393**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			29.27	*29.27*	
Pipe Removal	**1,300.00**	**LF**	**38,056**	**38,056**	
			120.66	*120.66*	
Reconstruction	**2,600.00**	**LF**	**313,723**	**313,723**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			119.76	*119.76*	
Pipe Placement	**2,600.00**	**LF**	**311,386**	**311,386**	
			243.72	*243.72*	
05 01 01 01 04 9-in Gas Line	**3,260.00**	**LF**	**794,523**	**794,523**	
			30.71	*30.71*	
Demolition	**1,630.00**	**LF**	**50,054**	**50,054**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			29.27	*29.27*	
Pipe Removal	**1,630.00**	**LF**	**47,717**	**47,717**	
			228.36	*228.36*	
Reconstruction	**3,260.00**	**LF**	**744,470**	**744,470**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			227.65	*227.65*	
Pipe Placement	**3,260.00**	**LF**	**742,133**	**742,133**	
			143.22	*143.22*	
05 01 01 01 05 8-in Petroleum Line	**530.00**	**LF**	**75,906**	**75,906**	
			38.09	*38.09*	
Demolition	**265.00**	**LF**	**10,095**	**10,095**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			29.27	*29.27*	
Pipe Removal	**265.00**	**LF**	**7,758**	**7,758**	
			124.17	*124.17*	
Reconstruction	**530.00**	**LF**	**65,812**	**65,812**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			119.76	*119.76*	
Pipe Placement	**530.00**	**LF**	**63,475**	**63,475**	
			295.55	*295.55*	
05 01 01 01 06 11-in Petroleum Line	**530.00**	**LF**	**156,644**	**156,644**	
			41.85	*41.85*	
Demolition	**265.00**	**LF**	**11,090**	**11,090**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			33.03	*33.03*	
Pipe Removal	**265.00**	**LF**	**8,753**	**8,753**	
			274.63	*274.63*	
Reconstruction	**530.00**	**LF**	**145,554**	**145,554**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			270.22	*270.22*	
Pipe Placement	**530.00**	**LF**	**143,217**	**143,217**	
			295.55	*295.55*	
05 01 01 01 07 12-in Petroleum Line	**530.00**	**LF**	**156,644**	**156,644**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			41.85	*41.85*	
Demolition	**265.00**	**LF**	**11,090**	**11,090**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			33.03	*33.03*	
Pipe Removal	**265.00**	**LF**	**8,753**	**8,753**	
			274.63	*274.63*	
Reconstruction	**530.00**	**LF**	**145,554**	**145,554**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			270.22	*270.22*	
Pipe Placement	**530.00**	**LF**	**143,217**	**143,217**	
			244.65	*244.65*	
05 01 01 01 08 Petroleum Line	**1,980.00**	**LF**	**484,398**	**484,398**	
			31.63	*31.63*	
Demolition	**990.00**	**LF**	**31,318**	**31,318**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			29.27	*29.27*	
Pipe Removal	**990.00**	**LF**	**28,981**	**28,981**	
			228.83	*228.83*	
Reconstruction	**1,980.00**	**LF**	**453,080**	**453,080**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			227.65	*227.65*	
Pipe Placement	**1,980.00**	**LF**	**450,743**	**450,743**	
			245.45	*245.45*	
05 01 01 01 09 Petroleum Line	**1,478.00**	**LF**	**362,771**	**362,771**	
			32.44	*32.44*	
Demolition	**739.00**	**LF**	**23,970**	**23,970**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			29.27	*29.27*	
Pipe Removal	**739.00**	**LF**	**21,633**	**21,633**	
			229.23	*229.23*	
Reconstruction	**1,478.00**	**LF**	**338,801**	**338,801**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			227.65	*227.65*	
Pipe Placement	**1,478.00**	**LF**	**336,464**	**336,464**	
			246.11	*246.11*	
05 01 01 01 10 Petroleum Line	**1,222.00**	**LF**	**300,746**	**300,746**	
			33.10	*33.10*	
Demolition	**611.00**	**LF**	**20,223**	**20,223**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			29.27	*29.27*	
Pipe Removal	**611.00**	**LF**	**17,886**	**17,886**	
			229.56	*229.56*	
Reconstruction	**1,222.00**	**LF**	**280,523**	**280,523**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			227.65	*227.65*	
Pipe Placement	**1,222.00**	**LF**	**278,186**	**278,186**	
			455.24	*455.24*	
05 01 01 01 11 18-in	**2,600.00**	**LF**	**1,183,625**	**1,183,625**	
			51.34	*51.34*	
Demolition	**1,300.00**	**LF**	**66,744**	**66,744**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			49.54	*49.54*	
Pipe Removal	**1,300.00**	**LF**	**64,407**	**64,407**	
			429.57	*429.57*	
Reconstruction	**2,600.00**	**LF**	**1,116,881**	**1,116,881**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			428.67	*428.67*	
Pipe Placement	**2,600.00**	**LF**	**1,114,544**	**1,114,544**	
			245.77	*245.77*	
05 01 01 01 12 Unknown	**1,340.00**	**LF**	**329,336**	**329,336**	
			32.76	*32.76*	
Demolition	**670.00**	**LF**	**21,951**	**21,951**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			29.27	*29.27*	
Pipe Removal	**670.00**	**LF**	**19,614**	**19,614**	
			229.39	*229.39*	
Reconstruction	**1,340.00**	**LF**	**307,385**	**307,385**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			227.65	*227.65*	
Pipe Placement	**1,340.00**	**LF**	**305,048**	**305,048**	
			38.09	*38.09*	
05 01 01 01 13 9-in Abandoned	**265.00**	**LF**	**10,095**	**10,095**	
			38.09	*38.09*	
Demolition	**265.00**	**LF**	**10,095**	**10,095**	
			2,336.99	*2,336.99*	
Earthwork	**1.00**	**EA**	**2,337**	**2,337**	
			29.27	*29.27*	
Pipe Removal	**265.00**	**LF**	**7,758**	**7,758**	
05 02 Federal Costs	**1.00**	**LS**	**492,251,149**	**492,251,149**	
05 02 11 Levees and Floodwalls	**1.00**	**LS**	**44,411,707**	**44,411,707**	
			6,462.38	*6,462.38*	
05 02 11 01 T-Wall	**6,616.00**	**LF**	**42,755,129**	**42,755,129**	
			6,890.44	*6,890.44*	
05 02 11 01 01 Type 1	**1,407.00**	**LF**	**9,694,851**	**9,694,851**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			17.51	*17.51*	
05 02 11 01 01 01 Earthwork	**5,941.00**	**CY**	**104,036**	**104,036**	
			15.03	*15.03*	
05 02 02 01 01 01 01 Excavation	**5,941.00**	**CY**	**89,317**	**89,317**	
			7.85	*7.85*	
05 02 02 01 01 01 02 Fill	**1,876.00**	**CY**	**14,719**	**14,719**	
			11,344.09	*11,344.09*	
05 02 11 01 01 02 Battered Pipe Piles	**469.00**	**EA**	**5,320,376**	**5,320,376**	
			324.51	*324.51*	
05 02 11 01 01 03 Sheet Pile	**1,407.00**	**LF**	**456,580**	**456,580**	
			567.37	*567.37*	
05 02 11 01 01 04 Concrete	**6,722.00**	**CY**	**3,813,859**	**3,813,859**	
			477.26	*477.26*	
05 02 02 01 01 04 01 Footing	**4,065.00**	**CY**	**1,940,061**	**1,940,061**	
			704.97	*704.97*	
05 02 02 01 01 04 02 Wall	**2,658.00**	**CY**	**1,873,798**	**1,873,798**	
			6,251.77	*6,251.77*	
05 02 11 01 02 Type 2	**5,209.00**	**LF**	**32,565,459**	**32,565,459**	
			17.73	*17.73*	
05 02 11 01 02 01 Earthwork	**17,604.00**	**CY**	**312,037**	**312,037**	
			15.47	*15.47*	
05 02 11 01 02 01 01 Excavation	**17,604.00**	**CY**	**272,296**	**272,296**	
			7.85	*7.85*	
05 02 11 01 02 01 02 Fill	**5,064.00**	**CY**	**39,741**	**39,741**	
			11,171.33	*11,171.33*	
05 02 11 01 02 02 Battered Pipe Piles	**1,736.00**	**EA**	**19,393,424**	**19,393,424**	
			324.51	*324.51*	
05 02 11 01 02 03 Sheet Pile	**5,209.00**	**LF**	**1,690,388**	**1,690,388**	
			609.43	*609.43*	
05 02 11 01 02 04 Concrete	**18,328.00**	**CY**	**11,169,611**	**11,169,611**	
			477.22	*477.22*	
05 02 11 01 02 04 01 Footing	**12,540.00**	**CY**	**5,984,308**	**5,984,308**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			895.87	*895.87*	
05 02 11 01 02 04 02 Wall	**5,788.00**	**CY**	**5,185,302**	**5,185,302**	
			110.23	*110.23*	
05 02 11 01 03 Riprap	**4,489.00**	**CY**	**494,819**	**494,819**	
			11,584.46	*11,584.46*	
05 02 11 02 Floodwall	**143.00**	**LF**	**1,656,578**	**1,656,578**	
			29,422.96	*29,422.96*	
05 02 11 02 01 48-inch Concrete Piles	**36.00**	**EA**	**1,059,226**	**1,059,226**	
			17,791.40	*17,791.40*	
05 02 11 02 02 Steel Pipe Piles	**18.00**	**EA**	**320,245**	**320,245**	
			4,358.30	*4,358.30*	
05 02 11 02 03 6-in Square Piles	**36.00**	**EA**	**156,899**	**156,899**	
			1,278.80	*1,278.80*	
05 02 11 02 04 Reinforced Concrete Pile Cap	**94.00**	**CY**	**120,207**	**120,207**	
05 02 13 Pumping Plant	**1.00**	**LS**	**415,910,004**	**415,910,004**	
05 02 13 00 Mob, Demob and Site Prep	**1.00**	**LS**	**2,502,669**	**2,502,669**	
01 02 11 03 01 Mobilization	**1.00**	**LS**	**877,649**	**877,649**	
01 02 11 03 02 Demobilization	**1.00**	**LS**	**784,653**	**784,653**	
			840,367.07	*840,367.07*	
01 02 11 03 03 Site Access	**1.00**	**EA**	**840,367**	**840,367**	
			4.38	*4.38*	
Access Road	**192,000.00**	**SF**	**840,367**	**840,367**	
			404,740,492.98	*404,740,492.98*	
05 02 13 01 Dickinson Bayou Pump Station	**1.00**	**EA**	**404,740,493**	**404,740,493**	
