PHASE 2.5 CONTINUED CONCEPTUAL DESIGN SERVICES FOR PERMANENT PROTECTION SYSTEM FOR THE OUTFALL CANALS AT 17TH STREET, ORLEANS AVENUE, AND LONDON AVENUE

90-DAY IMPLEMENTATION STUDY FINAL REPORT

Prepared for

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Acronyms and Abbreviations

B&V	Black and Veatch
cfs	cubic feet per second
DPS	Drainage Pump Stations
DSM	Deep Soil Mixing
EL	Elevation
ERDC	Engineer Research and Development Center
FOS	Factor of Safety
FSI	Formed Suction Intake
ft	feet
H	Horizontal
HEC-RAS	Hydrologic Engineering Center's River Analysis System
hp	horsepower
HSDRSDG	Hurricane and Storm Damage Reduction System Design Guidelines
Hz	Hertz
I-10	Interstate 10
I-610	Interstate 610
ICS	Interim Closure Structures
IHNC	Inner Harbor Navigation Canal
IPCC	Intergovernmental Panel on Climate Change
IPET	Interagency Performance Evaluation Task Force
MVK	USACE Vicksburg District
N/A	Not Applicable
NAVD88	North American Vertical Datum 1988
NEPA	National Environmental Policy Act
NFS	Non-Federal Sponsor
No.	Number
NPSH	Net Positive Suction Head
NRHP	National Register of Historic Places
NTP	Notice to Proceed
O&M	Operation and Maintenance
pcf	pounds per cubic foot
psf	pounds per square foot
RFP	Request For Proposal
SELA	Southeast Louisiana Urban Flood Control Project
SWBNO	Sewerage and Water Board of New Orleans
SWE	Safe Water Elevation
SWL	Static Water Level
U.S.	United States
USACE	United States Army Corps of Engineers
V	Vertical
WS	Water Surface
WSE	Water Surface Elevation

1.0 INTRODUCTION

The purpose of this report is to document the three primary pump station options for the U.S. Army Corps of Engineers (USACE), Hurricane Protection Office Permanent Protection Project, and to provide input to the Report to Congress for P.L. 110-252 drafted in October 2008. This 90-Day Implementation Study Report describes the engineering background for conceptual pump station designs used to develop rough order of magnitude cost estimates and construction schedules. It describes several variations of the pump station options and provides cost comparisons of these options. The assumptions made during the analysis that impacted the pump station cost estimates are documented. Actual pump station size, pump types and number of pumps will be determined by the design/build contractor for the Permanent Protection Project. The report includes a Background section, Permanent Protection Engineering Considerations section, Permanent Protection Options section, and Opinion of Probable Cost and Construction Schedules For Options 1, 2, and 2a section.

The Permanent Protection Project will provide storm surge protection to the three main outfall canals (17^{th} Street, Orleans Avenue, and London Avenue) that discharge storm water into Lake Pontchartrain by installing permanent pump stations and closure structures. The pump stations and closure structures will be constructed as the primary means of providing permanent storm surge protection. The pump stations will discharge flood water from the 17^{th} Street, Orleans Avenue, and London Avenue canals into Lake Pontchartrain in order to maintain canal drainage during flood events. The closure of the canals with pump stations is consistent with the findings and lessons learned by the Interagency Performance Evaluation Task Force (IPET). The present maximum pump capacities of the existing Drainage Pump Stations discharging into 17^{th} Street, Orleans Avenue, and London Avenue Canals are 10,500 cubic feet per second (cfs), 2,690 cfs, and 7,980 cfs, respectively.

Variations of three primary options were evaluated and are referred to as Options 1, 2, and 2a.

- ✓ **Option 1** includes the construction of new pump stations at or near the mouths of the 17th Street, Orleans Avenue, and London Avenue Canals in the New Orleans area as directed in PL 109-124. The pump stations are designed to operate concurrently and in series with the existing Drainage Pump Stations serving these canals. This is the least cost of the three options and is within the present Authorized and Appropriated amount for the permanent protection project.

- ✓ **Option 2** includes construction of new pump stations at or near the mouths of the 17th Street, Orleans Avenue, and London Avenue canals, deepening the existing canals, and removal of some of the Existing Drainage Pump Stations. Deeping the existing canals will allow the water to flow by gravity from the existing interior drainage elements to the new pump stations at the Lake. This option includes diversion of a portion of the storm water drainage away from the outfall canals to reduce the overall flow of water into the canals, thus reducing the size of the pump stations. This option costs more than Option 1, and costs less than Option 2a. Option 2 exceeds the Authorized and Appropriated amount for the permanent protection project.

- ✓ **Option 2a** is the same as Option 2 with the addition of a new pump station in Jefferson Parish to intercept drainage into the 17th Street Canal and discharge the diverted flow directly to the Mississippi River. The cost of this option exceeds the cost of both Options 1 and 2. Option 2a exceeds the Authorized and Appropriated amount for the permanent protection project.

Local stakeholders have indicated a preference for Option 2 or 2a through partnering meetings and correspondence. As indicated above, an Option 1 pump station is the only pump station that is currently within the Authorized and Appropriated amount for the Permanent Pump Station Project. In response to the stakeholder’s preference, the Hurricane Protection Office requested that the Option 1 pump station be designed to accommodate future changes of the canal drainage system to a gravity drainage system of Option 2 or 2a.

Several variations of the Option 1 pump station were developed to assist in determining the engineering process associated with converting an Option 1 pump station into an Option 2 or 2a pump station and drainage system. This process can be accomplished in four distinct, stand alone construction sequences. The four-phased construction sequencing is documented in this report to further support the decision making process. Construction sequence 1 of the four-phased construction approach represents construction of a stand alone fully functional Option 1 pump station, while implementation of construction sequences 2, 3 and 4 will result in conversion of the Option 1 pump station into an Option 2 drainage system. The cost of implementing the four phased construction approach exceeds the cost of Option 2 and exceeds the Authorized and Appropriate amount for the permanent protection project.

Several variations of the Option 1 pump station were formulated to represent the pump station that will be constructed as part of construction sequence 1. The Option 1 pump station variations include:

- ✓ Non-Adaptable Option 1: Each new pump station is designed and constructed with a shallow foundation that requires significant demolition and subsequent reconstruction of the substructure and foundation if the canal is deepened in the future. The pump intake is a formed suction intake (FSI) that allows for efficient passage of water through the pump system. The new pump station is designed for existing drainage pump station capacity with additional pump station bays and additional pump station superstructure to accommodate the future expansion. Other features include a breakwater, and the gated section gravity by-pass.

- ✓ Base Adaptable Option 1: Each new pump station is designed and constructed with a deep foundation that eliminates the need for significant foundation modifications if the canal is deepened in the future. The intake area includes a stem wall with an elevation that matches the existing canal elevation and an intake area that is a wet well. The invert of the wet well matches the invert elevation of an Option 2 pump station, which will allow for installation of a formed suction intake in the future. Without the deepened wet well a FSI will be required for an Option 1 pump station. The new pump station is designed for existing drainage pump station capacity. This option includes a discharge stilling basin that results in elimination of the breakwater and the gated gravity by-pass is not included.

- ✓ Robust Adaptable Option 1: New pump station is designed and constructed with all of the adaptable features that reduce the cost of conversion to an Option 2 pump station in the future. These adaptable features include: lower sill elevations, deepened canal transitions, additional pump station bays, additional pump station superstructure, and formed suction intake designed to accommodate the lowered canal water levels required for Option 2. This variation includes breakwaters and the gated gravity by-pass.

2.0 BACKGROUND

The storm water drainage collected from the New Orleans Metropolitan Area is pumped mainly into three canals:17th Street, Orleans Avenue, and London Avenue Canal. Figure 2-1 indicates the various drainage basins involved. The outfall canals connect pump stations located on the interior of the City to Lake Pontchartrain, where the storm water is discharged.

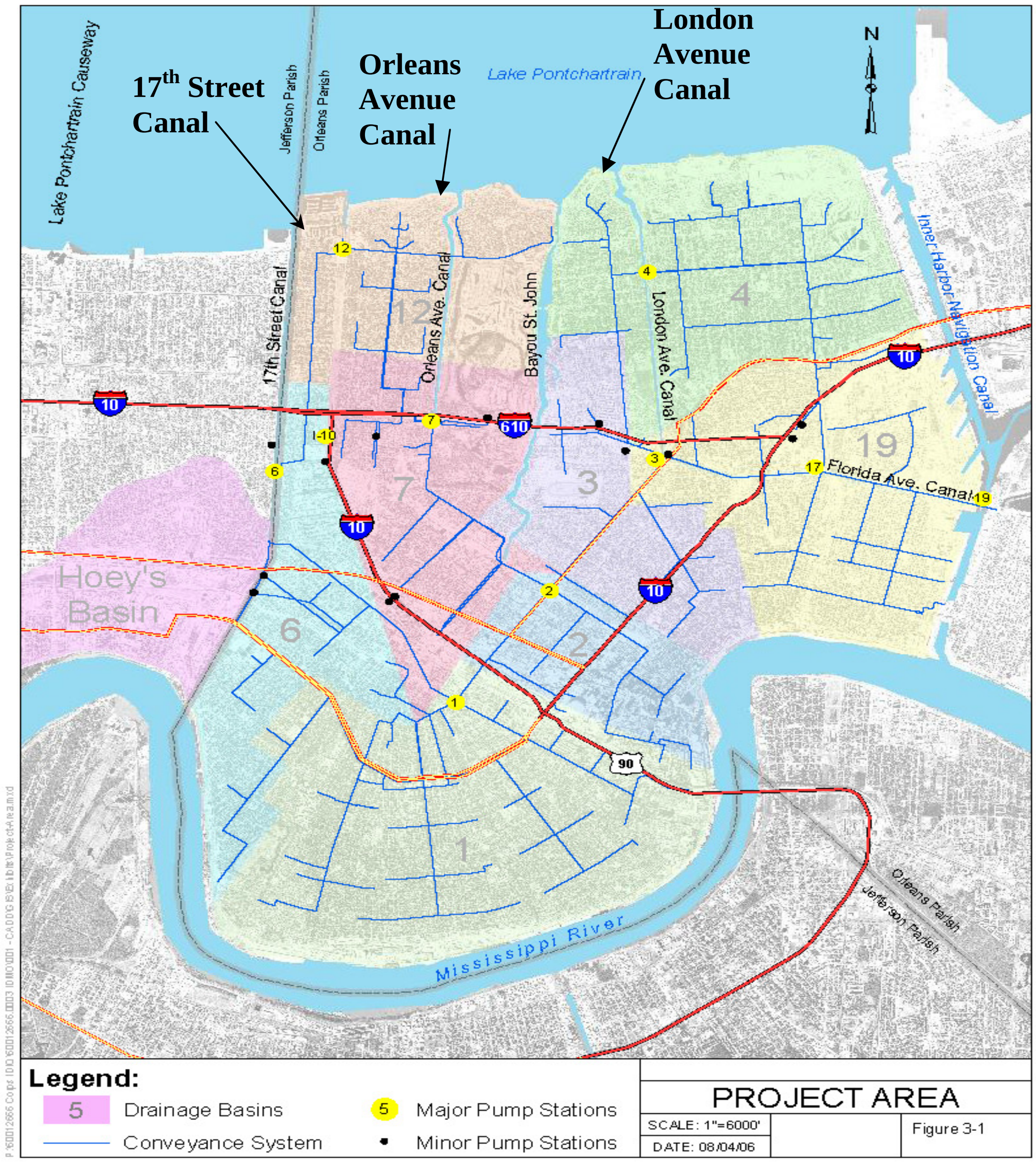

FIGURE 2-1 - Area Under Consideration

The existing major pump stations are located on what generally constituted the fringe of New Orleans before the city had not expanded to the shore of Lake Pontchartrain. Drainage Pump Stations (DPS) 3, 6, and 7 were constructed between 1897 and 1903, and DPS 4 was constructed in the 1940's. These pump stations are operated by the Sewerage and Water Board of New Orleans (SWBNO). Figure 2-2 indicates the locations of DPS 3, 4, 6, and 7.

The expansion of the city northward to the shores of Lake Pontchartrain resulted in the need to carry interior drainage from the pump stations to the lake. These pump stations are operated by the SWBNO. In the 1980's, the Corps recommended constructing gated closure structures at the lakefront for these three outfall canals as part of the Lake Pontchartrain and Vicinity Hurricane Protection Project. Local stakeholders disagreed with this recommendation and, at their request, Congress directed the Corps to construct parallel protection along the Orleans Avenue and London Avenue canals.

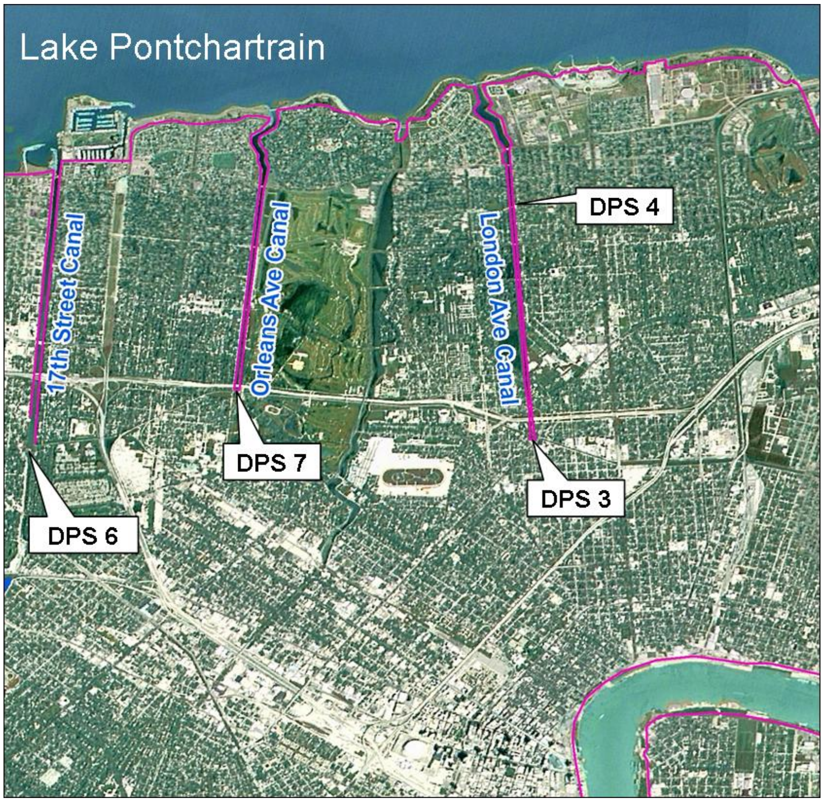

FIGURE 2-2 - Existing DPS Locations

In the aftermath of Hurricane Katrina, and failures of the parallel protection on the drainage canals, the USACE, in concert with local stakeholders began to explore options to address the hurricane storm surge and evacuation of water in the area. Immediately after receiving Congressional authorization (P.L. 109-234) to design and construct permanent pump stations for 17th Street, Orleans Avenue, and London Avenue Canals, the USACE entered into a collaborative process with local stakeholders to evaluate options. This report documents the preliminary engineering information that supports development of the pump station options.

2.2 Existing Drainage Pump Stations and Interim Control Structure Facilities

The Permanent Protection System alternatives must work in conjunction with the DPS systems or replace them. The Option 1 pump stations will work in series with the existing discharge pump stations to discharge storm water to Lake Pontchartrain from the discharge canals. The Option 2 pump stations and deepening of the discharge canals will replace the existing discharge pump stations. Both, Option 1 and Option 2 pump stations will replace the existing Interim Control Structure (ICS) facilities that were designed and constructed to provide temporary closure of the canals against storm surges. The existing DPS 3, 4, 6, and 7 and the location of the existing ICS facilities are described below.

2.2.1 Drainage Pump Station 6 (DPS 6)

DPS 6 is located at the upstream end of the 17th Street Canal and currently lifts drainage water to allow gravity flow from the pump station discharge to Lake Pontchartrain. DPS 6 houses pumps that are all electric motor driven with some receiving power from the Entergy utility lines and others from the dedicated 25 Hz SWBNO power system.

The station is manned twenty-four hours a day and has smaller pumps sized to operate for dry weather flows and larger pumps dedicated to the higher flows experienced during storm events. The dry weather flow pumps are piped to discharge to the Mississippi River. The equipment is housed in a brick building built in stages between 1897 and 1930, with a later addition built between 1986 and1989 and is currently on the NRHP due to the Wood Screw Pumps, the early architectural style, and the historical importance of the drainage system of New Orleans. Two additions to the pump station were added in an unknown year and are not currently considered historic. Table 2-2 lists the major equipment that constitutes this pump station.

TABLE 2-2 – DPS 6 Major Equipment

Pump ID	Pump Capacity (CFS)	Pump/Driver Type	Power Supply (Hz)	Remarks
A	550	H/E	25	• 60Hz – power from Entergy with back-up dual feed, switched by Entergy • 25Hz – SWBNO power with back-up feeders • H = Horizontal • V = Vertical • C = Centrifugal • E = Electric
B	550	H/E	25	
C	1,000	H/E	25	
D	1,000	H/E	25	
E	1,000	H/E	25	
F	1,000	H/E	25	
G	1,000	H/E	25	
H	1,100	H/E	60	
I	1,100	H/E	60	
V1	250	V/E	60	
V2	250	V/E	60	
V3	250	V/E	60	
V4	250	V/E	60	
CD1	90	C/E	25	
CD2	90	C/E	25	
Total	9,480			

2.2.2 Drainage Pump Station 7 (DPS 7)

DPS 7 is located at the upstream end of the Orleans Avenue Canal and currently lifts drainage water to allow gravity flow from the pump station discharge to Lake Pontchartrain. DPS 7 houses pumps that are all electric motor driven with some receiving power from the Entergy utility lines and others from the dedicated 25 Hertz (Hz) SWBNO power system.

The station is manned twenty four hours a day and has smaller pumps sized to operate for dry weather flows and larger pumps dedicated to the higher flows experienced during storm events. The equipment is housed in a brick building built between 1897 and 1900 that is currently on the National Register of Historic Places (NRHP) due to the Wood Screw Pumps, the early architectural style, and the historical importance of the drainage system of New Orleans. Table 2-1 lists the major equipment that constitutes this pump station.

TABLE 2-1 – DPS 7 Major Equipment

Pump ID	Pump Capacity (CFS)	Pump/Driver Type	Power Supply (Hz)	Remarks
A	550	H/E	25	• 60Hz – power from Entergy without back-up • 25Hz – SWBNO power with back-up feeders • H = Horizontal • V = Vertical • E = Electric
C	1,000	H/E	25	
D	1,000	H/E	60	
CD1	70	V/E	25	
CD2	70	V/E	25	
Total	2,690			

2.2.3 Drainage Pump Station 3 (DPS 3)

DPS 3 is located at the upstream end of the London Avenue Canal and currently lifts drainage water to allow gravity flow from the pump station discharge to Lake Pontchartrain. DPS 3 houses pumps that are all electric motor driven from the dedicated 25 Hz SWBNO power system.

The station is manned twenty four hours a day and has smaller pumps sized to operate for dry weather flows and larger pumps dedicated to the higher flows experienced during storm events. The equipment is housed in a brick building built in three stages between 1901 and 1931 that is currently on the NRHP due to the Wood Screw Pumps, the early architectural style and the historical importance of the drainage system of New Orleans. Table 2-3 lists the major equipment that constitutes this pump station.

TABLE 2-3 – DPS 3 Major Equipment

Pump ID	Pump Capacity (CFS)	Pump/Driver Type	Power Supply (Hz)	Remarks
A	550	H/E	25	• Pumps CD1 and CD2 each have 2 pumps. 1 motor (40 cfs each) • 25Hz – SWBNO power with back-up feeders • H = Horizontal • C = Centrifugal • E = Electric
B	550	H/E	25	
C	1,000	H/E	25	
D	1,000	H/E	25	
E	1,000	H/E	25	
CD1L/1R	80	C/E	25	
CD2L/1R	80	C/E	25	
Total	4,260			

2.2.4 Drainage Pump Station 4 (DPS 4)

DPS 4 is located at the midpoint of the London Avenue Canal and currently lifts drainage water to allow gravity flow from the pump station discharge to Lake Pontchartrain. DPS 4 houses pumps that are all electric motor driven with some receiving power from the Entergy utility lines and others from the dedicated 25 Hz SWBNO power system.

The station is manned twenty four hours a day and has smaller pumps sized to operate for dry weather flows and larger pumps dedicated to the higher flows experienced during storm events. The equipment is housed in a brick building built between 1945 and 1946 and is not listed on the NRHP. Table 2-4 lists the major equipment that constitutes this pump station.

TABLE 2-4 – DPS 4 Major Equipment

Pump ID	Pump Capacity (CFS)	Pump/Driver Type	Power Supply (Hz)	Remarks
1	320	C/E	60	• 60Hz – power from Entergy without back-up • 25Hz – SWBNO power with back-up feeders • H = Horizontal • V = Vertical • C = Centrifugal • E = Electric
2	320	C/E	60	
C	1,000	H/E	25	
D	1,000	H/E	25	
E	1,000	H/E	25	
CD1	80	V/E	25	
Total	3,720			

2.2.5 Existing Interim Closure Structures Facilities

The outfall canals are currently protected by the ICS Facilities. The ICS Facilities were constructed after Katrina as a temporary flood protection measure. The ICS facilities are intended to prevent storm surge from entering the canals and are intended to be replaced by the new permanent protection system. The Government will operate the ICS facilities during the construction of the new pump stations. Once the new pump stations are constructed the ICS will be decommissioned and removed. Figure 3-1 to 3-3 shows the location of the ICS Facilities relative to the proposed permanent protection pump stations.

The ICS facilities are comprised of gravity abutments (non-overflow gravity structures) that tie into the existing hurricane protection system, a gated closure structure that allows gravity by-pass of storm water into Lake Pontchartrain during normal rainfall events, and pump systems that lift storm water out of the outfall canals and discharge into Lake Pontchartrain when the gated section is closed. These facilities were constructed in three phases. Phase 1 included the non-overflow structures, the gate closure structure, MWI hydraulic pumps, pump platforms, power units, and the engine platforms. Phase 2 included additional MWI hydraulic pumps, power units and pump platforms. Phase 3 included Fairbanks Morse and Patterson direct drive diesel pumps, power units, and pump platforms. The 17th Street Canal ICS includes all three construction phases; the Orleans Avenue Canal ICS includes phase 1 construction only; and the London Avenue Canal ICS includes phases 1 and 3.

2.2.5.1 Gravity Abutment Transitions

The gravity abutments (non-overflow structures) transition from the existing line of protection to the gate closure structures. In all cases, the non-overflow structures are cellular sheet pile cofferdams that are filled with soil. Table 2-5 documents the specific geometry and cell types for each ICS facility. The Orleans Avenue and London Avenue non-overflow structures are wider and the cell sheet piles are embedded to greater depths.

TABLE 2-5 – Non-Overflow Information

Parameter		ICS Facility		
		17th Street	Orleans Ave	London Ave
Length of Left Non-Overflow		~315’	~125’	~97’
Length of Right Non-Overflow		N/A (Ties Into Existing Protection)	~125’	~97’
Cofferdam Cell Type		Arch	Cellular	Cellular
Cell Width (Gravity Section)		24'-10.25"	60.59’	45.94’
Cell Height Above Grade		~12.0’	~16.0’	~16.0’
Sheet Pile Penetration into Soil		-27.00'	-50.00’	-54.00’
Sheet Pile Type		PS 27.5	PS 27.5	PS 27.5
Soil Fill		Yes	Yes	Yes
Cell Cap Material		Crushed Stone	Reinforced Concrete Cap	Reinforced Concrete Cap
Steel Piles (Placed in Interior of Cells to Support Concrete Cap)		NA	H14x73 Tip Elev. -70.0	H14x73 Tip Elev. -66.25’

2.2.5.2 Gated Closure Structures

The primary elements of the gated closure structure are the foundation soil improvements (not provided at London Avenue ICS), riprap protection, structural steel substructure, structural steel superstructure, grated platform, abutments, gate seal, bulkheads, bulkhead hoist and bulkhead slots. Scour pads and erosion prevention measures were constructed upstream, downstream and along the sides of the gate closure structures to ensure the closure remains in place during significant storm events. The gate closure structures house bulkheads that can be lowered through static water to separate the canals from Lake Pontchartrain. Table 2-6 summarizes the gate closure opening dimensions and capacity.

TABLE 2-6 – Gate Closure Dimensions and Capacities

Parameter		ICS Facility		
		17th Street	Orleans Ave	London Ave
Low Lake Elevation		+1’	+1’	+1’
Gate Sill Elevation		-10’	-8’	-8’
Water Passage Height		11’	9’	9’
Gate Opening Width		10.25’	10.25’	10.25’
Number of Gates		11	5	13
Water Passage Width		112.75’	51.25’	133.25’
Water Passage Area		1240.25 sf	461.25 sf	1199.25 sf
Flow-rate		12500 cfs	3390 cfs	8980 cfs
Water Velocity		10.08 ft/sec	7.35 ft/sec	7.49 ft/sec

2.2.5.3 Pump Facilities

The pump facilities include the pumps, power units, pump platforms, discharge piping, and engine platforms. Table 2-7 shows the number of pumps, type of pumps, the location of the power units for each ICS Facility, and each pump installation phase.
The pump installation phases are defined as follows:

- ✓ Phase 1 – Hydraulically driven pumps made by MWI with power units placed at the engine platforms on the protected side of the canals (except the west side engine platform at 17th Street is on the non-protected side of the canal).

- ✓ Phase 2 – Hydraulically driven pumps made by MWI with power units placed at the phase 2 pump platforms.

- ✓ Phase 3 – Diesel direct drive pumps made by Fairbanks Morse or Patterson with power unit at the phase 3 pump platforms.

TABLE 2-7 – Pump Systems at Each ICS Facility

Parameter			ICS Facility		
			17th Street	Orleans Ave	London Ave
Phase 1	Number of Pumps		12	10	12
	Pump Type		MWI	MWI	MWI
	Power Unit Location		Engine Platforms	Engine Platforms	Engine Platforms
Phase 2	Number of Pumps		6	N/A	N/A
	Pump Type		MWI	N/A	N/A
	Power Unit Location		Pump Platform	N/A	N/A
Phase 3	Number of Pumps		11/14	N/A	8
	Pump Type		Fairbanks Morse/MWI	N/A	Patterson
	Power Unit Location		Pump Platform/Gate Closure Platform	N/A	Pump Platform

2.3 Prior Studies and Reports.

The engineering development for Options 1, 2, and 2a relies heavily on the *Conceptual Design Report for Permanent Flood Gates and Pump Stations, dated 2006*, performed by GEC. The engineering analysis from the report was reviewed and updated as necessary to document the current understanding for the pump station options. Several other studies have been performed for the Permanent Protection Project since 2006. These reports address non-pump station options, environmental issues, and site location issues. *Appendix A* documents pertinent studies, reports, and projects that provide background information relative to the pump station options.

3.0 PERMANENT PROTECTION ENGINEERING CONSIDERATIONS

The pump station option formulation process included evaluation of several engineering considerations that impact the performance and cost of the permanent protection pump stations. The evaluation of the engineering considerations is intended to produce a set of data that supports the development of each option and to support a performance based design/build construction approach.

The major engineering considerations evaluated during the alternative formulation process include:

- ✓ Permanent Pump Station Site Location
- ✓ Canal Hydraulics
  - Canal Wall/Levee Modifications to Meet Required Safe Water Elevation
  - Gated Gravity By-Pass for Drainage of Normal Flows
  - Diversion of Storm Water Away From the Outfall Canals
- ✓ Canal Deepening
  - Canal Deepening Alternatives
  - Deepened Canal Hydraulics
  - Canal Geotechnical Conditions
  - Site Access During Construction
  - Impacts to Existing Bridges
- ✓ Pump Station Size and Pump Systems
  - Pump Station Capacity
  - Pump Type and Configuration
  - Wave Attenuation and Impact on Pumps
  - Electric Versus Diesel Driven Pumps
  - Station Generator Layout and Configuration
  - Amount of Fuel Required to Support Pump Station During and After a Hurricane Event
- ✓ Other Geotechnical and Civil Issues
  - Integration of Final Pump Station into existing permanent hurricane protection features at each site
  - Location of the Temporary Canal Bypass during Construction
  - Excavation and Cofferdam Methods
  - Settlement and Stability Issues
  - Decommissioning and By-Pass of Existing DPS 3, 4, 6, and 7

3.1 Permanent Pump Station Site Location

The potential site locations were developed and evaluated in the *Site Selection Analysis for Permanent Flood Gates and Pump Stations, 17th Street, Orleans Avenue, and London Avenue, dated 2007,* performed by Black & Veatch (B&V). The Site Selection Analysis

Study is used to support the ongoing National Environmental Policy Act (NEPA) process. The Option 1, 2, and 2a pump stations presented in this report are based on the preliminary sites selected in the ongoing NEPA process. All Options within this report utilize the same site locations for each canal. This provides a basis for consistent comparison of each option.

The Option 1 pump station (construction sequence 1 of the four phased construction approach) construction site access requirements are shown by the permanent and temporary right-of-way in Figures 3-1 to 3-3. The Option 2 pump stations require the same right-of-way as the Option 1 pump stations and require temporary right-of-way along the canals, along the planned location for the storm water diversions, and around the existing DPS 3, 4, 6, and 7. Diversion of Storm water is discussed in Section 3.2.3, Canal Deepening is discussed in Section 3.3, and Decommissioning and Bypass of the Existing DPS 3, 4, 6, and 7 is discussed in Section 3.6.3.

3.1.1 17th Street Canal Proposed Site Location

The proposed location of 17th Street Canal pump station is just downstream of the existing ICS, see Figure 3-1. Any ancillary facilities will be located on the east side of the new pump station (in the large violet shaded area of Figure 3-1). A temporary canal bypass will be required on the west bank of the existing canal during construction.

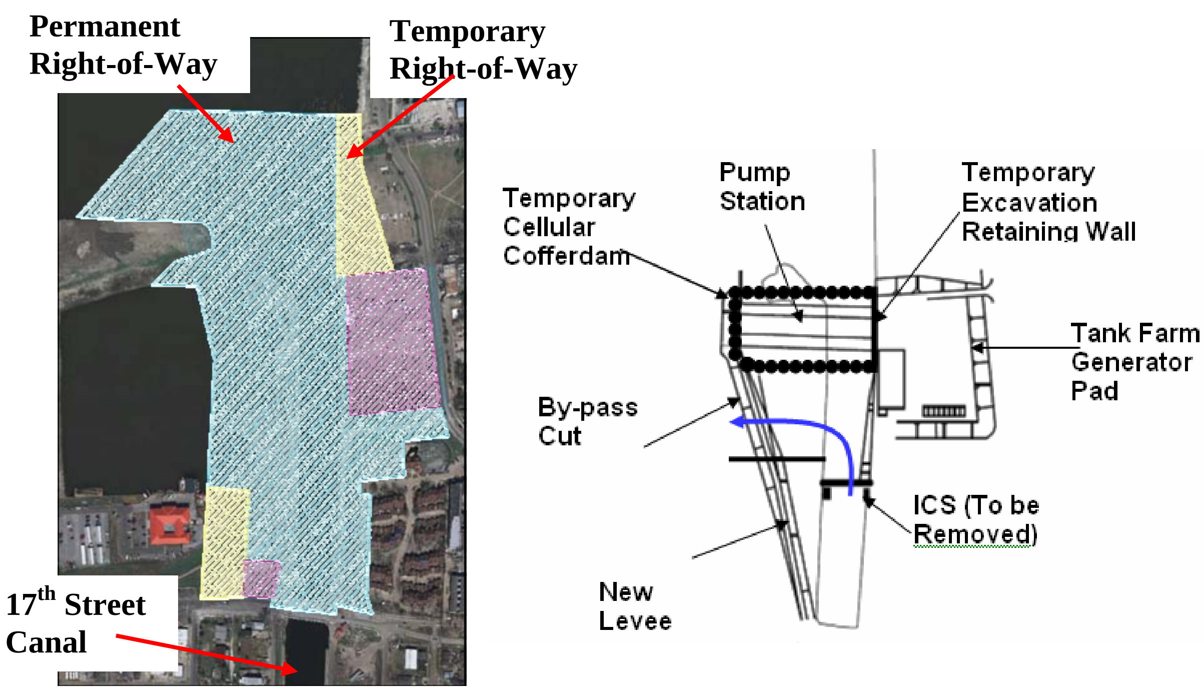

FIGURE 3-1 - 17th Street Canal – Proposed Permanent Protection Location A

3.1.2 Orleans Avenue Canal Proposed Site Location

The proposed location of the new pump station on the Orleans Avenue Canal is just south of Lakeshore Drive Bridge, see Figure 3-2. Lakeshore Drive Bridge will not be impacted by the new pump station construction. The pump station is located on the west bank of the canal to allow the existing channel to act as the bypass during construction. Any ancillary facilities are on the west side of the pump station (in the violet shaded area of Figure 3-2) and accessible from Lakeshore Drive.

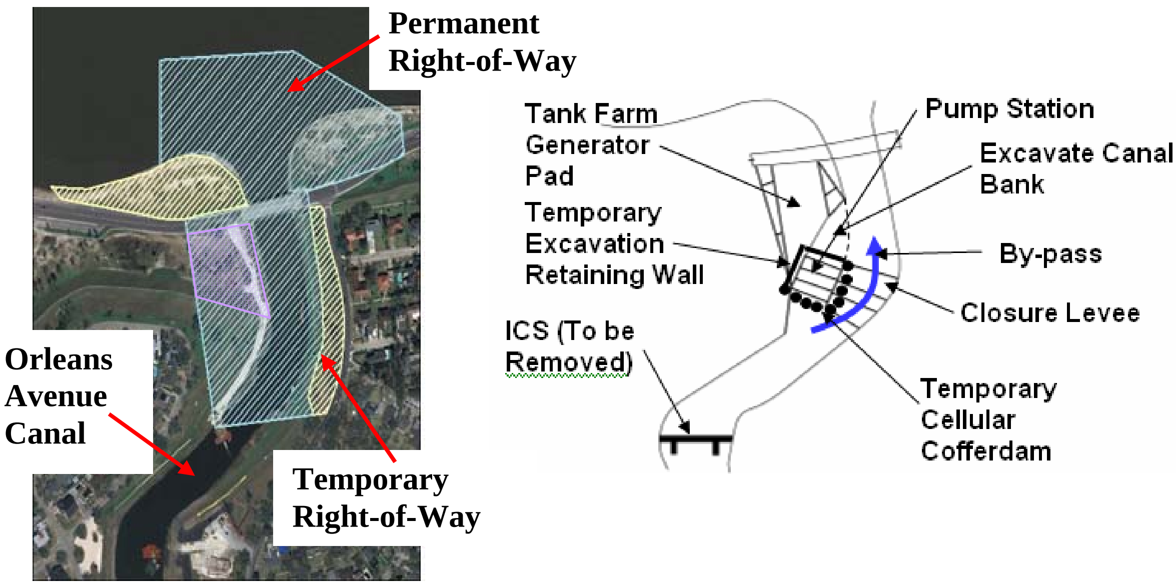

FIGURE 3-2 - Orleans Avenue Canal Proposed Permanent Protection Location B

3.1.3 London Avenue Canal Proposed Site Location

On London Avenue Canal, the proposed site location is about 1,000 feet upstream of the Lakeshore Drive Bridge, see Figure 3-3. The site location does not impact the University of New Orleans student housing or other buildings. This location takes advantage of the bend in the canal to protect the pump station from waves. This location will allow the existing canal to act as a temporary by-pass during construction. Ancillary facilities will be on the east side of the pump station (in the violet shaded area of Figure 3-3).

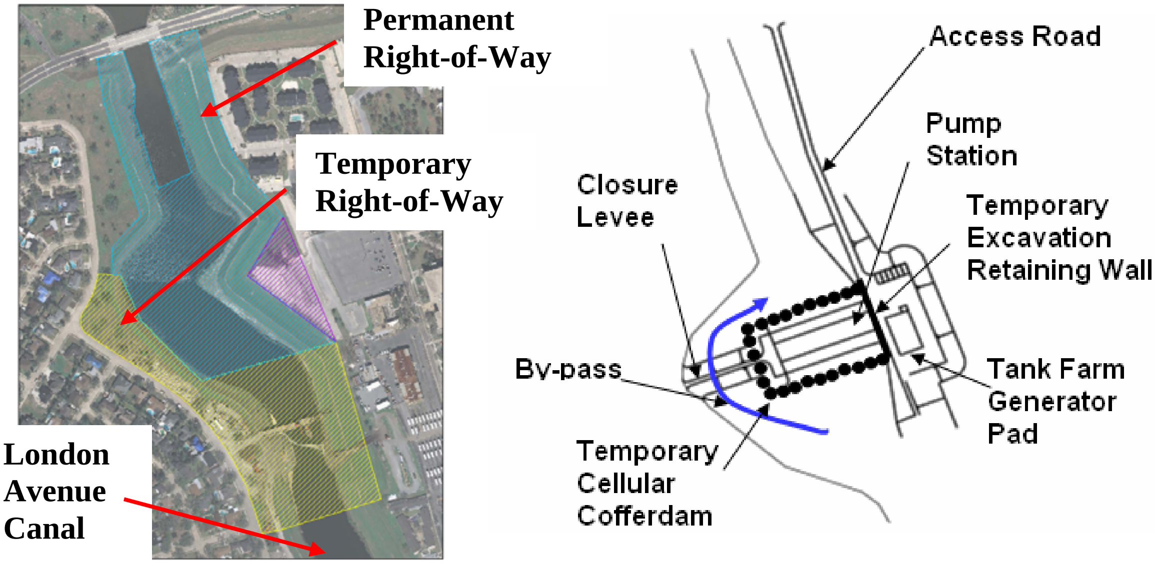

FIGURE 3-3 - London Avenue Canal Proposed Permanent Protection Location C

3.1.4 Utilities

Existing utilities will be impacted during construction of the new pump stations. The majority of existing utilities impacted by construction are located in the vicinity of the 17th Street, Orleans Avenue, and London Avenue Canals near Lake Pontchartrain. The only utilities impacted are above ground secondary electric lines, small diameter utility service lines that service existing residences, and/or light commercial businesses within the required right of way. These utilities will need to be terminated at the edge of the required right of way and removed or relocated. The costs to adjust these existing utilities are minimal and ancillary to the overall cost of the new pump stations. Utility impacts due to other features associated with an Option 2 or 2a pump station are discussed in Sections 3.2.3, 3.3, and 3.6.3.

3.2 Canal Hydraulics

The outfall canals convey to Lake Pontchartrain storm water that is discharged by the existing DPS system. During high lake elevations the hydraulic performance of the canals is significantly affected. The existing DPS system and canals were modeled to evaluate how they perform now and to evaluate how they will perform if the permanent pump stations are constructed.

For each of the three canals, two separate hydraulic models were developed for this study using the Hydrologic Engineering Center's River Analysis System (HEC-RAS) software. For each canal, the first of the two hydraulic models simulates Option 1 and the second simulates Option 2 conditions in the canal. The hydraulic model for Option 1 reflects the proposed pump station locations. The hydraulic model for Option 2 reflects the proposed pump station locations and deeper canals. The models were based on HEC-RAS geometry developed by the Vicksburg District Corps of Engineers (MVK). The models were used to evaluate Option 1 pump stations operating in series with existing drainage pump stations. The results were included in the *Operating Scenario Analysis Final Report: Phase 2 Conceptual Design Services for Permanent Pump Stations and Canal Closures at Outfalls, dated February 2008*, performed by B&V.

The Design Criteria in *Appendix B* documents the existing canal and pump station information, and the basis of design for the permanent pump station Options. For this study, the following analyses were conducted. All hydraulic evaluations were performed using the HEC-RAS numerical models except for the analysis regarding breakwater and wave attenuation (the Hydraulic Analysis is documented in *Appendix C*).

- ✓ During pump mode for Option 1 at the design canal discharge condition, the canal water surface elevation was determined for a given suction side elevation at the new pump station. The minimum suction side elevation for the existing canals was assumed to be -1 foot North American Vertical Datum 1988 (NAVD88) (2004.65). The preferred operating suction side elevation was assumed to be +1 foot. The canal water surface elevations were compared to canal safe water elevations to determine whether the safe water elevation would be exceeded along the canal. The results of this evaluation are documented in *Appendix B and C*.

- ✓ During pump mode for Option 2 or 2a at the design canal discharge condition, the maximum suction side elevation and canal invert at the new pump station for the deepened canal was determined such that the current flowline elevation upstream of the existing drainage pump station is not exceeded. The results of this evaluation are documented in *Appendix B and C*.

- ✓ During gates-open operating mode (Option 1 only), the gate clear opening width of the gated gravity by-pass and the resulting impact to the safe water elevation along each canal were determined. The analysis is documented in *Appendix C* and the details of the gated section are discussed in Section 3.2.2.

- ✓ Option 2 and 2a deepened canal geometries were evaluated to determine the impacts for each canal invert selected. This analysis is discussed in Section 3.3. The analysis is also documented in *Appendix C*.

- ✓ The breakwater design required to reduce the total wave height to 1 to 2 feet at the pump station discharge was evaluated. Breakwaters are discussed in Section 3.4.3.

3.2.1 Canal Wall/Levee Safe Water Elevation Evaluation

The existing canal walls and levees form the parallel protection system for which the safe water elevations are determined. Safe water elevations are defined to equal maximum allowable canal water surface elevation at any point along the canal. The maximum allowable water surface elevation is based on the ability of the existing canal walls and levees to remain stable when loaded by the water. Currently, the safe water elevations along all three canals are being assessed. For this study, the assumed current safe water elevations in NAVD88 (2004.65) are as follows:

- ✓ 17th Street Canal = +6.0 feet
- ✓ Orleans Avenue Canal = +8.0 feet
- ✓ London Avenue Canal = +5.0 feet from approximately 4,000 feet downstream of DPS 3 to Lake Pontchartrain; +9.0 feet from DPS 3 to approximately 4,000 feet downstream of DPS 3;

During evaluation of the various pump station alternatives, the impacts to the parallel protection were checked. The two primary pump scenarios that were evaluated include pump in series (Option 1 = existing DPS pump to new permanent pump stations) and single source pump (Option 2 or 2a = removal of existing DPS and pump once at the new permanent pump stations). The later will eliminate the need for the existing parallel protection since the channel will be deepened to allow the water to drain by gravity to the new permanent pump station and the water surface elevation will be below the elevation of the surrounding grade.

The pump in series scenario can result in circumstances in which the canal water elevation exceeds the existing safe water elevation. For example, if the pump in series system includes a gated structure at the permanent pump station, then under certain combinations of Lake Pontchartrain elevations and DPS discharges the canal water elevation will exceed the safe water elevations in the canals. These various combinations of lake and canal elevations will need to be evaluated to determine a standard operating procedure for closing the gated section and initiating pumping at the new permanent pump stations. Generally, the pump in series system is capable of operating in a manner that prevents the water elevation in the canals from exceeding the safe water elevations, which is consistent with the operation of the ICS presently in service at each canal.

The only option that will include parallel protection modification costs is the Non-Adaptable Option 1. This will account for complexity associated with closing the gated section and initiating pumping. This is discussed in more detail in Section 3.2.2 Gated Versus Non-Gated Gravity By-pass.

3.2.2 Gated Versus Non-Gated Gravity Bypass

The Option 1 pump stations include a gated gravity bypass. The gated gravity bypass is constructed during construction sequence 1 of the four phased construction approach. The Option 2 pump stations do not include a gated gravity by-pass since the water elevation in the canals is lower than the water elevation in Lake Pontchartrain. The goal of this study was to re-visit the gated gravity by-pass that is recommended in the *Conceptual Design Report for Permanent Flood Gates and Pump Stations, dated 2006,* performed by GEC.

Figure 3-4 shows a plan of the pump station with the gated bypass adjacent to the pump station footprint. Figure 3-5 shows a general cross-section through the gated bypass. The plan and cross-section show the general concept that was used to develop the costs for the gated bypass. The non-gated cross-sections (pump station super and substructure) are shown in the cross-section of the pump stations in Section 4.0. While developing the costs for the gated section, the Option 1 pump stations were formulated with and without the gated gravity by-pass. This variation in Option 1 provided the cost impact of including the gated gravity by-pass as part of the pump station system. Pump station systems that by-pass the majority of storm water by gravity (gated system) and those that require the pump station to operate during each rain event (non-gated system) were evaluated and compared. *Appendix F* documents the evaluation and comparison.

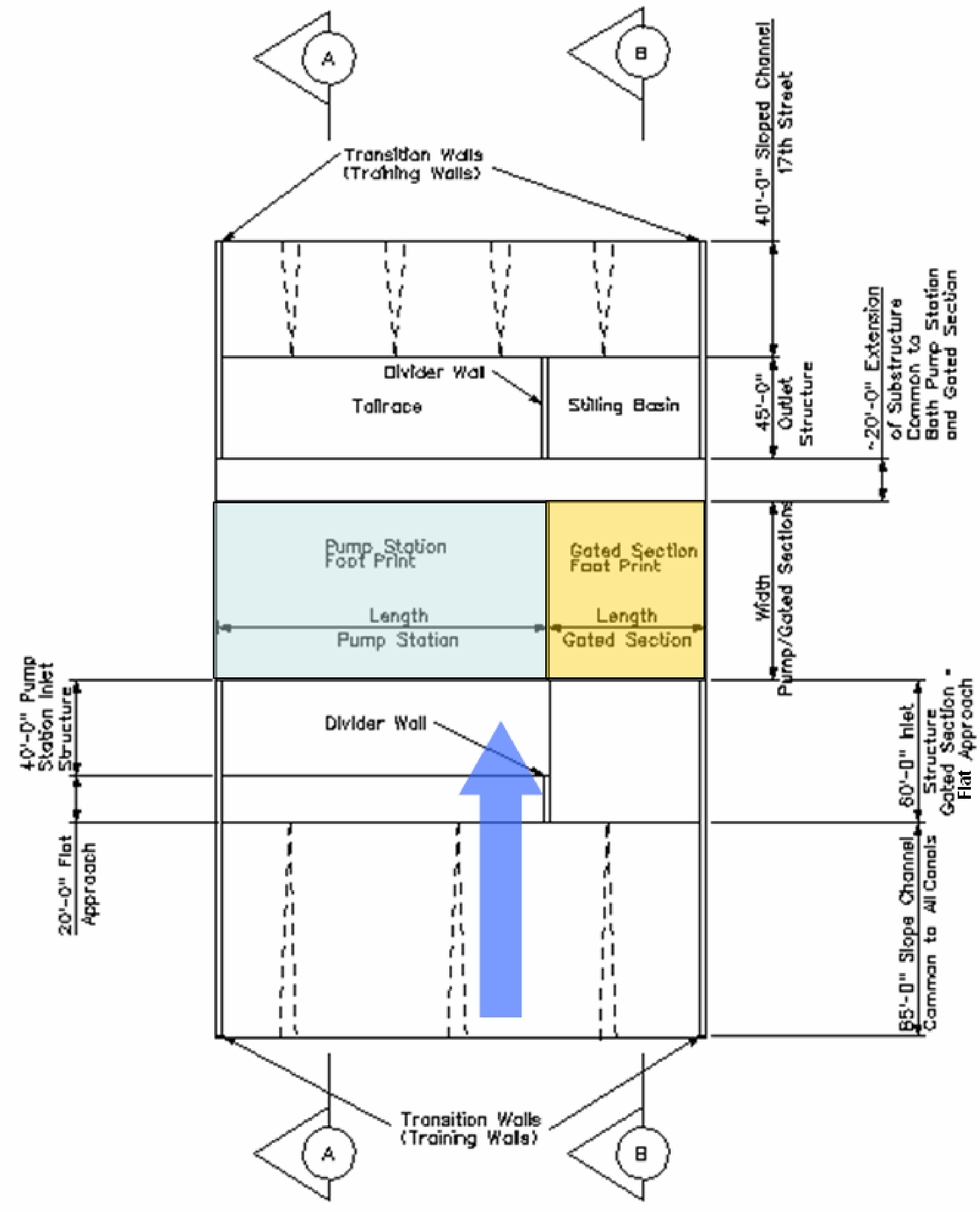

FIGURE 3-4 - Plan of Pump Station and Gated Section

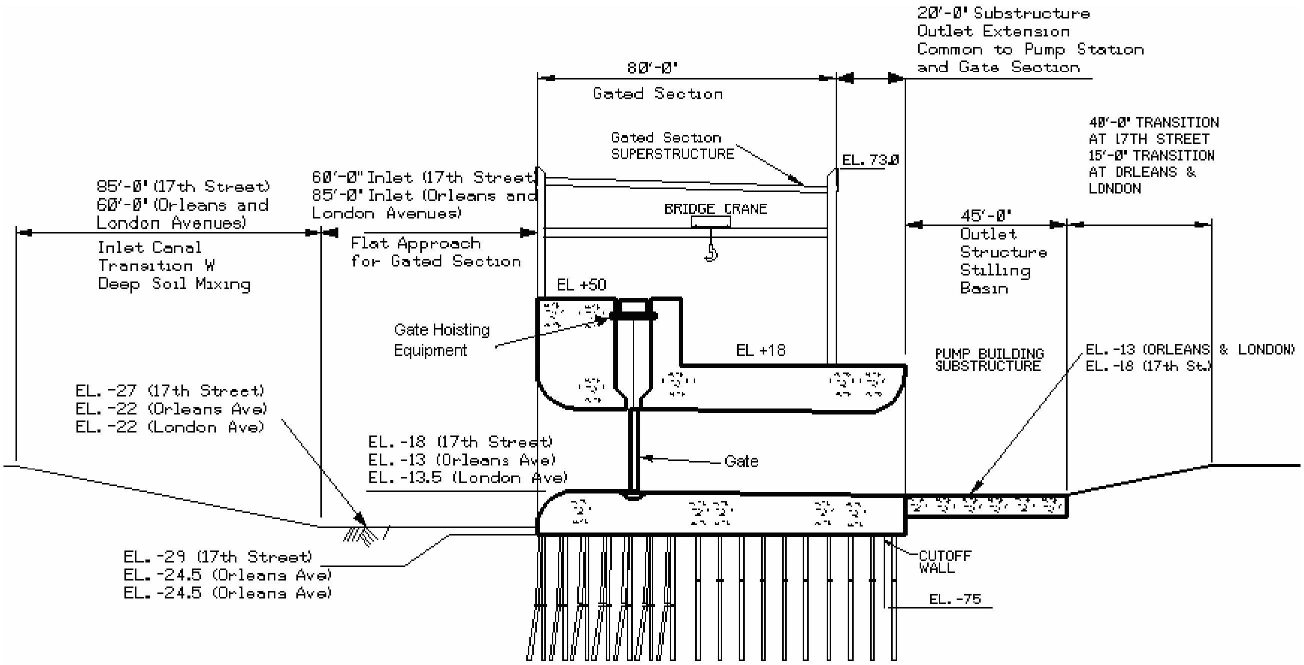

FIGURE 3-5 - Typical Gated Section Cross-Section

The gated bypass for Option 1 will remain open during normal conditions. The storm water flow from the canals will discharge through the opened gated bypass directly into Lake Pontchartrain without having to operate the new Option 1 pump stations. When a combination of lake stage and discharge flow from the existing pump stations creates a condition where the water in the canals approaches the safe water elevation in the canals, the gates would be closed, and the new pump stations will operate. The advantage of this arrangement is that the operation costs of the new pump station would be minimized since the amount of time in which the new pump stations and the existing DPS would operate in series will be minimized. A disadvantage of this system is that the existing canal floodwalls and levees may need to be modified to accommodate the potential for higher safe water elevations during maximum storm water discharges. This could be mitigated by establishing an operating scenario that results in closure of the gates and the initiation of series pumping to prevent exceedence of the safe water elevation in the canals. Although not evaluated as part of this study, another disadvantage is that an adaptable or non-adaptable Option 1 pump station with a gate section may require changes to the types of pumps and operation when the station is converted to an Option 2 pump station.

The non-gated system will discharge storm water through the pump station by pumping directly into Lake Pontchartrain during normal (non-hurricane events) and hurricane events. This option requires the existing pump stations and the new pump stations to operate in series during rainfall events to keep the water level below the safe water elevation in the canals. The advantage of this system is that the gated section and any wall modification costs are not required. A disadvantage is that the operating scenario of non-gated system may require changes to the number and types of pumps when compared to a gated system, thus changing the layout of the pump station.

Both the Non-Adaptable and Robust Adaptable Option 1 pump station include gated sections. The Base Adaptable Option 1 pump station does not include a gated section. The Option 1 variations show the cost impact associated with including a gated bypass. The gated bypass costs are documented in *Appendix I* and summarized in Section 5.0. A gated bypass is not included in the Options 2 and 2a pump stations since the elevation of the water in Lake Pontchartrain is higher than the elevation of the water in the canals.

Based on the analysis performed for this study, it is recommended that the Option 1 pump stations incorporate a gated section. The Option 2 scenarios will not include a gated section due to elevation differences between the interior canal water elevation and the lake elevation.

3.2.3 Diversion of Storm Water Away From the Outfall Canals

Diversion of storm water away from the three outfall canals will reduce the maximum design discharge for the respective canal. Diversion of storm water was considered as part of Options 2 and 2a only. The reduction in maximum design discharge will result in a smaller new permanent pump station and a reduction in the canal deepening requirements associated with Options 2 and 2a. These diversions could be constructed during construction sequence 2 of the four phased construction approach to convert from an Option 1 into an Option 2 pump station.

Operating scenarios for Option 2, Option 2a, and any associated flow diversions were not investigated as part of this study. However, the operation of Option 2 or Option 2a pump stations as part of the overall system, including any flow diversions, would need to be evaluated if selected for implementation.

During the plan formulation process, potential diversion projects were considered for evaluation. The goal was to identify cost effective diversions on the basis of reducing the cost of implementing an Option 2 pump station. The initial screening of the diversion projects was based on the conceptual engineering and rough order of magnitude cost information presented in Appendix B of *Final Report of Alternatives Analysis of the Interim Drainage Maintenance Opportunities for Orleans East Bank Project, dated 2006,* performed by DMJM Harris. This screening process resulted in the identification of three diversions for further evaluation.

The three primary diversions that were identified for evaluation include the Hoey's Basin Diversion; the London Avenue Canal to IHNC Diversion Alternative 1 (referred to as the Florida Avenue Diversion); and the London Avenue Canal to IHNC Diversion Alternative 2 (referred to as Dwyer Diversion). The diversions were evaluated to determine if any of the three diversions are cost effective as part of the Option 2 pump stations. In addition, the Hoey's Basin Diversion is incorporated into Option 2a. Details showing each diversion and calculations supporting the development of each diversion are included in *Appendix G.*

The Hoey's basin diversion will include a pump station to pump storm water out of Hoey's Basin in Jefferson Parish and direct it to the Mississippi River via pressurized force main. This diversion will divert 1,600 cfs of storm water away from 17th Street Canal. The Florida Avenue Diversion will divert storm water from the London Avenue Canal to the IHNC via the Florida Avenue Canal. Approximately 1,100 cfs will be diverted from London Canal into the Florida Avenue Canal through the use of existing pumps in DPS 3. This water will then flow to DPS 19 to be pumped into the IHNC. The Dwyer Diversion will intercept storm water from the region east of DPS 4 and direct this flow via a new canal and new pump station into the IHNC. Approximately 1,000 cfs would be diverted from London Canal to the IHNC. Additional details and figures used for diversion cost analysis are documented in *Appendix G*.

The cost analysis of these diversions indicates that the only diversion that is cost effective is the Florida Avenue Diversion on London Avenue Canal. Thus, the Florida Avenue diversion is included as part of Option 2 and Option 2a. The cost analysis of these diversions is documented in *Appendix I* and the cost summaries are shown in Section 5.0.

3.2.3.1 Hoey's Basin Diversion

As required by Title III, Chapter 3 of Public Law 110-252 the Hoey's Basin diversion of flow from the 17th Street Canal was investigated and included as part of Option 2a. Hoey's Basin is approximately 2,500 acres of Jefferson Parish, bounded by Monticello Canal on the east, Metairie Road on the north, Causeway Boulevard on the west, and the Mississippi River on the south. The 2000 census population for the basin area was 12,598. The majority of the land use is residential with a smattering of commercial, light industrial, and parks.

Hoey's Canal is approximately 1.85 miles long and stretches west-east from Causeway Boulevard to south of Earhart Expressway. Hoey's Canal collects the drainage from the Hoey's Basin. At the east end, Hoey's Canal connects with the L&V Ditch and runs northeast to intersect with Geisenheimer Canal, north of Airline Highway (US 61). The water from the canal network flows by gravity to the existing DPS 6 which discharges the flow into the 17th Street Canal. The proposed diversion will divert the flow collected from the canal into the Mississippi River by adding a pump station and force main. This diversion will operate in concert with an existing gate in the canal network which serves to isolate Hoey's Basin drainage system from DPS 6. Key features of this diversion include the pump station, the force main with road and rail road crossings, the levee crossing, and energy diffusion box within the river. Refer to Plate 1 in *Appendix G* for a figure depicting the location of these features.

The new pump station will have a capacity of 1,600 cfs, which is the capacity that the canals can convey to the pump station as indicated in the *Master Drainage Plan for Hoey's Basin, dated 2008,* performed by BCG Engineering and Consulting, Inc. Upstream of the pump station, the canals will be improved by slope paving. A transition from the canal to the pump station will be constructed to account for the minimum submergence required for the pumps and to improve the flow into the pump station. The

Creosote Ditch will be relocated to allow the installation of the pump station. The pump station will be approximately 106 feet long by 115 feet wide, and will be located between Earhart Expressway and Jefferson Highway. Refer to Plate 4 in *Appendix G* for a plan and section of the pump station. The total width includes 35 feet of inlet works, including climber screens, and a force main discharge. The pump station will contain 4 diesel driven 400 cfs pumps with a discharge head of approximately 75 feet. Typical pump curves and factory cut sheets for these pumps are found in *Appendix E*. These pumps are the largest pumps that can be driven with a standard diesel engine. Larger capacity pumps would require custom diesel engines. The pump station will include a small pump house generator system to power lights, controls and instrumentation, and ancillary systems. The station is provided with a fuel tank farm sized to provide four days of fuel storage at maximum capacity.

The pump station will discharge into one 13 foot diameter force main that will be routed as shown in Figure 3-6 and in more detail on Plate 1 in *Appendix G*. This routing generally follows an abandoned railroad right-of-way. The force main will be routed above grade and supported on pile supported pipe cradles spaced at approximately 10 feet to the maximum extent possible. A typical pipe cradle is depicted on Plate 5 in *Appendix G*. As shown on Figure 3-6, the pipeline crosses several railways and thoroughfares. To cross these railways and thoroughfares, three distinct approaches were taken.

- ✓ In the case of railroads or Jefferson Highway, the pipeline will be tunneled below grade. This will minimize the impact of the force main installation on the highway and railway traffic.

- ✓ In the case where the road can be easily detoured, the pipeline will be installed below grade via an open cut approach. Pipes could be installed in the manner depicted on the Open Cut Detail on Plate 5 in *Appendix G*.

- ✓ In the case of River Road, an overhead pipe bridge will be installed. River Road is adjacent to the levee and will preclude installation of the pipe below grade without significant road modifications. The pipe bridge is designed so that traffic can pass beneath the bridge.

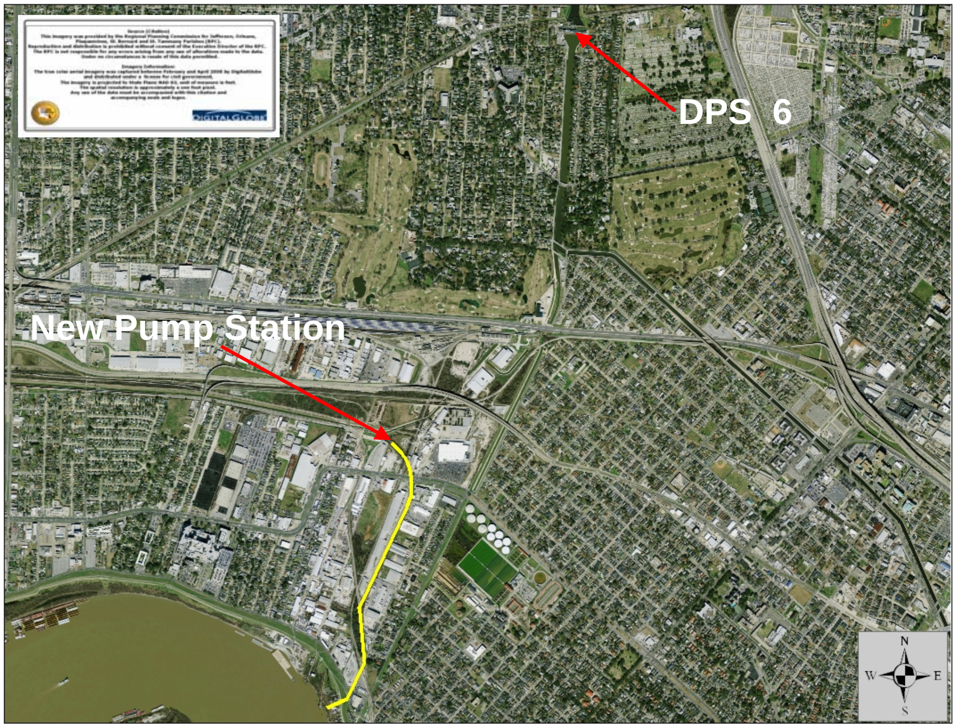

FIGURE 3-6 - Plan of Hoey's Basin Diversion

The pipeline will transition to five 6 foot diameter pipes prior to crossing over the pipe bridge. The pipes will then cross over the levee and discharge in to the Mississippi River via a discharge box with protective dolphins. The discharge box will prevent erosion at the point of discharge into the river.

Operating scenarios and pump operation at the new pump station at Hoey's Basin and at the 17^{th} Street Canal Option 2a pump station were not evaluated.

3.2.3.2 Florida Avenue Diversion

The London Avenue Canal begins just west of the intersection of North Broad Street (Hwy 90) and Florida Avenue. The canal continues due north and discharges into Lake Pontchartrain. There are two pump stations pumping into the canal: DPS 3 is at North Broad Street and Florida Avenue and has a capacity of 4,260 cfs, and DPS 4 west of Prentiss Avenue has a capacity of 3,720 cfs.

This proposed diversion will modify DPS 3 to divert a flow capacity of 1,100 cfs to go through the Florida Avenue Canal to DPS 19 to be discharged into the IHNC, as outlined in the *Final Report of Alternatives Analysis of the Interim Drainage Maintenance Opportunities for Orleans East Bank Project, dated 2006,* performed by DMJM Harris. Figure 3-7 and Plate 2 in *Appendix G* show the general layout of this diversion.

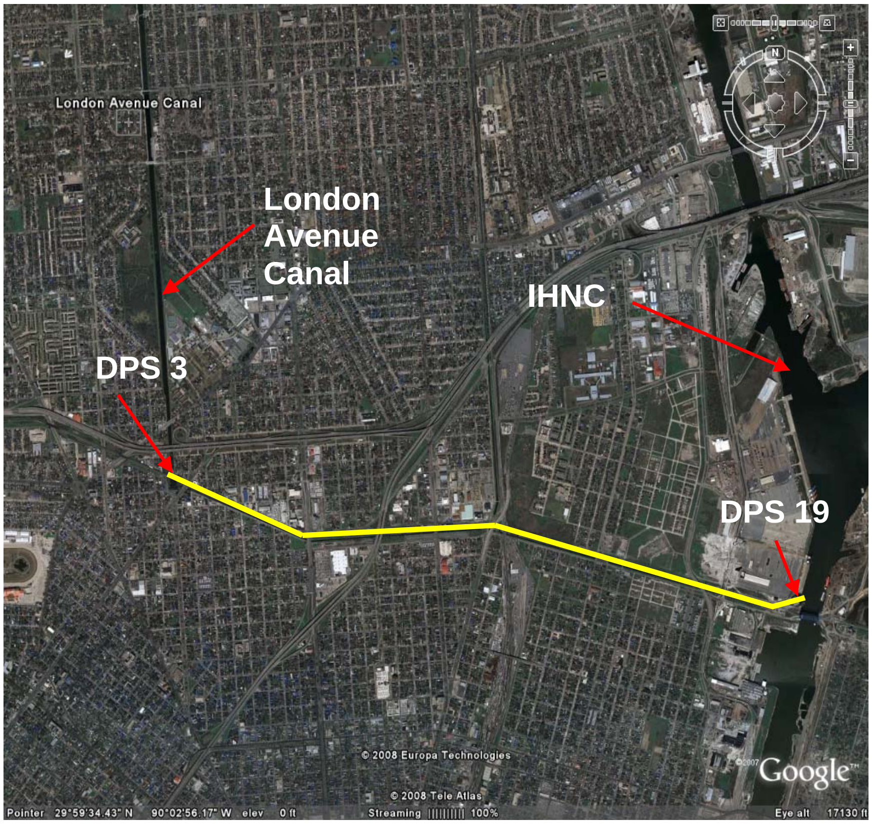

FIGURE 3-7 - Florida Avenue Diversion

DPS 3 currently has two 550 cfs pumps which have a discharge that can be diverted from the London Avenue Canal to the Florida Avenue Canal through the use of gates on the discharge side of the pumps. Modifications are required to the discharge flume of the pumps at DPS 3 to prevent recirculation of water around the pump station.

The modifications are depicted in Plate 6 of *Appendix G*. An earthen berm and flood wall will be constructed to prevent the flow of water from Florida Avenue Canal to the inlet side of the pump station. The pump station discharge gate that allows the pumps to discharge water to the London Canal will be permanently sealed, and the gates that allow discharge of water to the Florida Avenue Canals will be permanently removed to allow flow in only this direction. This diversion will require that a portion of DPS 3 along with the two 550 cfs pumps remain in place and operable.

The *Final Report of Alternatives Analysis of the Interim Drainage Maintenance Opportunities for Orleans East Bank Project, dated 2006*, performed by DMJM Harris identified only one flow restriction that limits the capacity of the Florida Avenue Canal between Louisa Street and Piety Street. Removal of the Louisa to Piety Street flow restriction is required to allow this diversion to function properly. This restriction is currently scheduled to be removed as part of a Southeast Louisiana Urban Flood Control Project (SELA) to be completed in 2011. Therefore, the cost of removal for this restriction is not included in the diversion cost for this report.

Operating scenarios and pump operation at the revised DPS 3 pump station, at DPS 19, and at the London Avenue Canal Option 2 pump station were not evaluated.

3.2.3.3 Dwyer Diversion

This proposed diversion will divert a portion of the storm water from the DPS 4 to the IHNC. The existing drainage system runs from Peoples Avenue Canal through a box culvert along Prentiss Avenue to DPS 4 and then is discharged into the London Avenue Canal. Key features of this diversion include a new pump station, construction of a new canal, a transition and junction box to connect the new canal to the Peoples Avenue Canal culvert, discharge piping, and a stilling basin. These features are depicted on Plate 3 in *Appendix G*.

The new pump station will have a capacity of 1,000 cfs. This capacity was calculated based on the assumption of 1 cfs per acre of contributory area provided by SWBNO. The pump station will be installed between Congress Drive and France Road. A transition will be made from the new canal to the pump station to account for the minimum submergence required for the pumps and to improve the flow into the pump station. The pump station will be approximately 75 feet long by 115 feet wide. The total width includes 35 feet of inlet works, including climber screens, and discharge force mains. The pump station is depicted on Plate 7 in *Appendix G*. The pump station will contain 3 diesel driven 333 cfs pumps with a discharge head of approximately 50 feet. Typical pump curves and factory cut sheets for these pumps are found in *Appendix E*. The pump station will include a small pump house generator system and a fuel tank farm sized to provide four days of fuel storage at maximum pumping capacity. The pump station will require additional right of way allocation.

The new canal will flow east to the new pump station from a location near the Norfolk Southern Railroad tracks which is just east of Peoples Avenue near the junction of Peoples Avenue and Filmore Avenue. The canal will be a trapezoidal channel approximately 4,000 feet long and will be sloped to the pump station. A typical canal cross section is depicted on Plate 9 of *Appendix G*. The canal will generally be 100 foot wide at the top with 3H:1V side slopes. The bottom and side slopes of the canal will be paved.

Figure 3-8 and Plate 3 in *Appendix G* shows the general layout of the Dwyer Diversion. This layout minimizes impact on private properties by routing of the diversion through public property. The canal crosses two roads, Press Drive and Congress Drive. Both roads and existing culverts will be removed and replaced with new larger box culverts as depicted on Plate 9 of *Appendix G*.

FIGURE 3-8 - Dwyer Diversion Layout

The canal will be tied into the existing drainage system via a new junction box which will be installed into Peoples Avenue Canal near the junction of Peoples Avenue and Filmore Avenue. The new junction box will be connected to the new canal via two tunneled 10 foot diameter conduits which will cross below the Norfolk Southern Railroad tracks. A transition or deepened canal will be provided on the east end of the new canal to allow connection to the new two tunneled lines. This is depicted on Plate 8 of *Appendix G*.

The pumps within the pump station will discharge into three 6 foot diameter force mains. The force mains will be routed over France Road via a pipe bridge similar to the one depicted on Plate 10 of *Appendix G*. The pipes will discharge into a concrete lined stilling basin with riprap that will dissipate the energy before entry into the IHNC. The stilling basin will require a large right of way purchase and removal of some rail spurs. As is shown on Figure 3-8 the stilling basin will be shifted to minimize the impact on commercial real estate in the area. The stilling basin is depicted on Plate 9 of *Appendix G*.

Operating scenarios and pump operation at the new pump station and at the London Avenue Canal Option 2 pump station were not evaluated.

3.3 Canal Deepening

Option 2 requires approximately 12 miles of canal to be deepened to permit gravity flow of storm water from the existing interior drainage system to the new pump station at or near the lake. Bypass and demolition of the existing drainage pump stations is required to allow the gravity flow of storm water into the deepened canals. Once the canals are deepened, the parallel protection levees and flood walls can be removed. Deepening of the canals will occur during construction sequence 3 of the four phase construction approach to convert from an Option 1 to an Option 2 pump station.

The hydraulic issues associated with deepening the canal include development of a cross section area that adequately conveys the water to the new pump stations while maintaining the gravity drainage elevations presently existing at the DPS pump station inlets. A hydraulic analysis was performed to determine the canal cross-sections required to maintain the present flowline elevation at the intake of each existing pump station. The HEC-RAS model, version 4.0, was used for the analysis. The base model was provided by the Corps of Engineers Vicksburg District, and the geometry was modified as described below to simulate a deepened canal. Modeled flows represent the full potential canal inflows, as well as the canal inflows reduced by potential diversions. The hydraulic model was developed based on the NAVD88 (2004.65) datum.

The primary geotechnical issues associated with deepening of the canals include local stability of the existing flood walls during construction and the stability of the final canal side slopes and canal invert after construction. Additionally, the deepened canal and lower canal water elevation may result in subsidence of the ground surface adjacent to the canals. The original concept design for deepening of the canals addressed the subsidence issue by developing a sealed drainage canal as documented in *Conceptual Design Report for Permanent Flood Gates and Pump Stations, dated 2006*, performed by GEC. A conceptual seepage cut-off design is presented in Appendix D to conform with the canal stabilization concepts presented in this report. The design limitations on subsidence for final design will need to be determined in future studies and agreements with the adjacent affected community.

The widths of the canals are relatively narrow.

17^{th} Street	212 ft
Orleans	142 ft
London	varies, average 122 ft

In order to provide sufficient cross sectional area for the drainage, vertical walls or slopes of 1H:1V are required.

An open cut approach to deepening the canal will result in laid back slopes that extend beyond the adjacent canal flood walls and right of way. The revised canal deepening alternatives presented in this report maintain canal flow capacity during construction and do not require dewatering. The alternatives maintain the sealed drainage canal approach.

The following analyses were performed to support the conceptual design of alternative methods and develop a rough order of magnitude costs for to deepen the canals. During detailed design an analysis of each individual reach will be performed in accordance with the requirements of the latest requirements of the "Hurricane and Storm Damage Reduction System Design Guidelines" (HSDRSDG).

3.3.1 17th Street Deepened Canal Geotechnical Conditions

The typical stratification for the 17th Street Canal is taken from the *Performance Evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System, Draft Final Report of the Interagency Performance Evaluation Task Force (IPET), Volume V – The Performance – Levees and Floodwalls, dated 2006*, performed by the U.S. Army Corps of Engineers. From the top down the stratification includes; Marsh Clay, a peat layer, Lacustrine Clay, Relic Beach Sand, and Bay Sound Clay. Pleistocene sand and clay strata are below the Bay Sound Clay.

The existing bottom of the canal is at approximate elevation -18 feet (NAVD88, 2004.65). The new bottom needs to be at an approximate elevation of -27 feet In order to provide sufficient cross sectional area for the drainage, vertical walls or slopes of 1H:1V are required.

The strength and physical properties used to characterize these strata are also taken from the IPET report, Volume V, Appendices 1, 3, 4 and 6 and recent studies performed by the HPO to determine the Safe Water Elevation (SWE) for this canal's flood walls. Based on the previous studies for the SWE on this canal the section with the highest present Factor of Safety (FOS), between Stations 552 +21.5 and the closure structure was selected for evaluation. The soil parameters are based on the soil investigation for this Reach. The cross –section was evaluated for the base excavation depth of elevation -27.5 feet NAVD88 with a cut slope of 1H:1V. The cross-section was evaluated with Spencer's method using GeoSlope program SlopeW Version 7.13. The factor of safety was less than 1. Based on the previous SWE studies it is anticipated that the remaining reaches would have as low or lower FOS. This is an unstable slope and will require a retaining structure or other stabilization method to meet the minimum FOS of 1.4 required by the HSDRSDG. The analysis is provided in Appendix D.

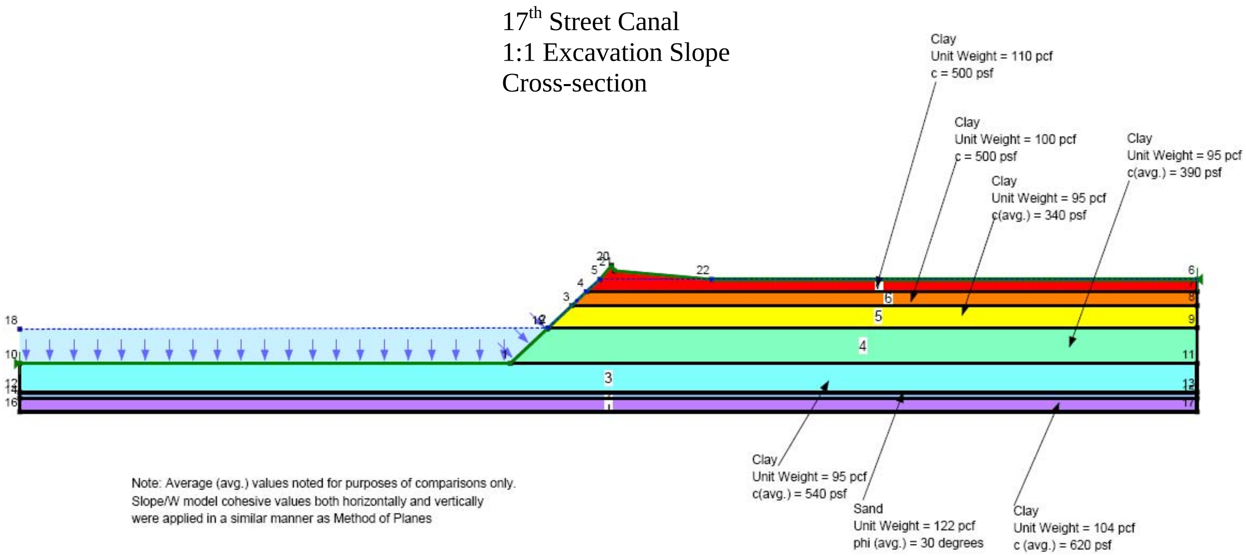

FIGURE 3-9- 17th Street Geology

Stability analysis of the deepened canal shows the steepened slopes of the canal do not meet safety criteria. The slopes of the canal were flattened to determine the safe slope which will produce a factor of safety of 1.4. Slopes of 4H:1V produce the required minimum factors of safety (*Appendix D*). When 4H:1V slopes are projected out, significant amounts of additional property are required. In addition the flatter slopes will impact the existing floodwalls, preventing the continued operation of the present operating water levels. Therefore flatter slopes are not practical and the design is modified to include methods for stabilizing the slopes of the deepened canal.

The lower flow line in the canal creates a potential recharging situation in which ground water from the adjoining properties will flow into the canal. This will result in dewatering of the nearby properties and very likely increase subsidence. Preliminary seepage flow analysis has been performed to estimate the shape and influence of the drawdown curve extending away from the deepened canal. When the canal liner is modeled with a wall seepage barrier but without a base seal and the source of water is set 1000 feet from the canal, drawdown is high. The model shows a drawdown of 5 feet 100 feet from the canal to 1 foot at a distance of 300 feet from the canal (*Appendix D*). This extends well into the neighboring property and will produce unacceptable settlement. The drawdown would be greater if seepage through both the canal sides and base was permitted. The canal was modeled with both base and side seepage cut-offs. The permeability was varied between 1 x 10^{-6} to 1 x 10^{-7} cm/sec. With a lower permeability cut-off the, drawdown is less than 1 foot at 50 feet from the levee (*Appendix D*). This magnitude of drawdown will not produce settlement of structures. This type of design will minimize recharge of groundwater to the canal.

During discussion of the seepage analysis it was pointed out that the drainage system in the neighborhoods will act to artificially hold the water table up. When the recharge effect is added to the model, the drawdown is still present but is significantly reduced. The model predicts drawdown to be 1 foot at 100 feet from the levee. The recharging effect of the drain system is modeled based only on verbal description and is presented to show the possible effect. This system, its water source, and continuity need to be verified before to determine if this effect can be assured before final design decisions are made.

3.3.2 17th Street Deepened Canal Hydraulics

Total maximum design canal discharge at the new pump station is 12,500 cfs, which includes the potential capacity increase of 2,000 cfs at DPS 6. A diversion from Hoey's Basin of 1,600 cfs was considered to provide a reduced 17th Street Canal flow of 10,900 cfs.

The maximum allowable upstream water surface elevation within the canal corresponds to the maximum allowable water surface elevation on the suction side of DPS 6. For purposes of this study, a maximum suction side elevation at DPS 6 of -10.9 feet NAVD88 (2004.65) was used.

A suction side water surface elevation at the new pump station of -14.0 feet was selected for use. Two modified canal cross sections were considered.

- ✓ Case 1 - A 150-foot wide rectangular cross section with a tremie concrete bottom and vertical sheet-pile side walls.
- ✓ Case 2- A trapezoidal cross section with a bottom width of 150 feet and 1:1 side slopes lined with fabric formed concrete.

The modified canal invert profile has slope 0.00045 between the new pump station and DPS 6. This slope is within the range of slopes currently used for conveyance canals in the New Orleans area. A concrete lining was assumed to minimize friction losses in the canal. A Manning's n-value of 0.020 and 0.022 was used for Case 1 and Case 2 cross sections, respectively.

Using the starting water surface elevation and each of the two cases of canal cross sections described above, an iterative approach was used to determine the canal invert elevation that would result in a maximum canal water surface elevation at DPS 6 equal to the maximum allowable suction side elevation at this pump station. The HEC-RAS model was run for several canal invert elevations at flows of 12,500 cfs and 10,900 cfs to determine the resulting canal water surface elevation at DPS 6. Based on the results of the analysis, the following canal invert elevations were determined to be required. The water surface profile within the canal, the existing canal invert elevations, and the required deepened canal invert elevations for these flow conditions are shown in Figures 3-10 and 3-11.

For a canal discharge capacity of 12,500 cfs, the following invert elevations are required to maintain the safe water elevation in the canal and the appropriate water surface elevation at DPS 6:

- ✓ Case 1 Rectangular cross-section – new pump station invert -29.8 feet., NAVD88 (2004.65)
- ✓ Case 2 Trapezoidal cross-section – new pump station invert -29.5 feet., NAVD88 (2004.65)

For a canal discharge capacity of 10,900 cfs, the following invert elevations are required to maintain the safe water elevation in the canal and the appropriate water surface elevations at DPS 6:

- ✓ Case 1 Rectangular cross-section – new pump station invert -27.5 feet., NAVD88 (2004.65)
- ✓ Case 2 Trapezoidal cross-section – new pump station invert -27.2 feet., NAVD88 (2004.65)

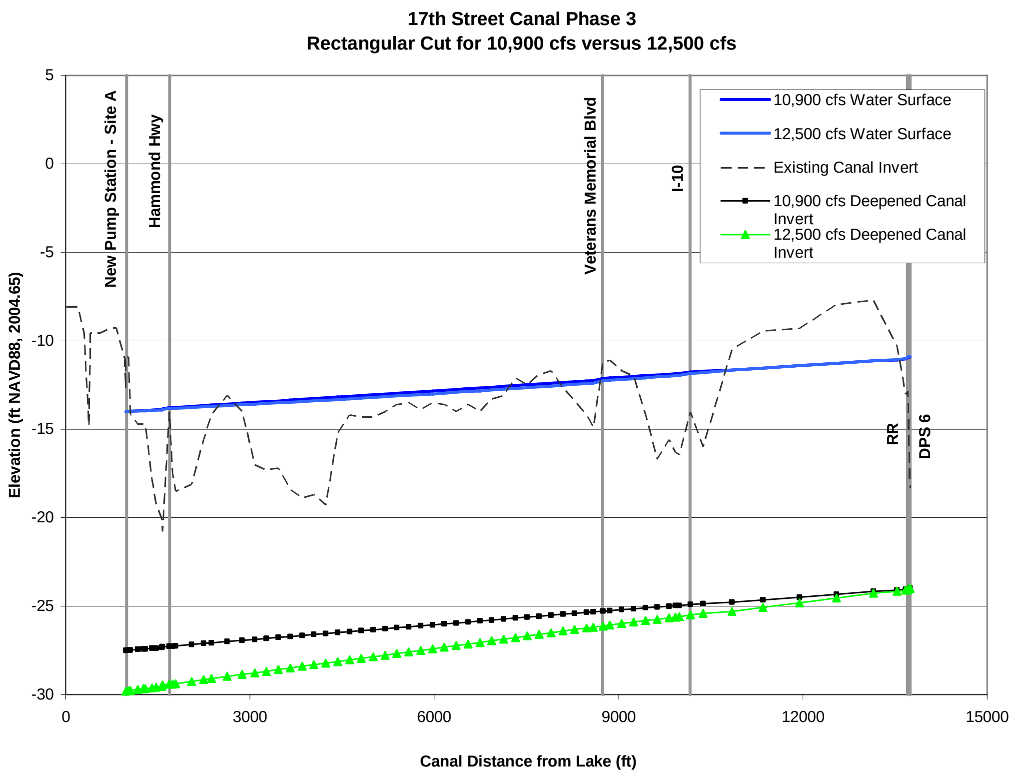

FIGURE 3-10 - 17th Street Canal Rectangular Cross-Section Water Surface Profiles

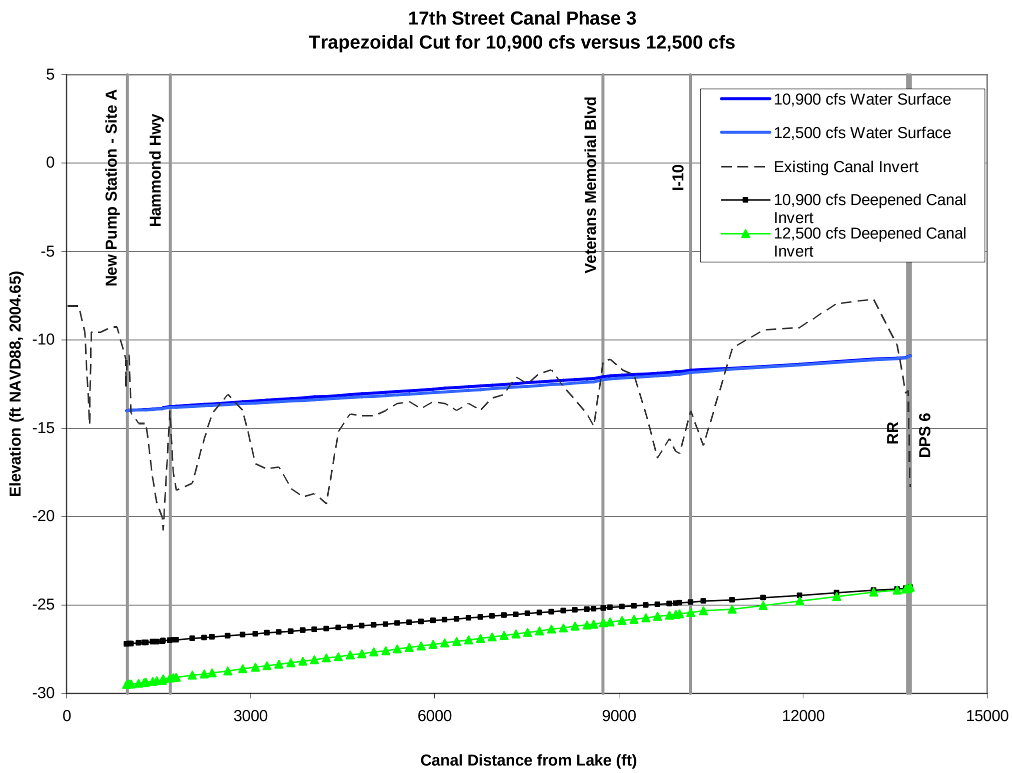

FIGURE 3-11 - 17th Street Canal Trapezoidal Cross-Section Water Surface Profiles

3.3.3 Orleans Avenue Deepened Canal Geotechnical Engineering

The typical stratification for the Orleans Canal is taken from the *Performance Evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System, Draft Final Report of the Interagency Performance Evaluation Task Force (IPET), Volume V – The Performance – Levees and Floodwalls, dated 2006,* performed by the U.S. Army Corps of Engineers. From the top down the stratification includes; Marsh Clay, Relic Beach Sand, and Bay Sound Clay. Pleistocene sand and clay strata are below the Bay Sound Clay.

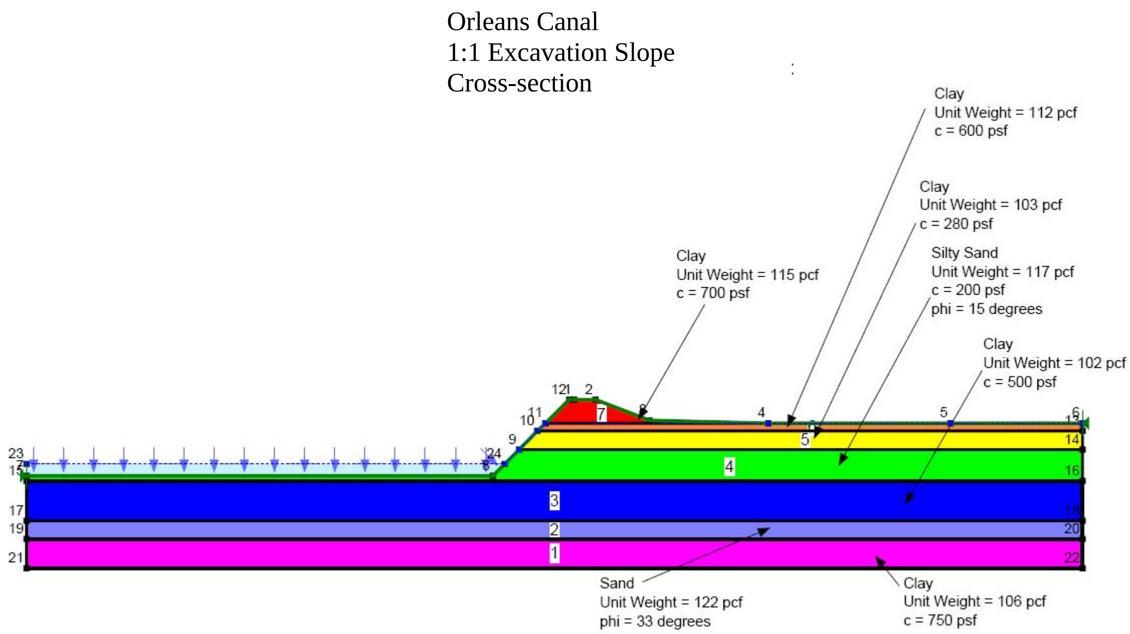

FIGURE 3-12 - Orleans Canal Geology

The existing bottom of the canal is at approximate elevation -10 feet (NAVD88, 2004.65). The new bottom needs to be at an approximate elevation of -19 feet. In order to provide sufficient cross sectional area for the drainage, vertical walls or slopes of 1H:1V are required.

The strength and physical properties used to characterize these strata are also taken from the IPET report, Volume V, Appendices 1, 3, 4 and 6 and recent studies performed by the HPO to determine the SWE for this canal's flood walls. Based on the previous studies for the SWE on this canal the section with the highest present Factor of Safety (FOS), between Station14+00 to the lakefront was selected for evaluation. The soil parameters are based on the soil investigation for this Reach. The cross –section was evaluated for the base excavation depth of elevation -19 feet NAVD88 with a cut slope of 1H:1V. The cross-section was evaluated with Spencer's method using GeoSlope program SlopeW Version 7.13. The factor of safety was less than 1. Based on the previous SWE studies it is anticipated that the remaining reaches would have as low or lower FOS. This is an unstable slope and will require a retaining structure or other stabilization method to meet the minimum FOS of 1.4 required by the HSDRSDG. The analysis is provided in *Appendix D* and the design is modified to include a concrete liner for the deepened canal.

Stability analysis of the deepened canal shows the steepened slopes of the canal do not meet safety criteria. The slopes of the canal were flattened to determine the safe slope which will produce a factor of safety of 1.4. Slopes of 2.5H:1V produce the required minimum factors of safety (*Appendix D*). When 2.5H:1V slopes are projected out the flatter slopes will impact the existing floodwalls, preventing the continued operation of the present operating water levels. In addition, additional property is required. Therefore, flatter slopes are not practical and the design is modified to include methods for stabilizing the slopes of the deepened canal.

The lower flow line in the canal creates a potential recharging situation in which ground water from the adjoining properties will flow into the canal. The analysis of this threat was discussed previously. The design will minimize recharge of groundwater to the canal.

3.3.4 Orleans Avenue Deepened Canal Hydraulics

Total maximum design canal discharge at the new pump station is 3,390 cfs, which includes the potential capacity increase of 700 cfs at DPS 7. No diversions are considered from this canal.

The maximum allowable upstream water surface elevation within the canal corresponds to the maximum allowable water surface elevation on the suction side of DPS 7. For purposes of this study, a maximum suction side elevation at DPS 7 of -9.4 feet NAVD88 (2004.65) was used. A starting water surface elevation at the new pump station of -12.0 feet was selected for use.

Two modified canal cross sections were considered.

- ✓ Case 1 - A 100-foot wide rectangular cross section with a tremie concrete bottom and vertical sheet-pile side walls.
- ✓ Case 2- A trapezoidal cross section with a bottom width of 100 feet and 1:1 side slopes lined with fabric formed concrete.

Inspection of the existing canal invert profile indicates the canal invert does not vary significantly. The modified canal invert profile was considered to be horizontal (constant elevation) between the new pump station and DPS 7. This invert profile configuration approximates the profile configuration of the existing canal. A Manning's n-value of 0.020 and 0.022 was used for Case 1 and Case 2 cross sections, respectively.

Using the starting water surface elevation and each of the two cases of canal cross sections described above, an iterative approach was used to determine the canal invert elevation that would result in a maximum canal water surface elevation at DPS 7 equal to the maximum allowable suction side elevation at this pump station. The HEC-RAS model was run for several canal invert elevations to determine the resulting canal water surface elevation at DPS 7. Based on the results of the analysis, the following canal invert elevations were determined to be required. The water surface profile within the canal, the existing canal invert elevations, and the required deepened canal invert elevations are shown in Figures 3-13 and 3-14.

For a canal discharge capacity of 3,390 cfs, the following invert elevations are required to maintain the safe water elevation in the canal and the appropriate water surface elevation at DPS 7:

- ✓ Case 1 Rectangular cross-section – new pump station invert -19.5 feet., NAVD88 (2004.65)
- ✓ Case 2 Trapezoidal cross-section – new pump station invert -19.5 feet., NAVD88 (2004.65)

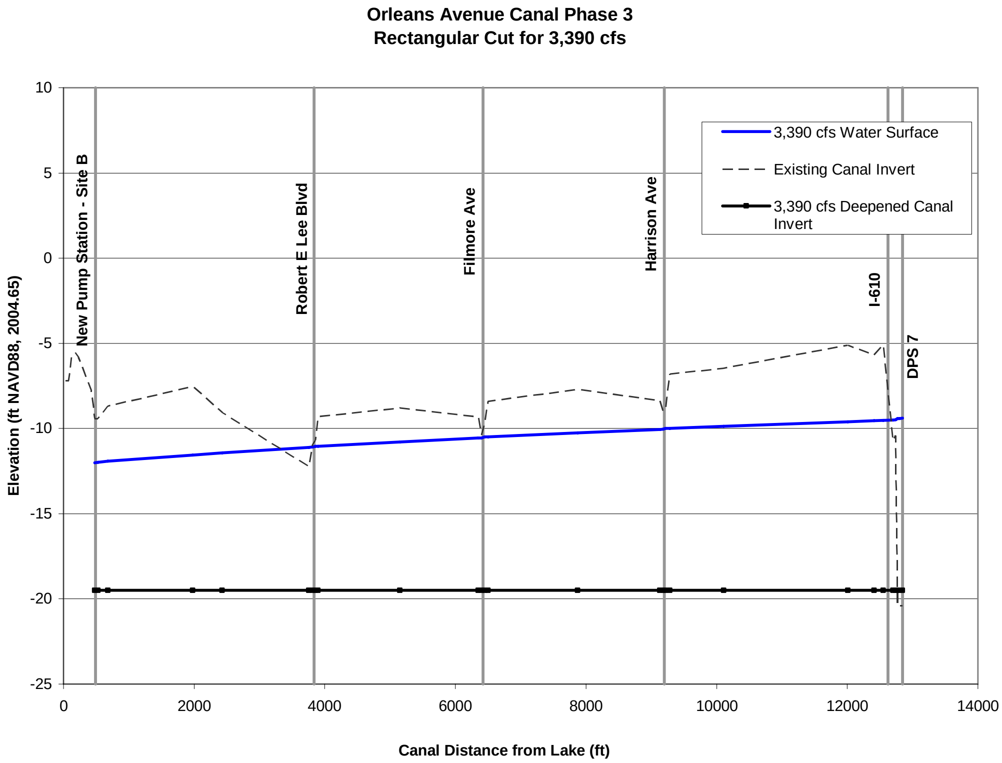

FIGURE 3-13 - Orleans Avenue Canal Rectangular Cross-Section Water Surface Profiles

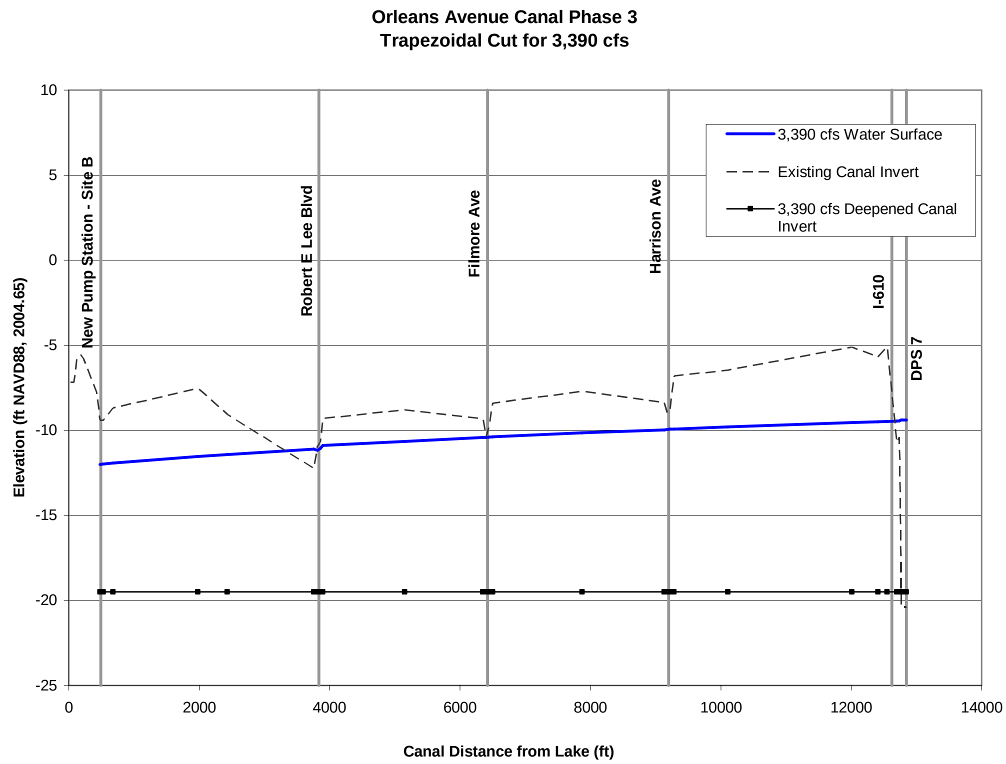

FIGURE 3-14 - Orleans Avenue Canal Trapezoidal Cross-Section Water Surface Profiles

3.3.5 London Avenue Deepened Canal Geotechnical Engineering

The typical stratification for the London Canal is taken from the *Performance Evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System, Draft Final Report of the Interagency Performance Evaluation Task Force (IPET), Volume V – The Performance – Levees and Floodwalls, dated 2006,* performed by the U.S. Army Corps of Engineers. From the top down the stratification includes; Marsh Clay, Relic Beach Sand, and Bay Sound Clay. Pleistocene sand and clay strata are below the Bay Sound Clay. The existing bottom of the canal is at approximate elevation -13 feet (NAVD88, 2004.65). The new bottom needs to be at an approximate elevation of -27 feet. In order to provide sufficient cross sectional area for the drainage, vertical walls or slopes of 1H:1V are required.

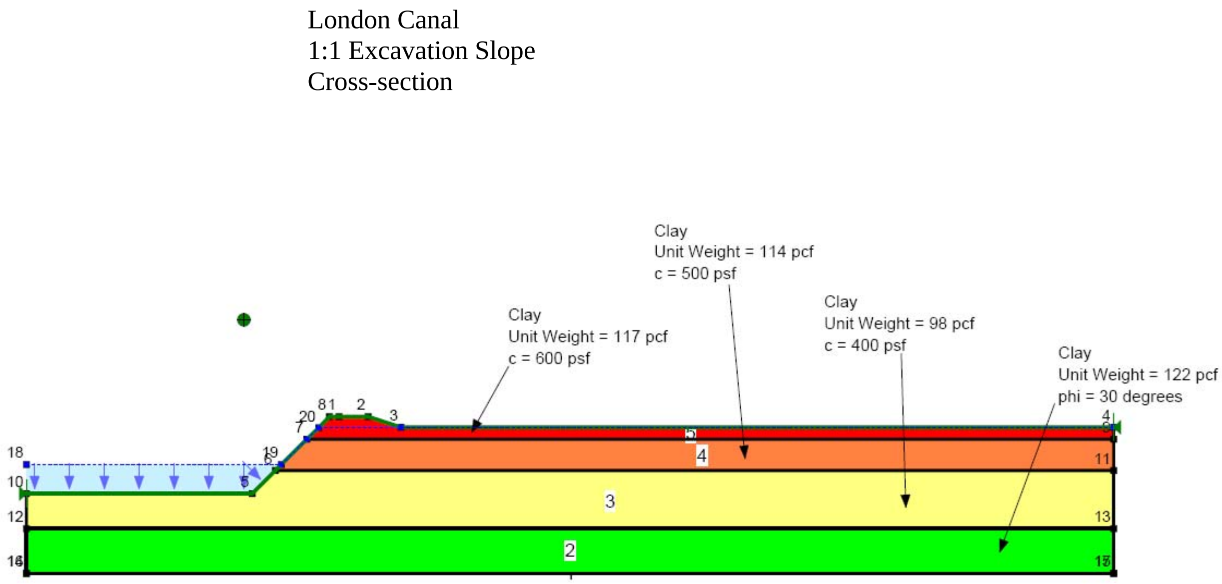

FIGURE 3-15 - London Canal Geology

The strength and physical properties used to characterize these strata are also taken from the IPET report, Volume V, Appendices 1, 3, 4 and 6 and recent studies performed by the HPO to determine the SWE for this canal's flood walls. Based on the previous studies for the SWE on this canal the section with the highest present FOS, between Stations 18+00 to 37+00 was selected for evaluation. The soil parameters are based on the soil investigation for this Reach. The cross –section was evaluated for the base excavation depth of elevation -27 feet NAVD88 with a cut slope of 1H:1V. The cross-section was evaluated with Spencer's method using GeoSlope program SlopeW Version 7.13. The factor of safety was less than 1. Based on the previous SWE studies it is anticipated that the remaining reaches would have as low or lower FOS. This is an unstable slope and will require a retaining structure or other stabilization method to meet the minimum FOS of 1.4 required by the HSDRSDG. The analysis is provided in *Appendix D*.

Stability analysis of the deepened canal shows the steepened slopes of the canal do not meet safety criteria. The slopes of the canal were flattened to determine the safe slope which will produce a factor of safety of 1.4. Slopes of 3.5H:1V produce the required minimum factors of safety (*Appendix D*). When 3.5H:1V slopes are projected out, significant amounts of additional property are required. In addition the flatter slopes will impact the existing floodwalls, preventing the continued operation of the present operating water levels. Therefore flatter slopes are not practical and the design is modified to include methods for stabilizing the slopes of the deepened canal.

The lower flow line in the canal creates a potential recharging situation in which ground water from the adjoining properties will flow into the canal. The analysis of this threat was discussed previously. The design will minimize recharge of groundwater to the canal.

3.3.6 London Avenue Deepened Canal Hydraulics

Total maximum design canal discharge at the new pump station is 8,980 cfs, which includes 1,000 cfs to account for a potential new pump station along London Avenue Canal. Two potential diversions of 1,000 cfs to Dwyer Avenue Canal and 1,100 cfs to Florida Avenue Canal were considered. These result in London Avenue Canal discharges of 7,980 cfs and 7,880 cfs, respectively.

The maximum allowable upstream water surface elevation within the canal corresponds to the maximum allowable water surface elevation on the suction side of DPS 3. For purposes of this study, a maximum suction side elevation at DPS 3 of -9.9 feet NAVD88 (2004.65) was used. A starting water surface elevation at the new pump station of -13.0 feet was selected for use.

Two modified canal cross sections were considered.

- ✓ Case 1 - A rectangular cross section with a tremie concrete bottom and vertical sheet-pile side walls. The bottom width is 80 feet between DPS 3 and DPS 4 and 100 feet between DPS and the new pump station.
- ✓ Case 2- A trapezoidal cross section with 1H:1V side slopes lined with fabric formed concrete. The bottom width is 80 feet between DPS 3 and DPS 4 and 100 feet between DPS and the new pump station.

The modified canal invert profile has slope 0.0005 between the new pump station and DPS 3. This slope is within the range of slopes currently used for conveyance canals in the New Orleans area. A concrete lining was assumed to minimize friction losses in the canal. A Manning's n-value of 0.020 and 0.022 was used for Case 1 and Case 2 cross sections, respectively.

Using the starting water surface elevation and each of the two cases of canal cross sections described above, an iterative approach was used to determine the canal invert elevation that would result in a maximum canal water surface elevation at DPS 3 equal to the maximum allowable suction side elevation at this pump station. The HEC-RAS model was run for several canal invert elevations at flows of 8,980 cfs, 7,980 cfs, and 7,880 cfs to determine the resulting canal water surface elevation at DPS 3. Based on the results of the analysis, the following canal invert elevations were determined to be required. The water surface profile within the canal, the existing canal invert elevations, and the required deepened canal invert elevations for these flow conditions are shown in Figures 3-16 through 3-19.

For a canal discharge capacity of 8,980 cfs, the following invert elevations are required to maintain the safe water elevation in the canal and the appropriate water surface elevation at DPS 3:

- ✓ Case 1 Rectangular cross-section – new pump station invert -28 feet., NAVD88 (2004.65)
- ✓ Case 2 Trapezoidal cross-section – new pump station invert -29 feet., NAVD88 (2004.65)

For a canal discharge capacity that is reduced to 7,980 cfs by constructing the Dwyer Diversion, the following invert elevations are required to maintain the safe water elevation in the canal and the appropriate water surface elevation at DPS 3:

- ✓ Case 1 Rectangular cross-section – new pump station invert -27.4 feet., NAVD88 (2004.65)
- ✓ Case 2 Trapezoidal cross-section – new pump station invert -28.5 feet., NAVD88 (2004.65)

For a canal discharge capacity that is reduced to 7,880 cfs by constructing the Florida Avenue Diversion, the following invert elevations are required to maintain the safe water elevation in the canal and the appropriate water surface elevation at DPS 3:

- ✓ Case 1 Rectangular cross-section – new pump station invert -26.1 feet., NAVD88 (2004.65)
- ✓ Case 2 Trapezoidal cross-section – new pump station invert -27.1 feet., NAVD88 (2004.65)

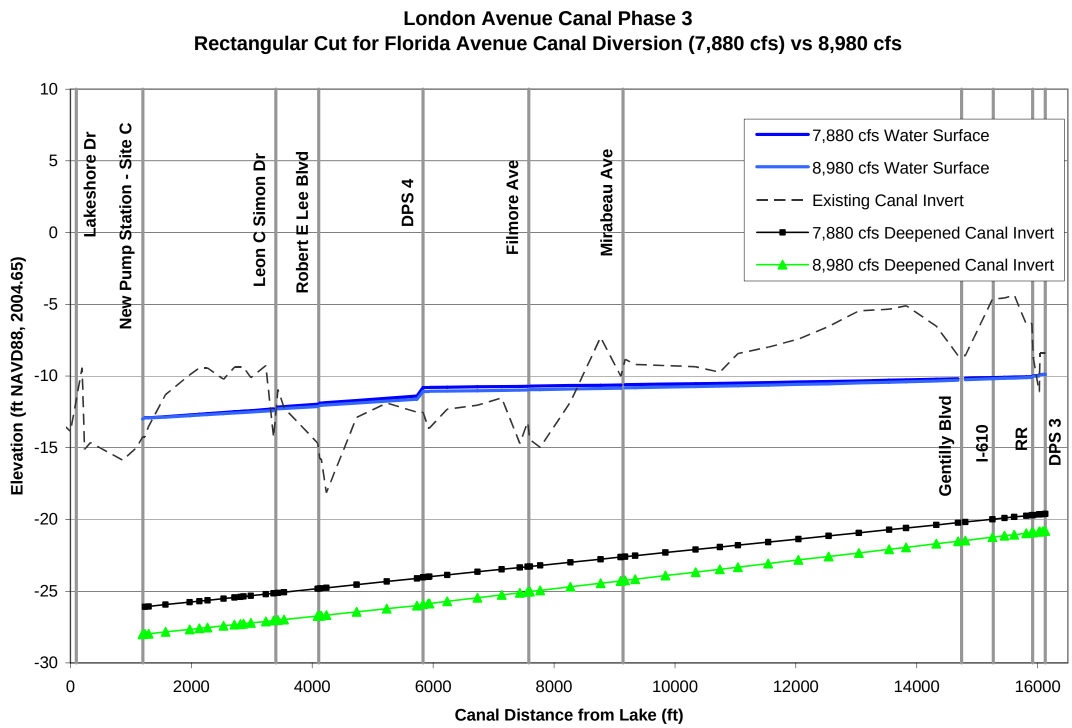

FIGURE 3-16 - London Avenue Canal Rectangular Cross-Section Water Surface Profiles, Full Flow and Florida Avenue Canal Diversion

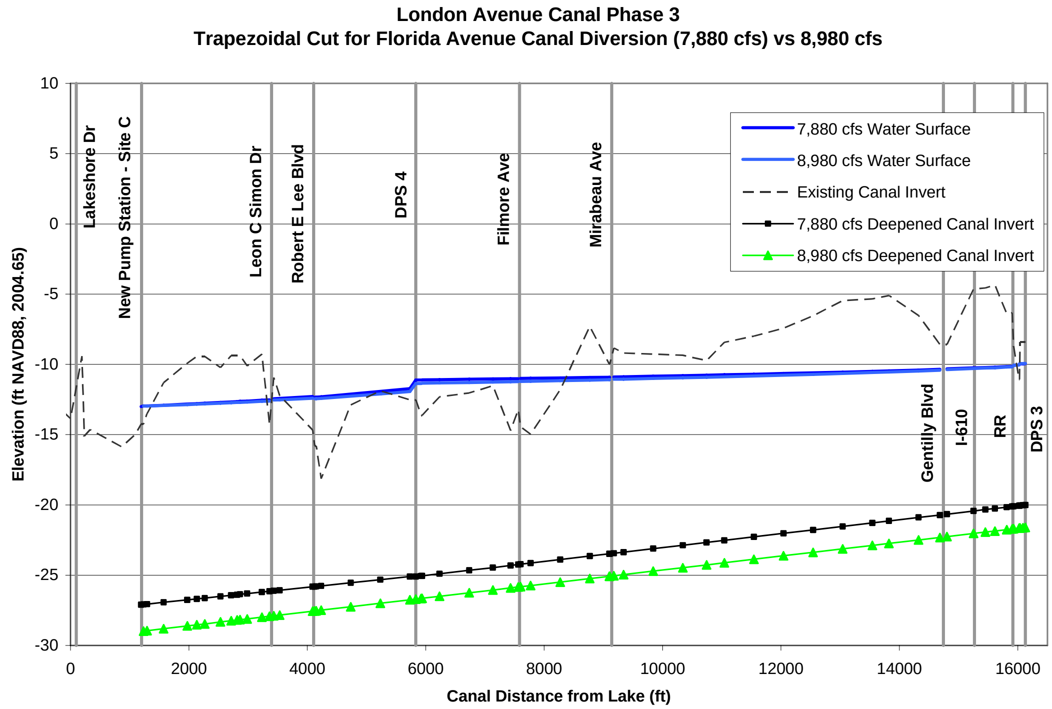

FIGURE 3-17 - London Avenue Canal Trapezoidal Cross-Section Water Surface Profiles, Full Flow and Florida Avenue Canal Diversion

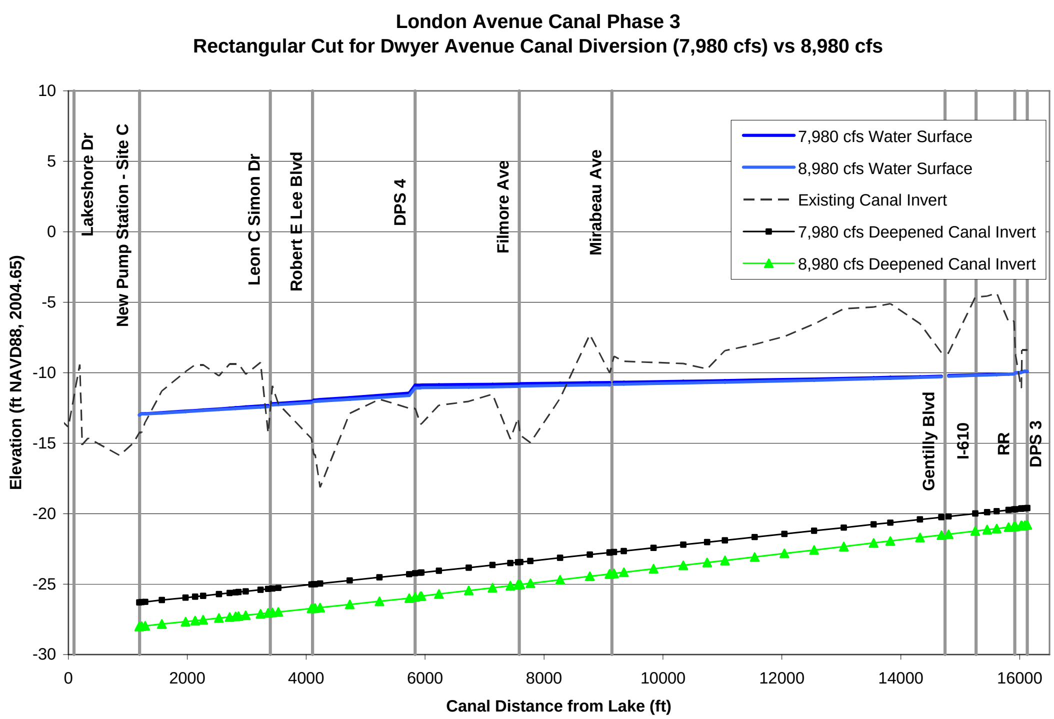

FIGURE 3-18 - London Avenue Canal Rectangular Cross-Section Water Surface Profiles, Full Flow and Dwyer Avenue Canal Diversion

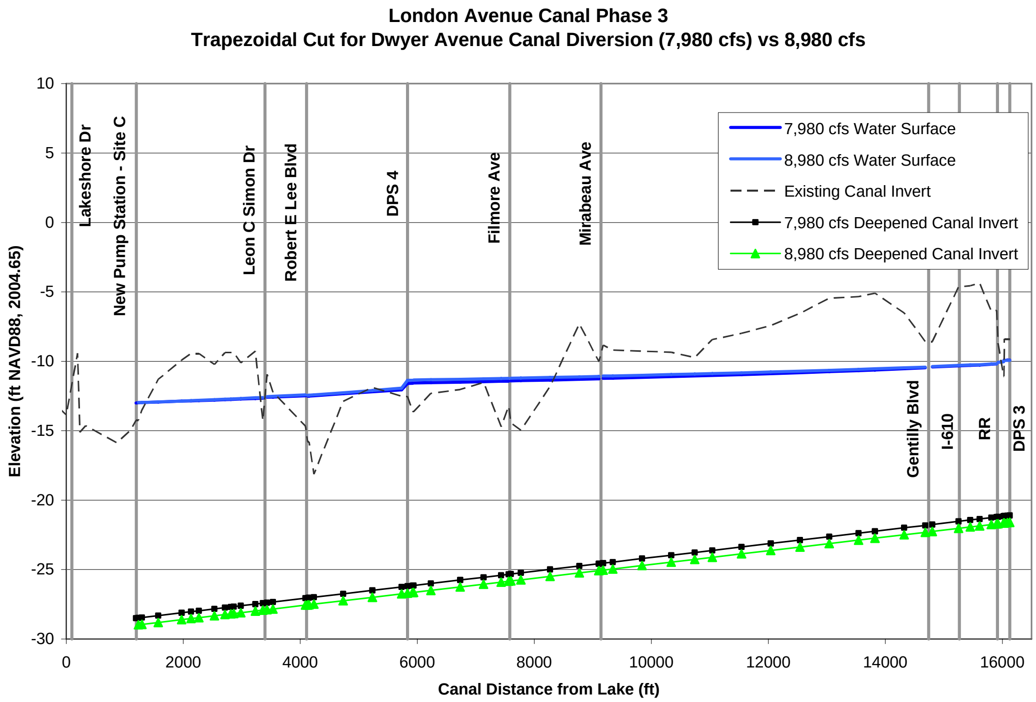

FIGURE 3-19 - London Avenue Canal Trapezoidal Cross-Section Water Surface Profiles, Full Flow and Dwyer Avenue Canal Diversion

3.3.7 Canal Deepening Alternatives

Canal deepening has to occur while the existing operation of the DPS and ICS pump and gate remains in service for most of the construction period. Therefore, the present operating water levels in the canals and floodwalls are used until the new pump stations are in service. The analysis of the canal deepening alternatives required evaluation of constructability, geotechnical stability, and canal hydraulics. Alternatives have been developed which allowed the canal deepening construction to be accomplished without taking the canals out of service during the construction or restricting flow in the canals.

The widths of the canals are relatively narrow.

17th Street	212 ft
Orleans	142 ft
London	varies, average 122 ft

In order to provide sufficient cross sectional area for the drainage, vertical walls or slopes of 1H:1V are required. Due to the soft sediments on the canal banks, stabilization of the canal banks will be required. Three canal deepening alternatives were developed and are described in Sections 3.3.7.1 through 3.3.7.3.

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3.3.7.1 Vertical Walls and Pile Supported Concrete Slab Alternative

This alternative uses a rectangular channel section as provided on Figure 3-20.

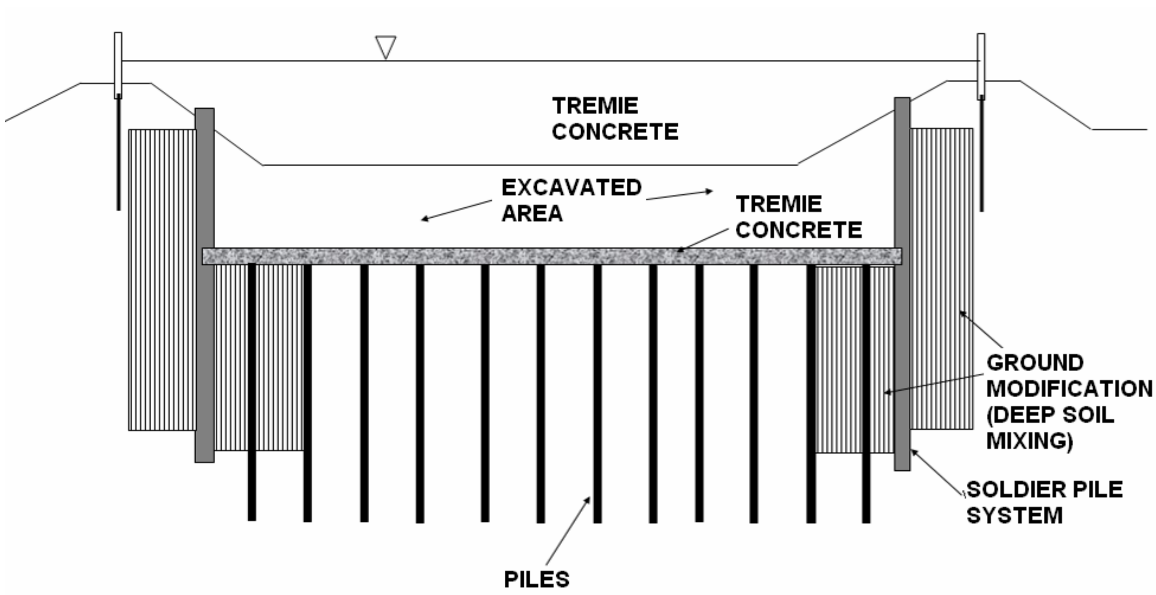


FIGURE 3-20 - Vertical Walls and Pile Supported Concrete Slab

The cross-sections required are as follows:

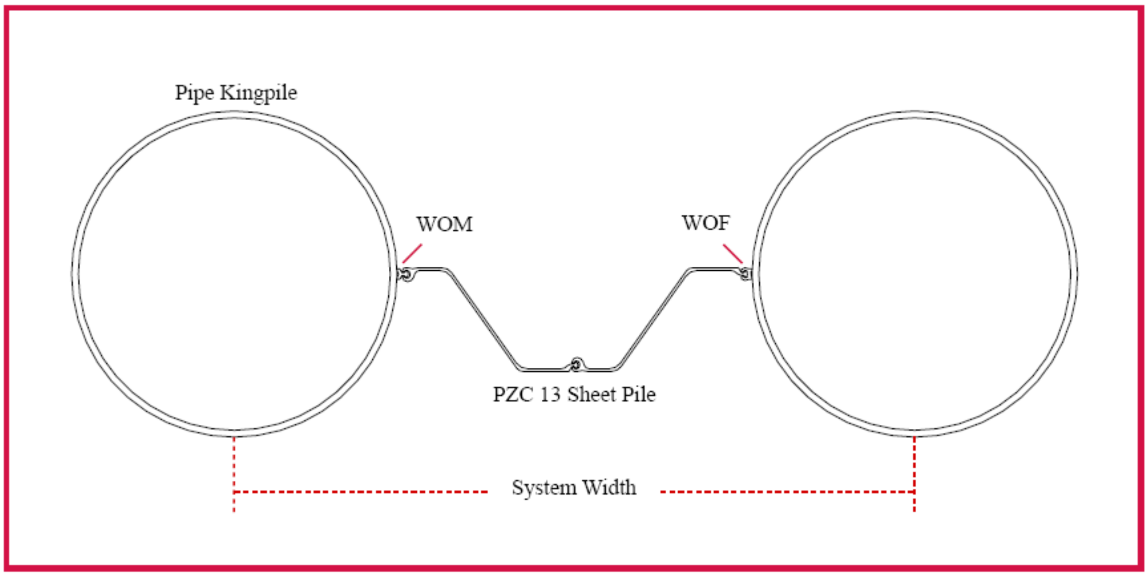
17th Street Canal	Average depth elevation -27.5 ft NAVD Base width 150 ft
Orleans Canal	Average depth elevation -19.5 ft NAVD Base width 100 ft
London Canal	Average depth elevation -27.4 ft NAVD The bottom width is 80 feet between DPS 3 and DPS 4 and 100 feet between DPS and the new pump station.

All work in the canal will be performed from barges. The operating water level in the canals will not be impacted during construction. Construction of the canal wall system is anticipated as follows:

- ✓ The soldier pile wall will be installed to full depth. There will be no stresses on the wall as no soil removal will be performed at this time.
- ✓ The DSM will be installed on both sides of the wall. The DSM is installed after the soldier piles to avoid disruption of the DSM columns by the construction of

the soldier pile wall. The top of the DSM performed in the interior of the canal will be terminated below the level of final canal excavation.

This alternative provides support of the existing floodwalls of the canal through a combination of a soldier pile system and DSM. The soldier piles and DSM will provide the support of the existing parallel protection floodwalls during construction, support of the final canal banks and act as the vertical seepage cut-off.   The soldier pile wall concept utilizes a king pile, a large diameter pipe pile such as the LB Foster combi-wall system, or deep H-pile ARBED system with z-sheets between the king piles. A typical king pile system is shown below.



Due to the soft sediments on the canal banks the conceptual design of the system also utilizes DSM to reduce the active loads on the vertical canal walls and increase passive pressure at the toe of the wall. The reduction in active pressure reduces the deflections of the walls after the water level in the canal is reduced. The performance of the DSM must be performed by a specialty contractor experienced with this work. Placement of the columns in close proximity to the existing flood wall should be performed in stages to avoid a failure of the supporting soils while the soil-cement column formed during this process is curing. Undermining of the existing wall must be avoided. Reduction of the stability of the existing flood walls will be minimized as the interior soils will not be excavated until the new soldier piles and DSM support system is in-place prior to canal excavation.

Calculations are provided in *Appendix D*.

- ✓ The canal will be excavated to the required depth.

After installation of the vertical wall the canal will be dredged to meet the required depth of excavation. Since the canal water level will not be lowered during construction, the water level adjacent to the canals will not be impacted. Hydraulic dredging or hydraulic pumping and disposal of dredged material to the lake are not considered practical due to potential contamination identified in the canal sediments. Dredging is anticipated to be performed using a clamshell bucket to transfer material onto a floating barge. The barge will be moved to access areas along the canal bank to transfer dredged material to trucks for final disposal in a landfill.

- ✓ The piles for the base slab will be driven.
- ✓ The tremie concrete slab will be installed.

The water elevation in the canals will be lowered when existing DPS 3, 4, 6, and 7 are decommissioned and removed. To resist the uplift pressures on the base slab, piles will be driven prior to the placement of the base slab. A pile spacing of 7 feet for approximately 17 ton piles has been estimated. The base slab provides the canal seal prevents seepage, depression of the groundwater levels, and subsidence adjacent to the canal when the canal water levels are lowered. The base slab will be constructed using a tremie below water. The base slab will be a 3 foot thick un-reinforced slab. The slab will be anchored to the piles.

3.3.7.2 Deep Soil Mixed Seepage Cutoff with Vertical Walls and Concrete Slab Alternative

The canal cross-sections for this alternative are the same previously identified for the pile restrained concrete base slab. This alternative uses a deep seepage cut-off between the soldier pile walls restrained by the overlaying soil instead of the pile restrained base slab. This alternative is shown in Figure 3-21.

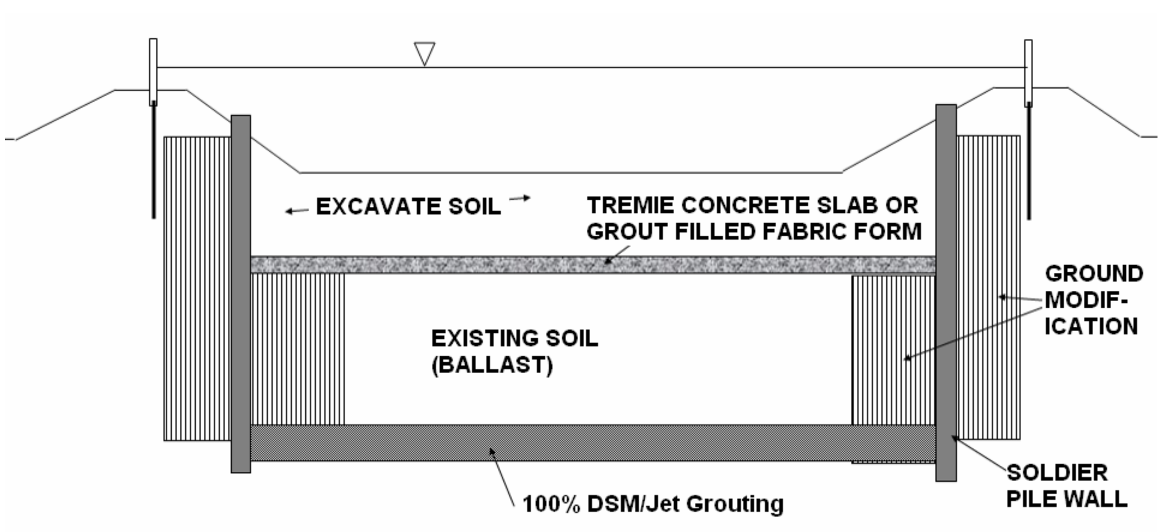


FIGURE 3-21 - Deep Soil Mixed Seepage Cutoff with Vertical Walls and Concrete Slab

All work in the canal will be performed from barges. The operating water level in the canals will not be impacted during construction. Construction of this canal wall system is anticipated as follows:

- ✓ The soldier pile wall will be installed to full depth. There will be no stresses on the wall as no soil removal will be performed at this time.
- ✓ The DSM will be installed on both side of the wall. The DSM is installed after the soldier piles to avoid disruption of the DSM columns by the driving activities. The top of the DSM performed in the interior of the canal will be terminated below the level of final canal excavation.

This alternative provides support of the existing floodwalls of the canal through a combination of soldier pile system and DSM. The DSM will provide the support of the existing parallel protection floodwalls as described in the previous alternative. The soldier piles are extended to the depth of the deep seepage cut-off. The channel bank support is constructed using soldier piles to support the vertical sides of the canal. Due to the soft sediments on the canal banks the conceptual design of the system also utilizes DSM to reduce the active loads on the vertical canal walls and increase passive pressure at the toe of the wall. The reduction in active pressure reduces the deflections of the walls after the water level in the canal is reduced. The performance of the DSM must be performed by a specialty contractor experienced with this work. Placement of the columns in close proximity to the existing flood wall should be performed in stages to avoid a failure of the supporting soils while the soil-cement column formed during this process is curing. Undermining of the existing wall must be avoided. Reduction of the stability of the existing flood walls will be minimized as the interior soils will not be excavated until the new soldier piles and DSM support system is in-place prior to canal excavation. Calculations are provided in *Appendix D*.

- ✓ The canal will be excavated to the required depth.

After installation of the vertical wall the canal will be dredged to meet the required depth of excavation. Since the canal water level will not be lowered during construction, the water level adjacent to the canals will not be impacted. Hydraulic dredging or hydraulic pumping and disposal of dredged material to the lake are not considered practical due to potential contamination identified in the canal sediments. Dredging is anticipated to be performed using a clamshell bucket to transfer material onto a floating barge. The barge will be moved to access areas along the canal bank to transfer dredged material to trucks for final disposal in a landfill.

- ✓ The base seepage cut-off will be installed.

The water elevation in the canals will reduce when existing DPS 3, 4, 6, and 7 are decommissioned and removed. To reduce seepage into the canal, the base of the deepened canal is sealed by the placement of a deep horizontal seepage barrier of jet grouting or DSM between the soldier pile walls. The barrier will be constructed in overlapping columns to perform a continuous seal across the base. The uplift pressures will be resisted by the weight of the soil above the seepage barrier.

- ✓ The base erosion control slab will be installed

A tremie concrete slab or grout-filled-fabric form will be placed at the bottom of the canal for flow control and erosion protection. This concrete slab is not subject to uplift pressures and is not a structural slab.

3.3.7.3 Deep Soil Mixed Seepage Cutoff with Armored Trapezoid Canal

This is a trapezoidal canal alternative that incorporates a perimeter deep soil mixing/jet grouting component to control seepage, ground modification to improve slope stability, and grout filled fabric form to form the canal perimeter, see Figure 3-22.

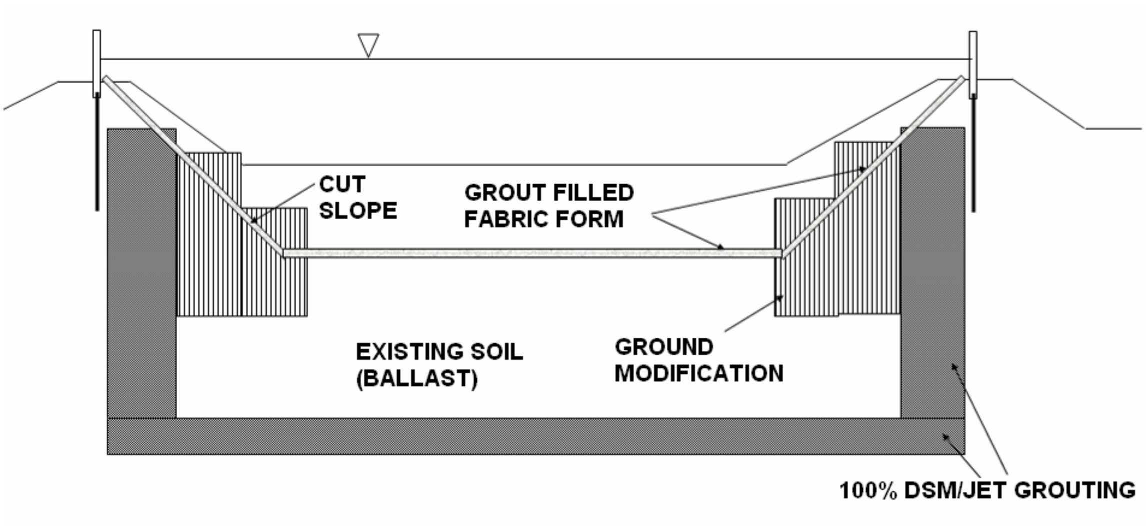


FIGURE 3-22 - Deep Soil Mixed Seepage Cutoff with Armored Trapezoid Canal

The cross-sections required are as follows:

17th Street Canal	Average depth elevation -27.2 ft NAVD Base width 150 ft Slopes 1H:1V
Orleans Canal	Average depth elevation -19.5 ft NAVD Base width 100 ft Slopes 1H:1V
London Canal	Average depth elevation -28.5 ft NAVD The bottom width is 80 feet between DPS 3 and DPS 4 and 100 feet between DPS and the new pump station. Slopes 1H:1V

Construction of the canal wall system is anticipated as follows:

- ✓ The DSM that will provide the slope stabilization for the steepened canal will be installed on both sides of the canal.

This alternative eliminates the vertical soldier pile wall by providing support of the interior banks and existing floodwalls of the canal through ground modification. Due to canal width limitations, steep slopes on the order of 1H:1V are required to remain within the limits of the existing canal flood walls. The DSM is required to increase the strength of the existing soil to provide the required stability of the steepened slopes. The DSM will also provide the support of the existing parallel protection floodwalls during excavation of the canal. The DSM within the interior of the canal will be extended to a depth sufficient to maintain the required FOS as specified in the HSDRSDG.

The performance of the DSM must be performed by a specialty contractor experienced with this work. Placement of the columns in close proximity to the existing flood wall should be performed in stages to avoid a failure of the supporting soils while the soil-cement column formed during this process is curing. Undermining of the existing wall must be avoided. Reduction of the stability of the existing flood walls will be minimized as the interior soils will not be excavated until the DSM support system is in-place prior to canal excavation. The stabilization of the soil will be performed from barges within the canals. Calculations are provided in *Appendix D.*

- ✓ Install bank seepage barriers

To reduce seepage into the canal, the sides of the deepened canal will be sealed by the placement of vertical seepage barriers using jet grouting or DSM. The vertical seepage barrier will extend to the depth of horizontal seepage barrier to provide a seal between the two barriers. Reduction of the stability of the existing flood walls will be minimized as the interior soils will not be excavated until the DSM support system is in-place prior to canal excavation.

- ✓ The canal will be excavated to the required depth.

After installation of the vertical wall the canal will be dredged to meet the required depth of excavation. Since the canal water level will not be lowered during construction, the water level adjacent to the canals will not be impacted. Hydraulic dredging or hydraulic pumping and disposal of dredged material to the lake are not considered practical due to potential contamination identified in the canal sediments. Dredging is anticipated to be performed using a clamshell bucket to transfer material onto a floating barge. The barge will be moved to access areas along the canal bank to transfer dredged material to trucks for final disposal in a landfill.

- ✓ The base seepage cut-off will be installed.

To reduce seepage into the canal, the base of the deepened canal is sealed by the placement of a deep horizontal seepage barrier of jet grouting or DSM between the vertical bank seepage cut-off walls. The barrier will be constructed in overlapping columns to perform a continuous seal across the base. The uplift pressures will be resisted by the weight of the soil above the seepage barrier.

- ✓ The base erosion control slab will be installed

To provide a smooth channel and erosion protection for the slopes of the canal a 6 to 8 inch thick grout filled fabric form liner will be placed across the slopes and base of the canal. A tremie concrete slab was not considered as placement of a tremie concrete slab was not considered practical on the steep excavated bank slopes.

The least evaluated cost of several methods reviewed was the trapezoidal canal section and was included in the estimate.

3.3.8 Site Access During Construction

The deepening of the canal construction activity will occur entirely within the existing canal flood walls. The construction is anticipated to be performed primarily from barges. Temporary construction easements will be necessary to provide locations for staging the access of barges, equipment, and material between bridges crossing the canals as access below the bridges for equipment and barges is not considered practical. In addition, these access points will provide staging for transfer of dredge material from the canal to trucks for haul to disposal sites. The canal deepening requires no demolition of structures. Earthwork at this site is almost exclusively excavation, resulting in a significant volume of earth materials to be removed from the project site.

The 17th Street Canal is crossed by four bridges. These bridges cross the canal between DPS 6 and the outfall into Lake Pontchartrain (three roadway bridges and one railroad bridge). These bridges and their locations are identified as follows.

- ✓ **Southern Railroad Bridge –** The Southern R. R. Bridge over the 17th Street Outfall Canal is located approximately 200 feet downstream of DPS 6.

- ✓ **Interstate 10 (I-10) Bridges -** The two I-10 Bridges (eastbound and westbound) over the 17th Street Canal are located approximately 0.5 miles downstream of DPS 6.

- ✓ **Veterans Boulevard Bridges –** The two Veterans Boulevard Bridges (eastbound and westbound) over the 17th Street Outfall Canal are located approximately 0.8 miles downstream of DPS 6.

- ✓ **Hammond Highway Bridge –** The Hammond Highway Bridge over the 17th Street Canal is located 2.0 miles downstream of DPS 6.

Construction access points are located between the Veterans Boulevard Bridges, the Veterans Boulevard, the Hammond Highway Bridge, and at the DPS 6 south of the railroad bridge. The area adjacent to the canal consists of residential and commercial development. This will require temporary access agreements on existing commercial development parking areas or temporary access from the bridges during construction. Temporary access from the bridges will require closure of one lane.

The Orleans Avenue Canal is crossed by one bridge directly upstream of DPS 7 and five bridges between the DPS 7 and the outfall into Lake Pontchartrain. These bridges and their locations are identified as follows:

- ✓ **Southern Railroad Bridge –**The Southern Railroad Bridge over Orleans Avenue Canal is located approximately 120 feet upstream of DPS 7.
- ✓ **Interstate 610 (I-610) Bridge –** The I-610 Bridge over Orleans Avenue Canal approximately 200 feet downstream of DPS 7.
- ✓ **Harrison Avenue Bridge –** The Harrison Avenue Bridge over the Orleans Avenue Canal is located approximately 0.7 miles downstream of DPS 7.
- ✓ **Filmore Avenue Bridge –** The Filmore Avenue Bridge over the Orleans Avenue Canal is located approximately 1.2 miles downstream of DPS 7.
- ✓ **Robert E. Lee Boulevard Bridge –** The Robert E. Lee Boulevard Bridge over the Orleans Avenue Canal is located approximately 1.7 miles downstream of DPS 7.
- ✓ **Lakeshore Drive Bridge –** The Lakeshore Drive Bridge over the Orleans Avenue Canal is located approximately 2.4 miles downstream of DPS 7.

The area adjacent to a large portion of the canal is City Park. It is anticipated that construction access to the canal from the City Park will be obtained.

The London Avenue Canal is crossed by eight bridges between the DPS 3 and the outfall into Lake Pontchartrain. These bridges and their locations are identified as follows:

- ✓ **Southern Railroad Bridge –**The Southern Railroad Bridge over London Avenue Canal is located just down stream of DPS 3.
- ✓ **Interstate 610 (I-610) Bridges –** The two I-610 Bridges (eastbound and westbound) over London Avenue Canal approximately 0.2 miles downstream of DPS 3.
- ✓ **Gentilly Boulevard Bridge –** The Gentilly Boulevard Bridge over the London Avenue Canal is located approximately 0.2 miles downstream of DPS 3.

- ✓ **Mirabeau Avenue Bridge –** The Mirabeau Avenue Bridge over the London Avenue Canal is located approximately 1.2 miles downstream of DPS 3.

- ✓ **Filmore Avenue Bridge –** The Filmore Avenue Bridge over the London Avenue Canal is located approximately 1.4 miles downstream of DPS 3.

- ✓ **Robert E. Lee Boulevard Bridge –** The Robert E. Lee Boulevard Bridge over the London Avenue Canal is located approximately 2.0 miles downstream of DPS 3.

- ✓ **Leon C. Simon Boulevard Bridge –** The Leon C. Simon Boulevard Bridge over the London Avenue Canal is located approximately 2.1 miles downstream of DPS. 3.

- ✓ **Lakeshore Drive Bridge –** The Lakeshore Drive Bridge over the London Avenue Canal is located approximately 2.6 miles downstream of DPS 3.

Construction access points are located between the bridges north of the I-610 bridges and at the DPS 3 station south of the railroad bridge to facilitate deepening of the canal. The area adjacent to the canal consists of residential, University of New Orleans and commercial development. This will require temporary access agreements on existing commercial development parking areas or from the University areas or temporary access from the bridges during construction. Temporary access from the bridges will require closure of one lane of the bridges.

3.3.9 Bridge Modifications

The deepening of the canals will result in some excavation near or adjacent to bridges. To ensure the continued stability of these structures, these structures will be modified in a conservative manner, or in a few cases replaced. The following structures will be required to be modified or replaced:

- ✓ 17th Street Canal - Hammond Highway, Veterans Boulevard, I-10, and replacement of the Southern Railroad bridges.

- ✓ Orleans Avenue Canal - Lakeshore Drive, Robert E. Lee, Filmore Avenue, and Harrison Avenue bridges.

- ✓ London Avenue Canal - Leon C. Simon Boulevard, Filmore Avenue, Mirabeau Avenue, Gentilly Boulevard, and the replacement of Robert E. Lee Boulevard and Southern Railroad bridges.

3.3.10 Utilities

There are existing utilities that pass over and under the existing canal and run-along the existing bridges that span the canals. The majority of the impacted utilities are above ground secondary electric lines and small diameter utility service lines that service existing residences and/or light commercial businesses within the required right of way. These utilities will need to be terminated at the edge of the required right of way, removed and re-routed.

There are some larger storm water lines that pass over and under the canals. There is a large (10' diameter) storm water siphon that passes under the 17th Street Canal. This siphon will be undermined by the deepening of the 17th Street Canal. The siphon will be modified to allow drainage of storm water directly into the canal. Similar modifications will be made to above ground storm water pipes that pass over the canals. These systems will be removed back to the edge of the new deepened canal and modified to allow drainage directly into the canal.

3.4 Pump Station and Pumping Systems

The width of the pump station superstructure and associated substructure is a function of the maximum discharge capacity, type of pump, and pump driver that is selected. During the plan formulation process, pump station capacity, the configuration of the pump systems, and the pump drivers were evaluated. Calculations and details of the mechanical and electrical systems are included in *Appendix E*.

The maximum discharge capacity of the pump station is directly related to the maximum discharge capacity of the existing DPS system and the capacity of the outfall canals. Table 3-1 documents the maximum discharge capacities of the existing DPS system, the ICS facilities, and the maximum DPS discharges associated with specific storm events. These capacities are shown without potential diversions of storm water described in Section 3.2.3. The Option 1, 2, and 2a pump station discharge pump design capacities are based on the existing DPS discharge capacities.

TABLE 3-1 - Discharge Capacities

Discharge Scenario	**Discharge Capacity Per Canal (cfs)**		
	17th Street	**Orleans Avenue**	**London Avenue**
SWBNO Reported Future	12,500	3,390	8,980
Existing DPS	**10,500**	**2,690**	**7,980**
ICS	9,200	2,200	5,200
100 Year Storm Event (tentative)	9,385	2,100	5,900
10 Year Storm Event (tentative)	7,900	1,900	3,800

The difference in head from the protected side to the discharge side (Lake Pontchartrain) has a direct impact on the type of pump, driver and pump capacity that is selected. Table

3-2 provides a summary of the static head the pumps are required to pump against. These elevations are based on a design canal elevation of 0.0 feet for Option 1 and -14.0 feet for Option 2. The maximum static lake elevation is 10.2 feet. The design static head (pool to pool difference) is flow independent and represents the pool to pool difference during a hurricane.

TABLE 3-2 - Pump Static Head

	Option 1	Option 2	Option 2a
Design static head: Design canal wse to max lake wse	10.2 feet	24.2 feet	24.2 feet

The static head associated with the Option 1 pump station allows more flexibility in selection of the type of pumps and drivers. The Option 2 pump station static head is approaching a height that limits the type of pump and driver that can efficiently discharge the water.

3.4.1 Adaptable Pump Station Impacts on Pumps

Pumping systems were evaluated to determine if the pumps placed in an adaptable Option 1 pump station could be designed to accommodate the change in head associated with conversion of the pump station into an Option 2 pump station. As is illustrated above, the capacity of the pumps will be the same regardless of which option pump station is considered; however, the operating head which is based in part on the design static head will be different. Because the capacities of the options are the same certain aspects of the pumps will be similar. Due to the difference in operating head, some aspects of the pump systems will vary between the Option 1 and Option 2 pump station. Finally, other aspects could be made to be similar at an additional cost.

The basic dimensions of the inlet, pump, and outlet structure volute and outlet of the pump station are based on capacity. The pump capacity is the same for both options, thus the pump and station dimensions will be similar between an Option 1 and an Option 2 pump station.

The size, type, pitch, and speed of the propeller, and the size of the pump driver are based on operating head which varies between an Option 1 and Option 2 pump station. When the pump station is converted from an Option 1 to an Option 2 pump station, the pump propellers and the bowl assembly section of the pump will change in size and thus be replaced. The size of the pump driver has a significant impact on the pump cost. The impact of the driver size change varies between Diesel engine driven pumps and electric motor driven pumps.

Diesel engines cannot be simply oversized to accommodate both Options. Caterpillar, a manufacturer of diesel engines, recommended the use of electric driven pumps or engine replacement upon conversion between options. Large engines designed for efficient operation for Option 2 cannot be installed initially since the typical operation during Option 1 will load the engine at 15 to 20 percent, this would be close to the idling speed for the large engines. Engines consistently operated at or near idling speed have excessive wear leading to more maintenance. If smaller drivers are selected initially, during the conversion from Option 1 to Option 2 it should be investigated if some of the Option 1 diesel drivers for larger pumps might be used to drive smaller pumps in the Option 2 pump station.

Large electric motors are more tolerant of the light loading. Thus oversized electric motors could be installed and operated at a reduced load. The efficiency of the electric motor decreases when lightly loaded and as the motor size increases, the motor starting current required will increase. These factors will increase the required onsite electric generator capacity, but the impact on the number of generators is considered minor. If oversized electric motors are provided on the pumps, the engine generators that provide power to the motors will need to be replaced or additional engine generators would need to be installed when the pump station is converted from an Option 1 to an Option 2 pump station.

The basis for determining if a larger motor should be installed now or later should depend on the timing of the future conversion of the pump stations. The motor insulation will deteriorate with time. If the conversion between an Option 1 and an Option 2 pump station is more than 20 years, the average life span of motor insulation, then installation of an appropriately sized electric motor for the Option 1 pump station is the recommended alternative. The motors would then be replaced when the pump station is converted from an Option 1 to an Option 2 pump station. If the smaller motors are initially elected and the conversion occurs before the end of the useful life of the motor, use of two motors in series is an alternative that might be pursued when the pump station is converted. The second motor could be added and the gear box changed out at the time of conversion.

Other aspects of the pumps that could be made similar for the Option 1 and Option 2 pumps at an additional cost are the size of pump shaft and bearings and the gear box. Both the pump shaft and bearings can be oversized to function for both Option1 and Option 2 pumps. In a similar manner, the gear box could be reused for both options provided that the pump speed is the same. If the pump speed varies between Option 1 and Option 2, the gear drive will need to be modified or replaced to accommodate the change in pump speed.

3.4.2 Formed Suction Intake and Submersible Intake

A FSI design was developed by the USACE Engineer Research and Development Center (ERDC) in Vicksburg. A FSI is designed to minimize the required submergence on the pump as well as reduce the intake depth required when compared to open rectangular wet well intakes. A FSI is a cost effective approach to designing pump station intakes because it effectively reduces the size of the pump station substructure by minimizing the depth of the intake sill. A FSI is designed to eliminate unsteady flow or flow separations at the pump intake. A FSI requires forming and shaping during concrete placement and is usually lined with steel due to the FSI's complex geometry and to prevent cavitation damage to the concrete surfaces.

A wet well type intake is another approach to an intake design.   If there is sufficient water elevation at the intake to provide sufficient submergence in combination with the flow rate then a submersible or wet well type intake for the pumps is a viable intake design approach. A submersible or wet well type intake would normally increase the overall cost of the pump station because it requires additional submergence of the pump which makes the pump station substructure deeper.

A FSI is required for Option 1 Non-Adaptable, Option 2, and Option 2a to improve laminar inflow into the pumps and to reduce the required submergence and pump station foundation depth. The Base Adaptable Option 1 pump station does not require a FSI because the foundation of the pump station is deepened to reflect the depth of an Option 2 pump station. The deeper foundation in combination with the Option 1 canal water elevations allows the pump intake to be adequately submerged in the water to eliminate the need for a FSI. A FSI would be required to be constructed in the wet well area of the Base Adaptable Option 1 pump station if the pump station is converted into an Option 2 pump station. The Robust Adaptable Option 1 Pump Station included a FSI as part of the adaptability of the pump station. The construction of the FSI during construction sequence 1 of the four phased construction approach reduces the future cost of converting the pump station to an Option 2 Pump Station and thus is included in the Robust Adaptable Option 1 Pump Station. Refer to Section 4.0 for additional information about adaptable features included in each pump station.

3.4.3 Energy Recovery Using Discharge Siphon

The conceptual layout and design of the pumps included energy recovery utilizing a discharge siphon to reduce the energy requirements of the pumping system. Figure 3-24 shows the cross section of a conceptual pump station arrangement with siphon recovery.

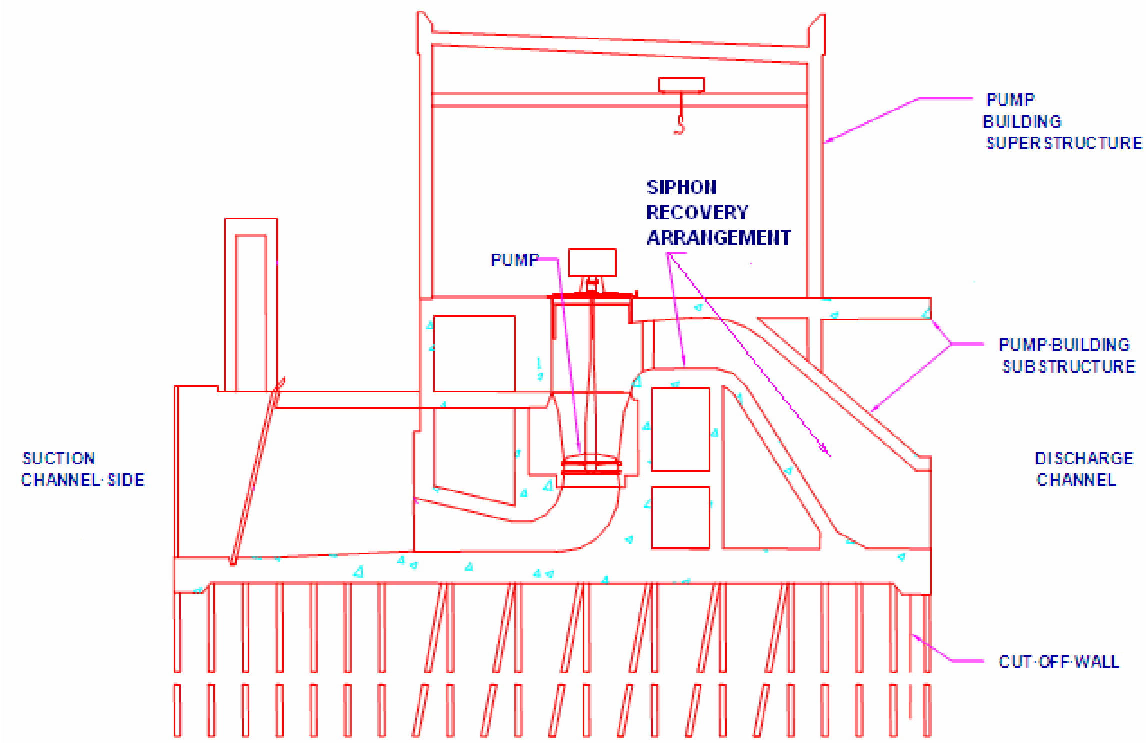


FIGURE 3-24 - Conceptual Pump Station Layout with Siphon Recovery

The siphon discharge sill of the pumps is set at elevation +18 which matches or exceeds the crest of the existing levee system. A siphon sill elevation of +18 is used in Option 1, Option 2, and Option 2a pump stations. This sill elevation along with valves and vacuum breakers is a positive means of preventing backflow into the canals through the pump station during a storm event. When the pumps are started, the discharge tunnel or pipe is full of air and the pumps must lift or discharge the water to an elevation that exceeds the siphon discharge sill elevation. This elevation exceeds the combination of wave run up and the storm surge static water elevation in Lake Pontchartrain. This elevation and the fact that wave attenuation is included in each pump station results in a consistent pump motor horse power for priming.

Discharging water to this higher elevation reduces the pump capacity to a rate approximately 60 to 70 percent of the design flow rate for a short period of time. As the water crests the siphon, the water velocity in the siphon clears out the air in the siphon and establishes the siphon increases the pump capacity to full capacity. Once the siphon is developed, the pumping head reduces to just the static head between the canal level and the pump station tailwater plus internal losses of the pumping station inlet and outlet structure and the full pump capacity can be utilized.

During priming the pump discharges to an elevation at approximately the centerline of the discharge pipe which can be 10 to 20 feet higher than the maximum working head. Refer to the page Titled “New Orleans Major Canal Permanent Pumping Stations (1 of 2)” in Appendix E for specific examples. Pump drivers need to be designed to this priming head. In the case of electric motors, the motors must be sized so that priming does not enter into the service factor of the motor, which will reduce motor life by overheating the insulation. In contrast, engines have a short term intermittent rating, which is higher than the continuous rating that can be utilized during priming. The use of this intermittent rating for priming can be considered during engine selection.

Based on the 1000 cfs pumps proposed for Option 1 Robust Adaptable shown in *Appendix E*, the driver requirements for priming the siphon discharge are approximately 1600 hp for both the engines and motors. Normal operating loads at the design condition is 1300 hp at a lake level of 10.5 feet. At a lake level of 1 foot, the siphon reduces the pumping head by 9.5 feet. In theory, the energy recovered by the siphon allows for a reduction of approximately 1000 hp from the priming operating conditions. However, it is likely that the addition of some artificial head loss would be required to prevent cavitation in the pump intake due to the pump "running off" the pump's curve when the net static head approaches zero. The amount of energy that can be recovered by a siphon will be determined by the type and specific curve of the pump selected.

3.4.4 Wave Attenuation (Wave Surge Impact on Pumps)

A disadvantage of the siphon is that it subjects the pumping units to wave action from the lake. During the design hurricane event, the storm surge static water elevation in Lake Pontchartrain is assumed to be 10.2 feet. The design wave height for this event is 8.2 feet with a wave run up of 9 feet at vertical walls. The waves will have a period of approximately 6 seconds. The proposed location of the permanent protection system on the 17th Street and Orleans Avenue Canals are exposed to the design hurricane event storm surge and waves from Lake Pontchartrain. The London Avenue permanent pump station is expected to be located a sufficient distance upstream of Lake Pontchartrain to be subjected to reduced storm surge and wave heights per *Effects of Wave Action on a Hurricane Protection Structure for London Avenue Outfall Canal, Lake Pontchartrain, New Orleans, Louisiana, Hydraulic Model Investigation, dated 1987,* performed by the U.S. Army Corps of Engineers. Refer to *Appendix B* for additional design criteria information.

The pump analysis and design is sensitive to tailwater elevation fluctuations. The rapid fluctuation of the tailwater during a hurricane event may have a significant impact on the pump torque and resulting in oscillating current on the motor and mechanical stresses in the pump and driver. These fluctuations are a direct result of the wave regime that develops during a hurricane event. The concern with wave action on the siphon is that there is a short hydraulic connection between the pump and the lake. If the lake has a wave of 9 feet striking the face of the pump station, then the pumping unit will be exposed to the pulsations equivalent to the 9 feet. For a pumping unit rated at 12 feet, this is a significant increase possibly doubling the operating head acting on the pumping unit which could result in permanent damage to the pumping units or decrease the pump service life. Several pump manufacturers were contacted regarding this issue. Generally, pump manufacturers indicate that additional testing must be performed to determine the impact that waves will have on the pumping unit.

To prevent damage to the pumps, methods of wave attenuation (reduction of the effective wave height) at the pump station discharge were investigated. Two specific methods were developed. These include construction of wave attenuation structures (breakwaters) downstream of the pump stations or construction of a stilling basin/weir at the pump discharge.

A breakwater is similar to a small manmade island on the lake side of the pump stations on which the large waves will break prior to impacting the pump station. The result is the break water absorbs the energy of the large waves, and smaller attenuated waves impact the pump station discharge. These smaller waves have a marginal effect on the pumps. Figure 3-25 shows a conceptual breakwater configuration which would be required to reduce the resulting wave heights to 1 to 2 foot maximum at the pump station discharge.

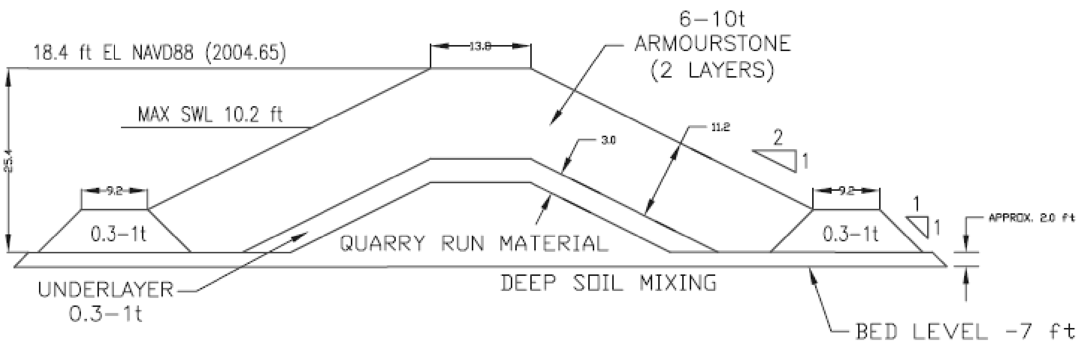


FIGURE 3-25 - Typical Breakwater Configuration that Reduces Resulting Wave Heights to 1 -2 Feet Maximum.

A stilling basin raises the tailwater elevation at the discharge of the pump station by constructing a weir wall on the discharge of the pump station. The weir wall absorbs the energy of the large waves and allows the pumps to be subjected to only the top two feed of the wave impulse. This wave impulse will have only a marginal effect on the pumps.

The rise in tailwater elevation induced by the stilling basin reduces the siphon recovery and increases the effective head on the pumps. This approach to wave attenuation increases the size of the drivers for the pumps and all ancillary equipment associated with the drivers. An advantage of this increase in discharge height is the pumps can be operated at full capacity without a storm surge. A disadvantage of this approach is the stilling basin may accumulate solids and require periodic cleaning. Figure 3-26 shows a conceptual stilling basin/weir configuration at the discharge side of the pump station.

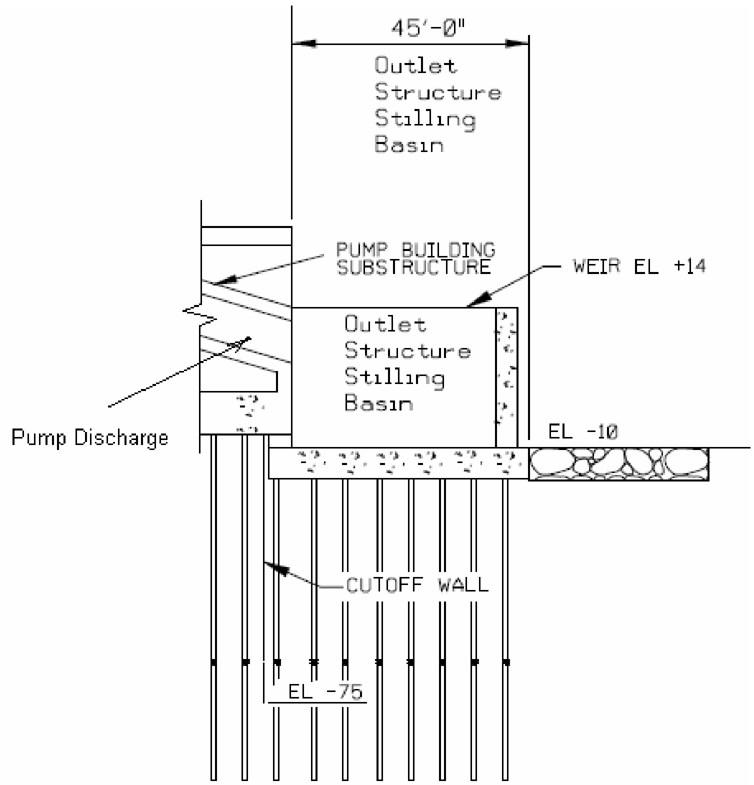


FIGURE 3-26 - Stilling Basin/Weir Configuration

The Option 1 variations included both types of discharge arrangements. Non-Adaptable Option 1 and Robust Adaptable Option 1 included a breakwater, while the Base Adaptable Option 1 includes the stilling basins/weir configuration. The Option 2, Option 2 Modified, Option 2a, and Option 2a Modified pump stations include both types of discharge arrangements, as well.

3.4.5 Other Issues Impacting Pump System Selection

The positioning of the pumps and type of drivers significantly impacts pump station superstructure and substructure size. A horizontal pumping system will require more horizontal building structure as compared to a vertical pump system but may result in a shorter building. A horizontal pump arrangement is shown in Figure 3-27.

Additionally, a diesel engine driven pump with auxiliary equipment will require more horizontal building structure than an electric motor driven pump. The *Conceptual Design Report for Permanent Flood Gates and Pump Stations, dated 2006*, performed by GEC indicates a bay spacing of 36 feet for 1000 cfs diesel engine driven pumps, 26 feet for 1000 cfs electric motor driven pumps, 16 feet for 500 cfs electric pumps, and 10 feet for 250 cfs electric motor driven pumps.

Vertical pumps are commonly utilized in flood control projects in the New Orleans region. This pump type requires less horizontal building structure and is generally self priming. For these reasons, a vertical pump system was selected as a basis of design for Option 1, 2, and 2a pump stations, see Figures 4-3, 4-4, 4-5, and 4-6. A mixture of diesel and electric pump drivers were selected for the Non-Adaptable Option 1, Robust Adaptable Option 1, Option 2, and Option 2a pump stations. The actual type of pump and combination of electric versus diesel driven pumps that can be installed as part of the Permanent Pump Station project will be impacted by economics, system capabilities, and environmental considerations. Since the pump stations for Option 2 and 2a would operate in both hurricane and non-hurricane storm events, noise impacts to neighboring residential areas would need to be considered.

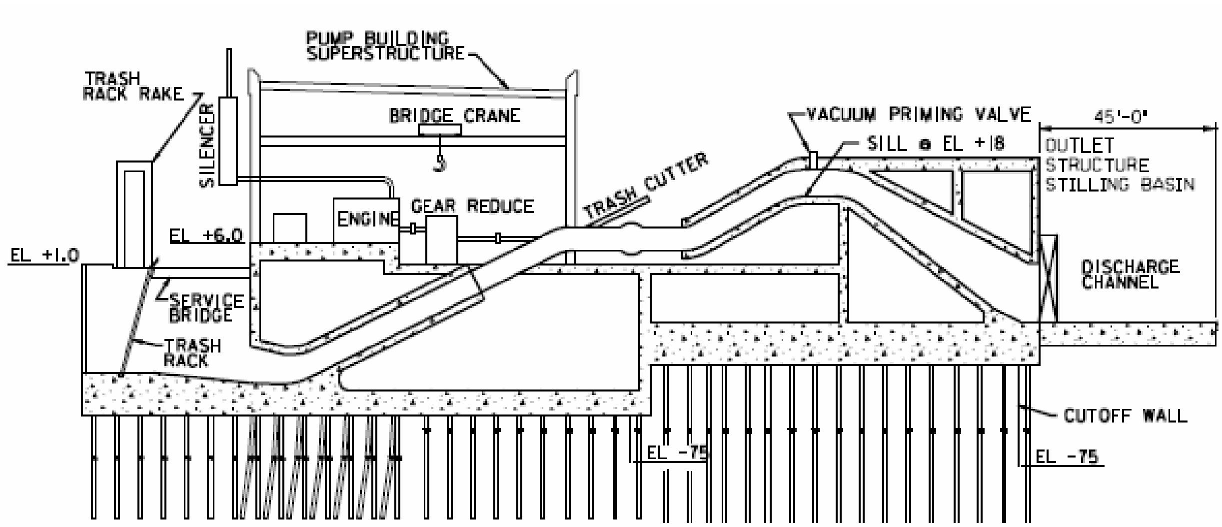


FIGURE 3-27 – Horizontal Pump System Layout

Some of the economic and system capabilities that will impact the final selection of pumping systems include:

- ✓ Costs of commodities (copper, steel, and iron) have significantly increased since 2006. This combined with high energy costs affect the overall cost of the motors and castings.

- ✓ The pump industry may be very busy with this and other major projects nationwide and, therefore, the pump costs of certain types of pumps may be higher than others.

- ✓ The process of converting from an Option 1 to an Option 2 pump station may require that the initial pumps be designed for the future “change out” to accommodate the future higher head or the initial pumps could be designed for the initial lower head condition at the lowest initial cost with full replacement when converting to the higher head Option 2 pump station.

- ✓ Engine costs have increased due to new emission requirements that will be in place in 2010. The new emission requirements are outlined in Title 40, Chapter I, Part 60 of the Code of Federal Regulations. These regulations established four categories of allowable emissions – Tier levels 1 through 4. Each increasing Tier level is more stringent and permits lesser amounts of nitrogen oxides (NOx), particulate matter (PM), carbon monoxide (CO), and hydrocarbons (HC). Tier levels are based on the horsepower rating of the engine. Engines smaller than 3,000 hp will have to comply with Tier 4 emission standards, while engines equal to or larger than 3,000 hp are exempt from emission standards beyond Tier 1.

- ✓ Ancillary pump station features that are directly tied to the type of pump driver selected include area for a fuel farm, and area to house electric driven generators. Diesel driven pumps require more superstructure to house the drivers, while the electric driven pumps require dedicated electrical generators that are on site. The generators can be protected by a building or individual enclosures.

3.5 Other Geotechnical and Civil Engineering Issues

Several site specific geotechnical and civil engineering issues were considered. The existing storm water drainage system is a dynamic system that must remain operable at all times to prevent flooding of interior areas. This system relies on the availability of the outfall system to transfer water directly to Lake Pontchartrain. Additionally, this system relies on the existing ICS as an emergency closure to prevent uncontrolled flooding of interior areas if the parallel protection system fails. The existing DPS, outfall canals, and ICS must remain operable during construction of the new permanent pump stations.

This requires the scheduling and coordination of several construction issues such as location and size of the temporary canal bypass during construction, existing soil conditions, appropriate excavation methods, and settlement and stability of existing and new systems.

The following assumptions were made:

- ✓ The new pump stations will be constructed using in the dry construction techniques. Based on this assumption, temporary cofferdams are required to allow for dewatering of the construction sites.
- ✓ The temporary canal bypasses are sized to pass the ICS discharge capacity (see Figures 3-1 to 3-3 for a plan of the construction site)
- ✓ The new permanent pump stations are located to allow for operation of the ICS facilities throughout construction.
- ✓ Soil conditions are typical to the New Orleans area. There are marsh materials, sands, and clays of various strengths. As a result, temporary construction features such as cofferdams are anticipated with sheet pile tip elevations of -60 feet or lower. DSM is also anticipated to improve stability of temporary structures and excavations. Pump stations are pile supported.

Several geotechnical stability analyses were run to demonstrate that the new permanent protection pump stations as proposed are designed adequately for the site conditions and loading conditions within the New Orleans area. The primary items that required geotechnical stability analysis include the pump station, the pump station excavation scenario, and the canal geometry associated with the canal deepening. Canal deepening and the associated stability are discussed in Section 3.3. The geotechnical analysis is documented in *Appendix D.*

3.5.1 Pump Station Construction and Stability Analysis

The new pump station on the 17th Street Canal will be located at the end of the canal or directly within Lake Pontchartrain, while the new pump stations on Orleans and London Avenue Canals will be located in portions of the existing canals. The excavations for the pump station will be relatively deep (depth of foundation ranges from -20 to -30 feet).

During construction the permanent hurricane protection features at each site must be maintained. In all locations the new pump station is located downstream of the existing ICS which will remain in operation. All existing hurricane protection features will be protected during construction.

In order to facilitate in the dry construction, a cofferdam is required to ring the excavation and allow for construction of the new pump station. A single wall sheet pile structure will not be suitable to support the deep excavations and provide a dry construction site. Gravity cellular structures, similar to those provided for the ICS will be constructed in a ring around the new pump station footprint to allow for dewatering of the site and construction of the pump stations in dry conditions. The height of the temporary cellular cofferdam is determined by performing an optimization study that evaluates risk of flooding/overtopping during construction. Generally, the height of the cofferdam cells should be evaluated against the 10 year, 25 year, and 50 year storm events. During severe storm events it is expected that the excavations would be evacuated and flooded. In areas where the new pump stations are constructed within the existing embankments the excavation can be supported by a soldier pile system. These retaining systems will be design to maintain the existing level of hurricane protection. DSM is included in the temporary construction scenario to stabilize the upper soft materials that are typical to this region.

The 17th Street Canal will require excavation of a channel through the existing west bank of the 17th Street Canal outfall levee. A temporary retaining wall will be constructed along the bypass to prevent erosion from migrating back towards the line of protection during construction. The temporary canal by-pass and temporary wall will be removed when the pump station is ready for operation and the new west levee is constructed.

The stability of the temporary excavation systems and the banks of the temporary canal bypass scenarios are similar for all pump station options. The temporary construction bypasses for the Orleans and London sites use the existing canal channels. Stability analysis for the temporary excavation systems are documented in *Appendix D.*

The stability analysis of the new permanent pump stations is based on the results as presented in *Conceptual Design Report for Permanent Flood Gates and Pump Stations*, *dated 2006*, performed by GEC. The sliding, overturning and uplift stability of the proposed pump stations were not revisited as part of this study.

3.5.2 ICS Facilities Decommissioning and Removal

As indicated, ICS facilities must remain operational during construction of the new permanent pump stations. The Government will remain responsible for operating the ICS facilities during construction of the new permanent pump stations. At the completion of the new pump station construction, the existing ICS facilities will be decommissioned and removed. The ICS facilities decommissioning and removal will occur during construction sequence 1 of the four phase construction approach that allows for conversion of an Option 1 to an Option 2 pump station.

There are several cost opportunities for the Government regarding decommissioning and removal of the existing ICS facilities. The Government may have the opportunity to allow a contractor to assume ownership over the ICS facilities at no cost to the Government. The contractor will then be allowed to salvage and sell any of the ICS components, as long as, the decommissioning and removal process does not compromise the existing protection systems. Other more standard contracting options include paying the new permanent pump station contractor to remove the stations, or issuing the decommissioning and removal contract as a separate construction project. The design/build request for proposal documents should promote re-usage of materials if possible.

3.5.3 Decommissioning and Removal of Existing Drainage Pump Stations

The decommissioning and removal of the existing DPS 3, 4, 6, and 7 are a component of the complete Option 2 pump station systems. If an adaptable Option 1 pump station is converted into an Option 2 pump station, the decommissioning and removal of the existing drainage pump stations 3, 4, 6, and 7 represents construction sequence 4 of the four phase construction approach. Figures 3-28 to 3-31 schematically show each drainage pump station and the associated by-pass.

Once the canal deepening and modification to the Option 1 pump station (construction sequence 3 of the four phased construction approach) is completed, the water level in the canal is lowered allowing for bypass of the existing SWBNO pump station. The bypass has to be constructed to maintain the water surface differential across the existing pump station until all systems and features are in place to allow for a fully functional system at the new lowered canal water surface elevation. When all systems are ready and the water surface elevation of the canal has been lowered, the bypass is completely opened. Once the bypass is opened, the existing pump stations will be demolished and the cross section at those locations restored to a typical canal cross section. Once the water level in the canal is lowered, the existing levees and floodwalls lining both sides of the canals can also be removed down to existing grade. A detailed set of drawings showing the decommissioning and bypass of each DPS is provided in *Appendix H*.

DPS 3, 6, and 7 are on the NRHP. Consideration may be given to keeping at least the historic portion of the existing pump station(s). Other potential uses for the existing historic pump stations should be further investigated before a final decision is made. If the existing pump stations are demolished, the requirements of the State Historic Preservation Office will be followed in terms of full documentation of each of the facilities. Input from the SWBNO indicates their preference that the pump stations be demolished after decommissioning. The cost estimates include the cost of demolition and restoration of the site to the required drainage canal cross section.

FIGURE 3-28 – DPS 3 Decommissioning and Removal

FIGURE 3–29 – DPS 4 Decommissioning and Removal

FIGURE 3–30 – DPS 6 Decommissioning and Removal

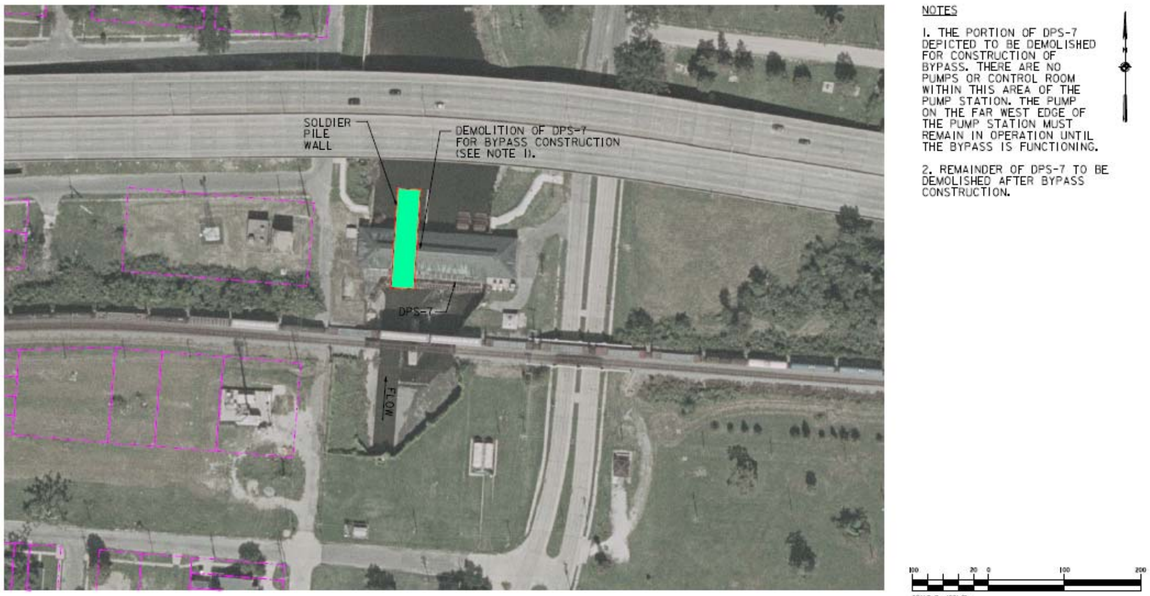


FIGURE 3–31 – DPS 7 Decommissioning and Removal

4.0 PERMANENT PROTECTION OPTIONS

The Permanent Protection Options required for consideration in this report are the new pump station options that are located near the mouths of the 17th Street, Orleans Avenue, and London Avenue Canals. In brief, these Options are defined as:

- ✓ Option 1 (Authorized Project): New pump stations and closure structures at or near the mouths of 17th Street, Orleans Avenue, and London Avenue Canals operating concurrently and in series with the existing pump stations serving these canals. This option includes decommissioning and removal of the ICS facilities. The variations of Option 1 that are considered include:
  - Non-Adaptable Option 1: The original Option 1 pump station as described in *Conceptual Design Report for Permanent Flood Gates and Pump Stations, dated 2006*, performed by GEC is updated to reflect current costs with some engineering adjustments to account for different site conditions and lessons learned.
  - Base Adaptable Option 1: A new pump station and closure structure designed and constructed to be able to accommodate some of the adaptable features.
  - Robust Adaptable Option 1: A new pump station and closure structure designed and constructed to be able to accommodate a wide variety of adaptable features.

- ✓ Option 2 (Not Authorized): New pump stations at or near the lake with deepened canals to carry gravity flow to the new pump stations including any diversions which are cost effective. Option 2 includes the decommissioning and removal of the ICS facilities and removal and by-pass of the existing drainage pump stations.

- ✓ Option 2a (Not Authorized): New pump stations at or near the lake with deepened canals to carry gravity flows to the new pump stations. This option is similar to Option 2 except for the addition of the Hoey's Basin Diversion from Jefferson Parish. This diversion results in a reduction of the storm water flow in the 17th Street Canal. As a consequence, the new 17th Street Canal pump station and deepened canal capacity will be reduced by the amount of storm water diverted from Jefferson Parish. The diverted storm water from Jefferson Parish will be collected and pumped directly to the Mississippi River.

- ✓ Option 2 Modified (Not Authorized) and Option 2a Modified (Not Authorized): New pump stations at or near the lake with deepened canals to carry gravity flows to the new pump stations. These options are similar to Option 2 and Option 2a respectively except for the addition of a stilling basin on the tail water of the pump station and the elimination of the breakwaters downstream of 17th Street Canal and Orleans Avenue Canal Pump Stations.

- ✓ Conversion of an adaptable Option 1 Pump Station to an Option 2 Pump Station. An evaluation of a four phase construction strategy that will accommodate conversion of an adaptable Option 1 pump station into an Option 2 pump station.

A comparison of the pump station primary features included as part of each pump station option is shown in Table 4-1. This table shows the differences between each pump station and may be used to understand the cost differences between the pump stations. The opinion of probable costs and schedules were produced for Options 1, 2, and 2a pump stations. The opinion of probable costs, are documented in *Appendix I* and the Construction Schedules are included in *Appendix J*. The Cost Estimates and Construction Schedules are summarized in Section 5.0.

TABLE 4-1 – Option 1, 2 and 2a Features

Pump Station Features Included in Option Variation	Adaptable Feature						Other Features									
	Deepened Sill	Pump Station Sized for Future Pump Capacity	Pump Capacity Sized for Future Pump Capacity	Formed Suction Intake	Fuel Storage and Generator Sized for Future Capacity	Canal Transitions	Includes Breakwater	Stilling Basin at Discharge	Includes Gated Bypass	Includes Floodwall/Levee Upgrades	All Electric Pumps	Includes Siphon Recovery	Removal of ICS Facilities (Construction sequence 1)	Diversions (Construction sequence 2)	Deepened Canals (Construction sequence 3)	Removal of Existing DPS 3, 4, 6, and 7 (Construction sequence 4)
Non-Adaptable Option 1	No	Yes	No	Yes	No	No	Yes	No	Yes	Yes	No	Yes	Yes	No	No	No
Base Adaptable Option 1	Yes[1]	No	No	No	No	No	No	Yes	No	No	Yes	Yes	Yes	No	No	No
Robust Adaptable Option 1	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	No	No
Option 2	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes[2]	Yes	Yes
Option 2 Modified	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes[2]	Yes	Yes
Option 2a	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes	Yes[3]	Yes	Yes
Option 2a Modified	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes[3]	Yes	Yes

1 - The Base Adaptable Option 1 Pump Station includes a deepened foundation that is lower than the existing canal invert. An end wall extends from the wet well invert up to the existing canal invert.
2 - The Option 2 Pump Station includes the Florida Avenue Diversion on the London Avenue Canal
3 - The Option 2a Pump Station includes the Hoey's Basin Diversion on the 17th Street Canal and the Florida Avenue Diversion on the London Avenue Canal.

4.1 Option 1: New Pump Stations Operating in Series with Existing Pump Stations

The Option 1 pump station system includes new permanent pump stations with gated gravity bypasses at or near the mouths of the three outfall canals. The existing SWBNO drainage pump stations that discharge into the canals will remain in service. The canals will continue to convey storm water from the existing pump stations to the new pump stations and closure structures at the lakefront.

The pump stations include the pump station building and equipment, intake wet well, discharge section, canal transitions, individual generators with enclosures, a tank farm, and all the ancillary systems required for a fully functional facility.

Figure 4-1 shows the centerline profile of 17th Street Canal. Other canal profiles are similar. This figure shows the centerline profile from the existing pump station through the drainage canal and through the new pump station to Lake Pontchartrain. This demonstrates the relative elevation of the intake of the new pump station in comparison to the current elevation of the bottom of the canal and the existing pump station.

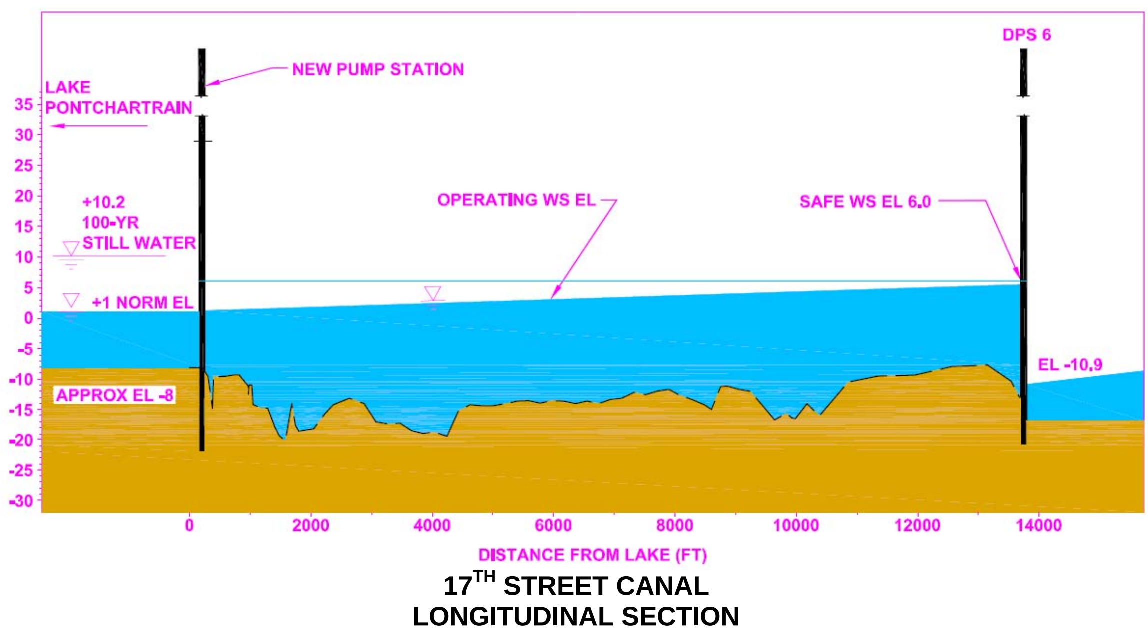


FIGURE 4-1 - Option 1, 17th Street Canal Profile (Profiles on other canals are similar)

Option 1 canals are considered "above-grade" canals because canal water levels are higher than the adjacent protected properties. This is shown schematically in Figure 4-2.

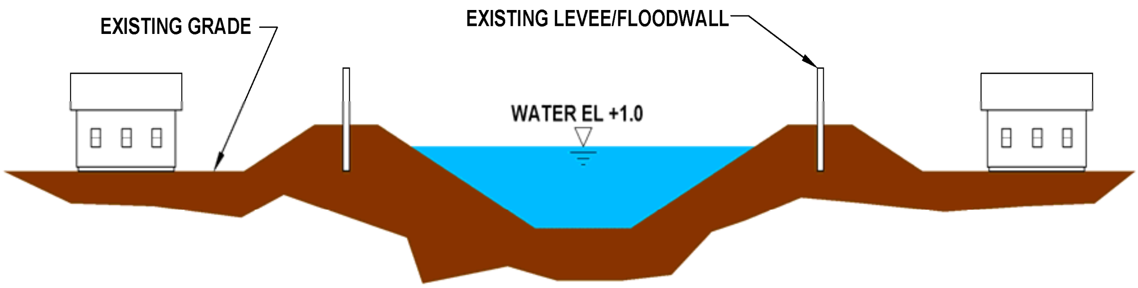


FIGURE 4-2 - Option 1 Typical Canal Cross Section

The new pump stations function as the closure structures that are required to protect the outfall canals systems against the storm surge from the design hurricane event. Several variations of the Option 1 pump station were evaluated as in Section 4.0. Generally, these variations addressed the inclusion of features to allow an Option 1 pump station to be converted to an Option 2 pump station in the future. This type of pump station is referred to as an Adaptable Option 1 pump station. The adaptable features reflect input from the New Orleans District and Stakeholders. The process of converting an Option 1 pump station to an Option 2 pump station and gravity drainage system may be accomplished through a four phased construction approach. The four phased construction approach is discussed in detail in Section 4.5.

Typical adaptable features include:

- ✓ Additional pump bays to accommodate increased future pump station capacity
- ✓ Lower sill or foundation elevation to accommodate future canal deepening
- ✓ Canal transitions from existing grade to deeper sill elevation
- ✓ Either inclusion of a formed suction intake or a suction inlet that can be adaptable to a formed suction intake in the future
- ✓ Evaluation of the pump systems to determine if the pumps, motors and engines placed in the Option 1 pump station can be designed to accommodate the change in head associated with the Option 2 pump station.

Three Option 1 pump stations were developed and costs were estimated. These pump stations include a Non-Adaptable Option 1, a Base Adaptable Option 1, and a Robust Adaptable Option 1. Each Option 1 variation includes different adaptable features, as well as other considerations that impact costs. Other considerations that impact the costs of an Option 1 pump station include:

- ✓ Whether a breakwater is included
- ✓ Whether a gated gravity bypass is included
- ✓ Whether canal wall or levee modifications are required
- ✓ Whether electric or diesel driven pumps are installed

- ✓ Whether generators are constructed with separate enclosures or housed in a generator building

Table 4-1 documents the primary adaptable and other features that are included in each Option 1 pump station. The intent of the variation in features per option is to determine the cost impact associated with each feature.

4.1.1 Pump Station Pump Capacity

The discharge capacity of the existing DPS system is 10,500 cfs; 2,690 cfs, and 7,980 cfs to the 17th Street, Orleans Avenue, and London Avenue Canals, respectively. However, the SWBNO plans on increasing the maximum discharge capacities in the future. The corresponding future discharge capacities are 12,500 cfs; 3,390 cfs; and 8,980 cfs.

As indicated in Table 4-1, none of the Option 1 pump stations include the future pump capacity; however, both the Non-Adaptable and the Robust Adaptable Option 1 pump stations includes construction of pump station superstructure and substructure for additional pump bays to accommodate future expansion.

4.1.2 Canal Wall/Levee Modification

In some locations on the 17th Street and London Avenue Canals, the safe water elevation may not be sufficient to accommodate full future flow capacity with gated sections. To alleviate this concern, adjusting the operational limits of the new stations should be considered or some of the existing canal walls may need to be strengthened or replaced.

As indicated in Table 4-1, the Non-Adaptable and Robust Option 1 gated pump stations include wall modifications and the Base Adaptable Option 1 does not. The variation in assumptions allows for a determination as to the effect wall modifications have on the cost of the Option 1 pump station.

4.1.3 Bridge Modifications

Bridge modifications are not required for any of the Option 1 variations. The *Conceptual Design Report for Permanent Flood Gates and Pump Stations, dated 2006*, performed by GEC indicates that the existing bridge at Gentilly Boulevard may create a hydraulic restriction in the London Avenue drainage system and may require modification. The study also indicates modifications to the bridge at Lakeshore Drive at London Avenue Canal may be required.

The re-evaluation of London Avenue Canal hydraulics and parallel protection system indicates that modification to Gentilly Bridge is no longer required. In the 2006 study modification to the Gentilly Bridge was required since the safe water elevation at Gentilly Bridge was assumed to be +5.0 feet. The hydraulic constriction at the bridge causes the water surface to exceed +5.0 for higher flows. The safe water elevation is now understood to be +9.0 feet at Gentilly Bridge, and the predicted canal water surface elevation is below that elevation.

Since the proposed site for the London Avenue Canal new pump station has been moved since the 2006 study, modifications to Lakeshore Drive Bridge are no longer required. In the 2006 study the permanent pump station was located in Lake Pontchartrain, which required modification to Lakeshore Drive Bridge. The proposed site location (See Figure 3-3) is sufficiently upstream of Lakeshore Drive to eliminate the need to modify the bridge.

4.1.4 Non-Adaptable Option 1 Pump Station (Update of Option 1 Pump Station from 2006 Report)

The Non-Adaptable Option 1 Pump Stations were documented in the *Conceptual Design Report for Permanent Flood Gates and Pump Stations*, *dated 2006*, performed by GEC. The Non-Adaptable Option 1 Pump Station was updated herein to reflect current engineering design approaches and costs. There are no adaptable features added to the pump station. The pump station configuration and layout are similar at each canal location except for overall pump station size, the elevation of the inlet structure, and the elevation of the outlet structure. Other features vary such as the number of pumps, size of power supply facilities, and amount of fuel supply. Refer to the page titled "Summary of Pump Station Information" in *Appendix E* for a summary of the electrical and mechanical components of the pump stations. This table lists the number and capacity of each pump, number and capacity of each generator, number and size of fuel tanks and size and type of engine drivers assumed for each pump station.

The Non-Adaptable Option 1 pump station cross-section is shown in Figures 4-3. The pump stations consist of an inlet structure, pump station (substructure and superstructure), outlet structure, and discharge channel. Each pump station site layout includes a generator building and a fuel storage farm. Table 4-2 documents the assumed footprint for each pump station and associated features. The *Conceptual Design Report for Permanent Flood Gates and Pump Stations*, *dated 2006*, performed by GEC, serves as the basis for the pump stations length.

TABLE 4-2 – Non Adaptable Option 1 Pump Station Plan Geometry

Feature	Canal					
	17th Street		Orleans Avenue		London Avenue	
	Length (ft)	Width (ft)	Length (ft)	Width (ft)	Length (ft)	Width (ft)
Pump Station	400	80	130	80	300	80
Inlet Structure	400	40	130	40	300	40
Outlet Structure	400	20	130	20	300	20
Generator Building	190	70	70	70	160	70
Gated Section	92	80	61	80	92	80
Gated Section (Clear Opening)	60 feet		40 feet		60 feet	

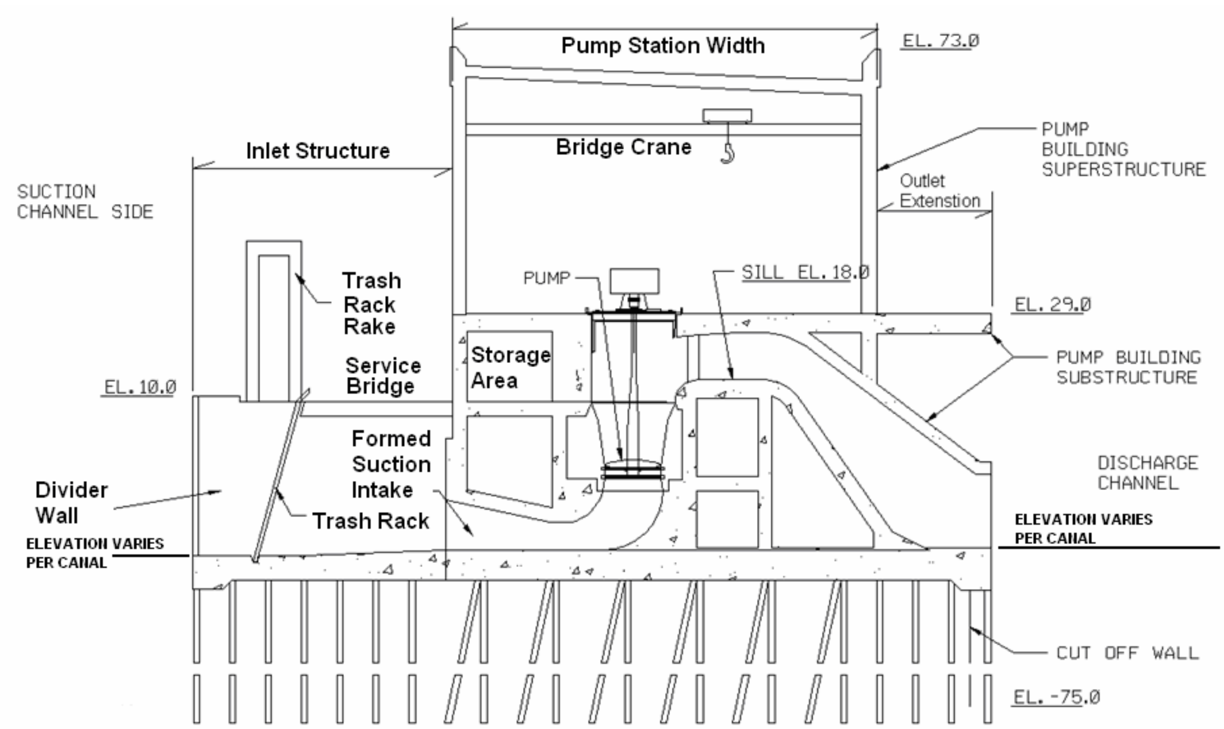


FIGURE 4-3 - Non-Adaptable Option 1 Pump Station

4.1.4.1 17th Street Canal Pump Station

Refer to Table 4-1 for a list of features that are included in the design of the Non-Adaptable Pump Station. The Non-Adaptable Option 1 pump station on the 17th Street Canal includes a pile foundation, substructure, formed suction inlets for each pump bay, a pump station building, a generator building, and tank farm for fuel. The forebay is formed by transitioning from the canal cross section to the intake section of the pump station at an angle of approximately 10 degrees from the canal edge line. The transition is required to produce good flow characteristics across the entire width of the pump station intakes. Concrete training walls are used to form the transitions. The 17th Street

Canal pump station is exposed to wave action. A breakwater is included to reduce the impact of wave action to 1 to 2 feet.

The pump station is designed to match the capacity of the existing pump stations discharging into this canal. The pumps include a combination of diesel and electric driven pumps from 1,000 cfs down to 250 cfs. Refer to the page titled "Pump Sizes" in *Appendix E* for the specific number of each capacity pump provided currently and for the number of future for which space has been allocated. In addition, refer to the page titled "New Orleans Major Canal Permanent Pumping Stations (1 of 2)" *Appendix E* which documents the primary design point, brake and motor horsepower requirements of the pumps at the 17th Street Canal pump station. As can be seen from the "Pump Sizes" page a variety of pump sizes will be provided to match the inflow into the canal produced by DPS 6 and the smaller pump stations which discharge into the 17th Street Canal. Electric pumps will be provided with diesel generator backup in the event of power loss at the station. Additional generating capacity is provided for house lights, controls and instrumentation, and ancillary systems required for a fully operational system. Refer to the page titled "90-day Implementation Study, Pump Driver Power Criteria, Option 1 Non-Adaptable and Robust Adaptable" in *Appendix E* for details on sizing the generators for this pump station. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity. Refer to the page titled "Fuel Storage Estimate" in *Appendix E* for documentation and estimates of the fuel storage requirements for the 17th Street pump station.

A gated section is included adjacent to the pump station superstructure. The gated section allows the canal water to bypass the pump station by gravity for normal conditions. The gated section is intended to close during high lake water elevations.

The gated section was modeled with an invert elevation of -18 feet. The clear opening was evaluated at 60, 100, and 130 feet in total width. The velocity at normal lake depth is 9.9 feet per second for the 60-foot clear opening, and 6.1 feet per second for the 100-foot clear opening. The 100 foot clear opening increases the water surface elevations by less than 0.1 feet when compared to the 130-foot clear opening. The 60-foot clear opening increases the water surface elevations by up to 0.4 feet. A 60-foot clear opening was selected for the gated bypass.

4.1.4.2 Orleans Avenue Canal Pump Station

The Non-Adaptable Option 1 pump station on the Orleans Avenue Canal includes a pile foundation, substructure, formed suction inlets for each pump bay, a pump station building, a generator building, and tank farm for fuel. The forebay and tailrace transitions for the pump station are similar to the description for the 17th Street Canal pump station. The Orleans Avenue Canal pump station is exposed to wave action. A breakwater is included to reduce the impact of wave action to 1 to 2 feet.

The pump station will be designed to match the capacity of the existing pump station discharging into this canal. The installed pumps could include a combination of diesel

and electric driven pumps from 1,000 cfs down to 250 cfs. Refer to the page titled "Pump Sizes" in *Appendix E* for the specific number of each capacity pump provided currently and for the number of future for which space has been allocated. In addition, refer to the page titled "New Orleans Major Canal Permanent Pumping Stations (1 of 2)" *Appendix E* which documents the primary design point, brake and motor horsepower requirements of the pumps at the 17th Street Canal pump station which would be similar to those provided for the Orleans Avenue Canal pump station. Electric pumps will be provided with diesel generator backup in the event of power loss at the station. Additional generating capacity for house lights and auxiliary systems will also be provided. Refer to the page titled "90-day Implementation Study, Pump Driver Power Criteria, Option 1 Non-Adaptable and Robust Adaptable" in *Appendix E* for details on sizing the generators for this pump station. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity. Refer to the page titled "Fuel Storage Estimate" in *Appendix E* for documentation and estimates of the fuel storage requirements for the Orleans Avenue Canal pump station.
A gated section is included adjacent to the pump station superstructure. The gated section allows the canal water to bypass the pump station by gravity for normal conditions. The gated section is intended to close during high lake water elevations.

The gated section was modeled with an invert elevation of -13 feet. The clear opening was evaluated at 40 and 60 feet in total width. A clear opening width of 40 feet appears to be acceptable in terms of safe water elevation not being exceeded. The velocity at normal lake depth (1 foot) is 5.8 feet per second for a flow of 3,390 cfs.

4.1.4.3 London Avenue Canal Pump Station

The Non-Adaptable Option 1 London Avenue pump station includes a pile foundation, substructure, formed suction inlets for each pump bay, a pump station building, a generator building, and tank farm for fuel tanks. The forebay and tailrace transitions for the pump station are similar to the description for the 17th Street Canal pump station. The London Avenue Canal pump station is located at a sufficient distance from Lake Pontchartrain such that wave action is reduced, and a breakwater is not required.

The pump station will be designed to match the capacity of the existing pump stations discharging into this canal. The installed pumps could include a combination of diesel and electric driven pumps from 1,000 cfs down to 250 cfs. Refer to the page titled "Pump Sizes" in *Appendix E* for the specific number of each capacity pump provided currently and for the number of future for which space has been allocated. In addition, refer to the page titled "New Orleans Major Canal Permanent Pumping Stations (1 of 2)" *Appendix E* which documents the primary design point, brake and motor horsepower requirements of the pumps which would be similar to those provided for the London Avenue pump station. Electric pumps will be provided with diesel generator backup in the event of power loss at the station. Additional generating capacity for house lights and auxiliary systems will also be provided. Refer to the page titled "90-day Implementation Study, Pump Driver Power Criteria, Option 1 Non-Adaptable and Robust Adaptable" in *Appendix E* for details on sizing the generators for this pump station. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity. Refer to the page titled "Fuel Storage Estimate" in *Appendix E* for documentation and estimates of the fuel storage requirements for the London Avenue Canal pump station.

A gated section is included adjacent to the pump station superstructure. The gated section allows the canal water to bypass the pump station by gravity for normal conditions. The gated section is intended to close during high lake water elevations

The gated section was modeled with an invert elevation of -14 feet. The clear opening width was evaluated at 60, 90 and 120 feet in total width. For a flow of 8,980 cfs and a Lake Pontchartrain elevation of +3.0 feet the safe water elevation of the parallel protection is exceeded for a greater distance for the 60 and 90 foot clear opening widths than for the 120 foot clear opening width. The results for the 90 foot clear opening width is similar to the 120 foot clear opening width in the downstream reaches in that the safe water elevation is not exceeded until upstream of the Robert E Lee Bridge. For the maximum flow case, the 60 foot clear opening width requires improvements to the parallel protection starting upstream of Leon C Simon Bridge. Both the 60 and 90 foot gates require parallel protection improvement in the very upstream reach, where the water surface exceeds +9.0 feet. A 60-foot clear opening was selected for the gated bypass. The gates and pump station at London Avenue Canal will operate such that safe water elevations are not exceeded.

4.1.5 Base Adaptable Option 1 Pump Station

The Base Adaptable Option 1 Pump Station includes the following adaptable feature: an inlet system that operates as a wet well with a substructure depth that matches an Option 2 substructure depth. Table 4-1 provides a list of other features that are included in the design of the Base Adaptable Pump Station. As indicated in this table, this option does not include other adaptable features such as canal transitions to deeper invert elevations, additional pump bays or superstructure room for drivers, nor additional space for generators or fuel tanks. The proposed construction of the project, will not include the larger power supplies, larger back-up power supplies or tank farms, larger pump shafts and propellers, larger pump motors, larger real estate requirements, formed suction intakes, etc. that might be required when the pump station is converted to an Option 2 Pump Station.

The pump station configuration and layout are similar at each canal location except for overall pump station size, the elevation of the inlet structure and the elevation of the outlet structure. Other features vary such as the number of pumps, size of power supply facilities, and amount of fuel supply. Refer to the page titled "Summary of Pump Station Information" in *Appendix E* for a summary of the electrical and mechanical components of the pump stations. This table lists the number and capacity of each pump, number and capacity of each generator, number and size of fuel tanks and size and type of engine drivers assumed for each pump station.

This Option 1 variation does not include breakwaters, or the gated section for gravity bypass of normal storm water discharges. The exclusion of a gated section for gravity by-pass allows control of canal water level below safe water elevation and eliminates the need for canal floodwall upgrades. An operational analysis of this non-gated Option 1 station was not conducted for this study; however, such an analysis is recommended for either a gated or non-gated adaptable Option 1 pump station. As noted in the following sections the range of pump sizes selected reflects those at the existing drainage pump stations. The pump station is configured with a stilling basin/weir outlet that dissipates the energy of the wave action during a storm surge. The weir also establishes a constant discharge head, which facilitates pump maintenance and exercise during non storm events. Table 4-3 documents the plan geometry of the Base Adaptable Option 1 Pump Stations and Figure 4-4 shows a typical cross section through a Base Adaptable Option 1 Pump Station. The page titled "Approximate Pump Building Lengths" in *Appendix E* serves as the basis for the pump stations length.

TABLE 4-3 – Base Adaptable Option 1 Pump Station Plan Geometry

	Canal					
	17th Street		Orleans Avenue		London Avenue	
Feature	Length (ft)	Width (ft)	Length (ft)	Width (ft)	Length (ft)	Width (ft)
Pump Station	290	60	80	60	220	60
Inlet Structure	290	40	80	40	220	40
Outlet Structure	290	465	80	465	220	465
No Generator Building (Generators Installed with Individual Protective Enclosures)	N/A	N/A	N/A	N/A	N/A	N/A
Gated Section	No Gated Section Included					
Gated Section (Clear Opening)						

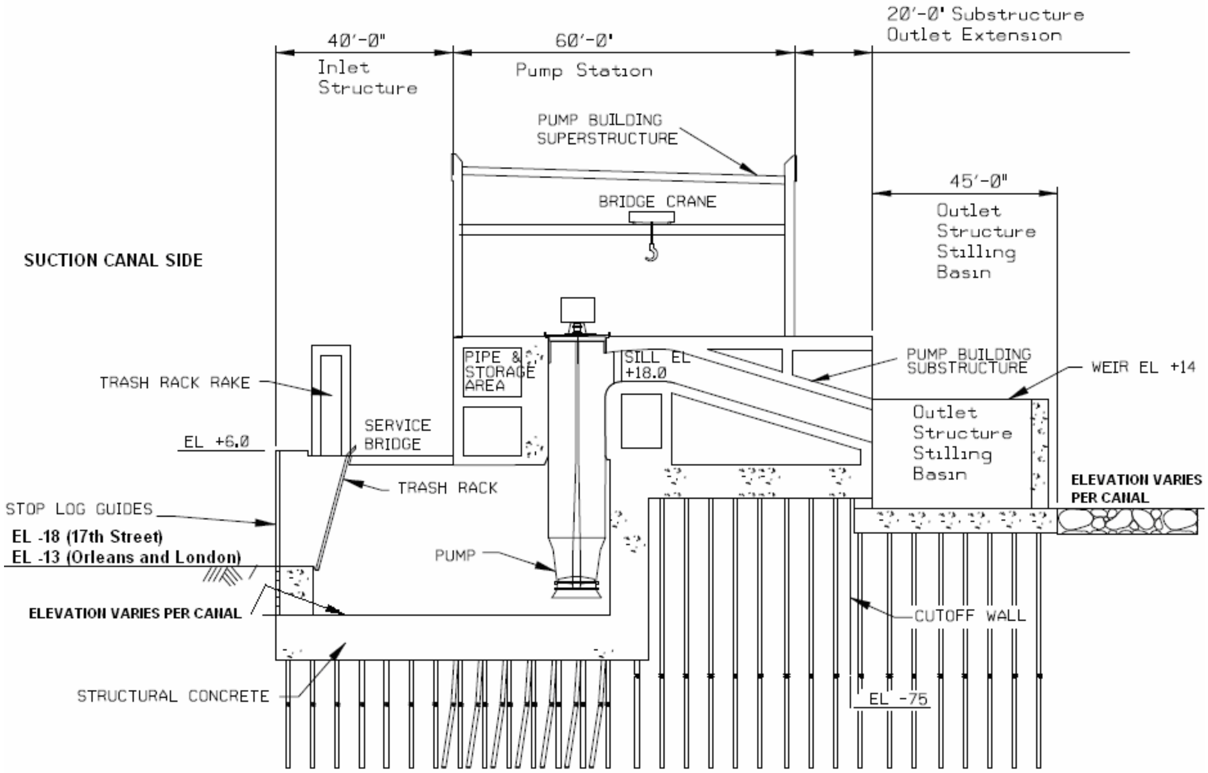


FIGURE 4-4 - Base Adaptable Option 1 Pump Station

4.1.5.1 17th Street Canal Pump Station

The Base Adaptable Option 1 pump station on the 17th Street Canal includes a pile foundation, substructure, wet well inlet for each pump bay, vertical pumps that are submerged adequately into the wet well for the Option 1 pump scenarios, a pump station building, a generator building, and tank farm for fuel. The forebay is formed by transitioning from the canal cross section to the intake section of the pump station at an angle of approximately 10 degrees from the canal edge line. The transition is required to produce good flow characteristics across the entire width of the pump station intakes.

The pump station will be designed to match the capacity of the existing pump stations discharging into this canal. The pumps could include a combination of electric driven pumps from 1,000 cfs down to 250 cfs. Refer to the page titled “Pump Sizes” in *Appendix E* for the specific number of each capacity pump provided. In addition, refer to the page titled “New Orleans Major Canal Permanent Pumping Stations (1 of 2)” *Appendix E* which documents the primary design point, brake and motor horsepower requirements of the pumps at the 17th Street Canal pump station. As can be seen from the “Pump Sizes” page a variety of pump sizes will be provided to match the inflow into the canal produced by DPS 6 and the smaller pump stations which discharge into the canal. Electric pumps should be provided with diesel generator backup in the event of power loss at the station. Additional generating capacity is provided for house lights, controls and instrumentation, and ancillary systems required for a fully operational system. Refer to the page titled “90-day Implementation Study, Pump Driver Power Criteria, Option 1

Base Adaptable" in *Appendix E* for details on sizing the generators for this pump station. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity. Refer to the page titled "Fuel Storage Estimate" in *Appendix E* for documentation and estimates of the fuel storage requirements for the 17th Street Canal Pump Station.

4.1.5.2 Orleans Avenue Canal Pump Station

The Base Adaptable Option 1 pump station on the Orleans Avenue Canal includes a pile foundation, substructure, wet well inlet for each pump bay, vertical pumps that are submerged adequately into the wet well for the Option 1 pump scenarios, a pump station building, a generator building, and tank farm for fuel. The forebay transitions for the pump station are similar to the description for the 17th Street Canal pump station. A transition is required on the discharge side of the pump station (tailrace), but can be formed with a much steeper angle of about 30 degrees.

The pump station will be designed to match the capacity of the existing pump station discharging into this canal. The installed pumps could include a combination of diesel and electric driven pumps from 1,000 cfs down to 250 cfs. Refer to the page titled "Pump Sizes" in *Appendix E* for the specific number of each capacity pump provided. In addition, refer to the page titled "New Orleans Major Canal Permanent Pumping Stations (1 of 2)" *Appendix E* which documents the primary design point, brake and motor horsepower requirements of the pumps at the 17th Street pump station which would be similar to those provided for the Orleans Avenue Canal pump station. Electric pumps will be provided with diesel generator backup in the event of power loss at the station. Additional generating capacity for house lights and auxiliary systems will also be provided. Refer to the page titled "90-day Implementation Study, Pump Driver Power Criteria, Option 1 Base Adaptable" in *Appendix E* for details on sizing the generators for this pump station. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity. Refer to the page titled "Fuel Storage Estimate" in *Appendix E* for documentation and estimates of the fuel storage requirements for the Orleans Avenue Canal pump station.

4.1.5.3 London Avenue Canal Pump Station

The Base Adaptable Option 1 London Avenue Canal pump station includes a pile foundation, substructure, wet well inlet for each pump bay, vertical pumps that are submerged adequately into the wet well for the Option 1 pump scenarios, a pump station building, a generator building, and tank farm for fuel tanks. The forebay and tailrace transitions for the pump station are similar to the description for the 17th Street Canal pump station.

The pump station on London Avenue Canal will be designed to match the capacity of the existing pump stations discharging into this canal. The installed pumps could include a combination of diesel and electric driven pumps from 1,000 cfs down to 250 cfs. Refer to the page titled "Pump Sizes" in *Appendix E* for the specific number of each capacity pump provided. In addition, refer to the page titled "New Orleans Major Canal Permanent Pumping Stations (1 of 2)" *Appendix E* which documents the primary design point, brake and motor horsepower requirements of the pumps at the 17th Street Canal pump station which would be similar to those provided for the London Avenue Canal pump station. Electric pumps will be provided with diesel generator backup in the event of power loss at the station. Additional generating capacity for house lights and auxiliary systems will also be provided. Refer to the page titled "90-day Implementation Study, Pump Driver Power Criteria, Option 1 Base Adaptable" in *Appendix E* for details on sizing the generators for this pump station. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity. Refer to the page titled "Fuel Storage Estimate" in *Appendix E* for documentation and estimates of the fuel storage requirements for the London Avenue Canal pump station.

4.1.6 Robust Adaptable Option 1 Pump Station

The Robust Adaptable Option 1 Pump Station is designed to accommodate all of the feasible adaptable features associated with allowing conversion to an Option 2 pump station in the future. The adaptable features include: lower inlet elevation that matches the Option 2 invert elevation, channel transitions from the existing canal grade to the lower inlet invert elevation, a formed suction intake for each pump, additional pump bays and superstructure space to allow for expansion to the future pump capacities, and larger pump components that are sized to allow for change out for future increases in operational heads. Refer to Table 4-1 for a list of other features that are included in the design of the Robust Adaptable Pump Station. The proposed construction of the project, will not include the larger power supplies, larger back-up power supplies or tank farms, larger pump motors, larger real estate requirements, etc. that might be required for the future additional features.

The pump station configuration and layout are similar at each canal location except for overall pump station size, the elevation of the inlet structure and the elevation of the outlet structure. Other features vary such as the number of pumps, size of power supply facilities, and amount of fuel supply. Refer to the page titled "Summary of Pump Station Information" in *Appendix E* for a summary of the electrical and mechanical components of the pump stations. This table lists the number and capacity of each pump, number and capacity of each generator, number and size of fuel tanks and size and type of engine drivers assumed for each pump station.

This option includes breakwaters for the 17th Street and Orleans Avenue Canal pump stations, as well as gated sections to allow for gravity bypass of normal storm water discharges into Lake Pontchartrain. An operational analysis of this gated Option 1 station was not conducted for this study; however, such an analysis is recommended for either a gated or non-gated adaptable Option 1 pump station. As noted in the following sections the range of pump sizes selected reflects those at the existing drainage pump stations. Table 4-4 documents the plan geometry of the Robust Adaptable Option 1 Pump Stations and Figure 4-5 shows a typical cross section through a Robust Adaptable Option 1 Pump

Station. The *Conceptual Design Report for Permanent Flood Gates and Pump Stations, dated 2006*, performed by GEC, serves as the basis for the pump stations length.

TABLE 4-4 – Robust Adaptable Option 1 Pump Station Plan Geometry

	Canal					
	17th Street		Orleans Avenue		London Avenue	
Feature	Length (ft)	Width (ft)	Length (ft)	Width (ft)	Length (ft)	Width (ft)
Pump Station	400	80	130	80	300	80
Inlet Structure	400	40	130	40	300	40
Outlet Structure	400	20	130	20	300	20
Generator Building	190	70	70	70	160	70
Gated Section	92	80	61	80	92	80
Gated Section (Clear Opening)	60 feet		40 feet		60 feet	

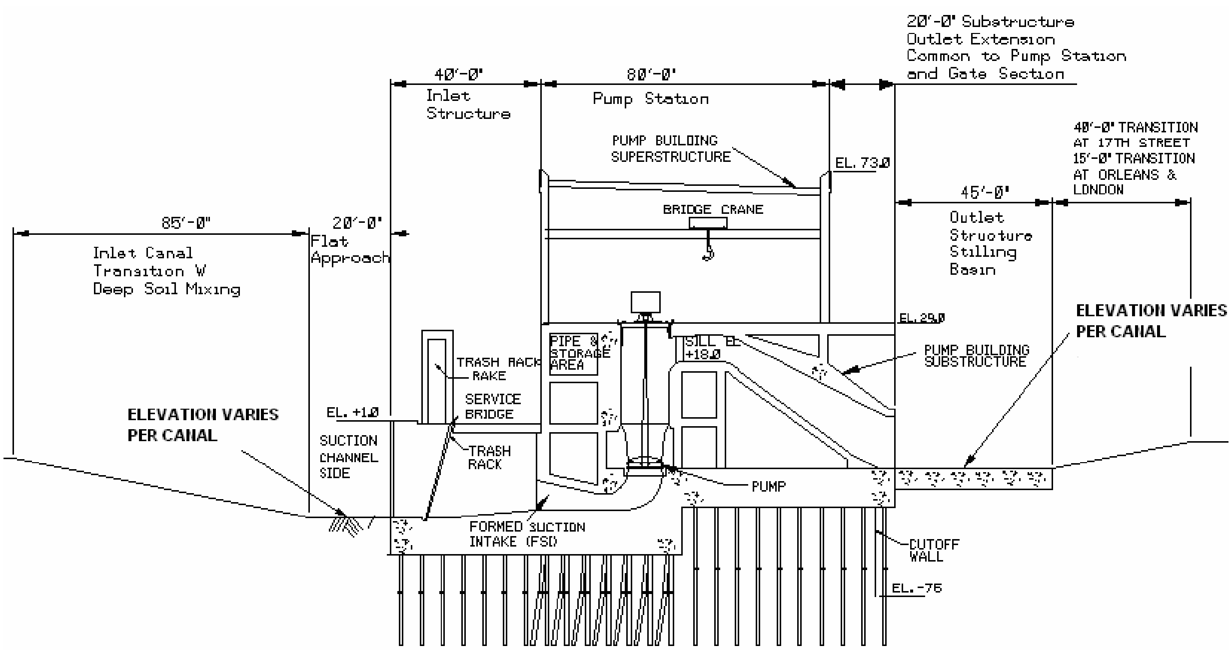


FIGURE 4-5 - Robust Adaptable Option 1 Pump Station

4.1.6.1 17th Street Canal Pump Station

The Robust Adaptable Option 1 pump station on the 17th Street Canal includes a pile foundation, substructure, inlet canal transition with deep soil mixing for stability and erosion protection, a 20 foot long flat approach, formed suction inlets for each pump bay, a pump station building, a generator building, and tank farm for fuel. The forebay is formed by transitioning from the canal cross section to the intake section of the pump station at an angle of approximately 10 degrees from the canal edge line. The transition is required to produce good flow characteristics across the entire width of the pump station intakes.

The pump station will be designed to match the capacity of the existing pump stations discharging into this canal. The pumps could include a combination of diesel and electric driven pumps from 1,000 cfs down to 250 cfs. Refer to the page titled "Pump Sizes" in *Appendix E* for the specific number of each capacity pump provided currently and for the number of future for which space has been allocated. In addition, refer to the page titled "New Orleans Major Canal Permanent Pumping Stations (1 of 2)" *Appendix E* which documents the primary design point, brake and motor horsepower requirements of the pumps at the 17th Street Canal pump station. As can be seen from the "Pump Sizes" page a variety of pump sizes will be provided to match the inflow into the canal produced by DPS 6 and the smaller pump stations which discharge into the canal. Electric pumps should be provided with diesel generator backup in the event of power loss at the station. Refer to the page titled "90-day Implementation Study, Pump Driver Power Criteria, Option 1 Non-Adaptable and Robust Base Adaptable" in *Appendix E* for details on sizing the pump station. Additional generating capacity is provided for house lights, controls and instrumentation, and ancillary systems required for a fully operational system. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity. Refer to the page titled "Fuel Storage Estimate" in *Appendix E* for documentation and estimates of the fuel storage requirements for the 17th Street Canal pump station.

4.1.6.2 Orleans Avenue Canal Pump Station

The Robust Adaptable Option 1 pump station on the Orleans Avenue Canal includes a pile foundation, substructure, inlet canal transition with DSM for stability and erosion protection, a 20 foot flat approach, formed suction inlets for each pump bay, a pump station building, a generator building, and tank farm for fuel. The forebay and tailrace transitions for the pump station are similar to the description above for the 17th Street Canal pump station.

The pump station on Orleans Avenue Canal will be designed to match the capacity of the existing pump station discharging into this canal. The installed pumps could include a combination of diesel and electric driven pumps from 1,000 cfs down to 250 cfs. Refer to the page titled "Pump Sizes" in *Appendix E* for the specific number of each capacity pump provided currently and for the number of future pumps for which space has been allocated. In addition, refer to the page titled "New Orleans Major Canal Permanent Pumping Stations (1 of 2)" *Appendix E* which documents the primary design point, brake and motor horsepower requirements of the pumps at the 17th Street Canal pump station which are similar to those at Orleans Avenue Canal Pump Station. Electric pumps will be provided with diesel generator backup in the event of power loss at the station. Additional generating capacity for house lights and auxiliary systems will also be provided. Refer to the page titled "90-day Implementation Study, Pump Driver Power Criteria, Option 1 Non-Adaptable and Robust Adaptable" in *Appendix E* for details on sizing the generators for this pump station. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity. Refer to the page titled "Fuel Storage Estimate" in *Appendix E* for documentation and estimates of the fuel storage requirements for the Orleans Avenue Canal pump station.

4.1.6.3 London Avenue Canal Pump Station

The Robust Adaptable Option 1 London Avenue Canal pump station includes a pile foundation, substructure, inlet canal transition with deep soil mixing for stability and erosion protection, a 20 foot flat approach, formed suction inlets for each pump bay, a pump station building, a generator building, and tank farm for fuel tanks. The forebay and tailrace transitions for the pump station are similar to the description above for the 17th Street Canal pump station.

The pump station on London Avenue Canal will be designed to match the capacity of the existing pump stations discharging into this canal. The installed pumps could include a combination of diesel and electric driven pumps from 1,000 cfs down to 250 cfs. Refer to the page titled "Pump Sizes" in *Appendix E* for the specific number of each capacity pump provided currently and for the number of future pumps for which space has been allocated. In addition, refer to the page titled "New Orleans Major Canal Permanent Pumping Stations (1 of 2)" *Appendix E* which documents the primary design point, brake and motor horsepower requirements of the pumps at the 17^{th} Street Canal pump station which are similar to those at London Avenue Canal pump station. Electric pumps will be provided with diesel generator backup in the event of power loss at the station. Additional generating capacity for house lights and auxiliary systems will also be provided. Refer to the page titled "90-day Implementation Study, Pump Driver Power Criteria, Option 1 Non-Adaptable and Robust Adaptable" in *Appendix E* for details on sizing the generators for this pump station. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity. Refer to the page titled "Fuel Storage Estimate" in *Appendix E* for documentation and estimates of the fuel storage requirements for the London Avenue Canal pump station.

4.2 Option 2: New Pump Stations at or Near the Lakefront with Deepened Canals, Removal of Existing Pump stations, and Diversions

Option 2 includes constructing new pump stations at or near the lakefront and necessary canal modifications that allow gravity flow of storm water to the pump station. Canal modifications will include deepening, widening, lining, etc. The existing DPS 3, 4, 6, and 7 will no longer be required and will be decommissioned and removed. The deepened canals will allow the water that is currently pumped by the existing pump stations to flow by gravity all the way to the new permanent protection pump stations at the lakefront. The deepened canals will be sized to accommodate SWBNO reported future discharge capacities as shown in Table 3-1. With the canals deepened the need for levees and floodwalls along the existing canals from the existing pump stations to the lake could be eliminated. The canal water elevation will no longer be elevated above the surrounding ground level. The deepened canals will impact the existing bridges that cross the canals. In some cases, the bridges require modification and in other cases the bridges will need to be replaced.

The pump station is the closure structure for the outfall canal that prevents hurricane storm surge and waves from propagating into the canal. Gates for bypassing flow are not required for Option 2 since there will be no condition under which the lake water will be allowed to flow up the outfall canals past the pump station. The new permanent pump stations will operate anytime storm water flows in the canals.

The locations of the new pump stations at or near the lakefront are the same as the locations considered for Option 1. The pump stations include the pump station building and equipment, intake and discharge sections, canal transitions, generator building and equipment, a tank farm, and all the ancillary systems required for a fully functional facility. Similar to the Option 1 pump stations, the general configuration and layout are similar at each canal location except for overall pump station size, the elevation of the inlet structure and the elevation of the outlet structure. Other features vary such as the number of pumps, size of power supply facilities, and amount of fuel supply.
Refer to the page titled "Summary of Pump Station Information" in *Appendix E* for a summary of the electrical and mechanical components of the pump stations. This table lists the number and capacity of each pump, number and capacity of each generator, number and size of fuel tanks and size and type of engine drivers assumed for each pump station.

Table 4-5 documents the plan geometry of the Option 2 pump stations and Figure 4-6 shows a typical cross section through an Option 2 Pump Station. The page titled "Approximate Pump Building Lengths" in *Appendix E* serves as the basis for the pump stations length.

TABLE 4-5 – Option 2 Pump Station Plan Geometry

	Canal					
	17th Street		Orleans Avenue		London Avenue	
Feature	Length (ft)	Width (ft)	Length (ft)	Width (ft)	Length (ft)	Width (ft)
Pump Station	400	80	130	80	300	80
Inlet Structure	400	40	130	40	300	40
Outlet Structure	400	20	130	20	300	20
Generator Building	400	70	70	70	280	70
Gated Section	Gated Section not feasible for Option 2 pump stations					
Gated Section (Clear Opening)						

A cofferdam is required for the construction of the pump station. A temporary bypass will be required to route canal flows around the cofferdam during construction. The pump stations are of sufficient size to accommodate the future expected increases in flow. Since the motors for the pumps are larger, the standby power requirements may also be greater. The greater power requirements will require a larger tank farm for fuel. Overall, more real estate is required for Option 2 because of the larger generator and tank farm requirements.

The new pump stations will be constructed with bypasses around the construction sites so that the existing systems can continue to function. The timing of the closure of each bypass will have to be coordinated with the commissioning and initial operation of each new pump station, lowering of the water level in the canal, bypass of the existing ICS, and bypass of the existing pump stations.

The Option 2 center line profile elevation of 17th Street Canal is depicted in Figures 4-1 and 4-7. Figure 4-7 shows the water level in the canal at a much lower elevation than shown in Figure 4-1 and shows a gravity bypass at existing DPS 6. This Option, therefore, eliminates the need to pump the water twice. However, the water will have to be lifted higher from the deepened canal into the lake. This has a significant impact on the type and size of pumps. Required pump capacity remains the same as Option 1; modification to pump components and larger motors will be required to provide for the additional lift.

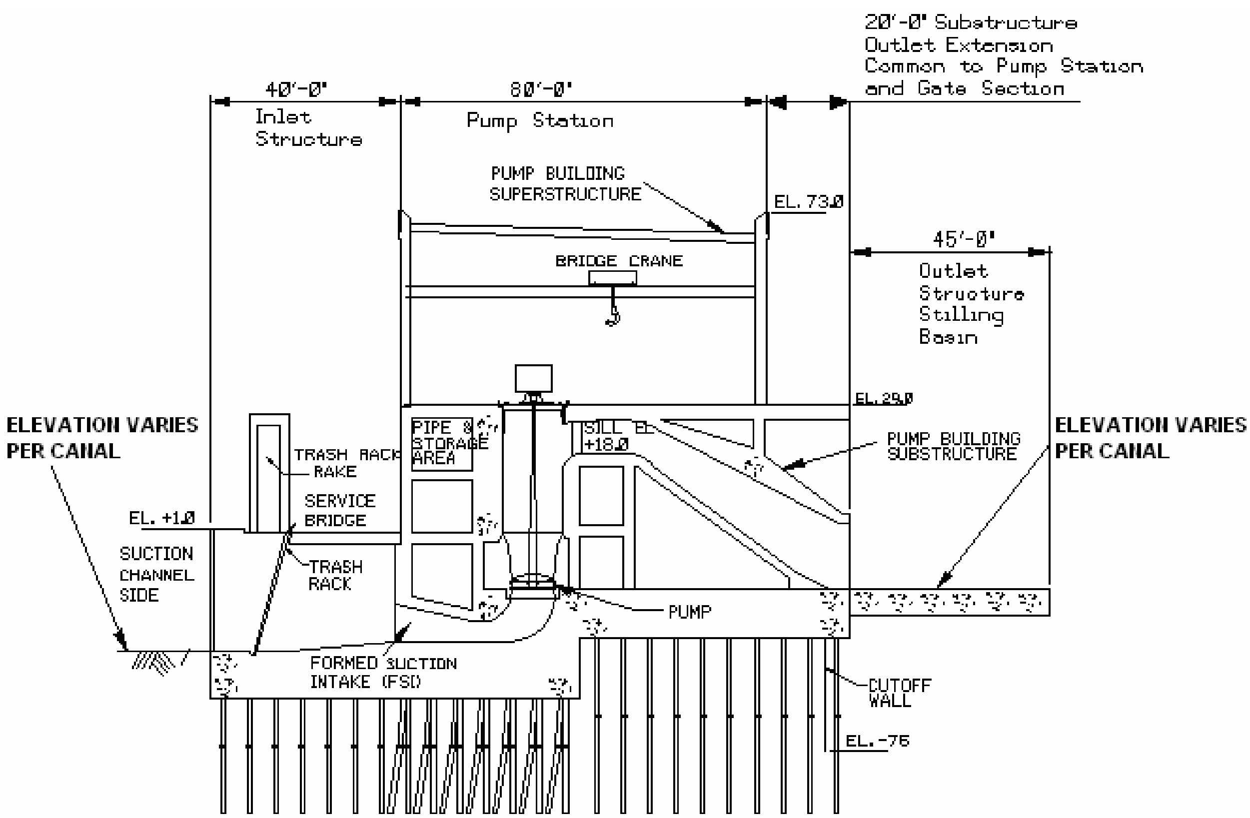


FIGURE 4-6 – Option 2 Pump Station Typical Cross Section

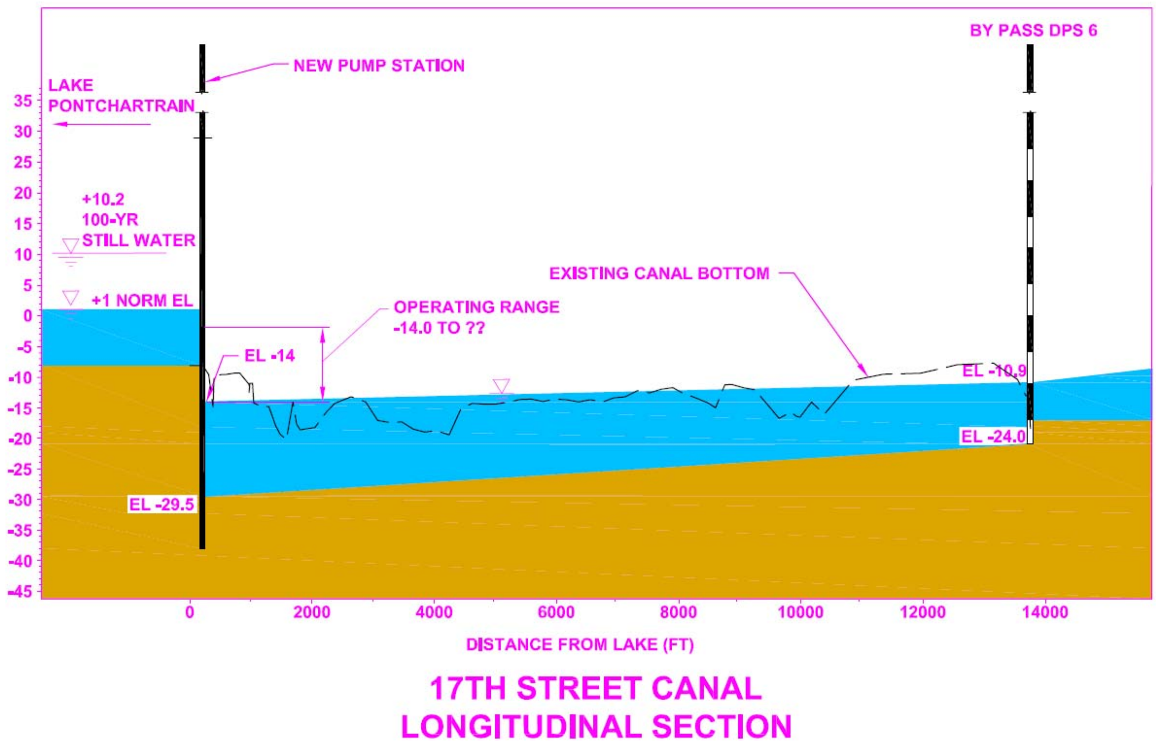


FIGURE 4-7 - Option 2, 17th Street Canal Profile

The foundation elevation of an Option 2 pump station will be the same as an adaptable Option 1 pump station. The pump station is required to be designed for the additional depth and future water level difference between the Lake and the canal. The significance of the below-grade canal can be seen by comparing Figure 4-2 and Figure 4-8. Comparison shows that Option 2 results in a water surface elevation lower than the adjacent developed areas, where in Option 1, the water surface elevation is still above the adjacent ground elevation.

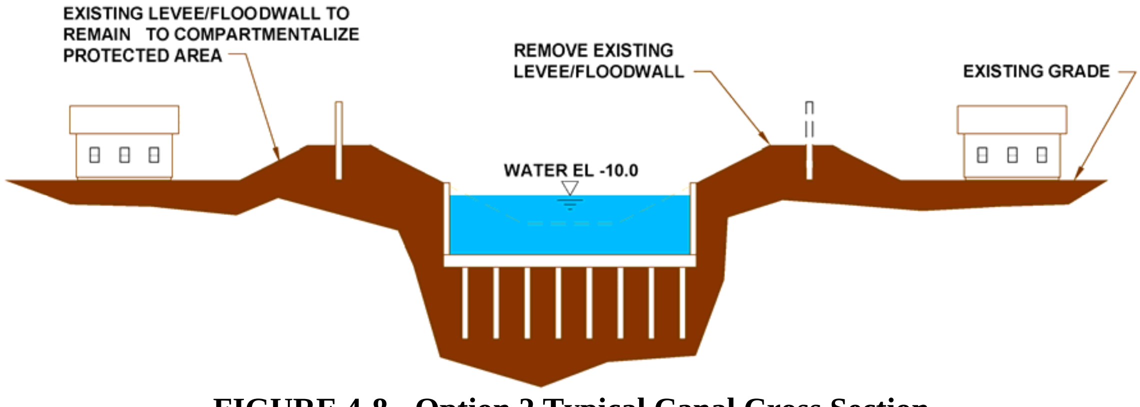


FIGURE 4-8 - Option 2 Typical Canal Cross Section

The Option 2 pump station includes storm water diversions that are economically cost effective. The diversion study that was performed is documented in Section 3.2.3

indicates that the Florida Avenue Diversion is an economically cost effective alternative. This alternative will reduce the flow in London Avenue canal by 1,100 cfs.

4.2.1 17th Street Canal Option 2 Pump Station

The Option 2 pump station on the 17th Street Canal includes a pile foundation, substructure, formed suction inlets for each pump bay with a lowered invert elevation, a pump station building, a generator building, and tank farm for fuel. A gated section is not required. The intake basin (forebay) is formed by transitioning from the canal cross section to the intake section of the pump station at an angle of approximately 10 degrees from the canal edge line. The transition is required to produce good flow characteristics across the entire width of the pump station intakes.

The pump station on the 17th Street Canal is designed to pump 10,500 cfs. The superstructure and substructure are designed to accommodate a future total discharge of 12,500 cfs. The installed pumps could include a combination of diesel and electric driven pumps from 1,000 cfs down to 250 cfs. Refer to the page titled “Pump Sizes” in *Appendix E* for the specific number of each capacity pump provided currently and for the number of future for which space has been allocated. In addition, refer to the page titled “New Orleans Major Canal Permanent Pumping Stations (2 of 2)” *Appendix E* which documents the primary design point, brake and motor horsepower requirements of the pumps at the 17th Street Canal pump station. As can be seen from the “Pump Sizes” page a variety of pump sizes will be provided to match the inflow into the canal produced varied rain events. Electric pumps are provided with diesel generator backup in the event of power loss at the station. Additional generating capacity is provided for house lights, controls and instrumentation, and ancillary systems required for a fully operational system. The total lift for the Option 2 pump station is about twice the height of the lift for the Option 1 pump station, which essentially doubles the power requirements. Refer to the page titled “90-day Implementation Study, Pump Driver Power Criteria, Option 2” in *Appendix E* for details on sizing the generators for this pump station. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity. Refer to the page titled “Fuel Storage Estimate” in *Appendix E* for documentation and estimates of the fuel storage requirements for the 17th Street Canal pump station.

4.2.2 Orleans Avenue Canal Option 2 Pump Station

The Option 2 pump station on the Orleans Avenue Canal includes a pile foundation, substructure, FSI for each pump bay, a pump station building, a generator building, and tank farm for fuel. The forebay and tailrace and transitions for the pump station are similar to the description above for the 17th Street pump station.

The pump station on Orleans Avenue Canal is designed to pump 2,690 cfs. The superstructure and substructure are designed to accommodate a future total discharge of 3,390 cfs. The installed pumps could include a combination of diesel and electric driven pumps from 1,000 cfs down to 250 cfs. Refer to the page titled “Pump Sizes” in

Appendix E for the specific number of each capacity pump provided currently and for the number of future for which space has been allocated. In addition, refer to the page titled "New Orleans Major Canal Permanent Pumping Stations (2 of 2)" *Appendix E* which documents the primary design point, brake and motor horsepower requirements of the pumps at the 17th Street Canal pump station which would be similar to the requirements at Orleans Avenue Canal pump station. Electric pumps will be provided with diesel generator backup in the event of power loss at the station. Additional generating capacity for house lights and auxiliary systems will also be provided. Refer to the page titled "90-day Implementation Study, Pump Driver Power Criteria, Option 2" in *Appendix E* for details on sizing the generators for this pump station. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity. Refer to the page titled "Fuel Storage Estimate" in *Appendix E* for documentation and estimates of the fuel storage requirements for the Orleans Avenue Canal pump station.

4.2.3 London Avenue Canal Option 2 Pump Station

The London Avenue pump station includes a pile foundation, substructure, formed suction inlets for each pump bay, a pump station building, a generator building, and tank farm. No gated section is needed or provided. The forebay and tailrace and transitions for the pump station are similar to the description above for the 17th Street Canal pump station.

The pump station on London Avenue canal is designed to pump 6,880 cfs. The 6,880 cfs discharge capacity is based on construction of the Florida Avenue Diversion which is cost effective. See Section 3.2.3 for a detailed discussion of the diversion and Section 5.0 for the cost summary of the diversion. The superstructure and substructure are designed to accommodate a future total flow of 7,880 cfs. The installed pumps could include a combination of diesel and electric driven pumps from 1,000 cfs down to 250 cfs. Refer to the page titled "Pump Sizes" in *Appendix E* for the specific number of each capacity pump provided currently and for the number of future for which space has been allocated. In addition, refer to the page titled "New Orleans Major Canal Permanent Pumping Stations (2 of 2)" *Appendix E* which documents the primary design point, brake and motor horsepower requirements of the pumps at the 17th Street Canal pump station which would be similar to the requirements at London Avenue Canal pump station. Electric pumps will be provided with diesel generator backup in the event of power loss at the station. Refer to the page titled "90-day Implementation Study, Pump Driver Power Criteria, Option 2" in *Appendix E* for details on sizing the generators for this pump station. Additional generating capacity for house lights and auxiliary systems will also be provided. The tank farm is sized for storage of sufficient fuel for four days of continuous operation at maximum capacity. Refer to the page titled "Fuel Storage Estimate" in *Appendix E* for documentation and estimates of the fuel storage requirements for the London Avenue Canal pump station.

4.2.3.1 Florida Avenue Diversion

A diversion project which is cost effective is the diversion of 1,100 cfs from DPS 3 through the Florida Avenue Canal to DPS 19 and into the IHNC, see Figure 3-7. This diversion requires that 1,100 cfs pump capacity remain at DPS 3 and be permanently directed into the Florida Avenue Canal. Plate 3 in *Appendix H* illustrates the portion of the existing pump station that will remain in service. Section 3.2.3.2 provides a complete description of the required modifications to make the Florida Avenue diversion permanent. In addition to the diversion, the bypass of the existing DPS 3 must be completed as illustrated in *Appendix H*, Plate 8 to maintain the portion of the pump station and discharge flume that will be utilized for the Florida Diversion.

The diversion is assumed to operate whenever a rain event occurs which would result in the activation of the new London Avenue Canal pump station. Thus, implementing this diversion allows the new pump station to be designed for 7,880 cfs with an installed pump capacity of 6,880 cfs. This reduction in pumping capacity results in a reduction of pumps as is documented in the page titled “Pump Sizes” in *Appendix E.* The diversion also allows for a reduction in London Avenue Canal flow capacity to a capacity of 7,880 cfs. If the Florida Avenue diversion is not utilized upon each rain event, a careful operation plan must be developed to insure the London Avenue Canal or pump capacity is not exceeded. Exceeding the pump station or canal capacities could result in localized flooding. The cost of the improvements required for the diversion and the reduced cost of the London Avenue Canal and Pump station are provided in Appendix I and summarized in Section 5.0.

4.3 Option 2a: Option 2 in Combination with Hoey’s Basin Diversion (Discharges Directly to the Mississippi River in Jefferson Parish)

Option 2a is similar to Option 2 with the addition of the Hoey’s Basin diversion to divert storm water from Jefferson Parish to the Mississippi River. This diversion was investigated as required by Title III, Chapter 3 of Public Law 110-252. The diversion is completely described in Section 3.2.3.1., and includes modifications to Hoey’s canal, a new pump station in Jefferson Parish, a 13-foot diameter force main installed above and below grade, a levee crossing and a diffuser structure within the Mississippi River.

This diversion, if implemented, was assumed to operate whenever a rain event occurs that activates the new 17th Street Canal pump station. Thus by implementing this diversion allows the new 17th Street Canal pump station to be designed for 10,900 cfs with an installed pump capacity of 8,900 cfs. This reduction in pumping capacity results in a reduction of pumps as is documented in the page titled “Pump Sizes” in *Appendix E.* The diversion also allows for a reduction in the deepened 17th Street Canal capacity to 10,900 cfs. If the Hoey’s Basin diversion is not utilized upon each rain event, a careful operation plan must be developed to insure the 17th Street Canal or pump station capacity is not exceeded at any point during operation. Exceeding the pump station or canal capacities could result in localized flooding.

Table 4-6 presents the overall geometry of Pump Station 2a. Note the length at 17th Street Canal pump station is reduced and indicated on the page titled "Approximate Pump Building Lengths" in *Appendix E.* This is a direct result of the reduction of the number pumps provided in the pump station. In addition, the page titled "Summary of Pump Station Information" in *Appendix E* summarizes the electrical and mechanical components of the pump stations. Note the decrease in fuel storage, number of generator and number of pumps documented for the 17th Street Canal pump station when the Option 2 and Option 2a are compared. The amount of fuel storage required is indicated on the page titled "Fuel Storage Estimate" in *Appendix E.* In addition, the number of generators required in indicated on the page titled "90-day Implementation Study, Pump Driver Power Criteria, Option 2a" in *Appendix E*.

TABLE 4-6 – Option 2a Pump Station Plan Geometry

	Canal					
	17th Street		Orleans Avenue		London Avenue	
Feature	Length (ft)	Width (ft)	Length (ft)	Width (ft)	Length (ft)	Width (ft)
Pump Station	330	80	130	80	300	80
Inlet Structure	400	40	130	40	300	40
Outlet Structure	400	20	130	20	300	20
Generator Building	310	70	70	70	280	70
Gated Section	Gated Section not feasible for Option 2 pump stations					

Both the reduction in pump station capacity and canal capacity result in a cost savings. However, the overall cost of the diversion is higher than the cost saving incurred from 17th Street Canal pump station or canal capacity reductions. The cost of the diversion components and the increased overall project cost are provided in *Appendix I* and summarized in Section 5.0.

4.4 Option 2 Modified and 2a Modified: Similar to Options 2 and 2a Excluding a Breakwater

Option 2 Modified and Option 2a Modified are similar to Option 2 and 2a with the exception that the breakwater is removed from the 17th Street and Orleans Avenue Canal pump stations and that all the pump stations and support facilities are modified to include a stilling basin/weir as shown in Figure 3-26. Other aspects including the canal modifications and DPS decommissioning and removal are consistent between the Option 2 and Option 2a and Option 2 Modified and Option 2a Modified.

As described in Section 3.4.4., the addition of a stilling basin/weir increases the tail water elevation of the pump station, effectively increasing the fuel, generator, pump head and driver sizes required of the pump systems. A summary of the number fuel tanks, generators, and size of the pump drivers is included on the page titled "Summary of Pump Station Information" in *Appendix E*. The increase in primary operating head and motor horsepower is indicated on the page titled "New Orleans Major Canal Permanent

Pumping Stations (2 of 2) found in *Appendix E*. The amount of fuel storage required is indicated on the page titled "Fuel Storage Estimate" in *Appendix E*. In addition, the number of generators required is indicated on the page titled "90-day Implementation Study, Pump Driver Power Criteria, Option 2 Modified" and the page titled "90-day Implementation Study, Pump Driver Power Criteria, Option 2a Modified, " both of which are found in *Appendix E*.

The overall pump outlet structure size and geometry is modified by the inclusion of the stilling basin/weir. The overall pump station width will match the lengths of Option 2 and Option 2a respectively. The overall pump station width will match the Option 1 Base Adaptable which in a similar manner includes a stilling basin. Table 4-7 indicates the overall geometry of the Option 2 Modified Pump Station and Table 4-8 indicates the overall geometry of the Option 2a Modified Pump Station geometry.

TABLE 4-7 – Option 2 Modified Pump Station Plan Geometry

Feature	Canal					
	17th Street		Orleans Avenue		London Avenue	
	Length (ft)	Width (ft)	Length (ft)	Width (ft)	Length (ft)	Width (ft)
Pump Station	400	80	130	80	300	80
Inlet Structure	400	40	130	40	300	40
Outlet Structure	400	65	130	65	300	65
Generator Building	580	70	100	70	400	70
Gated Section	Gated Section not feasible for Option 2 Modified pump stations					

TABLE 4-8 – Option 2 a Modified Pump Station Plan Geometry

Feature	Canal					
	17th Street		Orleans Avenue		London Avenue	
	Length (ft)	Width (ft)	Length (ft)	Width (ft)	Length (ft)	Width (ft)
Pump Station	330	80	130	80	300	80
Inlet Structure	400	40	130	40	300	40
Outlet Structure	400	65	130	65	300	65
Generator Building	490	70	100	70	400	70
Gated Section	Gated Section not feasible for Option 2a Modified pump stations					

4.5 Four Phased Construction Approach to Convert an Adaptable Option 1 Pump Station into an Option 2 Pump Station

A four phase construction approach has been developed to convert an Adaptable Option 1 pump station into an Option 2 or 2a project in the future. Studies were performed to determine the features and sequencing required to accomplish the required transition. Each construction phase is intended to be a stand-alone project that when complete allows for the drainage system to evacuate storm water during all phases of the process. The construction sequencing has been evaluated in four distinct phases as follows:

- ✓ Construction Sequence No. 1 – Construct an Adaptable Option 1 pump station including demolition of the existing ICS facilities.

- ✓ Construction Sequence No. 2 – Construct cost effective diversion systems to reduce the required flow of the canals.

- ✓ Construction Sequence No. 3 – Deepen the existing canals to permit gravity flow of storm water to the new pump stations. Convert the pump station substructure, pump components and motors to the larger sizes and upgrade the supporting generating and fuel storage capacity required for the increase in lift height.

- ✓ Construction Sequence No. 4 – Using reconfigured pump stations; pump the canals down to the new required water surface elevation. Construct bypass around existing pump stations and demolish existing pump stations, fill and re-grade site to new canal cross section.

After Construction Sequence No. 1 is completed the pump station will operate in series with the existing SWBNO drainage pump stations. The pumps and ancillary equipment will be designed for the lower lift requirements for lifting the water from the current water surface elevation in the canal to the storm surge elevation in the Lake. Also included is the demolition of the existing ICS facilities.

Construction Sequence No. 2 includes the consideration of several diversion projects. If the flow in any of the canals can be reduced by diverting some of the storm water to another location, the future cost of the deepening of the canal could be reduced because lower flow requires less excavation. In addition, if the flow in the canals is reduced then the required future pump capacity at the new pump station will be reduced.

Section 3.2.3 provides a detailed discussion of the diversion alternatives. Cost estimates are provided in Appendix I for each of the diversion projects. The costs were compared to the cost of Option 2 without diversions to determine whether the proposed diversions were effective in reducing the overall cost of Option 2.

Diversions could be constructed independent of any other Construction Sequence. If diversions are desired, the greatest benefit will be obtained by construction of the diversion project as early as possible, even prior to construction of the Option 1 pump station. This allows taking maximum advantage of the cost savings that can be produced by implementation of the diversion projects.

Construction Sequence No. 3 is the first step in converting the Option 1 pump station into an Option 2 full project. This sequence includes deepening of the existing canals, upgrading the Option 1 pumps to Option 2 pumps, and installation of additional generating capacity and fuel tanks. Deepening of the canal will include modification of bridge foundations and relocation of utilities. During construction the existing pump station will still operate in series with the new Option 2 pump station. Once the Option 2 pumps are in service and the canal and bridge modifications are complete, the elevation of the water surface in the canals will be lowered. The existing drainage pump stations will discharge into the lowered canal with minimal differential between the intake and discharge sides of the pump stations.

Construction Sequence No. 4 includes bypass and decommissioning of the existing pump stations. The permanent by-pass will be constructed to divert water around the existing pump stations. Once the by-passes are functioning the existing pump stations will be decommissioned. The space occupied by the pump station will be filled to the existing ground elevation. A dry weather weir is constructed at the approximate location of the existing pump stations. Small pump stations will be constructed to pump the collected dry weather flows to the existing dry weather flow system which discharges to the Mississippi River.

Construction Sequence No. 3 and No. 4 may be implemented under the same construction contract; however, construction scheduling is critical to ensure that the existing storm water drainage system remains operable during construction and the canals maintain existing full flow capacities. For example, the construction of the bypass around the existing drainage pump stations could be in progress while completing the canal deepening. Once the canal deepening is completed and the water surface elevation is lowered, the bypass could be opened. As soon as the bypass is opened, the existing pump stations are no longer required, and the system operates in the full Option 2 mode.

Once the water surface elevation of the canal is permanently lowered, the existing levees and walls which formed the parallel protection system are no longer required and could be demolished. Since the new water surface elevation in the canal is lower than the existing grade surrounding the canal, the existing levees and flood walls could be demolished to approximately the level of the surrounding grade. In some cases, surrounding interior drainage may be reconfigured to drain through drainage swales and ditches into the lowered canals instead of being directed toward the location of the demolished pump stations.

APPENDIX A

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APPENDIX B

Design Criteria

The following design criteria and assumptions are a product of engineering judgment, lessons learned during project evaluation and study, input from New Orleans District and input from stakeholders. All elevations are provided in NAVD88 (2004.65) datum.

1.0 Hurricane Protection Office and New Orleans District Specified Design Criteria.

The still water elevation, design wave height and design wave period were provided by the Hurricane Protection Office per *Conceptual breakwater designs for 17th Street and Orleans Ave Canals permanent pump station protection, New Orleans, LA Hurricane Protection Project, dated August 2008.* Safe water elevations were provided by the Hurricane Protection Office in 2007. They are based on studies performed by the HPO and updated by Black & Veatch.

1.1 Static Lake Water Elevation = 10.2 ft

1.2 Design Wave Height = 8.2 ft

1.3 Design Wave Period = 6 seconds

1.4 Lake Wave Run-up for vertical walls = 9 ft

1.5 Lake Wave Run-up for sloped armored earthen walls = 4.5 ft

1.6 Pump Station Fuel system storage requirement = 4 days full flow

1.7 Life cycle cost calculations based on 50 year life

1.8 Safe Water Elevations (SWE) are as follows. For Option 1, these safe water elevations are defined to equal maximum allowable canal water surface elevation at any point along the canal. Option 1 cost estimates are developed with canal wall modifications to raise the safe water elevation above the operating canal water surface elevation.

1.8.1 17th Street Canal:
- Current SWE: 6.0 ft (official), varies between 6.5 to 13.3 ft (unofficial)

1.8.2 Orleans Canal:
- Current SWE: 8.0 ft;

1.8.3 London Avenue Canal:
- Current SWE: 5.0 ft from Lake Pontchartrain to approximately 4,000 ft north of DPS 3, 9.0 ft from 4,000 ft north of DPS 3 to DPS 3

1.9 The HEC-RAS hydraulic model provided by MVK provides the basis for canal hydraulic evaluations.

1.10 Design canal and pumping station capacities are as follows:

Table B- 1 17th Street Canal Pumping Station Capacities

17th Street Canal	Option 1	Option 2	Option 2a
Existing DPS 6 capacity	9,480 cfs	9,480 cfs	9,480 cfs
Canal Street Pump Station	160 cfs	160 cfs	160 cfs
I-10 Pump Station	860 cfs	860 cfs	860 cfs
Diversion	**N/A**	**N/A**	**1,600 cfs**
Deepened canal capacity	**N/A**	**12,500 cfs**	**10,900 cfs**
Pump capacity installed	**10,500 cfs**	**10,500 cfs**	**8,900 cfs**
Potential future pump capacity increase	2,000 cfs	2,000 cfs	2,000 cfs
Potential increased station capacity	**12,500 cfs**	**12,500 cfs**	**10,900 cfs**

Table B- 2 Orleans Avenue Canal Pumping Station Capacities

Orleans Avenue Canal	Option 1	Option 2	Option 2a
Existing DPS 7 capacity	2,690 cfs	2,690 cfs	2,690 cfs
Diversion	**N/A**	**N/A**	**N/A**
Deepened canal capacity	**N/A**	**3,390 cfs**	**3,390 cfs**
Pump capacity installed	**2,690 cfs**	**2,690 cfs**	**2,690 cfs**
Potential future pump capacity increase	700 cfs	700 cfs	700 cfs
Potential increased station capacity	**3,390 cfs**	**3,390 cfs**	**3,390 cfs**

London Avenue Canal	Option 1	Option 2	Option 2a
Existing DPS 3 capacity	4,260 cfs	4,260 cfs	4,260 cfs
Existing DPS 4 capacity	3,720 cfs	3,720 cfs	3,720 cfs
Florida Avenue Diversion to IHNC	**N/A**	**1,100 cfs**	**1,100 cfs**
Deepened canal capacity	**N/A**	**7,880 cfs**	**7,880 cfs**
Pump capacity installed	**7,980 cfs**	**6,880 cfs**	**6,880 cfs**
Potential pump capacity increase	1,000 cfs	1,000 cfs	1,000 cfs
Potential increased station capacity	**8,980 cfs**	**7,880 cfs**	**7,880 cfs**

2.0 Assumptions

The following assumptions are organized as general assumptions that govern the overall development of each solution and as Option-specific assumptions.

2.1 General Assumptions

2.1.1 Design Build project funds and necessary authorizations will be available when needed.

2.1.2 Canal capacity is based on existing pump capacity plus planned expansion.

2.1.3 Option 1 – Gated Pump Stations. New Gated Pump Stations will operate to ensure the combination of Lake Pontchartrain elevation and canal discharge do not cause the canal centerline water profile exceed the defined safe water elevation.

2.1.4 Option 2 – Deepened Canal. The Deepened Canal will operate to pump all canal discharges, except for any dry weather discharges presently pumped to the Mississippi River from each pump station. Design canal flow line elevations NAVD 88 (2004.65) at design canal discharge are as follows:

Table B- 3 Maximum Suction Side Elevations at Drainage Pump Stations (DPS)

17th Street Canal	**Pump-On WSEL**
DPS 6 suction side	-10.9 ft
Orleans Canal	WSEL
DPS 7 suction side	-9.4 ft
London Avenue Canal	WSEL
DPS 3 suction side	-9.9 ft
DPS 4 suction side	-10.4 ft

2.1.5 The By-Pass capacity which the Design Build Contractor is to maintain are as follows:
- 17th Street Canal: 9,200 cfs
- Orleans Avenue Canal: 2,200 cfs
- London Avenue Canal: 5,200 cfs

2.1.6 General Groundwater Elevation in Orleans parish = -4 to -6 ft

2.1.7 General Groundwater Elevation in Jefferson parish = -3 to -1 ft

2.1.8 No adverse subsidence will be imparted to the surrounding neighborhood. The deepened canal will be concrete-lined.

2.1.9 The following datum conversions were used:
- NGVD29 – 0.5 ft = NAVD88 (2004.65)
- Cairo Datum – 20.93 ft = NAVD88 (2004.65)

2.1.10 Property acquisition for Right-of-Way will be primarily limited to publicly held land.

2.1.11 Interior drainage rainfall intensity is based on the 10-year storm. This is defined by the local stakeholders.

2.1.12 Canal Contamination Depth (not hazardous) = 3 ft. This defines the depth of soil that requires disposal off site.

2.1.13 O&M costs include all new pump stations for 50 years.

2.1.14 The project will be designed for the 1-percent-chance-annual-exceedance (100-yr) Hurricane Protection Level.

2.1.15 The Non-Federal Sponsor (NFS) will maintain the local pump stations through decommissioning of existing drainage pump stations.