			78,687,222.83	*78,687,222.83*	
05 02 13 01 01 Pump Station Structure	**1.00**	**EA**	**78,687,223**	**78,687,223**	
			40,014,084.41	*40,014,084.41*	
05 02 13 01 01 01 Foundation	**1.00**	**EA**	**40,014,084**	**40,014,084**	
			12,792.65	*12,792.65*	
05 02 03 01 01 01 01 24-in Pipe Pile	**1,982.00**	**EA**	**25,355,031**	**25,355,031**	
			30.19	*30.19*	
05 02 03 01 01 01 02 Sheet Pile	**12,672.00**	**SF**	**382,531**	**382,531**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			442.81	*442.81*	
05 02 03 01 01 01 03 Foundation Base Slab	**28,372.00**	**CY**	**12,563,533**	**12,563,533**	
			469.57	*469.57*	
05 02 03 01 01 01 04 Mud Slab	**3,648.00**	**CY**	**1,712,990**	**1,712,990**	
			663.21	*663.21*	
05 02 13 01 01 02 Substructure	**36,247.00**	**CY**	**24,039,430**	**24,039,430**	
			659.93	*659.93*	
05 02 03 01 01 02 01 Concrete Substructure	**34,655.00**	**CY**	**22,869,991**	**22,869,991**	
			735.03	*735.03*	
05 02 03 01 01 02 02 Concrete Safe House	**1,591.00**	**CY**	**1,169,439**	**1,169,439**	
			11,541,902.61	*11,541,902.61*	
05 02 13 01 01 03 Superstructure	**1.00**	**EA**	**11,541,903**	**11,541,903**	
			2,144.88	*2,144.88*	
05 02 03 01 01 03 01 Precast Wall Panels	**4,034.00**	**CY**	**8,652,448**	**8,652,448**	
			24,273.94	*24,273.94*	
05 02 03 01 01 03 02 Steel Columns	**64.00**	**EA**	**1,553,532**	**1,553,532**	
			1,335,922.28	*1,335,922.28*	
05 02 03 01 01 03 03 Roof Beams	**1.00**	**EA**	**1,335,922**	**1,335,922**	
			3,091,805.56	*3,091,805.56*	
05 02 13 01 01 04 Crane Frame	**1.00**	**EA**	**3,091,806**	**3,091,806**	
			9,314.49	*9,314.49*	
05 02 03 01 01 04 01 Steel Columns	**64.00**	**EA**	**596,128**	**596,128**	
			13,624.33	*13,624.33*	
05 02 03 01 01 04 02 Top Rail	**38.00**	**EA**	**517,725**	**517,725**	
			4,269.08	*4,269.08*	
05 02 03 01 01 04 03 Crane Rails	**38.00**	**EA**	**162,225**	**162,225**	
			9,556.46	*9,556.46*	
05 02 03 01 01 04 04 Infill Framing	**190.00**	**EA**	**1,815,728**	**1,815,728**	
			603,928.58	*603,928.58*	
05 02 13 01 02 Fuel Tank Foundations	**1.00**	**EA**	**603,929**	**603,929**	
			9,446.23	*9,446.23*	
05 02 13 01 02 01 Steel Pipe Piles	**56.00**	**EA**	**528,989**	**528,989**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			499.60	*499.60*	
05 02 13 01 02 02 Concrete Pile Cap	**150.00**	**CY**	**74,940**	**74,940**	
			22,938,114.50	*22,938,114.50*	
05 02 13 01 03 Sheetpile Cofferdam	**1.00**	**EA**	**22,938,115**	**22,938,115**	
			40.32	*40.32*	
05 02 13 01 03 01 Steel Sheetpile	**339,352.00**	**SF**	**13,681,453**	**13,681,453**	
			78.79	*78.79*	
05 02 13 01 03 02 Cofferdam Fill	**117,480.00**	**CY**	**9,256,661**	**9,256,661**	
			82,071,725.65	*82,071,725.65*	
05 02 13 01 04 Discharge Pipes	**1.00**	**EA**	**82,071,726**	**82,071,726**	
			4,774.22	*4,774.22*	
05 02 13 01 04 01 Discharge Pipes	**16,222.00**	**LF**	**77,447,427**	**77,447,427**	
			19.91	*19.91*	
05 02 13 01 04 02 Excavation	**232,223.00**	**CY**	**4,624,299**	**4,624,299**	
			220,439,501.42	*220,439,501.42*	
01 02 13 01 05 Mechanical Items	**1.00**	**EA**	**220,439,501**	**220,439,501**	
			17,858,178.35	*17,858,178.35*	
05 02 13 01 05 01 Pump, Engine and Gearbox	**12.00**	**EA**	**214,298,140**	**214,298,140**	
			18,768.85	*18,768.85*	
05 02 13 01 05 02 Jacket Water Tank	**4.00**	**EA**	**75,075**	**75,075**	
			4,566.91	*4,566.91*	
05 02 13 01 05 03 Auxiliary Jacket Water Pumps	**16.00**	**EA**	**73,071**	**73,071**	
			65,309.15	*65,309.15*	
05 02 13 01 05 04 Start Air Compressor	**8.00**	**EA**	**522,473**	**522,473**	
			31,856.92	*31,856.92*	
05 02 13 01 05 05 Start Air Bottle	**8.00**	**EA**	**254,855**	**254,855**	
			3,830.68	*3,830.68*	
05 02 13 01 05 06 Fuel Oil Purifier	**12.00**	**EA**	**45,968**	**45,968**	
			3,706.27	*3,706.27*	
05 02 13 01 05 07 Fuel Oil Pumps	**16.00**	**EA**	**59,300**	**59,300**	
			3,706.27	*3,706.27*	
05 02 13 01 05 08 Fuel Oil Transfer Pump	**12.00**	**EA**	**44,475**	**44,475**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			10,013.35	*10,013.35*	
05 02 13 01 05 09 Fuel Oil Day Tank	**16.00**	**EA**	**160,214**	**160,214**	
			120,205.60	*120,205.60*	
05 02 13 01 05 10 Fuel Oil Settling Tank	**6.00**	**EA**	**721,234**	**721,234**	
			1,384.93	*1,384.93*	
05 02 13 01 05 11 Prelube Pump	**16.00**	**EA**	**22,159**	**22,159**	
			3,830.68	*3,830.68*	
05 02 13 01 05 12 Lube Oil Purifier	**4.00**	**EA**	**15,323**	**15,323**	
			10,013.35	*10,013.35*	
05 02 13 01 05 13 Lube Oil Tank	**2.00**	**EA**	**20,027**	**20,027**	
			5,975.50	*5,975.50*	
05 02 13 01 05 14 Lube Oil Cooler	**16.00**	**EA**	**95,608**	**95,608**	
			155,391.48	*155,391.48*	
05 02 13 01 05 15 Overhead Crane	**2.00**	**EA**	**310,783**	**310,783**	
			7,942.29	*7,942.29*	
05 02 13 01 05 16 Control Room HVAC Package Unit	**1.00**	**EA**	**7,942**	**7,942**	
			572,658.03	*572,658.03*	
05 02 13 01 05 17 Fixed Fire Protection System	**1.00**	**EA**	**572,658**	**572,658**	
			276,060.84	*276,060.84*	
05 02 13 01 05 18 Emergency Diesel Generator	**4.00**	**EA**	**1,104,243**	**1,104,243**	
			29,895.08	*29,895.08*	
05 02 13 01 05 19 Stop Logs / Roller Gate	**24.00**	**EA**	**717,482**	**717,482**	
			11,958.03	*11,958.03*	
05 02 13 01 05 20 Trash Rack	**24.00**	**EA**	**286,993**	**286,993**	
			852,116.32	*852,116.32*	
05 02 13 01 05 21 Trash Rake	**1.00**	**EA**	**852,116**	**852,116**	
			5,494.62	*5,494.62*	
05 02 13 01 05 22 Exhaust Fan	**12.00**	**EA**	**65,935**	**65,935**	
			3,369.49	*3,369.49*	
05 02 13 01 05 23 Sump Blower	**12.00**	**EA**	**40,434**	**40,434**	
			1,881.65	*1,881.65*	
05 02 13 01 05 24 Submersible Nonclog Sump Pump	**12.00**	**EA**	**22,580**	**22,580**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			1,074.06	*1,074.06*	
05 02 13 01 05 25 Air Start Valve	**16.00**	**EA**	**17,185**	**17,185**	
			4,153.46	*4,153.46*	
05 02 13 01 05 26 Air Dryer	**8.00**	**EA**	**33,228**	**33,228**	
			22.61	*22.61*	
05 02 13 02 Dredging	**383,268.00**	**CY**	**8,666,842**	**8,666,842**	
05 02 15 Floodway Control - Diversion Structure	**1.00**	**LS**	**31,929,438**	**31,929,438**	
			31,929,438.00	*31,929,438.00*	
05 02 15 01 Dickinson Bayou Sector Gate	**1.00**	**EA**	**31,929,438**	**31,929,438**	
			5,541,219.07	*5,541,219.07*	
05 02 15 01 01 Sector Gate	**1.00**	**EA**	**5,541,219**	**5,541,219**	
			2,541,161.63	*2,541,161.63*	
05 02 15 01 01 01 Sector Gate Steel	**2.00**	**EA**	**5,082,323**	**5,082,323**	
			229,447.90	*229,447.90*	
05 02 15 01 01 02 UHMW Fenders	**2.00**	**EA**	**458,896**	**458,896**	
			118,459.18	*118,459.18*	
05 02 15 01 02 Bulkhead Storage Platform	**1.00**	**EA**	**118,459**	**118,459**	
			9,309.08	*9,309.08*	
05 02 15 01 02 01 Steel Pipe Piles	**8.00**	**EA**	**74,473**	**74,473**	
			415.75	*415.75*	
05 02 15 01 02 02 Concrete	**105.80**	**CY**	**43,987**	**43,987**	
			14,365,856.44	*14,365,856.44*	
05 02 15 01 03 Monoliths	**1.00**	**EA**	**14,365,856**	**14,365,856**	
			22.61	*22.61*	
05 02 15 01 03 01 Earthwork	**13,302.00**	**CY**	**300,798**	**300,798**	
			49.13	*49.13*	
05 02 15 01 03 02 Steel Piles	**46,872.00**	**SF**	**2,302,686**	**2,302,686**	
			468.49	*468.49*	
05 02 15 01 03 03 Tremie Concrete	**4,093.00**	**CY**	**1,917,534**	**1,917,534**	
			540.13	*540.13*	
05 02 15 01 03 04 Concrete	**9,373.00**	**CY**	**5,062,670**	**5,062,670**	
			468.30	*468.30*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
05 02 04 01 03 04 01 Fill Pile Tops	**754.00**	**CY**	**353,096**	**353,096**	
			468.56	*468.56*	
05 02 04 01 03 04 02 Base Slab Concrete	**5,116.00**	**CY**	**2,397,131**	**2,397,131**	
			660.13	*660.13*	
05 02 04 01 03 04 03 Monolith Walls and Thrust Block	**3,503.00**	**CY**	**2,312,443**	**2,312,443**	
			10,659.16	*10,659.16*	
05 02 15 01 03 05 Control Building	**2.00**	**EA**	**21,318**	**21,318**	
			13,486.83	*13,486.83*	
05 02 15 01 03 06 Steel Pipe Piles	**353.00**	**EA**	**4,760,850**	**4,760,850**	
			322,252.88	*322,252.88*	
05 02 15 01 04 Bulkheads	**4.00**	**EA**	**1,289,012**	**1,289,012**	
			7,544,507.92	*7,544,507.92*	
05 02 15 01 05 Mechanical Items	**1.00**	**EA**	**7,544,508**	**7,544,508**	
			887,820.16	*887,820.16*	
05 02 15 01 05 01 Hinge and Pintel	**1.00**	**EA**	**887,820**	**887,820**	
			6,656,687.76	*6,656,687.76*	
05 02 15 01 05 02 Machinery and Operating Equipment	**1.00**	**EA**	**6,656,688**	**6,656,688**	
			3,144.62	*3,144.62*	