2.1.16 Necessary local agreements with the NFS are signed in appropriate time frames and do not slow the work.

2.1.17 All geotechnical issues are relatively straightforward and can be solved with prudent application of the technologies already in use in the New Orleans area and cause no major impacts.

2.1.18 Utilities are reasonably available, causing no major problems.

2.1.19 Interruptions to existing utilities due to construction are assumed to be short term and manageable.

2.1.20 Required construction by-pass capacity is specified in the RFP and the resulting contract as a Design Build contractor responsibility.

2.1.21 The Government will give Notice to Proceed (NTP) for design without all the real estate being acquired

2.1.22 A pump discharge siphon sill elevation will be set at the top of the levee elevation, roughly 18 ft, as a positive means to prevent backflow from Lake Pontchartrain to the canals during a storm event.

2.2 Option 1 Specific Assumptions

2.2.1 17th Street and Orleans Avenue Canals can accommodate existing pump station capacities without exceeding safe water elevations for Lake Pontchartrain elevations up to 5 ft.

2.2.2 London Avenue Canal can accommodate existing pump station capacities through modification of canal walls to increase the Safe Water Elevation (SWE) or through installation of a permanent closure and continuous pumping to prevent the water from exceeding the current SWE.

2.2.3 Work will be accomplished within public right-of-way. Acquisition of public right-of-way is not considered to be a significant issue.

2.2.4 If gates are included, then they are normally open to allow gravity flow through the closure structures.

2.2.5 The Interim Control Structures (ICS) facility is removed as part of this option.

2.3 Option 2 and 2a Specific Assumptions

2.3.1 In Option 2a, the flow diverted from 17th Street Canal to the Mississippi River is 1,600 cfs as reported in NY Associated (2007) and BCG Jefferson Parish Master Drainage Plan (2008).

2.3.2 Potential diversions from London Avenue Canal include 1,100 cfs from DPS 3 to the IHNC via Florida Avenue Canal and 1,000 cfs from DPS 4 to the IHNC via Dwyer Avenue Canal. The Florida Avenue Canal flow is based on diverting two 550 cfs pumps located in DPS 3 and the diversions requirements are outlined in DMJM Harris report (2006). The Dwyer Avenue Canal flow is based on approximately 1 cfs per acre of contributory area.

2.3.3 Bridge modifications are executed concurrent with canal deepening.

2.3.4 The deepened canal is concrete lined with a trapezoidal cross-section and deep soil mixing to stabilize the foundation and side slopes. A jet grout or deep soil mixed side and base seepage cut-offs are included to minimize reductions in the existing ground water table to prevent subsidence of adjacent structures.

2.3.5 If gates are included in order to facilitate the new pump station construction, then the gates are permanently closed at the start of canal deepening.

2.3.6 Real Estate Requirements to support flow diversions from 17th Street or London Avenue Canal are relatively simple and relatively easy to meet

2.3.7 Work is accomplished inside the existing right-of-way, and other public lands. Acquisition of public right-of-way is not considered to be a significant issue.

2.3.8 The bridge modifications required result in no major disruptions to major traffic arteries (i.e., I-10 and other major arterials).

2.3.9 After the canal is deepened, the existing DPS 3, 4, 6, and 7 facilities will be decommissioned and demolished to facilitate gravity drainage to the new pump stations.

2.3.10 Canal levees and floodwalls are no longer required for hurricane protection and will be removed.

2.4 Specific Assumptions for Phasing from Adaptable Option 1 to Option 2 or Option 2a Pump Stations

2.4.1 A four phased construction approach will facilitate conversion of an adaptable Option 1 to an Option 2 or Option 2a pump station. The four phases, or construction sequences, are defined as follow:

- Construction sequence I includes the construction of the permanent pump stations at the discharge of each canal. The pump stations are designed to accommodate the deepened canal. Construction sequence I is equivalent to Option 1 construction.
- Construction sequence II includes construction of diversions.
- Construction sequence III includes stabilization and deepening of the canals, modification of the pump station intakes and pump modifications for the increased head.
- Construction sequence IV includes decommissioning and demolition of the existing DPS and removal of the existing canal floodwalls and earthen levees.

2.4.2 Each phase may be implemented as a separate construction contract. Each phase may be implemented as a Design/Build contract.

2.4.3 Hoey's Basin and IHNC Diversions are two separate design/build contracts that are separate from the four phase construction approach. However, implementation of these diversions must be coordinated with the four phase approach.

2.4.4 Pumps are replaced or modified in construction sequence III, to increase the required horsepower to handle the increased head.

2.4.5 Additional new generators and fuel storage will be constructed and installed in construction sequence III

2.4.6 Construction sequence I motors are replaced in construction sequence III.

2.4.7 Construction sequence III and construction sequence IV are executed together in three (3) Separate Design Build contracts, one for each canal.

2.4.8 Construction sequence IV required real estate is available by end of construction sequence III.

3.0 Criteria Developed Using Engineering Calculations and Models:

3.1 Pump Design Criteria.

Refer to pages titled New Orleans Major Canal Permanent Pumping Stations Pages 1 and 2 of 2) in *Appendix E* for a summary of pump design criteria.

3.2 Site Selection.

The selected sites are:

a. 17th Street Canal – Site A

b. Orleans Avenue Canal – Site B

c. London Avenue Canal – Site C

3.3 Canal Hydraulics.

Appendix C describes the hydraulic model used for this study. The following tables summarize the results of the modeling used as the study basis throughout the report.

Table B- 4 Canal Water Surface Elevations for Existing Canal Geometry and Pumping Capacities

New Orleans Permanent Protection Project
Option 1 (Construction Sequence 1) Canal Hydraulics - Pumping Mode
Existing Canal Geometry and Existing Pumping Capacity

Canal	Total Q cfs	Safe Water Elevation ft, NAVD88	At Suction Side-New PS Flowline EL ft, NAVD88		At Existing DPS Flowline EL ft, NAVD88	
17th	10500	6.0	1.0		5.5	
Orleans	2690	8.0	1.0		3.6	
London	7980	5.0[1], 9.0[2]	-1.0		7.3	

Table B- 5 Canal Water Surface Elevations for Existing Canal Geometry and Future Pumping Capacities Reduced by Flow Diversions

New Orleans Permanent Protection Project
Construction Sequence 2 Canal Hydraulics - Pumping Mode
Existing Canal Geometry and Future Pumping Capacity Reduced by Flow Diversions

Canal	Total Q cfs	Safe Water Elevation ft, NAVD88	At Suction Side-New PS Flowline EL ft, NAVD88		At Existing DPS Flowline EL ft, NAVD88	
17th	10900	6.0	1.0		5.7	
Orleans	3390	8.0	1.0		4.3	
London	7880[3]	5.0[1], 9.0[2]	-1.0		5.8	
London	7980[4]	5.0[1], 9.0[2]	-1.0		7.3	

[1] Current safe water elevation from approximately 4,000 feet downstream of DPS 3 north to Lake Pontchartrain
[2] Current safe water elevation from DPS 3 north to approximately 4,000 feet downstream of DPS 3
[3] 1,100 cfs diverted from DPS 3 to IHNC via Florida Avenue Canal
[4] 1,000 cfs diverted from DPS 4 drainage area to IHNC via Dwyer Avenue Canal

Table B- 6 Canal Water Surface Elevations for Deepened Canal and Future Pumping Capacities Without Flow Diversions

New Orleans Permanent Protection Project
Construction Sequence 3 Canal Hydraulics *Without Diversions* – Pumping Mode
Deepened Canal Section Without Diversions

Canal	Total Q cfs	x-Section Width ft	At Suction Side-New PS Flowline EL ft, NAVD88	At Suction Side-New PS Invert EL ft, NAVD88	At Existing DPS Flowline EL ft, NAVD88	At Existing DPS Invert EL ft, NAVD88
Rectangular Cross Section, Sheet Pile Walls, Tremie Concrete Bottom						
17th	12500	150	-14.0	-29.8	-10.9	-24.0
Orleans	3390	100	-12.0	-19.5	-9.4	-19.5
London	8980	100	-13.0	-28.0	-9.9	-20.8
Trapezoidal Cross Section (1:1 side-slope), Fabric Form Lining						
17th	12500	150	-14.0	-29.5	-10.9	-24.0
Orleans	3390	100	-12.0	-19.5	-9.4	-19.5
London	8980	80[5], 100[6]	-13.0	-29.0	-9.9	-21.6

Table B- 7 Canal Water Surface Elevations for Deepened Canal and Future Pumping Capacities With Flow Diversions

New Orleans Permanent Protection Project
Construction Sequence 3 Canal Hydraulics *With Diversions* – Pumping Mode
Deepened Canal Section With Diversions

Canal	Total Q cfs	x-Section Width ft	At Suction Side-New PS Flowline EL ft, NAVD88	At Suction Side-New PS Invert EL ft, NAVD88	At Existing DPS Flowline EL ft, NAVD88	At Existing DPS Invert EL ft, NAVD88
Rectangular Cross Section, Sheet Pile Walls, Tremie Concrete Bottom						
17th	10,900	150	-14.0	-27.5	-10.9	-24.0
Orleans	3390	100	-12.0	-19.5	-9.4	-19.5
London	7880	100	-13.0	-26.1	-9.9	-19.6
London	7980	100	-13.0	-27.4	-9.9	-20.2
Trapezoidal Cross Section (1:1 side-slope), Fabric Form Lining						
17th	10,900	150	-14.0	-27.2	-10.9	-24.0
Orleans	3390	100	-12.0	-19.5	-9.4	-19.5
London	7880[7]	80[5], 100[6]	-13.0	-27.1	-9.9	-20.0
London	7980[8]	80[5], 100[6]	-13.0	-28.5	-9.9	-21.1

[5] Bottom width of channel between existing DPS 3 and DPS 4
[6] Bottom width of channel between existing DPS 4 and new pump station
[7] 1,100 cfs diverted from DPS 3 to IHNC via Florida Avenue Canal
[8] 1,000 cfs diverted from DPS 4 drainage area to IHNC via Dwyer Avenue Canal

3.4 Summary of Longitudinal Canal Profiles

A general overview of the operating water surface elevations in each canal is shown in the figures below.

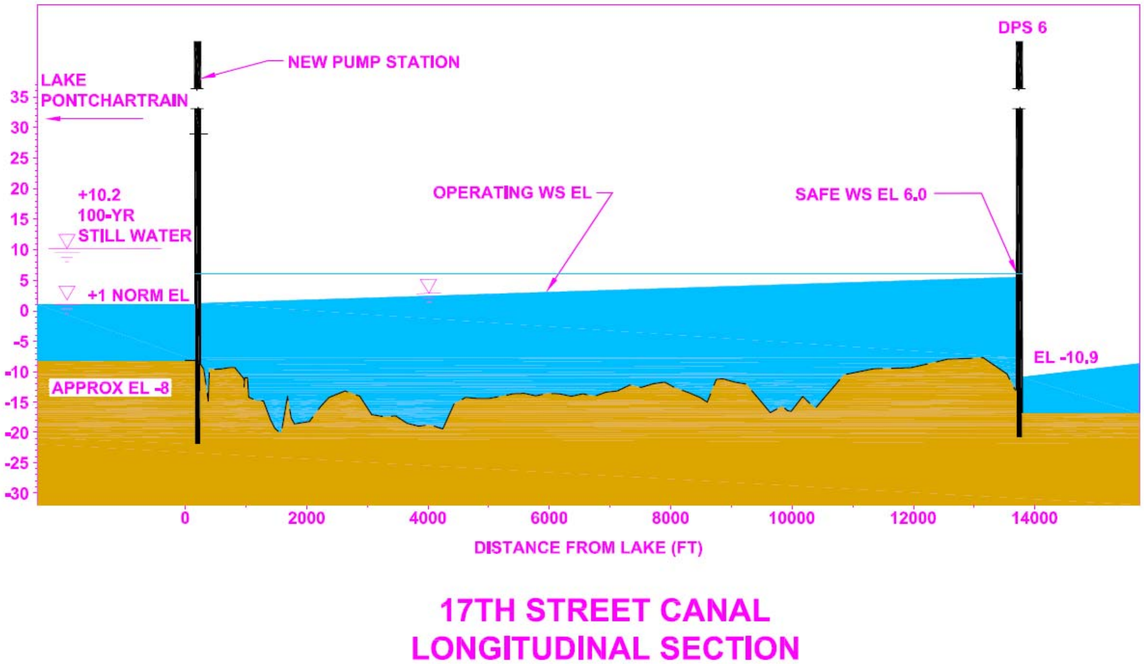

Figure B- 1 17th Street Canal Longitudinal Profile for Option 1

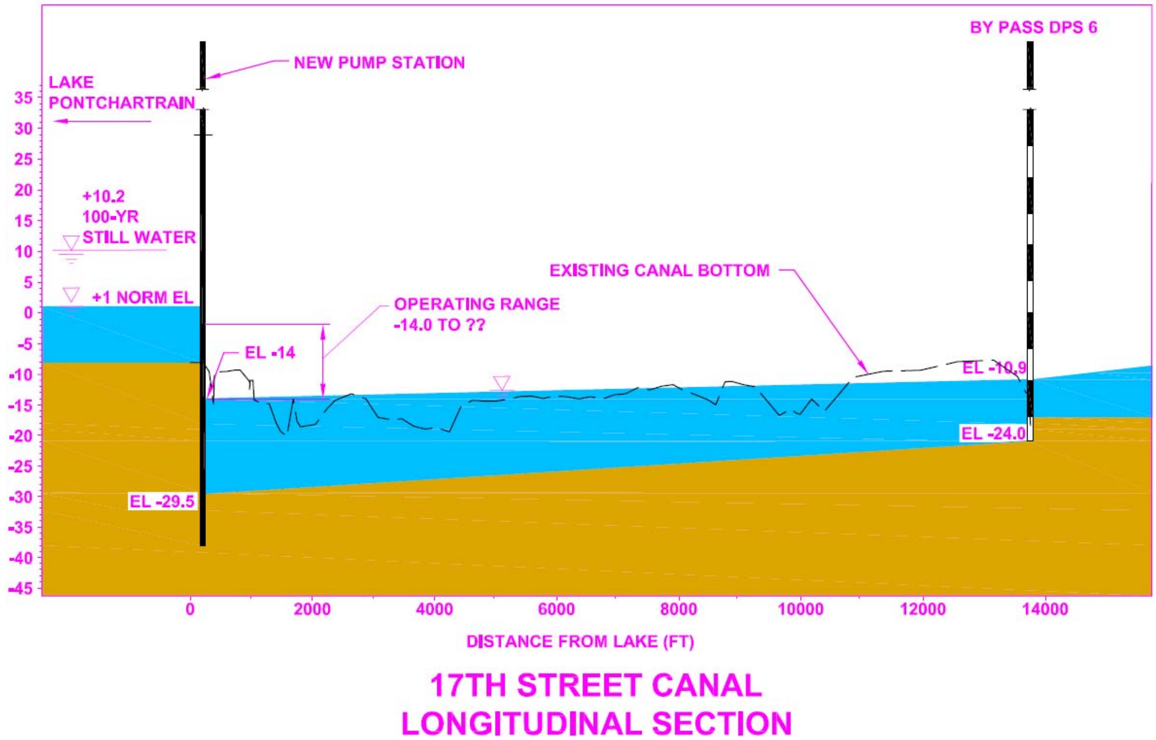

Figure B- 2 17th Street Canal Longitudinal Profile for Option 2

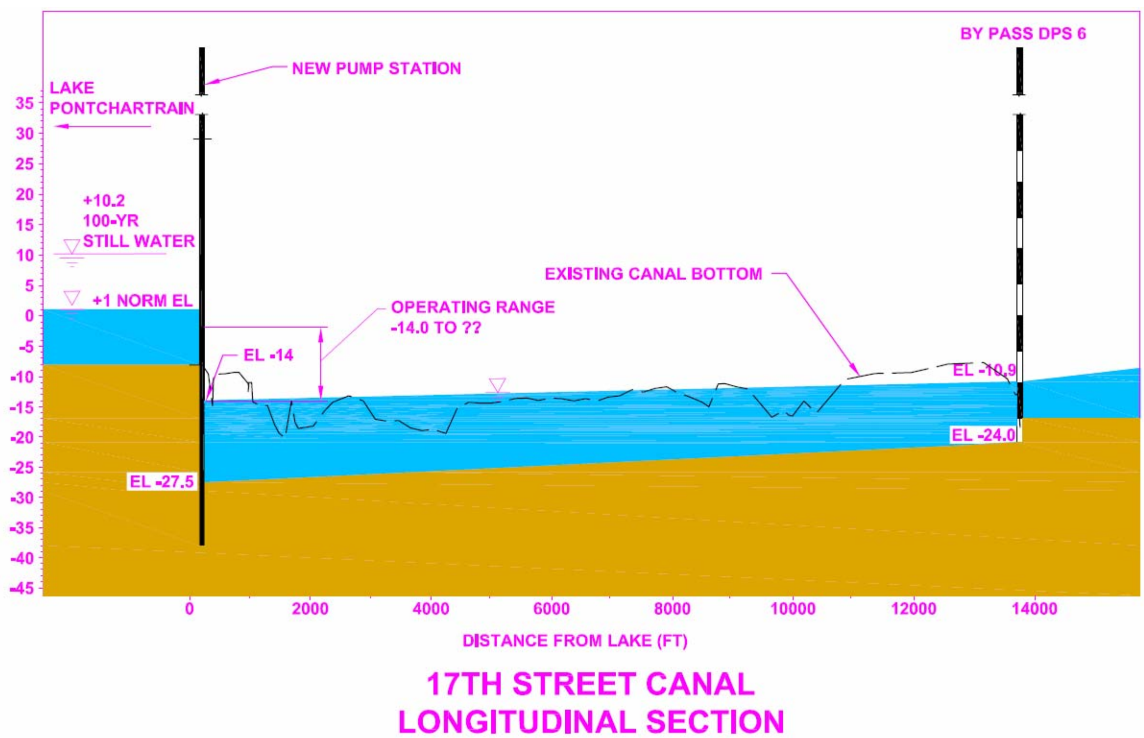

Figure B- 3 17th Street Canal Longitudinal Profile for Option 2a

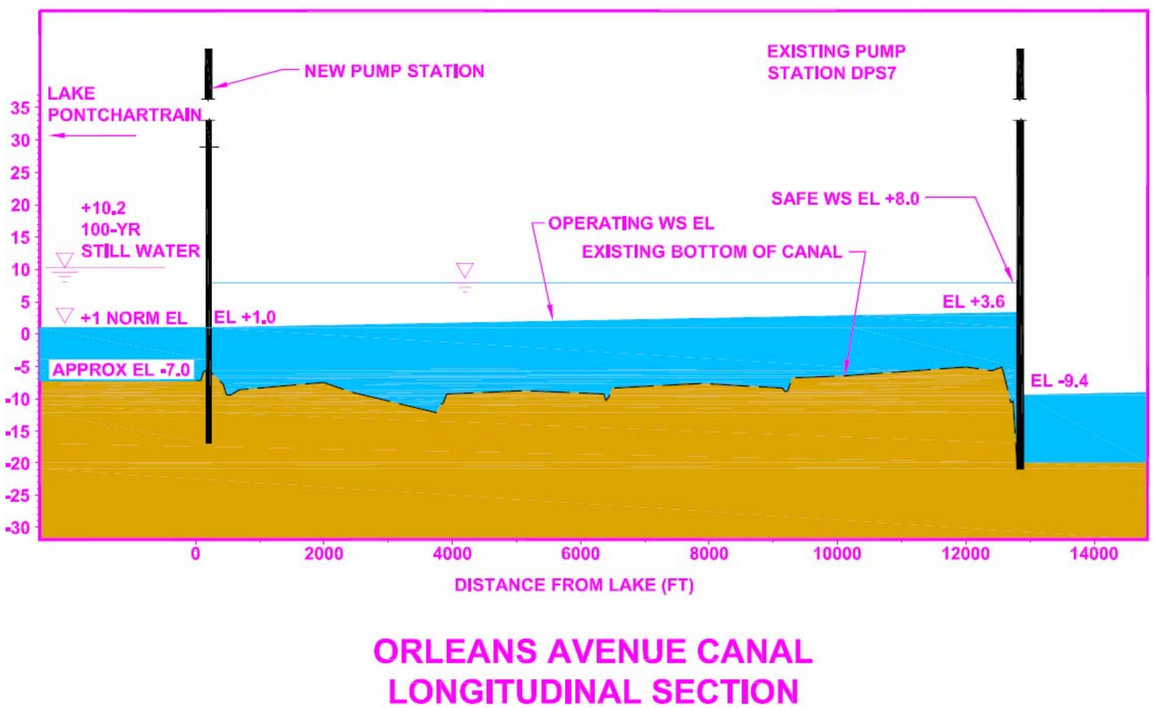

Figure B- 4 Orleans Avenue Canal Longitudinal Profile for Option 1

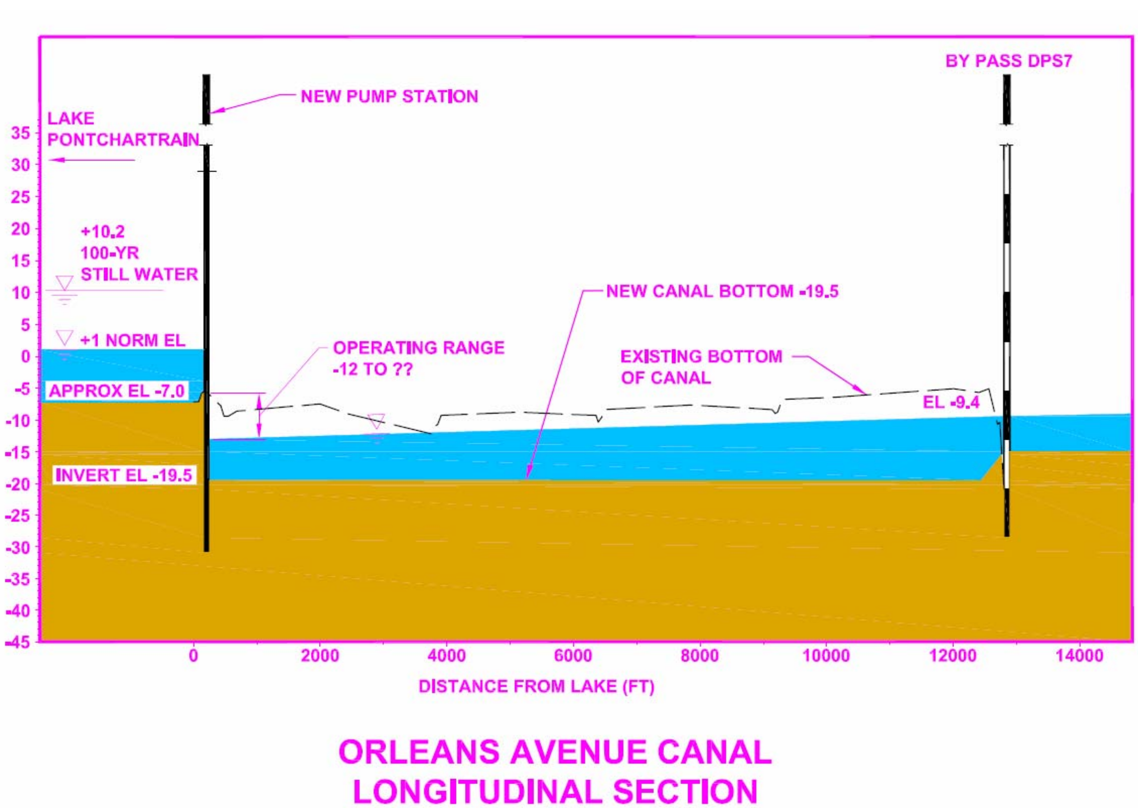

Figure B- 5 Orleans Avenue Canal Longitudinal Profile for Option 2

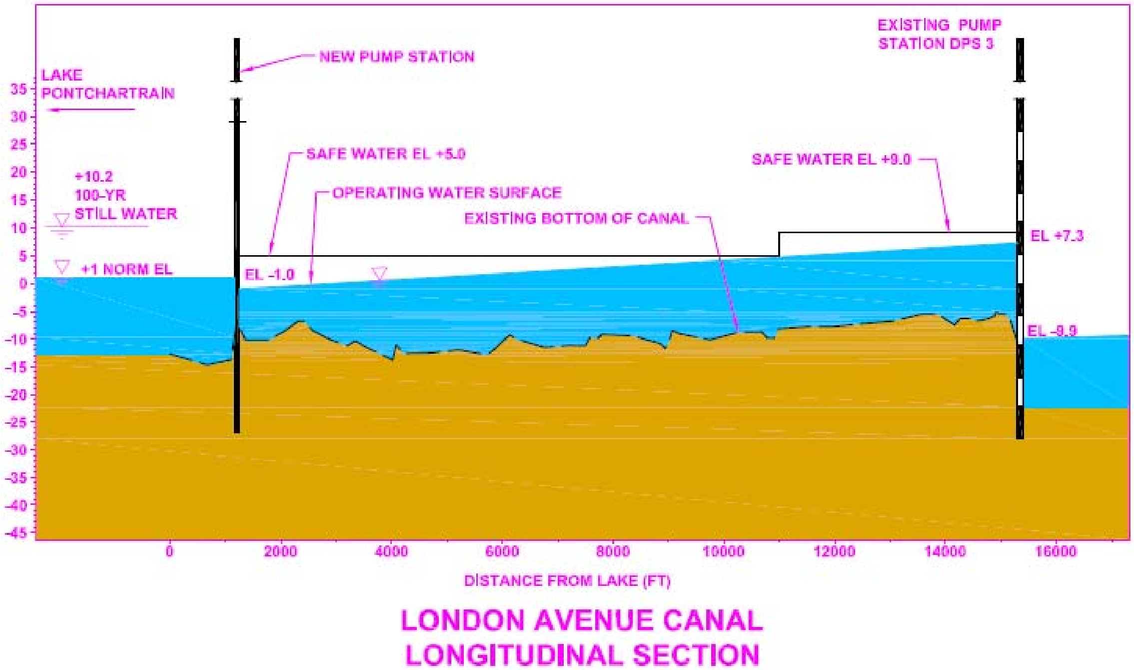

Figure B- 6 London Avenue Canal Longitudinal Profile for Option 1

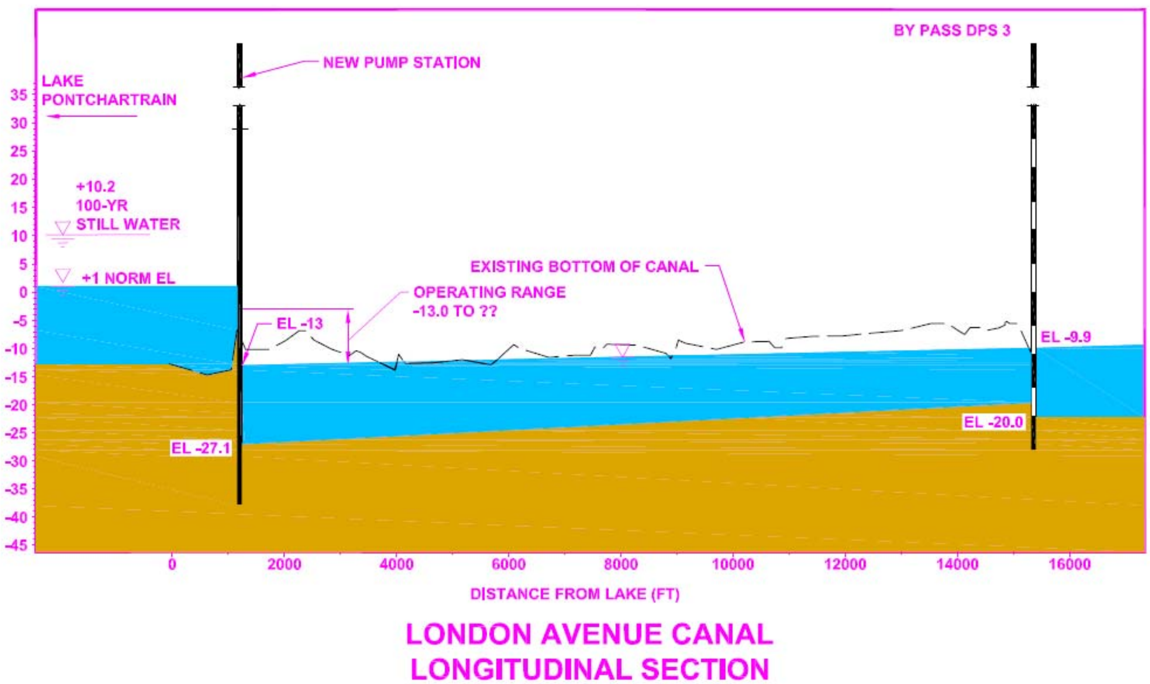

Figure B- 7 London Avenue Canal Longitudinal Profile for Option 1

APPENDIX C

Hydraulic Analysis

C.1. Hydraulic Model

The Vicksburg District Corps of Engineers developed an HEC-RAS hydraulic model of the three outfall canals for the Hurricane Protection Office as part of the Interagency Performance Evaluation Team (IPET) analysis of Hurricane Katrina. The canal geometry, including bridge data, was updated in 2006 and 2007 as part of the Operating Scenario Analysis (Black & Veatch, 2008). This existing conditions Vicksburg District HEC-RAS model was used to determine water surface profiles for the Option 1 scenarios described below.

For the Option 2 and Option 2a modeled scenarios, the existing conditions canal geometry was modified to a deepened canal using the Channel Design/Modification Tool in HEC-RAS version 4.0.

The HEC-RAS model elevations for both existing conditions and the deepened canal are in NAVD88 (2004.65).

C.2. Modeled Canal Flows

An Option 1 pump station would operate in series with the existing New Orleans Sewerage and Water Board drainage pump stations. The canals would not be deepened, but would remain in their existing condition. The existing drainage pump station capacities and the proposed future capacities were modeled as canal flows. The modeled canal flows for each of the three outfall canals are shown in Table C- 1.

Table C- 1 Existing Canal Geometry Modeled Canal Flows

	Modeled Canal Flow (cfs)	
Canal	Existing	Future
17th Street	10,500	12,500
Orleans Avenue	2,690	3,390
London Avenue	7,980	8,980

An Option 2 or Option 2a pump station would require a deepened canal in order to allow stormwater to gravity drain to the new pump station. Diversions of flow from 17th Street or London Avenue Canals have the potential to reduce the required pump station capacity, as well as reduce the amount of canal deepening required. The deepened canal modeled flows are shown in Table C- 2.

Table C- 2 Deepened Canal Geometry Modeled Canal Flows

Canal	Maximum Future Capacity (cfs)	Potential Diversion (cfs)	Modeled Canal Flow (cfs)
17th Street	12,500	0	12,500
		1,600	10,900
		2,400	10,100
Orleans Avenue	3,390	0	3,390
London Avenue	8,980	0	8,980
		1,000	7,980
		1,100	7,890

Two potential 17th Street Canal flow diversions were modeled to reflect two variations of the Hoey's Basin Pump to the Mississippi River project: 1,600 and 2,400 cfs. The 1,600 cfs project was recommended by Brown Cunningham and Gannuch in their 2008 Master Drainage Plan for Jefferson Parish (March 2008). Therefore, the Option 2a deepened canal invert is based on reducing the 17th Street Canal flow by a 1,600 cfs diversion, that is, modeling 10,900 cfs in 17th Street Canal. The results of modeling a 2,400 cfs flow diversion, 10,100 cfs in 17th Street Canal, are presented in this appendix for information only.

Two potential London Avenue Canal diversions were modeled: (1) 1,000 cfs diversion from DPS 4 to the IHNC via an improved Dwyer Avenue Canal and new pump station at Dwyer Avenue Canal and (2) 1,100 cfs diversion from DPS 3 to the IHNC via the Florida Avenue Canal. Only the second diversion proved to be potentially cost effective; therefore, the Option 2 and Option 2a deepened canal inverts are based on the results of modeling 7,890 cfs in London Avenue Canal. The results of modeling the 1,000 cfs diversion from DPS 4 are presented in this appendix for information only.

C.3. Roughness Factors

The Manning's n-values used in the existing conditions HEC-RAS model were determined by the Vicksburg District and are shown in Table C- 3.

Table C- 3 Summary of Roughness Factors for Existing Conditions Model

Canal	Manning's n-value
17th Street	0.020 – 0.025
Orleans Avenue	0.025 – 0.030
London Avenue	0.020 – 0.038

The Manning's n-values used in the deepened canal HEC-RAS model were set to either 0.020 or 0.022.

Two types of deepened canal cross sections were modeled: (1) a rectangular cross section with vertical side walls of steel sheet-pile and a tremie concrete bottom and (2) a trapezoidal cross section with 1:1 side slopes and uniform fabric-form over the entire cross section. The calculations of Manning's n-values for the deepened canal cross sections are described below.

Rectangular cross section. Manning's n for corrugated metal is 0.025 to 0.030 (normal to maximum values). Sheet pile Manning's n value is taken to be 0.025. Manning's n for unfinished concrete is 0.017 to 0.020 (normal to maximum values). Increasing n for an unclean channel by 10% is recommended in the literature (Stonestreet, Copeland, and McVan, 1991). Therefore, the unfinished concrete Manning's n value is taken to be 0.019. (0.017 increased by 10%) A consolidated Manning's n value of 0.020 is used for the rectangular cross section:

> Assume 15' depth, 100' bottom width. Therefore, 30' of wetted perimeter exposed to n=0.025 and 100' to n=0.019. Weighted n= (100/130*0.019 + 30/130*0.025) = 0.020.

Trapezoidal cross section. Manning's n for uniform section fabric-form is 0.020 according to Hydrotex, a manufacturer. A value of 0.022 is used per a 6/26/08 email from Hydrotex stating 0.022 is on the "high side" (Evans, 2008). Since the entire trapezoidal cross section is lined with fabric-form, a Manning's n value of 0.022 is used for trapezoidal cross section.

Because it is more cost effective, the Option 2 and Option 2a cost estimates are based on a deepened trapezoidal cross section. The results of modeling the rectangular cross section are presented in this appendix for information only.

C.4. Results for Option 1, Existing Conditions Canal

Results for Option 1 include gates open, where the downstream boundary condition is the water surface elevation of Lake Pontchartrain, and pumping mode where the downstream boundary condition is the suction side flowline elevation at the Option 1 pump station. Additionally, an analysis of various gate sizes was performed.

The following figures and tables are HEC-RAS output for 17th Street, Orleans Avenue Canal, and London Avenue Canal for the flows shown in Table C- 1. The gates open results are for Lake Pontchartrain elevations of 5 feet, 6 feet and 3 feet NAVD88 (2004.65), respectively. For the given flows, these are the maximum lake elevations requiring gate closure proposed in the Operating Scenario Analysis (Black & Veatch, 2008) and were developed assuming improvements to the safe water elevations along London Avenue Canal. The pumping mode results assume a suction side elevation of 1 foot for 17th Street and Orleans Avenue Canals, and a suction side elevation of -1 foot for London Avenue Canal.

A gate analysis was performed to confirm that the size of the gate did not result in an increase of the water surface elevation in the canal above the safe water elevation. Gate widths used for the cost estimates of the pump stations with gates were 60 feet, 40 feet, and 60 feet for 17th Street, Orleans Avenue and London Avenue Canals, respectively. The following table shows the coefficients used for the gate analysis.

Table C- 4 HEC-RAS Gate and Weir Coefficients for New Pump Station Gate

Canal	Coefficient			
	Gate Discharge	Gate Orifice	Gate Weir	Overflow Weir
17th Street	0.6	0.8	3.0	2.6
Orleans Avenue	0.6	0.8	3.0	2.6
London Avenue	0.6	0.8	3.0	2.6

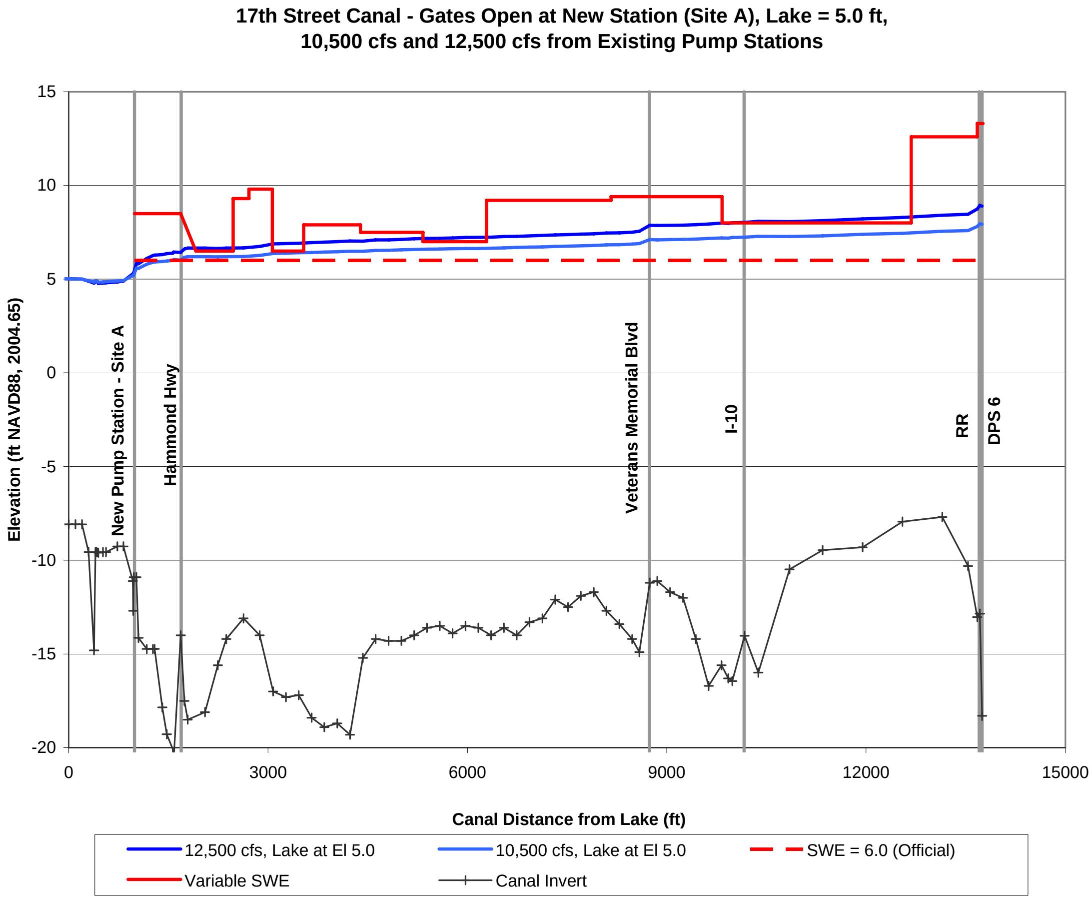

Figure C- 1 17th Street Canal Water Surface Profiles for Lake Pontchartrain Elevation 5.0 ft

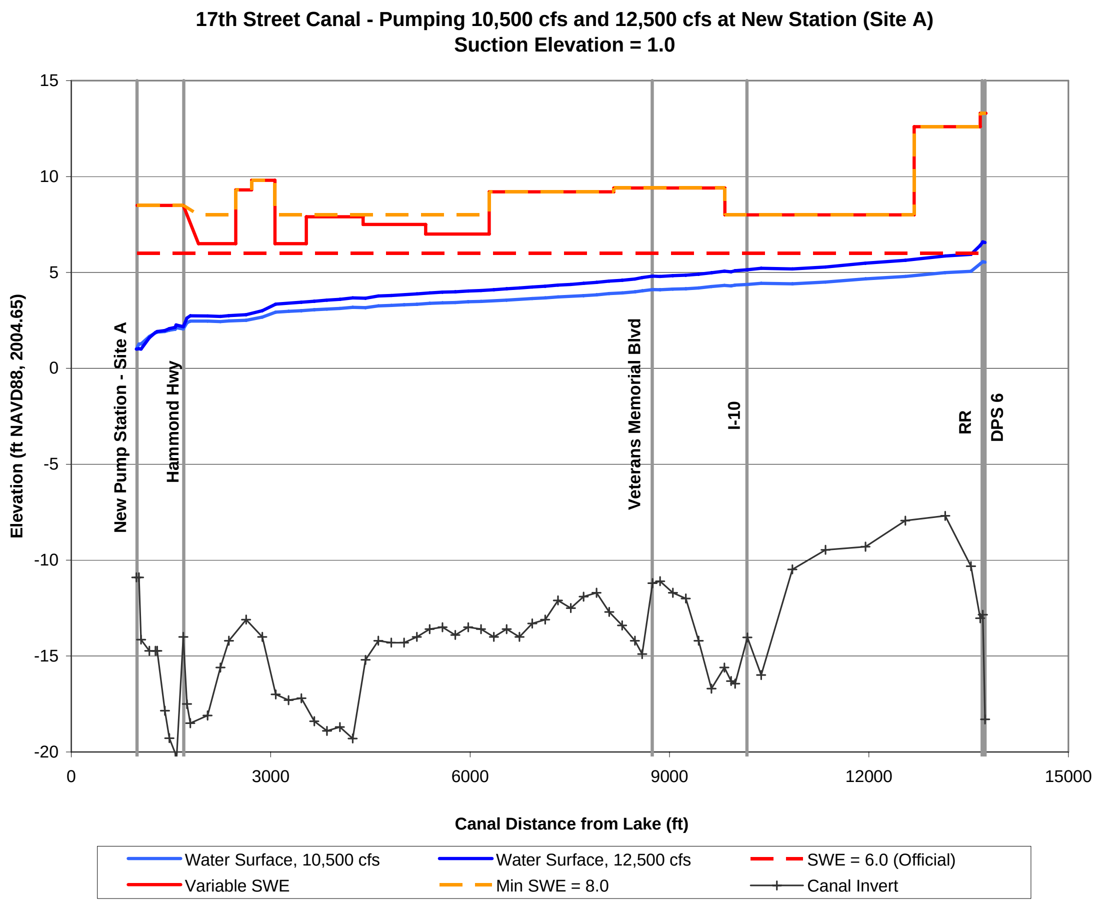

Figure C- 2 17th Street Canal Water Surface Profiles for Pumping at New Station

Option 1

17th Street Canal HEC-RAS Results for Gates Open

17th Street Canal 10,500 cfs Canal Flow, Lake = 5.0 ft

HEC-RAS Plan: 10500_lake5 River: 17th Street Reach: 1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	13748	PF 1	9480.00	-18.30	7.93		8.03	0.000041	2.58	3678.01	253.99	0.12
1	13713	PF 1	9480.00	-12.85	7.95	-6.37	8.02	0.000031	2.11	4488.32	352.96	0.10
1	13708		Bridge									
1	13673	PF 1	9480.00	-13.03	7.81	-5.81	7.89	0.000039	2.28	4154.56	354.06	0.12
1	13535	PF 1	9480.00	-10.31	7.59	-2.36	7.83	0.000123	3.99	2374.71	218.44	0.21
1	13148	PF 1	9480.00	-7.69	7.55	-1.31	7.80	0.000126	3.99	2373.10	222.55	0.22
1	12548	PF 1	9640.00	-7.94	7.45	-1.34	7.72	0.000129	4.17	2313.19	206.97	0.22
1	11948	PF 1	9640.00	-9.30	7.39	-2.37	7.65	0.000114	4.07	2369.17	198.04	0.21
1	11348	PF 1	9640.00	-9.46	7.31	-2.33	7.58	0.000120	4.13	2334.85	199.65	0.21
1	10848	PF 1	9640.00	-10.48	7.27	-3.15	7.51	0.000103	3.96	2434.17	204.23	0.20
1	10379	PF 1	10500.00	-15.99	7.28	-6.62	7.48	0.000071	3.65	2889.55	213.36	0.17
1	10171	PF 1	10500.00	-14.03	7.24	-5.98	7.46	0.000072	3.81	2770.88	191.29	0.17
1	10161		Bridge									
1	9987	PF 1	10500.00	-16.44	7.22	-7.09	7.41	0.000059	3.48	3025.21	203.64	0.16
1	9927	PF 1	10500.00	-16.30	7.19	-6.33	7.40	0.000060	3.68	2905.19	201.53	0.16
1	9824	PF 1	10500.00	-15.60	7.20	-7.13	7.38	0.000049	3.39	3150.52	210.87	0.14
1	9631	PF 1	10500.00	-16.70	7.17	-6.90	7.37	0.000059	3.63	2944.76	202.02	0.16
1	9438	PF 1	10500.00	-14.20	7.14	-5.44	7.36	0.000067	3.78	2850.84	204.17	0.17
1	9245	PF 1	10500.00	-12.00	7.12	-4.69	7.34	0.000073	3.82	2795.38	203.52	0.17
1	9052	PF 1	10500.00	-11.70	7.11	-4.52	7.33	0.000073	3.78	2827.78	207.52	0.17
1	8859	PF 1	10500.00	-11.10	7.10	-4.23	7.32	0.000074	3.77	2831.35	211.46	0.17
1	8745	PF 1	10500.00	-11.20	7.11	-4.77	7.30	0.000109	3.44	3048.68	225.11	0.16
1	8735		Bridge									
1	8590	PF 1	10500.00	-14.90	6.90	-6.81	7.07	0.000094	3.31	3172.63	221.17	0.15
1	8480	PF 1	10500.00	-14.20	6.87	-6.51	7.06	0.000105	3.46	3037.35	214.00	0.16
1	8287	PF 1	10500.00	-13.40	6.84	-5.58	7.03	0.000113	3.55	2956.82	211.18	0.17
1	8094	PF 1	10500.00	-12.70	6.83	-5.39	7.01	0.000103	3.39	3096.12	219.40	0.16
1	7901	PF 1	10500.00	-11.70	6.80	-5.10	6.98	0.000110	3.47	3023.06	218.08	0.16
1	7708	PF 1	10500.00	-11.90	6.78	-5.48	6.96	0.000106	3.45	3046.85	214.94	0.16
1	7515	PF 1	10500.00	-12.50	6.76	-5.43	6.94	0.000100	3.38	3108.41	215.39	0.16
1	7322	PF 1	10500.00	-12.10	6.74	-5.38	6.92	0.000096	3.34	3142.81	214.96	0.15
1	7129	PF 1	10500.00	-13.10	6.72	-5.47	6.90	0.000100	3.37	3114.20	216.48	0.16
1	6936	PF 1	10500.00	-13.30	6.71	-6.20	6.87	0.000093	3.28	3197.79	216.76	0.15
1	6743	PF 1	10500.00	-14.00	6.69	-6.39	6.86	0.000094	3.30	3183.21	215.87	0.15
1	6550	PF 1	10500.00	-13.60	6.67	-6.47	6.84	0.000088	3.24	3242.10	217.05	0.15
1	6357	PF 1	10500.00	-14.00	6.65	-6.25	6.82	0.000090	3.23	3248.67	221.32	0.15
1	6164	PF 1	10500.00	-13.60	6.64	-6.35	6.80	0.000084	3.16	3318.66	222.13	0.14
1	5971	PF 1	10500.00	-13.50	6.63	-6.45	6.78	0.000082	3.05	3443.43	238.76	0.14
1	5778	PF 1	10500.00	-13.90	6.62	-6.65	6.76	0.000077	3.03	3460.11	232.75	0.14
1	5585	PF 1	10500.00	-13.50	6.61	-6.90	6.74	0.000070	2.95	3555.16	232.38	0.13
1	5392	PF 1	10500.00	-13.60	6.60	-7.05	6.73	0.000069	2.91	3606.44	238.15	0.13
1	5199	PF 1	10500.00	-14.00	6.58	-7.02	6.71	0.000074	2.96	3544.80	236.89	0.13
1	5006	PF 1	10500.00	-14.30	6.56	-7.11	6.70	0.000072	3.00	3497.84	225.30	0.13
1	4813	PF 1	10500.00	-14.30	6.54	-7.18	6.68	0.000070	2.99	3506.35	221.83	0.13
1	4620	PF 1	10500.00	-14.20	6.53	-7.63	6.67	0.000068	2.99	3506.69	217.02	0.13
1	4427	PF 1	10500.00	-15.20	6.49	-6.38	6.65	0.000088	3.23	3246.43	213.14	0.15
1	4234	PF 1	10500.00	-19.30	6.49	-9.74	6.63	0.000063	2.97	3540.88	208.17	0.13
1	4041	PF 1	10500.00	-18.70	6.46	-8.95	6.61	0.000072	3.12	3369.62	201.40	0.13
1	3848	PF 1	10500.00	-18.90	6.45	-9.56	6.60	0.000071	3.14	3346.08	195.87	0.13
1	3655	PF 1	10500.00	-18.40	6.42	-9.29	6.58	0.000077	3.21	3275.36	198.24	0.14
1	3462	PF 1	10500.00	-17.20	6.41	-8.96	6.57	0.000078	3.22	3259.85	196.01	0.14
1	3269	PF 1	10500.00	-17.30	6.39	-8.71	6.55	0.000079	3.24	3244.44	198.93	0.14
1	3076	PF 1	10500.00	-17.00	6.37	-8.41	6.53	0.000082	3.27	3213.67	197.98	0.14
1	2873	PF 1	10500.00	-14.00	6.27	-4.50	6.50	0.000168	3.91	2687.09	206.78	0.19
1	2630	PF 1	10500.00	-13.10	6.21	-4.02	6.46	0.000171	4.00	2623.21	200.89	0.20
1	2372	PF 1	10500.00	-14.20	6.20	-5.45	6.41	0.000127	3.68	2853.97	202.58	0.17
1	2244	PF 1	10500.00	-15.60	6.19	-5.86	6.39	0.000120	3.59	2923.34	202.54	0.17
1	2051	PF 1	10500.00	-18.10	6.20	-8.62	6.36	0.000080	3.20	3282.71	208.02	0.14
1	1791	PF 1	10500.00	-18.50	6.20	-10.13	6.33	0.000056	2.81	3739.63	216.83	0.12
1	1741	PF 1	10500.00	-17.50	6.16	-8.52	6.32	0.000082	3.20	3280.78	211.79	0.14
1	1686	PF 1	10500.00	-14.00	6.02	-5.85	6.28	0.000146	4.05	2609.62	196.36	0.19
1	1674		Bridge									
1	1576	PF 1	10500.00	-20.78	6.05	-9.58	6.21	0.000076	3.30	3198.33	195.75	0.14
1	1566	PF 1	10500.00	-20.07	6.00	-9.99	6.19	0.000088	3.46	3030.50	178.00	0.15
1	1475	PF 1	10500.00	-19.28	5.97	-9.48	6.17	0.000095	3.54	2968.80	177.00	0.15
1	1408	PF 1	10500.00	-17.85	5.94	-8.36	6.14	0.000101	3.61	2909.13	178.00	0.16
1	1293	PF 1	10500.00	-14.73	5.92	-7.62	6.11	0.000088	3.44	3053.40	177.00	0.15
1	1265	PF 1	10500.00	-14.73	5.90	-7.63	6.08	0.000088	3.44	3055.71	177.00	0.15
1	1175	PF 1	10500.00	-14.73	5.80	-7.64	5.98	0.000090	3.47	3028.10	177.00	0.15
1	1050	PF 1	10500.00	-14.14	5.58	-7.49	5.78	0.000099	3.59	2922.79	177.00	0.16
1	1020	PF 1	10500.00	-10.90	5.59	-6.12	5.78	0.000097	3.45	3041.60	189.39	0.15
1	1000		Inl Struct									
1	980	PF 1	10500.00	-10.90	5.24		5.44	0.000104	3.53	2975.76	189.35	0.16
1	971	PF 1	10500.00	-12.70	5.18	-5.92	5.42	0.000145	3.97	2642.18	189.00	0.19
1	965	PF 1	10500.00	-11.10	5.19		5.38	0.000198	3.49	3004.35	189.39	0.15
1	823	PF 1	10500.00	-9.26	4.93	-2.56	5.32	0.000309	5.06	2074.76	184.54	0.27
1	731	PF 1	10500.00	-9.26	4.90	-2.56	5.30	0.000312	5.07	2069.10	184.43	0.27
1	561	PF 1	10500.00	-9.56	4.87	-2.87	5.24	0.000283	4.89	2146.62	187.83	0.25
1	515	PF 1	10500.00	-9.56	4.85	-2.88	5.22	0.000281	4.87	2154.45	188.84	0.25

17th Street Canal 10,500 cfs Canal Flow, Lake = 5.0 ft (continued)

HEC-RAS Plan: 10500_lake5 River: 17th Street Reach: 1 Profile: PF 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	445	PF 1	10500.00	-9.60	4.84	-2.07	5.20	0.000370	4.79	2189.88	240.00	0.28
1	421	PF 1	10500.00	-9.56	4.92	-3.92	5.15	0.000174	3.84	2732.12	228.31	0.20
1	401	PF 1	10500.00	-9.56	4.92	-3.92	5.15	0.000174	3.84	2731.29	228.30	0.20
1	380	PF 1	10500.00	-14.80	4.85		5.13	0.000148	4.20	2499.06	144.00	0.18
1	300	PF 1	10500.00	-9.56	4.92		5.08	0.000111	3.26	3224.94	246.78	0.16
1	200	PF 1	10500.00	-8.08	5.00		5.04	0.000028	1.64	6407.25	522.49	0.08
1	100	PF 1	10500.00	-8.08	5.01		5.04	0.000017	1.29	8125.98	659.45	0.06
1	0	PF 1	10500.00	-8.08	5.02		5.03	0.000011	1.04	10133.40	819.46	0.05
1	-100	PF 1	10500.00	-8.08	5.02		5.03	0.000007	0.85	12390.92	999.46	0.04
1	-750	PF 1	10500.00	-8.08	5.01		5.02	0.000007	0.85	12386.17	999.45	0.04
1	-1200.*	PF 1	10500.00	-8.08	5.01		5.02	0.000006	0.79	13218.78	1066.12	0.04
1	-1650.*	PF 1	10500.00	-8.08	5.01		5.02	0.000006	0.75	14051.36	1132.79	0.04
1	-2100.*	PF 1	10500.00	-8.08	5.01		5.02	0.000005	0.71	14883.96	1199.46	0.04
1	-2550.*	PF 1	10500.00	-8.08	5.01		5.01	0.000005	0.67	15716.43	1266.12	0.03
1	-3000.*	PF 1	10500.00	-8.08	5.00		5.01	0.000004	0.63	16548.91	1332.79	0.03
1	-3450.*	PF 1	10500.00	-8.08	5.00		5.01	0.000004	0.60	17381.49	1399.45	0.03
1	-3900.*	PF 1	10500.00	-8.08	5.00		5.01	0.000003	0.58	18213.79	1466.12	0.03
1	-4350.*	PF 1	10500.00	-8.08	5.00		5.01	0.000003	0.55	19046.05	1532.78	0.03
1	-4800	PF 1	10500.00	-8.08	5.00	-6.33	5.00	0.000003	0.53	19878.66	1599.45	0.03

17th Street Canal 12,500 cfs Canal Flow, Lake = 5.0 ft

HEC-RAS Plan: 12500_lake5 River: 17th Street Reach: 1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	13748	PF 1	11480.00	-18.30	8.90		9.04	0.000049	2.92	3928.11	260.75	0.13
1	13713	PF 1	11480.00	-12.85	8.93	-5.86	9.01	0.000040	2.35	4886.84	399.29	0.12
1	13708		Bridge									
1	13673	PF 1	11480.00	-13.03	8.74	-5.28	8.84	0.000050	2.54	4516.48	392.45	0.13
1	13535	PF 1	11480.00	-10.31	8.46	-1.51	8.76	0.000156	4.45	2581.02	241.05	0.24
1	13148	PF 1	11480.00	-7.69	8.41	-0.57	8.73	0.000144	4.48	2564.50	222.55	0.23
1	12548	PF 1	11640.00	-7.94	8.29	-0.58	8.63	0.000153	4.68	2489.44	213.17	0.24
1	11948	PF 1	11640.00	-9.30	8.22	-1.58	8.54	0.000138	4.59	2535.48	204.69	0.23
1	11348	PF 1	11640.00	-9.46	8.12	-1.51	8.46	0.000149	4.66	2500.40	210.49	0.24
1	10848	PF 1	11640.00	-10.48	8.07	-2.34	8.38	0.000122	4.49	2599.72	210.62	0.22
1	10379	PF 1	12500.00	-15.99	8.08	-5.73	8.34	0.000084	4.12	3061.10	213.36	0.18
1	10171	PF 1	12500.00	-14.03	8.03	-5.19	8.32	0.000086	4.31	2924.55	196.88	0.19
1	10161		Bridge									
1	9987	PF 1	12500.00	-16.44	8.01	-6.26	8.25	0.000071	3.94	3187.81	206.88	0.17
1	9927	PF 1	12500.00	-16.30	7.97	-5.46	8.24	0.000073	4.18	3067.53	212.89	0.18
1	9824	PF 1	12500.00	-15.60	7.99	-6.26	8.22	0.000060	3.85	3317.52	215.05	0.16
1	9631	PF 1	12500.00	-16.70	7.94	-5.98	8.20	0.000071	4.12	3102.80	206.83	0.17
1	9438	PF 1	12500.00	-14.20	7.91	-4.60	8.19	0.000081	4.28	3008.32	206.22	0.18
1	9245	PF 1	12500.00	-12.00	7.88	-3.94	8.17	0.000087	4.32	2951.61	205.69	0.19
1	9052	PF 1	12500.00	-11.70	7.87	-3.75	8.15	0.000087	4.27	2986.71	209.57	0.19
1	8859	PF 1	12500.00	-11.10	7.86	-3.46	8.13	0.000088	4.26	2992.88	213.68	0.19
1	8745	PF 1	12500.00	-11.20	7.87	-4.07	8.11	0.000129	3.88	3220.96	225.35	0.18
1	8735		Bridge									
1	8590	PF 1	12500.00	-14.90	7.55	-6.03	7.77	0.000115	3.77	3316.60	221.37	0.17
1	8480	PF 1	12500.00	-14.20	7.51	-5.73	7.75	0.000132	3.94	3175.92	217.12	0.18
1	8287	PF 1	12500.00	-13.40	7.47	-4.84	7.73	0.000140	4.04	3091.39	213.29	0.19
1	8094	PF 1	12500.00	-12.70	7.46	-4.68	7.69	0.000127	3.86	3234.87	219.55	0.18
1	7901	PF 1	12500.00	-11.70	7.42	-4.39	7.66	0.000136	3.96	3159.27	218.28	0.18
1	7708	PF 1	12500.00	-11.90	7.40	-4.71	7.64	0.000131	3.93	3180.01	215.10	0.18
1	7515	PF 1	12500.00	-12.50	7.38	-4.74	7.61	0.000124	3.86	3241.04	215.55	0.18
1	7322	PF 1	12500.00	-12.10	7.36	-4.70	7.58	0.000120	3.82	3274.26	215.15	0.17
1	7129	PF 1	12500.00	-13.10	7.33	-4.72	7.56	0.000124	3.85	3245.31	216.64	0.18
1	6936	PF 1	12500.00	-13.30	7.31	-5.43	7.53	0.000116	3.76	3328.35	216.88	0.17
1	6743	PF 1	12500.00	-14.00	7.28	-5.60	7.50	0.000117	3.77	3312.08	216.03	0.17
1	6550	PF 1	12500.00	-13.60	7.27	-5.74	7.48	0.000111	3.71	3370.89	217.18	0.17
1	6357	PF 1	12500.00	-14.00	7.24	-5.49	7.46	0.000113	3.70	3379.05	221.50	0.17
1	6164	PF 1	12500.00	-13.60	7.23	-5.62	7.43	0.000105	3.62	3448.78	222.29	0.16
1	5971	PF 1	12500.00	-13.50	7.22	-5.54	7.41	0.000103	3.49	3582.91	238.87	0.16
1	5778	PF 1	12500.00	-13.90	7.20	-5.93	7.38	0.000097	3.48	3595.10	232.86	0.16
1	5585	PF 1	12500.00	-13.50	7.18	-6.21	7.36	0.000089	3.39	3689.35	232.50	0.15
1	5392	PF 1	12500.00	-13.60	7.17	-6.35	7.34	0.000087	3.34	3743.30	238.28	0.15
1	5199	PF 1	12500.00	-14.00	7.15	-6.29	7.32	0.000093	3.40	3679.67	236.99	0.15
1	5006	PF 1	12500.00	-14.30	7.12	-6.38	7.31	0.000091	3.45	3624.79	225.42	0.15
1	4813	PF 1	12500.00	-14.30	7.10	-6.48	7.29	0.000088	3.44	3630.48	221.94	0.15
1	4620	PF 1	12500.00	-14.20	7.09	-6.93	7.27	0.000087	3.45	3627.23	217.15	0.15
1	4427	PF 1	12500.00	-15.20	7.03	-5.69	7.25	0.000112	3.72	3362.26	213.28	0.17
1	4234	PF 1	12500.00	-19.30	7.04	-8.94	7.22	0.000081	3.42	3654.17	208.32	0.14
1	4041	PF 1	12500.00	-18.70	7.00	-8.13	7.20	0.000092	3.59	3477.42	201.58	0.15
1	3848	PF 1	12500.00	-18.90	6.98	-8.70	7.18	0.000091	3.62	3449.87	196.02	0.15
1	3655	PF 1	12500.00	-18.40	6.95	-8.41	7.16	0.000099	3.70	3379.14	198.41	0.16
1	3462	PF 1	12500.00	-17.20	6.92	-8.16	7.14	0.000100	3.72	3361.43	196.17	0.16
1	3269	PF 1	12500.00	-17.30	6.90	-7.84	7.12	0.000102	3.74	3346.53	199.05	0.16
1	3076	PF 1	12500.00	-17.00	6.88	-7.56	7.10	0.000106	3.77	3314.09	198.10	0.16
1	2873	PF 1	12500.00	-14.00	6.74	-3.68	7.06	0.000212	4.49	2785.94	206.88	0.22
1	2630	PF 1	12500.00	-13.10	6.67	-3.24	7.00	0.000217	4.60	2715.97	200.99	0.22
1	2372	PF 1	12500.00	-14.20	6.66	-4.68	6.94	0.000162	4.24	2946.86	202.68	0.20
1	2244	PF 1	12500.00	-15.60	6.64	-5.14	6.91	0.000154	4.15	3015.64	202.65	0.19
1	2051	PF 1	12500.00	-18.10	6.66	-7.81	6.87	0.000104	3.70	3378.18	208.18	0.16
1	1791	PF 1	12500.00	-18.50	6.66	-9.39	6.83	0.000073	3.26	3839.57	216.96	0.14
1	1741	PF 1	12500.00	-17.50	6.61	-7.69	6.82	0.000106	3.70	3375.48	211.90	0.16
1	1686	PF 1	12500.00	-14.00	6.43	-4.97	6.77	0.000187	4.68	2688.62	196.51	0.22
1	1674		Bridge									
1	1576	PF 1	12500.00	-20.78	6.45	-8.74	6.68	0.000099	3.83	3278.18	195.85	0.16
1	1566	PF 1	12500.00	-20.07	6.39	-9.04	6.64	0.000116	4.03	3100.14	178.00	0.17
1	1475	PF 1	12500.00	-19.28	6.36	-8.44	6.62	0.000126	4.12	3036.45	177.00	0.18
1	1408	PF 1	12500.00	-17.85	6.31	-7.49	6.58	0.000134	4.20	2974.95	178.00	0.18
1	1293	PF 1	12500.00	-14.73	6.28	-6.94	6.53	0.000117	4.01	3117.66	177.00	0.17
1	1265	PF 1	12500.00	-14.73	6.26	-6.95	6.51	0.000117	4.01	3118.65	177.00	0.17
1	1175	PF 1	12500.00	-14.73	6.11	-6.97	6.37	0.000121	4.05	3084.27	177.00	0.17
1	1050	PF 1	12500.00	-14.14	5.82	-6.79	6.10	0.000135	4.22	2964.72	177.00	0.18
1	1020	PF 1	12500.00	-10.90	5.83	-5.52	6.09	0.000131	4.05	3087.07	189.42	0.18
1	1000		Inl Struct									
1	980	PF 1	12500.00	-10.90	5.35		5.62	0.000144	4.17	2996.44	189.37	0.18
1	971	PF 1	12500.00	-12.70	5.26	-5.15	5.60	0.000201	4.70	2657.47	189.00	0.22
1	965	PF 1	12500.00	-11.10	5.28		5.54	0.000276	4.14	3020.75	189.40	0.18
1	823	PF 1	12500.00	-9.26	4.90	-1.75	5.46	0.000441	6.04	2069.35	184.43	0.32
1	731	PF 1	12500.00	-9.26	4.85	-1.75	5.42	0.000447	6.06	2061.01	184.27	0.32
1	561	PF 1	12500.00	-9.56	4.81	-2.08	5.34	0.000407	5.85	2135.68	187.63	0.31
1	515	PF 1	12500.00	-9.56	4.79	-2.06	5.32	0.000404	5.83	2142.43	188.63	0.31

17th Street Canal 12,500 cfs Canal Flow, Lake = 5.0 ft (continued)

HEC-RAS Plan: 12500_lake5 River: 17th Street Reach: 1 Profile: PF 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	445	PF 1	12500.00	-9.60	4.77	-1.34	5.28	0.000537	5.75	2172.67	239.60	0.34
1	421	PF 1	12500.00	-9.56	4.89	-3.35	5.22	0.000248	4.59	2724.67	228.22	0.23
1	401	PF 1	12500.00	-9.56	4.88	-3.35	5.21	0.000248	4.59	2723.47	228.20	0.23
1	380	PF 1	12500.00	-14.80	4.79		5.18	0.000212	5.02	2490.02	144.00	0.21
1	300	PF 1	12500.00	-9.56	4.89		5.12	0.000159	3.89	3216.53	246.77	0.19
1	200	PF 1	12500.00	-8.08	5.00		5.06	0.000040	1.95	6407.53	522.49	0.10
1	100	PF 1	12500.00	-8.08	5.01		5.05	0.000025	1.54	8128.78	659.45	0.08
1	0	PF 1	12500.00	-8.08	5.02		5.05	0.000016	1.23	10138.62	819.46	0.06
1	-100	PF 1	12500.00	-8.08	5.03		5.04	0.000010	1.01	12398.53	999.46	0.05
1	-750	PF 1	12500.00	-8.08	5.02		5.03	0.000010	1.01	12391.79	999.46	0.05
1	-1200.*	PF 1	12500.00	-8.08	5.02		5.03	0.000009	0.95	13223.84	1066.12	0.05
1	-1650.*	PF 1	12500.00	-8.08	5.01		5.03	0.000008	0.89	14055.84	1132.79	0.04
1	-2100.*	PF 1	12500.00	-8.08	5.01		5.02	0.000007	0.84	14887.83	1199.46	0.04
1	-2550.*	PF 1	12500.00	-8.08	5.01		5.02	0.000006	0.80	15719.68	1266.12	0.04
1	-3000.*	PF 1	12500.00	-8.08	5.01		5.02	0.000006	0.76	16551.54	1332.79	0.04
1	-3450.*	PF 1	12500.00	-8.08	5.00		5.01	0.000005	0.72	17383.46	1399.45	0.04
1	-3900.*	PF 1	12500.00	-8.08	5.00		5.01	0.000005	0.69	18215.12	1466.12	0.03
1	-4350.*	PF 1	12500.00	-8.08	5.00		5.01	0.000004	0.66	19046.71	1532.78	0.03
1	-4800	PF 1	12500.00	-8.08	5.00	-6.21	5.01	0.000004	0.63	19878.66	1599.45	0.03

Option 1

17^{th} Street Canal HEC-RAS Results for Pumping at New Station

17th Street Canal 10,500 cfs Canal Flow, Pumping at New Station, Suction Side = 1.0 ft

HEC-RAS Plan: 10500_suction1 River: 17th Street Reach: 1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	13748	PF 1	9480.00	-18.30	5.53		5.68	0.000070	3.08	3079.80	245.33	0.15
1	13713	PF 1	9480.00	-12.85	5.56	-6.37	5.65	0.000043	2.53	3752.17	291.66	0.12
1	13708		Bridge									
1	13673	PF 1	9480.00	-13.03	5.45	-5.81	5.57	0.000053	2.76	3437.90	275.83	0.14
1	13535	PF 1	9480.00	-10.31	5.06	-2.36	5.47	0.000234	5.10	1857.48	191.29	0.29
1	13148	PF 1	9480.00	-7.69	4.99	-1.31	5.40	0.000253	5.17	1835.11	197.83	0.30
1	12548	PF 1	9640.00	-7.94	4.79	-1.34	5.24	0.000273	5.40	1784.56	190.03	0.31
1	11948	PF 1	9640.00	-9.30	4.67	-2.37	5.09	0.000222	5.19	1858.08	178.71	0.28
1	11348	PF 1	9640.00	-9.46	4.50	-2.33	4.94	0.000251	5.36	1800.06	181.74	0.30
1	10848	PF 1	9640.00	-10.48	4.41	-3.15	4.81	0.000212	5.11	1888.26	179.83	0.28
1	10379	PF 1	10500.00	-15.99	4.43	-6.62	4.75	0.000133	4.52	2322.51	185.54	0.23
1	10171	PF 1	10500.00	-14.03	4.38	-5.98	4.71	0.000134	4.66	2253.04	170.84	0.23
1	10161		Bridge									
1	9987	PF 1	10500.00	-16.44	4.34	-7.09	4.63	0.000110	4.26	2466.75	186.27	0.21
1	9927	PF 1	10500.00	-16.30	4.30	-6.33	4.61	0.000115	4.47	2354.22	180.05	0.21
1	9824	PF 1	10500.00	-15.60	4.32	-7.13	4.58	0.000092	4.10	2574.43	191.14	0.19
1	9631	PF 1	10500.00	-16.70	4.26	-6.90	4.56	0.000113	4.43	2382.58	184.52	0.21
1	9438	PF 1	10500.00	-14.20	4.19	-5.44	4.53	0.000135	4.69	2261.39	196.38	0.23
1	9245	PF 1	10500.00	-12.00	4.15	-4.69	4.51	0.000152	4.79	2203.88	195.37	0.24
1	9052	PF 1	10500.00	-11.70	4.13	-4.52	4.48	0.000154	4.75	2220.70	199.89	0.24
1	8859	PF 1	10500.00	-11.10	4.10	-4.23	4.45	0.000161	4.77	2209.05	202.17	0.25
1	8745	PF 1	10500.00	-11.20	4.11	-4.77	4.41	0.000217	4.39	2389.71	207.57	0.23
1	8735		Bridge									
1	8590	PF 1	10500.00	-14.90	4.04	-6.81	4.30	0.000163	4.10	2561.40	197.82	0.20
1	8480	PF 1	10500.00	-14.20	3.99	-6.51	4.28	0.000202	4.31	2437.39	203.35	0.22
1	8287	PF 1	10500.00	-13.40	3.93	-5.58	4.23	0.000222	4.46	2356.42	201.02	0.23
1	8094	PF 1	10500.00	-12.70	3.90	-5.39	4.18	0.000216	4.28	2454.49	218.72	0.23
1	7901	PF 1	10500.00	-11.70	3.83	-5.10	4.14	0.000237	4.42	2378.12	217.11	0.24
1	7708	PF 1	10500.00	-11.90	3.79	-5.48	4.09	0.000224	4.36	2406.18	214.18	0.23
1	7515	PF 1	10500.00	-12.50	3.76	-5.43	4.04	0.000209	4.26	2462.41	214.60	0.22
1	7322	PF 1	10500.00	-12.10	3.72	-5.38	3.99	0.000200	4.21	2494.15	214.02	0.22
1	7129	PF 1	10500.00	-13.10	3.67	-5.47	3.95	0.000213	4.28	2454.58	215.69	0.22
1	6936	PF 1	10500.00	-13.30	3.64	-6.20	3.91	0.000194	4.14	2533.57	216.16	0.21
1	6743	PF 1	10500.00	-14.00	3.60	-6.39	3.87	0.000197	4.17	2517.12	215.03	0.21
1	6550	PF 1	10500.00	-13.60	3.56	-6.47	3.82	0.000185	4.09	2568.46	216.32	0.21
1	6357	PF 1	10500.00	-14.00	3.52	-6.25	3.78	0.000193	4.11	2556.92	220.38	0.21
1	6164	PF 1	10500.00	-13.60	3.49	-6.35	3.74	0.000177	4.01	2620.61	221.32	0.21
1	5971	PF 1	10500.00	-13.50	3.47	-6.45	3.70	0.000182	3.91	2688.26	238.14	0.20
1	5778	PF 1	10500.00	-13.90	3.43	-6.65	3.67	0.000167	3.86	2720.17	232.16	0.20
1	5585	PF 1	10500.00	-13.50	3.41	-6.90	3.63	0.000148	3.73	2813.73	231.75	0.19
1	5392	PF 1	10500.00	-13.60	3.39	-7.05	3.60	0.000148	3.69	2843.15	237.38	0.19
1	5199	PF 1	10500.00	-14.00	3.34	-7.02	3.57	0.000160	3.78	2779.86	236.36	0.19
1	5006	PF 1	10500.00	-14.30	3.31	-7.11	3.53	0.000151	3.79	2767.28	224.60	0.19
1	4813	PF 1	10500.00	-14.30	3.28	-7.18	3.50	0.000145	3.77	2783.86	221.16	0.19
1	4620	PF 1	10500.00	-14.20	3.25	-7.63	3.47	0.000139	3.75	2797.08	216.27	0.18
1	4427	PF 1	10500.00	-15.20	3.17	-6.38	3.44	0.000192	4.13	2540.55	212.31	0.21
1	4234	PF 1	10500.00	-19.30	3.18	-9.74	3.39	0.000125	3.68	2852.55	207.23	0.17
1	4041	PF 1	10500.00	-18.70	3.12	-8.95	3.36	0.000145	3.89	2699.08	200.25	0.19
1	3848	PF 1	10500.00	-18.90	3.09	-9.56	3.33	0.000140	3.90	2691.09	194.88	0.19
1	3655	PF 1	10500.00	-18.40	3.05	-9.29	3.30	0.000158	4.03	2607.69	197.16	0.20
1	3462	PF 1	10500.00	-17.20	3.01	-8.96	3.27	0.000160	4.04	2596.25	194.99	0.20
1	3269	PF 1	10500.00	-17.30	2.97	-8.71	3.23	0.000166	4.09	2566.20	198.13	0.20
1	3076	PF 1	10500.00	-17.00	2.93	-8.41	3.20	0.000173	4.14	2534.39	197.16	0.20
1	2873	PF 1	10500.00	-14.00	2.67	-4.50	3.12	0.000472	5.40	1944.56	205.85	0.31
1	2630	PF 1	10500.00	-13.10	2.51	-4.02	3.00	0.000495	5.58	1881.71	200.11	0.32
1	2372	PF 1	10500.00	-14.20	2.47	-5.45	2.86	0.000336	5.00	2100.35	201.77	0.27
1	2244	PF 1	10500.00	-15.60	2.44	-5.86	2.81	0.000311	4.85	2166.48	201.60	0.26
1	2051	PF 1	10500.00	-18.10	2.46	-8.62	2.73	0.000189	4.19	2507.45	206.71	0.21
1	1791	PF 1	10500.00	-18.50	2.46	-10.13	2.66	0.000121	3.58	2931.09	215.77	0.17
1	1741	PF 1	10500.00	-17.50	2.38	-8.52	2.65	0.000188	4.21	2495.34	202.64	0.21
1	1686	PF 1	10500.00	-14.00	2.06	-5.85	2.56	0.000420	5.67	1850.32	178.67	0.31
1	1674		Bridge									
1	1576	PF 1	10500.00	-20.78	2.12	-9.58	2.41	0.000176	4.29	2449.52	184.87	0.21
1	1566	PF 1	10500.00	-20.07	2.04	-9.99	2.36	0.000186	4.48	2342.26	167.88	0.21
1	1475	PF 1	10500.00	-19.28	1.99	-9.48	2.32	0.000208	4.61	2278.37	167.91	0.22
1	1408	PF 1	10500.00	-17.85	1.92	-8.36	2.27	0.000230	4.76	2207.78	169.37	0.23
1	1293	PF 1	10500.00	-14.73	1.89	-7.62	2.20	0.000200	4.48	2343.56	174.52	0.22
1	1265	PF 1	10500.00	-14.73	1.85	-7.63	2.16	0.000200	4.48	2343.05	174.49	0.22
1	1175	PF 1	10500.00	-14.73	1.66	-7.64	1.99	0.000210	4.56	2303.10	173.29	0.22
1	1050	PF 1	10500.00	-14.14	1.27	-7.49	1.63	0.000248	4.84	2170.02	171.36	0.24
1	1020	PF 1	10500.00	-10.90	1.27	-6.11	1.62	0.000259	4.72	2226.69	187.95	0.24
1	1000		Inl Struct									
1	980	PF 1	10500.00	-10.90	1.00	-6.11	1.36	0.000279	4.83	2175.32	187.85	0.25

17th Street Canal 12,500 cfs Canal Flow, Pumping at New Station, Suction Side = 1.0 ft

HEC-RAS Plan: 12500_suction_1 River: 17th Street Reach: 1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	13748	PF 1	11480.00	-18.30	6.66		6.84	0.000078	3.42	3357.76	248.98	0.16
1	13713	PF 1	11480.00	-12.85	6.69	-5.86	6.81	0.000048	2.81	4082.16	291.90	0.13
1	13708		Bridge									
1	13673	PF 1	11480.00	-13.03	6.51	-5.28	6.65	0.000063	3.07	3740.85	291.68	0.15
1	13535	PF 1	11480.00	-10.31	6.05	-1.51	6.53	0.000265	5.60	2051.39	202.00	0.31
1	13148	PF 1	11480.00	-7.69	5.97	-0.57	6.47	0.000279	5.65	2033.27	206.55	0.32
1	12548	PF 1	11640.00	-7.94	5.74	-0.58	6.29	0.000300	5.91	1968.67	196.09	0.33
1	11948	PF 1	11640.00	-9.30	5.60	-1.58	6.11	0.000253	5.74	2027.60	184.58	0.31
1	11348	PF 1	11640.00	-9.46	5.41	-1.51	5.95	0.000283	5.92	1967.73	186.98	0.32
1	10848	PF 1	11640.00	-10.48	5.31	-2.34	5.80	0.000245	5.67	2052.18	186.34	0.30
1	10379	PF 1	12500.00	-15.99	5.33	-5.73	5.73	0.000155	5.01	2493.16	192.67	0.24
1	10171	PF 1	12500.00	-14.03	5.27	-5.19	5.68	0.000158	5.19	2407.82	177.18	0.25
1	10161		Bridge									
1	9987	PF 1	12500.00	-16.44	5.23	-6.26	5.58	0.000129	4.75	2633.46	191.43	0.23
1	9927	PF 1	12500.00	-16.30	5.17	-5.46	5.56	0.000133	5.01	2513.09	186.13	0.23
1	9824	PF 1	12500.00	-15.60	5.20	-6.26	5.52	0.000106	4.59	2743.82	196.22	0.21
1	9631	PF 1	12500.00	-16.70	5.12	-5.98	5.50	0.000130	4.95	2543.61	189.66	0.23
1	9438	PF 1	12500.00	-14.20	5.05	-4.60	5.47	0.000154	5.22	2429.66	198.61	0.25
1	9245	PF 1	12500.00	-12.00	5.00	-3.94	5.44	0.000172	5.32	2370.20	197.63	0.26
1	9052	PF 1	12500.00	-11.70	4.97	-3.75	5.40	0.000174	5.28	2390.33	201.95	0.26
1	8859	PF 1	12500.00	-11.10	4.94	-3.46	5.37	0.000180	5.29	2381.04	205.73	0.26
1	8745	PF 1	12500.00	-11.20	4.96	-4.07	5.32	0.000255	4.87	2568.87	215.80	0.25
1	8735		Bridge									
1	8590	PF 1	12500.00	-14.90	4.87	-6.03	5.20	0.000201	4.58	2729.52	208.90	0.22
1	8480	PF 1	12500.00	-14.20	4.81	-5.73	5.17	0.000234	4.80	2604.95	206.13	0.24
1	8287	PF 1	12500.00	-13.40	4.73	-4.84	5.12	0.000257	4.96	2519.80	204.00	0.25
1	8094	PF 1	12500.00	-12.70	4.70	-4.68	5.05	0.000245	4.75	2630.70	218.91	0.24
1	7901	PF 1	12500.00	-11.70	4.63	-4.39	5.00	0.000268	4.90	2550.86	217.37	0.25
1	7708	PF 1	12500.00	-11.90	4.58	-4.71	4.95	0.000256	4.85	2575.19	214.38	0.25
1	7515	PF 1	12500.00	-12.50	4.54	-4.74	4.89	0.000240	4.75	2630.69	214.81	0.24
1	7322	PF 1	12500.00	-12.10	4.50	-4.70	4.84	0.000231	4.70	2660.75	214.26	0.23
1	7129	PF 1	12500.00	-13.10	4.44	-4.72	4.79	0.000245	4.77	2620.70	215.89	0.24
1	6936	PF 1	12500.00	-13.30	4.40	-5.43	4.74	0.000225	4.63	2699.08	216.31	0.23
1	6743	PF 1	12500.00	-14.00	4.35	-5.60	4.69	0.000229	4.66	2680.13	215.24	0.23
1	6550	PF 1	12500.00	-13.60	4.32	-5.74	4.64	0.000216	4.58	2731.34	216.50	0.23
1	6357	PF 1	12500.00	-14.00	4.27	-5.49	4.60	0.000225	4.59	2721.49	220.61	0.23
1	6164	PF 1	12500.00	-13.60	4.24	-5.62	4.55	0.000207	4.49	2784.81	221.51	0.22
1	5971	PF 1	12500.00	-13.50	4.20	-5.54	4.50	0.000210	4.36	2864.32	238.29	0.22
1	5778	PF 1	12500.00	-13.90	4.17	-5.93	4.46	0.000194	4.32	2890.45	232.29	0.22
1	5585	PF 1	12500.00	-13.50	4.14	-6.21	4.42	0.000174	4.19	2982.89	231.89	0.21
1	5392	PF 1	12500.00	-13.60	4.11	-6.35	4.38	0.000173	4.15	3015.42	237.55	0.21
1	5199	PF 1	12500.00	-14.00	4.06	-6.29	4.34	0.000187	4.24	2949.49	236.48	0.21
1	5006	PF 1	12500.00	-14.30	4.02	-6.38	4.30	0.000179	4.27	2926.64	224.75	0.21
1	4813	PF 1	12500.00	-14.30	3.99	-6.48	4.27	0.000172	4.25	2939.48	221.30	0.21
1	4620	PF 1	12500.00	-14.20	3.95	-6.93	4.23	0.000167	4.24	2947.98	216.43	0.20
1	4427	PF 1	12500.00	-15.20	3.85	-5.69	4.19	0.000229	4.66	2684.75	212.48	0.23
1	4234	PF 1	12500.00	-19.30	3.86	-8.94	4.13	0.000152	4.18	2993.60	207.42	0.19
1	4041	PF 1	12500.00	-18.70	3.79	-8.13	4.09	0.000176	4.41	2832.62	200.48	0.21
1	3848	PF 1	12500.00	-18.90	3.75	-8.70	4.06	0.000172	4.43	2819.48	195.07	0.21
1	3655	PF 1	12500.00	-18.40	3.69	-8.41	4.02	0.000192	4.57	2735.50	197.36	0.22
1	3462	PF 1	12500.00	-17.20	3.65	-8.16	3.98	0.000195	4.59	2721.01	195.18	0.22
1	3269	PF 1	12500.00	-17.30	3.60	-7.84	3.94	0.000202	4.64	2691.23	198.28	0.22
1	3076	PF 1	12500.00	-17.00	3.55	-7.56	3.89	0.000212	4.70	2656.83	197.31	0.23
1	2873	PF 1	12500.00	-14.00	3.23	-3.68	3.80	0.000556	6.07	2060.69	206.13	0.34
1	2630	PF 1	12500.00	-13.10	3.04	-3.24	3.65	0.000588	6.29	1987.35	200.22	0.35
1	2372	PF 1	12500.00	-14.20	2.99	-4.68	3.49	0.000407	5.67	2205.26	201.88	0.30
1	2244	PF 1	12500.00	-15.60	2.96	-5.14	3.43	0.000379	5.51	2270.04	201.73	0.29
1	2051	PF 1	12500.00	-18.10	2.98	-7.81	3.33	0.000234	4.78	2614.74	206.89	0.24
1	1791	PF 1	12500.00	-18.50	2.99	-9.39	3.25	0.000152	4.11	3043.64	215.92	0.19
1	1741	PF 1	12500.00	-17.50	2.87	-7.69	3.23	0.000235	4.82	2595.87	203.46	0.24
1	1686	PF 1	12500.00	-14.00	2.46	-4.97	3.11	0.000539	6.51	1921.60	182.06	0.35
1	1674		Bridge									
1	1576	PF 1	12500.00	-20.78	2.53	-8.74	2.91	0.000227	4.95	2525.97	188.12	0.24
1	1566	PF 1	12500.00	-20.07	2.43	-9.04	2.84	0.000243	5.19	2406.45	169.10	0.24
1	1475	PF 1	12500.00	-19.28	2.35	-8.44	2.80	0.000272	5.34	2339.49	168.94	0.25
1	1408	PF 1	12500.00	-17.85	2.26	-7.49	2.73	0.000303	5.52	2265.18	170.26	0.27
1	1293	PF 1	12500.00	-14.73	2.21	-6.94	2.64	0.000262	5.21	2400.60	174.76	0.25
1	1265	PF 1	12500.00	-14.73	2.16	-6.95	2.59	0.000264	5.21	2397.59	174.73	0.25
1	1175	PF 1	12500.00	-14.73	1.91	-6.97	2.35	0.000281	5.33	2345.09	173.55	0.26
1	1050	PF 1	12500.00	-14.14	1.35	-6.79	1.86	0.000344	5.72	2184.47	171.48	0.28
1	1020	PF 1	12500.00	-10.90	1.36	-5.52	1.84	0.000359	5.57	2242.98	187.98	0.28
1	1000		Inl Struct									
1	980	PF 1	12500.00	-10.90	1.00	-5.52	1.51	0.000396	5.75	2175.32	187.85	0.30

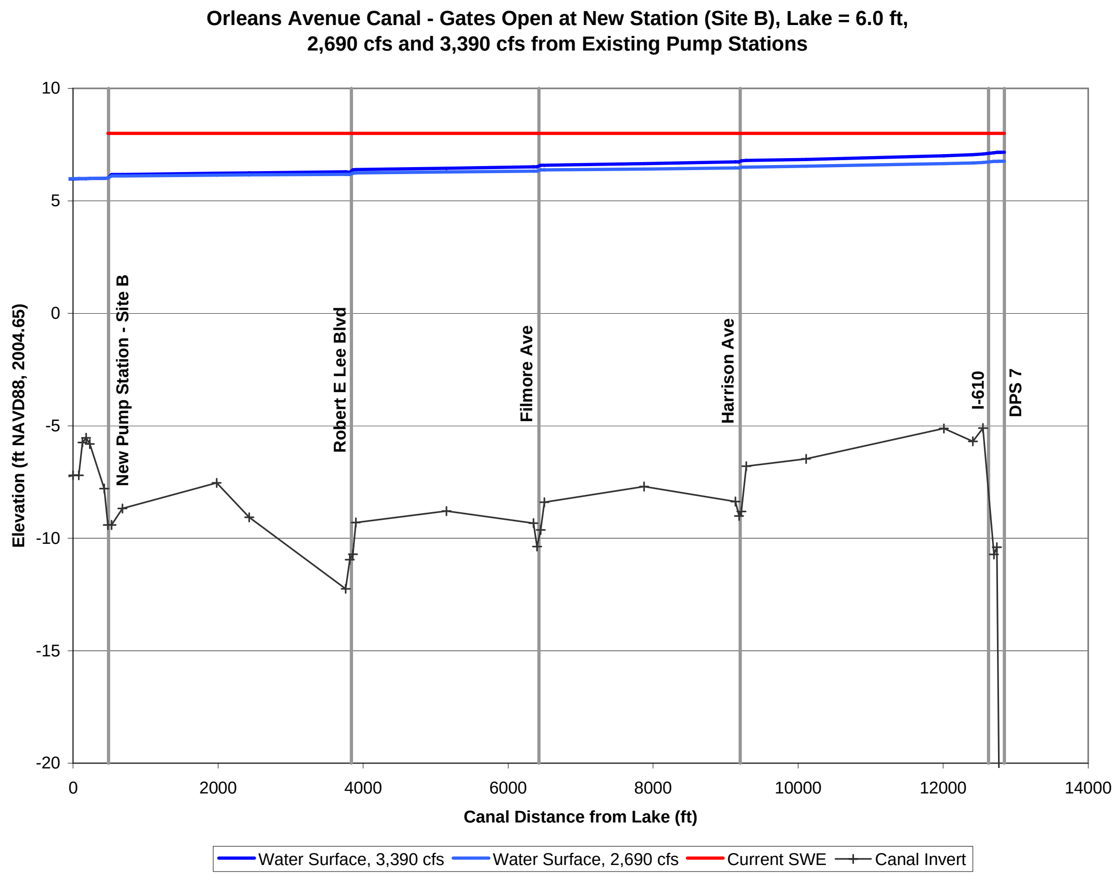

Figure C- 3 Orleans Avenue Canal Water Surface Profiles for Lake Pontchartrain Elevation 6.0 ft

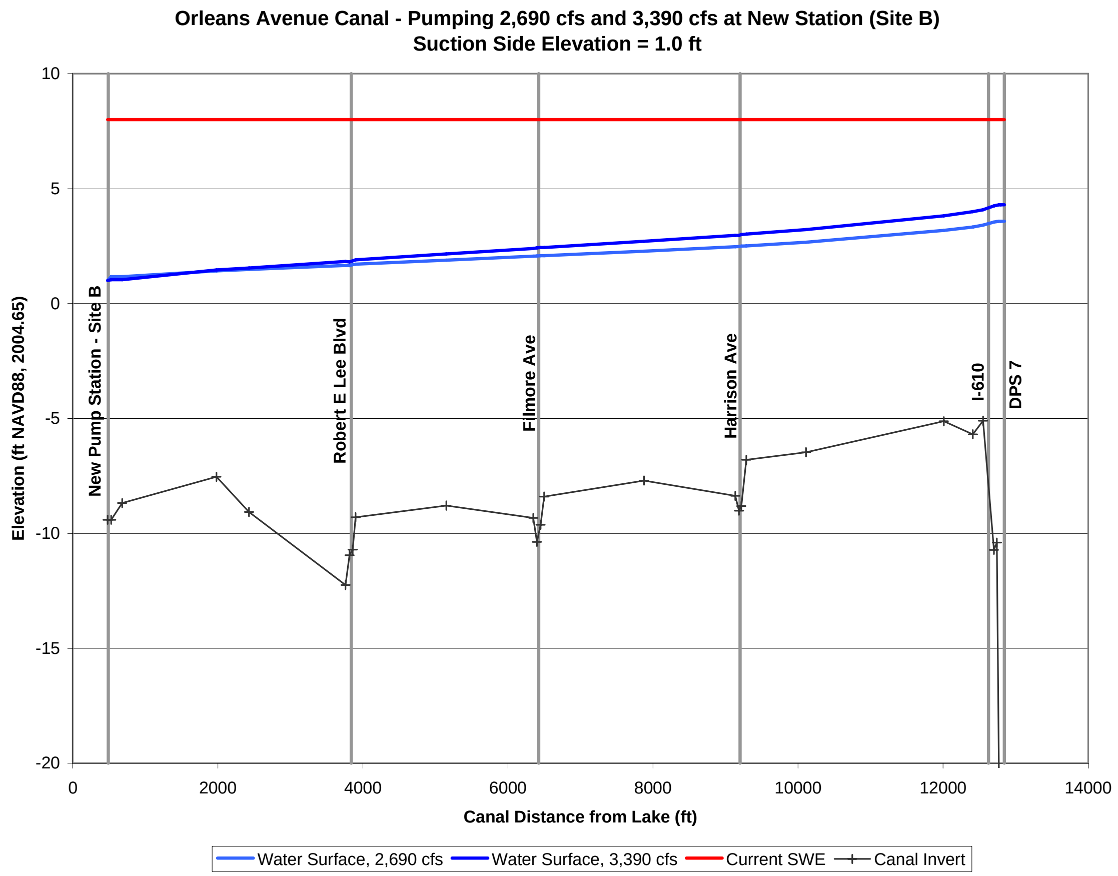

Figure C- 4 Orleans Avenue Canal Water Surface Profiles for Pumping at New Station

Option 1
Orleans Avenue Canal HEC-RAS Results for Gates Open

Orleans Avenue Canal 2,690 cfs Canal Flow, Lake = 6.0 ft

HEC-RAS Plan: 2690_lake6 River: Orleans Reach: 2 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
2	12845	PF 1	2690.00	-20.40	6.76		6.77	0.000003	0.76	3530.95	130.00	0.03
2	12795	PF 1	2690.00	-20.40	6.76		6.77	0.000003	0.76	3530.93	130.00	0.03
2	12770	PF 1	2690.00	-20.40	6.76		6.77	0.000003	0.76	3530.92	130.00	0.03
2	12740	PF 1	2690.00	-10.40	6.75		6.77	0.000008	0.98	2744.69	160.00	0.04
2	12700	PF 1	2690.00	-10.72	6.75	-4.94	6.77	0.000017	1.21	2268.55	230.23	0.06
2	12625		Bridge									
2	12550	PF 1	2690.00	-5.10	6.70	-0.39	6.75	0.000052	1.81	1505.24	186.16	0.11
2	12410	PF 1	2690.00	-5.69	6.68	-0.74	6.74	0.000092	1.93	1396.44	164.12	0.12
2	12010	PF 1	2690.00	-5.12	6.65	-1.21	6.71	0.000081	1.93	1417.89	158.00	0.11
2	10110	PF 1	2690.00	-6.47	6.54	-3.04	6.58	0.000053	1.60	1684.63	174.20	0.09
2	9285	PF 1	2690.00	-6.80	6.50	-3.24	6.54	0.000043	1.55	1776.17	170.79	0.08
2	9217	PF 1	2690.00	-8.81	6.50	-4.16	6.53	0.000045	1.59	1696.68	150.38	0.08
2	9201		Bridge									
2	9185	PF 1	2690.00	-9.01	6.46	-4.69	6.50	0.000041	1.55	1741.00	149.91	0.08
2	9135	PF 1	2690.00	-8.37	6.46	-4.59	6.50	0.000036	1.45	1866.64	174.00	0.08
2	7875	PF 1	2690.00	-7.70	6.41	-4.15	6.45	0.000042	1.46	1846.50	180.49	0.08
2	6500	PF 1	2690.00	-8.40	6.37	-4.65	6.39	0.000034	1.36	1970.70	180.74	0.07
2	6450	PF 1	2690.00	-9.63	6.37	-5.04	6.39	0.000030	1.32	2037.33	175.12	0.07
2	6425		Bridge									
2	6400	PF 1	2690.00	-10.37	6.32	-5.47	6.35	0.000028	1.30	2075.31	174.27	0.07
2	6350	PF 1	2690.00	-9.33	6.32	-5.27	6.35	0.000027	1.33	2086.15	189.18	0.07
2	5150	PF 1	2690.00	-8.79	6.28	-4.82	6.31	0.000033	1.37	1969.44	180.81	0.07
2	3900	PF 1	2690.00	-9.30	6.24	-5.21	6.27	0.000032	1.34	2012.09	181.32	0.07
2	3860	PF 1	2690.00	-10.71	6.23	-5.72	6.27	0.000038	1.57	1710.06	134.45	0.08
2	3838		Bridge									
2	3816	PF 1	2690.00	-10.95	6.17	-5.72	6.21	0.000041	1.62	1661.82	132.55	0.08
2	3760	PF 1	2690.00	-12.25	6.18	-6.97	6.20	0.000023	1.16	2376.49	250.67	0.06
2	2430	PF 1	2690.00	-9.07	6.15	-4.81	6.17	0.000023	1.05	2572.41	279.34	0.06
2	1980	PF 1	2690.00	-7.54	6.14	-4.42	6.16	0.000021	1.02	2635.83	270.05	0.06
2	680	PF 1	2690.00	-8.68	6.10	-4.20	6.12	0.000030	1.13	2390.38	283.88	0.07
2	530	PF 1	2690.00	-9.41	6.10	-6.17	6.12	0.000022	1.03	2623.55	273.11	0.06
2	500		Inl Struct									
2	480	PF 1	2690.00	-9.41	6.01	-6.02	6.03	0.000028	1.20	2236.51	219.93	0.07
2	430	PF 1	2690.00	-7.79	6.00	-3.08	6.03	0.000042	1.37	1967.06	221.31	0.08
2	230	PF 1	2690.00	-5.81	5.99	-1.82	6.02	0.000021	1.39	1939.63	232.85	0.08
2	180	PF 1	2690.00	-5.54	5.99	-2.87	6.02	0.000018	1.40	1924.93	199.28	0.08
2	155		Bridge									
2	130	PF 1	2690.00	-5.74	5.99	-3.14	6.02	0.000017	1.37	1966.02	203.05	0.08
2	80	PF 1	2690.00	-7.20	5.99	-3.42	6.01	0.000016	1.38	1950.58	192.23	0.08
2	0	PF 1	2690.00	-7.20	5.98		6.01	0.000016	1.38	1950.33	192.22	0.08
2	-380*	PF 1	2690.00	-7.52	6.00		6.00	0.000004	0.69	3922.83	332.36	0.04
2	-760*	PF 1	2690.00	-7.84	6.00		6.00	0.000001	0.45	5996.03	472.49	0.02
2	-1140*	PF 1	2690.00	-8.16	6.00		6.00	0.000001	0.33	8170.86	612.62	0.02
2	-1520*	PF 1	2690.00	-8.48	6.00		6.00	0.000000	0.26	10447.74	752.76	0.01
2	-1900*	PF 1	2690.00	-8.80	6.00		6.00	0.000000	0.21	12826.52	892.90	0.01
2	-2280*	PF 1	2690.00	-9.12	6.00		6.00	0.000000	0.18	15307.36	1033.05	0.01
2	-2660*	PF 1	2690.00	-9.44	6.00		6.00	0.000000	0.15	17890.13	1173.34	0.01
2	-3040*	PF 1	2690.00	-9.76	6.00		6.00	0.000000	0.13	20577.46	1309.48	0.01
2	-3420*	PF 1	2690.00	-10.08	6.00		6.00	0.000000	0.12	23363.63	1454.56	0.01
2	-3800	PF 1	2690.00	-10.40	6.00	-9.96	6.00	0.000000	0.10	26240.00	1600.00	0.00

Orleans Avenue Canal 3,390 cfs Canal Flow, Lake = 6.0 ft

HEC-RAS Plan: 3390_lake6 River: Orleans Reach: 2 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
2	12845	PF 1	3390.00	-20.40	7.10		7.12	0.000005	0.95	3575.60	130.00	0.03
2	12795	PF 1	3390.00	-20.40	7.10		7.12	0.000005	0.95	3575.57	130.00	0.03
2	12770	PF 1	3390.00	-20.40	7.10		7.12	0.000005	0.95	3575.56	130.00	0.03
2	12740	PF 1	3390.00	-10.40	7.09		7.12	0.000012	1.21	2799.10	160.00	0.05
2	12700	PF 1	3390.00	-10.72	7.08	-4.39	7.12	0.000025	1.48	2346.39	232.61	0.08
2	12625		Bridge									
2	12550	PF 1	3390.00	-5.10	7.02	0.04	7.09	0.000074	2.19	1564.37	187.47	0.13
2	12410	PF 1	3390.00	-5.69	6.99	-0.26	7.08	0.000130	2.34	1446.95	164.12	0.14
2	12010	PF 1	3390.00	-5.12	6.94	-0.74	7.03	0.000116	2.35	1464.16	158.00	0.13
2	10110	PF 1	3390.00	-6.47	6.78	-2.56	6.84	0.000079	1.96	1726.90	175.52	0.11
2	9285	PF 1	3390.00	-6.80	6.72	-2.76	6.78	0.000064	1.91	1814.42	171.40	0.10
2	9217	PF 1	3390.00	-8.81	6.72	-3.64	6.78	0.000068	1.96	1729.84	150.40	0.10
2	9201		Bridge									
2	9185	PF 1	3390.00	-9.01	6.66	-4.15	6.72	0.000062	1.91	1770.85	149.93	0.10
2	9135	PF 1	3390.00	-8.37	6.66	-4.05	6.71	0.000054	1.79	1901.33	174.00	0.09
2	7875	PF 1	3390.00	-7.70	6.59	-3.64	6.64	0.000063	1.81	1878.01	180.49	0.10
2	6500	PF 1	3390.00	-8.40	6.52	-4.14	6.56	0.000051	1.70	1997.73	180.74	0.09
2	6450	PF 1	3390.00	-9.63	6.52	-4.55	6.56	0.000046	1.64	2063.49	175.14	0.08
2	6425		Bridge									
2	6400	PF 1	3390.00	-10.37	6.45	-4.95	6.49	0.000043	1.62	2096.87	174.28	0.08
2	6350	PF 1	3390.00	-9.33	6.44	-4.73	6.49	0.000041	1.66	2109.30	189.18	0.08
2	5150	PF 1	3390.00	-8.79	6.39	-4.30	6.43	0.000051	1.71	1987.86	180.81	0.09
2	3900	PF 1	3390.00	-9.30	6.32	-4.68	6.37	0.000049	1.67	2026.61	181.32	0.09
2	3860	PF 1	3390.00	-10.71	6.30	-5.15	6.36	0.000060	1.97	1719.83	134.48	0.10
2	3838		Bridge									
2	3816	PF 1	3390.00	-10.95	6.20	-5.12	6.27	0.000065	2.03	1666.51	132.57	0.10
2	3760	PF 1	3390.00	-12.25	6.22	-6.32	6.25	0.000037	1.45	2386.63	251.06	0.08
2	2430	PF 1	3390.00	-9.07	6.17	-4.25	6.20	0.000037	1.31	2579.13	279.51	0.08
2	1980	PF 1	3390.00	-7.54	6.16	-4.01	6.18	0.000033	1.28	2640.87	270.17	0.07
2	680	PF 1	3390.00	-8.68	6.10	-3.66	6.13	0.000048	1.42	2389.65	283.85	0.09
2	530	PF 1	3390.00	-9.41	6.10	-5.70	6.12	0.000035	1.29	2622.60	273.09	0.07
2	500		Inl Struct									
2	480	PF 1	3390.00	-9.41	6.01	-5.51	6.05	0.000045	1.52	2237.50	220.00	0.08
2	430	PF 1	3390.00	-7.79	6.00	-2.27	6.04	0.000067	1.72	1966.72	221.30	0.10
2	230	PF 1	3390.00	-5.81	5.99	-1.45	6.03	0.000033	1.75	1938.35	232.80	0.11
2	180	PF 1	3390.00	-5.54	5.98	-2.49	6.03	0.000028	1.76	1923.68	199.26	0.10
2	155		Bridge									
2	130	PF 1	3390.00	-5.74	5.98	-2.79	6.02	0.000027	1.73	1964.38	202.98	0.10
2	80	PF 1	3390.00	-7.20	5.98	-3.01	6.02	0.000026	1.74	1948.88	192.19	0.10
2	0	PF 1	3390.00	-7.20	5.97		6.02	0.000026	1.74	1948.48	192.19	0.10
2	-380*	PF 1	3390.00	-7.52	5.99		6.01	0.000006	0.86	3922.21	332.36	0.04
2	-760*	PF 1	3390.00	-7.84	6.00		6.00	0.000002	0.57	5995.73	472.49	0.03
2	-1140*	PF 1	3390.00	-8.16	6.00		6.00	0.000001	0.41	8170.70	612.62	0.02
2	-1520*	PF 1	3390.00	-8.48	6.00		6.00	0.000001	0.32	10447.66	752.76	0.02
2	-1900*	PF 1	3390.00	-8.80	6.00		6.00	0.000000	0.26	12826.48	892.90	0.01
2	-2280*	PF 1	3390.00	-9.12	6.00		6.00	0.000000	0.22	15307.34	1033.05	0.01
2	-2660*	PF 1	3390.00	-9.44	6.00		6.00	0.000000	0.19	17890.12	1173.34	0.01
2	-3040*	PF 1	3390.00	-9.76	6.00		6.00	0.000000	0.16	20577.46	1309.48	0.01
2	-3420*	PF 1	3390.00	-10.08	6.00		6.00	0.000000	0.15	23363.63	1454.56	0.01
2	-3800	PF 1	3390.00	-10.40	6.00	-9.88	6.00	0.000000	0.13	26240.00	1600.00	0.01

Option 1

Orleans Canal HEC-RAS Results for Pumping at New Station

Orleans Avenue Canal 2,690 cfs Canal Flow, Pumping at New Station, Suction Side = 1.0 ft

HEC-RAS Plan: 2690_B_suction1 River: Orleans Reach: 2 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
2	12845	PF 1	2690.00	-20.40	3.58		3.59	0.000005	0.86	3117.51	130.00	0.03
2	12795	PF 1	2690.00	-20.40	3.58		3.59	0.000005	0.86	3117.48	130.00	0.03
2	12770	PF 1	2690.00	-20.40	3.58		3.59	0.000005	0.86	3117.47	130.00	0.03
2	12740	PF 1	2690.00	-10.40	3.57		3.59	0.000015	1.20	2234.92	160.00	0.06
2	12700	PF 1	2690.00	-10.72	3.54	-4.94	3.59	0.000054	1.72	1566.92	204.96	0.11
2	12625		Bridge									
2	12550	PF 1	2690.00	-5.10	3.41	-0.39	3.54	0.000249	2.90	926.93	167.45	0.22
2	12410	PF 1	2690.00	-5.69	3.33	-0.74	3.49	0.000417	3.14	857.88	155.00	0.23
2	12010	PF 1	2690.00	-5.12	3.18	-1.21	3.33	0.000376	3.10	872.29	153.69	0.23
2	10110	PF 1	2690.00	-6.47	2.67	-3.04	2.77	0.000221	2.57	1046.48	158.14	0.18
2	9285	PF 1	2690.00	-6.80	2.51	-3.24	2.61	0.000179	2.45	1116.70	160.04	0.16
2	9217	PF 1	2690.00	-8.81	2.50	-4.16	2.59	0.000181	2.45	1096.67	150.02	0.16
2	9201		Bridge									
2	9185	PF 1	2690.00	-9.01	2.48	-4.69	2.56	0.000157	2.35	1144.29	149.55	0.15
2	9135	PF 1	2690.00	-8.37	2.47	-4.59	2.55	0.000138	2.23	1207.43	158.00	0.14
2	7875	PF 1	2690.00	-7.70	2.28	-4.15	2.37	0.000156	2.31	1163.60	157.07	0.15
2	6500	PF 1	2690.00	-8.40	2.08	-4.65	2.16	0.000142	2.20	1221.02	165.41	0.14
2	6450	PF 1	2690.00	-9.63	2.08	-5.04	2.15	0.000129	2.09	1288.85	174.45	0.14
2	6425		Bridge									
2	6400	PF 1	2690.00	-10.37	2.07	-5.47	2.13	0.000114	2.02	1334.39	174.05	0.13
2	6350	PF 1	2690.00	-9.33	2.06	-5.27	2.13	0.000114	2.08	1307.59	170.89	0.13
2	5150	PF 1	2690.00	-8.79	1.89	-4.82	1.97	0.000151	2.25	1194.83	165.46	0.15
2	3900	PF 1	2690.00	-9.30	1.71	-5.21	1.78	0.000142	2.21	1215.69	163.97	0.14
2	3860	PF 1	2690.00	-10.71	1.69	-5.72	1.78	0.000151	2.44	1103.08	132.66	0.15
2	3838		Bridge									
2	3816	PF 1	2690.00	-10.95	1.65	-5.72	1.75	0.000163	2.52	1069.04	129.85	0.15
2	3760	PF 1	2690.00	-12.25	1.66	-6.97	1.72	0.000133	2.01	1338.81	200.63	0.14
2	2430	PF 1	2690.00	-9.07	1.48	-4.81	1.54	0.000143	1.96	1372.10	226.16	0.14
2	1980	PF 1	2690.00	-7.54	1.42	-4.42	1.48	0.000126	1.86	1442.56	232.89	0.13
2	680	PF 1	2690.00	-8.68	1.17	-4.20	1.26	0.000235	2.36	1139.02	206.28	0.18
2	530	PF 1	2690.00	-9.41	1.17	-6.17	1.22	0.000119	1.92	1404.25	203.89	0.13
2	500		Inl Struct									
2	480	PF 1	2690.00	-9.41	1.00	-6.02	1.07	0.000153	2.16	1243.26	180.33	0.15

Orleans Avenue Canal 3,390 cfs Canal Flow, Pumping at New Station, Suction Side = 1.0 ft

HEC-RAS Plan: 3390_suction_1 River: Orleans Reach: 2 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
2	12845	PF 1	3390.00	-20.40	4.36		4.37	0.000007	1.05	3218.23	130.00	0.04
2	12795	PF 1	3390.00	-20.40	4.36		4.37	0.000007	1.05	3218.19	130.00	0.04
2	12770	PF 1	3390.00	-20.40	4.36		4.37	0.000007	1.05	3218.17	130.00	0.04
2	12740	PF 1	3390.00	-10.40	4.34		4.37	0.000020	1.44	2358.16	160.00	0.07
2	12700	PF 1	3390.00	-10.72	4.31	-4.39	4.37	0.000063	1.97	1727.84	213.15	0.12
2	12625		Bridge									
2	12550	PF 1	3390.00	-5.10	4.15	0.04	4.31	0.000264	3.22	1051.48	169.12	0.23
2	12410	PF 1	3390.00	-5.69	4.06	-0.26	4.25	0.000450	3.49	971.99	157.70	0.25
2	12010	PF 1	3390.00	-5.12	3.89	-0.74	4.08	0.000409	3.47	983.08	155.97	0.24
2	10110	PF 1	3390.00	-6.47	3.31	-2.56	3.45	0.000264	2.95	1148.68	160.09	0.19
2	9285	PF 1	3390.00	-6.80	3.12	-2.76	3.25	0.000219	2.84	1214.64	161.68	0.18
2	9217	PF 1	3390.00	-8.81	3.11	-3.64	3.23	0.000223	2.86	1187.37	150.08	0.18
2	9201		Bridge									
2	9185	PF 1	3390.00	-9.01	3.07	-4.15	3.19	0.000196	2.75	1233.56	149.60	0.17
2	9135	PF 1	3390.00	-8.37	3.07	-4.05	3.18	0.000174	2.60	1302.09	159.35	0.16
2	7875	PF 1	3390.00	-7.70	2.83	-3.64	2.94	0.000198	2.71	1249.46	158.42	0.17
2	6500	PF 1	3390.00	-8.40	2.57	-4.14	2.68	0.000186	2.60	1301.89	167.77	0.16
2	6450	PF 1	3390.00	-9.63	2.57	-4.55	2.66	0.000167	2.47	1373.57	174.52	0.16
2	6425		Bridge									
2	6400	PF 1	3390.00	-10.37	2.55	-4.95	2.64	0.000149	2.39	1417.77	174.08	0.15
2	6350	PF 1	3390.00	-9.33	2.53	-4.73	2.63	0.000151	2.47	1389.20	172.62	0.15
2	5150	PF 1	3390.00	-8.79	2.31	-4.30	2.42	0.000204	2.68	1264.43	168.75	0.17
2	3900	PF 1	3390.00	-9.30	2.06	-4.68	2.17	0.000196	2.66	1273.10	165.67	0.17
2	3860	PF 1	3390.00	-10.71	2.02	-5.15	2.16	0.000211	2.95	1147.79	132.80	0.18
2	3838		Bridge									
2	3816	PF 1	3390.00	-10.95	1.97	-5.12	2.12	0.000230	3.05	1110.65	130.04	0.18
2	3760	PF 1	3390.00	-12.25	1.99	-6.32	2.08	0.000191	2.41	1405.88	209.96	0.16
2	2430	PF 1	3390.00	-9.07	1.73	-4.25	1.82	0.000202	2.37	1428.78	229.52	0.17
2	1980	PF 1	3390.00	-7.54	1.65	-4.01	1.73	0.000179	2.27	1495.15	235.19	0.16
2	680	PF 1	3390.00	-8.68	1.27	-3.66	1.40	0.000358	2.92	1159.90	209.43	0.22
2	530	PF 1	3390.00	-9.41	1.26	-5.70	1.35	0.000181	2.38	1424.32	204.76	0.16
2	500		Inl Struct									
2	480	PF 1	3390.00	-9.41	1.00	-5.51	1.12	0.000242	2.73	1243.26	180.33	0.18

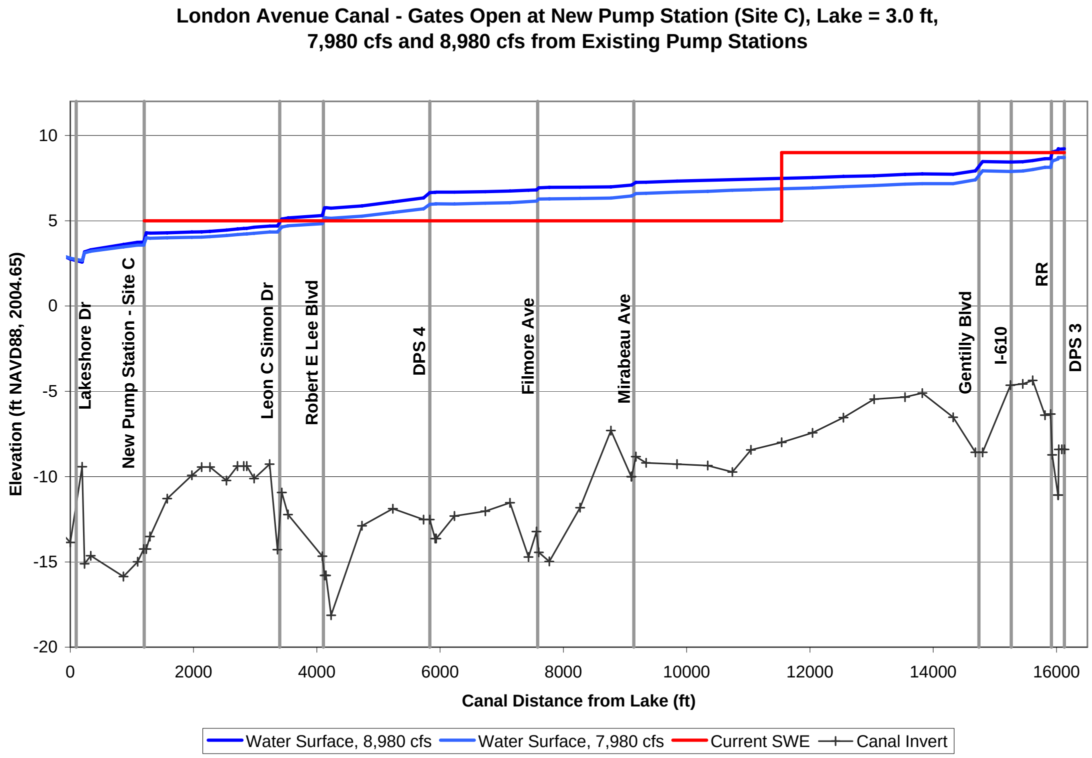

Figure C- 5 London Avenue Canal Water Surface Profiles for Lake Pontchartrain Elevation 3.0 ft

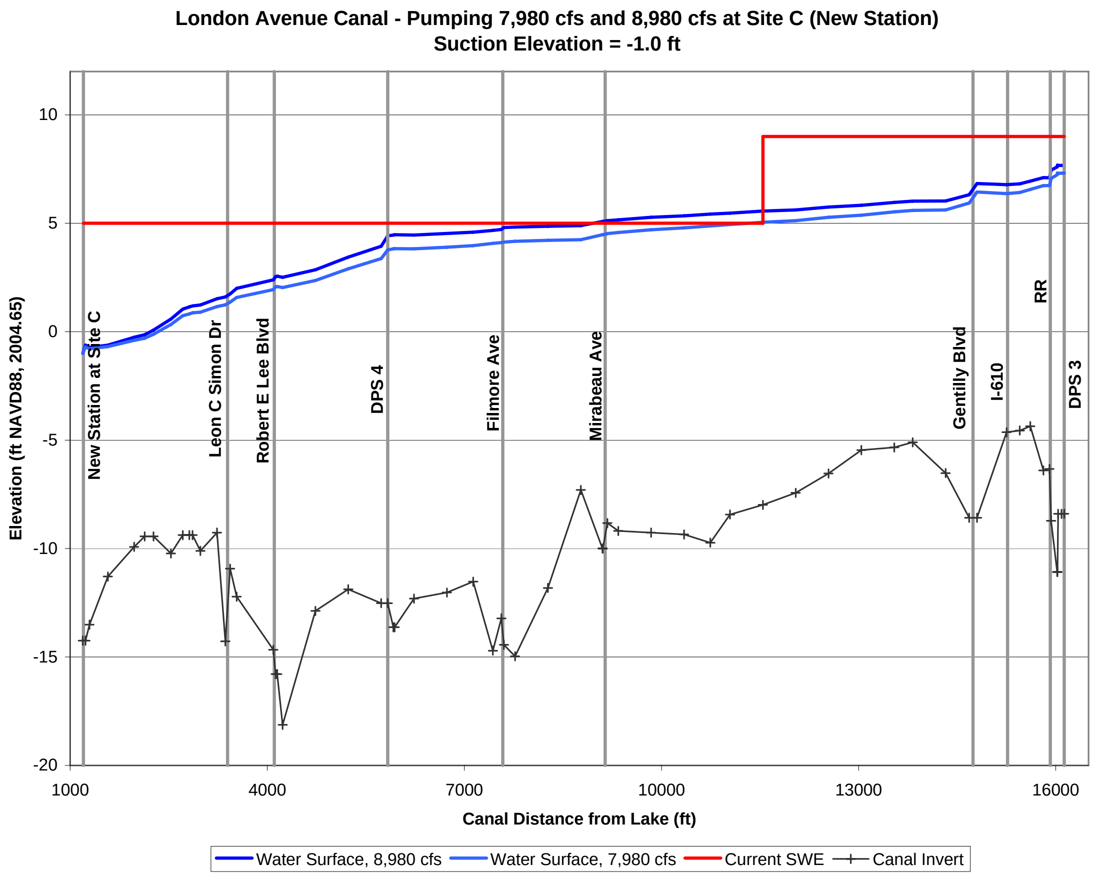

Figure C- 6 London Avenue Canal Water Surface Profiles for Pumping at New Station

Option 1
London Avenue Canal HEC-RAS Results for Gates Open

London Avenue Canal 7,980 cfs Canal Flow, Lake = 3.0 ft

HEC-RAS Plan: 7980_60_lake3 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	15300	PF 1	4260.00	-8.40	8.70	-5.34	8.75	0.000025	1.78	2393.81	140.00	0.08
1	15250	PF 1	4260.00	-8.40	8.70	-5.34	8.75	0.000025	1.78	2393.67	140.00	0.08
1	15200	PF 1	4260.00	-8.40	8.70	-5.34	8.75	0.000025	1.78	2393.50	140.00	0.08
1	15191	PF 1	4260.00	-11.08	8.71	-6.37	8.74	0.000010	1.48	2885.31	168.71	0.06
1	15188		Bridge									
1	15185	PF 1	4260.00	-11.08	8.62	-6.37	8.65	0.000010	1.49	2870.40	168.70	0.06
1	15092	PF 1	4260.00	-8.72	8.50	0.21	8.63	0.000081	2.79	1527.98	169.22	0.16
1	15079.5		Bridge									
1	15067	PF 1	4260.00	-6.33	8.13	0.38	8.26	0.000090	2.92	1461.05	163.16	0.17
1	14975	PF 1	4260.00	-6.40	8.13	-1.55	8.25	0.000053	2.85	1539.78	131.45	0.14
1	14775	PF 1	4260.00	-4.36	8.00	0.87	8.22	0.000134	3.80	1120.46	107.00	0.21
1	14675	PF 1	4260.00	-4.56	7.92	0.97	8.19	0.000187	4.22	1009.48	108.54	0.24
1	14475	PF 1	4260.00	-4.64	7.89	0.70	8.15	0.000177	4.14	1029.06	108.99	0.24
1	14354	PF 1	4260.00	-8.58	7.93	-2.85	8.04	0.000050	2.62	1626.47	130.24	0.13
1	14294.5		Bridge									
1	14235	PF 1	4260.00	-8.58	7.40	-2.85	7.51	0.000051	2.74	1556.95	130.13	0.14
1	13875	PF 1	4260.00	-6.52	7.18	-0.10	7.44	0.000127	4.19	1065.45	102.00	0.22
1	13656	PF 1	4260.00	-5.10	7.18	0.14	7.36	0.000095	3.48	1308.22	143.03	0.19
1	13375	PF 1	4260.00	-5.34	7.15	-0.21	7.32	0.000204	3.43	1320.73	143.08	0.18
1	12875	PF 1	4260.00	-5.46	7.06	-0.41	7.22	0.000187	3.31	1364.90	140.00	0.18
1	12375	PF 1	4260.00	-6.54	7.00	-1.81	7.13	0.000130	2.91	1519.79	139.00	0.15
1	11875	PF 1	4260.00	-7.43	6.92	-2.12	7.06	0.000143	3.09	1456.41	137.94	0.16
1	11375	PF 1	4260.00	-7.99	6.88	-2.57	6.99	0.000110	2.71	1604.61	137.00	0.14
1	10875	PF 1	4260.00	-8.43	6.82	-2.90	6.94	0.000115	2.79	1563.23	135.00	0.14
1	10575	PF 1	4260.00	-9.73	6.79	-3.89	6.90	0.000103	2.72	1618.38	135.82	0.13
1	10175	PF 1	4260.00	-9.35	6.73	-3.68	6.86	0.000112	2.84	1551.05	131.29	0.14
1	9675	PF 1	4260.00	-9.27	6.68	-3.51	6.80	0.000114	2.70	1603.57	135.90	0.14
1	9175	PF 1	4260.00	-9.19	6.61	-3.36	6.74	0.000123	2.85	1524.75	131.29	0.14
1	9009	PF 1	4260.00	-8.83	6.59	-2.70	6.72	0.000129	2.89	1527.59	141.49	0.15
1	8974		Bridge									
1	8939	PF 1	4260.00	-10.00	6.45	-3.87	6.57	0.000111	2.85	1571.25	140.54	0.14
1	8934	PF 1	4260.00	-10.00	6.45	-3.87	6.57	0.000111	2.85	1571.17	140.54	0.14
1	8771	PF 1	4260.00	-7.30	6.33	-0.79	6.50	0.000212	3.41	1288.72	131.30	0.19
1	8271	PF 1	4260.00	-11.82	6.31	-5.55	6.42	0.000089	2.69	1646.90	131.35	0.13
1	7771	PF 1	4260.00	-14.97	6.29	-6.98	6.37	0.000075	2.31	1846.12	131.63	0.11
1	7601	PF 1	4260.00	-14.44	6.27	-6.78	6.35	0.000069	2.40	1860.20	150.83	0.11
1	7582		Bridge									
1	7563	PF 1	4260.00	-13.22	6.15	-6.48	6.23	0.000069	2.30	1895.74	151.31	0.11
1	7433	PF 1	4260.00	-14.71	6.12	-6.03	6.21	0.000091	2.48	1727.42	135.00	0.12
1	7133	PF 1	4260.00	-11.53	6.06	-4.28	6.18	0.000112	2.77	1585.14	138.00	0.14
1	6733	PF 1	4260.00	-12.03	6.03	-5.03	6.14	0.000097	2.65	1672.46	147.77	0.13
1	6233	PF 1	4260.00	-12.31	5.98	-5.35	6.09	0.000096	2.60	1693.88	144.00	0.13
1	5938	PF 1	4260.00	-13.63	5.99	-8.50	6.06	0.000051	2.08	2101.33	146.00	0.09
1	5928.5		Bridge									
1	5919	PF 1	4260.00	-13.63	5.98	-8.50	6.05	0.000051	2.08	2100.27	146.00	0.09
1	5833	PF 1	4260.00	-12.52	5.96	-5.83	6.04	0.000081	2.29	1860.17	148.35	0.11
2	5733	PF 1	7980.00	-12.52	5.70	-3.31	6.00	0.000304	4.38	1822.30	148.35	0.22
2	5233	PF 1	7980.00	-11.88	5.49	-2.98	5.83	0.000379	4.67	1707.57	148.02	0.24
2	4733	PF 1	7980.00	-12.88	5.27	-2.71	5.64	0.000375	4.88	1672.30	147.86	0.25
2	4233	PF 1	7980.00	-18.13	5.15	-6.50	5.46	0.000285	4.48	1821.11	148.00	0.22
2	4150	PF 1	7980.00	-15.79	5.17	-6.54	5.39	0.000178	3.77	2165.24	176.85	0.18
2	4126	PF 1	7980.00	-15.79	5.17	-6.54	5.39	0.000178	3.77	2164.44	176.84	0.18
2	4108		Bridge									
2	4090	PF 1	7980.00	-14.67	4.83	-5.43	5.07	0.000225	3.97	2050.11	181.56	0.20
2	3533	PF 1	7980.00	-12.22	4.71	-4.82	4.94	0.000231	3.93	2090.14	209.23	0.20
2	3433	PF 1	7980.00	-10.93	4.64	-3.89	4.91	0.000317	4.16	1918.67	183.89	0.23
2	3397		Bridge									
2	3361	PF 1	7980.00	-14.28	4.34	-5.10	4.58	0.000260	3.91	2041.41	184.01	0.21
2	3233	PF 1	7980.00	-9.27	4.34	-3.04	4.52	0.000270	3.39	2356.77	276.15	0.20
2	2983	PF 1	7980.00	-10.11	4.27	-3.49	4.45	0.000273	3.36	2377.42	283.53	0.20
2	2863	PF 1	7980.00	-9.38	4.23	-4.57	4.42	0.000262	3.45	2314.25	292.76	0.17
2	2813	PF 1	7980.00	-9.38	4.22	-4.57	4.40	0.000263	3.45	2311.77	292.51	0.17
2	2713	PF 1	7980.00	-9.38	4.19	-4.57	4.38	0.000265	3.46	2306.74	291.99	0.17
2	2533	PF 1	7980.00	-10.23	4.14	-2.55	4.30	0.000439	3.24	2465.74	312.15	0.20
2	2268	PF 1	7980.00	-9.44	4.07	-3.84	4.19	0.000325	2.83	2820.32	348.90	0.18
2	2133	PF 1	7980.00	-9.44	4.04	-3.84	4.17	0.000131	2.84	2810.79	348.17	0.18
2	1973	PF 1	7980.00	-9.92	4.03	-3.65	4.14	0.000114	2.73	2920.46	346.16	0.17
2	1573	PF 1	7980.00	-11.29	4.00	-4.36	4.10	0.000095	2.49	3202.47	379.74	0.15
2	1293	PF 1	7980.00	-13.51	3.98	-6.30	4.07	0.000079	2.36	3374.66	375.82	0.14
2	1233	PF 1	7980.00	-14.25	4.00	-10.07	4.05	0.000031	1.73	4620.05	379.74	0.09
2	1200		Inl Struct									
2	1193	PF 1	7980.00	-14.25	3.57	-6.90	3.66	0.000088	2.39	3338.33	372.44	0.14
2	1093	PF 1	7980.00	-14.99	3.57	-7.51	3.65	0.000071	2.29	3488.86	379.35	0.13
2	863	PF 1	7980.00	-15.86	3.47	-7.06	3.61	0.000144	3.04	2628.15	314.06	0.18
2	330	PF 1	7980.00	-14.64	3.22	-5.48	3.50	0.000232	4.26	1873.63	190.80	0.24
2	230	PF 1	7980.00	-15.11	3.12	-5.97	3.47	0.000241	4.74	1683.16	147.68	0.25
2	193	PF 1	7980.00	-9.42	2.67	-1.66	3.41	0.000748	6.94	1150.12	134.44	0.42
2	96.5		Bridge									

London Avenue Canal 7,980 cfs Canal Flow, Lake = 3.0 ft (continued)

HEC-RAS Plan: 7980_60_lake3 Profile: PF 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
2	0	PF 1	7980.00	-13.86	2.81		3.12	0.000202	4.48	1780.13	144.04	0.22
2	-140	PF 1	7980.00	-13.30	2.98		3.04	0.000031	1.90	4195.52	300.00	0.09
2	-606.66*	PF 1	7980.00	-13.17	3.00		3.02	0.000010	1.15	6909.75	444.44	0.05
2	-1073.3*	PF 1	7980.00	-12.83	3.00		3.01	0.000006	0.89	8940.16	588.89	0.04
2	-1540.*	PF 1	7980.00	-12.54	3.00		3.01	0.000004	0.72	11027.17	733.33	0.03
2	-2006.6*	PF 1	7980.00	-12.45	3.00		3.01	0.000003	0.61	13024.42	877.78	0.03
2	-2473.3*	PF 1	7980.00	-12.27	3.00		3.01	0.000002	0.53	14959.83	1022.22	0.02
2	-2940.*	PF 1	7980.00	-12.12	3.00		3.00	0.000002	0.47	16861.70	1166.67	0.02
2	-3406.6*	PF 1	7980.00	-12.05	3.00		3.00	0.000001	0.43	18726.92	1311.11	0.02
2	-3873.3*	PF 1	7980.00	-12.09	3.00		3.00	0.000001	0.39	20595.83	1455.56	0.02
2	-4340	PF 1	7980.00	-12.25	3.00	-10.96	3.00	0.000001	0.35	23103.75	1600.00	0.02

London Avenue Canal 8,980 cfs Canal Flow, Lake = 3.0 ft

HEC-RAS Plan: 8980_60_lake3 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	15300	PF 1	4260.00	-8.40	9.22	-5.34	9.26	0.000023	1.73	2466.18	140.00	0.07
1	15250	PF 1	4260.00	-8.40	9.21	-5.34	9.26	0.000023	1.73	2466.05	140.00	0.07
1	15200	PF 1	4260.00	-8.40	9.21	-5.34	9.26	0.000023	1.73	2465.89	140.00	0.07
1	15191	PF 1	4260.00	-11.08	9.22	-6.37	9.26	0.000009	1.43	2972.45	168.75	0.06
1	15188		Bridge									
1	15185	PF 1	4260.00	-11.08	9.13	-6.37	9.17	0.000009	1.44	2957.20	168.74	0.06
1	15092	PF 1	4260.00	-8.72	9.03	0.21	9.14	0.000069	2.63	1618.46	172.90	0.15
1	15079.5		Bridge									
1	15067	PF 1	4260.00	-6.33	8.64	0.38	8.76	0.000083	2.75	1547.40	178.55	0.16
1	14975	PF 1	4260.00	-6.40	8.64	-1.55	8.75	0.000046	2.74	1607.42	131.51	0.13
1	14775	PF 1	4260.00	-4.36	8.53	0.87	8.73	0.000115	3.62	1177.02	107.00	0.19
1	14675	PF 1	4260.00	-4.56	8.46	0.97	8.71	0.000156	3.99	1068.35	108.75	0.22
1	14475	PF 1	4260.00	-4.64	8.44	0.70	8.67	0.000148	3.91	1088.69	109.13	0.22
1	14354	PF 1	4260.00	-8.58	8.47	-2.85	8.57	0.000044	2.51	1697.12	130.36	0.12
1	14294.5		Bridge									
1	14235	PF 1	4260.00	-8.58	7.93	-2.85	8.04	0.000044	2.63	1626.39	130.24	0.13
1	13875	PF 1	4260.00	-6.52	7.73	-0.10	7.97	0.000108	3.99	1122.35	102.00	0.20
1	13656	PF 1	4260.00	-5.10	7.75	0.14	7.90	0.000079	3.28	1388.71	143.03	0.17
1	13375	PF 1	4260.00	-5.34	7.72	-0.21	7.87	0.000170	3.24	1402.12	143.08	0.17
1	12875	PF 1	4260.00	-5.46	7.64	-0.41	7.79	0.000156	3.13	1446.64	140.00	0.16
1	12375	PF 1	4260.00	-6.54	7.60	-1.81	7.71	0.000110	2.76	1602.17	139.00	0.14
1	11875	PF 1	4260.00	-7.43	7.53	-2.12	7.65	0.000120	2.93	1539.97	137.94	0.14
1	11375	PF 1	4260.00	-7.99	7.49	-2.57	7.59	0.000093	2.57	1688.53	137.00	0.13
1	10875	PF 1	4260.00	-8.43	7.44	-2.90	7.55	0.000097	2.65	1647.23	135.00	0.13
1	10575	PF 1	4260.00	-9.73	7.41	-3.89	7.52	0.000087	2.59	1703.50	135.82	0.12
1	10175	PF 1	4260.00	-9.35	7.37	-3.68	7.48	0.000095	2.70	1634.35	131.29	0.13
1	9675	PF 1	4260.00	-9.27	7.33	-3.51	7.43	0.000097	2.57	1690.89	135.90	0.13
1	9175	PF 1	4260.00	-9.19	7.26	-3.36	7.38	0.000103	2.70	1610.57	131.29	0.13
1	9009	PF 1	4260.00	-8.83	7.25	-2.70	7.36	0.000107	2.73	1620.84	141.66	0.14
1	8974		Bridge									
1	8939	PF 1	4260.00	-10.00	7.09	-3.87	7.20	0.000094	2.70	1661.89	140.73	0.13
1	8934	PF 1	4260.00	-10.00	7.09	-3.87	7.20	0.000094	2.70	1661.82	140.73	0.13
1	8771	PF 1	4260.00	-7.30	6.99	-0.79	7.15	0.000172	3.20	1375.92	131.30	0.17
1	8271	PF 1	4260.00	-11.82	6.97	-5.55	7.07	0.000076	2.56	1734.57	131.35	0.12
1	7771	PF 1	4260.00	-14.97	6.96	-6.98	7.03	0.000065	2.20	1934.43	131.63	0.10
1	7601	PF 1	4260.00	-14.44	6.94	-6.78	7.02	0.000059	2.28	1962.00	151.12	0.10
1	7582		Bridge									
1	7563	PF 1	4260.00	-13.22	6.81	-6.48	6.89	0.000059	2.19	1996.51	151.52	0.10
1	7433	PF 1	4260.00	-14.71	6.79	-6.03	6.87	0.000077	2.35	1817.71	135.00	0.11
1	7133	PF 1	4260.00	-11.53	6.74	-4.28	6.85	0.000094	2.62	1678.59	138.00	0.13
1	6733	PF 1	4260.00	-12.03	6.71	-5.03	6.81	0.000081	2.50	1773.45	147.77	0.12
1	6233	PF 1	4260.00	-12.31	6.68	-5.35	6.77	0.000080	2.47	1793.37	144.00	0.12
1	5938	PF 1	4260.00	-13.63	6.68	-8.50	6.74	0.000044	1.98	2202.12	146.00	0.09
1	5928.5		Bridge									
1	5919	PF 1	4260.00	-13.63	6.67	-8.50	6.73	0.000044	1.99	2201.16	146.00	0.09
1	5833	PF 1	4260.00	-12.52	6.65	-5.83	6.73	0.000069	2.17	1963.29	148.35	0.11
2	5733	PF 1	8980.00	-12.52	6.34	-2.75	6.68	0.000328	4.68	1917.07	148.35	0.23
2	5233	PF 1	8980.00	-11.88	6.11	-2.35	6.50	0.000408	4.99	1799.44	148.02	0.25
2	4733	PF 1	8980.00	-12.88	5.87	-2.17	6.29	0.000405	5.22	1761.21	147.86	0.26
2	4233	PF 1	8980.00	-18.13	5.74	-5.82	6.09	0.000312	4.82	1908.42	148.00	0.23
2	4150	PF 1	8980.00	-15.79	5.77	-6.01	6.02	0.000195	4.06	2271.03	178.90	0.19
2	4126	PF 1	8980.00	-15.79	5.76	-6.01	6.02	0.000196	4.06	2270.13	178.88	0.19
2	4108		Bridge									
2	4090	PF 1	8980.00	-14.67	5.31	-4.93	5.60	0.000251	4.30	2137.34	181.79	0.21
2	3533	PF 1	8980.00	-12.22	5.17	-4.31	5.45	0.000256	4.25	2189.24	213.59	0.21
2	3433	PF 1	8980.00	-10.93	5.10	-3.41	5.42	0.000348	4.48	2002.88	184.00	0.24
2	3397		Bridge									
2	3361	PF 1	8980.00	-14.28	4.70	-4.60	4.98	0.000297	4.26	2106.12	184.07	0.22
2	3233	PF 1	8980.00	-9.27	4.69	-2.64	4.90	0.000305	3.66	2455.57	280.55	0.22
2	2983	PF 1	8980.00	-10.11	4.62	-3.06	4.82	0.000307	3.63	2476.38	287.59	0.22
2	2863	PF 1	8980.00	-9.38	4.56	-4.26	4.79	0.000304	3.78	2374.88	298.97	0.18
2	2813	PF 1	8980.00	-9.38	4.55	-4.26	4.77	0.000306	3.79	2371.98	298.67	0.18
2	2713	PF 1	8980.00	-9.38	4.52	-4.26	4.74	0.000308	3.80	2366.08	298.07	0.19
2	2533	PF 1	8980.00	-10.23	4.46	-2.21	4.65	0.000494	3.50	2567.08	315.91	0.22
2	2268	PF 1	8980.00	-9.44	4.38	-3.47	4.53	0.000370	3.06	2930.64	354.84	0.19
2	2133	PF 1	8980.00	-9.44	4.35	-3.47	4.50	0.000149	3.08	2919.47	354.07	0.19
2	1973	PF 1	8980.00	-9.92	4.34	-3.31	4.47	0.000130	2.97	3027.43	349.79	0.18
2	1573	PF 1	8980.00	-11.29	4.30	-3.96	4.42	0.000108	2.71	3318.35	382.48	0.16
2	1293	PF 1	8980.00	-13.51	4.28	-5.89	4.39	0.000091	2.57	3488.65	380.49	0.15
2	1233	PF 1	8980.00	-14.25	4.30	-9.74	4.36	0.000037	1.90	4736.37	384.94	0.10
2	1200		Inl Struct									
2	1193	PF 1	8980.00	-14.25	3.75	-6.46	3.85	0.000105	2.64	3402.62	375.36	0.15
2	1093	PF 1	8980.00	-14.99	3.74	-7.03	3.84	0.000086	2.53	3554.03	382.36	0.15
2	863	PF 1	8980.00	-15.86	3.61	-6.56	3.79	0.000174	3.36	2674.94	316.80	0.20
2	330	PF 1	8980.00	-14.64	3.30	-4.96	3.65	0.000289	4.75	1890.17	192.51	0.27
2	230	PF 1	8980.00	-15.11	3.18	-5.40	3.62	0.000300	5.31	1691.86	148.02	0.28
2	193	PF 1	8980.00	-9.42	2.58	-1.17	3.54	0.000977	7.89	1138.15	134.09	0.48
2	96.5		Bridge									

London Avenue Canal 8,980 cfs Canal Flow, Lake = 3.0 ft (continued)

HEC-RAS Plan: 8980_60_lake3 Profile: PF 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
2	0	PF 1	8980.00	-13.86	2.76		3.16	0.000259	5.07	1772.52	143.79	0.25
2	-140	PF 1	8980.00	-13.30	2.98		3.05	0.000039	2.14	4193.95	300.00	0.10
2	-606.66*	PF 1	8980.00	-13.17	3.00		3.02	0.000012	1.30	6909.50	444.44	0.06
2	-1073.3*	PF 1	8980.00	-12.83	3.00		3.02	0.000007	1.00	8940.21	588.89	0.05
2	-1540.*	PF 1	8980.00	-12.54	3.00		3.01	0.000005	0.81	11027.39	733.33	0.04
2	-2006.6*	PF 1	8980.00	-12.45	3.00		3.01	0.000003	0.69	13024.71	877.78	0.03
2	-2473.3*	PF 1	8980.00	-12.27	3.00		3.01	0.000003	0.60	14960.12	1022.22	0.03
2	-2940.*	PF 1	8980.00	-12.12	3.00		3.01	0.000002	0.53	16861.95	1166.67	0.02
2	-3406.6*	PF 1	8980.00	-12.05	3.00		3.00	0.000002	0.48	18727.09	1311.11	0.02
2	-3873.3*	PF 1	8980.00	-12.09	3.00		3.00	0.000002	0.44	20595.90	1455.56	0.02
2	-4340	PF 1	8980.00	-12.25	3.00	-10.88	3.00	0.000001	0.39	23103.75	1600.00	0.02

Option 1
London Canal HEC-RAS Results for Pumping at New Station

London Avenue Canal 7,980 cfs Canal Flow, Pumping at New Station, Suction Side = -1.0 ft

HEC-RAS Plan: 7980_suction_-1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	15300	PF 1	4260.00	-8.40	7.31	-5.34	7.37	0.000033	1.94	2199.07	140.00	0.09
1	15250	PF 1	4260.00	-8.40	7.31	-5.34	7.36	0.000033	1.94	2198.89	140.00	0.09
1	15200	PF 1	4260.00	-8.40	7.30	-5.34	7.36	0.000033	1.94	2198.66	140.00	0.09
1	15191	PF 1	4260.00	-11.08	7.32	-6.37	7.36	0.000013	1.61	2650.92	168.61	0.07
1	15188		Bridge									
1	15185	PF 1	4260.00	-11.08	7.24	-6.37	7.28	0.000014	1.62	2637.07	168.60	0.07
1	15092	PF 1	4260.00	-8.72	7.07	0.21	7.24	0.000125	3.29	1295.23	154.60	0.20
1	15079.5		Bridge									
1	15067	PF 1	4260.00	-6.33	6.74	0.38	6.92	0.000135	3.42	1245.30	149.18	0.21
1	14975	PF 1	4260.00	-6.40	6.74	-1.55	6.90	0.000079	3.22	1357.88	131.28	0.17
1	14775	PF 1	4260.00	-4.36	6.56	0.87	6.86	0.000213	4.41	966.39	107.00	0.26
1	14675	PF 1	4260.00	-4.56	6.42	0.97	6.81	0.000299	5.02	847.82	101.80	0.31
1	14475	PF 1	4260.00	-4.64	6.37	0.70	6.75	0.000271	4.92	865.13	98.75	0.29
1	14354	PF 1	4260.00	-8.58	6.44	-2.85	6.58	0.000074	2.97	1432.21	129.93	0.16
1	14294.5		Bridge									
1	14235	PF 1	4260.00	-8.58	5.93	-2.85	6.09	0.000079	3.12	1366.95	129.82	0.17
1	13875	PF 1	4260.00	-6.52	5.62	-0.10	5.98	0.000211	4.90	906.20	102.00	0.27
1	13656	PF 1	4260.00	-5.10	5.59	0.14	5.85	0.000170	4.18	1080.80	143.03	0.24
1	13375	PF 1	4260.00	-5.34	5.53	-0.21	5.78	0.000366	4.13	1089.10	143.08	0.24
1	12875	PF 1	4260.00	-5.46	5.37	-0.41	5.60	0.000339	3.98	1127.97	140.00	0.23
1	12375	PF 1	4260.00	-6.54	5.27	-1.81	5.45	0.000223	3.44	1278.60	139.00	0.19
1	11875	PF 1	4260.00	-7.43	5.12	-2.12	5.33	0.000252	3.70	1208.35	137.94	0.20
1	11375	PF 1	4260.00	-7.99	5.05	-2.57	5.20	0.000191	3.20	1353.60	137.00	0.18
1	10875	PF 1	4260.00	-8.43	4.94	-2.90	5.11	0.000203	3.31	1309.46	135.00	0.18
1	10575	PF 1	4260.00	-9.73	4.88	-3.89	5.04	0.000177	3.22	1360.04	135.82	0.17
1	10175	PF 1	4260.00	-9.35	4.79	-3.68	4.97	0.000196	3.37	1296.32	131.29	0.18
1	9675	PF 1	4260.00	-9.27	4.70	-3.51	4.86	0.000203	3.24	1334.24	135.90	0.18
1	9175	PF 1	4260.00	-9.19	4.57	-3.36	4.75	0.000229	3.44	1256.97	131.29	0.19
1	9009	PF 1	4260.00	-8.83	4.52	-2.70	4.71	0.000248	3.54	1235.57	140.94	0.20
1	8974		Bridge									
1	8939	PF 1	4260.00	-10.00	4.47	-3.87	4.65	0.000198	3.41	1294.58	139.98	0.18
1	8934	PF 1	4260.00	-10.00	4.47	-3.87	4.65	0.000198	3.42	1294.43	139.98	0.18
1	8771	PF 1	4260.00	-7.30	4.24	-0.79	4.52	0.000454	4.30	1015.12	131.30	0.26
1	8271	PF 1	4260.00	-11.82	4.21	-5.55	4.36	0.000156	3.20	1371.00	131.35	0.16
1	7771	PF 1	4260.00	-14.97	4.17	-6.98	4.28	0.000124	2.72	1567.27	131.63	0.14
1	7601	PF 1	4260.00	-14.44	4.13	-6.78	4.26	0.000121	2.86	1539.11	149.91	0.14
1	7582		Bridge									
1	7563	PF 1	4260.00	-13.22	4.11	-6.48	4.23	0.000119	2.72	1588.80	150.68	0.14
1	7433	PF 1	4260.00	-14.71	4.07	-6.03	4.20	0.000158	2.94	1450.86	135.00	0.16
1	7133	PF 1	4260.00	-11.53	3.97	-4.28	4.15	0.000212	3.36	1296.46	138.00	0.18
1	6733	PF 1	4260.00	-12.03	3.90	-5.03	4.06	0.000181	3.21	1358.37	147.77	0.17
1	6233	PF 1	4260.00	-12.31	3.82	-5.35	3.97	0.000181	3.17	1381.89	144.00	0.17
1	5938	PF 1	4260.00	-13.63	3.83	-8.50	3.92	0.000085	2.44	1785.39	146.00	0.12
1	5928.5		Bridge									
1	5919	PF 1	4260.00	-13.63	3.82	-8.50	3.91	0.000085	2.44	1783.86	146.00	0.12
1	5833	PF 1	4260.00	-12.52	3.77	-5.83	3.89	0.000148	2.77	1535.61	148.35	0.15
2	5733	PF 1	7980.00	-12.52	3.37	-3.31	3.82	0.000589	5.41	1476.24	148.35	0.30
2	5233	PF 1	7980.00	-11.88	2.90	-2.98	3.46	0.000847	6.03	1324.29	148.02	0.36
2	4733	PF 1	7980.00	-12.88	2.36	-2.71	3.01	0.000930	6.50	1241.15	147.86	0.38
2	4233	PF 1	7980.00	-18.13	2.04	-6.50	2.58	0.000673	5.91	1361.49	145.89	0.32
2	4150	PF 1	7980.00	-15.79	2.08	-6.54	2.45	0.000412	4.87	1640.27	156.66	0.26
2	4126	PF 1	7980.00	-15.79	2.07	-6.54	2.44	0.000414	4.88	1638.52	156.52	0.26
2	4108		Bridge									
2	4090	PF 1	7980.00	-14.67	1.94	-5.43	2.36	0.000542	5.19	1538.39	163.22	0.29
2	3533	PF 1	7980.00	-12.22	1.58	-4.82	2.03	0.000625	5.36	1494.81	172.25	0.31
2	3433	PF 1	7980.00	-10.93	1.36	-3.89	1.92	0.000944	6.01	1328.09	165.86	0.37
2	3397		Bridge									
2	3361	PF 1	7980.00	-14.28	1.24	-5.10	1.69	0.000672	5.37	1486.01	169.57	0.32
2	3233	PF 1	7980.00	-9.27	1.16	-3.04	1.57	0.000895	5.18	1541.40	234.72	0.36
2	2983	PF 1	7980.00	-10.11	0.90	-3.49	1.34	0.000981	5.33	1498.28	233.52	0.37
2	2863	PF 1	7980.00	-9.38	0.87	-4.57	1.21	0.000731	4.69	1701.59	250.72	0.27
2	2813	PF 1	7980.00	-9.38	0.82	-4.57	1.17	0.000741	4.71	1694.23	250.44	0.27
2	2713	PF 1	7980.00	-9.38	0.74	-4.57	1.09	0.000764	4.75	1679.06	249.89	0.28
2	2533	PF 1	7980.00	-10.23	0.33	-2.55	0.83	0.002117	5.70	1400.28	247.17	0.42
2	2268	PF 1	7980.00	-9.44	-0.12	-3.84	0.30	0.001742	5.18	1539.53	270.97	0.38
2	2133	PF 1	7980.00	-9.44	-0.30	-3.84	0.15	0.000764	5.35	1491.06	268.58	0.40
2	1973	PF 1	7980.00	-9.92	-0.40	-3.65	0.02	0.000727	5.22	1528.86	275.68	0.39
2	1573	PF 1	7980.00	-11.29	-0.69	-4.36	-0.29	0.000808	5.07	1573.53	320.18	0.40
2	1293	PF 1	7980.00	-13.51	-0.79	-6.30	-0.48	0.000413	4.45	1794.57	268.88	0.30
2	1233	PF 1	7980.00	-14.25	-0.70	-10.07	-0.59	0.000098	2.64	3018.60	310.61	0.15
2	1200		Inl Struct									
2	1193	PF 1	7980.00	-14.25	-1.00	-6.90	-0.72	0.000401	4.28	1865.75	271.99	0.29

London Avenue Canal 8,980 cfs Canal Flow, Pumping at New Station, Suction Side = -1.0 ft

HEC-RAS Plan: 8980_suction_-1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	15300	PF 1	4260.00	-8.40	7.67	-5.34	7.73	0.000030	1.89	2250.18	140.00	0.08
1	15250	PF 1	4260.00	-8.40	7.67	-5.34	7.73	0.000030	1.89	2250.01	140.00	0.08
1	15200	PF 1	4260.00	-8.40	7.67	-5.34	7.73	0.000030	1.89	2249.79	140.00	0.08
1	15191	PF 1	4260.00	-11.08	7.68	-6.37	7.72	0.000012	1.57	2712.41	168.63	0.07
1	15188		Bridge									
1	15185	PF 1	4260.00	-11.08	7.60	-6.37	7.64	0.000013	1.58	2698.26	168.63	0.07
1	15092	PF 1	4260.00	-8.72	7.45	0.21	7.60	0.000112	3.14	1354.63	158.46	0.19
1	15079.5		Bridge									
1	15067	PF 1	4260.00	-6.33	7.10	0.38	7.27	0.000119	3.28	1300.00	151.25	0.20
1	14975	PF 1	4260.00	-6.40	7.11	-1.55	7.25	0.000071	3.11	1405.59	131.32	0.16
1	14775	PF 1	4260.00	-4.36	6.94	0.87	7.22	0.000187	4.23	1007.15	107.00	0.24
1	14675	PF 1	4260.00	-4.56	6.82	0.97	7.18	0.000276	4.78	890.55	108.13	0.29
1	14475	PF 1	4260.00	-4.64	6.78	0.70	7.12	0.000262	4.69	907.89	108.71	0.29
1	14354	PF 1	4260.00	-8.58	6.83	-2.85	6.96	0.000066	2.87	1483.25	130.01	0.15
1	14294.5		Bridge									
1	14235	PF 1	4260.00	-8.58	6.32	-2.85	6.46	0.000070	3.01	1416.71	129.90	0.16
1	13875	PF 1	4260.00	-6.52	6.03	-0.10	6.36	0.000183	4.69	948.56	102.00	0.26
1	13656	PF 1	4260.00	-5.10	6.02	0.14	6.25	0.000144	3.97	1141.74	143.03	0.23
1	13375	PF 1	4260.00	-5.34	5.96	-0.21	6.19	0.000310	3.92	1151.50	143.08	0.22
1	12875	PF 1	4260.00	-5.46	5.83	-0.41	6.04	0.000285	3.77	1192.71	140.00	0.21
1	12375	PF 1	4260.00	-6.54	5.75	-1.81	5.91	0.000190	3.27	1344.99	139.00	0.18
1	11875	PF 1	4260.00	-7.43	5.62	-2.12	5.81	0.000213	3.51	1277.33	137.94	0.19
1	11375	PF 1	4260.00	-7.99	5.56	-2.57	5.70	0.000162	3.04	1423.79	137.00	0.16
1	10875	PF 1	4260.00	-8.43	5.47	-2.90	5.62	0.000171	3.15	1380.94	135.00	0.17
1	10575	PF 1	4260.00	-9.73	5.42	-3.89	5.57	0.000151	3.06	1433.05	135.82	0.16
1	10175	PF 1	4260.00	-9.35	5.34	-3.68	5.50	0.000166	3.20	1368.70	131.29	0.17
1	9675	PF 1	4260.00	-9.27	5.27	-3.51	5.41	0.000170	3.06	1411.25	135.90	0.16
1	9175	PF 1	4260.00	-9.19	5.16	-3.36	5.32	0.000189	3.25	1334.20	131.29	0.18
1	9009	PF 1	4260.00	-8.83	5.12	-2.70	5.29	0.000203	3.32	1320.08	141.10	0.18
1	8974		Bridge									
1	8939	PF 1	4260.00	-10.00	5.08	-3.87	5.24	0.000164	3.22	1379.41	140.15	0.17
1	8934	PF 1	4260.00	-10.00	5.08	-3.87	5.24	0.000164	3.22	1379.29	140.15	0.17
1	8771	PF 1	4260.00	-7.30	4.89	-0.79	5.13	0.000351	3.97	1100.70	131.30	0.23
1	8271	PF 1	4260.00	-11.82	4.86	-5.55	5.00	0.000130	3.02	1457.45	131.35	0.15
1	7771	PF 1	4260.00	-14.97	4.83	-6.98	4.93	0.000104	2.57	1654.85	131.63	0.13
1	7601	PF 1	4260.00	-14.44	4.80	-6.78	4.92	0.000101	2.70	1639.94	150.20	0.13
1	7582		Bridge									
1	7563	PF 1	4260.00	-13.22	4.71	-6.48	4.81	0.000101	2.58	1678.33	150.87	0.13
1	7433	PF 1	4260.00	-14.71	4.67	-6.03	4.79	0.000133	2.79	1531.81	135.00	0.15
1	7133	PF 1	4260.00	-11.53	4.59	-4.28	4.74	0.000173	3.17	1381.47	138.00	0.17
1	6733	PF 1	4260.00	-12.03	4.53	-5.03	4.67	0.000149	3.02	1451.32	147.77	0.16
1	6233	PF 1	4260.00	-12.31	4.46	-5.35	4.60	0.000148	2.98	1474.79	144.00	0.16
1	5938	PF 1	4260.00	-13.63	4.47	-8.50	4.55	0.000072	2.32	1879.44	146.00	0.11
1	5928.5		Bridge									
1	5919	PF 1	4260.00	-13.63	4.46	-8.50	4.54	0.000072	2.32	1878.08	146.00	0.11
1	5833	PF 1	4260.00	-12.52	4.42	-5.83	4.53	0.000122	2.61	1632.51	148.35	0.14
2	5733	PF 1	8980.00	-12.52	3.94	-2.75	4.46	0.000625	5.75	1561.24	148.35	0.31
2	5233	PF 1	8980.00	-11.88	3.44	-2.35	4.07	0.000891	6.39	1404.30	148.02	0.37
2	4733	PF 1	8980.00	-12.88	2.85	-2.17	3.59	0.000990	6.93	1314.71	147.86	0.39
2	4233	PF 1	8980.00	-18.13	2.51	-5.82	3.13	0.000750	6.36	1429.92	148.00	0.34
2	4150	PF 1	8980.00	-15.79	2.56	-6.01	2.99	0.000454	5.26	1715.54	162.32	0.27
2	4126	PF 1	8980.00	-15.79	2.54	-6.01	2.97	0.000456	5.26	1713.52	162.18	0.27
2	4108		Bridge									
2	4090	PF 1	8980.00	-14.67	2.39	-4.93	2.88	0.000590	5.58	1613.74	169.38	0.31
2	3533	PF 1	8980.00	-12.22	2.00	-4.31	2.51	0.000692	5.76	1567.49	177.12	0.33
2	3433	PF 1	8980.00	-10.93	1.74	-3.41	2.39	0.001067	6.44	1393.39	171.73	0.40
2	3397		Bridge									
2	3361	PF 1	8980.00	-14.28	1.60	-4.60	2.13	0.000754	5.80	1547.98	171.51	0.34
2	3233	PF 1	8980.00	-9.27	1.52	-2.64	1.99	0.000977	5.52	1627.35	240.43	0.37
2	2983	PF 1	8980.00	-10.11	1.23	-3.06	1.73	0.001075	5.70	1576.69	238.12	0.39
2	2863	PF 1	8980.00	-9.38	1.19	-4.26	1.59	0.000827	5.10	1760.05	252.87	0.29
2	2813	PF 1	8980.00	-9.38	1.14	-4.26	1.55	0.000840	5.13	1751.61	252.56	0.29
2	2713	PF 1	8980.00	-9.38	1.04	-4.26	1.46	0.000869	5.18	1734.10	251.91	0.30
2	2533	PF 1	8980.00	-10.23	0.58	-2.21	1.17	0.002348	6.13	1464.16	250.13	0.45
2	2268	PF 1	8980.00	-9.44	0.07	-3.47	0.57	0.001997	5.64	1592.34	273.55	0.41
2	2133	PF 1	8980.00	-9.44	-0.14	-3.47	0.39	0.000890	5.85	1533.81	270.69	0.43
2	1973	PF 1	8980.00	-9.92	-0.26	-3.31	0.25	0.000858	5.73	1567.26	278.10	0.43
2	1573	PF 1	8980.00	-11.29	-0.62	-3.96	-0.13	0.000975	5.62	1598.12	320.91	0.44
2	1293	PF 1	8980.00	-13.51	-0.73	-5.89	-0.35	0.000514	4.97	1808.41	270.40	0.34
2	1233	PF 1	8980.00	-14.25	-0.62	-9.74	-0.49	0.000122	2.95	3041.36	311.49	0.17
2	1200		Inl Struct									
2	1193	PF 1	8980.00	-14.25	-1.00	-6.46	-0.64	0.000507	4.81	1865.75	271.99	0.32

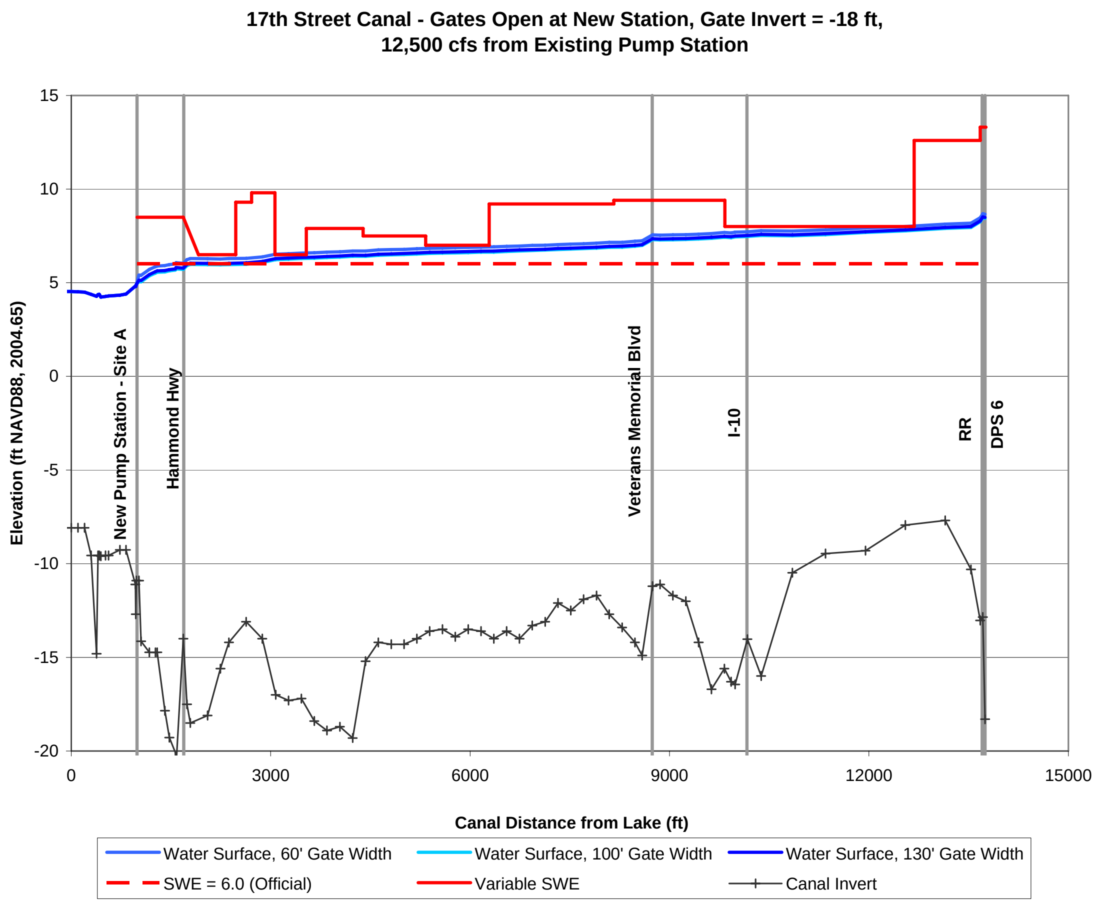

Figure C- 7 17th Street Canal Gate Width Impact on Water Surface Profile

Table C- 5 17th Street Canal Gate Velocities for Future Canal Flow of 12,500 cfs

Gate Width (ft)	Gate Invert (ft NAVD88, 2004.65)	Lake Elevation (ft NAVD88, 2004.65)	Velocity Through Gate (ft/s)
60	-18.0	1	9.9
60	-18.0	5	8.7
100	-18.0	1	6.1
100	-18.0	5	5.3
130	-18.0	1	4.7
130	-18.0	5	4.1

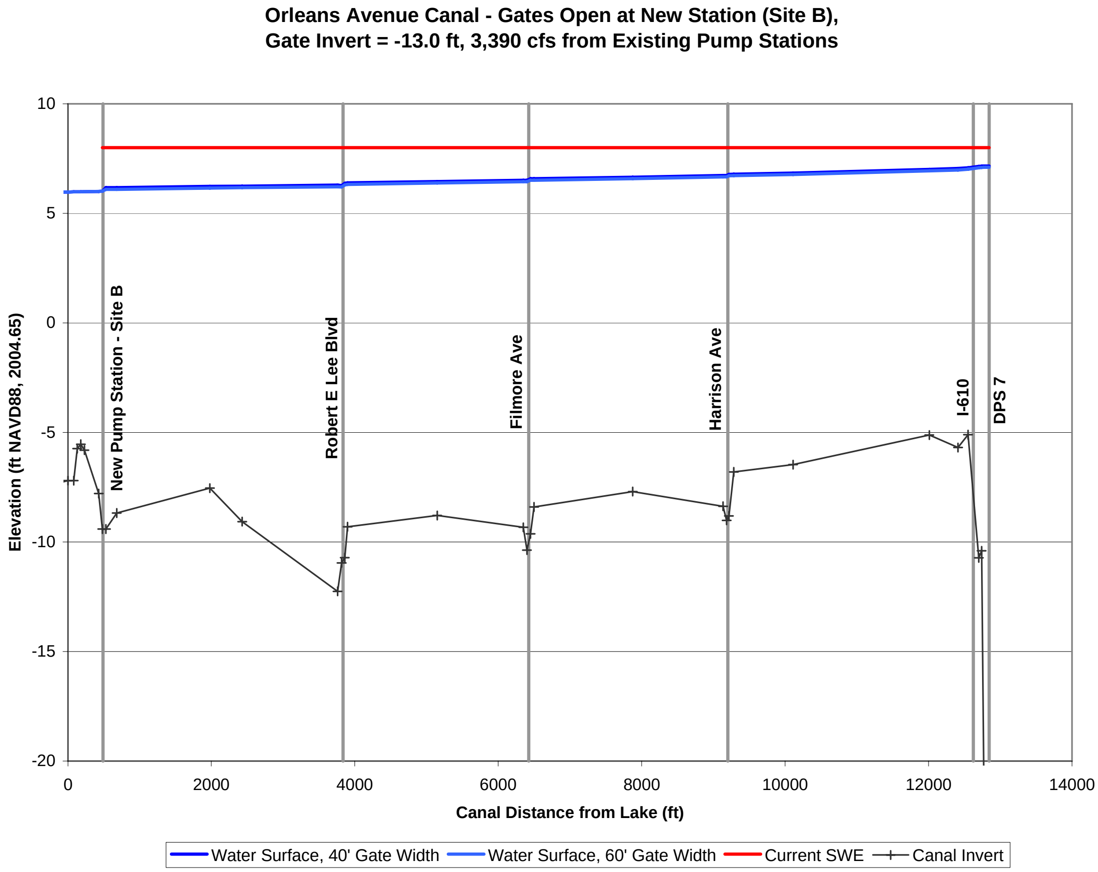

Figure C- 8 Orleans Avenue Canal Gate Width Impact on Water Surface Profile

Table C- 6 Orleans Avenue Canal Gate Velocities for Future Canal Flow of 3,390 cfs

Gate Width (ft)	Gate Invert (ft NAVD88, 2004.65)	Lake Elevation (ft NAVD88, 2004.65)	Velocity Through Gate (ft/s)
40	-13.0	1	5.8
40	-13.0	6	4.4
60	-13.0	1	3.9
60	-13.0	6	3.0

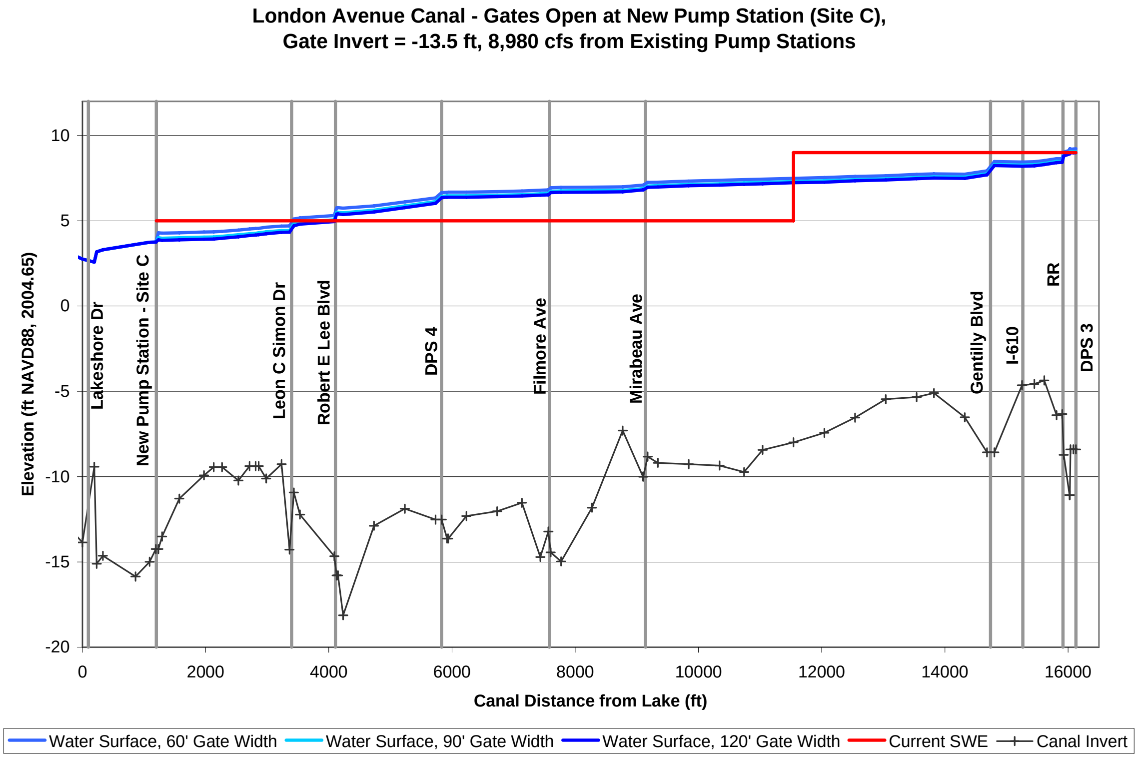

Figure C- 9 London Avenue Canal Gate Width Impact on Water Surface Profile

Table C- 7 London Avenue Canal Gate Velocities for Future Canal Flow of 8,980 cfs

Gate Width (ft)	Gate Invert (ft NAVD88, 2004.65)	Lake Elevation (ft NAVD88, 2004.65)	Velocity Through Gate (ft/s)
60	-13.5	1	9.0
60	-13.5	3	8.4
90	-13.5	1	6.1
90	-13.5	3	5.7
120	-13.5	1	4.6
120	-13.5	3	4.3

C.5. Results for Option 2 and Option 2a, Deepened Canal

Results for Option 2 and Option 2a are for pumping mode only since there are no gates in a deepened canal scenario. The model was used to determine the Option 2 or Option 2a suction side invert elevation required to not exceed a prescribed water surface at the upstream end of each canal. This prescribed water surface elevation is the current maximum suction side flowline elevation at the existing drainage pumping station (Table C- 8).

Table C- 8 Maximum Suction Side Elevations at Existing Drainage Pumping Station (DPS)

17th Street Canal	Pump-On WSEL (ft NAVD88, 2004.65)
DPS 6 suction side	-10.9
Orleans Avenue Canal	WSEL
DPS 7 suction side	-9.4
London Avenue Canal	WSEL
DPS 3 suction side	-9.9
DPS 4 suction side	-10.4

The following tables are HEC-RAS output for 17th Street, Orleans Avenue Canal, and London Avenue Canal for the flows shown in Table C- 2.

Option 2 and Option 2a

17th Street Canal HEC-RAS Results for Pumping at New Station

17th Street Canal 12,500 cfs Canal Flow, Rectangular Cross Section

HEC-RAS Plan: 12500_Rect_Tremi River: 17th Street Reach: 1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	13748	PF 1	11480.00	-24.00	-10.88		-10.35	0.000247	5.83	1967.72	150.00	0.28
1	13713	PF 1	11480.00	-24.08	-10.91	-18.42	-10.41	0.000314	5.66	2027.40	201.29	0.31
1	13708		Bridge									
1	13673	PF 1	11480.00	-24.10	-10.99	-18.43	-10.49	0.000278	5.71	2010.54	178.56	0.30
1	13535	PF 1	11480.00	-24.16	-11.06	-18.49	-10.53	0.000248	5.84	1964.87	150.00	0.28
1	13148	PF 1	11480.00	-24.27	-11.12	-18.60	-10.59	0.000245	5.82	1972.55	150.00	0.28
1	12548	PF 1	11640.00	-24.54	-11.27	-18.82	-10.74	0.000245	5.85	1990.12	150.00	0.28
1	11948	PF 1	11640.00	-24.81	-11.41	-19.09	-10.89	0.000238	5.79	2009.99	150.00	0.28
1	11348	PF 1	11640.00	-25.08	-11.54	-19.36	-11.03	0.000230	5.73	2030.54	150.00	0.27
1	10848	PF 1	11640.00	-25.30	-11.65	-19.58	-11.15	0.000224	5.69	2047.37	150.00	0.27
1	10379	PF 1	12500.00	-25.41	-11.80	-19.41	-11.22	0.000261	6.12	2041.76	150.00	0.29
1	10171	PF 1	12500.00	-25.50	-11.85	-19.50	-11.27	0.000259	6.11	2047.39	150.00	0.29
1	10161		Bridge									
1	9987	PF 1	12500.00	-25.59	-11.96	-19.60	-11.38	0.000260	6.11	2044.82	150.00	0.29
1	9927	PF 1	12500.00	-25.61	-11.97	-19.61	-11.39	0.000259	6.11	2045.48	150.00	0.29
1	9824	PF 1	12500.00	-25.66	-12.00	-19.67	-11.42	0.000258	6.10	2049.13	150.00	0.29
1	9631	PF 1	12500.00	-25.74	-12.04	-19.74	-11.47	0.000256	6.08	2054.39	150.00	0.29
1	9438	PF 1	12500.00	-25.82	-12.09	-19.83	-11.52	0.000254	6.07	2059.70	150.00	0.29
1	9245	PF 1	12500.00	-25.90	-12.13	-19.90	-11.56	0.000252	6.05	2065.07	150.00	0.29
1	9052	PF 1	12500.00	-25.99	-12.18	-19.99	-11.61	0.000249	6.03	2072.10	150.00	0.29
1	8859	PF 1	12500.00	-26.07	-12.22	-20.07	-11.66	0.000247	6.02	2077.60	150.00	0.28
1	8745	PF 1	12500.00	-26.12	-12.25	-20.12	-11.69	0.000246	6.01	2080.60	150.00	0.28
1	8735		Bridge									
1	8590	PF 1	12500.00	-26.19	-12.39	-20.19	-11.83	0.000250	6.04	2069.68	150.00	0.29
1	8480	PF 1	12500.00	-26.23	-12.41	-20.23	-11.85	0.000249	6.03	2072.47	150.00	0.29
1	8287	PF 1	12500.00	-26.32	-12.46	-20.32	-11.90	0.000247	6.01	2078.78	150.00	0.28
1	8094	PF 1	12500.00	-26.41	-12.51	-20.42	-11.95	0.000244	5.99	2085.16	150.00	0.28
1	7901	PF 1	12500.00	-26.50	-12.56	-20.51	-12.00	0.000242	5.98	2091.62	150.00	0.28
1	7708	PF 1	12500.00	-26.59	-12.60	-20.58	-12.05	0.000240	5.96	2098.15	150.00	0.28
1	7515	PF 1	12500.00	-26.68	-12.65	-20.68	-12.10	0.000237	5.94	2104.75	150.00	0.28
1	7322	PF 1	12500.00	-26.78	-12.69	-20.78	-12.15	0.000234	5.92	2113.02	150.00	0.28
1	7129	PF 1	12500.00	-26.87	-12.74	-20.87	-12.20	0.000232	5.90	2119.78	150.00	0.28
1	6936	PF 1	12500.00	-26.96	-12.78	-20.96	-12.25	0.000230	5.88	2126.61	150.00	0.28
1	6743	PF 1	12500.00	-27.05	-12.83	-21.05	-12.29	0.000227	5.86	2133.51	150.00	0.27
1	6550	PF 1	12500.00	-27.14	-12.87	-21.14	-12.34	0.000225	5.84	2140.48	150.00	0.27
1	6357	PF 1	12500.00	-27.23	-12.91	-21.23	-12.39	0.000223	5.82	2147.53	150.00	0.27
1	6164	PF 1	12500.00	-27.32	-12.96	-21.32	-12.43	0.000221	5.80	2154.64	150.00	0.27
1	5971	PF 1	12500.00	-27.41	-13.00	-21.41	-12.48	0.000218	5.78	2161.82	150.00	0.27
1	5778	PF 1	12500.00	-27.50	-13.04	-21.50	-12.52	0.000216	5.76	2169.07	150.00	0.27
1	5585	PF 1	12500.00	-27.59	-13.08	-21.60	-12.57	0.000214	5.74	2176.39	150.00	0.27
1	5392	PF 1	12500.00	-27.68	-13.12	-21.68	-12.61	0.000212	5.72	2183.78	150.00	0.26
1	5199	PF 1	12500.00	-27.77	-13.16	-21.77	-12.66	0.000209	5.70	2191.24	150.00	0.26
1	5006	PF 1	12500.00	-27.86	-13.20	-21.86	-12.70	0.000207	5.69	2198.76	150.00	0.26
1	4813	PF 1	12500.00	-27.95	-13.24	-21.95	-12.74	0.000205	5.67	2206.35	150.00	0.26
1	4620	PF 1	12500.00	-28.04	-13.28	-22.05	-12.78	0.000203	5.65	2214.01	150.00	0.26
1	4427	PF 1	12500.00	-28.13	-13.32	-22.13	-12.83	0.000200	5.63	2221.73	150.00	0.26
1	4234	PF 1	12500.00	-28.22	-13.36	-22.22	-12.87	0.000198	5.61	2229.52	150.00	0.26
1	4041	PF 1	12500.00	-28.31	-13.39	-22.31	-12.91	0.000196	5.59	2237.37	150.00	0.25
1	3848	PF 1	12500.00	-28.40	-13.43	-22.40	-12.95	0.000194	5.57	2245.29	150.00	0.25
1	3655	PF 1	12500.00	-28.49	-13.47	-22.49	-12.99	0.000192	5.55	2253.27	150.00	0.25
1	3462	PF 1	12500.00	-28.59	-13.50	-22.59	-13.03	0.000189	5.52	2262.90	150.00	0.25
1	3269	PF 1	12500.00	-28.68	-13.54	-22.68	-13.07	0.000187	5.50	2271.02	150.00	0.25
1	3076	PF 1	12500.00	-28.77	-13.58	-22.77	-13.11	0.000185	5.48	2279.20	150.00	0.25
1	2873	PF 1	12500.00	-28.86	-13.61	-22.87	-13.15	0.000183	5.47	2287.16	150.00	0.25
1	2630	PF 1	12500.00	-28.97	-13.66	-22.97	-13.20	0.000181	5.44	2297.18	150.00	0.25
1	2372	PF 1	12500.00	-29.09	-13.70	-23.09	-13.25	0.000178	5.41	2308.44	150.00	0.24
1	2244	PF 1	12500.00	-29.15	-13.72	-23.16	-13.27	0.000177	5.40	2314.00	150.00	0.24
1	2051	PF 1	12500.00	-29.25	-13.76	-23.25	-13.31	0.000174	5.38	2324.07	150.00	0.24
1	1791	PF 1	12500.00	-29.38	-13.81	-23.38	-13.36	0.000171	5.35	2336.20	150.00	0.24
1	1741	PF 1	12500.00	-29.40	-13.81	-23.40	-13.37	0.000171	5.35	2338.15	150.00	0.24
1	1686	PF 1	12500.00	-29.41	-13.82	-23.41	-13.37	0.000171	5.34	2338.88	150.00	0.24
1	1674		Bridge									
1	1576	PF 1	12500.00	-29.46	-13.88	-23.46	-13.44	0.000171	5.35	2337.06	150.00	0.24
1	1566	PF 1	12500.00	-29.54	-13.91	-23.54	-13.47	0.000170	5.33	2344.99	150.00	0.24
1	1475	PF 1	12500.00	-29.58	-13.92	-23.58	-13.48	0.000169	5.32	2348.79	150.00	0.24
1	1408	PF 1	12500.00	-29.61	-13.93	-23.61	-13.49	0.000168	5.32	2351.67	150.00	0.24
1	1293	PF 1	12500.00	-29.66	-13.95	-23.67	-13.51	0.000167	5.30	2356.47	150.00	0.24
1	1265	PF 1	12500.00	-29.67	-13.96	-23.67	-13.52	0.000167	5.30	2357.17	150.00	0.24
1	1175	PF 1	12500.00	-29.71	-13.97	-23.71	-13.53	0.000166	5.29	2361.03	150.00	0.24
1	1050	PF 1	12500.00	-29.77	-13.99	-23.78	-13.56	0.000165	5.28	2367.17	150.00	0.23
1	1020	PF 1	12500.00	-29.78	-13.99		-13.56	0.000164	5.28	2367.95	150.00	0.23
1	980	PF 1	12500.00	-29.80	-14.00	-23.80	-13.57	0.000164	5.27	2370.00	150.00	0.23

17th Street Canal 12,500 cfs Canal Flow, Trapezoidal Cross Section

HEC-RAS Plan: 12500_trpzd-29.5 River: 17th Street Reach: 1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	13748	PF 1	11480.00	-24.00	-10.91		-10.46	0.000247	5.38	2134.63	176.18	0.27
1	13713	PF 1	11480.00	-24.08	-10.95	-18.48	-10.52	0.000293	5.27	2180.23	214.23	0.29
1	13708		Bridge									
1	13673	PF 1	11480.00	-24.10	-11.02	-18.50	-10.58	0.000265	5.33	2153.93	191.51	0.28
1	13535	PF 1	11480.00	-24.15	-11.07	-18.56	-10.62	0.000247	5.38	2133.23	176.16	0.27
1	13148	PF 1	11480.00	-24.26	-11.13	-18.67	-10.68	0.000244	5.36	2142.26	176.26	0.27
1	12548	PF 1	11640.00	-24.51	-11.28	-18.86	-10.83	0.000245	5.39	2159.48	176.46	0.27
1	11948	PF 1	11640.00	-24.77	-11.42	-19.12	-10.98	0.000237	5.34	2180.95	176.70	0.27
1	11348	PF 1	11640.00	-25.02	-11.55	-19.37	-11.12	0.000231	5.29	2201.34	176.93	0.26
1	10848	PF 1	11640.00	-25.23	-11.66	-19.58	-11.24	0.000225	5.25	2219.21	177.14	0.26
1	10379	PF 1	12500.00	-25.33	-11.80	-19.41	-11.30	0.000262	5.65	2213.10	177.07	0.28
1	10171	PF 1	12500.00	-25.42	-11.85	-19.51	-11.36	0.000259	5.63	2219.71	177.14	0.28
1	10161		Bridge									
1	9987	PF 1	12500.00	-25.50	-11.95	-19.58	-11.45	0.000260	5.64	2216.44	177.10	0.28
1	9927	PF 1	12500.00	-25.53	-11.96	-19.61	-11.47	0.000259	5.63	2219.06	177.13	0.28
1	9824	PF 1	12500.00	-25.57	-11.99	-19.65	-11.50	0.000259	5.63	2221.51	177.16	0.28
1	9631	PF 1	12500.00	-25.65	-12.03	-19.74	-11.55	0.000256	5.61	2227.67	177.23	0.28
1	9438	PF 1	12500.00	-25.73	-12.08	-19.82	-11.59	0.000254	5.60	2233.91	177.30	0.28
1	9245	PF 1	12500.00	-25.81	-12.12	-19.90	-11.64	0.000252	5.58	2240.22	177.37	0.28
1	9052	PF 1	12500.00	-25.88	-12.17	-19.96	-11.69	0.000250	5.57	2244.65	177.42	0.28
1	8859	PF 1	12500.00	-25.96	-12.21	-20.05	-11.73	0.000248	5.55	2251.09	177.49	0.27
1	8745	PF 1	12500.00	-26.01	-12.24	-20.09	-11.77	0.000247	5.54	2254.60	177.53	0.27
1	8735		Bridge									
1	8590	PF 1	12500.00	-26.08	-12.37	-20.16	-11.89	0.000250	5.57	2244.89	177.42	0.28
1	8480	PF 1	12500.00	-26.12	-12.39	-20.20	-11.91	0.000249	5.56	2248.18	177.46	0.28
1	8287	PF 1	12500.00	-26.20	-12.44	-20.28	-11.96	0.000247	5.55	2253.64	177.52	0.27
1	8094	PF 1	12500.00	-26.29	-12.49	-20.37	-12.01	0.000245	5.53	2261.14	177.61	0.27
1	7901	PF 1	12500.00	-26.37	-12.53	-20.45	-12.06	0.000243	5.51	2266.85	177.67	0.27
1	7708	PF 1	12500.00	-26.46	-12.58	-20.54	-12.11	0.000240	5.50	2274.51	177.76	0.27
1	7515	PF 1	12500.00	-26.55	-12.63	-20.63	-12.16	0.000238	5.48	2282.28	177.85	0.27
1	7322	PF 1	12500.00	-26.63	-12.67	-20.71	-12.21	0.000236	5.46	2288.25	177.91	0.27
1	7129	PF 1	12500.00	-26.72	-12.72	-20.81	-12.26	0.000234	5.44	2296.18	178.00	0.27
1	6936	PF 1	12500.00	-26.80	-12.76	-20.88	-12.31	0.000232	5.43	2302.32	178.07	0.27
1	6743	PF 1	12500.00	-26.89	-12.81	-20.97	-12.35	0.000229	5.41	2310.42	178.16	0.26
1	6550	PF 1	12500.00	-26.98	-12.85	-21.06	-12.40	0.000227	5.39	2318.62	178.25	0.26
1	6357	PF 1	12500.00	-27.06	-12.90	-21.14	-12.45	0.000225	5.38	2325.02	178.33	0.26
1	6164	PF 1	12500.00	-27.15	-12.94	-21.23	-12.49	0.000222	5.36	2333.38	178.42	0.26
1	5971	PF 1	12500.00	-27.23	-12.98	-21.31	-12.54	0.000220	5.34	2339.95	178.49	0.26
1	5778	PF 1	12500.00	-27.32	-13.03	-21.41	-12.59	0.000218	5.32	2348.47	178.59	0.26
1	5585	PF 1	12500.00	-27.40	-13.07	-21.48	-12.63	0.000216	5.31	2355.21	178.66	0.26
1	5392	PF 1	12500.00	-27.49	-13.11	-21.57	-12.68	0.000214	5.29	2363.90	178.76	0.26
1	5199	PF 1	12500.00	-27.58	-13.15	-21.66	-12.72	0.000211	5.27	2372.69	178.86	0.25
1	5006	PF 1	12500.00	-27.66	-13.19	-21.74	-12.76	0.000209	5.25	2379.68	178.94	0.25
1	4813	PF 1	12500.00	-27.75	-13.23	-21.83	-12.81	0.000207	5.23	2388.63	179.04	0.25
1	4620	PF 1	12500.00	-27.83	-13.27	-21.91	-12.85	0.000205	5.22	2395.79	179.12	0.25
1	4427	PF 1	12500.00	-27.92	-13.31	-22.00	-12.89	0.000203	5.20	2404.90	179.22	0.25
1	4234	PF 1	12500.00	-28.00	-13.35	-22.09	-12.93	0.000201	5.18	2412.22	179.30	0.25
1	4041	PF 1	12500.00	-28.09	-13.39	-22.17	-12.97	0.000198	5.16	2421.50	179.40	0.25
1	3848	PF 1	12500.00	-28.18	-13.43	-22.26	-13.01	0.000196	5.14	2430.86	179.51	0.25
1	3655	PF 1	12500.00	-28.26	-13.46	-22.34	-13.06	0.000194	5.13	2438.43	179.59	0.25
1	3462	PF 1	12500.00	-28.35	-13.50	-22.43	-13.10	0.000192	5.11	2447.96	179.70	0.24
1	3269	PF 1	12500.00	-28.43	-13.54	-22.51	-13.14	0.000190	5.09	2455.69	179.79	0.24
1	3076	PF 1	12500.00	-28.52	-13.57	-22.60	-13.17	0.000188	5.07	2465.38	179.89	0.24
1	2873	PF 1	12500.00	-28.61	-13.61	-22.69	-13.21	0.000186	5.05	2474.80	180.00	0.24
1	2630	PF 1	12500.00	-28.72	-13.66	-22.80	-13.26	0.000183	5.03	2486.69	180.13	0.24
1	2372	PF 1	12500.00	-28.83	-13.70	-22.91	-13.31	0.000180	5.00	2498.20	180.26	0.24
1	2244	PF 1	12500.00	-28.89	-13.72	-22.97	-13.34	0.000179	4.99	2504.80	180.33	0.24
1	2051	PF 1	12500.00	-28.97	-13.76	-23.05	-13.37	0.000177	4.97	2513.04	180.42	0.23
1	1791	PF 1	12500.00	-29.10	-13.81	-23.18	-13.43	0.000174	4.95	2527.46	180.58	0.23
1	1741	PF 1	12500.00	-29.12	-13.82	-23.20	-13.44	0.000174	4.94	2529.78	180.61	0.23
1	1686	PF 1	12500.00	-29.13	-13.82	-23.21	-13.44	0.000173	4.94	2530.65	180.62	0.23
1	1674		Bridge									
1	1576	PF 1	12500.00	-29.18	-13.88	-23.26	-13.50	0.000174	4.94	2529.65	180.61	0.23
1	1566	PF 1	12500.00	-29.25	-13.90	-23.33	-13.53	0.000171	4.93	2535.42	178.00	0.23
1	1475	PF 1	12500.00	-29.29	-13.92	-23.37	-13.54	0.000170	4.92	2538.21	177.00	0.23
1	1408	PF 1	12500.00	-29.32	-13.93	-23.41	-13.56	0.000169	4.91	2543.29	178.00	0.23
1	1293	PF 1	12500.00	-29.37	-13.95	-23.46	-13.58	0.000168	4.91	2547.15	177.00	0.23
1	1265	PF 1	12500.00	-29.38	-13.96	-23.46	-13.58	0.000168	4.91	2547.96	177.00	0.23
1	1175	PF 1	12500.00	-29.42	-13.97	-23.50	-13.60	0.000167	4.90	2552.49	177.00	0.23
1	1050	PF 1	12500.00	-29.47	-13.99	-23.56	-13.62	0.000166	4.89	2557.79	177.00	0.23
1	1020	PF 1	12500.00	-29.48	-13.99		-13.62	0.000167	4.88	2562.79	180.97	0.23
1	980	PF 1	12500.00	-29.50	-14.00	-23.60	-13.63	0.000166	4.87	2565.25	181.00	0.23

17th Street Canal 10,900 cfs Canal Flow, Trapezoidal Cross Section

HEC-RAS Plan: 10900_Trpzd-27.2 River: 17th Street Reach: 1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	13748	PF 1	10680.00	-24.00	-10.90		-10.51	0.000213	5.00	2136.06	176.19	0.25
1	13713	PF 1	10680.00	-24.05	-10.94	-18.72	-10.56	0.000255	4.90	2177.55	214.28	0.27
1	13708		Bridge									
1	13673	PF 1	10680.00	-24.06	-11.00	-18.72	-10.62	0.000230	4.96	2151.33	191.59	0.26
1	13535	PF 1	10680.00	-24.09	-11.04	-18.76	-10.65	0.000216	5.02	2127.61	176.10	0.25
1	13148	PF 1	10680.00	-24.15	-11.09	-18.81	-10.70	0.000215	5.02	2128.70	176.11	0.25
1	12548	PF 1	10840.00	-24.30	-11.24	-18.91	-10.84	0.000222	5.09	2129.77	176.12	0.26
1	11948	PF 1	10840.00	-24.45	-11.37	-19.06	-10.97	0.000221	5.08	2132.95	176.16	0.26
1	11348	PF 1	10840.00	-24.59	-11.50	-19.21	-11.10	0.000220	5.08	2134.35	176.17	0.26
1	10848	PF 1	10840.00	-24.72	-11.61	-19.33	-11.21	0.000219	5.07	2138.05	176.22	0.26
1	10379	PF 1	10900.00	-24.78	-11.67	-19.37	-11.27	0.000221	5.10	2138.27	176.22	0.26
1	10171	PF 1	10900.00	-24.83	-11.72	-19.42	-11.31	0.000221	5.10	2138.90	176.23	0.26
1	10161		Bridge									
1	9987	PF 1	10900.00	-24.88	-11.80	-19.47	-11.39	0.000223	5.11	2133.06	176.16	0.26
1	9927	PF 1	10900.00	-24.89	-11.81	-19.48	-11.41	0.000223	5.11	2132.41	176.15	0.26
1	9824	PF 1	10900.00	-24.92	-11.84	-19.52	-11.43	0.000223	5.11	2133.65	176.17	0.26
1	9631	PF 1	10900.00	-24.96	-11.88	-19.55	-11.47	0.000223	5.11	2133.51	176.16	0.26
1	9438	PF 1	10900.00	-25.01	-11.92	-19.60	-11.51	0.000222	5.11	2135.15	176.18	0.26
1	9245	PF 1	10900.00	-25.05	-11.96	-19.65	-11.55	0.000222	5.11	2135.03	176.18	0.26
1	9052	PF 1	10900.00	-25.10	-12.00	-19.70	-11.60	0.000222	5.10	2136.69	176.20	0.26
1	8859	PF 1	10900.00	-25.14	-12.04	-19.73	-11.64	0.000222	5.10	2136.58	176.20	0.26
1	8745	PF 1	10900.00	-25.17	-12.07	-19.77	-11.66	0.000222	5.10	2136.96	176.20	0.26
1	8735		Bridge									
1	8590	PF 1	10900.00	-25.21	-12.18	-19.80	-11.77	0.000226	5.13	2124.85	176.07	0.26
1	8480	PF 1	10900.00	-25.23	-12.20	-19.82	-11.79	0.000226	5.13	2124.88	176.07	0.26
1	8287	PF 1	10900.00	-25.28	-12.24	-19.87	-11.83	0.000225	5.13	2125.63	176.08	0.26
1	8094	PF 1	10900.00	-25.33	-12.29	-19.93	-11.88	0.000225	5.13	2126.39	176.08	0.26
1	7901	PF 1	10900.00	-25.38	-12.33	-19.97	-11.93	0.000225	5.12	2127.16	176.09	0.26
1	7708	PF 1	10900.00	-25.43	-12.38	-20.02	-11.97	0.000225	5.12	2127.93	176.10	0.26
1	7515	PF 1	10900.00	-25.48	-12.42	-20.07	-12.02	0.000224	5.12	2128.72	176.11	0.26
1	7322	PF 1	10900.00	-25.53	-12.47	-20.13	-12.06	0.000224	5.12	2129.51	176.12	0.26
1	7129	PF 1	10900.00	-25.58	-12.52	-20.18	-12.11	0.000224	5.12	2130.32	176.13	0.26
1	6936	PF 1	10900.00	-25.63	-12.56	-20.22	-12.15	0.000224	5.11	2131.13	176.14	0.26
1	6743	PF 1	10900.00	-25.68	-12.61	-20.27	-12.20	0.000223	5.11	2131.95	176.15	0.26
1	6550	PF 1	10900.00	-25.73	-12.65	-20.32	-12.25	0.000223	5.11	2132.79	176.16	0.26
1	6357	PF 1	10900.00	-25.78	-12.70	-20.37	-12.29	0.000223	5.11	2133.63	176.17	0.26
1	6164	PF 1	10900.00	-25.83	-12.74	-20.42	-12.34	0.000222	5.11	2134.48	176.18	0.26
1	5971	PF 1	10900.00	-25.88	-12.79	-20.47	-12.38	0.000222	5.10	2135.35	176.19	0.26
1	5778	PF 1	10900.00	-25.93	-12.83	-20.52	-12.43	0.000222	5.10	2136.22	176.20	0.26
1	5585	PF 1	10900.00	-25.98	-12.88	-20.58	-12.47	0.000222	5.10	2137.10	176.21	0.26
1	5392	PF 1	10900.00	-26.03	-12.92	-20.62	-12.52	0.000221	5.10	2138.00	176.22	0.26
1	5199	PF 1	10900.00	-26.08	-12.97	-20.68	-12.56	0.000221	5.10	2138.90	176.23	0.26
1	5006	PF 1	10900.00	-26.13	-13.01	-20.72	-12.61	0.000221	5.09	2139.81	176.24	0.26
1	4813	PF 1	10900.00	-26.18	-13.06	-20.77	-12.65	0.000220	5.09	2140.74	176.25	0.26
1	4620	PF 1	10900.00	-26.23	-13.10	-20.82	-12.70	0.000220	5.09	2141.67	176.26	0.26
1	4427	PF 1	10900.00	-26.28	-13.15	-20.87	-12.74	0.000220	5.09	2142.62	176.27	0.26
1	4234	PF 1	10900.00	-26.33	-13.19	-20.92	-12.79	0.000220	5.08	2143.58	176.28	0.26
1	4041	PF 1	10900.00	-26.38	-13.23	-20.97	-12.83	0.000219	5.08	2144.55	176.29	0.26
1	3848	PF 1	10900.00	-26.43	-13.28	-21.02	-12.88	0.000219	5.08	2145.53	176.30	0.26
1	3655	PF 1	10900.00	-26.48	-13.32	-21.07	-12.92	0.000219	5.08	2146.52	176.31	0.26
1	3462	PF 1	10900.00	-26.53	-13.37	-21.13	-12.97	0.000218	5.08	2147.52	176.32	0.26
1	3269	PF 1	10900.00	-26.58	-13.41	-21.18	-13.01	0.000218	5.07	2148.53	176.34	0.26
1	3076	PF 1	10900.00	-26.63	-13.46	-21.22	-13.06	0.000218	5.07	2149.56	176.35	0.26
1	2873	PF 1	10900.00	-26.68	-13.50	-21.28	-13.10	0.000217	5.07	2150.21	176.35	0.26
1	2630	PF 1	10900.00	-26.74	-13.56	-21.33	-13.16	0.000217	5.07	2151.10	176.36	0.26
1	2372	PF 1	10900.00	-26.81	-13.62	-21.41	-13.22	0.000217	5.06	2153.27	176.39	0.26
1	2244	PF 1	10900.00	-26.84	-13.65	-21.43	-13.25	0.000217	5.06	2153.29	176.39	0.26
1	2051	PF 1	10900.00	-26.89	-13.69	-21.49	-13.29	0.000216	5.06	2154.37	176.40	0.26
1	1791	PF 1	10900.00	-26.97	-13.75	-21.56	-13.36	0.000215	5.05	2157.04	176.43	0.25
1	1741	PF 1	10900.00	-26.98	-13.76	-21.58	-13.37	0.000215	5.05	2157.17	176.43	0.25
1	1686	PF 1	10900.00	-26.99	-13.77	-21.58	-13.37	0.000215	5.05	2157.79	176.44	0.25
1	1674		Bridge									
1	1576	PF 1	10900.00	-27.01	-13.84	-21.60	-13.44	0.000218	5.07	2149.72	176.35	0.26
1	1566	PF 1	10900.00	-27.05	-13.87	-21.64	-13.47	0.000217	5.07	2150.33	176.36	0.26
1	1475	PF 1	10900.00	-27.08	-13.89	-21.68	-13.49	0.000217	5.06	2152.20	176.38	0.26
1	1408	PF 1	10900.00	-27.09	-13.91	-21.69	-13.51	0.000217	5.07	2151.34	176.37	0.26
1	1293	PF 1	10900.00	-27.12	-13.93	-21.71	-13.53	0.000217	5.06	2152.23	176.38	0.26
1	1265	PF 1	10900.00	-27.13	-13.94	-21.73	-13.54	0.000217	5.06	2152.78	176.38	0.26
1	1175	PF 1	10900.00	-27.15	-13.96	-21.75	-13.56	0.000217	5.06	2152.86	176.38	0.26
1	1050	PF 1	10900.00	-27.18	-13.98	-21.77	-13.59	0.000216	5.06	2153.38	176.39	0.26
1	1020	PF 1	10900.00	-27.19	-13.99		-13.59	0.000216	5.06	2154.00	176.40	0.26
1	980	PF 1	10900.00	-27.20	-14.00	-21.81	-13.60	0.000216	5.06	2154.24	176.40	0.26

17th Street Canal 10,100 cfs Canal Flow, Rectangular Cross Section

HEC-RAS Plan: 10100_Rect_Tremi River: 17th Street Reach: 1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	13748	PF 1	9080.00	-24.00	-10.89		-10.56	0.000155	4.62	1966.43	150.00	0.22
1	13713	PF 1	9080.00	-24.03	-10.91	-19.19	-10.60	0.000199	4.49	2020.13	201.30	0.25
1	13708		Bridge									
1	13673	PF 1	9080.00	-24.03	-10.96	-19.19	-10.64	0.000175	4.53	2006.15	178.70	0.24
1	13535	PF 1	9080.00	-24.06	-11.00	-19.22	-10.67	0.000157	4.64	1958.53	150.00	0.23
1	13148	PF 1	9080.00	-24.09	-11.04	-19.24	-10.71	0.000157	4.64	1957.06	150.00	0.23
1	12548	PF 1	9240.00	-24.19	-11.15	-19.29	-10.81	0.000163	4.72	1955.66	150.00	0.23
1	11948	PF 1	9240.00	-24.28	-11.25	-19.38	-10.90	0.000164	4.73	1954.39	150.00	0.23
1	11348	PF 1	9240.00	-24.37	-11.35	-19.47	-11.00	0.000164	4.73	1953.08	150.00	0.23
1	10848	PF 1	9240.00	-24.45	-11.43	-19.55	-11.08	0.000164	4.73	1952.70	150.00	0.23
1	10379	PF 1	10100.00	-24.49	-11.56	-19.29	-11.14	0.000200	5.21	1939.96	150.00	0.26
1	10171	PF 1	10100.00	-24.52	-11.60	-19.32	-11.18	0.000201	5.21	1937.95	150.00	0.26
1	10161		Bridge									
1	9987	PF 1	10100.00	-24.55	-11.68	-19.36	-11.26	0.000203	5.23	1930.05	150.00	0.26
1	9927	PF 1	10100.00	-24.56	-11.70	-19.35	-11.27	0.000203	5.23	1929.69	150.00	0.26
1	9824	PF 1	10100.00	-24.57	-11.72	-19.37	-11.29	0.000204	5.24	1927.92	150.00	0.26
1	9631	PF 1	10100.00	-24.60	-11.76	-19.40	-11.33	0.000204	5.24	1926.74	150.00	0.26
1	9438	PF 1	10100.00	-24.63	-11.79	-19.43	-11.37	0.000205	5.25	1925.54	150.00	0.26
1	9245	PF 1	10100.00	-24.66	-11.83	-19.46	-11.40	0.000205	5.25	1924.33	150.00	0.26
1	9052	PF 1	10100.00	-24.68	-11.87	-19.48	-11.44	0.000206	5.26	1921.49	150.00	0.26
1	8859	PF 1	10100.00	-24.71	-11.91	-19.51	-11.48	0.000206	5.26	1920.24	150.00	0.26
1	8745	PF 1	10100.00	-24.73	-11.94	-19.53	-11.51	0.000207	5.26	1919.19	150.00	0.26
1	8735		Bridge									
1	8590	PF 1	10100.00	-24.76	-12.05	-19.55	-11.61	0.000211	5.30	1906.65	150.00	0.26
1	8480	PF 1	10100.00	-24.77	-12.07	-19.57	-11.63	0.000212	5.30	1905.24	150.00	0.26
1	8287	PF 1	10100.00	-24.80	-12.11	-19.60	-11.68	0.000212	5.31	1903.14	150.00	0.26
1	8094	PF 1	10100.00	-24.83	-12.16	-19.63	-11.72	0.000213	5.31	1901.01	150.00	0.26
1	7901	PF 1	10100.00	-24.86	-12.20	-19.66	-11.76	0.000214	5.32	1898.85	150.00	0.26
1	7708	PF 1	10100.00	-24.89	-12.25	-19.69	-11.81	0.000215	5.33	1896.67	150.00	0.26
1	7515	PF 1	10100.00	-24.93	-12.29	-19.73	-11.85	0.000215	5.33	1896.09	150.00	0.26
1	7322	PF 1	10100.00	-24.96	-12.33	-19.76	-11.89	0.000216	5.33	1893.87	150.00	0.26
1	7129	PF 1	10100.00	-24.99	-12.38	-19.78	-11.94	0.000216	5.34	1891.63	150.00	0.26
1	6936	PF 1	10100.00	-25.02	-12.42	-19.82	-11.98	0.000217	5.35	1889.36	150.00	0.27
1	6743	PF 1	10100.00	-25.05	-12.47	-19.85	-12.02	0.000218	5.35	1887.06	150.00	0.27
1	6550	PF 1	10100.00	-25.08	-12.52	-19.88	-12.07	0.000219	5.36	1884.74	150.00	0.27
1	6357	PF 1	10100.00	-25.11	-12.56	-19.91	-12.11	0.000220	5.37	1882.38	150.00	0.27
1	6164	PF 1	10100.00	-25.14	-12.61	-19.94	-12.16	0.000221	5.37	1880.00	150.00	0.27
1	5971	PF 1	10100.00	-25.18	-12.65	-19.98	-12.20	0.000221	5.37	1879.22	150.00	0.27
1	5778	PF 1	10100.00	-25.21	-12.70	-20.01	-12.25	0.000222	5.38	1876.80	150.00	0.27
1	5585	PF 1	10100.00	-25.24	-12.74	-20.04	-12.29	0.000223	5.39	1874.34	150.00	0.27
1	5392	PF 1	10100.00	-25.27	-12.79	-20.07	-12.34	0.000224	5.40	1871.86	150.00	0.27
1	5199	PF 1	10100.00	-25.30	-12.84	-20.10	-12.38	0.000225	5.40	1869.34	150.00	0.27
1	5006	PF 1	10100.00	-25.33	-12.88	-20.13	-12.43	0.000226	5.41	1866.79	150.00	0.27
1	4813	PF 1	10100.00	-25.36	-12.93	-20.15	-12.48	0.000227	5.42	1864.21	150.00	0.27
1	4620	PF 1	10100.00	-25.39	-12.98	-20.19	-12.52	0.000228	5.43	1861.60	150.00	0.27
1	4427	PF 1	10100.00	-25.43	-13.03	-20.23	-12.57	0.000228	5.43	1860.58	150.00	0.27
1	4234	PF 1	10100.00	-25.46	-13.07	-20.26	-12.61	0.000229	5.44	1857.92	150.00	0.27
1	4041	PF 1	10100.00	-25.49	-13.12	-20.29	-12.66	0.000230	5.44	1855.22	150.00	0.27
1	3848	PF 1	10100.00	-25.52	-13.17	-20.31	-12.71	0.000231	5.45	1852.49	150.00	0.27
1	3655	PF 1	10100.00	-25.55	-13.22	-20.35	-12.76	0.000232	5.46	1849.72	150.00	0.27
1	3462	PF 1	10100.00	-25.58	-13.27	-20.38	-12.80	0.000233	5.47	1846.91	150.00	0.27
1	3269	PF 1	10100.00	-25.61	-13.32	-20.41	-12.85	0.000234	5.48	1844.07	150.00	0.28
1	3076	PF 1	10100.00	-25.64	-13.37	-20.44	-12.90	0.000236	5.49	1841.18	150.00	0.28
1	2873	PF 1	10100.00	-25.68	-13.42	-20.48	-12.95	0.000236	5.49	1839.51	150.00	0.28
1	2630	PF 1	10100.00	-25.72	-13.48	-20.52	-13.01	0.000238	5.50	1836.26	150.00	0.28
1	2372	PF 1	10100.00	-25.76	-13.54	-20.56	-13.07	0.000239	5.51	1832.36	150.00	0.28
1	2244	PF 1	10100.00	-25.78	-13.58	-20.58	-13.11	0.000240	5.52	1830.23	150.00	0.28
1	2051	PF 1	10100.00	-25.81	-13.63	-20.61	-13.15	0.000241	5.53	1827.15	150.00	0.28
1	1791	PF 1	10100.00	-25.86	-13.70	-20.65	-13.23	0.000243	5.54	1823.34	150.00	0.28
1	1741	PF 1	10100.00	-25.86	-13.72	-20.65	-13.24	0.000244	5.54	1821.63	150.00	0.28
1	1686	PF 1	10100.00	-25.87	-13.72	-20.67	-13.25	0.000244	5.54	1822.03	150.00	0.28
1	1674		Bridge									
1	1576	PF 1	10100.00	-25.88	-13.80	-20.68	-13.32	0.000248	5.58	1811.47	150.00	0.28
1	1566	PF 1	10100.00	-25.91	-13.85	-20.71	-13.36	0.000249	5.58	1809.52	150.00	0.28
1	1475	PF 1	10100.00	-25.92	-13.87	-20.72	-13.39	0.000250	5.59	1807.45	150.00	0.28
1	1408	PF 1	10100.00	-25.93	-13.89	-20.73	-13.40	0.000250	5.59	1806.35	150.00	0.28
1	1293	PF 1	10100.00	-25.95	-13.92	-20.74	-13.43	0.000251	5.60	1804.91	150.00	0.28
1	1265	PF 1	10100.00	-25.96	-13.93	-20.76	-13.44	0.000251	5.59	1805.20	150.00	0.28
1	1175	PF 1	10100.00	-25.97	-13.95	-20.76	-13.46	0.000252	5.60	1803.14	150.00	0.28
1	1050	PF 1	10100.00	-25.99	-13.98	-20.78	-13.49	0.000252	5.61	1801.26	150.00	0.29
1	1020	PF 1	10100.00	-25.99	-13.99		-13.50	0.000253	5.61	1800.02	150.00	0.29
1	980	PF 1	10100.00	-26.00	-14.00	-20.81	-13.51	0.000253	5.61	1800.00	150.00	0.29

17th Street Canal 10,100 cfs Canal Flow, Trapezoidal Cross Section

HEC-RAS Plan: 10100_Trpzd-26.0 River: 17th Street Reach: 1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	13748	PF 1	9080.00	-24.00	-10.94		-10.66	0.000156	4.26	2129.17	176.12	0.22
1	13713	PF 1	9080.00	-24.03	-10.97	-19.23	-10.69	0.000187	4.19	2167.38	214.06	0.23
1	13708		Bridge									
1	13673	PF 1	9080.00	-24.03	-11.01	-19.24	-10.73	0.000168	4.24	2143.59	191.49	0.22
1	13535	PF 1	9080.00	-24.06	-11.04	-19.26	-10.76	0.000157	4.28	2122.09	176.04	0.22
1	13148	PF 1	9080.00	-24.09	-11.08	-19.30	-10.80	0.000158	4.28	2120.36	176.02	0.22
1	12548	PF 1	9240.00	-24.19	-11.19	-19.34	-10.89	0.000163	4.36	2119.03	176.00	0.22
1	11948	PF 1	9240.00	-24.28	-11.29	-19.43	-10.99	0.000164	4.36	2117.50	175.98	0.22
1	11348	PF 1	9240.00	-24.37	-11.39	-19.53	-11.09	0.000164	4.37	2115.94	175.97	0.22
1	10848	PF 1	9240.00	-24.45	-11.47	-19.60	-11.17	0.000164	4.37	2115.47	175.96	0.22
1	10379	PF 1	10100.00	-24.49	-11.58	-19.35	-11.22	0.000200	4.80	2102.68	175.81	0.24
1	10171	PF 1	10100.00	-24.52	-11.63	-19.38	-11.27	0.000201	4.81	2100.35	175.79	0.25
1	10161		Bridge									
1	9987	PF 1	10100.00	-24.55	-11.70	-19.41	-11.34	0.000203	4.83	2092.22	175.70	0.25
1	9927	PF 1	10100.00	-24.56	-11.71	-19.42	-11.35	0.000203	4.83	2091.80	175.69	0.25
1	9824	PF 1	10100.00	-24.57	-11.74	-19.42	-11.37	0.000204	4.83	2089.75	175.67	0.25
1	9631	PF 1	10100.00	-24.60	-11.77	-19.46	-11.41	0.000204	4.84	2088.37	175.65	0.25
1	9438	PF 1	10100.00	-24.63	-11.81	-19.49	-11.45	0.000205	4.84	2086.97	175.64	0.25
1	9245	PF 1	10100.00	-24.66	-11.85	-19.52	-11.49	0.000205	4.84	2085.56	175.62	0.25
1	9052	PF 1	10100.00	-24.68	-11.89	-19.54	-11.52	0.000206	4.85	2082.25	175.58	0.25
1	8859	PF 1	10100.00	-24.71	-11.93	-19.57	-11.56	0.000207	4.85	2080.79	175.57	0.25
1	8745	PF 1	10100.00	-24.73	-11.95	-19.58	-11.59	0.000207	4.86	2079.58	175.55	0.25
1	8735		Bridge									
1	8590	PF 1	10100.00	-24.76	-12.05	-19.61	-11.68	0.000211	4.89	2067.28	175.41	0.25
1	8480	PF 1	10100.00	-24.77	-12.07	-19.63	-11.70	0.000211	4.89	2065.65	175.39	0.25
1	8287	PF 1	10100.00	-24.80	-12.12	-19.66	-11.75	0.000212	4.90	2063.21	175.36	0.25
1	8094	PF 1	10100.00	-24.83	-12.16	-19.69	-11.79	0.000213	4.90	2060.74	175.34	0.25
1	7901	PF 1	10100.00	-24.86	-12.21	-19.71	-11.83	0.000214	4.91	2058.24	175.31	0.25
1	7708	PF 1	10100.00	-24.89	-12.25	-19.75	-11.88	0.000215	4.91	2055.71	175.28	0.25
1	7515	PF 1	10100.00	-24.93	-12.29	-19.79	-11.92	0.000215	4.91	2055.04	175.27	0.25
1	7322	PF 1	10100.00	-24.96	-12.34	-19.81	-11.96	0.000216	4.92	2052.47	175.24	0.25
1	7129	PF 1	10100.00	-24.99	-12.38	-19.85	-12.01	0.000216	4.93	2049.87	175.21	0.25
1	6936	PF 1	10100.00	-25.02	-12.43	-19.87	-12.05	0.000217	4.93	2047.23	175.18	0.25
1	6743	PF 1	10100.00	-25.05	-12.47	-19.91	-12.10	0.000218	4.94	2044.57	175.15	0.25
1	6550	PF 1	10100.00	-25.08	-12.52	-19.94	-12.14	0.000219	4.95	2041.86	175.12	0.26
1	6357	PF 1	10100.00	-25.11	-12.57	-19.97	-12.18	0.000220	4.95	2039.13	175.09	0.26
1	6164	PF 1	10100.00	-25.14	-12.61	-20.00	-12.23	0.000221	4.96	2036.35	175.06	0.26
1	5971	PF 1	10100.00	-25.18	-12.66	-20.03	-12.27	0.000221	4.96	2035.44	175.05	0.26
1	5778	PF 1	10100.00	-25.21	-12.70	-20.06	-12.32	0.000222	4.97	2032.62	175.02	0.26
1	5585	PF 1	10100.00	-25.24	-12.75	-20.09	-12.36	0.000223	4.98	2029.76	174.98	0.26
1	5392	PF 1	10100.00	-25.27	-12.80	-20.13	-12.41	0.000224	4.98	2026.86	174.95	0.26
1	5199	PF 1	10100.00	-25.30	-12.84	-20.16	-12.46	0.000225	4.99	2023.93	174.92	0.26
1	5006	PF 1	10100.00	-25.33	-12.89	-20.19	-12.50	0.000226	5.00	2020.96	174.88	0.26
1	4813	PF 1	10100.00	-25.36	-12.94	-20.22	-12.55	0.000227	5.01	2017.94	174.85	0.26
1	4620	PF 1	10100.00	-25.39	-12.98	-20.26	-12.59	0.000228	5.01	2014.89	174.81	0.26
1	4427	PF 1	10100.00	-25.43	-13.03	-20.29	-12.64	0.000229	5.02	2013.69	174.80	0.26
1	4234	PF 1	10100.00	-25.46	-13.08	-20.32	-12.69	0.000230	5.02	2010.58	174.76	0.26
1	4041	PF 1	10100.00	-25.49	-13.13	-20.35	-12.73	0.000231	5.03	2007.42	174.73	0.26
1	3848	PF 1	10100.00	-25.52	-13.17	-20.38	-12.78	0.000232	5.04	2004.23	174.69	0.26
1	3655	PF 1	10100.00	-25.55	-13.22	-20.41	-12.83	0.000233	5.05	2000.98	174.65	0.26
1	3462	PF 1	10100.00	-25.58	-13.27	-20.44	-12.88	0.000234	5.06	1997.69	174.62	0.26
1	3269	PF 1	10100.00	-25.61	-13.32	-20.46	-12.92	0.000236	5.06	1994.36	174.58	0.26
1	3076	PF 1	10100.00	-25.64	-13.37	-20.50	-12.97	0.000237	5.07	1990.98	174.54	0.26
1	2873	PF 1	10100.00	-25.68	-13.42	-20.54	-13.02	0.000238	5.08	1988.99	174.52	0.27
1	2630	PF 1	10100.00	-25.72	-13.48	-20.57	-13.08	0.000239	5.09	1985.17	174.47	0.27
1	2372	PF 1	10100.00	-25.76	-13.55	-20.61	-13.15	0.000241	5.10	1980.59	174.42	0.27
1	2244	PF 1	10100.00	-25.78	-13.58	-20.64	-13.18	0.000242	5.11	1978.09	174.39	0.27
1	2051	PF 1	10100.00	-25.81	-13.64	-20.67	-13.23	0.000243	5.12	1974.47	174.35	0.27
1	1791	PF 1	10100.00	-25.86	-13.71	-20.72	-13.30	0.000245	5.13	1969.96	174.30	0.27
1	1741	PF 1	10100.00	-25.86	-13.72	-20.72	-13.31	0.000246	5.13	1967.98	174.28	0.27
1	1686	PF 1	10100.00	-25.87	-13.73	-20.73	-13.32	0.000245	5.13	1968.43	174.28	0.27
1	1674		Bridge									
1	1576	PF 1	10100.00	-25.88	-13.80	-20.74	-13.39	0.000250	5.16	1957.48	174.15	0.27
1	1566	PF 1	10100.00	-25.91	-13.85	-20.77	-13.43	0.000251	5.17	1955.19	174.13	0.27
1	1475	PF 1	10100.00	-25.92	-13.87	-20.77	-13.45	0.000252	5.17	1952.77	174.10	0.27
1	1408	PF 1	10100.00	-25.93	-13.89	-20.79	-13.47	0.000252	5.18	1951.47	174.09	0.27
1	1293	PF 1	10100.00	-25.95	-13.92	-20.80	-13.50	0.000253	5.18	1949.77	174.07	0.27
1	1265	PF 1	10100.00	-25.96	-13.92	-20.82	-13.51	0.000253	5.18	1950.10	174.07	0.27
1	1175	PF 1	10100.00	-25.97	-13.95	-20.83	-13.53	0.000254	5.19	1947.69	174.04	0.27
1	1050	PF 1	10100.00	-25.99	-13.98	-20.85	-13.56	0.000255	5.19	1945.48	174.02	0.27
1	1020	PF 1	10100.00	-25.99	-13.99		-13.57	0.000255	5.20	1944.04	174.00	0.27
1	980	PF 1	10100.00	-26.00	-14.00	-20.86	-13.58	0.000255	5.20	1944.00	174.00	0.27

Option 2 and Option 2a
Orleans Avenue Canal HEC-RAS Results for Pumping at New Station

17th Street Canal 10,900 cfs Canal Flow, Rectangular Cross Section

HEC-RAS Plan: 10900_Rect_Tremi River: 17th Street Reach: 1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	13748	PF 1	10680.00	-24.00	-10.92		-10.46	0.000216	5.44	1962.23	150.00	0.27
1	13713	PF 1	10680.00	-24.05	-10.95	-18.65	-10.51	0.000276	5.30	2015.89	201.10	0.29
1	13708		Bridge									
1	13673	PF 1	10680.00	-24.06	-11.02	-18.66	-10.57	0.000245	5.34	2000.53	178.46	0.28
1	13535	PF 1	10680.00	-24.10	-11.08	-18.70	-10.61	0.000219	5.47	1953.59	150.00	0.27
1	13148	PF 1	10680.00	-24.16	-11.13	-18.76	-10.67	0.000218	5.46	1954.40	150.00	0.27
1	12548	PF 1	10840.00	-24.33	-11.28	-18.88	-10.80	0.000224	5.54	1957.90	150.00	0.27
1	11948	PF 1	10840.00	-24.49	-11.41	-19.04	-10.94	0.000222	5.53	1961.98	150.00	0.27
1	11348	PF 1	10840.00	-24.65	-11.54	-19.20	-11.07	0.000221	5.51	1966.21	150.00	0.27
1	10848	PF 1	10840.00	-24.78	-11.65	-19.33	-11.18	0.000220	5.50	1969.30	150.00	0.27
1	10379	PF 1	10900.00	-24.85	-11.71	-19.37	-11.24	0.000222	5.53	1970.92	150.00	0.27
1	10171	PF 1	10900.00	-24.91	-11.76	-19.43	-11.28	0.000221	5.52	1973.08	150.00	0.27
1	10161		Bridge									
1	9987	PF 1	10900.00	-24.96	-11.85	-19.49	-11.37	0.000223	5.54	1966.98	150.00	0.27
1	9927	PF 1	10900.00	-24.97	-11.86	-19.50	-11.38	0.000223	5.54	1966.43	150.00	0.27
1	9824	PF 1	10900.00	-25.00	-11.88	-19.52	-11.41	0.000223	5.54	1967.48	150.00	0.27
1	9631	PF 1	10900.00	-25.05	-11.92	-19.57	-11.45	0.000222	5.54	1968.88	150.00	0.27
1	9438	PF 1	10900.00	-25.10	-11.96	-19.62	-11.49	0.000222	5.53	1970.29	150.00	0.27
1	9245	PF 1	10900.00	-25.15	-12.01	-19.68	-11.53	0.000221	5.53	1971.71	150.00	0.27
1	9052	PF 1	10900.00	-25.20	-12.05	-19.72	-11.57	0.000221	5.52	1973.15	150.00	0.27
1	8859	PF 1	10900.00	-25.25	-12.09	-19.78	-11.61	0.000220	5.52	1974.60	150.00	0.27
1	8745	PF 1	10900.00	-25.28	-12.11	-19.81	-11.64	0.000220	5.52	1974.96	150.00	0.27
1	8735		Bridge									
1	8590	PF 1	10900.00	-25.32	-12.24	-19.85	-11.76	0.000225	5.55	1962.46	150.00	0.27
1	8480	PF 1	10900.00	-25.35	-12.26	-19.88	-11.78	0.000224	5.55	1964.04	150.00	0.27
1	8287	PF 1	10900.00	-25.40	-12.30	-19.93	-11.82	0.000224	5.55	1964.72	150.00	0.27
1	8094	PF 1	10900.00	-25.46	-12.35	-19.99	-11.87	0.000223	5.54	1967.00	150.00	0.27
1	7901	PF 1	10900.00	-25.51	-12.39	-20.03	-11.92	0.000223	5.54	1967.72	150.00	0.27
1	7708	PF 1	10900.00	-25.57	-12.44	-20.09	-11.96	0.000222	5.53	1970.03	150.00	0.27
1	7515	PF 1	10900.00	-25.62	-12.48	-20.14	-12.01	0.000222	5.53	1970.78	150.00	0.27
1	7322	PF 1	10900.00	-25.67	-12.53	-20.20	-12.05	0.000221	5.53	1971.54	150.00	0.27
1	7129	PF 1	10900.00	-25.73	-12.57	-20.26	-12.10	0.000221	5.52	1973.90	150.00	0.27
1	6936	PF 1	10900.00	-25.78	-12.62	-20.31	-12.14	0.000220	5.52	1974.69	150.00	0.27
1	6743	PF 1	10900.00	-25.84	-12.66	-20.36	-12.19	0.000219	5.51	1977.08	150.00	0.27
1	6550	PF 1	10900.00	-25.89	-12.70	-20.41	-12.23	0.000219	5.51	1977.90	150.00	0.27
1	6357	PF 1	10900.00	-25.95	-12.75	-20.48	-12.28	0.000218	5.50	1980.33	150.00	0.27
1	6164	PF 1	10900.00	-26.00	-12.79	-20.52	-12.32	0.000218	5.50	1981.19	150.00	0.27
1	5971	PF 1	10900.00	-26.06	-12.84	-20.58	-12.37	0.000217	5.49	1983.65	150.00	0.27
1	5778	PF 1	10900.00	-26.11	-12.88	-20.63	-12.41	0.000217	5.49	1984.54	150.00	0.27
1	5585	PF 1	10900.00	-26.17	-12.92	-20.70	-12.46	0.000216	5.49	1987.04	150.00	0.27
1	5392	PF 1	10900.00	-26.22	-12.97	-20.75	-12.50	0.000216	5.48	1987.97	150.00	0.27
1	5199	PF 1	10900.00	-26.28	-13.01	-20.81	-12.54	0.000215	5.48	1990.50	150.00	0.26
1	5006	PF 1	10900.00	-26.33	-13.05	-20.86	-12.59	0.000215	5.47	1991.47	150.00	0.26
1	4813	PF 1	10900.00	-26.38	-13.10	-20.90	-12.63	0.000214	5.47	1992.45	150.00	0.26
1	4620	PF 1	10900.00	-26.44	-13.14	-20.97	-12.68	0.000213	5.46	1995.03	150.00	0.26
1	4427	PF 1	10900.00	-26.49	-13.18	-21.02	-12.72	0.000213	5.46	1996.04	150.00	0.26
1	4234	PF 1	10900.00	-26.55	-13.23	-21.08	-12.76	0.000212	5.45	1998.66	150.00	0.26
1	4041	PF 1	10900.00	-26.60	-13.27	-21.13	-12.81	0.000212	5.45	1999.71	150.00	0.26
1	3848	PF 1	10900.00	-26.66	-13.31	-21.18	-12.85	0.000211	5.44	2002.37	150.00	0.26
1	3655	PF 1	10900.00	-26.71	-13.35	-21.24	-12.89	0.000211	5.44	2003.46	150.00	0.26
1	3462	PF 1	10900.00	-26.77	-13.40	-21.30	-12.94	0.000210	5.43	2006.15	150.00	0.26
1	3269	PF 1	10900.00	-26.82	-13.44	-21.35	-12.98	0.000209	5.43	2007.28	150.00	0.26
1	3076	PF 1	10900.00	-26.88	-13.48	-21.41	-13.02	0.000208	5.42	2010.01	150.00	0.26
1	2873	PF 1	10900.00	-26.93	-13.52	-21.45	-13.07	0.000208	5.42	2010.86	150.00	0.26
1	2630	PF 1	10900.00	-27.00	-13.58	-21.52	-13.12	0.000207	5.41	2013.57	150.00	0.26
1	2372	PF 1	10900.00	-27.07	-13.63	-21.60	-13.18	0.000207	5.41	2015.83	150.00	0.26
1	2244	PF 1	10900.00	-27.11	-13.66	-21.63	-13.21	0.000206	5.40	2017.63	150.00	0.26
1	2051	PF 1	10900.00	-27.17	-13.70	-21.70	-13.25	0.000205	5.39	2020.46	150.00	0.26
1	1791	PF 1	10900.00	-27.25	-13.76	-21.78	-13.31	0.000204	5.39	2023.26	150.00	0.26
1	1741	PF 1	10900.00	-27.26	-13.77	-21.79	-13.32	0.000204	5.39	2023.44	150.00	0.26
1	1686	PF 1	10900.00	-27.27	-13.78	-21.79	-13.33	0.000204	5.39	2024.03	150.00	0.26
1	1674		Bridge									
1	1576	PF 1	10900.00	-27.30	-13.85	-21.83	-13.39	0.000206	5.40	2018.20	150.00	0.26
1	1566	PF 1	10900.00	-27.34	-13.88	-21.87	-13.43	0.000206	5.40	2019.02	150.00	0.26
1	1475	PF 1	10900.00	-27.37	-13.90	-21.90	-13.45	0.000205	5.39	2020.78	150.00	0.26
1	1408	PF 1	10900.00	-27.38	-13.91	-21.91	-13.46	0.000205	5.40	2020.18	150.00	0.26
1	1293	PF 1	10900.00	-27.41	-13.94	-21.94	-13.48	0.000205	5.39	2021.14	150.00	0.26
1	1265	PF 1	10900.00	-27.42	-13.94	-21.95	-13.49	0.000205	5.39	2021.66	150.00	0.26
1	1175	PF 1	10900.00	-27.45	-13.96	-21.97	-13.51	0.000204	5.39	2023.46	150.00	0.26
1	1050	PF 1	10900.00	-27.48	-13.99	-22.01	-13.54	0.000204	5.39	2024.14	150.00	0.26
1	1020	PF 1	10900.00	-27.49	-13.99		-13.54	0.000204	5.38	2024.72	150.00	0.26
1	980	PF 1	10900.00	-27.50	-14.00	-22.04	-13.55	0.000204	5.38	2025.00	150.00	0.26

Orleans Avenue Canal 3,390 cfs Canal Flow, Rectangular Cross Section

HEC-RAS Plan: 3390_Rect_Tremie River: Orleans Reach: 2 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
2	12845	PF 1	3390.00	-19.50	-9.40		-9.30	0.000067	2.58	1312.57	130.00	0.14
2	12795	PF 1	3390.00	-19.50	-9.41		-9.30	0.000067	2.58	1312.12	130.00	0.14
2	12770	PF 1	3390.00	-19.50	-9.41		-9.30	0.000067	2.58	1311.89	130.00	0.14
2	12740	PF 1	3390.00	-19.50	-9.47		-9.31	0.000175	3.20	1058.36	160.00	0.22
2	12700	PF 1	3390.00	-19.50	-9.50	-16.21	-9.32	0.000123	3.39	1000.07	100.00	0.19
2	12625		Bridge									
2	12550	PF 1	3390.00	-19.50	-9.53	-16.20	-9.35	0.000125	3.40	996.64	100.00	0.19
2	12410	PF 1	3390.00	-19.50	-9.55	-16.20	-9.37	0.000125	3.41	994.81	100.00	0.19
2	12010	PF 1	3390.00	-19.50	-9.60	-16.20	-9.42	0.000127	3.43	989.54	100.00	0.19
2	10110	PF 1	3390.00	-19.50	-9.87	-16.20	-9.68	0.000138	3.52	963.22	100.00	0.20
2	9285	PF 1	3390.00	-19.50	-9.99	-16.20	-9.79	0.000144	3.56	951.02	100.00	0.20
2	9217	PF 1	3390.00	-19.50	-10.00	-16.20	-9.80	0.000145	3.57	949.98	100.00	0.20
2	9201		Bridge									
2	9185	PF 1	3390.00	-19.50	-10.04	-16.20	-9.84	0.000146	3.58	946.18	100.00	0.21
2	9135	PF 1	3390.00	-19.50	-10.05	-16.20	-9.85	0.000147	3.59	945.41	100.00	0.21
2	7875	PF 1	3390.00	-19.50	-10.25	-16.20	-10.04	0.000157	3.66	925.32	100.00	0.21
2	6500	PF 1	3390.00	-19.50	-10.48	-16.20	-10.26	0.000170	3.76	901.63	100.00	0.22
2	6450	PF 1	3390.00	-19.50	-10.49	-16.20	-10.27	0.000171	3.76	900.72	100.00	0.22
2	6425		Bridge									
2	6400	PF 1	3390.00	-19.50	-10.54	-16.20	-10.31	0.000173	3.78	896.39	100.00	0.22
2	6350	PF 1	3390.00	-19.50	-10.55	-16.20	-10.32	0.000174	3.79	895.47	100.00	0.22
2	5150	PF 1	3390.00	-19.50	-10.78	-16.20	-10.54	0.000189	3.89	872.41	100.00	0.23
2	3900	PF 1	3390.00	-19.50	-11.04	-16.20	-10.79	0.000208	4.01	846.04	100.00	0.24
2	3860	PF 1	3390.00	-19.50	-11.05	-16.20	-10.80	0.000208	4.01	845.37	100.00	0.24
2	3838		Bridge									
2	3816	PF 1	3390.00	-19.50	-11.09	-16.20	-10.84	0.000212	4.03	840.70	100.00	0.25
2	3760	PF 1	3390.00	-19.50	-11.10	-16.20	-10.85	0.000213	4.04	839.64	100.00	0.25
2	2430	PF 1	3390.00	-19.50	-11.43	-16.20	-11.15	0.000241	4.20	807.27	100.00	0.26
2	1980	PF 1	3390.00	-19.50	-11.55	-16.20	-11.27	0.000253	4.26	795.25	100.00	0.27
2	680	PF 1	3390.00	-19.50	-11.93	-16.20	-11.62	0.000296	4.48	756.53	100.00	0.29
2	530	PF 1	3390.00	-19.50	-11.98	-16.20	-11.67	0.000302	4.51	751.63	100.00	0.29
2	480	PF 1	3390.00	-19.50	-12.00	-16.20	-11.68	0.000304	4.52	750.00	100.00	0.29

Orleans Avenue Canal 3,390 cfs Canal Flow, Trapezoidal Cross Section

HEC-RAS Plan: 3390_Trpzd-19.5 River: Orleans Reach: 2 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
2	12845	PF 1	3390.00	-19.50	-9.40		-9.29	0.000081	2.58	1313.59	130.00	0.14
2	12795	PF 1	3390.00	-19.50	-9.40		-9.30	0.000081	2.58	1313.05	130.00	0.14
2	12770	PF 1	3390.00	-19.50	-9.40		-9.30	0.000081	2.58	1312.78	130.00	0.14
2	12740	PF 1	3390.00	-19.50	-9.44		-9.30	0.000150	2.96	1146.35	160.00	0.19
2	12700	PF 1	3390.00	-19.50	-9.46	-16.24	-9.31	0.000117	3.07	1105.18	120.09	0.18
2	12625		Bridge									
2	12550	PF 1	3390.00	-19.50	-9.49	-16.24	-9.34	0.000118	3.08	1101.57	120.03	0.18
2	12410	PF 1	3390.00	-19.50	-9.50	-16.24	-9.36	0.000119	3.08	1099.50	119.99	0.18
2	12010	PF 1	3390.00	-19.50	-9.55	-16.24	-9.40	0.000121	3.10	1093.54	119.89	0.18
2	10110	PF 1	3390.00	-19.50	-9.80	-16.24	-9.64	0.000131	3.19	1063.80	119.40	0.19
2	9285	PF 1	3390.00	-19.50	-9.92	-16.24	-9.76	0.000137	3.23	1050.06	119.16	0.19
2	9217	PF 1	3390.00	-19.50	-9.93	-16.24	-9.77	0.000137	3.23	1048.89	119.15	0.19
2	9201		Bridge									
2	9185	PF 1	3390.00	-19.50	-9.96	-16.24	-9.79	0.000139	3.24	1045.24	119.08	0.19
2	9135	PF 1	3390.00	-19.50	-9.97	-16.24	-9.80	0.000139	3.25	1044.37	119.07	0.19
2	7875	PF 1	3390.00	-19.50	-10.15	-16.24	-9.98	0.000149	3.32	1021.88	118.69	0.20
2	6500	PF 1	3390.00	-19.50	-10.38	-16.24	-10.20	0.000161	3.41	995.47	118.24	0.21
2	6450	PF 1	3390.00	-19.50	-10.39	-16.25	-10.21	0.000162	3.41	994.45	118.23	0.21
2	6425		Bridge									
2	6400	PF 1	3390.00	-19.50	-10.42	-16.25	-10.24	0.000164	3.42	990.34	118.16	0.21
2	6350	PF 1	3390.00	-19.50	-10.43	-16.24	-10.25	0.000164	3.43	989.31	118.14	0.21
2	5150	PF 1	3390.00	-19.50	-10.65	-16.24	-10.45	0.000178	3.52	963.84	117.71	0.22
2	3900	PF 1	3390.00	-19.50	-10.89	-16.24	-10.69	0.000196	3.63	934.88	117.22	0.23
2	3860	PF 1	3390.00	-19.50	-11.07	-15.58	-10.71	0.000373	4.82	703.08	91.85	0.31
2	3838		Bridge									
2	3816	PF 1	3390.00	-19.50	-11.17	-15.58	-10.80	0.000387	4.88	694.46	91.67	0.31
2	3760	PF 1	3390.00	-19.50	-11.10	-16.24	-10.89	0.000212	3.72	910.32	116.80	0.24
2	2430	PF 1	3390.00	-19.50	-11.42	-16.24	-11.19	0.000242	3.88	872.79	116.15	0.25
2	1980	PF 1	3390.00	-19.50	-11.54	-16.24	-11.30	0.000255	3.95	858.83	115.91	0.26
2	680	PF 1	3390.00	-19.50	-11.93	-16.24	-11.66	0.000301	4.17	813.86	115.13	0.28
2	530	PF 1	3390.00	-19.50	-11.98	-16.24	-11.71	0.000308	4.19	808.15	115.03	0.28
2	480	PF 1	3390.00	-19.50	-12.00	-16.24	-11.73	0.000310	4.20	806.25	115.00	0.28

Option 2 and Option 2a
London Avenue Canal HEC-RAS Results for Pumping at New Station

London Avenue Canal 8,980 cfs Canal Flow, Rectangular Cross Section

HEC-RAS Plan: 8980_Rect_Tremie Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	15300	PF 1	4260.00	-20.80	-9.89	-16.96	-9.65	0.000148	3.90	1091.14	100.00	0.21
1	15250	PF 1	4260.00	-20.82	-9.89	-16.99	-9.66	0.000148	3.90	1092.58	100.00	0.21
1	15200	PF 1	4260.00	-20.84	-9.90	-17.01	-9.67	0.000147	3.89	1093.87	100.00	0.21
1	15191	PF 1	4260.00	-20.85	-9.90	-17.01	-9.67	0.000170	3.81	1117.24	121.81	0.22
1	15188		Bridge									
1	15185	PF 1	4260.00	-20.85	-9.99	-17.01	-9.76	0.000175	3.85	1106.30	121.47	0.22
1	15092	PF 1	4260.00	-20.90	-10.01	-17.07	-9.77	0.000149	3.91	1088.90	100.00	0.21
1	15079.5		Bridge									
1	15067	PF 1	4260.00	-20.91	-10.10	-17.08	-9.86	0.000153	3.94	1080.95	100.00	0.21
1	14975	PF 1	4260.00	-20.96	-10.11	-17.13	-9.87	0.000151	3.93	1084.64	100.00	0.21
1	14775	PF 1	4260.00	-21.06	-10.14	-17.22	-9.90	0.000148	3.90	1091.86	100.00	0.21
1	14675	PF 1	4260.00	-21.13	-10.16	-17.30	-9.93	0.000146	3.88	1096.65	100.00	0.21
1	14475	PF 1	4260.00	-21.23	-10.19	-17.39	-9.96	0.000143	3.86	1103.98	100.00	0.20
1	14354	PF 1	4260.00	-21.46	-10.25	-17.63	-10.03	0.000137	3.80	1121.04	100.00	0.20
1	14294.5		Bridge									
1	14235	PF 1	4260.00	-21.52	-10.29	-17.68	-10.07	0.000136	3.79	1122.71	100.00	0.20
1	13875	PF 1	4260.00	-21.69	-10.34	-17.86	-10.12	0.000131	3.75	1135.15	100.00	0.20
1	13656	PF 1	4260.00	-21.94	-10.40	-18.11	-10.19	0.000125	3.69	1154.25	100.00	0.19
1	13375	PF 1	4260.00	-22.08	-10.43	-18.25	-10.22	0.000121	3.66	1165.06	100.00	0.19
1	12875	PF 1	4260.00	-22.33	-10.48	-18.50	-10.28	0.000115	3.60	1184.63	100.00	0.18
1	12375	PF 1	4260.00	-22.58	-10.54	-18.74	-10.34	0.000109	3.54	1204.48	100.00	0.18
1	11875	PF 1	4260.00	-22.82	-10.58	-18.98	-10.40	0.000104	3.48	1223.56	100.00	0.18
1	11375	PF 1	4260.00	-23.07	-10.63	-19.23	-10.45	0.000099	3.42	1243.90	100.00	0.17
1	10875	PF 1	4260.00	-23.32	-10.68	-19.49	-10.50	0.000094	3.37	1264.48	100.00	0.17
1	10575	PF 1	4260.00	-23.47	-10.70	-19.64	-10.53	0.000092	3.34	1276.86	100.00	0.16
1	10175	PF 1	4260.00	-23.67	-10.73	-19.83	-10.57	0.000088	3.29	1293.59	100.00	0.16
1	9675	PF 1	4260.00	-23.91	-10.77	-20.08	-10.61	0.000084	3.24	1313.65	100.00	0.16
1	9175	PF 1	4260.00	-24.16	-10.81	-20.33	-10.65	0.000080	3.19	1334.92	100.00	0.15
1	9009	PF 1	4260.00	-24.24	-10.82	-20.41	-10.67	0.000079	3.18	1341.68	100.00	0.15
1	8974		Bridge									
1	8939	PF 1	4260.00	-24.28	-10.85	-20.44	-10.69	0.000078	3.17	1343.31	100.00	0.15
1	8934	PF 1	4260.00	-24.28	-10.85	-20.44	-10.69	0.000078	3.17	1343.27	100.00	0.15
1	8771	PF 1	4260.00	-24.44	-10.87	-20.60	-10.72	0.000076	3.14	1356.88	100.00	0.15
1	8271	PF 1	4260.00	-24.69	-10.90	-20.86	-10.76	0.000072	3.09	1378.51	100.00	0.15
1	7771	PF 1	4260.00	-24.94	-10.94	-21.10	-10.79	0.000069	3.04	1400.29	100.00	0.14
1	7601	PF 1	4260.00	-25.02	-10.95	-21.19	-10.81	0.000068	3.03	1407.20	100.00	0.14
1	7582		Bridge									
1	7563	PF 1	4260.00	-25.04	-10.97	-21.20	-10.83	0.000068	3.03	1406.94	100.00	0.14
1	7433	PF 1	4260.00	-25.11	-10.98	-21.28	-10.84	0.000067	3.01	1413.12	100.00	0.14
1	7133	PF 1	4260.00	-25.26	-11.00	-21.42	-10.86	0.000065	2.99	1426.31	100.00	0.14
1	6733	PF 1	4260.00	-25.45	-11.02	-21.61	-10.88	0.000063	2.95	1442.97	100.00	0.14
1	6233	PF 1	4260.00	-25.70	-11.05	-21.86	-10.92	0.000060	2.91	1465.18	100.00	0.13
1	5938	PF 1	4260.00	-25.85	-11.06	-22.02	-10.94	0.000059	2.88	1478.59	100.00	0.13
1	5928.5		Bridge									
1	5919	PF 1	4260.00	-25.86	-11.08	-22.02	-10.95	0.000059	2.88	1478.49	100.00	0.13
1	5833	PF 1	4260.00	-25.90	-11.08	-22.07	-10.95	0.000058	2.87	1482.02	100.00	0.13
2	5733	PF 1	8980.00	-26.00	-11.62	-19.70	-11.01	0.000283	6.24	1438.06	100.00	0.29
2	5233	PF 1	8980.00	-26.22	-11.75	-19.92	-11.16	0.000278	6.21	1446.53	100.00	0.29
2	4733	PF 1	8980.00	-26.44	-11.89	-20.14	-11.30	0.000273	6.17	1455.26	100.00	0.29
2	4233	PF 1	8980.00	-26.66	-12.02	-20.36	-11.43	0.000268	6.13	1464.24	100.00	0.28
2	4150	PF 1	8980.00	-26.70	-12.04	-20.39	-11.46	0.000267	6.13	1466.08	100.00	0.28
2	4126	PF 1	8980.00	-26.71	-12.05	-20.41	-11.46	0.000267	6.12	1466.43	100.00	0.28
2	4108		Bridge									
2	4090	PF 1	8980.00	-26.72	-12.12	-20.42	-11.53	0.000270	6.15	1460.21	100.00	0.28
2	3533	PF 1	8980.00	-26.97	-12.26	-20.66	-11.68	0.000264	6.11	1470.75	100.00	0.28
2	3433	PF 1	8980.00	-27.01	-12.29	-20.71	-11.71	0.000264	6.10	1472.15	100.00	0.28
2	3397		Bridge									
2	3361	PF 1	8980.00	-27.04	-12.41	-20.73	-11.82	0.000268	6.14	1463.30	100.00	0.28
2	3233	PF 1	8980.00	-27.10	-12.44	-20.80	-11.86	0.000267	6.13	1465.95	100.00	0.28
2	2983	PF 1	8980.00	-27.21	-12.50	-20.91	-11.93	0.000264	6.11	1470.56	100.00	0.28
2	2863	PF 1	8980.00	-27.26	-12.54	-20.96	-11.96	0.000263	6.10	1472.47	100.00	0.28
2	2813	PF 1	8980.00	-27.29	-12.55	-20.99	-11.97	0.000262	6.09	1474.20	100.00	0.28
2	2713	PF 1	8980.00	-27.33	-12.57	-21.02	-12.00	0.000262	6.09	1475.62	100.00	0.28
2	2533	PF 1	8980.00	-27.41	-12.62	-21.11	-12.05	0.000260	6.07	1479.06	100.00	0.28
2	2268	PF 1	8980.00	-27.53	-12.68	-21.22	-12.12	0.000257	6.05	1484.51	100.00	0.28
2	2133	PF 1	8980.00	-27.59	-12.72	-21.28	-12.15	0.000256	6.04	1487.14	100.00	0.28
2	1973	PF 1	8980.00	-27.66	-12.76	-21.36	-12.19	0.000254	6.03	1490.18	100.00	0.28
2	1573	PF 1	8980.00	-27.83	-12.86	-21.52	-12.30	0.000250	6.00	1497.48	100.00	0.27
2	1293	PF 1	8980.00	-27.96	-12.92	-21.66	-12.37	0.000247	5.97	1503.84	100.00	0.27
2	1233	PF 1	8980.00	-27.98	-12.91	-21.67	-12.41	0.000362	5.66	1586.02	169.84	0.33
2	1193	PF 1	8980.00	-28.00	-13.00	-21.70	-12.44	0.000249	5.99	1500.00	100.00	0.27

London Avenue Canal 8,980 cfs Canal Flow, Trapezoidal Cross Section

HEC-RAS Plan: 8980_Trpzd-29.0 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	15300	PF 1	4260.00	-21.60	-9.93	-17.24	-9.68	0.000174	3.98	1069.84	103.34	0.22
1	15250	PF 1	4260.00	-21.62	-9.94	-17.25	-9.69	0.000173	3.98	1071.22	103.37	0.22
1	15200	PF 1	4260.00	-21.64	-9.94	-17.27	-9.70	0.000172	3.97	1072.42	103.39	0.22
1	15191	PF 1	4260.00	-21.65	-9.94	-17.28	-9.70	0.000200	3.90	1093.62	123.36	0.23
1	15188		Bridge									
1	15185	PF 1	4260.00	-21.65	-10.04	-17.28	-9.80	0.000207	3.94	1081.14	122.86	0.23
1	15092	PF 1	4260.00	-21.70	-10.07	-17.33	-9.82	0.000176	4.00	1065.83	103.26	0.22
1	15079.5		Bridge									
1	15067	PF 1	4260.00	-21.71	-10.17	-17.34	-9.92	0.000180	4.03	1055.90	103.07	0.22
1	14975	PF 1	4260.00	-21.76	-10.19	-17.39	-9.94	0.000179	4.02	1059.44	103.14	0.22
1	14775	PF 1	4260.00	-21.86	-10.25	-17.50	-9.98	0.000195	4.19	1017.33	93.61	0.22
1	14675	PF 1	4260.00	-21.93	-10.26	-17.56	-10.02	0.000174	3.98	1069.57	103.34	0.22
1	14475	PF 1	4260.00	-22.03	-10.29	-17.66	-10.05	0.000170	3.96	1076.58	103.47	0.22
1	14354	PF 1	4260.00	-22.26	-10.37	-17.89	-10.13	0.000163	3.90	1093.03	103.79	0.21
1	14294.5		Bridge									
1	14235	PF 1	4260.00	-22.32	-10.42	-17.95	-10.18	0.000162	3.89	1093.71	103.80	0.21
1	13875	PF 1	4260.00	-22.49	-10.47	-18.13	-10.24	0.000157	3.86	1103.74	102.00	0.21
1	13656	PF 1	4260.00	-22.74	-10.54	-18.38	-10.32	0.000150	3.79	1124.29	104.39	0.20
1	13375	PF 1	4260.00	-22.88	-10.58	-18.51	-10.36	0.000146	3.75	1134.92	104.59	0.20
1	12875	PF 1	4260.00	-23.13	-10.65	-18.76	-10.44	0.000138	3.69	1154.21	104.96	0.20
1	12375	PF 1	4260.00	-23.38	-10.71	-19.01	-10.51	0.000132	3.63	1173.92	105.34	0.19
1	11875	PF 1	4260.00	-23.62	-10.77	-19.25	-10.57	0.000125	3.57	1192.94	105.70	0.19
1	11375	PF 1	4260.00	-23.87	-10.83	-19.50	-10.64	0.000119	3.51	1213.43	106.08	0.18
1	10875	PF 1	4260.00	-24.12	-10.88	-19.76	-10.70	0.000113	3.45	1234.30	106.48	0.18
1	10575	PF 1	4260.00	-24.27	-10.91	-19.90	-10.73	0.000110	3.42	1246.91	106.71	0.18
1	10175	PF 1	4260.00	-24.47	-10.95	-20.10	-10.78	0.000106	3.37	1264.04	107.03	0.17
1	9675	PF 1	4260.00	-24.71	-11.00	-20.34	-10.83	0.000101	3.32	1284.66	107.42	0.17
1	9175	PF 1	4260.00	-24.96	-11.05	-20.59	-10.88	0.000096	3.26	1306.71	107.83	0.17
1	9009	PF 1	4260.00	-25.04	-11.06	-20.67	-10.90	0.000094	3.24	1313.74	107.96	0.16
1	8974		Bridge									
1	8939	PF 1	4260.00	-25.08	-11.09	-20.72	-10.93	0.000094	3.24	1315.13	107.98	0.16
1	8934	PF 1	4260.00	-25.08	-11.09	-20.72	-10.93	0.000094	3.24	1315.08	107.98	0.16
1	8771	PF 1	4260.00	-25.24	-11.12	-20.87	-10.96	0.000091	3.20	1329.26	108.25	0.16
1	8271	PF 1	4260.00	-25.49	-11.16	-21.12	-11.00	0.000087	3.15	1351.96	108.66	0.16
1	7771	PF 1	4260.00	-25.74	-11.20	-21.37	-11.05	0.000082	3.10	1374.97	109.09	0.15
1	7601	PF 1	4260.00	-25.82	-11.21	-21.45	-11.06	0.000081	3.08	1382.27	109.22	0.15
1	7582		Bridge									
1	7563	PF 1	4260.00	-25.84	-11.23	-21.47	-11.08	0.000081	3.08	1382.08	109.22	0.15
1	7433	PF 1	4260.00	-25.91	-11.24	-21.54	-11.10	0.000080	3.07	1388.66	109.34	0.15
1	7133	PF 1	4260.00	-26.06	-11.26	-21.69	-11.12	0.000078	3.04	1402.71	109.59	0.15
1	6733	PF 1	4260.00	-26.25	-11.29	-21.88	-11.15	0.000075	3.00	1420.49	109.92	0.15
1	6233	PF 1	4260.00	-26.50	-11.32	-22.13	-11.19	0.000071	2.95	1444.35	110.35	0.14
1	5938	PF 1	4260.00	-26.65	-11.34	-22.28	-11.21	0.000069	2.92	1458.83	110.61	0.14
1	5928.5		Bridge									
1	5919	PF 1	4260.00	-26.66	-11.36	-22.29	-11.22	0.000069	2.92	1458.53	110.61	0.14
1	5833	PF 1	4260.00	-26.70	-11.36	-22.33	-11.23	0.000069	2.91	1462.34	110.68	0.14
2	5733	PF 1	8980.00	-26.75	-11.93	-19.66	-11.30	0.000344	6.39	1405.01	109.64	0.31
2	5233	PF 1	8980.00	-27.00	-12.10	-19.90	-11.47	0.000337	6.35	1414.40	109.81	0.31
2	4733	PF 1	8980.00	-27.25	-12.26	-20.15	-11.64	0.000331	6.31	1424.18	109.99	0.31
2	4233	PF 1	8980.00	-27.49	-12.42	-20.39	-11.81	0.000325	6.27	1433.17	110.15	0.31
2	4150	PF 1	8980.00	-27.53	-12.44	-20.44	-11.83	0.000324	6.26	1434.66	110.18	0.31
2	4126	PF 1	8980.00	-27.55	-12.45	-20.46	-11.84	0.000323	6.25	1436.06	110.20	0.31
2	4108		Bridge									
2	4090	PF 1	8980.00	-27.56	-12.41	-21.38	-12.00	0.000207	5.15	1744.52	130.30	0.25
2	3533	PF 1	8980.00	-27.84	-12.52	-21.67	-12.12	0.000199	5.08	1767.00	130.64	0.24
2	3433	PF 1	8980.00	-27.89	-12.54	-21.72	-12.14	0.000197	5.07	1771.03	130.71	0.24
2	3397		Bridge									
2	3361	PF 1	8980.00	-27.92	-12.61	-21.75	-12.21	0.000199	5.09	1765.44	130.62	0.24
2	3233	PF 1	8980.00	-27.99	-12.63	-21.82	-12.23	0.000197	5.07	1771.45	130.71	0.24
2	2983	PF 1	8980.00	-28.11	-12.68	-21.94	-12.28	0.000194	5.04	1781.14	130.86	0.24
2	2863	PF 1	8980.00	-28.17	-12.70	-22.00	-12.31	0.000193	5.03	1786.16	130.94	0.24
2	2813	PF 1	8980.00	-28.19	-12.71	-22.02	-12.32	0.000192	5.02	1787.55	130.96	0.24
2	2713	PF 1	8980.00	-28.24	-12.73	-22.07	-12.34	0.000191	5.01	1791.67	131.02	0.24
2	2533	PF 1	8980.00	-28.33	-12.76	-22.16	-12.37	0.000188	4.99	1799.21	131.14	0.24
2	2268	PF 1	8980.00	-28.47	-12.81	-22.30	-12.43	0.000185	4.96	1811.58	131.33	0.24
2	2133	PF 1	8980.00	-28.53	-12.83	-22.36	-12.45	0.000183	4.94	1816.39	131.40	0.23
2	1973	PF 1	8980.00	-28.61	-12.86	-22.44	-12.48	0.000181	4.93	1823.34	131.50	0.23
2	1573	PF 1	8980.00	-28.81	-12.92	-22.63	-12.55	0.000176	4.88	1840.93	131.77	0.23
2	1293	PF 1	8980.00	-28.95	-12.97	-22.78	-12.61	0.000172	4.85	1853.41	131.96	0.23
2	1233	PF 1	8980.00	-28.98	-12.97	-22.81	-12.62	0.000217	4.74	1895.33	169.77	0.25
2	1193	PF 1	8980.00	-29.00	-13.00	-22.82	-12.64	0.000172	4.84	1856.00	132.00	0.23