05 02 15 01 06 Navigation Approach Walls	**480.00**	**LF**	**1,509,420**	**1,509,420**	
05 02 15 01 07 Electrical	**1.00**	**LS**	**1,240,955**	**1,240,955**	
05 02 15 01 07 01 Telephone/Communication System	**1.00**	**LS**	**29,888**	**29,888**	
05 02 15 01 07 02 Floodgate Lights and Fixtures	**1.00**	**LS**	**178,859**	**178,859**	
05 02 15 01 07 03 Floodgate Video/CCTV System	**1.00**	**LS**	**85,256**	**85,256**	
05 02 15 01 07 04 Floodgate Fire Alarm and Detection System	**1.00**	**LS**	**77,195**	**77,195**	
05 02 15 01 07 05 Floodgate Controls	**1.00**	**LS**	**291,161**	**291,161**	
05 02 15 01 07 06 Incoming Power	**1.00**	**LS**	**94,167**	**94,167**	
05 02 15 01 07 07 Floodgate Lighting Conductors	**1.00**	**LS**	**49,202**	**49,202**	
05 02 15 01 07 08 Motor Control Center	**1.00**	**LS**	**138,318**	**138,318**	
05 02 15 01 07 09 Automatic Transfer Switches	**1.00**	**LS**	**171,029**	**171,029**	
05 02 15 01 07 10 Power Transformers	**1.00**	**LS**	**47,421**	**47,421**	
05 02 15 01 07 11 Conductors	**1.00**	**LS**	**16,989**	**16,989**	
05 02 15 01 07 12 Conduits	**1.00**	**LS**	**46,098**	**46,098**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
05 02 15 01 07 13 Motors	**1.00**	**LS**	**15,373**	**15,373**	
			138.47	*138.47*	
05 02 15 01 08 Riprap	**2,311.00**	**CY**	**320,009**	**320,009**	
10 Contract 3 - Galveston Island	**1.00**	**LS**	**409,841,536**	**409,841,536**	
10 01 Non-Federal Costs	**1.00**	**LS**	**6,072,754**	**6,072,754**	
10 01 02 02 - Relocations	**1.00**	**LS**	**6,072,754**	**6,072,754**	
			6,072,754.35	*6,072,754.35*	
10 01 02 01 Utility and Pipeline Relocations	**1.00**	**EA**	**6,072,754**	**6,072,754**	
			3,474,313.52	*3,474,313.52*	
10 01 02 01 01 Galveston Island #1 Pump Station	**1.00**	**EA**	**3,474,314**	**3,474,314**	
			29.89	*29.89*	
10 01 02 01 01 01 1-in PVC Water Line	**944.00**	**LF**	**28,214**	**28,214**	
			16.48	*16.48*	
Demolition	**472.00**	**LF**	**7,778**	**7,778**	
			2,588.97	*2,588.97*	
Earthwork	**1.00**	**EA**	**2,589**	**2,589**	
			10.99	*10.99*	
Pipe Removal	**472.00**	**LF**	**5,189**	**5,189**	
			21.65	*21.65*	
Reconstruction	**944.00**	**LF**	**20,437**	**20,437**	
			10,341.08	*10,341.08*	
Earthwork	**1.00**	**EA**	**10,341**	**10,341**	
			10.69	*10.69*	
Pipe Placement	**944.00**	**LF**	**10,095**	**10,095**	
			96.05	*96.05*	
10 01 02 01 01 02 12-in AC Water Line	**470.00**	**LF**	**45,144**	**45,144**	
			18.30	*18.30*	
Demolition	**235.00**	**LF**	**4,300**	**4,300**	
			1,938.03	*1,938.03*	
Earthwork	**1.00**	**EA**	**1,938**	**1,938**	
			10.05	*10.05*	
Pipe Removal	**235.00**	**LF**	**2,362**	**2,362**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			86.90	*86.90*	
Reconstruction	**470.00**	**LF**	**40,844**	**40,844**	
			7,722.52	*7,722.52*	
Earthwork	**1.00**	**EA**	**7,723**	**7,723**	
			70.47	*70.47*	
Pipe Placement	**470.00**	**LF**	**33,121**	**33,121**	
			286.39	*286.39*	
10 01 02 01 01 03 18-in CI Water Line	**11,476.00**	**LF**	**3,286,566**	**3,286,566**	
			23.84	*23.84*	
Demolition	**5,738.00**	**LF**	**136,780**	**136,780**	
			47,163.59	*47,163.59*	
Earthwork	**1.00**	**EA**	**47,164**	**47,164**	
			15.62	*15.62*	
Pipe Removal	**5,738.00**	**LF**	**89,617**	**89,617**	
			274.47	*274.47*	
Reconstruction	**11,476.00**	**LF**	**3,149,786**	**3,149,786**	
			188,639.57	*188,639.57*	
Earthwork	**1.00**	**EA**	**188,640**	**188,640**	
			258.03	*258.03*	
Pipe Placement	**11,476.00**	**LF**	**2,961,146**	**2,961,146**	
			247.33	*247.33*	
10 01 02 01 01 04 20-in DI Water Line	**60.00**	**EA**	**14,840**	**14,840**	
			26.47	*26.47*	
Demolition	**30.00**	**LF**	**794**	**794**	
			325.47	*325.47*	
Earthwork	**1.00**	**EA**	**325**	**325**	
			15.62	*15.62*	
Pipe Removal	**30.00**	**LF**	**469**	**469**	
			234.10	*234.10*	
Reconstruction	**60.00**	**LF**	**14,046**	**14,046**	
			1,316.67	*1,316.67*	
Earthwork	**1.00**	**EA**	**1,317**	**1,317**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			212.15	*212.15*	
Pipe Placement	**60.00**	**LF**	**12,729**	**12,729**	
			63.51	*63.51*	
10 01 02 01 01 05 18-in PVC Sewer Line	**264.00**	**LF**	**16,767**	**16,767**	
			23.83	*23.83*	
Demolition	**132.00**	**LF**	**3,146**	**3,146**	
			1,079.97	*1,079.97*	
Earthwork	**1.00**	**EA**	**1,080**	**1,080**	
			15.65	*15.65*	
Pipe Removal	**132.00**	**LF**	**2,066**	**2,066**	
			51.59	*51.59*	
Reconstruction	**264.00**	**LF**	**13,621**	**13,621**	
			4,334.67	*4,334.67*	
Earthwork	**1.00**	**EA**	**4,335**	**4,335**	
			35.18	*35.18*	
Pipe Placement	**264.00**	**LF**	**9,286**	**9,286**	
			40.35	*40.35*	
10 01 02 01 01 06 8-in Clay Sewer Line	**210.00**	**LF**	**8,473**	**8,473**	
			15.55	*15.55*	
Demolition	**105.00**	**LF**	**1,632**	**1,632**	
			576.97	*576.97*	
Earthwork	**1.00**	**EA**	**577**	**577**	
			10.05	*10.05*	
Pipe Removal	**105.00**	**LF**	**1,055**	**1,055**	
			32.57	*32.57*	
Reconstruction	**210.00**	**LF**	**6,840**	**6,840**	
			2,307.88	*2,307.88*	
Earthwork	**1.00**	**EA**	**2,308**	**2,308**	
			21.58	*21.58*	
Pipe Placement	**210.00**	**LF**	**4,533**	**4,533**	
			24.01	*24.01*	
10 01 02 01 01 07 36-in Storm Drain	**410.00**	**LF**	**9,846**	**9,846**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			48.03	*48.03*	
Demolition	**205.00**	**LF**	**9,846**	**9,846**	
			4,497.41	*4,497.41*	
Earthwork	**1.00**	**EA**	**4,497**	**4,497**	
			26.09	*26.09*	
Pipe Removal	**205.00**	**LF**	**5,348**	**5,348**	
			21.11	*21.11*	
10 01 02 01 01 08 Box Culverts	**3,054.00**	**LF**	**64,464**	**64,464**	
			42.22	*42.22*	
Demolition	**1,527.00**	**LF**	**64,464**	**64,464**	
			41,837.72	*41,837.72*	
Earthwork	**1.00**	**EA**	**41,838**	**41,838**	
			14.82	*14.82*	
Pipe Removal	**1,527.00**	**LF**	**22,626**	**22,626**	
			85,139.86	*85,139.86*	
10 01 02 01 02 Galveston Island #2 Pump Station	**1.00**	**EA**	**85,140**	**85,140**	
			173.52	*173.52*	
10 01 02 01 02 01 30-in PVC Water Line	**312.00**	**LF**	**54,137**	**54,137**	
			39.74	*39.74*	
Demolition	**156.00**	**LF**	**6,200**	**6,200**	
			2,130.35	*2,130.35*	
Earthwork	**1.00**	**EA**	**2,130**	**2,130**	
			26.09	*26.09*	
Pipe Removal	**156.00**	**LF**	**4,070**	**4,070**	
			153.64	*153.64*	
Reconstruction	**312.00**	**LF**	**47,937**	**47,937**	
			8,550.99	*8,550.99*	
Earthwork	**1.00**	**EA**	**8,551**	**8,551**	
			126.24	*126.24*	
Pipe Placement	**312.00**	**LF**	**39,386**	**39,386**	
			215.40	*215.40*	
10 01 02 01 02 02 12-in CI Water Line	**60.00**	**LF**	**12,924**	**12,924**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			18.80	*18.80*	
Demolition	**30.00**	**LF**	**564**	**564**	
			251.50	*251.50*	
Earthwork	**1.00**	**EA**	**251**	**251**	
			10.41	*10.41*	
Pipe Removal	**30.00**	**LF**	**312**	**312**	
			206.00	*206.00*	
Reconstruction	**60.00**	**LF**	**12,360**	**12,360**	
			991.20	*991.20*	
Earthwork	**1.00**	**EA**	**991**	**991**	
			189.48	*189.48*	
Pipe Placement	**60.00**	**LF**	**11,369**	**11,369**	
			70.71	*70.71*	
10 01 02 01 02 03 20-in HDPE Water Line	**200.00**	**EA**	**14,141**	**14,141**	
			41.46	*41.46*	
Demolition	**100.00**	**LF**	**4,146**	**4,146**	
			2,189.53	*2,189.53*	
Earthwork	**1.00**	**EA**	**2,190**	**2,190**	
			19.57	*19.57*	
Pipe Removal	**100.00**	**LF**	**1,957**	**1,957**	
			49.97	*49.97*	
Reconstruction	**200.00**	**LF**	**9,995**	**9,995**	
			2,189.53	*2,189.53*	
Earthwork	**1.00**	**EA**	**2,190**	**2,190**	
			39.03	*39.03*	
Pipe Placement	**200.00**	**LF**	**7,805**	**7,805**	
			16.69	*16.69*	
10 01 02 01 02 04 Box Culverts	**236.00**	**LF**	**3,938**	**3,938**	
			33.37	*33.37*	
Demolition	**118.00**	**LF**	**3,938**	**3,938**	
			2,189.53	*2,189.53*	
Earthwork	**1.00**	**EA**	**2,190**	**2,190**	

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Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			14.82	*14.82*	
Pipe Removal	**118.00**	**LF**	**1,748**	**1,748**	
			2,372,932.45	*2,372,932.45*	
10 01 02 01 03 Galveston Island #3 Pump Station	**1.00**	**EA**	**2,372,932**	**2,372,932**	
			64.84	*64.84*	
10 01 02 01 03 01 8-in PVC Water Line	**2,066.00**	**LF**	**133,961**	**133,961**	
			18.27	*18.27*	
Demolition	**1,033.00**	**LF**	**18,874**	**18,874**	
			8,491.81	*8,491.81*	
Earthwork	**1.00**	**EA**	**8,492**	**8,492**	
			10.05	*10.05*	
Pipe Removal	**1,033.00**	**LF**	**10,382**	**10,382**	
			55.71	*55.71*	
Reconstruction	**2,066.00**	**LF**	**115,087**	**115,087**	
			33,967.25	*33,967.25*	