London Avenue Canal 7,980 cfs Canal Flow, Rectangular Cross Section

HEC-RAS Plan: 7980_Divert_Dwyr Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	15300	PF 1	4260.00	-20.20	-9.89	-16.37	-9.63	0.000177	4.13	1030.93	100.00	0.23
1	15250	PF 1	4260.00	-20.22	-9.90	-16.38	-9.63	0.000176	4.13	1032.25	100.00	0.23
1	15200	PF 1	4260.00	-20.24	-9.91	-16.41	-9.64	0.000176	4.12	1033.40	100.00	0.23
1	15191	PF 1	4260.00	-20.25	-9.90	-16.41	-9.65	0.000202	4.03	1056.79	121.80	0.24
1	15188		Bridge									
1	15185	PF 1	4260.00	-20.25	-10.00	-16.41	-9.74	0.000209	4.08	1044.25	121.40	0.25
1	15092	PF 1	4260.00	-20.30	-10.03	-16.47	-9.77	0.000179	4.15	1026.72	100.00	0.23
1	15079.5		Bridge									
1	15067	PF 1	4260.00	-20.31	-10.14	-16.48	-9.86	0.000184	4.19	1017.42	100.00	0.23
1	14975	PF 1	4260.00	-20.36	-10.15	-16.53	-9.88	0.000183	4.17	1020.83	100.00	0.23
1	14775	PF 1	4260.00	-20.46	-10.19	-16.63	-9.92	0.000179	4.15	1027.46	100.00	0.23
1	14675	PF 1	4260.00	-20.53	-10.21	-16.70	-9.95	0.000177	4.13	1031.77	100.00	0.23
1	14475	PF 1	4260.00	-20.63	-10.24	-16.79	-9.98	0.000173	4.10	1038.51	100.00	0.22
1	14354	PF 1	4260.00	-20.86	-10.32	-17.03	-10.06	0.000165	4.04	1054.30	100.00	0.22
1	14294.5		Bridge									
1	14235	PF 1	4260.00	-20.92	-10.37	-17.09	-10.11	0.000165	4.04	1055.20	100.00	0.22
1	13875	PF 1	4260.00	-21.09	-10.42	-17.26	-10.18	0.000159	3.99	1066.64	100.00	0.22
1	13656	PF 1	4260.00	-21.34	-10.50	-17.51	-10.26	0.000151	3.93	1084.45	100.00	0.21
1	13375	PF 1	4260.00	-21.48	-10.53	-17.65	-10.30	0.000147	3.89	1094.56	100.00	0.21
1	12875	PF 1	4260.00	-21.73	-10.60	-17.90	-10.37	0.000140	3.83	1112.94	100.00	0.20
1	12375	PF 1	4260.00	-21.98	-10.66	-18.15	-10.44	0.000133	3.76	1131.66	100.00	0.20
1	11875	PF 1	4260.00	-22.22	-10.72	-18.38	-10.51	0.000126	3.71	1149.67	100.00	0.19
1	11375	PF 1	4260.00	-22.47	-10.78	-18.63	-10.57	0.000120	3.64	1169.00	100.00	0.19
1	10875	PF 1	4260.00	-22.72	-10.83	-18.88	-10.63	0.000114	3.58	1188.63	100.00	0.18
1	10575	PF 1	4260.00	-22.87	-10.87	-19.03	-10.67	0.000111	3.55	1200.45	100.00	0.18
1	10175	PF 1	4260.00	-23.07	-10.91	-19.23	-10.71	0.000106	3.50	1216.48	100.00	0.18
1	9675	PF 1	4260.00	-23.31	-10.95	-19.48	-10.77	0.000101	3.45	1235.71	100.00	0.17
1	9175	PF 1	4260.00	-23.56	-11.00	-19.73	-10.82	0.000096	3.39	1256.19	100.00	0.17
1	9009	PF 1	4260.00	-23.64	-11.01	-19.81	-10.84	0.000095	3.37	1262.70	100.00	0.17
1	8974		Bridge									
1	8939	PF 1	4260.00	-23.68	-11.04	-19.84	-10.86	0.000094	3.37	1263.96	100.00	0.17
1	8934	PF 1	4260.00	-23.68	-11.04	-19.84	-10.86	0.000094	3.37	1263.91	100.00	0.17
1	8771	PF 1	4260.00	-23.84	-11.07	-20.00	-10.90	0.000091	3.34	1277.02	100.00	0.16
1	8271	PF 1	4260.00	-24.09	-11.11	-20.25	-10.94	0.000087	3.28	1297.95	100.00	0.16
1	7771	PF 1	4260.00	-24.34	-11.15	-20.51	-10.99	0.000083	3.23	1319.07	100.00	0.16
1	7601	PF 1	4260.00	-24.42	-11.16	-20.58	-11.00	0.000082	3.21	1325.76	100.00	0.16
1	7582		Bridge									
1	7563	PF 1	4260.00	-24.44	-11.19	-20.60	-11.03	0.000082	3.21	1325.18	100.00	0.16
1	7433	PF 1	4260.00	-24.51	-11.20	-20.68	-11.04	0.000081	3.20	1331.19	100.00	0.15
1	7133	PF 1	4260.00	-24.66	-11.22	-20.83	-11.06	0.000078	3.17	1344.02	100.00	0.15
1	6733	PF 1	4260.00	-24.85	-11.25	-21.02	-11.10	0.000075	3.13	1360.21	100.00	0.15
1	6233	PF 1	4260.00	-25.10	-11.28	-21.27	-11.13	0.000072	3.08	1381.86	100.00	0.15
1	5938	PF 1	4260.00	-25.25	-11.30	-21.42	-11.16	0.000070	3.05	1394.96	100.00	0.14
1	5928.5		Bridge									
1	5919	PF 1	4260.00	-25.26	-11.31	-21.42	-11.17	0.000070	3.05	1394.70	100.00	0.14
1	5833	PF 1	4260.00	-25.30	-11.32	-21.47	-11.17	0.000069	3.05	1398.14	100.00	0.14
2	5733	PF 1	7980.00	-25.40	-11.76	-19.57	-11.23	0.000262	5.85	1364.05	100.00	0.28
2	5233	PF 1	7980.00	-25.62	-11.88	-19.80	-11.36	0.000257	5.81	1373.58	100.00	0.28
2	4733	PF 1	7980.00	-25.84	-12.01	-20.01	-11.49	0.000251	5.77	1383.39	100.00	0.27
2	4233	PF 1	7980.00	-26.06	-12.13	-20.24	-11.62	0.000246	5.73	1393.48	100.00	0.27
2	4150	PF 1	7980.00	-26.10	-12.15	-20.27	-11.64	0.000245	5.72	1395.50	100.00	0.27
2	4126	PF 1	7980.00	-26.11	-12.15	-20.29	-11.64	0.000245	5.72	1395.91	100.00	0.27
2	4108		Bridge									
2	4090	PF 1	7980.00	-26.12	-12.21	-20.29	-11.70	0.000247	5.74	1390.76	100.00	0.27
2	3533	PF 1	7980.00	-26.37	-12.34	-20.54	-11.84	0.000241	5.69	1402.59	100.00	0.27
2	3433	PF 1	7980.00	-26.41	-12.37	-20.58	-11.87	0.000240	5.68	1404.22	100.00	0.27
2	3397		Bridge									
2	3361	PF 1	7980.00	-26.44	-12.47	-20.62	-11.96	0.000244	5.71	1397.03	100.00	0.27
2	3233	PF 1	7980.00	-26.50	-12.50	-20.67	-12.00	0.000242	5.70	1400.00	100.00	0.27
2	2983	PF 1	7980.00	-26.61	-12.56	-20.78	-12.06	0.000240	5.68	1405.23	100.00	0.27
2	2863	PF 1	7980.00	-26.66	-12.59	-20.84	-12.09	0.000239	5.67	1407.44	100.00	0.27
2	2813	PF 1	7980.00	-26.69	-12.60	-20.86	-12.10	0.000238	5.66	1409.30	100.00	0.27
2	2713	PF 1	7980.00	-26.73	-12.62	-20.90	-12.12	0.000237	5.66	1410.97	100.00	0.27
2	2533	PF 1	7980.00	-26.81	-12.66	-20.98	-12.17	0.000235	5.64	1414.86	100.00	0.26
2	2268	PF 1	7980.00	-26.93	-12.72	-21.11	-12.23	0.000232	5.62	1420.97	100.00	0.26
2	2133	PF 1	7980.00	-26.99	-12.75	-21.16	-12.26	0.000230	5.60	1423.96	100.00	0.26
2	1973	PF 1	7980.00	-27.06	-12.79	-21.24	-12.30	0.000229	5.59	1427.45	100.00	0.26
2	1573	PF 1	7980.00	-27.23	-12.87	-21.41	-12.39	0.000225	5.56	1435.79	100.00	0.26
2	1293	PF 1	7980.00	-27.36	-12.93	-21.53	-12.46	0.000221	5.53	1442.88	100.00	0.26
2	1233	PF 1	7980.00	-27.38	-12.92	-21.55	-12.50	0.000324	5.24	1524.14	169.73	0.31
2	1193	PF 1	7980.00	-27.40	-13.00	-21.58	-12.52	0.000223	5.54	1440.00	100.00	0.26

London Avenue Canal 7,980 cfs Canal Flow, Trapezoidal Cross Section

HEC-RAS Plan: 7980_Trpzd-28.5 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	15300	PF 1	4260.00	-21.10	-9.91	-16.73	-9.64	0.000200	4.17	1020.59	102.38	0.23
1	15250	PF 1	4260.00	-21.12	-9.92	-16.76	-9.65	0.000199	4.17	1021.85	102.41	0.23
1	15200	PF 1	4260.00	-21.14	-9.93	-16.77	-9.66	0.000198	4.16	1022.91	102.43	0.23
1	15191	PF 1	4260.00	-21.15	-9.92	-16.78	-9.66	0.000231	4.08	1045.10	122.95	0.25
1	15188		Bridge									
1	15185	PF 1	4260.00	-21.15	-10.03	-16.78	-9.77	0.000240	4.13	1031.12	122.40	0.25
1	15092	PF 1	4260.00	-21.20	-10.07	-16.84	-9.79	0.000203	4.20	1014.68	102.27	0.23
1	15079.5		Bridge									
1	15067	PF 1	4260.00	-21.21	-10.19	-16.84	-9.91	0.000210	4.25	1003.40	102.05	0.24
1	14975	PF 1	4260.00	-21.26	-10.21	-16.90	-9.93	0.000208	4.23	1006.60	102.11	0.24
1	14775	PF 1	4260.00	-21.36	-10.27	-17.00	-9.97	0.000226	4.40	968.60	93.09	0.24
1	14675	PF 1	4260.00	-21.43	-10.29	-17.06	-10.02	0.000203	4.20	1015.48	102.28	0.23
1	14475	PF 1	4260.00	-21.53	-10.33	-17.16	-10.06	0.000199	4.17	1021.84	102.41	0.23
1	14354	PF 1	4260.00	-21.76	-10.41	-17.40	-10.15	0.000191	4.11	1036.83	102.70	0.23
1	14294.5		Bridge									
1	14235	PF 1	4260.00	-21.82	-10.47	-17.45	-10.21	0.000191	4.11	1036.68	102.70	0.23
1	13875	PF 1	4260.00	-21.99	-10.54	-17.63	-10.28	0.000184	4.07	1046.51	101.52	0.22
1	13656	PF 1	4260.00	-22.24	-10.62	-17.87	-10.37	0.000176	4.00	1064.58	103.24	0.22
1	13375	PF 1	4260.00	-22.38	-10.67	-18.01	-10.42	0.000171	3.97	1074.33	103.43	0.22
1	12875	PF 1	4260.00	-22.63	-10.74	-18.26	-10.51	0.000163	3.90	1092.14	103.77	0.21
1	12375	PF 1	4260.00	-22.88	-10.82	-18.51	-10.59	0.000155	3.84	1110.42	104.12	0.21
1	11875	PF 1	4260.00	-23.12	-10.89	-18.75	-10.67	0.000148	3.78	1128.06	104.46	0.20
1	11375	PF 1	4260.00	-23.37	-10.96	-19.01	-10.74	0.000141	3.71	1147.19	104.83	0.20
1	10875	PF 1	4260.00	-23.62	-11.02	-19.25	-10.81	0.000134	3.65	1166.75	105.20	0.19
1	10575	PF 1	4260.00	-23.77	-11.06	-19.40	-10.85	0.000130	3.61	1178.60	105.42	0.19
1	10175	PF 1	4260.00	-23.97	-11.10	-19.60	-10.91	0.000125	3.57	1194.73	105.73	0.19
1	9675	PF 1	4260.00	-24.21	-11.16	-19.84	-10.97	0.000119	3.51	1214.16	106.10	0.18
1	9175	PF 1	4260.00	-24.46	-11.21	-20.09	-11.03	0.000113	3.45	1235.04	106.49	0.18
1	9009	PF 1	4260.00	-24.54	-11.23	-20.17	-11.05	0.000111	3.43	1241.68	106.61	0.18
1	8974		Bridge									
1	8939	PF 1	4260.00	-24.58	-11.26	-20.21	-11.08	0.000111	3.43	1242.68	106.63	0.18
1	8934	PF 1	4260.00	-24.58	-11.26	-20.21	-11.08	0.000111	3.43	1242.62	106.63	0.18
1	8771	PF 1	4260.00	-24.74	-11.30	-20.37	-11.12	0.000108	3.39	1256.05	106.88	0.17
1	8271	PF 1	4260.00	-24.99	-11.35	-20.61	-11.17	0.000102	3.33	1277.65	107.29	0.17
1	7771	PF 1	4260.00	-25.24	-11.39	-20.87	-11.23	0.000097	3.28	1299.59	107.70	0.17
1	7601	PF 1	4260.00	-25.32	-11.41	-20.96	-11.24	0.000096	3.26	1306.54	107.82	0.17
1	7582		Bridge									
1	7563	PF 1	4260.00	-25.34	-11.43	-20.97	-11.27	0.000096	3.26	1306.04	107.82	0.17
1	7433	PF 1	4260.00	-25.41	-11.44	-21.04	-11.28	0.000095	3.25	1312.34	107.93	0.16
1	7133	PF 1	4260.00	-25.56	-11.47	-21.19	-11.31	0.000092	3.21	1325.78	108.18	0.16
1	6733	PF 1	4260.00	-25.75	-11.50	-21.38	-11.35	0.000088	3.17	1342.76	108.49	0.16
1	6233	PF 1	4260.00	-26.00	-11.54	-21.63	-11.39	0.000084	3.12	1365.64	108.92	0.16
1	5938	PF 1	4260.00	-26.15	-11.56	-21.78	-11.42	0.000082	3.09	1379.57	109.17	0.15
1	5928.5		Bridge									
1	5919	PF 1	4260.00	-26.16	-11.58	-21.80	-11.43	0.000082	3.09	1379.10	109.16	0.15
1	5833	PF 1	4260.00	-26.20	-11.59	-21.83	-11.44	0.000081	3.08	1382.74	109.23	0.15
2	5733	PF 1	7980.00	-26.25	-12.05	-19.68	-11.50	0.000314	5.97	1337.78	108.40	0.30
2	5233	PF 1	7980.00	-26.50	-12.20	-19.93	-11.65	0.000306	5.92	1348.77	108.61	0.30
2	4733	PF 1	7980.00	-26.75	-12.34	-20.18	-11.81	0.000299	5.87	1360.19	108.82	0.29
2	4233	PF 1	7980.00	-26.99	-12.48	-20.42	-11.96	0.000292	5.82	1370.88	109.01	0.29
2	4150	PF 1	7980.00	-27.03	-12.51	-20.46	-11.98	0.000291	5.81	1372.66	109.04	0.29
2	4126	PF 1	7980.00	-27.05	-12.51	-20.48	-11.99	0.000290	5.81	1374.12	109.07	0.29
2	4108		Bridge									
2	4090	PF 1	7980.00	-27.06	-12.48	-21.35	-12.13	0.000186	4.78	1670.64	129.16	0.23
2	3533	PF 1	7980.00	-27.34	-12.58	-21.62	-12.23	0.000178	4.71	1694.40	129.53	0.23
2	3433	PF 1	7980.00	-27.39	-12.59	-21.68	-12.25	0.000177	4.70	1698.69	129.59	0.23
2	3397		Bridge									
2	3361	PF 1	7980.00	-27.42	-12.66	-21.71	-12.31	0.000178	4.71	1694.44	129.53	0.23
2	3233	PF 1	7980.00	-27.49	-12.68	-21.78	-12.34	0.000176	4.69	1700.74	129.63	0.23
2	2983	PF 1	7980.00	-27.61	-12.72	-21.89	-12.38	0.000173	4.66	1711.02	129.78	0.23
2	2863	PF 1	7980.00	-27.67	-12.74	-21.96	-12.40	0.000171	4.65	1716.32	129.87	0.23
2	2813	PF 1	7980.00	-27.69	-12.75	-21.98	-12.41	0.000171	4.65	1717.83	129.89	0.23
2	2713	PF 1	7980.00	-27.74	-12.76	-22.03	-12.43	0.000169	4.63	1722.23	129.96	0.22
2	2533	PF 1	7980.00	-27.83	-12.79	-22.12	-12.46	0.000167	4.61	1730.19	130.08	0.22
2	2268	PF 1	7980.00	-27.97	-12.83	-22.25	-12.51	0.000163	4.58	1743.16	130.28	0.22
2	2133	PF 1	7980.00	-28.03	-12.85	-22.32	-12.53	0.000162	4.56	1748.29	130.36	0.22
2	1973	PF 1	7980.00	-28.11	-12.87	-22.39	-12.55	0.000160	4.55	1755.61	130.47	0.22
2	1573	PF 1	7980.00	-28.31	-12.93	-22.59	-12.62	0.000155	4.50	1774.11	130.75	0.22
2	1293	PF 1	7980.00	-28.45	-12.97	-22.73	-12.66	0.000152	4.47	1787.23	130.95	0.21
2	1233	PF 1	7980.00	-28.48	-12.98	-22.76	-12.68	0.000192	4.36	1829.71	169.24	0.23
2	1193	PF 1	7980.00	-28.50	-13.00	-22.79	-12.69	0.000151	4.46	1790.25	131.00	0.21

London Avenue Canal 7,880 cfs Canal Flow, Rectangular Cross Section

HEC-RAS Plan: 7880_Rect_Tremie Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	15300	PF 1	3160.00	-19.60	-9.93	-16.46	-9.76	0.000119	3.27	967.25	100.00	0.19
1	15250	PF 1	3160.00	-19.62	-9.93	-16.48	-9.77	0.000118	3.26	968.80	100.00	0.18
1	15200	PF 1	3160.00	-19.64	-9.94	-16.49	-9.77	0.000118	3.26	970.23	100.00	0.18
1	15191	PF 1	3160.00	-19.64	-9.93	-16.50	-9.78	0.000136	3.19	991.61	121.67	0.20
1	15188		Bridge									
1	15185	PF 1	3160.00	-19.65	-10.00	-16.51	-9.84	0.000138	3.21	985.16	121.43	0.20
1	15092	PF 1	3160.00	-19.69	-10.02	-16.55	-9.85	0.000119	3.27	967.49	100.00	0.19
1	15079.5		Bridge									
1	15067	PF 1	3160.00	-19.70	-10.08	-16.56	-9.91	0.000121	3.28	962.29	100.00	0.19
1	14975	PF 1	3160.00	-19.74	-10.09	-16.60	-9.92	0.000120	3.27	965.22	100.00	0.19
1	14775	PF 1	3160.00	-19.82	-10.11	-16.68	-9.95	0.000117	3.25	970.99	100.00	0.18
1	14675	PF 1	3160.00	-19.89	-10.13	-16.74	-9.96	0.000115	3.24	976.25	100.00	0.18
1	14475	PF 1	3160.00	-19.98	-10.15	-16.84	-9.99	0.000113	3.21	983.13	100.00	0.18
1	14354	PF 1	3160.00	-20.17	-10.20	-17.03	-10.04	0.000108	3.17	997.39	100.00	0.18
1	14294.5		Bridge									
1	14235	PF 1	3160.00	-20.22	-10.23	-17.08	-10.07	0.000107	3.16	999.21	100.00	0.18
1	13875	PF 1	3160.00	-20.38	-10.26	-17.24	-10.11	0.000103	3.12	1011.61	100.00	0.17
1	13656	PF 1	3160.00	-20.59	-10.31	-17.45	-10.16	0.000098	3.07	1027.91	100.00	0.17
1	13375	PF 1	3160.00	-20.71	-10.34	-17.57	-10.19	0.000096	3.05	1037.37	100.00	0.17
1	12875	PF 1	3160.00	-20.93	-10.38	-17.78	-10.24	0.000091	3.00	1055.05	100.00	0.16
1	12375	PF 1	3160.00	-21.14	-10.42	-18.00	-10.29	0.000086	2.95	1071.93	100.00	0.16
1	11875	PF 1	3160.00	-21.36	-10.46	-18.22	-10.33	0.000082	2.90	1090.04	100.00	0.15
1	11375	PF 1	3160.00	-21.57	-10.50	-18.43	-10.37	0.000078	2.85	1107.33	100.00	0.15
1	10875	PF 1	3160.00	-21.79	-10.53	-18.64	-10.41	0.000074	2.81	1125.81	100.00	0.15
1	10575	PF 1	3160.00	-21.92	-10.55	-18.77	-10.43	0.000072	2.78	1136.74	100.00	0.15
1	10175	PF 1	3160.00	-22.09	-10.58	-18.94	-10.46	0.000069	2.75	1151.12	100.00	0.14
1	9675	PF 1	3160.00	-22.30	-10.61	-19.16	-10.50	0.000066	2.70	1168.99	100.00	0.14
1	9175	PF 1	3160.00	-22.52	-10.64	-19.37	-10.53	0.000063	2.66	1188.02	100.00	0.14
1	9009	PF 1	3160.00	-22.59	-10.65	-19.45	-10.54	0.000062	2.65	1194.04	100.00	0.13
1	8974		Bridge									
1	8939	PF 1	3160.00	-22.62	-10.67	-19.48	-10.56	0.000062	2.64	1195.34	100.00	0.13
1	8934	PF 1	3160.00	-22.62	-10.67	-19.48	-10.56	0.000062	2.64	1195.31	100.00	0.13
1	8771	PF 1	3160.00	-22.77	-10.69	-19.63	-10.58	0.000060	2.61	1208.42	100.00	0.13
1	8271	PF 1	3160.00	-22.98	-10.71	-19.83	-10.61	0.000057	2.58	1226.73	100.00	0.13
1	7771	PF 1	3160.00	-23.20	-10.74	-20.06	-10.64	0.000054	2.54	1246.18	100.00	0.13
1	7601	PF 1	3160.00	-23.27	-10.75	-20.13	-10.65	0.000053	2.52	1252.31	100.00	0.13
1	7582		Bridge									
1	7563	PF 1	3160.00	-23.29	-10.76	-20.15	-10.66	0.000053	2.52	1252.72	100.00	0.13
1	7433	PF 1	3160.00	-23.34	-10.77	-20.20	-10.67	0.000053	2.51	1257.06	100.00	0.12
1	7133	PF 1	3160.00	-23.47	-10.78	-20.33	-10.69	0.000051	2.49	1268.63	100.00	0.12
1	6733	PF 1	3160.00	-23.64	-10.80	-20.50	-10.71	0.000050	2.46	1283.77	100.00	0.12
1	6233	PF 1	3160.00	-23.86	-10.82	-20.72	-10.73	0.000047	2.42	1303.55	100.00	0.12
1	5938	PF 1	3160.00	-23.98	-10.84	-20.84	-10.75	0.000046	2.40	1314.27	100.00	0.12
1	5928.5		Bridge									
1	5919	PF 1	3160.00	-23.99	-10.85	-20.85	-10.76	0.000046	2.40	1314.50	100.00	0.12
1	5833	PF 1	3160.00	-24.03	-10.85	-20.89	-10.76	0.000046	2.40	1318.13	100.00	0.12
2	5733	PF 1	7880.00	-24.10	-11.43	-18.32	-10.83	0.000320	6.22	1267.44	100.00	0.31
2	5233	PF 1	7880.00	-24.32	-11.58	-18.55	-10.99	0.000315	6.19	1273.98	100.00	0.31
2	4733	PF 1	7880.00	-24.54	-11.73	-18.76	-11.14	0.000310	6.15	1280.79	100.00	0.30
2	4233	PF 1	7880.00	-24.76	-11.88	-18.99	-11.30	0.000305	6.12	1287.86	100.00	0.30
2	4150	PF 1	7880.00	-24.80	-11.91	-19.02	-11.33	0.000304	6.11	1289.39	100.00	0.30
2	4126	PF 1	7880.00	-24.81	-11.91	-19.03	-11.33	0.000304	6.11	1289.66	100.00	0.30
2	4108		Bridge									
2	4090	PF 1	7880.00	-24.82	-11.99	-19.04	-11.40	0.000308	6.14	1283.12	100.00	0.30
2	3533	PF 1	7880.00	-25.07	-12.16	-19.30	-11.58	0.000302	6.10	1291.49	100.00	0.30
2	3433	PF 1	7880.00	-25.11	-12.19	-19.33	-11.61	0.000302	6.10	1292.50	100.00	0.30
2	3397		Bridge									
2	3361	PF 1	7880.00	-25.14	-12.31	-19.36	-11.72	0.000309	6.14	1283.03	100.00	0.30
2	3233	PF 1	7880.00	-25.20	-12.35	-19.42	-11.76	0.000307	6.13	1285.16	100.00	0.30
2	2983	PF 1	7880.00	-25.31	-12.42	-19.53	-11.84	0.000304	6.11	1288.74	100.00	0.30
2	2863	PF 1	7880.00	-25.36	-12.46	-19.59	-11.88	0.000303	6.11	1290.16	100.00	0.30
2	2813	PF 1	7880.00	-25.39	-12.47	-19.61	-11.90	0.000302	6.10	1291.69	100.00	0.30
2	2713	PF 1	7880.00	-25.43	-12.50	-19.65	-11.93	0.000302	6.10	1292.68	100.00	0.30
2	2533	PF 1	7880.00	-25.51	-12.56	-19.74	-11.98	0.000300	6.08	1295.35	100.00	0.30
2	2268	PF 1	7880.00	-25.63	-12.63	-19.86	-12.06	0.000297	6.06	1299.72	100.00	0.30
2	2133	PF 1	7880.00	-25.69	-12.67	-19.91	-12.10	0.000295	6.05	1301.82	100.00	0.30
2	1973	PF 1	7880.00	-25.76	-12.72	-19.99	-12.15	0.000293	6.04	1304.22	100.00	0.29
2	1573	PF 1	7880.00	-25.93	-12.83	-20.15	-12.27	0.000290	6.02	1309.90	100.00	0.29
2	1293	PF 1	7880.00	-26.06	-12.91	-20.29	-12.35	0.000286	5.99	1315.16	100.00	0.29
2	1233	PF 1	7880.00	-26.08	-12.90	-20.30	-12.40	0.000414	5.63	1398.58	169.98	0.35
2	1193	PF 1	7880.00	-26.10	-13.00	-20.32	-12.44	0.000289	6.02	1310.00	100.00	0.29

London Avenue Canal 7,880 cfs Canal Flow, Trapezoidal Cross Section

HEC-RAS Plan: 7880_Trpzd-27.1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	15300	PF 1	3160.00	-20.00	-9.98	-16.41	-9.79	0.000159	3.50	901.95	100.04	0.21
1	15250	PF 1	3160.00	-20.02	-9.99	-16.43	-9.80	0.000159	3.50	903.35	100.07	0.21
1	15200	PF 1	3160.00	-20.04	-9.99	-16.45	-9.80	0.000158	3.49	904.58	100.09	0.20
1	15191	PF 1	3160.00	-20.05	-9.99	-16.46	-9.81	0.000185	3.41	926.26	121.51	0.22
1	15188		Bridge									
1	15185	PF 1	3160.00	-20.05	-10.07	-16.46	-9.88	0.000191	3.45	916.80	121.13	0.22
1	15092	PF 1	3160.00	-20.10	-10.09	-16.51	-9.90	0.000160	3.51	900.70	100.01	0.21
1	15079.5		Bridge									
1	15067	PF 1	3160.00	-20.11	-10.18	-16.52	-9.98	0.000164	3.54	893.41	99.87	0.21
1	14975	PF 1	3160.00	-20.16	-10.19	-16.57	-10.00	0.000162	3.52	896.98	99.94	0.21
1	14775	PF 1	3160.00	-20.26	-10.24	-16.68	-10.03	0.000172	3.63	870.12	92.02	0.21
1	14675	PF 1	3160.00	-20.33	-10.25	-16.74	-10.06	0.000156	3.48	907.86	100.16	0.20
1	14475	PF 1	3160.00	-20.43	-10.28	-16.84	-10.10	0.000153	3.45	914.99	100.30	0.20
1	14354	PF 1	3160.00	-20.66	-10.34	-17.07	-10.17	0.000145	3.39	931.71	100.63	0.20
1	14294.5		Bridge									
1	14235	PF 1	3160.00	-20.72	-10.39	-17.13	-10.21	0.000144	3.39	933.34	100.66	0.20
1	13875	PF 1	3160.00	-20.89	-10.44	-17.30	-10.26	0.000138	3.34	945.51	100.52	0.19
1	13656	PF 1	3160.00	-21.14	-10.50	-17.55	-10.33	0.000130	3.28	964.56	101.28	0.19
1	13375	PF 1	3160.00	-21.28	-10.53	-17.69	-10.37	0.000126	3.24	975.37	101.50	0.18
1	12875	PF 1	3160.00	-21.53	-10.59	-17.94	-10.43	0.000119	3.18	995.03	101.88	0.18
1	12375	PF 1	3160.00	-21.78	-10.64	-18.19	-10.49	0.000112	3.11	1015.11	102.28	0.17
1	11875	PF 1	3160.00	-22.02	-10.69	-18.43	-10.55	0.000106	3.05	1034.54	102.66	0.17
1	11375	PF 1	3160.00	-22.27	-10.74	-18.68	-10.60	0.000099	2.99	1055.40	103.06	0.16
1	10875	PF 1	3160.00	-22.52	-10.78	-18.93	-10.65	0.000094	2.94	1076.62	103.47	0.16
1	10575	PF 1	3160.00	-22.67	-10.81	-19.08	-10.68	0.000090	2.90	1089.46	103.72	0.16
1	10175	PF 1	3160.00	-22.87	-10.84	-19.28	-10.72	0.000086	2.85	1106.87	104.06	0.15
1	9675	PF 1	3160.00	-23.11	-10.88	-19.52	-10.76	0.000082	2.80	1127.86	104.46	0.15
1	9175	PF 1	3160.00	-23.36	-10.92	-19.77	-10.80	0.000077	2.75	1150.22	104.89	0.15
1	9009	PF 1	3160.00	-23.44	-10.93	-19.85	-10.81	0.000076	2.73	1157.37	105.02	0.14
1	8974		Bridge									
1	8939	PF 1	3160.00	-23.48	-10.95	-19.89	-10.83	0.000075	2.73	1159.55	105.06	0.14
1	8934	PF 1	3160.00	-23.48	-10.95	-19.89	-10.83	0.000075	2.73	1159.51	105.06	0.14
1	8771	PF 1	3160.00	-23.64	-10.97	-20.05	-10.86	0.000072	2.69	1173.93	105.34	0.14
1	8271	PF 1	3160.00	-23.89	-11.00	-20.30	-10.90	0.000068	2.64	1196.92	105.77	0.14
1	7771	PF 1	3160.00	-24.14	-11.03	-20.55	-10.93	0.000065	2.59	1220.20	106.21	0.13
1	7601	PF 1	3160.00	-24.22	-11.04	-20.63	-10.94	0.000063	2.57	1227.62	106.35	0.13
1	7582		Bridge									
1	7563	PF 1	3160.00	-24.24	-11.06	-20.65	-10.96	0.000063	2.57	1228.13	106.36	0.13
1	7433	PF 1	3160.00	-24.31	-11.07	-20.71	-10.97	0.000062	2.56	1234.77	106.49	0.13
1	7133	PF 1	3160.00	-24.46	-11.08	-20.87	-10.98	0.000060	2.53	1248.97	106.75	0.13
1	6733	PF 1	3160.00	-24.65	-11.11	-21.06	-11.01	0.000058	2.49	1266.97	107.09	0.13
1	6233	PF 1	3160.00	-24.90	-11.13	-21.31	-11.04	0.000055	2.45	1291.05	107.54	0.12
1	5938	PF 1	3160.00	-25.05	-11.15	-21.46	-11.05	0.000053	2.42	1305.65	107.81	0.12
1	5928.5		Bridge									
1	5919	PF 1	3160.00	-25.06	-11.15	-21.47	-11.06	0.000053	2.42	1305.80	107.81	0.12
1	5833	PF 1	3160.00	-25.10	-11.16	-21.51	-11.07	0.000052	2.41	1309.66	107.88	0.12
2	5733	PF 1	7880.00	-25.10	-11.76	-18.58	-11.14	0.000378	6.33	1245.08	106.68	0.33
2	5233	PF 1	7880.00	-25.32	-11.95	-18.80	-11.33	0.000375	6.31	1248.73	106.75	0.33
2	4733	PF 1	7880.00	-25.54	-12.13	-19.02	-11.52	0.000372	6.29	1252.58	106.82	0.32
2	4233	PF 1	7880.00	-25.76	-12.31	-19.24	-11.70	0.000368	6.27	1256.63	106.89	0.32
2	4150	PF 1	7880.00	-25.80	-12.34	-19.28	-11.73	0.000367	6.27	1257.65	106.91	0.32
2	4126	PF 1	7880.00	-25.81	-12.35	-19.29	-11.74	0.000367	6.27	1257.75	106.92	0.32
2	4108		Bridge									
2	4090	PF 1	7880.00	-25.82	-12.31	-20.16	-11.90	0.000234	5.14	1533.30	127.02	0.26
2	3533	PF 1	7880.00	-26.07	-12.44	-20.41	-12.03	0.000227	5.09	1549.31	127.27	0.26
2	3433	PF 1	7880.00	-26.11	-12.46	-20.44	-12.06	0.000226	5.08	1551.58	127.30	0.26
2	3397		Bridge									
2	3361	PF 1	7880.00	-26.14	-12.54	-20.47	-12.13	0.000228	5.10	1545.54	127.21	0.26
2	3233	PF 1	7880.00	-26.20	-12.56	-20.53	-12.16	0.000227	5.09	1549.57	127.27	0.26
2	2983	PF 1	7880.00	-26.31	-12.62	-20.64	-12.22	0.000224	5.06	1556.73	127.39	0.26
2	2863	PF 1	7880.00	-26.36	-12.64	-20.70	-12.25	0.000222	5.05	1559.79	127.43	0.25
2	2813	PF 1	7880.00	-26.39	-12.65	-20.72	-12.26	0.000221	5.04	1562.26	127.47	0.25
2	2713	PF 1	7880.00	-26.43	-12.68	-20.76	-12.28	0.000220	5.04	1564.60	127.51	0.25
2	2533	PF 1	7880.00	-26.51	-12.71	-20.84	-12.32	0.000218	5.02	1569.94	127.59	0.25
2	2268	PF 1	7880.00	-26.63	-12.77	-20.96	-12.38	0.000215	4.99	1578.32	127.72	0.25
2	2133	PF 1	7880.00	-26.69	-12.80	-21.03	-12.41	0.000213	4.98	1582.48	127.79	0.25
2	1973	PF 1	7880.00	-26.76	-12.83	-21.10	-12.45	0.000211	4.96	1587.30	127.86	0.25
2	1573	PF 1	7880.00	-26.93	-12.91	-21.26	-12.53	0.000206	4.93	1598.87	128.04	0.25
2	1293	PF 1	7880.00	-27.06	-12.96	-21.40	-12.59	0.000203	4.90	1608.60	128.20	0.24
2	1233	PF 1	7880.00	-27.08	-12.97	-21.41	-12.61	0.000260	4.77	1653.45	169.31	0.27
2	1193	PF 1	7880.00	-27.10	-13.00	-21.43	-12.63	0.000203	4.90	1608.81	128.20	0.24

C.6. Hydraulic Analysis References

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Geotech

Final Report
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Uplift Pile Analysis
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D.3.3 London Canal
Soldier Pile Analyses
DSM Stability Analysis
Uplift Pile Analysis
Uplift Calculations

D.1 Pump Station

D.1.1 Stability Calculations

17th St. Canal Pump Station (Option 2):

Structure Geometry:

Effective Width of the Structure (from Mechanical Calcs): $B_{eff} := 80ft$

Variables:

Elevation of Channel Invert: $EL_{invert} := -27ft$

Bottom of Pump Structure: $EL_{c\_bot} := -39ft$

Elevation of water in the channel: $EL_{wps} := -13ft$

Water Level in Lake Ponchatrain: $EL_{we} := 12ft$

Unit Weight of Water: $\gamma_w := 62.4pcf$

Unit Weight of Concrete: $\gamma_{concrete} := 145pcf$

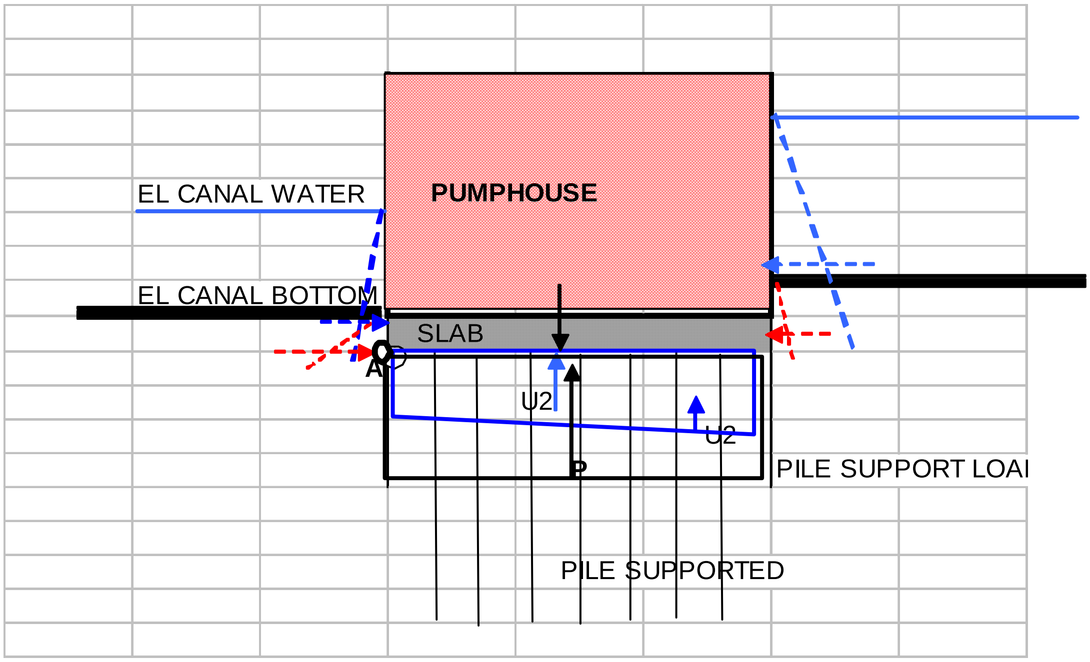
Vertical Geometry:

Check the stability of the structure at the potential failure plane along the bottom of the structure.

Failure Plane: $\phi_{soil} := 30deg$

$EL_f := EL_{c\_bot}$ $\phi_{fail} := \phi_{soil}$ Plane := "Bottom of Cell"

$EL_f = -39\,ft$



Case 1

Determine the thickness of the base slab to resist uplift using only the dead weight of the slab. Solve by iterating the bottom of the slab elevation until FS=1.2

w_{str1} - is the lower bound value of the weight of the structure used for uplift: $w_{str1} := 500psf$

weight of the water in the canal: $w_{canal} := (EL_{wps} - EL_{invert}) \cdot \gamma_w$

weight of the structure below grade: $w_{slab} := (EL_{invert} - EL_{c\_bot}) \cdot \gamma_{concrete}$

uplift pressure from the lake: $Lake := \gamma_w \cdot ((EL_{we} - EL_{c\_bot}))$

uplift pressure from the canal: $Canal := \gamma_w \cdot (EL_{wps} - EL_{c\_bot})$

Average Uplift: $Uplift_{avg} := \frac{Lake + Canal}{2}$

Gravity Load: $w_{gravity} := w_{str1} + w_{canal} + w_{slab}$

$$FS := \frac{w_{gravity}}{Uplift_{avg}}$$

$FS = 1.3$

Lateral Loads:

Force of water:

$$F_{w1} := \frac{1}{2}\gamma_w \cdot (EL_{we} - EL_f)^2 \qquad F_{w1} = 81.15\,\frac{kip}{ft}$$

Force of the water from Lake Ponchatrain

$$F_{w2} := \frac{1}{2}\gamma_w \cdot (EL_{wps} - EL_f)^2 \qquad F_{w2} = 21.09\,\frac{kip}{ft}$$

Force of the water from the canal

Moment Arm:

$$l_{w1} := \left[\frac{1}{3}\cdot(EL_{we} - EL_f)\right] \qquad l_{w1} = 17\,\text{length}$$

$$l_{w2} := \left[\frac{1}{3}\cdot(EL_{wps} - EL_f)\right] \qquad l_{w2} = 8.67\,\text{length}$$

Depth of slab of the pump structure:

$$H := EL_{invert} - EL_f \qquad H = 12\,ft$$

Active Pressure:

$$K_a := \frac{(1 - \sin(\phi_{soil}))}{(1 + \sin(\phi_{soil}))} \qquad P_a := 0.5\cdot\gamma_{soil\_b}\cdot K_a\cdot H^2 \qquad P_a = 1.92\,\frac{kip}{ft}$$

Moment Arm:

$$l_a := \left[\frac{1}{3}\cdot(EL_{invert} - EL_{c\_bot})\right]$$

$$K_a = 0.33$$

$$l_a = 4\,ft$$

Passive Pressure:

In EM 1110-2-2502, the passive pressure phi angle is reduced and it is appropriate to perform the same operation here.

$$FS := 1.5$$

$$\phi_{soil\_p} := \operatorname{atan}\left(\frac{\tan(\phi_{soil})}{FS}\right) \qquad \phi_{soil\_p} = 21.05\,deg$$

$$K_p := \frac{(1 + \sin(\phi_{soil\_p}))}{(1 - \sin(\phi_{soil\_p}))} \qquad P_p := 0.5\cdot\gamma_{soil\_b}\cdot K_p\cdot H^2 \qquad P_p = 12.22\,\frac{kip}{ft}$$

$$K_p = 2.12$$

Moment arm:

$$l_p := \left[\frac{1}{3}\cdot(EL_{invert} - EL_{c\_bot})\right]$$

Vertical Loads:

Load from the structure(upper bound value for designing foundations) : $w_{str2} := 500psf$

Weight of the Structure: $W_{str} := B_{eff} \cdot w_{str2}$

$W_{str} = 40 \frac{kip}{ft}$

Moment Arm: $l_{str} := \frac{B_{eff}}{2}$ $l_{str} = 40\,ft$

Total Uplift Pressure: $Area_1 := B_{eff} \cdot (\gamma_w) \cdot (EL_{wps} - EL_{c\_bot})$

$l_{area1} := \frac{B_{eff}}{2}$

$Area_2 := 0.5B_{eff} \cdot \gamma_w \cdot (EL_{we} - EL_{c\_bot})$

$l_{area2} := \frac{2}{3} B_{eff}$ $l_{area2} = 53.33\,length$

Weight of the Slab: $W_{slab} := B_{eff} \cdot \gamma_{concrete} \cdot (EL_{invert} - EL_{c\_bot})$

$W_{slab} = 139.2 \frac{kip}{ft}$

Moment Arm: $l_{slab} := \frac{B_{eff}}{2}$

Calculate Total Moments and Forces:

Moments are calculated about the point of rotation (the toe of the structure).

Resisting Moment: $M_{resist} := P_p \cdot l_p + F_{w2} \cdot l_{w2} + W_{str} \cdot l_{str} + W_{slab} \cdot l_{slab}$

Overturning Moment $M_{over} := F_{w1} \cdot l_{w1} + P_a \cdot l_a + Area_1 \cdot l_{area1} + Area_2 \cdot l_{area2}$

Net Moment: $M_{net} := (M_{resist}) - M_{over}$

$M_{resist} = 7399.7\,kip$ $M_{over} = 1.3 \times 10^4\,kip$ $M_{net} = -5968\,kip$

Since Mnet is negative, uplift resistance is necessary either through pile resistance or some other method.

Re- Calculate Total Moments and Forces with Required Tension:

Tension Required: $T_{rqd} := 145 \frac{kip}{ft}$

Moment Arm of Tension: $l_{rqd} := \frac{2}{3} \cdot B_{eff}$

Resisting Moment: $M_{resist} := P_p \cdot l_p + F_{w2} \cdot l_{w2} + W_{str} \cdot l_{str} + W_{slab} \cdot l_{slab} + T_{rqd} \cdot l_{rqd}$

Overturning Moment $M_{over} := F_{w1} \cdot l_{w1} + P_a \cdot l_a + Area_1 \cdot l_{area1} + Area_2 \cdot l_{area2}$

Net Moment: $M_{net} := (M_{resist}) - M_{over}$

$M_{resist} = 15133\, kip$ $M_{over} = 1.3 \times 10^4\, kip$ $M_{net} = 1765\, kip$

Total Gross Weight/Vertical Forces: $F_{vert} := W_{str} - Area_1 - Area_2 + W_{slab} + T_{rqd}$

$F_{vert} = 67.1 \frac{kip}{ft}$

Resultant Location:

$x_{r1} := \frac{M_{net}}{F_{vert}}$ $x_{r1} = 26.3\, ft$

$\%_{comp1} := \min\left(3 \cdot \frac{x_{r1}}{B_{eff}}, 1\right)$ $\%_{comp1} = 98.62\,\%$

Per criteria resultant must be within middle third which is equivalent to 100% of base in compression, overturning is OK

$\%_{comp\_norm} := 100\%$

$Check_{overturn\_norm} := if(\%_{comp1} \geq \%_{comp\_norm}, "OK", "No Good")$

$Check_{overturn\_norm} = "No Good"$ Plane = "Bottom of Cell"

Forces:

Total Driving Force: $F_{drive} := F_{w1} + P_a$ $F_{drive} = 83.1 \frac{kip}{ft}$

Total Horizontal Force: $F_{resist} := P_p + F_{w2}$ $F_{resist} = 33.3 \frac{kip}{ft}$

External Stability Check - Load Case 1

Sliding Factor of Safety Criteria: $FOS_{slide\_norm} := 1.5$

Shear Strength required: $S_{required} := 54 \frac{kip}{ft}$

$$V_{all} := F_{vert} \cdot \tan(\phi_{fail}) + S_{required}$$

$$FOS_{slide} := \frac{(V_{all} + F_{resist})}{F_{drive}}$$

$FOS_{slide} = 1.52$

$$Check_{slide\_norm} := \text{if}(FOS_{slide} \geq FOS_{slide\_norm}, \text{"OK"}, \text{"No Good"})$$

$Check_{slide\_norm} = \text{"OK"}$ $\quad$ $Plane = \text{"Bottom of Cell"}$

Bearing Capacity Check:

Eccentricity $\quad e_1 := \frac{B_{eff}}{2} - x_{r1}$ $\quad e_1 = 13.7\, ft$

Maximum Foundation Pressure:

$$q_{bearing} := \text{if}\left[\%_{comp1} < 1.0, \left[4 \cdot \frac{F_{vert}}{3 \cdot [(B_{eff}) - 2 \cdot e_1]}\right], \frac{F_{vert}}{B_{eff}} \cdot \left(1 + 6 \cdot \frac{e_1}{B_{eff}}\right)\right]$$

$q_{bearing} = 1.7 \frac{kip}{ft^2}$

$$q_{bearing} := \text{if}(\%_{comp1} \leq 0.0, 0 \cdot ksf, q_{bearing})$$

$$q_{min} := \text{if}\left[\%_{comp1} < 1.0, 0 \cdot ksf, \frac{F_{vert}}{B_{eff}} \cdot \left(1 - 6 \cdot \frac{e_1}{B_{eff}}\right)\right]$$

$q_{min} = 0\, ksf$

London Canal Pump Station (Option 2):

Structure Geometry:

Effective Width of the Structure (from Mechanical Calcs): $B_{eff} := 80ft$

Variables:

Elevation of Channel Invert: $EL_{invert} := -27ft$

Bottom of Pump Structure: $EL_{c\_bot} := -38ft$

Elevation of water in the channel: $EL_{wps} := -13ft$

Water Level in Lake Ponchatrain: $EL_{we} := 12ft$

Unit Weight of Water: $\gamma_w := 62.4pcf$

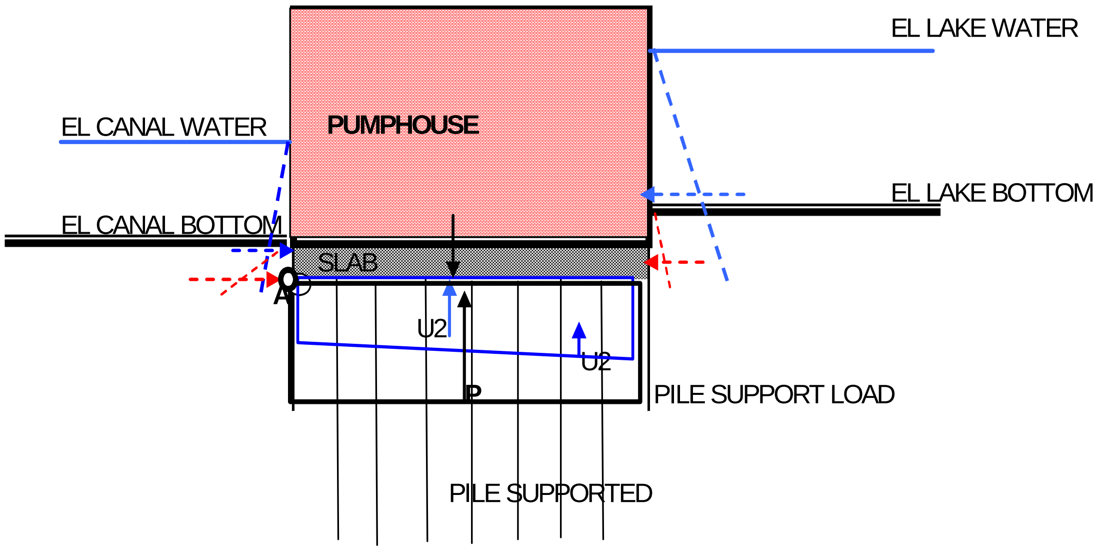
Unit Weight of Concrete: $\gamma_{concrete} := 145pcf$

Vertical Geometry:

Check the stability of the structure at the potential failure plane along the bottom of the structure.

Failure Plane: $\phi_{soil} := 30deg$

$EL_f := EL_{c\_bot}$ $\phi_{fail} := \phi_{soil}$ Plane := "Bottom of Cell"



Case 1

Determine the thickness of the base slab to resist uplift using only the dead weight of the slab. Solve by iterating the bottom of the slab elevation until FS=1.3

w_{str1} - is the lower bound value of the weight of the structure used for uplift: $w_{str1} := 500psf$

weight of the water in the canal: $w_{canal} := (EL_{wps} - EL_{invert})\cdot\gamma_w$

weight of the structure below grade: $w_{slab} := (EL_{invert} - EL_{c\_bot})\cdot\gamma_{concrete}$

uplift pressure from the lake: $Lake := \gamma_w\cdot((EL_{we} - EL_{c\_bot}))$

uplift pressure from the canal: $Canal := \gamma_w\cdot(EL_{wps} - EL_{c\_bot})$

Average Uplift: $Uplift_{avg} := \frac{Lake + Canal}{2}$

Gravity Load: $w_{gravity} := w_{str1} + w_{canal} + w_{slab}$

$$FS := \frac{w_{gravity}}{Uplift_{avg}}$$

$FS = 1.3$

Lateral Loads:

Force of water:

$F_{w1} := \frac{1}{2}\gamma_w \cdot (EL_{we} - EL_f)^2$ $\quad F_{w1} = 78\frac{kip}{ft}$ Force of the water from Lake Ponchatrain

$F_{w2} := \frac{1}{2}\gamma_w \cdot (EL_{wps} - EL_f)^2$ $\quad F_{w2} = 19.5\frac{kip}{ft}$ Force of the water from the canal

Moment Arm: $l_{w1} := \left[\frac{1}{3}\cdot(EL_{we} - EL_f)\right]$

$l_{w2} := \left[\frac{1}{3}\cdot(EL_{wps} - EL_f)\right]$

Depth of slab of the pump structure:

$H := EL_{invert} - EL_f$

Active Pressure:

$K_a := \frac{(1 - \sin(\phi_{soil}))}{(1 + \sin(\phi_{soil}))}$ $\quad P_a := 0.5\cdot\gamma_{soil\_b}\cdot K_a\cdot H^2$ $\quad P_a = 1.61\frac{kip}{ft}$

Moment Arm: $l_a := \left[\frac{1}{3}\cdot(EL_{invert} - EL_{c\_bot})\right]$

Passive Pressure:

In EM 1110-2-2502, the passive pressure phi angle is reduced and it is appropriate to perform the same operation here.

$FS := 1.5$

$\phi_{soil\_p} := atan\left(\frac{\tan(\phi_{soil})}{FS}\right)$ $\quad \phi_{soil\_p} = 21.05\,deg$

$K_p := \frac{(1 + \sin(\phi_{soil\_p}))}{(1 - \sin(\phi_{soil\_p}))}$ $\quad P_p := 0.5\cdot\gamma_{soil\_b}\cdot K_p\cdot H^2$ $\quad P_p = 10.27\frac{kip}{ft}$

Moment arm: $l_p := \left[\frac{1}{3}\cdot(EL_{invert} - EL_{c\_bot})\right]$

Vertical Loads:

Load from the structure(upper bound value for designing foundations) : $w_{str2} := 500psf$

Weight of the Structure: $W_{str} := B_{eff} \cdot w_{str2}$

$W_{str} = 40\,\frac{kip}{ft}$

Moment Arm: $l_{str} := \frac{B_{eff}}{2}$

Total Uplift Pressure: $Area_1 := B_{eff} \cdot (\gamma_w) \cdot (EL_{wps} - EL_{c\_bot})$

$l_{area1} := \frac{B_{eff}}{2}$

$Area_2 := 0.5 B_{eff} \cdot \gamma_w \cdot (EL_{we} - EL_{c\_bot})$

$l_{area2} := \frac{2}{3} B_{eff}$

Weight of the Slab: $W_{slab} := B_{eff} \cdot \gamma_{concrete} \cdot (EL_{invert} - EL_{c\_bot})$

$W_{slab} = 127.6\,\frac{kip}{ft}$

Moment Arm: $l_{slab} := \frac{B_{eff}}{2}$

Calculate Total Moments and Forces:

Moments are calculated about the point of rotation (the toe of the structure).

Resisting Moment: $M_{resist} := P_p \cdot l_p + F_{w2} \cdot l_{w2} + W_{str} \cdot l_{str} + W_{slab} \cdot l_{slab}$

Overturning Moment $M_{over} := F_{w1} \cdot l_{w1} + P_a \cdot l_a + Area_1 \cdot l_{area1} + Area_2 \cdot l_{area2}$

Net Moment: $M_{net} := (M_{resist}) - M_{over}$

$M_{resist} = 6904.1\,kip$ $M_{over} = 1.3 \times 10^4\,kip$ $M_{net} = -6050\,kip$

Since Mnet is negative, uplift resistance is necessary either through pile resistance or some other method.

Re- Calculate Total Moments and Forces with Required Tension:

Tension Required: $T_{rqd} := 145 \frac{kip}{ft}$

Moment Arm of Tension: $l_{rqd} := \frac{2}{3} \cdot B_{eff}$

Resisting Moment: $M_{resist} := P_p \cdot l_p + F_{w2} \cdot l_{w2} + W_{str} \cdot l_{str} + W_{slab} \cdot l_{slab} + T_{rqd} \cdot l_{rqd}$

Overturning Moment $M_{over} := F_{w1} \cdot l_{w1} + P_a \cdot l_a + Area_1 \cdot l_{area1} + Area_2 \cdot l_{area2}$

Net Moment: $M_{net} := (M_{resist}) - M_{over}$

$M_{resist} = 14637.5\,kip$ $M_{over} = 1.3 \times 10^4\,kip$ $M_{net} = 1684\,kip$

Total Gross Weight/Vertical Forces: $F_{vert} := W_{str} - Area_1 - Area_2 + W_{slab} + T_{rqd}$

$F_{vert} = 63 \frac{kip}{ft}$

Resultant Location:

$x_{r1} := \frac{M_{net}}{F_{vert}}$ $x_{r1} = 26.72\,ft$

$\%_{comp1} := \min\left(3 \cdot \frac{x_{r1}}{B_{eff}}, 1\right)$ $\%_{comp1} = 100\,\%$

Per criteria resultant must be within middle third which is equivalent to 100% of base in compression, overturning is OK

$\%_{comp\_norm} := 100\%$

$Check_{overturn\_norm} := \text{if}\left(\%_{comp1} \geq \%_{comp\_norm}, \text{"OK"}, \text{"No Good"}\right)$

$Check_{overturn\_norm} = \text{"OK"}$ $Plane = \text{"Bottom of Cell"}$

Forces:

Total Driving Force: $F_{drive} := F_{w1} + P_a$ $F_{drive} = 79.6 \frac{kip}{ft}$

Total Horizontal Force: $F_{resist} := P_p + F_{w2}$ $F_{resist} = 29.8 \frac{kip}{ft}$

External Stability Check - Load Case 1

Sliding Factor of Safety Criteria: $FOS_{slide\_norm} := 1.5$

Shear Strength required: $S_{required} := 54 \frac{kip}{ft}$

$$V_{all} := F_{vert} \cdot \tan(\phi_{fail}) + S_{required}$$

$$FOS_{slide} := \frac{(V_{all} + F_{resist})}{F_{drive}}$$

$FOS_{slide} = 1.51$

$$Check_{slide\_norm} := if(FOS_{slide} \geq FOS_{slide\_norm}, \text{"OK"}, \text{"No Good"})$$

$Check_{slide\_norm} = \text{"OK"}$ $Plane = \text{"Bottom of Cell"}$

Bearing Capacity Check:

Eccentricity $e_1 := \frac{B_{eff}}{2} - x_{r1}$ $e_1 = 13.28\ ft$

Maximum Foundation Pressure:

$$q_{bearing} := if\left[\%_{comp1} < 1.0, \left[4 \cdot \frac{F_{vert}}{3 \cdot [(B_{eff}) - 2 \cdot e_1]}\right], \frac{F_{vert}}{B_{eff}} \cdot \left(1 + 6 \cdot \frac{e_1}{B_{eff}}\right)\right]$$

$q_{bearing} = 1.57 \frac{kip}{ft^2}$

$$q_{bearing} := if(\%_{comp1} \leq 0.0, 0 \cdot ksf, q_{bearing})$$

$$q_{min} := if\left[\%_{comp1} < 1.0, 0 \cdot ksf, \frac{F_{vert}}{B_{eff}} \cdot \left(1 - 6 \cdot \frac{e_1}{B_{eff}}\right)\right]$$

$q_{min} = 3.34 \times 10^{-3}\ ksf$

Orleans Canal Pump Station (Option 2):

Structure Geometry:

Effective Width of the Structure (from Mechanical Calcs): $B_{eff} := 70ft$

Variables:

Elevation of Channel Invert: $EL_{invert} := -27ft$

Bottom of Pump Structure: $EL_{c\_bot} := -38ft$

Elevation of water in the channel: $EL_{wps} := -13ft$

Water Level in Lake Ponchatrain: $EL_{we} := 12ft$

Unit Weight of Water: $\gamma_w := 62.4pcf$

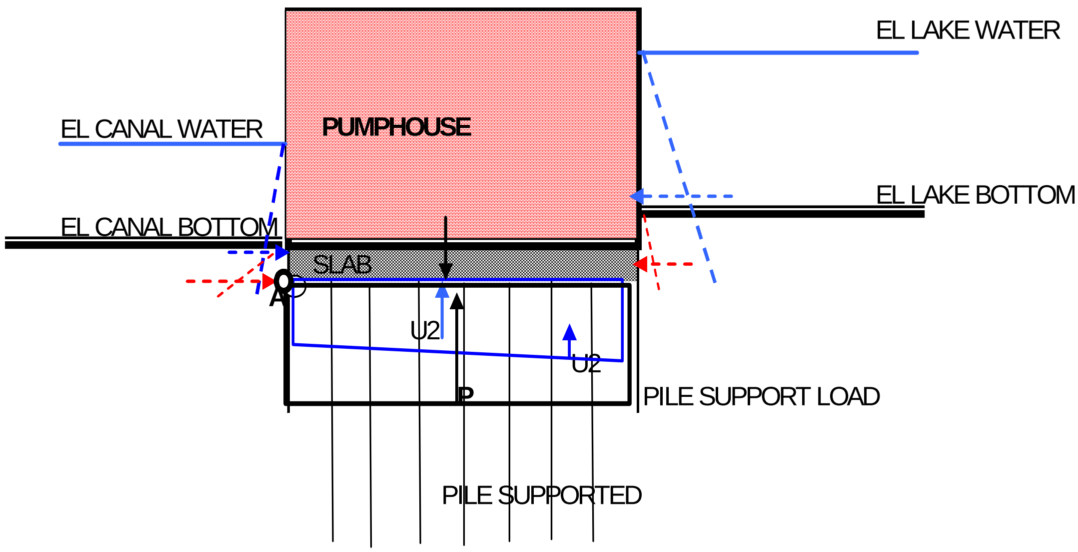
Unit Weight of Concrete: $\gamma_{concrete} := 145pcf$

Vertical Geometry:

Check the stability of the structure at the potential failure plane along the bottom of the structure.

Failure Plane: $\phi_{soil} := 30deg$

$EL_f := EL_{c\_bot}$ $\phi_{fail} := \phi_{soil}$ Plane := "Bottom of Cell"



Case 1

Determine the thickness of the base slab to resist uplift using only the dead weight of the slab. Solve by iterating the bottom of the slab elevation until FS=1.1

w_{str1} - is the lower bound value of the weight of the structure used for uplift:

$$w_{str1} := 500psf$$

weight of the water in the canal:

$$w_{canal} := \left(EL_{wps} - EL_{invert}\right)\cdot\gamma_w$$

weight of the structure below grade:

$$w_{slab} := \left(EL_{invert} - EL_{c\_bot}\right)\cdot\gamma_{concrete}$$

uplift pressure from the lake:

$$Lake := \gamma_w\cdot\left(\left(EL_{we} - EL_{c\_bot}\right)\right)$$

uplift pressure from the canal:

$$Canal := \gamma_w\cdot\left(EL_{wps} - EL_{c\_bot}\right)$$

Average Uplift:

$$Uplift_{avg} := \frac{Lake + Canal}{2}$$

Gravity Load:

$$w_{gravity} := w_{str1} + w_{canal} + w_{slab}$$

$$FS := \frac{w_{gravity}}{Uplift_{avg}}$$

$$FS = 1.3$$

Lateral Loads:

Force of water:

$$F_{w1} := \frac{1}{2}\gamma_w \cdot \left(EL_{we} - EL_f\right)^2 \qquad F_{w1} = 78\,\frac{kip}{ft}$$

Force of the water from Lake Ponchatrain

$$F_{w2} := \frac{1}{2}\gamma_w \cdot \left(EL_{wps} - EL_f\right)^2 \qquad F_{w2} = 19.5\,\frac{kip}{ft}$$

Force of the water from the canal

Moment Arm:

$$l_{w1} := \left[\frac{1}{3}\cdot\left(EL_{we} - EL_f\right)\right]$$

$$l_{w2} := \left[\frac{1}{3}\cdot\left(EL_{wps} - EL_f\right)\right]$$

Depth of slab of the pump structure:

$$H := EL_{invert} - EL_f$$

Active Pressure:

$$K_a := \frac{\left(1 - \sin\left(\phi_{soil}\right)\right)}{\left(1 + \sin\left(\phi_{soil}\right)\right)} \qquad P_a := 0.5\cdot\gamma_{soil\_b}\cdot K_a\cdot H^2 \qquad P_a = 1.61\,\frac{kip}{ft}$$

Moment Arm:

$$l_a := \left[\frac{1}{3}\cdot\left(EL_{invert} - EL_{c\_bot}\right)\right]$$

Passive Pressure:

In EM 1110-2-2502, the passive pressure phi angle is reduced and it is appropriate to perform the same operation here.

$$FS := 1.5$$

$$\phi_{soil\_p} := \operatorname{atan}\left(\frac{\tan\left(\phi_{soil}\right)}{FS}\right) \qquad \phi_{soil\_p} = 21.05\,deg$$

$$K_p := \frac{\left(1 + \sin\left(\phi_{soil\_p}\right)\right)}{\left(1 - \sin\left(\phi_{soil\_p}\right)\right)} \qquad P_p := 0.5\cdot\gamma_{soil\_b}\cdot K_p\cdot H^2 \qquad P_p = 10.27\,\frac{kip}{ft}$$

Moment arm:

$$l_p := \left[\frac{1}{3}\cdot\left(EL_{invert} - EL_{c\_bot}\right)\right]$$

Vertical Loads:

Load from the structure(upper bound value for designing foundations) : $w_{str2} := 500psf$

Weight of the Structure: $W_{str} := B_{eff} \cdot w_{str2}$

$W_{str} = 35 \frac{kip}{ft}$

Moment Arm: $l_{str} := \frac{B_{eff}}{2}$

Total Uplift Pressure: $Area_1 := B_{eff} \cdot (\gamma_w) \cdot (EL_{wps} - EL_{c\_bot})$

$l_{area1} := \frac{B_{eff}}{2}$

$Area_2 := 0.5 B_{eff} \cdot \gamma_w \cdot (EL_{we} - EL_{c\_bot})$

$l_{area2} := \frac{2}{3} B_{eff}$

Weight of the Slab: $W_{slab} := B_{eff} \cdot \gamma_{concrete} \cdot (EL_{invert} - EL_{c\_bot})$

$W_{slab} = 111.65 \frac{kip}{ft}$

Moment Arm: $l_{slab} := \frac{B_{eff}}{2}$

Calculate Total Moments and Forces:

Moments are calculated about the point of rotation (the toe of the structure).

Resisting Moment: $M_{resist} := P_p \cdot l_p + F_{w2} \cdot l_{w2} + W_{str} \cdot l_{str} + W_{slab} \cdot l_{slab}$

Overturning Moment $M_{over} := F_{w1} \cdot l_{w1} + P_a \cdot l_a + Area_1 \cdot l_{area1} + Area_2 \cdot l_{area2}$

Net Moment: $M_{net} := (M_{resist}) - M_{over}$

$M_{resist} = 5332.9\, kip$ $M_{over} = 1 \times 10^4\, kip$ $M_{net} = -4891\, kip$

Since Mnet is negative, uplift resistance is necessary either through pile resistance or some other method.

Re- Calculate Total Moments and Forces with Required Tension:

Tension Required: $T_{rqd} := 140 \frac{kip}{ft}$

Moment Arm of Tension: $l_{rqd} := \frac{2}{3} \cdot B_{eff}$

Resisting Moment: $M_{resist} := P_p \cdot l_p + F_{w2} \cdot l_{w2} + W_{str} \cdot l_{str} + W_{slab} \cdot l_{slab} + T_{rqd} \cdot l_{rqd}$

Overturning Moment $M_{over} := F_{w1} \cdot l_{w1} + P_a \cdot l_a + Area_1 \cdot l_{area1} + Area_2 \cdot l_{area2}$

Net Moment: $M_{net} := (M_{resist}) - M_{over}$

$M_{resist} = 11866.2\ kip$ $M_{over} = 1 \times 10^4\ kip$ $M_{net} = 1642\ kip$

Total Gross Weight/Vertical Forces: $F_{vert} := W_{str} - Area_1 - Area_2 + W_{slab} + T_{rqd}$

$F_{vert} = 68.3 \frac{kip}{ft}$

Resultant Location:

$x_{r1} := \frac{M_{net}}{F_{vert}}$ $x_{r1} = 24.06\ ft$

$\%_{comp1} := \min\left(3 \cdot \frac{x_{r1}}{B_{eff}}, 1\right)$ $\%_{comp1} = 100\ \%$

Per criteria resultant must be within middle third which is equivalent to 100% of base in compression, overturning is OK

$\%_{comp\_norm} := 100\%$

$Check_{overturn\_norm} := if(\%_{comp1} \geq \%_{comp\_norm}, \text{"OK"}, \text{"No Good"})$

$Check_{overturn\_norm} = \text{"OK"}$ $Plane = \text{"Bottom of Cell"}$

Forces:

Total Driving Force: $F_{drive} := F_{w1} + P_a$ $F_{drive} = 79.6 \frac{kip}{ft}$

Total Horizontal Force: $F_{resist} := P_p + F_{w2}$ $F_{resist} = 29.8 \frac{kip}{ft}$

External Stability Check - Load Case 1

Sliding Factor of Safety Criteria: $FOS_{slide\_norm} := 1.5$

Shear Strength required: $S_{required} := 50 \frac{kip}{ft}$

$$V_{all} := F_{vert} \cdot \tan(\phi_{fail}) + S_{required}$$

$$FOS_{slide} := \frac{(V_{all} + F_{resist})}{F_{drive}}$$

$FOS_{slide} = 1.5$

$$Check_{slide\_norm} := \text{if}(FOS_{slide} \geq FOS_{slide\_norm}, \text{"OK"}, \text{"No Good"})$$

$Check_{slide\_norm} = \text{"No Good"}$ $\text{›lane} = \text{"Bottom of Cell"}$

Bearing Capacity Check:

Eccentricity $e_1 := \frac{B_{eff}}{2} - x_{r1}$ $e_1 = 10.94\ ft$

Maximum Foundation Pressure:

$$q_{bearing} := \text{if}\left[\%_{comp1} < 1.0, \left[4 \cdot \frac{F_{vert}}{3 \cdot \left[(B_{eff}) - 2 \cdot e_1\right]}\right], \frac{F_{vert}}{B_{eff}} \cdot \left(1 + 6 \cdot \frac{e_1}{B_{eff}}\right)\right]$$

$q_{bearing} = 1.89 \frac{kip}{ft^2}$

$$q_{bearing} := \text{if}(\%_{comp1} \leq 0.0, 0 \cdot ksf, q_{bearing})$$

$$q_{min} := \text{if}\left[\%_{comp1} < 1.0, 0 \cdot ksf, \frac{F_{vert}}{B_{eff}} \cdot \left(1 - 6 \cdot \frac{e_1}{B_{eff}}\right)\right]$$

$q_{min} = 0.06\ ksf$

D.1.2 Piling Calculations

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Building a world of difference.

OWNER	USACE - Missisippi Valley Division - New Orleans	COMP'D BY	GDS
PROJECT	Permanent Protection System for Outfall Canals	DATE	06-Apr-09
PROJECT NO.	041919 FILE NO. 03.00	CKD BY	JAL
TITLE	GEOTECHNICAL PILE CAPACITY OF DRIVEN PCC PILES	DATE	4/13/2009
		PAGE	1
		TEMPLATE RE	1.00

PURPOSE: Estimate the geotechnical, compression capacity for 16 " PCC driven piles for proposed pumpstations protected side profiles

REFERENCES:

1. Engineering Manual 1110-2-2906
2. MVN Guidelines Dated 12 June 08
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.
21.
22.
23.
24.
25.

ASSUMPTIONS:

1. Assume groundwater at surface
2. Use unit weights and strength lines from Reference 2
3. For S-Case, use an Angle of Internal Friction of 23 degrees based on stiff, fat clay for the entire soil depth
4.

DISCUSSION:

For each profile use the following ground surface elevations based on backcalculating from overburden pressure estimated on page 7 of Reference 2

Protected Side (PTC)	-1	ft
Centerline (CTL)	10	ft
Flood Side (FLD)	9	ft

RESULTS: As stated in the body of the calculation

Revision No.	List of Revisions	Description of Revision	Revision Date
0		Initial Issue	

OWNER	USACE - Missisippi Valley Division - New Orleans	COMP'D BY	GDS
PROJECT		DATE	
PROJECT NO.	FILE NO. 01.00	CKD BY	
TITLE	GEOTECHNICAL PILE CAPACITY OF DRIVEN PCC PILES	DATE	
		PAGE	2
		TEMPLATE F	1.00

SOIL STRENGTH PROPERTIES

From MVN Guidelines Dated 12 June 08 (ref 4)

A. Cohesion vs Adhesion

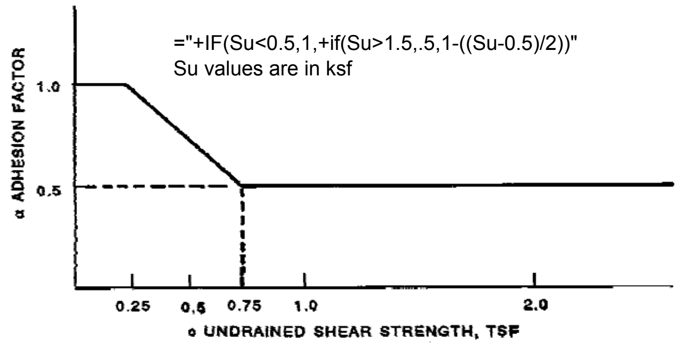


Figure 4-5a. Values of α versus undrained shear strength

B. Overburden Pressures limited to less than 3.5 ksf "=+IF((Overburden Stress)<3.5,Overburden Stress,3.5)"
C. Tip Bearing is not present for Su < 1 ksf "=+IF(Su<1,0,Su*9)"
D. Strengths for S-Case

Table 4-6

S Case Shear Strength

Soil Type	Consistency	Angle of Internal Friction ϕ
Fat clay (CH)	Very soft	13° to 17°
Fat clay (CH)	Soft	17° to 20°
Fat clay (CH)	Medium	20° to 21°
Fat clay (CH)	Stiff	21° to 23°
Silt (ML)		25° to 28°

Conditions related to Pile Materials

A. Side Resistance Factors

Table 4-3

Values of δ

Pile Material	δ
Steel	0.67 ϕ to 0.83 ϕ
Concrete	0.90 ϕ to 1.0 ϕ
Timber	0.80 ϕ to 1.0 ϕ

Soil strata has not yet been determined for the subsurface beneath the proposed pump station.
We anticipate the subsurface is the Baysound Clay above Pleistocene Clay.
The Baysound Clay is estimated to increase in undrained shear strength from 200 psf and increase by 0.17 psf per foot of depth
This is conservative. The undrained strength of the Pleistocene clay is anticipated to be 1100 psf.

CANAL	REQUIRED UPLIFT CAPACITY (TONS)	LENGTH "Q" FT	"S" FT	REQUIRED PILE LENGTH (FT)
17TH	11	25	38	**38**
ORLEANS	8	20	30	**30**
LONDON	14	30	46	**46**

PILE DESIGN - 17th Street Q CASE

PILE LOAD TEST	
F.S. SIDE RESISTANCE	2.0
F.S. END BEARING	2.0

INPUT VARIABLES		
PCC-PILE	16	IN

PILE DIMESIONS		
Circ.	5.33	ft.
Area	1.78	sq. ft.

TENSION

GROUND ELEVATION =	-26
DEPTH TO GROUNDWATER =	-13

CRITICAL DEPTH FT
20.00

NEGLECT SIDE RESISTANCE IN TOP	
5	FEET

DEPTH	ELEVATION	γtotal (KCF)	γeff (KCF)	σ'vo (KSF)	SOIL TYPE	Su (KSF)	Φ	Kc	Kt	Nc	Nq	CLAY α Adhesion Factor	CLAY fs (KSF)	CLAY qb (KSF)	SAND OR SILT UNCORRECTED δ	SAND OR SILT UNCORRECTED fs (KSF)	SAND OR SILT Correct for Critical Depth fs (KSF)	SAND OR SILT UNCORR qb (KSF)	SAND OR SILT Correct for Critical Depth qb (KSF)	ULTIMATE LOADS SIDE RESISTANCE AT EACH FOOT KIPS	ULTIMATE LOADS TOTAL SIDE RESISTANCE AT EACH DEPTH KIPS	ULTIMATE LOADS END BEARING AT EACH DEPTH KIPS	TOTAL A.LLOWABLE LOAD KIPS	TOTAL A.LLOWABLE LOAD TONS
0	-26	0.100	0.0376	0.00	CLAY	0.200	0	1.00	1.0	9.0	1.0	1.00	0.20	0.00	0	0.00	0.00	0	0.00	0.00	0.00	0.00	**0**	**0**
1	-27	0.100	0.0376	0.04	CLAY	0.217	0	1.00	1.0	9.0	1.0	1.00	0.22	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0**	**0**
2	-28	0.100	0.0376	0.08	CLAY	0.234	0	1.00	1.0	9.0	1.0	1.00	0.23	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0**	**0**
3	-29	0.100	0.0376	0.11	CLAY	0.251	0	1.00	1.0	9.0	1.0	1.00	0.25	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0**	**0**
4	-30	0.100	0.0376	0.15	CLAY	0.285	0	1.00	1.0	9.0	1.0	1.00	0.29	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0**	**0**
5	-31	0.100	0.0376	0.19	CLAY	0.293	0	1.00	1.0	9.0	1.0	1.00	0.29	0.00	0	0.00	0.00	0.00	0.00	1.56	1.56	0.00	**1**	**0**
6	-32	0.100	0.0376	0.23	CLAY	0.302	0	1.00	1.0	9.0	1.0	1.00	0.30	0.00	0	0.00	0.00	0.00	0.00	1.61	3.17	0.00	**2**	**1**
7	-33	0.100	0.0376	0.26	CLAY	0.310	0	1.00	1.0	9.0	1.0	1.00	0.31	0.00	0	0.00	0.00	0.00	0.00	1.65	4.83	0.00	**2**	**1**
8	-34	0.100	0.0376	0.30	CLAY	0.319	0	1.00	1.0	9.0	1.0	1.00	0.32	0.00	0	0.00	0.00	0.00	0.00	1.70	6.53	0.00	**3**	**2**
9	-35	0.100	0.0376	0.34	CLAY	0.327	0	1.00	1.0	9.0	1.0	1.00	0.33	0.00	0	0.00	0.00	0.00	0.00	1.74	8.27	0.00	**4**	**2**
10	-36	0.100	0.0376	0.38	CLAY	0.335	0	1.00	1.0	9.0	1.0	1.00	0.34	0.00	0	0.00	0.00	0.00	0.00	1.79	10.06	0.00	**5**	**3**
11	-37	0.100	0.0376	0.41	CLAY	0.344	0	1.00	1.0	9.0	1.0	1.00	0.34	0.00	0	0.00	0.00	0.00	0.00	1.83	11.89	0.00	**6**	**3**
12	-38	0.100	0.0376	0.45	CLAY	0.352	0	1.00	1.0	9.0	1.0	1.00	0.35	0.00	0	0.00	0.00	0.00	0.00	1.88	13.77	0.00	**7**	**3**
13	-39	0.100	0.0376	0.49	CLAY	0.361	0	1.00	1.0	9.0	1.0	1.00	0.36	0.00	0	0.00	0.00	0.00	0.00	1.92	15.70	0.00	**8**	**4**
14	-40	0.100	0.0376	0.53	CLAY	0.369	0	1.00	1.0	9.0	1.0	1.00	0.37	0.00	0	0.00	0.00	0.00	0.00	1.97	17.66	0.00	**9**	**4**
15	-41	0.100	0.0376	0.56	CLAY	0.377	0	1.00	1.0	9.0	1.0	1.00	0.38	0.00	0	0.00	0.00	0.00	0.00	2.01	19.68	0.00	**10**	**5**
16	-42	0.100	0.0376	0.60	CLAY	0.386	0	1.00	1.0	9.0	1.0	1.00	0.39	0.00	0	0.00	0.00	0.00	0.00	2.06	21.73	0.00	**11**	**5**
17	-43	0.100	0.0376	0.64	CLAY	0.394	0	1.00	1.0	9.0	1.0	1.00	0.39	0.00	0	0.00	0.00	0.00	0.00	2.10	23.84	0.00	**12**	**6**
18	-44	0.100	0.0376	0.68	CLAY	0.403	0	1.00	1.0	9.0	1.0	1.00	0.40	0.00	0	0.00	0.00	0.00	0.00	2.15	25.98	0.00	**13**	**6**
19	-45	0.100	0.0376	0.71	CLAY	0.411	0	1.00	1.0	9.0	1.0	1.00	0.41	0.00	0	0.00	0.00	0.00	0.00	2.19	28.18	0.00	**14**	**7**
20	-46	0.100	0.0376	0.75	CLAY	0.419	0	1.00	1.0	9.0	1.0	1.00	0.42	0.00	0	0.00	0.00	0.00	0.00	2.24	30.41	0.00	**15**	**8**
21	-47	0.100	0.0376	0.79	CLAY	0.428	0	1.00	1.0	9.0	1.0	1.00	0.43	0.00	0	0.00	0.00	0.00	0.00	2.28	32.69	0.00	**16**	**8**
22	-48	0.100	0.0376	0.83	CLAY	0.436	0	1.00	1.0	9.0	1.0	1.00	0.44	0.00	0	0.00	0.00	0.00	0.00	2.33	35.02	0.00	**18**	**9**
23	-49	0.100	0.0376	0.86	CLAY	0.445	0	1.00	1.0	9.0	1.0	1.00	0.44	0.00	0	0.00	0.00	0.00	0.00	2.37	37.39	0.00	**19**	**9**
24	-50	0.100	0.0376	0.90	CLAY	0.453	0	1.00	1.0	9.0	1.0	1.00	0.45	0.00	0	0.00	0.00	0.00	0.00	2.42	39.81	0.00	**20**	**10**
25	-51	0.100	0.0376	0.94	CLAY	0.461	0	1.00	1.0	9.0	1.0	1.00	0.46	0.00	0	0.00	0.00	0.00	0.00	2.46	42.27	0.00	**21**	**11**
26	-52	0.100	0.0376	0.98	CLAY	0.470	0	1.00	1.0	9.0	1.0	1.00	0.47	0.00	0	0.00	0.00	0.00	0.00	2.51	44.77	0.00	**22**	**11**
27	-53	0.100	0.0376	1.02	CLAY	0.478	0	1.00	1.0	9.0	1.0	1.00	0.48	0.00	0	0.00	0.00	0.00	0.00	2.55	47.32	0.00	**24**	**12**
28	-54	0.100	0.0376	1.05	CLAY	0.487	0	1.00	1.0	9.0	1.0	1.00	0.49	0.00	0	0.00	0.00	0.00	0.00	2.60	49.92	0.00	**25**	**12**
29	-55	0.100	0.0376	1.09	CLAY	0.495	0	1.00	1.0	9.0	1.0	1.00	0.50	0.00	0	0.00	0.00	0.00	0.00	2.64	52.56	0.00	**26**	**13**
30	-56	0.100	0.0376	1.13	CLAY	0.503	0	1.00	1.0	9.0	1.0	1.00	0.50	0.00	0	0.00	0.00	0.00	0.00	2.68	55.24	0.00	**28**	**14**
31	-57	0.100	0.0376	1.17	CLAY	0.512	0	1.00	1.0	9.0	1.0	0.99	0.51	0.00	0	0.00	0.00	0.00	0.00	2.71	57.95	0.00	**29**	**14**
32	-58	0.100	0.0376	1.20	CLAY	0.520	0	1.00	1.0	9.0	1.0	0.99	0.51	0.00	0	0.00	0.00	0.00	0.00	2.75	60.70	0.00	**30**	**15**
33	-59	0.100	0.0376	1.24	CLAY	0.529	0	1.00	1.0	9.0	1.0	0.99	0.52	0.00	0	0.00	0.00	0.00	0.00	2.78	63.48	0.00	**32**	**16**
34	-60	0.100	0.0376	1.28	CLAY	0.537	0	1.00	1.0	9.0	1.0	0.98	0.53	0.00	0	0.00	0.00	0.00	0.00	2.81	66.29	0.00	**33**	**17**
35	-61	0.100	0.0376	1.32	CLAY	0.545	0	1.00	1.0	9.0	1.0	0.98	0.53	0.00	0	0.00	0.00	0.00	0.00	2.84	69.13	0.00	**35**	**17**
36	-62	0.100	0.0376	1.35	CLAY	0.554	0	1.00	1.0	9.0	1.0	0.97	0.54	0.00	0	0.00	0.00	0.00	0.00	2.87	72.01	0.00	**36**	**18**
37	-63	0.100	0.0376	1.39	CLAY	0.562	0	1.00	1.0	9.0	1.0	0.97	0.54	0.00	0	0.00	0.00	0.00	0.00	2.91	74.91	0.00	**37**	**19**
38	-64	0.100	0.0376	1.43	CLAY	0.571	0	1.00	1.0	9.0	1.0	0.96	0.55	0.00	0	0.00	0.00	0.00	0.00	2.94	77.85	0.00	**39**	**19**
39	-65	0.100	0.0376	1.47	CLAY	0.579	0	1.00	1.0	9.0	1.0	0.96	0.56	0.00	0	0.00	0.00	0.00	0.00	2.97	80.81	0.00	**40**	**20**
40	-66	0.100	0.0376	1.50	CLAY	0.587	0	1.00	1.0	9.0	1.0	0.96	0.56	0.00	0	0.00	0.00	0.00	0.00	3.00	83.81	0.00	**42**	**21**
41	-67	0.100	0.0376	1.54	CLAY	0.596	0	1.00	1.0	9.0	1.0	0.95	0.57	0.00	0	0.00	0.00	0.00	0.00	3.03	86.84	0.00	**43**	**22**
42	-68	0.100	0.0376	1.58	CLAY	0.604	0	1.00	1.0	9.0	1.0	0.95	0.57	0.00	0	0.00	0.00	0.00	0.00	3.05	89.89	0.00	**45**	**22**
43	-69	0.100	0.0376	1.62	CLAY	0.613	0	1.00	1.0	9.0	1.0	0.94	0.58	0.00	0	0.00	0.00	0.00	0.00	3.08	92.97	0.00	**46**	**23**
44	-70	0.100	0.0376	1.65	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	97.08	0.00	**49**	**24**
45	-71	0.100	0.0376	1.69	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	101.19	0.00	**51**	**25**
46	-72	0.100	0.0376	1.73	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	105.29	0.00	**53**	**26**
47	-73	0.100	0.0376	1.77	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	109.40	0.00	**55**	**27**
48	-74	0.100	0.0376	1.80	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	113.51	0.00	**57**	**28**
49	-75	0.100	0.0376	1.84	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	117.61	0.00	**59**	**29**
50	-76	0.100	0.0376	1.88	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	121.72	0.00	**61**	**30**
51	-77	0.100	0.0376	1.92	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	125.83	0.00	**63**	**31**
52	-78	0.100	0.0376	1.96	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	129.93	0.00	**65**	**32**
53	-79	0.100	0.0376	1.99	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	134.04	0.00	**67**	**34**
54	-80	0.100	0.0376	2.03	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	138.15	0.00	**69**	**35**
55	-81	0.100	0.0376	2.07	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	142.25	0.00	**71**	**36**
56	-82	0.100	0.0376	2.11	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	146.36	0.00	**73**	**37**
57	-83	0.100	0.0376	2.14	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	150.47	0.00	**75**	**38**
58	-84	0.100	0.0376	2.18	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	154.57	0.00	**77**	**39**
59	-85	0.100	0.0376	2.22	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	158.68	0.00	**79**	**40**
60	-86	0.100	0.0376	2.26	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	162.79	0.00	**81**	**41**
61	-87	0.100	0.0376	2.29	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	166.89	0.00	**83**	**42**
62	-88	0.100	0.0376	2.33	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	171.00	0.00	**85**	**43**
63	-89	0.100	0.0376	2.37	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	175.11	0.00	**88**	**44**
64	-90	0.100	0.0376	2.41	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	179.21	0.00	**90**	**45**
65	-91	0.100	0.0376	2.44	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	183.32	0.00	**92**	**46**
66	-92	0.100	0.0376	2.48	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	187.43	0.00	**94**	**47**
67	-93	0.100	0.0376	2.52	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	191.53	0.00	**96**	**48**
68	-94	0.100	0.0376	2.56	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	195.64	0.00	**98**	**49**
69	-95	0.100	0.0376	2.59	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	199.75	0.00	**100**	**50**
70	-96	0.100	0.0376	2.63	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	203.85	0.00	**102**	**51**
71	-97	0.100	0.0376	2.67	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	207.96	0.00	**104**	**52**
72	-98	0.100	0.0376	2.71	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	212.07	0.00	**106**	**53**
73	-99	0.100	0.0376	2.74	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	216.17	0.00	**108**	**54**
74	-100	0.100	0.0376	2.78	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	220.28	0.00	**110**	**55**
75	-101	0.100	0.0376	2.82	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	224.39	0.00	**112**	**56**
76	-102	0.100	0.0376	2.86	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	228.49	0.00	**114**	**57**
77	-103	0.100	0.0376	2.90	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	232.60	0.00	**116**	**58**
78	-104	0.100	0.0376	2.93	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	236.71	0.00	**118**	**59**
79	-105	0.100	0.0376	2.97	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	240.81	0.00	**120**	**60**
80	-106	0.100	0.0376	3.01	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	244.92	0.00	**122**	**61**
81	-107	0.100	0.0376	3.05	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	249.03	0.00	**125**	**62**
82	-108	0.100	0.0376	3.08	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	253.13	0.00	**127**	**63**
83	-109	0.100	0.0376	3.12	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	257.24	0.00	**129**	**64**
84	-110	0.100	0.0376	3.16	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	261.35	0.00	**131**	**65**
85	-111	0.100	0.0376	3.20	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	265.45	0.00	**133**	**66**
86	-112	0.100	0.0376	3.23	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	269.56	0.00	**135**	**67**
87	-113	0.100	0.0376	3.27	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	273.67	0.00	**137**	**68**
88	-114	0.100	0.0376	3.31	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	277.77	0.00	**139**	**69**
89	-115	0.100	0.0376	3.35	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	281.88	0.00	**141**	**70**
90	-116	0.100	0.0376	3.38	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	285.99	0.00	**143**	**71**
91	-117	0.100	0.0376	3.42	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	290.09	0.00	**145**	**73**
92	-118	0.100	0.0376	3.46	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	294.20	0.00	**147**	**74**
93	-119	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	298.31	0.00	**149**	**75**
94	-120	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	302.41	0.00	**151**	**76**
95	-121	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	306.52	0.00	**153**	**77**
96	-122	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	310.63	0.00	**155**	**78**
97	-123	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	314.73	0.00	**157**	**79**
98	-124	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	318.84	0.00	**159**	**80**
99	-125	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	322.95	0.00	**161**	**81**
100	-126	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	327.05	0.00	**164**	**82**
101	-127	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	331.16	0.00	**166**	**83**
102	-128	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	335.27	0.00	**168**	**84**
103	-129	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	339.37	0.00	**170**	**85**
104	-130	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	343.48	0.00	**172**	**86**
105	-131	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	347.59	0.00	**174**	**87**
106	-132	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	351.69	0.00	**176**	**88**
107	-133	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	355.80	0.00	**178**	**89**
108	-134	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	359.91	0.00	**180**	**90**
109	-135	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	364.01	0.00	**182**	**91**
110	-136	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	368.12	0.00	**184**	**92**
111	-137	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	372.23	0.00	**186**	**93**
112	-138	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	376.33	0.00	**188**	**94**
113	-139	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	380.44	0.00	**190**	**95**
114	-140	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	384.55	0.00	**192**	**96**

PILE DESIGN - 17th Street Q CASE

PILE LOAD TEST

F.S. SIDE RESISTANCE	2.0
F.S. END BEARING	2.0

INPUT VARIABLES		
PCC-PILE	16	IN

TENSION

PILE DIMESIONS		
Circ.	5.33	ft.
Area	1.78	sq. ft.

GROUND ELEVATION =	-26
DEPTH TO GROUNDWATER =	-13

CRITICAL DEPTH FT: 20.00

NEGLECT SIDE RESISTANCE IN TOP 5 FEET

												CLAY			SAND OR SILT					ULTIMATE LOADS			TOTAL A.LLOWABLE LOAD	
DEPTH	ELEVATION	γ_{total} (KCF)	γ_{eff} (KCF)	σ'_{vo} (KSF)	SOIL TYPE	Su (KSF)	Φ	Kc	Kt	Nc	Nq	α Adhesion Factor	fs (KSF)	qb (KSF)	UNCORRECTED δ	fs (KSF)	Correct for Critical Depth fs (KSF)	UNCORR qb (KSF)	Correct for Critical Depth qb (KSF)	SIDE RESISTANCE AT EACH FOOT KIPS	TOTAL SIDE RESISTANCE AT EACH DEPTH KIPS	END BEARING AT EACH DEPTH KIPS	KIPS	TONS
115	-141	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	388.65	0.00	194	97
116	-142	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	392.76	0.00	196	98
117	-143	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	396.87	0.00	198	99
118	-144	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	400.97	0.00	200	100
119	-145	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	405.08	0.00	203	101
120	-146	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	409.19	0.00	205	102
121	-147	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	413.29	0.00	207	103
122	-148	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	417.40	0.00	209	104
123	-149	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	421.51	0.00	211	105
124	-150	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	425.61	0.00	213	106
125	-151	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	429.72	0.00	215	107
126	-152	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	433.83	0.00	217	108
127	-153	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	437.93	0.00	219	109
128	-154	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	442.04	0.00	221	111
129	-155	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	446.15	0.00	223	112
130	-156	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	450.25	0.00	225	113
131	-157	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	454.36	0.00	227	114
132	-158	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	458.47	0.00	229	115
133	-159	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	462.57	0.00	231	116
134	-160	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	466.68	0.00	233	117
135	-161	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	470.79	0.00	235	118
136	-162	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	474.89	0.00	237	119
137	-163	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	479.00	0.00	239	120
138	-164	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	483.11	0.00	242	121
139	-165	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	487.21	0.00	244	122
140	-166	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	491.32	0.00	246	123
141	-167	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	495.43	0.00	248	124
142	-168	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	499.53	0.00	250	125
143	-169	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	503.64	0.00	252	126
144	-170	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	507.75	0.00	254	127
145	-171	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	511.85	0.00	256	128
146	-172	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	515.96	0.00	258	129
147	-173	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	520.07	0.00	260	130
148	-174	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	524.17	0.00	262	131
149	-175	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	528.28	0.00	264	132
150	-176	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	532.39	0.00	266	133
151	-177	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	536.49	0.00	268	134
152	-178	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	540.60	0.00	270	135
153	-179	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	544.71	0.00	272	136
154	-180	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	548.81	0.00	274	137
155	-181	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	552.92	0.00	276	138
156	-182	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	557.03	0.00	279	139
157	-183	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	561.13	0.00	281	140
158	-184	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	565.24	0.00	283	141
159	-185	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	569.35	0.00	285	142
160	-186	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	573.45	0.00	287	143
161	-187	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	577.56	0.00	289	144
162	-188	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	581.67	0.00	291	145
163	-189	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	585.77	0.00	293	146

PILE DESIGN 17th Street- S CASE

PILE LOAD TEST	
F.S. SIDE RESISTANCE	1.5
F.S. END BEARING	1.5

INPUT VARIABLES		
PCC-PILE	16	IN

TENSION

NEGLECT SIDE RESISTANCE IN TOP	
5	FEET

PILE DIMESIONS		
Circ.	5.33	ft.
Area	1.78	sq. ft.

GROUND ELEVATION =	-26
DEPTH TO GROUNDWATER =	-13

CRITICAL DEPTH FT: 20.00

											CLAY, SILT, OR SAND					ULTIMATE LOADS			TOTAL A.LLOWABLE LOAD	
											UNCORRECTED		Correct for Critical Depth	UNCORR	Correct for Critical Depth	SIDE RESISTANCE AT EACH FOOT	TOTAL SIDE RESISTAN AT EACH DEPTH	END BEARING AT EACH DEPTH		
DEPTH	ELEVATION	γtotal	γeff	σ'vo	SOIL	Su	Φ	Kc	Kt	Nq	δ	fs	fs (KSF)	qb	qb (KSF)					
		(KCF)	(KCF)	(KSF)	TYPE	(KSF)						(KSF)		(KSF)		KIPS	KIPS	KIPS	KIPS	TONS
0	-26	0.100	0.0376	0.00	CLAY	0.200	23	1.00	0.7	10.0	21.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
1	-27	0.100	0.0376	0.04	CLAY	0.217	23	1.00	0.7	10.0	21.85	0.01	0.01	0.38	0.38	0.00	0.00	0.00	0	0
2	-28	0.100	0.0376	0.08	CLAY	0.234	23	1.00	0.7	10.0	21.85	0.02	0.02	0.75	0.75	0.00	0.00	0.00	0	0
3	-29	0.100	0.0376	0.11	CLAY	0.251	23	1.00	0.7	10.0	21.85	0.03	0.03	1.13	1.13	0.00	0.00	0.00	0	0
4	-30	0.100	0.0376	0.15	CLAY	0.285	23	1.00	0.7	10.0	21.85	0.04	0.04	1.50	1.50	0.00	0.00	0.00	0	0
5	-31	0.100	0.0376	0.19	CLAY	0.293	23	1.00	0.7	10.0	21.85	0.05	0.05	1.88	1.88	0.28	0.28	0.00	0	0
6	-32	0.100	0.0376	0.23	CLAY	0.302	23	1.00	0.7	10.0	21.85	0.06	0.06	2.26	2.26	0.34	0.62	0.00	0	0
7	-33	0.100	0.0376	0.26	CLAY	0.310	23	1.00	0.7	10.0	21.85	0.07	0.07	2.63	2.63	0.39	1.01	0.00	1	0
8	-34	0.100	0.0376	0.30	CLAY	0.319	23	1.00	0.7	10.0	21.85	0.08	0.08	3.01	3.01	0.45	1.46	0.00	1	0
9	-35	0.100	0.0376	0.34	CLAY	0.327	23	1.00	0.7	10.0	21.85	0.09	0.09	3.38	3.38	0.51	1.97	0.00	1	1
10	-36	0.100	0.0376	0.38	CLAY	0.335	23	1.00	0.7	10.0	21.85	0.11	0.11	3.76	3.76	0.56	2.53	0.00	2	1
11	-37	0.100	0.0376	0.41	CLAY	0.344	23	1.00	0.7	10.0	21.85	0.12	0.12	4.14	4.14	0.62	3.15	0.00	2	1
12	-38	0.100	0.0376	0.45	CLAY	0.352	23	1.00	0.7	10.0	21.85	0.13	0.13	4.51	4.51	0.68	3.83	0.00	3	1
13	-39	0.100	0.0376	0.49	CLAY	0.361	23	1.00	0.7	10.0	21.85	0.14	0.14	4.89	4.89	0.73	4.56	0.00	3	2
14	-40	0.100	0.0376	0.53	CLAY	0.369	23	1.00	0.7	10.0	21.85	0.15	0.15	5.26	5.26	0.79	5.35	0.00	4	2
15	-41	0.100	0.0376	0.56	CLAY	0.377	23	1.00	0.7	10.0	21.85	0.16	0.16	5.64	5.64	0.84	6.19	0.00	4	2
16	-42	0.100	0.0376	0.60	CLAY	0.386	23	1.00	0.7	10.0	21.85	0.17	0.17	6.02	6.02	0.90	7.09	0.00	5	2
17	-43	0.100	0.0376	0.64	CLAY	0.394	23	1.00	0.7	10.0	21.85	0.18	0.18	6.39	6.39	0.96	8.05	0.00	5	3
18	-44	0.100	0.0376	0.68	CLAY	0.403	23	1.00	0.7	10.0	21.85	0.19	0.19	6.77	6.77	1.01	9.06	0.00	6	3
19	-45	0.100	0.0376	0.71	CLAY	0.411	23	1.00	0.7	10.0	21.85	0.20	0.20	7.14	7.14	1.07	10.13	0.00	7	3
20	-46	0.100	0.0376	0.75	CLAY	0.419	23	1.00	0.7	10.0	21.85	0.21	0.21	7.52	7.52	1.13	11.26	0.00	8	4
21	-47	0.100	0.0376	0.79	CLAY	0.428	23	1.00	0.7	10.0	21.85	0.22	0.21	7.90	7.52	1.13	12.38	0.00	8	4
22	-48	0.100	0.0376	0.83	CLAY	0.436	23	1.00	0.7	10.0	21.85	0.23	0.21	8.27	7.52	1.13	13.51	0.00	9	5
23	-49	0.100	0.0376	0.86	CLAY	0.445	23	1.00	0.7	10.0	21.85	0.24	0.21	8.65	7.52	1.13	14.63	0.00	10	5
24	-50	0.100	0.0376	0.90	CLAY	0.453	23	1.00	0.7	10.0	21.85	0.25	0.21	9.02	7.52	1.13	15.76	0.00	11	5
25	-51	0.100	0.0376	0.94	CLAY	0.461	23	1.00	0.7	10.0	21.85	0.26	0.21	9.40	7.52	1.13	16.89	0.00	11	6
26	-52	0.100	0.0376	0.98	CLAY	0.470	23	1.00	0.7	10.0	21.85	0.27	0.21	9.78	7.52	1.13	18.01	0.00	12	6
27	-53	0.100	0.0376	1.02	CLAY	0.478	23	1.00	0.7	10.0	21.85	0.28	0.21	10.15	7.52	1.13	19.14	0.00	13	6
28	-54	0.100	0.0376	1.05	CLAY	0.487	23	1.00	0.7	10.0	21.85	0.30	0.21	10.53	7.52	1.13	20.26	0.00	14	7
29	-55	0.100	0.0376	1.09	CLAY	0.495	23	1.00	0.7	10.0	21.85	0.31	0.21	10.90	7.52	1.13	21.39	0.00	14	7
30	-56	0.100	0.0376	1.13	CLAY	0.503	23	1.00	0.7	10.0	21.85	0.32	0.21	11.28	7.52	1.13	22.51	0.00	15	8
31	-57	0.100	0.0376	1.17	CLAY	0.512	23	1.00	0.7	10.0	21.85	0.33	0.21	11.66	7.52	1.13	23.64	0.00	16	8
32	-58	0.100	0.0376	1.20	CLAY	0.520	23	1.00	0.7	10.0	21.85	0.34	0.21	12.03	7.52	1.13	24.77	0.00	17	8
33	-59	0.100	0.0376	1.24	CLAY	0.529	23	1.00	0.7	10.0	21.85	0.35	0.21	12.41	7.52	1.13	25.89	0.00	17	9
34	-60	0.100	0.0376	1.28	CLAY	0.537	23	1.00	0.7	10.0	21.85	0.36	0.21	12.78	7.52	1.13	27.02	0.00	18	9
35	-61	0.100	0.0376	1.32	CLAY	0.545	23	1.00	0.7	10.0	21.85	0.37	0.21	13.16	7.52	1.13	28.14	0.00	19	9
36	-62	0.100	0.0376	1.35	CLAY	0.554	23	1.00	0.7	10.0	21.85	0.38	0.21	13.54	7.52	1.13	29.27	0.00	20	10
37	-63	0.100	0.0376	1.39	CLAY	0.562	23	1.00	0.7	10.0	21.85	0.39	0.21	13.91	7.52	1.13	30.40	0.00	20	10
38	-64	0.100	0.0376	1.43	CLAY	0.571	23	1.00	0.7	10.0	21.85	0.40	0.21	14.29	7.52	1.13	31.52	0.00	21	11
39	-65	0.100	0.0376	1.47	CLAY	0.579	23	1.00	0.7	10.0	21.85	0.41	0.21	14.66	7.52	1.13	32.65	0.00	22	11
40	-66	0.100	0.0376	1.50	CLAY	0.587	23	1.00	0.7	10.0	21.85	0.42	0.21	15.04	7.52	1.13	33.77	0.00	23	11
41	-67	0.100	0.0376	1.54	CLAY	0.596	23	1.00	0.7	10.0	21.85	0.43	0.21	15.42	7.52	1.13	34.90	0.00	23	12
42	-68	0.100	0.0376	1.58	CLAY	0.604	23	1.00	0.7	10.0	21.85	0.44	0.21	15.79	7.52	1.13	36.02	0.00	24	12
43	-69	0.100	0.0376	1.62	CLAY	0.613	23	1.00	0.7	10.0	21.85	0.45	0.21	16.17	7.52	1.13	37.15	0.00	25	12
44	-70	0.100	0.0376	1.65	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.46	0.21	16.54	7.52	1.13	38.28	0.00	26	13
45	-71	0.100	0.0376	1.69	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.47	0.21	16.92	7.52	1.13	39.40	0.00	26	13
46	-72	0.100	0.0376	1.73	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.49	0.21	17.30	7.52	1.13	40.53	0.00	27	14
47	-73	0.100	0.0376	1.77	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.50	0.21	17.67	7.52	1.13	41.65	0.00	28	14
48	-74	0.100	0.0376	1.80	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.51	0.21	18.05	7.52	1.13	42.78	0.00	29	14
49	-75	0.100	0.0376	1.84	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.52	0.21	18.42	7.52	1.13	43.90	0.00	29	15
50	-76	0.100	0.0376	1.88	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.53	0.21	18.80	7.52	1.13	45.03	0.00	30	15
51	-77	0.100	0.0376	1.92	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.54	0.21	19.18	7.52	1.13	46.16	0.00	31	15
52	-78	0.100	0.0376	1.96	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.55	0.21	19.55	7.52	1.13	47.28	0.00	32	16
53	-79	0.100	0.0376	1.99	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.56	0.21	19.93	7.52	1.13	48.41	0.00	32	16
54	-80	0.100	0.0376	2.03	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.57	0.21	20.30	7.52	1.13	49.53	0.00	33	17
55	-81	0.100	0.0376	2.07	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.58	0.21	20.68	7.52	1.13	50.66	0.00	34	17
56	-82	0.100	0.0376	2.11	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.59	0.21	21.06	7.52	1.13	51.78	0.00	35	17
57	-83	0.100	0.0376	2.14	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.60	0.21	21.43	7.52	1.13	52.91	0.00	35	18
58	-84	0.100	0.0376	2.18	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.61	0.21	21.81	7.52	1.13	54.04	0.00	36	18
59	-85	0.100	0.0376	2.22	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.62	0.21	22.18	7.52	1.13	55.16	0.00	37	18
60	-86	0.100	0.0376	2.26	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.63	0.21	22.56	7.52	1.13	56.29	0.00	38	19
61	-87	0.100	0.0376	2.29	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.64	0.21	22.94	7.52	1.13	57.41	0.00	38	19
62	-88	0.100	0.0376	2.33	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.65	0.21	23.31	7.52	1.13	58.54	0.00	39	20
63	-89	0.100	0.0376	2.37	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.66	0.21	23.69	7.52	1.13	59.66	0.00	40	20
64	-90	0.100	0.0376	2.41	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.68	0.21	24.06	7.52	1.13	60.79	0.00	41	20
65	-91	0.100	0.0376	2.44	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.69	0.21	24.44	7.52	1.13	61.92	0.00	41	21
66	-92	0.100	0.0376	2.48	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.70	0.21	24.82	7.52	1.13	63.04	0.00	42	21
67	-93	0.100	0.0376	2.52	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.71	0.21	25.19	7.52	1.13	64.17	0.00	43	21
68	-94	0.100	0.0376	2.56	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.72	0.21	25.57	7.52	1.13	65.29	0.00	44	22
69	-95	0.100	0.0376	2.59	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.73	0.21	25.94	7.52	1.13	66.42	0.00	44	22
70	-96	0.100	0.0376	2.63	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.74	0.21	26.32	7.52	1.13	67.54	0.00	45	23
71	-97	0.100	0.0376	2.67	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.75	0.21	26.70	7.52	1.13	68.67	0.00	46	23
72	-98	0.100	0.0376	2.71	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.76	0.21	27.07	7.52	1.13	69.80	0.00	47	23
73	-99	0.100	0.0376	2.74	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.77	0.21	27.45	7.52	1.13	70.92	0.00	47	24
74	-100	0.100	0.0376	2.78	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.78	0.21	27.82	7.52	1.13	72.05	0.00	48	24
75	-101	0.100	0.0376	2.82	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.79	0.21	28.20	7.52	1.13	73.17	0.00	49	24
76	-102	0.100	0.0376	2.86	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.80	0.21	28.58	7.52	1.13	74.30	0.00	50	25
77	-103	0.100	0.0376	2.90	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.81	0.21	28.95	7.52	1.13	75.43	0.00	50	25
78	-104	0.100	0.0376	2.93	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.82	0.21	29.33	7.52	1.13	76.55	0.00	51	26
79	-105	0.100	0.0376	2.97	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.83	0.21	29.70	7.52	1.13	77.68	0.00	52	26
80	-106	0.100	0.0376	3.01	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.84	0.21	30.08	7.52	1.13	78.80	0.00	53	26
81	-107	0.100	0.0376	3.05	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.85	0.21	30.46	7.52	1.13	79.93	0.00	53	27
82	-108	0.100	0.0376	3.08	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.87	0.21	30.83	7.52	1.13	81.05	0.00	54	27
83	-109	0.100	0.0376	3.12	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.88	0.21	31.21	7.52	1.13	82.18	0.00	55	27
84	-110	0.100	0.0376	3.16	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.89	0.21	31.58	7.52	1.13	83.31	0.00	56	28
85	-111	0.100	0.0376	3.20	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.90	0.21	31.96	7.52	1.13	84.43	0.00	56	28
86	-112	0.100	0.0376	3.23	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.91	0.21	32.34	7.52	1.13	85.56	0.00	57	29
87	-113	0.100	0.0376	3.27	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.92	0.21	32.71	7.52	1.13	86.68	0.00	58	29
88	-114	0.100	0.0376	3.31	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.93	0.21	33.09	7.52	1.13	87.81	0.00	59	29
89	-115	0.100	0.0376	3.35	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.94	0.21	33.46	7.52	1.13	88.93	0.00	59	30
90	-116	0.100	0.0376	3.38	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.95	0.21	33.84	7.52	1.13	90.06	0.00	60	30
91	-117	0.100	0.0376	3.42	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.96	0.21	34.22	7.52	1.13	91.19	0.00	61	30
92	-118	0.100	0.0376	3.46	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.97	0.21	34.59	7.52	1.13	92.31	0.00	62	31
93	-119	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	34.97	7.52	1.13	93.44	0.00	62	31
94	-120	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	94.56	0.00	63	32
95	-121	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	95.69	0.00	64	32
96	-122	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	96.81	0.00	65	32
97	-123	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	97.94	0.00	65	33
98	-124	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	99.07	0.00	66	33
99	-125	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	100.19	0.00	67	33
100	-126	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	101.32	0.00	68	34
101	-127	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	102.44	0.00	68	34
102	-128	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	103.57	0.00	69	35
103	-129	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	104.69	0.00	70	35
104	-130	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	105.82	0.00	71	35
105	-131	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	106.95	0.00	71	36
106	-132	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	108.07	0.00	72	36
107	-133	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	109.20	0.00	73	36
108	-134	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	110.32	0.00	74	37
109	-135	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	111.45	0.00	74	37
110	-136	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	112.57	0.00	75	38
111	-137	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	113.70	0.00	76	38
112	-138	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	114.83	0.00	77	38
113	-139	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	115.95	0.00	77	39
114	-140	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	117.08	0.00	78	39

PILE DESIGN 17th Street- S CASE

PILE LOAD TEST

F.S. SIDE RESISTANCE	1.5
F.S. END BEARING	1.5

INPUT VARIABLES		
PCC-PILE	16	IN

TENSION

NEGLECT SIDE RESISTANCE IN TOP 5 FEET

PILE DIMESIONS		
Circ.	5.33	ft.
Area	1.78	sq. ft.

CRITICAL DEPTH FT 20.00

GROUND ELEVATION =	-26
DEPTH TO GROUNDWATER =	-13

DEPTH	ELEVATION	γ_{total} (KCF)	γ_{eff} (KCF)	σ'_{vo} (KSF)	SOIL TYPE	Su (KSF)	Φ	Kc	Kt	Nq	CLAY, SILT, OR SAND: UNCORRECTED δ	fs (KSF)	Correct for Critical Depth fs (KSF)	UNCORR qb (KSF)	Correct for Critical Depth qb (KSF)	ULTIMATE LOADS: SIDE RESISTANCE AT EACH FOOT KIPS	TOTAL SIDE RESISTANCE AT EACH DEPTH KIPS	END BEARING AT EACH DEPTH KIPS	TOTAL A.LLOWABLE LOAD KIPS	TONS
115	-141	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	118.20	0.00	79	39
116	-142	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	119.33	0.00	80	40
117	-143	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	120.46	0.00	80	40
118	-144	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	121.58	0.00	81	41
119	-145	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	122.71	0.00	82	41
120	-146	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	123.83	0.00	83	41
121	-147	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	124.96	0.00	83	42
122	-148	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	126.08	0.00	84	42
123	-149	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	127.21	0.00	85	42
124	-150	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	128.34	0.00	86	43
125	-151	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	129.46	0.00	86	43
126	-152	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	130.59	0.00	87	44
127	-153	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	131.71	0.00	88	44
128	-154	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	132.84	0.00	89	44
129	-155	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	133.96	0.00	89	45
130	-156	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	135.09	0.00	90	45
131	-157	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	136.22	0.00	91	45
132	-158	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	137.34	0.00	92	46
133	-159	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	138.47	0.00	92	46
134	-160	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	139.59	0.00	93	47
135	-161	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	140.72	0.00	94	47
136	-162	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	141.84	0.00	95	47
137	-163	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	142.97	0.00	95	48
138	-164	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	144.10	0.00	96	48
139	-165	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	145.22	0.00	97	48
140	-166	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	146.35	0.00	98	49
141	-167	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	147.47	0.00	98	49
142	-168	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	148.60	0.00	99	50
143	-169	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	149.72	0.00	100	50
144	-170	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	150.85	0.00	101	50
145	-171	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	151.98	0.00	101	51
146	-172	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	153.10	0.00	102	51
147	-173	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	154.23	0.00	103	51
148	-174	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	155.35	0.00	104	52
149	-175	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	156.48	0.00	104	52
150	-176	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	157.60	0.00	105	53
151	-177	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	158.73	0.00	106	53
152	-178	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	159.86	0.00	107	53
153	-179	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	160.98	0.00	107	54
154	-180	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	162.11	0.00	108	54
155	-181	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	163.23	0.00	109	54
156	-182	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	164.36	0.00	110	55
157	-183	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	165.49	0.00	110	55
158	-184	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	166.61	0.00	111	56
159	-185	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	167.74	0.00	112	56
160	-186	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	168.86	0.00	113	56
161	-187	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	169.99	0.00	113	57
162	-188	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	171.11	0.00	114	57
163	-189	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	172.24	0.00	115	57

PILE DESIGN - Orleans Q CASE

PILE LOAD TEST

F.S. SIDE RESISTANCE	2.0
F.S. END BEARING	2.0

INPUT VARIABLES		
PCC-PILE	16	IN

TENSION

PILE DIMESIONS		
Circ.	5.33	ft.
Area	1.78	sq. ft.

CRITICAL DEPTH FT 20.00

NEGLECT SIDE RESISTANCE IN TOP 5 FEET

GROUND ELEVATION =	-17
DEPTH TO GROUNDWATER =	-13

DEPTH	ELEVATION	γ_{total} (KCF)	γ_{eff} (KCF)	σ'_{vo} (KSF)	SOIL TYPE	Su (KSF)	Φ	Kc	Kt	Nc	Nq	CLAY α Adhesion Factor	CLAY fs (KSF)	CLAY qb (KSF)	SAND OR SILT UNCORRECTED δ	SAND OR SILT UNCORRECTED fs (KSF)	Correct for Critical Depth fs (KSF)	UNCORR qb (KSF)	Correct for Critical Depth qb (KSF)	ULTIMATE LOADS SIDE RESISTANCE AT EACH FOOT KIPS	ULTIMATE LOADS TOTAL SIDE RESISTANCE AT EACH DEPTH KIPS	ULTIMATE LOADS END BEARING AT EACH DEPTH KIPS	TOTAL A.LLOWABLE LOAD KIPS	TOTAL A.LLOWABLE LOAD TONS
0	-17	0.100	0.0376	0.00	CLAY	0.200	0	1.00	1.0	9.0	1.0	1.00	0.20	0.00	0	0.00	0.00	0	0.00	0.00	0.00	0.00	0	0
1	-18	0.100	0.0376	0.04	CLAY	0.217	0	1.00	1.0	9.0	1.0	1.00	0.22	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
2	-19	0.100	0.0376	0.08	CLAY	0.234	0	1.00	1.0	9.0	1.0	1.00	0.23	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
3	-20	0.100	0.0376	0.11	CLAY	0.251	0	1.00	1.0	9.0	1.0	1.00	0.25	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
4	-21	0.100	0.0376	0.15	CLAY	0.285	0	1.00	1.0	9.0	1.0	1.00	0.29	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
5	-22	0.100	0.0376	0.19	CLAY	0.293	0	1.00	1.0	9.0	1.0	1.00	0.29	0.00	0	0.00	0.00	0.00	0.00	1.56	1.56	0.00	1	0
6	-23	0.100	0.0376	0.23	CLAY	0.302	0	1.00	1.0	9.0	1.0	1.00	0.30	0.00	0	0.00	0.00	0.00	0.00	1.61	3.17	0.00	2	1
7	-24	0.100	0.0376	0.26	CLAY	0.310	0	1.00	1.0	9.0	1.0	1.00	0.31	0.00	0	0.00	0.00	0.00	0.00	1.65	4.83	0.00	2	1
8	-25	0.100	0.0376	0.30	CLAY	0.319	0	1.00	1.0	9.0	1.0	1.00	0.32	0.00	0	0.00	0.00	0.00	0.00	1.70	6.53	0.00	3	2
9	-26	0.100	0.0376	0.34	CLAY	0.327	0	1.00	1.0	9.0	1.0	1.00	0.33	0.00	0	0.00	0.00	0.00	0.00	1.74	8.27	0.00	4	2
10	-27	0.100	0.0376	0.38	CLAY	0.335	0	1.00	1.0	9.0	1.0	1.00	0.34	0.00	0	0.00	0.00	0.00	0.00	1.79	10.06	0.00	5	3
11	-28	0.100	0.0376	0.41	CLAY	0.344	0	1.00	1.0	9.0	1.0	1.00	0.34	0.00	0	0.00	0.00	0.00	0.00	1.83	11.89	0.00	6	3
12	-29	0.100	0.0376	0.45	CLAY	0.352	0	1.00	1.0	9.0	1.0	1.00	0.35	0.00	0	0.00	0.00	0.00	0.00	1.88	13.77	0.00	7	3
13	-30	0.100	0.0376	0.49	CLAY	0.361	0	1.00	1.0	9.0	1.0	1.00	0.36	0.00	0	0.00	0.00	0.00	0.00	1.92	15.70	0.00	8	4
14	-31	0.100	0.0376	0.53	CLAY	0.369	0	1.00	1.0	9.0	1.0	1.00	0.37	0.00	0	0.00	0.00	0.00	0.00	1.97	17.66	0.00	9	4
15	-32	0.100	0.0376	0.56	CLAY	0.377	0	1.00	1.0	9.0	1.0	1.00	0.38	0.00	0	0.00	0.00	0.00	0.00	2.01	19.68	0.00	10	5
16	-33	0.100	0.0376	0.60	CLAY	0.386	0	1.00	1.0	9.0	1.0	1.00	0.39	0.00	0	0.00	0.00	0.00	0.00	2.06	21.73	0.00	11	5
17	-34	0.100	0.0376	0.64	CLAY	0.394	0	1.00	1.0	9.0	1.0	1.00	0.39	0.00	0	0.00	0.00	0.00	0.00	2.10	23.84	0.00	12	6
18	-35	0.100	0.0376	0.68	CLAY	0.403	0	1.00	1.0	9.0	1.0	1.00	0.40	0.00	0	0.00	0.00	0.00	0.00	2.15	25.98	0.00	13	6
19	-36	0.100	0.0376	0.71	CLAY	0.411	0	1.00	1.0	9.0	1.0	1.00	0.41	0.00	0	0.00	0.00	0.00	0.00	2.19	28.18	0.00	14	7
20	-37	0.100	0.0376	0.75	CLAY	0.419	0	1.00	1.0	9.0	1.0	1.00	0.42	0.00	0	0.00	0.00	0.00	0.00	2.24	30.41	0.00	15	8
21	-38	0.100	0.0376	0.79	CLAY	0.428	0	1.00	1.0	9.0	1.0	1.00	0.43	0.00	0	0.00	0.00	0.00	0.00	2.28	32.69	0.00	16	8
22	-39	0.100	0.0376	0.83	CLAY	0.436	0	1.00	1.0	9.0	1.0	1.00	0.44	0.00	0	0.00	0.00	0.00	0.00	2.33	35.02	0.00	18	9
23	-40	0.100	0.0376	0.86	CLAY	0.445	0	1.00	1.0	9.0	1.0	1.00	0.44	0.00	0	0.00	0.00	0.00	0.00	2.37	37.39	0.00	19	9
24	-41	0.100	0.0376	0.90	CLAY	0.453	0	1.00	1.0	9.0	1.0	1.00	0.45	0.00	0	0.00	0.00	0.00	0.00	2.42	39.81	0.00	20	10
25	-42	0.100	0.0376	0.94	CLAY	0.461	0	1.00	1.0	9.0	1.0	1.00	0.46	0.00	0	0.00	0.00	0.00	0.00	2.46	42.27	0.00	21	11
26	-43	0.100	0.0376	0.98	CLAY	0.470	0	1.00	1.0	9.0	1.0	1.00	0.47	0.00	0	0.00	0.00	0.00	0.00	2.51	44.77	0.00	22	11
27	-44	0.100	0.0376	1.02	CLAY	0.478	0	1.00	1.0	9.0	1.0	1.00	0.48	0.00	0	0.00	0.00	0.00	0.00	2.55	47.32	0.00	24	12
28	-45	0.100	0.0376	1.05	CLAY	0.487	0	1.00	1.0	9.0	1.0	1.00	0.49	0.00	0	0.00	0.00	0.00	0.00	2.60	49.92	0.00	25	12
29	-46	0.100	0.0376	1.09	CLAY	0.495	0	1.00	1.0	9.0	1.0	1.00	0.50	0.00	0	0.00	0.00	0.00	0.00	2.64	52.56	0.00	26	13
30	-47	0.100	0.0376	1.13	CLAY	0.503	0	1.00	1.0	9.0	1.0	1.00	0.50	0.00	0	0.00	0.00	0.00	0.00	2.68	55.24	0.00	28	14
31	-48	0.100	0.0376	1.17	CLAY	0.512	0	1.00	1.0	9.0	1.0	0.99	0.51	0.00	0	0.00	0.00	0.00	0.00	2.71	57.95	0.00	29	14
32	-49	0.100	0.0376	1.20	CLAY	0.520	0	1.00	1.0	9.0	1.0	0.99	0.51	0.00	0	0.00	0.00	0.00	0.00	2.75	60.70	0.00	30	15
33	-50	0.100	0.0376	1.24	CLAY	0.529	0	1.00	1.0	9.0	1.0	0.99	0.52	0.00	0	0.00	0.00	0.00	0.00	2.78	63.48	0.00	32	16
34	-51	0.100	0.0376	1.28	CLAY	0.537	0	1.00	1.0	9.0	1.0	0.98	0.53	0.00	0	0.00	0.00	0.00	0.00	2.81	66.29	0.00	33	17
35	-52	0.100	0.0376	1.32	CLAY	0.545	0	1.00	1.0	9.0	1.0	0.98	0.53	0.00	0	0.00	0.00	0.00	0.00	2.84	69.13	0.00	35	17
36	-53	0.100	0.0376	1.35	CLAY	0.554	0	1.00	1.0	9.0	1.0	0.97	0.54	0.00	0	0.00	0.00	0.00	0.00	2.87	72.01	0.00	36	18
37	-54	0.100	0.0376	1.39	CLAY	0.562	0	1.00	1.0	9.0	1.0	0.97	0.54	0.00	0	0.00	0.00	0.00	0.00	2.91	74.91	0.00	37	19
38	-55	0.100	0.0376	1.43	CLAY	0.571	0	1.00	1.0	9.0	1.0	0.96	0.55	0.00	0	0.00	0.00	0.00	0.00	2.94	77.85	0.00	39	19
39	-56	0.100	0.0376	1.47	CLAY	0.579	0	1.00	1.0	9.0	1.0	0.96	0.56	0.00	0	0.00	0.00	0.00	0.00	2.97	80.81	0.00	40	20
40	-57	0.100	0.0376	1.50	CLAY	0.587	0	1.00	1.0	9.0	1.0	0.96	0.56	0.00	0	0.00	0.00	0.00	0.00	3.00	83.81	0.00	42	21
41	-58	0.100	0.0376	1.54	CLAY	0.596	0	1.00	1.0	9.0	1.0	0.95	0.57	0.00	0	0.00	0.00	0.00	0.00	3.03	86.84	0.00	43	22
42	-59	0.100	0.0376	1.58	CLAY	0.604	0	1.00	1.0	9.0	1.0	0.95	0.57	0.00	0	0.00	0.00	0.00	0.00	3.05	89.89	0.00	45	22
43	-60	0.100	0.0376	1.62	CLAY	0.613	0	1.00	1.0	9.0	1.0	0.94	0.58	0.00	0	0.00	0.00	0.00	0.00	3.08	92.97	0.00	46	23
44	-61	0.100	0.0376	1.65	CLAY	0.621	0	1.00	1.0	9.0	1.0	0.94	0.58	0.00	0	0.00	0.00	0.00	0.00	3.11	96.08	0.00	48	24
45	-62	0.100	0.0376	1.69	CLAY	0.629	0	1.00	1.0	9.0	1.0	0.94	0.59	0.00	0	0.00	0.00	0.00	0.00	3.14	99.22	0.00	50	25
46	-63	0.100	0.0376	1.73	CLAY	0.638	0	1.00	1.0	9.0	1.0	0.93	0.59	0.00	0	0.00	0.00	0.00	0.00	3.17	102.39	0.00	51	26
47	-64	0.100	0.0376	1.77	CLAY	0.646	0	1.00	1.0	9.0	1.0	0.93	0.60	0.00	0	0.00	0.00	0.00	0.00	3.19	105.59	0.00	53	26
48	-65	0.100	0.0376	1.80	CLAY	0.655	0	1.00	1.0	9.0	1.0	0.92	0.60	0.00	0	0.00	0.00	0.00	0.00	3.22	108.81	0.00	54	27
49	-66	0.100	0.0376	1.84	CLAY	0.663	0	1.00	1.0	9.0	1.0	0.92	0.61	0.00	0	0.00	0.00	0.00	0.00	3.25	112.06	0.00	56	28
50	-67	0.100	0.0376	1.88	CLAY	0.671	0	1.00	1.0	9.0	1.0	0.91	0.61	0.00	0	0.00	0.00	0.00	0.00	3.27	115.33	0.00	58	29
51	-68	0.100	0.0376	1.92	CLAY	0.680	0	1.00	1.0	9.0	1.0	0.91	0.62	0.00	0	0.00	0.00	0.00	0.00	3.30	118.63	0.00	59	30
52	-69	0.100	0.0376	1.96	CLAY	0.688	0	1.00	1.0	9.0	1.0	0.91	0.62	0.00	0	0.00	0.00	0.00	0.00	3.33	121.95	0.00	61	30
53	-70	0.100	0.0376	1.99	CLAY	0.697	0	1.00	1.0	9.0	1.0	0.90	0.63	0.00	0	0.00	0.00	0.00	0.00	3.35	125.30	0.00	63	31
54	-71	0.100	0.0376	2.03	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	129.41	0.00	65	32
55	-72	0.100	0.0376	2.07	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	133.52	0.00	67	33
56	-73	0.100	0.0376	2.11	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	137.62	0.00	69	34
57	-74	0.100	0.0376	2.14	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	141.73	0.00	71	35
58	-75	0.100	0.0376	2.18	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	145.84	0.00	73	36
59	-76	0.100	0.0376	2.22	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	149.94	0.00	75	37
60	-77	0.100	0.0376	2.26	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	154.05	0.00	77	39
61	-78	0.100	0.0376	2.29	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	158.16	0.00	79	40
62	-79	0.100	0.0376	2.33	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	162.26	0.00	81	41
63	-80	0.100	0.0376	2.37	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	166.37	0.00	83	42
64	-81	0.100	0.0376	2.41	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	170.48	0.00	85	43
65	-82	0.100	0.0376	2.44	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	174.58	0.00	87	44
66	-83	0.100	0.0376	2.48	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	178.69	0.00	89	45
67	-84	0.100	0.0376	2.52	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	182.80	0.00	91	46
68	-85	0.100	0.0376	2.56	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	186.90	0.00	93	47
69	-86	0.100	0.0376	2.59	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	191.01	0.00	96	48
70	-87	0.100	0.0376	2.63	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	195.12	0.00	98	49
71	-88	0.100	0.0376	2.67	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	199.22	0.00	100	50
72	-89	0.100	0.0376	2.71	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	203.33	0.00	102	51
73	-90	0.100	0.0376	2.74	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	207.44	0.00	104	52
74	-91	0.100	0.0376	2.78	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	211.54	0.00	106	53
75	-92	0.100	0.0376	2.82	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	215.65	0.00	108	54
76	-93	0.100	0.0376	2.86	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	219.76	0.00	110	55
77	-94	0.100	0.0376	2.90	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	223.86	0.00	112	56
78	-95	0.100	0.0376	2.93	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	227.97	0.00	114	57
79	-96	0.100	0.0376	2.97	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	232.08	0.00	116	58
80	-97	0.100	0.0376	3.01	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	236.18	0.00	118	59
81	-98	0.100	0.0376	3.05	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	240.29	0.00	120	60
82	-99	0.100	0.0376	3.08	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	244.40	0.00	122	61
83	-100	0.100	0.0376	3.12	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	248.50	0.00	124	62
84	-101	0.100	0.0376	3.16	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	252.61	0.00	126	63
85	-102	0.100	0.0376	3.20	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	256.72	0.00	128	64
86	-103	0.100	0.0376	3.23	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	260.82	0.00	130	65
87	-104	0.100	0.0376	3.27	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	264.93	0.00	132	66
88	-105	0.100	0.0376	3.31	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	269.04	0.00	135	67
89	-106	0.100	0.0376	3.35	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	273.14	0.00	137	68
90	-107	0.100	0.0376	3.38	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	277.25	0.00	139	69
91	-108	0.100	0.0376	3.42	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	281.36	0.00	141	70
92	-109	0.100	0.0376	3.46	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	285.46	0.00	143	71
93	-110	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	289.57	0.00	145	72
94	-111	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	293.68	0.00	147	73
95	-112	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	297.78	0.00	149	74
96	-113	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	301.89	0.00	151	75
97	-114	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	306.00	0.00	153	76
98	-115	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	310.10	0.00	155	78
99	-116	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	314.21	0.00	157	79
100	-117	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	318.32	0.00	159	80
101	-118	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	322.42	0.00	161	81
102	-119	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	326.53	0.00	163	82
103	-120	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	330.64	0.00	165	83
104	-121	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	334.74	0.00	167	84
105	-122	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	338.85	0.00	169	85
106	-123	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	342.96	0.00	171	86
107	-124	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	347.06	0.00	174	87
108	-125	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	351.17	0.00	176	88
109	-126	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	355.28	0.00	178	89
110	-127	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	359.38	0.00	180	90
111	-128	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	363.49	0.00	182	91
112	-129	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	367.60	0.00	184	92
113	-130	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	371.70	0.00	186	93
114	-131	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	375.81	0.00	188	94

PILE DESIGN - Orleans Q CASE

PILE LOAD TEST

F.S. SIDE RESISTANCE	2.0
F.S. END BEARING	2.0

INPUT VARIABLES		
PCC-PILE	16	IN

PILE DIMESIONS		
Circ.	5.33	ft.
Area	1.78	sq. ft.