Earthwork	**1.00**	**EA**	**33,967**	**33,967**	
			39.26	*39.26*	
Pipe Placement	**2,066.00**	**LF**	**81,119**	**81,119**	
			215.23	*215.23*	
10 01 02 01 03 02 12-in CI Water Line	**880.00**	**LF**	**189,400**	**189,400**	
			18.62	*18.62*	
Demolition	**440.00**	**LF**	**8,191**	**8,191**	
			3,609.76	*3,609.76*	
Earthwork	**1.00**	**EA**	**3,610**	**3,610**	
			10.41	*10.41*	
Pipe Removal	**440.00**	**LF**	**4,581**	**4,581**	
			205.92	*205.92*	
Reconstruction	**880.00**	**LF**	**181,209**	**181,209**	
			14,468.63	*14,468.63*	
Earthwork	**1.00**	**EA**	**14,469**	**14,469**	
			189.48	*189.48*	
Pipe Placement	**880.00**	**LF**	**166,740**	**166,740**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			240.46	*240.46*	
10 01 02 01 03 03 20-in DI Water Line	**70.00**	**EA**	**16,832**	**16,832**	
			23.65	*23.65*	
Demolition	**35.00**	**LF**	**828**	**828**	
			281.09	*281.09*	
Earthwork	**1.00**	**EA**	**281**	**281**	
			15.62	*15.62*	
Pipe Removal	**35.00**	**LF**	**547**	**547**	
			228.64	*228.64*	
Reconstruction	**70.00**	**LF**	**16,005**	**16,005**	
			1,153.94	*1,153.94*	
Earthwork	**1.00**	**EA**	**1,154**	**1,154**	
			212.15	*212.15*	
Pipe Placement	**70.00**	**LF**	**14,851**	**14,851**	
			252.72	*252.72*	
10 01 02 01 03 04 30-in Clay Sewer Line	**7,592.00**	**LF**	**1,918,639**	**1,918,639**	
			43.62	*43.62*	
Demolition	**3,796.00**	**LF**	**165,592**	**165,592**	
			66,558.66	*66,558.66*	
Earthwork	**1.00**	**EA**	**66,559**	**66,559**	
			26.09	*26.09*	
Pipe Removal	**3,796.00**	**LF**	**99,033**	**99,033**	
			230.91	*230.91*	
Reconstruction	**7,592.00**	**LF**	**1,753,047**	**1,753,047**	
			166,389.24	*166,389.24*	
Earthwork	**1.00**	**EA**	**166,389**	**166,389**	
			208.99	*208.99*	
Pipe Placement	**7,592.00**	**LF**	**1,586,658**	**1,586,658**	
			286.37	*286.37*	
10 01 02 01 03 05 24-in CI Sewer Line	**80.00**	**LF**	**22,909**	**22,909**	
			23.75	*23.75*	
Demolition	**40.00**	**LF**	**950**	**950**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			325.47	*325.47*	
Earthwork	**1.00**	**EA**	**325**	**325**	
			15.62	*15.62*	
Pipe Removal	**40.00**	**LF**	**625**	**625**	
			274.49	*274.49*	
Reconstruction	**80.00**	**LF**	**21,959**	**21,959**	
			1,316.67	*1,316.67*	
Earthwork	**1.00**	**EA**	**1,317**	**1,317**	
			258.03	*258.03*	
Pipe Placement	**80.00**	**LF**	**20,642**	**20,642**	
			408.32	*408.32*	
10 01 02 01 03 06 42-in PVC Sewer Line	**60.00**	**LF**	**24,499**	**24,499**	
			47.79	*47.79*	
Demolition	**30.00**	**LF**	**1,434**	**1,434**	
			650.94	*650.94*	
Earthwork	**1.00**	**EA**	**651**	**651**	
			26.09	*26.09*	
Pipe Removal	**30.00**	**LF**	**783**	**783**	
			384.43	*384.43*	
Reconstruction	**60.00**	**LF**	**23,066**	**23,066**	
			1,642.15	*1,642.15*	
Earthwork	**1.00**	**EA**	**1,642**	**1,642**	
			357.06	*357.06*	
Pipe Placement	**60.00**	**LF**	**21,424**	**21,424**	
			24.00	*24.00*	
10 01 02 01 03 07 42-in Storm Drain	**2,488.00**	**LF**	**59,720**	**59,720**	
			48.01	*48.01*	
Demolition	**1,244.00**	**LF**	**59,720**	**59,720**	
			27,265.53	*27,265.53*	
Earthwork	**1.00**	**EA**	**27,266**	**27,266**	
			26.09	*26.09*	
Pipe Removal	**1,244.00**	**LF**	**32,454**	**32,454**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			21.13	*21.13*	
10 01 02 01 03 08 Box Culverts	**330.00**	**LF**	**6,972**	**6,972**	
			42.25	*42.25*	
Demolition	**165.00**	**LF**	**6,972**	**6,972**	
			4,526.99	*4,526.99*	
Earthwork	**1.00**	**EA**	**4,527**	**4,527**	
			14.82	*14.82*	
Pipe Removal	**165.00**	**LF**	**2,445**	**2,445**	
			140,368.52	*140,368.52*	
10 01 02 01 04 Galveston Island #4 Pump Station	**1.00**	**EA**	**140,369**	**140,369**	
			48.73	*48.73*	
10 01 02 01 04 01 6-in PVC Water Line	**187.00**	**LF**	**9,113**	**9,113**	
			15.59	*15.59*	
Demolition	**93.50**	**LF**	**1,458**	**1,458**	
			517.79	*517.79*	
Earthwork	**1.00**	**EA**	**518**	**518**	
			10.05	*10.05*	
Pipe Removal	**93.50**	**LF**	**940**	**940**	
			40.94	*40.94*	
Reconstruction	**187.00**	**LF**	**7,655**	**7,655**	
			2,056.38	*2,056.38*	
Earthwork	**1.00**	**EA**	**2,056**	**2,056**	
			29.94	*29.94*	
Pipe Placement	**187.00**	**LF**	**5,599**	**5,599**	
			86.44	*86.44*	
10 01 02 01 04 02 6-in CI Water Line	**140.00**	**LF**	**12,102**	**12,102**	
			12.44	*12.44*	
Demolition	**70.00**	**LF**	**871**	**871**	
			384.65	*384.65*	
Earthwork	**1.00**	**EA**	**385**	**385**	
			6.94	*6.94*	
Pipe Removal	**70.00**	**LF**	**486**	**486**	

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Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			80.22	*80.22*	
Reconstruction	**140.00**	**LF**	**11,231**	**11,231**	
			1,538.59	*1,538.59*	
Earthwork	**1.00**	**EA**	**1,539**	**1,539**	
			69.23	*69.23*	
Pipe Placement	**140.00**	**LF**	**9,693**	**9,693**	
			96.02	*96.02*	
10 01 02 01 04 03 12-in AC Water Line	**80.00**	**LF**	**7,682**	**7,682**	
			18.19	*18.19*	
Demolition	**40.00**	**LF**	**728**	**728**	
			325.47	*325.47*	
Earthwork	**1.00**	**EA**	**325**	**325**	
			10.05	*10.05*	
Pipe Removal	**40.00**	**LF**	**402**	**402**	
			86.93	*86.93*	
Reconstruction	**80.00**	**LF**	**6,954**	**6,954**	
			1,316.67	*1,316.67*	
Earthwork	**1.00**	**EA**	**1,317**	**1,317**	
			70.47	*70.47*	
Pipe Placement	**80.00**	**LF**	**5,638**	**5,638**	
			52.89	*52.89*	
10 01 02 01 04 04 12-in Clay Sewer Line	**830.00**	**LF**	**43,900**	**43,900**	
			18.29	*18.29*	
Demolition	**415.00**	**LF**	**7,589**	**7,589**	
			3,417.44	*3,417.44*	
Earthwork	**1.00**	**EA**	**3,417**	**3,417**	
			10.05	*10.05*	
Pipe Removal	**415.00**	**LF**	**4,171**	**4,171**	
			43.75	*43.75*	
Reconstruction	**830.00**	**LF**	**36,312**	**36,312**	
			13,640.16	*13,640.16*	
Earthwork	**1.00**	**EA**	**13,640**	**13,640**	

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Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			27.32	*27.32*	
Pipe Placement	**830.00**	**LF**	**22,671**	**22,671**	
			19.89	*19.89*	
10 01 02 01 04 05 36-in Storm Drain	**2,662.00**	**LF**	**52,951**	**52,951**	
			39.78	*39.78*	
Demolition	**1,331.00**	**LF**	**52,951**	**52,951**	
			18,226.33	*18,226.33*	
Earthwork	**1.00**	**EA**	**18,226**	**18,226**	
			26.09	*26.09*	
Pipe Removal	**1,331.00**	**LF**	**34,724**	**34,724**	
			34.81	*34.81*	
10 01 02 01 04 06 Box Culverts	**420.00**	**LF**	**14,621**	**14,621**	
			69.63	*69.63*	
Demolition	**210.00**	**LF**	**14,621**	**14,621**	
			11,509.81	*11,509.81*	
Earthwork	**1.00**	**EA**	**11,510**	**11,510**	
			14.82	*14.82*	
Pipe Removal	**210.00**	**LF**	**3,112**	**3,112**	
			403,768,781.75	*403,768,781.75*	
10 02 Federal Costs	**1.00**	**EA**	**403,768,782**	**403,768,782**	
10 02 13 Pumping Plant	**1.00**	**LS**	**258,876,370**	**258,876,370**	
10 02 13 00 Mob, Demob and Site Prep	**1.00**	**LS**	**1,196,091**	**1,196,091**	
10 02 13 00 01 Mobilization	**1.00**	**LS**	**708,566**	**708,566**	
10 02 13 00 02 Demobilization	**1.00**	**LS**	**487,525**	**487,525**	
			69,834,187.80	*69,834,187.80*	
10 02 13 01 Galveston Island #1 Pump Station	**1.00**	**EA**	**69,834,188**	**69,834,188**	
			17,297,448.07	*17,297,448.07*	
10 02 13 01 01 Pump Station Structure	**1.00**	**EA**	**17,297,448**	**17,297,448**	
			11,650,710.56	*11,650,710.56*	
10 02 13 01 01 01 Foundation	**1.00**	**EA**	**11,650,711**	**11,650,711**	
			15,189.09	*15,189.09*	
24-in Pipe Pile	**680.00**	**EA**	**10,328,579**	**10,328,579**	

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Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			25.70	*25.70*	
Sheet Pile	**8,772.75**	**SF**	**225,427**	**225,427**	
			358.37	*358.37*	
Foundation Base Slab	**2,421.00**	**CY**	**867,623**	**867,623**	
			359.63	*359.63*	
Mud Slab	**637.00**	**CY**	**229,081**	**229,081**	
			3,456,690.28	*3,456,690.28*	
10 02 13 01 01 02 Substructure	**1.00**	**EA**	**3,456,690**	**3,456,690**	
			551.31	*551.31*	
Concrete Substructure	**6,270.00**	**CY**	**3,456,690**	**3,456,690**	
			1,533,423.44	*1,533,423.44*	
10 02 13 01 01 03 Superstructure	**1.00**	**EA**	**1,533,423**	**1,533,423**	
			1,130.32	*1,130.32*	
Precast Wall Panels	**577.00**	**CY**	**652,196**	**652,196**	
			16,722.38	*16,722.38*	
Steel Columns	**48.00**	**EA**	**802,674**	**802,674**	
			1,454.69	*1,454.69*	
Roof Beams	**54.00**	**EA**	**78,553**	**78,553**	
			656,623.79	*656,623.79*	
10 02 13 01 01 04 Crane Frame	**1.00**	**EA**	**656,624**	**656,624**	
			5,086.04	*5,086.04*	
Steel Columns	**48.00**	**EA**	**244,130**	**244,130**	
			3,307.42	*3,307.42*	
Top Rail	**30.00**	**EA**	**99,223**	**99,223**	
			996.86	*996.86*	
Crane Rails	**30.00**	**EA**	**29,906**	**29,906**	
			1,889.10	*1,889.10*	
Infill Framing	**150.00**	**EA**	**283,365**	**283,365**	
			651,522.94	*651,522.94*	
10 02 13 01 02 Fuel Tank Foundations	**1.00**	**EA**	**651,523**	**651,523**	
			7,852.49	*7,852.49*	
10 02 13 01 02 01 Steel Pipe Piles	**72.00**	**EA**	**565,379**	**565,379**	

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Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			358.93	*358.93*	
10 02 13 01 02 02 Concrete Pile Cap	**240.00**	**CY**	**86,144**	**86,144**	
			48,813,295.82	*48,813,295.82*	
10 02 13 01 03 Mechanical Items	**1.00**	**EA**	**48,813,296**	**48,813,296**	
			5,123,508.00	*5,123,508.00*	
10 02 13 01 03 01 Pump, Engine and Gearbox	**9.00**	**EA**	**46,111,572**	**46,111,572**	
			8,649.81	*8,649.81*	
10 02 13 01 03 02 Jacket Water Tank	**3.00**	**EA**	**25,949**	**25,949**	
			3,099.04	*3,099.04*	
10 02 13 01 03 03 Auxiliary Jacket Water Pumps	**11.00**	**EA**	**34,089**	**34,089**	
			54,144.23	*54,144.23*	
10 02 13 01 03 04 Start Air Compressor	**3.00**	**EA**	**162,433**	**162,433**	
			14,847.89	*14,847.89*	
10 02 13 01 03 05 Start Air Bottle	**3.00**	**EA**	**44,544**	**44,544**	
			3,092.51	*3,092.51*	
10 02 13 01 03 06 Fuel Oil Purifier	**16.00**	**EA**	**49,480**	**49,480**	
			1,750.59	*1,750.59*	
10 02 13 01 03 07 Fuel Oil Pumps	**11.00**	**EA**	**19,257**	**19,257**	
			1,750.59	*1,750.59*	
10 02 13 01 03 08 Fuel Oil Transfer Pump	**16.00**	**EA**	**28,009**	**28,009**	
			7,423.94	*7,423.94*	
10 02 13 01 03 09 Fuel Oil Day Tank	**11.00**	**EA**	**81,663**	**81,663**	
			18,577.33	*18,577.33*	
10 02 13 01 03 10 Fuel Oil Settling Tank	**9.00**	**EA**	**167,196**	**167,196**	
			1,170.28	*1,170.28*	
10 02 13 01 03 11 Prelube Pump	**11.00**	**EA**	**12,873**	**12,873**	
			3,092.51	*3,092.51*	
10 02 13 01 03 12 Lube Oil Purifier	**2.00**	**EA**	**6,185**	**6,185**	
			7,423.94	*7,423.94*	
10 02 13 01 03 13 Lube Oil Tank	**1.00**	**EA**	**7,424**	**7,424**	
			5,109.57	*5,109.57*	
10 02 13 01 03 14 Lube Oil Cooler	**11.00**	**EA**	**56,205**	**56,205**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			132,466.96	*132,466.96*	
10 02 13 01 03 15 Overhead Crane	**1.00**	**EA**	**132,467**	**132,467**	
			6,093.92	*6,093.92*	
10 02 13 01 03 16 Control Room HVAC Package Unit	**1.00**	**EA**	**6,094**	**6,094**	
			66,919.45	*66,919.45*	
10 02 13 01 03 17 Fixed Fire Protection System	**1.00**	**EA**	**66,919**	**66,919**	
			235,853.22	*235,853.22*	
10 02 13 01 03 18 Emergency Diesel Generator	**2.00**	**EA**	**471,706**	**471,706**	
			25,804.38	*25,804.38*	
10 02 13 01 03 19 Stop Logs / Roller Gate	**9.00**	**EA**	**232,239**	**232,239**	
			82,574.02	*82,574.02*	
10 02 13 01 03 20 Trash Rack	**9.00**	**EA**	**743,166**	**743,166**	
			30,646.54	*30,646.54*	
10 02 13 01 03 21 Trash Rake	**9.00**	**EA**	**275,819**	**275,819**	
			4,592.44	*4,592.44*	
10 02 13 01 03 22 Exhaust Fan	**4.00**	**EA**	**18,370**	**18,370**	
			2,751.92	*2,751.92*	
10 02 13 01 03 23 Sump Blower	**9.00**	**EA**	**24,767**	**24,767**	
			1,574.20	*1,574.20*	
10 02 13 01 03 24 Submersible Nonclog Sump Pump	**9.00**	**EA**	**14,168**	**14,168**	
			915.78	*915.78*	
10 02 13 01 03 25 Air Start Valve	**11.00**	**EA**	**10,074**	**10,074**	
			3,542.02	*3,542.02*	
10 02 13 01 03 26 Air Dryer	**3.00**	**EA**	**10,626**	**10,626**	
			3,071,920.97	*3,071,920.97*	
10 02 13 01 04 Electrical	**1.00**	**EA**	**3,071,921**	**3,071,921**	
10 02 13 01 04 01 Telephone/Communication System	**1.00**	**LS**	**14,209**	**14,209**	
10 02 13 01 04 02 Pump Station Lights and Fixtures	**1.00**	**LS**	**130,059**	**130,059**	
10 02 13 01 04 03 Pump Station Video/CCTV System	**1.00**	**LS**	**43,986**	**43,986**	
10 02 13 01 04 04 Fuel Storage Video/CCTV System	**1.00**	**LS**	**35,155**	**35,155**	
10 02 13 01 04 05 Pump Station Fire Alarm and Detection System	**1.00**	**LS**	**27,236**	**27,236**	
10 02 13 01 04 06 Fuel Storage Fire Alarm and Detection System	**1.00**	**LS**	**20,640**	**20,640**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
10 02 13 01 04 07 Pump Station Controls and Sensors	**1.00**	**LS**	**505,822**	**505,822**	
10 02 13 01 04 08 Fuel Storage Controls and Sensors	**1.00**	**LS**	**370,041**	**370,041**	
10 02 13 01 04 09 Incoming Power	**1.00**	**LS**	**13,500**	**13,500**	
10 02 13 01 04 10 Pump Station Lighting Conductors	**1.00**	**LS**	**507,762**	**507,762**	
10 02 13 01 04 11 Fuel Storage Lighting	**1.00**	**LS**	**29,035**	**29,035**	
10 02 13 01 04 12 Motor Control Center	**1.00**	**LS**	**501,832**	**501,832**	
			57,905.83	*57,905.83*	
10 02 13 01 04 13 Pump Station Receptacles	**1.00**	**EA**	**57,906**	**57,906**	
			17,267.07	*17,267.07*	
10 02 13 01 04 14 Fuel Storage Receptacles	**1.00**	**EA**	**17,267**	**17,267**	
10 02 13 01 04 15 Automatic Transfer Switches	**1.00**	**LS**	**116,359**	**116,359**	
			375,500.56	*375,500.56*	
10 02 13 01 04 16 Stand-by Generators	**1.00**	**EA**	**375,501**	**375,501**	
10 02 13 01 04 17 Power Transformers	**1.00**	**LS**	**84,441**	**84,441**	
10 02 13 01 04 18 Conductors	**1.00**	**LS**	**43,135**	**43,135**	
10 02 13 01 04 19 Conduits	**1.00**	**LS**	**129,660**	**129,660**	
10 02 13 01 04 20 Motors	**1.00**	**LS**	**48,376**	**48,376**	
			27,159,282.90	*27,159,282.90*	
10 02 13 02 Galveston Island #2 Pump Station	**1.00**	**EA**	**27,159,283**	**27,159,283**	
			7,137,218.56	*7,137,218.56*	
10 02 13 02 01 Pump Station Structure	**1.00**	**EA**	**7,137,219**	**7,137,219**	
			3,814,162.46	*3,814,162.46*	
10 02 13 02 01 01 Foundation	**1.00**	**EA**	**3,814,162**	**3,814,162**	
			13,202.27	*13,202.27*	
24-in Pipe Pile	**248.00**	**EA**	**3,274,162**	**3,274,162**	
			25.70	*25.70*	
Sheet Pile	**2,924.25**	**SF**	**75,142**	**75,142**	
			364.11	*364.11*	
Foundation Base Slab	**1,062.00**	**CY**	**386,683**	**386,683**	
			368.75	*368.75*	
Mud Slab	**212.00**	**CY**	**78,174**	**78,174**	
			1,794,052.04	*1,794,052.04*	

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Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
10 02 13 02 01 02 Substructure	**1.00**	**EA**	**1,794,052**	**1,794,052**	
			551.34	*551.34*	
Concrete Substructure	**3,254.00**	**CY**	**1,794,052**	**1,794,052**	
			1,017,456.67	*1,017,456.67*	
10 02 13 02 01 03 Superstructure	**1.00**	**EA**	**1,017,457**	**1,017,457**	
			1,130.31	*1,130.31*	
Precast Wall Panels	**305.00**	**CY**	**344,745**	**344,745**	
			17,767.53	*17,767.53*	
Steel Columns	**24.00**	**EA**	**426,421**	**426,421**	
			8,209.69	*8,209.69*	
Roof Beams	**30.00**	**EA**	**246,291**	**246,291**	
			511,547.39	*511,547.39*	
10 02 13 02 01 04 Crane Frame	**1.00**	**EA**	**511,547**	**511,547**	
			5,449.33	*5,449.33*	
Steel Columns	**24.00**	**EA**	**130,784**	**130,784**	
			5,088.34	*5,088.34*	
Top Rail	**18.00**	**EA**	**91,590**	**91,590**	
			1,533.63	*1,533.63*	
Crane Rails	**18.00**	**EA**	**27,605**	**27,605**	
			2,906.31	*2,906.31*	
Infill Framing	**90.00**	**EA**	**261,568**	**261,568**	
			288,593.29	*288,593.29*	
10 02 13 02 02 Fuel Tank Foundations	**1.00**	**EA**	**288,593**	**288,593**	
			7,803.42	*7,803.42*	
10 02 13 02 02 01 Steel Pipe Piles	**32.00**	**EA**	**249,710**	**249,710**	
			363.40	*363.40*	
10 02 13 02 02 02 Concrete Pile Cap	**107.00**	**CY**	**38,884**	**38,884**	
			17,203,224.52	*17,203,224.52*	
10 02 13 02 03 Mechanical Items	**1.00**	**EA**	**17,203,225**	**17,203,225**	
			5,123,508.00	*5,123,508.00*	
10 02 13 02 03 01 Pump, Engine and Gearbox	**3.00**	**EA**	**15,370,524**	**15,370,524**	
			8,649.81	*8,649.81*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
10 02 13 02 03 02 Jacket Water Tank	**1.00**	**EA**	**8,650**	**8,650**	
			3,099.04	*3,099.04*	
10 02 13 02 03 03 Auxiliary Jacket Water Pumps	**2.00**	**EA**	**6,198**	**6,198**	
			54,144.23	*54,144.23*	
10 02 13 02 03 04 Start Air Compressor	**1.00**	**EA**	**54,144**	**54,144**	
			14,847.89	*14,847.89*	
10 02 13 02 03 05 Start Air Bottle	**1.00**	**EA**	**14,848**	**14,848**	
			3,092.51	*3,092.51*	
10 02 13 02 03 06 Fuel Oil Purifier	**4.00**	**EA**	**12,370**	**12,370**	
			1,750.59	*1,750.59*	
10 02 13 02 03 07 Fuel Oil Pumps	**2.00**	**EA**	**3,501**	**3,501**	
			1,750.59	*1,750.59*	
10 02 13 02 03 08 Fuel Oil Transfer Pump	**4.00**	**EA**	**7,002**	**7,002**	