TENSION

GROUND ELEVATION =	-17
DEPTH TO GROUNDWATER =	-13

NEGLECT SIDE RESISTANCE IN TOP 5 FEET

CRITICAL DEPTH FT 20.00

DEPTH	ELEVATION	γ_{total} (KCF)	γ_{eff} (KCF)	σ'_{vo} (KSF)	SOIL TYPE	Su (KSF)	Φ	Kc	Kt	Nc	Nq	CLAY: α Adhesion Factor	CLAY: fs (KSF)	CLAY: qb (KSF)	SAND OR SILT: δ	SAND OR SILT: UNCORRECTED fs (KSF)	SAND OR SILT: Correct for Critical Depth fs (KSF)	SAND OR SILT: UNCORR qb (KSF)	SAND OR SILT: Correct for Critical Depth qb (KSF)	ULTIMATE LOADS: SIDE RESISTANCE AT EACH FOOT KIPS	ULTIMATE LOADS: TOTAL SIDE RESISTANCE AT EACH DEPTH KIPS	ULTIMATE LOADS: END BEARING AT EACH DEPTH KIPS	TOTAL A.LLOWABLE LOAD KIPS	TOTAL A.LLOWABLE LOAD TONS
115	-132	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	379.92	0.00	190	95
116	-133	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	384.02	0.00	192	96
117	-134	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	388.13	0.00	194	97
118	-135	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	392.24	0.00	196	98
119	-136	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	396.34	0.00	198	99
120	-137	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	400.45	0.00	200	100
121	-138	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	404.56	0.00	202	101
122	-139	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	408.66	0.00	204	102
123	-140	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	412.77	0.00	206	103
124	-141	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	416.88	0.00	208	104
125	-142	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	420.98	0.00	210	105
126	-143	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	425.09	0.00	213	106
127	-144	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	429.20	0.00	215	107
128	-145	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	433.30	0.00	217	108
129	-146	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	437.41	0.00	219	109
130	-147	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	441.52	0.00	221	110
131	-148	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	445.62	0.00	223	111
132	-149	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	449.73	0.00	225	112
133	-150	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	453.84	0.00	227	113
134	-151	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	457.94	0.00	229	114
135	-152	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	462.05	0.00	231	116
136	-153	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	466.16	0.00	233	117
137	-154	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	470.26	0.00	235	118
138	-155	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	474.37	0.00	237	119
139	-156	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	478.48	0.00	239	120
140	-157	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	482.58	0.00	241	121
141	-158	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	486.69	0.00	243	122
142	-159	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	490.80	0.00	245	123
143	-160	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	494.90	0.00	247	124
144	-161	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	499.01	0.00	250	125
145	-162	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	503.12	0.00	252	126
146	-163	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	507.22	0.00	254	127
147	-164	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	511.33	0.00	256	128
148	-165	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	515.44	0.00	258	129
149	-166	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	519.54	0.00	260	130
150	-167	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	523.65	0.00	262	131
151	-168	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	527.76	0.00	264	132
152	-169	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	531.86	0.00	266	133
153	-170	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	535.97	0.00	268	134
154	-171	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	540.08	0.00	270	135
155	-172	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	544.18	0.00	272	136
156	-173	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	548.29	0.00	274	137
157	-174	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	552.40	0.00	276	138
158	-175	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	556.50	0.00	278	139
159	-176	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	560.61	0.00	280	140
160	-177	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	564.72	0.00	282	141
161	-178	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	568.82	0.00	284	142
162	-179	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	572.93	0.00	286	143
163	-180	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	577.04	0.00	289	144

PILE DESIGN Orleans- S CASE

PILE LOAD TEST	
F.S. SIDE RESISTANCE	1.5
F.S. END BEARING	1.5

INPUT VARIABLES		
PCC-PILE	16	IN

TENSION

NEGLECT SIDE RESISTANCE IN TOP	
5	FEET

PILE DIMESIONS		
Circ.	5.33	ft.
Area	1.78	sq. ft.

CRITICAL DEPTH FT
20.00

GROUND ELEVATION =	-17
DEPTH TO GROUNDWATER =	-13

DEPTH	ELEVATION	γtotal (KCF)	γeff (KCF)	σ'vo (KSF)	SOIL TYPE	Su (KSF)	Φ	Kc	Kt	Nq	CLAY, SILT, OR SAND: δ	UNCORRECTED fs (KSF)	Correct for Critical Depth fs (KSF)	UNCORR qb (KSF)	Correct for Critical Depth qb (KSF)	ULTIMATE LOADS: SIDE RESISTANCE AT EACH FOOT KIPS	TOTAL SIDE RESISTANCE AT EACH DEPTH KIPS	END BEARING AT EACH DEPTH KIPS	TOTAL A.LLOWABLE LOAD KIPS	TONS
0	-17	0.100	0.0376	0.00	CLAY	0.200	23	1.00	0.7	10.0	21.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
1	-18	0.100	0.0376	0.04	CLAY	0.217	23	1.00	0.7	10.0	21.85	0.01	0.01	0.38	0.38	0.00	0.00	0.00	0	0
2	-19	0.100	0.0376	0.08	CLAY	0.234	23	1.00	0.7	10.0	21.85	0.02	0.02	0.75	0.75	0.00	0.00	0.00	0	0
3	-20	0.100	0.0376	0.11	CLAY	0.251	23	1.00	0.7	10.0	21.85	0.03	0.03	1.13	1.13	0.00	0.00	0.00	0	0
4	-21	0.100	0.0376	0.15	CLAY	0.285	23	1.00	0.7	10.0	21.85	0.04	0.04	1.50	1.50	0.00	0.00	0.00	0	0
5	-22	0.100	0.0376	0.19	CLAY	0.293	23	1.00	0.7	10.0	21.85	0.05	0.05	1.88	1.88	0.28	0.28	0.00	0	0
6	-23	0.100	0.0376	0.23	CLAY	0.302	23	1.00	0.7	10.0	21.85	0.06	0.06	2.26	2.26	0.34	0.62	0.00	0	0
7	-24	0.100	0.0376	0.26	CLAY	0.310	23	1.00	0.7	10.0	21.85	0.07	0.07	2.63	2.63	0.39	1.01	0.00	1	0
8	-25	0.100	0.0376	0.30	CLAY	0.319	23	1.00	0.7	10.0	21.85	0.08	0.08	3.01	3.01	0.45	1.46	0.00	1	0
9	-26	0.100	0.0376	0.34	CLAY	0.327	23	1.00	0.7	10.0	21.85	0.09	0.09	3.38	3.38	0.51	1.97	0.00	1	1
10	-27	0.100	0.0376	0.38	CLAY	0.335	23	1.00	0.7	10.0	21.85	0.11	0.11	3.76	3.76	0.56	2.53	0.00	2	1
11	-28	0.100	0.0376	0.41	CLAY	0.344	23	1.00	0.7	10.0	21.85	0.12	0.12	4.14	4.14	0.62	3.15	0.00	2	1
12	-29	0.100	0.0376	0.45	CLAY	0.352	23	1.00	0.7	10.0	21.85	0.13	0.13	4.51	4.51	0.68	3.83	0.00	3	1
13	-30	0.100	0.0376	0.49	CLAY	0.361	23	1.00	0.7	10.0	21.85	0.14	0.14	4.89	4.89	0.73	4.56	0.00	3	2
14	-31	0.100	0.0376	0.53	CLAY	0.369	23	1.00	0.7	10.0	21.85	0.15	0.15	5.26	5.26	0.79	5.35	0.00	4	2
15	-32	0.100	0.0376	0.56	CLAY	0.377	23	1.00	0.7	10.0	21.85	0.16	0.16	5.64	5.64	0.84	6.19	0.00	4	2
16	-33	0.100	0.0376	0.60	CLAY	0.386	23	1.00	0.7	10.0	21.85	0.17	0.17	6.02	6.02	0.90	7.09	0.00	5	2
17	-34	0.100	0.0376	0.64	CLAY	0.394	23	1.00	0.7	10.0	21.85	0.18	0.18	6.39	6.39	0.96	8.05	0.00	5	3
18	-35	0.100	0.0376	0.68	CLAY	0.403	23	1.00	0.7	10.0	21.85	0.19	0.19	6.77	6.77	1.01	9.06	0.00	6	3
19	-36	0.100	0.0376	0.71	CLAY	0.411	23	1.00	0.7	10.0	21.85	0.20	0.20	7.14	7.14	1.07	10.13	0.00	7	3
20	-37	0.100	0.0376	0.75	CLAY	0.419	23	1.00	0.7	10.0	21.85	0.21	0.21	7.52	7.52	1.13	11.26	0.00	8	4
21	-38	0.100	0.0376	0.79	CLAY	0.428	23	1.00	0.7	10.0	21.85	0.22	0.21	7.90	7.52	1.13	12.38	0.00	8	4
22	-39	0.100	0.0376	0.83	CLAY	0.436	23	1.00	0.7	10.0	21.85	0.23	0.21	8.27	7.52	1.13	13.51	0.00	9	5
23	-40	0.100	0.0376	0.86	CLAY	0.445	23	1.00	0.7	10.0	21.85	0.24	0.21	8.65	7.52	1.13	14.63	0.00	10	5
24	-41	0.100	0.0376	0.90	CLAY	0.453	23	1.00	0.7	10.0	21.85	0.25	0.21	9.02	7.52	1.13	15.76	0.00	11	5
25	-42	0.100	0.0376	0.94	CLAY	0.461	23	1.00	0.7	10.0	21.85	0.26	0.21	9.40	7.52	1.13	16.89	0.00	11	6
26	-43	0.100	0.0376	0.98	CLAY	0.470	23	1.00	0.7	10.0	21.85	0.27	0.21	9.78	7.52	1.13	18.01	0.00	12	6
27	-44	0.100	0.0376	1.02	CLAY	0.478	23	1.00	0.7	10.0	21.85	0.28	0.21	10.15	7.52	1.13	19.14	0.00	13	6
28	-45	0.100	0.0376	1.05	CLAY	0.487	23	1.00	0.7	10.0	21.85	0.30	0.21	10.53	7.52	1.13	20.26	0.00	14	7
29	-46	0.100	0.0376	1.09	CLAY	0.495	23	1.00	0.7	10.0	21.85	0.31	0.21	10.90	7.52	1.13	21.39	0.00	14	7
30	-47	0.100	0.0376	1.13	CLAY	0.503	23	1.00	0.7	10.0	21.85	0.32	0.21	11.28	7.52	1.13	22.51	0.00	15	8
31	-48	0.100	0.0376	1.17	CLAY	0.512	23	1.00	0.7	10.0	21.85	0.33	0.21	11.66	7.52	1.13	23.64	0.00	16	8
32	-49	0.100	0.0376	1.20	CLAY	0.520	23	1.00	0.7	10.0	21.85	0.34	0.21	12.03	7.52	1.13	24.77	0.00	17	8
33	-50	0.100	0.0376	1.24	CLAY	0.529	23	1.00	0.7	10.0	21.85	0.35	0.21	12.41	7.52	1.13	25.89	0.00	17	9
34	-51	0.100	0.0376	1.28	CLAY	0.537	23	1.00	0.7	10.0	21.85	0.36	0.21	12.78	7.52	1.13	27.02	0.00	18	9
35	-52	0.100	0.0376	1.32	CLAY	0.545	23	1.00	0.7	10.0	21.85	0.37	0.21	13.16	7.52	1.13	28.14	0.00	19	9
36	-53	0.100	0.0376	1.35	CLAY	0.554	23	1.00	0.7	10.0	21.85	0.38	0.21	13.54	7.52	1.13	29.27	0.00	20	10
37	-54	0.100	0.0376	1.39	CLAY	0.562	23	1.00	0.7	10.0	21.85	0.39	0.21	13.91	7.52	1.13	30.40	0.00	20	10
38	-55	0.100	0.0376	1.43	CLAY	0.571	23	1.00	0.7	10.0	21.85	0.40	0.21	14.29	7.52	1.13	31.52	0.00	21	11
39	-56	0.100	0.0376	1.47	CLAY	0.579	23	1.00	0.7	10.0	21.85	0.41	0.21	14.66	7.52	1.13	32.65	0.00	22	11
40	-57	0.100	0.0376	1.50	CLAY	0.587	23	1.00	0.7	10.0	21.85	0.42	0.21	15.04	7.52	1.13	33.77	0.00	23	11
41	-58	0.100	0.0376	1.54	CLAY	0.596	23	1.00	0.7	10.0	21.85	0.43	0.21	15.42	7.52	1.13	34.90	0.00	23	12
42	-59	0.100	0.0376	1.58	CLAY	0.604	23	1.00	0.7	10.0	21.85	0.44	0.21	15.79	7.52	1.13	36.02	0.00	24	12
43	-60	0.100	0.0376	1.62	CLAY	0.613	23	1.00	0.7	10.0	21.85	0.45	0.21	16.17	7.52	1.13	37.15	0.00	25	12
44	-61	0.100	0.0376	1.65	CLAY	0.621	23	1.00	0.7	10.0	21.85	0.46	0.21	16.54	7.52	1.13	38.28	0.00	26	13
45	-62	0.100	0.0376	1.69	CLAY	0.629	23	1.00	0.7	10.0	21.85	0.47	0.21	16.92	7.52	1.13	39.40	0.00	26	13
46	-63	0.100	0.0376	1.73	CLAY	0.638	23	1.00	0.7	10.0	21.85	0.49	0.21	17.30	7.52	1.13	40.53	0.00	27	14
47	-64	0.100	0.0376	1.77	CLAY	0.646	23	1.00	0.7	10.0	21.85	0.50	0.21	17.67	7.52	1.13	41.65	0.00	28	14
48	-65	0.100	0.0376	1.80	CLAY	0.655	23	1.00	0.7	10.0	21.85	0.51	0.21	18.05	7.52	1.13	42.78	0.00	29	14
49	-66	0.100	0.0376	1.84	CLAY	0.663	23	1.00	0.7	10.0	21.85	0.52	0.21	18.42	7.52	1.13	43.90	0.00	29	15
50	-67	0.100	0.0376	1.88	CLAY	0.671	23	1.00	0.7	10.0	21.85	0.53	0.21	18.80	7.52	1.13	45.03	0.00	30	15
51	-68	0.100	0.0376	1.92	CLAY	0.680	23	1.00	0.7	10.0	21.85	0.54	0.21	19.18	7.52	1.13	46.16	0.00	31	15
52	-69	0.100	0.0376	1.96	CLAY	0.688	23	1.00	0.7	10.0	21.85	0.55	0.21	19.55	7.52	1.13	47.28	0.00	32	16
53	-70	0.100	0.0376	1.99	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.56	0.21	19.93	7.52	1.13	48.41	0.00	32	16
54	-71	0.100	0.0376	2.03	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.57	0.21	20.30	7.52	1.13	49.53	0.00	33	17
55	-72	0.100	0.0376	2.07	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.58	0.21	20.68	7.52	1.13	50.66	0.00	34	17
56	-73	0.100	0.0376	2.11	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.59	0.21	21.06	7.52	1.13	51.78	0.00	35	17
57	-74	0.100	0.0376	2.14	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.60	0.21	21.43	7.52	1.13	52.91	0.00	35	18
58	-75	0.100	0.0376	2.18	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.61	0.21	21.81	7.52	1.13	54.04	0.00	36	18
59	-76	0.100	0.0376	2.22	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.62	0.21	22.18	7.52	1.13	55.16	0.00	37	18
60	-77	0.100	0.0376	2.26	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.63	0.21	22.56	7.52	1.13	56.29	0.00	38	19
61	-78	0.100	0.0376	2.29	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.64	0.21	22.94	7.52	1.13	57.41	0.00	38	19
62	-79	0.100	0.0376	2.33	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.65	0.21	23.31	7.52	1.13	58.54	0.00	39	20
63	-80	0.100	0.0376	2.37	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.66	0.21	23.69	7.52	1.13	59.66	0.00	40	20
64	-81	0.100	0.0376	2.41	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.68	0.21	24.06	7.52	1.13	60.79	0.00	41	20
65	-82	0.100	0.0376	2.44	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.69	0.21	24.44	7.52	1.13	61.92	0.00	41	21
66	-83	0.100	0.0376	2.48	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.70	0.21	24.82	7.52	1.13	63.04	0.00	42	21
67	-84	0.100	0.0376	2.52	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.71	0.21	25.19	7.52	1.13	64.17	0.00	43	21
68	-85	0.100	0.0376	2.56	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.72	0.21	25.57	7.52	1.13	65.29	0.00	44	22
69	-86	0.100	0.0376	2.59	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.73	0.21	25.94	7.52	1.13	66.42	0.00	44	22
70	-87	0.100	0.0376	2.63	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.74	0.21	26.32	7.52	1.13	67.54	0.00	45	23
71	-88	0.100	0.0376	2.67	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.75	0.21	26.70	7.52	1.13	68.67	0.00	46	23
72	-89	0.100	0.0376	2.71	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.76	0.21	27.07	7.52	1.13	69.80	0.00	47	23
73	-90	0.100	0.0376	2.74	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.77	0.21	27.45	7.52	1.13	70.92	0.00	47	24
74	-91	0.100	0.0376	2.78	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.78	0.21	27.82	7.52	1.13	72.05	0.00	48	24
75	-92	0.100	0.0376	2.82	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.79	0.21	28.20	7.52	1.13	73.17	0.00	49	24
76	-93	0.100	0.0376	2.86	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.80	0.21	28.58	7.52	1.13	74.30	0.00	50	25
77	-94	0.100	0.0376	2.90	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.81	0.21	28.95	7.52	1.13	75.43	0.00	50	25
78	-95	0.100	0.0376	2.93	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.82	0.21	29.33	7.52	1.13	76.55	0.00	51	26
79	-96	0.100	0.0376	2.97	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.83	0.21	29.70	7.52	1.13	77.68	0.00	52	26
80	-97	0.100	0.0376	3.01	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.84	0.21	30.08	7.52	1.13	78.80	0.00	53	26
81	-98	0.100	0.0376	3.05	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.85	0.21	30.46	7.52	1.13	79.93	0.00	53	27
82	-99	0.100	0.0376	3.08	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.87	0.21	30.83	7.52	1.13	81.05	0.00	54	27
83	-100	0.100	0.0376	3.12	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.88	0.21	31.21	7.52	1.13	82.18	0.00	55	27
84	-101	0.100	0.0376	3.16	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.89	0.21	31.58	7.52	1.13	83.31	0.00	56	28
85	-102	0.100	0.0376	3.20	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.90	0.21	31.96	7.52	1.13	84.43	0.00	56	28
86	-103	0.100	0.0376	3.23	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.91	0.21	32.34	7.52	1.13	85.56	0.00	57	29
87	-104	0.100	0.0376	3.27	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.92	0.21	32.71	7.52	1.13	86.68	0.00	58	29
88	-105	0.100	0.0376	3.31	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.93	0.21	33.09	7.52	1.13	87.81	0.00	59	29
89	-106	0.100	0.0376	3.35	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.94	0.21	33.46	7.52	1.13	88.93	0.00	59	30
90	-107	0.100	0.0376	3.38	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.95	0.21	33.84	7.52	1.13	90.06	0.00	60	30
91	-108	0.100	0.0376	3.42	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.96	0.21	34.22	7.52	1.13	91.19	0.00	61	30
92	-109	0.100	0.0376	3.46	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.97	0.21	34.59	7.52	1.13	92.31	0.00	62	31
93	-110	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	34.97	7.52	1.13	93.44	0.00	62	31
94	-111	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	94.56	0.00	63	32
95	-112	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	95.69	0.00	64	32
96	-113	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	96.81	0.00	65	32
97	-114	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	97.94	0.00	65	33
98	-115	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	99.07	0.00	66	33
99	-116	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	100.19	0.00	67	33
100	-117	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	101.32	0.00	68	34
101	-118	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	102.44	0.00	68	34
102	-119	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	103.57	0.00	69	35
103	-120	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	104.69	0.00	70	35
104	-121	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	105.82	0.00	71	35
105	-122	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	106.95	0.00	71	36
106	-123	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	108.07	0.00	72	36
107	-124	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	109.20	0.00	73	36
108	-125	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	110.32	0.00	74	37
109	-126	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	111.45	0.00	74	37
110	-127	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	112.57	0.00	75	38
111	-128	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	113.70	0.00	76	38
112	-129	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	114.83	0.00	77	38
113	-130	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	115.95	0.00	77	39
114	-131	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	117.08	0.00	78	39

PILE DESIGN Orleans- S CASE

PILE LOAD TEST

F.S. SIDE RESISTANCE	1.5
F.S. END BEARING	1.5

INPUT VARIABLES		
PCC-PILE	16	IN

TENSION

NEGLECT SIDE RESISTANCE IN TOP	
5	FEET

PILE DIMESIONS		
Circ.	5.33	ft.
Area	1.78	sq. ft.

CRITICAL DEPTH FT: 20.00

GROUND ELEVATION =	-17
DEPTH TO GROUNDWATER =	-13

DEPTH	ELEVATION	γtotal (KCF)	γeff (KCF)	σ'vo (KSF)	SOIL TYPE	Su (KSF)	Φ	Kc	Kt	Nq	CLAY, SILT, OR SAND: UNCORRECTED δ	fs (KSF)	Correct for Critical Depth fs (KSF)	UNCORR qb (KSF)	Correct for Critical Depth qb (KSF)	ULTIMATE LOADS: SIDE RESISTANCE AT EACH FOOT KIPS	TOTAL SIDE RESISTAN AT EACH DEPTH KIPS	END BEARING AT EACH DEPTH KIPS	TOTAL A.LLOWABLE LOAD KIPS	TONS
115	-132	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	118.20	0.00	79	39
116	-133	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	119.33	0.00	80	40
117	-134	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	120.46	0.00	80	40
118	-135	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	121.58	0.00	81	41
119	-136	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	122.71	0.00	82	41
120	-137	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	123.83	0.00	83	41
121	-138	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	124.96	0.00	83	42
122	-139	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	126.08	0.00	84	42
123	-140	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	127.21	0.00	85	42
124	-141	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	128.34	0.00	86	43
125	-142	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	129.46	0.00	86	43
126	-143	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	130.59	0.00	87	44
127	-144	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	131.71	0.00	88	44
128	-145	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	132.84	0.00	89	44
129	-146	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	133.96	0.00	89	45
130	-147	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	135.09	0.00	90	45
131	-148	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	136.22	0.00	91	45
132	-149	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	137.34	0.00	92	46
133	-150	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	138.47	0.00	92	46
134	-151	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	139.59	0.00	93	47
135	-152	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	140.72	0.00	94	47
136	-153	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	141.84	0.00	95	47
137	-154	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	142.97	0.00	95	48
138	-155	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	144.10	0.00	96	48
139	-156	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	145.22	0.00	97	48
140	-157	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	146.35	0.00	98	49
141	-158	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	147.47	0.00	98	49
142	-159	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	148.60	0.00	99	50
143	-160	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	149.72	0.00	100	50
144	-161	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	150.85	0.00	101	50
145	-162	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	151.98	0.00	101	51
146	-163	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	153.10	0.00	102	51
147	-164	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	154.23	0.00	103	51
148	-165	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	155.35	0.00	104	52
149	-166	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	156.48	0.00	104	52
150	-167	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	157.60	0.00	105	53
151	-168	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	158.73	0.00	106	53
152	-169	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	159.86	0.00	107	53
153	-170	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	160.98	0.00	107	54
154	-171	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	162.11	0.00	108	54
155	-172	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	163.23	0.00	109	54
156	-173	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	164.36	0.00	110	55
157	-174	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	165.49	0.00	110	55
158	-175	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	166.61	0.00	111	56
159	-176	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	167.74	0.00	112	56
160	-177	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	168.86	0.00	113	56
161	-178	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	169.99	0.00	113	57
162	-179	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	171.11	0.00	114	57
163	-180	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	172.24	0.00	115	57

PILE DESIGN -London Q CASE

PILE LOAD TEST

F.S. SIDE RESISTANCE	2.0
F.S. END BEARING	2.0

INPUT VARIABLES		
PCC-PILE	16	IN

TENSION

NEGLECT SIDE RESISTANCE IN TOP 5 FEET

PILE DIMESIONS		
Circ.	5.33	ft.
Area	1.78	sq. ft.

CRITICAL DEPTH FT 20.00

GROUND ELEVATION =	-24
DEPTH TO GROUNDWATER =	-13

DEPTH	ELEVATION	γ_{total} (KCF)	γ_{eff} (KCF)	σ'_{vo} (KSF)	SOIL TYPE	Su (KSF)	Φ	Kc	Kt	Nc	Nq	CLAY: α Adhesion Factor	CLAY: fs (KSF)	CLAY: qb (KSF)	SAND OR SILT: UNCORRECTED δ	SAND OR SILT: UNCORRECTED fs (KSF)	SAND OR SILT: Correct for Critical Depth fs (KSF)	SAND OR SILT: UNCORR qb (KSF)	SAND OR SILT: Correct for Critical Depth qb (KSF)	ULTIMATE LOADS: SIDE RESISTANCE AT EACH FOOT KIPS	ULTIMATE LOADS: TOTAL SIDE RESISTANCE AT EACH DEPTH KIPS	ULTIMATE LOADS: END BEARING AT EACH DEPTH KIPS	TOTAL A.LLOWABLE LOAD KIPS	TOTAL A.LLOWABLE LOAD TONS
0	-24	0.100	0.0376	0.00	CLAY	0.200	0	1.00	1.0	9.0	1.0	1.00	0.20	0.00	0	0.00	0.00	0	0.00	0.00	0.00	0.00	**0**	**0**
1	-25	0.100	0.0376	0.04	CLAY	0.217	0	1.00	1.0	9.0	1.0	1.00	0.22	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0**	**0**
2	-26	0.100	0.0376	0.08	CLAY	0.234	0	1.00	1.0	9.0	1.0	1.00	0.23	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0**	**0**
3	-27	0.100	0.0376	0.11	CLAY	0.251	0	1.00	1.0	9.0	1.0	1.00	0.25	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0**	**0**
4	-28	0.100	0.0376	0.15	CLAY	0.285	0	1.00	1.0	9.0	1.0	1.00	0.29	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0**	**0**
5	-29	0.100	0.0376	0.19	CLAY	0.293	0	1.00	1.0	9.0	1.0	1.00	0.29	0.00	0	0.00	0.00	0.00	0.00	1.56	1.56	0.00	**1**	**0**
6	-30	0.100	0.0376	0.23	CLAY	0.302	0	1.00	1.0	9.0	1.0	1.00	0.30	0.00	0	0.00	0.00	0.00	0.00	1.61	3.17	0.00	**2**	**1**
7	-31	0.100	0.0376	0.26	CLAY	0.310	0	1.00	1.0	9.0	1.0	1.00	0.31	0.00	0	0.00	0.00	0.00	0.00	1.65	4.83	0.00	**2**	**1**
8	-32	0.100	0.0376	0.30	CLAY	0.319	0	1.00	1.0	9.0	1.0	1.00	0.32	0.00	0	0.00	0.00	0.00	0.00	1.70	6.53	0.00	**3**	**2**
9	-33	0.100	0.0376	0.34	CLAY	0.327	0	1.00	1.0	9.0	1.0	1.00	0.33	0.00	0	0.00	0.00	0.00	0.00	1.74	8.27	0.00	**4**	**2**
10	-34	0.100	0.0376	0.38	CLAY	0.335	0	1.00	1.0	9.0	1.0	1.00	0.34	0.00	0	0.00	0.00	0.00	0.00	1.79	10.06	0.00	**5**	**3**
11	-35	0.100	0.0376	0.41	CLAY	0.344	0	1.00	1.0	9.0	1.0	1.00	0.34	0.00	0	0.00	0.00	0.00	0.00	1.83	11.89	0.00	**6**	**3**
12	-36	0.100	0.0376	0.45	CLAY	0.352	0	1.00	1.0	9.0	1.0	1.00	0.35	0.00	0	0.00	0.00	0.00	0.00	1.88	13.77	0.00	**7**	**3**
13	-37	0.100	0.0376	0.49	CLAY	0.361	0	1.00	1.0	9.0	1.0	1.00	0.36	0.00	0	0.00	0.00	0.00	0.00	1.92	15.70	0.00	**8**	**4**
14	-38	0.100	0.0376	0.53	CLAY	0.369	0	1.00	1.0	9.0	1.0	1.00	0.37	0.00	0	0.00	0.00	0.00	0.00	1.97	17.66	0.00	**9**	**4**
15	-39	0.100	0.0376	0.56	CLAY	0.377	0	1.00	1.0	9.0	1.0	1.00	0.38	0.00	0	0.00	0.00	0.00	0.00	2.01	19.68	0.00	**10**	**5**
16	-40	0.100	0.0376	0.60	CLAY	0.386	0	1.00	1.0	9.0	1.0	1.00	0.39	0.00	0	0.00	0.00	0.00	0.00	2.06	21.73	0.00	**11**	**5**
17	-41	0.100	0.0376	0.64	CLAY	0.394	0	1.00	1.0	9.0	1.0	1.00	0.39	0.00	0	0.00	0.00	0.00	0.00	2.10	23.84	0.00	**12**	**6**
18	-42	0.100	0.0376	0.68	CLAY	0.403	0	1.00	1.0	9.0	1.0	1.00	0.40	0.00	0	0.00	0.00	0.00	0.00	2.15	25.98	0.00	**13**	**6**
19	-43	0.100	0.0376	0.71	CLAY	0.411	0	1.00	1.0	9.0	1.0	1.00	0.41	0.00	0	0.00	0.00	0.00	0.00	2.19	28.18	0.00	**14**	**7**
20	-44	0.100	0.0376	0.75	CLAY	0.419	0	1.00	1.0	9.0	1.0	1.00	0.42	0.00	0	0.00	0.00	0.00	0.00	2.24	30.41	0.00	**15**	**8**
21	-45	0.100	0.0376	0.79	CLAY	0.428	0	1.00	1.0	9.0	1.0	1.00	0.43	0.00	0	0.00	0.00	0.00	0.00	2.28	32.69	0.00	**16**	**8**
22	-46	0.100	0.0376	0.83	CLAY	0.436	0	1.00	1.0	9.0	1.0	1.00	0.44	0.00	0	0.00	0.00	0.00	0.00	2.33	35.02	0.00	**18**	**9**
23	-47	0.100	0.0376	0.86	CLAY	0.445	0	1.00	1.0	9.0	1.0	1.00	0.44	0.00	0	0.00	0.00	0.00	0.00	2.37	37.39	0.00	**19**	**9**
24	-48	0.100	0.0376	0.90	CLAY	0.453	0	1.00	1.0	9.0	1.0	1.00	0.45	0.00	0	0.00	0.00	0.00	0.00	2.42	39.81	0.00	**20**	**10**
25	-49	0.100	0.0376	0.94	CLAY	0.461	0	1.00	1.0	9.0	1.0	1.00	0.46	0.00	0	0.00	0.00	0.00	0.00	2.46	42.27	0.00	**21**	**11**
26	-50	0.100	0.0376	0.98	CLAY	0.470	0	1.00	1.0	9.0	1.0	1.00	0.47	0.00	0	0.00	0.00	0.00	0.00	2.51	44.77	0.00	**22**	**11**
27	-51	0.100	0.0376	1.02	CLAY	0.478	0	1.00	1.0	9.0	1.0	1.00	0.48	0.00	0	0.00	0.00	0.00	0.00	2.55	47.32	0.00	**24**	**12**
28	-52	0.100	0.0376	1.05	CLAY	0.487	0	1.00	1.0	9.0	1.0	1.00	0.49	0.00	0	0.00	0.00	0.00	0.00	2.60	49.92	0.00	**25**	**12**
29	-53	0.100	0.0376	1.09	CLAY	0.495	0	1.00	1.0	9.0	1.0	1.00	0.50	0.00	0	0.00	0.00	0.00	0.00	2.64	52.56	0.00	**26**	**13**
30	-54	0.100	0.0376	1.13	CLAY	0.503	0	1.00	1.0	9.0	1.0	1.00	0.50	0.00	0	0.00	0.00	0.00	0.00	2.68	55.24	0.00	**28**	**14**
31	-55	0.100	0.0376	1.17	CLAY	0.512	0	1.00	1.0	9.0	1.0	0.99	0.51	0.00	0	0.00	0.00	0.00	0.00	2.71	57.95	0.00	**29**	**14**
32	-56	0.100	0.0376	1.20	CLAY	0.520	0	1.00	1.0	9.0	1.0	0.99	0.51	0.00	0	0.00	0.00	0.00	0.00	2.75	60.70	0.00	**30**	**15**
33	-57	0.100	0.0376	1.24	CLAY	0.529	0	1.00	1.0	9.0	1.0	0.99	0.52	0.00	0	0.00	0.00	0.00	0.00	2.78	63.48	0.00	**32**	**16**
34	-58	0.100	0.0376	1.28	CLAY	0.537	0	1.00	1.0	9.0	1.0	0.98	0.53	0.00	0	0.00	0.00	0.00	0.00	2.81	66.29	0.00	**33**	**17**
35	-59	0.100	0.0376	1.32	CLAY	0.545	0	1.00	1.0	9.0	1.0	0.98	0.53	0.00	0	0.00	0.00	0.00	0.00	2.84	69.13	0.00	**35**	**17**
36	-60	0.100	0.0376	1.35	CLAY	0.554	0	1.00	1.0	9.0	1.0	0.97	0.54	0.00	0	0.00	0.00	0.00	0.00	2.87	72.01	0.00	**36**	**18**
37	-61	0.100	0.0376	1.39	CLAY	0.562	0	1.00	1.0	9.0	1.0	0.97	0.54	0.00	0	0.00	0.00	0.00	0.00	2.91	74.91	0.00	**37**	**19**
38	-62	0.100	0.0376	1.43	CLAY	0.571	0	1.00	1.0	9.0	1.0	0.96	0.55	0.00	0	0.00	0.00	0.00	0.00	2.94	77.85	0.00	**39**	**19**
39	-63	0.100	0.0376	1.47	CLAY	0.579	0	1.00	1.0	9.0	1.0	0.96	0.56	0.00	0	0.00	0.00	0.00	0.00	2.97	80.81	0.00	**40**	**20**
40	-64	0.100	0.0376	1.50	CLAY	0.587	0	1.00	1.0	9.0	1.0	0.96	0.56	0.00	0	0.00	0.00	0.00	0.00	3.00	83.81	0.00	**42**	**21**
41	-65	0.100	0.0376	1.54	CLAY	0.596	0	1.00	1.0	9.0	1.0	0.95	0.57	0.00	0	0.00	0.00	0.00	0.00	3.03	86.84	0.00	**43**	**22**
42	-66	0.100	0.0376	1.58	CLAY	0.604	0	1.00	1.0	9.0	1.0	0.95	0.57	0.00	0	0.00	0.00	0.00	0.00	3.05	89.89	0.00	**45**	**22**
43	-67	0.100	0.0376	1.62	CLAY	0.613	0	1.00	1.0	9.0	1.0	0.94	0.58	0.00	0	0.00	0.00	0.00	0.00	3.08	92.97	0.00	**46**	**23**
44	-68	0.100	0.0376	1.65	CLAY	0.621	0	1.00	1.0	9.0	1.0	0.94	0.58	0.00	0	0.00	0.00	0.00	0.00	3.11	96.08	0.00	**48**	**24**
45	-69	0.100	0.0376	1.69	CLAY	0.629	0	1.00	1.0	9.0	1.0	0.94	0.59	0.00	0	0.00	0.00	0.00	0.00	3.14	99.22	0.00	**50**	**25**
46	-70	0.100	0.0376	1.73	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	103.33	0.00	**52**	**26**
47	-71	0.100	0.0376	1.77	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	107.44	0.00	**54**	**27**
48	-72	0.100	0.0376	1.80	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	111.54	0.00	**56**	**28**
49	-73	0.100	0.0376	1.84	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	115.65	0.00	**58**	**29**
50	-74	0.100	0.0376	1.88	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	119.76	0.00	**60**	**30**
51	-75	0.100	0.0376	1.92	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	123.86	0.00	**62**	**31**
52	-76	0.100	0.0376	1.96	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	127.97	0.00	**64**	**32**
53	-77	0.100	0.0376	1.99	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	132.08	0.00	**66**	**33**
54	-78	0.100	0.0376	2.03	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	136.18	0.00	**68**	**34**
55	-79	0.100	0.0376	2.07	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	140.29	0.00	**70**	**35**
56	-80	0.100	0.0376	2.11	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	144.40	0.00	**72**	**36**
57	-81	0.100	0.0376	2.14	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	148.50	0.00	**74**	**37**
58	-82	0.100	0.0376	2.18	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	152.61	0.00	**76**	**38**
59	-83	0.100	0.0376	2.22	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	156.72	0.00	**78**	**39**
60	-84	0.100	0.0376	2.26	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	160.82	0.00	**80**	**40**
61	-85	0.100	0.0376	2.29	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	164.93	0.00	**82**	**41**
62	-86	0.100	0.0376	2.33	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	169.04	0.00	**85**	**42**
63	-87	0.100	0.0376	2.37	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	173.14	0.00	**87**	**43**
64	-88	0.100	0.0376	2.41	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	177.25	0.00	**89**	**44**
65	-89	0.100	0.0376	2.44	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	181.36	0.00	**91**	**45**
66	-90	0.100	0.0376	2.48	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	185.46	0.00	**93**	**46**
67	-91	0.100	0.0376	2.52	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	189.57	0.00	**95**	**47**
68	-92	0.100	0.0376	2.56	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	193.68	0.00	**97**	**48**
69	-93	0.100	0.0376	2.59	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	197.78	0.00	**99**	**49**
70	-94	0.100	0.0376	2.63	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	201.89	0.00	**101**	**50**
71	-95	0.100	0.0376	2.67	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	206.00	0.00	**103**	**51**
72	-96	0.100	0.0376	2.71	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	210.10	0.00	**105**	**53**
73	-97	0.100	0.0376	2.74	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	214.21	0.00	**107**	**54**
74	-98	0.100	0.0376	2.78	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	218.32	0.00	**109**	**55**
75	-99	0.100	0.0376	2.82	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	222.42	0.00	**111**	**56**
76	-100	0.100	0.0376	2.86	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	226.53	0.00	**113**	**57**
77	-101	0.100	0.0376	2.90	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	230.64	0.00	**115**	**58**
78	-102	0.100	0.0376	2.93	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	234.74	0.00	**117**	**59**
79	-103	0.100	0.0376	2.97	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	238.85	0.00	**119**	**60**
80	-104	0.100	0.0376	3.01	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	242.96	0.00	**121**	**61**
81	-105	0.100	0.0376	3.05	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	247.06	0.00	**124**	**62**
82	-106	0.100	0.0376	3.08	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	251.17	0.00	**126**	**63**
83	-107	0.100	0.0376	3.12	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	255.28	0.00	**128**	**64**
84	-108	0.100	0.0376	3.16	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	259.38	0.00	**130**	**65**
85	-109	0.100	0.0376	3.20	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	263.49	0.00	**132**	**66**
86	-110	0.100	0.0376	3.23	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	267.60	0.00	**134**	**67**
87	-111	0.100	0.0376	3.27	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	271.70	0.00	**136**	**68**
88	-112	0.100	0.0376	3.31	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	275.81	0.00	**138**	**69**
89	-113	0.100	0.0376	3.35	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	279.92	0.00	**140**	**70**
90	-114	0.100	0.0376	3.38	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	284.02	0.00	**142**	**71**
91	-115	0.100	0.0376	3.42	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	288.13	0.00	**144**	**72**
92	-116	0.100	0.0376	3.46	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	292.24	0.00	**146**	**73**
93	-117	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	296.34	0.00	**148**	**74**
94	-118	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	300.45	0.00	**150**	**75**
95	-119	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	304.56	0.00	**152**	**76**
96	-120	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	308.66	0.00	**154**	**77**
97	-121	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	312.77	0.00	**156**	**78**
98	-122	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	316.88	0.00	**158**	**79**
99	-123	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	320.98	0.00	**160**	**80**
100	-124	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	325.09	0.00	**163**	**81**
101	-125	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	329.20	0.00	**165**	**82**
102	-126	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	333.30	0.00	**167**	**83**
103	-127	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	337.41	0.00	**169**	**84**
104	-128	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	341.52	0.00	**171**	**85**
105	-129	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	345.62	0.00	**173**	**86**
106	-130	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	349.73	0.00	**175**	**87**
107	-131	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	353.84	0.00	**177**	**88**
108	-132	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	357.94	0.00	**179**	**89**
109	-133	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	362.05	0.00	**181**	**91**
110	-134	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	366.16	0.00	**183**	**92**
111	-135	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	370.26	0.00	**185**	**93**
112	-136	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	374.37	0.00	**187**	**94**
113	-137	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	378.48	0.00	**189**	**95**
114	-138	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	382.58	0.00	**191**	**96**

PILE DESIGN -London Q CASE

PILE LOAD TEST

F.S. SIDE RESISTANCE	2.0
F.S. END BEARING	2.0

INPUT VARIABLES		
PCC-PILE	16	IN

TENSION

PILE DIMESIONS		
Circ.	5.33	ft.
Area	1.78	sq. ft.

GROUND ELEVATION =	-24
DEPTH TO GROUNDWATER =	-13

CRITICAL DEPTH FT 20.00

NEGLECT SIDE RESISTANCE IN TOP 5 FEET

DEPTH	ELEVATION	γ_{total} (KCF)	γ_{eff} (KCF)	σ'_{vo} (KSF)	SOIL TYPE	Su (KSF)	Φ	Kc	Kt	Nc	Nq	CLAY α Adhesion Factor	CLAY fs (KSF)	CLAY qb (KSF)	SAND OR SILT UNCORRECTED δ	SAND OR SILT fs (KSF)	SAND OR SILT Correct for Critical Depth fs (KSF)	SAND OR SILT UNCORR qb (KSF)	SAND OR SILT Correct for Critical Depth qb (KSF)	ULTIMATE LOADS SIDE RESISTANCE AT EACH FOOT KIPS	ULTIMATE LOADS TOTAL SIDE RESISTANCE AT EACH DEPTH KIPS	ULTIMATE LOADS END BEARING AT EACH DEPTH KIPS	TOTAL A.LLOWABLE LOAD KIPS	TOTAL A.LLOWABLE LOAD TONS
115	-139	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	386.69	0.00	193	97
116	-140	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	390.80	0.00	195	98
117	-141	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	394.90	0.00	197	99
118	-142	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	399.01	0.00	200	100
119	-143	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	403.12	0.00	202	101
120	-144	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	407.22	0.00	204	102
121	-145	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	411.33	0.00	206	103
122	-146	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	415.44	0.00	208	104
123	-147	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	419.54	0.00	210	105
124	-148	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	423.65	0.00	212	106
125	-149	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	427.76	0.00	214	107
126	-150	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	431.86	0.00	216	108
127	-151	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	435.97	0.00	218	109
128	-152	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	440.08	0.00	220	110
129	-153	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	444.18	0.00	222	111
130	-154	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	448.29	0.00	224	112
131	-155	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	452.40	0.00	226	113
132	-156	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	456.50	0.00	228	114
133	-157	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	460.61	0.00	230	115
134	-158	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	464.72	0.00	232	116
135	-159	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	468.82	0.00	234	117
136	-160	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	472.93	0.00	236	118
137	-161	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	477.04	0.00	239	119
138	-162	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	481.14	0.00	241	120
139	-163	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	485.25	0.00	243	121
140	-164	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	489.36	0.00	245	122
141	-165	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	493.46	0.00	247	123
142	-166	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	497.57	0.00	249	124
143	-167	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	501.68	0.00	251	125
144	-168	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	505.78	0.00	253	126
145	-169	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	509.89	0.00	255	127
146	-170	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	514.00	0.00	257	128
147	-171	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	518.10	0.00	259	130
148	-172	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	522.21	0.00	261	131
149	-173	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	526.32	0.00	263	132
150	-174	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	530.42	0.00	265	133
151	-175	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	534.53	0.00	267	134
152	-176	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	538.64	0.00	269	135
153	-177	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	542.74	0.00	271	136
154	-178	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	546.85	0.00	273	137
155	-179	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	550.96	0.00	275	138
156	-180	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	555.06	0.00	278	139
157	-181	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	559.17	0.00	280	140
158	-182	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	563.28	0.00	282	141
159	-183	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	567.38	0.00	284	142
160	-184	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	571.49	0.00	286	143
161	-185	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	575.60	0.00	288	144
162	-186	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	579.70	0.00	290	145
163	-187	0.100	0.0376	3.50	CLAY	1.100	0	1.00	1.0	9.0	1.0	0.70	0.77	9.90	0	0.00	0.00	0.00	0.00	4.11	583.81	0.00	292	146

PILE DESIGN London- S CASE

PILE LOAD TEST

F.S. SIDE RESISTANCE	1.5
F.S. END BEARING	1.5

INPUT VARIABLES		
PCC-PILE	16	IN

TENSION

NEGLECT SIDE RESISTANCE IN TOP 5 FEET

PILE DIMENSIONS		
Circ.	5.33	ft.
Area	1.78	sq. ft.

CRITICAL DEPTH FT: 20.00

GROUND ELEVATION =	-24
DEPTH TO GROUNDWATER =	-13

DEPTH	ELEVATION	γtotal (KCF)	γeff (KCF)	σ'vo (KSF)	SOIL TYPE	Su (KSF)	Φ	Kc	Kt	Nq	CLAY, SILT, OR SAND: UNCORRECTED δ	fs (KSF)	Correct for Critical Depth fs (KSF)	UNCORR qb (KSF)	Correct for Critical Depth qb (KSF)	ULTIMATE LOADS: SIDE RESISTANCE AT EACH FOOT KIPS	TOTAL SIDE RESISTANCE AT EACH DEPTH KIPS	END BEARING AT EACH DEPTH KIPS	TOTAL A.LLOWABLE LOAD KIPS	TONS
0	-24	0.100	0.0376	0.00	CLAY	0.200	23	1.00	0.7	10.0	21.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0
1	-25	0.100	0.0376	0.04	CLAY	0.217	23	1.00	0.7	10.0	21.85	0.01	0.01	0.38	0.38	0.00	0.00	0.00	0	0
2	-26	0.100	0.0376	0.08	CLAY	0.234	23	1.00	0.7	10.0	21.85	0.02	0.02	0.75	0.75	0.00	0.00	0.00	0	0
3	-27	0.100	0.0376	0.11	CLAY	0.251	23	1.00	0.7	10.0	21.85	0.03	0.03	1.13	1.13	0.00	0.00	0.00	0	0
4	-28	0.100	0.0376	0.15	CLAY	0.285	23	1.00	0.7	10.0	21.85	0.04	0.04	1.50	1.50	0.00	0.00	0.00	0	0
5	-29	0.100	0.0376	0.19	CLAY	0.293	23	1.00	0.7	10.0	21.85	0.05	0.05	1.88	1.88	0.28	0.28	0.00	0	0
6	-30	0.100	0.0376	0.23	CLAY	0.302	23	1.00	0.7	10.0	21.85	0.06	0.06	2.26	2.26	0.34	0.62	0.00	0	0
7	-31	0.100	0.0376	0.26	CLAY	0.310	23	1.00	0.7	10.0	21.85	0.07	0.07	2.63	2.63	0.39	1.01	0.00	1	0
8	-32	0.100	0.0376	0.30	CLAY	0.319	23	1.00	0.7	10.0	21.85	0.08	0.08	3.01	3.01	0.45	1.46	0.00	1	0
9	-33	0.100	0.0376	0.34	CLAY	0.327	23	1.00	0.7	10.0	21.85	0.09	0.09	3.38	3.38	0.51	1.97	0.00	1	1
10	-34	0.100	0.0376	0.38	CLAY	0.335	23	1.00	0.7	10.0	21.85	0.11	0.11	3.76	3.76	0.56	2.53	0.00	2	1
11	-35	0.100	0.0376	0.41	CLAY	0.344	23	1.00	0.7	10.0	21.85	0.12	0.12	4.14	4.14	0.62	3.15	0.00	2	1
12	-36	0.100	0.0376	0.45	CLAY	0.352	23	1.00	0.7	10.0	21.85	0.13	0.13	4.51	4.51	0.68	3.83	0.00	3	1
13	-37	0.100	0.0376	0.49	CLAY	0.361	23	1.00	0.7	10.0	21.85	0.14	0.14	4.89	4.89	0.73	4.56	0.00	3	2
14	-38	0.100	0.0376	0.53	CLAY	0.369	23	1.00	0.7	10.0	21.85	0.15	0.15	5.26	5.26	0.79	5.35	0.00	4	2
15	-39	0.100	0.0376	0.56	CLAY	0.377	23	1.00	0.7	10.0	21.85	0.16	0.16	5.64	5.64	0.84	6.19	0.00	4	2
16	-40	0.100	0.0376	0.60	CLAY	0.386	23	1.00	0.7	10.0	21.85	0.17	0.17	6.02	6.02	0.90	7.09	0.00	5	2
17	-41	0.100	0.0376	0.64	CLAY	0.394	23	1.00	0.7	10.0	21.85	0.18	0.18	6.39	6.39	0.96	8.05	0.00	5	3
18	-42	0.100	0.0376	0.68	CLAY	0.403	23	1.00	0.7	10.0	21.85	0.19	0.19	6.77	6.77	1.01	9.06	0.00	6	3
19	-43	0.100	0.0376	0.71	CLAY	0.411	23	1.00	0.7	10.0	21.85	0.20	0.20	7.14	7.14	1.07	10.13	0.00	7	3
20	-44	0.100	0.0376	0.75	CLAY	0.419	23	1.00	0.7	10.0	21.85	0.21	0.21	7.52	7.52	1.13	11.26	0.00	8	4
21	-45	0.100	0.0376	0.79	CLAY	0.428	23	1.00	0.7	10.0	21.85	0.22	0.21	7.90	7.52	1.13	12.38	0.00	8	4
22	-46	0.100	0.0376	0.83	CLAY	0.436	23	1.00	0.7	10.0	21.85	0.23	0.21	8.27	7.52	1.13	13.51	0.00	9	5
23	-47	0.100	0.0376	0.86	CLAY	0.445	23	1.00	0.7	10.0	21.85	0.24	0.21	8.65	7.52	1.13	14.63	0.00	10	5
24	-48	0.100	0.0376	0.90	CLAY	0.453	23	1.00	0.7	10.0	21.85	0.25	0.21	9.02	7.52	1.13	15.76	0.00	11	5
25	-49	0.100	0.0376	0.94	CLAY	0.461	23	1.00	0.7	10.0	21.85	0.26	0.21	9.40	7.52	1.13	16.89	0.00	11	6
26	-50	0.100	0.0376	0.98	CLAY	0.470	23	1.00	0.7	10.0	21.85	0.27	0.21	9.78	7.52	1.13	18.01	0.00	12	6
27	-51	0.100	0.0376	1.02	CLAY	0.478	23	1.00	0.7	10.0	21.85	0.28	0.21	10.15	7.52	1.13	19.14	0.00	13	6
28	-52	0.100	0.0376	1.05	CLAY	0.487	23	1.00	0.7	10.0	21.85	0.30	0.21	10.53	7.52	1.13	20.26	0.00	14	7
29	-53	0.100	0.0376	1.09	CLAY	0.495	23	1.00	0.7	10.0	21.85	0.31	0.21	10.90	7.52	1.13	21.39	0.00	14	7
30	-54	0.100	0.0376	1.13	CLAY	0.503	23	1.00	0.7	10.0	21.85	0.32	0.21	11.28	7.52	1.13	22.51	0.00	15	8
31	-55	0.100	0.0376	1.17	CLAY	0.512	23	1.00	0.7	10.0	21.85	0.33	0.21	11.66	7.52	1.13	23.64	0.00	16	8
32	-56	0.100	0.0376	1.20	CLAY	0.520	23	1.00	0.7	10.0	21.85	0.34	0.21	12.03	7.52	1.13	24.77	0.00	17	8
33	-57	0.100	0.0376	1.24	CLAY	0.529	23	1.00	0.7	10.0	21.85	0.35	0.21	12.41	7.52	1.13	25.89	0.00	17	9
34	-58	0.100	0.0376	1.28	CLAY	0.537	23	1.00	0.7	10.0	21.85	0.36	0.21	12.78	7.52	1.13	27.02	0.00	18	9
35	-59	0.100	0.0376	1.32	CLAY	0.545	23	1.00	0.7	10.0	21.85	0.37	0.21	13.16	7.52	1.13	28.14	0.00	19	9
36	-60	0.100	0.0376	1.35	CLAY	0.554	23	1.00	0.7	10.0	21.85	0.38	0.21	13.54	7.52	1.13	29.27	0.00	20	10
37	-61	0.100	0.0376	1.39	CLAY	0.562	23	1.00	0.7	10.0	21.85	0.39	0.21	13.91	7.52	1.13	30.40	0.00	20	10
38	-62	0.100	0.0376	1.43	CLAY	0.571	23	1.00	0.7	10.0	21.85	0.40	0.21	14.29	7.52	1.13	31.52	0.00	21	11
39	-63	0.100	0.0376	1.47	CLAY	0.579	23	1.00	0.7	10.0	21.85	0.41	0.21	14.66	7.52	1.13	32.65	0.00	22	11
40	-64	0.100	0.0376	1.50	CLAY	0.587	23	1.00	0.7	10.0	21.85	0.42	0.21	15.04	7.52	1.13	33.77	0.00	23	11
41	-65	0.100	0.0376	1.54	CLAY	0.596	23	1.00	0.7	10.0	21.85	0.43	0.21	15.42	7.52	1.13	34.90	0.00	23	12
42	-66	0.100	0.0376	1.58	CLAY	0.604	23	1.00	0.7	10.0	21.85	0.44	0.21	15.79	7.52	1.13	36.02	0.00	24	12
43	-67	0.100	0.0376	1.62	CLAY	0.613	23	1.00	0.7	10.0	21.85	0.45	0.21	16.17	7.52	1.13	37.15	0.00	25	12
44	-68	0.100	0.0376	1.65	CLAY	0.621	23	1.00	0.7	10.0	21.85	0.46	0.21	16.54	7.52	1.13	38.28	0.00	26	13
45	-69	0.100	0.0376	1.69	CLAY	0.629	23	1.00	0.7	10.0	21.85	0.47	0.21	16.92	7.52	1.13	39.40	0.00	26	13
46	-70	0.100	0.0376	1.73	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.49	0.21	17.30	7.52	1.13	40.53	0.00	27	14
47	-71	0.100	0.0376	1.77	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.50	0.21	17.67	7.52	1.13	41.65	0.00	28	14
48	-72	0.100	0.0376	1.80	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.51	0.21	18.05	7.52	1.13	42.78	0.00	29	14
49	-73	0.100	0.0376	1.84	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.52	0.21	18.42	7.52	1.13	43.90	0.00	29	15
50	-74	0.100	0.0376	1.88	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.53	0.21	18.80	7.52	1.13	45.03	0.00	30	15
51	-75	0.100	0.0376	1.92	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.54	0.21	19.18	7.52	1.13	46.16	0.00	31	15
52	-76	0.100	0.0376	1.96	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.55	0.21	19.55	7.52	1.13	47.28	0.00	32	16
53	-77	0.100	0.0376	1.99	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.56	0.21	19.93	7.52	1.13	48.41	0.00	32	16
54	-78	0.100	0.0376	2.03	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.57	0.21	20.30	7.52	1.13	49.53	0.00	33	17
55	-79	0.100	0.0376	2.07	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.58	0.21	20.68	7.52	1.13	50.66	0.00	34	17
56	-80	0.100	0.0376	2.11	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.59	0.21	21.06	7.52	1.13	51.78	0.00	35	17
57	-81	0.100	0.0376	2.14	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.60	0.21	21.43	7.52	1.13	52.91	0.00	35	18
58	-82	0.100	0.0376	2.18	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.61	0.21	21.81	7.52	1.13	54.04	0.00	36	18
59	-83	0.100	0.0376	2.22	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.62	0.21	22.18	7.52	1.13	55.16	0.00	37	18
60	-84	0.100	0.0376	2.26	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.63	0.21	22.56	7.52	1.13	56.29	0.00	38	19
61	-85	0.100	0.0376	2.29	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.64	0.21	22.94	7.52	1.13	57.41	0.00	38	19
62	-86	0.100	0.0376	2.33	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.65	0.21	23.31	7.52	1.13	58.54	0.00	39	20
63	-87	0.100	0.0376	2.37	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.66	0.21	23.69	7.52	1.13	59.66	0.00	40	20
64	-88	0.100	0.0376	2.41	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.68	0.21	24.06	7.52	1.13	60.79	0.00	41	20
65	-89	0.100	0.0376	2.44	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.69	0.21	24.44	7.52	1.13	61.92	0.00	41	21
66	-90	0.100	0.0376	2.48	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.70	0.21	24.82	7.52	1.13	63.04	0.00	42	21
67	-91	0.100	0.0376	2.52	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.71	0.21	25.19	7.52	1.13	64.17	0.00	43	21
68	-92	0.100	0.0376	2.56	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.72	0.21	25.57	7.52	1.13	65.29	0.00	44	22
69	-93	0.100	0.0376	2.59	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.73	0.21	25.94	7.52	1.13	66.42	0.00	44	22
70	-94	0.100	0.0376	2.63	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.74	0.21	26.32	7.52	1.13	67.54	0.00	45	23
71	-95	0.100	0.0376	2.67	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.75	0.21	26.70	7.52	1.13	68.67	0.00	46	23
72	-96	0.100	0.0376	2.71	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.76	0.21	27.07	7.52	1.13	69.80	0.00	47	23
73	-97	0.100	0.0376	2.74	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.77	0.21	27.45	7.52	1.13	70.92	0.00	47	24
74	-98	0.100	0.0376	2.78	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.78	0.21	27.82	7.52	1.13	72.05	0.00	48	24
75	-99	0.100	0.0376	2.82	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.79	0.21	28.20	7.52	1.13	73.17	0.00	49	24
76	-100	0.100	0.0376	2.86	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.80	0.21	28.58	7.52	1.13	74.30	0.00	50	25
77	-101	0.100	0.0376	2.90	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.81	0.21	28.95	7.52	1.13	75.43	0.00	50	25
78	-102	0.100	0.0376	2.93	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.82	0.21	29.33	7.52	1.13	76.55	0.00	51	26
79	-103	0.100	0.0376	2.97	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.83	0.21	29.70	7.52	1.13	77.68	0.00	52	26
80	-104	0.100	0.0376	3.01	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.84	0.21	30.08	7.52	1.13	78.80	0.00	53	26
81	-105	0.100	0.0376	3.05	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.85	0.21	30.46	7.52	1.13	79.93	0.00	53	27
82	-106	0.100	0.0376	3.08	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.87	0.21	30.83	7.52	1.13	81.05	0.00	54	27
83	-107	0.100	0.0376	3.12	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.88	0.21	31.21	7.52	1.13	82.18	0.00	55	27
84	-108	0.100	0.0376	3.16	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.89	0.21	31.58	7.52	1.13	83.31	0.00	56	28
85	-109	0.100	0.0376	3.20	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.90	0.21	31.96	7.52	1.13	84.43	0.00	56	28
86	-110	0.100	0.0376	3.23	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.91	0.21	32.34	7.52	1.13	85.56	0.00	57	29
87	-111	0.100	0.0376	3.27	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.92	0.21	32.71	7.52	1.13	86.68	0.00	58	29
88	-112	0.100	0.0376	3.31	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.93	0.21	33.09	7.52	1.13	87.81	0.00	59	29
89	-113	0.100	0.0376	3.35	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.94	0.21	33.46	7.52	1.13	88.93	0.00	59	30
90	-114	0.100	0.0376	3.38	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.95	0.21	33.84	7.52	1.13	90.06	0.00	60	30
91	-115	0.100	0.0376	3.42	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.96	0.21	34.22	7.52	1.13	91.19	0.00	61	30
92	-116	0.100	0.0376	3.46	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.97	0.21	34.59	7.52	1.13	92.31	0.00	62	31
93	-117	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	34.97	7.52	1.13	93.44	0.00	62	31
94	-118	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	94.56	0.00	63	32
95	-119	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	95.69	0.00	64	32
96	-120	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	96.81	0.00	65	32
97	-121	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	97.94	0.00	65	33
98	-122	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	99.07	0.00	66	33
99	-123	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	100.19	0.00	67	33
100	-124	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	101.32	0.00	68	34
101	-125	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	102.44	0.00	68	34
102	-126	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	103.57	0.00	69	35
103	-127	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	104.69	0.00	70	35
104	-128	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	105.82	0.00	71	35
105	-129	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	106.95	0.00	71	36
106	-130	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	108.07	0.00	72	36
107	-131	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	109.20	0.00	73	36
108	-132	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	110.32	0.00	74	37
109	-133	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	111.45	0.00	74	37
110	-134	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	112.57	0.00	75	38
111	-135	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	113.70	0.00	76	38
112	-136	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	114.83	0.00	77	38
113	-137	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	115.95	0.00	77	39
114	-138	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	117.08	0.00	78	39

PILE DESIGN London- S CASE

PILE LOAD TEST	
F.S. SIDE RESISTANCE	1.5
F.S. END BEARING	1.5

INPUT VARIABLES		
PCC-PILE	16	IN

PILE DIMESIONS		
Circ.	5.33	ft.
Area	1.78	sq. ft.

TENSION

CRITICAL DEPTH FT
20.00

NEGLECT SIDE RESISTANCE IN TOP	
5	FEET

GROUND ELEVATION =	-24
DEPTH TO GROUNDWATER =	-13

DEPTH	ELEVATION	γtotal (KCF)	γeff (KCF)	σ'vo (KSF)	SOIL TYPE	Su (KSF)	Φ	Kc	Kt	Nq	CLAY, SILT, OR SAND: UNCORRECTED δ	fs (KSF)	Correct for Critical Depth fs (KSF)	UNCORR qb (KSF)	Correct for Critical Depth qb (KSF)	ULTIMATE LOADS: SIDE RESISTANCE AT EACH FOOT KIPS	TOTAL SIDE RESISTAN AT EACH DEPTH KIPS	END BEARING AT EACH DEPTH KIPS	TOTAL A.LLOWABLE LOAD KIPS	TONS
115	-139	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	118.20	0.00	79	39
116	-140	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	119.33	0.00	80	40
117	-141	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	120.46	0.00	80	40
118	-142	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	121.58	0.00	81	41
119	-143	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	122.71	0.00	82	41
120	-144	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	123.83	0.00	83	41
121	-145	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	124.96	0.00	83	42
122	-146	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	126.08	0.00	84	42
123	-147	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	127.21	0.00	85	42
124	-148	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	128.34	0.00	86	43
125	-149	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	129.46	0.00	86	43
126	-150	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	130.59	0.00	87	44
127	-151	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	131.71	0.00	88	44
128	-152	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	132.84	0.00	89	44
129	-153	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	133.96	0.00	89	45
130	-154	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	135.09	0.00	90	45
131	-155	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	136.22	0.00	91	45
132	-156	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	137.34	0.00	92	46
133	-157	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	138.47	0.00	92	46
134	-158	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	139.59	0.00	93	47
135	-159	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	140.72	0.00	94	47
136	-160	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	141.84	0.00	95	47
137	-161	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	142.97	0.00	95	48
138	-162	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	144.10	0.00	96	48
139	-163	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	145.22	0.00	97	48
140	-164	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	146.35	0.00	98	49
141	-165	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	147.47	0.00	98	49
142	-166	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	148.60	0.00	99	50
143	-167	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	149.72	0.00	100	50
144	-168	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	150.85	0.00	101	50
145	-169	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	151.98	0.00	101	51
146	-170	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	153.10	0.00	102	51
147	-171	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	154.23	0.00	103	51
148	-172	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	155.35	0.00	104	52
149	-173	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	156.48	0.00	104	52
150	-174	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	157.60	0.00	105	53
151	-175	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	158.73	0.00	106	53
152	-176	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	159.86	0.00	107	53
153	-177	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	160.98	0.00	107	54
154	-178	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	162.11	0.00	108	54
155	-179	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	163.23	0.00	109	54
156	-180	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	164.36	0.00	110	55
157	-181	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	165.49	0.00	110	55
158	-182	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	166.61	0.00	111	56
159	-183	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	167.74	0.00	112	56
160	-184	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	168.86	0.00	113	56
161	-185	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	169.99	0.00	113	57
162	-186	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	171.11	0.00	114	57
163	-187	0.100	0.0376	3.50	CLAY	1.100	23	1.00	0.7	10.0	21.85	0.98	0.21	35.00	7.52	1.13	172.24	0.00	115	57

D.1.3 Cofferdam Calculations

Preliminary Cofferdam Cell Design:

Cell Geometry:

Diameter of Cell $D_C := 52.5 \cdot ft$

Effective Width of Cell calculated in accordance with EM 11110-2-2503. The equivalent cell width is the width of an equivalent rectangular section having the same section modulus as that of the circular structure.

Section Modulus: $Section_{modulus} := \dfrac{\pi \cdot D_C^{\,3}}{32}$

$B_{eff} := \sqrt[3]{Section_{modulus} \cdot 6}$ $B_{eff} = 44.01\ ft$

Excavation and Cofferdam Profile:

Elev at Top of Cell: $El_{c\_top} := 6ft$

Elev at Top of Seal Slab: $El_{sealslab} := -26ft$

Elev of Canal Bottom: $El_{canal} := -10ft$

Thickness of Seal Slab: $T_{sealslab} := 10ft$

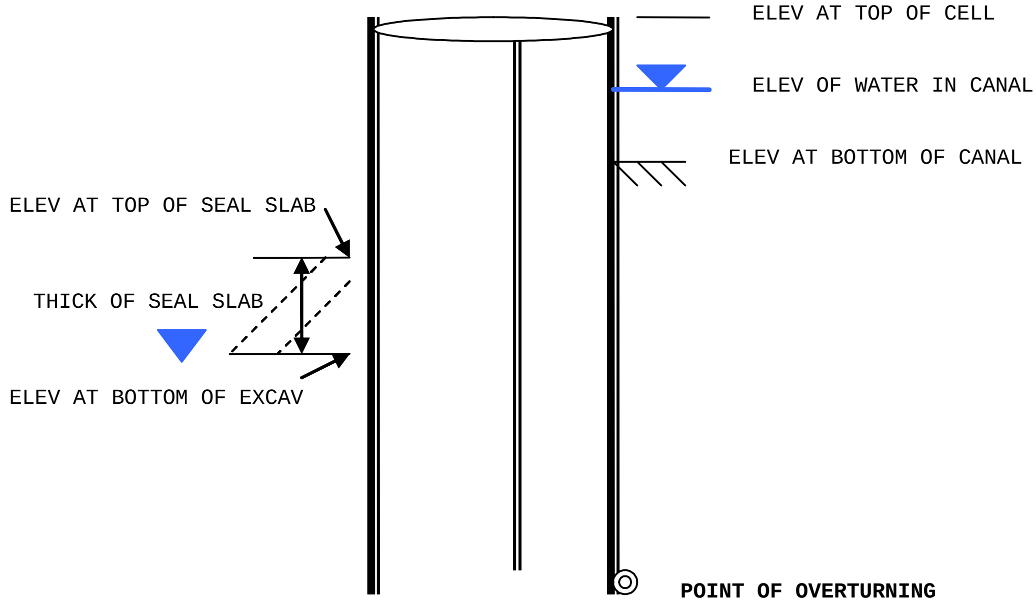
Elevation of Excavation $El_{exc} := El_{sealslab} - T_{sealslab}$ $El_{exc} = -36\ ft$

Length of Sheetpile above excavation $L_{cell} := El_{c\_top} - El_{exc}$ $L_{cell} = 42\ ft$

Use embedment that is 1/2 length above excvation $L_{emb} := \dfrac{L_{cell}}{2}$ $L_{emb} = 21\ ft$

Total Sheetpile Length $L_{sheet} := L_{cell} + L_{emb}$ $L_{sheet} = 63\ ft$

Elevation at Bottom of Sheets $EL_{c\_bot} := El_{c\_top} - L_{sheet}$ $EL_{c\_bot} = -57\ ft$



(ASSUME GROUNDWATER IS ENCOUNTERED BELOW SEAL SLAB)

Cofferdam Cell - Geometry

Vertical Geometry:

Check the stability of the cell at potential failure planes including the bottom of the sheets.

Failure Plane:

Elevation at Base of Fill $El_f := El_{exc}$ $El_f = -36\,ft$

$\phi_{soil} := 30deg$ $\phi_{fail} := \phi_{soil}$ $\phi_{fail} = 30\,deg$

Properties of Fill and Native Soil Materials

Fill Material in the Cell	Native Soil
$\gamma_{f\_sat} := 125psf$	$\gamma_{s\_sat} := 90psf$
$\gamma_{f\_b} := \gamma_{f\_sat} - \gamma_w$	$\gamma_{s\_b} := \gamma_{s\_sat} - \gamma_w$
$\gamma_{f\_b} = 62.6\,psf$	$\gamma_{s\_b} = 27.6\,psf$

Depth of fill $El_{c\_top} - El_f = 42\,ft$

Riverside Cells - Freebody Diagram

**Note :Diagram is for variable clarification and is not necessarily representative of this case.

Case 1 - Usual Load Condition Design High Tailwater

Water Level on Cofferdam Exterior: $EL_{we} := 5ft$

For uplift calculations assume that water pressure at face of cofferdam or excavation is zero. This can be modeled by assuming that the water surface on the inside of the cofferdam or excavation is at the failure plane.

Water Level on Cofferdam Interior: $EL_{wc\_i} := El_{exc}$ $\quad EL_{wc\_i} = -36\,ft$

Assume that the soil on the exterior face of the cofferdam has reached equilibrium and is saturated to the exterior water elevation.

Soil Saturation Elevation Exterior Face of Cell: $EL_{wc\_e} := El_{canal}$ $\quad EL_{wc\_e} = -10\,ft$

Depth of embedment of sheets: $H := El_{canal} - EL_{c\_bot}$

$H = 47\,ft$

Lateral Loads:

Force of water: Force of the water is equal all around the cell and thus not included in the analysis. The formula is left in the calculation for the future.

$$F_w := \frac{1}{2}\gamma_w \cdot \left(EL_{we} - El_f\right)^2 \qquad F_w = 52.45\,\frac{kip}{ft}$$

Moment Arm: $l_w := \left[\frac{1}{3}\cdot\left(EL_{we} - El_f\right)\right]$

Current Force: Water moving downstream one way on the canal will place a greater force on one side of the cell. Using the AASHTO Standard Specifications for Highway Bridges (2002) that river pressure is calculated from section 3.18.1.

$K_{stream} := 0.7$ This is a constant used for circular piers.

$C_1 := 0.80$ Adjusts the current velocity to the near shore condition for this project

$C_2 := 0.75$ Adjusts the current velocity to the normal load case

$V_{avg} := 7 \cdot C_1 \cdot C_2$ Average velocity in fps for the canal

$P_{avg} := K_{stream} \cdot V_{avg}^{2} \cdot psf$

$P_{avg} = 12.35\ psf$

$F_{current} := \left[P_{avg} \cdot B_{eff} \cdot \left(EL_{we} - El_{canal}\right)\right]$ $\quad F_{current} = 8.15\ kip$

Moment Arm: $l_{current} := \left(EL_{we} - El_{canal}\right) \cdot \left(\frac{2}{3}\right) + \left(El_{canal} - EL_{c\_bot}\right)$

Drag on crane barge:

$F_{drag} := 27.82 \cdot kip$ From barge drag calculations

Moment Arm: $l_{drag} := EL_{we} - 3 \cdot ft - EL_{c\_bot}$

Impact Force:

$F_{impact} := 80kip$

This is the impact load that the calculation says a cell can take when it is struck. This load is iterated on until a solution is reached and the base of the cell is 100% in compression. This calculation does take into account the added benefit of the weight of the concrete plug, but it does not add in the benefit that the plug adds to the pullout failure mode.

Moment Arm: $l_{impact} := EL_{we} + 3ft - EL_{c\_bot}$

Active Pressure:

$K_a := \frac{\left(1 - \sin\left(\phi_{soil}\right)\right)}{\left(1 + \sin\left(\phi_{soil}\right)\right)}$ $\quad P_a := 0.5 \cdot \gamma_{soil\_b} \cdot K_a \cdot H^{2} \cdot B_{eff}$ $\quad P_a = 609.22\ kip$

Moment Arm: $l_a := \left[\frac{1}{3} \cdot \left(El_{canal} - EL_{c\_bot}\right)\right]$ $\quad K_a = 0.33$

Passive Pressure:

In EM 1110-2-2502, the passive pressure phi angle is reduced and it is appropriate to perform the same operation here.

$FS := 1.5$

$\phi_{soil\_p} := atan\left(\frac{\tan\left(\phi_{soil}\right)}{FS}\right)$ $\quad \phi_{soil\_p} = 21.05\ deg$

$$K_p := \frac{(1 + \sin(\phi_{soil\_p}))}{(1 - \sin(\phi_{soil\_p}))} \qquad P_p := 0.5 \cdot \gamma_{soil\_b} \cdot K_p \cdot H^2 \cdot B_{eff} \qquad P_p = 3.88 \times 10^3 \, kip$$

$$l_p := \left[\frac{1}{3} \cdot (El_{canal} - EL_{c\_bot})\right] \qquad K_p = 2.12$$

Force from the Ice (Ice forces will not coincide with impact forces):

$F_{ice} := 0 kip$

Moment Arm: $l_{ice} := 0 ft$

Vertical Loads:

Surcharge : $w_{schg} := 250 \cdot psf$

The Surcharge provides an allowance for equipment on the top of the cell.

$$W_{schg} := w_{schg} \cdot B_{eff}^{\ 2} \qquad W_{schg} = 484.2 \, kip$$

$$l_{schg} := \frac{B_{eff}}{2} \qquad l_{schg} = 22 \, ft$$

Fill Below Water line:

$$W_{fill\_2} := \left[\gamma_{soil\_b} \cdot \left[B_{eff} \cdot (EL_{wc\_i} - El_{sealslab}) \cdot B_{eff}\right]\right] + \left[\gamma_{conc\_b} \cdot \left[B_{eff} \cdot (El_{sealslab} - EL_{c\_bot}) \cdot B_{eff}\right]\right]$$

$$W_{fill\_2} = 8.28 \times 10^3 \, kip$$

Moment Arm (from toe) $l_{fill\_2} := \frac{1}{2} B_{eff}$ $\qquad l_{fill\_2} = 22 \, ft$

Fill Above Water Line: $W_{fill\_1} := \gamma_{soil\_sat} \cdot \left[B_{eff} (El_{c\_top} - EL_{wc\_i}) \cdot B_{eff}\right]$ $\qquad W_{fill\_1} = 8.13 \times 10^3 \, kip$

Moment Arm (from toe) $l_{fill\_1} := \frac{1}{2} B_{eff}$ $\qquad l_{fill\_1} = 22 \, ft$

Calculate Total Moments and Forces:

Moments are calculated about the point of rotation (the toe of the cell).

Resisting Moment: $M_{resist} := W_{fill\_1} \cdot l_{fill\_1} + W_{fill\_2} \cdot l_{fill\_2} + P_p \cdot l_p$

Overturning Moment $M_{over} := F_{current} \cdot l_{current} + F_{drag} \cdot l_{drag} + F_{impact} \cdot l_{impact} + P_a \cdot l_a$

Net Moment: $M_{net} := (M_{resist}) - M_{over}$

$M_{resist} = 4.2 \times 10^5 \, kip \cdot ft$ $M_{over} = 1.7 \times 10^4 \, kip \cdot ft$ $M_{net} = 4 \times 10^5 \, kip \cdot ft$

Total Gross Weight/Vertical Forces: $F_{vert} := W_{fill\_1} + W_{fill\_2}$

Total Driving Force: $F_{drive} := F_{impact} + F_{current} + P_a$

Total Horizontal Force from soil pressure: $F_{resist} := P_p$

$F_{vert} = 1.6 \times 10^4 \, kip$ $F_{drive} = 697.4 \, kip$ $F_{resist} = 3876.8 \, kip$

Resultant Location:

$$x_{r1} := \frac{M_{net}}{F_{vert}} \qquad x_{r1} = 24.68 \, ft$$

$$\%_{comp1} := \min\left(3 \cdot \frac{x_{r1}}{B_{eff}}, 1\right) \qquad \%_{comp1} = 100\,\%$$

Per criteria resultant must be within middle third which is equivalent to 100% of base in compression, overturning is OK

$$\%_{comp\_norm} := 100\%$$

$$Check_{overturn\_norm} := if\left(\%_{comp1} \geq \%_{comp\_norm}, \text{"OK"}, \text{"No Good"}\right)$$

$$Check_{overturn\_norm} = \text{"OK"}$$

External Stability Check - Load Case 1

Sliding Factor of Safety Criteria: $FOS_{slide\_norm} := 1.5$

No cohesion at any interface: $c_x := 0 \cdot ksi$

$$V_{all} := F_{vert} \cdot \tan(\phi_{fail}) + c_x \cdot \left(B_{eff}^{\,2} \cdot \%_{comp1}\right)$$

$$FOS_{slide} := \frac{(V_{all} + F_{resist})}{F_{drive}}$$

$$FOS_{slide} = 19.15$$

$$Check_{slide\_norm} := if(FOS_{slide} \geq FOS_{slide\_norm}, \text{"OK"}, \text{"No Good"})$$

$$Check_{slide\_norm} = \text{"OK"}$$

Bearing Capacity Check:

Eccentricity

$$e_1 := \frac{B_{eff}}{2} - x_{r1}$$

$$e_1 = -2.67\,ft$$

Maximum Foundation Pressure:

$$q_{bearing} := if\left[\%_{comp1} < 1.0, \left[4 \cdot \frac{F_{vert}}{3B_{eff} \cdot [(B_{eff}) - 2 \cdot e_1]}\right], \frac{F_{vert}}{B_{eff}^2} \cdot \left(1 + 6 \cdot \frac{e_1}{B_{eff}}\right)\right]$$

$$q_{bearing} = 5.38 \frac{kip}{ft^2}$$

$$q_{bearing} := if(\%_{comp1} \leq 0.0, 0 \cdot ksf, q_{bearing})$$

$$q_{min} := if\left[\%_{comp1} < 1.0, 0 \cdot ksf, \frac{F_{vert}}{B_{eff}^2} \cdot \left(1 - 6 \cdot \frac{e_1}{B_{eff}}\right)\right]$$

$$q_{min} = 11.56 \frac{kip}{ft^2}$$

Bearing Capacity Check

Cell 15WC will be sitting entirely on a concrete dam so there are no bearing capacity issues. The bearing capacity is still checked throughout the calculation, but the results indicating a bearing capacity issue are ignored since the cell will be bearing on concrete.

Purpose: Estimate the bearing capacity of the soil beneath the cell.

Using Terzaghi's Equation for a circular footing:

$$q_{ult} := 1.3 \cdot c \cdot N_c + \sigma_{zd} \cdot N_q + 0.3 \gamma_{effective} \cdot B_{eff} \cdot N_\gamma$$

q_{ult} = ultimate bearing capacity

c' = effective cohesion for soil beneath a foundation

N_c, N_q, N_γ = Terzaghi's Bearing Capacity Factors

σ'_{zd} = vertical effective stress at depth D below the ground surface

B = width of footing

$\gamma_{effective}$ = effective unit weight of soil

FS = Factor of Safety

Soil Conditions and input values:

$\phi := 32deg$

$c := 0psf$

$H = 47\,ft$

$B_{eff} = 44.01\,ft$

$\sigma_{zd} := (H \cdot \gamma_{soil\_b})$

$N_c := 44$

$N_q := 28.5$

$N_\gamma := 28$

$FS := 3$

$\sigma_{zd} = 1.77 \times 10^3\,psf$

$q_{ult} := 1.3 \cdot c \cdot N_c + \sigma_{zd} \cdot N_q + 0.3 \gamma_{soil\_b} \cdot B_{eff} \cdot N_\gamma$

$q_{ult} = 6.43 \times 10^4\,psf$

$FS_{bearing\_norm} := 3$

$$q_{allowable} := \frac{q_{ult}}{FS_{bearing\_norm}}$$

$q_{allowable} = 21.42\,ksf$

$Check_{bearing\_capacity} := if(q_{allowable} \ge q_{bearing}, \text{"OK"}, \text{"No Good"})$

$Check_{bearing\_capacity} = \text{"OK"}$

Save data for summary table

$j := 0$

$$Table_{(j)} := \left(\frac{M_{net}}{kip \cdot ft} \quad \frac{F_{drive}}{kip} \quad \frac{F_{vert}}{kip} \quad \frac{x_{r1}}{ft} \quad FOS_{slide} \quad \frac{q_{min}}{ksf} \quad \frac{q_{bearing}}{ksf} \right)$$

Internal Stability Check - Load Case 1

VERTICAL SHEAR RESISTANCE

Excessive shear on a vertical plane through the center of the cell is a possible mode of failure by tilting. For stability the shearing resistance of the fill and the frictional resistance in the interlocks must exceed the shear do to the overturning forces.

Calculate coefficient of earth pressure (by Kryine) for use in the fill, and the resulting earth pressures for moist and saturated states.

$$K_c := \frac{\cos(\phi_{soil})^2}{2 - \cos(\phi_{soil})^2} \qquad K_c = 0.6$$

$$p_c := \gamma_{soil\_sat} \cdot K_c \qquad p_c = 60\,\text{pcf}$$

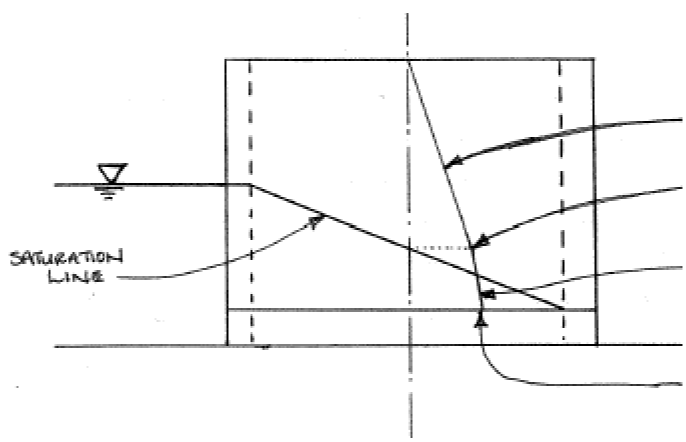
$$p'_c := \gamma_{soil\_b} \cdot K_c \qquad p'_c = 22.56\,\text{pcf}$$

Calculate the resulting pressures at the top of the cell, the water level within the cell, and the base of the cell to define the pressure diagram:

$$p_{c\_top} := w_{schg}$$

$$p_{c\_moist} := p_c \cdot (El_{c\_top} - EL_{we}) + p_{c\_top} \qquad p_{c\_moist} = 0.31\,\text{ksf}$$

$$p_{c\_bot} := p'_c \cdot [(EL_{we}) - EL_{c\_bot}] + p_{c\_moist} \qquad p_{c\_bot} = 1.71\,\text{ksf}$$



$p_c = 60 \frac{psf}{ft}$

$p_{c\_moist} = 0.31\,\text{ksf}$

$p'_c = 22.56 \frac{psf}{ft}$

$p_{c\_bot} = 1.71\,\text{ksf}$

Calculate coefficient of earth pressure for at the piling to calculate interlock forces, and the resulting earth pressures for moist and saturated states.

$K_{sp} := 1.5 \cdot K_a$ $\quad K_{sp} = 0.5$

$p_{sp} := \gamma_{soil\_sat} \cdot K_{sp}$ $\quad p_{sp} = 50\,\text{pcf}$

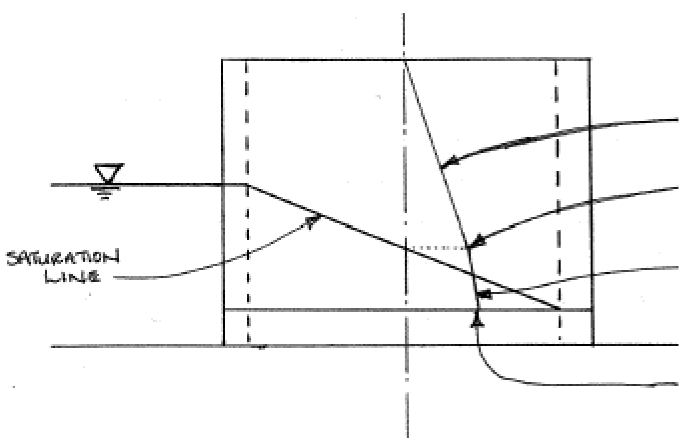
$p'_{sp} := \gamma_{soil\_b} \cdot K_{sp}$ $\quad p'_{sp} = 18.8\,\text{pcf}$

Calculate the resulting pressures at the top of the cell, the water level within the cell, and the base of the cell to define the pressure diagram:

$p_{sp\_top} := w_{schg}$

$p_{sp\_moist} := p_{sp} \cdot (El_{c\_top} - EL_{we}) + p_{sp\_top}$ $\quad p_{sp\_moist} = 0.3\,\text{ksf}$

$p_{sp\_bot} := p'_{sp} \cdot (EL_{we} - EL_{c\_bot}) + p_{sp\_moist}$ $\quad p_{sp\_bot} = 1.47\,\text{ksf}$



$p_{sp} = 50\,\frac{\text{psf}}{\text{ft}}$

$p_{sp\_moist} = 0.3\,\text{ksf}$

$p'_{sp} = 18.8\,\frac{\text{psf}}{\text{ft}}$

$p_{sp\_bot} = 1.47\,\text{ksf}$

Calculate total lateral pressure due to cell fill:

$$P_C := B_{eff} \cdot \left[\frac{1}{2} \cdot p_{c\_moist} \cdot (El_{c\_top} - EL_{we}) + \frac{1}{2} \cdot (p_{c\_moist} + p_{c\_bot}) \cdot (EL_{we} - EL_{c\_bot}) \right]$$

$P_C = 2760.9\,\text{kip}$

Calculate total lateral pressure at sheet piling resulting in interlock tension.

$$P_T := B_{eff} \cdot \left[\frac{1}{2} \cdot p_{sp\_moist} \cdot \left(El_{c\_top} - EL_{we} \right) + \frac{1}{2} \cdot \left(p_{sp\_moist} + p_{sp\_bot} \right) \cdot \left(EL_{we} - El_{canal} \right) \right]$$

$$P_T = 589.4 \text{ kip}$$

Calculate shear resistance of fill and pile interlock friction.

$$Q_R := P_C \cdot \tan\left(\phi_{soil}\right) + f \cdot P_T \qquad Q_R = 1.74 \times 10^3 \text{ kip}$$

Calculate shear flow:

$$Q := \frac{3 \cdot \left(P_p \cdot l_p - P_a \cdot l_a + F_{current} \cdot l_{current} + F_{impact} \cdot l_{impact} \right)}{2 \cdot B_{eff}} \qquad Q = 1.94 \times 10^3 \text{ kip}$$

Calculate factor of safety for vertical shear:

$$FOS_{v\_shear\_norm} := 1.1$$

$$FS := \frac{Q}{Q_R} \qquad FS = 1.11$$

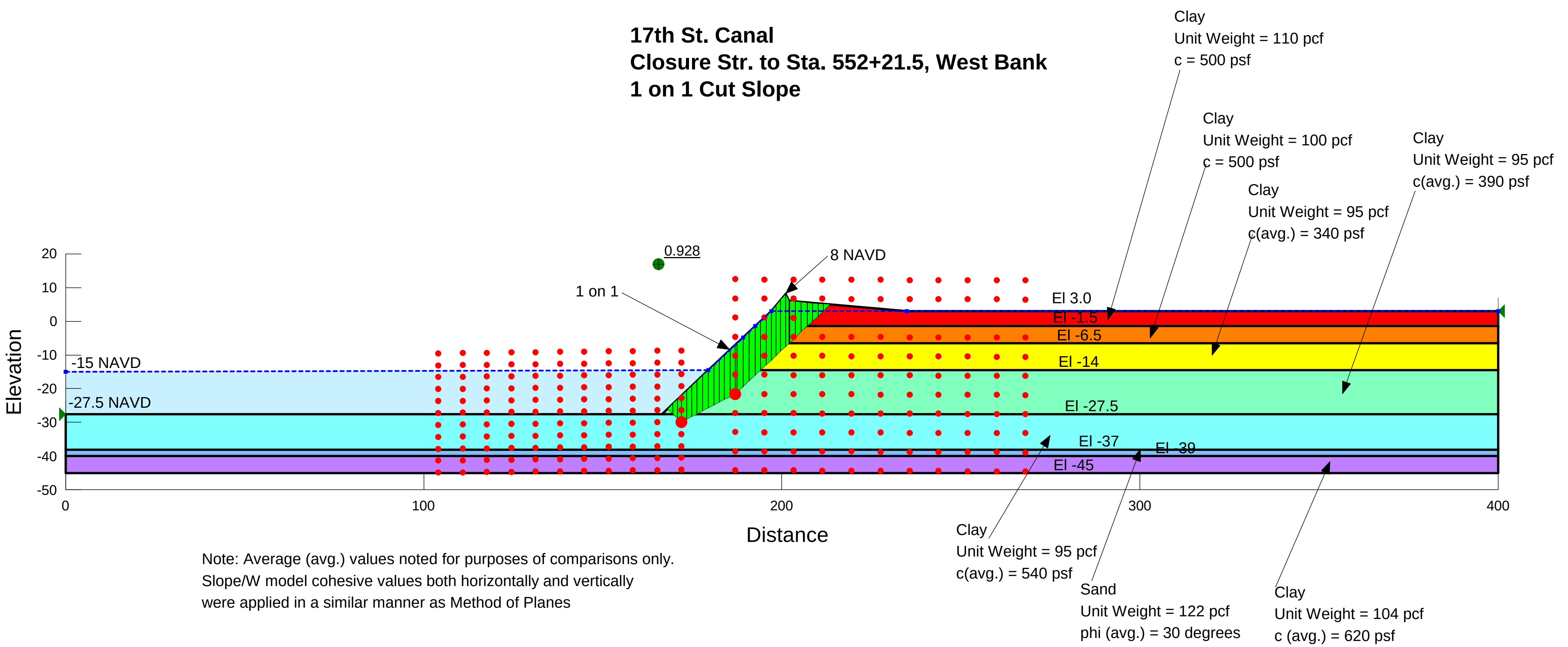
$$\text{Vertical\_Shear\_Check} := \text{if}\left(FS > FOS_{v\_shear\_norm}, \text{"OK"}, \text{"NG"} \right)$$

$$\text{Vertical\_Shear\_Check} = \text{"OK"}$$

D.2 Canal Deepening

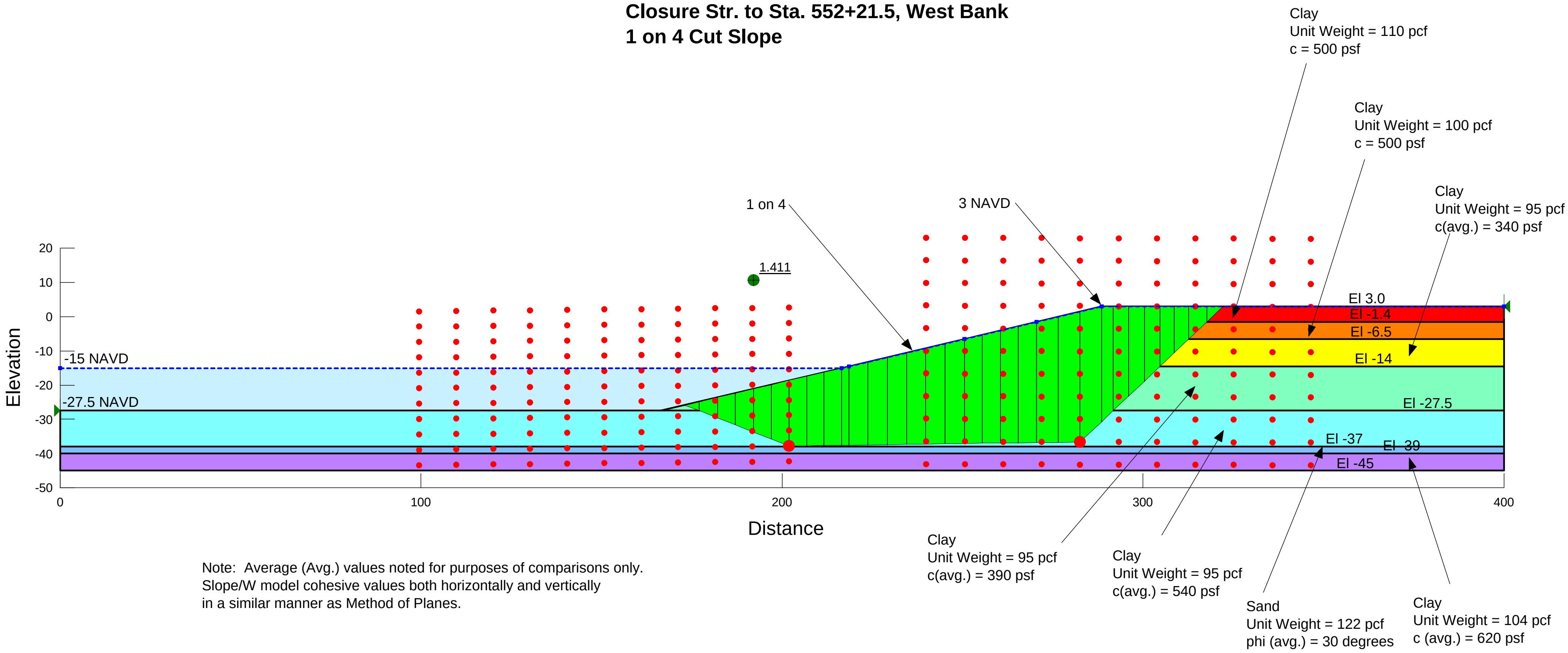
D.2.1 Open Cut Slope Stability

D.2.1 .1 - 17th St Canal
Steepened Slope (1V:1H)
FOS =1.4



Note: Average (avg.) values noted for purposes of comparisons only.
Slope/W model cohesive values both horizontally and vertically
were applied in a similar manner as Method of Planes

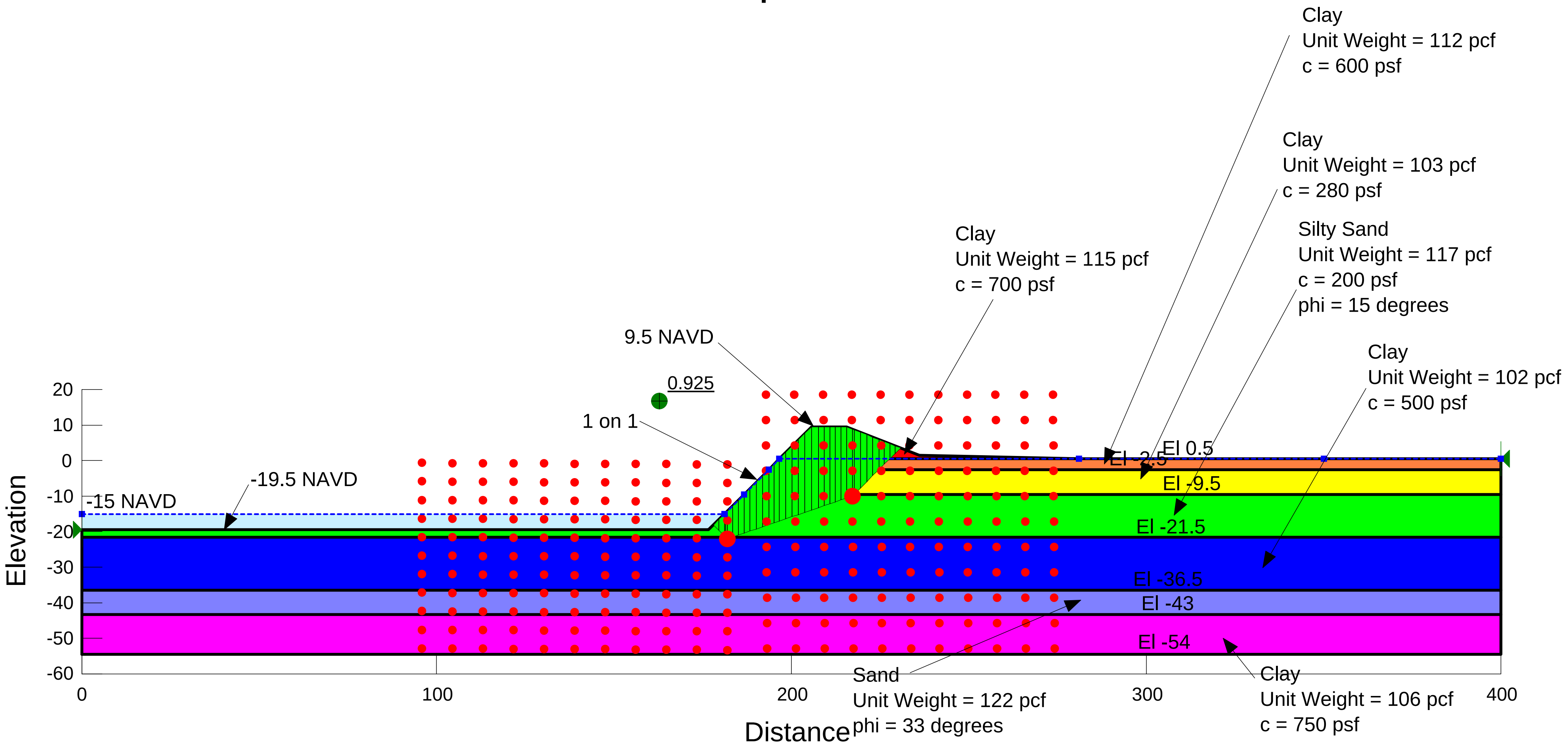
17th St. Canal
Closure Str. to Sta. 552+21.5, West Bank
1 on 4 Cut Slope



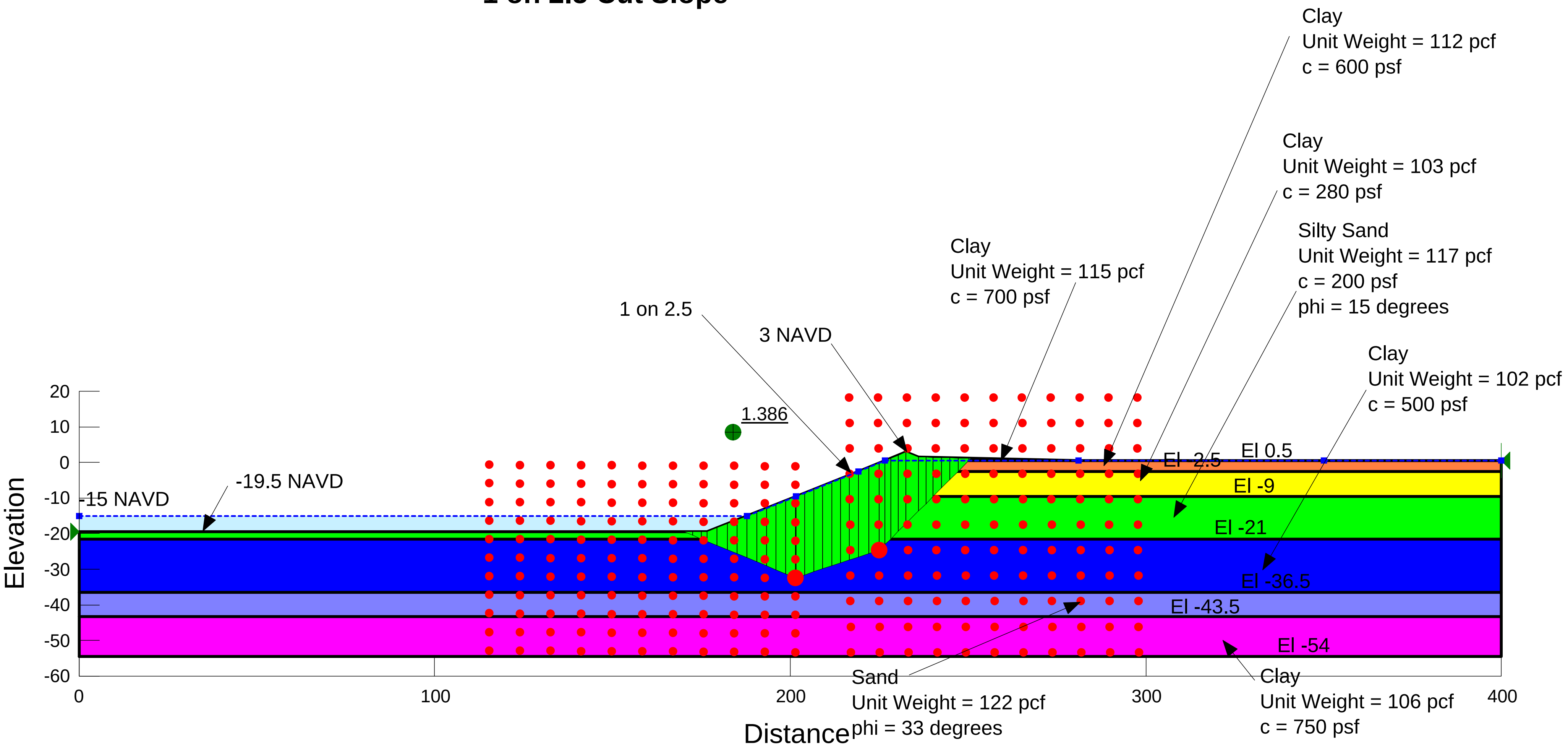
Note: Average (Avg.) values noted for purposes of comparisons only.
Slope/W model cohesive values both horizontally and vertically
in a similar manner as Method of Planes.

D.2.1 .2 - Orleans Canal
Steepened Slope (1V:1H)
FOS =1.4

Orleans Canal
Sta. 104+00 to Lakefront, East/West Banks
1 on 1 Cut Slope

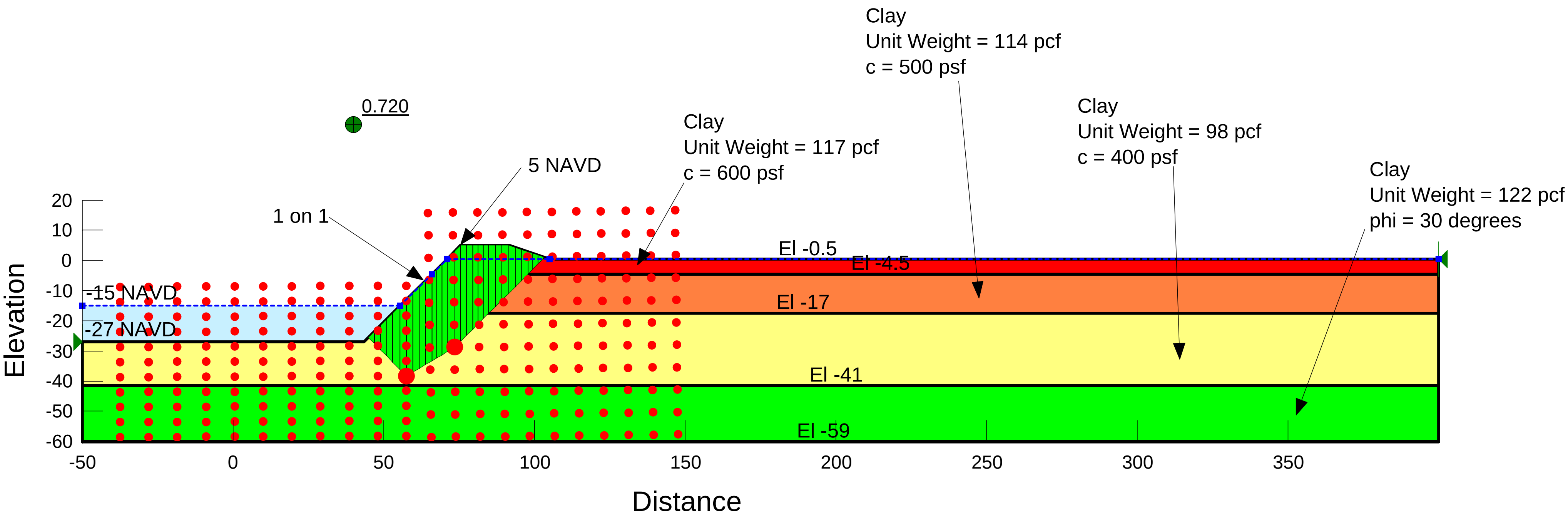


Orleans Canal
Sta. 104+00 to Lakefront, East/West Banks
1 on 2.5 Cut Slope

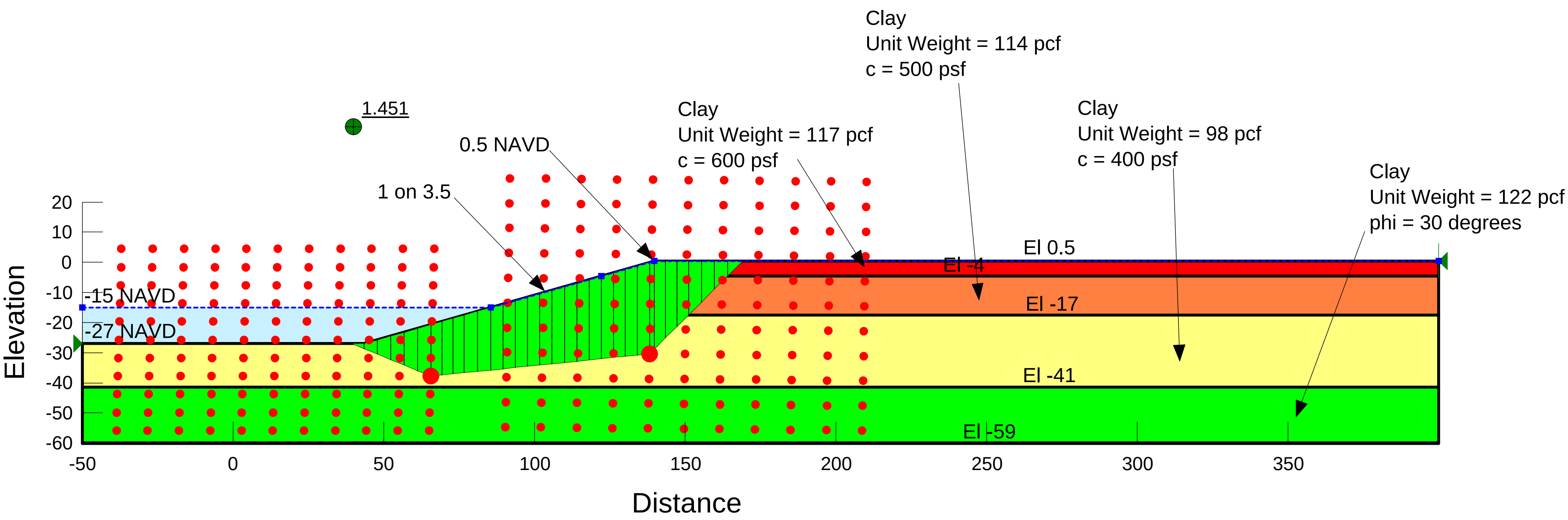


D.2.1 .1 - London Canal
Steepened Slope (1V:1H)
FOS =1.4

London Canal
Sta. 18+00 to 37+00, West Bank
1 on 1 Cut Slope



London Canal
Sta. 18+00 to 37+00, West Bank
1 on 3.5 Cut Slope



D.2.2 Seepage

D.3 Canal Excavation Alternatives

MEMORANDUM

USACE - HPO
90-Day Study
Canal Deepening – Seepage Analysis
Drawdown

B&V Project 41919
Task 2.5C
December 29, 2008

SEEPAGE EVALUATION

A. CANAL WITH MODIFIED SOIL SLOPES

The intent of this analysis was to evaluate the potential for drawdown of the groundwater on the land side of the canal due to the canal deepening. The side slopes of the canal are to be modified with jet grouting to reduce permeability and deep soil mixing to increase strength. The groundwater is assumed to be at elevation -1 feet and the constant head source is 1200 feet from the edge of the canal.

Hydraulic conductivities for the soil were provided in the IPET report, Appendix V-8, page 3, (See Below). Soil layering is a general profile and is not related to any specific canal system.

> relevant materials are the sand at the base of the section, the overlying marsh (peat) layer, and the clayey levee fill. The permeability of the sand, based on field pumping tests, was 1.5×10^{-2} cm/sec. The permeability of the marsh layer was estimated as 1×10^{-5} cm/sec, and the permeability of the levee fill and the Bay Sound clay was estimated as 1×10^{-6} cm/sec. Thorough

The hydraulic conductivity of the soil modification is assumed between 1×10^{-6} and 1×10^{-7} cm/sec. The following sentence is from FHWA-RD-99-138, "An Introduction to Deep Soil Mixing Methods as Used in Geotechnical Applications". For the analysis, the hydraulic conductivity was varied to evaluate the difference in drawdown adjacent to the canal.

> Either soil/cement walls (UCS of 0.1 to 2 MPa and a permeability of 10^{-8} to 10^{-9} m/s,) soil-bentonite, or soil-clay-bentonite walls (permeability of 10^{-9} to 10^{-10} m/s) can be formed (the latter as low-strength cut-offs at sites with low differential heads).

SUMMARY –
The results of the steady-state seepage analysis indicate that modified soil with hydraulic conductivity of 1×10^{-6} cm/sec will have a drawdown of 1 foot at a distance of 280 feet from the edge of the canal. The modified soil with hydraulic conductivity of 1×10^{-7} cm/sec will have a drawdown of less than 1 foot at a distance of 50 feet from the edge of the canal.

B. CANAL WITH NO FLOW SIDE BOUNDARY AND PRESSURE RELIEF BASE

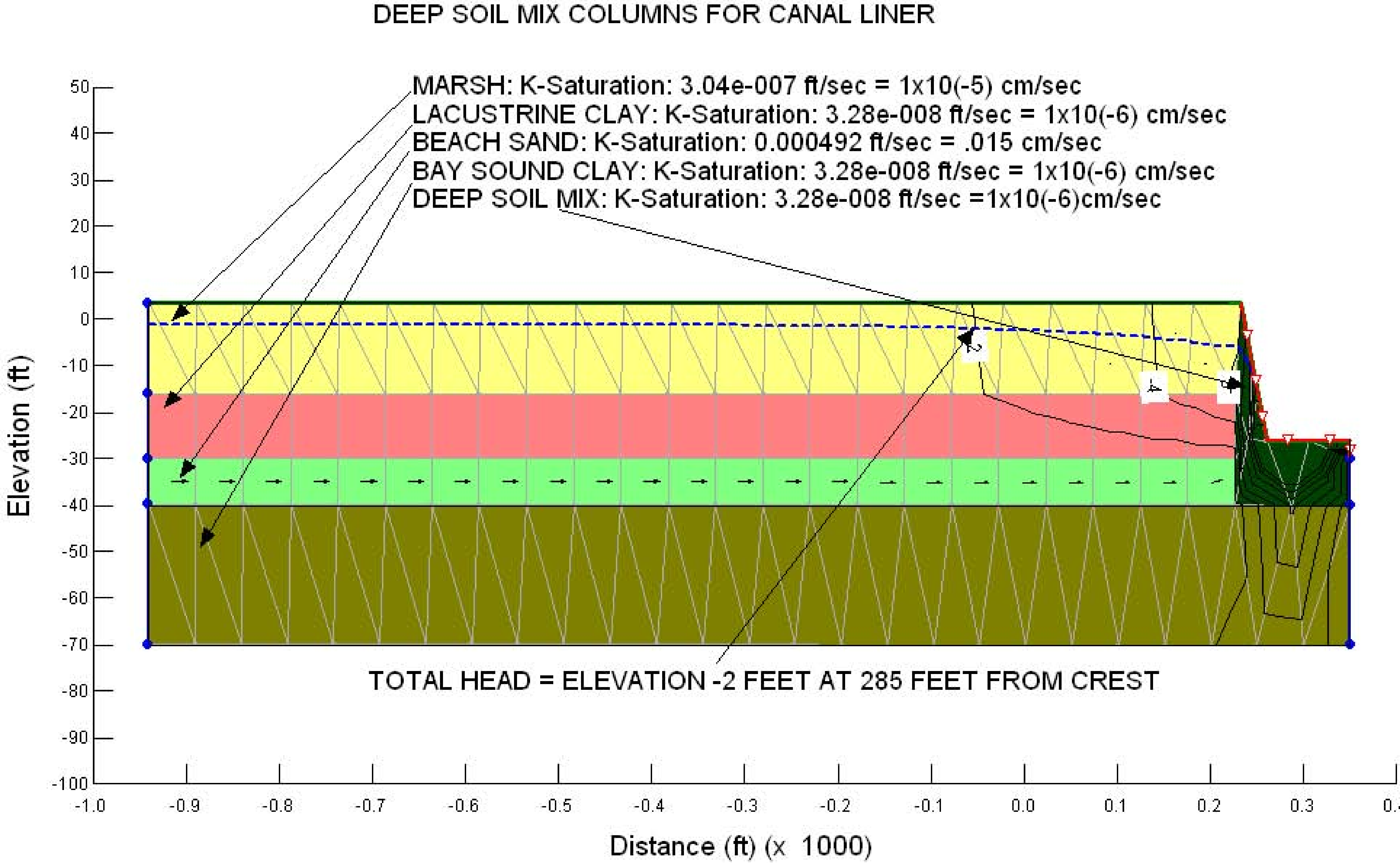
The intent of this analysis is to evaluate the canal model presented in the 2006 report. The analysis assumes the canal side slope is an impermeable vertical barrier below elevation -10 feet. The base of the canal is assumed to have pressure relief at the base.

SUMMARY –
For the condition with a no flow boundary at the side and seepage relief at the base, the drawdown ranged from 1 foot at a distance of approximately 300 feet with approximately 5 feet of drawdown at 100 feet from the canal.