			7,423.94	*7,423.94*	
10 02 13 02 03 09 Fuel Oil Day Tank	**2.00**	**EA**	**14,848**	**14,848**	
			18,577.33	*18,577.33*	
10 02 13 02 03 10 Fuel Oil Settling Tank	**1.00**	**EA**	**18,577**	**18,577**	
			1,170.28	*1,170.28*	
10 02 13 02 03 11 Prelube Pump	**2.00**	**EA**	**2,341**	**2,341**	
			3,092.51	*3,092.51*	
10 02 13 02 03 12 Lube Oil Purifier	**2.00**	**EA**	**6,185**	**6,185**	
			7,423.94	*7,423.94*	
10 02 13 02 03 13 Lube Oil Tank	**1.00**	**EA**	**7,424**	**7,424**	
			5,109.57	*5,109.57*	
10 02 13 02 03 14 Lube Oil Cooler	**2.00**	**EA**	**10,219**	**10,219**	
			132,466.96	*132,466.96*	
10 02 13 02 03 15 Overhead Crane	**1.00**	**EA**	**132,467**	**132,467**	
			6,093.92	*6,093.92*	
10 02 13 02 03 16 Control Room HVAC Package Unit	**1.00**	**EA**	**6,094**	**6,094**	
			66,919.45	*66,919.45*	
10 02 13 02 03 17 Fixed Fire Protection System	**1.00**	**EA**	**66,919**	**66,919**	
			235,853.22	*235,853.22*	

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Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
10 02 13 02 03 18 Emergency Diesel Generator	**1.00**	**EA**	**235,853**	**235,853**	
			25,804.38	*25,804.38*	
10 02 13 02 03 19 Stop Logs / Roller Gate	**3.00**	**EA**	**77,413**	**77,413**	
			247,722.07	*247,722.07*	
10 02 13 02 03 20 Trash Rack	**3.00**	**EA**	**743,166**	**743,166**	
			122,586.14	*122,586.14*	
10 02 13 02 03 21 Trash Rake	**3.00**	**EA**	**367,758**	**367,758**	
			4,592.44	*4,592.44*	
10 02 13 02 03 22 Exhaust Fan	**4.00**	**EA**	**18,370**	**18,370**	
			2,751.92	*2,751.92*	
10 02 13 02 03 23 Sump Blower	**3.00**	**EA**	**8,256**	**8,256**	
			1,574.20	*1,574.20*	
10 02 13 02 03 24 Submersible Nonclog Sump Pump	**3.00**	**EA**	**4,723**	**4,723**	
			915.78	*915.78*	
10 02 13 02 03 25 Air Start Valve	**2.00**	**EA**	**1,832**	**1,832**	
			3,542.02	*3,542.02*	
10 02 13 02 03 26 Air Dryer	**1.00**	**EA**	**3,542**	**3,542**	
			2,530,246.53	*2,530,246.53*	
10 02 13 02 04 Electrical	**1.00**	**EA**	**2,530,247**	**2,530,247**	
10 02 13 02 04 01 Telephone/Communication System	**1.00**	**LS**	**14,959**	**14,959**	
10 02 13 02 04 02 Pump Station Lights and Fixtures	**1.00**	**LS**	**47,791**	**47,791**	
10 02 13 02 04 03 Pump Station Video/CCTV System	**1.00**	**LS**	**43,986**	**43,986**	
10 02 13 02 04 04 Fuel Storage Video/CCTV System	**1.00**	**LS**	**35,155**	**35,155**	
10 02 13 02 04 05 Pump Station Fire Alarm and Detection System	**1.00**	**LS**	**56,364**	**56,364**	
10 02 13 02 04 06 Fuel Storage Fire Alarm and Detection System	**1.00**	**LS**	**169,351**	**169,351**	
10 02 13 02 04 07 Pump Station Controls and Sensors	**1.00**	**LS**	**505,822**	**505,822**	
10 02 13 02 04 08 Fuel Storage Controls and Sensors	**1.00**	**LS**	**471,355**	**471,355**	
10 02 13 02 04 09 Incoming Power	**1.00**	**LS**	**13,500**	**13,500**	
10 02 13 02 04 10 Pump Station Lighting Conductors	**1.00**	**LS**	**12,581**	**12,581**	
10 02 13 02 04 11 Fuel Storage Lighting	**1.00**	**LS**	**26,612**	**26,612**	
10 02 13 02 04 12 Motor Control Center	**1.00**	**LS**	**488,538**	**488,538**	
			57,905.83	*57,905.83*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
10 02 13 02 04 13 Pump Station Receptacles	1.00	EA	57,906	57,906	
			17,267.07	*17,267.07*	
10 02 13 02 04 14 Fuel Storage Receptacles	1.00	EA	17,267	17,267	
10 02 13 02 04 15 Automatic Transfer Switches	1.00	LS	69,761	69,761	
			314,364.90	*314,364.90*	
10 02 13 02 04 16 Stand-by Generators	1.00	EA	314,365	314,365	
10 02 13 02 04 17 Power Transformers	1.00	LS	50,147	50,147	
10 02 13 02 04 18 Conductors	1.00	LS	18,129	18,129	
10 02 13 02 04 19 Conduits	1.00	LS	74,252	74,252	
10 02 13 02 04 20 Motors	1.00	LS	42,405	42,405	
			81,386,319.27	*81,386,319.27*	
10 02 13 03 Galveston Island #3 Pump Station	1.00	EA	81,386,319	81,386,319	
			22,381,083.16	*22,381,083.16*	
10 02 13 03 01 Pump Station Structure	1.00	EA	22,381,083	22,381,083	
			13,754,445.96	*13,754,445.96*	
10 02 13 03 01 01 Foundation	1.00	EA	13,754,446	13,754,446	
			15,197.63	*15,197.63*	
24-in Pipe Pile	752.00	EA	11,428,618	11,428,618	
			25.70	*25.70*	
Sheet Pile	9,747.50	SF	250,474	250,474	
			357.10	*357.10*	
Foundation Base Slab	5,101.00	CY	1,821,586	1,821,586	
			358.94	*358.94*	
Mud Slab	707.00	CY	253,767	253,767	
			5,793,126.36	*5,793,126.36*	
10 02 13 03 01 02 Substructure	1.00	EA	5,793,126	5,793,126	
			551.41	*551.41*	
Concrete Substructure	10,506.00	CY	5,793,126	5,793,126	
			1,873,232.82	*1,873,232.82*	
10 02 13 03 01 03 Superstructure	1.00	EA	1,873,233	1,873,233	
			1,130.27	*1,130.27*	
Precast Wall Panels	622.00	CY	703,031	703,031	

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Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			17,767.53	*17,767.53*	
Steel Columns	**52.00**	**EA**	**923,912**	**923,912**	
			4,246.39	*4,246.39*	
Roof Beams	**58.00**	**EA**	**246,291**	**246,291**	
			960,278.02	*960,278.02*	
10 02 13 03 01 04 Crane Frame	**1.00**	**EA**	**960,278**	**960,278**	
			5,449.33	*5,449.33*	
Steel Columns	**52.00**	**EA**	**283,365**	**283,365**	
			5,088.34	*5,088.34*	
Top Rail	**32.00**	**EA**	**162,827**	**162,827**	
			1,533.63	*1,533.63*	
Crane Rails	**32.00**	**EA**	**49,076**	**49,076**	
			2,906.31	*2,906.31*	
Infill Framing	**160.00**	**EA**	**465,010**	**465,010**	
			719,839.34	*719,839.34*	
10 02 13 03 02 Fuel Tank Foundations	**1.00**	**EA**	**719,839**	**719,839**	
			7,803.42	*7,803.42*	
10 02 13 03 02 01 Steel Pipe Piles	**80.00**	**EA**	**624,274**	**624,274**	
			358.33	*358.33*	
10 02 13 03 02 02 Concrete Pile Cap	**266.70**	**CY**	**95,565**	**95,565**	
			55,003,947.12	*55,003,947.12*	
10 02 13 03 03 Mechanical Items	**1.00**	**EA**	**55,003,947**	**55,003,947**	
			5,123,508.00	*5,123,508.00*	
10 02 13 03 03 01 Pump, Engine and Gearbox	**10.00**	**EA**	**51,235,080**	**51,235,080**	
			8,649.81	*8,649.81*	
10 02 13 03 03 02 Jacket Water Tank	**4.00**	**EA**	**34,599**	**34,599**	
			3,099.04	*3,099.04*	
10 02 13 03 03 03 Auxiliary Jacket Water Pumps	**13.00**	**EA**	**40,288**	**40,288**	
			54,144.23	*54,144.23*	
10 02 13 03 03 04 Start Air Compressor	**3.00**	**EA**	**162,433**	**162,433**	
			14,847.89	*14,847.89*	
10 02 13 03 03 05 Start Air Bottle	**5.00**	**EA**	**74,239**	**74,239**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			3,092.51	*3,092.51*	
10 02 13 03 03 06 Fuel Oil Purifier	**18.00**	**EA**	**55,665**	**55,665**	
			1,750.59	*1,750.59*	
10 02 13 03 03 07 Fuel Oil Pumps	**13.00**	**EA**	**22,758**	**22,758**	
			1,750.59	*1,750.59*	
10 02 13 03 03 08 Fuel Oil Transfer Pump	**18.00**	**EA**	**31,511**	**31,511**	
			7,423.94	*7,423.94*	
10 02 13 03 03 09 Fuel Oil Day Tank	**13.00**	**EA**	**96,511**	**96,511**	
			18,577.33	*18,577.33*	
10 02 13 03 03 10 Fuel Oil Settling Tank	**9.00**	**EA**	**167,196**	**167,196**	
			1,170.28	*1,170.28*	
10 02 13 03 03 11 Prelube Pump	**13.00**	**EA**	**15,214**	**15,214**	
			3,092.51	*3,092.51*	
10 02 13 03 03 12 Lube Oil Purifier	**2.00**	**EA**	**6,185**	**6,185**	
			7,423.94	*7,423.94*	
10 02 13 03 03 13 Lube Oil Tank	**1.00**	**EA**	**7,424**	**7,424**	
			5,109.57	*5,109.57*	
10 02 13 03 03 14 Lube Oil Cooler	**13.00**	**EA**	**66,424**	**66,424**	
			132,466.96	*132,466.96*	
10 02 13 03 03 15 Overhead Crane	**1.00**	**EA**	**132,467**	**132,467**	
			6,093.92	*6,093.92*	
10 02 13 03 03 16 Control Room HVAC Package Unit	**1.00**	**EA**	**6,094**	**6,094**	
			66,919.45	*66,919.45*	
10 02 13 03 03 17 Fixed Fire Protection System	**1.00**	**EA**	**66,919**	**66,919**	
			235,853.22	*235,853.22*	
10 02 13 03 03 18 Emergency Diesel Generator	**2.00**	**EA**	**471,706**	**471,706**	
			25,804.38	*25,804.38*	
10 02 13 03 03 19 Stop Logs / Roller Gate	**10.00**	**EA**	**258,044**	**258,044**	
			74,316.62	*74,316.62*	
10 02 13 03 03 20 Trash Rack	**10.00**	**EA**	**743,166**	**743,166**	
			122,586.14	*122,586.14*	
10 02 13 03 03 21 Trash Rake	**10.00**	**EA**	**1,225,861**	**1,225,861**	

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Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
			4,592.44	*4,592.44*	
10 02 13 03 03 22 Exhaust Fan	**4.00**	**EA**	**18,370**	**18,370**	
			2,751.92	*2,751.92*	
10 02 13 03 03 23 Sump Blower	**10.00**	**EA**	**27,519**	**27,519**	
			1,574.20	*1,574.20*	
10 02 13 03 03 24 Submersible Nonclog Sump Pump	**10.00**	**EA**	**15,742**	**15,742**	
			915.78	*915.78*	
10 02 13 03 03 25 Air Start Valve	**13.00**	**EA**	**11,905**	**11,905**	