MARSH: K-Saturation: 3.04e-007 ft/sec = 1x10(-5) cm/sec
LACUSTRINE CLAY: K-Saturation: 3.28e-008 ft/sec = 1x10(-6) cm/sec
BEACH SAND: K-Saturation: 0.000492 ft/sec = .015 cm/sec
BAY SOUND CLAY: K-Saturation: 3.28e-008 ft/sec = 1x10(-6) cm/sec
PRESSURE RELIEF AT BASE
Elevation (ft)
Distance (ft) (x 1000)


MARSH: K-Saturation: 3.04e-007 ft/sec = 1x10(-5) cm/sec
LACUSTRINE CLAY: K-Saturation: 3.28e-008 ft/sec = 1x10(-6) cm/sec
BEACH SAND: K-Saturation: 0.000492 ft/sec = .015 cm/sec
BAY SOUND CLAY: K-Saturation: 3.28e-008 ft/sec = 1x10(-6) cm/sec
PRESSURE RELIEF AT BASE
-2
-4
-6
TOTAL HEAD = ELEVAITON -2 AT 290 FEET FROM CREST
Elevation (ft)
Distance (ft) (x 1000)
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-1.0
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0
0.1
0.2
0.3
0.4

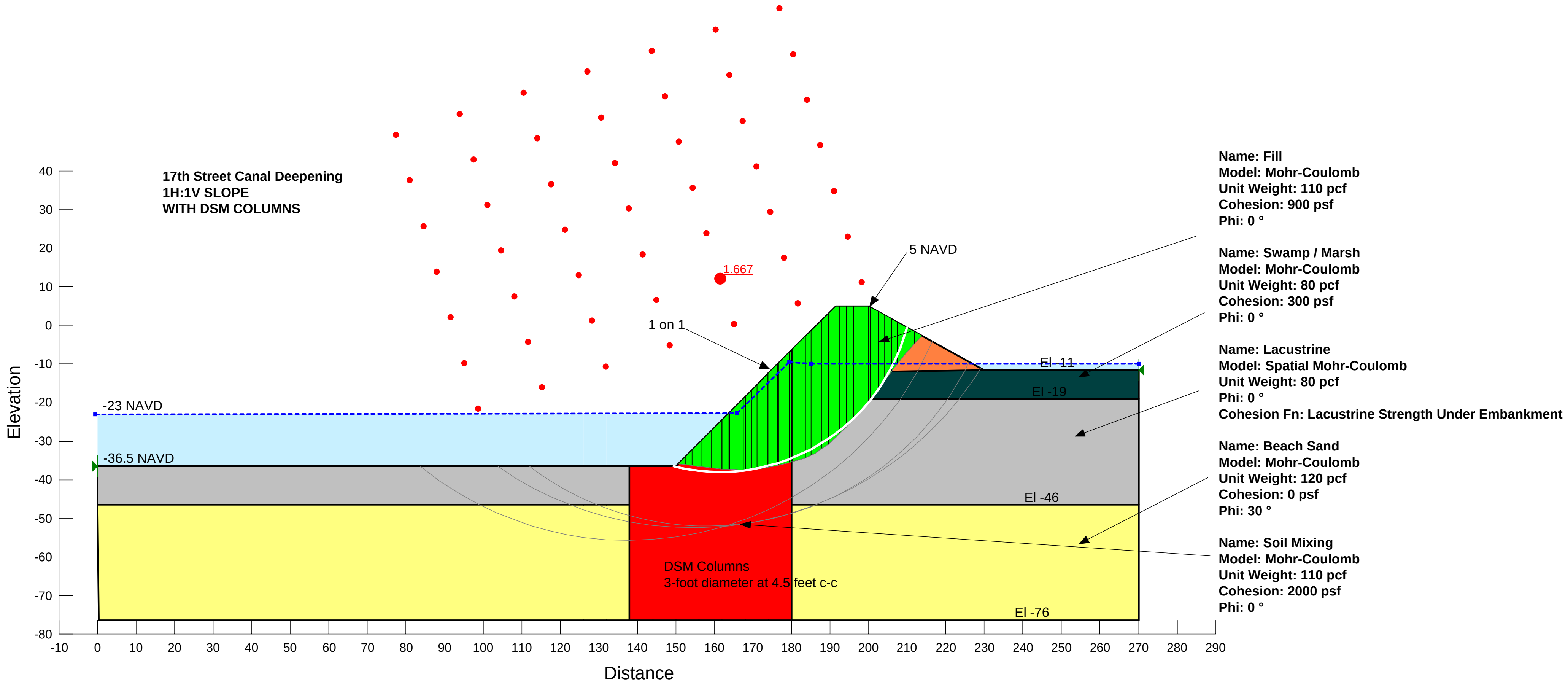
DEEP SOIL MIX COLUMNS FOR CANAL LINER

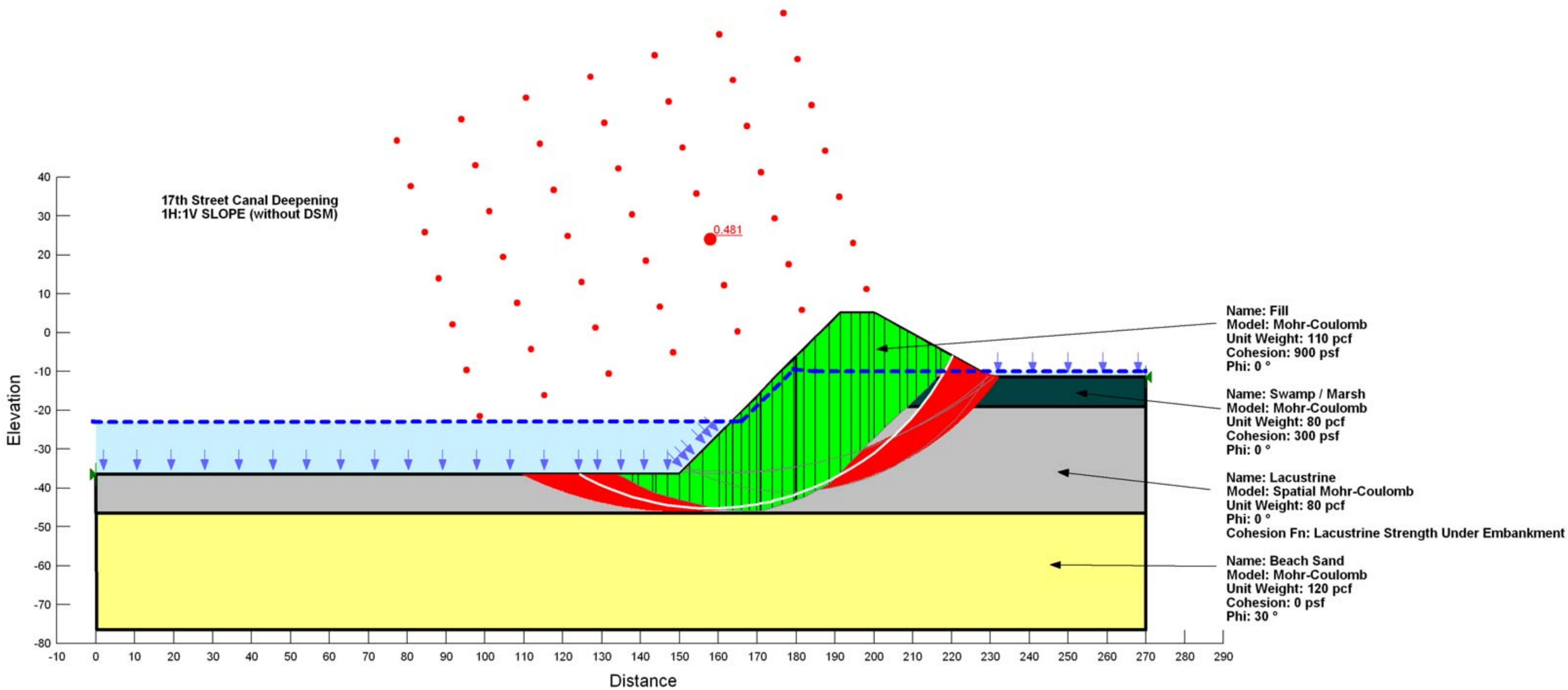

DEEP SOIL MIX COLUMNS FOR CANAL LINER
MARSH: K-Saturation: 3.04e-007 ft/sec = 1x10(-5) cm/sec
LACUSTRINE CLAY: K-Saturation: 3.28e-008 ft/sec = 1x10(-6) cm/sec
BEACH SAND: K-Saturation: 0.000492 ft/sec = .015 cm/sec
BAY SOUND CLAY: K-Saturation: 3.28e-008 ft/sec = 1x10(-6) cm/sec
DEEP SOIL MIX: K-Saturation: 3.28e-008 ft/sec =1x10(-6)cm/sec
TOTAL HEAD = ELEVATION -2 FEET AT 285 FEET FROM CREST
Elevation (ft)
Distance (ft) (x 1000)
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-1.0
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0
0.1
0.2
0.3
0.4

DEEP SOIL MIX COLUMNS FOR CANAL LINER

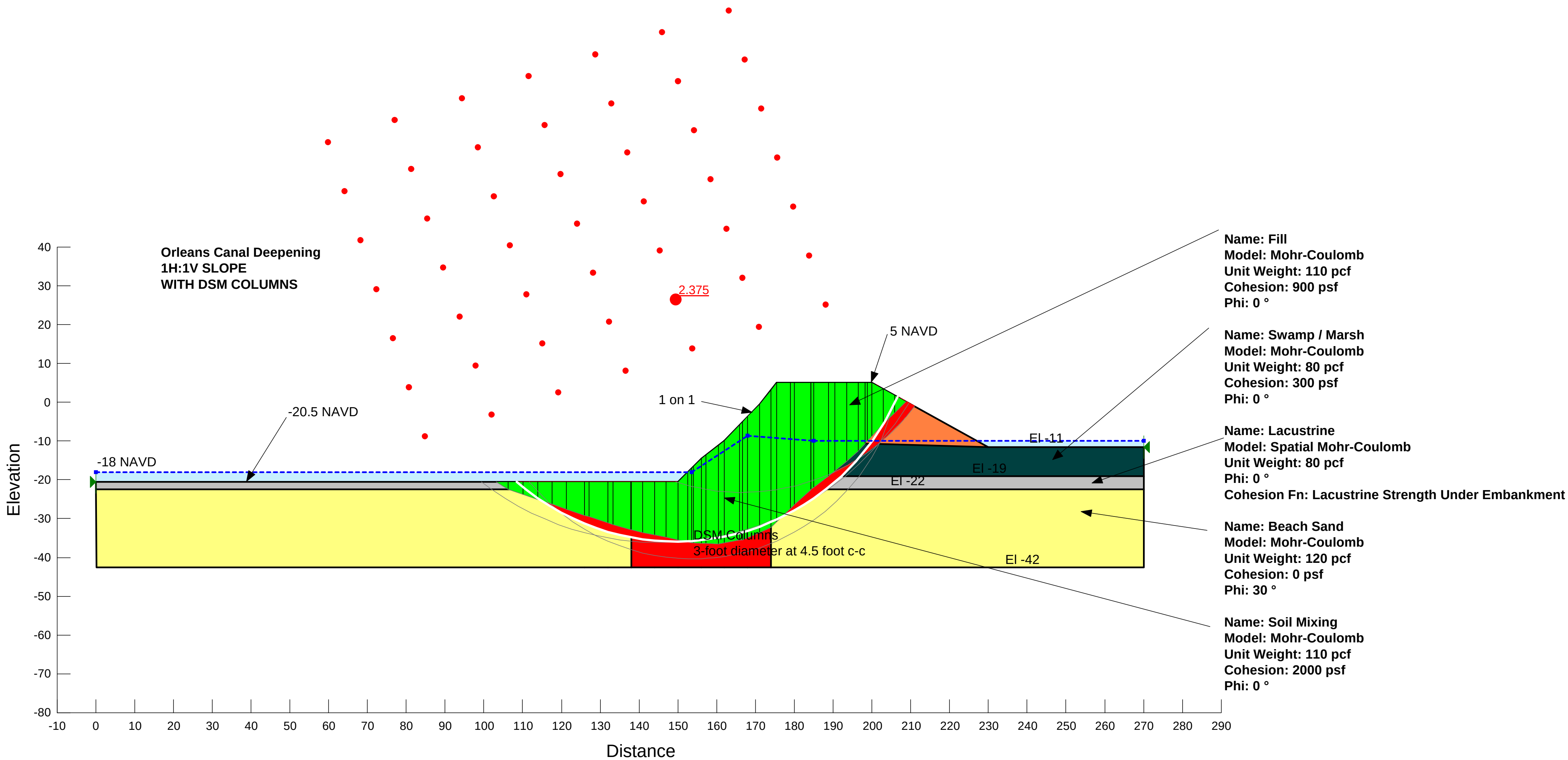
DEEP SOIL MIX COLUMNS FOR CANAL LINER
MARSH: K-Saturation: 3.04e-007 ft/sec = 1x10(-5) cm/sec
LACUSTRINE CLAY: K-Saturation: 3.28e-008 ft/sec = 1x10(-6) cm/sec
BEACH SAND: K-Saturation: 0.000492 ft/sec = .015 cm/sec
BAY SOUND CLAY: K-Saturation: 3.28e-008 ft/sec = 1x10(-6) cm/sec
DEEP SOIL MIX: K-Saturation: 3.28e-009 ft/sec =1x10(-7)cm/sec
TOTAL HEAD = ELEVATION -1 FEET AT 100 FEET FROM CREST
Elevation (ft)
Distance (ft) (x 1000)
-2
-4

D.3.1 17th St. Canal

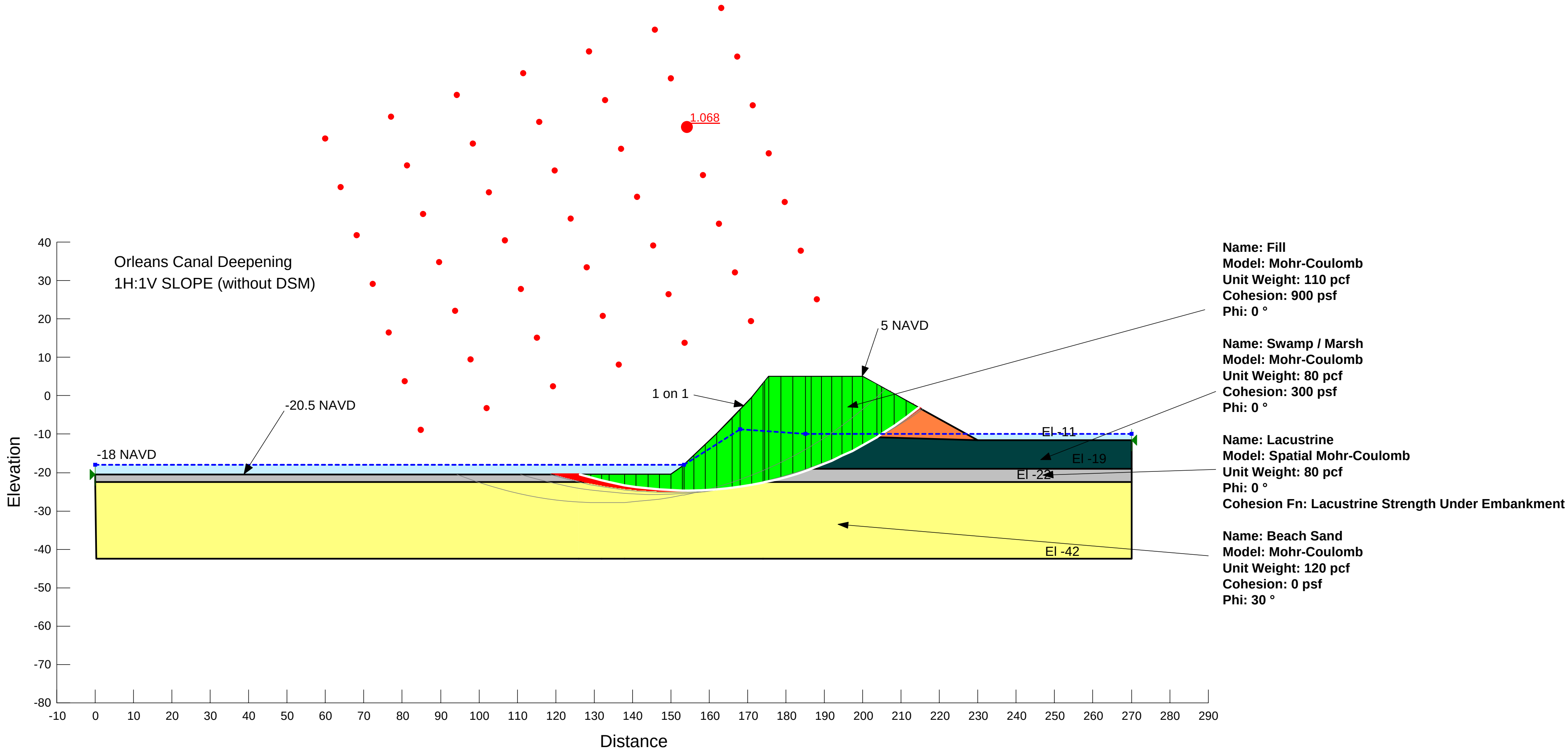

17th Street Canal Deepening
1H:1V SLOPE
WITH DSM COLUMNS
1.667
5 NAVD
1 on 1
El -11
El -19
-23 NAVD
-36.5 NAVD
El -46
El -76
DSM Columns
3-foot diameter at 4.5 feet c-c
Name: Fill
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 900 psf
Phi: 0 °
Name: Swamp / Marsh
Model: Mohr-Coulomb
Unit Weight: 80 pcf
Cohesion: 300 psf
Phi: 0 °
Name: Lacustrine
Model: Spatial Mohr-Coulomb
Unit Weight: 80 pcf
Phi: 0 °
Cohesion Fn: Lacustrine Strength Under Embankment
Name: Beach Sand
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Name: Soil Mixing
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 2000 psf
Phi: 0 °
Elevation
Distance
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290


17th Street Canal Deepening
1H:1V SLOPE (without DSM)
0.481
Name: Fill
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 900 psf
Phi: 0 °
Name: Swamp / Marsh
Model: Mohr-Coulomb
Unit Weight: 80 pcf
Cohesion: 300 psf
Phi: 0 °
Name: Lacustrine
Model: Spatial Mohr-Coulomb
Unit Weight: 80 pcf
Phi: 0 °
Cohesion Fn: Lacustrine Strength Under Embankment
Name: Beach Sand
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Elevation
Distance

D.3.2 Orleans Canal

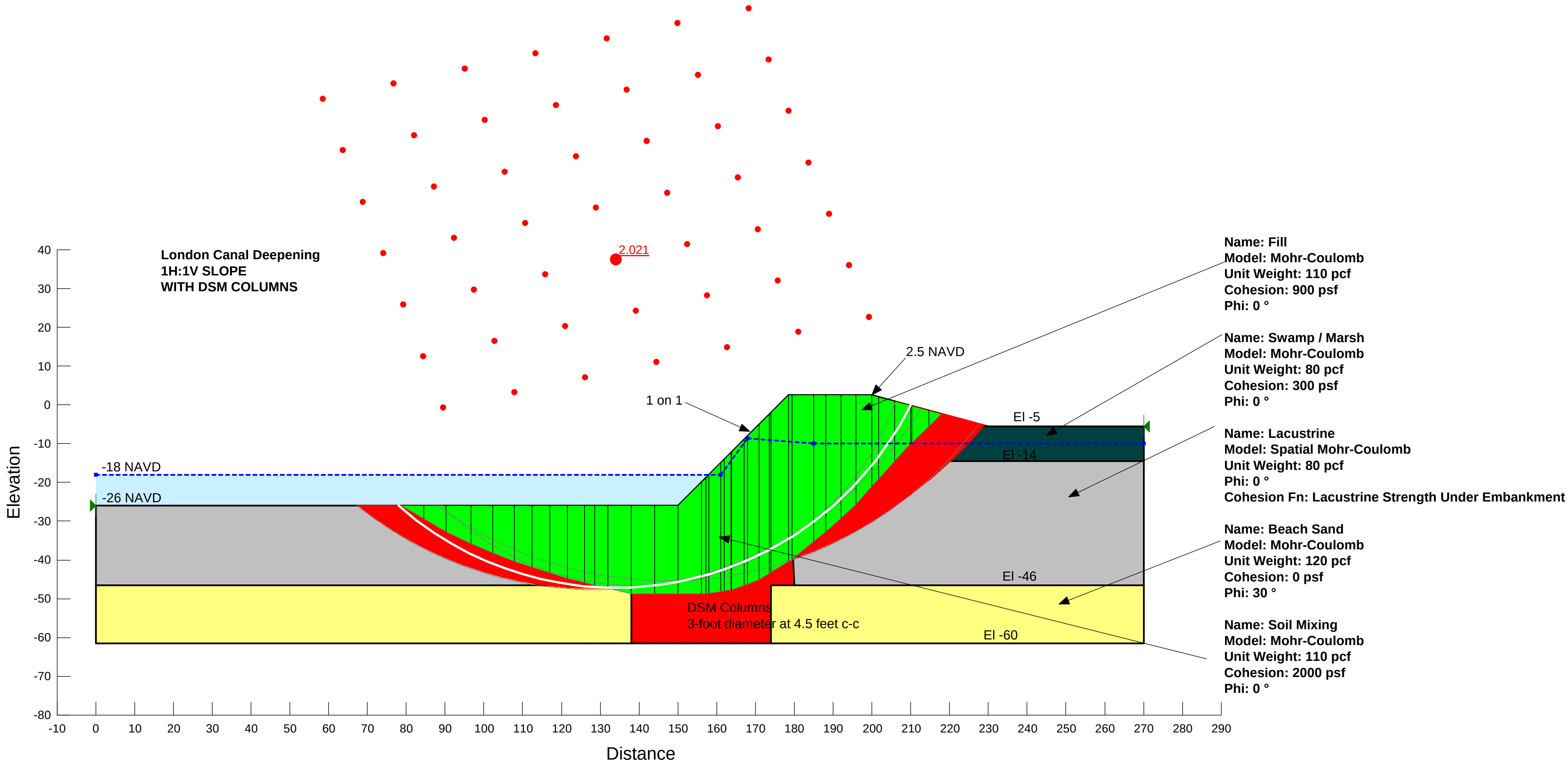


Orleans Canal Deepening
1H:1V SLOPE
WITH DSM COLUMNS
2.375
5 NAVD
1 on 1
-20.5 NAVD
-18 NAVD
El -11
El -19
El -22
El -42
DSM Columns
3-foot diameter at 4.5 foot c-c
Name: Fill
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 900 psf
Phi: 0 °
Name: Swamp / Marsh
Model: Mohr-Coulomb
Unit Weight: 80 pcf
Cohesion: 300 psf
Phi: 0 °
Name: Lacustrine
Model: Spatial Mohr-Coulomb
Unit Weight: 80 pcf
Phi: 0 °
Cohesion Fn: Lacustrine Strength Under Embankment
Name: Beach Sand
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Name: Soil Mixing
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 2000 psf
Phi: 0 °
Elevation
Distance

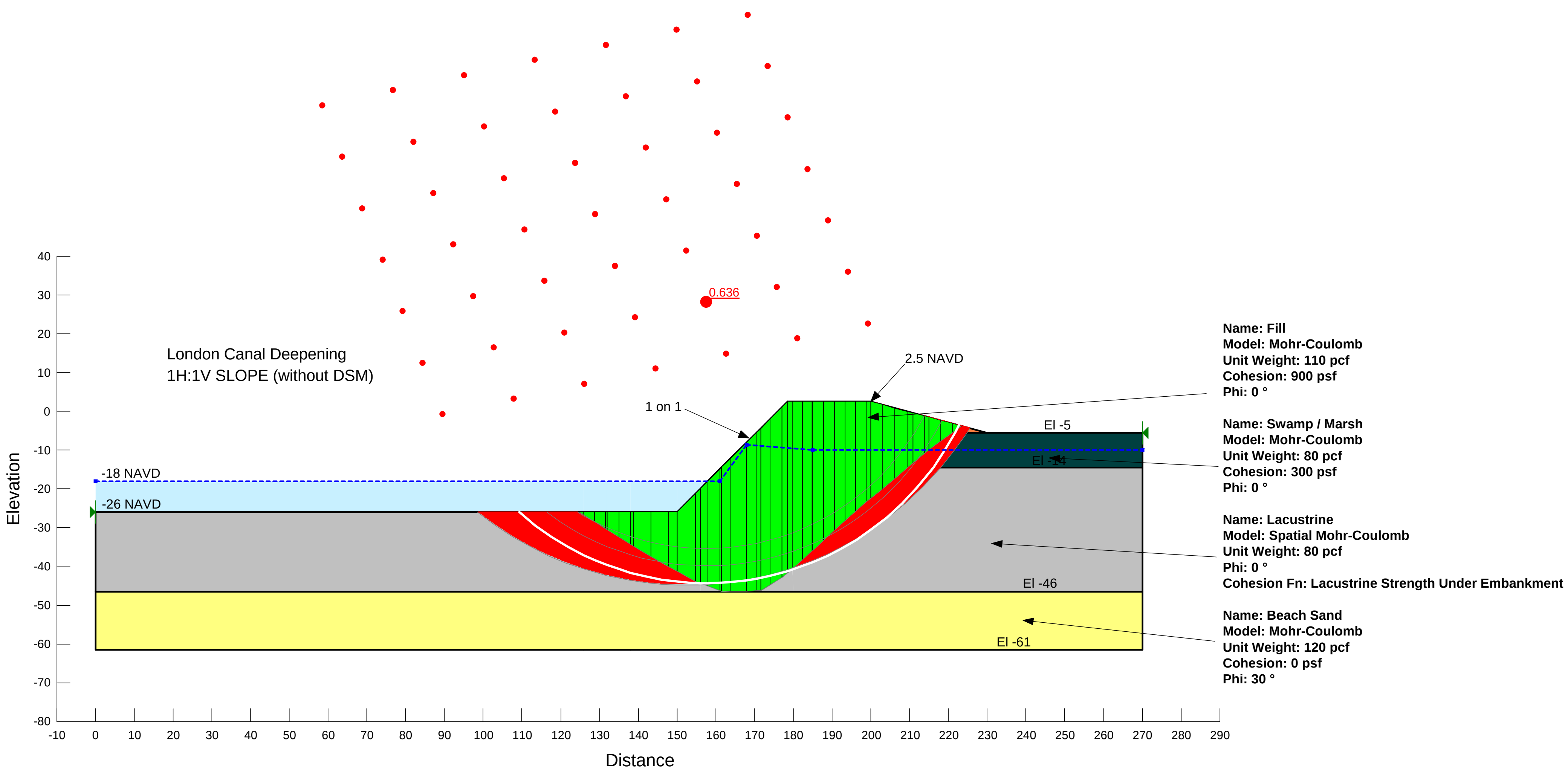


Orleans Canal Deepening
1H:1V SLOPE (without DSM)
1.068
5 NAVD
1 on 1
-20.5 NAVD
-18 NAVD
El -11
El -19
El -22
El -42
Name: Fill
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 900 psf
Phi: 0 °
Name: Swamp / Marsh
Model: Mohr-Coulomb
Unit Weight: 80 pcf
Cohesion: 300 psf
Phi: 0 °
Name: Lacustrine
Model: Spatial Mohr-Coulomb
Unit Weight: 80 pcf
Phi: 0 °
Cohesion Fn: Lacustrine Strength Under Embankment
Name: Beach Sand
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Elevation
Distance

D.3.3 London Canal



London Canal Deepening
1H:1V SLOPE
WITH DSM COLUMNS
2.021
2.5 NAVD
1 on 1
El -5
El -14
-18 NAVD
-26 NAVD
El -46
El -60
DSM Columns
3-foot diameter at 4.5 feet c-c
Name: Fill
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 900 psf
Phi: 0 °
Name: Swamp / Marsh
Model: Mohr-Coulomb
Unit Weight: 80 pcf
Cohesion: 300 psf
Phi: 0 °
Name: Lacustrine
Model: Spatial Mohr-Coulomb
Unit Weight: 80 pcf
Phi: 0 °
Cohesion Fn: Lacustrine Strength Under Embankment
Name: Beach Sand
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Name: Soil Mixing
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 2000 psf
Phi: 0 °
Elevation
Distance



London Canal Deepening
1H:1V SLOPE (without DSM)
0.636
2.5 NAVD
1 on 1
El -5
El -14
El -46
El -61
-18 NAVD
-26 NAVD
Name: Fill
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 900 psf
Phi: 0 °
Name: Swamp / Marsh
Model: Mohr-Coulomb
Unit Weight: 80 pcf
Cohesion: 300 psf
Phi: 0 °
Name: Lacustrine
Model: Spatial Mohr-Coulomb
Unit Weight: 80 pcf
Phi: 0 °
Cohesion Fn: Lacustrine Strength Under Embankment
Name: Beach Sand
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Elevation
Distance

APPENDIX E

Mechanical/Electrical

Final Report
March 13, 2009

Pump Sizes

Option 1 A & B

Pump Station & Condition	Required Capcity (cfs)	Provided Capacity (cfs)	Number of 1000 cfs engine driven pumps	Number of 1000 cfs electric pumps	Number of 500 cfs pumps	Number of 250 cfs pumps	Number of 150 cfs pumps
17th St. (Initial)	10,500	10500	3	6	2	2	0
17th St. (Future)	12,500	12500	4	7	2	2	0
Orleans (Initial)	2690	2750	2	0	1	1	0
Orleans (Future)	3390	3400	2	0	2	1	1
London (Initial)	7980	8000	3	4	1	2	0
London (Future)	8980	9000	4	4	1	2	0

Option 1C

Pump Station & Condition	Required Capcity (cfs)	Provided Capacity (cfs)	Number of 1000 cfs engine driven pumps	Number of 1000 cfs electric pumps	Number of 500 cfs pumps	Number of 250 cfs pumps	Number of 150 cfs pumps
17th St. (Initial)	10,500	10500	0	9	2	2	0
Orleans (Initial)	2690	2750	0	2	1	1	0
London (Initial)	7980	8000	0	7	1	2	0

Option 2 **(Includes Florida Diversion)**

Pump Station & Condition	Required Capcity (cfs)	Provided Capacity (cfs)	Number of 1000 cfs engine driven pumps	Number of 1000 cfs electric pumps	Number of 500 cfs pumps	Number of 250 cfs pumps	Number of 150 cfs pumps
17th St. (Initial)	10,500	10500	3	6	2	2	0
17th St. (Future)	12,500	12500	4	7	2	2	0
Orleans (Initial)	2690	2750	2	0	1	1	0
Orleans (Future)	3390	3400	2	0	2	1	1
London (Initial)	6880	7000	2	4	1	2	0
London (Future)	7880	8000	3	4	1	2	0

Option 2A **(Includes Florida Diversion and Hoey's Diversion)**

Pump Station & Condition	Required Capcity (cfs)	Provided Capacity (cfs)	Number of 1000 cfs engine driven pumps	Number of 1000 cfs electric pumps	Number of 500 cfs pumps	Number of 250 cfs pumps	Number of 150 cfs pumps
17th St. (Initial)	8,900	9000	3	5	1	2	0
17th St. (Future)	10,900	11000	3	7	1	2	0
Orleans (Initial)	2690	2750	2	0	1	1	0
Orleans (Future)	3390	3400	2	0	2	1	1
London (Initial)	6880	7000	2	4	1	2	0
London (Future)	7880	8000	3	4	1	2	0

Option 2M **(Includes Florida Diversion)**

Pump Station & Condition	Required Capcity (cfs)	Provided Capacity (cfs)	Number of 1000 cfs engine driven pumps	Number of 1000 cfs electric pumps	Number of 500 cfs pumps	Number of 250 cfs pumps	Number of 150 cfs pumps
17th St. (Initial)	10,500	10500	3	6	2	2	0
17th St. (Future)	12,500	12500	4	7	2	2	0
Orleans (Initial)	2690	2750	2	0	1	1	0
Orleans (Future)	3390	3400	2	0	2	1	1
London (Initial)	6880	7000	2	4	1	2	0
London (Future)	7880	8000	3	4	1	2	0

Option 3A

Pump Station & Condition	Required Capcity (cfs)	Provided Capacity (cfs)	Number of 1000 cfs engine driven pumps	Number of 1000 cfs electric pumps	Number of 500 cfs pumps	Number of 250 cfs pumps	Number of 150 cfs pumps
17th St. (Initial)	8,900	9000	3	5	1	2	0
17th St. (Future)	10,900	11000	3	7	1	2	0
Orleans (Initial)	2690	2750	2	0	1	1	0
Orleans (Future)	3390	3400	2	0	2	1	1
London (Initial)	6880	7000	2	4	1	2	0
London (Future)	7880	8000	3	4	1	2	0

Option 2

Pump Station & Condition	Required Capcity (cfs)	Provided Capacity (cfs)	Number of 1000 cfs engine driven pumps	Number of 1000 cfs electric pumps	Number of 500 cfs pumps	Number of 250 cfs pumps	Number of 150 cfs pumps
17th St. (Initial)	10,500	10500	3	6	2	2	0
17th St. (Future)	12,500	12500	4	7	2	2	0
Orleans (Initial)	2690	2750	2	0	1	1	0
Orleans (Future)	3390	3400	2	0	2	1	1
London (Initial)	7890	8000	3	4	1	2	0
London (Future)	8890	9000	4	4	1	2	0

Approximate Pump Building Lengths

Option 1A & B Refer to 2006 CDR

Option 1c	Quantity		Length (ft)	Extension (ft)	Study Qty
17th Street Canal					
1000 cfs motors	9	@	26	234	
500 cfs motors	2	@	16	32	
250 cfs motors	2	@	10	20	
Total				286	290
Orleans Canal					
1000 cfs motors	2	@	26	52	
500 cfs motors	1	@	16	16	
250 cfs motors	1	@	10	10	
Total				78	80
London Canal					
1000 cfs motors	7	@	26	182	
500 cfs motors	1	@	16	16	
250 cfs motors	2	@	10	20	
Total				218	220

Option 2 & 2M**	Quantity		Length (ft)	Extension (ft)	Study Qty
17th Street Canal					
1000 cfs engine	4	@	36	144	
1000 cfs motors	7	@	26	182	
500 cfs motors	2	@	16	32	
250 cfs motors	2	@	10	20	
Total				378	380
Orleans Canal					
1000 cfs engine	2	@	36	72	
1000 cfs motors	0	@	26	0	
500 cfs motors	2	@	16	32	
250 cfs motors*	2	@	10	20	
Total				124	130
London Canal					
1000 cfs engine	3	@	36	108	
1000 cfs motors	4	@	26	104	
500 cfs motors	1	@	16	16	
250 cfs motors	2	@	10	20	
Total				248	250

* includes one 150 cfs pump
** future bays included

Option 2A & 2AM**	Quantity		Length (ft)	Extension (ft)	Study Qty
17th Street Canal					
1000 cfs engine	3	@	36	108	
1000 cfs motors	7	@	26	182	
500 cfs motors	1	@	16	16	
250 cfs motors	2	@	10	20	
Total				326	330
Orleans Canal					
1000 cfs engine	2	@	36	72	
1000 cfs motors	0	@	26	0	
500 cfs motors	2	@	16	32	
250 cfs motors*	2	@	10	20	
Total				124	130
London Canal					
1000 cfs engine	3	@	36	108	
1000 cfs motors	4	@	26	104	
500 cfs motors	1	@	16	16	
250 cfs motors	2	@	10	20	
Total				248	250

* includes one 150 cfs pump
** future bays included

Fuel Storage Estimate

Option 1 A & B

Pump Station	Required Capacity (cfs)	Installed Power (hp)	Installed Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks	Future Capacity (cfs)	Future Power (hp)	Future Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks
17th St.	10,500	16900	79,282	4	12,500	20100	94,294	5
Orleans	2,690	4450	20,876	2	3,390	5500	25,802	2
London	7,980	12900	60,517	4	8,980	14500	68,023	4

Option 1C

Pump Station	Required Capacity (cfs)	Installed Power (hp)	Installed Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks	Future Capacity (cfs)	Future Power (hp)	Future Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks
17th St.	10,500	21000	98,516	5	-	-	-	-
Orleans	2,690	5500	25,802	2	-	-	-	-
London	7,980	16000	75,060	4	-	-	-	-

Option 2 **(Base Case without diversions)**

Pump Station	Required Capacity (cfs)	Installed Power (hp)	Installed Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks	Future Capacity (cfs)	Future Power (hp)	Future Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks
17th St.	10,500	32100	150,589	8	12,500	38300	179,675	9
Orleans	2,690	8650	40,579	3	3,390	10650	49,962	3
London	6,880	24600	115,405	6	7,880	27800	130,417	7

Misc. Feature

Pump Station	Required Capacity (cfs)	Installed Power (hp)	Installed Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks	Future Capacity (cfs)	Future Power (hp)	Future Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks
Dywer	1,000	9000	42,221	3	1,000	9000	42,221	3

Option 2 **(Includes Florida Diversion)**

Pump Station	Required Capacity (cfs)	Installed Power (hp)	Installed Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks	Future Capacity (cfs)	Future Power (hp)	Future Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks
17th St.	10,500	32100	150,589	8	12,500	38300	179,675	9
Orleans	2,690	8650	40,579	3	3,390	10650	49,962	3
London	6,880	21400	100,393	6	7,880	24600	115,405	6
DPS3 to Florida	1,100	-	-	-	1,100	-	-	-

Option 2A **(Includes Florida Diversion and Hoey's Diversion)**

Pump Station	Required Capacity (cfs)	Installed Power (hp)	Installed Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks	Future Capacity (cfs)	Future Power (hp)	Future Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks
17th St.	8,900	27600	129,478	7	10,900	33600	157,626	8
Orleans	2,690	8650	40,579	3	3,390	10650	49,962	3
London	6,880	21400	100,393	6	7,880	24600	115,405	6
DPS3 to Florida	1,100	-	-	-	1,100	-	-	-
Hoey's PS	1,600	20,000	93,825	5	1,600	20,000	93,825	5

Option 2M **(Includes Florida Diversion)**

Pump Station	Required Capacity (cfs)	Installed Power (hp)	Installed Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks	Future Capacity (cfs)	Future Power (hp)	Future Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks
17th St.	10,500	53000	248,636	13	12,500	63200	296,487	15
Orleans	2,690	14100	66,147	4	3,390	17300	81,159	5
London	6,880	35300	165,601	9	7,880	40500	189,995	10
DPS3 to Florida	1,100	-	-	-	1,100	-	-	-

Option 2aM **(Includes Florida Diversion and Hoey's Diversion)**

Pump Station	Required Capacity (cfs)	Installed Power (hp)	Installed Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks	Future Capacity (cfs)	Future Power (hp)	Future Fuel Usage (gallons per 4 days)	# of 20,000 Gallon Fuel Tanks
17th St.	8,900	45500	213,452	11	10,900	55500	260,364	14
Orleans	2,690	14100	66,147	4	3,390	17300	81,159	5
London	6,880	35300	165,601	9	7,880	40500	189,995	10
DPS3 to Florida	1,100	-	-	-	1,100	-	-	-
Hoey's PS	1,600	20,000	93,825	5	1,600	20,000	93,825	5

NOTE: Fuel consumption assumes pumps operate at 80% load to acount for the siphon recovery, engines and generators operation at 94% efficiency, and fuel consumption is 0.07 gal/KW/Hr. Storage volumes are based on 4 days of 100% operation. Fuel tanks also include an additional 10% for building usage

New Orleans Hurricane Pumping Station/Gate Closure Study
Pump Driver Power Criteria
Option 1 A & B

17th Street Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	1241			Engine		1%
1000	1241			Engine		1%
1000	1241			Engine		1%
1000	1052	2750	1800	Genset		1%
1000	1052	2750	1800	Genset		1%
1000	1052	2750	1800	Genset		1%
1000	1052	2750	1800	Genset		1%
1000	1052	2750	1800	Genset		1%
1000	1052	2750	1800	Grd/Gen	1%	1%
500	526	1500	900	Grd/Gen	5%	1%
500	526	1500	900	Grd/Gen	10%	1%
250	263	750	450	Grd/Gen	50%	1%
250	263	750	450	Grd/Gen	100%	1%
10500	11613		13500	Total hp (1hp=1kVA)		
	7890			Total elec pump bhp		
			675	Building Loads (kVA)		
			14175	Total Load (kVA)		
			12.8	MW @ 0.9 PF		
			1969	Amps @ 4160V		
			5175	Utility kVA		
			719	Utility Amps @ 4160V		
			16	MW, Load Assuming 80%		
			6	# of 3MW Generators (N+1)		

Orleans Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	1241			Engine		1%
1000	1241			Engine		1%
500	526	1500	900	Grd/Gen	5%	1%
250	263	750	450	Grd/Gen	100%	1%
2750	3271		1350	Total hp (1hp=1kVA)		
	789			Total elec pump bhp		
			68	Building Loads (kVA)		
			1418	Total Load (kVA)		
			1.3	MW @ 0.9 PF		
			197	Amps @ 4160V		
			1418	Utility kVA		
			197	Utility Amps @ 4160V		
			2	MW, Load Assuming 80%		
			2	# of 3MW Generators (N+1)		

London Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	1241			Engine		1%
1000	1241			Engine		1%
1000	1241			Engine		1%
1000	1052	2750	1800	Genset		1%
1000	1052	2750	1800	Genset		1%
1000	1052	2750	1800	Genset		1%
1000	1052	2750	1800	Grd/Gen	1%	1%
500	526	1500	900	Grd/Gen	10%	1%
250	263	750	450	Grd/Gen	50%	1%
250	263	750	450	Grd/Gen	100%	1%
8000	8983		9000	Total hp (1hp=1kVA)		
	5260			Total elec pump bhp		
			450	Building Loads (kVA)		
			9450	Total Load (kVA)		
			8.5	MW @ 0.9 PF		
			1313	Amps @ 4160V		
			4050	Utility kVA		
			563	Utility Amps @ 4160V		
			11	MW, Load Assuming 80%		
			5	# of 3MW Generators (N+1)		

* Source Legend:

Engine	Diesel Engine Driver directly connected to pump (storm event)
Genset	Electric Power from Generator Sets only (storm event)
Grd/Gen	Electric Power from Entergy grid (normal) with backup power from Gensets (storm event)

Notes:

1 Driver size estimated based on the maximum of Parish requirement of 60% flow at lake with tide or Parish requirement of max flow at normal lake with tide (see pump sheet)
2 Engine Fuel Usage = 20 hp per gal/hr
3 MW = 0.9 x 1000kVA (0.9 PF)
4 Building Loads = 5% of non-grid loads
5 Nameplate rating of motor is based on priming requirement
6 Load hp is based on max continuous duty load rating of motor

New Orleans Hurricane Pumping Station/Gate Closure Study
Pump Driver Power Criteria
Option 1c

17th Street Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Grd/Gen	1%	1%
500	1750	1750	1000	Grd/Gen	5%	1%
500	1750	1750	1000	Grd/Gen	10%	1%
250	800	800	500	Grd/Gen	50%	1%
250	800	800	500	Grd/Gen	100%	1%
10500	32100		21000	Total hp (1hp=1kVA)		
	32100			Total elec pump bhp		
			1050	Building Loads (kVA)		
			22050	Total Load (kVA)		
			19.8	MW @ 0.9 PF		
			3063	Amps @ 4160V		
			6050	Utility kVA		
			840	Utility Amps @ 4160V		
			25	MW, Load Assuming 80%		
			9	# of 3MW Generators (N+1)		

Orleans Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Genset		1%
500	1750	1750	1000	Grd/Gen	5%	1%
250	800	800	500	Grd/Gen	100%	1%
2750	8550		5500	Total hp (1hp=1kVA)		
	8550			Total elec pump bhp		
			275	Building Loads (kVA)		
			5775	Total Load (kVA)		
			5.2	MW @ 0.9 PF		
			802	Amps @ 4160V		
			1775	Utility kVA		
			247	Utility Amps @ 4160V		
			6	MW, Load Assuming 80%		
			3	# of 3MW Generators (N+1)		

London Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Genset		1%
1000	3000	3000	2000	Grd/Gen	1%	1%
500	1750	1750	1000	Grd/Gen	10%	1%
250	800	800	500	Grd/Gen	50%	1%
250	800	800	500	Grd/Gen	100%	1%
8000	24350		16000	Total hp (1hp=1kVA)		
	24350			Total elec pump bhp		
			800	Building Loads (kVA)		
			16800	Total Load (kVA)		
			15.1	MW @ 0.9 PF		
			2333	Amps @ 4160V		
			4800	Utility kVA		
			667	Utility Amps @ 4160V		
			19	MW, Load Assuming 80%		
			7	# of 3MW Generators (N+1)		

* Source Legend:

Engine	Diesel Engine Driver directly connected to pump (storm event)
Genset	Electric Power from Generator Sets only (storm event)
Grd/Gen	Electric Power from Entergy grid (normal) with backup power from Gensets (storm event)

Notes:

1 Driver size estimated based on the maximum of Parish requirement of 60% flow at lake with tide or Parish requirement of max flow at normal lake with tide (see pump sheet)
2 Engine Fuel Usage = 20 hp per gal/hr
3 MW = 0.9 x 1000kVA (0.9 PF)
4 Building Loads = 5% of non-grid loads
5 Nameplate rating of motor is based on priming requirement
6 Load hp is based on max continuous duty load rating of motor

New Orleans Hurricane Pumping Station/Gate Closure Study
Pump Driver Power Criteria
Option 2 Base No Diversions

17th Street Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	3206			Engine		1%
1000	3206			Engine		1%
1000	3206			Engine		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Grd/Gen	1%	1%
500	1359	2250	1925	Grd/Gen	5%	1%
500	1359	2250	1925	Grd/Gen	10%	1%
250	680	1250	950	Grd/Gen	50%	1%
250	680	1250	950	Grd/Gen	100%	1%
10500	30010		28700	Total hp (1hp=1kVA)		
	20392			Total elec pump bhp		
			1435	Building Loads (kVA)		
			30135	Total Load (kVA)		
			27.1	MW @ 0.9 PF		
			4185	Amps @ 4160V		
			11010	Utility kVA		
			1529	Utility Amps @ 4160V		
			34	MW, Load Assuming 80%		
			12	# of 3MW Generators (N+1)		

Orleans Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	3206			Engine		1%
1000	3206			Engine		1%
500	1359	2250	1925	Grd/Gen	5%	1%
250	680	1250	950	Grd/Gen	100%	1%
2750	8451		2875	Total hp (1hp=1kVA)		
	2039			Total elec pump bhp		
			144	Building Loads (kVA)		
			3019	Total Load (kVA)		
			2.7	MW @ 0.9 PF		
			419	Amps @ 4160V		
			3019	Utility kVA		
			419	Utility Amps @ 4160V		
			3	MW, Load Assuming 80%		
			2	# of 3MW Generators (N+1)		

London Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	3206			Engine		1%
1000	3206			Engine		1%
1000	3206			Engine		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Grd/Gen	1%	1%
500	1359	2250	1925	Grd/Gen	10%	1%
250	680	1250	950	Grd/Gen	50%	1%
250	680	1250	950	Grd/Gen	100%	1%
8000	23213		19125	Total hp (1hp=1kVA)		
	13595			Total elec pump bhp		
			956	Building Loads (kVA)		
			20081	Total Load (kVA)		
			18.1	MW @ 0.9 PF		
			2789	Amps @ 4160V		
			8606	Utility kVA		
			1195	Utility Amps @ 4160V		
			23	MW, Load Assuming 80%		
			9	# of 3MW Generators (N+1)		

* Source Legend:

Engine	Diesel Engine Driver directly connected to pump (storm event)
Genset	Electric Power from Generator Sets only (storm event)
Grd/Gen	Electric Power from Entergy grid (normal) with backup power from Gensets (storm event)

Notes:

1 Driver size estimated based on the maximum of Parish requirement of 60% flow at lake with tide or Parish requirement of max flow at normal lake with tide (see pump sheet)
2 Engine Fuel Usage = 20 hp per gal/hr
3 MW = 0.9 x 1000kVA (0.9 PF)
4 Building Loads = 5% of non-grid loads
5 Nameplate rating of motor is based on priming requirement
6 Load hp is based on max continuous duty load rating of motor

New Orleans Hurricane Pumping Station/Gate Closure Study
Pump Driver Power Criteria
Option 2

17th Street Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	3206			Engine		1%
1000	3206			Engine		1%
1000	3206			Engine		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Grd/Gen	1%	1%
500	1359	2250	1925	Grd/Gen	5%	1%
500	1359	2250	1925	Grd/Gen	10%	1%
250	680	1250	950	Grd/Gen	50%	1%
250	680	1250	950	Grd/Gen	100%	1%
10500	30010		28700	Total hp (1hp=1kVA)		
	20392			Total elec pump bhp		
			1435	Building Loads (kVA)		
			30135	Total Load (kVA)		
			27.1	MW @ 0.9 PF		
			4185	Amps @ 4160V		
			11010	Utility kVA		
			1529	Utility Amps @ 4160V		
			34	MW, Load Assuming 80%		
			12	# of 3MW Generators (N+1)		

Orleans Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	3206			Engine		1%
1000	3206			Engine		1%
500	1359	2250	1925	Grd/Gen	5%	1%
250	680	1250	950	Grd/Gen	100%	1%
2750	8451		2875	Total hp (1hp=1kVA)		
	2039			Total elec pump bhp		
			144	Building Loads (kVA)		
			3019	Total Load (kVA)		
			2.7	MW @ 0.9 PF		
			419	Amps @ 4160V		
			3019	Utility kVA		
			419	Utility Amps @ 4160V		
			3	MW, Load Assuming 80%		
			2	# of 3MW Generators (N+1)		

London Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	3206			Engine		1%
1000	3206			Engine		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Grd/Gen	1%	1%
500	1359	2250	1925	Grd/Gen	10%	1%
250	680	1250	950	Grd/Gen	50%	1%
250	680	1250	950	Grd/Gen	100%	1%
7000	20007		19125	Total hp (1hp=1kVA)		
	13595			Total elec pump bhp		
			956	Building Loads (kVA)		
			20081	Total Load (kVA)		
			18.1	MW @ 0.9 PF		
			2789	Amps @ 4160V		
			8606	Utility kVA		
			1195	Utility Amps @ 4160V		
			23	MW, Load Assuming 80%		
			9	# of 3MW Generators (N+1)		

* Source Legend:

Engine	Diesel Engine Driver directly connected to pump (storm event)
Genset	Electric Power from Generator Sets only (storm event)
Grd/Gen	Electric Power from Entergy grid (normal) with backup power from Gensets (storm event)

Notes:

1 Driver size estimated based on the maximum of Parish requirement of 60% flow at lake with tide or Parish requirement of max flow at normal lake with tide (see pump sheet)
2 Engine Fuel Usage = 20 hp per gal/hr
3 MW = 0.9 x 1000kVA (0.9 PF)
4 Building Loads = 5% of non-grid loads
5 Nameplate rating of motor is based on priming requirement
6 Load hp is based on max continuous duty load rating of motor

New Orleans Hurricane Pumping Station/Gate Closure Study
Pump Driver Power Criteria
Option 2A

17th Street Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	3206			Engine		1%
1000	3206			Engine		1%
1000	3206			Engine		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Grd/Gen	5%	1%
500	1359	2250	1925	Grd/Gen	10%	1%
250	680	1250	950	Grd/Gen	50%	1%
250	680	1250	950	Grd/Gen	100%	1%
9000	25932		22950	Total hp (1hp=1kVA)		
	16314			Total elec pump bhp		
			1148	Building Loads (kVA)		
			24098	Total Load (kVA)		
			21.7	MW @ 0.9 PF		
			3347	Amps @ 4160V		
			8798	Utility kVA		
			1222	Utility Amps @ 4160V		
			27	MW, Load Assuming 80%		
			10	# of 3 MW Generators (N+1)		

Orleans Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	3206			Engine		1%
1000	3206			Engine		1%
500	1359	2250	1925	Grd/Gen	5%	1%
250	680	1250	950	Grd/Gen	100%	1%
2750	8451		2875	Total hp (1hp=1kVA)		
	2039			Total elec pump bhp		
			144	Building Loads (kVA)		
			3019	Total Load (kVA)		
			2.7	MW @ 0.9 PF		
			419	Amps @ 4160V		
			3019	Utility kVA		
			419	Utility Amps @ 4160V		
			3	MW, Load Assuming 80%		
			2	# of 3MW Generators (N+1)		

London Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	3206			Engine		1%
1000	3206			Engine		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Genset		1%
1000	2719	4550	3825	Grd/Gen	1%	1%
500	1359	2250	1925	Grd/Gen	10%	1%
250	680	1250	950	Grd/Gen	50%	1%
250	680	1250	950	Grd/Gen	100%	1%
7000	20007		19125	Total hp (1hp=1kVA)		
	13595			Total elec pump bhp		
			956	Building Loads (kVA)		
			20081	Total Load (kVA)		
			18.1	MW @ 0.9 PF		
			2789	Amps @ 4160V		
			8606	Utility kVA		
			1195	Utility Amps @ 4160V		
			23	MW, Load Assuming 80%		
			9	# of 3MW Generators (N+1)		

* Source Legend:

Engine	Diesel Engine Driver directly connected to pump (storm event)
Genset	Electric Power from Generator Sets only (storm event)
Grd/Gen	Electric Power from Entergy grid (normal) with backup power from Gensets (storm event)

Notes:

1. Driver size estimated based on the maximum of Parish requirement of 60% flow at lake with tide or Parish requirement of max flow at normal lake with tide (see pump sheet)
2. Engine Fuel Usage = 20 hp per gal/hr
3. MW = 0.9 x 1000kVA (0.9 PF)
4. Building Loads = 5% of non-grid loads
5. Nameplate rating of motor is based on priming requirement
6. Load hp is based on max continuous duty load rating of motor

New Orleans Hurricane Pumping Station/Gate Closure Study
Pump Driver Power Criteria
Option 2M

17th Street Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	5200			Engine		1%
1000	5200			Engine		1%
1000	5200			Engine		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Grd/Gen	1%	1%
500	1859	4000	3098	Grd/Gen	5%	1%
500	1859	4000	3098	Grd/Gen	10%	1%
250	929	2000	1548	Grd/Gen	50%	1%
250	929	2000	1548	Grd/Gen	100%	1%
10500	43484		46473.33	Total hp (1hp=1kVA)		
	27884			Total elec pump bhp		
			2324	Building Loads (kVA)		
			48797	Total Load (kVA)		
			43.9	MW @ 0.9 PF		
			6777	Amps @ 4160V		
			17814	Utility kVA		
			2474	Utility Amps @ 4160V		
			55	MW, Load Assuming 80%		
			19	# of 3MW Generators (N+1)		

Orleans Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	5200			Engine		1%
1000	5200			Engine		1%
500	1859	4000	3098	Grd/Gen	5%	1%
250	929	2000	1548	Grd/Gen	100%	1%
2750	13188		4646.667	Total hp (1hp=1kVA)		
	2788			Total elec pump bhp		
			232	Building Loads (kVA)		
			4879	Total Load (kVA)		
			4.4	MW @ 0.9 PF		
			678	Amps @ 4160V		
			4879	Utility kVA		
			678	Utility Amps @ 4160V		
			5	MW, Load Assuming 80%		
			3	# of 3MW Generators (N+1)		

London Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	5200			Engine		1%
1000	5200			Engine		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Grd/Gen	1%	1%
1859	4000	3098	1925	Grd/Gen	10%	1%
250	929	2000	1548	Grd/Gen	50%	1%
250	929	2000	1548	Grd/Gen	100%	1%
8359	31130		29808.33	Total hp (1hp=1kVA)		
	20730			Total elec pump bhp		
			1490	Building Loads (kVA)		
			31299	Total Load (kVA)		
			28.2	MW @ 0.9 PF		
			4347	Amps @ 4160V		
			12709	Utility kVA		
			1765	Utility Amps @ 4160V		
			35	MW, Load Assuming 80%		
			13	# of 3MW Generators (N+1)		

* Source Legend:

Engine	Diesel Engine Driver directly connected to pump (storm event)
Genset	Electric Power from Generator Sets only (storm event)
Grd/Gen	Electric Power from Entergy grid (normal) with backup power from Gensets (storm event)

Notes:

1 Driver size estimated based on the maximum of Parish requirement of 60% flow at lake with tide or Parish requirement of max flow at normal lake with tide (see pump sheet)
2 Engine Fuel Usage = 20 hp per gal/hr
3 MW = 0.9 x 1000kVA (0.9 PF)
4 Building Loads = 5% of non-grid loads
5 Nameplate rating of motor is based on priming requirement
6 Load hp is based on max continuous duty load rating of motor

New Orleans Hurricane Pumping Station/Gate Closure Study
Pump Driver Power Criteria
Option 2AM

17th Street Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	5200			Engine		1%
1000	5200			Engine		1%
1000	5200			Engine		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Grd/Gen	5%	1%
500	1859	4000	3098	Grd/Gen	10%	1%
250	929	2000	1548	Grd/Gen	50%	1%
250	929	2000	1548	Grd/Gen	100%	1%
9000	37907		37178.33	Total hp (1hp=1kVA)		
	22307			Total elec pump bhp		
			1859	Building Loads (kVA)		
			39037	Total Load (kVA)		
			35.1	MW @ 0.9 PF		
			5422	Amps @ 4160V		
			14251	Utility kVA		
			1979	Utility Amps @ 4160V		
			44	MW, Load Assuming 80%		
			16	# of 3 MW Generators (N+1)		

Orleans Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	5200			Engine		1%
1000	5200			Engine		1%
500	1859	4000	3098	Grd/Gen	5%	1%
250	929	2000	1548	Grd/Gen	100%	1%
2750	13188		4646.667	Total hp (1hp=1kVA)		
	2788			Total elec pump bhp		
			232	Building Loads (kVA)		
			4879	Total Load (kVA)		
			4.4	MW @ 0.9 PF		
			678	Amps @ 4160V		
			4879	Utility kVA		
			678	Utility Amps @ 4160V		
			5	MW, Load Assuming 80%		
			3	# of 3MW Generators (N+1)		

London Canal						
Pump	Driver	Motor hp	Motor hp	Source*	Utilization	
cfs	bhp	Nameplate	Load		Grid	Ind
1000	5200			Engine		1%
1000	5200			Engine		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Genset		1%
1000	3718	7000	6197	Grd/Gen	1%	1%
500	4000	833	1925	Grd/Gen	10%	1%
250	929	2000	1548	Grd/Gen	50%	1%
250	929	2000	1548	Grd/Gen	100%	1%
7000	31130		29808.33	Total hp (1hp=1kVA)		
	20730			Total elec pump bhp		
			1490	Building Loads (kVA)		
			31299	Total Load (kVA)		
			28.2	MW @ 0.9 PF		
			4347	Amps @ 4160V		
			12709	Utility kVA		
			1765	Utility Amps @ 4160V		
			35	MW, Load Assuming 80%		
			13	# of 3MW Generators (N+1)		

* Source Legend:

Engine	Diesel Engine Driver directly connected to pump (storm event)
Genset	Electric Power from Generator Sets only (storm event)
Grd/Gen	Electric Power from Entergy grid (normal) with backup power from Gensets (storm event)

Notes:

1 Driver size estimated based on the maximum of Parish requirement of 60% flow at lake with tide or Parish requirement of max flow at normal lake with tide (see pump sheet)
2 Engine Fuel Usage = 20 hp per gal/hr
3 MW = 0.9 x 1000kVA (0.9 PF)
4 Building Loads = 5% of non-grid loads
5 Nameplate rating of motor is based on priming requirement
6 Load hp is based on max continuous duty load rating of motor

New Orleans Major Canal Permanent Pumping Stations (1 of 2)

Option 1A and 1B	1000 cfs	500 cfs	250 cfs
Lake Pontchartrain			
Normal Water Surface, ft	1	1	1
Primary Rating Point Water Surface Elevation, ft	2.5	2.5	2.5
Secondary Rating Point Water Surface Elevation, ft	12	12	12
Minimum Design Lake Elevation, ft	-1	-1	-1
Canal Elevation			
Maximum Canal Working Elevation, ft	1	1	1
Design Canal Working Elevation, ft	0	0	0
Minimum Canal Working Elevation, ft	-1	-1	-1
Pumping Station Elevation			
Top of siphon invert elevation for priming, ft	18	18	18
Engine/motor floor elevation, ft	12	12	12
Sill Elevation, assume Type 10 FSI	Based on Minimum Canal and Largest Pump FSI		
Assumed station and screen losses, ft	2	2	2
Primary Point, 100 % design flow, TDH	4.5	4.5	4.5
Secondary Point 60 % design flow, TDH	14	14	14

Option1C	1000 cfs	500 cfs	250 cfs
Lake Pontchartrain			
Wier Elevation	14	14	14
Primary Rating Point Water Surface Elevation over Wier	16.5	16.5	16.5
Secondary Rating Point Water Surface Elevation	18	18	18
Minimum Design Lake Elevation	-1	-1	-1
Canal Elevation			
Maximum Canal Working Elevation	1	1	1
Design Canal Working Elevation	0	0	0
Minimum Canal Working Elevation	-1	-1	-1
Pumping Station Elevation			
Top of siphon invert elevation for priming	18	18	18
Maximum priming elevation	22	22	22
Engine/motor floor elevation	12	12	12
Sill Elevation	Based on Minimum Canal and Largest Pump FSI		
Assumed station and screen losses, feet	2	2	2
Primary Point, 100 % design flow, TDH	18.5	18.5	18.5
Secondary Point, 60 % design flow, TDH	25	20	20

New Orleans Major Canal Permanent Pumping Stations (2 of 2)

Option 2 and Option 2A	1000 cfs	500 cfs	250 cfs
Lake Pontchartrain			
Normal Water Surface	1	1	1
Primary Rating Point Water Surface Elevation	2.5	2.5	2.5
Secondary Rating Point Water Surface Elevation	12	12	12
Minimum Design Lake Elevation	-1	-1	-1
Canal Elevation			
Maximum Canal Working Elevation	-13	-13	-13
Design Canal Working Elevation	-14	-14	-14
Minimum Canal Working Elevation	-15	-15	-15
Pumping Station Elevation			
Top of siphon invert elevation for priming	18	18	18
Maximum priming elevation	22	22	22
Engine/motor floor elevation	12	12	12
Sill Elevation, assume Type 10 FSI	Based on Minimum Canal and Largest Pump FSI		
Assumed station and screen losses, feet	2	2	2
Primary Point, 100 % design flow, TDH	18.5	18.5	18.5
Secondary Point, 60 % design flow, TDH	28	28	28

Option 2M and Option 2AM	1000 cfs	500 cfs	250 cfs
Lake Pontchartrain			
Wier Elevation	14	14	14
Primary Rating Point Water Surface Elevation over Wier	16.5	16.5	16.5
Secondary Rating Point Water Surface Elevation	18	18	18
Minimum Design Lake Elevation	-1	-1	-1
Canal Elevation			
Maximum Canal Working Elevation	-13	-13	-13
Design Canal Working Elevation	-14	-14	-14
Minimum Canal Working Elevation	-15	-15	-15
Pumping Station Elevation			
Top of siphon invert elevation for priming	18	18	18
Maximum priming elevation	22	22	22
Engine/motor floor elevation	12	12	12
Sill Elevation, assume Type 10 FSI	Based on Minimum Canal and Largest Pump FSI		
Assumed station and screen losses, feet	2	2	2
Primary Point, 100 % design flow, TDH	32.5	32.5	32.5
Secondary Point, 60 % design flow, TDH	39	39	39

Option 1C

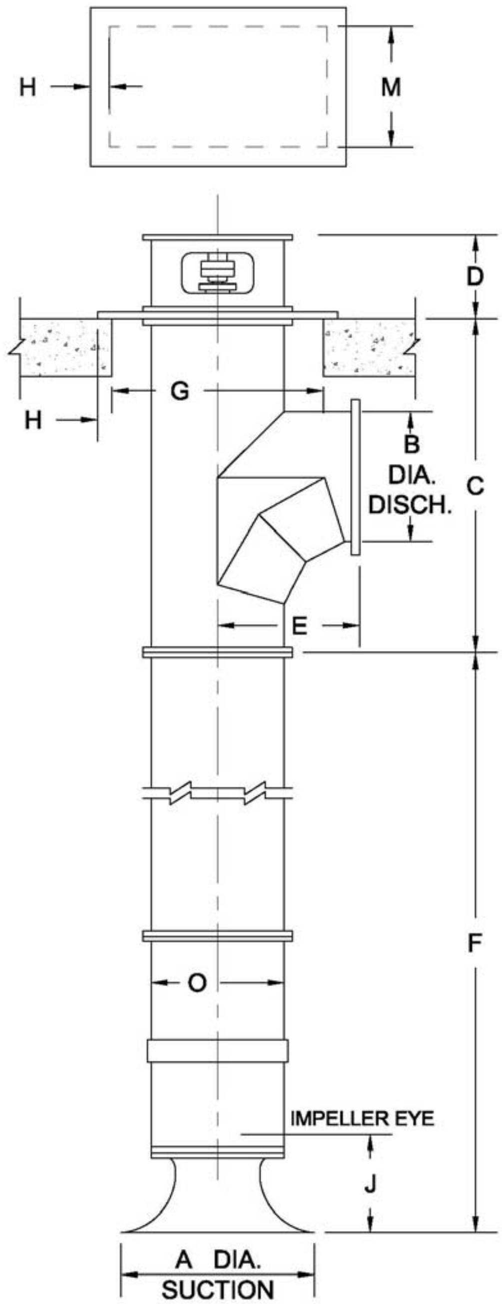
Vertical Mixed Flow Column Pump

Parts and Material List

PART NAME	MATERIAL	ASTM #/UNS#
Suction Bell	Carbon Steel	A36
Impeller	316L Stainless Steel	A743, CF3M
Impeller Cone	316L Stainless Steel	A743, CF3M
Diffuser	Ductile Iron	A536, Gr. 65-45-12
Pump Shaft (s)	410 Stainless Steel	A276, Type 410 SS
Shaft Tube (s)	Carbon Steel	A36
Column Pipe (s)	Carbon Steel	A36
Discharge Elbow, Baseplate, & Motor Pedestal	Carbon Steel	A36
Foundation Plates	Carbon Steel	A36
Adjustable Coupling	Forged Steel	A668, CL D
Intermediate Shaft Coupling	410 Stainless Steel	A743, CA15
Bearing	Elastomeric	Thordon SXL
Shaft Sleeve	420 Stainless Steel	A743, CA40
Gland	Bronze	B584, C93200
Wear Rings	420 Stainless Steel	A743,CA40
Stuffing Box & Bearing Hsg.	Cast Iron	A48, CL 30
Packing	Teflon	N/A

Option 1C

168 x 108 WCAX



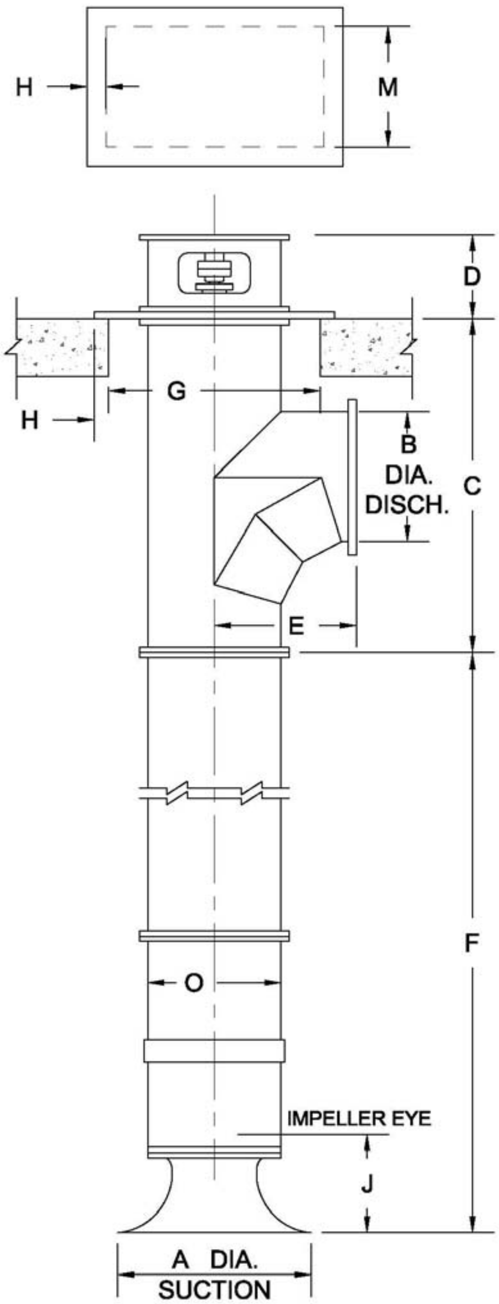
Dimensions in Inches

A	=	168
B	=	108
C	=	210
D	=	62
E	=	90
F	=	390
G	=	172
H	=	8.0
J	=	78
M	=	172
O	=	108

Dimensions are Approximate and Subject to Change

Option 1C

120 x 78 WCAX



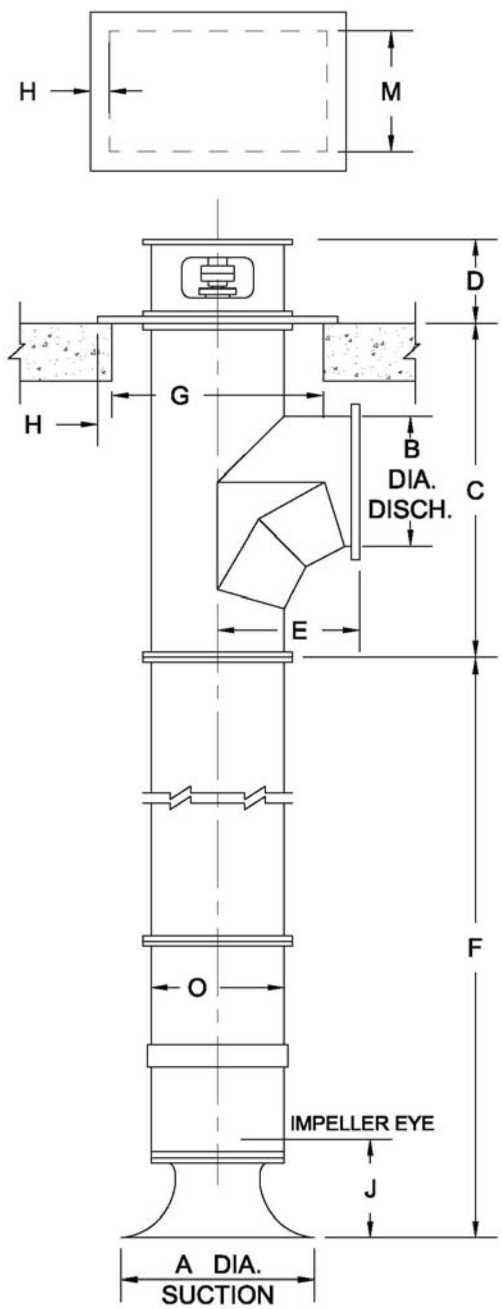
Dimensions
in Inches

A	=	120
B	=	78
C	=	177
D	=	53
E	=	66
F	=	435
G	=	124
H	=	6.0
J	=	56
M	=	124
O	=	78

Dimensions are Approximate and
Subject to Change

Option 1C

90 x 60 WCAX



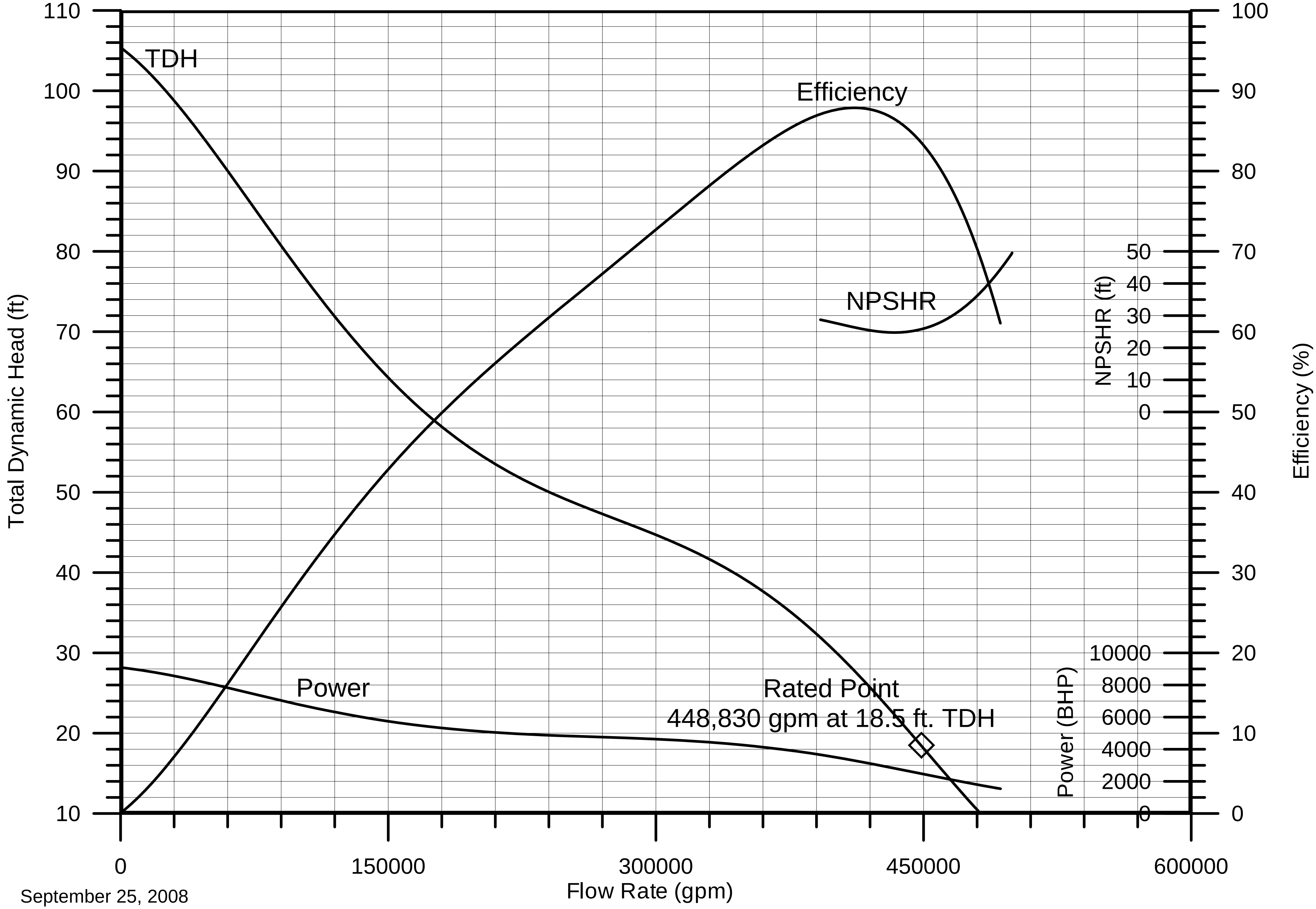
Dimensions
in Inches

A	=	90
B	=	60
C	=	168
D	=	44
E	=	51
F	=	456
G	=	94
H	=	6.0
J	=	41
M	=	94
O	=	57

Dimensions are Approximate and
Subject to Change

Option 1C

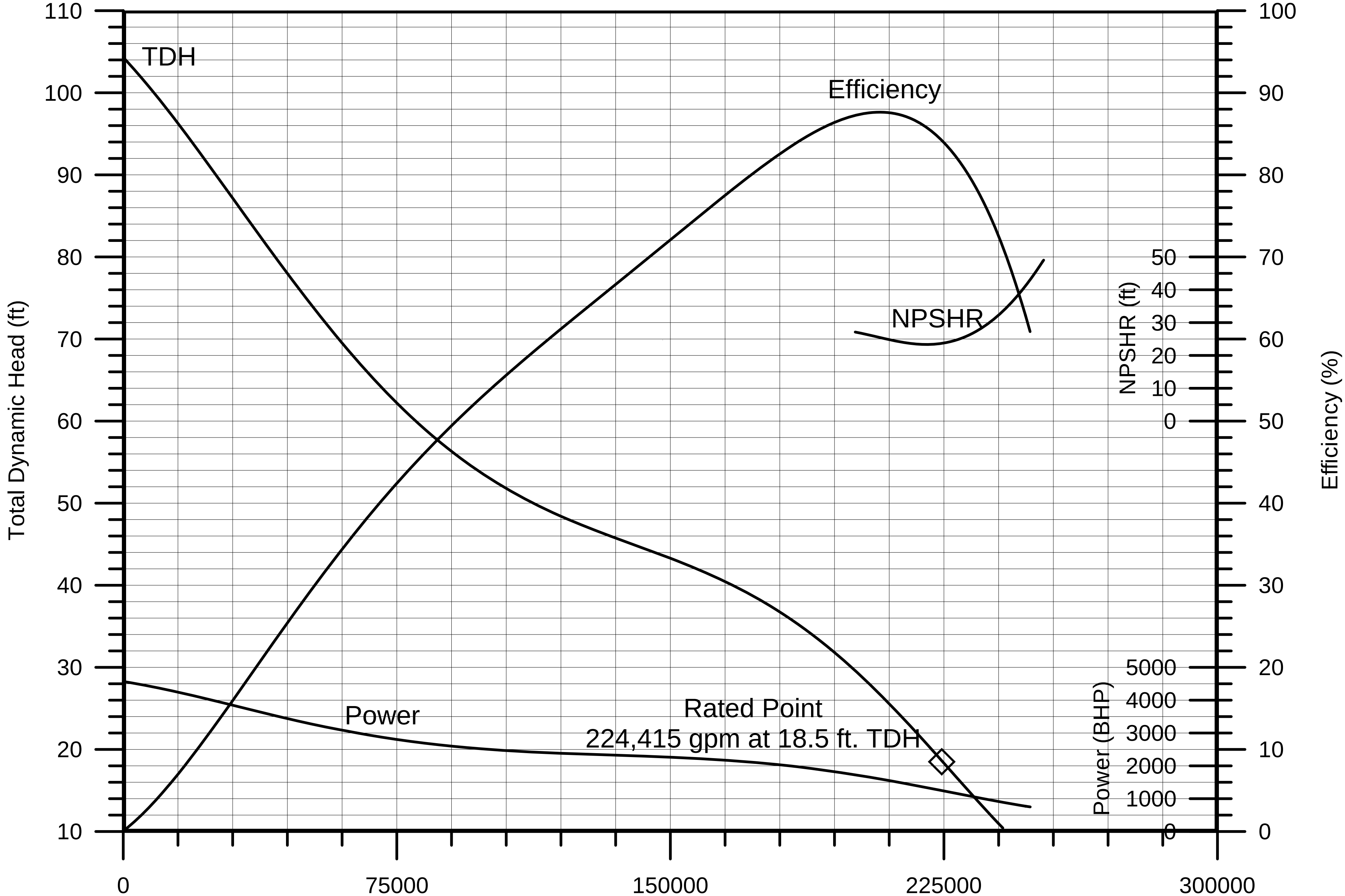
New Orleans
ITT Flygt Curve Number 72914
168 x 108 WCAX at 235 RPM



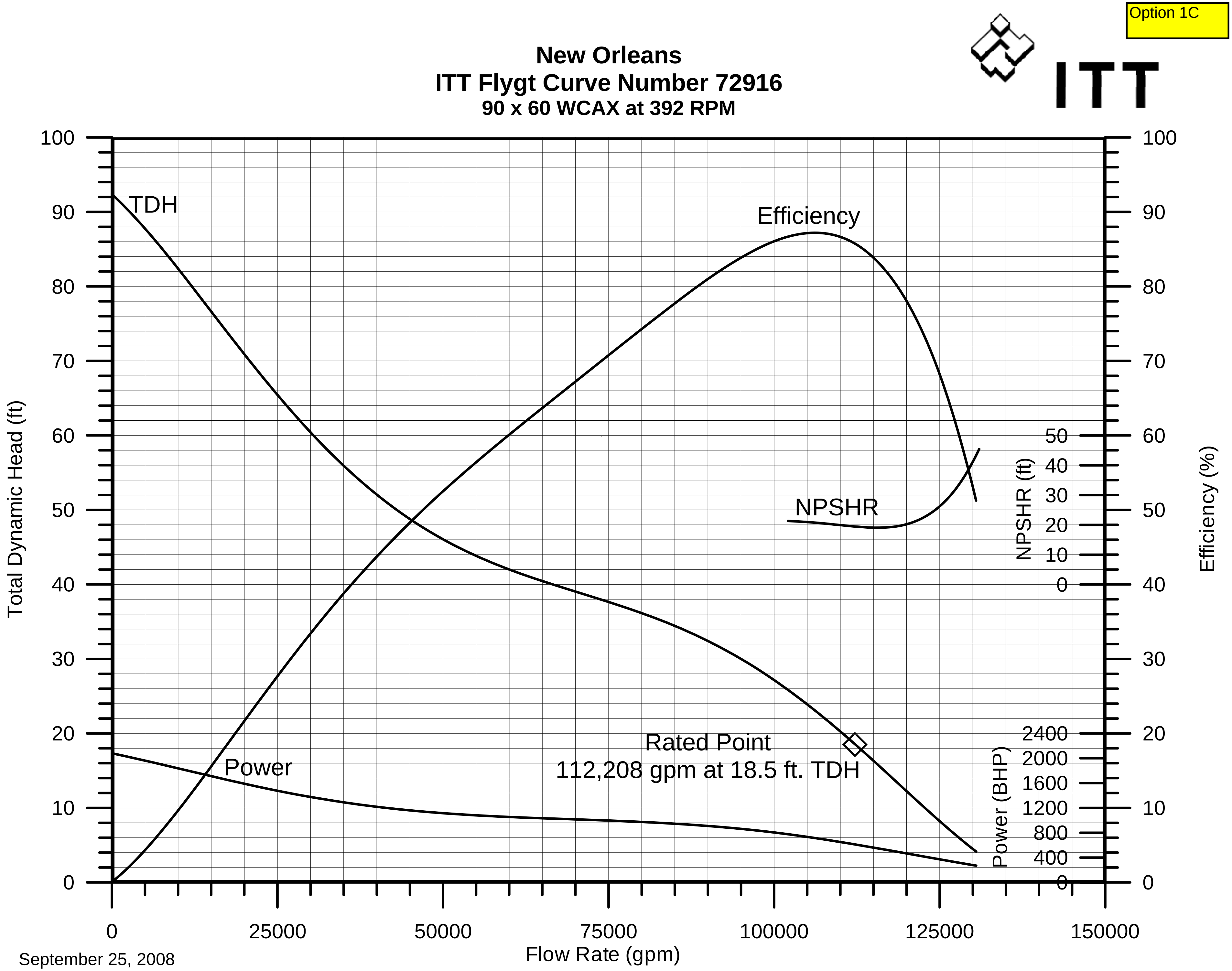
September 25, 2008

Option 1C

New Orleans
ITT Flygt Curve Number 72915
120 x 78 WCAX at 321 RPM



September 25, 2008


Option 1C
ITT
New Orleans
ITT Flygt Curve Number 72916
90 x 60 WCAX at 392 RPM
TDH
Efficiency
NPSHR
Rated Point
112,208 gpm at 18.5 ft. TDH
Power
Total Dynamic Head (ft)
NPSHR (ft)
Efficiency (%)
Power (BHP)
Flow Rate (gpm)
0
25000
50000
75000
100000
125000
150000
100
90
80
70
60
50
40
30
20
10
0
2400
2000
1600
1200
800
400
September 25, 2008

ITT

Option 1A - Robust Adaptable

Option 2 Pumps

Vertical Mixed Flow Column Pump

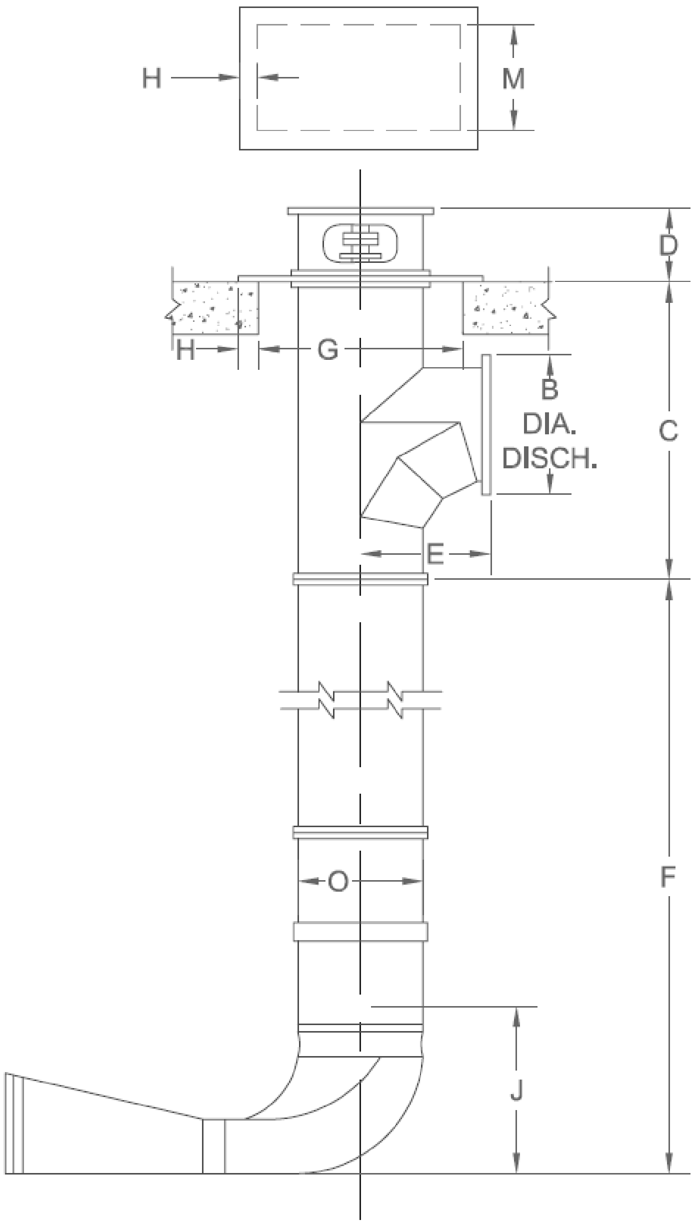
Parts and Material List

PART NAME	MATERIAL	ASTM #/UNS#
FSI	Carbon Steel	A36
Impeller	316L Stainless Steel	A743, CF3M
Impeller Cone	316L Stainless Steel	A743, CF3M
Diffuser	Ductile Iron	A536, Gr. 65-45-12
Pump Shaft (s)	410 Stainless Steel	A276, Type 410 SS
Shaft Tube (s)	Carbon Steel	A36
Column Pipe (s)	Carbon Steel	A36
Discharge Elbow, Baseplate, & Motor Pedestal	Carbon Steel	A36
Foundation Plates	Carbon Steel	A36
Adjustable Coupling	Forged Steel	A668, CL D
Intermediate Shaft Coupling	410 Stainless Steel	A743, CA15
Bearing	Elastomeric	Thordon SXL
Shaft Sleeve	420 Stainless Steel	A743, CA40
Gland	Bronze	B584, C93200
Wear Rings	420 Stainless Steel	A743,CA40
Stuffing Box & Bearing Hsg.	Cast Iron	A48, CL 30
Packing	Teflon	N/A

Option 1A - Robust Adaptable

Option 2 Pumps

132 WCAX



Dimensions in Inches

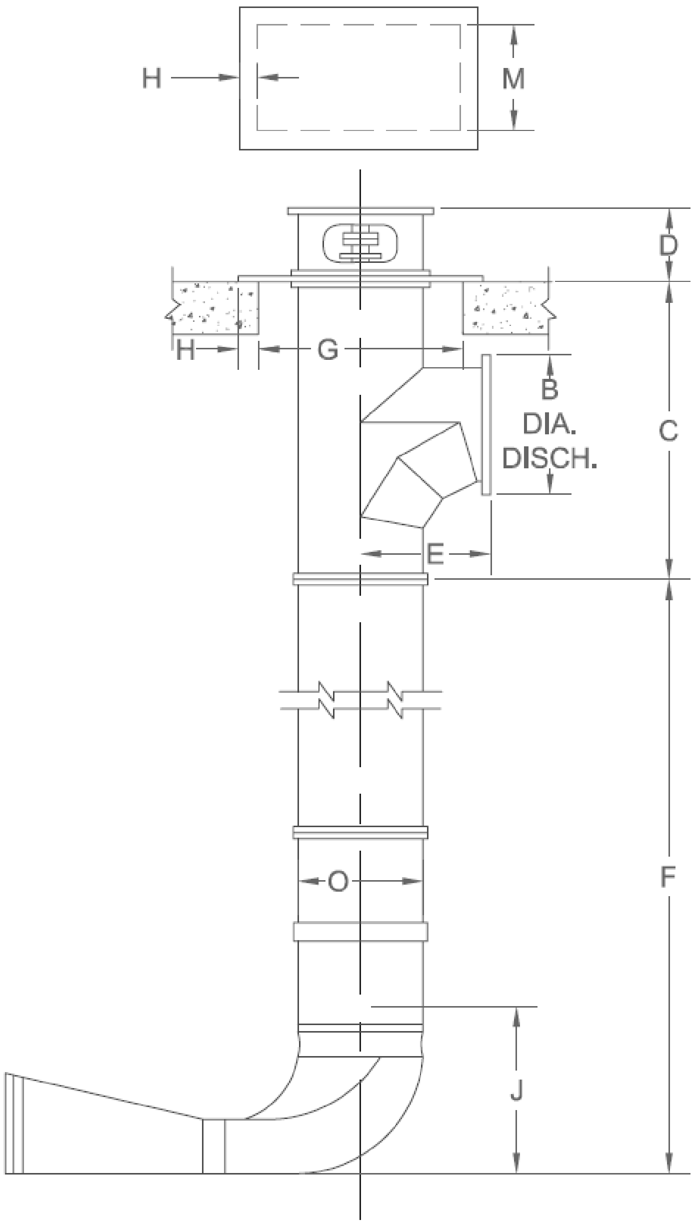
B	=	132
C	=	212
D	=	82
E	=	112
F	=	213
G	=	198
H	=	10.0
J (Impeller Eye)	=	85
O	=	132

Dimensions are approximate and subject to change.
Dimension “d” for FSI is 106.1

Option 1A - Robust Adaptable

Option 2 Pumps

108 WCAX



Dimensions in Inches

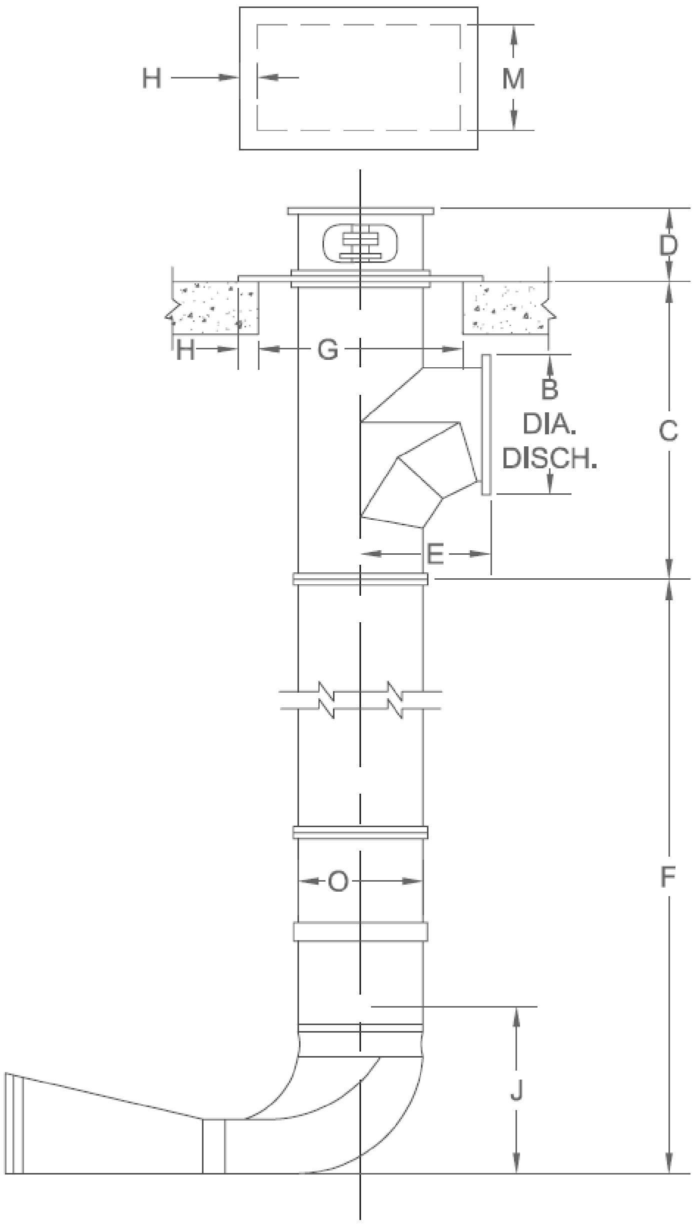
B	=	108
C	=	186
D	=	62
E	=	90
F	=	323
G	=	162
H	=	8.0
J (Impeller Eye)	=	72
O	=	108

Dimensions are approximate and subject to change.
Dimension “d” for FSI is 87.95

Option 1A - Robust Adaptable

Option 2 Pumps

96 WCAX



Dimensions in Inches

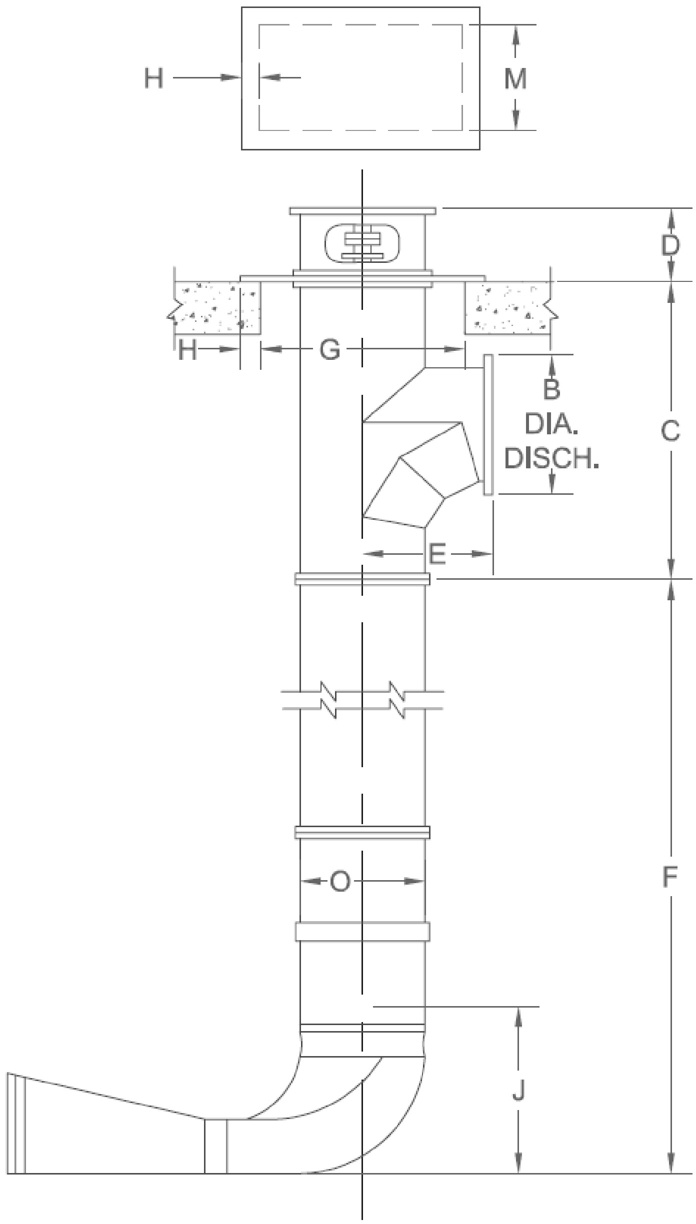
B	=	96
C	=	191
D	=	59
E	=	81
F	=	234
G	=	144
H	=	7.0
J (Impeller Eye)	=	66
O	=	96

Dimensions are approximate and subject to change.
Dimension “d” for FSI is 73.8

Option 1A - Robust Adaptable

Option 2 Pumps

78 WCAX



Dimensions in Inches

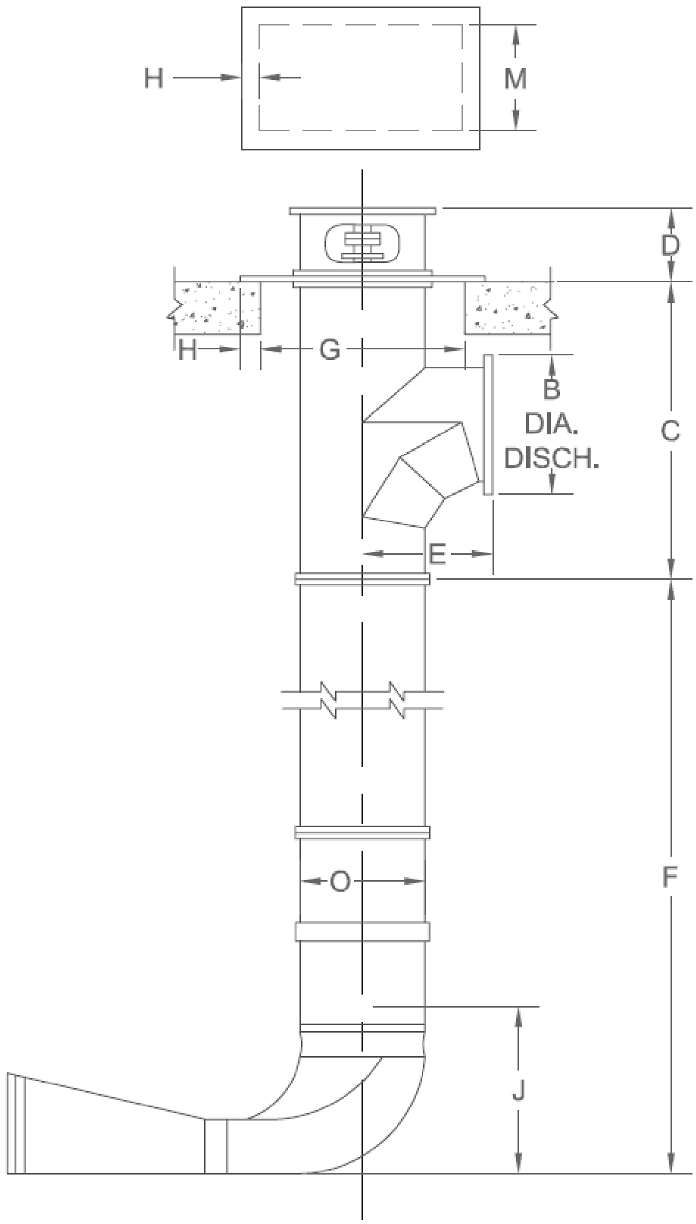
B	=	78
C	=	162
D	=	53
E	=	66
F	=	347
G	=	112
H	=	6.0
J (Impeller Eye)	=	50
O	=	78

Dimensions are approximate and subject to change.
Dimension “d” for FSI is 61.2

Option 1A - Robust Adaptable

Option 2 Pumps

66 WCAX



Dimensions in Inches

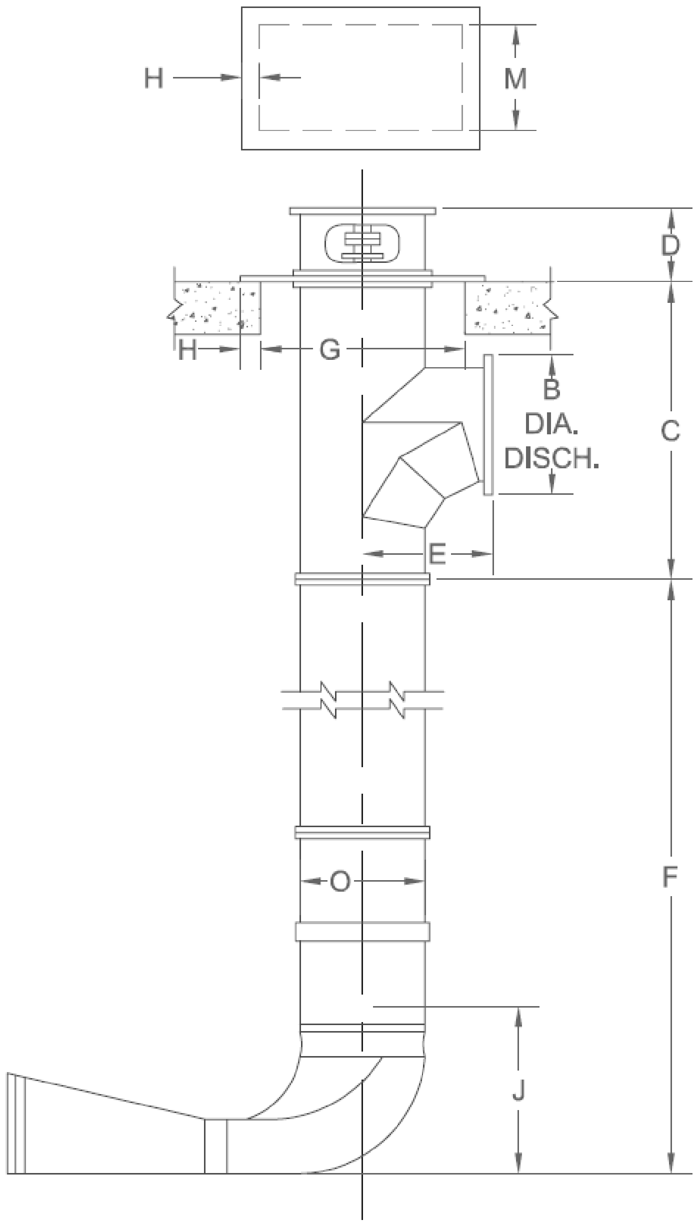
B	=	66
C	=	167
D	=	47
E	=	57
F	=	258
G	=	100
H	=	6.0
J (Impeller Eye)	=	39
O	=	66

Dimensions are approximate and subject to change.
Dimension “d” for FSI is 51.2

Option 1A - Robust Adaptable

Option 2 Pumps

60 WCAX



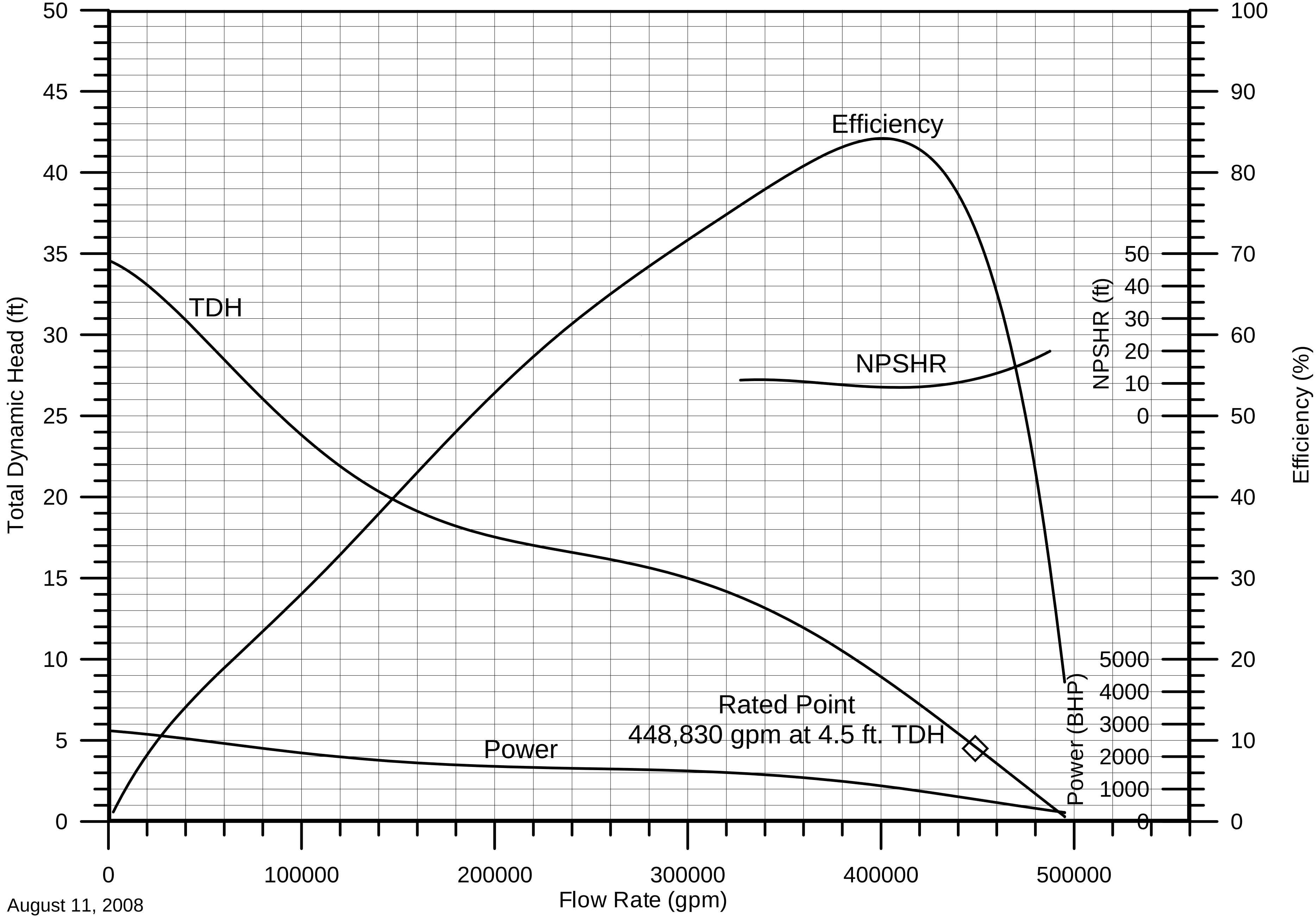
Dimensions in Inches

B	=	60
C	=	147
D	=	44
E	=	51
F	=	362
G	=	91
H	=	6.0
J (Impeller Eye)	=	39
O	=	60

Dimensions are approximate and subject to change.
Dimension “d” for FSI is 42.1

Option 1A - Robust Adaptable

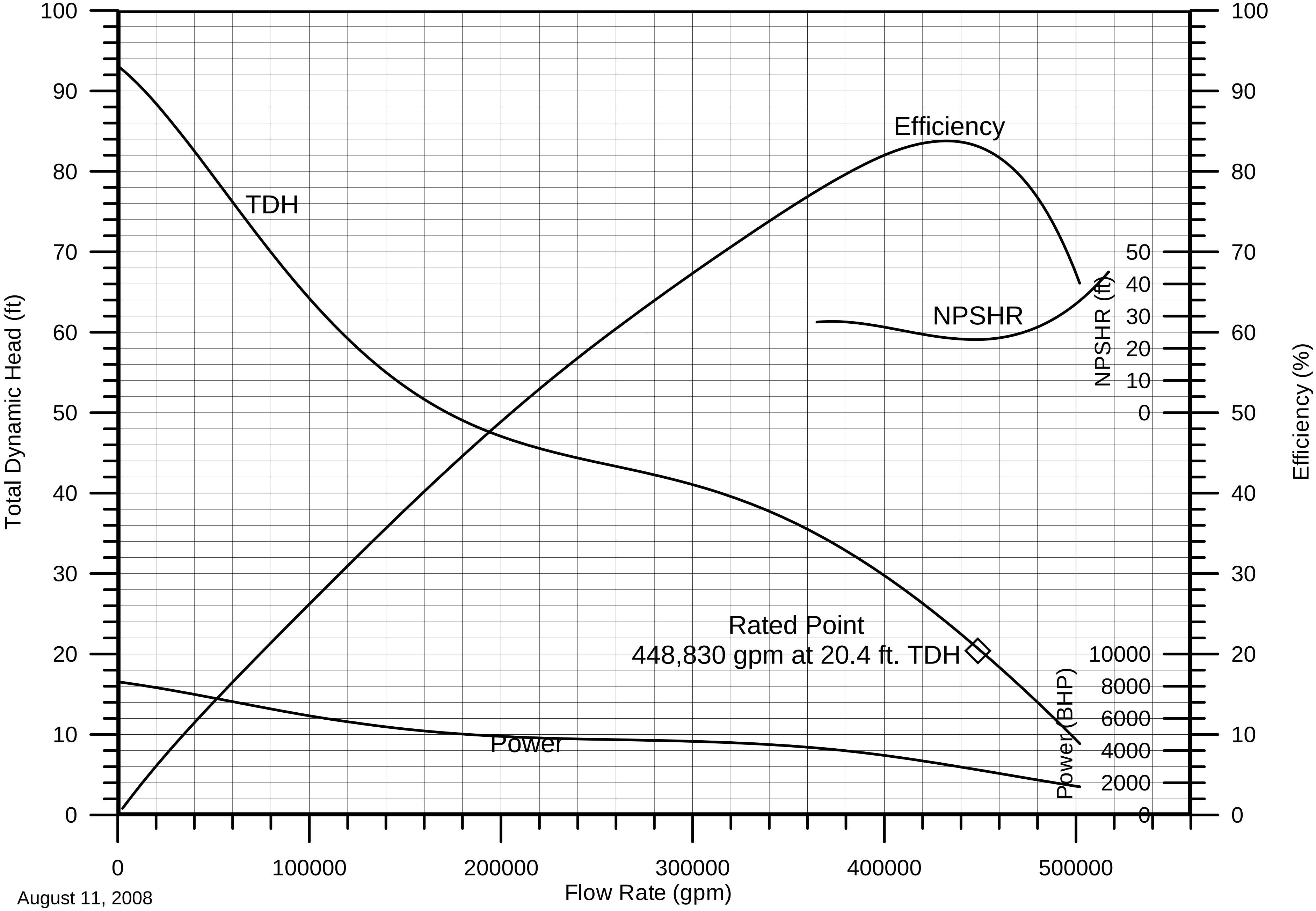
New Orleans 1000 cfs
Option 1 & Option 2/3 Initial
ITT Flygt Curve Number 72813
132 WCAX at 110 RPM



August 11, 2008

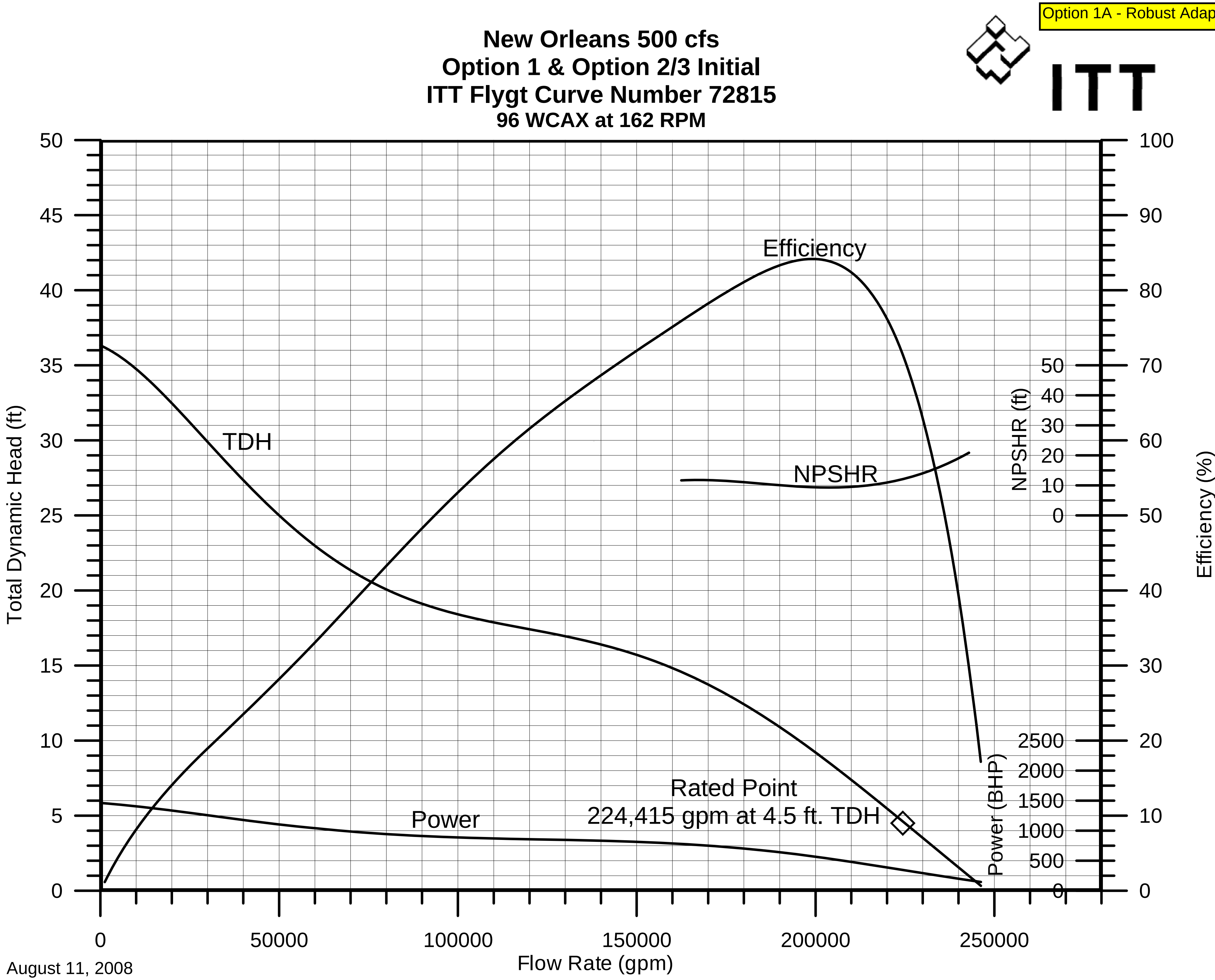
Option 2

New Orleans 1000 cfs
Option 2/3 Future
ITT Flygt Curve Number 72814
108 WCAX at 215 RPM



August 11, 2008

Option 1A - Robust Adaptable

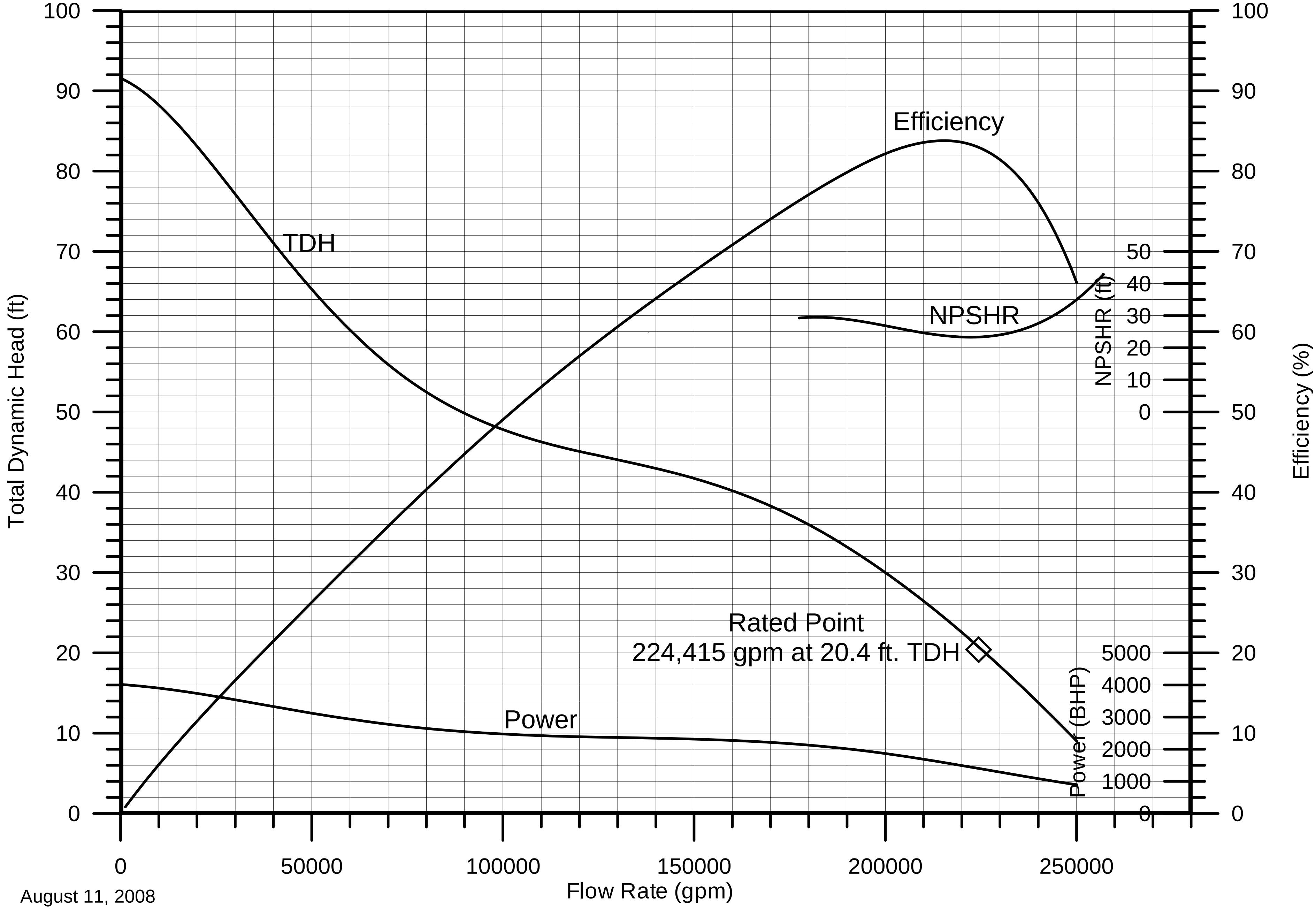


August 11, 2008

Option 2

ITT

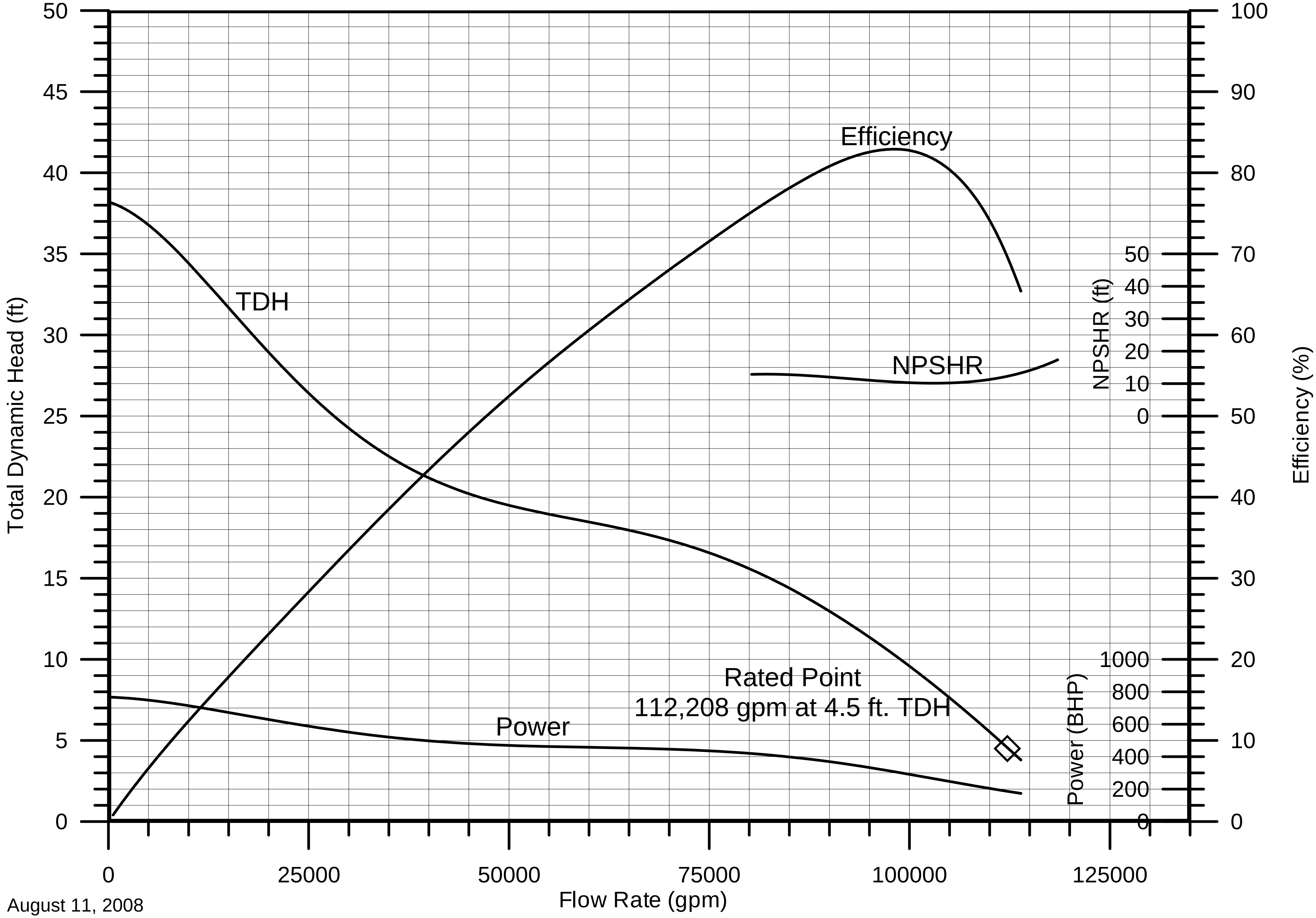
New Orleans 500 cfs
Option 2/3 Future
ITT Flygt Curve Number 72816
78 WCAX at 310 RPM



August 11, 2008

Option 1A - Robust Adaptable

New Orleans 250 cfs
Option 1 & Option 2/3 Initial
ITT Flygt Curve Number 72817
66 WCAX at 240 RPM

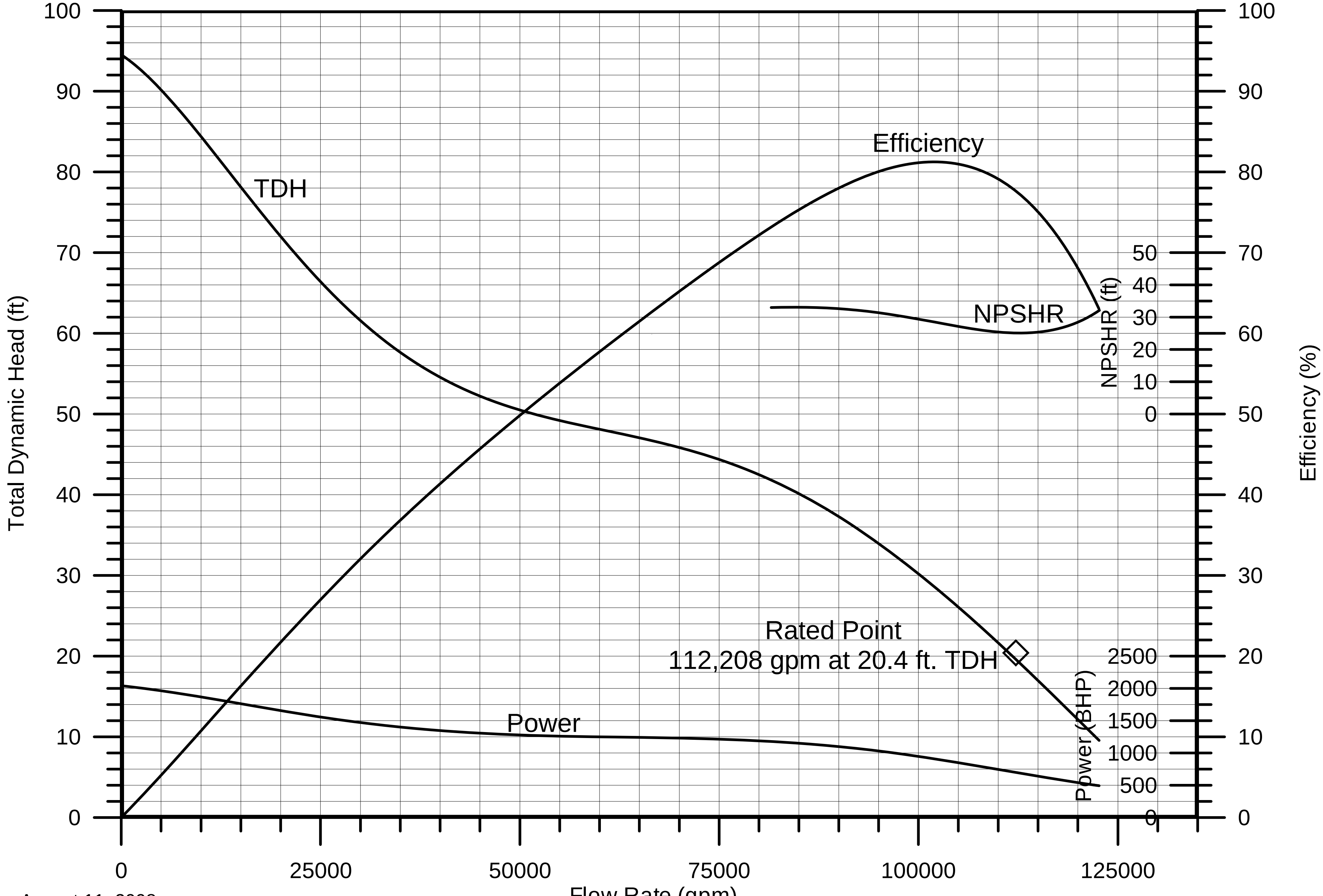


August 11, 2008

Option 2

ITT

New Orleans 250 cfs
Option 2/3 Future
ITT Flygt Curve Number 72818
60 WCAX at 460 RPM



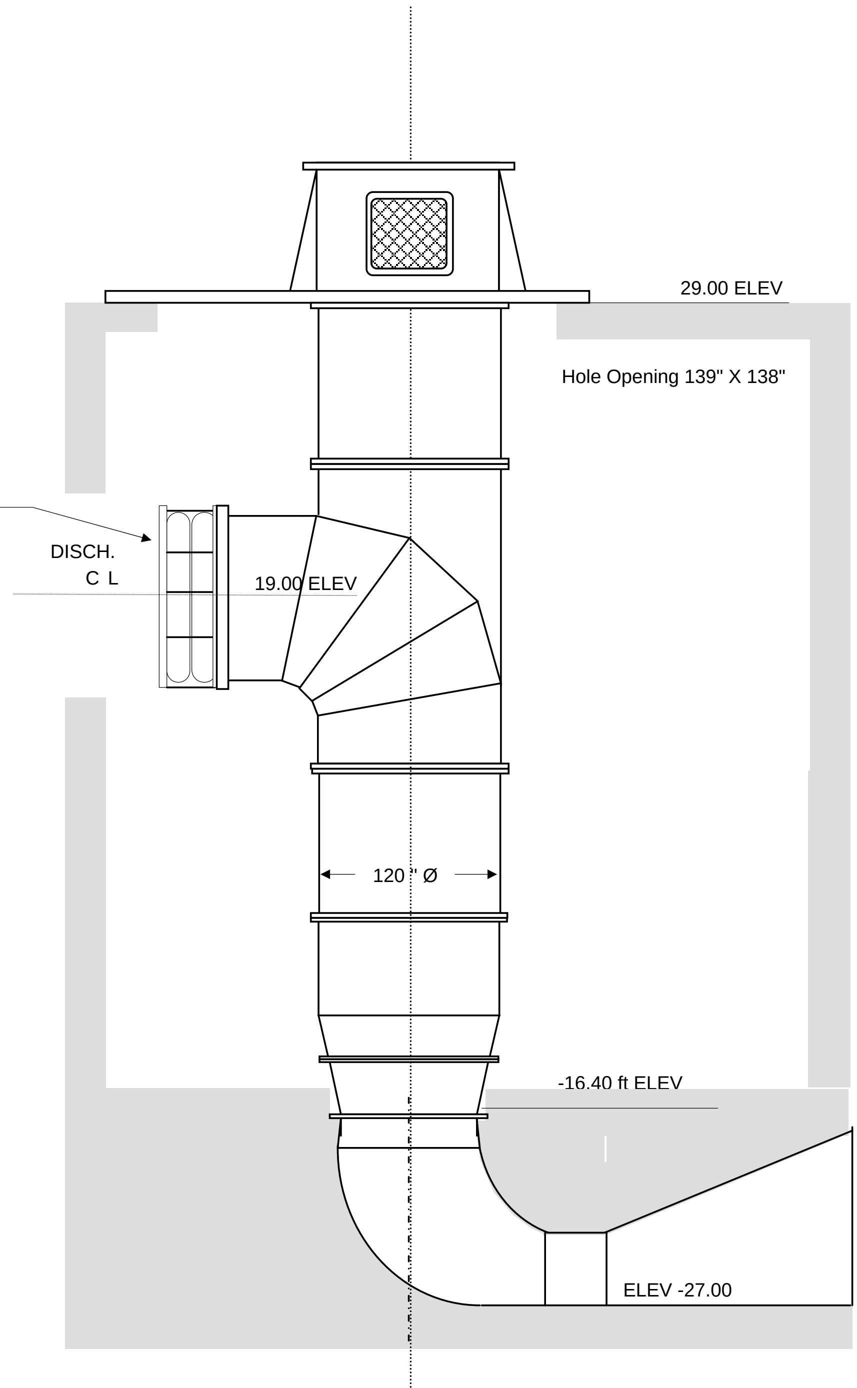
August 11, 2008

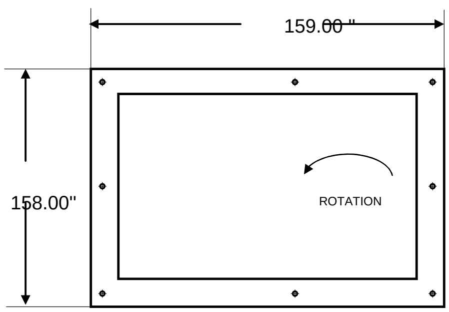
Option 2

VERTICAL CIRCULATING PUMP - STYLE AFS

PRELIMINARY OUTLINE DRAWING

DISCHARGE FLANGE DETAILS	
NOMINAL SIZE	**120 "**
FLANGE O.D.	**132 "**
Ø BOLT CIRCLE	**127 "**
NO. HOLES	**72**
Ø HOLES	**2 5/8 "**





Estimated Pump Weight = 170,000 lbs.

Impeller inlet diameter - 99.38"

RATED OPERATING CONDITIONS	
CAPACITY - CFS	**1000**
TDH IN FEET	**20.40 ft**
ENGINE HORSEPOWER	**3250 HP**
SPEED IN RPM	**133 RPM**

NOTE: DIMENSIONS ARE PRELIMINARY AND ARE NOT TO BE USED FOR CONSTRUCTION PURPOSES.

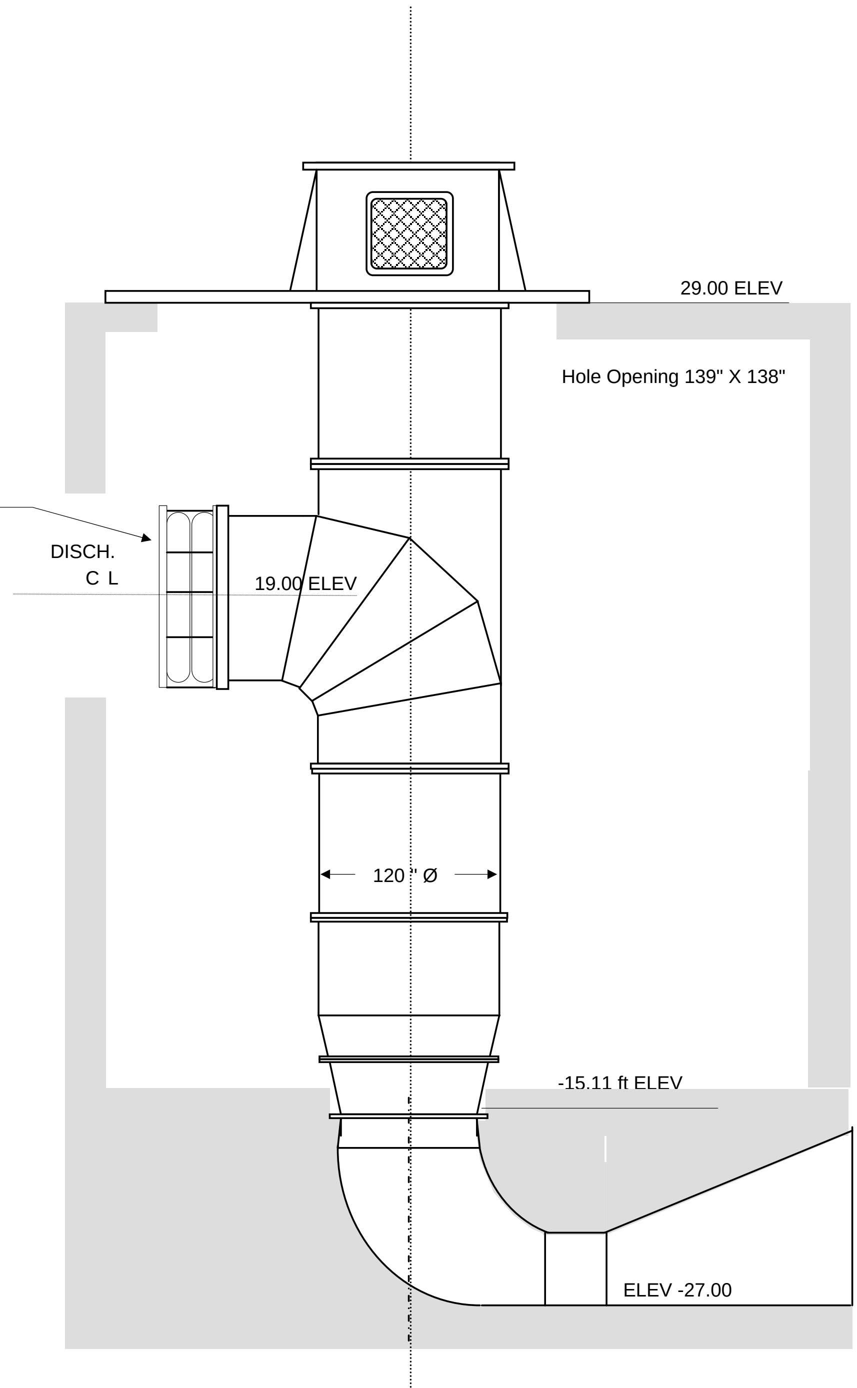
USER: **Option #2/3 Future**	DRAWN BY: **R. Cornman**	DATE: **7 Au 08**	PROP. NO.
LOCATION: **New Orleans**			
ENGINEER: **B & V**	FLOWSERVE		DRAWING NO. **SK-1**
PUMP SIZE AND TYPE: **133APMA**			

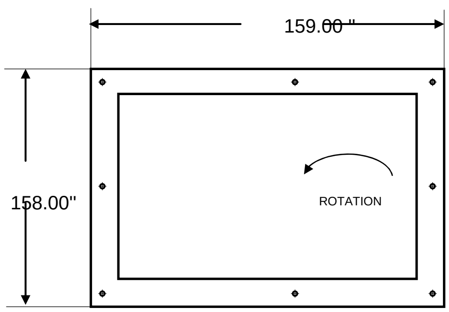
Option 1A

VERTICAL CIRCULATING PUMP - STYLE AFS

PRELIMINARY OUTLINE DRAWING

DISCHARGE FLANGE DETAILS	
NOMINAL SIZE	**120 "**
FLANGE O.D.	**132 "**
Ø BOLT CIRCLE	**127 "**
NO. HOLES	**72**
Ø HOLES	**2 5/8 "**





Estimated Pump Weight = 165,000 lbs.

Impeller inlet diameter - 111.5"

RATED OPERATING CONDITIONS	
CAPACITY - CFS	**1000**
TDH IN FEET	**4.50 ft**
ENGINE HORSEPOWER	**1500 HP**
SPEED IN RPM	**115 RPM**

NOTE: DIMENSIONS ARE PRELIMINARY AND ARE NOT TO BE USED FOR CONSTRUCTION PURPOSES.

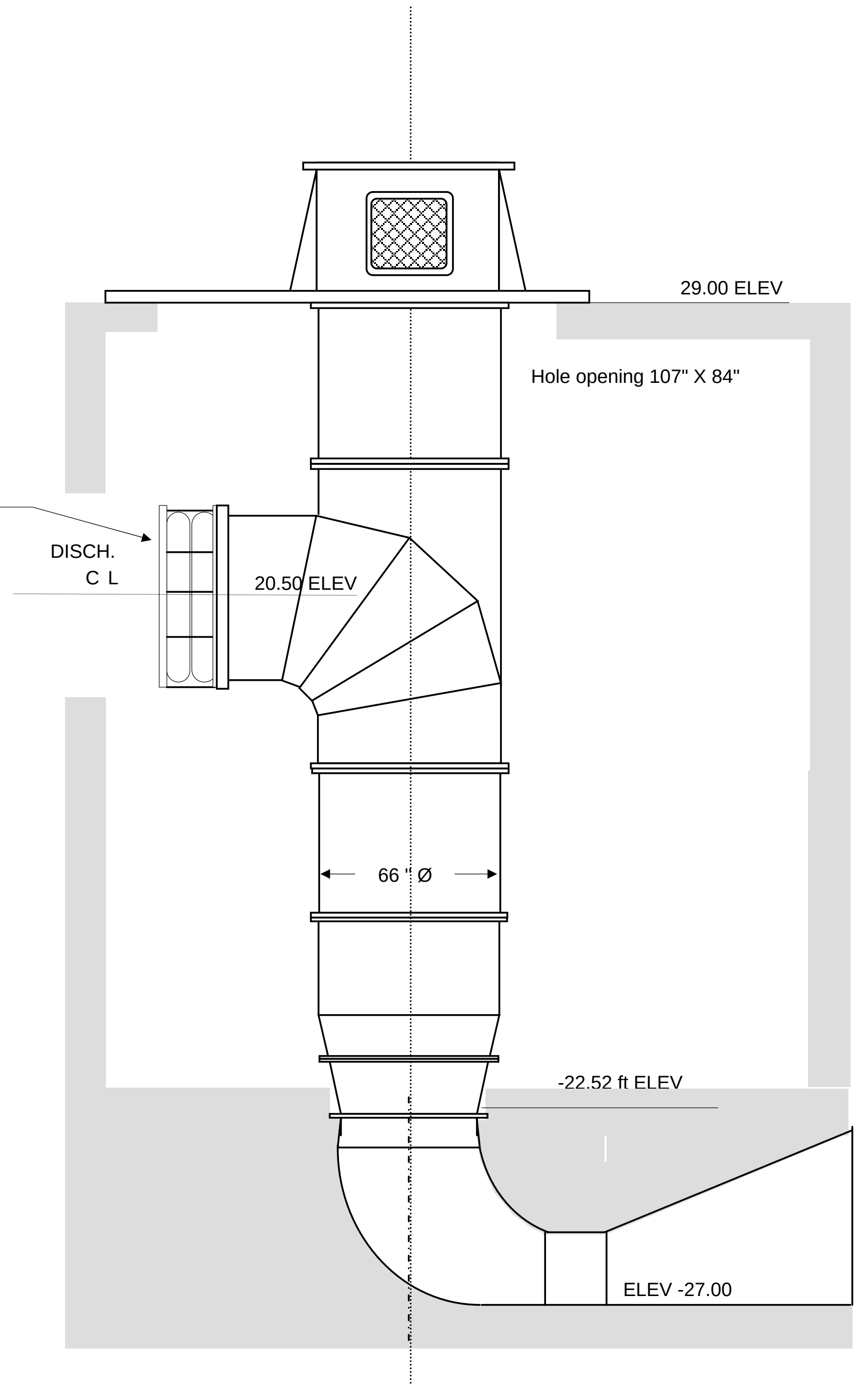
USER: **Option #1 & #2/3 Initial**	DRAWN BY: **R. Cornman**	DATE: **5 Au 08**	PROP. NO.
LOCATION: **New Orleans**			
ENGINEER: **B & V**	FLOWSERVE		DRAWING NO.
PUMP SIZE AND TYPE: **133APS**			**SK-1**

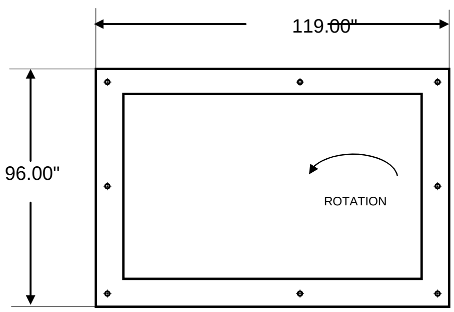
Option 2

VERTICAL CIRCULATING PUMP - STYLE AFS

PRELIMINARY OUTLINE DRAWING

DISCHARGE FLANGE DETAILS	
NOMINAL SIZE	**66 "**
FLANGE O.D.	**80 "**
Ø BOLT CIRCLE	**76 "**
NO. HOLES	**52**
Ø HOLES	**1 5/8 "**





Estimated Pump Weight = 52,000 lbs.

Impeller inlet diameter = 42.0"

RATED OPERATING CONDITIONS	
CAPACITY - CFS	**250**
TDH IN FEET	**20.40 ft**
ENGINE HORSEPOWER	**800 HP**
SPEED IN RPM	**316 RPM**

NOTE: DIMENSIONS ARE PRELIMINARY AND ARE NOT TO BE USED FOR CONSTRUCTION PURPOSES.

USER: **Option #2/3 Final**	DRAWN BY: **R. Cornman**	DATE: **7 Au 08**	PROP. NO.
LOCATION: **New Orleans**			
ENGINEER: **B & V**	FLOWSERVE		DRAWING NO. **SK-1**
PUMP SIZE AND TYPE: **56APMA**			

Option 1A

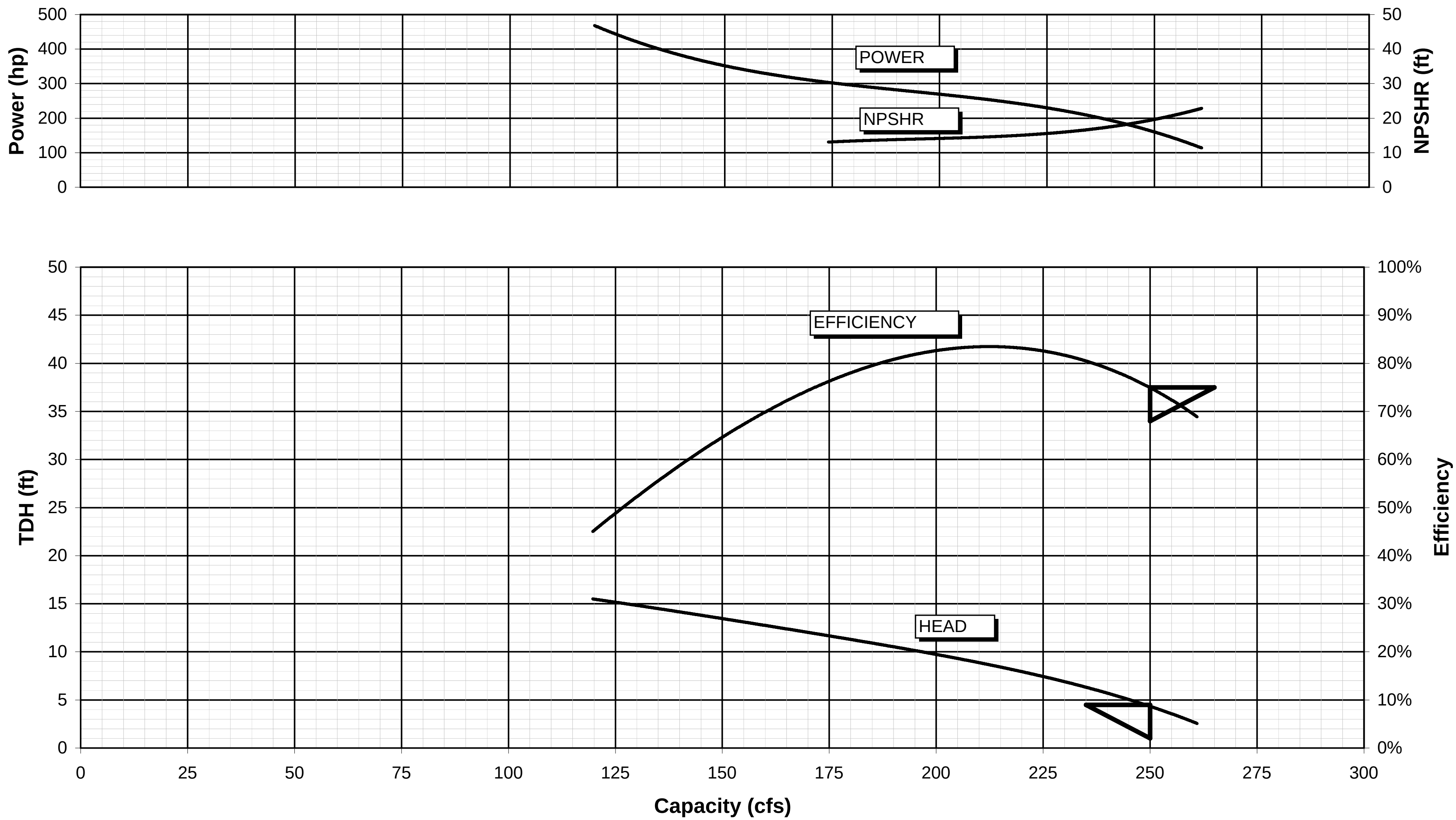
FLOWSERVE

Proposed Performance

Order Number		**Liquid**	Drainage Water	**Speed (RPM)**	272	**Capacity (cfs)**	250
Customer	B & V / New Orleans	**Temperature (°F)**		**Pump type**	63APS	**TDH (ft)**	4.5
Service	Option #1& 2/3 Initial	**Viscosity (Cp)**		**Pump Serial No.**		**Efficiency**	75.0%
Date	7/17/2008	**Specific Gravity**	1.00			**NPSHR (ft)**	

Rev. A

Curves are approximate. Pump is guaranteed for one set of conditions. Capacity, head, and efficiency guarantees are based on shop test and when handling clear, cold, fresh water at a temperature of not over 85 degrees.

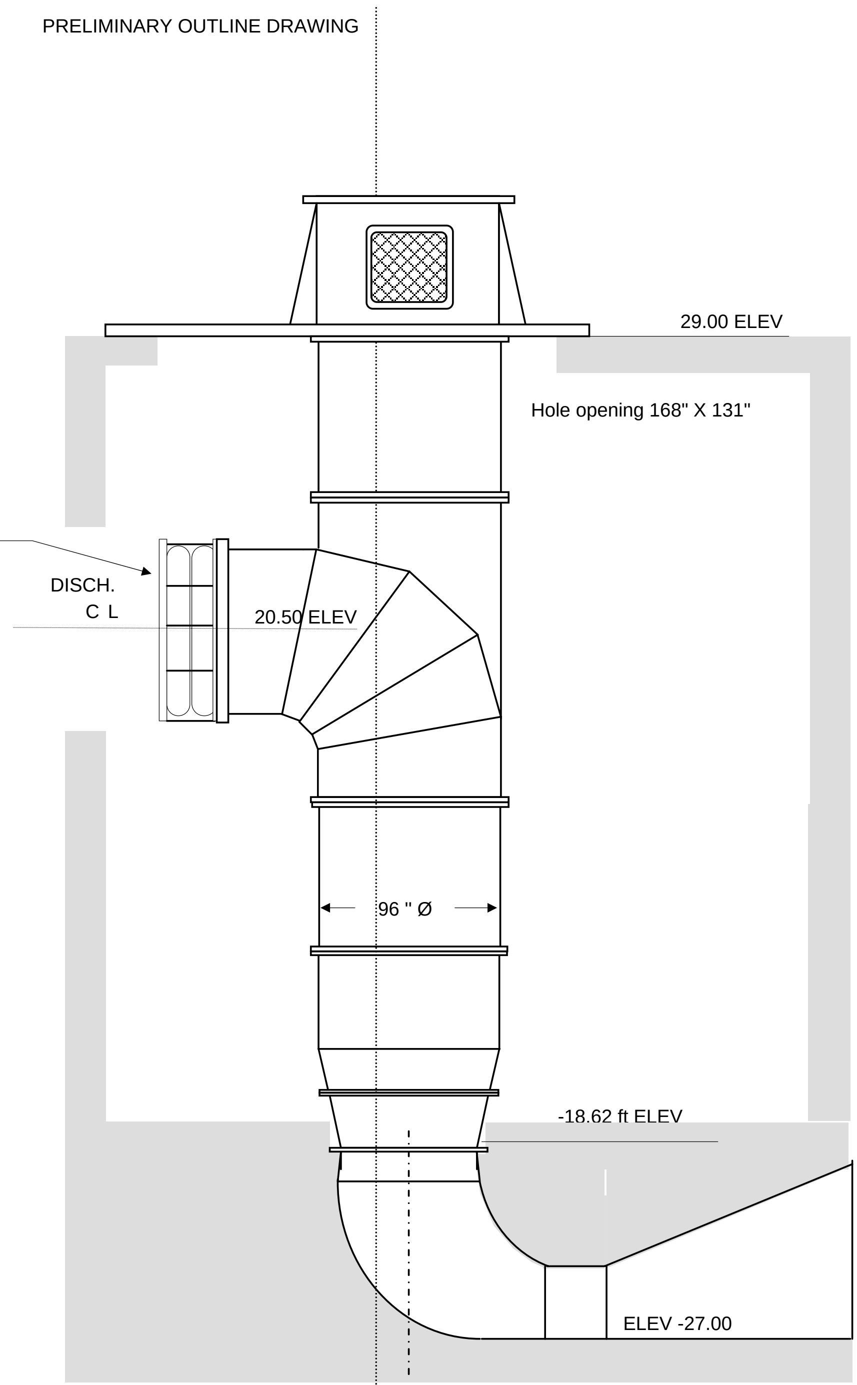


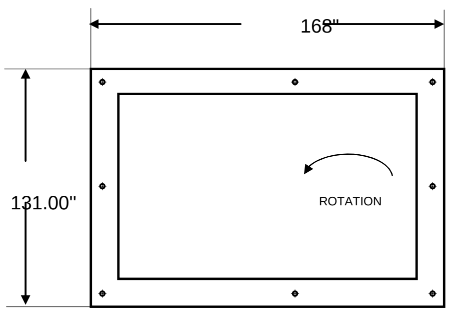
Option 1A

VERTICAL CIRCULATING PUMP - STYLE AFS

PRELIMINARY OUTLINE DRAWING

DISCHARGE FLANGE DETAILS	
NOMINAL SIZE	**96 "**
FLANGE O.D.	**113 1/4 "**
Ø BOLT CIRCLE	**108 1/2 "**
NO. HOLES	**68**
Ø HOLES	**2 3/8 "**





Estimated Pump Weight = 106,000 lbs.

Impeller inlet diameter = 78.5"

RATED OPERATING CONDITIONS	
CAPACITY - CFS	**500**
TDH IN FEET	**4.50 ft**
ENGINE HORSEPOWER	**900 HP**
SPEED IN RPM	**179 RPM**

NOTE: DIMENSIONS ARE PRELIMINARY AND ARE NOT TO BE USED FOR CONSTRUCTION PURPOSES.

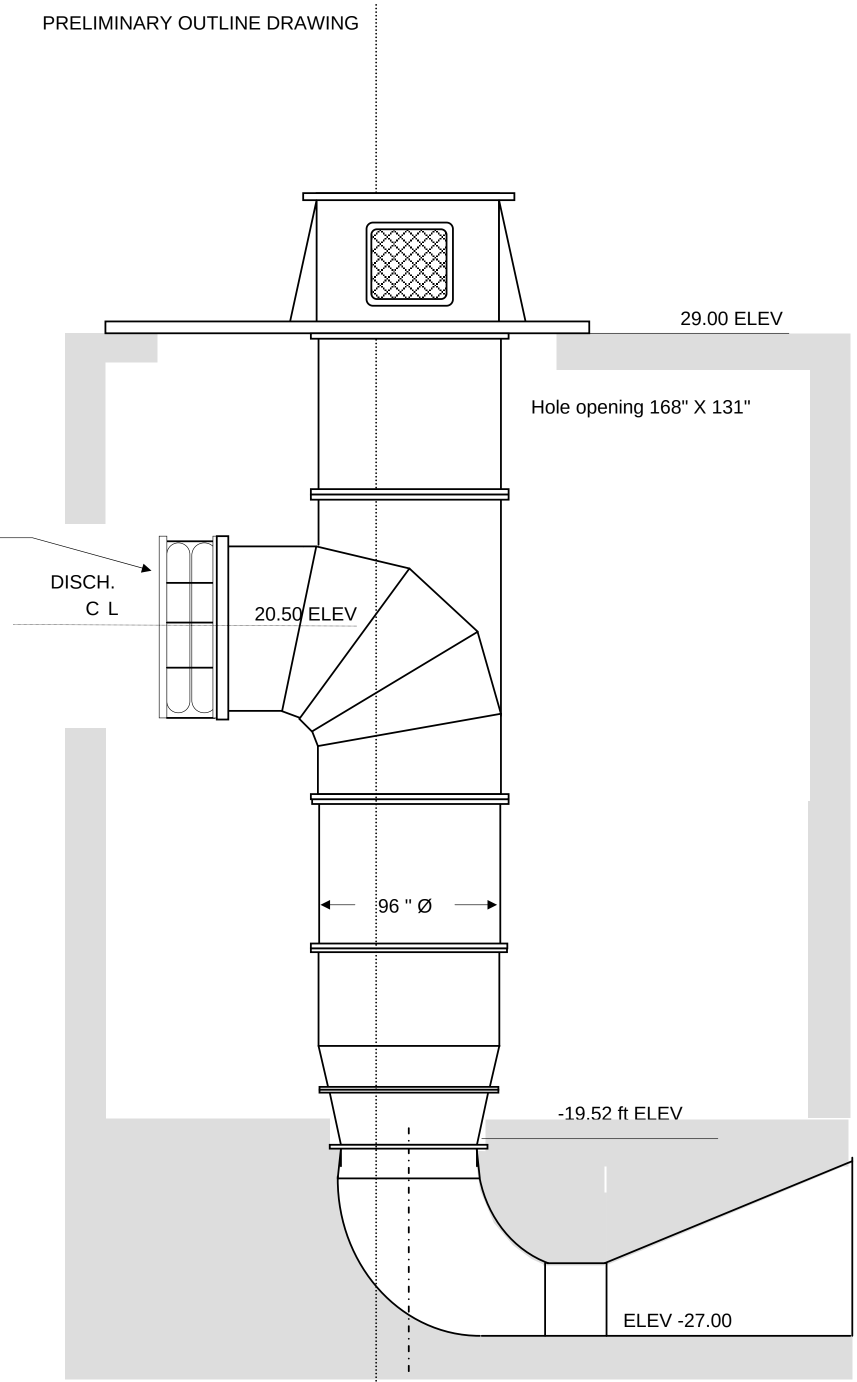
USER: **Option #1 & #2/3 Initial** LOCATION: **New Orleans**	DRAWN BY: **R. Cornman**	DATE: **5 Au 08**	PROP. NO.
ENGINEER: **B & V** PUMP SIZE AND TYPE: **90APS**	FLOWSERVE		DRAWING NO. **SK-1**

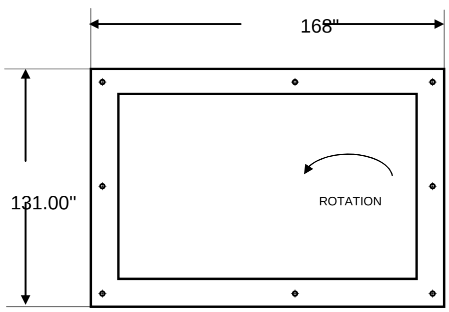
Option 2

VERTICAL CIRCULATING PUMP - STYLE AFS

PRELIMINARY OUTLINE DRAWING

DISCHARGE FLANGE DETAILS	
NOMINAL SIZE	**96 "**
FLANGE O.D.	**113 1/4 "**
Ø BOLT CIRCLE	**108 1/2 "**
NO. HOLES	**68**
Ø HOLES	**2 3/8 "**





Estimated Pump Weight = 110,000 lbs.

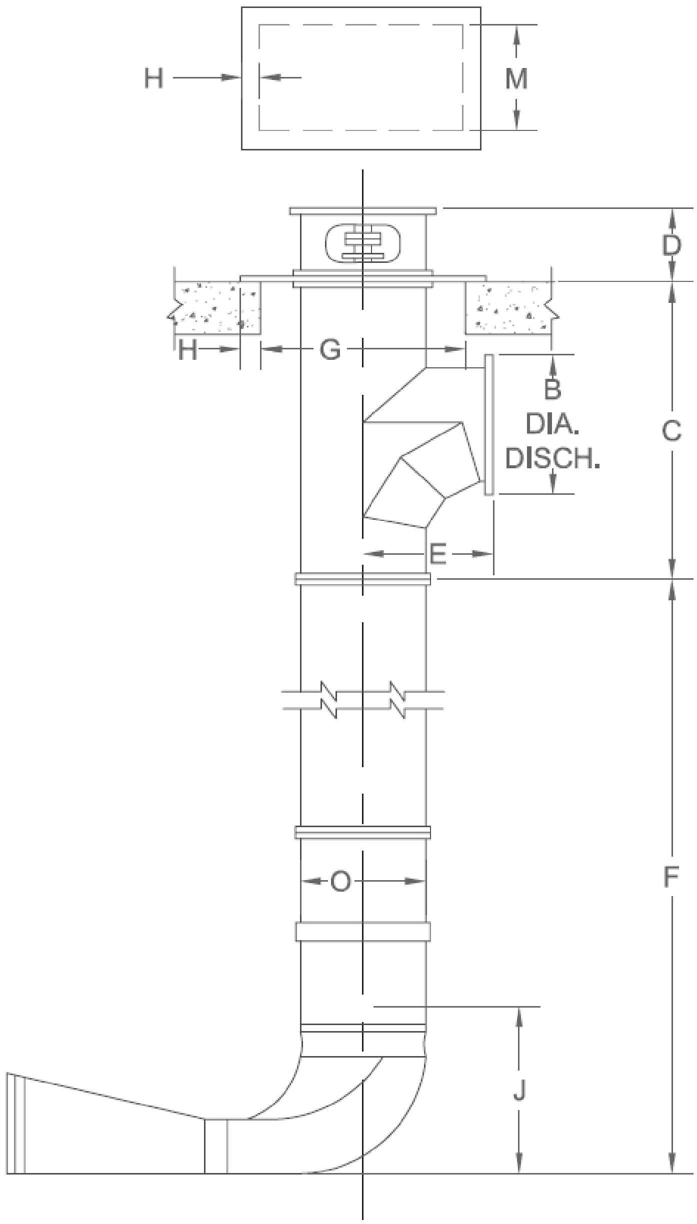
Impeller inlet diameter = 70.25"

RATED OPERATING CONDITIONS	
CAPACITY - CFS	**500**
TDH IN FEET	**20.40 ft**
ENGINE HORSEPOWER	**1800 HP**
SPEED IN RPM	**188 RPM**

NOTE: DIMENSIONS ARE PRELIMINARY AND ARE NOT TO BE USED FOR CONSTRUCTION PURPOSES.

USER: **Option #2/3 Final**	DRAWN BY: **R. Cornman**	DATE: **7 Au 08**	PROP. NO.
LOCATION: **New Orleans**			
ENGINEER: **B & V**	FLOWSERVE		DRAWING NO. **SK-1**
PUMP SIZE AND TYPE: **94APMA**			

Hoeys Basin
78 WCA



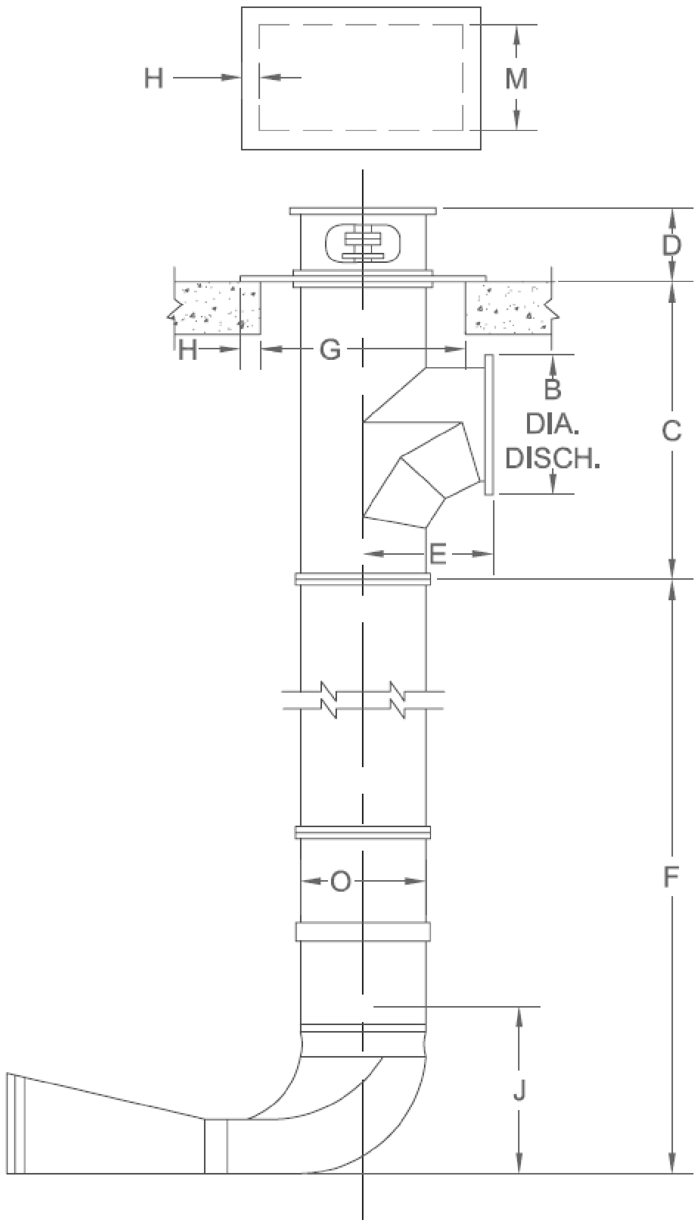
Dimensions in Inches

B	=	78
C	=	119
D	=	58
E	=	66
F	=	159
G	=	112
H	=	6.0
J (Impeller Eye)	=	92
M	=	90
O	=	78

Dimensions are approximate and subject to change.

Dimension “d” for FSI is 68.95 in.

Dwyers Channel
72 WCA



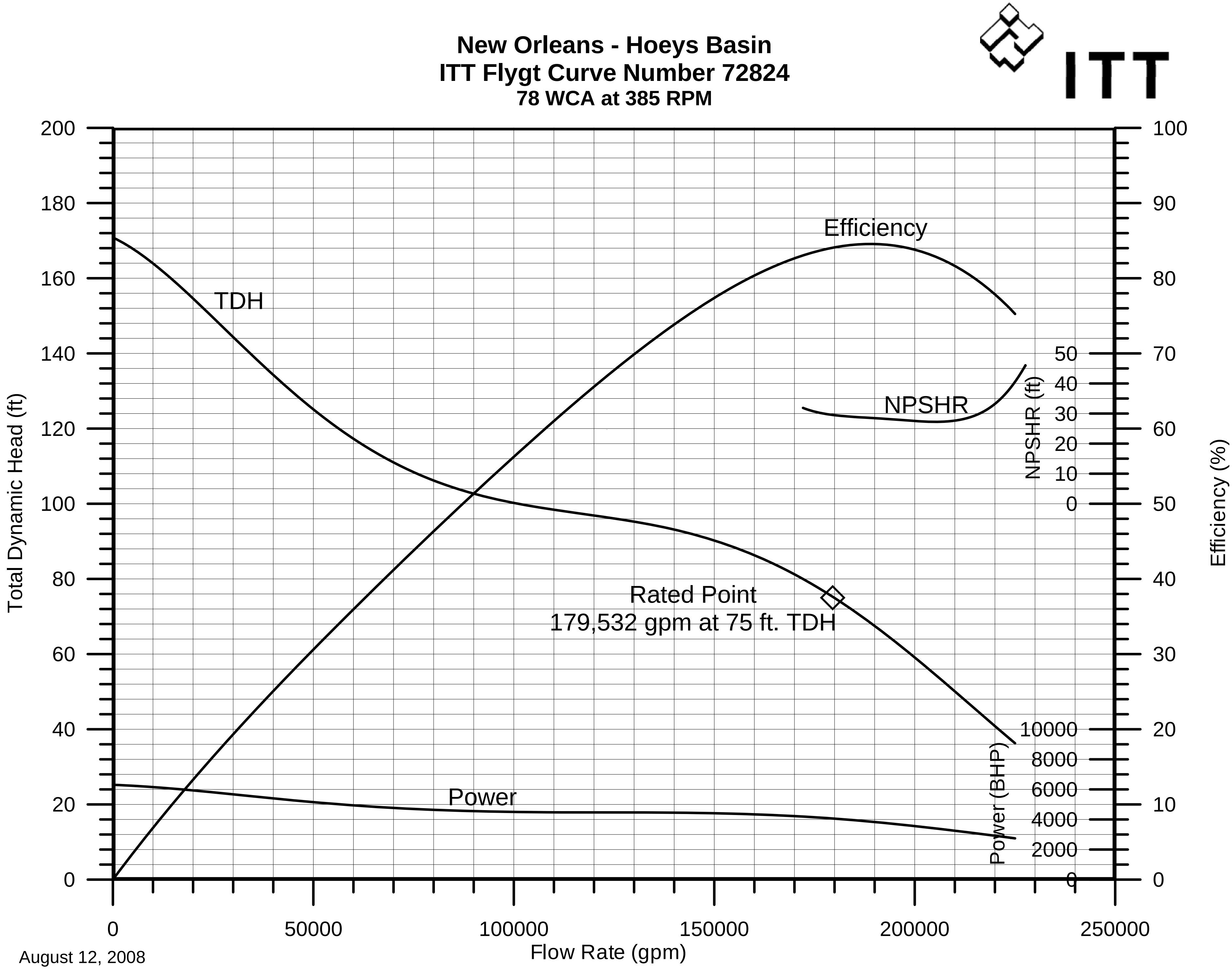
Dimensions in Inches

B	=	72
C	=	110
D	=	55
E	=	60
F	=	151
G	=	104
H	=	6.0
J (Impeller Eye)	=	85
M	=	84
O	=	72

Dimensions are approximate and subject to change.

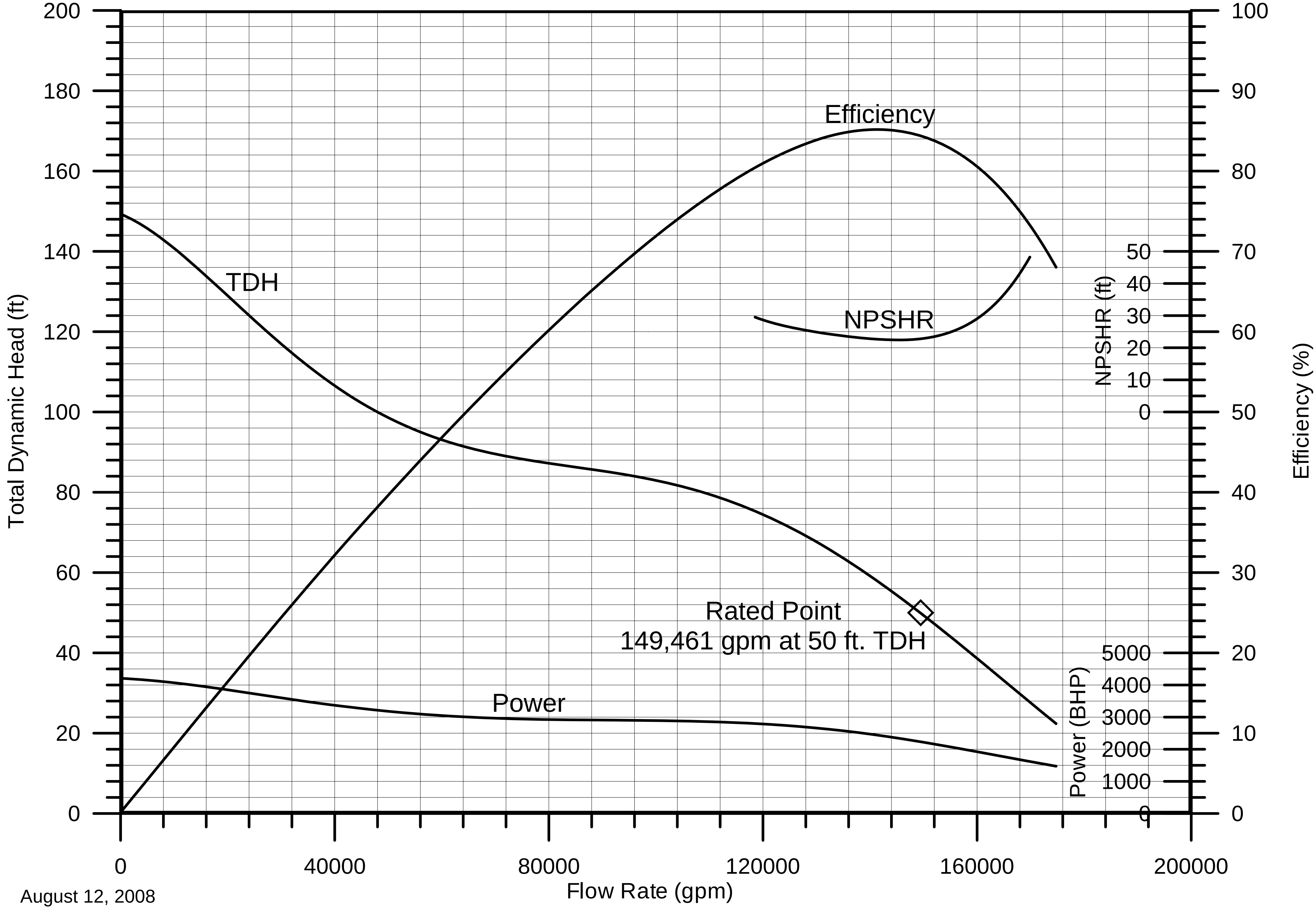
Dimension “d” for FSI is 63.59 in.

New Orleans - Hoeys Basin
ITT Flygt Curve Number 72824
78 WCA at 385 RPM



August 12, 2008

New Orleans - Dwyer Channel
ITT Flygt Curve Number 72825
72 WCA at 390 RPM



August 12, 2008

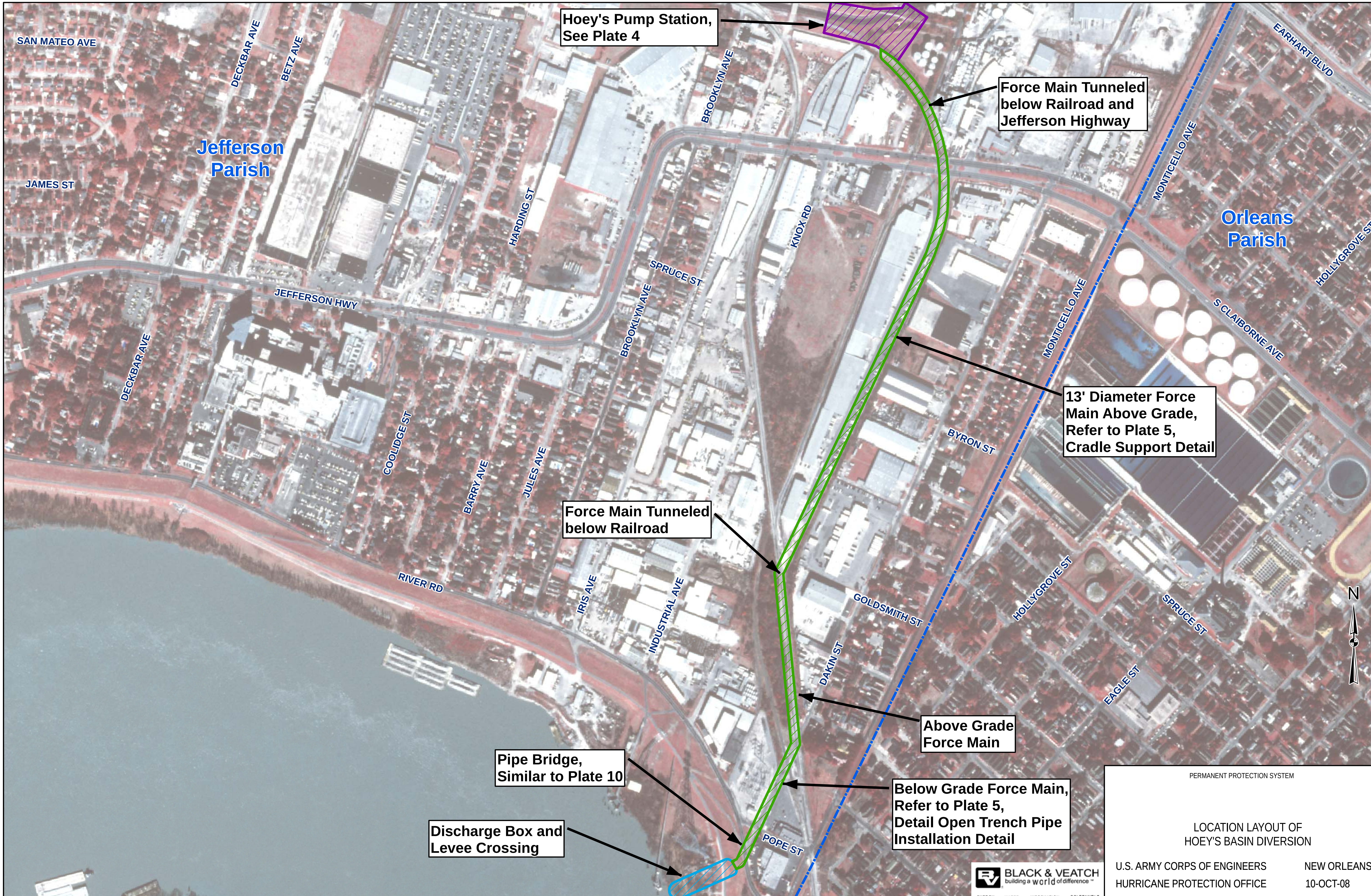
APPENDIX F

Gated Bypass

APPENDIX G

Diversions

Final Report
March 13, 2009



PERMANENT PROTECTION SYSTEM

LOCATION LAYOUT OF
HOEY'S BASIN DIVERSION

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U.S. ARMY CORPS OF ENGINEERS	NEW ORLEANS
HURRICANE PROTECTION OFFICE	10-OCT-08

PLATE: 1


Orleans Parish
DPS#3
DPS#17
DPS#19
Modifications to Pump Station outfall, See Plate 6
Modifications to Piety St and Louisa St Box Culvert, Performed by SELA
VIRGIL BLVD
FOY ST
FAIRMONT DR
CLEMATIS AVE
CLOVER ST
MYRTLE ST
SAGE ST
DAHLIA WALK
ST FERDINAND ST
ACACIA ST
ELDER ST
HIGGINS BLVD
FRANCE RD
ALVAR ST
REPUBLIC ST
GENTILLY BLVD
ST ANTHONY AVE
MANDEVILLE ST
PLEASURE ST
HUMANITY ST
RABBITS ST
BENEFIT ST
TREASURE ST
PEOPLES AVE
PRESS ST
METROPOLITAN ST
DESIRE PKWY
LONDON AVE
ALLEN ST
ELYSIAN FIELDS AV OV
ABUNDANCE ST
MUSIC ST
SPAIN ST
FLORIDA AVE
INDUSTRY ST
AGRICULTURE ST
BRUXELLES ST
N BROAD ST
A P TUREAUD AVE
HOPE ST
LAW ST
NEW ORLEANS ST
ANNETTE ST
PAUGER ST
ST ROCH AVE
FRANKLIN AVE
ALMONASTER AVE
FELICIANA ST
N ROCHEBLAVE ST
AUBRY ST
ST ANTHONY ST
MARIGNY ST
N JOHNSON ST
N GALVEZ ST
MAZANT ST
ONZAGA ST
N ROMAN ST
MONTEGUT ST
CONGRESS ST
ELYSIAN FIELDS AVE
N CLAIBORNE AVE
COLUMBUS ST
N ROBERTSON ST
N VILLERE ST
ARTS ST
URQUHART ST
10
610
N
PERMANENT PROTECTION SYSTEM
LOCATION LAYOUT OF
FLORIDA AVE DIVERSION
U.S. ARMY CORPS OF ENGINEERS
HURRICANE PROTECTION OFFICE
NEW ORLEANS
10-OCT-08
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PLATE: 2

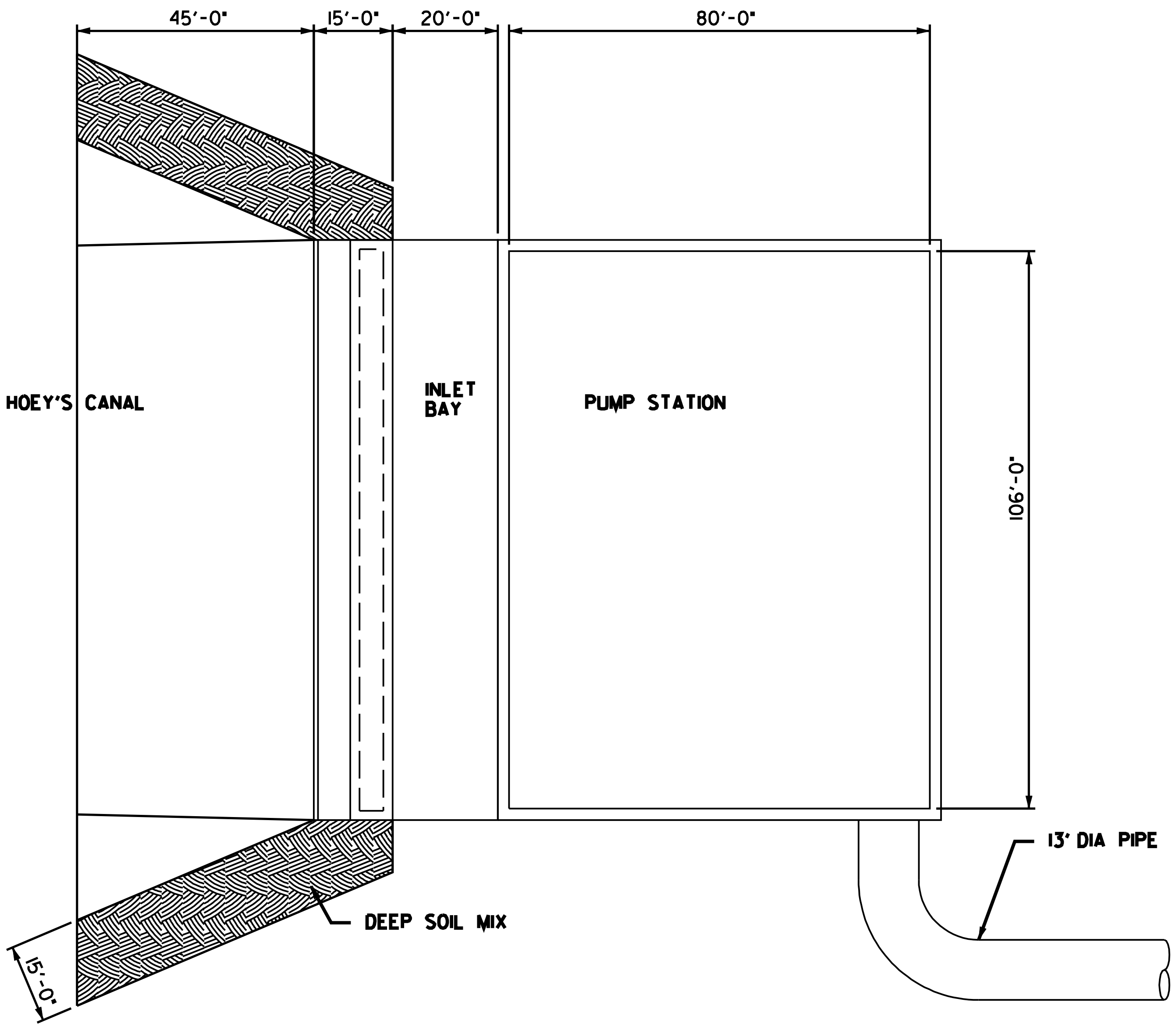
PERMANENT PROTECTION SYSTEM

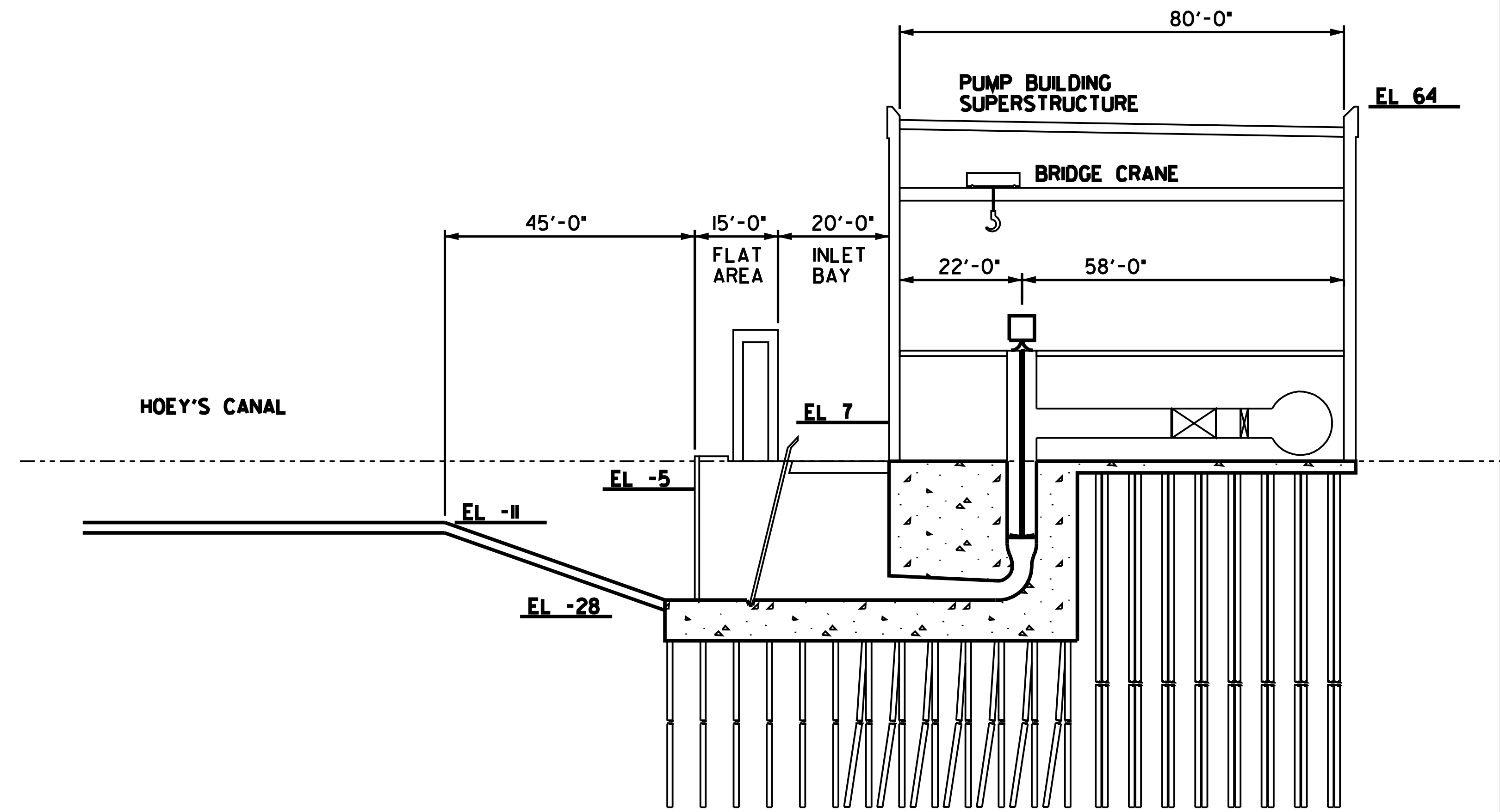
LOCATION LAYOUT OF
DWYER DIVERSION

U.S. ARMY CORPS OF ENGINEERS — NEW ORLEANS

HURRICANE PROTECTION OFFICE — 10-OCT-08

PLATE: 3





PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

HOEY'S PUMP STATION

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PLATE: 4

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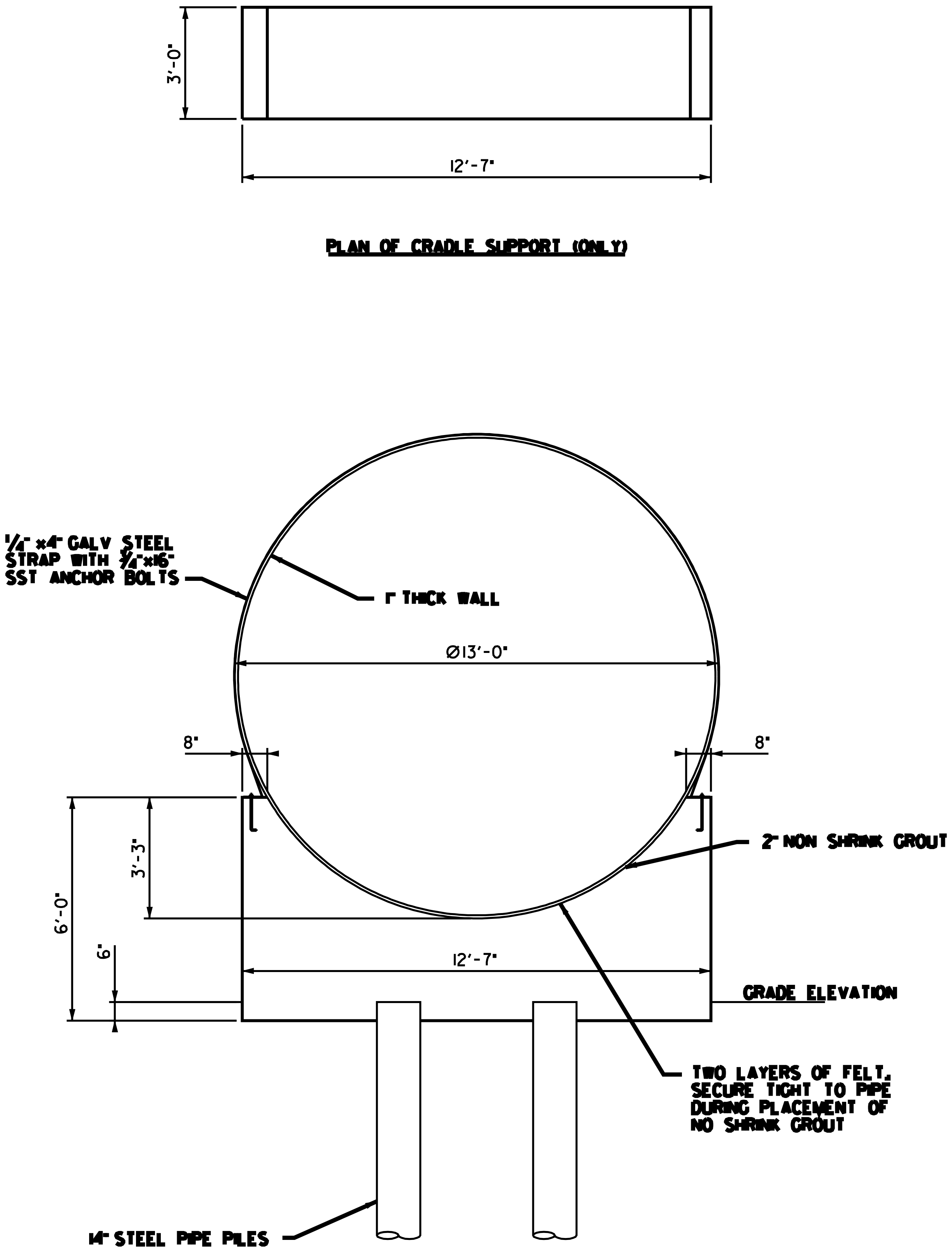
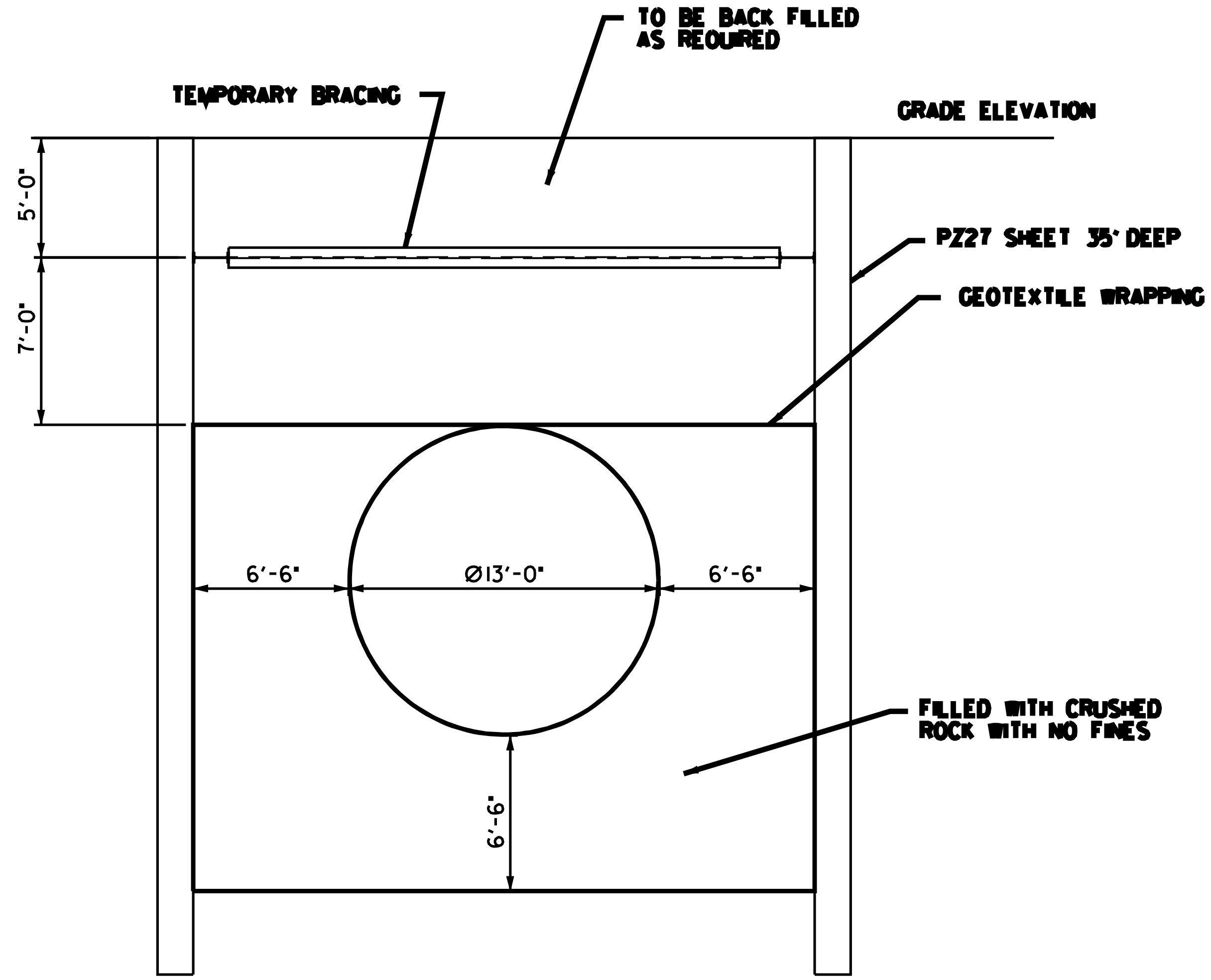
10/10/2008



SECTION

CRADLE SUPPORT DETAIL

ABOVE GROUND PIPE
SPACED EVERY 10'



OPEN TRENCH

PIPE INSTALLATIN DETAIL

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

HOEY'S
DETAILS

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HURRICANE PROTECTION OFFICE | 30-AUG-08

PLATE: 5

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10/10/2008

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

FLORIDA AVE DIVERSION
DPS-3 MODIFICATION

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HURRICANE PROTECTION OFFICE 30-AUG-08

PLATE: 6

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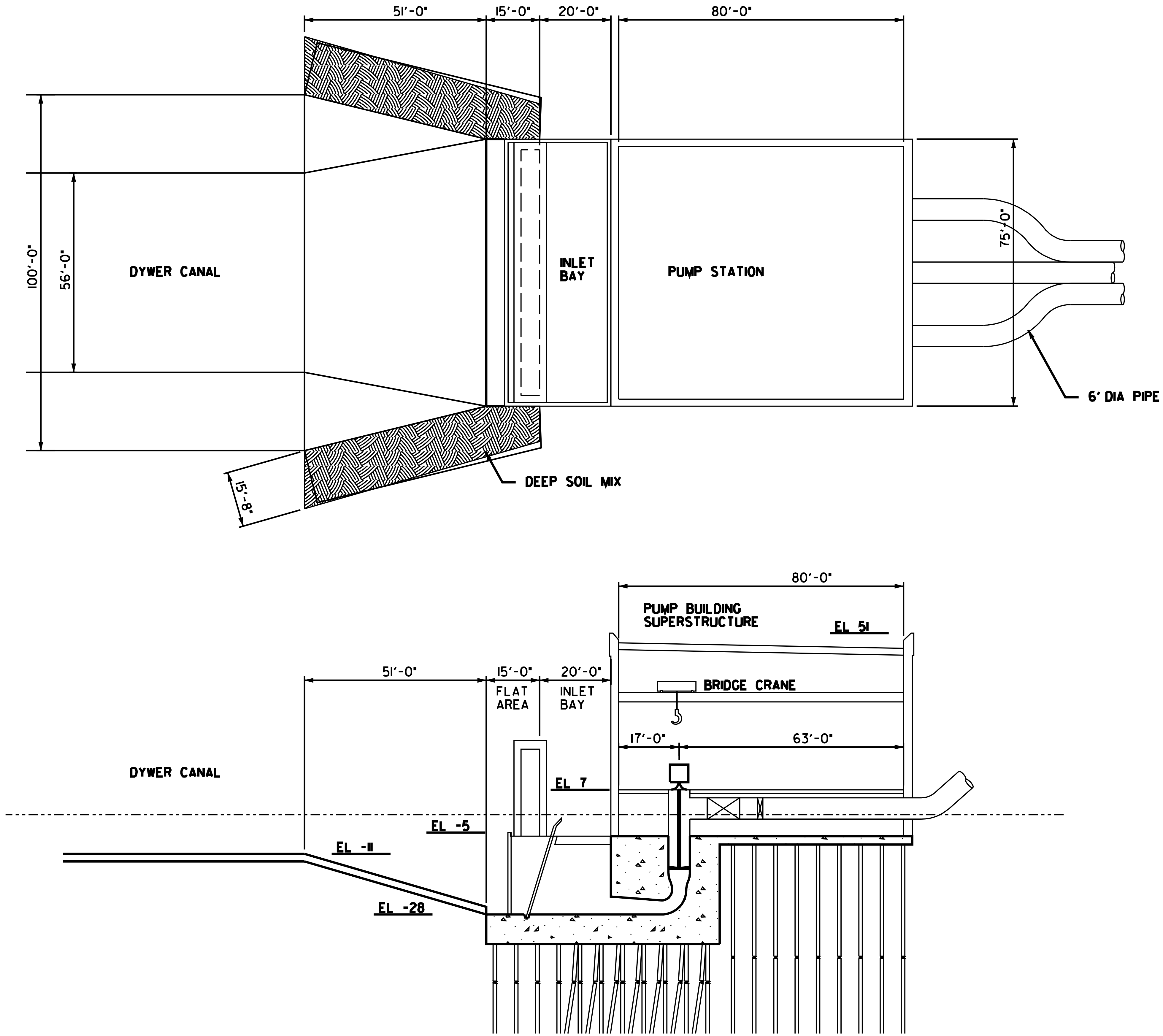

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

DWYER PUMP STATION

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HURRICANE PROTECTION OFFICE — 30-AUG-08

PLATE: 7

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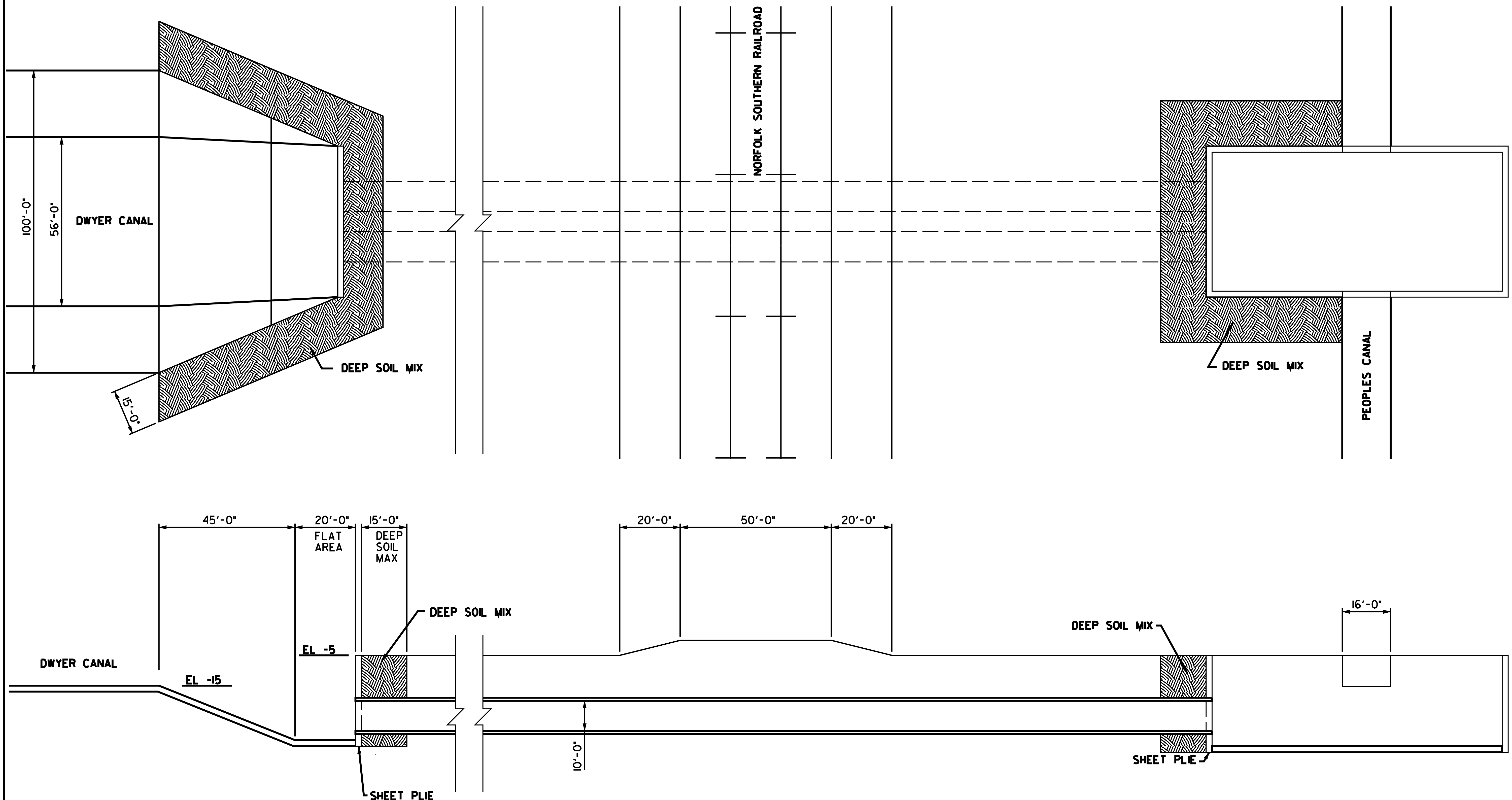

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

DWYER AND PEOPLES CANEL

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PLATE: 8

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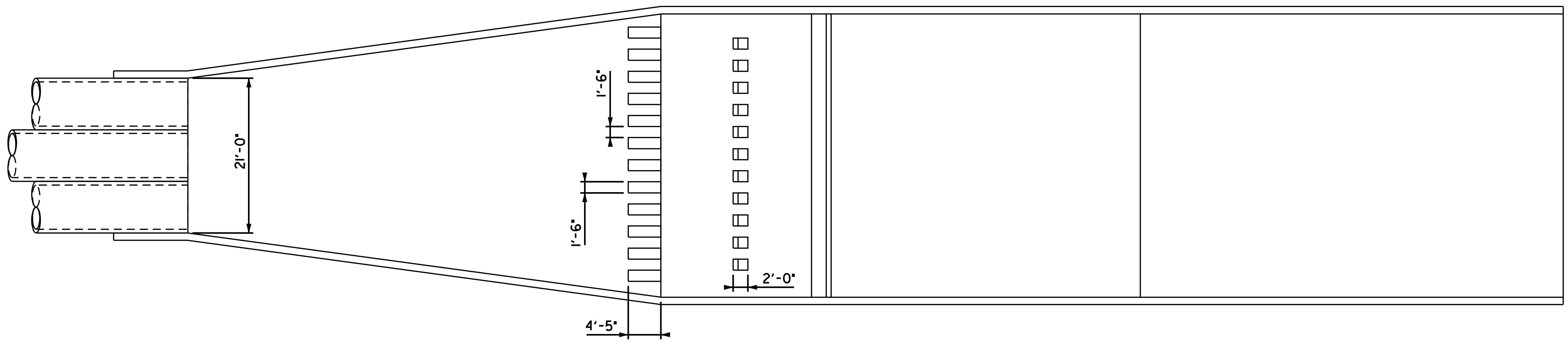
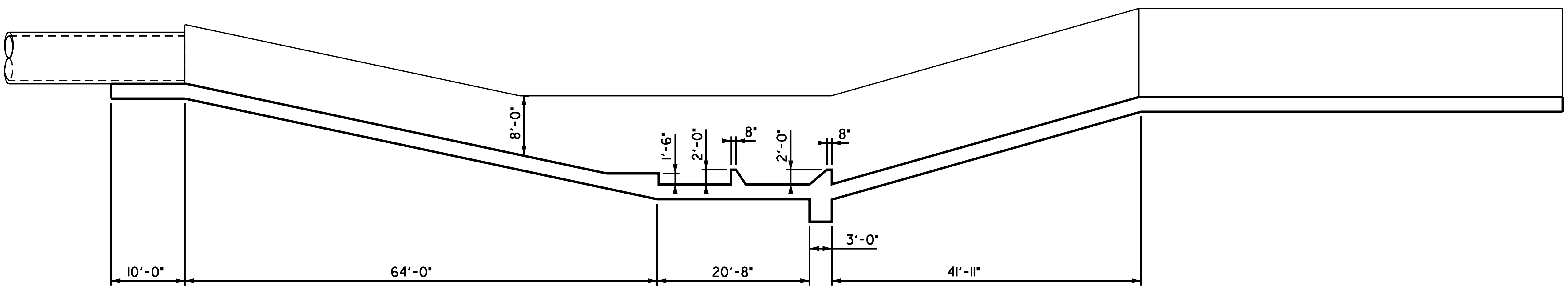
10/10/2008

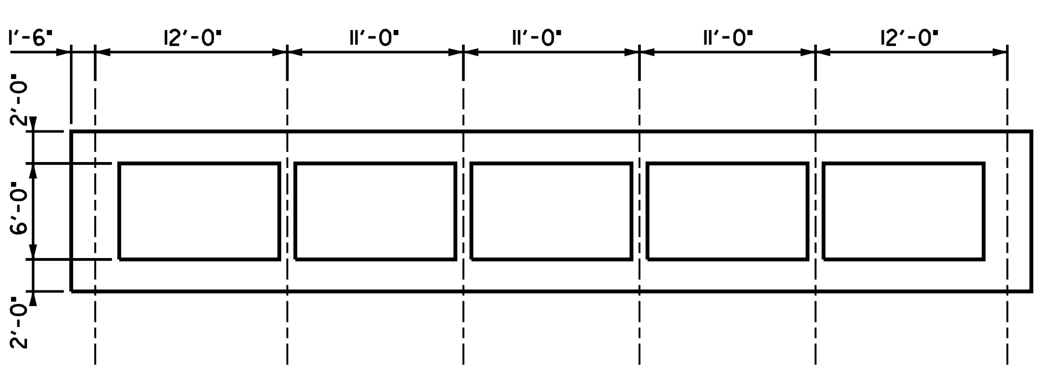


STILLING BASIN PLAN

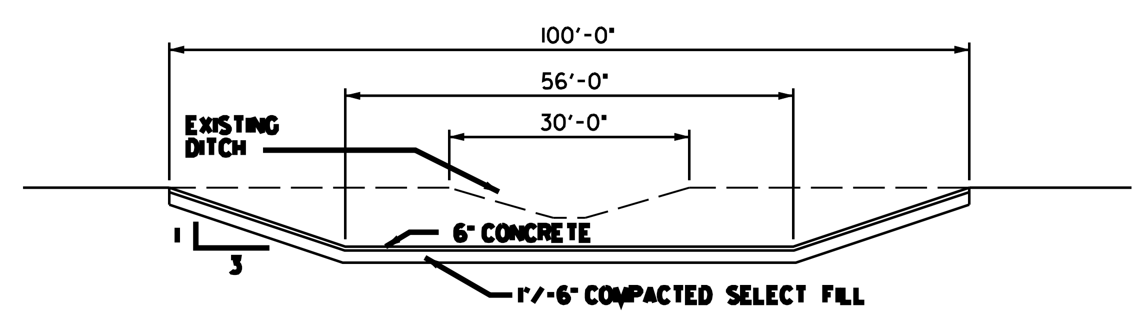


STILLING BASIN SECTION

DWYER STILLING BASIN



60x10 BOX CULVERT AT PRESS DRIVE + CONGRESS DRIVE



CANAL CROSS SECTION

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PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

DWYER
DETAILS

U.S. ARMY CORPS OF ENGINEERS — NEW ORLEANS
HURRICANE PROTECTION OFFICE — 30-AUG-08

PLATE: 9

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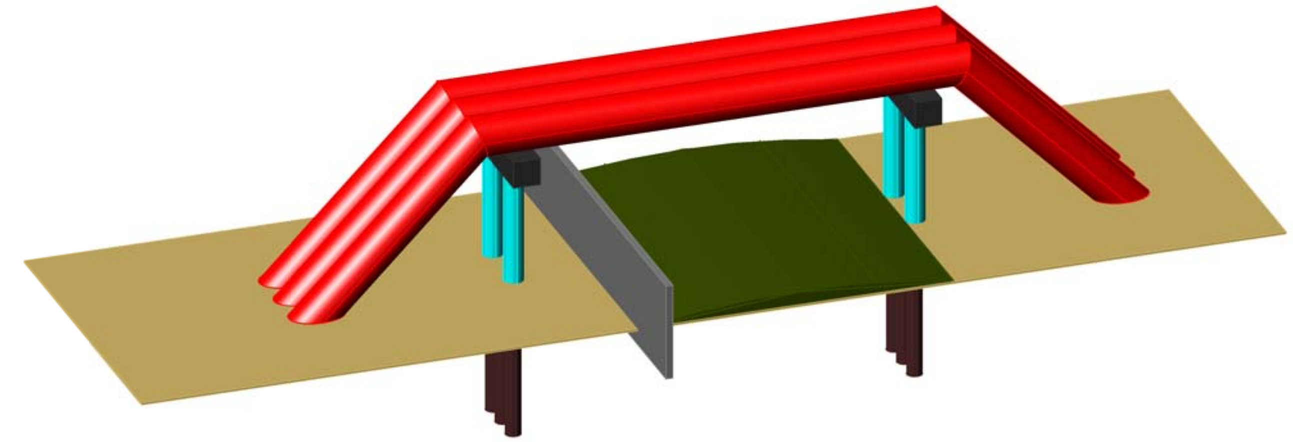

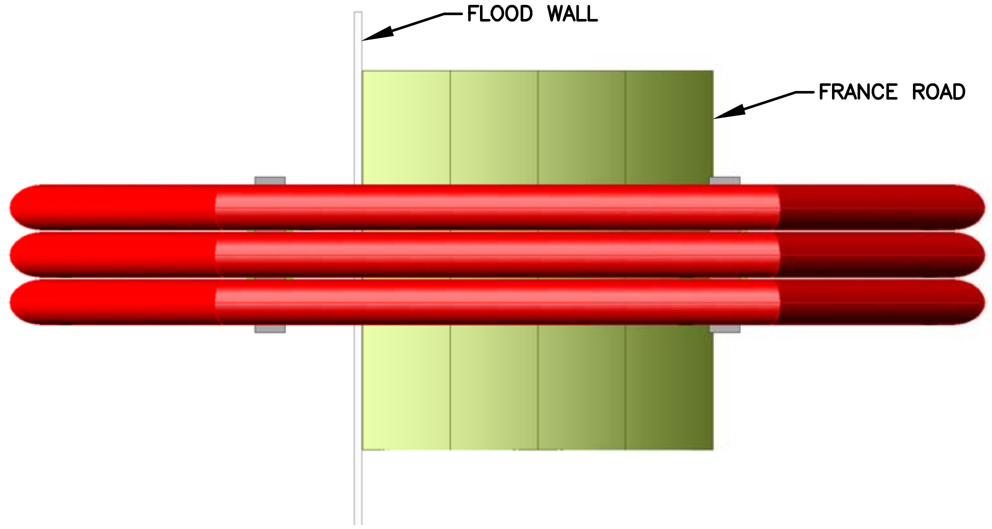

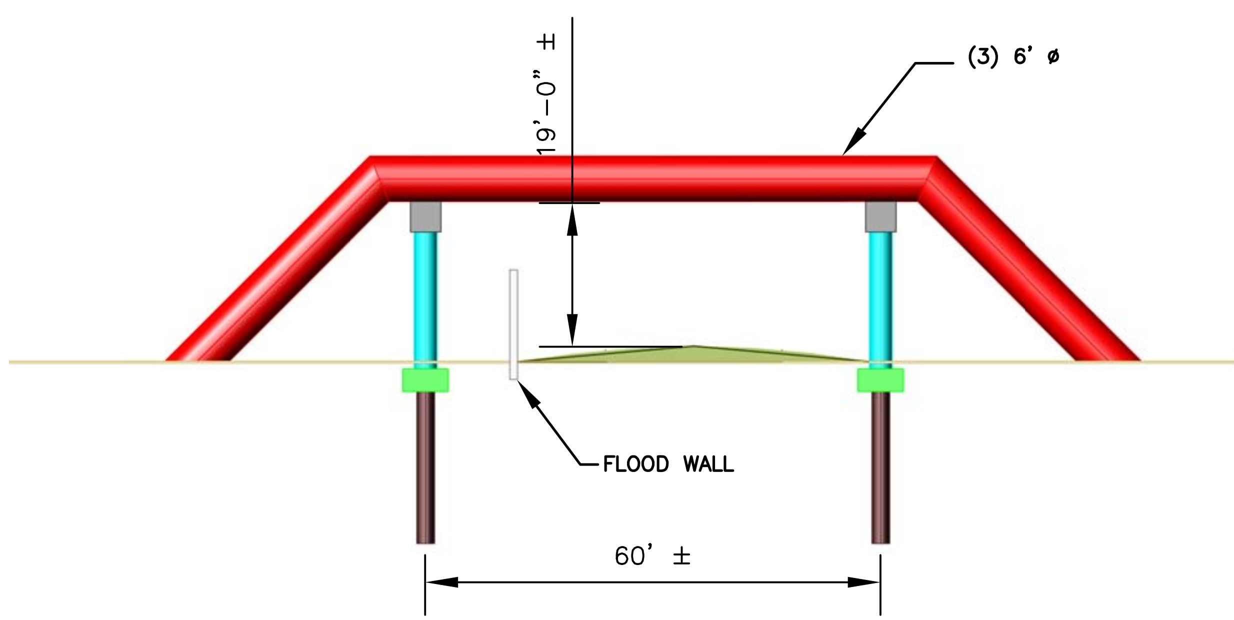

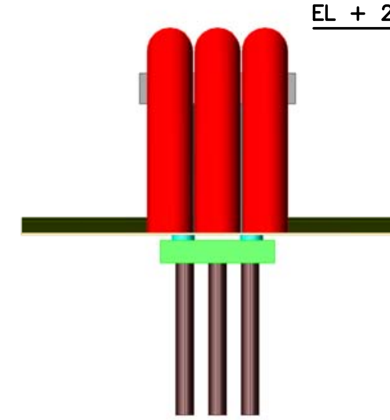

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

DWYER PIPE BRIDGE

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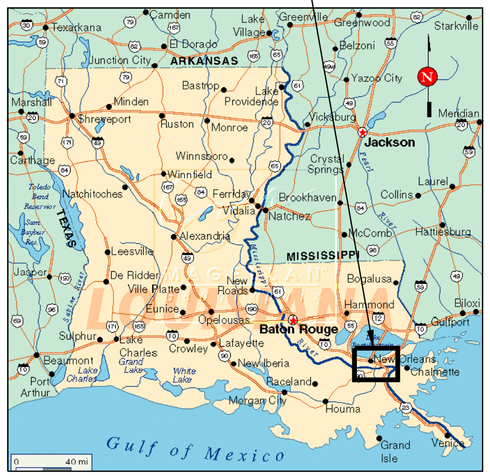
HURRICANE PROTECTION OFFICE 30-AUG-08

PLATE: 10

APPENDIX H

Decommissioning and Bypass of Existing DPS Numbers 3, 4, 6, and 7

SEE ENLARGED LOCATION MAP - NEW ORLEANS



LOCATION MAP- LOUISIANA

DPS - 7 ORLEANS AVE CANAL

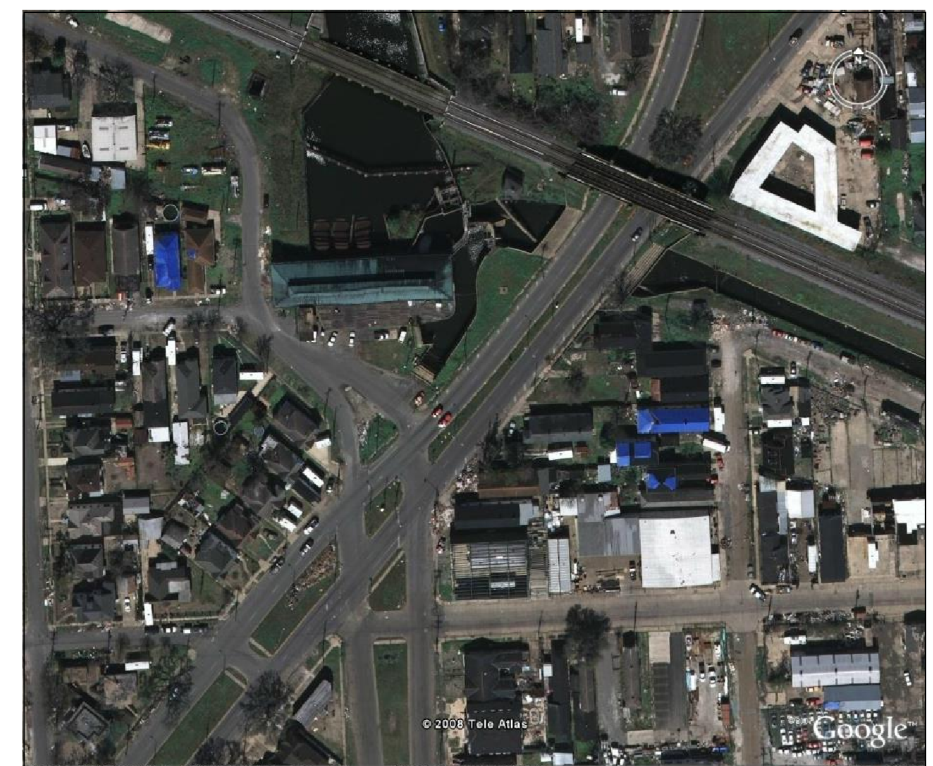
DPS - 6 17TH STREET CANAL

DPS - 4 LONDON AVE CANAL

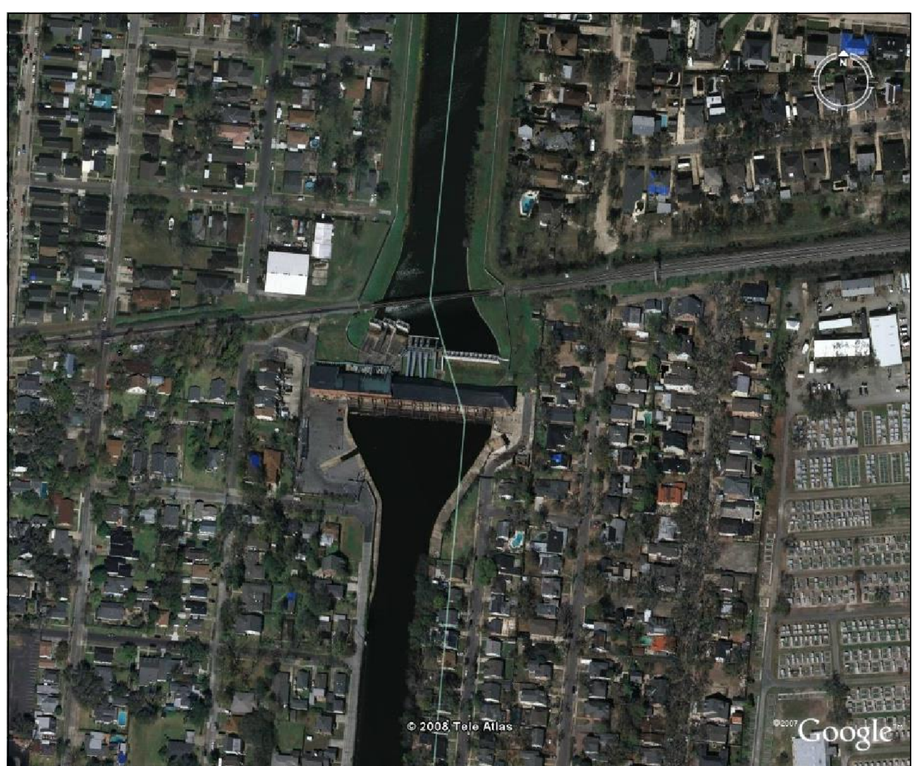
DPS - 3 LONDON AVE CANAL

ENLARGED LOCATION MAP - NEW ORLEANS

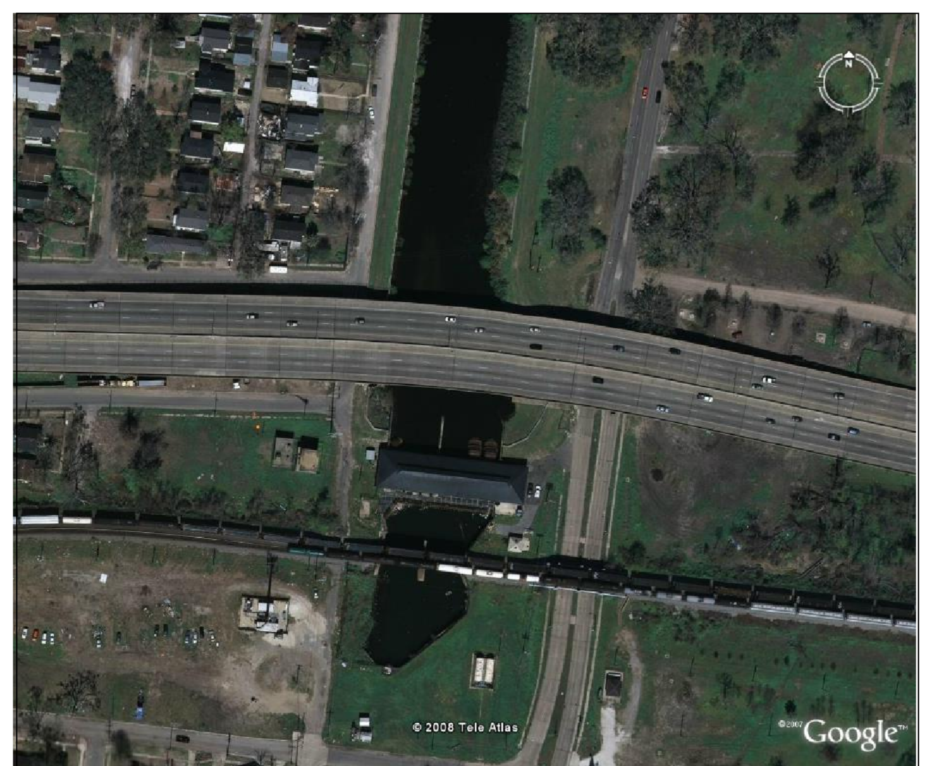
VICINITY MAP - DPS - 4



VICINITY MAP - DPS - 3



VICINITY MAP - DPS - 6



VICINITY MAP - DPS - 7

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

LOCATION AND VICINITY MAPS

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U.S. ARMY CORPS OF ENGINEERS	NEW ORLEANS
HURRICANE PROTECTION OFFICE	30-AUG-08

PLATE: 1

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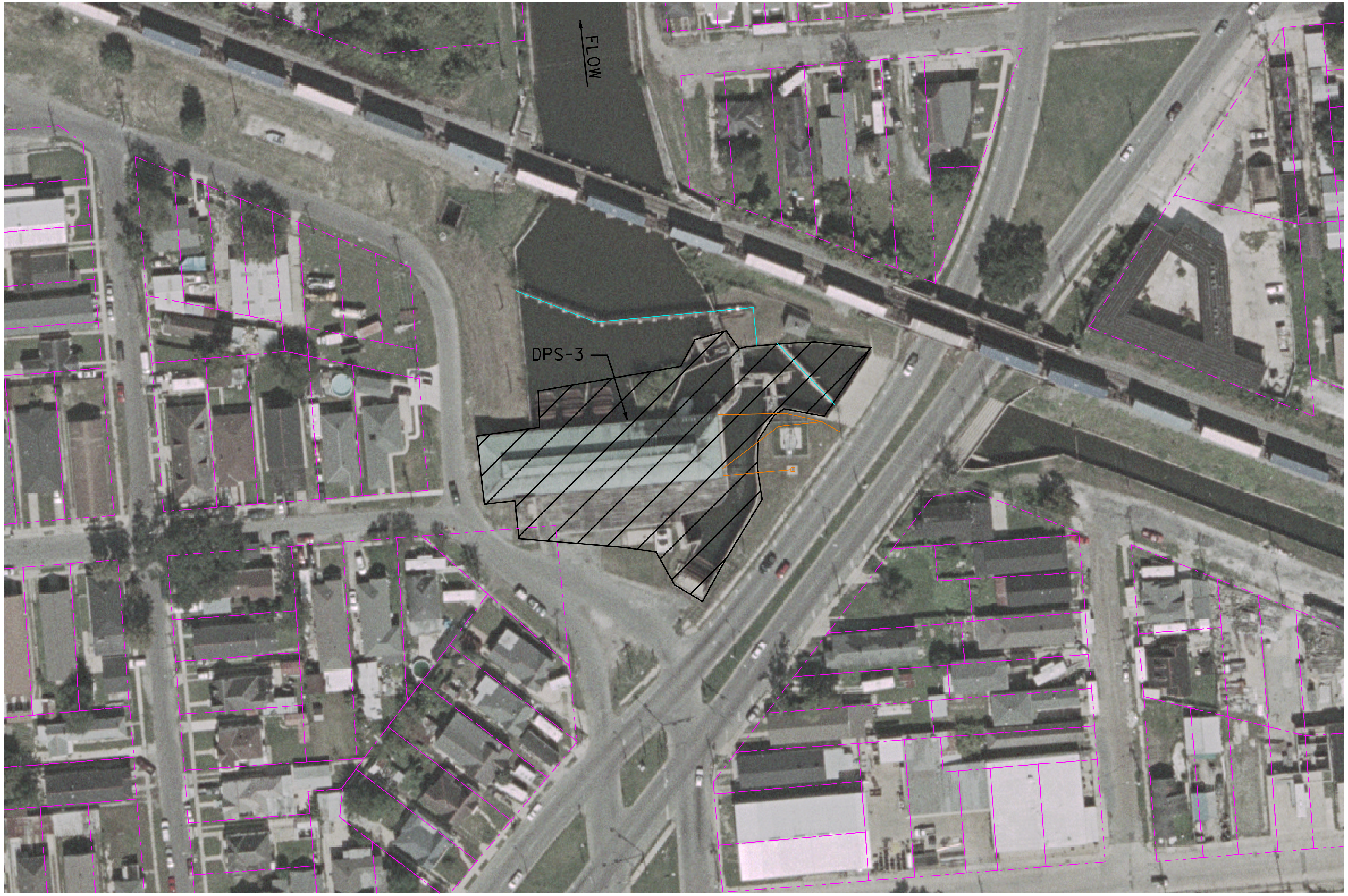

NOTES

1. DPS-3 TO BE DEMOLISHED AFTER BYPASS CONSTRUCTION.

N

100 20 0 100 200

SCALE: 1" = 100'-0"

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

DPS-3 LONDON AVE CANAL
DEMOLITION PLAN - OPTION A

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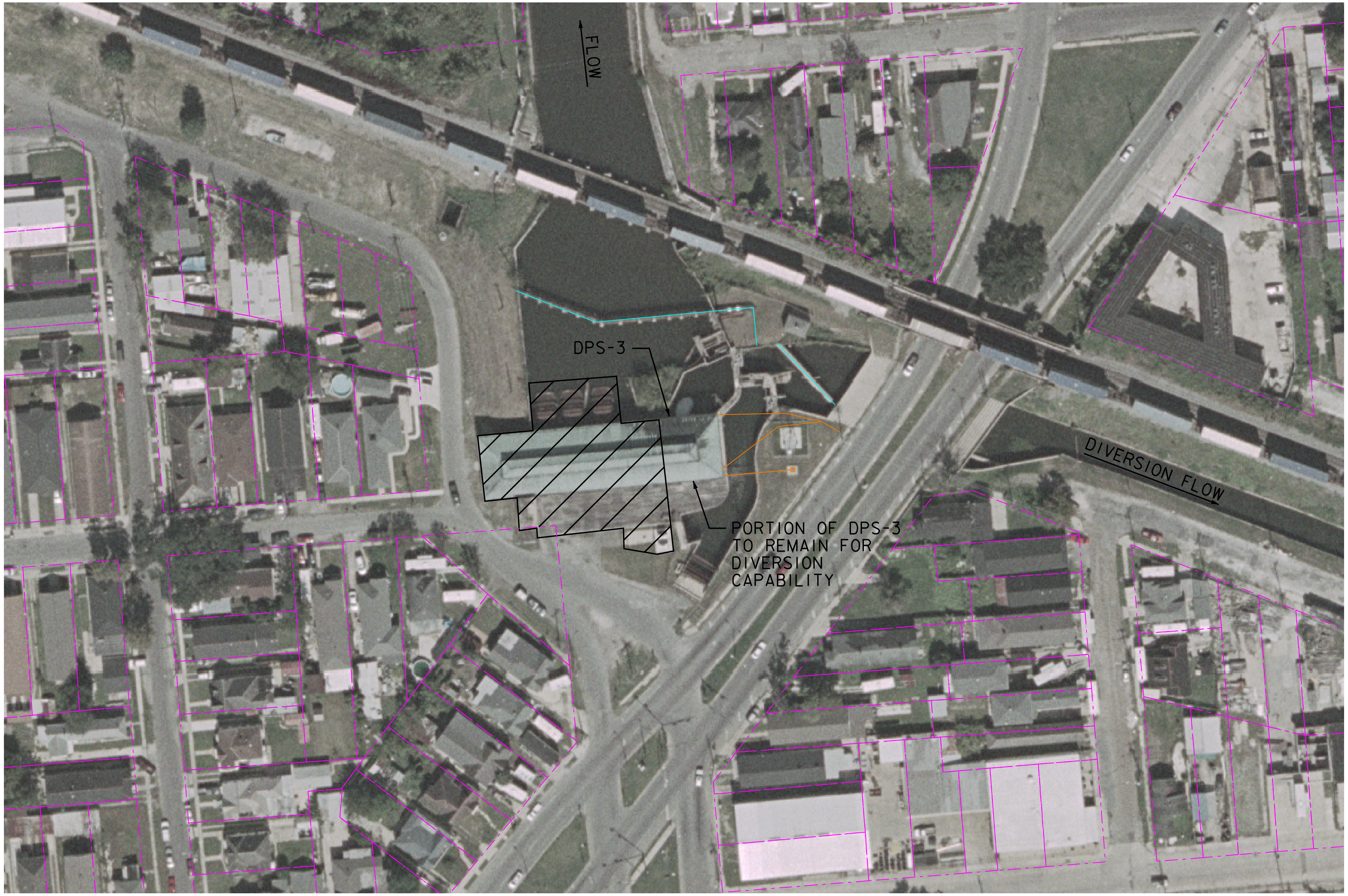
U.S. ARMY CORPS OF ENGINEERS NEW ORLEANS
HURRICANE PROTECTION OFFICE 30-AUG-08

PLATE: 2



NOTES

1. PORTION OF DPS-3 TO BE DEMOLISHED AFTER BYPASS CONSTRUCTION.

N

100 20 0 100 200

SCALE: 1" = 100'-0"

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

DPS-3 LONDON AVE CANAL
DEMOLITION PLAN - OPTION B

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U.S. ARMY CORPS OF ENGINEERS	NEW ORLEANS
HURRICANE PROTECTION OFFICE	30-AUG-08

PLATE: 3

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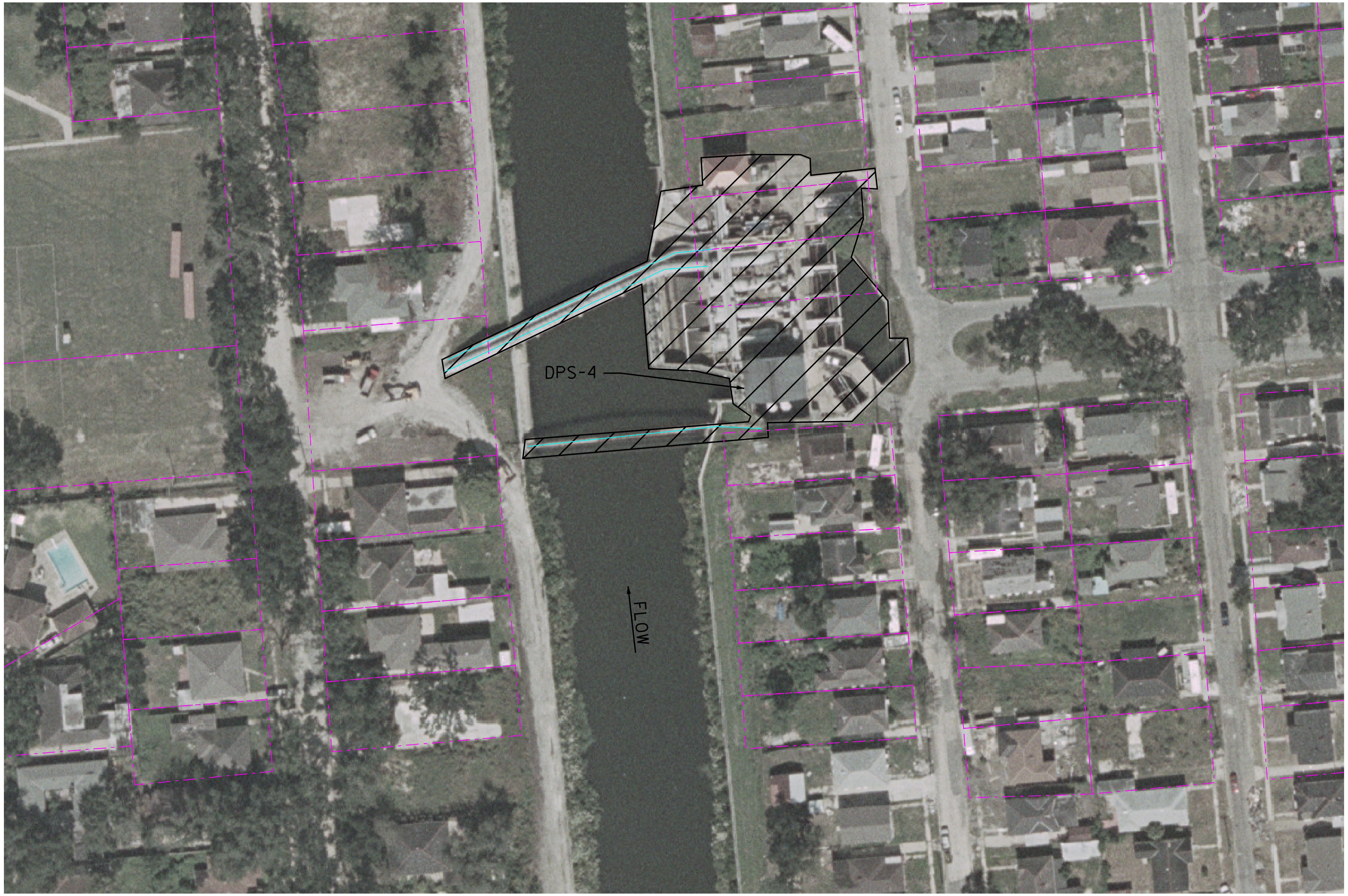
8/11/2008



<u>NOTES</u>

1. DPS-4 TO BE DEMOLISHED AFTER BYPASS CONSTRUCTION.

100 20 0 100 200

SCALE: 1" = 100'-0"

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

DPS-4 LONDON AVE CANAL
DEMOLITION PLAN

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HURRICANE PROTECTION OFFICE	30-AUG-08

PLATE: 4

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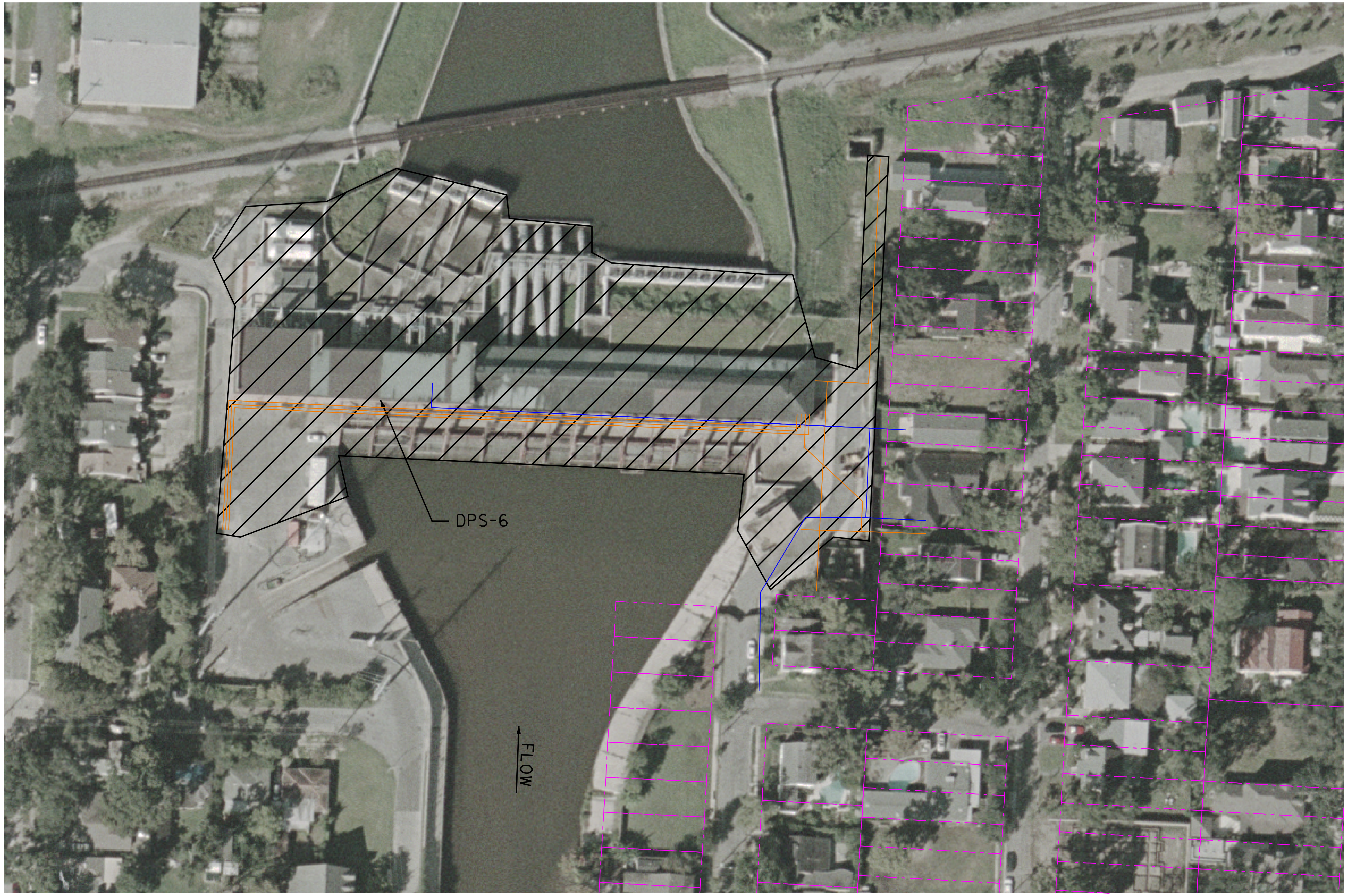

NOTES

1. DPS-6 TO BE DEMOLISHED AFTER BYPASS CONSTRUCTION.

N

100 20 0 100 200

SCALE: 1" = 100'-0"

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

DPS-6 17TH STREET CANAL
DEMOLITION PLAN

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HURRICANE PROTECTION OFFICE | 30-AUG-08

PLATE: 5

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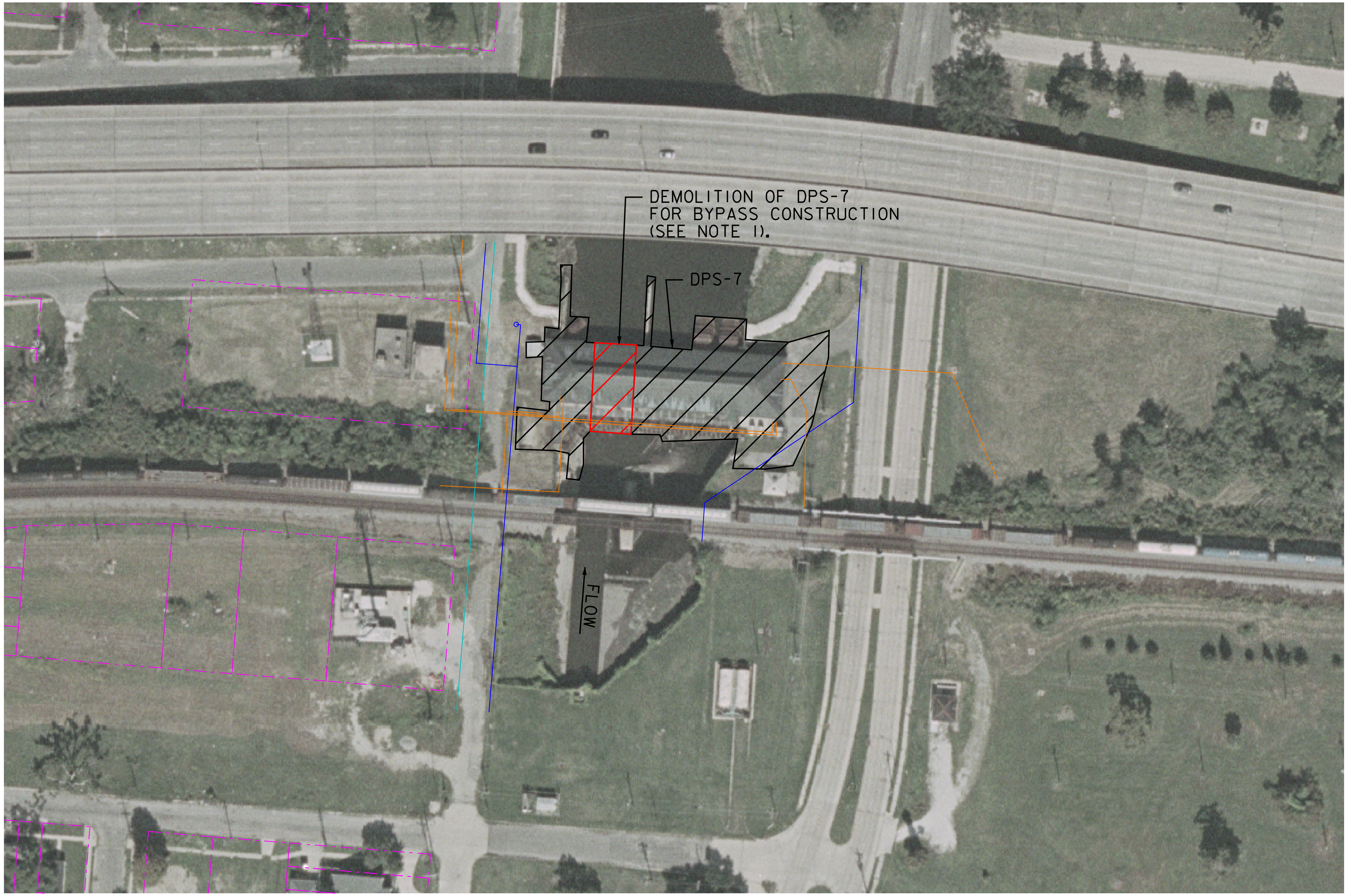
8/11/2008



NOTES

1. THE PORTION OF DPS-7 DEPICTED TO BE DEMOLISHED FOR CONSTRUCTION OF BYPASS. THERE ARE NO PUMPS OR CONTROL ROOM WITHIN THIS AREA OF THE PUMP STATION. THE PUMP ON THE FAR WEST EDGE OF THE PUMP STATION MUST REMAIN IN OPERATION UNTIL THE BYPASS IS FUNCTIONING.

2. REMAINDER OF DPS-7 TO BE DEMOLISHED AFTER BYPASS CONSTRUCTION.

100 20 0 100 200

SCALE: 1" = 100'-0"

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

DPS-7 ORLEANS AVE CANAL
DEMOLITION PLAN

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U.S. ARMY CORPS OF ENGINEERS NEW ORLEANS
HURRICANE PROTECTION OFFICE 30-AUG-08

PLATE: 6

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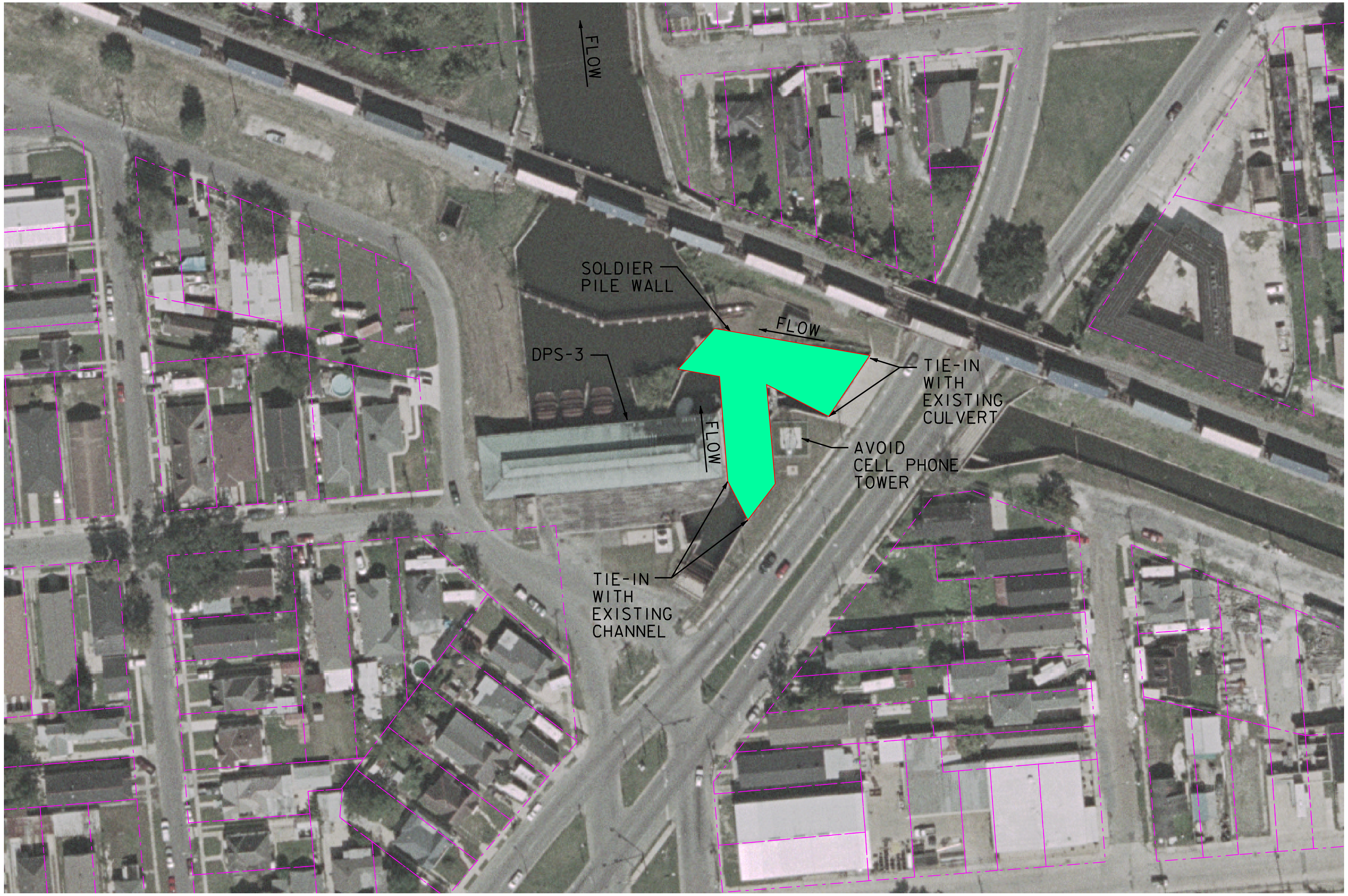

NOTES

1. DPS-3 TO BE DEMOLISHED AFTER BYPASS CONSTRUCTION.

2. STAGE OPENING OF BYPASS WITH COMPLETION OF SOLDIER PILE WALL.

N

100 20 0 100 200

SCALE: 1" = 100'-0"

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

DPS-3 LONDON AVE CANAL
BYPASS PLAN - OPTION A

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U.S. ARMY CORPS OF ENGINEERS — NEW ORLEANS
HURRICANE PROTECTION OFFICE — 30-AUG-08

PLATE: 7

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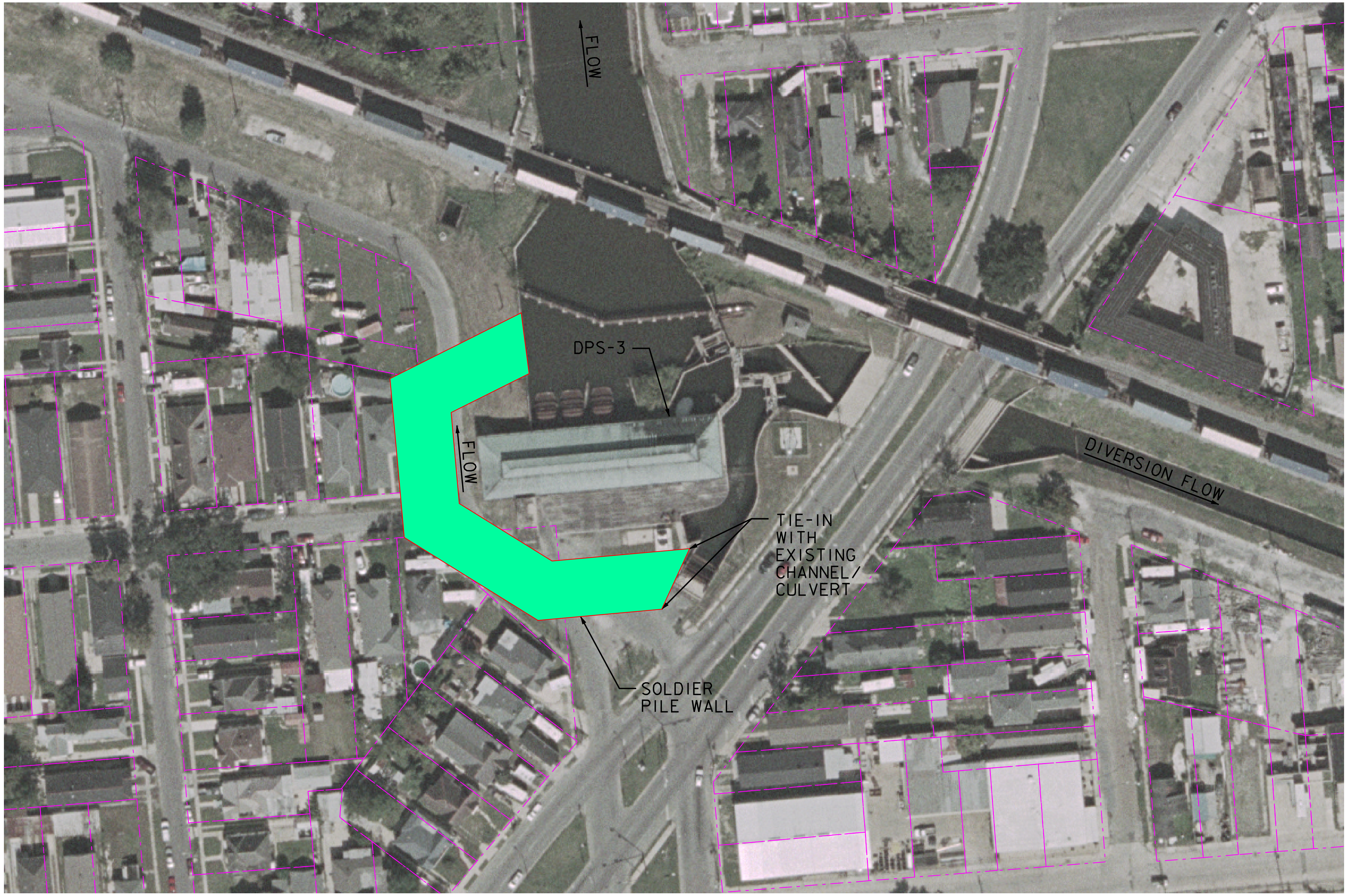

NOTES

1. DPS-3 TO BE DEMOLISHED AFTER BYPASS CONSTRUCTION.

2. STAGE OPENING OF BYPASS WITH COMPLETION OF SOLDIER PILE WALL.

N

100 20 0 100 200

SCALE: 1" = 100'-0"

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

DPS-3 LONDON AVE CANAL
BYPASS PLAN - OPTION B

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U.S. ARMY CORPS OF ENGINEERS NEW ORLEANS
HURRICANE PROTECTION OFFICE 30-AUG-08

PLATE: 8

z:projects:41919_90_Day_Study:50.0 - Detailed Design:50.3 - Graphics:DGN:NEW_ORLEANS_90DAY_C-0103B.dgn
8/11/2008

NOTES

1. DPS-4 TO BE DEMOLISHED AFTER BYPASS CONSTRUCTION.

2. STAGE OPENING OF BYPASS WITH COMPLETION OF SOLDIER PILE WALL.

N

100 20 0 100 200

SCALE: 1" = 100'-0"

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

DPS-4 LONDON AVE CANAL
BYPASS PLAN

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U.S. ARMY CORPS OF ENGINEERS — NEW ORLEANS
HURRICANE PROTECTION OFFICE — 30-AUG-08

PLATE: 9

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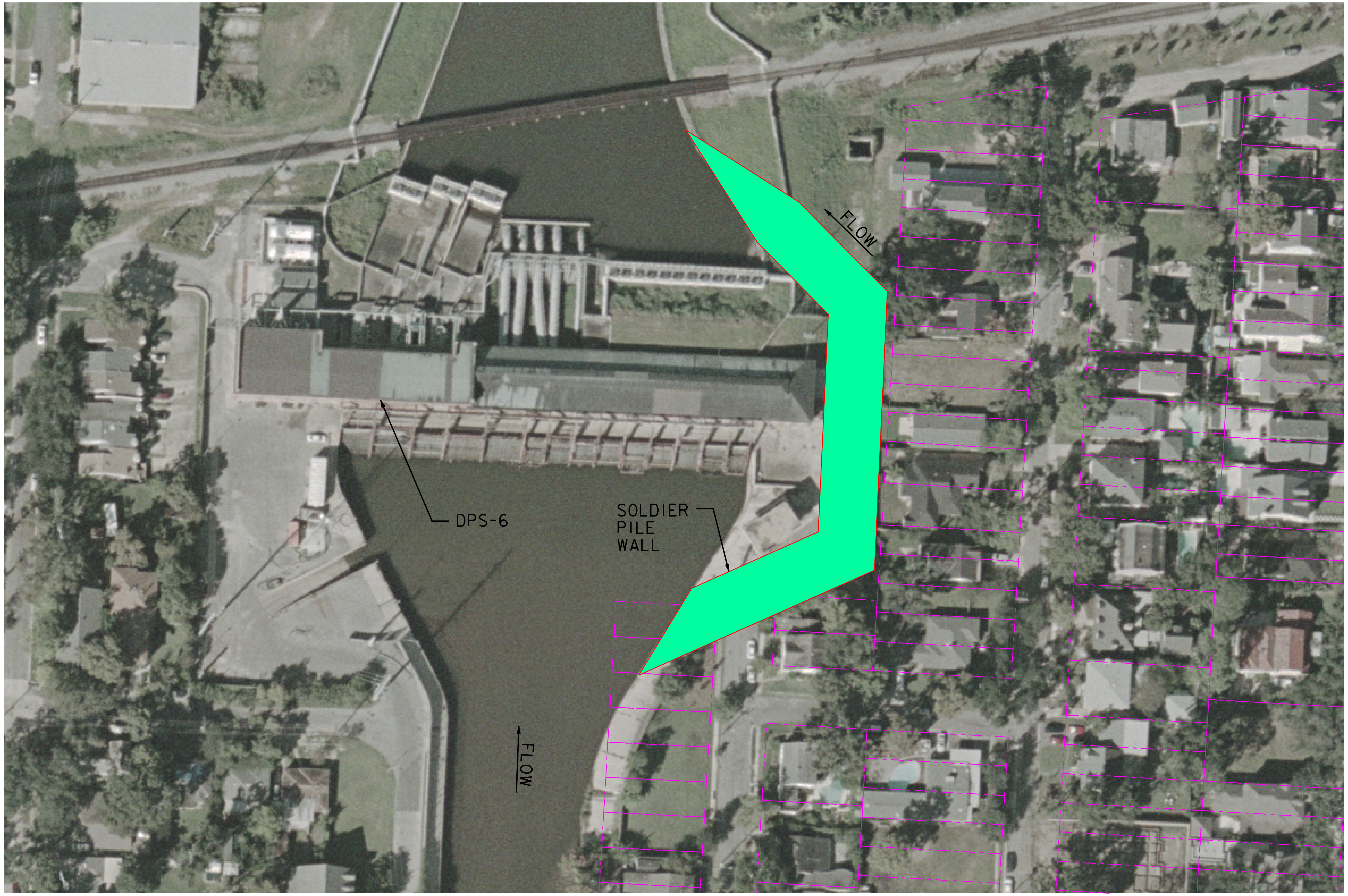
8/11/2008



NOTES

1. DPS-6 TO BE DEMOLISHED AFTER BYPASS CONSTRUCTION.

2. STAGE OPENING OF BYPASS WITH COMPLETION OF SOLDIER PILE WALL.

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

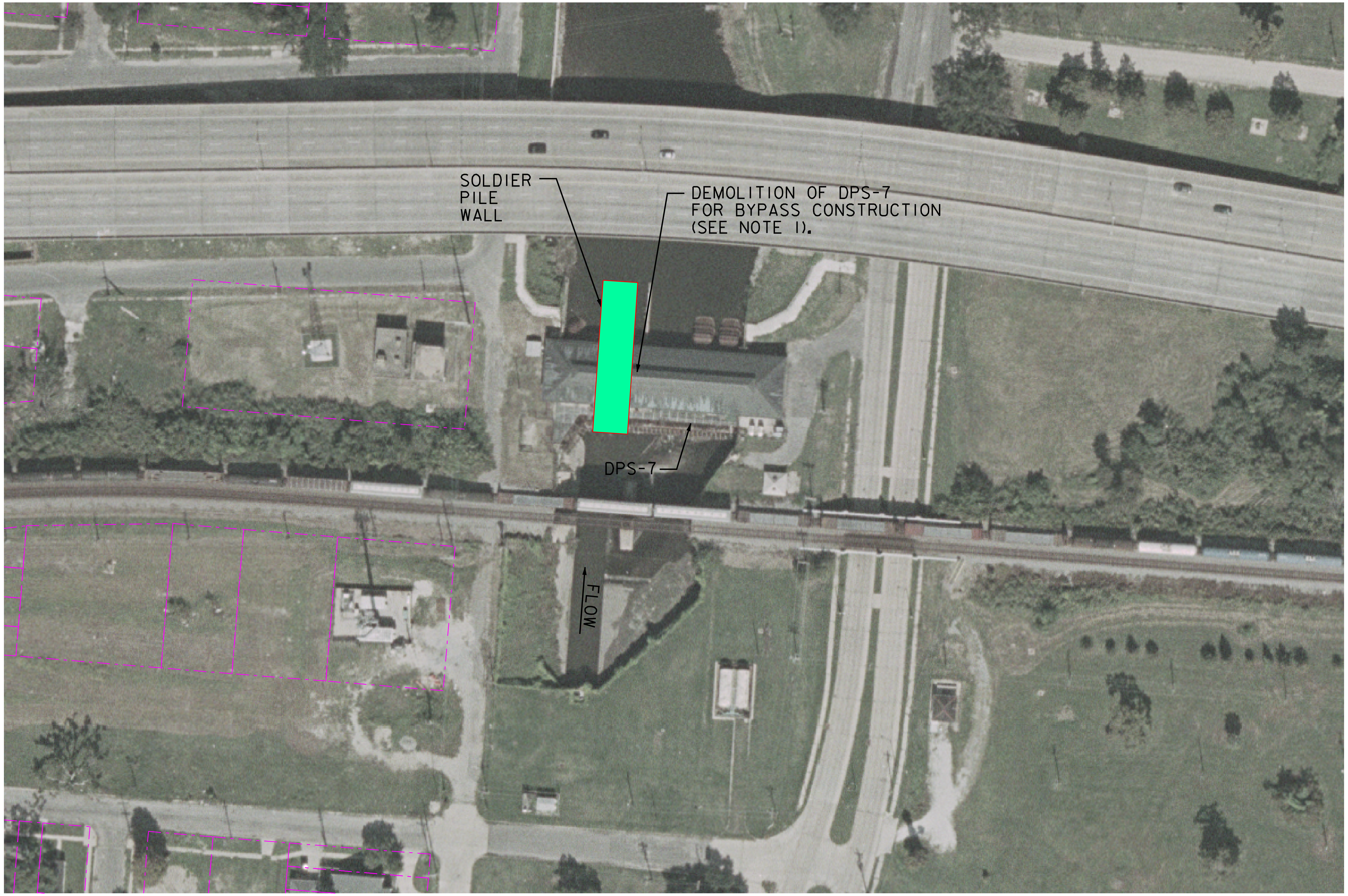
DPS-6 17TH STREET CANAL
BYPASS PLAN

BLACK & VEATCH building a world of difference™
ENERGY WATER INFORMATION GOVERNMENT

U.S. ARMY CORPS OF ENGINEERS	NEW ORLEANS
HURRICANE PROTECTION OFFICE	30-AUG-08

PLATE: 10

z:projects:41919_90_Day_Study:50.0 - Detailed Design:50.3 - Graphics:DGN:NEW_ORLEANS_90DAY_C-0106.dgn
8/11/2008



NOTES

1. THE PORTION OF DPS-7 DEPICTED TO BE DEMOLISHED FOR CONSTRUCTION OF BYPASS. THERE ARE NO PUMPS OR CONTROL ROOM WITHIN THIS AREA OF THE PUMP STATION. THE PUMP ON THE FAR WEST EDGE OF THE PUMP STATION MUST REMAIN IN OPERATION UNTIL THE BYPASS IS FUNCTIONING.

2. REMAINDER OF DPS-7 TO BE DEMOLISHED AFTER BYPASS CONSTRUCTION.

N

100 20 0 100 200

SCALE: 1" = 100'-0"

PERMANENT PROTECTION SYSTEM
17TH STREET, ORLEANS AVE AND LONDON AVE
OUTFALL CANALS
ORLEANS PARISH

DPS-7 ORLEANS AVE CANAL
BYPASS PLAN

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U.S. ARMY CORPS OF ENGINEERS NEW ORLEANS
HURRICANE PROTECTION OFFICE 30-AUG-08

PLATE: 11

z:projects:41919_90_Day_Study:50.0 - Detailed Design:50.3 - Graphics:DGN:NEW_ORLEANS_90DAY_C-0107.dgn
8/11/2008