			3,542.02	*3,542.02*	
10 02 13 03 03 26 Air Dryer	**3.00**	**EA**	**10,626**	**10,626**	
			3,281,449.66	*3,281,449.66*	
10 02 13 03 04 Electrical	**1.00**	**EA**	**3,281,450**	**3,281,450**	
10 02 13 03 04 01 Telephone/Communication System	**1.00**	**LS**	**14,959**	**14,959**	
10 02 13 03 04 02 Pump Station Lights and Fixtures	**1.00**	**LS**	**130,059**	**130,059**	
10 02 13 03 04 03 Pump Station Video/CCTV System	**1.00**	**LS**	**43,986**	**43,986**	
10 02 13 03 04 04 Fuel Storage Video/CCTV System	**1.00**	**LS**	**35,155**	**35,155**	
10 02 13 03 04 05 Pump Station Fire Alarm and Detection System	**1.00**	**LS**	**27,236**	**27,236**	
10 02 13 03 04 06 Fuel Storage Fire Alarm and Detection System	**1.00**	**LS**	**20,640**	**20,640**	
10 02 13 03 04 07 Pump Station Controls and Sensors	**1.00**	**LS**	**505,822**	**505,822**	
10 02 13 03 04 08 Fuel Storage Controls and Sensors	**1.00**	**LS**	**370,041**	**370,041**	
10 02 13 03 04 09 Incoming Power	**1.00**	**LS**	**13,500**	**13,500**	
10 02 13 03 04 10 Pump Station Lighting Conductors	**1.00**	**LS**	**507,762**	**507,762**	
10 02 13 03 04 11 Fuel Storage Lighting	**1.00**	**LS**	**29,035**	**29,035**	
10 02 13 03 04 12 Motor Control Center	**1.00**	**LS**	**501,832**	**501,832**	
			57,905.83	*57,905.83*	
10 02 13 03 04 13 Pump Station Receptacles	**1.00**	**EA**	**57,906**	**57,906**	
			17,267.07	*17,267.07*	
10 02 13 03 04 14 Fuel Storage Receptacles	**1.00**	**EA**	**17,267**	**17,267**	
10 02 13 03 04 15 Automatic Transfer Switches	**1.00**	**LS**	**69,761**	**69,761**	
			665,170.35	*665,170.35*	
10 02 13 03 04 16 Stand-by Generators	**1.00**	**EA**	**665,170**	**665,170**	
10 02 13 03 04 17 Power Transformers	**1.00**	**LS**	**50,147**	**50,147**	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
10 02 13 03 04 18 Conductors	**1.00**	**LS**	**43,135**	**43,135**	
10 02 13 03 04 19 Conduits	**1.00**	**LS**	**129,660**	**129,660**	
10 02 13 03 04 20 Motors	**1.00**	**LS**	**48,376**	**48,376**	
			79,300,488.90	*79,300,488.90*	
10 02 13 04 Galveston Island #4 Pump Station	**1.00**	**EA**	**79,300,489**	**79,300,489**	
			20,333,612.37	*20,333,612.37*	
10 02 13 04 01 Pump Station Structure	**1.00**	**EA**	**20,333,612**	**20,333,612**	
			12,256,895.41	*12,256,895.41*	
10 02 13 04 01 01 Foundation	**1.00**	**EA**	**12,256,895**	**12,256,895**	
			13,204.79	*13,204.79*	
24-in Pipe Pile	**752.00**	**EA**	**9,930,003**	**9,930,003**	
			25.70	*25.70*	
Sheet Pile	**9,747.50**	**SF**	**250,474**	**250,474**	
			356.89	*356.89*	
Foundation Base Slab	**5,107.00**	**CY**	**1,822,651**	**1,822,651**	
			358.94	*358.94*	
Mud Slab	**707.00**	**CY**	**253,767**	**253,767**	
			5,243,206.13	*5,243,206.13*	
10 02 13 04 01 02 Substructure	**1.00**	**EA**	**5,243,206**	**5,243,206**	
			551.34	*551.34*	
Concrete Substructure	**9,510.00**	**CY**	**5,243,206**	**5,243,206**	
			1,873,232.82	*1,873,232.82*	
10 02 13 04 01 03 Superstructure	**1.00**	**EA**	**1,873,233**	**1,873,233**	
			1,130.27	*1,130.27*	
Precast Wall Panels	**622.00**	**CY**	**703,031**	**703,031**	
			17,767.53	*17,767.53*	
Steel Columns	**52.00**	**EA**	**923,912**	**923,912**	
			4,246.39	*4,246.39*	
Roof Beams	**58.00**	**EA**	**246,291**	**246,291**	
			960,278.02	*960,278.02*	
10 02 13 04 01 04 Crane Frame	**1.00**	**EA**	**960,278**	**960,278**	
			5,449.33	*5,449.33*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
Steel Columns	**52.00**	**EA**	**283,365**	**283,365**	
			5,088.34	*5,088.34*	
Top Rail	**32.00**	**EA**	**162,827**	**162,827**	
			1,533.63	*1,533.63*	
Crane Rails	**32.00**	**EA**	**49,076**	**49,076**	
			2,906.31	*2,906.31*	
Infill Framing	**160.00**	**EA**	**465,010**	**465,010**	
			719,839.34	*719,839.34*	
10 02 13 04 02 Fuel Tank Foundations	**1.00**	**EA**	**719,839**	**719,839**	
			7,803.42	*7,803.42*	
10 02 13 04 02 01 Steel Pipe Piles	**80.00**	**EA**	**624,274**	**624,274**	
			358.33	*358.33*	
10 02 13 04 02 02 Concrete Pile Cap	**266.70**	**CY**	**95,565**	**95,565**	
			55,003,947.12	*55,003,947.12*	
10 02 13 04 03 Mechanical Items	**1.00**	**EA**	**55,003,947**	**55,003,947**	
			5,123,508.00	*5,123,508.00*	
10 02 13 04 03 01 Pump, Engine and Gearbox	**10.00**	**EA**	**51,235,080**	**51,235,080**	
			8,649.81	*8,649.81*	
10 02 13 04 03 02 Jacket Water Tank	**4.00**	**EA**	**34,599**	**34,599**	
			3,099.04	*3,099.04*	
10 02 13 04 03 03 Auxiliary Jacket Water Pumps	**13.00**	**EA**	**40,288**	**40,288**	
			54,144.23	*54,144.23*	
10 02 13 04 03 04 Start Air Compressor	**3.00**	**EA**	**162,433**	**162,433**	
			14,847.89	*14,847.89*	
10 02 13 04 03 05 Start Air Bottle	**5.00**	**EA**	**74,239**	**74,239**	
			3,092.51	*3,092.51*	
10 02 13 04 03 06 Fuel Oil Purifier	**18.00**	**EA**	**55,665**	**55,665**	
			1,750.59	*1,750.59*	
10 02 13 04 03 07 Fuel Oil Pumps	**13.00**	**EA**	**22,758**	**22,758**	
			1,750.59	*1,750.59*	
10 02 13 04 03 08 Fuel Oil Transfer Pump	**18.00**	**EA**	**31,511**	**31,511**	
			7,423.94	*7,423.94*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
10 02 13 04 03 09 Fuel Oil Day Tank	**13.00**	**EA**	**96,511**	**96,511**	
			18,577.33	*18,577.33*	
10 02 13 04 03 10 Fuel Oil Settling Tank	**9.00**	**EA**	**167,196**	**167,196**	
			1,170.28	*1,170.28*	
10 02 13 04 03 11 Prelube Pump	**13.00**	**EA**	**15,214**	**15,214**	
			3,092.51	*3,092.51*	
10 02 13 04 03 12 Lube Oil Purifier	**2.00**	**EA**	**6,185**	**6,185**	
			7,423.94	*7,423.94*	
10 02 13 04 03 13 Lube Oil Tank	**1.00**	**EA**	**7,424**	**7,424**	
			5,109.57	*5,109.57*	
10 02 13 04 03 14 Lube Oil Cooler	**13.00**	**EA**	**66,424**	**66,424**	
			132,466.96	*132,466.96*	
10 02 13 04 03 15 Overhead Crane	**1.00**	**EA**	**132,467**	**132,467**	
			6,093.92	*6,093.92*	
10 02 13 04 03 16 Control Room HVAC Package Unit	**1.00**	**EA**	**6,094**	**6,094**	
			66,919.45	*66,919.45*	
10 02 13 04 03 17 Fixed Fire Protection System	**1.00**	**EA**	**66,919**	**66,919**	
			235,853.22	*235,853.22*	
10 02 13 04 03 18 Emergency Diesel Generator	**2.00**	**EA**	**471,706**	**471,706**	
			25,804.38	*25,804.38*	
10 02 13 04 03 19 Stop Logs / Roller Gate	**10.00**	**EA**	**258,044**	**258,044**	
			74,316.62	*74,316.62*	
10 02 13 04 03 20 Trash Rack	**10.00**	**EA**	**743,166**	**743,166**	
			122,586.14	*122,586.14*	
10 02 13 04 03 21 Trash Rake	**10.00**	**EA**	**1,225,861**	**1,225,861**	
			4,592.44	*4,592.44*	
10 02 13 04 03 22 Exhaust Fan	**4.00**	**EA**	**18,370**	**18,370**	
			2,751.92	*2,751.92*	
10 02 13 04 03 23 Sump Blower	**10.00**	**EA**	**27,519**	**27,519**	
			1,574.20	*1,574.20*	
10 02 13 04 03 24 Submersible Nonclog Sump Pump	**10.00**	**EA**	**15,742**	**15,742**	
			915.78	*915.78*	

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Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
10 02 13 04 03 25 Air Start Valve	**13.00**	**EA**	**11,905**	**11,905**	
			3,542.02	*3,542.02*	
10 02 13 04 03 26 Air Dryer	**3.00**	**EA**	**10,626**	**10,626**	
			3,243,090.07	*3,243,090.07*	
10 02 13 04 04 Electrical	**1.00**	**EA**	**3,243,090**	**3,243,090**	
10 02 13 04 04 01 Telephone/Communication System	**1.00**	**LS**	**14,959**	**14,959**	
10 02 13 04 04 02 Pump Station Lights and Fixtures	**1.00**	**LS**	**130,059**	**130,059**	
10 02 13 04 04 03 Pump Station Video/CCTV System	**1.00**	**LS**	**43,986**	**43,986**	
10 02 13 04 04 04 Fuel Storage Video/CCTV System	**1.00**	**LS**	**35,155**	**35,155**	
10 02 13 04 04 05 Pump Station Fire Alarm and Detection System	**1.00**	**LS**	**27,236**	**27,236**	
10 02 13 04 04 06 Fuel Storage Fire Alarm and Detection System	**1.00**	**LS**	**20,640**	**20,640**	
10 02 13 04 04 07 Pump Station Controls and Sensors	**1.00**	**LS**	**505,822**	**505,822**	
10 02 13 04 04 08 Fuel Storage Controls and Sensors	**1.00**	**LS**	**370,041**	**370,041**	
10 02 13 04 04 09 Incoming Power	**1.00**	**LS**	**13,500**	**13,500**	
10 02 13 04 04 10 Pump Station Lighting Conductors	**1.00**	**LS**	**507,762**	**507,762**	
10 02 13 04 04 11 Fuel Storage Lighting	**1.00**	**LS**	**29,035**	**29,035**	
10 02 13 04 04 12 Motor Control Center	**1.00**	**LS**	**463,473**	**463,473**	
			57,905.83	*57,905.83*	
10 02 13 04 04 13 Pump Station Receptacles	**1.00**	**EA**	**57,906**	**57,906**	
			17,267.07	*17,267.07*	
10 02 13 04 04 14 Fuel Storage Receptacles	**1.00**	**EA**	**17,267**	**17,267**	
10 02 13 04 04 15 Automatic Transfer Switches	**1.00**	**LS**	**69,761**	**69,761**	
			665,170.35	*665,170.35*	
10 02 13 04 04 16 Stand-by Generators	**1.00**	**EA**	**665,170**	**665,170**	
10 02 13 04 04 17 Power Transformers	**1.00**	**LS**	**50,147**	**50,147**	
10 02 13 04 04 18 Conductors	**1.00**	**LS**	**43,135**	**43,135**	
10 02 13 04 04 19 Conduits	**1.00**	**LS**	**129,660**	**129,660**	
10 02 13 04 04 20 Motors	**1.00**	**LS**	**48,376**	**48,376**	
			144,892,411.71	*144,892,411.71*	
10 02 15 Floodway Control	**1.00**	**EA**	**144,892,412**	**144,892,412**	
10 02 15 01 Stormwater Conduit	**1.00**	**LS**	**144,892,412**	**144,892,412**	
			4.38	*4.38*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
10 02 15 01 01 Excavation	**833,244.00**	**CY**	**3,647,400**	**3,647,400**	
			3,153.84	*3,153.84*	
10 02 15 01 02 32' x 13' Drainage Conduit	**9,540.00**	**LF**	**30,087,589**	**30,087,589**	
			41.26	*41.26*	
Aggregate Base	**11,307.00**	**CY**	**466,488**	**466,488**	
			449.57	*449.57*	
Reinforced Concrete Slab	**16,960.00**	**CY**	**7,624,644**	**7,624,644**	
			874.63	*874.63*	
Reinforced Concrete Walls	**13,780.00**	**CY**	**12,052,444**	**12,052,444**	
			586.32	*586.32*	
Reinforced Concrete Elevated Slab	**16,960.00**	**CY**	**9,944,013**	**9,944,013**	
			2,182.52	*2,182.52*	
10 02 15 01 03 20' x 10' Drainage Conduit	**5,670.00**	**LF**	**12,374,894**	**12,374,894**	
			41.26	*41.26*	
Aggregate Base	**4,200.00**	**CY**	**173,278**	**173,278**	
			458.87	*458.87*	
Reinforced Concrete Slab	**6,300.00**	**CY**	**2,890,867**	**2,890,867**	
			874.34	*874.34*	
Reinforced Concrete Walls	**6,300.00**	**CY**	**5,508,311**	**5,508,311**	
			603.56	*603.56*	
Reinforced Concrete Elevated Slab	**6,300.00**	**CY**	**3,802,438**	**3,802,438**	
			2,911.05	*2,911.05*	
10 02 15 01 04 30' x 10' Drainage Conduit	**9,540.00**	**LF**	**27,771,430**	**27,771,430**	
			41.26	*41.26*	
Aggregate Base	**10,600.00**	**CY**	**437,320**	**437,320**	
			450.53	*450.53*	
Reinforced Concrete Slab	**15,900.00**	**CY**	**7,163,478**	**7,163,478**	
			1,006.17	*1,006.17*	
Reinforced Concrete Walls	**10,600.00**	**CY**	**10,665,375**	**10,665,375**	
			597.81	*597.81*	
Reinforced Concrete Elevated Slab	**15,900.00**	**CY**	**9,505,257**	**9,505,257**	
			2,668.55	*2,668.55*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
10 02 15 01 05 25' x 10' Drainage Conduit	**3,011.00**	**LF**	**8,035,003**	**8,035,003**	
			41.26	*41.26*	
Aggregate Base	**2,788.00**	**CY**	**115,023**	**115,023**	
			454.25	*454.25*	
Reinforced Concrete Slab	**4,182.00**	**CY**	**1,899,691**	**1,899,691**	
			1,006.16	*1,006.16*	
Reinforced Concrete Walls	**3,346.00**	**CY**	**3,366,600**	**3,366,600**	
			634.55	*634.55*	
Reinforced Concrete Elevated Slab	**4,182.00**	**CY**	**2,653,689**	**2,653,689**	
			58.46	*58.46*	
10 02 15 01 06 Road Work	**127,345.00**	**SY**	**7,445,201**	**7,445,201**	
			23.29	*23.29*	
Demo Roadway	**127,345.00**	**SY**	**2,965,835**	**2,965,835**	
			35.18	*35.18*	
New Roadway	**127,345.00**	**SY**	**4,479,366**	**4,479,366**	
			7.75	*7.75*	
10 02 15 01 07 Backfill	**454,632.00**	**CY**	**3,522,110**	**3,522,110**	
			15.24	*15.24*	
10 02 15 01 08 Disposal	**378,611.00**	**CY**	**5,768,283**	**5,768,283**	
			51,954.48	*51,954.48*	
10 02 15 01 09 Junction Structures	**27.00**	**EA**	**1,402,771**	**1,402,771**	
			44,586.33	*44,586.33*	
10' x 35' Junction Structure	**9.00**	**EA**	**401,277**	**401,277**	
			41.26	*41.26*	
Aggregate Base	**233.00**	**CY**	**9,613**	**9,613**	
			432.30	*432.30*	
Reinforced Concrete Slab	**350.00**	**CY**	**151,305**	**151,305**	
			464.30	*464.30*	
Reinforced Concrete Walls	**200.00**	**CY**	**92,860**	**92,860**	
			421.43	*421.43*	
Reinforced Concrete Elevated Slab	**350.00**	**CY**	**147,500**	**147,500**	
			34,944.73	*34,944.73*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
10' x 25' Junction Structure	**8.00**	**EA**	**279,558**	**279,558**	
			41.26	*41.26*	
Aggregate Base	**148.00**	**CY**	**6,106**	**6,106**	
			439.19	*439.19*	
Reinforced Concrete Slab	**222.00**	**CY**	**97,499**	**97,499**	
			460.02	*460.02*	
Reinforced Concrete Walls	**177.78**	**CY**	**81,781**	**81,781**	
			424.20	*424.20*	
Reinforced Concrete Elevated Slab	**222.00**	**CY**	**94,172**	**94,172**	
			39,987.75	*39,987.75*	
10' x 30' Junction Structure	**4.00**	**EA**	**159,951**	**159,951**	
			41.26	*41.26*	
Aggregate Base	**89.00**	**CY**	**3,672**	**3,672**	
			434.71	*434.71*	
Reinforced Concrete Slab	**133.00**	**CY**	**57,817**	**57,817**	
			473.92	*473.92*	
Reinforced Concrete Walls	**89.00**	**CY**	**42,179**	**42,179**	
			423.18	*423.18*	
Reinforced Concrete Elevated Slab	**133.00**	**CY**	**56,283**	**56,283**	
			49,239.25	*49,239.25*	
25' x 25' Junction Structure	**1.00**	**EA**	**49,239**	**49,239**	
			41.26	*41.26*	
Aggregate Base	**19.00**	**CY**	**784**	**784**	
			425.33	*425.33*	
Reinforced Concrete Slab	**28.00**	**CY**	**11,909**	**11,909**	
			439.47	*439.47*	
Reinforced Concrete Walls	**56.00**	**CY**	**24,610**	**24,610**	
			426.28	*426.28*	
Reinforced Concrete Elevated Slab	**28.00**	**CY**	**11,936**	**11,936**	
			59,165.49	*59,165.49*	
30' x 30' Junction Structure	**4.00**	**EA**	**236,662**	**236,662**	
			41.26	*41.26*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
Aggregate Base	**89.00**	**CY**	**3,672**	**3,672**	
			434.71	*434.71*	
Reinforced Concrete Slab	**133.00**	**CY**	**57,817**	**57,817**	
			445.28	*445.28*	
Reinforced Concrete Walls	**267.00**	**CY**	**118,890**	**118,890**	
			423.18	*423.18*	
Reinforced Concrete Elevated Slab	**133.00**	**CY**	**56,283**	**56,283**	
			69,021.01	*69,021.01*	
35' x 35' Junction Structure	**4.00**	**EA**	**276,084**	**276,084**	
			41.26	*41.26*	
Aggregate Base	**104.00**	**CY**	**4,291**	**4,291**	
			440.47	*440.47*	
Reinforced Concrete Slab	**156.00**	**CY**	**68,714**	**68,714**	
			441.17	*441.17*	
Reinforced Concrete Walls	**311.00**	**CY**	**137,203**	**137,203**	
			422.29	*422.29*	
Reinforced Concrete Elevated Slab	**156.00**	**CY**	**65,877**	**65,877**	
			24.82	*24.82*	
10 02 15 01 10 Temporary Shoring	**1,806,500.00**	**SF**	**44,837,732**	**44,837,732**	
15 Contract 4 - Offats Bayou Sector Gate	**1.00**	**LS**	**34,113,337**	**34,113,337**	
15 02 Federal Costs	**1.00**	**LS**	**34,113,337**	**34,113,337**	
15 02 15 Floodway Control - Diversion Structure	**1.00**	**LS**	**34,113,337**	**34,113,337**	
15 02 15 01 Offats Bayou Sector Gate	**1.00**	**LS**	**34,113,337**	**34,113,337**	
			132.48	*132.48*	
15 02 15 01 01 24" Pipe Piles	**32,580.00**	**VLF**	**4,316,144**	**4,316,144**	
			533.40	*533.40*	
15 02 15 01 02 CIP Structural Concrete	**12,789.00**	**CY**	**6,821,657**	**6,821,657**	
			26,382.44	*26,382.44*	
15 02 15 01 03 Sector Gate Leafs	**344.00**	**TON**	**9,075,561**	**9,075,561**	
			4,946,829.54	*4,946,829.54*	
15 02 15 01 04 Cofferdam	**1.00**	**EA**	**4,946,830**	**4,946,830**	
			30.36	*30.36*	

Currency in US dollars

Description	Quantity	UOM	ContractCost	ProjectCost	CostOverride
15 02 15 01 05 Steel Sheet Pile, PZC-13	**2,672.00**	**SF**	**81,120**	**81,120**	
			19,389.79	*19,389.79*	
15 02 15 01 06 Timber Pile Clusters	**4.00**	**EA**	**77,559**	**77,559**	
			51.82	*51.82*	
15 02 15 01 07 Embankment	**2,299.00**	**CY**	**119,137**	**119,137**	
			82.46	*82.46*	
15 02 15 01 08 Riprap	**5,593.00**	**TON**	**461,184**	**461,184**	
			1,683.64	*1,683.64*	
15 02 15 01 09 Clearing and Grubbing	**1.90**	**ACR**	**3,199**	**3,199**	
			195,288.94	*195,288.94*	
15 02 15 01 10 Access Road	**1.00**	**EA**	**195,289**	**195,289**	
			142,852.61	*142,852.61*	
15 02 15 01 11 Control / Generator Buildings	**1.00**	**EA**	**142,853**	**142,853**	
			2,300,331.99	*2,300,331.99*	
15 02 15 01 12 Installation and Testing of Sector Gate	**1.00**	**EA**	**2,300,332**	**2,300,332**	
			19,696.84	*19,696.84*	
15 02 15 01 13 Needle Girders	**1.00**	**EA**	**19,697**	**19,697**	
			203,145.00	*203,145.00*	
15 02 15 01 14 Guide Walls	**1.00**	**EA**	**203,145**	**203,145**	
			1,007,401.65	*1,007,401.65*	
15 02 15 01 15 Gate Operating Machinery	**1.00**	**EA**	**1,007,402**	**1,007,402**	
			110,269.87	*110,269.87*	
15 02 15 01 16 Electrical - Energy Service Fee	**1.00**	**EA**	**110,270**	**110,270**	
			4,231,958.51	*4,231,958.51*	
15 02 15 01 17 Electrical - Miscellaneous	**1.00**	**EA**	**4,231,959**	**4,231,959**	

Labor ID: NLS2016 EQ ID: EP16R06 Currency in US dollars TRACES MII Version 4.3